

**“AEROMYCOLOGICAL STUDIES OVER JOWAR AND
SOYBEAN FIELD AT OSMANABAD”**

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CERTIFICATE

This is to certify that the work incorporated in this thesis entitiled “AEROMYCOLOGICAL STUDIES OVER JOWAR AND SOYBEAN FIELD AT OSMANABAD” was carried out by Miss. Dipika Anandrao kalshetti under my supervision and the same has not been submitted elsewhere for award of any degree.

Dr. Baburao Yadavrao Patil

Research Guide

“AEROMYCOLOGICAL STUDIES OVER JOWAR AND SOYBEAN FIELD AT OSMANABAD”

Aerobiological study concerns with the utilization in diverse fields viz., plant pathology, palynology veterinary science, medicine, meteorology, ecology, forestry etc. Airspora has vital role to play in the growth and development of various crops as it gives the critical vision towards the several crop diseases. The fungal spores are observed in the atmosphere almost in all seasons. The occurrence of these fungal spores varies from time to time and place to place and these changes depend upon the climatic conditions, topographical conditions of the region and this scenario indicates that there is a vast scope for the studying the airspora in any season and at varied places. In the country the work was carried out by Cunningham (1873) and published in the form of book entitled as "Microscopic Examinations of Air". Di-Meena (1955) in New Zealand, Buller and Low (1911) in Canada, applied various methods to study the components of airspora. In the country, Shenoi and Ramalingam (1976) carried out the studies on airspora of *Sorghum* crop fields at Mysore.

Scope of fungal airspora:

Besides, advancement in research in various fields, many airborne fungi still continue to pose challenges. Most airborne fungi are potential allergens causing diseases viz., hay fever, asthma, cough, common cold, Skin infections in human beings and domestic animals. Fungal deposition cause great damage to household articles such as papers, fabrics, paints, varnishes, wood, leather, food grains, food preparation and causes rotting of fruits and vegetables in market, store houses and kitchen. This trough's light on significance of fungal airspora of any given region. The agricultural crop plants constantly suffer from various types of diseases of which fungal diseases have dominant role. In the country crop diseases destroy food grains on large scale. The farmers cost expenditure on crop protection measures, Agriculture and allied sciences aim at maximum production but there is a need of matching the production technology with protection technology. Most part of the aerobiological investigations includes aspects like aero mycology in relation to plant pathology which beneficial in disease forecasting of crop.

In Marathwada region the crops viz., Cotton, Sugarcane Legumes like Soybean, Mung, Ground nut and Non-legumes like Jowar, rice, wheat and vegetables are cultivated on large scale.

For the present investigation, the legume (*Soybean*) and Non-legume (*Jowar*) crops from kharif and Rabi Seasons respectively studied. Jowar contains carbohydrates, proteins, fat, minerals and vitamins essential for humans and animals. Soybean is important oil yielding commercial crop useful for animal feed and human diet. Fungal pathogens play quite vital role in causing the diseases and bringing in the losses in yielding. The major fungal diseases which cause extensive damage to jowar and Soybean crop in the country and Marathwada region are Smuts, Rusts, Downy Mildews, Leaf Spots, etc.

By taking this view into consideration, the present work “Aeromycological studies over jowar and Soybean field at Osmanabad” was selected for research study.

Scope of Research Work:

The most fungal pathogens which cause diseases are air-borne, therefore aerobiological approach of fungal pathogens, their liberation, dissemination, spreading, infective ability and seasonal variations can be procured and can be helpful in reducing the crop diseases and the subsequent loss can be reduced. With the study of concentration of airspora from outdoor environments, it can be helpful for the study of occurrence of in both environments of Rabi Seasons and Kharif Seasons.

Objectives Accomplished:

Studied the airspora over jowar fields for two Rabi season, studied the airspora over soybean crop fields for two kharif season, prepared the permanent slides, studied the fungal colonies on culture plates, analyzed the air quality and quantity of atmosphere at the Osmanabad, obtained data correlated with the meteorological parameters like temperature, relative humidity and rainfall. This data was maintained throughout the study period, Systematic studies on this aspect will provide the data on quantity of airspora at particular locality and season and correlation between weather condition and airspora established.

Experimental Results:

- From the present investigation of Aeromycology of jowar field in first Rabi season 7 other types and 61 fungal spore types like 32 from *Deuteromycotina*, 18 from *Ascomycotina*, 5 from *Basidiomycotina*, 4 from *Zygomycotina* and lowest number of

spores from *Myxomycotina* i.e. 2.were observed. From the present investigation of Aeromycology of jowar field in Second Rabi season 7 other types and 62 fungal spore types like 33 from *Deuteromycotina*, 18 from *Ascomycotina*, 5 6, from *Basidiomycotina*, 4 from *Zygomycotina* and lowest number of spores from *Myxomycotina* i.e. 2.observed.

- During the investigation of Aeromycology of jowar field in First and second Rabi seasons of fungal spores 1369998 are counted to the total airspora. The spores belonged to *Deuteromycotina* of both the season contributed highest percentage 47.70%, followed by *Basidiomycotina* 23.83%, *Ascomycotina* 12.58%, *Zygomycotina* 4.15%, *Myxomycotina* 2.53% and Other types 9.19%.
- The dominant spore types are *Cladosporium*15.48% as a dominant type followed by *Curvularia*5.76%, *Nigrospora*5.69%, *Alternaria* 4.93%, Smut Spores 9.82%, Rust spores 10.13%, *Heliminthosporium* 1.62% etc. Pathogenic Spore types like *Alternaria*, *Curvularia*, *Heliminthosporium*, Rust spores and Smut spores have been observed in sufficient higher concentration.
- Month wise , monthly, Season wise, Group wise and variation in the two Rabi seasons it also have studied are result were Summarized in tables. □□
- Petriplate exposures Season wise variation it also have studied are result were summarized in tables.
- During the Investigation of Aeromycology of Soybean field in First kharif season 7 other types and 63 fungal spore types like 34 from *Deuteromycotina*, 18 from *Ascomycotina*, 5 from *Basidiomycotina*, 4 from *Zygomycotina* and lowest number of spores from *Myxomycotina* i.e. 2.
- During the Investigation of Aeromycology of Soybean field in Second kharif season 7 other types and 65 fungal spore types like 36 from *Deuteromycotina*, 18 from *Ascomycotina*, 5 from *Basidiomycotina*, 4 from *Zygomycotina* and lowest number of spores from *Myxomycotina* i.e. 2
- During the investigation of Aeromycology of Soybean field in first and second Kharif Seasons of Fungal spores 1638916 are counted to the total airspora. The spores belonged to *Deuteromycotina* of both the season contributed highest percentage 63.49% Followed by *Basidiomycotina* 12.07%, *Ascomycotina* 10.50%, *Zygomycotina* 3.24%, *Myxomycotina* 2.15% and other types 8.54%.

- The dominant Spore types are *Cladosporium* 16.82% as a followed by *Curvularia* 11.50%, Rust Spores 8.33%, *Alternaria* 5.82%, *Periconia* 5.16%, *Memnoniella* 4.15%, *Nigrospora* 4.02%, *Aspergillus* 2.98%, *Lophiostoma* 2.93%, *Cunnighamella* 2.63%, *Physarum* 1.45%, *Leptosphaeria* 1.36%, *Didymosphaeria* 1.23%, *Claviceps* 1.06%, *Helminthosporium* 1.04%, all the airborne fungal spores of *Deuteromycotina* group causes leaf spot diseases on soybean and different crop plant around the field. This study is very most important in disease forecasting system of many crop plants to the avoidance and treatment of diseases.
- Month wise, monthly, Season wise, Group wise and variation in the two *kharif* seasons it also has studied are result were summarized in tables.

Petri plate exposure and Season wise variation studied and their results have been summarized in tabular format.

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DECLARATION

I hereby declare that the thesis entitled “AEROMYCOLOGICAL STUDIES OVER JOWAR AND SOYBEAN FIELD AT OSMANABAD” has been based on the original work carried out in laboratory of Department of Botany, S.M.D.M Mahavidyalaya, Kalamb has not been submitted elsewhere by me for the award of any degree.

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Dipika Anandrao Kalshetti

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ABBREVIATIONS

Sr. No.	Symbols/Legends	Description
1	AC	Alternating Current
2	A.R	Average Rainfall
3	A.R.H.	Average Relative Humidity
4	A.T.	Average Temperature
5	C.F.	Conversion Factor
6	Cm	Centimeters
7	Cmm	Cubic meter multiplied
8	°C	Degree Celsius
9	EC	Electric Clock
10	EPS	Electric Power Supply
11	et al.,	Allied (and others)
12	Fig.	Figure
13	GJ.	Glycerin Jelly
14	gm.	Gram
15	Ha	Hector
16	I.S.T.	Indian Standard Time
17	JS-335	Jawahar Soybean Variety
18	Kg	Kilogram
19	L	Liter
20	L.P.C.B.S	Lacto Phenol Cotton Blue Stain
21	M-35-I	Maldandi Jowar Variety

22	Mm	mill micron
23	M.E.A.	Microscopic Examination of Air
24	Mh	Million hectars
25	MI	Metabolic Inhibitor
26	ml	Milliliter
27	M.P.	Meteorological Parameter
28	M.S.I.	Mean Sea Level
29	PC.	Phenol Crystal
30	PDA	Potato Dextrose Agar
31	pH	Potential of Hydrogen
32	PJ	Petroleum Jelly
33	Spp.	Species
34	Sq.	Square
35	Um	Micrometer
36	V	Volume
37	V	Voltage
38	V.C.T.A.S.	Volumetric Continuous Tilak Air Sampler
39	Qt.	Quintal

Chapter - I

INTRODUCTION

Several kinds of living organisms sustain in the environment that vary from microorganisms to macro organisms. Unlike the water and soil, air is the most significant component of environment. The biopollutants like pollen grains, many insects, fungal spores that increase the level of pollutants in air and these pollutants are causes of many diseases of plants and animals. Aerobiology is concerned with the source of organisms or materials, their release into the atmosphere, dispersion, deposition and impact on living organisms like plants, animals and human beings. There are many pathogenic fungi, which have to undergo aerobiological phase in its life history. In many leaf spotting fungi, 90% of the spore released by a source within the crop which is responsible for short distance transport and subsequent spread of disease within the crop, however only 10% of the release spore transported upward within the air currents. Aerobiology is a scientific and multidisciplinary approach focused on the transport of the organism and biologically significant materials. Aerobiology is interdisciplinary science closely related with mycology, palyonology, meteorology, phytogeography, allergy, entomology, bio-deterioration and Cosmo biology (Edmonds, 1979). Phytopathology short distance transport of spores is much more important than the long distance transport of spores (Franking, 1978). According to Jacobs (1951) aerobiology includes the dispersion of insect population, fungal spores, bacteria, viruses, molds and pollens. An intervention in the ecological system has created the need to monitor air-spores in order to take the necessary measures to prevent serious damage by pathogens. Forecasting of different diseases have been developed which ultimately resulted in “prevention rather than cure” of the plants. Major parts of the aerobiological investigations include certain important aspects like general Aeromycology and its study in relation to plant pathology that are helpful in disease forecasting of crop.

As the information of microbes obtained about its release, dissemination and spread infective ability and seasonal variation, it would be ultimately helpful in reducing in the crop losses. Though innumerable viable pathogens are released into the air, very few have been studied extensively, thus enormous scope for investigating other pathogens

also. Aerobiology, thus, is useful both to agriculturists and plant pathologist, in their ultimate air of protecting the crops.

The recent studies in aerobiology, however, made origin about a century ago, when Louis Pasteur (1861) proved in his classical experiments in combating theory of spontaneous generations of life and in developing the germ theory of disease that air is the carrier of many common germs. But our existing knowledge regarding the composition of aerospora can be said to have been started accumulating during 1870's with Ehrenberg's (1872) first published information on the micro-organisms and Cunningham's (1873) Further investigated micro-organic contents of air in India.

Extensive and exhaustive work on airspora was carried out by Gregory (1952 onwards); Tilak and coworkers (1968 and onwards) at Aurangabad and Subba Reddy and his coworkers (1970) in India. Zadoks (1967) stressed the importance of studies on long distance dissemination in tracking source of infections and pathways of spread. Berger (1969) had made successful attempt to forecast *Cercospora* blight of clearly in Florida by using daily hydro thermograph and spore trap record to permit accurate prediction of *Cercospora apii* attack on Florida clearly in Florida in 1968. He also studied the epidemiology of Helminthosporiose of Florida sweet corn. He found that spores of this fungus become freely air borne after release and the spore counts were valuable in forecasting the sweet corn blight during all seasons in Florida.

Kiyusawa (1972) observed a closed relation between the numbers of spores trapped and severity of disease and reliable forecasting system was developed, Stakman and Christensen (1946) made an elaborate study to establish the exact relationship between aerobiology and plant disease, also emphasized its role in disease control through forecasting. Similarly Carter and Moller (1961) in Australia studied the factors governing the survival and dissemination of ascospores of *Mycosphaerella pinodes*.

Scope:

Aerobiological studies have wide scope because the investigations in aerobiology have direct application in various fields like plant pathology, veterinary science, medicine, meteorology, ecology, palyonology, forestry and defense organizations. The occurrence of fungal airspora varies from time to time and from place to place and variations are

largely determined by environmental conditions. The topography of the region and the type over which such airspora study is carried out, this indicates that there is wide scope for the study of airspora at any given season and place.

Significance of fungal Airspora:

Fungal airspora has a significant place in human and animal health, plant diseases and in determination of the extent of bio-deterioration active in a given region. Despite recent advances in Medical, veterinary and life sciences, many airborne fungi still continue to pose challenges, many airborne fungi are potential allergens causing seasonal hay fever, asthma, cough, common cold and several types of Skin infections in human beings and domestic animals. Fungal deposition cause great damage to household articles and causes rotting of fruits and vegetables in market, store houses and kitchen. Crop diseases caused by airborne fungi constitute another important aspect of concern in agriculture.

Aerobiology in abroad and India:

Ainsworth (1952) studied incidence of airborne *Cladosporium* in London region, Collins-Williams and Best (1955) reported atmosphere molds counts in Taranto (Canada). Di-Meena (1955), studied the airspora of Dunedin (New Zealand), Cammack (1955) studied the seasonal changes in the airspora components of southern Nigeria. Other important contribution includes Paddy, Kramer and his co-workers (1957 and onwards) in United States. Davies *et al.*, (1963) studied the comparison between summer and autumn airspora at London and Liverpool. Rees (1964) studied the airspora of Brisbane. Milton Darwin (1966) conducted a study of atmospheric mould spores in Tuscan, Arizona. Mustafa and Kamal (1976) studied the fungal population in the atmosphere of Kuwait. Other noteworthy contributions on aero mycological studies were of Rooks and Shapire (1958) in Iowa, Kaute. Mushin *et al.*, (2012) seasonal distribution pattern of outdoor airborne fungi in Iraq. In India the credit of first research in aerobiology goes to Cunningham (1873) for his aerobiological studies in presidency jail at Calcutta, He published his comprehensive work in the form of a book entitled “Microscopic examination of Air” which perhaps happens to the first writing on aerobiology in India. After a long gap aerobiological work was further initiated by many plant pathologists. In

this connection Mehta's (1940, 1952) work is noteworthy. He tackled the problem of wheat rust and caught uredospore of three rusts of wheat and barley with aero scope experiments. He collected data from sixty two stations placed at different altitudes in different parts of country. After such a long term survey he traced the annual flow of transport of such inoculums (Uredospore) from hilly regions to plains. He further observed that the infection was due to over summering of rust on cereal crops and self-grown plants at 2000 meters or more height on the hills where from the inoculums was carried down by air to the plains during early winter. This finding proved to be a milestone in the solution of rust problems in India.

After Mehta's pioneer work on aerobiology, efforts have been made to find out the airspora over economic crops. Rajan *et al.*, (1952) studied the atmospheric fungal flora at Kanpur. Sreeramulu and Sheshavataram (1962) worked the airspora over paddy fields at Pentapadu in Andhra Pradesh. Sen. Gupta and Chattopadhyay (1963) studied the prevalence of airborne conidia of *Helminthosporium oryzae* over paddy fields near Chinsurah. Agarwal and Gupta (1965, 1966) studied *Colleotrichum* and *Alternaria* over chili fields near Agra. Sreeramulu and Ramlingam (1966) made a two year survey of airspora of paddy fields near Visakhapatnam. Sreeramulu and Vittal (1966 and 1971) studied the aerobiology of rice stack barn fungus *Trichoconis Padwickii* and periodicity in the uredospore content of air within and above sugarcane fields. Sreeramulu and Ram Krishna (1971) worked the airspora over the Sugarcane, rice, Sorghum fields and banana plantation in Andhra Pradesh. Mishra and Srivastava (1971-1972) studied the fungal airspora over paddy, wheat and barley fields in Gorakhpur. Sreeramulu (1970) studied the dispersal of conidia of *Cercospora* in the atmosphere over Groundnut fields. Sharma and Singh (1973) reported the spore content of air over sorghum field. Kumar and Gupta (1976) reported the spore content of air over sorghum fields. Reddy and Ramakrishna (1978) studied the spore concentration within and above sorghum crop. Verma (1979) studied the only fungal component of airspora over arhar fields in Gorakhpur. Dixit and Gupta (1981) reported the airspora over a barley field near Agra. Jankibai and Reddy (1981) studied the fungal airspora of Visakhapatnam. Agashe and vinay (1983) Aerobiological studies of Bangalore. Nair *et al.*, (1986) worked the airborne pollen, spores and other plant materials in India. Sarma and Sarma (1993) reported the incidence

of air borne fungal spores in Guwahati. Chakraborty *et al.*, (2003) studied the aeromycoflora of an agricultural farm in west Bengal India. Uddin (2004) worked the airspora over a rice field in rabbi season in the state of west Bengal, India. Mishra and Bhandari (2006) studied the fungal flora of Jabalpur, Madhya Pradesh Sahney and purwar (2007) carried out the study of air borne fungi at Allahabad. Arya and Arya (2007) studied the aeromycoflora of fruit market of Baroda, India. Debnath and Baruah (2008) studied seasonal variation of air mycoflora over tea plantation in Jorhat district, Assam. Panda *et al.*, (2009) recorded the seasonal incidence of airborne fungi in coastal Belt of Orissa.

Aerobiology in Maharashtra:

In Maharashtra, aerobiological studies were initiated at Poona in Army medical college, Poona, by Karla and Dumbry (1957). Later on Karnik (1962) Caubal and Deodikar (1964) Chitale and Bajaj (1973, 1974, and 1975) published their frequently recorded reports of work done at different parts of Maharashtra. Tilak and his co-workers (1967 and onwards) actively engaged in the field of aerobiology and have been studied airspora over sugarcane, maize, jowar, bajra, cotton, vegetables, arhar, groundnut fields, vegetable market and banana plantation at Aurangabad. In addition to this Tilak and his co-workers (1967 and onwards) have studied airspora of orange, mung, hybrid jowar (CSH-1) and wheat fields from Nanded and Vaijapur.

Tilak and Srinivasulu (1967) reported airspora at Aurangabad. Talde (1969) studied airspora over banana fields at Parbhani. Kulkarni (1971) reported the airspora over sugarcane and vegetable fields from Aurangabad. Gaikwad (1974) studied the airspora over the *sorghum* fields at Ahmedpur.

Pande (1976) studied the air spora over orange, mung and over hybrid Sorghum (CSH-1) at Nanded. Mane (1978) reported the airspora over bajra and wheat at Vaijapur. Tilak and Chakre (1978) emphasized on the concentration of ascospores of *Claviceps fusiformis* over bajra fields. Bhalke (1981) studied the airspora over Sorghum fields and Shastri (1981) over maize fields and vegetable market at Aurangabad. Tilak and Kulkarni (1978) reported that occurrence of seasonal distribution of rust and smut spores in air over sugarcane fields at Aurangabad. Tilak and Bhalke (1979) studied diurnal periodicity of insect parts, ascospores, *Cladosporium* and *Alternaria* in the airspora at Aurangabad. Mane (1981) made a systematic aerobiological approach to rust disease of bajra caused

by *Puccinia penniseti*. Apart from the investigations, the aerobiological studies over different fields were carried out by Tilak and Bhalke (1978), Tilak and Mane (1981), Tilak and Babu (1982), Tilak and Patil (1982), Tilak and Bhasale (1982), Tilak and Pillai (1982), Tilak and Saibaba (1982).

The present investigations deal with the air spora over different crop fields. Babu (1983) studied the systematic approach to rust and blast disease of bajra. Patil (1983) reported the airspora over the banana fields. Pillai (1983) worked the airspora over the pigeon pea fields. Saibaba (1983) studied the airspora over cotton fields. Bhasale (1983) worked the airspora over the vegetable fields. Wankhade (1983) recorded the airspora over jowar fields. Kale (1983) studied airspora over cotton and jowar fields at Parli-vaijinath. Patil (1985) and Jogdand (1987) studied the air spora of jowar fields at Aurangabad. Quazi (1985) studied the air spora over groundnut fields and analyzed the concentration of Cercospora and rust spores in relation to meteorological parameters and disease incidence. Venugopalachari (1986) and Ramakrishna Reddy (1987) studied the air spora over the jowar, groundnut and banana fields at Aurangabad and Nanded respectively. Ramachandran Rao (1987) reported the air spora component over bajra and sunflower field at Aurangabad. Jagan Mohan Reddy (1988) studied the airspora over sunflower fields at Aurangabad. Sankaye (1989) reported the airspora over groundnut fields at Latur. Deshmukh (1989) studied the airspora over jowar and groundnut fields at Parli-vaijinath. Kotwal (1993) studied the airspora at Nashik. Meshram (1990) studied the airspora over gram fields at Udgir. Mahabade (1990) recorded the Aeromycological studies at Chalisgaon. Vaidya (1990) studies in airspora at Aurangabad and its relevance with environmental parameters, Aher (1993), Singh (1993) studied the impact of environmental parameters on airborne indoor and outdoor microbes at Ahmednagar and Aurangabad Respectively. Ban (1991) recorded the airspora over sunflower fields at Kandahar. Bhadane (1991) studied air spora over jowar and groundnut fields respectively at Dhulia. Kavishwar (1990), Ahuja (1991), Thube (1992) Patil (1992), Narpurne (1994) studied the airspora over jowar fields at different places in Maharashtra.

Thite (1998) reported the environmental bio pollution at Shrigonda. Sarma and Pande (2000) studied the microbial population over groundnut fields. Garje (2002) studied the extramural environmental biopollution. Rajurkar (1996) studied the aerobiological

investigation at Parbhani. Shastri (1996) worked the Aerobiological survey of fungal spores in two different seasons over maize fields. Shinde (1996) studied the airspora over jowar and sunflower fields. Sharma (1996) Aeromycological studies at siddhipet. Pawar (1997) studied the airspora over some crop fields at Aurangabad. Pawar (1998) studied aero-mycological at Nanded. Jogdand (1998) studied the airspora at Aurangabad. Tuljapurkar (2000) studied the Atmospheric concentration of microbes in ambient air over some crop fields. Deshmukh (2001) studied the aero-mycological studies over Green gram field. Kadam (2002) studied the aerobiological investigations over sugarcane field at shankarnagar. Suryawanshi (2002) studied the aero-microbiological investigations over different crop field like sunflower and Wheat. Mali (2002) studied the airspora over bajra and jowar fields at Kada (Beed). Ambhore (2003) studied the Aeromycological studies over Maize crops of Maharashtra. Patel (2003) studied the Aeromycology over vegetable fields. Gopan (2004) studied in airspora over bajra and groundnut fields at Beed (Namalgaon phata). Sonawane (2004) studied the Aeromycological at Nashik. Munde (2006) studied the airspora over Chili fields at Parli-vaijinath. Chavan (2007) studied the Aeromycological studies over paddy fields at Raigad in Konkon region.

Soybean Crop Field:

The present investigations deal with the airspora over Soybean fields. Soybean (*Glycine Max* L.) is an annual legume and is an edible oil seed crop which is very useful for animal feed and human diet. Nutritionally soybean is very good source of protein near about 40-41% protein, 18% oil, 17-19% and 31,4% carbohydrates content occurs in soybean seed. The protein quality of soybean is equal to the meat, fish and egg and it is very much nutritious and produces soya milk, soya cake, soya peat, cattle feed etc. It is third most important oil seed of India. It has highest content of protein and other valuable essential components such as Vitamin A, Vitamin E, Vitamin C, Vitamin B1, Vitamin B2, Vitamin B3, Vitamin B5, Vitamin B6, Vitamin B12, Folic acid etc. In India, soybean production is 3 to 5%. In India the crop is cultivated in Madhya Pradesh, Gujarat, Maharashtra, Himachal Pradesh, Uttar Pradesh, Punjab and Delhi. In Maharashtra the area under soybean crop is 35.809 thousands hectares and the production is 39.456 thousands tones and the yield is 1102 kg/ha. In Marathwada region Parbhani, Hingoli,

Nanded, Latur and Osmanabad are the major soybean producing districts. This crop is cultivated in both Kharif and Rabi seasons in the region. The major yields losses of the crop are due to biotic stress viz., fungi, bacteria, viruses, nematode and insects pests. Among these, pathogenic fungi result major yield loss and decreasing the seed, vigour, quality, nutritional values of soybean. Fungal pathogen affect to the root, stem, leaves, flower, pod and seed. It is the main, damaging cause on the foliar part of the soybean crop. Rust, Smut, rot, spot and wilt occur on the root, stem and leaf of soybean.

Jowar crop field:

The present investigations deal with the airspora over jowar (*Sorghum vulgare* L.) fields. Jowar is the most important millet, grown in India. It is mainly used as staple food. It contains all the essential nutrients of food like carbohydrates, proteins, fat, minerals and vitamins. It is a crop of tropics but its distribution is up to latitude as high as 45 degrees and suited to regions of low or moderate rainfall. In the world the total area under *Sorghum* is about 32 Million hectares. Africa has been claimed to be the center of origin for cultivation of *Sorghum*. Two decades ago jowar was the fifth most important food crop of the world preceded by wheat, rice, maize and barley (Rachie, 1970). During the past decade it has made spectacular progress in plantation, production and per hectare yield has gone up to the third position among the food crops. In India *sorghum* occupies an area of about 17-18 million hectares and produce about 8-10 million tons annually. India is one of the leading countries in the world for the production of jowar and forms the staple food of the poor class people living in dry parts of the country. The plant height varies from less than three feet up to 6 or 8 feet and the grains may be minutes or big, white, red yellow or dark brown. The yield per hectare varies considerably depending upon weather, it is dry or irrigated crop and various, other factors depending upon the climatic conditions, however adopted the intensity of cultivation practices. The *sorghum* growing states are Andhra Pradesh, Karnataka, Maharashtra, Gujarat, Madhya Pradesh, Rajasthan, Utter Pradesh and very little area in Tamil Nadu. In Maharashtra it is grown in all parts of Marathwada, Vidarbha and Western Maharashtra except konkan region. The *sorghum* crop is also vulnerable to various types of microbial diseases which cause extensive damage leading to loss in grains production and poor quality of grains and fodders for livestock. Fungal pathogens cause diseases and bring about loss in yield. In

India, major microbial diseases which cause extensive damage to *sorghum* are smuts, rusts, downy mildews, leaf spots, rots, ergots or sugary diseases, bacterial diseases, viral diseases parasites. About fifty diseases of *Sorghum* are known of which 30 are found in India but, only 10 are of major important, amongst which like leaf spot caused by *Alternaria* sp., *Heliminthosporium* sp., *Curvularia* sp., *Cladosporium* sp. *Ascochyta* sp., *Diplodia* sp., rust disease caused by *Puccinia* sp. smut caused by *Sphaecelotheca* sp. and various insect pests. The Aeromycological investigations of the crop were not deeply studied in this region. It was therefore, essential to conduct the air monitoring experiments in order to trap the pathogenic fungal spores, their source, dispersion and impact of metrological parameters. However, during present investigation, more concentration has been given on fungal components of airspora over *Sorghum* crop fields in order to have confirmation and rigidity to the conclusion. The fungal observations were carried out for two Rabi seasons over the same crop fields.

The present study concerns with the airspora analysis of pathogenic as well as non-pathogenic fungal spores over *Sorghum* fields. This study further includes concentration of different fungal spore types with their identification in seasonal variations. The role of metrological parameters in airspora composition and variations was considered in detail with reference to each pathogenic component in comparison with earlier reports. Such investigation would be of immense use in future supplemented in establishing useful disease forecasting system for the prevention, avoidance and treatment of diseases of *Sorghum* crop.

PLATE - 1

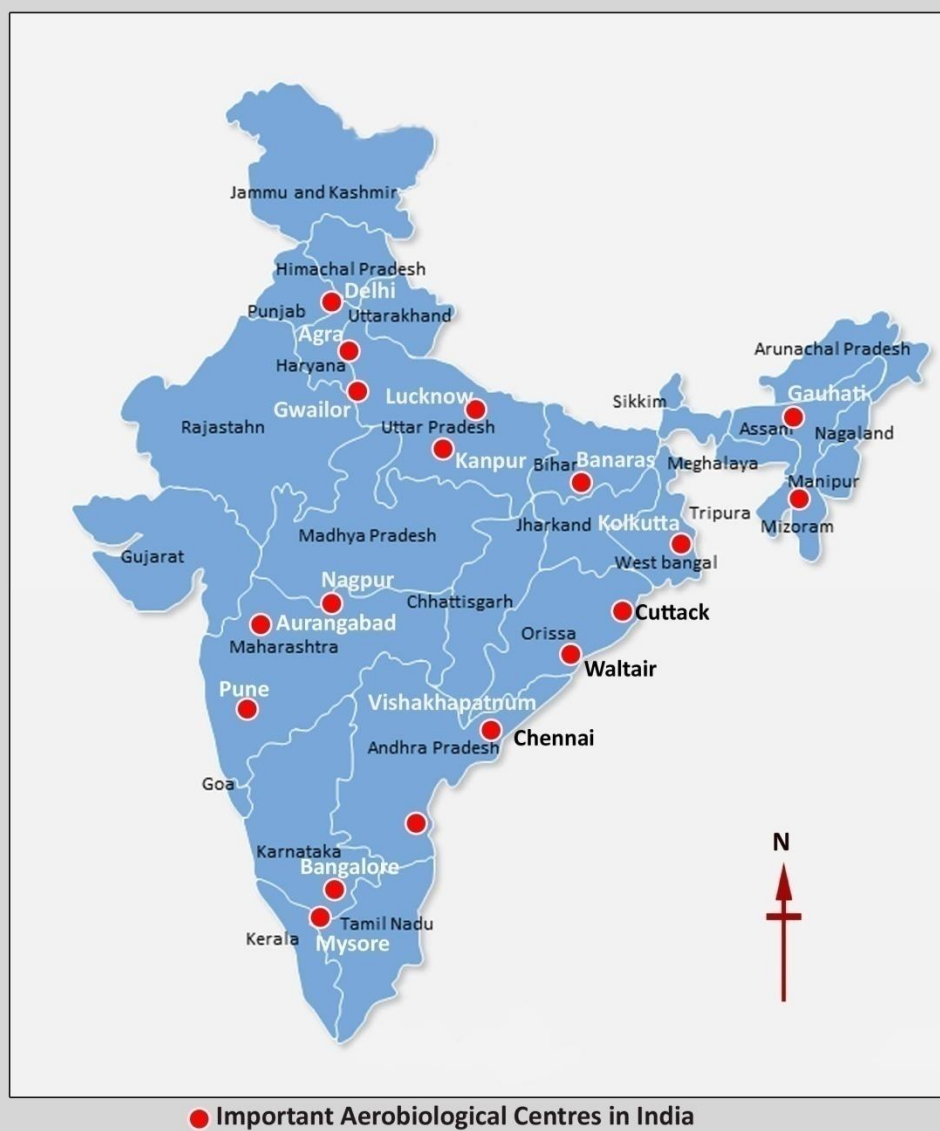


PLATE - 2



Map of Mahashatra



Map of Osmanabad

Chapter - II

REVIEW OF LITERATURE

Kanade *et al.*, (2018) studied the Aeromycoflora over Jowar and pomegranate fields at Baramati in Maharashtra and found out the total 34 fungal spores belongs to the Myxomycotina (5.88%), Mastigomycotina (11.76%), Ascomycotina (50.00%), Basidiomycotina (5.88%) and Deuteromycotina (20.58%) was reported. Mohture and kalkar (2017) studied Aeromycological investigation in the atmosphere of Nagpur, Maharashtra (India) and observed the 21 different fungi were identified during the study period. *Aspergillus Niger* (9.87%, 6.34%), *Aspergillus Flavus* (2.80%, 1.61%), *Aspergillus Fumigatus* (3.73%, 2.27%), *Alternaria alternata* (17.48%, 18.45%), *Heliminthosporium sativum* (2.02%, 3.50%), *Heliminthosporium* sp. (3.50%, 4.26%), *Fusarium Oxysporum* (7.46%, 7.41%), *Curvularia lunata* (15.38%, 15.33%), *Cladosporium Cladosporioides* (10.88%, 10.88%), *Cladosporium* sp. (8.08%, 10.79%) and *Nigrospora* sp. (3.73%, 5.08%) were predominantly found during first and second year respectively. Maximum numbers of colonies were identified during winter seasons (42.11%, 46.93%) followed by rainy (33.88%, 29.99%) and summer season (24.01%, 23.08%). Patil and Mali (2017) Investigated fungal airspora over the Jowar crop fields and observed the 61 fungal spore types during kharif and Rabi seasons from June, 2015 to January, 2016, for two consecutive seasons and the one year period. In the study season 57946 spores/m³ were captured from kharif season while 37870 spore/m³ from Rabi season. The most occurring species were *Alternaria*, *plasmopara*, *Physarum*, *Uredospore*, *Leptosphaeria*, *Cladosporium*, etc. Spore concentration of class Deuteromycotina (Imperfect fungi) was found to be most dominant as compare to other classes of fungi on the contrary Myxomycotina was found to be less. Among these *Alternaria* was found to be most dominant and having percentage contribution (20.02%) to the total airspora. Sonawane *et al.*, (2017) carried out the survey of bio-aerosols over groundnut fields at Newasa district Ahmednagar (M.S) and observed 72 bio-aerosols were trapped with 68 fungal spore types and 04 to other types over ground field respectively the other types including hyphal fragments, insects parts, plant parts and pollen grains from among the trapped 62 fungal spore types, in two kharif seasons, 35 belonged to the group Deuteromycotina, 22 to

Ascomycotina, 06 to Zygomycotina, 04 to other types, 03 to Basidiomycotina and 02 to Myxomycotina. During the period of investigations in the First and Second seasons (2012 and 2013) the group Deuteromycotina maximum contributed (60.00% and 60.24%) with 255304/m³ and 224812/m³ respectively followed by Ascomycotina with (16.28% and 18.12%) with 69286/m³ and 67620/m³ respectively. Basidiomycotina (13.80% and 11.18%) with 58702/m³ and second kharif seasons was 425474/m³ and 373198/m³ respectively. During the period of first and second kharif seasons 2012 and 2013 it was evident that Sept, 2012 and Aug, 2013 month were found maximum monthly average percentage contribution by the group of Deuteromycotina (30.48% and 31.27%) with maximum concentration 77812/m³ and 70308/m³ in air was recorded in September in both the Seasons. Deuteromycotina dominated the total airspora, with the fungal spore types belonged to the group Phycomycetes (15.06%), *Smut spores* (7.26% and 6.88%), *Alternaria* (5.54% and 5.22%), *Aspergillus* (3.83% and 4.18%), *Cercospora* (3.03% and 3.67%), *Basidiospores* (4.44% and 1.50%), *Helminthosporium* (2.56% and 2.95%), *Nigrospora* (2.44% and 2.63%), *Uredospore* (2.10% and 2.40%), *Epicoccum* (2.13% and 1.98%). Bodge and Mhatre (2017) carried out an investigation of Aeromycological studies over some paddy fields in the Ratnagiri Dist. of Maharashtra state. His analysis revealed that, 50 fungal spores were observed out of which 2 belongs to Zygomycotina, 03 belongs to Basidiomycotina, and 17 to Ascomycotina, 28 belongs to Deuteromycotina and 03 of other types. The total concentration was 422884 spores/m³ and 384370 spores/m³ in the first (2009) and second (2010) kharif season respectively. Deuteromycotina contributed highest percentage and lowest percentage contribution was found to be that of Zygomycotina to the total airspora. The group of Deuteromycotina contributed (61.02% and 60.84%), followed by Ascomycotina (23.27% and 24.92%), Basidiomycotina (9.44% and 7.74%), Zygomycotina (0.66% and 0.80%) and other types (5.62% and 5.69%) in the first (2009) and second (2010) Kharif seasons respectively. Throughout the period of investigation the concentration of *Cladosporium* (6.98% and 7.31%), *Alternaria* (3.79% and 2.88%), *Helminthosporium* (3.81% and 3.96%), *Nigrospora* (3.26% and 3.3%) and *Cercospora* was found to be more as compare to other types of spores and concentration of melioli (0.20% and 0.24%), *Cunnighamella* (0.21% and 0.25%). Baraskar and Patil (2017) studied the Aerobiological investigation of *Cladosporium* spores over Jowar crop

fields at Jamkhed in Maharashtra and observed the 87 bio-components were found and their percentage contribution were represented by group wise in the order of dominance such as Deuteromycotina (63.22% and 50.98%), Basidiomycotina (20.00% and 11.00%), Ascomycotina (7.30% and 14.76%), other types (7.69% and 10.71%), Zygomycotina (0.56% and 11.54%), Myxomycotina (0.50% and 1.00%) and Mycelia sterilia (0.65%) during both Rabi and Kharif seasons. However, the *Cladosporium* Spore was found to be dominant type throughout the investigations period contributing (6.17% and 15.11%), spores to the total airspora. Kshirsagar *et al.*, (2016) studied the fungal spore of groundnut fields in Beed District (M.S). He observed 58 fungal spore types. The percentage contribution of Different spore types to the total airspora was calculated and is given *Alternaria*, *Cladosporium* and *Smut spores* made a major components of airspora contributed 11.69%, 30.38% and 9.31% spores respectively. The *Smut Spores*, *Curvularia*, *Nigrospora*, *Periconia*, *Heliminthosporium*, Hyphal Fragments contributed 3 to 9 % to the total airspora, *Cunnighamella*, *Rust spores*, *Drechslera*, Deuteromycotina recorded maximum percentage contribution to the total airspora (66.59%) and as a followed by the group of Basidiomycotina (14.10%), Ascomycotina (8.14%), other types (7.14%) and Zygomycotina (3.76%). Baig and Sumia (2016) reported the Pathogenic and non-Pathogenic fungal Flora over *Sorghum* crop field at Aurangabad and observed the 32 Fungal Spore types, which 02 belonged to Phycomycetes, 09 to Ascomycetes, 04 to Basidiomycetes and 16 to Deuteromycetes. *Chaetomium*, *Didymosphaeria* *Sporormia*, *Alternaria*, *Cercospora*, *Curvularia* and *Cladosporium* were most dominant spore types. Pathogenic spore types *Alternaria*, *Cercospora*, *Curvularia*, *Heliminthosporium*, and *Periconia* *Smut spores*, *Rust spores* were recorded in sufficient high concentration. *Alternaria*, *Rust spores* were found pathogenic to *Sorghum* crop. The *Heliminthosporium* spore types was also found to be pathogenic close relation between the number spores trapped and severity of diseases was observed by Kiyusawa (1972) and Gaikwad (1974) studied the airspora over *Sorghum* fields at Ahmedpur. Deuteromycetes group were found dominant (60%) it was followed by Ascomycetes (30%), Basidiomycetes with (12.90%) and Phycomycetes (6.4%). Baraskar and Patil (2016) investigated bio-components over Jowar Crop fields at Jamkhed and found the 80 Fungal Spore types and 8 other types were found the group Deuteromycotina was found to be most dominated to the airspora, having

highest concentration (63.22% and 50.98%) in Rabi and Kharif seasons respectively as followed by Basidiomycotina (20.00% and 11.00%), Ascomycotina (7.30% and 14.76%), other types (7.69% and 10.71%), Zygomycotina (0.56% and 11.54%), Myxomycotina (0.56% and 1.00%), Mycelia sterilia 0.65% in Rabi seasons. Pathare and Sayyed (2016) studied on the Composition and Components of airspora belonging to Ascomycetes over Green Gram fields During Kharif Seasons at Kada in Maharashtra State and observed the 14 types of fungal spores belonged to the Ascomycetes and apart from these various dust particles were also seen in respectively. Analysis the spores, revealed that 14 types of fungal spores belonged to the Ascomycetes the *Ascotricha* Berk; Spores contributed 1.29% to the total airspora over the green gram field. Mean concentration ($266/\text{m}^3$) and minimum ($266/\text{m}^3$) respectively. *Chaetomium* Kunz ex Fr; spores concentration 1.39% to the total airspora. The maximum monthly mean concentration ($1246/\text{m}^3$) was recorded in the month of July, 2007 and minimum ($364/\text{m}^3$) in Aug, 2007. *Claviceps* Tul; their contribution to the total air spora was recorded 0.39%. The maximum monthly mean concentration ($378/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($238/\text{m}^3$) in July, 2007. *Didymosphaeria* Fuck; their contribution to the total airspora was recorded 0.39%. The maximum monthly mean concentration ($378/\text{m}^3$) was recorded in month of Aug, 2007 and minimum ($238/\text{m}^3$) in July, 2007. *Hypoxylon* Bull ex. Fr. Their Contribution to the total air spora was recorded as 0.72% and the maximum monthly mean concentration ($532/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($154/\text{m}^3$) in June, 2007. *Hysterium* Tode ex. Fr. their concentration to the total airspora was recorded as 0.42%. The maximum monthly mean concentration ($392/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($112/\text{m}^3$) in June 2007. *Leptosphaeria* Ces. And de Not. Their contribution to the total airspora was recorded as 0.52%. The maximum monthly mean concentration ($504/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($70/\text{m}^3$) in June, 2007. *Sordaria* Ces. And de Not. Their contribution to the total airspora was recorded as 0.18%. The maximum monthly mean concentration ($196/\text{m}^3$) was recorded in the month of July, 2007 and minimum ($84/\text{m}^3$) in Aug, 2007. *Sporormia* de Not. Their contribution to the total airspora was recorded 0.26%. The maximum monthly mean concentration ($196/\text{m}^3$) was recorded in the month of July, 2007 and minimum ($84/\text{m}^3$) in Aug, 2007. *Teichospora* Fuck. Their contribution to the total airspora was

recorded as 0.37%. The maximum monthly mean concentration ($280/\text{m}^3$) was recorded in month of July and Aug, 2007 and minimum ($28/\text{m}^3$) in June, 2007. *Valsaria* Ces. And de Not. Their contribution to the total airspora was recorded as 0.45% the maximum monthly mean concentration ($448/\text{m}^3$) was recorded in the month of July and Aug, 2007 and minimum ($112/\text{m}^3$) in June, (2007). *Melanospora* corda. Their contribution to the total airspora was recorded as 0.95%. The maximum monthly mean concentration ($1064/\text{m}^3$) was recorded in the month of July, 2007 & minimum ($154/\text{m}^3$) in June 2007. *Parodiella* (Speg) thesis & Syd. Their contribution to the total airspora was recorded as 0.20%. The Maximum monthly mean concentration ($308/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($14/\text{m}^3$) in June, 2007. *Pleospora* Rash. Their contribution of the total airspora was recorded as 0.54%. The maximum monthly mean concentration ($448/\text{m}^3$) was recorded in the month of Aug, 2007 and minimum ($84/\text{m}^3$) in June, 2007. Kardule and Jadhav (2016) Study of Atmospheric mycoflora over Bajra crop fields at shiral locality in Maharashtra and carried this study in two Kharif seasons during years 2013 and 2014. In the year 2013, 80 types of air borne components were trapped and identified. While In the year 2014, 83 types air borne components were trapped and identified. In the 1st kharif season class Deuteromycotina is dominant 64.85% of the total airspora, followed by the Basidiomycotina 11.61%, other types 9.79%, Ascomycotina 7.26%, Zygomycotina 5.78% and Myxomycotina 0.68%. In the 2nd seasons the class Deuteromycotina dominant 66.72% of the total airspora followed by the Basidiomycotina 10.99%, other types 10.96%, Ascomycotina 6.78%, Zygomycotina 3.92% and Myxomycotina 0.60%, in 1st Kharif season of 2013 *Cladosporium* spore types is a dominant and contributed 18.69%, it was followed by *Curvularia* (7.23%), *Alternaria* (6.60%), *Hyphal Fragments* (5.52%), *Rust spores* (5.50%), *Basidiospores* (3.86%), *Nigrospora* (3.86%), *Periconia* (3.52%), *Albugo* (3.47%), *Pseudotorula* (3.33%), *Aspergillus* (1.32%), *Rhizopus* (1.32%), *Cercospora* (1.16%) and *Cunnighamella* (0.81%), In 2nd Kharif season 2014 also the *Cladosporium* spore types is dominant and contributed 19.11% it was followed by *Alternaria* (7.36%), *Curvularia* (6.68%), *Hyphal fragments* (5.96%), *Rust spores* (5.16%), *Nigrospora* (4.69%), *Periconia* (4.34%), *Basidiospores* (4.00%), *Pseudotorula* (3.32%), *Torula* (3.20%), *Rhizopus* (4.00%), *Aspergillus* (1.35%), *Cercospora* (1.16%) and *Cunnighamella* (0.73%). Allapure (2016) carried out Aeromycological study over sunflower fields at

Udgir Region (M.S) and recorded 32 fungal spore types and other 03 types were recorded, out of which 03 belong to phycomycotina, 03 to Basidiomycotina, 09 to Ascomycotina and 17 to Deuteromycotina. The group Deuteromycotina is the most dominated group and represented by 48.57% of total airspora. The next dominated group is Ascomycotina which is represented by 25.71% of airspora. It was followed by Basidiomycotina 8.57%, Phycomycotina 8.57% and 8.57% belonging to other types, Hyphal fragments, insect parts and pollen grains. Occurrence some of the dominant spore type in decreasing order are *Cercospora* (13.22%), *Aspergillus* (9.52%), *Alternaria* (7.34%), *Nigrospora* (7.34%), *Leptosphaeria* (7.16%), *Rust spores* (6.58%), *Cladosporium* (4.23%), *Claviceps* (4.23%), *Smut Spores* (4.23%), *Fusarium* (3.29%), *Curvularia* (3.23%), *Bitrimonospora* (2.46%) and Basidiospores (2.46%). Similar observation were recorded by Rangaswami G. mahadevan A (2006), Jadhav et al (2010), Mali N.S and Gaikwad Y.B (2011), Arsule and Pande (2012) and Shinde and Mahajan (2013). Suryawanshi and Bajgire (2016) studied the Aerobiological survey on soybean crop field at. Naldurg Dist.Osmanabad (M.S) and observed the out of 69 fungal spore types. The highest no. 45 spore types belonged to Deuteromycetes and lowest, 02 spore types belonged to Myxomycetes, 16 to Ascomycetes, 03 to Zygomycetes, 03 to Basidiomycetes and 07 to other type, during both consecutive seasons. Deuteromycetes contributed with highest percentage during this study, the dominant spore type is *Cladosporium* it was followed by *Alternaria*, *Periconia*, *Curvularia*, *Helminthosporium*, *Nigrospora* and *Cercospora* etc. during the summer season total number of fungal spores (196056 spores/m³) was recorded. The fungal spore type in *Cladosporium* (10.44%), it was followed by *Periconia* (9.72%), *Leptosphaeria* (8.34%), *Alternaria* (6.06%), *Bispora* (5.33%) and *Curvularia* (4.94%) was dominated during the summer season and the rainy season total number of fungal spores, (283999 spore/m³) was recorded. The dominant fungal spore types in *Cladosporium* (7.77%), it was followed by *Alternaria* (7.20%), *Periconia* (6.03%), *Bispora* (5.06%) and *Physarum* (4.35%) was dominated during rainy season. Aher *et al.*, (2015) reported the qualitative Assessment of airborne deuterospores over pomegranate (*Punica granatum* L.) field and observed the 42 Fungal spore types of deuterospores, the percentage contribution of each spore type of Deuteromycetes to the total airspora, revealed that *Cladosporium* contributed the highest (29.49%), it was followed by *Epicoccum* (9.27%), *Nigrospora*

(2.86%), *Alternaria* (2.30%), *Botrytis* (2.18%) *Botryodiplodia* (2.00%) and *Curvularia* (1.53%). Influence of meteorological factors on incidence of deuterospores was observed. Patil *et al.*, (2015) Studies on the Aeromycoflora over jowar crop fields at Barshi Area during Kharif Season and observed the total 61 types of fungal spores were recorded and other types included Hyphal fragments and pollen grains 61 spore types including 30 from of Deuteromycotina, 20 from of Ascomycotina, 04 Mastigomycotina, 03 Zygomycotina, 02 Basidiomycotina, 01 Myxomycotina and 01 from other types. Deuteromycotina contribute the highest percentage (39.59%) as a dominant group. Mastigomycotina (20.81%), Myxomycotina (8.72%), Ascomycotina (8.62%), Basidiomycotina (8.62%), Zygomycotina (4.61%) and other types (12.48%). Ambhore (2014) reported the impact of environmental parameters on atmospheric concentration of *Cladosporium* over paddy crop fields at shrivardhan Dist. Raigad (M.S) and observed in the high incidence of spores *Cladosporium* in the air was due to the capability of producing those spores directly on hyphae copious fruiting ability with passive mechanism of spore liberation. Beside the spore of *Cladosporium* liberate in the air in an enormous amount, as it was already suggested by Gregory (1964). In the first crop season the highest monthly concentration was ($49070/\text{m}^3$) was observed in the month of august 2010. When there was 90.7% relative humidity 4.6 km/hr. Wind velocity and 294.2 mm rainfall. In second season the highest monthly concentration ($36750/\text{m}^3$) was observed in the month of September, 2011. when there was recorded of moderate range of temperature 21.02, 28.0°C 64-93% Relative humidity and 280.5 mm rainfall during the first season the highest spore catch ($2800/\text{m}^3$) was recorded on 1st September 2011, there was recorded of 29.25°C of mean temperature, 75.5% relative humidity, 5.2km/hr. wind velocity. These finding have clearly brought out that there was a closer relationship between the environmental parameter. Gadekar (2014) studied the fungal diversity and their concentration and impact of jowar crop from Pune district of Maharashtra and observed 63 fungal spore types, 34 from Deuteromycotina, 18 from Ascomycotina, 4 from Basidiomycotina and 2 from Phycomycotina. Percentage contribution of these fungal spore groups to the total airspora revealed that Deuteromycotina (60.19%) as a dominant group followed by Ascomycotina (13.25%), Basidiomycotina (21.35%), Phycomycotina (0.54%) and other types (2.96%), Average percentage contribution of each spore types to the total airspora revealed that

Cladosporium (15%) as a dominant types followed by *Curvularia* (7.5%), *Alternaria* (7%), *Smut spores* (6%) and *Cercospora* (5%). Gadekar (2014) worked the Diversity of fungal spores over Jowar crop, observed the 63 fungal spore types and other types included the Hyphal fragments, Pollen grains, Protozoan cysts, Insects parts etc. Analysis of fungal diversity after air sampling revealed that, 63 spore types including the 34 from Deuteromycotina, 18 from Ascomycotina, 4 from Basidiomycotina, 2 from Zygomycotina, percentage contribution of the fungal spore types to the total airspora revealed that Deuteromycotina (60%) as a dominant group as a followed by Ascomycotina (19%), Basidiomycotina (16%), other types (2.5%) and Zygomycotina (1.5%). Ahire *et al.*, (2013) studied the fungal airspora over sugarcane fields at Nasik using Tilak air sampler and observed the 50 fungal spore types to the total airspora. Their contribution to the total airspora with (69.39%), the highest contribution was *Cladosporium* which is most dominant fungus. The class Basidiomycetes, 05 spore types were trapped; the *smut spores* showed highest contribution the smut spores got a second position, among the total airspora. The class Ascomycetes, 15 types of Ascospores was collected and their average percentage of occurrence ranged between (0.004-0.93 percent), their total airspora contribution was (04.50%). Bembrekar and Bodke (2013) worked out the studies on the composition and components of airspora belonging to Phycomycetes over cotton crop field during two consecutive Kharif seasons and observed the four types of fungal spores belonging to Phycomycetes. Enumeration of the identified spores of fungi belonging to Phycomycetes, *Acaulopage Drechs*, *Albugo Pers.*, *Mucor Micheli ex, Fr.*, and *Rhizopus Ehrenb* etc. The spore concentration in the first test Kharif season from 21-06-2009 to 30-11-2009 and second test Kharif seasons from 21-06-2010 to 30-11-2010. *Acaulopage Drechs* was recorded (1498/m³ and 1190/m³) respectively. They contributed with (0.91% and 0.74%) and average percentage contribution was recorded (0.82%), *Albugo Pers.* was recorded (4830/m³ and 5334/m³) respectively. They contributed (2.95% and 3.32%) and average percentage contribution was recorded (2408/m³ and 238/m³) respectively. They contributed (1.47% and 0.14%) and average percentage contribution was recorded (0.80%), and *Rhizopus Ehrenb* was recorded (462/m³ and 2772/m³) respectively. They contributed (0.28% and 1.72%) to the total airspora. The average percentage contribution for both the test seasons was recorded (1%) of the total airspora. Karne (2013) studied the

Aeromycological investigations in the ambient air over some crop field in contents to pathogenic and Allergenic Fungal bio-aerosols and observed the 46 bio-aerosols were trapped in the air sampler over the jowar crop fields of which 20 types (74.4%), were pathogenic and 25 type (81.5%) were allergenic in nature 50 bio-aerosols were recorded over the wheat crop fields of which 21 types (71.7%) were pathogenic and 25 types (81.5%), were allergenic in nature. 50 bio-aerosols were recorded over the wheat crop fields of which 21 types (71.7%) were pathogenic and 25 types (85.8%) were allergenic in the atmosphere over the groundnut fields 47 bio aerosols were recorded of which 21 types (71.6%) were pathogenic and 26 types (81.9%) were allergenic in nature. from these 03 different crop fields total 30 type of bio aerosols were recorded of which 27 belonged to fungal spore types, and 03 types belonged to other types. Baviskar and Suryawanshi (2013) carried out Aeromycological study of APMC fruit market of Vashi and observed the 25 fungal spore types were trapped, *sphaeropsis yri putrescens*, *venturiaiae equalis*, *Botrytis cinerea*, *Alternaria alternata*, *Mucor piriformis*, *Aspergillus Fumigatus*, *Aspergillus Flavus*, *Aspergillus tenuis*, *Aspergillus Niger* *Phytophthora*, *caltorum*, *Phytophthora*, *Parasitio Sclerotinafructigena*, *Rhizopus nigricans*, *Rhizopus stolonisfer*, *Rhizopus arrhizus*, *Penicillium Chrysogenum*, *Penicillium citrinum*, *Penicillium digitatum*, *Penicillium funiculosium*, *Penicillium italicum*, *Penicillium Solitum*, *Penicillium commune*, *Penicillium regulosum*, *Penicillium expansum* and *Curvularia lunata* using gravity slide and agar plate exposing method . Agar plates were exposed at 0, 5, 10, 15 minutes at different levels and accordingly the mycoflora were trapped the *Penicillium expansum* and *Aspergillus* sp. was dominated. Gadekar (2013) Reported the Aerobiological investigations over jowar crop field at Rahuri and observed 63 fungal spore types including 34 from Deuteromycotina, 18 from Ascomycotina, 04 from Basidiomycotina, 02 from Phycomycotina and other types 05. Percentage contribution of the total airspora revealed that, Deuteromycotina (60.37%) as a dominant group followed by Ascomycotina (18.96%), Basidiomycotina (16.63%), other types (2.54%) and Phycomycotina (1.5%). Average percentage contribution of each spore types to the total airspora of four consecutive seasons revealed that *Cladosporium* (15.44%), as a dominant type followed by *Curvularia* (7.65%), *Alternaria* (7.32%), *Smut Spores* (6.49%), *Cercospora* (4.94%), *Helminthosporium* (4.13%). Sonawane (2013) carried out Aeromycological studies of

groundnut field at Nasik (M.S.) and found out the total 48 fungal spore types and 04 to other types (Other types including fungal fragments, pollen grains, insect scales and unidentified spores). Out of which 02 belong to Myxomycotina, 05 to Zygomycotina, 12 to Ascomycotina, 03 to Basidiomycotina and 26 to Deuteromycotina. The average percentage contribution of each spore group over the groundnut fields was as follows Deuteromycotina (51.33%) it was followed by Basidiomycotina (16.43%), Ascomycotina (13.86%), Zygomycotina (10.99%), other types (6.36%) and Myxomycotina (0.65%) among the spores the maximum percentage contribution of following spores were observed *Cladosporium* contributed in highest number (9.23%) to the total airspora, followed by *Alternaria* (7.45%), *Uredospore* (5.79%), *Cercospora* (5.27%), *Leptosphaeria* (4.54%), *Curvularia* (3.34%), *Helminthosporium* (2.86%), *Pithomyces* (3.71%) etc. Pathogenic spores of groundnut contributed (26.92%) to the total airspora. Spores like *Alternaria*, *Cercospora*, *Helminthosporium* and *Leptosphaeria* which are responsible for initiating leaf spot diseases of groundnut *Urediniospores* responsible for rust disease of groundnut were also recorded. Similar observations were recorded by earlier workers like Rees (1964), Srinivasulu (1967), Sreeramulu (1995), Aher and Pande (2004) and Kadam *et al.*, (2008). Shinde and Mahajan (2013) studied the overview of Aerobiology over groundnut crop fields at Patan (M.S). He observed the total 95 bio-components, including the various types of fungal spores of saprophytic fungi, parasitic fungi, pathogenic fungi and other bio-components like Algal Filaments, Fungal hyphae, Pollen grains, Protozoa cysts, Insect parts, plant parts, mites and other unidentified fungal spore was observed, 02 types from Myxomycotina, 04 types from Phycomycotina, 25 types from Ascomycotina, 05 types from Basidiomycotina and 51 spore types Deuteromycotina, while the 08 different types of bio-components was recorded. the classwise percentage contribution during Kharif and summer seasons revealed that group Deuteromycotina has been to be dominant with (54.80% and 66.70%) it was followed by Ascomycotina with (23.40% and 7.29%), Basidiomycotina with (11.34% and 9.76%), other types (7.48% and 13.49%), Phycomycotina (2.28% and 2.21%) and Myxomycotina (0.60% and 0.52%), spore contribution to the total airspora of two Seasons. Deuteromycotina was dominated (58.19%) it was followed by Ascomycotina (18.81%), Basidiomycotina (10.89%), other types (9.91%), Phycomycotina (2.26%) and Myxomycotina (0.62%). the dominant spore

types in descending order have been found to be *Cladosporium* (15.53%), *Aspergillus* (9.19%) and *Nigrospora* (6.23%) and least in occurrence have been found to be *ceratosporium* (0.004%). The average percentage contribution of airspora was more during Kharif (rainy) with (71.49%) as compared to summer seasons (28.50%). Pawar (2013) studied the Seasonwise comparative total Deuteromycotina fungal flora and its percentage contribution over Groundnut field. He revealed that the spores of *Aspergillus* and *Cercospora* occurred predominately. The *Aspergillus* spores contributed (8.24% and 4.31%) in first and second winter seasons and (3.67% and 4.08%) during first and second summer seasons respectively. *Cercospora* spores contributed (7.85% and 7.02%) in first and second winter seasons and (2.85% and 3.97%) during first and second summer seasons respectively. *Curvularia* spores contributed (0.62% and 1.22%) in first and second winter seasons and (0.32% and 0.98%) during first and second summer seasons respectively. *Cladosporium* spores contributed (1.54% and 1.56%) in first and second winter seasons and (1.35% and 1.73%) during first and second summer seasons respectively. Reddy and Kadam (2013) studied the effect of meteorological factors on the air borne fungi over sugarcane (*Saccharum Officinarum*). He observed the 78 fungal spore types and 05 other types, the total airspora comprising Phycomycetes by 3 with (1.28%), Ascomycetes 18 with (8.77%), Basidiomycetes by 4 with (15.58%) and Deuteromycetes by 53 with (68.75%) and other were 5 with (5.62%) maximum *Ascospores* showed their seasonal maxima in the rainy period and their number found to depended on the occurrence and amount of rainfall rather than vegetation in the area. Deuteromycetes contributed highest percentage because of their large number and parasitic & saprophytic ability in nature. *Cladosporium* showed maximum in occurrence and dominated in the airspora. Lohare and Kamble (2013) studied the Atmospheric concentration of *Cercospora* over soybean crop field. He observed the airspora composition over soybean crop fields comprises, Phycomycetes (0.13%), Ascomycetes (15.24%), Basidiomycetes (3.43%), Deuteromycetes (68.08%) and remaining were other biological components like fungal hyphae, insect parts, pollen grains etc. In the season Deuteromycetes group contributed highest percentage 68.08% to the total airspora of the season, in this investigation total number of spore counted (1278985spores/m³) the concentration of pathogenic *Cercospora* was found 94% to the total airspora. The maximum spore concentration was found (4970

spores/m³) in the month of September, 2010 and minimum (1442 spores/m³) in the month of August, 2010 the concentration of *Cercospora* and their relation with disease incidence. Sinha et al (2013) reported Aeromycological survey of pimpri- chinchwad area, Pune and observed the 26 culturable genera were recorded. The genera such as *Aspergillus*, *Penicillium* and *Trichoderma* were precisely identified by their cultures. The maximum contributed of the airspora in 2010-2012 was *Cladosporium* sp.1 with (8.79%) contribution followed by *Aspergillus* sp.1 (6.15%) and *Helminthosporium* (5.79%). In second year, *Cladosporium* with (6.58%) contribution to the highest and it was followed by *Helminthosporium* (5.38%), *Aspergillus* sp.1 (4.90%) and *Alternaria* sp.1 with (4.47%) contribution. Mahobia et al (2017) recorded the atmospheric studies of fungal bio-aerosols in the market area of Nawapara (Rajim), district-Raipur (Chhattisgarh) the present investigation 728 colonies of 67 fungal sp. were identified maximum 51 fungal sp. were observed in the month of December, while minimum 09 fungal sp. Were observed in may. Out of total fungal flora the percentage contribution of different classes were as follows: Zygomycotina (2.60%), Ascomycotina (1.09%), anamorphic fungi (92.85%) and Mycelia sterilia (3.43%). out of total fungal population *Cladosporium* *Cladosporides* (15.10%) was most dominated were as *Aspergillus Niger* (12.08%), *Aspergillus Flavus* (10.43%), *Aspergillus vesicular* (5.49%), *Cladosporium Oxysporum* (3.15) and *Curvularia clavate* (2.47%) were dominant fungal bio-aerosols. Kshirsagar and Pande (2012) worked the prevalence of *Cladosporium* spores over the sunflower fields at Rajuri (N) M.S India and observed the 70 types of Fungal spores of which 38 types belonged to Deuteromycotina, 21 to Ascomycotina, 05 to other types, 04 to Basidiomycotina and 02 to Zygomycotina During winter season of 2003-2004. Deuteromycotina contributed with highest percentage of 67.11% to the total airspora followed by Basidiomycotina 24.76%, other types 5.46%, Ascomycotina 2.58% and Zygomycotina 0.09% to the total mycosporphytes. However, mycosporphytes viz. *Cladosporium* was found to the dominated type contributed 16.76% to the total airspora. Mali *et al.*, (2012) studied the fungal diversity in ambient air over bajra crop field. He observed the 92 types of airborne components were included of which, 48 belonged to Deuteromycotina stood first 63.77% and 62.12% to the total airspora followed by 7 to other types 11.55% and 13.65%, 27 to Ascomycotina 11.37 % and 10.72%, 04 to Basidiomycotina 9.92% and 10.85%, 4 to

Zygomycotina 2.69% and 1.96%, 02 to Myxomycotina 0.70% and 0.70%. Pande *et al.*, (2012) studied the Atmospheric fungal Diversity over the vegetable market at Aurangabad place in Maharashtra and observed the 61 types of bio-pollutants of which 54 belonged to fungal spore types and 07 to other types. During study period the fungal spore count (606858/m³) was recorded in August, 2008 the total 54 fungal spore counts. The *Cladosporium* (90050/m³) with percentage contribution (28.68%) dominated of the total airspora; it was followed by *Alternaria* (299012/m³) with (9.52%) *Nigrospora* (169120/m³) with (5.39%) *Periconia* (138516/m³) with (4.41%) etc. the pathogenic spore types like *Alternaria*, *Aspergillus*, *Cladosporium*, *Curvularia*, *Cercospora*, *plasmopara* and *Heliminthosporium* etc. was recorded in the year 2008. Mali *et al.*, (2011) Studied the fungal Diversity over green gram crop field (M.S) and observed the 49 types of airborne components were recorded of which belongs 02 to Zygomycotina 14 to Ascomycotina, 03 to Basidiomycotina, 25 of Deuteromycotina and 05 to other types. In the Kharif season, group Deuteromycotina Was contributed with the highest percentage (62.70%), to the total airspora, it was followed by other types (17.92%), Ascomycotina (9.5%), Basidiomycotina (6.52%), and Zygomycotina (3.34%). The airborne spore like *Cladosporium* dominated airspora composition and contributed with (10.10%), it was followed by *Alternaria* 9.68% *Curvularia* 7.89% *Hyphal fragments* 7.24% *Nigrospora* 7.68% *Heliminthosporium* 7.74%, *Rust spores* 4.39%, *Pseudotorula* 3.38% and *Drechslera* 2.96%. Kadam *et al.*, (2011) studied airborne imperfect Fungi over bajra (*Pennisetum typhoid*) fields at Ahmedpur (M.S). He recorded 58 types of fungal spores, out of which, 03 belonged to Mastigomycotina, 13 to Ascomycotina, 04 to Basidiomycotina, 33 to Deuteromycotina and 05 to other types. Deuteromycotina (imperfect fungi was the dominated group and its contribution was (67.49%) the revealed that, 33 spore type of imperfect fungi showed the dominance to the airspora. It is evident that among all these types, *Cladosporium* (25.39%) was found to be the most dominant spore types in the air; it was followed by *Curvularia* (7.19%), *Heliminthosporium* (7.15%), *Alternaria* (5.31%) and *Nigrospora* (5.02%). Mali and Gaikwad (2011) studied the pathogenic Airspora and Epidemiology of Groundnut crop field at Solapur during the Kharif seasons and reported the 42 fungal spore types of which 03, Type belonged to Phycomycetes, 11 to Ascomycetes, 02 to Basidiomycetes and 26 to Deuteromycetes. The spores like *Cladosporium* sp, *Alternaria*

sp, *Helminthosporium* sp, *Aspergillus* sp, *Alternaria* sp, *Drechslera* sp, *Geotrichum* sp, *Fusarium* sp, *Curvularia* sp, were the dominant fungal pathogenic spore types recorded. Arsule and Pande (2011) studied the fungal airspora over the groundnut fields at Newasa in Maharashtra and observed the total 72 types of airborne components were trapped during Kharif seasons of 2007 and 2008 out of total 72 airborne biocomponents 2 belonged to Myxomycotina, 6 to Zygomycotina, 22 to Ascomycotina, 03 to other types. The group of Deuteromycotina spores dominated (60.00% and 60.24%) the Kharif seasons, it was followed by the group Ascomycotina with (16.28% and 18.12%), Basidiomycotina (13.80% and 11.18%), Zygomycotina (6.48% and 6.98%), other types (1.67% and 2.19%) and Myxomycotina with (1.76% and 1.29%) respectively in the both Kharif seasons. *Cladosporium* spore type contributed with Maximum concentration (15.06% and 9.03%) respectively. The Myxomycotina contributed (1.76% and 1.29%), in first and second Kharif seasons respectively and was represented by only two members like *Physarum* and *Stemonitis*. Basidiomycotina spore types contributed (13.80% and 11.18%) to the total counts of airspora during first and second Kharif seasons respectively. Chavan (2011) studied the diversity of fungal spore in the paddy fields (*Oryzae Sativa* L.). (Sheshavatham v-1965, Sreeramulu-1970 Dhaware S.A-1976) some of the spores cause many diseases to paddy crop like *Pyricularia*, *Curvularia*, *Cercospora*, *Fusarium*, *Helminthosporium*, *Phoma*, *Nigrospora* Species causes “ Grain discoloration *Alternaria* causes “stack Burn ” diseases. Jadhav *et al.*, (2010) reported the Airspora over Groundnut crop field at Kalamb (M.S) and observed the 71 airborne fungi were identified, of the 71 spore types. 41 spore types belong to Deuteromycetes, 17 to Ascomycetes, 04 to Basidiomycetes and 6 to other types. The fungal spores group is concerned, the group Deuteromycetes (77.00%), Deuteromycetes group was dominated, followed by the other types (10.13%), Basidiomycetes (7.34%), Ascomycetes (4.62%) and Phycomycetes (0.91%).

Chapter - III

MATERIAL AND METHODS

Aerobiological investigations concern with trapping the air spora i.e. airborne bio-particles and micro organisms stuck on solid /or liquid surfaces and the apparatus utilized for such study is air sampler, the sampler depends on its efficiency in catching the factors of air spora and the component that one wants to investigate through the day and night. The present aerobiological investigations were carried out by Tilak air sampler which was devised by Tilak (1968). This sampler (Tilak and Kulkarni 1970) based on suction and impact on principle. In the present aerobiological investigations the air sampler was operated continuously for the period of two seasons over the jowar crop fields. The technical description and method of working of Tilak sampler is described below. In the present investigations two types of techniques have been used simultaneously. **(1)** Petri plate exposure and **(2)** Air sampling using volumetric air sampler (Tilak and Kulkarni, 1970) with the volumetric air sampling method the fungal spores could be identified only up to generic level, whereas by culture plate technique one can identify the fungus up to species level, however in second technique there are some drawbacks viz., some spore are obligate parasitic fungi (Rust, Smuts, Powdery and downy mildews) are unable to grow on media and some of the saporific fungi inherently allow growth rate on all media.

TILAK AIR SAMPLER: (Plate III)

The apparatus runs on electric power supply (AC 230 V) and provides a continuous sampling for air for eight days. The air sampler consists of two mechanical systems the electrical clock mechanism and the exhaust fan system. The electric clock is fitted in the instrument is synchronized with the motor of the exhaust fan, which completes one rotation in eight days. The air is sucked through the orifice of the projecting tube at the rate of 5 liters per minutes and it impinging on cello phone tape on the outer surface of the drum. The cello phone tape which is one centimeter in breadth is affixed on the outer surface of the circular drum. The drum is fitted on the clock system and rotates in

anticlockwise direction (fashion) and takes 8 days for one complete rotation, thus giving a trace of catches of a week (8 days).

The cellophane tape was slightly coated with adhesive white petroleum jelly. The tape thus coated with adhesive, faces the orifice of outward projecting tube 0.5 cm away from it. When sampler is operated the drum rotates continuously with clock mechanism giving continuous air sampling for 8 days. Before the tape is mounted on the glass slides, at the end of eight days, it is divided in to 8 equal parts with graduation on the surface of the drum, thus, each parts corresponds to 24 hours trace measuring 8.4cm in length. Such parts are again divided into sixteen equal parts, each measuring 4.2cm.

These segments correspond to sampling of twelve hours period of day or night accordingly. Now each cellophane segment is mounted on a date labeled glass slides with glycerin jelly as mountant. At the time of air sampling the air sucked through the orifice tube the help of small exhaust fan having three prongs and fitted in the circular opening in the cover lid of air sampler. This forces the air out of collections chamber creating a vacuums in the collecting chambers. An exhaust whole 6 x 2.7cm is kept with lid of the aperture. The air sampler is modified form of Panzers *et al.*, (1957), slide spore collector, gives the data for 24 hrs only. It has the collection efficiency of 70% whereas the Tilak air sampler collection efficiency is 75% greater retention capacity, portable, economical and provides continuous data for air sampling for 8 days. Its special merits is that it provides volumetric data (number of spores/m³), which enables to analyze the microbial populations both quantitatively and qualitatively, as it provides continuous sampling. When the sampler was compared with other air sampler, it was found that the Rotorod sampler (Perkins *et al.*, 1957) is useful only for spot sampling although its collection efficiency is 85%. The Hirst spores trap (Hirst 1952) with 45 % collecting efficiency has the disadvantages of capital cost, power requirements and unsuitability and for trapping splash dispersed spores.

SAMPLING METHODS:

Air sampling was carried out by operating continuous Tilak air sampler in the center of the crop fields kept at constant height of 3 feet from ground level with orifice towards.

Air was sampled at the rate of 5 liters/min and the transparent cellophane tape coated with adhesive white petroleum jelly was changed after every eight days at near about 6 hours. The slides were prepared as described earlier (Tilak and Srinivasulu, 1967). Glycerin for visual examinations and it was prepared by mixing-

Gelatin – 40 gm

Glycerol – 120 ml

Distilled water- 140 ml

Phenol – 0.5 gm

Thus measured amounts of glycerol (glycerin) and distilled water are mixed thoroughly in a beaker and heated in a water bath for 2-3 hours. During heating this mixture, gelatin is added slowly by stirring to avoid the clumping. After complete dissolution of gelatin, a pinch (0.5gm) of phenol crystals is added as preservatives and metabolic inhibitor. After cooling it forms a transparent cake of glycerin jelly, this glycerin jelly was used for the permanent slides. At room temperature the glycerin jelly solidifies, so before mounting it was heated for liquefaction.

SCANNING:

Scanning of the slides were done regularly after the slides preparation area of 9600 sq. microns of the total area of the trace obtained in a day is scanned under 10x, 40x eye piece of objective combination of binocular research microscope, as 12 transverse (6 for each slide) corresponds to 24 hours each giving a data for two hours period. The conversion factor used for the volumetric Tilak air sampler is “14”. The air sampler being volumetric the number of spores/m³ can be calculated in the following ways-

- 1) Sampled area = 8.4 cm x 1 cm = 8.4cm² = 84000000
- 2) Scanned area = 20x20x24 = 9600 mm²
- 3) Volume of air sample per min. = 5 liters
- 4) Volume of air sample in 24 hrs = 5 x 24 x 60 = 7200 liters
- 5) To convert one liter of air into cubic meter multiplied by = 0.001000028
- 6) Vol. of air sample in 24hrs in terms of cm³=7200 x 0.001000028 =7.3 m³
- 7) Volume of air sampled in scanned area in 24 hrs

$$\frac{9600 \times 7200}{10000} = 69.12 \text{ liters}$$

8) Volume of the air sample in the scanned area during 24 hrs =

$$\frac{1000}{69.12} = 14.20 \text{ m}^3 (1\text{m}^3=1000 \text{ meters})$$

Hence the conversion factor for this sampler is 14.2 but for simplicity in calculation we use '14'.

If total number of spores from catches is '10' then total number of spores per m^3 of air = $10 \times 14 = 140/\text{m}^3$ is the total number of spores/ m^3 of air at particular site and height at that time. Assuming the trapping efficiency to be 75% with the help of conversion factor we can easily estimate the spore concentration/ m^3 of air. The conversion factor is constant irrespective of locality and season and weather. All the times are given in the Indian standard time (I.S.T.).

COMPOSITION OF CATCHES:

The identification of the spores type trapped was based on 1) Morphological characters, 2) visual identification by comparison with reference slides prepared from parasitic and saprophytic fungal collection on and around the crop field study, 3) by exposing culture plates periodically on experimental fields for identification of saprophytic forms and hyphal fragments which may produce conidia in culture.

The composition of catches varies from place to place also impacted by surroundings. However, the common components are dust particles, fungal spores, pollen grains, hyphal fragments, insect parts, insect scales, protozoan cysts and miscellaneous particles. In culture plates some forms like obligate parasites may not grow most of the saprophytes have been identified and it is possible to identify them even up to species level.

Petriplate Culture method:

Potato - 200gm.

Dextrose- 20gm

Agar-Agar -20gm

Distilled Water-1000ml.

Thus measured amount of 200 gm peeled potato cut in the small pieces and take approximately distilled water. Potato boiled in the distilled water. Until softness will come boiled potatoes pass through the double folded muslin cloth 20 gm dextrose and 20 gm Agar-Agar added in to the filtrate of the potato. Lastly 1000ml volume made by adding distilled water and PH was adjusted to 6.5.

COLLECTION OF DATA:

The Petriplate containing PDA was exposed in the air at both the seasons. After exposing Petriplate were left at room temperature for 7 to 8 days until the colonies matured. The slides were prepared by using lacto phenol cotton blue stain and then were identified by colony morphology and characteristics of sporulation.

SAMPLING SITE

Air sampling was carried out using the 'Tilak Air sampler' in Soybean crop fields in the Osmanabad. This is located between the latitudes $18^{\circ}11'$ north latitude and between $76^{\circ}02'$ east longitudes. Which is one of the district places of Maharashtra state? The osmanabad is about 664 meters above the mean sea level (M.S.I.) with hillock at north eastern border.

The area of about one acre was brought under the soybean cultivation. The air sampling was conducted throughout the period of sowing to harvesting. The first crop season from 01st July, 2015 to 31st October, 2015 and the second crop season from 01st July, 2016 to 31st October, 2016. Over the fields for two crop seasons i, e two kharif seasons. In both the years the first crop was sown in the month of July-August and was harvested in October-November and was thus called as kharif crop season or main crop season.

The crop selected for aerospora studies in soybean (JS-335). The crop is grown in Kharif season, the observations were conducted for two season over the same fields, the

observation were started with sowing and continued till a few days after harvesting seasons, sampling period, sowing and harvesting dates are presented below in the tabular form.

(Table I - A)

Crop	Season	Date of installing sampler	Date of sowing	Date of harvesting	Date of sampling stopped	Period of sampling days
Soybean (JS-335 Jawahar)	Kharif-I	1-07-2015	8-7-2015	24-10-2015	31-10-2015	106
Soybean (JS-335 Jawahar)	Kharif-II	1-07-2016	8-7-2016	24-10-2016	31-10-2016	109

Soybean variety Jawahar 335 (JS-335) is very high yielding and resistant to the bacterial pustule, bacterial blight, bud blight and Alternaria leaf blight. The average productivity is 25-30 Qt/hectar. Oil percentage in soybean 17-19 and protein percentage is 40-41. Complete crop season duration from 95-100 days.

JOWAR CROP FIELDS:

The aerobiological studies over jowar crop field for two Rabi seasons in order to understand the air spora components over the crop. The air sampling was conducted throughout the period of sowing to harvesting. The first crop season from 1st November, 2015 to 28th February, 2016 and the second crop season from 01st November, 2016 to 28th February, 2017 over the fields for two crop seasons i.e. two Rabi seasons. Air sampling was carried out with the help of volumetric continuous Tilak air sampler (Tilak and Kulkarni, 1970). The air sampler was kept at center to subjected crop field at 3 feet above the ground level. The procedure and method are as described in detail in the earlier part i.e. Part-I. Scanning of the slides prepared, identification of the aerospora components their qualitative and quantitative analysis and their percentage contribution were obtained

by using the same method and procedure as described earlier in part I. The area of about one acre was brought under the jowar cultivation. In both the years the jowar crop was sown in the month of November and harvested in Feb-March and was thus called as Rabi or winter crop season or second crop season. The crop selected for air spora studies in jowar (M35-1). The crop is grown in Rabi seasons, the observation were conducted for two seasons over the same field. The observation was started with sowing and continued till a few days after harvesting seasons; sampling period, sowing and harvesting dates are presented below in the tabular form.

(Table I- B)

Crop	Season	Date of installing sampler	Date of sowing	Date of harvesting	Date of sampling stopped	Period of sampling days
Jowar (M-35-I Maldandi)	Rabi-I	1-11-2015	9-11-2015	21-2-2016	28-2-2016	105
Jowar (M-35-I Maldandi)	Rabi-II	1-11-2016	8-11-2016	23-2-2016	28-2-2017	108

M35-1 Maldandi Variety is high yielding and water resistant. The average grain production is 15-18 Qt/hectare. It contains 50-90 Qt/hectare fodder, complete crop season duration from 125-130 days.

METEOROLOGICAL DATA:

The meteorological data was obtained from Meteorology Department, college of agriculture Osmanabad. The record of daily and monthly temperature, relative humidity and rainfall was maintained during the investigation period.

CLIMATE AND RAINFALL:

The climate of Osmanabad district is generally dry except monsoon season. The year is divided into three seasons i.e. rainy season, starts from July and last up to the end of October, then winter season November to February and summer season followed it from March to June. The mean maximum temperature during the hot season was found to be

42.3⁰ C in the month of February 2015, whereas it was 40.8⁰C in the same month of 2016 and minimum for cool dry season during the year 2015 recorded as 13.7⁰C in the December, whereas in 2016 it was 17.3⁰C in the December. The total rainfall recorded in 2015 was 710 mm in 2016 it was 886 mm. The total rainy days in 2015 were 38 and in 2016 were 59 days.

(Table- I C)

Meteorological data during sampling period of air over the field of Soybean and Jowar for the first kharif and first Rabi season from (01st July, 2015 to 28th Feb, 2016).

Sr.No	Meteorological Data	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1	Average rainfall (mm)	90.60	205.00	233.20	144.20	-	-	-	37.00
2	Average relative humidity (%)	70.48	72.48	68.98	78.65	89.02	84.03	75.07	60.03
3	Average temperature (⁰ c)	30.02	31.04	31.02	28.58	25.02	27.03	29.06	34.04

(Table- I D)

Meteorological data during sampling period of air over the field of Soybean and Jowar for the second kharif and second Rabi season from (01st July, 2016 to 28th Feb, 2017).

Sr.No	Meteorological Data	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1	Average rainfall (mm)	98.20	248.20	295.00	197.60	-	-	-	47.00
2	Average relative humidity (%)	78.06	76.04	77.08	80.02	91.03	83.02	78.02	68.07
3	Average temperature (⁰ c)	32.01	29.07	26.04	24.06	21.04	22.07	23.07	31.09

Chapter IV

EXPERIMENTAL RESULTS

Composition and components of air-spores over soybean fields:

Composition of the catches:

Apart from the dust particles more than 74 types of fungal spores, Algal filaments, Hyphal fragments, pollen grains, insect scales, protozoan cysts and unidentified spores were trapped on the cello tape, exposed in the sampler. The unidentified spores were grouped under one heterogeneous and quite artificial group called 'other types'. The components of airspora are grouped under two main groups viz., fungal spores and other types a list of the catches identified from the slides has been given below and has been provide in alphabetical order under each group. The fungal spores group includes

Air Spora by Air Sampling Method:

Physarum Pers, Stemonitis Roth, Cunnighamella Matr, Mucor ex.Fr, Rhizopus Ehrenb, Sclerospora graminicola schroet, Ascospores, Bitrimonospora Sivanesan. Talde & Tilak, Chaetomium Kunze ex.Fr., Claviceps Tul., Cucurbitaria Grey ex. Grev., Didymosphaeria Fuck., Hypoxylon Bull.ex.Fr., Leptosphaeria Ces and de Not, Lophiostoma Ces and de Not, Massaria de Not, Melanospora Corda, Metasphaeria Sacc., Otthia Nits, Parodiella (Speg), Pleospora Rabenh., Sordaria Ces & de Not, Sporormia de Not, Teichospora Fuckel., Basidiospores, Ganoderma, Rust Spores, Smut Spores, Urediniospores, Alternaria Ness ex Waltr, Aspergillus Link, Beltraniella Subram., Beltrania Penzig, Bispore Corda, Botryodiplodia Sacc. Cercospora Fries., Cladosporium Lin ex Fr., Cordana Preuss., Corynespora Gussow., Curvularia Boedijn, Dictyoarthrinium Hughes, Diplodia Fr., Drechslera It, Epicoccum Link ex wallr, Exosporium Link ex wallr, Fusariella Sacc., Fusarium, Haplosporella Speg, Harknessia Cooch, Helminthosporium, Heterosporium Klotzch ex Cooke, Lacellina Sacc., Lacelinopsis Subram., Memnoniella Hohnel., Nigrospora Zimm, Papularia Fr. Penicillium Link ex Fr.,

Periconia Tode ex Schw., *Pestalotia de Not*, *Pithomyces Berk & Br.*, *Pseudotorula Subram*, *Pyricularia Sacc.*, *Spegazzinia Sacc.*, *Sporidesmium*, *Tetraploa Berk and Br.*, *Torula Pers Link ex Fries.*, *Trichoconis Clem.* And the Other types groups include *Algal Filaments*, *Epidermal hairs*, *Hyphal Fragments*, *Insect Scales*, *Pollen grains*, *Protozoan Cysts*, *Unidentified Spores*. From the 74 spore types, 38 spore types belong to Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 spore types to other types dominated the airspora by exhibiting the highest percentage Deuteromycotina (63.49%), followed by Basidiomycotina (12.07%), Ascomycotina (10.50%), other types (8.54%), Zygomycotina (3.24%) and Myxomycotina (2.15%). Sufficiently high contribution by other types was due to heterogeneous of the group and high incidence of the hyphal fragments, pollen grains, insect parts, and unidentified spores which are components of the group.

Chief Constituents and their contribution to the total airspora:

The dominance of spore type in the air is determined by its percentage contribution to the total airspora. The total spore catch of each type was estimated and presented in Table I. From the table I it is evident that *Cladosporium* (16.82%), *Curvularia* (11.50%), *Smut Spores* (8.33%), *Alternaria* (5.82%), *Periconia* (5.16%), *Memnoniella* (4.15%), *Nigrospora* (4.02%), *Aspergillus* (2.98%), *Lophiostoma* (2.93%) and *Cunninghamella* (2.63%), *Insect scales* (2.26%), *Pollen grains* (2.07), *Hyphal Fragments* (2.02%) were dominant types in the airspora over soybean crop fields.

Comparative contribution and Seasonal Variations in the airspora:

Air sampling in both the seasons started in July and continued till the end of October. The total period air sampling in both the seasons was more or less 109 days. The total airspora of first kharif season was 758464/m³ and in second season was 880152/m³. Average percentage contribution of each spore types to the total airspora of two kharif seasons have been presented in Table I. variation in the total airspora and percentage contribution of different spore types to the total airspora of two kharif seasons have been presented in Table II. The Monthwise spore concentration and percentage contribution of each spore type to the total airspora is presented in table III-A and III-B. The monthly average

percentage contribution of each spore type to the total airspora is presented in Table IV-A and IV-B. The Monthwise and Monthly average percentage contribution of each spore group in both seasons are represented in Table V-A, V-B and VI-A, VI-B. The Monthwise total seasonal concentration of each spore group to the total airspora in the two kharif seasons are represented in Table VII. Total spore concentration and Percentage contribution of each spore group in two kharif seasons are represented in Table VIII. Concentration between certain pathogenic fungal spore types and percentage contributions are represented in Table-IX.

Phyisarum (Pers.): The spores one celled spherical, violaceous or purplish brown in mass, slightly thick walled minutely echinulate, 8-10 μm in diameter. They contributed 1.45% to the total air-spores in the first and second Kharif seasons respectively. The maximum concentration ($3892/\text{m}^3$) was recorded in the month of September, 2015 and ($3752/\text{m}^3$) in September; 2016. Total number of spores in the first season ($11886/\text{m}^3$) was comparatively more or less equal in the second season ($11942/\text{m}^3$). The Percentage contribution in the first season (1.57%) was higher than that in the second season (1.36%). Suryawanshi and Bajgire (2014) reported 4.35% contributions to the total airspora over Soybean fields. Lohare (2016) found that the incidence of airspora over soybean fields.

Stemonitis Roth.: The spores, one celled spherical violet brown to dark brown on black in mass, finely echinulate 9-12 μm in diameter. It is found in dead wood or leaves. They contributed 0.69% to the total air-spores in the first and second Kharif seasons respectively. The maximum concentration ($2492/\text{m}^3$) was recorded in the month of September, 2015 and minimum concentration ($658/\text{m}^3$) in August, 2015. The Percentage contribution in the first season (0.75%) was higher than that in the second season (0.65%). Total number of spores in the first season ($5670/\text{m}^3$) was slightly lower than that in the second season ($5754/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 1.66% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Cunninghamella Matr: The spores of *cunninghamella* are oval to globular in shape, one celled and smooth or sometimes rough walled and hyaline. The spores were maximum in

rainy season and contributed 2.63% to the total air-spores in the first and second Kharif seasons respectively. The maximum concentration ($6636/\text{m}^3$) was recorded in September, 2015 and ($6692/\text{m}^3$) in September; 2016. The percentage contribution in the first season (2.85%) was higher than that in the second season (2.43%). The total number of spores in the first season ($21644/\text{m}^3$) was slightly higher than that in the second season ($21406/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 3.98% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Mucor Micheliex.Fr. The spores one celled globose to oval thin walled smooth dark in mass 3-5 μm in diameter. They contributed 0.03% to the total airspora in the first and second Kharif seasons respectively. The maximum concentration ($126/\text{m}^3$) was recorded in October, 2015 and minimum concentration ($42/\text{m}^3$) in August, 2016. The percentage contribution in the first season (0.05%) was higher than that in the second season (0.02%). The total number of spores in the first season ($378/\text{m}^3$) was higher than that in the second season ($182/\text{m}^3$).

Rhizopus Ehrenb. The Spores unequal, irregular, round oval, angular, striate, 9-11 x 7-7.5 μm in diameter. This is a common saprophytic and facultative parasite on mature fruits, vegetables and many other substrates. The spores were recorded throughout the period of investigation. Its contribution to the total air-spores was (0.19%). The maximum concentration ($700/\text{m}^3$) was recorded in the month of September, 2015 and minimum concentration ($126/\text{m}^3$) in the month of August, 2015. The percentage contribution in the first season (0.22%) was higher than that in the second season (0.17%). The total number of spores in the first season ($1652/\text{m}^3$) was higher than that in the second season ($1540/\text{m}^3$).

Sclerospora graminicola schroet: The sporangia hyaline, thin walled, globose to elliptical, 15-28.5x14-25 μm in diameter. They contributed 0.38% to the total airspora in the first and second Kharif seasons respectively. The maximum conc. ($1680/\text{m}^3$) was recorded in August, 2015 and whereas minimum conc. ($140/\text{m}^3$) in October, 2015. The highest mean concentration (0.76%) was observed in August, 2015 and the lowest mean concentration (0.08%) in October, 2015. The percentage contribution in the first season (0.40%) was higher than that in the second season (0.37%). The present investigations of

this spore types suggest that low temperature and high humid conditions are favourable for discharge of the sporangial population of *Sclerospora* in the air. Suryawanshi and Bajgire (2014) reported 0.12% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Ascospores: Ascospores are hyaline, ellipsoidal, unilaterally flattened, 3-5 x 4.5-6um, and have a thin slime sheath that forms a brim at the flattened side of the spore. They contributed 0.05% to the total airspora in the first and second Kharif seasons respectively. The maximum concentration (168/m³) was recorded in August 2016 and whereas minimum concentration (56/m³) in August, 2015. The highest mean concentration (0.08) was observed in October, 2016 and the lowest means concentration (0.02%) in August, 2015. The percentage contribution in the first season (0.05%) was higher than that in the second season (0.05%).

Bitrimonospora Sivaneson, Talde and Tilak, The Spores dark, brown to black in colour, globose with a very thick outer wall. 23.4-34.2um in diameter. They contributed 0.44% to the total air-sporain the first and second Kharif seasons respectively. The maximum concentration (1750/m³) was observed in October, 2015 and (1540/m³) in October 2016. The percentage contribution in the first season (0.49%) was higher than that in the second season (0.40%). The highest mean concentration (0.97%) observed in October, 2015 and lowest mean concentration (0.09%) in July, 2016. Suryawanshi and Bajgire (2014) reported 1.29% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Chaetomium Kunze ex Fr.: The spores are dark, circular, to triangular, unicellular, 10-12 x 9-10 um in diameter. They were encountered throughout the period of investigations. It contributed 0.91% to the total airspora in the first and second Kharif seasons respectively. The percentage contribution in the first season (0.97%) was higher than that in the second season (0.86%). The highest mean concentration (1.43%) was observed in September, 2015 whereas the lowest mean concentration (0.54%) in August, 2016. Suryawanshi and Bajgire (2014) reported 2.39% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field. **Claviceps** Tul: Ascospores elongated, slightly curved hyaline and septet, 59.5-84 x 1.2-2.5 um in

diameter. Their contribution to the total air- spora was found to be 1.06%. The percentage contribution in the first season (0.98%) was lower than that in the second season (1.13%). The highest mean concentration (1.25%) was observed in September, 2016 and October, 2016 and the lowest means concentration (0.14%) in August, 2015.

Cucurbitaria Gray ex Grev: The spores oblong, fusiform, yellow or brown 24-36 x 9.16 um in diameter with 5-7 transverse septa and one to many longitudinal septa in most of the segments markedly constricted at the middle septum, multiseriate, spore occurred frequently. They contributed 0.54% to the total airspora in the first and second Kharif seasons respectively. The maximum concentration (1540/m³) was recorded in October, 2015 and minimum concentration (784/m³) in July, 2015. The percentage contribution in the first season (0.59%) was higher than that in the second season (0.49%). The total number of spores in the first season (4452/m³) was slightly higher than that in the second season (4382/m³). Suryawanshi and Bajgire (2014) reported 1.47% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Didymosphaeria Fuck.: The spores with single septum, brown, elliptic or cylindrical, slightly constricted at the septum, 9.4-17 x 6.7-8.2 um in diameter. They contributed 1.22% to the total airsporain the first and second Kharif seasons respectively. The percentage contribution in the first season (1.26%) was higher than that in the second season (1.19%). Maximum concentration (2744/m³) was observed in August, 2015 and (2940/m³) in August, 2016. The total number of spores in the first season (9548/m³) was lower than that in the second season (10500/m³). The occurrence of these spores appears to be correlated with rainfall and humid conditions. Daily scanning records indicated that even scanty rainfall caused spore liberation which subsequently increased the spore concentration in the air-spore. Suryawanshi and Bajgire (2014) reported 3.49% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Hypoxylon Bull.ex Fr.: The spores elliptic, fusiform to bean shaped, dark brown, non-septet, with a distinct colorless furrow down one side 10.2-16.2 x 6.2-7 um in diameter. The spores were recorded in both seasons. They contributed 0.37% to the total air-sporain

the first and second Kharif seasons respectively. Percentage contribution in the first season (0.39%) was higher than that in the second season (0.35%). The highest mean concentration (0.66%) was observed in September, 2015 and lowest mean concentration (0.05%) in July, 2015. Total number of the spores in the first season ($2968/\text{m}^3$) was lower than that in the second season ($3122/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.01% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Leptosphaeria Ces & de Not: The spores lightly colored, two to multiseptate, fusiform, with one swollen cell, $12.2-14.4 \times 4.1-4.9$ μm in diameter. The catch was maximum during the rainy season. They contributed 1.35% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in the first season (1.35%) was equal in the second season (1.35%). The highest mean concentration (1.58%) was observed in August, 2015 and the lowest mean concentration (1.10%) in July, 2016. The Maximum concentration ($4060/\text{m}^3$) was recorded in August, 2016 and minimum concentration ($1568/\text{m}^3$) in July, 2015. Total number of the spores in the first season ($10248/\text{m}^3$) was lower than that in the second season ($11900/\text{m}^3$).

Lophiostoma Ces & de Not: The spores fusiform, olive brown, 5-7 septet, slightly constricted at septum $18-22 \times 6-7$ μm in diameter. They contributed 2.92% to the total airspora in the first and second Kharif seasons respectively. The maximum conc. ($9352/\text{m}^3$) was recorded in August, 2016 and minimum conc. ($3500/\text{m}^3$) in July, 2015. Percentage contribution in the first season (3.11%) was higher than that in the second season (2.77%). Total number of the spores in the first season ($23576/\text{m}^3$) was lower than that in the second season ($24374/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.18 % contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Massaria de Not: The spores elliptic, fusiform, $40-100 \times 10-24$ μm dark brown with well-marked median septum and ultimately two other septa containing large oil drops. They contributed 0.02% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in the first season (0.04%) was higher than that in the second

season (0.01%). Maximum concentration ($280/\text{m}^3$) was recorded in August, 2015 and lowest concentration ($14/\text{m}^3$) in July, 2016.

Melanospora Corda: The spores are ovoid, often irregular in shape, blackish green, $20\text{-}25 \times 14\text{-}17 \text{ }\mu\text{m}$ in diameter. They contributed 0.05% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in the first season (0.06%) was slightly higher than that in the second season (0.05%). Maximum concentration ($280/\text{m}^3$) was recorded in September, 2015 and September, 2016 and minimum concentration ($56/\text{m}^3$) in October, 2015 and 2016. Total number of the spores in the first season ($476/\text{m}^3$) was higher than that in the second season ($420/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.05% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Metasphaeria Sacc: The spores are ellipsoid to oblong or fusicold, two many septate, hyaline, and rarely colored, $12\text{-}72 \times 2.5\text{-}9.5 \text{ }\mu\text{m}$ in diameter. It contributed (0.45%) to the total airsporain the first and second Kharif seasons respectively. Maximum conc. ($1148/\text{m}^3$) was recorded in September, 2015 and ($1400/\text{m}^3$) in September, 2016. The percentage contribution in the first season (0.43%) was lower than that in the second season (0.46%). Total number of spores in the first season ($3304/\text{m}^3$) was lower than that in the second season ($4032/\text{m}^3$).

Oothia Nits: The spores elliptical to slightly inequitlateral one septate, slightly constricted at the septum, dark brown, $22\text{-}26 \times 10\text{-}14 \mu\text{m}$ in diameter. Its contribution to the total airspora was 0.04%. Percentage contribution in the first season (0.03%) was lower than that in the second season (0.05%). maximum mean conc. (0.08%) was observed in September 2016 and minimum conc. (0.02%) in July and August, 2015.

Parodiella (Speg.) Theiss & Syd: The spores two celled, elliptic, distinctly striated, striations spirally converging towards end, border and constricted at septum, $22\text{-}24.6 \times 7.6\text{-}8.8 \mu\text{m}$ in diameter. It contributed 0.13% to the total air-sporain the first and second Kharif seasons respectively. Maximum conc. ($868/\text{m}^3$) was recorded in September 2015 and minimum conc. ($28/\text{m}^3$) in July and August, 2015. Percentage contribution in the first season (0.14%) was higher than that in the second season (0.12%).

Pleospora Rabh: Spores yellow to brown, with several septa and one or more longitudinal septa in most or all the segments, 30.2-30 x 13-15.2µm. They contributed 0.46% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the first season (0.47%) was higher than that in the second season (0.45%). maximum number of spores (1680/m³) was observed in September, 2016 and minimum (560/m³) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.06% contribution to the total airspora over Soybean fields. Lohare (2016) found that the incidence of airspora over soybean fields.

Sordaria Ces & de Not: The spores sub-globose to elliptical, non-septate almost black and opaque at maturity, with a germ pore at the lower end of the spores. The spores are of two types, one 19.2-23 x 15,2µm and another type 34.4 -38.2 x 20.2-23 µm. They contributed 0.19% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the first season (0.21%) was higher than that in the second season (0.18%). maximum concentration (0.30%) was observed in August, 2015 and minimum concentration (0.14%) in October, 2016. Suryawanshi and Bajgire (2014) reported 2.22% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Sporormiade Not: The spores dark brown with three cross septa and showing a tendency to break up at the septa, surrounding by hyaline gelatinous sheath, 28.4-34 x 6-7.2 µm. Its contributed to the total air-spora was 0.18%. Percentage contribution in the first season (0.17%) was lower than that in the second season (0.19%). The maximum concentration (532/m³) was observed in September, 2016 and minimum concentration (140/m³) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.54% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Teichospora Rick.: Ascospores usually clavate with up to seven transverse septa constricted at the middle septum only, with one or two longitudinal septa in most of the segments, yellowish brown.16-25 x 8-11 µm. They contributed 0.07% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the

first season (0.02%) was lower than that in the second season (0.11%). Total number of spores in the first season (182/m³) was lower than that in the second season (966/m³).

Basidiospores: All the types of Basidiospores like (hyaline and colored) are included under this category except Ganoderma. Their contribution to the total airspora was 1.75%. Percentage contribution in the first season (2.17%) was higher than that in the second season (1.37%). The maximum conc. (2.96%) was observed in August, 2015 and minimum conc. (0.70%) in October, 2016. Suryawanshi and Bajgire (2014) reported 2.11% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Ganoderma Kurtz,: The spores unicellular, oval shaped, colored Basidiospores with outer hyaline wall, penetrated by projections of the inner brown wall. Its contribution to the total airspora was 0.04%. The percentage contribution in the first season (0.03%) was lower than that in the second season (0.06%). The highest mean concentration (0.11%) was observed in August, 2016 and lowest mean concentration (0.01%) in July, 2015. It belongs to 'Wet Spora' group.

Rust Spores: This group includes all the types of rust which were recorded during the period of investigations. They contributed 0.23% to the total air-sporain the first and second Kharif seasons respectively. The highest mean concentration (0.52%) was observed in September, 2016 and lowest concentration (0.07%). In October, 2015. Percentage contribution in the first season (0.11%) was lower than that in the second season (0.33%). The occurrence of these spores in the air may be due to rust infected cereals and other plants present in the neighboring fields.

Smut Spores: Spores dark brown or black in mass, one celled, rounded, shortly elliptical or angular, wall smooth or echinulate, 10-12µm in diameter. It is found on throughout period of investigation. They contributed 8.33% to the total airspora in the first and second Kharif seasons respectively. The highest concentration (18928/m³) was observed in September, 2015 and (21672/m³) in September, 2016. Percentage contribution in the first season (8.51%) was higher than that in the second season (8.18%). However, the maximum concentration (9.95%) was recorded October, 2016 and minimum

concentration (0.07%) in October, 2015. Suryawanshi and Bajgire (2014) reported 1.47% contributions to the total air-spores over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Urediniospores: It is unicellular, dikaryotic, brown colored spores with distinct double wall and germ pores. It is found throughout the period of investigation. Maximum conc. ($4452/\text{m}^3$) was recorded in 2015 and ($4424/\text{m}^3$) in September, 2016. The percentage contribution in the first season (1.82%) was higher than that in the second season (1.62%). Total number of spores in the first season ($13832/\text{m}^3$) was lower than that in the second season ($14266/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 5.8% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Alternaria Ness ex wallr: The conidia dark, typically with both cross and vertical septa, variously shaped, obclavate to elliptical or ovoid, frequently borne acropetally in long chains, less often borne singly and having apical simple or branched appendage of different sizes belonging to different species. The spores were recorded in both seasons. They contributed 5.82% to the total airspora in the first and second Kharif seasons respectively. The highest concentration (6.71%) was observed in July, 2016 and lowest concentration (4.99%) in September, 2015. whereas the total number of spores ($42518/\text{m}^3$) was lower than that in the second season ($52934/\text{m}^3$). Percentage contribution in first season (5.60%) was lower than that in the second season (6.01%). Spore number increased when rains were followed by dry weather. It clearly indicates that the rainy period favours the growth and sporulation whereas dry weather helped the spore liberation; causing subsequent increase in number in the air-spores. Suryawanshi and Bajgire (2014) reported 7.2% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Aspergillus Link,: Conidia one celled, globose, variously colored when in mass, produced basipetally. Rarely, conidia were trapped with conidiophores and conidial heads. Spores $4-5 \times 3.1 \mu\text{m}$. Their contribution to the total airspora was 5.82%. Percentage contribution in first season (2.73%) was lower than that in the second season (3.18%). The highest concentration (4.54%) was observed in September, 2016 and lowest

concentration (1.55%) in October, 2015. Suryawanshi and Bajgire (2014) reported 0.87% contribution to the total air-spores over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Beltraniella Subram.: Conidia one celled, top shaped, biconic, brown with a paler middle band, septa absent, 19-24.7 x 9-11 μm . Its contribution to the total airspora was 0.35%.percentage contribution in the first season (0.36%) was higher than that in the second season (0.35%). The highest conc. (0.57%) was noted in October, 2015 and lowest conc. (0.09%) in July, 2016. Total number of spores in the first season (2716/ m^3) was lower than that in the second season (3094/ m^3). Suryawanshi and Bajgire (2014) reported 0.7% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Beltrania Penzig: The conidia bioconic, smooth, one celled, brown with a paler middle band, 14-23.4 x 8-9.7 μm , rounded base with septa or denticulate at the base with a long conical, one celled hyaline, sub-hyaline septa at the apex. These spores contributed 0.16% to the total airsporain the first and second Kharif seasons respectively. The highest concentration (0.54%) was observed in July, 2015 and lowest (0.01%) in September and October, 2015. Total number of spores in the first season (1582/ m^3) was higher than that in the second season (1120/ m^3).Suryawanshi and Bajgire (2014) reported 1.08% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Bispora Corda: Conidia dark, oblong, two celled or less often three celled, with thick black septum, catenulate, 6-11 x 5-8 μm . They contributed 1.27% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the first season (1.33%) was comparatively higher than that in the second season (1.21%). The highest concentration (1.71%) was recorded in October, 2015 and lowest concentration (0.30%) in July, 2015. Suryawanshi and Bajgire (2014) reported 5.6% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Botryodiplodia sacc: The conidia dark, two celled, ovoid to elongate, 24-28 x 10-14 μm . The spores were observed in both seasons. They contributed 0.02% to the total airspora in the first and second Kharif seasons respectively. Maximum conc. (0.07%) was observed in October 2016 and minimum conc. (0.01%) in July and August, 2016 and July, August, September, 2015. Percentage contribution in the first season (0.01%) was lower than that in the second season (0.03%). Suryawanshi and Bajgire (2014) reported 0.99% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Cercospora Fries: The conidia hyaline, fusiform, uniseriate, several celled, 115-480 x 4.2-7.3 μm . spores of *Cercospora* occurred frequently. They 0.28% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in both seasons was same (0.29%). The highest concentration (0.38%) was observed in October, 2016 and minimum concentration (0.08%) in July, 2016. The total number of spores in the first season (2142/ m^3) was lower than that in the second season (2534/ m^3). Suryawanshi and Bajgire (2014) reported 1.31% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Cladosporium Link ex Fr: Conidia dark, one or two celled, variable in shape and size, ovoid to cylindrical or irregular, some typically lemon shaped, 4-24 x 2-4.7 μm , yellowish to light brown conidiophores variously branched and conidia in cluster or isolated spores of *Cladosporium* were encountered abundantly throughout the period of investigations. They contributed 16.82% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in the first season (14.10%) was lower than that in the second season (19.16%). The highest concentration (20.79%) was observed in September, 2016 and lowest concentration (12.01%) in August, 2015. Maximum number of spores (56000/ m^3) was observed in September, 2016. whereas minimum number (18200/ m^3) in July, 2015. Total number of spores in the first season (106960/ m^3) was lower than that in the second season (168616/ m^3). Suryawanshi and Bajgire (2014) reported 7.77% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Cordana Preuss.: The conidia ovate, one septate, not constricted at septum, both cells are more or less symmetrical with pointed base and round tip, sub-hyaline to brown, 20x8-10um. Percentage contribution in the first season (0.03%) was lower than that in the second season (0.05%). The maximum number of spores ($140/\text{m}^3$) was observed in September, 2016 and minimum concentration ($28/\text{m}^3$) in July, 2015. The highest mean concentration (0.06%) was observed in October, 2016 and lowest mean concentration (0.02%) in July, 2015.

Corynespora Gussow: Conidia terminal, single or sometimes in short chains, obclavate or cylindrical, straight or curved, smooth, brown with 4-20 pseudosepta, with a thick colorless exposure wall and prominent, dark basal scar, 40-280 x 18.4 um. They contributed 0.11% to the total airspora in the second Kharif season respectively. Maximum number of spores ($644/\text{m}^3$) was recorded in August, 2016 and minimum number of spores ($224/\text{m}^3$) in July, 2016. It occurs only in rainy season, its high concentration in the air after rainy season appears to be resulted with low humidity. Suryawanshi and Bajgire (2014) reported 0.18% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Curvularia Boedijn: Conidia dark, end cells lighter, 3-5 celled, more or less fusiform, typically curved or bent with one or two of the central cells distinctly larger and darker than the terminal cells, terminal cells pale, two types of the spores were trapped, one 19-32 x 7.5-17.5 um and another 30.5-49 x 9-23 um. The spores were present throughout the period of investigations with sufficiently high concentration. They contributed 11.50% to the total airspora in the first and second Kharif seasons respectively. Percentage contribution in the first season (11.78%) was slightly higher than that in the second season (11.26%). Maximum concentration (14.21%) was observed in August, 2015 and the minimum concentration (9.32%) in October, 2015. Total number of spores in the first season ($89334/\text{m}^3$) was lower than that in the second season ($99148/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 5.5% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Dictyoarthrinium Hughes: Conidia four celled, cross shaped, dark brown, 12-17.8 x 14.8um. They contributed 0.24% to the total airspora in the first and second Kharif seasons

respectively. Maximum number of spores ($672/\text{m}^3$) was observed in September, 2016 and minimum number of spores ($112/\text{m}^3$) in July, 2015. percentage contribution in the first season (0.23%) was slightly lower than that in the second season (0.24%). Their occurrence during high humid conditions and low temperature pointed out their affinity to 'Wet spora' group. Suryawanshi and Bajgire (2014) reported 0.05% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

DiplodiaFr: Conidia dark brown, two celled ellipsoid or ovoid, $12-15 \times 3$, $5-7 \text{ um}$. Its contribution to the airspora was 0.06%. Maximum number of spores ($350/\text{m}$) was recorded in September, 2016 and minimum number of spores ($14/\text{m}$) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.07% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Drechslera Ito.: Conidia sub-hyaline to yellowish brown, very slightly curved, sub-cylindrical, sometimes elongated, frequently widest in the basal portion and tapering somewhat toward apex, thin walled, 1-17 septate, not constricted at septa with basal cell with a clear scar indicating point of attachment to conidiophores, $50-125 \times 14-22.5 \text{ um}$. They contributed 0.01% to the total airspora in the second Kharif season respectively. Maximum number of spores ($98/\text{m}^3$) was noted in August, 2016 and minimum number of spores ($14/\text{m}^3$) in July 2016. Suryawanshi and Bajgire (2014) reported 0.04% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Epicoccum Link ex wallr.: Conidia dark, one celled or several celled, globose, sub-globose or irregular septate, aerolate, epispore varicose at the base with a scar, surrounded by a ring shaped basal cell, spores dark brown olivaceous or black, $7-9 \text{ um}$ in diameter. Total number of spores in the first season ($3262/\text{m}^3$) was also higher than that in the second season ($3164/\text{m}^3$). Maximum number of spores ($1106/\text{m}^3$) was observed in September, 2016 and minimum number of spores ($518/\text{m}^3$) in July, 2016. Their relative dominance was observed during day period and may belong to 'Day spora' group. Suryawanshi and Bajgire (2014) reported 0.2% contribution to the total airspora

over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Exosporium Link: Conidia apical, single, obligate, broadest towards the base, becoming much narrower and tapering above, brown, varicose, 3-7 septate, 55-74.5 x 18-25 μm in diameter. Each conidium has a prominent scar at broad base. They contributed 0.01% to the total airspora in the second Kharif season respectively. Maximum number of spores ($28/\text{m}^3$) were in September, 2016 and minimum number of spores ($14/\text{m}^3$) in August, 2016. Gaikwad (1974) reported 0.08% spores over Sorghum fields at Ahmedpur. Mane (1978) observed their incidence in air in the month of October with 0.02% contribution to the total airspora at Vaijapur, Bhalke (1981), recorded 0.05% of these spores to the total airspora over jowar fields at Aurangabad. Suryawanshi (2002) reported, Pole (1995) reported 0.310% and 0.3169% contribution to the total airspora over sunflower fields. Pawar (1998) reported 0.49% and 0.28% contribution to the total airspora over sunflower fields. Suryawanshi (2002) reported 0.08% and 0.01% contribution over Sunflower and wheat fields. Patil (2008) reported 0.08% to the total airspora over black gram field at Udgir. Arsule and Pande (2011) reported 0.82% over groundnut field. Kadam et al (2011) recorded 0.15% over bajra field. Sonawane (2013) reported 0.45% over groundnut field. Suryawanshi and Bajgire (2014) reported 3.23% contribution to the total airspora over Soybean field. Patil et al (2015) reported 0.56% over jowar field. Lohare (2016) found that the incidence of airspora over soybean field. Previously these spores were recorded from Aurangabad and Nanded (Tilak, 1989); Pole recorded these spores from Udgir (1985).

Fusariella Sacc.: Conidia dark, 3 celled, cylindrical, curved, borne in chains, not end to end, each conidium attached at side of the conidium below, 20-26 x 6-7 μm . They contributed 0.13% to the total airspora in the second Kharif season respectively. The highest number of spores ($812/\text{m}^3$) was observed in August, 2016 and lowest number ($294/\text{m}^3$) in July, 2016. Suryawanshi and Bajgire (2014) reported 0.21% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Fusarium Link: Spores hyaline, principally of two kinds, macro-conidia delicate, sickle-shaped, 3-6 septate, curved or bent at the pointed ends, typically cone shaped tapering toward either end, 30-70 x 2-5 μm in diameter. They contributed 0.67% to the total airspora in the first and second Kharif seasons respectively. Maximum number of spores (2198/ m^3) was reported in September, 2015 and minimum number of spores (560/ m^3) in July, 2016. Percentage contribution in the first season (0.81%) was higher than that in the second season (0.55%). Jogdand (1987) reported 0.365% contribution to the total airspora over jowar crop field. Jayswal (1993) reported 1.08%, Pole (1995) reported 0.133% and 0.1584%. Pawar (1998) reported 1.77% and 0.10%. Suryawanshi (2002) reported 0.79% and 0.02% to the total airspora over sunflower and wheat fields. Arsule and Pande (2011) reported 1.44% over groundnut field. Sonawane (2013) reported 0.70% over groundnut field. Suryawanshi and Bajgire (2014) reported 0.59% contribution to the total airspora over Soybean field. Patil et al (2015) reported 0.24% over jowar field. Patil and Mali (2017) recorded 0.48% over jowar field. Lohare (2016) found that the incidence of airspora over soybean field.

Haplosporella Speg.: Conidia large, dark, one celled, ovoid or oblong, 15-17 x 10.8-11.8 μm in diameter. They contributed 0.77% to the total airspora in the first and second Kharif seasons respectively. Maximum number of spores (1792/ m^3) was observed in August, 2016 and minimum number of spores (1358/ m^3) the highest mean concentration (1.05%) in July, 2015 and the lowest mean concentration (0.52%) in October 2016. Percentage contribution in the first season (0.83%) was higher than that in the second season (0.71%). Total number of spores in the first season (6342/ m^3) was higher than that in the second season (6286/ m^3). Suryawanshi and Bajgire (2014) reported 3.03% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Harknessia Cooke: Conidia dark, one celled, hexagonal sometimes ellipsoid, ovoid, drawn out into a hyaline pedicel. They contributed 0.06% to the total airspora in the first and second Kharif seasons respectively. In term of actual number, spore concentration in the first season (322/ m^3) was lower than that in the second season (616/ m^3). Maximum number of spores (210/ m^3) was observed in August, 2016 and minimum number of

spores ($28/\text{m}^3$) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.04% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Helminthosporium Link ex Fries: Spores obligate to cylindrical, slightly curved or bent, apex somewhat rounded, sub-hyaline to dark brown, with 3 to many pseudosepta with prominent basal scar, $35-95 \times 11-18 \text{ }\mu\text{m}$. They contributed 1.04% to the total airspora in the first and second Kharif seasons respectively. Maximum concentration in the first season ($8078/\text{m}^3$) was comparatively lesser than that in the second season ($8960/\text{m}^3$). The highest concentration (1.40%) was observed in July, 2015. and the lowest concentration (0.88%) in September, 2016. Maximum number of spores ($2800/\text{m}^3$) was observed in August, 2016 and minimum number of spores ($1680/\text{m}^3$) in July, 2015. Suryawanshi and Bajgire (2014) reported 1.48% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Heterosporium Koltzsch ex Cook: Conidia dark, typically three or more celled, cylindrical, wall rough, echinulate to varicose, $23-27 \times 7-7.6 \text{ }\mu\text{m}$. Conidia usually occur singly. They contributed 0.93% to the total airspora in the first and second Kharif seasons respectively. Total number of spores in the first season ($7588/\text{m}^3$) was slightly lower than that in the second season ($7700/\text{m}^3$). Maximum concentration (1.21%) was observed in July, 2015 and minimum concentration (0.78%) in September 2016. Maximum number of ($2240/\text{m}^3$) was observed in August, 2016 and minimum number of spores ($1568/\text{m}^3$) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.83% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field

Lacellina Sacc: Conidia acropleurogenous, single celled, sub-globose to globose or somewhat oval, pale, brown to dark, $4-7 \text{ }\mu\text{m}$ in diameter. When globose, $5-8 \times 3-6.5 \text{ }\mu\text{m}$, when otherwise smooth or more usually vericulose, often somewhat flattened in one plane, occur in chain. They contributed 1.14% to the total airspora in the first and second Kharif seasons respectively. Maximum number of spores ($3640/\text{m}^3$) were in August 2016 and minimum number of spores ($1848/\text{m}^3$) in July, 2015. The highest mean concentration (1.59%) in October, 2016 and lowest concentration (1.30%) in September 2015.

Suryawanshi and Bajgire (2014) reported 1.83% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Lacellinopsis Subram: Conidia produced acropetally in chains, one celled, mostly globose, sometimes sub globose, pale to reddish brown, 5-10 μm in diameter. They contributed 0.33% to the total airsporain the first and second Kharif seasons respectively. Maximum concentration (0.54%) was observed in July, 2015 and lowest concentration (0.26%) in September, 2016. Total number of spores in the first season ($2940/\text{m}^3$) was higher than that in the second season ($2520/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.91% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Memnoniella Hohnel: Conidia dark, one celled, globose to sub-rectangular or squarish, dark to opaque, rough to echinulate, 6-9 μm in diameter and 5-5.5 μm thick forming persistent simple chain to 2000 μm long. Conidia usually occur in chain. The spores were recorded in both seasons. They contributed 4.15% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the first season (4.82%) was higher than that in the second season (3.58%). The highest conc. (5.39%) was recorded in July, 2015 and lowest conc. (2.03%) in July, 2016. Maximum number of spores in the first season ($36554/\text{m}^3$) was higher than that in the second season ($31486/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.29% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora.

Nigrospora Zimm.: Conidia dark, one celled, globose, sub-globose or depressed globose, black and opaque, smooth, flattened 12-23 μm in diameter. Spores of *Nigrospora* were encountered regularly throughout the period of investigations. They contributed 4.02% to the total airsporain the first and second Kharif seasons respectively. The highest mean concentration (5.34%) was observed in August, 2015 whereas the lowest concentration (2.69%) in July, 2015. Maximum number of spores ($11816/\text{m}^3$) was observed in August, 2015 and minimum number of spores ($3500/\text{m}^3$) in July, 2015. Percentage contribution in the first season (3.86%) was lower than that in the second season (4.17%). Suryawanshi and Bajgire (2014) reported 2.68% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Papularia Fries: Conidia dark, one celled, ovoid, often lenticular inside view, with light band seen in edge view, 5-7.5 x 3-4 μm . They contributed 0.11% to the total airsporain the first and second Kharif seasons respectively. Percentage contribution in the first season (0.09%) was slightly lower than that in the second season (0.12%). Total number of spores in the first season ($742/\text{m}^3$) was lower than that in the second season ($1050/\text{m}^3$).

Penicillium Link: Conidium hyaline or brightly colored in mass, one celled, mostly globose or ovoid, 0.8-1.52 μm in diameter. They contributed 0.09% to the total airsporain the first and second Kharif seasons respectively. The total number of spores in the first season ($1050/\text{m}^3$) was lower than that in the second season ($2100/\text{m}^3$). The maximum concentration (630/m) was found in September, 2016 whereas minimum concentration (210/m) in July, 2015. Percentage contribution in the first season (0.14%) was slightly lower than that in the second season (0.24%).

Periconia Tode ex Schew: Conidia dark, one celled, globose, usually rough walled, often shows spiny wall, 9 -12 μm in diameter. These conidia occurred regularly through the period of investigation. They contributed 5.16% to the total airsporain the first and second kharif seasons respectively. The highest concentration ($14014/\text{m}^3$) was recorded in August, 2016 and the lowest concentration ($7840/\text{m}^3$) in July, 2016. Percentage contribution in the first season (5.24%) was slightly higher than that in the second season (5.09%). Total number of spores in the first season ($39760/\text{m}^3$) was lower than that in the second season ($44800/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 6.03% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Pestalotiade Not: Spores 5 distinct septate (false septate), 4 medium cells brown, end cells hyaline, 3-9 apical, cellular, simple or dichotomously branched appendages and 1 basal cellular simple or branched appendages, 14-23 x 5-7 μm . The spores occurred rarely during period of investigations. They contributed 0.01% to the total airsporain the first season respectively. Maximum number of spores ($70/\text{m}^3$) was observed in September, 2015 and minimum number of spores ($28/\text{m}^3$) in July, 2015. These spores was observed in the only one season. Suryawanshi and Bajgire (2014) reported 0.06% contribution to the

total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Pithomyces Berk and Br: Conidia single, colored, coliform, mostly broadly elliptical, oblong to pyriform or irregular many celled, transversely or vertically septate 21-27 x 10-17 μm in diameter. They contributed 0.96% to the total airspora in the first and second kharif seasons respectively. Total number of spores in the first season ($5964/\text{m}^3$) was lower than that in the second season ($9730/\text{m}^3$). The highest concentration ($3150/\text{m}^3$) was observed in September, 2016 and lowest concentration ($1232/\text{m}^3$) in July, 2015. Suryawanshi and Bajgire (2014) reported 0.55% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Pseudotorula Subram: Spores torulose, dark brown, elliptical to oval, usually 3-septate, constricted at one or more septa, thick walled, several celled, long, slender, single or branched acropetal chains, and 12.5-24 x 5.7-9 μm . The spores were trapped in both seasons. They contributed 1.52% to the total airspora in the first and second Kharif seasons respectively. The maximum concentration ($4060/\text{m}^3$) was observed in September, 2015 and minimum concentration ($2240/\text{m}^3$) in July, 2016. Percentage contribution in the first season (1.76%) was higher than that in the second season (1.32%). Suryawanshi and Bajgire (2014) reported 1.21% contributions to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Pyricularia Sacc: Three celled pyriform, narrow towards the apex, straight or slightly bent with a small and distinct hilum at base, hyaline to pale olive colored 19-23 x 7.9 μm . They contributed 0.03% to the total airspora in the first season respectively. The maximum concentration ($154/\text{m}^3$) was observed in October, 2015 and minimum concentration ($112/\text{m}^3$) in July, 2015. Sreeramulu and Ramlingam (1963) recorded 0.02% spores over Paddy fields near Vishakhapatnam.

Other reports are of Mane (1978) recorded 0.39% over bajra fields at Vaijapur. Tilak and Babu (1981) reported their average contribution as 28.15% in the total airspora of bajra fields at Aurangabad. They observed that moderate temperature and high humidity are

most favorable conditions for disease incidence and increase spore concentration while during low humidity and rise in temperature the concentration of spores were reduced.

The workers Shastri (1981), Babu (1983), Patil (1983) and Wankhade (1983) reported three spores from the air of Aurangabad over different crops. Patil (1985) and Jogdand (1987) reported 0.40% and 0.01% spores over jowar fields at Aurangabad respectively. Thube (1992) recorded 0.13% spores over jowar fields at Ahmednagar. Jayswal (1993) reported 0.19%, Pole (1995) recorded 0.19% and 0.08% of these spores over sunflower fields respectively. Suryanwanshi (2002) reported 0.09% and 0.66% of these spores over sunflower and wheat fields. Arsule and Pande (2011) recorded 1.1% over groundnut field. Mali et al (2012) reported 0.37% over bajra field. Kadam et al (2011) recorded 0.39% over bajra field. Suryawanshi and Bajgire (2014) reported 0.08% contribution to the total airspora over Soybean field. Patil et al (2015) reported 0.21% over jowar field. Lohare (2016) found that the incidence of airspora over soybean field.

Spegazzinia Sacc: Two types of conidia were reported, four celled spiny conidia were darker, with one persistent conidiophores and considerably projected spines. Four celled smooth conidia were dark without spines and with small persistent conidiophores, both 26.4-26.8 μm in diameter. The spores showed the infrequently occurrence in the air spora. They contributed 0.29% to the total airspora in the first and second Kharif seasons respectively. Total number of spores in the first season ($3108/\text{m}^3$) was higher than that in the second season ($1722/\text{m}^3$). The highest concentration ($980/\text{m}^3$) was observed in September, 2015 and lowest concentration ($252/\text{m}^3$) in July, 2016. Percentage contribution in the first season (0.41%) was higher than that in the second season (0.19%). Kramer and his coworkers (1959, 1960, 1963, and 1964) have reported them surely from the Kansas air. Sreeramulu and Ramlingam (1963) in Vishakhapatnam reported the sporadic occurrence and few except the months of January, November and December when comparatively high. Kulkarni (1971) reported 0.12% spores over Sugarcane fields at Nanded. Mane (1978) reported 0.19% spores over bajra fields at Vaijapur. Tilak and Bhalke (1978) recorded 0.25% spores from Aurangabad air spora. The other workers Shastri (1981), Babu (1983), Patil (1983), Bhasale (1983), Pillai (1983), Saibaba (1983) and Wankhade (1983) from Aurangabad. Patil (1985) and

Jogdand (1987) reported 0.10% and 0.02% spores over jowar fields at Aurangabad respectively. Kavishwar (1990), Ahuja (1991) and Bhadane (1991) reported these spores from different atmosphere of the Marathwada region. Thube (1992) recorded 0.15% spores over jowar fields at Ahmednagar. Shinde (1996) reported 0.24% at Nanded. Pawar (1997) reported 1.11% and 0.05% of these spores over bajra fields at Aurangabad. Mali (2002) reported 0.13% and 0.10% of these spores over bajra and jowar fields at Kada (Beed). Suryawanshi (2002) reported 0.54% and 0.26% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.13% and 0.08% of these spores over bajra fields at Namalgaon phata (Beed). Kshirsagar (2007) reported 0.43%, 0.17% and 1.07, 0.67% to the total airspora over sunflower fields. Patil (2008) reported 0.11% to the total airspora over black gram field. Arsule and Pande (2011) recorded 0.01% over bajra field. Kadam et al (2011) reported 0.33% over bajra field. Patil et al (2015) recorded 0.02% over jowar field. Suryawanshi and Bajgire (2014) reported 0.09% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Sporidesmium de Not: Conidia dark elongated, septate, sometimes with longitudinal walls, borne in simple chains, developing basipetally. They contributed 0.19% to the total airspora in the first and second Kharif seasons respectively. Total number of spores in the first season ($1834/\text{m}^3$) was higher than that in the second season ($1302/\text{m}^3$). The maximum concentration ($630/\text{m}^3$) was reported in September, 2015 and the minimum concentration ($70/\text{m}^3$) in July, 2016. Percentage contribution in the first season (0.24%) was higher than that in the second season (0.15%). Tilak and Bhalke (1979) reported these spores from Aurangabad. Shastri (1981) while studying the airspora of vegetable market at Aurangabad observed maximum spore concentration in the month of November. Ramteke (1990) observed 0.03% spore contribution to the total airspora over Tur fields at Aurangabad. Aher (1993) observed 0.37% spore contribution to the total airspora over groundnut fields at Ahmednagar. Thite (1998) reported 0.69% of these spores over groundnut fields. Mali (2002) reported 0.02% and 0.11% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 0.28% and 0.20% of these spores over sunflower and wheat fields. Arsule and Pande (2011) recorded 0.55% over groundnut field. Mali et al., (2012) reported 0.02% over bajra field. Suryawanshi and Bajgire (2014)

reported 0.23% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Tetraploa Berk and Br: Conidia with three or four septate appendages smooth or rough, brown, 86.15×5.6 μm in diameter. They contributed 1.29 % to the total airsporain the first and second Kharif seasons respectively. Maximum concentration ($5488/\text{m}^3$) was encountered in September, 2015 and the minimum concentration ($280/\text{m}^3$) in August,2015.Total number of spores in the first season ($9576/\text{m}^3$) was lower than that in the second season ($11704/\text{m}^3$).Percentage contribution in the first season (1.26%) was slightly lower than that in the second season (1.33%). Suryawanshi and Bajgire (2014) reported 0.28% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

TorulaPers.: Conidia dark, present in simple or branched erect chains, unbroken chains up to $90 \times 6-10$ μm , apart into short length, singly, in two, in threes, in four or in groups, markedly or faintly echinulate. They contributed 0.06% to the total airsporain the first and second Kharif seasons respectively. The highest concentration ($280/\text{m}^3$) was recorded in September, 2016.whereas lowest concentration ($14/\text{m}^3$) in July, 2015.Total number of spores in the first season ($266/\text{m}^3$) was lower than that in the second season ($742/\text{m}^3$). Suryanwanshi and Bajgire (2014) reported 3.72% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Trichoconis Clements:Conidia elongatefucoids with a long hyaline appendage at the tip, 3-5septate, creamy yellow, slightly constricted at the septa, basal cells thick walled, straight, $98.5-157.5$ μm long including appendages and $8.5-18.8$ μm broad, rigid septate,2-5 μm thick. They contributed 0.04% to the total airsporain the first and second Kharif seasons respectively. The highest conc. ($210/\text{m}^3$) was observed in September, 2016 whereas lowest conc. ($14/\text{m}^3$) in July, 2015. Total number of spores in the first season ($238/\text{m}^3$) was comparatively lower than that in the second season ($532/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.02% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Algal Filaments: During present investigations some algal material was trapped along with the other aero mycology. It includes one celled filamentous forms belonging to

various groups of algae. All of them have been grouped in heterogeneous group. They contributed 1.06% to the total airsporain the first and second Kharif seasons respectively. The highest conc. ($3290/\text{m}^3$) was recorded in September, 2016 and lowest conc. ($1022/\text{m}^3$) in July, 2015. Total number of spores in the first season ($5572/\text{m}^3$) was lower than that in the second season ($11900/\text{m}^3$). Percentage contribution in the first season (0.73%) was lower than that in the second season (1.35%). Suryawanshi and Bajgire (2014) reported 0.44% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Epidermal hairs: During the period of investigation different types of epidermal hairs from various tax of plant kingdom were encountered. Mainly the airborne epidermal hairs included uniseriate, multicellular hairs, trichomes and very rarely unicellular, thick double walled, straight or curved hairs which may perhaps be root hairs. Root hairs many become airborne after their separation from the dried roots of different plants. Apart from hairs of different types, occasionally epidermal tissues, sometimes sclerenchyma tissue and fibers have also been encountered, but very rarely. They have been included in this heterogeneous group. They contributed 0.19% to the total airsporain the first and second Kharif seasons respectively. The maximum concentration ($560/\text{m}^3$) was observed in July, 2015 and July, 2016. The minimum concentration ($182/\text{m}^3$) in October, 2016. Total number of spores in the first season ($1610/\text{m}^3$) was slightly higher than that in the second season ($1596/\text{m}^3$). Percentage contribution in the first season (0.21%) was slightly higher than that in the second season (0.18%). Suryawanshi and Bajgire (2014) reported 0.08% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Hyphal Fragments: Hyphal fragments of all types (short, long, simple, branched, colored, hyaline) were encountered under this group. Whether long or short mostly dematiaceous hyphae were recorded frequently terminal portions of conidiophores were trapped. Most of the hyphal fragments were thick walled and broken. Hyaline were either less numerous or could not be recognized. Hyphal fragments occurred throughout the period of investigations. High numbers were encountered during the day time. They contributed 2.02% to the total airsporain the first and second Kharif seasons respectively.

The highest number of spores ($5740/\text{m}^3$) was found in August, 2016 and lowest number of spores ($2100/\text{m}^3$) in 2015. Percentage contribution in the first season (1.92%) was lower than that in the second season (2.11%). Total number of the spores in the first season ($14560/\text{m}^3$) was lower than that in the second season ($18620/\text{m}^3$). Suryawanshi and Bajgire (2014) reported 0.37% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Insects Scales: During the present studies insect scales, insect wings, insect skeleton and complete insects were trapped and all of these were considered under single category, insect parts. They were present in the airspora throughout and contributed 2.26% to the total airspora in the first and second Kharif seasons respectively. Total catches in the first season ($20860/\text{m}^3$) were higher than that in the second ($16240/\text{m}^3$). Percentage contribution in the first season (2.75%) was higher than that in the second season (1.84%). Regarding second abundance and variations it can be concluded that their abundance was mainly confined to rainy periods. However, concentration declined during rainy and prolonged dry periods. High humidity coupled with low temperature enriched the insect fauna which was confirmed by abundant insects trapped during that period. However, hot, dry and windy weather enriched air-spores with insect parts i.e. enrichment of insect fauna is prior to enrichment of insect parts. The source of insect parts was obviously insects. After death and decay of insects due to withering away of insect parts they were liberated in the air. Suryawanshi and Bajgire (2014) reported 0.06% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Pollen grains: All the pollen types grouped in a single category. Pollen load was mainly dominated by soybean pollen along with this pollen many other pollen of various weeds, shrubs, trees and crop plants were also present. However, they presented very less concentration. Pollen contributed 2.08% to the total airspora in the first and second Kharif seasons respectively. The highest conc. ($5600/\text{m}^3$) was recorded in September, 2015 and lowest conc. ($2856/\text{m}^3$) in July, 2016. Total number of pollen in the first season ($18760/\text{m}^3$) was higher than that in the second season ($15176/\text{m}^3$). Percentage contribution in the first season (2.47%) was higher than that in the second season

(1.72%). Suryawanshi and Bajgire (2014) reported 0.07% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Protozoan cysts: Hyaline, rounded to ovoid, single celled, double walled of two sizes, 28.5-45.6 μm in diameter and 95-121.6 x 87.4-121.6 μm . They contributed 0.22% to the total airsporain the first and second Kharif seasons respectively. Maximum number (700/ m^3) was observed in October, 2015 and minimum number (140/ m^3) in July 2016. Percentage contribution in the first season (0.33%) was higher than that in the second season (0.12%). Suryawanshi and Bajgire (2014) reported 0.001% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Unidentified spores: This group is somewhat artificial comprising of one celled, two celled, three celled and many celled hyaline faint and colored spores. This group was however, dominated by one celled, roundand elongated elliptic colored and hyaline spores. Though they were unidentified, their counts were found necessary to maintain the original picture of air spora. The spores which were not classified because of their unsuitable orientation on the adhesive surface or were partially obscured by debris or other particles were also included in this group. This is a heterogeneous group as such its composition and concentration changed considerably from season to season. Their contribution to the total air-spores was 0.70%. Total number of spores in the first season (6146/ m^3) was higher than that in the second season (5390/ m^3). Percentage contribution in the first season (0.81%) was higher than that in the second season (0.61%). Suryawanshi and Bajgire (2014) reported 0.01% contribution to the total airspora over Soybean field. Lohare (2016) found that the incidence of airspora over soybean field.

Fungal colonies from air by petriplates exposure method:

During the air sampling simultaneously petriplates containing PDA media were exposed for 10-15 minutes each interval of 15 days in the air of Soybean crop fields. Colonies were classified in to genera, more than 27 types of fungal colonies were observed.

Asexual fruiting bodies and non- sporulating fungal bodies were grouped in separate group called mycelia Sterilia. 27 types of fungal colonies have been isolated from air and identified up to generic level which has been listed below under their taxonomic group.

A) **ZYGOMYCOTINA:** *Cunnighamella Matruchot*, *Mucor Micheli.*, *Pythium Pringsheim*, *Rhizopus cohinii* and *Rhizopus Sp. Ehrenb.*

B) **ASCOMYCOTINA:** *Chaetomium Kunze ex Fr.* and *Neurospora Shear and Dodge.*

C) **DEUTEROMYCOTINA:** *Alternaria Nees ex Waller*, *Aspergillus Flavus Link ex Fries*, *Aspergillus Niger van Tieghem*, *Aspergillus sp. Link*, *Bipolaris Shoemaker*, *Cladosporium Link ex Fries*, *Curvularia Boed*, *Diplodia Fr*, *Epicoccum Link ex Fr*, *Fusarium Link*, *Helminthosporium Link ex Fries*, *Humicola Traaen*, *Papularia*, *Penicillium implicatum Biourge*, *Penicillium sp. Link*, *Pestalotia de Not*, *Phoma Desm*, *Torula Pers ex Fr* and *Trichoconis Pers*

.D) **MYCELIA STERILIA:** Unclassified group.

Out of 27 fungal types 19 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina and other non- sporulating to mycelia Sterilia, Deuteromycotina fungal colonies dominated the airspora by exhibiting more concentration (69.69%). It was followed by mycelia Sterilia (19.47%), Zygomycotina (5.69%) and Ascomycotina (5.15%). The monthwise variation in the total number and percentage contribution of different fungal colonies the air of soybean crop fields by petriplates exposure represented in **Table 1A**. The Monthwise fungal colony counts of different fungi, the air of soybean crop fields by petriplates exposure represented in **Table 2A and 2B**. The Monthwise average percentage contribution of each fungal colonies, the air of soybean crop fields by petriplates exposure represented in **Table 3A and 3B**. The monthwise total colonies count and average percentage contribution of each fungal group is represented in **Table 4A and 4B**. The monthwise total colonies count and average percentage contribution of each fungal group is represented in **Table 5A and 5B**. The Seasonwise total number of fungal colonies and percentage contribution of each spore group is represented in **Table 6A**.

A) ZYGOMYCOTINA: *Cunnighamella Matruchot*: Colonies dry, mucoid (thick stringy and wet), moist, smooth, rough, rugose (wrinkled), or concentric rings. These spores were recorded throughout the period of investigations and contributed (2.63%) to the total airspora. Whereas by Petriplate exposure (0.18%) to the total colony count. In air sampling maximum conc. ($6692/\text{m}^3$) was in the month of September, 2016 while in plate exposure (1 colony) in the month of September, 2015. The Seasonwise maximum conc. ($21644/\text{m}^3$) during the first kharif season by air sampling method. However (3 colonies) were during the second kharif season and total (4 colonies) during the first and second kharif seasons respectively.

***Mucor Micheli*:** Colonies are fast growing, tall, simple, unbranched sporangiophores. Lacking basal rhizoids, non- apophysate sporangia and pigmented zygosporangial. They contributed (0.03%) to the total airspora. whereas (0.97%) to the total colony count. Maximum concentration ($126/\text{m}^3$) was in the month of October, 2015 whereas (6 colonies) in the month of October, 2015 and September, 2016. The Seasonwise maximum concentration ($378/\text{m}^3$) was during the first kharif season whereas (11 colonies) during the second kharif season. Total (21 colonies) were during the first and second kharif seasons respectively.

***Pythium Pringseim*:** Pythium are usually coenocytic hyphae without Septation, single oospore, elongated and club shaped anthridia. Spores were reported only from Petriplate exposure. They contributed (0.51%) to the total colony count. Maximum concentration (6 colonies) was in the month of October, 2016. The Seasonwise maximum concentration (6 colonies) was recorded in second kharif season and total (11 colonies) during the first and second kharif seasons respectively.

***Rhizopus cohinii*:** Colonies are fast growing, dense cotton growth that is a first white becoming grey or yellowish brown with sporulation, Sporangiospores are globose to ovoid one-celled, hyaline to brown and striate. They were obtained from Petriplate exposure. They contributed (2.64%) to the total colony count. Maximum concentration (15 colonies) was in the month of September, 2016. The Seasonwise maximum concentration (33 colonies) during the second kharif season and total (57 colonies) during the first and second kharif seasons respectively.

Rhizopus sp. Ehrenb: Colonies are dark, grayish- brown, up to 10mm high producing simple rhizoids. Sporangiophores are brownish, up to 400 μm high and 10 μm wide, and may be produced in groups of one to four, usually in pairs. Sporangia are grayish black, spherical up to 100 μm in diameter. They contributed (0.19%) to the total airspora. Whereas by Petriplate exposure (1.39%) to the total colony count. Maximum concentration ($700/\text{m}^3$) was in the month of September, 2015. Whereas (7 colonies) in the month of October, 2016. The Seasonwise maximum concentration ($1652/\text{m}^3$) was during the first kharif season. Whereas (18 colonies) during second kharif season and total (30 colonies) during the first and second kharif seasons respectively.

.B) ASCOMYCOTINA: *Chaetomium Kunze ex Fr.:* Colonies are rapidly growing, cottony and white in colour initially, mature colonies become grey to olive in colour from the reverse the colour is tan to red or brown to black. They contributed (0.91%) to the total airspora. Whereas by Petriplate exposure (0.23%) to the total colony count. Maximum concentration ($3290/\text{m}^3$) was in the month of September, 2016. Whereas (3 colonies) in the month of August, 2016. The Seasonwise maximum concentration ($7630/\text{m}^3$) was during the second kharif season. Whereas (3 colonies) during the second kharif season and total (5 colonies) during the first and second kharif seasons respectively.

Neurospora Shear and Dodge. *Neurospora* are molds with broadly spreading colonies with abundant production of ascomata. Spores were reported only from Petriplate exposure. They contributed (4.91%) to the total colony count. Maximum concentration (25 colonies) was in the month of August, 2016. Whereas (20 colonies) in the month of August, 2015. The Seasonwise maximum concentration (58 colonies) was during the second kharif season. Whereas (48 colonies) during the first kharif season and total (106 colonies) during the first and second kharif seasons respectively.

C) DEUTEROMYCOTINA: *Alternaria Nees ex Waller:* Colonies at maturity orbicular, black, green and smoky, conidia dark, typically with both cross and vertical septa, variously shaped, obclavate to elliptical or ovoid, frequently borne acropetally in long chains, less often borne singly and having an apical simple or branched appendage; parasitic or saprophytic on plant material. These spores were recorded throughout the

period of investigations in air sampling and petriplates exposure method. Their contribution (5.82%) was to the total airspora and (6.35%) to the total colony count. Maximum concentration ($16408/\text{m}^3$) in the month of August, 2016, whereas (30 colonies) in the month of October, 2016. The Seasonwise maximum concentration ($52934/\text{m}^3$) was during the second kharif seasons. Whereas (77 colonies) during second kharif season and total (137 colonies) during the first and second kharif seasons respectively.

Aspergillus Flavus Link ex Fries: Colonies slightly floccose at the margins of the colony due to growth of sterile hyphae, conidial areas ranging in colour from sea foam yellow, citron-green, in old colonies altered by the disappearance of the green factor, leaving shaded of yellow- brown, reverse to yellowish at first becoming brownish; conidia pyriform to almost globose, nearly colourless to definitely yellowish green, varying from 3 μm in diameter to 3-4 x 4-5 μm . They were recorded throughout the period of investigations from petriplates exposure and contributed (3.29%) to the total colony count. Maximum concentration (25 colonies) was in the month of October, 2016. Whereas (20 colonies) in the month of October, 2015. The Seasonwise maximum concentration (41 colonies) was during the second kharif season. Total 69 colonies during the first and second kharif seasons respectively.

Aspergillus Niger van Tieghem: Colonies with abundant submerged mycelium colourless to coloured, reverse usually without coloured; conidiophores colourless to coloured, septate or non- septate, vesicle globose or subglobose thick walled. They were recorded from air sampling method and petriplates exposure methods. They contributed (12.46%) to the total colony count. Maximum concentration (40 colonies) was in the month of August and September, 2016. Whereas (35 colonies) in the month of September 2015. Seasonwise maximum concentration (149 colonies) during the second kharif season. Total (269 colonies) was during the first and second kharif seasons respectively.

Aspergillus sp.Link: Vegetative mycelium composed of septate, branching hyphae, colourless or brightly coloured, forming brown sclerotic, conidiophores arising from foot cells, more or less erect, each forming a head of conidia at tip; conidia one celled globose, variously coloured when in mass, catenulate, produced basipetally. They were recorded in air sampling and petriplates exposures throughout the period of

investigations. They contributed (5.82%) to the total airspora and (12.28%) to the total colony count. Maximum concentration ($12222/\text{m}^3$) was in the month of September, 2016. Whereas (90 colonies) in the month of October, 2015. The Seasonwise maximum concentration ($28042/\text{m}^3$) was during the second kharif season. Whereas (165 colonies) during the first kharif season. Total (355 colonies) was during the first and second kharif seasons respectively.

Bipolaris Shoemaker. Colonies are moderately fast growing, effuse, and grey to blackish brown, suede-like to floccose with a black reverse. Spores were reported only from Petriplate exposure methods. They contributed (0.88%) to the total colony count. Maximum concentration (4 colonies) was recorded in July, 2016. Whereas (3 colonies) was observed in the month of August and September, 2015 and 2016. The Seasonwise maximum concentration (12 colonies) was recorded in the second kharif seasons. Total (19 colonies) were recorded in first and second kharif seasons.

Cladosporium Link ex Fries. The colonies were dense, often a velvety olive green, but also other shaded of brown, dark or grayish green are seen. The erect pigmented conidiophores have tree like branching, the conidia are multi - shaped and Septate, two types of spores i, e lemon- shaped and another is torpedo-shaped. They were reported from air sampling and Petriplate exposure throughout the period of investigations. They contributed (16.82%) to the total airspora. whereas by Petriplate exposure (12.28%) to the total colony count. The Season wise maximum concentration ($106960/\text{m}^3$) was during the first season. Whereas (165 colonies) during second kharif season and (100 colonies) during the first kharif season respectively. Total (265 colonies) was during the first and second kharif seasons respectively.

Curvularia Boed. Colony spreading, subglobose, dark olive grey reverse bluish black, conidiophores erect, unbranched, conidia dark 3 to many celled, typically bent or curved with one or two of the central cell enlarged. They were recorded throughout the period of investigations from air sampling method and petriplates exposures method. They contributed (11.50%) to the total airspora, whereas (7.27%) to the total colony count. From air sampling maximum concentration ($34230/\text{m}^3$) was in the month of August, 2016. The Season wise maximum concentration ($99148/\text{m}^3$) was during second kharif

seasons. From Petriplate exposure maximum concentration (30 colonies) was in the month of October, 2015 and September, 2016. The Season wise maximum concentration (90 colonies) was during second kharif season. Total (157 colonies) was during the first and second kharif seasons respectively.

Diplodia Fr.: Pycnidia black, single, globose, immersed, erumpent, Ostiolate; conidiophores slender, simple; conidia dark, 2-celled, ellipsoid or ovoid parasitic or saprophytic. They were reported from air sampling method and petriplates exposures method. They contributed (0.06%) to the total airspora, whereas (0.55%) to the total colony counts and maximum conc. ($350/\text{m}^3$) in the month of September, 2016. Whereas (3 colonies) in the month of August and September, 2016. The Seasonwise maximum concentration ($924/\text{m}^3$) during the second kharif season, whereas (6 colonies) during the first and second kharif seasons. Total (12 colonies) during the 2015 and 2016 respectively.

Epicoccum Link ex Fr: Sporodochia, black brown, globose, usually very small conidiophores dark coloured, non-septate conidia dark one- celled or several celled. They were reported in air sampling methods and Petriplate exposure methods. They contributed (0.18%) to the total airspora and (0.18%) to the total colony count. Maximum concentration ($1106/\text{m}^3$) in the month of September, 2016 from air, whereas (1 colony) in the month of September, 2016 from Petriplate exposure. The Seasonwise maximum concentration ($3262/\text{m}^3$) during first kharif season from air. Whereas (3 colonies) during second kharif season. Total (4 colonies) during the first and second kharif seasons respectively.

Fusarium Link.: The different species often form brightly coloured colonies, e.g., pink yellow or apricot. The genus is readily recognized by the hyaline gondola- shaped septate macro conidia, produced in cushion like masses macro conidia several celled, slightly curved or bent at the pointed ends typically cone shaped. They contributed (0.67%) to the total airspora, whereas (2.13%) to the total colony count by Petriplate exposure. The maximum conc. ($2198/\text{m}^3$) in the month of September, 2015. Whereas (12 colonies) in the month of October, 2016. The Seasonwise maximum conc. ($6132/\text{m}^3$) during first kharif season, whereas (36 colonies) during first kharif seasons.

Helminthosporium Link ex Fries: Colonies brown to black, mycelium dark, brown, multi-septate, conidiophores erect and straight, unbranched, septate, geniculate at points below the typically containing more than three cells, cylindrical or ellipsoid, sometimes slightly curved or bent, ends rounded. The spores were observed in air by sampling method and petriplates exposure throughout the period of investigations. They contributed (1.04%) to the total airspora. Whereas by Petriplate exposure (2.06%) to the total colony count. Maximum concentration ($2800/\text{m}^3$) in the month of August, 2016. Whereas (10 colonies) in the month of October, 2015. The Season wise maximum concentration ($8960/\text{m}^3$) during second kharif seasons, whereas (30 colonies) during second kharif season. Total (46 colonies) during the first and second kharif seasons respectively.

Humicola Traaen.: Colonies fuscous to dark in colour, mycelium septate conidiophores sub cylindrical with single pore apically, sometimes absent; spores typically globose, first granular and yellow brown, finally dark 1-celled, with a cell wall with an easily discernible double contour, smooth Phialides largely confined to the aerial mycelium phialospores slightly obovate, hyaline 1 celled, $3 \times 2 \mu\text{m}$. They contributed (0.69%) to the total colony count. Maximum concentration (9 colonies) during second kharif season and (6 colonies) during first kharif season. Total (15 colonies) during first and second kharif seasons respectively.

Papularia.: Colonies black, conidiophores erect, hyaline, arising from smooth almost barrel shaped cells, producing the first conidium at the tip and further conidia laterally from the apex to base in that order; conidia borne on short, hyaline pegs; 1 celled lenticular to brown, with a hyaline rim at the periphery attached to the conidiophores by the rim. They were obtained from air sampling method and petriplates exposure method. They contributed (0.11%) to the total airspora. Whereas by Petriplate exposure (0.23%) to the total colony count. Maximum concentration. ($420/\text{m}^3$) in the month of September, 2016. However, in Petriplate exposure they were obtained from first and second kharif seasons respectively.

Penicillium Implicatum Biourge: Colonies tough, velvety or nearly so, nickel- green to dark porcelain- green (Ridgway), conidiophores short penicilli usually monoverticillate, but sometimes branch which bears a verticil of Phialides but retains its mono- verticillate

character; Phialides closely packed, mostly 8-12 in a verticil conidia elliptical and 2.5-3 x 3.2-5 μm many subglobose, heavy walled, smooth or roughened, dark green in mass. They were recorded in petriplates exposures. They contributed (0.51%) from the air of Petriplate exposure. Maximum concentration (7colonies) during second kharif season. Whereas (4 colonies) during first kharif season by Petriplate exposures. This fungus was recorded throughout the period of investigation in the Petriplate exposure from soybean fields. ***Penicillium sp.Link:*** Colonies are mostly having shades of dusty green. The conidiophores have characteristic pencil- like spore bearing organ (Phialides) from which the round hyaline conidia (2-5 μm) are in chains. The genus is dominating in temperature soil and the spores are easily liberated and dispersed in to air. They contributed (0.19%) to the total airspora.wheras by Petriplate exposure (6.58%) to the total colony count. From air maximum concentration ($630/\text{m}^3$) in the month of September, 2016. Whereas from (40 colonies) in the month of October, 2016. The Seasonwise maximum concentration ($2100/\text{m}^3$) during second kharif season. However from Petriplate exposure maximum concentration (45 colonies) during second kharif season. Total (142 colonies) during the first and second kharif seasons respectively.

Pestalotia de Not.: Colonies at first white, later becoming dirty to blackish conidiophores short, simple, conidia dark, several celled, with hyaline, pointed end cells, ellipsoid to fusiod. They contributed (0.01%) to the total airspora. Whereas by Petriplate exposure (0.37%) to the total colony count. Maximum concentration ($70/\text{m}^3$) was reported in September, 2015. Whereas from (3 colonies) in the month of July, 2015. The Seasonwise maximum concentration (5 colonies) during the first kharif season. Total (7 colonies) during the first and second kharif seasons respectively.

Phoma Desm.: Colonies dark brown, Pycnidia, globose or slightly lense shaped, with a small papilla at the apex; conidia small, one- celled, hyaline, ovoid to elongate, less than 15 μm in length and 10 μm in diameter. They contributed (0.32%) to the total colony count. They were obtained only from air by Petriplate exposure method. Maximum concentration (3 colonies) was in the month of July, 2015. The Season wise maximum concentration (4 colonies) was during first kharif season. Total 7 colonies during the first and second kharif seasons respectively.

Torula Pers ex Fr.: Colonies black, powdery, mycelium sub hyaline to brownish, septate, branched; conidia produced in simple or branched acropetally chains, each conidiophores with a characteristic apical Sporogenous cell, basal cell of conidiophores somewhat elongate, arising from the swollen apex of a hypha or from a subglobose cell arising laterally from a hypha; conidia dark brown when mature, hyaline when young, markedly echinulate or smooth, mostly 2-5 septate, deeply conidia 4-10 μm wide in the widest part, conidia sometimes fragmenting into 1- celled units. They were obtained from air by air sampling and plate exposure, by air sampling they contributed (0.06%) to the total airspora, whereas by Petriplate exposure (0.18%) to the total colony count. In air sampling maximum concentration ($280/\text{m}^3$) was in the month of September, 2016, while in plate exposure (1 colony) in the month of October, 2015. The Seasonwise maximum concentration ($742/\text{m}^3$) was recorded in 2016 by air sampling method.

Trichoderma Pers.: Colonies are fast growing, at first white and downy, later developing yellowish-green to deep green compact tufts. They contributed (0.37%) to the total colony count. Maximum concentration (3 colonies) was in the month of October, 2015. Whereas Season wise (5 colonies) was during the first kharif season and total (8 colonies) during the first and second kharif seasons.

D) MYCELIA STERILIA: *Unclassified spores (unclassified group):* All fungus spores caught on the slides except which could not be included under any of the named group were counted under this category, whereas in culture plate some of the types which could not sporulate due to their slow growth or due to inhibition by other fungi and only mycelial growth observed, such type also included under this category. The spores which were not classified were partially obscured by debris or other particles were also included in this group. They contributed (0.70 %) to the total airspora, whereas by Petriplate exposure (19.47%). Maximum concentration ($1680/\text{m}^3$) in the month of September, 2015 from air, whereas from plate exposure (90 colonies) in October, 2016. Maximum conc. ($6146/\text{m}^3$) during 2015 from season I, whereas (250 colonies) during second kharif season and total (420 colonies) during the first and second kharif seasons.

SOYBEAN CROP: TABLES

Table-I: Average percentage contribution of each spore types to the total airspora two kharif Seasons over Soybean crop fields (Season I: 1st July, 2015 to 31st Oct, 2015 and Season II: 1st July, 2016 to 31st Oct, 2016).

Sr. No.	Spore Types	Total airspora /m ³ of air	% contribution to the total airspora
A)	MYXOMYCOTINA		
1.	Physarum	23828	1.45
2.	Stemonitis	11424	0.69
	Total	35252	2.16
B)	ZYGOMYCOTINA		
1.	Cunnighamella	43050	2.63
2.	Mucor	560	0.03
3.	Rhizopus	3192	0.19
4.	Sclerospora	6314	0.38
	Total	53116	3.24
C)	ASCOMYCOTINA		
1.	Ascospores	854	0.05
2.	Bitrimonospora	7280	0.44
3.	Chaetomium	14966	0.91
4.	Claviceps	17416	1.06
5.	Cucurbitaria	8834	0.54
6.	Didymosphaeria	20048	1.23
7.	Hypoxyton	6090	0.37
8.	Leptosphaeria	22148	1.36
9.	Lophiostoma	47950	2.93
10.	Massaria	378	0.02
11.	Melanospora	896	0.05
12.	Metasphaeria	7336	0.45

13.	Otthia	700	0.04
14.	Parodiella	2142	0.13
15.	Pleospora	7616	0.46
16.	Sordaria	3220	0.19
17.	Sporormia	3052	0.18
18.	Teichospora	1148	0.07
	Total	172074	10.50
D)	BASIDIOMYCOTINA		
1.	Basidiospores	28588	1.75
2	Ganoderma	770	0.04
3.	Rust spores	3794	0.23
4.	Smut Spores	136556	8.33
5.	Urediniospores	28098	1.71
	Total	197806	12.07
E)	DEUTEROMYCOTINA		
1.	Alternaria	95452	5.82
2.	Aspergillus	48734	2.98
3.	Beltraniella	5810	0.35
4.	Beltrania	2702	0.16
5.	Bispora	20846	1.27
6.	Botryodiplodia	364	0.02
7.	Cercospora	4676	0.28
8.	Cladosporium	275576	16.82
9.	Cordana	714	0.04
10.	Corynespora	1778	0.11
11.	Curvularia	188482	11.50
12.	Dictyoarthrinium	3934	0.24
13.	Diplodia	1064	0.06
14.	Drechslera	210	0.01
15.	Epicoccum	6426	0.39
16.	Exosporium	42	0.01
17.	Fusariella	2212	0.13
18.	Fusarium	11004	0.67

19.	Haplosporella	12628	0.77
20	Harknessia	938	0.06
21	Heliminthosporium	17038	1.04
22	Heterosporium	15288	0.93
23.	Lacellina	23170	1.41
24.	Lacellinospsis	5460	0.33
25.	Memnoniella	68040	4.15
26.	Nigrospora	65926	4.02
27.	Papularia	1792	0.11
28.	Penicillium	3150	0.19
29.	Periconia	84560	5.16
30.	Pestalotia	98	0.01
31.	Pithomyces	15694	0.96
32.	Pseudotorula	25004	1.52
33.	Pyricularia	532	0.03
34.	Spegazzinia	4830	0.29
35.	Sporidesmium	3136	0.19
36.	Tetraploa	21280	1.29
37.	Torula	1008	0.06
38.	Trichoconis	770	0.04
	Total	1040368	63.49
F)	OTHER TYPES		
1.	Algal Filaments	17472	1.06
2.	Epidermal hairs	3206	0.19
3.	Hyphal Fragments	33180	2.02
4.	Insect Scales	37100	2.26
5.	Pollen grains	33936	2.07
6.	Protozoan cysts	3570	0.22
7.	Unidentified Spores	11536	0.70
	Total	140000	8.54
	Grand Total	16,38616	100.00

Table-II: Variation in the total airspora and percentage contribution of different spore types during (Season I: 1st July, 2015 to 31st Oct, 2015 and Season II: 1st July, 2016 to 31st Oct, 2016).

Sr. No.	Spore Types	Seasons total spores /m ³ of air		% contribution to the season's total airspora	
		2015	2016	2015	2016
A)	MYXOMYCOTINA				
1.	Physarum	11886	11942	1.57	1.36
2.	Stemonitis	5670	5754	0.75	0.65
	Total	17556	17696	2.31	2.01
B)	ZYGOMYCOTINA				
1.	Cunnighamella	21644	21406	2.86	2.43
2.	Mucor	378	182	0.05	0.02
3.	Rhizopus	1652	1540	0.22	0.17
4.	Sclerospora	3052	3262	0.40	0.37
	Total	26726	26390	3.52	2.99
C)	ASCOMYCOTINA				
1.	Ascospores	392	462	0.05	0.05
2.	Bitrimonospora	3710	3570	0.49	0.40
3.	Chaetomium	7336	7630	0.97	0.86
4.	Claviceps	7434	9982	0.98	1.13
5.	Cucurbitaria	4452	4382	0.59	0.49
6.	Didymosphaeria	9548	10500	1.27	1.19
7.	Hypoxyton	2968	3122	0.39	0.35
8.	Leptosphaeria	10248	11900	1.36	1.35
9.	Lophiostoma	23576	24374	3.12	2.77
10.	Massaria	322	56	0.04	0.01
11.	Melanospora	476	420	0.06	0.05
12.	Metasphaeria	3304	4032	0.43	0.46
13.	Otthia	210	490	0.03	0.05
14.	Parodiella	1106	1036	0.14	0.12
15.	Pleospora	3598	4018	0.47	0.45

16.	Sordaria	1610	1610	0.21	0.18
17.	Sporormia	1330	1722	0.17	0.19
18.	Teichospora	182	966	0.02	0.11
	Total	81802	90272	10.78	10.26
D)	BASIDIOMYCOTINA				
1.	Basidiospores	16492	12096	2.17	1.37
2	Ganoderma	252	518	0.03	0.06
3.	Rust Spores	854	2940	0.11	0.33
4.	Smut Spores	64582	71974	8.51	8.18
5.	Urediniospores	13832	14266	1.82	1.62
	Total	96012	101794	12.66	11.56
E)	DEUTEROMYCOTINA				
1.	Alternaria	42518	52934	5.60	6.01
2.	Aspergillus	20692	28042	2.73	3.18
3.	Beltraniella	2716	3094	0.36	0.35
4.	Beltrania	1582	1120	0.21	0.13
5.	Bispora	10136	10710	1.34	1.22
6.	Botryodiplodia	112	252	0.01	0.03
7.	Cercospora	2142	2534	0.28	0.29
8.	Cladosporium	106960	168616	14.10	19.16
9.	Cordana	280	434	0.04	0.05
10.	Corynespora	-	1778	-	0.20
11.	Curvularia	89334	99148	11.78	11.26
12.	Dictyoarthrinium	1778	2156	0.23	0.24
13.	Diplodia	140	924	0.02	0.10
14.	Drechslera	-	210	-	0.02
15.	Epicoccum	3262	3164	0.43	0.36
16.	Exosporium	-	42	-	0.01
17.	Fusariella	-	2212	-	0.25
18.	Fusarium	6132	4872	0.81	0.55

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19.	Haplosporella	6342	6286	0.84	0.71
20	Harknessia	322	616	0.04	0.07
21.	Heliminthosporium	8078	8960	1.06	1.02
22.	Heterosporium	7588	7700	1.00	0.87
23.	Lacellina	10948	12222	1.44	1.39
24.	Lacellinospsis	2940	2520	0.39	0.28
25.	Memnoniella	36554	31486	4.82	3.58
26.	Nigrospora	29316	36610	3.86	4.17
27.	Papularia	742	1050	0.09	0.12
28.	Penicillium	1050	2100	0.14	0.24
29.	Periconia	39760	44800	5.24	5.09
30.	Pestalotia	98	-	0.01	-
31.	Pithomyces	5964	9730	0.79	1.10
32.	Pseudotorula	13328	11676	1.76	1.33
33.	Pyricularia	532	-	0.07	-
34.	Spegazzinia	3108	1722	0.41	0.19
35.	Sporidesmium	1834	1302	0.24	0.15
36.	Tetraploa	9576	11704	1.26	1.33
37.	Torula	266	742	0.04	0.08
38.	Trichoconis	238	532	0.03	0.06
	Total	466368	574000	61.49	62.22
F)	OTHER TYPES				
1.	Algal Filaments	5572	11900	0.73	1.35
2.	Epidermal hairs	1610	1596	0.21	0.18
3.	Hyphal Fragments	14560	18620	1.93	2.11
4.	Insect Scales	20860	16240	2.76	1.84
5.	Pollen grains	18760	15176	2.48	1.72
6.	Protozoan cysts	2492	1078	0.33	0.12
7.	Unidentified Spores	6146	5390	0.81	0.61
	Total	70000	70000	9.23	7.95
	Grand Total	7,58464	8,80152	100.00	100.00

Table-III A: The monthwise concentration and percentage contribution of each spore types to the total airspora over Soybean cropfield (from: 1st July, 2015 to 31st Oct, 2015).

Spore Type	July-2015		Aug-2015		Sep-2015		Oct-2015		Total Spore Conce /m ³ of air	% Contribution to the total airspora
	Spore Conc e/m ³ of air	% Contribution	Spore Conce /m ³ of air	% Contribution	Spore Conc e/m ³ of air	% Contribution	Spore Conc e/m ³ of air	% Contribution		
MYXOMYCOTINA										
Physarum	2478	1.91	3388	1.53	3892	1.71	2128	1.18	11886	1.57
Stemonitis	1092	0.84	658	0.29	2492	1.09	1428	0.79	5670	0.75
Total	3570	2.75	4046	1.83	6384	2.81	3556	1.98	17556	2.31
ZYGOMYCOTINA										
Cunnighamella	4340	3.34	5754	2.59	6636	2.92	4914	2.73	21644	2.85
Mucor	56	0.04	112	0.05	84	0.03	126	0.07	378	0.05
Rhizopus	168	0.13	126	0.05	700	0.31	658	0.36	1652	0.22
Sclerospora	280	0.21	1680	0.76	952	0.42	140	0.08	3052	0.40
Total	4844	3.73	7672	3.46	8372	3.68	5838	3.24	26726	3.52
ASCOMYCOTINA										
Ascospores	84	0.06	56	0.02	112	0.05	140	0.08	392	0.05
Bitrimonospora	140	0.11	840	0.38	980	0.43	1750	0.97	3710	0.49
Chaetomium	1050	0.81	1400	0.63	3248	1.43	1638	0.91	7336	0.97
Claviceps	840	0.64	2520	1.14	2814	1.24	1260	0.70	7434	0.98
Cucurbitaria	784	0.60	1120	0.50	1008	0.44	1540	0.85	4452	0.59
Didymosphaeria	1680	1.29	2744	1.24	2688	1.18	2436	1.35	9548	1.26
Hypoxyton	70	0.05	1148	0.52	1512	0.66	238	0.13	2968	0.39
Leptosphaeria	1568	1.21	3500	1.58	2800	1.23	2380	1.32	10248	1.35
Lophiostoma	3500	2.69	9212	4.16	6412	2.82	4452	2.47	23576	3.11
Massaria	-	-	280	0.12	42	0.02	-	-	322	0.04
Melanosporea	-	-	140	0.06	280	0.12	56	0.03	476	0.06
Metasphaeria	266	0.20	840	0.38	1148	0.50	1050	0.58	3304	0.43
Ootthia	28	0.02	42	0.02	84	0.03	56	0.03	210	0.03

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Parodiella	28	0.02	28	0.01	868	0.38	182	0.10	1106	0.14
Pleospora	560	0.43	700	0.31	1512	0.66	826	0.46	3598	0.47
Sordaria	252	0.19	672	0.30	378	0.16	308	0.17	1610	0.21
Sporormia	140	0.11	378	0.17	420	0.18	392	0.22	1330	0.17
Teichospora	-	-	14	0.01	140	0.06	28	0.01	182	0.02
Total	10990	8.46	25634	11.58	26446	11.63	18732	10.41	81802	10.78
BASIDIOMYCOTINA										
Basidiospores	2660	2.05	6552	2.96	3080	1.35	4200	2.33	16492	2.17
Ganoderma	14	0.01	112	0.05	70	0.03	56	0.03	252	0.03
Rust Spores	140	0.10	280	0.12	308	0.13	126	0.07	854	0.11
Smut Spores	14014	10.79	14560	6.58	18928	8.35	17080	9.49	64582	8.51
Urediniospores	2212	1.70	3528	1.59	4452	1.96	3640	2.02	13832	1.82
Total	19040	14.66	25032	11.31	26838	11.80	25102	13.95	96012	12.66
DEUTEROMYCOTINA										
Alternaria	7140	5.49	13944	6.29	11354	4.99	10080	5.60	42518	5.60
Aspergillus	2100	1.62	7140	3.22	8652	3.80	2800	1.55	20692	2.73
Beltraniella	140	0.11	490	0.22	1064	0.47	1022	0.57	2716	0.36
Beltrania	700	0.54	840	0.38	28	0.01	14	0.01	1582	0.21
Bispora	392	0.30	3178	1.43	3486	1.53	3080	1.71	10136	1.33
Botryodiplodia	14	0.01	14	0.01	28	0.01	56	0.03	112	0.01
Cercospora	140	0.11	560	0.25	812	0.36	630	0.35	2142	0.29
Cladosporium	18200	14.01	26600	12.01	31360	13.79	30800	17.12	106960	14.10
Cordana	28	0.02	70	0.03	98	0.04	84	0.04	280	0.03
Curvularia	17654	13.59	31472	14.21	23464	10.32	16744	9.32	89334	11.78
Dictyoarthrinium	112	0.08	560	0.25	616	0.27	490	0.27	1778	0.23
Diplodia	14	0.01	28	0.01	56	0.02	42	0.02	140	0.02
Epicoccum	560	0.43	924	0.42	1092	0.48	686	0.38	3262	0.43
Fusarium	826	0.63	1624	0.73	2198	0.96	1484	0.82	6132	0.81
Haplosporella	1372	1.05	1750	0.79	1680	0.74	1540	0.85	6342	0.83

EXPERIMENTAL RESULTS

Harknessia	28	0.02	140	0.06	98	0.04	56	0.03	322	0.04
Heliminthosporium	1820	1.40	2100	0.95	2198	0.97	1960	1.09	8078	1.06
Heterosporium	1568	1.21	2128	0.96	2212	0.97	1680	0.93	7588	1.00
Lacellina	1848	1.42	3332	1.50	2968	1.30	2800	1.56	10948	1.44
Lacellinopsis	700	0.54	672	0.30	798	0.35	770	0.43	2940	0.39
Memnoniella	7000	5.39	11214	5.06	9940	4.37	8400	4.67	36554	4.82
Nigrospora	3500	2.69	11816	5.34	9800	4.31	4200	2.33	29316	3.86
Papularia	112	0.08	210	0.09	280	0.12	140	0.08	742	0.09
Penicillium	210	0.16	252	0.11	280	0.12	308	0.17	1050	0.14
Periconia	8400	6.47	11410	5.15	11200	4.94	8750	4.86	39760	5.24
Pestalotia	28	0.02	-	-	70	0.03	-	-	98	0.01
Pithomyces	1232	0.95	1512	0.68	1680	0.74	1540	0.85	5964	0.78
Pseudotorula	2240	1.72	3948	1.78	4060	1.78	3080	1.72	13328	1.76
Pyricularia	112	0.08	126	0.05	140	0.06	154	0.08	532	0.07
Spegazzinia	350	0.27	868	0.39	980	0.43	910	0.50	3108	0.41
Sporidesmium	140	0.11	504	0.22	630	0.28	560	0.31	1834	0.24
Tetraploa	-	-	280	0.01	5488	2.41	3808	2.12	9576	1.26
Torula	14	0.01	112	0.05	84	0.03	56	0.03	266	0.03
Trichoconis	14	0.01	42	0.02	126	0.05	56	0.03	238	0.03
Total	78708	60.61	139860	63.18	139020	61.14	108780	60.48	466368	61.49
OTHER TYPES										
Algal Filaments	1022	0.78	1400	0.63	1680	0.74	1470	0.82	5572	0.73
Epidermal hairs	560	0.43	476	0.21	378	0.16	196	0.11	1610	0.21
Hyphal Fragments	2100	1.62	4200	1.89	4900	2.15	3360	1.87	14560	1.92
Insect Scales	3640	2.87	6160	2.78	5390	2.37	5670	3.15	20860	2.75
Pollen grains	3500	2.69	4760	2.15	5600	2.46	4900	2.72	18760	2.47
Protozoan cysts	490	0.38	630	0.28	672	0.29	700	0.39	2492	0.33
Unidentified Spores	1400	0.08	1498	0.67	1680	0.74	1568	0.87	6146	0.81
Total	12712	9.79	19124	8.64	20300	8.94	17864	9.93	70000	9.24
Grand Total	129864	100	221368	100	227360	100	179872	100	758464	100

Table-III B: The monthwise concentration and percentage contribution of each spore types to the total airspora over Soybean crop field (from: 1st July, 2016 to 31st Oct, 2016).

Spore Types	July-2016		Aug-2016		Sept-2016		Oct-2016		Total Spore Conce/ m ³ of air	% Contribution to the total airspora
	Spore Conce/ m ³ of air	% Contribution	Spore Conce/ m ³ of air	% Contribution	Spore Conce/ m ³ of air	% Contribution	Spore Conce/ m ³ of air	% Contribution		
MYXOMYCOTIN A										
Physarum	2534	1.67	3472	1.33	3752	1.39	2184	1.09	11942	1.36
Stemonitis	1092	0.72	672	0.26	2464	0.91	1526	0.76	5754	0.65
Total	3626	2.39	4144	1.59	6216	2.31	3710	1.86	17696	2.01
ZYGOMYCOTIN A										
Cunnighamella	4312	2.84	5474	2.11	6692	2.48	4928	2.47	21406	2.43
Mucor	-	-	42	0.01	56	0.02	84	0.04	182	0.02
Rhizopus	140	0.09	196	0.07	532	0.19	672	0.34	1540	0.17
Sclerospora	420	0.27	952	0.36	980	0.36	910	0.45	3262	0.37
Total	4872	3.21	6664	2.57	8260	3.07	6594	3.31	26390	2.99
ASCOMYCOTIN A										
Ascospores	84	0.05	70	0.02	140	0.05	168	0.08	462	0.05
Bitrimono spora	140	0.09	840	0.32	1050	0.39	1540	0.77	3570	0.40

EXPERIMENTAL RESULTS

Chaetomium	1260	0.83	1400	0.54	3290	1.22	1680	0.84	7630	0.86
Claviceps	1330	0.87	2800	1.08	3360	1.25	2492	1.25	9982	1.13
Cucurbitaria	812	0.53	1148	0.44	994	0.37	1428	0.71	4382	0.49
Didymospheria	2100	1.38	2940	1.13	2800	1.04	2660	1.33	10500	1.19
Hypoxylon	140	0.09	1190	0.46	1540	0.57	252	0.12	3122	0.35
Leptosphaeria	1680	1.10	4060	1.56	3500	1.29	2660	1.33	11900	1.35
Lophiostoma	4200	2.76	9352	3.60	6398	2.37	4424	2.22	24374	2.77
Massaria	14	0.01	42	0.01	-	-	-	-	56	0.01
Melanospora	-	-	84	0.03	280	0.10	56	0.03	420	0.05
Metasphaeria	350	0.23	1022	0.39	1400	0.52	1260	0.63	4032	0.46
Otthia	56	0.03	98	0.04	210	0.08	126	0.06	490	0.05
Parodiella	-	-	140	0.05	728	0.27	168	0.08	1036	0.12
Pleospora	700	0.46	770	0.29	1680	0.62	868	0.43	4018	0.45
Sordaria	252	0.16	658	0.25	420	0.15	280	0.14	1610	0.18
Sporormia	280	0.18	490	0.19	532	0.19	420	0.21	1722	0.19
Teichospora	56	0.03	140	0.05	490	0.18	280	0.14	966	0.11
Total	13454	8.86	27244	10.49	28812	10.69	20762	10.42	90272	10.26
BASIDIO MYCOTINA										
Basidiospores	1260	0.83	6384	2.46	3052	1.13	1400	0.70	12096	1.37

EXPERIMENTAL RESULTS

Ganoderma	56	0.03	280	0.11	126	0.04	56	0.03	518	0.06
Rust Spores	140	0.09	420	0.16	1400	0.52	980	0.49	2940	0.33
Smut Spores	14672	9.66	15792	6.08	21672	8.04	19838	9.95	71974	8.18
Urediniopores	2576	1.69	3472	1.33	4424	1.64	3794	1.90	14266	1.62
Total	18704	12.32	26348	10.14	30674	11.39	26068	13.08	101794	11.56
DEUTEROMYCOTINA										
Alternaria	10192	6.71	16408	6.32	14840	5.51	11494	5.77	52934	6.01
Aspergillus	3080	2.03	9380	3.61	12222	4.54	3360	1.68	28042	3.18
Beltraniella	140	0.09	854	0.33	1092	0.40	1008	0.50	3094	0.35
Beltrania	252	0.16	518	0.19	210	0.08	140	0.07	1120	0.13
Bispora	490	0.32	3360	1.29	3570	1.32	3290	1.65	10710	1.21
Botryodiplodia	14	0.01	28	0.01	70	0.02	140	0.07	252	0.03
Cercospora	126	0.08	728	0.28	910	0.34	770	0.38	2534	0.29
Cladosporium	28700	18.90	45864	17.66	56000	20.79	38052	19.09	168616	19.16
Cordana	70	0.04	98	0.04	140	0.05	126	0.06	434	0.05
Corynespora	224	0.15	644	0.25	490	0.18	420	0.21	1778	0.20
Curvularia	19390	12.77	34230	13.18	26068	9.68	19460	9.76	99148	11.26
Dictyoarthrinium	294	0.19	630	0.24	672	0.25	560	0.28	2156	0.24
Diplodia	98	0.06	196	0.07	350	0.13	280	0.14	924	0.10

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Drechsler a	14	0.01	98	0.04	84	0.03	14	0.01	210	0.02
Epicoccu m	518	0.34	966	0.37	1106	0.41	574	0.29	3164	0.36
Exosporiu m	-	-	14	0.01	28	0.01	-	-	42	0.01
Fusariella	294	0.19	812	0.31	574	0.21	532	0.26	2212	0.25
Fusarium	560	0.37	1400	0.54	1540	0.57	1372	0.69	4872	0.55
Haplospor ella	1358	0.89	1792	0.69	1400	0.52	1736	0.87	6286	0.71
Harknessi a	98	0.06	210	0.08	168	0.06	140	0.07	616	0.07
Heliminth osporium	1680	1.10	2800	1.08	2380	0.88	2100	1.05	8960	1.02
Heterospor ium	1610	1.06	2240	0.86	2100	0.78	1750	0.88	7700	0.87
Lacellina	2128	1.40	3640	1.40	3290	1.22	3164	1.59	12222	1.39
Lacellinos psis	420	0.28	770	0.29	700	0.26	630	0.31	2520	0.28
Memnoni ella	3080	2.03	11396	4.39	10850	4.03	6160	3.09	31486	3.58
Nigrospor a	5880	3.87	11900	4.58	10430	3.87	8400	4.21	36610	4.17
Papularia	210	0.14	350	0.13	420	0.15	70	0.03	1050	0.12
Penicilliu m	490	0.32	560	0.21	630	0.23	420	0.21	2100	0.24
Periconia	7840	5.16	14014	5.39	12880	4.78	10066	5.05	44800	5.09
Pithomyce s	1540	1.01	2240	0.86	3150	1.17	2800	1.40	9730	1.10
Pseudotor ula	2492	1.64	3094	1.19	2940	1.09	3150	1.58	11676	1.32
Spegazzin ia	252	0.16	420	0.16	700	0.26	350	0.17	1722	0.19

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Sporidesmium	70	0.04	350	0.13	490	0.18	392	0.19	1302	0.15
Tetraploa	2380	1.57	3864	1.49	2800	1.04	2660	1.33	11704	1.33
Torula	70	0.04	224	0.08	280	0.10	168	0.08	742	0.08
Trichoconis	84	0.05	126	0.05	210	0.08	112	0.05	532	0.06
Total	96138	63.32	176218	67.85	175784	65.27	125860	63.15	574000	62.22
OTHER TYPES										
Algal Filaments	2520	1.66	3080	1.18	3290	1.22	3010	1.51	11900	1.35
Epidermal hairs	560	0.37	462	0.18	392	0.14	182	0.09	1596	0.18
Hyphal Fragments	4200	2.76	5740	2.21	4620	1.71	4060	2.03	18620	2.11
Insect Scales	3640	2.39	4480	1.72	5040	1.87	3080	1.54	16240	1.84
Pollen grains	2856	1.88	3780	1.46	4340	1.61	4200	2.11	15176	1.72
Protozoan cysts	140	0.09	280	0.11	350	0.13	308	0.15	1078	0.12
Unidentified Spores	1120	0.74	1260	0.48	1540	0.57	1470	0.74	5390	0.61
Total	15036	9.90	19082	7.35	19572	7.27	16310	8.18	70000	7.95
Grand Total	151830	100	259700	100	269318	100	199304	100	880152	100

Table-IVA: The monthly average percentage contribution of each spore types to the total airspora over Soybean crop field (from: 1st July, 2015 to 31st Oct, 2015).

Sr. No.	Spore Types	July-2015	Aug -2015	Sep -2015	Oct-2015
A)	MYXOMYCOTINA				
1.	Physarum	20.86	28.49	32.75	17.90
2.	Stemonitis	19.26	11.60	43.96	25.18
	Total	20.33	23.05	36.36	20.26
B)	ZYGOMYCOTINA				
1.	Cunnighamella	20.06	26.58	30.66	22.70
2.	Mucor	14.82	29.63	22.22	33.33
3.	Rhizopus	10.17	7.63	42.37	39.83
4.	Sclerospora	9.18	55.04	31.19	4.59
	Total	18.12	28.71	31.32	21.85
C)	ASCOMYCOTINA				
1.	Ascospores	21.43	14.28	28.57	35.72
2.	Bitrimonospora	3.77	22.64	26.42	47.17
3.	Chaetomium	14.32	19.08	44.27	22.33
4.	Claviceps	11.29	33.89	37.86	16.96
5.	Cucurbitaria	17.61	25.16	22.64	34.59
6.	Didymosphaeria	17.59	28.74	28.15	25.52
7.	Hypoxyton	2.36	38.68	50.94	8.02
8.	Leptosphaeria	15.30	34.16	27.32	23.22
9.	Lophiostoma	14.85	39.08	27.19	18.88
10.	Massaria	-	86.95	13.05	-
11.	Melanospora	-	29.42	58.82	11.76
12.	Metasphaeria	8.05	25.42	34.75	31.78
13.	Othia	13.33	20	40	26.67
14.	Parodiella	2.53	2.53	78.48	16.46

15.	Pleospora	15.56	19.45	42.03	22.96
16.	Sordaria	15.65	41.74	23.48	19.13
17.	Sporormia	10.53	28.42	31.58	29.47
18.	Teichospora	-	7.69	76.92	15.39
	Total	13.44	31.34	32.33	22.89
D)	BASIDIOMYCOTINA				
1.	Basidiospores	16.14	39.73	18.67	25.46
2.	Ganoderma	5.55	44.44	27.79	22.22
3.	Rust Spores	16.39	32.79	36.07	14.75
4.	Smut Spores	21.69	22.54	29.31	26.44
5.	Urediniospores	15.99	25.51	32.19	26.31
	Total	19.83	26.08	27.95	26.14
E)	DEUTEROMYCOTIN A				
1.	Alternaria	16.79	32.79	26.70	23.72
2.	Aspergillus	10.15	34.51	41.81	13.53
3.	Beltraniella	5.15	18.04	39.17	37.64
4.	Beltrania	44.26	53.09	1.77	0.88
5.	Bispora	3.87	31.35	34.39	30.39
6.	Botryodiplodia	12.5	12.5	25	50
7.	Cercospora	6.53	26.14	37.91	29.42
8.	Cladosporium	17.02	24.87	29.32	28.79
9.	Cordana	10	25	35	30
10.	Curvularia	19.76	35.23	26.26	18.75
11.	Dictyoarthrinium	6.29	31.49	34.65	27.57
12.	Diplodia	10	20	40	30
13.	Epicoccum	17.17	28.32	33.48	21.03
14.	Fusarium	13.48	26.48	35.84	24.20
15.	Haplosporella	21.63	27.59	26.49	24.29

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16.	Harknessia	8.69	43.48	30.44	17.39
17.	Heliminthosporium	22.53	25.99	27.22	24.26
18.	Heterosporium	20.66	28.04	29.15	22.15
19.	Lacellina	16.88	30.43	27.11	25.58
20.	Lacellinopsis	23.81	22.86	27.14	26.19
21.	Memnoniella	19.15	30.68	27.19	22.98
22.	Nigrospora	11.94	40.30	33.43	14.33
23.	Papularia	15.09	28.30	37.73	18.89
24.	Penicillium	20	24	26.66	29.34
25.	Periconia	21.13	28.69	28.17	22.01
26.	Pestalotia	28.57	-	71.43	-
27.	Pithomyces	20.66	25.35	28.17	25.82
28.	Pseudotorula	16.81	29.62	30.46	23.11
29.	Pyricularia	21.05	23.68	26.32	28.95
30.	Spegazzinia	11.26	27.93	31.53	29.28
31.	Sporidesmium	7.64	27.48	34.35	30.53
32.	Tetraploa	-	2.92	57.31	39.77
33.	Torula	14	5.27	112	42.10
34.	Trichoconis	5.88	17.65	52.94	23.53
	Total	16.88	29.99	29.81	23.32
F)	OTHER TYPES				
1.	Algal Filaments	18.34	25.13	30.15	26.38
2.	Epidermal hairs	34.78	29.57	23.48	12.17
3.	Hyphal Fragments	14.42	28.85	33.65	23.08
4.	Insect Scales	17.45	29.53	25.84	27.18
5.	Pollen grains	18.66	25.37	29.85	26.12
6.	Protozoan cysts	19.66	25.28	26.97	28.09
7.	Unidentified Spores	22.78	24.37	27.33	25.52
	Total	18.66	27.32	29.00	25.52

Table-IV B: The monthly average percentage contribution of each spore types to the total airspora over Soybeancrop field (from: 1st July, 2016 to 31st Oct, 2016).

Sr. No.	Spore Types	July-2016	Aug-2016	Sep- 2016	Oct- 2016
A)	MYXOMYCOTINA				
1.	Physarum	21.22	29.07	31.42	18.29
2.	Stemonitis	18.98	11.68	42.82	26.52
	Total	20.49	23.42	35.13	20.96
B)	ZYGOMYCOTINA				
1.	Cunnighamella	20.14	25.57	31.27	23.02
2.	Mucor	-	23.08	30.77	46.15
3.	Rhizopus	9.09	12.73	34.54	43.64
4.	Sclerospora	12.88	29.18	30.05	27.89
	Total	18.47	25.25	31.29	24.99
C)	ASCOMYCOTINA				
1.	Ascospores	18.18	15.15	30.30	36.37
2.	Bitrimonospora	3.92	23.53	29.41	43.14
3.	Chaetomium	16.51	18.35	43.12	22.02
4.	Claviceps	13.32	28.06	33.66	24.96
5.	Cucurbitaria	18.54	26.19	22.68	32.59
6.	Didymosphaeria	20	28	26.67	25.33
7.	Hypoxydon	4.48	38.11	49.33	8.08
8.	Leptosphaeria	14.12	34.12	29.41	22.35
9.	Lophiostoma	17.23	38.37	26.25	18.15
10.	Massaria	25	75	-	-
11.	Melanospora	-	20	66.66	13.34
12.	Metasphaeria	8.68	25.35	34.72	31.25
13.	Oothia	11.43	20	42.86	25.71
14.	Parodiella	-	13.51	70.27	16.22
15.	Pleospora	17.42	19.16	41.82	21.60

16.	Sordaria	15.65	40.87	26.09	17.39
17.	Sporormia	16.27	28.45	30.89	24.39
18.	Teichospora	5.79	14.49	50.73	28.99
	Total	14.91	30.18	31.92	22.99
D)	BASIDIOMYCOTINA				
1.	Basidiospores	10.42	52.78	25.23	11.57
2.	Ganoderma	10.81	54.06	24.32	10.81
3.	Rust Spores	4.76	14.28	47.63	33.33
4.	Smut Spores	20.38	21.94	30.11	27.57
5.	Urediniospores	18.06	24.34	31.01	26.59
	Total	18.38	25.88	30.13	25.61
E)	DEUTEROMYCOTINA				
1.	Alternaria	19.25	30.99	28.04	27.72
2.	Aspergillus	10.98	33.45	43.59	11.98
3.	Beltraniella	4.52	27.60	35.31	32.57
4.	Beltrania	22.5	46.25	18.75	12.5
5.	Bispora	4.57	31.37	33.33	30.73
6.	Botryodiplodia	5.55	11.11	27.78	55.56
7.	Cercospora	4.97	28.73	35.91	30.39
8.	Cladosporium	17.02	27.20	33.21	22.57
9.	Cordana	16.13	22.58	32.26	29.03
10.	Corynespora	12.59	36.22	27.56	23.63
11.	Curvularia	19.56	34.52	26.29	19.63
12.	Dictyoarthrinium	13.64	29.22	31.17	25.97
13.	Diplodia	10.61	21.21	37.88	30.30
14.	Drechslera	6.67	46.66	40	6.67
15.	Epicoccum	16.38	30.53	34.95	18.14
16.	Exosporium	-	33.33	66.67	-
17.	Fusariella	13.29	36.71	25.95	24.05

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18.	Fusarium	11.49	28.73	31.62	28.16
19.	Haplosporella	21.60	28.51	22.27	27.62
20.	Harknessia	15.91	34.09	27.27	22.73
21.	Heliminthosporium	18.75	31.25	26.56	23.44
22.	Heterosporium	20.91	29.09	27.27	22.73
23.	Lacellina	17.41	29.78	26.92	25.89
24.	Lacelinopsis	16.66	30.55	27.79	25
25.	Memnoniella	9.78	36.19	34.46	19.57
26.	Nigrospora	16.07	32.50	28.49	22.94
27.	Papularia	20	33.33	40	6.67
28.	Penicillium	23.34	26.66	30	20
29.	Periconia	17.5	31.28	28.75	22.47
30.	Pithomyces	15.83	23.02	32.37	28.78
31.	Pseudotorula	21.35	26.49	25.18	26.98
32.	Spegazzinia	14.73	24.39	40.65	20.33
33.	Sporidesmium	5.38	26.88	37.63	30.11
34.	Tetraploa	20.33	33.01	23.93	22.73
35.	Torula	9.43	30.19	37.73	22.65
36.	Trichoconis	15.79	23.68	39.48	21.05
	Total	16.76	30.7	30.62	21.93
F)	OTHER TYPES				
1.	Algal Filaments	21.18	25.88	27.65	25.29
2.	Epidermal hairs	35.09	28.95	24.56	11.40
3.	Hyphal Fragments	22.55	30.83	24.82	21.80
4.	Insect Scales	22.42	27.59	31.03	18.96
5.	Pollen grains	18.82	24.92	28.59	27.67
6.	Protozoan cysts	12.99	25.97	32.47	28.57
7.	Unidentified Spores	20.78	23.38	28.57	27.27
	Total	21.48	27.26	27.96	23.3

Table-VA: The monthwise average percentage contribution of each spore group to the total airspora during First kharif Season from (1st July, 2015 to 31st Oct, 2015).

Sr. No	Spore Group	July	August	September	October
A	Myxomycotina	2.75	1.83	2.81	1.98
B	Zygomycotina	3.73	3.46	3.68	3.24
C	Ascomycotina	8.46	11.58	11.63	10.41
D	Basidiomycotina	14.66	11.31	11.80	13.95
E	Deuteromycotina	60.61	63.18	61.14	60.48
F	Other types	9.79	8.64	8.94	9.93
	Total	100.00	100.00	100.00	100.00

Table-VB: The monthwise average percentage contribution of each spore group to the total airspora during Second kharif Season from (1st July, 2016 to 31st Oct, 2016).

Sr. No	Spore Group	July	August	September	October
A	Myxomycotina	2.39	1.59	2.31	1.86
B	Zygomycotina	3.21	2.57	3.07	3.31
C	Ascomycotina	8.86	10.49	10.69	10.42
D	Basidiomycotina	12.32	10.14	11.39	13.08
E	Deuteromycotina	63.32	67.85	65.27	63.15
F	Other types	9.90	7.35	7.27	8.18
	Total	100.00	100.00	100.00	100.00

Table-VI A: The monthly average percentage contribution of each spore group to the airspora during First Kharif Season from (1st July, 2015 to 31st Oct, 2015).

Sr. No	Spore Group	July	August	September	October	Total
A	Myxomycotina	20.33	23.05	36.36	20.26	100.00
B	Zygomycotina	18.12	28.71	31.32	21.85	100.00
C	Ascomycotina	13.44	31.34	32.33	22.89	100.00
D	Basidiomycotina	19.83	26.08	27.95	26.14	100.00
E	Deuteromycotina	16.88	29.99	29.81	23.32	100.00
F	Other types	18.16	27.32	29.00	25.52	100.00

Table-VI B: The monthly average percentage contribution of each spore group to the airspora during Second Kharif Season from (1st July, 2016 to 31st Oct, 2016).

Sr. No	Spore Group	July	August	September	October	Total
A	Myxomycotina	20.49	23.42	35.13	20.96	100.00
B	Zygomycotina	18.47	25.25	31.29	24.99	100.00
C	Ascomycotina	14.91	30.18	31.92	22.99	100.00
D	Basidiomycotina	18.38	25.88	30.13	25.61	100.00
E	Deuteromycotina	16.76	30.7	30.62	21.93	100.00
F	Other types	21.48	27.26	27.96	23.3	100.00

Table-VII: The monthwise total Seasonal Concentration of each spore group to the total airspora in the Ist and IInd Seasons.

Spore Group	July		August		September		October	
	I 2015	II 2016	I 2015	II 2016	I 2015	II 2016	I 2015	II 2016
Myxomycotina	3570	3626	4046	4144	6384	6216	3556	3710
Zygomycotina	4844	4872	7672	6664	8372	8260	5838	6594
Ascomycotina	10990	13454	25634	27244	26446	28812	18732	20762
Basidiomycotina	19040	18704	25032	26348	26838	30674	25102	26068
Deuteromycotina	78708	96138	139860	176218	139020	175784	108780	125860
Other types	12712	15036	19124	19082	20300	19572	17864	16310
Total	129864	151830	221368	259700	227360	269318	179872	199304

Table-VIII: Total spore concentration and percentage contribution of each spore group during Ist and IInd season (Season I: From 01st July, 2015 to 31st Oct, 2015; and Season II: From 01st July, 2016 to 31st Oct, 2016).

Spore Group	Total Spore Conce/m ³ of air			% contribution		Avg. % to the total airspora
	Season I	Season II	Season I and II	Season I	Season II	
Myxomycotina	17556	17696	32252	2.31	2.01	2.16
Zygomycotina	26726	26390	53116	3.52	2.99	3.24
Ascomycotina	81802	90272	172074	10.78	10.26	10.50
Basidiomycotina	96012	101794	197806	12.66	11.56	12.07
Deuteromycotina	466368	574000	1040368	61.49	65.22	63.49
Other types	70000	70,000	140000	9.23	7.95	8.54
Total	758464	880152	16,38616	100.00	100.00	100.00

Table-IX: Concentration between certain pathogenic fungal spore types and percentage contribution during (Season I: 1st July, 2015 to 31st Oct, 2015 and Season II: 1st July, 2016 to 31st Oct, 2016).

Sr.No	Pathogenic spore types	Seasons total spores/m ³ of air		% contribution to the total airspora		Disease
		I Season	II Season	I season	II Season	
1	Alternaria	42518	52934	5.60	6.01	Leaf spot
2	Cercospora	2142	2534	2.73	3.18	Leaf spot
3	Curvularia	89334	99148	11.78	11.26	Leaf spot
4	Periconia	39760	44800	5.24	5.09	Leaf spot
5	Rust spores	854	2940	0.11	0.33	Rust

Table-1A: Variation in total number and percentage contribution of different fungal colonies the air of Soybean crop fields by Petriplate exposure from (Season I: July, 2015 to Oct, 2015 and Season II: July, 2016 to Oct, 2016).

Sr. No	Fungal type	Total number of colonies	Percentage (%)
A)	ZYGOMYCOTINA		
1.	Cunnighamella	04	0.18
2.	Mucor	21	0.97
3.	Pythium	11	0.51
4.	Rhizopus cohinii	57	2.64
5	Rhizopus	30	1.39
	Total	123	5.69
B)	ASCOMYCOTINA		
1	Chaetomium	05	0.23
2	Neurospora	106	4.91
	Total	111	5.15
C)	DEUTEROMYCOTINA		
1.	Alternaria	137	6.35
2.	Aspergillus Flavus	71	3.29
3	Aspergillus Niger	269	12.46
4	Aspergillus	265	12.28
5	Bipolaris	19	0.88
6	Cladosporium	265	12.28
7	Curvularia	157	7.27
8	Diplodia	12	0.55
9	Epicoccum	04	0.18

10	Fusarium	59	2.13
11	Helminthosporium	46	2.06
12	Humicola	15	0.69
13	Penicillium implicatum	11	0.51
14	Penicillium sp.	142	6.58
15	Papularia	05	0.23
16	Pestalotia	08	0.37
17	Phoma	07	0.32
18	Torula	04	0.18
19	Trichoderma Veride	08	0.37
	Total	1504	69.69
D)	MYCELIA STERILIA		
1	Unclassified group	420	19.47
	Total	420	19.47
	Grand total	2158	100

Table-2A: The monthwise fungal colony counts of different fungi the air of Soybean crop field by Petri plate exposure from (Season I: July, 2015 to Oct, 2015).

Sr. No	Fungal type	July	Aug	Sept	Oct	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	-	-	01	-	01
2.	Mucor	01	01	02	06	10
3.	Pythium	-	-	-	05	05
4.	Rhizopus cohinii	01	05	10	08	24
5	Rhizopus	02	02	03	05	12
	Total	04	08	16	24	52
B)	ASCOMYCOTINA					
1	Chaetomium	-	02	-	-	02
2	Neurospora	10	20	15	03	48

	Total	10	22	15	03	50
C)	DEUTEROMYCOTINA					
1.	Alternaria	10	10	15	25	60
2.	Aspergillus Flavus	05	02	03	20	30
3	Aspergillus Niger	25	30	35	30	120
4	Aspergillus	30	25	20	90	165
5	Bipolaris	-	03	02	02	07
6	Cladosporium	30	20	30	20	100
7	Curvularia	07	10	20	30	67
8	Diplodia	02	-	02	02	06
9	Epicoccum	-	-	-	01	01
10	Fusarium	03	10	03	20	36
11	Helminthosporium	03	-	03	10	16
12	Humicola	01	05	-	-	06
13	Penicillium implicatum	01	02	-	01	04
14	Penicillium sp.	15	07	05	30	57
15	Papularia	-	-	-	01	01
16	Pestalotia	03	-	-	-	03
17	Phoma	03	-	-	01	04
18	Torula	-	-	-	01	01
19	Trichoderma Veride	01	01	-	03	05
	Total	139	125	138	287	689
D)	MYCELIA STERILIA					
1	Unclassified group	60	40	30	40	170
	Total	60	40	30	40	170
	Grand Total	213	195	199	354	961

Table-2B: The monthwise fungal colony counts of different fungi the air of Soybean crop field by Petriplate exposure from (Season II: July, 2016 to Oct, 2016).

Sr. No	Fungal type	July	Aug	Sept	Oct	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	-	-	03	-	03
2.	Mucor	02	01	06	02	11
3.	Pythium	-	-	-	06	06
4.	Rhizopus cohinii	-	06	15	12	33
5	Rhizopus	03	03	05	07	18
	Total	05	10	29	27	71
B)	ASCOMYCOTINA					
1	Chaetomium	-	03	-	-	03
2	Neurospora	12	25	18	03	58
	Total	12	28	18	03	61
C)	DEUTEROMYCOTINA					
1.	Alternaria	12	15	20	30	77
2.	Aspergillus Flavus	07	04	05	25	41
3	Aspergillus Niger	30	40	40	39	149
4	Aspergillus	35	30	25	10	100
5	Bipolaris	04	03	03	02	12
6	Cladosporium	50	40	45	30	165
7	Curvularia	10	10	30	40	90
8	Diplodia	-	03	03	-	06
9	Epicoccum	-	02	01	-	03
10	Fusarium	05	01	05	12	23

11	Helminthosporium	06	07	09	08	30
12	Humicola	-	05	-	04	09
13	Penicillium implicatum	01	02	-	04	07
14	Penicillium sp.	20	15	10	40	85
15	Papularia	01	-	02	01	04
16	Pestalotia	01	02	01	01	05
17	Phoma	01	01	-	01	03
18	Torula	01	01	-	01	03
19	Trichoderma veride	01	01	-	01	03
	Total	185	182	199	249	815
D)	MYCELIA STERILIA					
1	Unclassified Group	70	50	40	90	250
	Total	70	50	40	90	250
	Grand Total	272	270	286	369	1197

Table-3A: The monthwise average percentage contribution of fungal colonies, the air of Soybean crop field by Petri plate exposure from (Season I: July, 2015 to Oct, 2015).

Sr. No	Fungal type	July	Aug	Sept	Oct	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	--	--	0.50	--	0.10
2.	Mucor	0.47	0.52	1.01	1.69	1.04
3.	Pythium	--	--	--	1.41	0.52
4.	Rhizopus cohinii	0.47	2.56	5.02	2.26	2.49
5	Rhizopus	0.94	1.02	1.51	1.41	1.26
	Total	1.87	4.10	8.04	6.79	5.42
B)	ASCOMYCOTINA					

1	Chaetomium	--	1.02	--	--	0.22
2	Neurospora	4.69	10.26	7.54	0.85	4.99
	Total	4.69	11.28	7.54	0.85	5.20
C)	DEUTEROMYCOTINA					
1.	Alternaria	4.69	5.13	7.54	7.06	6.24
2.	Aspergillus Flavus	2.35	1.02	1.51	5.66	3.12
3	Aspergillus Niger	11.74	15.38	17.58	8.48	12.49
4	Aspergillus	14.08	12.82	10.05	25.42	17.18
5	Bipolaris	--	1.54	1.01	0.56	0.73
6	Cladosporium	14.08	10.26	15.07	5.65	10.41
7	Curvularia	3.28	5.14	10.05	8.48	6.97
8	Diplodia	0.94	--	1.01	0.56	0.62
9	Epicoccum	--	--	--	0.28	0.10
10	Fusarium	1.41	5.14	1.51	5.66	3.75
11	Helminthosporium	1.41	--	1.51	2.83	1.67
12	Humicola	0.47	2.56	--	--	0.62
13	Penicillium implicatum	0.47	1.02	--	0.29	0.41
14	Penicillium sp.	7.04	3.58	2.51	8.47	5.93
15	Papularia	--	--	--	0.28	0.10
16	Pestalotia	1.41	--	--	--	0.31
17	Phoma	1.41	--	--	0.28	0.42
18	Torula	--	--	--	0.28	0.10
19	Trichoderma veride	0.47	0.51	--	0.85	0.52
	Total	65.27	64.10	69.35	81.07	71.69
D)	MYCELIA STERILIA					
1	Unclassified group	28.17	20.52	15.07	11.29	17.69
	Total	28.17	20.52	15.07	11.29	17.69

Table-3B: The monthwise average percentage contribution of fungal colonies, the air of Soybean crop field by Petri plate exposure from (Season II: July, 2016 to Oct, 2016).

Sr. No	Fungal type	July	Aug	Sept	Oct	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	--	--	1.05	--	0.25
2.	Mucor	0.73	0.37	2.09	0.52	0.93
3.	Pythium	--	--	--	1.62	0.50
4.	Rhizopus cohinii	--	2.23	5.26	3.22	2.76
5	Rhizopus	1.10	1.11	1.75	1.85	1.50
	Total	1.84	3.70	10.14	7.32	5.94
B)	ASCOMYCOTINA					
1	Chaetomium	--	1.11	--	--	0.25
2	Neurospora	4.41	9.26	6.29	0.80	4.84
	Total	4.41	10.37	6.29	0.81	5.09
C)	DEUTEROMYCOTINA					
1.	Alternaria	4.41	5.56	6.99	8.12	6.44
2.	Aspergillus Flavus	2.57	1.48	1.76	6.75	3.43
3	Aspergillus niger	11.03	14.81	13.98	10.55	12.45
4	Aspergillus	12.88	11.11	8.75	2.70	8.36
5	Bipolaris	1.47	1.11	1.05	0.52	1.00
6	Cladosporium	18.38	14.81	15.74	8.13	13.78
7	Curvularia	3.68	3.71	10.49	10.80	7.52
8	Diplodia	--	1.11	1.05	--	0.50
9	Epicoccum	--	0.74	0.35	--	0.25
10	Fusarium	1.84	0.37	1.75	3.24	1.92

11	Helminthosporium	2.20	2.59	3.15	2.15	2.51
12	Humicola	--	1.85	--	1.47	0.75
13	Penicillium implicatum	0.37	0.74	--	1.08	0.58
14	Penicillium sp.	7.35	5.56	3.49	10.84	7.10
15	Papularia	0.37	--	0.69	0.25	0.33
16	Pestalotia	0.37	0.74	0.35	0.26	0.42
17	Phoma	0.37	0.37	--	0.26	0.25
18	Torula	0.37	0.37	--	0.26	0.25
19	Trichoderma veride	0.37	0.37	--	0.26	0.25
	Total	68.02	67.41	69.59	67.48	68.09
D)	MYCELIA STERILIA	--	--	--	--	--
1	Unclassified group	25.73	18.52	13.98	24.35	20.88
	Total	25.73	18.52	13.98	24.39	20.88

Table-4A: The monthwise total colonies count of each fungal group, the air of Soybean crop field by Petriplate exposure from (season I: July, 2015 to Oct, 2015).

Sr. No	Spore group	July	Aug	Sept	Oct	Total
1.	Zygomycotina	04	08	16	24	52
2.	Ascomycotina	10	22	15	03	50
3.	Deuteromycotina	139	125	138	287	689
4.	Mycelia sterilia	60	40	30	40	170
	Total	213	195	199	354	961

Table-4B: The monthwise total average percentage contributions of each fungal group, the air of Soybean crop field by Petri plate exposure from (season I: July, 2015 to Oct, 2015).

Sr. No	Spore group	July	Aug	Sept	Oct	Total
1.	Zygomycotina	1.87	4.10	8.04	6.79	5.42
2.	Ascomycotina	4.69	11.28	7.54	0.85	5.20
3.	Deuteromycotina	65.27	64.10	69.35	81.07	71.69
4.	Mycelia sterilia	28.17	20.52	15.07	11.29	17.69
	Total	100.00	100.00	100.00	100.00	100.00

Table-5A: The monthwise total colonies count of each fungal group, the air of Soybean crop field by Petri plate exposure from (Season II: July, 2016 to Oct, 2016).

Sr. No	Spore group	July	Aug	Sept	Oct	Total
1.	Zygomycotina	05	10	29	27	71
2.	Ascomycotina	12	28	18	03	61
3.	Deuteromycotina	185	182	199	249	815
4.	Mycelia sterilia	70	50	40	90	250
	Total	272	270	286	369	1197

Table-5B: The monthwise total average percentage contributions of each fungal group, the air of Soybean crop field by Petri plate exposure from (Season II: July, 2016 to Oct, 2016).

Sr. No	Spore group	July	Aug	Sept	Oct	Total
1.	Zygomycotina	1.84	3.70	10.14	7.32	5.94
2.	Ascomycotina	4.41	10.37	6.29	0.81	5.09
3.	Deuteromycotina	68.02	67.41	69.59	67.48	68.09
4.	Mycelia sterilia	25.73	18.52	13.98	24.39	20.88
	Total	100.00	100.00	100.00	100.00	100.00

Table-6A: The Seasonwise total number of fungal colonies and percentage contribution of each spore group from (Season I: July, 2015 to Oct, 2015 and Season II: July, 2016 to Oct, 2016).

Sr. No	Spore group	Total fungal colonies		Total fungal colonies	% contribution		Avg. %
		Season I	Season II	seasons I and II	Season I	Season II	
1.	Zygomycotina	52	71	123	5.42	5.94	5.69
2.	Ascomycotina	50	61	111	5.20	5.09	5.15
3.	Deuteromycotina	689	815	1504	71.69	68.09	69.69
4.	Mycelia sterilia	170	250	420	17.69	20.88	19.47
	Total	961	1197	2158	100.00	100.00	100.00

PLATE - 3



View of the Soybean Field



View of the Tilak Air sampler in the Soybean Field

PLATE - 4



Frogeye Leaf spot on Soybean



Mildew disease on soybean Leaf



Rust of Soybean Leaf

SOYBEAN CROP – GRAPHS

Fig-I.A-F: Histograms showing monthwise concentration and percentage contribution of each spore types to the total airspora over Soybean crop fields from (Season first: 1st July, 2015 to 31st Oct, 2015).

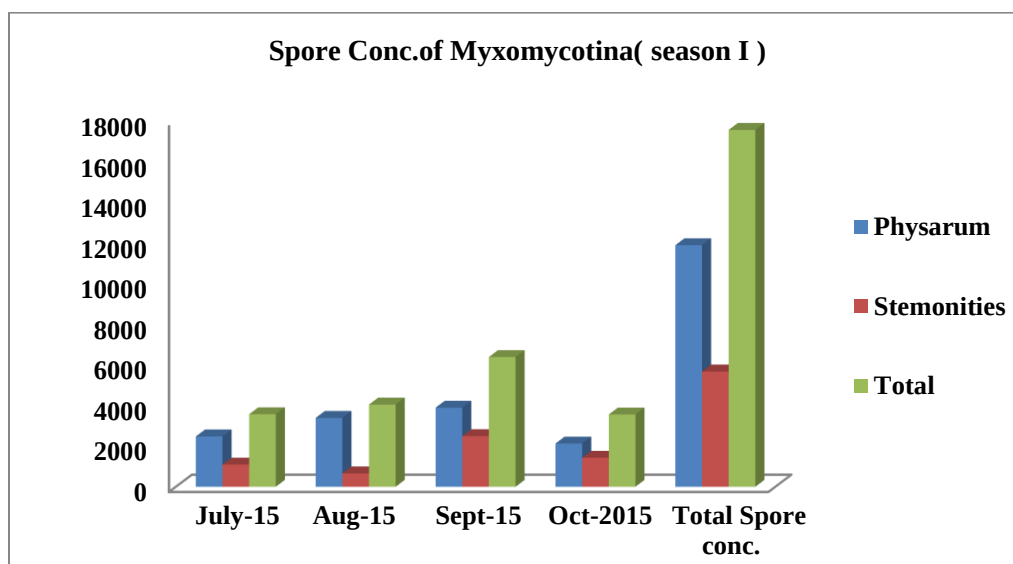
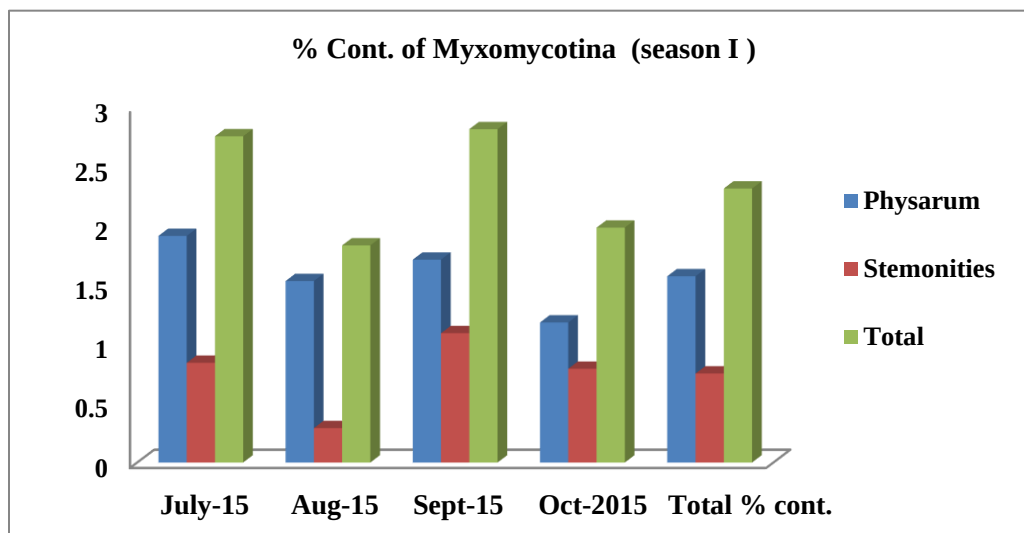
Fig-I: A

Fig-I: B

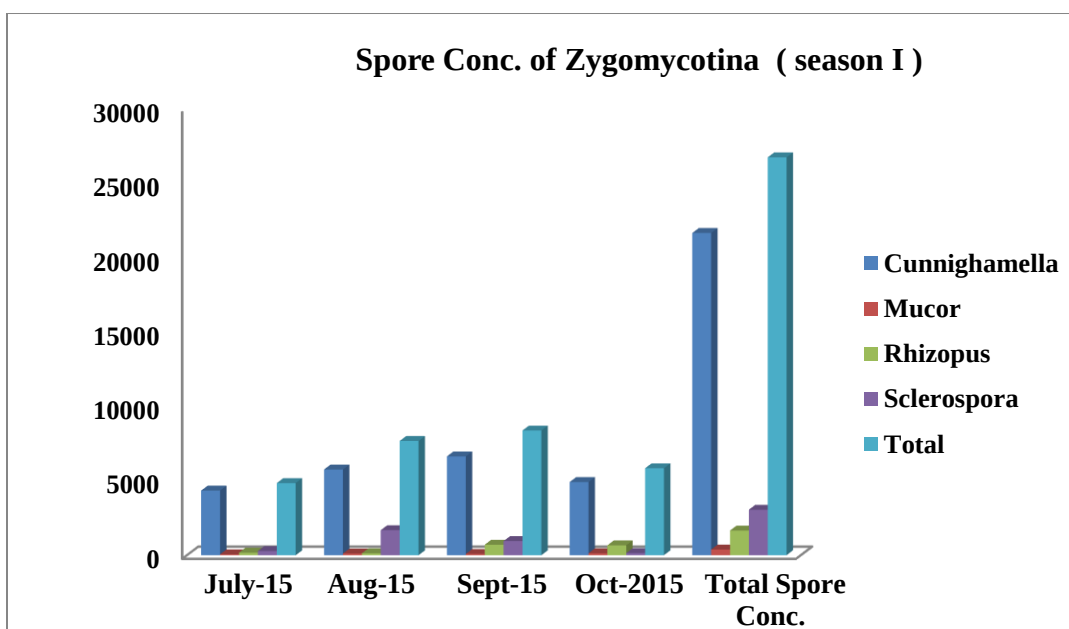
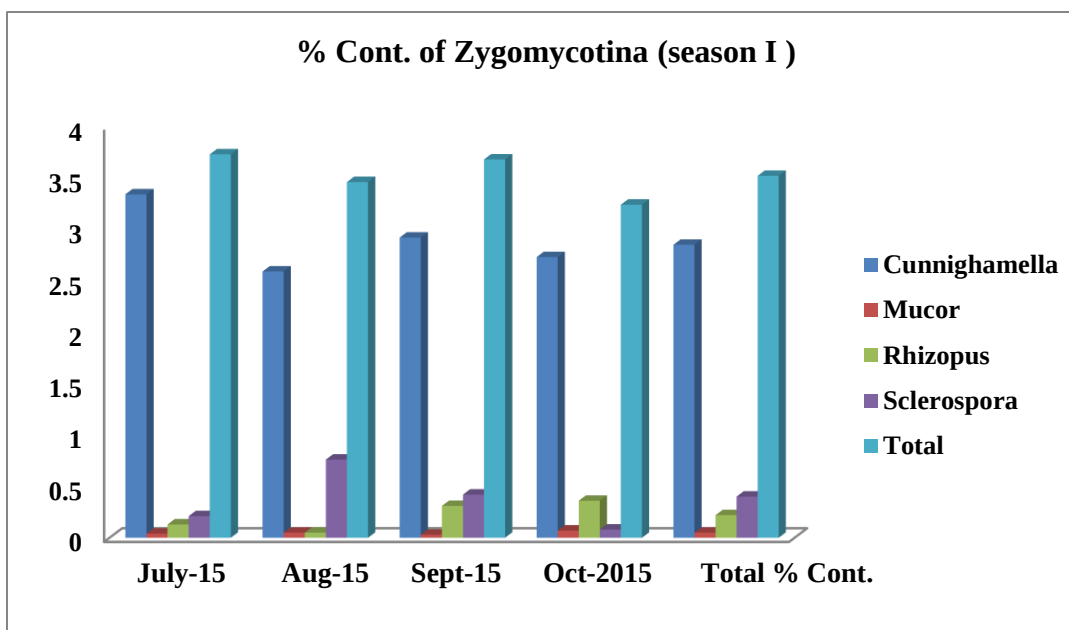


Fig-I: C

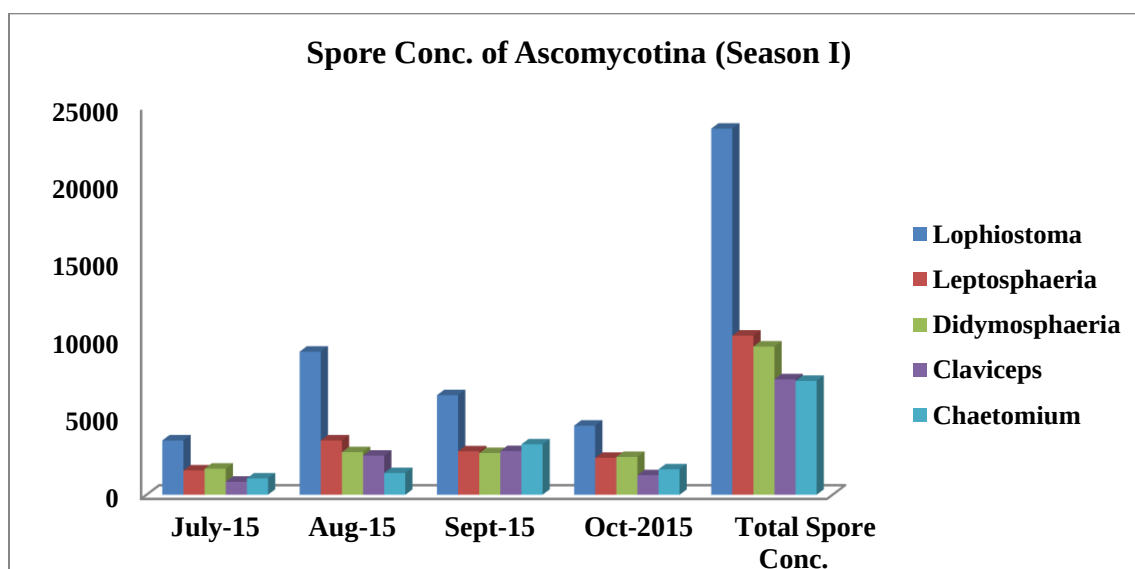
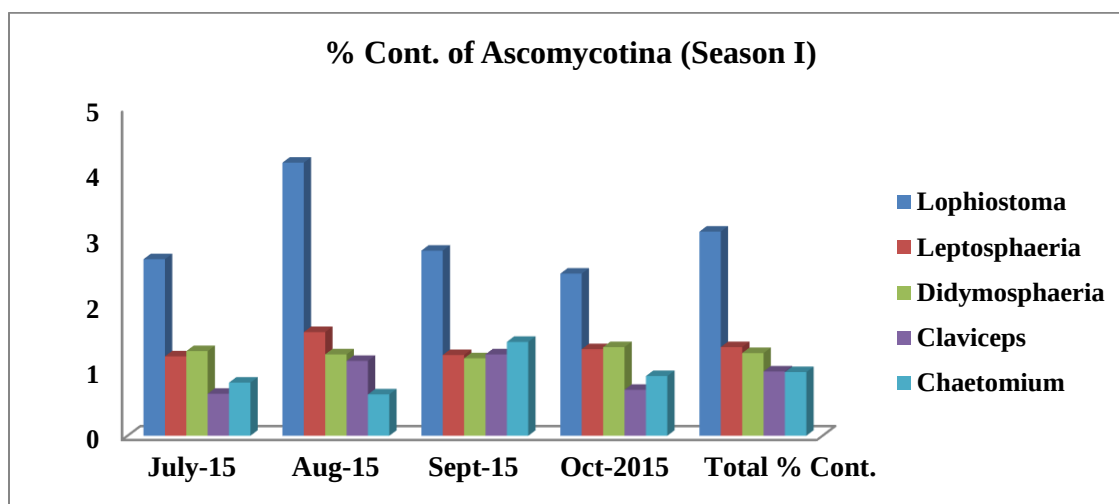


Fig-I: D

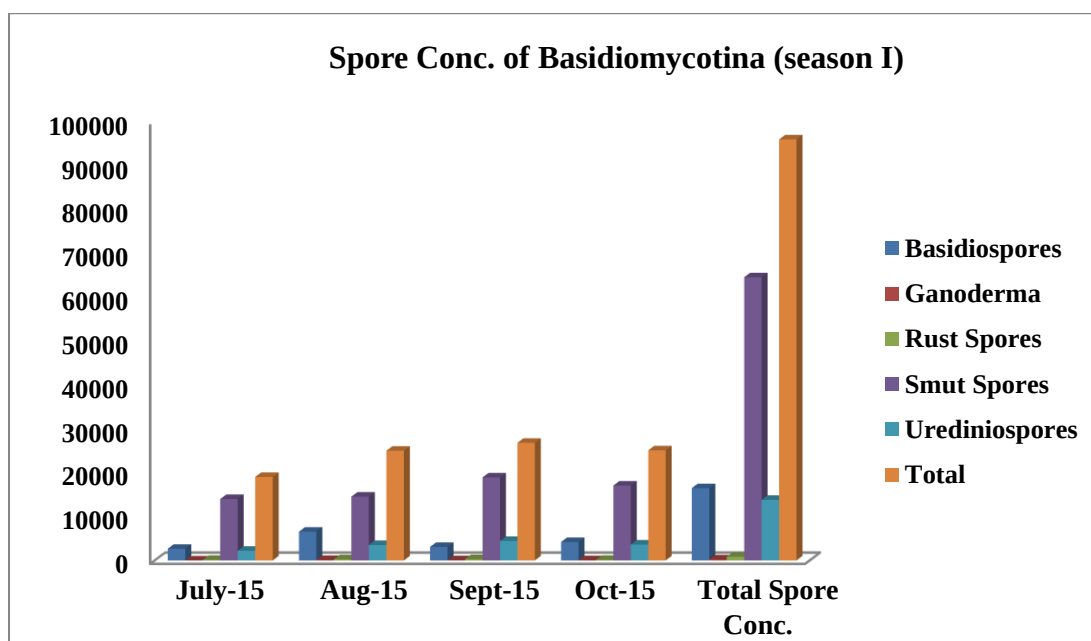
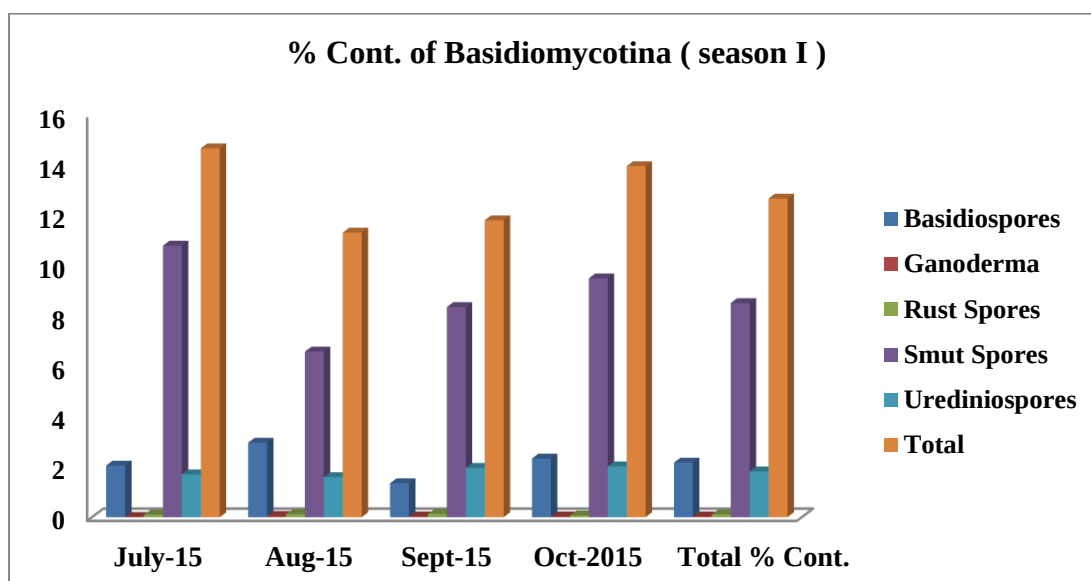


Fig-I: E

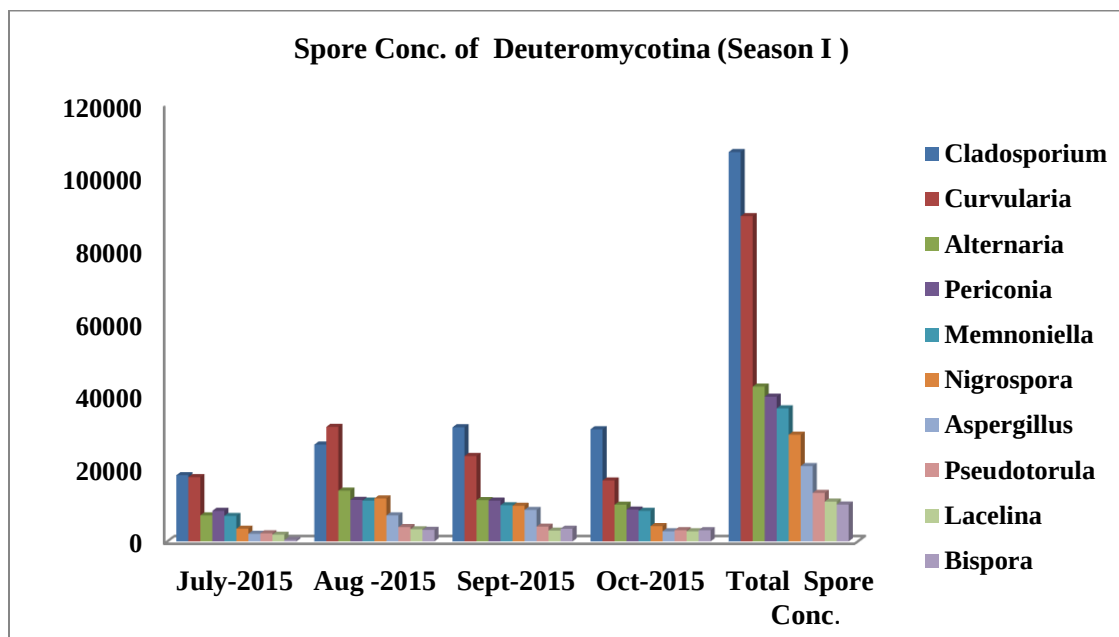
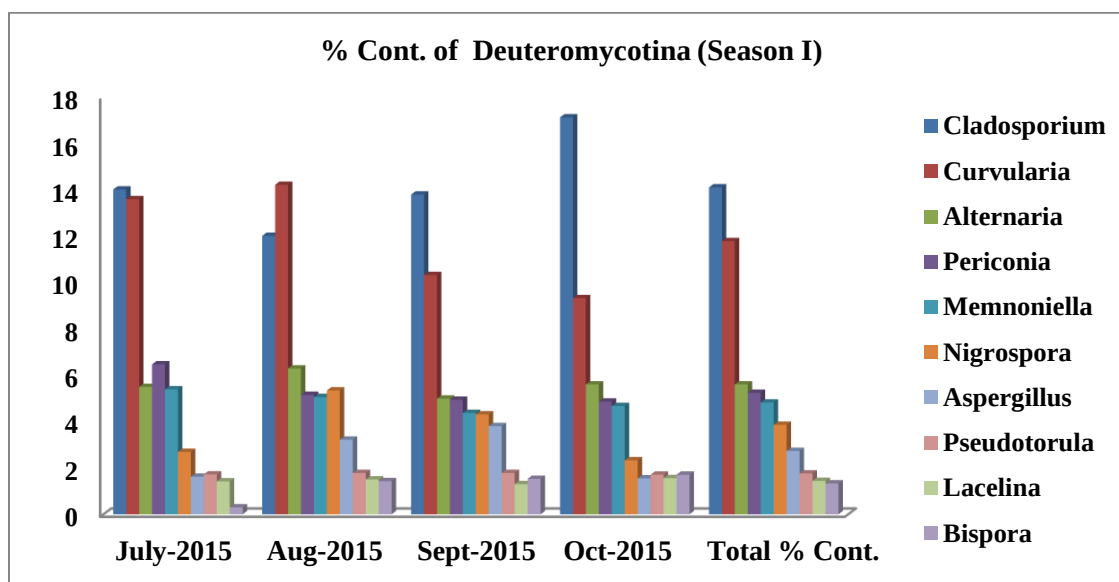


Fig-I: F

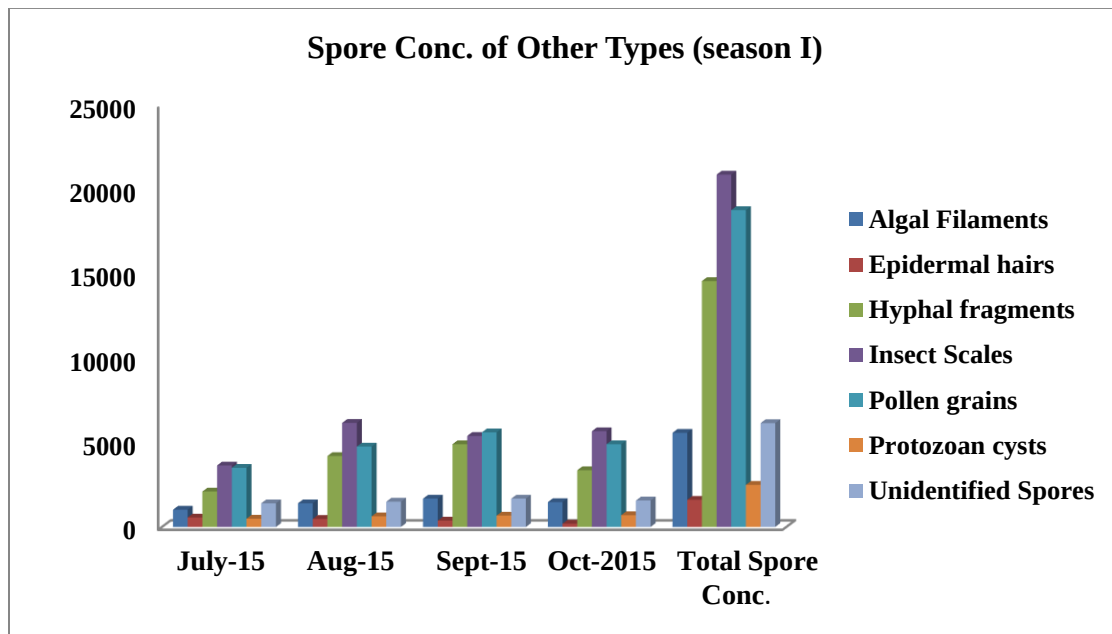
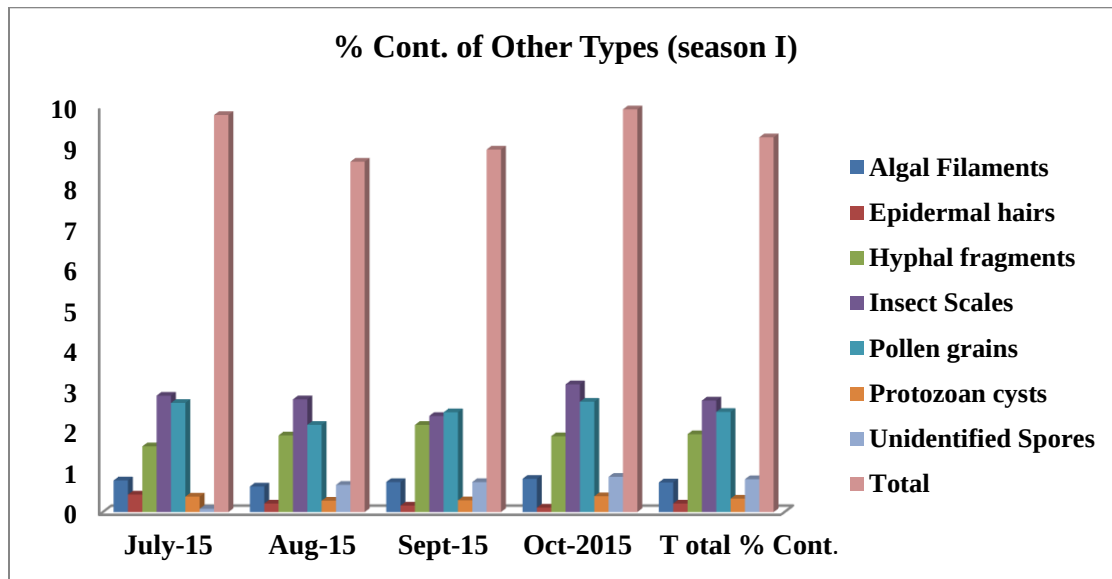


Fig-II.A-F: Histograms showing monthwise concentration and percentage contribution of each spore types to the total airspora Over Soybean crop field from (Season II: 1st July, 2016 to 31st Oct, 2016).

Fig-II: A

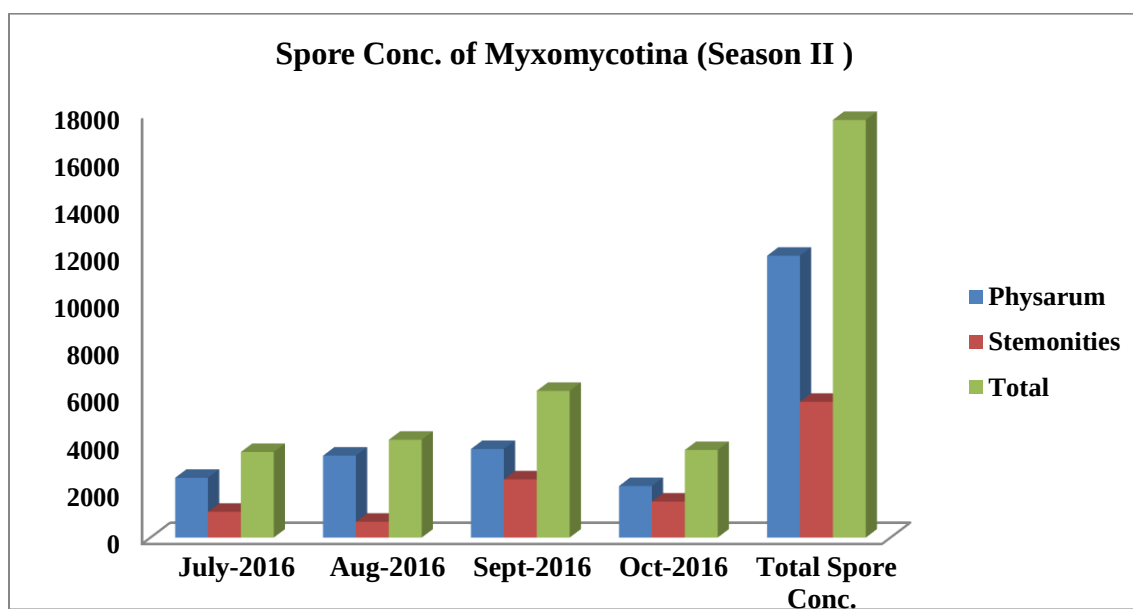
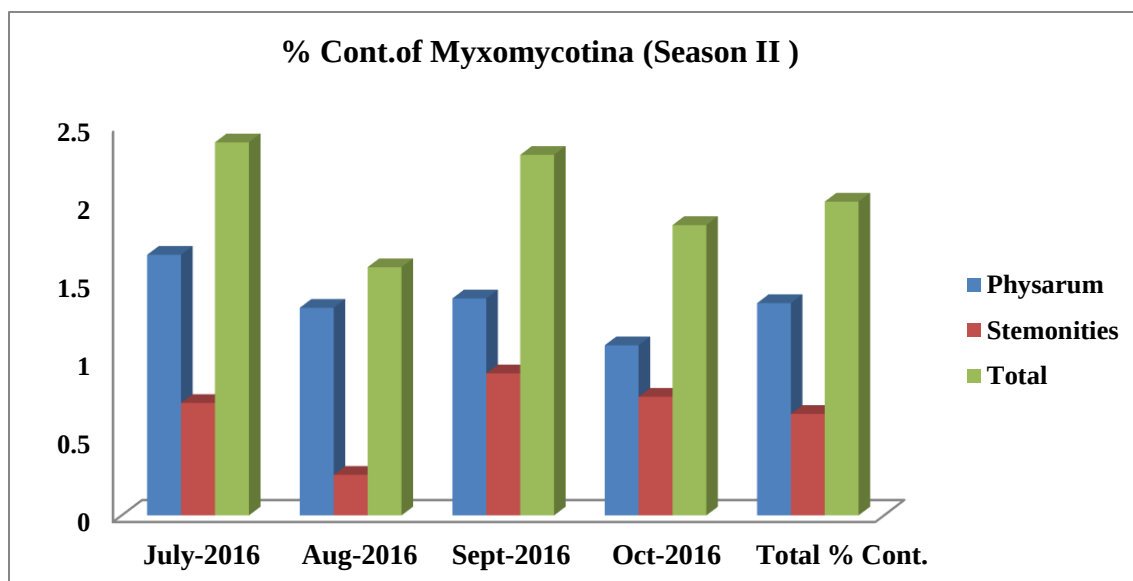


Fig-II: B

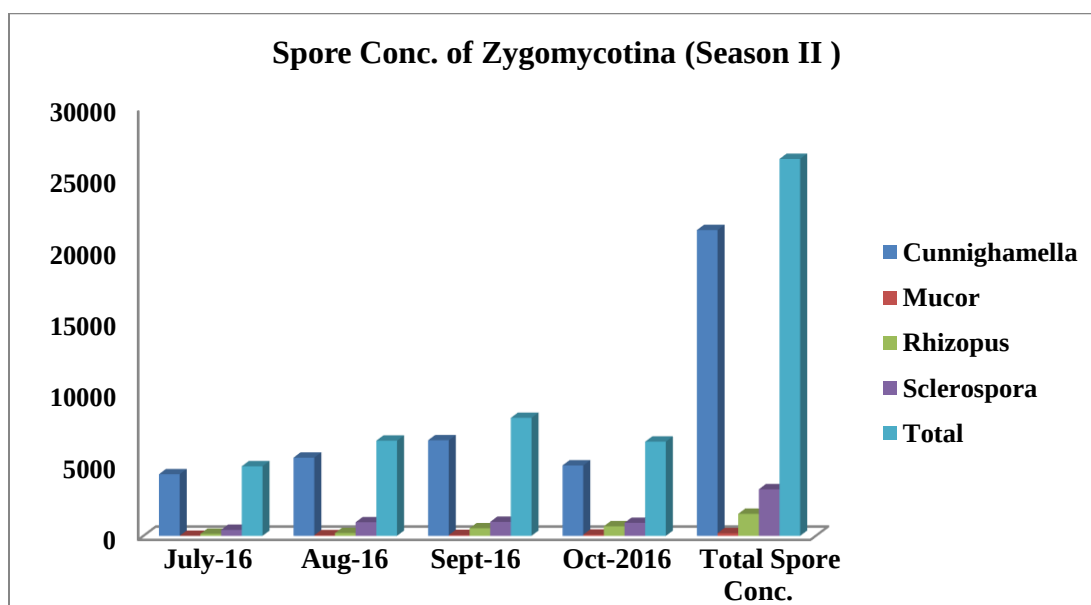
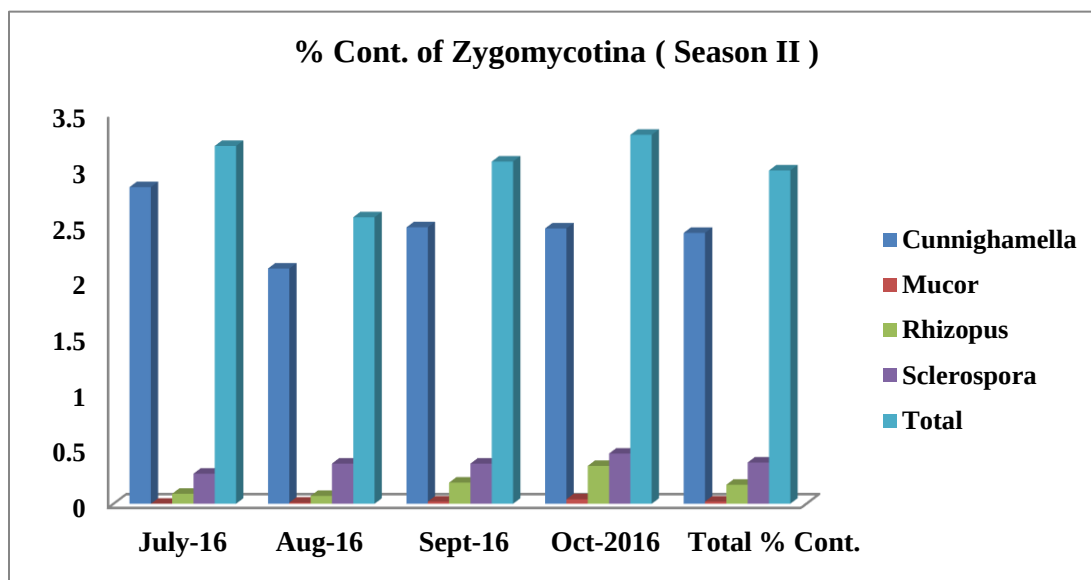


Fig-II: C

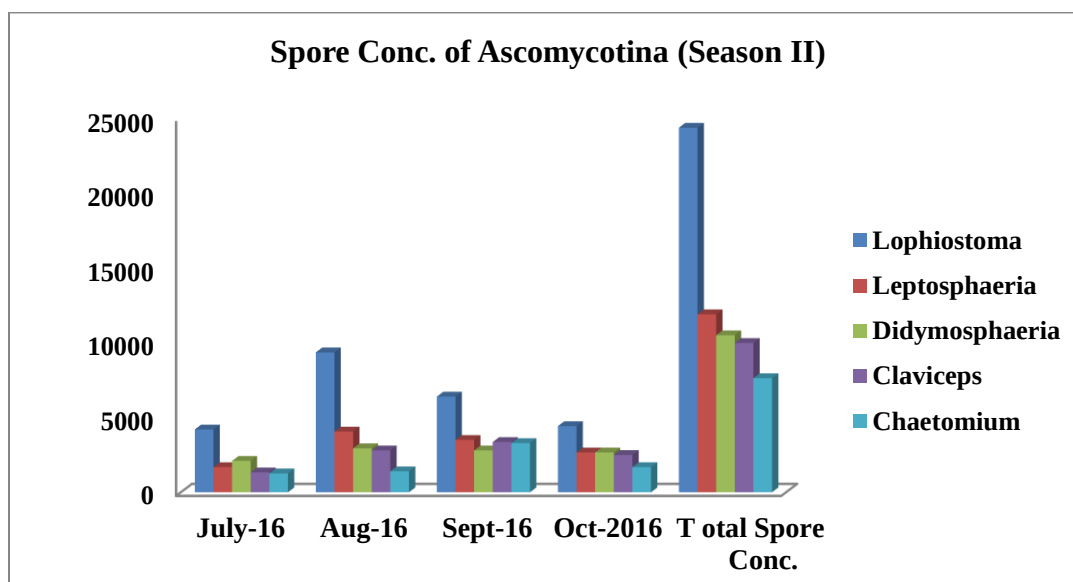
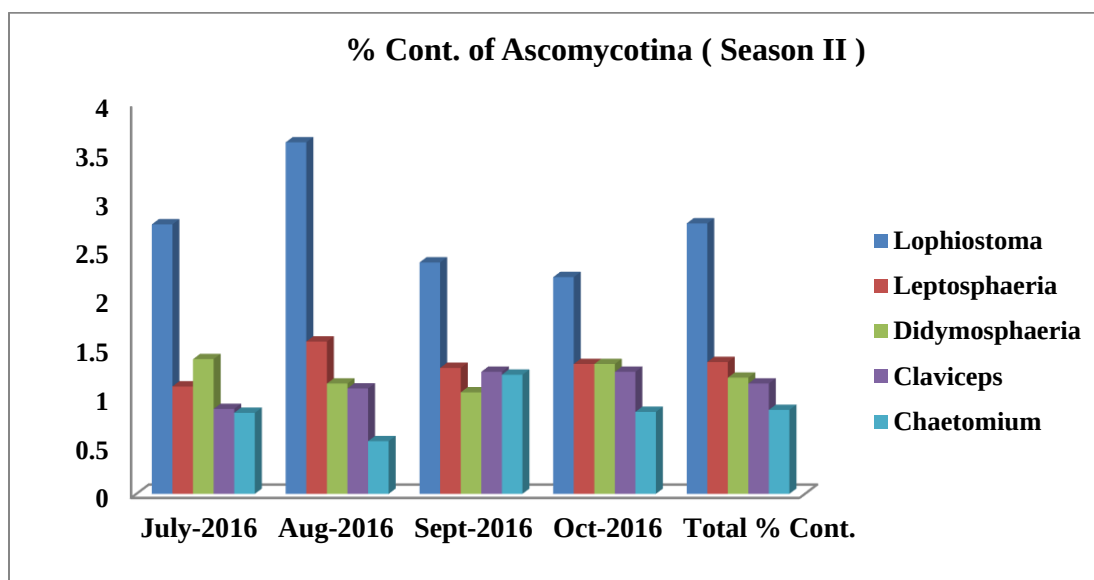


Fig-II: D

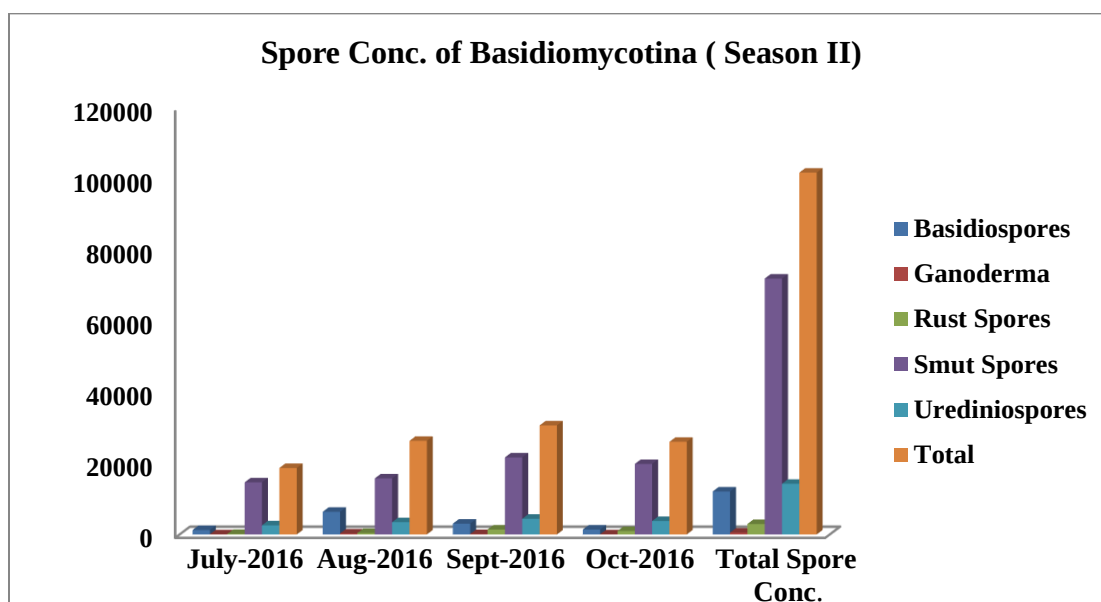
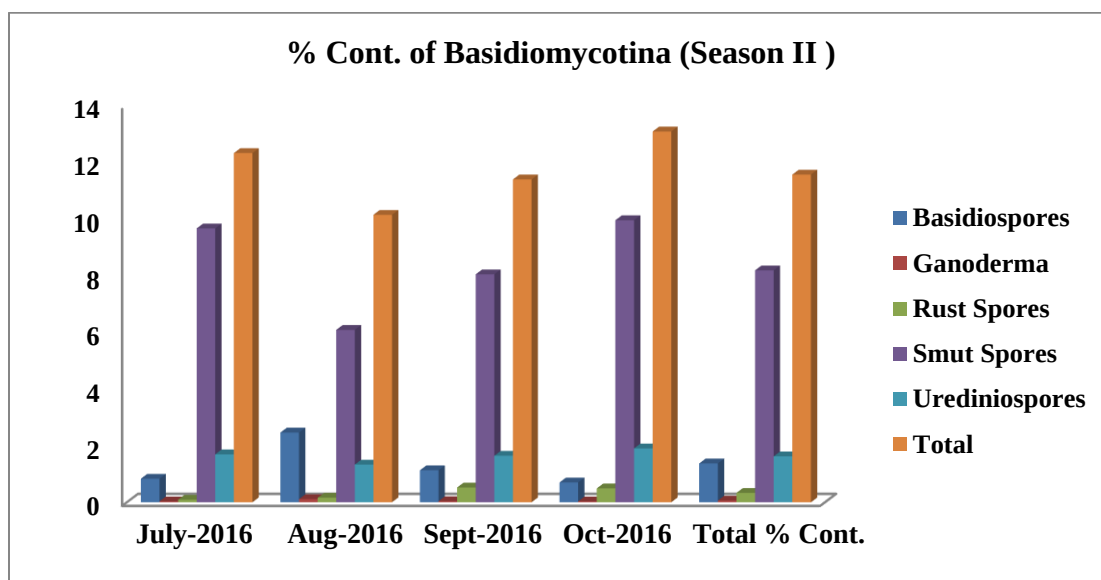


Fig-II: E

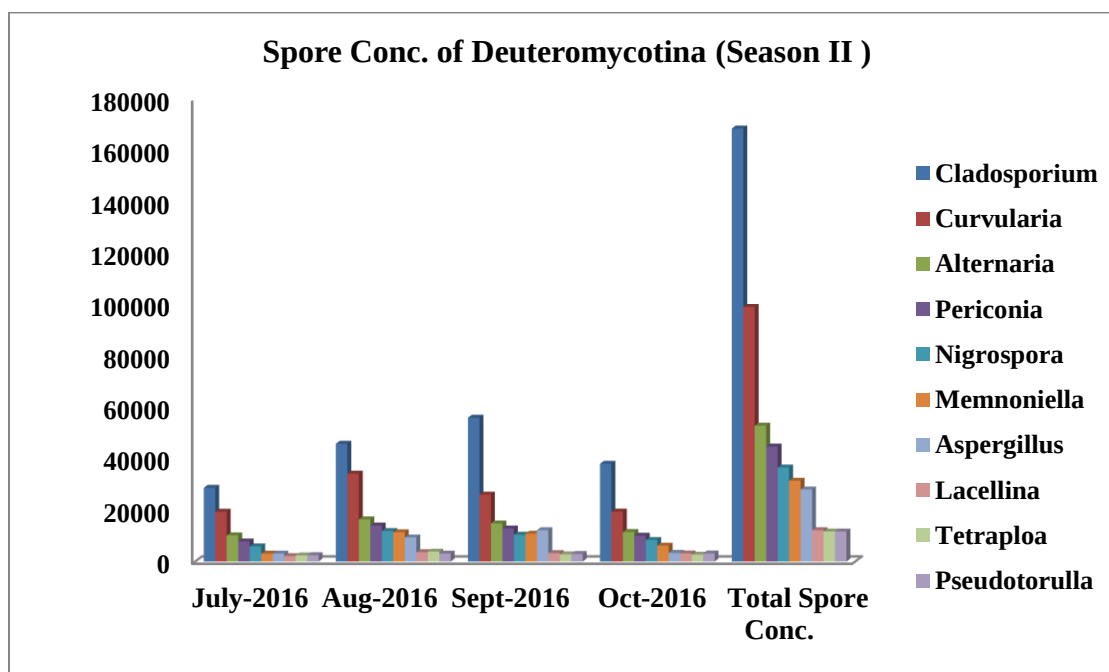
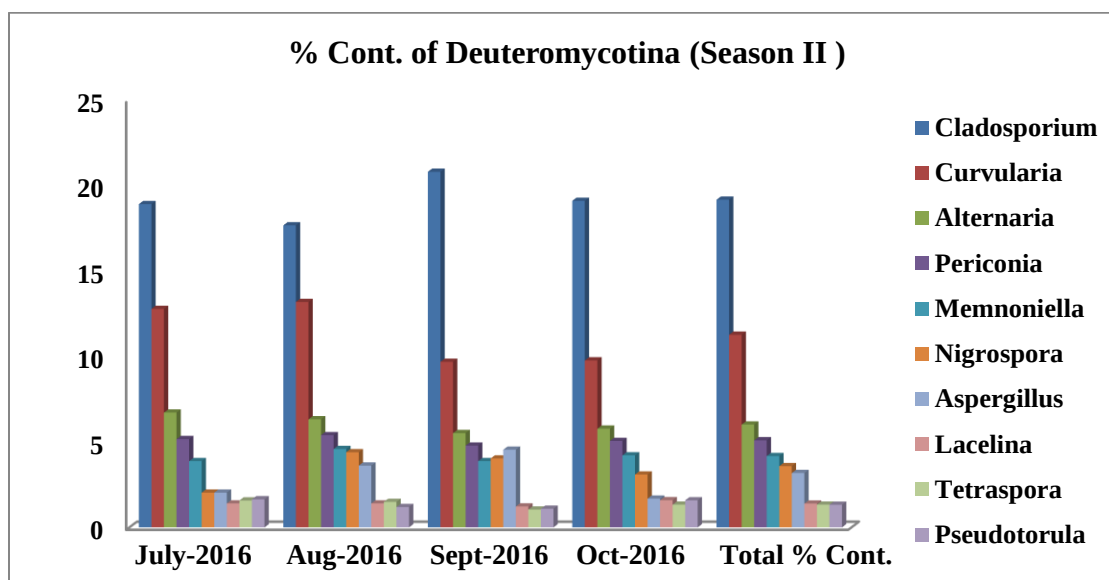


Fig-II: F

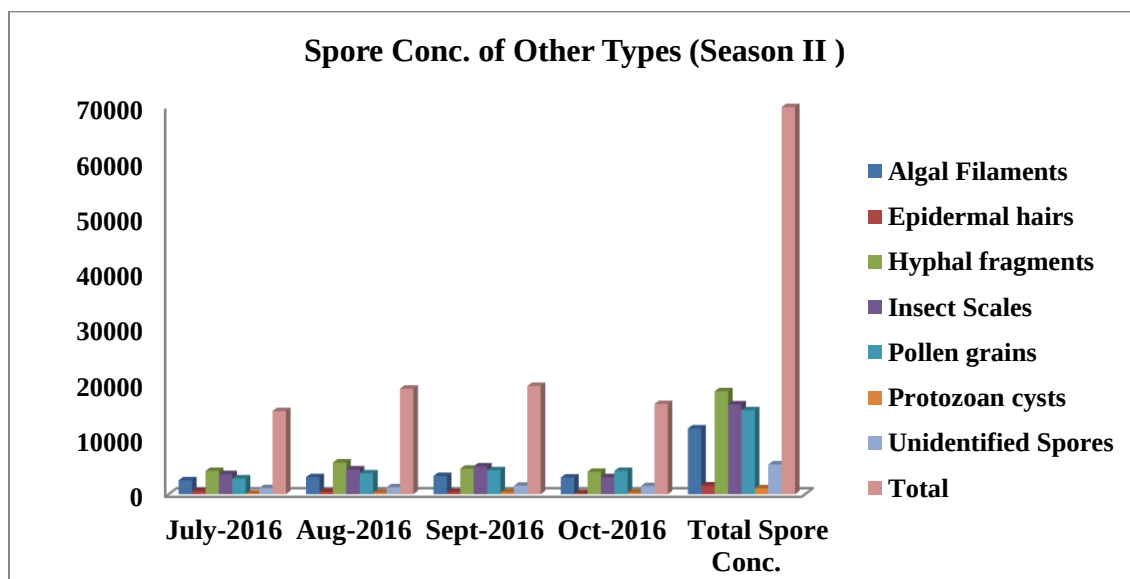
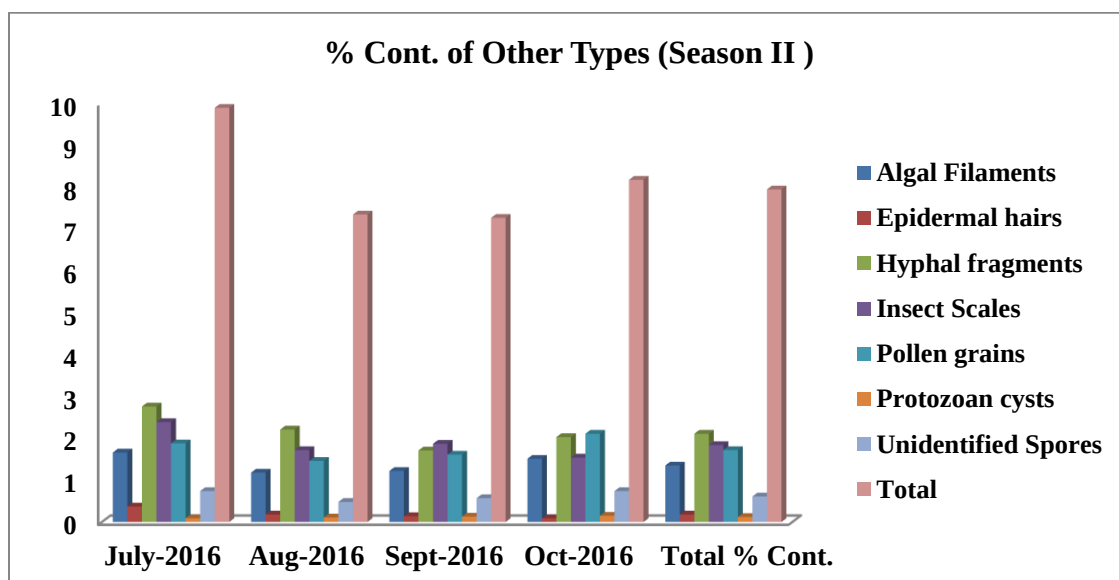


Fig-III: Histograms showing monthwise average percentage contribution of each spore group to the total airspora from First Kharif Season (1st July, 2015 to 31st Oct, 2015).

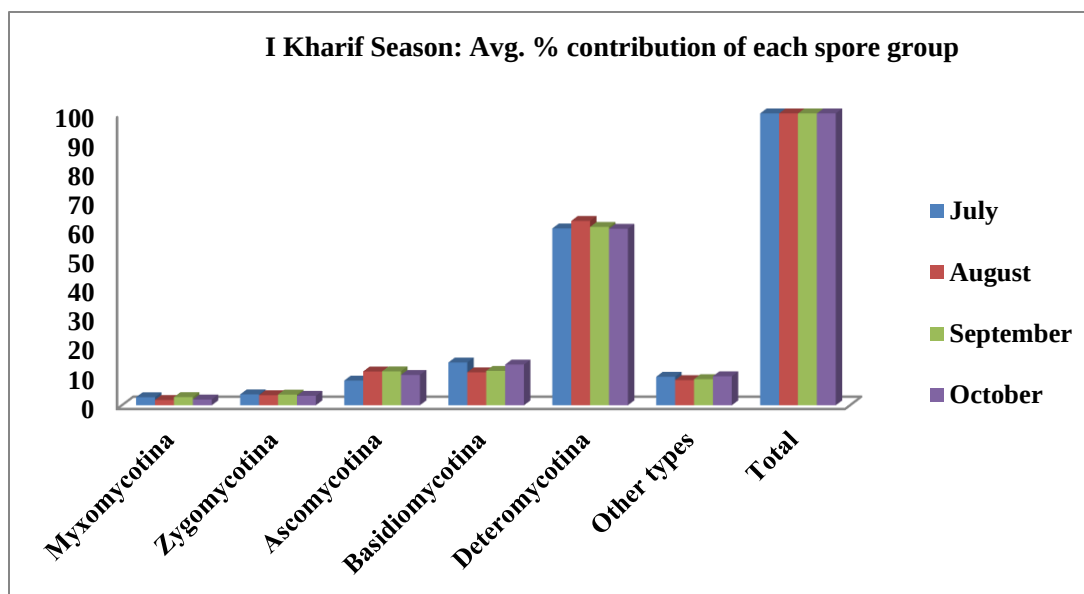


Fig-IV: Histograms showing monthwise average percentage contribution of each spore group to the total airspora from Second Kharif Season from (1st July, 2016 to 31st Oct, 2016).

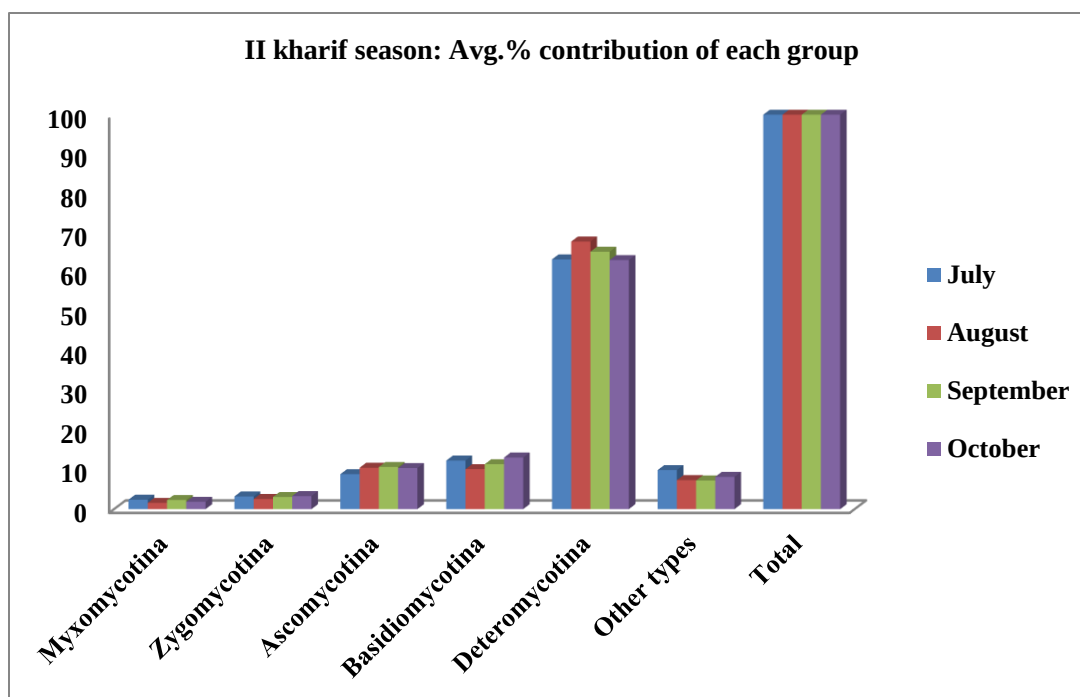


Fig-V: Histograms indicating monthly average percentage contribution of each spore group to the total airspora from First Kharif Season (1st July, 2015 to 31st Oct, 2015).

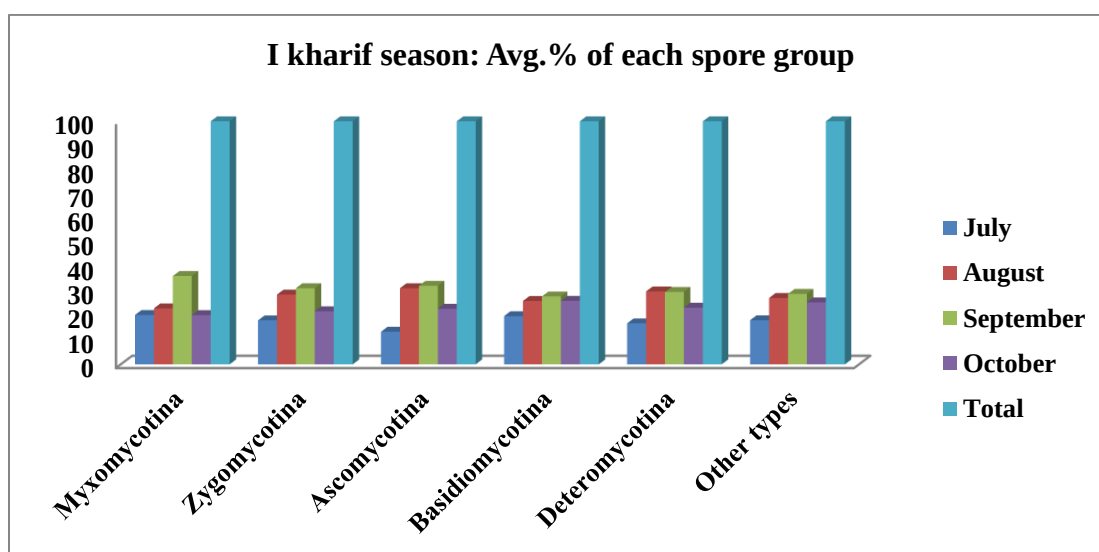


Fig-VI: Histograms indicating monthly average percentage contribution of each spore group to the total airspora from Second Kharif Season from (1st July, 2016 to 31st Oct, 2016).

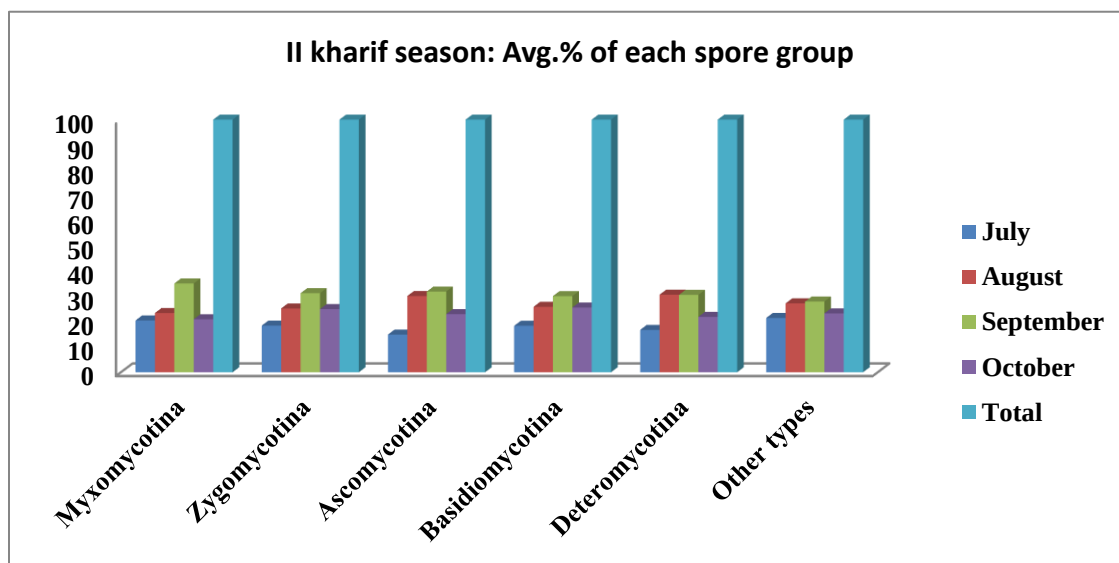


Fig-VII: Histograms showing monthwise total Seasonal concentration of each spore group to the total airspora in the Ist and IInd Seasons.

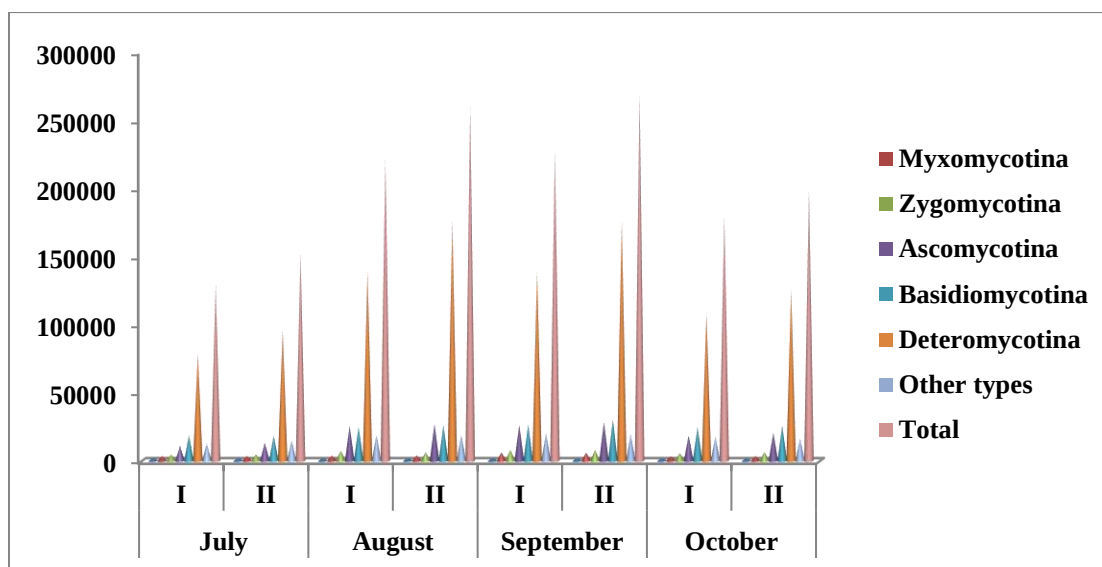


Fig-VIII: Histograms indicating total spore concentration of each spore group during the Ist and IInd Season (Season I: from 1st July, 2015 to 31st October, 2015 and Season II: from 1st July, 2016 to 31st October, 2016).

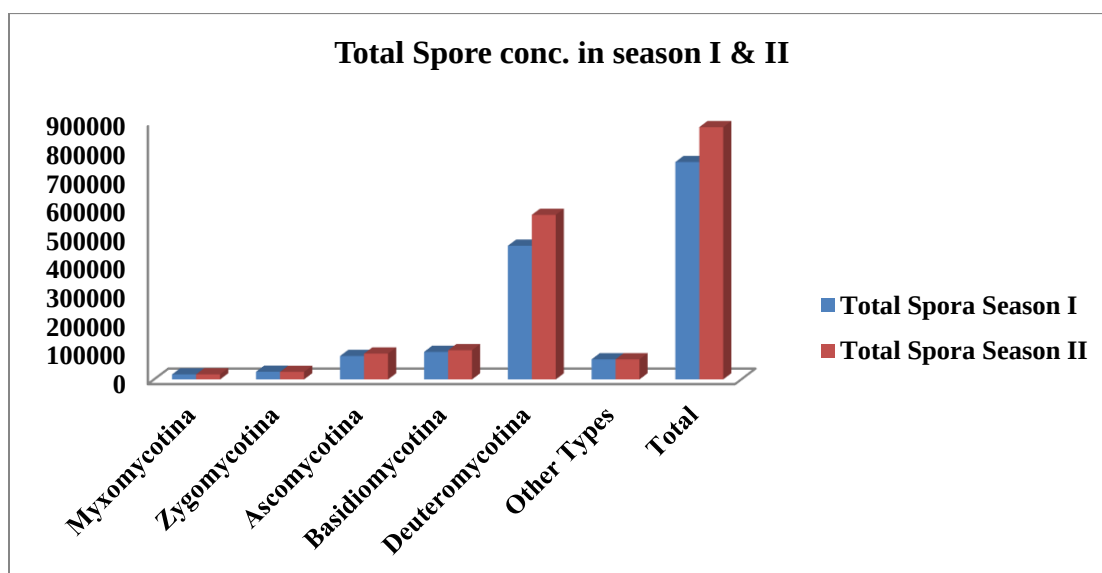


Fig-IX: Histograms indicating total percentage contribution of each spore group during Ist and IInd Season (Season I : from 1st July, 2015 to 31st October, 2015 and Season II : from 1st July, 2016 to 31st October, 2016).

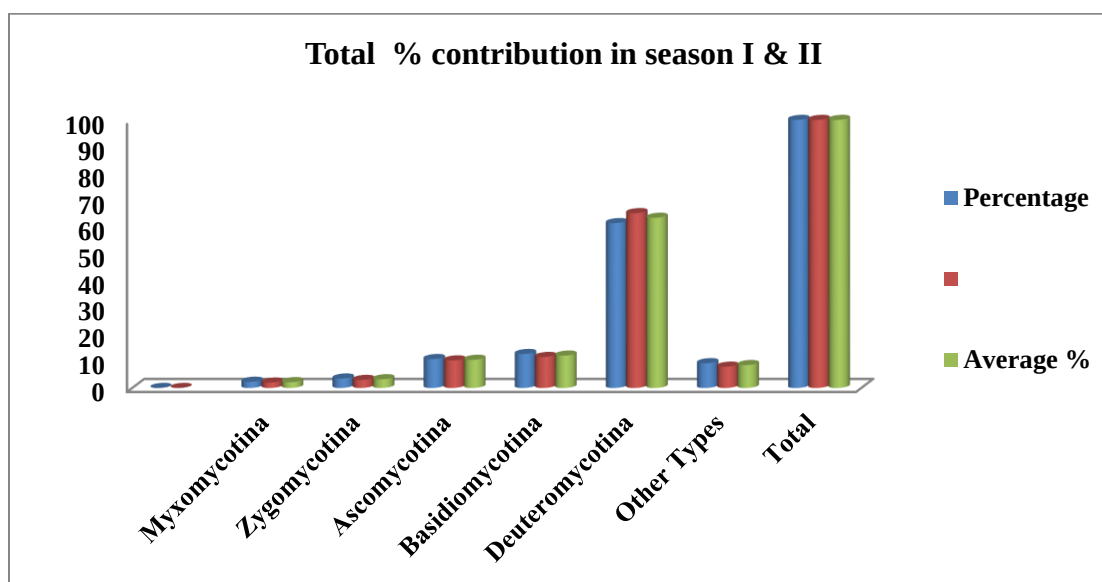


Fig-X: Histograms showing concentration of certain pathogenic spore types during (Season I: 1st July, 2015 to 31st Oct, 2015 and Season II: 1st July, 2016 to 31st Oct, 2016).

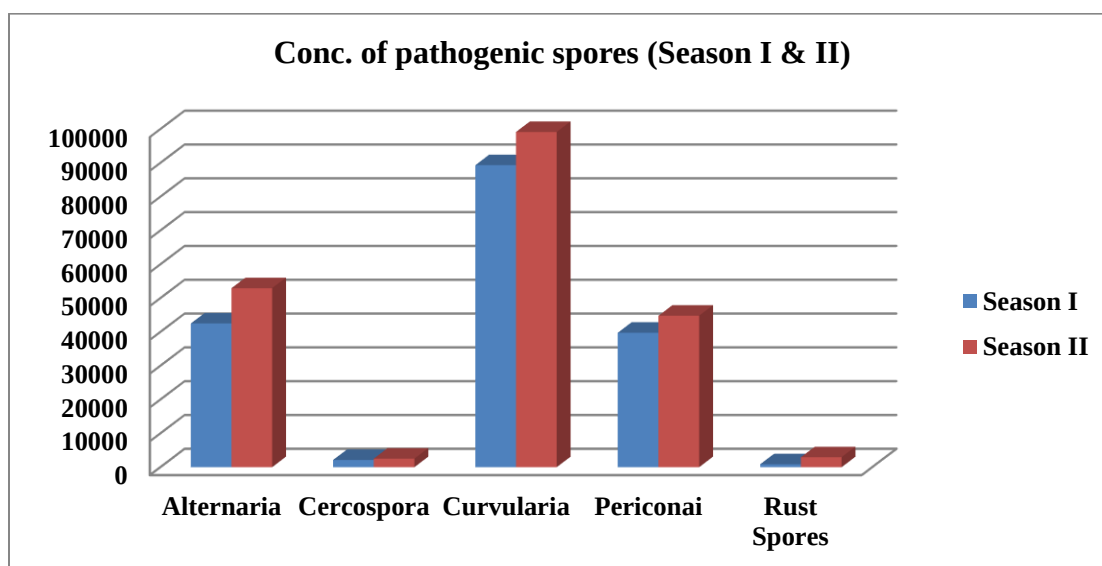


Fig-XI: Histograms indicating monthwise total fungal colony counts of each fungal group of the air of soybean crop field by Petriplate exposure from (Season I: July, 2015 to Oct, 2015).

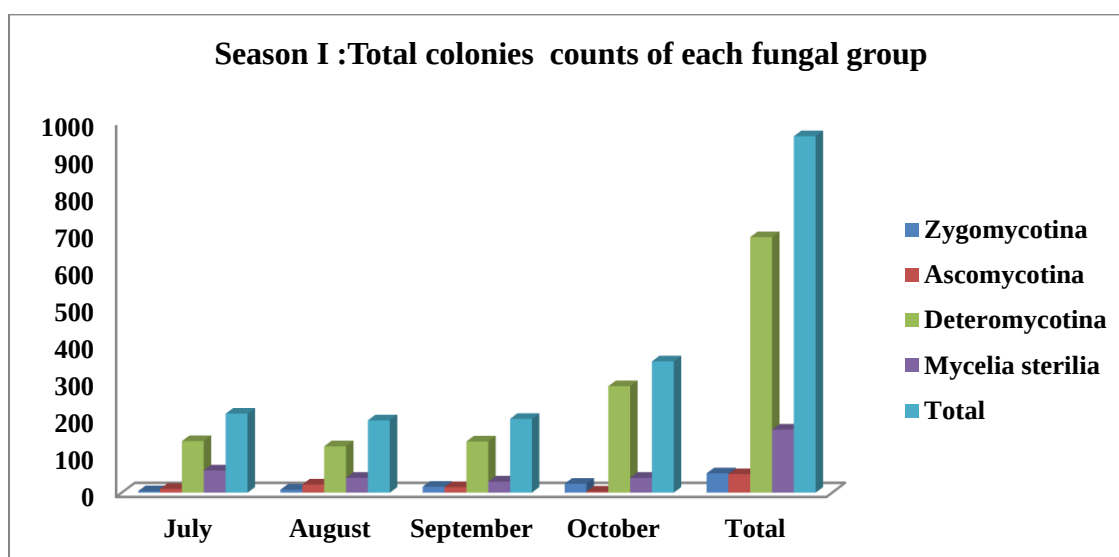


Fig-XII: Histograms indicating monthwise total average percentage contributions of each fungal group of the air of soybean crop field by Petriplate exposure from (Season I: July, 2015 to Oct, 2015).

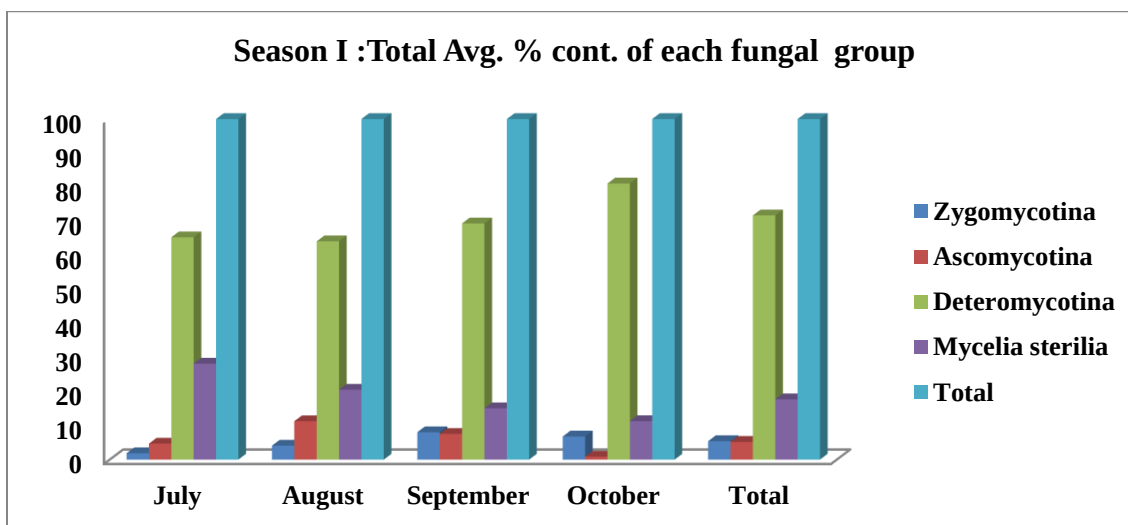


Fig-XIII: Histograms indicating monthwise total colonies count of each fungal group of the air of soybean crop field by Petriplate exposure from (Season II: July, 2016 to Oct, 2016).

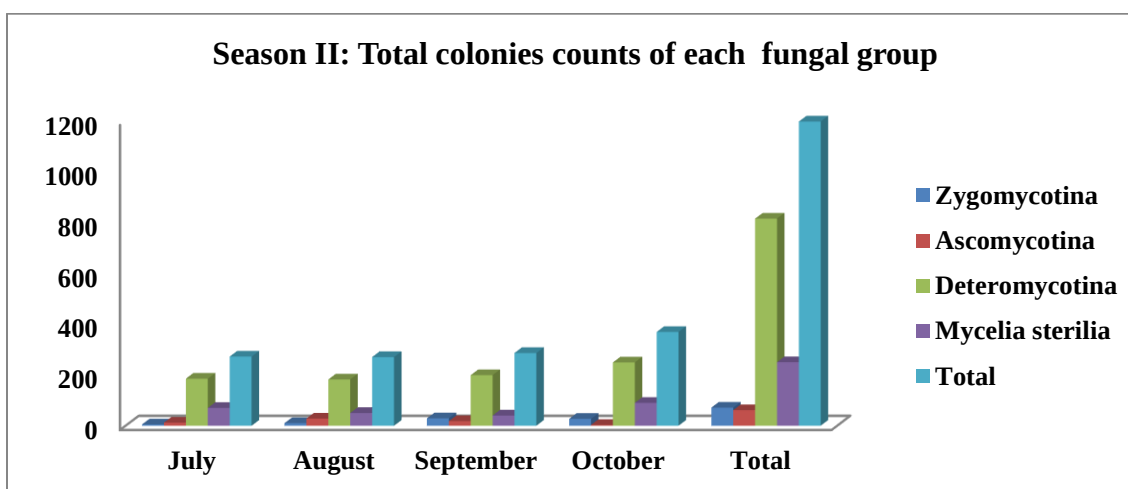


Fig-XV: Histograms indicating monthwise total average percentage contributions of each fungal group of the air of soybean crop field by Petriplate exposure from (Season II: July, 2016 to Oct, 2016).

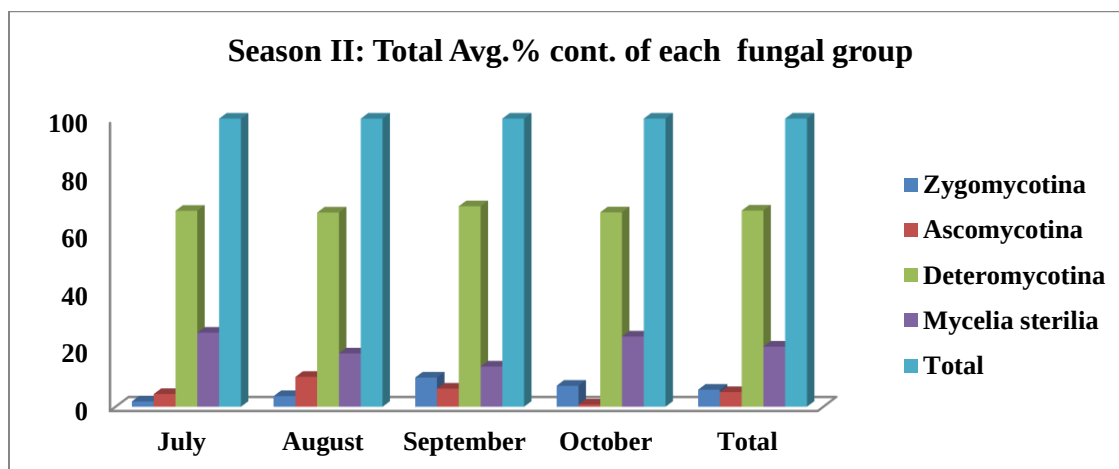


Fig-XVI: Histograms showing Seasonwise total number of fungal colonies and percentage contribution of each spore group from (Season I: July, 2015 to October, 2015 and Season II: July, 2016 to October, 2016).

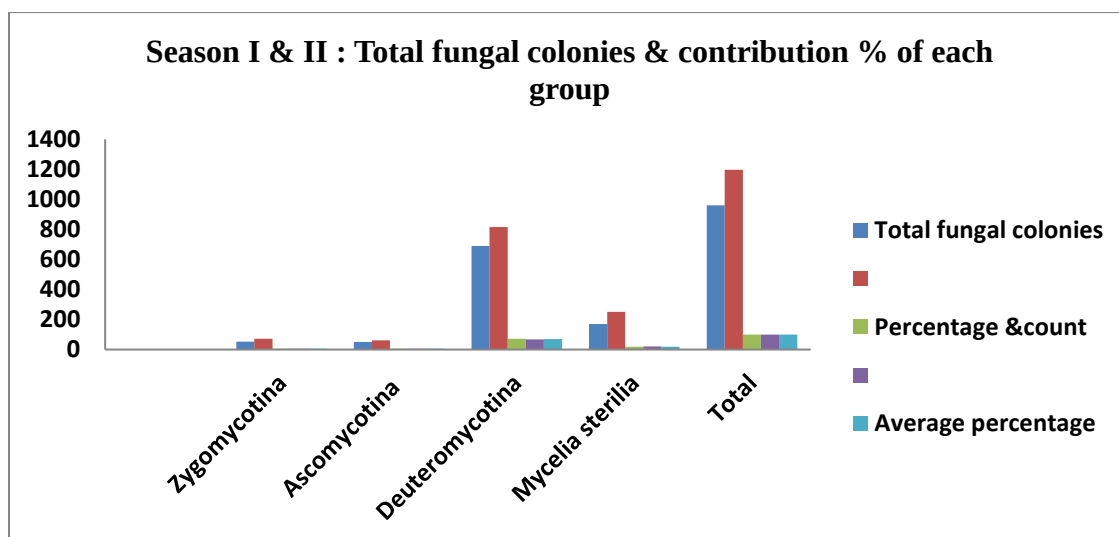
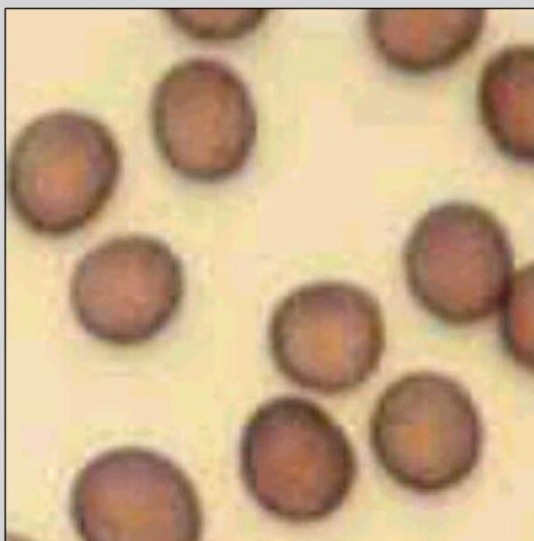


PLATE - 5

Myxomycotina



Physarium



Stemonitis

PLATE - 6

Zygomycotina



Cunninghamella



Mucor



Rhizopus



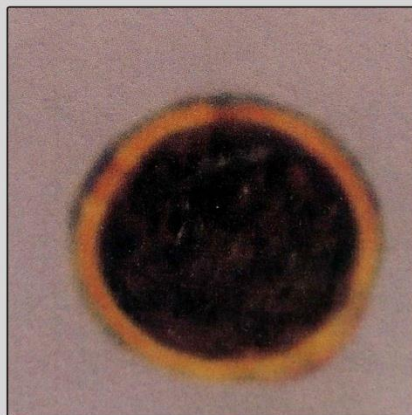
Sclerospora

PLATE - 7

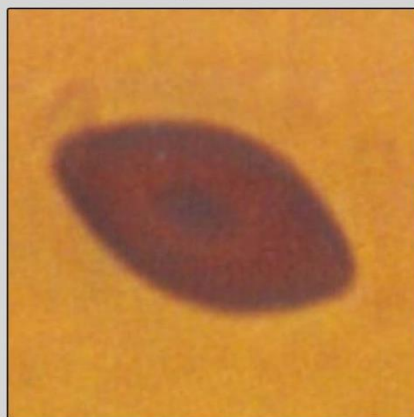
Ascomycotina



Ascospores



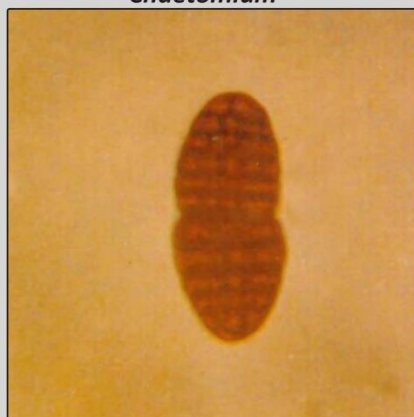
Bitrimonospora



Chaetomium



Claviceps

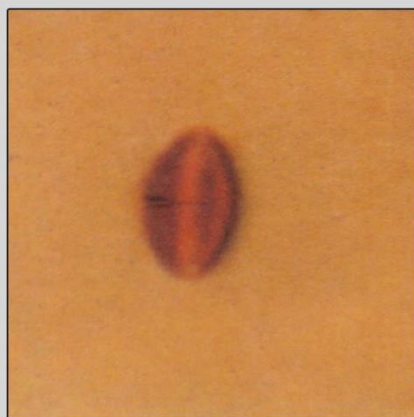


Cucurbitaria



Didymosporia

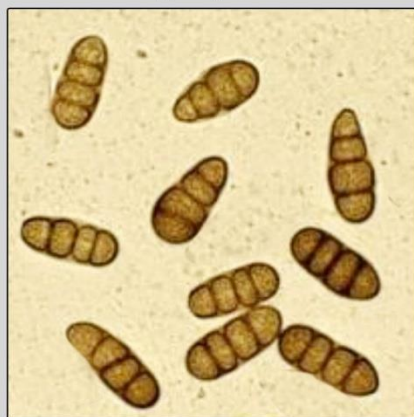
PLATE - 8



Hypoxylon



Leptosphaeria



Lophiostoma



Massaria



Melanospora



Otthia

PLATE - 9

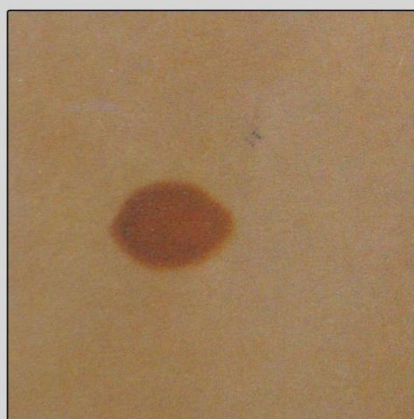
Ascomycotina



Parodiella



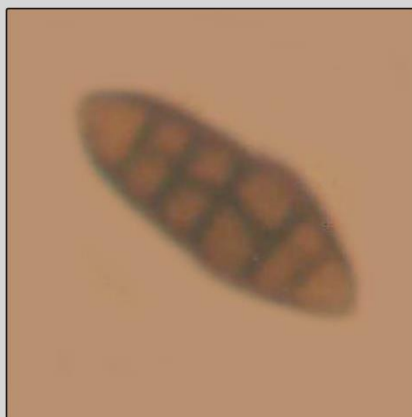
Pleospora



Sordaria



Sporormia



Teichospora

PLATE - 10

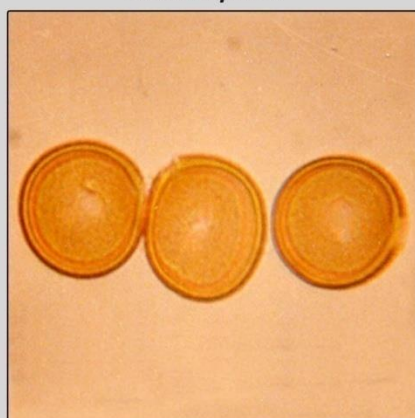
Basidiomycotina



Basidiospores



Ganoderma



Rust Spores



Smut Spores



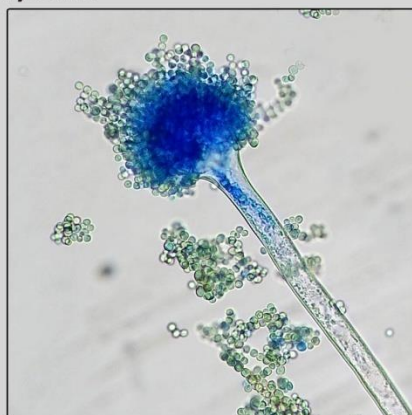
Urediniospores

PLATE - 11

Deuteromycotina



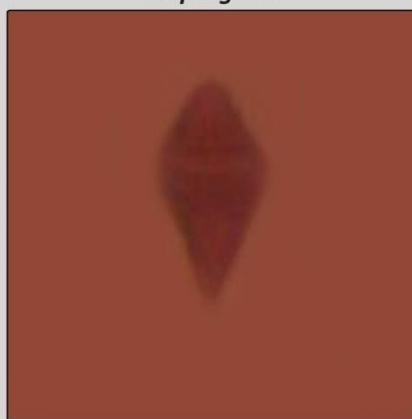
Alternaria



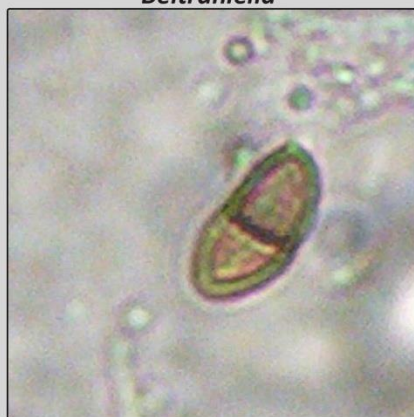
Aspergillus



Beltraniella



Beltrania



Bispora



Botryodiplodia

PLATE - 12

Deuteromycotina



Cercospora



Cladosporium



Cordana



Corynespora



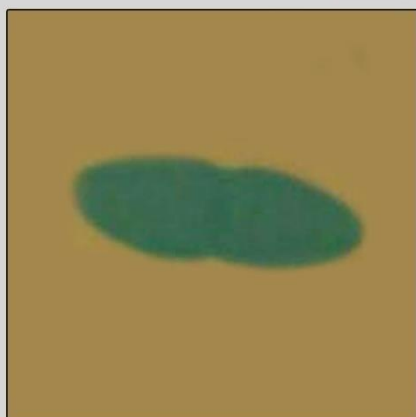
Curvularia



Dictyoarthrinium

PLATE - 13

Deuteromycotina



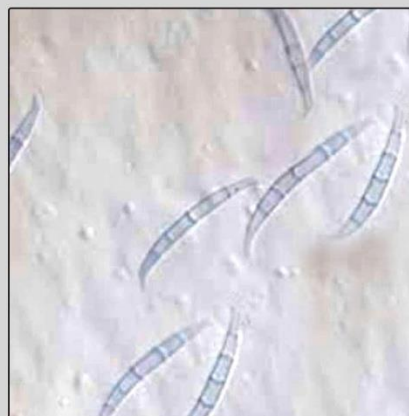
Diplodia



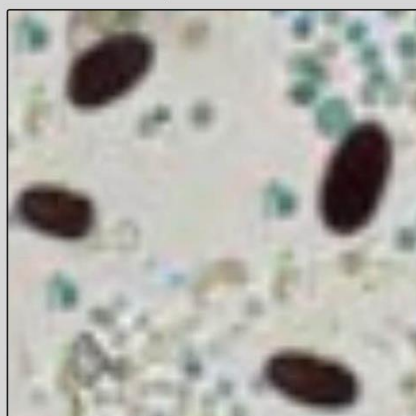
Drechslera



Epicoccum



Fusarium



Haplosporella



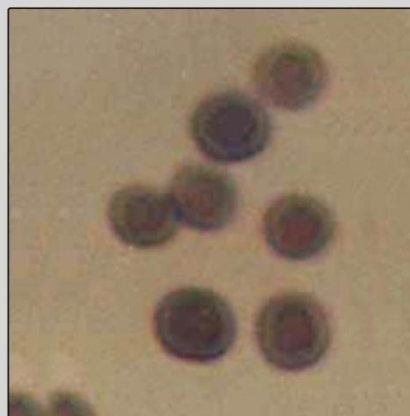
Helminthosporium

PLATE - 14

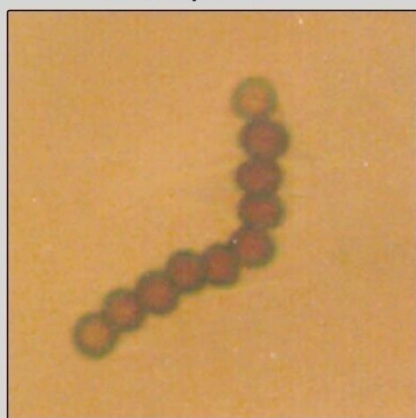
Deuteromycotina



Heterosporium



Lacelinopsis



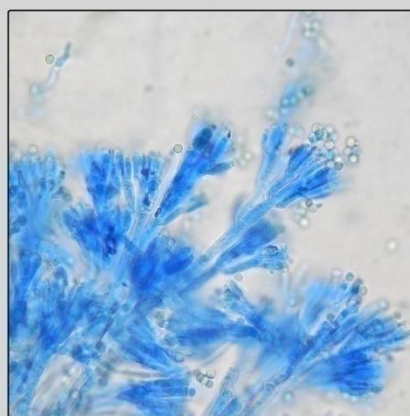
Memnoniella



Nigrospora



Papularia



Penicillium

PLATE - 15

Deuteromycotina



Periconia



Pestalotia



Pithomyces



Pseudotorula



Pyricularia



Spegazzinia

PLATE - 16

Deuteromycotina



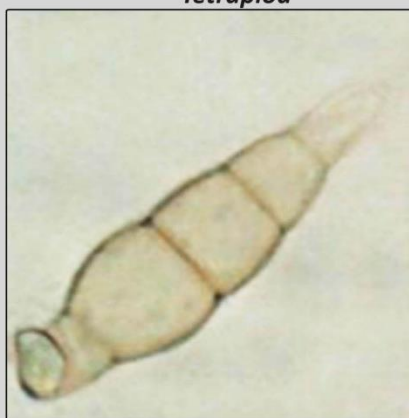
Sporidesmium



Tetraploa



Torula



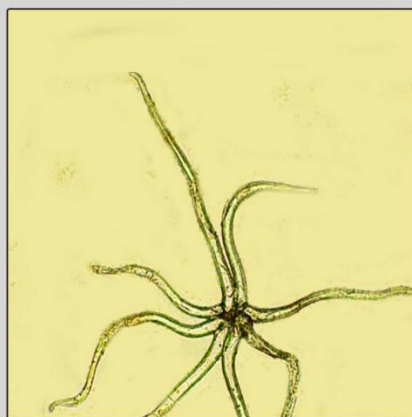
Trichoconis

PLATE - 17

Other types



Algal Filaments



Epidermal Hairs



Hyphal Fragments



Insect scales



Pollen Grains



Protozoan Cysts

JOWAR CROP:

Composition and components of air-spores over Jowar fields:

Composition of the catches: Apart from the dust particles more than 69 types of fungal spores, Algal filaments, Hyphal fragments, pollen grains, insect scales, protozoan cysts and unidentified spores were trapped on the cello tape, exposed in the sampler. The unidentified spores were grouped under one heterogeneous and quite artificial group called 'other types'. The components of airspora are grouped under two main groups viz., fungal spores, and other types a list of the catches identified from the slides has been given below and has been provide in alphabetical order under each group. The fungal spores includes

Air Spora by Air Sampling Method:

Physarum pers., *Stemonitis Roth.* *Cunninghamella Matr.*, *Mucor ex.Fr.*, *Rhizopus Ehrenb.*, *Sclerospora graminicola schroet.*, *Ascospores*, *Bitrimonospora Sivanesan.Talde& Tilak*, *Chaetomium Kunze ex.Fr.*, *Claviceps Tul.*, *Cucurbitaria Grey ex. Grev.*, *Didymosphaeria Fuck.*, *Hypoxyylon Bull.ex.F.*, *Leptosphaeria Ces and de Not.*, *Lophiostoma Ces and de Not.*, *Massaria de Not.*, *Melanospora Corda.*, *Metasphaeria Sacc.*, *Othia Nits* , *Parodiella (Speg).*, *Pleospora Rabenh.*, *Sordaria Ces & de Not.*, *Sporormia de Not.*, *TeichosporaFuckel.*, *Basidiospores*, *Ganoderma*, *Rust Spores*, *Smut spores*, *Urediniospores*, *Alternaria Ness ex Waltr.*, *Aspergillus Link.*, *Beltraniella Subram.*, *Beltrania Penzig.*, *Bispora Corda.*, *Botryodiplodia Sacc.*, *Cercospora Fries.*, *Cladosporium Link ex Fr.*, *Cordana Preuss.*, *Corynespora Gussow.*, *Curvularia Boedijn.*, *Dictyoarthrinium Hughes* , *Diplodia Fr.*, *Drechslera Ito.*, *Epicoccum Link ex wallr* , *Fusariella Sacc.*, *Haplosporella Speg.*, *Harknessia Coock.*, *Heliminthosporium.*, *Heterosporium Klotzch ex Cooke.*, *Lacellina Sacc.*, *Lacellinopsis Subram.*, *Memnoniella Hohnel.*, *Nigrospora Zimm.*, *Papularia Fr.*, *Penicillium Link ex Fr.*, *Periconia Tode ex Schw.*, *Pestalotia de Not.*, *Pithomyces Berk & Br.*, *Pseudotorula Subram.*, *Tetraploa Berk and Br.*, *Torula Pers Link ex Fries.*, *Trichoconis Clem* and the Other types include *Algal Filaments*, *Epidermal hairs*, *Hyphal Fragments*, *Insect Scales*, *Pollen grains*, *Protozoan Cysts*, *Unidentified Spores*. Out of 69 spore types, 33 spore types belong to

Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 to other types dominated the airspora by exhibiting the highest percentage Deuteromycotina (47.70%), followed by Basidiomycotina (23.83%), Ascomycotina(12.58%), other types (9.19%), Zygomycotina (4.15%) and Myxomycotina (2.53%). Sufficiently high contribution by other types was due to heterogeneous of the group and high incidence of the hyphal fragments, pollen grains, insect parts, and unidentified spores which are components of the group.

Chief Constituents and their contribution to the total air spora:

The Dominance of spore types in the air is determined by its percentage contribution to the total airspora. The total spore catch of each type was estimated and presented in Table No. I from the table I. it is evident that Cladosporium (15.48%), Curvularia (5.76%), Rust Spores (10.13%), Smut Spores (9.82%), Alternaria (4.93%), Periconia (3.45%), Nigrospora (5.69%), Lophiostoma (3.45%) & Cunninghamella (2.92%), Insect scales (2.07%), Hyphal Fragments (2.75%), were dominant types in the airspora over Jowar crop field.

Comparative contribution and Seasonal Variations in the airspora:

Air sampling in both the seasons started in November and continued till the end of February. The total period air sampling in both the seasons was more or less 108 days. The total airspora of first Rabi season was $649782/\text{m}^3$ and in second season was $720216/\text{m}^3$. Average percentage contribution of each spore types to the total airspora of two Rabi seasons have been presented in Table I. variation in the total airspora and percentage contribution of the different spore types to the total airspora have been presented in Table II. The Monthwise spore concentration and percentage contribution of each spore types to the total airspora is presented in Table III-A & III-B. The monthly average percentage contribution of each spore types to the total airspora is presented in Table IV-A and IV-B. The Monthwise and monthly average percentage contribution of each spore group in both seasons are represented in Table V-A, V-B & VI-A, VI-B. The Monthwise total seasonal concentration of each spore group in two Rabi seasons are represented in Table VII. Total spore concentration and Percentage contribution of each spore group in two Rabi seasons

are represented in Table VIII. Concentration between certain pathogenic fungal spore types and percentage contributions are represented in Table IX.

Physarum (Pers.): The spores one celled spherical, violaceous or purplish brown in mass, slightly thick walled minutely echinulate, 8-10 μm in diameter. They contributed 1.69% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration ($3850/\text{m}^3$) was recorded in January, 2016 and minimum conc. ($2044/\text{m}^3$) in February 2017. The total number of spores in the first season ($11774/\text{m}^3$) was comparatively more or less equal in the second season ($11438/\text{m}^3$). Percentage contribution in the first season (1.81%) was higher than that in the second season (1.59%). Pole (1995) reported 1.75% and 3.96 % contribution to the total airspora over sunflower field. Suryawanshi (2002) recorded 1.43% and 1.70 % contribution to the total airspora over sunflower and wheat fields. Arsule and Pande (2011) reported 0.43 % and Sonawane (2013) reported 0.35% contribution to the total airspora over groundnut fields at Nashik and Newasa respectively. Mali et al (2012) recorded 0.30% mean contribution to the total airspora over bajra fields. Patil et al (2015) reported 8.72% to the total airspora over jowar field. Patil and Mali (2017) recorded 9.61% contribution to the total airspora over jowar field.

Stemonitis Roth.: The Spores, one celled spherical violet brown to dark brown on black in mass, finely echinulate 9-12 μm in diameter. Vegetative body plasmodia type sporangia cylindrical fascinate, stipulate, calomel present stalk black and opaque, usually tough and shiny capillitium connect calomel and peridium limb totally absent. The maximum concentration ($1750/\text{m}^3$) was recorded in January, 2017 and minimum concentration ($1022/\text{m}^3$) in November, 2016. The percentage contribution in the first season (0.88%) was slightly higher than that in the second season (0.79%). Total number of spores in the first season ($5740/\text{m}^3$) was comparatively more or less equal in second season ($5726/\text{m}^3$). Pole (1995) reported 0.26% and 0.24% contribution to the total airspora over sunflower field. Suryawanshi (2002) recorded 0.4% and 0.35% contribution to the total airspora over sunflower and wheat fields. Arsule and Pande (2011) reported 1.11 % and Sonawane (2013) reported 0.35% contribution to the total airspora over groundnut fields at Nashik and Newasa respectively. Mali et al (2012) recorded 0.48% mean contribution

to the total airspora over bajra field. ***Cunnighamella*** Matr: The Spores of *cunnighamella* are oval to globular in shape, one celled and smooth or sometimes rough walled and hyaline. The spores were maximum in rainy season. They contributed 2.92% to the total airspora in the first and second rabbi seasons respectively. Maximum conc. ($6720/\text{m}^3$) was recorded in December, 2015 & ($6664/\text{m}^3$) in December, 2016. Percentage contribution in the first season (3.11%) was higher than that in the second season (2.76%). Total number of spores in the first season ($20216/\text{m}^3$) was slightly higher than that in the second season ($19866/\text{m}^3$). The incidence of *cunnighamella* spores in the air was recorded by Singh et al (1980) at Lucknow. They were reported 1% contribution of these spores to the total airspora. Other reports are of Tilak and Babu (1982) recorded 1.7%, Patil (1983) 5.56%, Bhasale (1983) 0.01% and Wankhade (1983) 0.60% of these spores over banana, vegetable and jowar fields respectively at Aurangabad. Patil (1985) reported 0.20% and Jogdand (1987) recorded 0.03% to the total airspora over jowar fields at Aurangabad. Ramakrishna Reddy (1987), Ahuja (1992) etc. studied the incidence of *cunnighamella* spores in the atmosphere of Aurangabad. Patil (1992) reported 1% mean concentration to the total airspora over jowar fields at Jalgaon. These spores were also reported by Thube (1992), Aher (1998), Thite (1998), and Mali (2002) in the atmosphere of Ahmednagar, Deola (Nashik), Shrigonda (Ahmednagar) and Kada (Beed). Suryawanshi (2002) reported 2.11% and 3.27% contribution to the total airspora over sunflower and wheat fields. Kshirsagar (2007) recorded 0.06 %, 2.16% and 0.76% to the total airspora over sunflower fields. Arsule and Pande (2011) reported 0.92% and Sonawane (2013) reported 1.21% contribution to the total airspora over groundnut fields at Nashik and Newasa respectively. Mali et al (2012) reported 0.52% over bajra field. Munde (2013) reported 0.24% contribution to the total airspora over chili field. Kardule and Jadhav (2016) recorded 0.73% over bajra field.

Mucor Micheli ex. Fr. The spores, one celled globose to oval thin walled smooth dark in mass 3-5 μm in diameter, saprophytic on a variety of substrates. They contributed 0.05% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration ($210/\text{m}^3$) was recorded in January 2016 and minimum concentration ($56/\text{m}^3$) in February 2017. Percentage contribution in the first season (0.07%) was higher than that in the second season (0.02%). Total number of spores in the first season

(476/m³) was higher than that in the second season (168/m³). These spores have been recorded from Aurangabad and also Gorakhpur, Delhi, Shillong, Gauhati, Calcutta, Waltair (Tilak, 1989). Other reports are of Pole (1995) reported 0.0001% contribution to the total airspora. It is reported first Rabi season over sunflower field. Suryawanshi (2002) reported 0.06% contribution to the total airspora over sunflower fields. Patil (2008) reported 0.80% contribution to the total airspora over black gram fields. Arsule and Pande (2011) reported 0.92% and Sonawane (2013) reported 1.21% contribution to the total airspora over groundnut fields at Nashik and Newasa respectively. Bembrekar and Bodke (2013) reported 0.80% contribution to the total airspora over cotton fields. Allapure (2016) recorded 0.88% over sunflower field at Udgir region.

Rhizopus Ehrenb: The Spores unequal, irregular, round oval, angular, striate, 9-11 x 7-7.5µm in diameter. This is a common saprophytic and facultative parasite on mature fruits, vegetables and many other substrates. The spores were recorded throughout the period of investigation. Its contribution to the total airspora was 0.19%. Maximum concentration (588/m³) was recorded in January, 2016 and minimum concentration (224/m³) in December, 2016. Percentage contribution in the first season (0.21%) was slightly higher than that in the second season (0.17%). Total number of spores in the first season (1400/m³) was higher than that in the second season (1274/m³). Rogers and Meier (1936) have reported *Rhizopus* spores between 2000 and 11.000 meters during the descent of balloon Explorer- II. Pady and Kapica (1953) collected *Rhizopus* over Arctic region of Canada. The incidence of spore type in the air had been reported by several workers while studying the airspora over different places. Kramer et al (1960) at Kansas reported that *Rhizopus* as a commonest spore type. Rees (1964) from Brisbane air spora, Turner (1966) from Hong Kong airspora. Gravesen (1972) reported the incidence of these spores in the environment of 44 Danish homes at Copenhagen, Denmark. In India, *Rhizopus* spores were recorded in the air by Mishra and kamal (1971) from Gorakhpur atmosphere, Agarwal and shivpuri (1974) from Delhi atmosphere. Pande (1976) from Nanded airspora. Other reports of Tilak and kulkarni (1975) recorded 0.20% of these spores to the total airspora over sugarcane fields at Aurangabad. Bhalke (1981) reported 2.22% spores over jowar fields at Aurangabad. Shastri (1981) recorded 0.95% spores from the air of vegetable market at Aurangabad. Patil (1983) and wankhade (1983)

recorded 0.59% and 0.55% of these spores over banana and jowar fields respectively at Aurangabad. Patil (1985) and Jogdand (1987) recorded 0.30% and 0.01% of these spores over jowar fields at Aurangabad. Patil (1992) recorded 0.22% of these spores over jowar fields at Jalgaon. Kshirsagar (2007) recorded 0.48% and 0.59% to the total airspora over sunflower fields. Patil (2008) recorded 1% to the total airspora over black gram fields. Arsule and Pande (2011) reported 1.49% and Sonawane (2013) reported 2.27% contribution to the total airspora over groundnut fields at Nashik and Newasa respectively. Mali et al (2011) reported 2.02% contribution to the total airspora over green gram field. Mali et al (2012) recorded 1.27% over bajra field. Bembrekar and Bodke (2013) reported 1% contribution to the total airspora over cotton field. Allapure (2016) recorded 2.17 % over sunflower field at Udgir region. Munde (2016) recorded 0.44% contribution to the total airspora over chilli fields. Kardule and Jadhav (2016) recorded 1.49% to the total airspora over bajra field.

Sclerospora graminicola schroet. The sporangia hyaline, thin walled, globose to elliptical, 15-28.5x14-25um in diameter. These spores were recorded in both crop seasons. They contributed 0.98% to the total airspora in the first and second rabi seasons respectively. Maximum conc. (2380/m³) was recorded in February 2016 and minimum concentration (1064/m³) in December 2016. Percentage contribution in the first season (1.05%) was higher than that in the second season (0.92%). Total number of spores in the first season (6818/m³) was slightly higher than that in the second season (6650/m³). Mane (1978) reported 0.36% contribution of these spores to the total airspora. Wankhade (1983) recorded 1.10% over jowar fields at Aurangabad. Pawar (1997), Thite (1998) and Mali (2002). Kshirsagar (2007) reported 0.03% and 0.01% to the total airspora over sunflower field. Arsule and Pande (2011) recorded 1.26% to the total airspora over groundnut field. Kardule and Jadhav (2016) recorded 0.19% contribution to the total airspora over bajra fields. Munde (2016) recorded 0.08% contribution to the total airspora over chilli field. Patil and Mali (2017) recorded 0.29% to the total airspora over jowar fields.

Ascospores: Ascospores are hyaline, ellipsoidal, unilaterally flattened, 3-5 x 4.5-6um, and have a thin slime sheath that forms a brim at the flattened side of the spore. They

contributed 0.04% to the total airspora in the first and second Rabi seasons respectively. Maximum conc. ($154/\text{m}^3$) was recorded in February, 2016 and minimum concentration ($56/\text{m}^3$) in November, 2015 and November & December 2016. Percentage contribution in the first season (0.05%) was slightly higher than that in the second season (0.04%). Total number of spores in the first season ($364/\text{m}^3$) was slightly higher than that in the second season ($266/\text{m}^3$). Allapure (2016) reported 0.67% to the total airspora over sunflower field at Udgir region.

Bitrimonospora Sivaneson, Talde & Tilak.: The spores, dark, brown to black in colour, globose with a very thick outer wall. $23.4\text{-}34.2\mu\text{m}$ in diameter. Their contributed to the total air-spores was found to be 0.66%. Percentage contribution in the first season (0.70%) was higher than that in the second season (0.62%). The highest concentration (0.96%) was observed in January, 2016 and lowest concentration (0.37%) in November, 2016. Total number of spores in the first season ($4592/\text{m}^3$) was slightly higher than that in the second season ($4466/\text{m}^3$). Sivanesan, Talde and Tilak (1974) reported and described this genus showing 0.02% contribution to the air as nocturnal wet spore type peak at 11.11 hours. Mane (1978) reported 0.03% spores over banana fields at Vaijapur. Shastri (1981) reported 0.04% and Patil (1983) reported 0.04% and 0.006% spores over maize and banana fields at Aurangabad respectively. Patil (1985) reported 0.02% and Jogdand (1987) reported 0.02% over jowar fields at Aurangabad. Suryanwanshi (2002) reported 1.09% and 0.16% to the total airspora over sunflower and wheat fields. Patil (2008) recorded 0.49% to the total airspora over black gram field. Arsule and Pande (2011) recorded 0.48% and Sonawane (2013) recorded 0.40% over groundnut fields at Newasa and Nashik respectively. Mali et al (2012) recorded 0.13% over bajra field. Allapure (2016) recorded 2.46% over sunflower field.

Chaetomium Kunze ex Fr: The spores are dark, circular, to triangular, unicellular, $10\text{-}12 \times 9\text{-}10 \mu\text{m}$ in diameter. They were encountered throughout the period of investigations. It contributed 1.33% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (1.39%) was higher than that in the second season (1.29%). The highest mean concentration (1.89%) was observed in November, 2015 and lowest mean concentration (0.92%) in February, 2017. There are several reports

of incidence of *Chaetomium* recorded from air. Pady (1951) collected *Chaetomium* *reflectus* over Arctic area of Canada. Sreeramulu and Ramlingam (1966) reported *Chaetomium* from the paddy field near Vishakhapatnam. Harvey, Hodkiss and Lewis (1969) isolated these spores at Cardiff from airspora samples. They also observed positive effect of Wet and moist air on spore liberation. However, direct impact of rain drops was found more effective in spore release. Mishra and kamal (1971) reported *Chaetomium* *glabosum* in winter only. Gaikwad (1974) reported 0.04% spores from Ahmedpur. Mane (1978) reported 0.15% spores from Vaijapur. Other reports are of Babu (1983), Patil (1983), Bhasale (1983), Pillai (1983), Saibaba (1983), Wankhade (1983), Quazi (1985) and Reddy (1987) over different crop fields at Aurangabad.

Patil (1985) reported 0.40% of spores to the total airspora. Jogdand (1987) and Kavishwar (1990) reported the spores over jowar fields at Aurangabad and Dhulia respectively. Malabade (1990) reported 0.24% contribution of this spore type to the total airspora over bajra fields. Patil (1992) recorded 3.63% mean contribution of these spores over jowar fields at Jalgaon. Pawar (1997), Aher (1998) and Thite (1998) reported 4.16% and 6.32%, 3.06% and 2.26%, 0.83% and 0.82% contribution of this spore type to the total airspora over bajra and groundnut fields respectively. Mali (2002) recorded 0.72% and 0.47% concentration to the total airspora over bajra and jowar fields. Gopan (2004) recorded 1.38% and 1.37% concentration to the total airspora over bajra field. Kshirsagar (2007) reported 0.30%, 2.76% and 0.58%, 0.84% to the total airspora over sunflower field. Patil (2008) recorded 0.94% to the total airspora over black gram fields. The fungus was collected on decaying dead branches of plants around the crop fields. Arsule and Pande (2011) reported 1.07% and Sonawane (2013) reported 1.31% over groundnut fields. Mali et al (2011) recorded 1.39% over green gram field. Patil et al (2015) recorded 0.75% over jowar field. Pathare and Sayyed (2016) reported 1.39% contributions to the total airspora over green gram field. Patil and Mali (2017) recorded 0.81% over jowar field.

***Claviceps* Tul.:** The ascospores elongated, slightly curved hyaline and septate, 59.5-84 x 1.2-2.5 μ m in diameter. Their contribution to the total airspora was found to be 0.56%. Percentage contribution in the first season (0.60%) was higher than that in the second season (0.53%). Total number of spores in the first season (3934/m³) was slightly higher

than that in the second season ($3822/\text{m}^3$). The highest mean concentration (0.84%) was observed in January, 2016 and the lowest mean concentration (0.36%) in November, 2016. Pande (1976) reported 0.11% of *Claviceps* spores over orange fields at Nanded. Shastri (1981) reported 0.001% spores in the airspora over maize fields at Aurangabad. Wankhade (1983) reported 0.02% of these spores over sorghum fields at Aurangabad. Pillai (1983) observed 0.02% of these spores to the total airspora at Aurangabad. Patil (1985) reported 0.01% contribution to the total airspora over jowar fields at Aurangabad. Pawar (1997) reported 0.69% and 1.86% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 1.12% and 0.31% of these spores over groundnut fields. Mali (2002) reported 0.31% and 0.38% of these spores over bajra and jowar fields. Gopan (2004) reported 0.87% and 0.82% of these spores over bajra fields. Kshirsagar (2007) reported 0.01% of these spores to the total airspora over sunflower fields. Mali et al., (2011) reported 0.39% over green gram fields. Patil et al (2015) reported 0.61% over jowar field. Pathare and Sayyed (2016) recorded 0.39% contribution to the total airspora over green gram field.

Cucurbitaria Gray ex Grev: The spores oblong, fusiform, yellow or brown $24\text{-}36 \times 9.16\mu\text{m}$ in diameter with 5-7 transverse septa and one too many longitudinal septa in most of the segments markedly constricted at the middle septum, multiseriate, spore occurred frequently. They contributed 0.68% to the total airspora in the first and second rabbi seasons respectively. Percentage contribution in the first season (0.73%) was higher than that in the second season (0.64%). Maximum conc. ($1470/\text{m}^3$) was recorded in January, 2016 and minimum conc. ($784/\text{m}^3$) in December, 2016. Total number of spores in the first season ($4732/\text{m}^3$) was also higher than that in the second season ($4620/\text{m}^3$). Tilak (1989) collected these spores on dead stems of various plants; Patil (1983) reported 0.02% contribution while Jogdand (1987) reported 0.004% to the total airspora over jowar fields. Pawar (1997) reported 0.20% and 0.62% spores to the total airspora. Aher (1998) reported 1.39% and 0.43% spores to the total airspora and Mali (2002) reported 0.02% to the total airspora. Suryawanshi (2002) recorded 0.64% and 0.09% contribution to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.37% and 0.27% of these spores over groundnut fields. Kshirsagar (2007) reported 0.04%, 0.15% and 0.68%, 0.67% to the total airspora over sunflower fields. Patil

(2008) reported 0.14% contribution to the total airspora over black gram field. Arsule and Pande (2011) recorded 0.64% over groundnut field. Patil et al (2015) reported 0.80% over jowar field.

Didymosphaeria Fuck.:The spores with single septum, brown, elliptic or cylindrical, slightly constricted at the septum, 9.4-17 x 6.7-8.2um in diameter. They contributed 1.96% to the total airspora in the first and second rabbi seasons respectively. Percentage contribution in the first season (2.14%) was higher than that in the second season (1.80%). Maximum conc. (2.78%) was recorded in November, 2015 and minimum conc. (1.43%) in February, 2017. Total number of spores in the first season (13930/m³) was higher than that in the second season (12978/m³). Incidence of this spore type in the air was recorded few workers. Other reports are of kulkarni (1971) recorded 0.34% over sugarcane fields, Bhalke (1981) reported 1.86% over Sorghum fields, Babu (1983) reported 1.86% over bajra fields, Patil (1983) reported 2.17% over banana fields and wankhade (1983) reported 0.87% of these spores over Sorghum fields at Aurangabad. Patil (1985) reported 1.80% over sorghum fields and Ramchander Rao (1987) reported 0.67% over sunflower fields at Aurangabad. Ahuja (1992) reported 0.09% over jowar field at Aurangabad. Thube (1992) reported 0.17% over wheat field at Ahmednagar. Pawar (1997) reported 2.62% and 2.87% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 0.69% and 0.88% of these spores over groundnut fields. Kadam (2002) recorded 1.06% mean contribution to the total airspora over sugarcane fields. Mali (2002) reported 1.76% and 1.78% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 1.13% and 2.36% contribution to the total airspora over sunflower and wheat fields. Gopan (2004) reported 2.95% and 2.99% of these spores over bajra fields. Kshirsagar (2007) recorded 0.76%, 2.86% and 0.29%, 0.93% of these spores over sunflower fields. Patil (2008) reported 0.53% contribution to the total airspora over black gram field. Arsule and Pande (2011) reported 1.06% and Sonawane (2013) reported 2.51% over groundnut fields at different region. Mali et al (2011) recorded 1.83% over green gram field. Patil et al (2015) reported 0.12% contribution to the total airspora over jowar field. Pathare and Sayyed (2016) reported 1.83% contributions to the total airspora over green gram field. Patil and Mali (2017) reported 0.11% over jowar field.

Hypoxylon Bull.ex Fr: The spores elliptic, fusiform to bean shaped, dark brown, non-septate, with a distinct colorless furrow down one side 10.2-16.2x6.2-7 μm in diameter. They contributed 0.14% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.16%) was higher than that in the second season (0.12%). The highest mean concentration (0.24%) was observed in December, 2015 and lowest mean concentration (0.08%) in January, 2016 and January, February, 2017. Total number of spores in the first season ($1022/\text{m}^3$) was higher than that in the second season ($896/\text{m}^3$). Ingold and Marshall (1963) reported while studying the spore discharge mechanism reported that in pyrenomycetes light has the opposite effect and mainly inhibit the spore discharge. Mane (1978) reported 0.72% spores to the total airspora at Vaijapur. Bhalke (1981) reported 1.22% over Sorghum fields at Aurangabad. Babu (1983) recorded 1.72 and 0.45% of these spores over jowar and banana fields at Aurangabad. Patil (1983) reported 0.14% to the total airspora over banana fields at Aurangabad. Patil (1985) recorded 0.03% and Jogdand (1987) reported 0.04% contribution to the total airspora over jowar fields at Aurangabad. Aher (1993) recorded 0.50% to the total airspora over groundnut fields at Ahmednagar. Pawar (1997) reported 0.99% and 1.45% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 3.81% of these spores over groundnut field. Mali (2002) reported 0.49% and 0.49% of these spores over bajra and jowar fields. Suryawanshi (2002) recorded 0.35% and 0.26% to the total airspora over Sunflower and wheat fields. Gopan (2004) reported 0.62 % and 0.58% of these spores over bajra fields. Kshirsagar (2007) recorded 0.01% to the total airspora over sunflower field. Patil (2008) reported 0.19% to the total airspora over black gram field. Arsule and Pande (2011) reported 0.88% over groundnut field. Mali et al (2011) reported 0.72% over green gram field. Patil et al (2015) reported 0.02% over jowar field. Allapure (2016) reported 0.64% over sunflower fields. Pathare and Sayyed (2016) recorded 0.72% contribution to the total airspora over green gram field.

Leptosphaeria Ces & de Not.: The spores, lightly coloured, two to multiseptate, fusiform, with one swollen cell, 12.2-14.4 x 4.1 -4.9 μm in diameter. The catch was maximum during the rainy season. Their contribution to the total airspora was found to be 1.35%. The percentage contribution in the first season (1.38%) was slightly higher than that in

the second season (1.32%). The highest mean concentration (1.58%) was observed in February, 2016 and lowest mean concentration (1.01%) in December, 2015. Total number of spores in the first season ($8960/\text{m}^3$) was lower than that in the second season ($9520/\text{m}^3$). Rees (1964) recorded 1.6% spores to the total airspora at Brisbane and stated that the spore is largely moisture regulated and nocturnal type unless rain induced day time liberation. Other reports are of Hamilton (1959), Lacey (1962), Sreeramulu and Ramlingam (1966), Tilak and srinivasulu (1967), Davies (1969), Agarwal and Shivpuri (1974). Mane (1978) reported 2.78% of these spores from Vaijapur atmosphere Bhalke (1981) reported 1.85%, Babu (1983) reported 0.02%, Patil (1985) reported 1.54% contribution to the total airspora over Jowar fields at Aurangabad. Thube (1992) reported 0.30% to the airspora over wheat fields at Ahmednagar. Aher (1993) reported 0.57% to the total airspora over groundnut fields at Ahmednagar. Pawar (1997) reported 0.91% and 1.31% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 5.36% and 3.44% of these spores over groundnut fields. Mali (2002) reported 2.24% and 2.36% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 2.03% and 1.10% contribution to the total airspora over sunflower and wheat fields. Gopan (2004) reported 1.53% and 2.60% of these spores over bajra fields. Patil (2008) reported 0.89% to the total airspora over black gram field. Arsule and Pande (2011) reported 1.13% and Sonawane (2013) reported 4.55% over groundnut fields at Newasa and Nashik respectively. Mali et al (2011) recorded 0.52% over green gram field. Patil et al (2015) reported 0.39% over jowar field. Allapure (2016) reported 7.16% over sunflower field. Pathare and Sayyed (2016) reported 0.52% contribution to the total airspora over green gram field. Mali et al (2017) recorded 4.39% over jowar field. In the present investigation it was observed that there is acute relationship between humidity, rainfall and spore release which consequently affect the concentration in the airspora.

Lophiostoma Ces & de Not.: The spores fusiform, olive brown, 5-7 septate, slightly constricted at septum $18-22 \times 6-7\mu\text{m}$ in diameter. They contributed 3.35% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration ($7182/\text{m}^3$) was recorded in December, 2015 and ($7168/\text{m}^3$) in December, 2016. Percentage contribution in the first season (3.54%) was higher than that in the second season (3.17%). Total number of spores in the first season ($23030/\text{m}^3$) was higher than

that in the second season ($22834/\text{m}^3$). Kulkarni (1971) reported these spores from Aurangabad airspora over vegetable fields. Mane (1978) recorded 0.12% over bajra field at Vaijapur. Meshram (1990) reported 0.26% to the total airspora over green gram fields at udgir, Narpurne (1993) reported 0.01% and 0.09% to the total airspora during first and second seasons respectively over vegetable fields. Pole (1995) reported Pawar (1997) reported 0.15% and 0.56% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 1.27% and 1.97% of these spores over groundnut fields. Mali (2002) reported 0.08% and 0.02% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 1.87% and 0.65% contribution to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.13% and 0.05% of these spores over bajra fields. Patil (2008) reported 0.87% contribution to the total airspora over black gram field. Arsule and Patil (2011) recorded 0.97% and Sonawane (2013) reported 1.30% over groundnut fields at Newasa and Nashik respectively. Patil et al (2015) reported 0.12% over jowar field. Patil and Mali (2017) reported 3.43% over jowar field.

Massaria de Not: The spores, elliptic, fusiform, $40-100 \times 10-24 \text{ um}$ dark brown with well-marked median septum and ultimately two other septa containing large oil drops, enclosed in a thick coat which is also usually constricted at the middle. It contributed 0.01% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.01%) was similarly equal that in the second season (0.01%). Total number of spores in the first season ($98/\text{m}^3$) was higher than that in the second season ($56/\text{m}^3$). Shastri (1981) reported 0.33% of these spores from airspora of vegetable market. Patil (1983) reported 0.06% of these spores over banana fields at Aurangabad. Bhagwan (1983), Patil (1985) and Jogdand (1987) reported these spores from Nanded and Aurangabad respectively. Kshirsagar (2016) reported 0.09% over groundnut field. Patil et al (2015) reported 0.46% over jowar field. Patil and Mali (2017) recorded 0.33% over jowar field.

Melanospora Corda.: The spores are ovoid, often irregular in shape, blackish green, $20-25 \times 14-17 \text{ um}$ in diameter. They contributed 0.04% to the total airspora in the first and second Rabi seasons respectively. Maximum conc. ($126/\text{m}^3$) was observed in November, 2015 and minimum conc. ($42/\text{m}^3$) in February, 2017. Percentage contribution in the first

season (0.05%) was higher than that in the second season (0.03%). Pande (1976) reported 0.2% of these spores to the total airspora over orange fields at Nanded. Mane (1978) recorded 0.15% to the total airspora over bajra fields at Vaijapur. Patil (1983) reported 0.20% spores over jowar fields at Aurangabad. Patil (1985) reported 0.20% spores over jowar fields at Aurangabad. Wankhade (1983), Reddy (1988), Meghraj (1989) recorded incidence of spores over different fields at Aurangabad. Pole (1995) reported 1.33% contribution over sunflower fields. Pawar (1997) recorded 0.39% and 0.66% of these spores to the total airspora over bajra fields at Aurangabad. Thite (1998) reported 0.51% and 0.61% of these spores over groundnut fields. Mali (2002) reported 0.78% and 0.45% of these spores over bajra and jowar fields respectively. Suryawanshi (2002) reported 0.17% and 0.43% of these spores over sunflower and wheat fields. Gopan (2004) reported 0.85% and 0.86% of these spores over bajra fields. Kshirsagar (2007) reported 0.19% to the total airspora over sunflower field. Patil (2008) reported 1.62% to the total airspora over black gram field. Arsule and Pande (2011) reported 1.03% and Sonawane (2013) reported 0.32% over groundnut fields at different region. Patil et al (2015) recorded 0.14% over jowar field. Pathare and Sayyed (2016) recorded 0.95% contribution to the total airspora over green gram field. Patil and Mali (2017) reported 0.18% over jowar field.

Metasphaeria Sacc. The Spores ellipsoid to oblong or fusicoid, two many septate, hyaline, rarely colored and 12-72 x 2.5-9.5 μm in diameter. It contributed 0.27% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.31%) was higher than that in the second season (0.22%). Total number of spores in the first season (2058/ m^3) was higher than that in the second season (1610/ m^3). Bhalke (1981) reported 0.85% reported 0.85% spores over sorghum fields. Shastri (1981) reported 0.06% spores from the air of vegetable market at Aurangabad. Patil (1985) recorded 0.50% to the total airspora over jowar fields at Aurangabad.

Oothia Nits.: The spores, elliptical to slightly inequilateral one septate, slightly constricted at the septum, dark brown, 22-26 x 10-14 μm in diameter. Its contribution to the total airspora was 0.15%. Percentage contribution in the first season (0.17%) was higher than that in the second season (0.13%). The maximum mean conc. (0.28%) was observed in

November, 2015 and minimum conc. (0.03%) in February, 2016. Shastri (1981) reported 0.12% spores from the airspora of vegetable market at Aurangabad. Bhasale (1983) reported 0.01% spores over vegetable fields at Aurangabad. Patil (1985) and Jogdand (1987) recorded it from jowar fields at Aurangabad. Arsule and Pande (2011) reported 0.35% to the total airspora over groundnut field.

Parodiella (Speg.) Theiss & Syd: The spores two celled, elliptic, distinctly striated, striations spirally converging towards end, border and constricted at septum, 22-24.6 x 7.6-8.8 μm in diameter. It contributed 0.02% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration (56/ m^3) was recorded in November, 2015; January, 2016 and minimum concentration (28/ m^3) in December, 2016. Percentage contribution in the first season (0.02%) was slightly higher than that in the second season (0.01%). Tilak and Kulkarni (1972) reported the occurrence of this spore type in the atmosphere of Aurangabad caves. Bhalke (1981) reported 0.85% of these spores over Sorghum fields at Aurangabad. Patil (1985) reported 0.06% and Jogdand (1987) reported 0.002% to the total airspora over jowar fields at Aurangabad. Kanhaiya Singh (1993) reported 0.02% to the total airspora over vegetable market at Aurangabad. Kshirsagar (2007) reported 0.09%, 0.10% and 0.29%, 0.34% to the total airspora over sunflower fields. Mali et al (2011) recorded 0.20% over green gram field. Mali et al (2012) recorded 0.06% over bajra field. Pathare and Sayyed (2016) recorded 0.20% contribution to the total airspora over green gram field.

Pleospora Rabh.: The spores yellow to brown, with several septa and one or more longitudinal septa in most or all the segments, 30.2-30 x 13-15.2 μm . They contributed 0.56% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.60%) was higher than that in the second season (0.53%). The highest mean concentration (0.84%) was noted in November, 2015 and lowest concentration (0.39%) in January, 2017. The maximum number of spores (1274/ m^3) was observed in November, 2015 and minimum number of spores (728/ m^3) in January, 2016 and January, 2017. It was also observed that the high humid conditions favor the incidence of these spores in the air. Dye and Vernon (1952) reported these spores from New Zealand. Richards (1956) from England, Kramer and Pady (1960) from

Kansas, reported the incidence of these spores in air. The occurrence of these spores in air was favoured by high humid conditions Bhalke (1981) reported 0.23% spores over jowar fields at Aurangabad. Patil and kulkarni (1981) reported the incidence of this spore in hospital ward at Kolhapur. Bhasale (1983) reported 0.09% of these spores from the air of vegetable fields at Aurangabad. Patil (1985) reported 0.40% and Jogdand (1987) recorded 0.23% contribution to the total airspora over jowar fields at Parbhani and Aurangabad respectively. Pawar (1997) reported 2.26% and 1.41% concentration to the total airspora at Aurangabad. Garje (2000) recorded 0.49% incidence of these spores to the total airspora over bajra fields at Aurangabad. Mali (2002) reported 0.75% and 0.56% concentration to the total airspora over bajra and jowar fields respectively. Suryawanshi (2002) reported 0.02% and 0.07% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.19% and 0.16% of these spores over bajra fields. Kshirsagar (2007) reported 0.16%, 0.18% and 0.78%, 0.67% to the total airspora over sunflower fields. Patil (2008) reported 0.16% to the total airspora over black gram field. Other reports are of Tilak and kulkarni (1979) from Aurangabad, Babu (1983) from Aurangabad. Wankhade (1983) over jowar fields from Aurangabad. Arsule and Pande (2011) reported 0.87% and Sonawane (2013) reported 0.34% over groundnut fields. Mali et al (2011) recorded 0.54% over green gram fields. Mali et al (2012) reported 0.74% over bajra fields. Patil et al (2015) reported 0.19% over jowar field. Allapure (2016) reported 3.05% over sunflower fields. Pathare and Sayyed (2016) reported 0.54% contribution to the total airspora over green gram fields. Patil and Mali (2017) reported 0.48% over jowar field.

Sordaria Ces & de Not.: The spores sub-globose to elliptical, non-septate almost black and opaque at maturity, with a germ pore at the lower end of the spores. The spores are of two types, one 19.2-23 x 15.2 μm and another type 34.4 -38.2 x 20.2-23 μm . They contributed 0.78% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.78%) was slightly higher than that in the second season (0.77%). Maximum concentration (0.97%) was observed in December, 2015 and February, 2017. The minimum concentration (0.32%) in November, 2015. Total number of spores in the first season (5110/ m^3) was lower than that in the second season (5586/ m^3). These spores were reported in air by Hamilton (1956), Meredith (1962),

Kramer et al (1963) and Davies (1969). Walkey and Harvey (1966) studied liberation of some species of *Sordaria* during day- light which justified their concentration at noon. Mane (1978) reported 1.81% spores from Vaijapur. Tilak and Bhalke (1981) reported 1.31% spores over jowar fields. Shastri (1981) recorded 0.10% spores over vegetable market at Aurangabad. Babu (1981) noted these spores from the air of hospital ward at Aurangabad. Patil (1985) reported 1.30 % and Jogdand (1987) noted 2.38% spores to the total airspora over jowar fields at Parbhani and Aurangabad. Deshmukh (1989) reported 0.4% and 0.36% to the total airspora. Patil (1992) reported 0.02% contribution to the total airspora over jowar fields at Jalgaon. Aher (1998) reported 1.88% and 1.63% of these spores over groundnut fields. Mali (2002) reported 0.09% and 0.03% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 0.66% to the total airspora. Gopan (2004) reported 0.11% of these spores over bajra field. Kshirsagar (2007) recorded 0.02% and 0.01% to the total airspora over sunflower fields. Patil (2008) recorded 0.97% to the total airspora over black gram field. Arsule and Pande (2011) recorded 1.19% over groundnut field. Sonawane (2013) recorded 0.50% over groundnut field. Mali et al (2011) recorded 0.18% over green gram field. Patil et al (2015) reported 0.02% over jowar field. Allapure (2016) recorded 0.70% over sunflower field. Pathare and Sayyed (2016) reported 0.18% over green gram fields.

Sporormia de Not: The spores, dark brown with three cross septa and showing a tendency to break up at the septa, surrounding by hyaline gelatinous sheath, 28.4-34 x 6-7.2 μm . Its contribution to the total airspora was 0.65%. Percentage contribution in the first season (0.77%) was higher than that in the second season (0.54%). The maximum concentration ($2100/\text{m}^3$) was observed in December, 2015 and minimum concentration ($350/\text{m}^3$) in January, 2016. Several workers reported the incidence of the spores in the air. Tilak and srinivasulu (1967 and 1971) reported 1.12% and 3.09% to the total airspora. Kulkarni (1971) recorded 0.28% of these spores over sugarcane fields. Tilak and kulkarni (1972) reported 1.3% to the total airspora. Patil (1983) and Pillai (1983) recorded 0.09% and 0.08% to the total airspora of Aurangabad. Wankhade (1983) observed 0.18% and 0.23% spores in two seasons respectively. Patil (1985) and Jogdand (1987) recorded 0.60% to the total airspora over jowar fields. Patil (1992) recorded 0.27% contribution of spores over jowar fields at Jalgaon. Pawar (1997) reported 0.49% and 2.33% of these

spores to the total airspora over bajra fields at Aurangabad. Mali (2002) reported 0.15% and 0.21% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 0.14% and 0.04% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.25% and 0.22% of these spores over bajra field. Kshirsagar (2007) reported 0.18%, 0.09% and 0.78%, 0.84% to the total airspora over sunflower fields. Patil (2008) recorded 0.97% to the total airspora over black gram field. Mali et al (2011) recorded 0.26% over green gram field. Patil et al (2015) reported 0.09% over jowar field. Allapure (2016) reported 0.52% over sunflower fields. Pathare and Sayyed (2016) recorded 0.26% contribution to the total airspora over green gram fields.

Teichospora Rick: Ascospores usually clavate with up to seven transverse septa constricted at the middle septum only, with one or two longitudinal septa in most of the segments, yellowish brown. 16-25 x 8-11 μm . They contributed 0.01% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.01%) was similarly that in the second season (0.01%). Maximum concentration ($56/\text{m}^3$) was observed in December, 2015 and minimum conc. ($14/\text{m}^3$) in February, 2017. Total number of spores in the first season ($84/\text{m}^3$) was higher than that in the second season ($14/\text{m}^3$). Other reports are of Babu (1983), Patil (1983), Bhasale (1983), Wankhade (1983) and Patil (1985), Jogdand (1987) over jowar fields at Aurangabad. Pawar (1997) reported 0.47% of these spores to the total airspora over bajra fields at Aurangabad. Mali (2002) reported 0.24% and 0.12% of these spores over bajra and jowar fields. Gopan (2004) reported 0.49% and 0.41% of these spores over bajra fields. Kshirsagar (2007) recorded 0.20%, 0.26% and 0.97%, 0.67% to the total airspora over sunflower fields. Mali et al (2011) reported 0.37% over green gram field. Pathare and Sayyed (2016) reported 0.37% contribution to the total airspora over green gram fields.

Basidiospores: All the types of Basidiospores like (hyaline and colored) are included under this category except Ganoderma. It is usually small, unicellular elliptic, with a germ pore and point of attachment at one end possess two layered wall smooth or rough. Their contribution to the total airspora was 1.82%. Percentage contribution in the first season (1.47%) was lower than that in the second season (2.14%). The maximum concentration (2.38%) was observed in November, 2016 and minimum concentration

(0.53%) in February, 2016. Total number of spores in the first season ($9590/\text{m}^3$) was lower than that in the second season ($15400/\text{m}^3$).

Shastri (1981) reported 0.59% spores over maize fields. Babu (1983) reported 0.30% from Aurangabad. Patil (1983) reported 6.70% from Aurangabad. Patil (1985) reported 6.14% spores over jowar fields at Parbhani. Jogdand (1987) reported 1.41% spores over jowar fields at Aurangabad. The incidence of Basidiospores were maximum in wet period. Thus it belongs to “wet spora” group. Kavishwar ((1990) reported 2.23% contributed to airspora at Dhulia. Mali (2002) recorded 3.69% and 4.48% of these spores over bajra and jowar fields. Suryawanshi (2002) reported 1.80% and 1.69% to the total airspora over sunflower and wheat fields. Kshirsagar (2007) recorded 0.80% to the total airspora over sunflower fields. Patil (2008) reported 0.07% to the total airspora over black gram field. Arsule and Pande (2011) reported 3.25% over groundnut fields. Mali et al (2011) recorded 0.58% over green gram field. Allapure (2016) reported 2.46% over sunflower fields.

Ganoderma Kurtz.: The spores unicellular, oval shaped, colored Basidiospores with outer hyaline wall, penetrated by projections of the inner brown wall. Its contribution to the total airspora was 0.01%. The percentage contribution in the first season (0.02%) was slightly higher than that in the second season (0.01%). The highest mean concentration (0.04%) was observed in November, 2015 and lowest mean concentration (0.02%) in January, 2017. Total number of spores in the first season ($126/\text{m}^3$) was higher than that in the second season ($98/\text{m}^3$). It belongs to ‘Wet spora’ group. Similar findings have been made by Hirst (1952) and Jankibai (1979), Babu (1983) recorded 1.52% of these spores from the air of hospital ward at Aurangabad. Patil (1985) and Jogdand (1987) reported 0.40% and 0.16% contribution of the total airspora over jowar fields at Aurangabad. Kavishwar (1990) reported 0.03% spores to the total airspora over jowar fields. Patil (1992) recorded 0.09% contribution over jowar fields at Jalgaon. Suryawanshi (2002) reported 1.80% to the total airspora over sunflower fields. Kshirsagar (2007) recorded 0.004% and 0.04% to the total airspora over sunflower fields. Patil (2008) reported 6.24% to the total airspora over black gram field. Mali et al (2012) reported 0.07% over bajra field. Sonawane (2013) reported 2.17% over groundnut fields.

Rust Spores: This group includes all the types of rust which were recorded during the period of investigations. They contributed 10.13% to the total airspora in the first and second rabbi seasons respectively. The highest mean concentration (12.30%) was observed in February, 2016 and lowest mean concentration (8.25%) in December, 2016. The percentage contribution in the first season (10.5%) was higher than that in the second season (9.48%). Total number of spores in the first season ($70532/\text{m}^3$) was higher than that in the second season ($68264/\text{m}^3$). Pady (1951) with slide exposure technique caught numerous rust spores in June, July and September. Hirst (1953) and Hamilton (1959) showed that peak in the release of most Urediniospores seen to be at about noon. Sanin and his co-workers (1976) studied the concentration of Urediniospores of *Puccinia graminis* near leaf surface of wheat and concluded that the concentration was correlated with wind velocity. In India Mehta (1952) found the source of penetration of cereal rusts, the role of barberry and presence of physiological races of rust fungi and traced serial route and rust inoculums, Sreeramulu and Ramlingam (1964) pointed out usual abundance of Urediniospores of rust (0.03%) from air over paddy fields at Vishakhapatnam. Tilak and srinivasulu (1967) reported 0.57% Urediniospores from airspora of Aurangabad. Kulkarni (1971) recorded these spores over sugarcane fields at Aurangabad. Gaikwad (1974) reported 1.05% to the total airspora at Ahmedpur. Nagarajan et al (1976) proved that rust infection of the central India was due to the Urediniospores which were transported from Niligiri hills and deposited along with rains.

Other reports are of Bhalke (1981), Shastri (1981), Babu (1983), Bhasale (1983), Pillai (1983) and wankhade (1983) from Aurangabad. Patil (1985) and Jogdand (1987) recorded 0.60% and 0.17% spores over jowar fields at Parbhani and Aurangabad respectively. Thube (1992) reported 0.11%, Sharma (1996) recorded 3.62%, 1.00% and 0.17% spore contribution during his studies at siddhipet (A.P). Pawar (1997) reported 0.09%, 5.17%, 3.16%, 3.42% spores to the total airspora over some crop fields at Aurangabad. Kadam (2002) reported 3.32% spore contribution to the total airspora over sugarcane field. Patil (2008) recorded % to the total airspora over black gram field. Mali et al., (2011) reported 4.39% over green gram field. Mali et al (2012) recorded 5.43% over bajra fields. Kshirsagar et al (2016) reported 1.71% over groundnut fields.

Smut Spores: The spores, dark brown or black in mass, one celled, rounded, shortly elliptical or angular, wall smooth or echinulate, 10-12 μm in diameter. It is found on throughout period of investigation. They contributed 9.82 % to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (10.78%) was higher than that in the second season (8.94%), however the maximum concentration (14.40%) was recorded in February, 2016 and minimum concentration (7.48%) in January; 2017. Total number of spores in the first season ($70056/\text{m}^3$) was higher than that in the second season ($64428/\text{m}^3$). Rees (1964) observed that smut spores were appeared to be more prevalent during the dry gusty, sunny periods especially early in the afternoon. Mills (1967) noted that there appeared to be no correlation between high temperature and maximum dispersal of smut spores. They observed very few spores between 22.00 and 6.00 hours while the maximum dispersal occurred between 11.00 and 15.00 hours. Kulkarni (1971) recorded smut spores over sugarcane fields at Aurangabad, which contributed on an average 3.89% to the total airspora. Gaikwad (1974) reported 7.23% of these spores over sorghum fields at Ahmedpur. Mane (1978) encountered 3.43% smut spores over bajra fields. Other reports are of Pande (1976) who reported 0.31% of these spores over sorghum fields at Nanded. Bhalke (1981) recorded 1.63% spores over sorghum fields at Aurangabad. Shastri (1981) reported 0.59% spores over maize fields. Patil (1983) noted 6.60% spores over banana fields and Bhasale (1983) reported 0.27% spores from Aurangabad. Babu (1983) reported 0.10% spores over bajra fields. Patil (1985) reported 0.60% and Jogdand (1987) reported 9.11% to the total airspora over jowar fields at Parbhani and Aurangabad respectively. Patil (1992) reported 2.63% contribution of smut spores over jowar fields at Jalgaon. Similarly other contributions were of Pawar (1997) 2.08% and 3.38%, Aher (1998) 2.48% and 3.18%, Thite (1998) 1.87% and 3.66% and Mali (2002) 1.17% and 5.52% over different fields at different places respectively. Gopan (2004) reported 1.67% and 1.10% of these spores over bajra fields. Kshirsagar (2007) reported 10.90%, 4.38% and 9.01%, 10.62% to the total airspora over sunflower field. Patil (2008) reported 0.13% to the total airspora over black gram field.

Arsule and Pande (2011) reported 7.08% over groundnut fields. Mali et al (2011) reported 1.55% over green gram field. Mali et al (2012) reported 0.87% over bajra fields.

Sonawane (2013) recorded 7.83% over groundnut field. Patil et al (2015) reported 2.41% of these spores over jowar field.

Urediniospores: It is unicellular, dikaryotic, brown colored spores with distinct double wall and germ pores. It is found throughout the period of investigation. They contributed 2.04% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (2.17%) was higher than that in the second season (1.93%). Maximum concentration (2.63%) was recorded in February, 2016 and minimum concentration (1.72%) in November, 2016. Total number of spores in the first season ($14084/m^3$) was slightly higher than that in the second season ($13902/m^3$). Pady (1951) with slide exposure technique caught numerous rust spores in June, July and September. Hirst (1953) and Hamilton (1959) showed that peak in the release of most Urediniospores seen to be at about noon. Sanin and his co- workers (1976) studied the concentration of Urediniospores of *Puccinia graminis* near leaf surface of wheat and concluded that the concentration was correlated with wind velocity.

In India Mehta (1952) found the source of penetration of cereal rusts, the role of barberry and presence of physiological races of rust fungi and traced serial route and rust inoculums, Sreeramulu and Ramlingam (1964) pointed out usual abundance of Urediniospores of rust (0.03%) from air over paddy fields at Vishakhapatnam. Tilak and srinivasulu (1967) reported 0.57% Urediniospores from airspora of Aurangabad. Kulkarni (1971) recorded these spores over sugarcane fields at Aurangabad. Kulkarni (1971) recorded these spores over sugarcane fields at Aurangabad. Gaikwad (1974) reported 1.05% to the total airspora at Ahmedpur. Nagarajan et al (1976) proved that rust infection of the central India was due to the Urediniospores which were transported from Niligiri hills and deposited along with rains. Other reports are of Bhalke (1981), Shastri (1981), Babu (1983), Bhasale (1983), Pillai (1983) and wankhade (1983) from Aurangabad. Patil (1985) and Jogdand (1987) recorded 0.60% and 0.17% spores over jowar fields at Parbhani and Aurangabad respectively. Thube (1992) reported 0.11%, Sharma (1996) recorded 3.62%, 1.00% and 0.17% spore contribution during his studies at siddhipet (A.P). Pawar (1997) reported 0.09%, 5.17%, 3.16%, 3.42% spores to the total airspora over some crop fields at Aurangabad. Suryanwanshi (2002) reported 1.12% and

2.11% to the total airspora over sunflower and Wheat fields. Kshirsagar (2007) recorded 13.76%, 10.46% and 4.65%, 4.47% to the total airspora over sunflower field. Patil (2008) reported 3.12% to the total airspora over black gram fields. Arsule and Pande (2011) reported 2.24% over groundnut field. Sonawane (2013) reported 5.79% over groundnut field. Patil et al (2015) reported 6.20% of these spores over jowar fields. Patil and Mali (2017) reported 7.06% over jowar field.

Alternaria Ness ex wall: The conidia dark, typically with both cross and vertical septa, variously shaped, obclavate to elliptical or ovoid, frequently borne acropetally in long chains, less often borne singly and having apical simple or branched appendage of different sizes belonging to different species. The spores were recorded in both seasons. Their contribution to the total airspora was 4.93%. Percentage contribution in the first season (4.79%) was lower than that in the second season (5.06%). The highest mean concentration (7.09%) was observed in February, 2017 and lowest concentration (3.68%) in December, 2016, whereas the maximum number of spores ($12250/\text{m}^3$) was observed in February, 2017 and minimum number of spores ($6020/\text{m}^3$) in November, 2015.

The spores of *Alternaria* have been reported to occur at various heights above ground level. Stakman et al (1923) reported numerous *Alternaria* spores in chains up to 3,300 meters. Meier et al (1935) reported it up to 5,500 meters over U.S.A. patil (1981) reported that spores of *Alternaria*, *Helminthosporium* and *Curvularia* occurred from the ground level to 5,000 feet in the air of Nagpur. Pady (1959) reported afternoon peak with occasional night peaks. Kramer and his coworkers (1959) reported 3.4% *Alternaria* spores from air. Meredith (1962) recorded 0.3% of these spores from Jamaica atmosphere. Pathak and Pady (1965) reported that the spores of this genus were low in the morning increased to maximum at noon, decreased slightly in the afternoon but increased to a second peak at 6.00 P.M. Turner (1966) collected 0.8% spores of this genus from the airspora of Hong Kong. Derrick (1966) recorded spores in large numbers from November to January. Yousef–Al-Doory (1967) reported their highest concentration in August. Tilak and Srinivasulu (1967) reported two types of *Alternaria* spores, one long (0.68%) and another short (9.74%). schenck (1968) in Florida reported high concentration in June. The concentration suddenly increased after the rains, however, the

prolonged dry period reduced the concentration considerably after 5-7 rainless days spore number was reduced to 0.1% or less. Mishra and kamal (1971) reported *A. humicola* and *A. tenuous* only in winter. Chen et al (1978) recorded 3.2% spores from Taipei airspora. In Maharashtra the reports of these conidia have been made by kulkarni (1971), Gaikwad (1974), Tilak and vishwe (1975), Pande (1976), Mane (1978) reported the occurrence of *Alternaria* spores from the air of Aurangabad, Ahmedpur, Nanded and Vaijapur respectively. Bhalke (1979), Chakre (1979), Kulkarni (1979), Babu (1983), Patil (1983), Saibaba (1983), Pillai (1983), Bhasale (1983), Wankhade (1983), patil (1985), Jogdand (1987), Ahuja (1992), Patil (1992), Zahid (1994), Naik (1995), Pawar (1997), Aher (1998), Thite (1998), Mali (2002) reported the presence of *Alternaria* spores to the total airspora over different crop fields. Suryawanshi (2002) reported 9.43% and 7.95% to the total airspora over sunflower and Wheat fields. Gopan (2004) reported 9.81% and 9.38% of these spores over bajra fields. Kshirsagar (2007) reported 16.93%, 24.57% and 10.85%, 13.83% to the total airspora over sunflower fields. Patil (2008) recorded 0.53% contribution to the total airspora over black gram field. Arsule and Pande (2011) reported 5.39% over groundnut field. Mali et al (2011) reported 9.68% over green gram field. Mali et al (2012) reported 7.19% over bajra field. Sonawane (2013) reported 7.45% over groundnut field. Patil et al (2015) reported 25.10% over jowar field. Allapure (2016) reported 7.34% over sunflower field. Patil and Mali (2017) reported 12.0% over jowar field.

Aspergillus Link: The conidia one celled, globose, variously colored when in mass, produced basipetally. Rarely, conidia were trapped with conidiophores and conidial heads. Spores 4-5 x 3.1µm. Their contribution to the total airspora was 0.84%. Percentage contribution in the first season (0.81%) was lower than that in the second season (0.86%). The highest mean concentration (1.02%) was observed in November, 2016 and lowest concentration (0.63%) in February, 2016. Total number of spores in the first season (5278/m³) was lower than that in the second season (6230/m³). Spores from upper air spora have been reported by Harz (1904), Browne (1930) and porter (1935). Other reports are of Hyde and Williams (1949) Rajan et al (1952), Pady and Kelly (1953), Richards (1956), Gregory and Hirst (1957), Davies (1961), Sreeramulu and Ramlingam (1963, 1966). Tilak and Srinivasulu (1967). Kramer and his co-workers (1959) in Kansas

recorded 5.4% *Aspergillus* colonies from the exposed Petri plates. In 1960 they found cooler temperature to be more favorable and occurred in high numbers, whereas low in summer. Sreeramulu (1961). In England while studying the air spora in cattle shed observed 3.2% concentration appeared during the afternoon with their daily maximum reducing at 18.00 hrs. Sreeramulu and Ramlingam (1963) recorded them in air at relatively high concentrations throughout the period of investigations but it showed considerably high concentration in middle of November and in the beginning in the January the daily peak was found at 18.00 hrs in 1966 they reported that *Aspergillus* exhibited “Day time double maxima”. Turner (1966) reported 10.5% *Aspergillus* conidia from air in Hong Kong. Hudson (1969) in Cambridge reported 14 species of this genus with Anderson sampler occurring more frequently in winter and spring. Mishra and kamal (1971) reported 22 species in winter and rainy seasons. Kulkarni (1971) reported these conidia over sugarcane and vegetable fields at Aurangabad. Some other reports are of Agarwal and shivpuri (1974), Gaikwad (1974), Tilak and vishwe (1975), Pande (1976), Tilak and Bhalke (1978), Jankibai (1979), Bhalke (1981), Shastri (1981), Babu (1983), Patil (1983), Saibaba (1983), Pillai (1983), Bhasale (1983), wankhade (1983). Patil (1985), Jogdand (1987), Sankaye (1989), Meshram (1990), kavishwar (1990), Patil (1992) reported to the total airspora over jowar fields and different crop fields from Aurangabad and other places. Patil (2008) reported 0.09% contribution to the total airspora over black gram field. Arsule and Pande (2011) reported 3.99% over groundnut field. Mali et al (2011) reported 2.99% over green gram field. Mali et al (2012) reported 1.48% over bajra field. Sonawane (2013) reported 1.91% over groundnut field. Patil et al (2015) recorded 0.83% over jowar fields. Allapure (2016) reported 9.52% over sunflower field. Patil and Mali (2017) reported 2.92% over jowar field.

Beltraniella Subram.: The conidia one celled, top shaped bionic, brown with a paler middle band, septa absent, 19-24.7 x 9-11um. Its contribution to the total airspora was 0.46%. The percentage contribution in the first season (0.56%) was higher than that in the second season (0.37%). The highest mean concentration (0.64%) was noted in November and December, 2015 and the lowest concentration (0.13%) in November, 2016. Total number of spores in the first season (3682/m³) was higher than that in the second season (2660/m³). Kulkarni (1971) recorded these spores over sugarcane fields at Aurangabad.

Pande (1976) reported 0.04% spores from Nanded over orange fields. Mane (1978) reported 0.04% spores from Vaijapur. Tilak and Bhalke (1978) reported them in the air over jowar fields at Aurangabad. Other reports are Tilak and Bhalke (1979) reported the incidence of these spores from the airspora of Aurangabad, kulkarni (1979), Jankibai (1979), from the airspora of Vishakhapatnam. Bhalke (1981), Shastri (1981), Babu (1983), Patil (1983), Bhasale (1983), wankhade (1983) reported different fields. Patil (1985) and Jogdand (1987) reported the conidia from the airspora of sorghum fields at Aurangabad. Sankaye (1989) reported 0.09% over sunflower fields and Meshram (1990) reported 0.13% over gram field at Latur and udgir respectively. Jadhav (1990) reported their percentage contribution to be 0.12% to the total airspora. Pawar (1997) recorded 1.51% and 0.61% from Aurangabad over bajra fields. Thite (1998) reported 0.07% and 0.47% from Shrigonda over groundnut fields and Mali (2002) reported 0.02% from Kada over bajra field. Gopan (2004) reported 0.15% and 0.07% of these spores over bajra fields. Kshirsagar (2007) reported 0.10% and 0.06% to the total airspora over sunflower field. Patil (2008) recorded 0.73% to the total airspora over black gram field. Sonawane (2013) reported 0.33%, Kshirsagar et al (2016) reported 0.31% over groundnut fields at Nashik and Beed respectively.

Beltrania Penzig. The conidia bio conic, smooth, one celled brown with a paler middle band, 14-23.4 x 8-9.7 μm , rounded base with septa or denticulate at the base with a long conical, one celled hyaline, sub-hyaline septa at the apex. These spores contributed 0.46% to the total airspora in the first and second Rabi seasons respectively. The percentage contribution in the first season (0.42%) was lower than that in the second season (0.50%). The highest mean concentration (0.65%) was observed in January, 2016 and the lowest concentration (0.16%) in November, 2015. Total number of spores in the first season (2716/ m^3) was lower than that in the second season (3640/ m^3). The present results agree with the earlier observations of Sreeramulu and Ramlingam (1963) they have reported spores for the first time from Vishakhapatnam. Other reports are of Tilak and Srinivasulu (1967), kulkarni (1971), Gaikwad (1974), Pande (1976), Bhalke (1981), Shastri (1981), Babu (1983), Patil (1983) over different crop fields at Aurangabad. Wankhade (1983) reported it over jowar fields. Patil (1985) reported 0.01%, Jogdand (1987) reported 0.008%, Sankaye (1989), Meshram (1990) and kavishwar (1990)

recorded 0.005% contribution to the total airspora from jowar fields respectively. Gopan (2004) reported 0.53% and 0.44% of these spores over bajra fields. Kshirsagar (2007) reported 0.01%, 0.06% and 0.19%, 0.34% to the total airspora over sunflower fields. Patil (2008) recorded 0.68 % to the total airspora over black gram fields. Arsule and Pande (2011) reported 0.87% over groundnut field. Mali et al (2011) reported 0.08% over green gram field. Mali et al (2012) reported 0.05% over bajra field. Sonawane (2013) reported 0.75% over groundnut fields at Nashik.

***Bispora Corda*:** The conidia dark, oblong, two celled or less often three celled, with thick black septum, catenulate, 6-11 x 5-8 μm . They contributed 0.39% to the total airspora in the first and second rabbi seasons respectively. Percentage contribution in the first season (0.42%) was higher than that in the second season (0.36%) the highest concentration (0.54%) was recorded in December, 2015 and lowest concentration (0.20%) in November, 2016. Total number of spores in the first season (2702/ m^3) was slightly higher than that in the second season (2604/ m^3).

Mane (1978) reported 0.12% of these spores over bajra and wheat fields at Vaijapur, while Patil (1985) reported 0.20% and Jogdand (1987) reported 0.14% spores to the total airspora over jowar fields at Parbhani and Aurangabad respectively. Other reports are of Rees (1964) in Brisbane. Turner (1966) in Hong Kong, Babu (1983), Patil (1983), Patil (1983), Bhasale (1983) and Pillai (1983) from Aurangabad airspora. Kavishwar (1990) from Dhulia over jowar fields. Patil (1992) recorded 1.29% contribution of spores over jowar fields at Jalgaon. Pawar (1997) reported 4.86% and 3.28%, Aher (1998) reported 3.58% and 3.29%, Mali (2002) reported 0.55% and 0.80% to the total airspora over bajra, groundnut and jowar fields respectively. Gopan (2004) reported 1.26% and 0.71% of these spores over bajra fields. Kshirsagar (2007) recorded 1.09%, 0.79% and 0.78%, 0.76% to the total airspora over sunflower fields. Patil (2008) recorded 0.13% contribution of spores over black gram field. Arsule and Pande (2011) reported 1.28% over groundnut field. Mali et al (2011) recorded 0.37% over green gram field. Sonawane (2013) reported 3.22% over groundnut field. Patil et al (2015) reported 0.02% over jowar field. Allapure (2016) recorded 2.05% over sunflower field.

Botryodiplodia sacc. The conidia dark, two celled, ovoid to elongate, 24-28 x 10-14 μm . The spores were observed in both seasons. They contributed 0.01% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration (0.03%) was observed in December, 2015; February 2016 and minimum concentration (0.02%) in December, 2016 and February, 2017. Percentage contribution in the first season (0.02%) was slightly higher than that in the second season (0.01%). Total number of spores in the first season ($112/\text{m}^3$) was higher than that in the second season ($70/\text{m}^3$). Meredith (1961) from Jamaica reported *Botryodiplodia theobromaepat*. Spores from the air Spora of Jamaican banana fields. Kramer and his coworkers (1964) at Kansas have reported one colony of Botryodiplodia. Kulkarni (1971) reported these spores from the airspora over sugarcane fields at Aurangabad.

Other reports are of Pande (1976) from Nanded, Mane (1978) from Vaijapur, Babu (1983) from Aurangabad; Patil (1983) from Aurangabad, wankhade (1983) from Aurangabad reported this spore type over different fields. Patil (1985) recorded 0.20% spores over jowar fields at Aurangabad. Patil (1992) reported 0.09% contribution over jowar fields at Jalgaon. Reddy (1990) recorded 0.40% incidence of these spores in the air over potato fields at zahirabad. Pawar (1997), Thite (1998) and Mali (2002) reported these spores over bajra, Groundnut and jowar fields respectively. Kshirsagar (2007) reported 0.04% and 0.01% to the total airspora over sunflower fields. Mali et al (2012) reported 0.07% over bajra field. Sonawane (2013) recorded 0.19% over groundnut field.

Cercospora Fries: The Conidia hyaline, fusiform, uniseriate, several celled, 115-480 x 4.2-7.3 μm . spores of Cercospora occurred frequently. They contributed 0.22% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.26%) was higher than that in the second season (0.19%). Maximum concentration (0.28%) was observed in November, 2015 and minimum concentration (0.09%) in November, 2016. Total number of spores in the first season ($1680/\text{m}^3$) was higher than that in the second season ($1386/\text{m}^3$). Richard (1956) in England reported it from air. Pady (1957) reported it from air of Kansas. Kramer et al (1959) recorded 1% spores from the air; Sreeramulu and Ramlingam (1966) recorded 0.14% to the total spore catches in rainy seasons.

Other reports are of kulkarni (1971) recorded 0.15% from Aurangabad. Babu (1983), Pande (1976) reported 0.33%, Mane (1978) recorded 1.65%, Patil (1983) reported 0.38%, Pillai (1983) reported 0.40% and wankhade (1983) reported 0.23% of these spores from airspora over different crop fields from Aurangabad. Patil (1985) reported 0.40% and Jogdand (1987) reported 0.62% conidia over jowar crop at Parbhani and Aurangabad. Kavishwar (1990) reported 0.16% spores over jowar fields at Dhulia. Pawar (1997) recorded 0.91% and 1.81%, Aher (1998) reported 2.44% and 2.55% Thite (1998) reported 11.89% and 9.69%, Mali (2002) recorded 1.89% and 2.44% of these spores from airspora over different fields. Gopan (2004) reported 1.10% and 1.81% of these spores over bajra fields. Kshirsagar (2007) reported 0.13%, 0.13% and 0.58%, 0.34% to the total airspora over sunflower fields. Patil (2008) recorded 5.31% to the total airspora over black gram field. Arsule and Pande (2011) reported 3.33% over groundnut field. Mali et al (2011) reported 0.26% over green gram field. Sonawane (2013) recorded 5.27% over groundnut field. Patil et al (2015) reported 1.80% over jowar field. Allapure (2016) reported 13.22% over sunflower field. Patil and Mali (2017) recorded 1.81% over jowar field.

Cladosporium Link ex Fr.: The conidia dark, one or two celled, variable in shape and size, ovoid to cylindrical or irregular, some typically lemon shaped, 4-24 x 2-4.7 μm , yellowish to light brown conidiophores variously branched and conidia in cluster or isolated spores of *Cladosporium* were encountered abundantly throughout the period of investigations. They contributed 15.48% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in first season (12.68%) was lower than that in the second season (18.01%). The highest mean concentration (20.50%) was observed in November, 2016 and lowest mean concentration (12.34%) in February, 2016. Total number of spores in the first season (82390/ m^3) was lower than that in the second season (129682/ m^3). The maximum number of spores (36400/ m^3) was observed in December, 2016 whereas minimum number (19670/ m^3) in February, 2016.

Stakman et al (1923) reported these spores from the upper air spora at altitude up to 3300 meters. In south- East Asia, it has been described as dominant components. Turner (1960) from Japan, Dye and Vernon (1952) from New Zealand, Sreeramulu (1962) from India

has reported these spores in the air. The dominance of the group has also been reported from England (Ainsworth, 1962; Gregory and Hirst, 1957; Lacey 1952 Africa (Dransfield 1960).

Detailed and extensive studies of Hirst (1953) showed that the pollen and spores of *Cladosporium* and other similar types are mostly removed by prolonged rains which, however, soon part in to the air a characteristic of damp airspora. Hirst (1953) and Gregory (1954) observed a transient increase in concentration of *Cladosporium* spores when the rains started. Sreeramulu (1962) encountered high number in December. Sreeramulu and Ramlingam (1964) observed that the spore type like *Cladosporium* which are washed off by the first showers of the rain. Take some time to recover their concentration to pre- rain level. Rees (1964) reported that the decline in spore number during December and January was possibly a temperature effect. Adams (1964) reported 39% spores from the total catches and seasonal incidence was observed from June to September.

Sreeramulu and Ramlingam ((1966) observed that in the catches of *Cladosporium* two peak occurred in a year which coincided with the period when plenty of dead and decaying vegetable matter was available in the fields. Tilak and srinivasulu (1967) did not encounter *Cladosporium* spores from August to November which is an unusual record. Harvey (1970) observed their abundance in wet air than dry air and numbers of spores released in humid air were generally intermediate between those of wet and dry samples. Other reports are of Bhalke (1981) reported 10.30% to the total airspora over sorghum fields at Aurangabad. Shastri (1981) reported 25.61%, Patil (1983) recorded 37.50%, wankhade (1983) recorded 67.29%, Patil (1985) recorded 46.64% and Jogdand (1987) reported 68.08% to the total airspora over vegetable market, banana, sorghum and jowar fields respectively.

Kavishwar (1990) reported 73.06%, Patil (1992) reported 5.01%, Pawar (1997) recorded 3.27% and 1.14%, and Thite (1998) recorded 9.31% and 7.26% to the total airspora over jowar, vegetable market, banana, bajra and groundnut fields respectively. Mali (2002) reported 17.11% and 18.25% over jowar and bajra fields. Gopan (2004) reported 14.61% and 15.53% of these spores over bajra fields. Kshirsagar (2007) reported 5.22%, 3.23%

and 16.76%, 14.67% to the total airspora over sunflower fields. Patil (2008) recorded 0.78% to the total airspora over black gram fields. Arsule and Pande (2011) reported 12.24% over groundnut field. Mali et al (2011) reported 10.10% over green gram field. Sonawane (2013) reported 9.23% over groundnut field. Patil et al (2015) recorded 0.80% over jowar field. Allapure (2016) reported 4.23% over sunflower field. Patil and Mali (2017) recorded 4.32% over jowar field.

Cordana Preuss.:The conidia ovate, one septate, not constricted at septum, both cells are more or less symmetrical with pointed base and round tip, sub-hyaline to brown, 20 x 8-10 μm . They contributed (0.02%) to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.02%) was similar that in the second season (0.02%). Maximum number of spores ($70/\text{m}^3$) was observed in November, 2015 and minimum number of spores ($28/\text{m}^3$) in February, 2017. The highest mean concentration (0.04%) was observed in November, 2015 and lowest mean concentration (0.02%) in February 2016 and in the months of January and February 2017.

Bhalke (1981) reported 0.54% of these spores over jowar fields at Aurangabad. Shastri (1981) 0.07% from the air of vegetable market and wankhade (1983) recorded 0.18% over jowar fields at Aurangabad. Patil (1985) recorded 0.14% and Jogdand (1987) recorded 0.42% over jowar fields at Parbhani and Aurangabad respectively. Kavishwar (1991) recorded 0.02% over jowar fields and Bhadane (1991) recorded 0.01% conidia over groundnut fields at Dhulia and Aurangabad respectively. Thite (1998) recorded 0.25% conidia over groundnut fields and Mali (2002) recorded 0.27% conidia over jowar fields. Gopan (2004) reported 0.31% and 0.47% of these spores over bajra fields. .Kshirsagar (2007) reported 0.01% to the total airspora over sunflower field. Patil (2008) recorded the 0.46% to the total airspora over black gram field. Mali et al (2012) reported 0.09% over bajra field. Sonawane (2013) reported 0.15% over groundnut field.

Corynespora Gussow.:The conidia terminal, single or sometimes in short chains, obclavate or cylindrical, straight or curved, smooth, brown with 4-20 pseudosepta, with a thick colorless exposure wall and prominent, dark basal scar, 40-280 x 18.4 μm . Their contributed 0.09% to the total airspora in the first and second Rabi seasons respectively. The percentage contribution in the first (0.10%) was slightly higher than that in the

second season (0.09%). The maximum number of spores ($210/\text{m}^3$) was noted in January, 2016, January, 2017 and minimum number of spores ($112/\text{m}^3$) in December, 2016. Total number of spores in the first season ($672/\text{m}^3$) was higher than that in the second season ($630/\text{m}^3$). Shastri (1981) reported 0.11% of these spores from the air of vegetable market at Aurangabad. Patil (1985) recorded 0.14% contribution to the total airspora over sorghum fields at Parbhani and Jogdand (1987) reported 0.01% contribution to the total airspora over sorghum fields at Aurangabad. Thite (1998) reported 0.32% and 2.04% of these spores over groundnut fields. Mali (2002) reported 0.07% and 0.15 of these spores over bajra and jowar fields. Suryawanshi (2002) reported 0.12% and 0.01% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.20% and 0.33% of these spores over bajra fields. Kshirsagar (2007) reported 0.03% and 0.08% of these spores over sunflower fields. Arsule and Pande (2011) reported 0.84% over groundnut fields. Mali et al (2011) reported 0.12% over green gram fields. Patil et al (2015) reported 0.09% over jowar fields.

Curvularia Boedijn.: The conidia dark, end cells lighter, 3-5 celled, more or less fusiform, typically curved or bent with one or two of the central cells distinctly larger and darker than the terminal cells, terminal cells pale, two types of the spores were trapped, one $19-32 \times 7.5-17.5 \text{ }\mu\text{m}$ and another $30.5-49 \times 9-23 \text{ }\mu\text{m}$. The spores were present throughout the period of investigations with sufficiently high concentration. They contributed 5.76% to the total airspora in the first and second Rabi seasons respectively. The percentage contribution in the first season (6.11%) was higher than that in the second season (5.44%). The maximum concentration (6.82%) was observed in December 2016 and minimum concentration (4.26%) in February 2017. Total number of spores in the first season ($39732/\text{m}^3$) was comparatively more or less equal that in the second season ($39200/\text{m}^3$). Panzer et al (1957) reported day peak with maximum between 08.00 and 17.00 hours. Meredith (1962) observed high concentration first at 08.00 hours reaching a peak at 14.00 hours in Jamaica. He also marked the rapid increase between 06.00 and 08.00 hours and suggested that dry conditions favoured easy spore liberation but it is not known whether *Curvularia* possesses any definite discharge mechanism. In the present investigations, increase in spore concentration was found related to rains or high humid conditions, followed by dry and sunny days. Moisture and humidity has positive effect on

sporulation while dry weather affected spore liberation consequently increasing spore load of airspora.

Sreeramulu and Ramlingam (1962) reported that spores of this fungus appeared during day time with their daily peak at 11.00 hours. Although they occurred throughout the season, slightly higher number was encountered in September and October. They further in (1963) found that their concentration was more between 10.00 hours to 18.00 hours. In another reports (1966) they found no marked seasonal changes in the catches, it exhibited “Day time double Maxima”. Other reports are of Tilak and srinivasulu (1967) from Aurangabad. Agarwal and shivpuri (1974) from Delhi airspora, Tilak and Bhalke (1978), kulkarni (1979), Bhalke (1981), Shastri (1981), Babu (1983), Patil (1983), Bhasale (1983), Pillai (1983) and wankhade (1983) reported these conidia in the airspora over different crop fields at Aurangabad. Patil (1985) reported 4.25% and Jogdand (1987) reported 1.53% conidia to the total airspora over jowar fields at Parbhani and Aurangabad. Kavishwar (1991) recorded 1.10% to the total airspora at Dhulia.

Mane (1978) at Vaijapur, Verma (1979), Bhagwan (1983) at Nanded , venugopalachari (1986), Ramakrishna Reddy (1987), Minhaj (1988), Meghraj (1989), Vaidya (1990) at Nanded and Aurangabad showed the incidence of these spores in the air. Pawar (1997) at Aurangabad, Aher (1998) at Deola, Thite (1998) at Shrigonda and Mali (2002) at Kada showed the incidence of these spores in the air. Gopan (2004) reported 3.65% and 3.42% of these spores over bajra fields. Kshirsagar (2007) reported 11.03%, 3.62% and 6.98%, 10.03% to the total airspora. Patil (2008) recorded 3.40% to the total airspora over black gram field. Arsule and Pande (2011) recorded 2.02% over groundnut field. Mali et al (2011) recorded 7.99% over green gram field. Sonawane (2013) reported 3.34% over groundnut field. Patil et al (2015) reported 0.12% over jowar field. Patil and Mali (2017) reported 2.03% over jowar field.

Dictyoarthrinium Hughes: The conidia four celled, cross shaped, dark brown, 12-17.8 x 14.8µm. They contributed 0.13% to the total airspora. The maximum number of spores (406/m³) was recorded in February, 2016 and minimum number of spores (140/m³) in December, 2016. Percentage contribution in the first season (0.15%) was slightly higher than that in the second season (0.13%). Total number of spores in the first season

(966/m³) was higher than that in the second season (910/m³). Kulkarni (1971) reported 0.02% of these spores to the total airspora over vegetable fields at Aurangabad.

Other reports are of mane (1978) from Vaijapur, Bhalke (1981), Shastri (1981), Babu (1983), patil (1983) and wankhade (1983) from Aurangabad over bajra, jowar, vegetable market, bajra ,banana and jowar fields respectively. Patil (1985) reported 0.14% conidia and Jogdand (1987) reported 0.13% conidia over jowar fields at Parbhani and Aurangabad respectively. Kavishwar (1991) reported 0.01% conidia over jowar fields at Dhulia. Pawar (1997) reported 0.82% and 0.73% conidia over bajra fields at Aurangabad. Aher (1998) reported 0.95% and 1.22% conidia over groundnut fields. Mali (2002) reported 0.04% conidia over bajra fields and 0.31% conidia over jowar fields. Gopan (2004) reported 0.09% and 0.06% of these spores over bajra fields. Kshirsagar (2007) reported 0.67%, 0.40% and 0.29%, 0.84% to the total airspora over sunflower fields respectively. Patil (2008) recorded 0.12% to the total airspora over black gram field. Arsule and Pande (2011) reported 0.49% over groundnut field. Mali et al (2012) reported 0.04% over bajra field. Sonawane (2013) reported 0.13% over groundnut field. Allapure (2016) reported 3.23% over sunflower field.

Diplodia Fr.:The conidia dark brown, two celled ellipsoid or ovoid, 12-15 x 3, 5-7 um. Its contribution to the total airspora was 0.08%. The maximum number of spores (280/m) was recorded in December, 2015 and minimum number of spores (56/m) in February, 2017. The percentage contribution in the first season (0.15%) was higher than that in the second season (0.04%). Kramer and Pady (1966) recorded conidia from Kansas airspora. Gaikwad (1974) reported 0.23% conidia from Ahmedpur. Other reports are of Mane (1978) reported 0.33% over bajra fields at Vaijapur. Kulkarni (1979) reported 0.16% conidia from Kolhapur. Bhalke (1981) reported 0.84%, Shastri (1981) reported 0.15%, Patil (1983) reported 0.11% and wankhade (1983) reported 0.14%, patil (1985) reported 0.10% conidia and Jogdand (1987) reported 0.05% conidia over jowar fields at Parbhani and Aurangabad. Kavishwar (1991) reported 0.01% conidia over jowar fields at Dhulia. Patil (1992) reported 0.29% contribution of these spores over jowar fields at Jalgaon. Shinde (1996) reported 0.10% conidia over sunflower fields at Nanded. Pawar (1997) reported 3.13% and 4.35% conidia over bajra fields at Aurangabad. Aher (1998) reported

1.61% and 1.24% conidia over groundnut fields. Mali (2002) reported 0.10% and 0.09% conidia over bajra and jowar fields. Gopan (2004) reported 0.10% and 0.20% of these spores over bajra fields. Kshirsagar (2007) reported 0.34% to the total airspora over sunflower field. Patil (2008) recorded 0.20% to the total airspora over black gram field. Arsule and Pande (2011) reported 1.01% over groundnut field. Patil et al (2015) recorded 0.09% over jowar field. Allapure (2016) reported 1.49% over sunflower field. Patil and Mali (2017) recorded 0.73% over jowar field.

Drechslera Ito.: The Conidia sub-hyaline to yellowish brown, very slightly curved, sub-cylindrical, sometimes elongated, frequently widest in the basal portion and tapering somewhat toward apex, thin walled, 1-17 septets, not constricted at septa with basal cell with a clear scar indicating point of attachment to conidiophores, 50-125 x 14-22.5 μm . They contributed 0.04% to the total airspora. Percentage contribution in the first season (0.04%) was slightly higher than that in the second season (0.03%). Total number of spores in the first season ($266/\text{m}^3$) was slightly higher than that in the second season ($252/\text{m}^3$). The highest concentration (0.06%) was observed in February, 2016 and lowest concentration (0.04%) in November and December, 2016. *Drechslera* spores have been obtained from the air by several workers. Meier et al. (1933), Pady (1957), Kramer et al. (1966) and Turner (1966) in low number. Ramlingam (1971) recorded high number of these spores in the air in the month of December. Shastri (1981) reported 0.03% of these spores from the air of vegetable market at Aurangabad. Wankhade (1983) reported these spores over jowar fields at Aurangabad. Patil (1985) reported 0.13% contribution to the total airspora and Jogdand (1987) reported 0.18% to the total airspora over jowar fields at Parbhani and Aurangabad respectively. Pawar (1997) reported 2.31% and 4.33% and 0.36% to the total airspora over groundnut fields at Shrigonda (Ahmednagar). Mali (2002) reported 1.67% and 2.60% to the total airspora over bajra and jowar fields at Kada (Beed). Gopan (2004) reported 2.67% and 2.33% of these spores over bajra field. Kshirsagar (2007) recorded 0.23%, 0.26% and 0.78%, 0.51% to the total airspora over sunflower fields. Mali et al (2011) reported 2.96% over green gram field. Patil et al (2015) reported 0.21% over jowar field. Kshirsagar et al (2016) reported 2.88% over groundnut field.

Epicoccum Link ex wallr. The conidia dark, one celled or several celled, globose, sub-globose or irregular septate, aerolate, epispore varicose at the base with a scar, surrounded by a ring shaped basal cell, spores dark brown olivaceous or black, 7-9 μm in diameter, their contribution to the total airspora was 0.69%. Total number of spores in the first season ($4788/\text{m}^3$) was comparatively more or less equal in the second season ($4732/\text{m}^3$). Maximum number of spores ($1554/\text{m}^3$) was observed in December, 2015 and minimum number of spores ($812/\text{m}^3$) in November, 2016. Percentage contribution in the first season (0.73%) was higher than that in the second season (0.66%). Meier et al (1933) reported *Epicoccum* from the airspora during the flights over the United States at the height from 150 meters to 5,500 meters. Dye and Vernon (1952) found it to be the third commonest spore type after *Cladosporium* and *stemphylium* in New Zealand. Richards (1956) showed that it was the fourth most common genus at nine states in Britain. Panzer et al (1957) showed its dominance during night period and called as “Night spora” with maximum concentration between 18.00 hours and 09.00 hours. Other reports in air fare from Lacey (1962). Sreeramulu and Ramlingam (1966), Davies (1969), Mishra and Srivastava (1970), kulkarni (1971), Rees (1964) from Brisbane reported 0.4% spores and 12.5% colonies. Some earlier workers assigned it to “Night spora” group such discrepancies are said to be due to difference in local environmental condition (Gregory 1961). Mane (1978) reported 0.25% concentration and called it a member of Day spora group. He observed peak at 14.00 hours.

Tilak and Bhalke (1978) reported 0.25% spores from air other reports are of Bhalke (1981) reported 0.14%, Shastri (1981) reported 0.03%, Patil (1983) reported 0.22%, patil (1985) reported 0.20% , Jogdand (1987) reported 0.07% to the total airspora over jowar, vegetable, banana and jowar fields at Aurangabad. Thube (1992) reported 0.10% contribution of these spores over jowar fields at Ahmednagar. Shinde (1996) reported 0.82% at Nanded. Similarly other reports are of Pawar (1997) 1.32% and 2.47%, Aher (1998) 1.9% and 1.85%, and Thite (1998) 0.45% and 1.12% to the total airspora over bajra, groundnut and groundnut fields at Aurangabad, Deola Nashik, Shrigonda, and Ahmednagar respectively. Mali (2002) also reported 1.16% and 1, 53% of these spores over bajra and jowar fields. Gopan (2004) reported 1.47% and 1.46% of these spores over bajra fields. Kshirsagar (2007) recorded 0.23% to the total airspora over sunflower field.

Patil (2008) recorded 0.09% to the total airspora over black gram field. Arsule and Pande (2011) reported 2.06% over groundnut field. Mali et al (2011) reported 0.69% over green gram field. Sonawane (2013) reported 0.39% over groundnut field. Patil et al (2015) reported 1.36% over jowar field. Patil and Mali (2017) reported 0.59% over jowar field.

Fusariella Sacc.: The conidia dark, 3 celled, cylindrical, curved, borne in chains, not end to end, each conidium attached at side of the conidia below, 20-26 x 6-7 μm . They contributed 0.29% to the total airspora in the first and second Rabi seasons respectively. The highest number of spores (602/ m^3) was observed in January, 2016 and the lowest number of spores (364/ m^3) in November, 2016. The percentage contribution in the first season (0.32%) was higher than that in the second season (0.28%). Total number of spores in the first season (2072/ m^3) was higher than that in the second season (2016/ m^3).

Meier et al (1933) reported these spores from the air during the flights over the United States at from 150 meters to 5,500 meters. Chen et al (1978) at Taipei pointed out that these spores belonged to 'Night spora' group. Mane (1978) recorded 0.13% of this concentration in the air spora over bajra fields at Vaijapur. Tilak (1989) reported these spores from Aurangabad, Nanded and Parbhani. Other reported are of Bhalke (1981) reported 0.14% spores over jowar fields, patil (1983) 0.11% spores over banana fields and wankhade (1983) 0.19% over jowar fields from Aurangabad. Patil (1985) reported 0.25% and Jogdand (1987) reported 0.2% to the total airspora over jowar fields at Aurangabad respectively. Reddy (1988), Zahid (1994), Naik (1995) reported these spores from air over different crop fields at Aurangabad respectively. Pole (1995) reported from udgir over jowar fields. Suryawanshi (2002) recorded 0.79% and 0.85% contribution to the total airspora over sunflower and wheat fields. Kshirsagar (2007) reported 1.61% 0.44% and 1.07%, 0.42% to the total airspora over sunflower fields. Patil (2008) reported 0.13% to the total airspora over black gram field. Arsule and Pande (2011) recorded 1.32% over groundnut field. Mali et al (2012) reported 0.38% over bajra field.

Haplosporella Speg.: The conidia large, dark, one celled, ovoid or oblong, 15-17 x 10.8-11.8 μm in diameter. They contributed 0.81% to the total air-spore in the first and second Rabi seasons respectively. Maximum number of spores (2520/ m^3) was observed in December, 2015 and minimum number of spores (1050/ m^3) in February, 2017. The

highest mean concentration (1.46%) was observed in December, 2015 and lowest mean concentration (0.59%) in January, 2017. Percentage contribution in the first season (0.96%) was higher than that in the second season (0.68%). Kulkarni (1971) recorded 0.51% spores from Aurangabad. Gaikwad (1974) reported 0.18% spores from Ahmedpur. Pande (1976) recorded 0.25% spores from Nanded. Mane (1978) recorded 0.56% spores from Vaijapur. Tilak and Bhalke (1978) also reported these spores from Aurangabad airspora over jowar fields. Other reports are of Bhalke (1981) 2.62%, Shastri (1981) 0.33%, Patil (1983) 0.09%, Wankhade (1983) 1.26%, Patil (1985) 0.75% and Jogdand (1987) 0.05% on jowar fields at Parbhani and Aurangabad. Kavishwar (1990) reported 0.03% over jowar fields at Dhulia. Patil (1992) reported 0.15% over jowar fields at Jalgaon. Thube (1992) and Ahuja (1992) also recorded these spores over different fields from this region. Pawar (1997) reported 0.29% and 0.83% of these spores over bajra fields at Aurangabad. Thite (1998) reported 0.45% and 0.53% of these spores over groundnut fields. Mali (2002) reported 0.58% and 0.27% of these spores over bajra and jowar fields. Gopan (2004) reported 0.52% and 0.26% of these spores over bajra fields. Kshirsagar (2007) recorded 0.04% and 0.004% and 0.68%, 1.26% to the total airspora over sunflower fields. Patil (2008) reported 0.14% to the total airspora over black gram field. Arsule and Pande (2011) recorded 0.8% over groundnut field. Mali et al (2011) reported 0.32% over green gram field. Kadam et al (2011) reported 0.99% over bajra field. Patil et al (2015) reported 0.43% over jowar field.

Harknessia Cooke.: The conidia dark, one celled, hexagonal sometimes ellipsoid, ovoid, drawn out into a hyaline pedicel. They contributed 0.03% to the total airspora in the first and second Rabi seasons respectively. In terms of actual number, spore concentration in the first season ($210/\text{m}^3$) was higher than that in the second season ($168/\text{m}^3$). Maximum number of spores ($98/\text{m}^3$) was observed in February, 2016 and minimum number of spores ($28/\text{m}^3$) in November, 2016. Percentage contribution in the first season (0.03%) was slightly higher than that in the second season (0.02%).

Wankhade (1983) recorded 0.22% in first season and 0.24% in second season over jowar fields. Patil (1985) and Jogdand (1987) reported 0.20% and 0.02% conidia to the total airspora over jowar fields at Aurangabad respectively. Suryawanshi (2002) recorded

0.08% and 0.24% contribution to the total airspora over sunflower and Wheat fields. Mali et al (2011) reported 0.65% over green gram field. Mali et al (2012) reported 0.30% over bajra field. Patil et al (2015) reported 0.07% over jowar field.

Heliminthosporium Link ex Fries: The spores oblavate to cylindrical, slightly curved or bent, apex somewhat rounded, sub-hyaline to dark brown, with 3 to many pseudosepta with prominent basal scar, 35-95 x 11- 18 μm . They contributed 1.61% to the total airspora in the first and second Rabi seasons respectively. Maximum number of spores (3150/ m^3) was observed in November, 2016 and minimum number of spores (1960/ m^3) in February, 2016. Percentage contribution in the first season (1.61%) was slightly higher than that in the second season (1.60%). Total number of spores in the first season (10500/ m^3) was comparatively lesser than that in the second season (11550/ m^3). Stakman et al (1923) and Meier et al (1933) have recorded *Heliminthosporium* spores up to 3,300 and 5,500 meters height respectively from the air spora. Padmanabhan et al (1952) reported *Heliminthosporium oryzae* conidia over rice fields. Kramer et al (1959) reported 0.3% spores at Kansas. Kramer and Pady (1960) at Kansas reported spores more frequently during growing seasons. No incidence of spore was observed in the air during winter months. Dransfield (1966) in Samru reported these spores 0.85% with maximum incidence in the air between September and November. In Hong Kong, turner (1900) recorded 0.2% spores. Meredith (1966) at Nebraska reported their low concentration throughout the months of October and November, conidia of *Heliminthosporium Turbicum* pass. Tilak and srinivasulu (1967) at Aurangabad reported *Heliminthosporium anamalum* long type (9.62%) and short type (9.74%) from the total catches. Berger (1970) found that nearly 50% of the trapped spores were produced at night and released in the morning as the humidity rapidly decreased. Kulkarni (1971) reported 2.83% spores from Aurangabad atmosphere. Gangopadhyaya and Chattopadhyay (1973) studied vertical dispersal of conidia of *H.oryzae* in vitro and concluded that increased in relative humidity from 85 to 100% increased dissemination of conidia about seven times and distance travelled double. Gaikwad (1974) reported 9.38% spores from the total airspora of Ahmedpur. Kamal and Singh (1975) reported these spores over maize and cowpea at Gorakhpur. Pande (1976) reported 2.74% spores from total air spora of Nanded. Mane (1978) noted 0.56% spores from Vaijapur. Tilak and Bhalke (1978) reported conidia from

Aurangabad airspora over jowar fields. Other reports are of Bhalke (1981) reported 4.68%, Shastri (1981) 1.75%, Patil (1983) reported 1.04% and wankhade (1983) reported 0.97% over jowar, maize, banana and jowar fields at Aurangabad. Patil (1985) reported 1.44% and Jogdand (1987) reported 0.40% over jowar fields at Parbhani and Aurangabad. Patil (1992) recorded 4.72% contribution of these spores over jowar fields at Jalgaon.

Pillai (1983), Bhagwan (1983), Venugopalachari (1986), Meghraj (1989), Vaidya (1990), Ahuja (1992), Patil (1992) and Zahid (1994) encountered these spores from different fields from Aurangabad. Pawar (1997) reported 8.04% and 5.64% of these spores over bajra fields at Aurangabad. Aher (1998) reported 3.72% and 3.52% of these spores over groundnut fields. Thite (1998) at Shrigonda. Mali (2002) reported 2.87% and 3.58% of these spores over bajra and jowar fields. Gopan (2004) reported 8.17% and 8.26% of these spores over bajra fields. Kshirsagar (2007) recorded 2.01%, 2.82% and 9.50%, 6.58% to the total airspora over sunflower fields. Patil (2008) reported 4.64% to the total airspora over black gram field.

Heterosporium Kolitzsch ex Cook.: The conidia dark, typically three or more celled, cylindrical, wall rough, echinulate to varicose, 23-27 x 7-7.6 μm . Conidia usually occur singly. They contributed 1.43% to the total airspora in the first and second Rabi seasons respectively. Total number of spores in the first season ($9828/\text{m}^3$) was slightly higher than that in the second season ($9772/\text{m}^3$). Maximum concentration (1.61%) was observed in January, 2016 and minimum concentration (1.28%) in November, 2016. Percentage contribution in the first season (1.52%) was higher than that in the second season (1.35%). Some of the reports of paddy (1957) reported them from Kansas atmosphere. Pande (1976) reported 0.02% spores from Nanded. Mane (1978) recorded 0.25% spores at Vaijapur. Tilak and Bhalke (1978), Babu (1983), Patil (1983), Saibaba (1983), Bhasale (1983) and wankhade (1983) reported these spores from Aurangabad. Patil (1985) reported 0.10% and Jogdand (1987) recorded 0.05% at Parbhani and Aurangabad respectively.

Kavishwar (1990) reported 0.01% over jowar fields at Dhulia. Patil (1992) reported 0.17% over jowar fields at Jalgaon. Pawar (1997) reported 3.72% and 1.43% of these

spores over bajra fields at Aurangabad. Aher (1998) reported 1.71% and 1.76% of these spores over groundnut fields. Thite (1998) reported 0.95% and 1.02% of these spores over groundnut fields. Mali (2002) reported 2.10 % and 1.99% of these spores over bajra and jowar fields. Gopan (2004) reported 2.64% and 2.03% of these spores over bajra fields. Kshirsagar (2007) recorded 1.74% and 1.63% to the total airspora over sunflower fields. Patil (2008) recorded 0.52% to the total airspora over black gram field. Arsule and Pande (2011) reported 1.68% over groundnut field. Mali et al (2011) reported 1.27% over green gram field. Kadam et al (2011) reported 1.05% over bajra field. Sonawane (2013) reported 1.67% over groundnut field. Patil et al (2015) recorded 0.41% over jowar field. Patil and Mali (2017) recorded 0.33% over jowar field.

Lacellina Sacc.: The conidia acropleurogenous, single celled, sub-globose to globose or somewhat oval, pale, brown to dark, 4-7 μm in diameter. When globose, 5-8 x 3-6.5 μm , when otherwise smooth or more usually vericulose, often somewhat flattened in one plane, occur in chain. They contributed 1.90% to the total airspora in the first and second rabbi seasons respectively. Maximum number of spores ($4200/\text{m}^3$) in January, 2017 and minimum number of spores ($2240/\text{m}^3$) in November, 2015. The highest mean concentration (2.28%) was recorded in February, 2017 and lowest mean concentration (1.48%) in November, 2015. Percentage contribution in the first season (1.79%) was lower than that in the second season (2.01%). Total number of spores in the first season ($11620/\text{m}^3$) was lower than that in the second season ($14420/\text{m}^3$). Shastri (1981) reported 0.07% spores from air of vegetable market. Patil (1983) reported 1.69% of these spores over banana fields at Aurangabad. Pillai (1983) observed 0.55% contribution of these spores to the total airspora. Patil (1985) reported 1.40% and Jogdand (1987) 0.001% conidia over jowar fields at Aurangabad. Rao (1987) recorded 0.46% and 0.04% contribution of these spores to the total airspora at Aurangabad. Pawar (1997), Thite (1998) and Mali (2002) recorded 0.20%, 0.07% and 0.24% contribution of these spores to the total airspora from different regions respectively. Gopan (2004) reported 0.13% and 0.24% of these spores over bajra fields. Kshirsagar (2007) recorded 0.004% to the total airspora over sunflower field. Arsule and Pande (2011) reported 0.62% over groundnut field. Kadam et al (2011) reported 0.57% over bajra field.

Lacelinopsis Subram.: The conidia produced acropetally in chains, one celled, mostly globose, sometimes sub globose, pale to reddish brown, 5-10 μm in diameter. They contributed 0.54% to the total airspora in the first and second Rabi seasons respectively. They contributed 0.54% to the total air spora. The highest concentration (0.80%) was observed in January, 2016 and lowest concentration (0.38%) in November, 2016 and December, 2016. In terms of actual number, spore concentration in the first season ($3766/\text{m}^3$) was comparatively more or less equal in the second season ($3724/\text{m}^3$). The percentage contribution in the first season (0.58%) was slightly higher than that in the second season (0.52%).

Mane (1978) reported 0.29% spores from Vaijapur. Tilak and Bhalke (1978) reported these spores from Aurangabad. Wankhade (1983) reported 0.35% of these spores over sorghum fields at Aurangabad. Patil (1985) reported 0.65% and Jogdand (1987) reported 0.06% of these spores over jowar fields at Aurangabad.

Sankaye (1989) reported 0.73% Pole (1995) reported 0.109% and 0.3105% and Suryawanshi (2007) recorded 0.60% and 0.50% of these spores over sunflower and wheat fields at different region. Mali et al (2011) reported 0.10% over green gram field. Mali et al (2012) reported 0.16% over bajra field. Kshirsagar et al (2016) recorded 0.22% over ground field.

Memnoniella Hohnel: The conidia dark, one celled, globose to sub-rectangular or squarish, dark to opaque, rough to echinulate, 6-9 μm in diameter and 5-5.5 μm thick forming persistent simple chain to 2000 μm long. Conidia usually occur in chain. The spores were recorded in both seasons. They contributed 0.20% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.29%) was higher than that in the second season (0.13%). The highest mean concentration (0.44%) was recorded in February, 2016 and lowest concentration (0.01%) in December, 2016. Total number of spores in the first season ($1890/\text{m}^3$) was higher than that in the second season ($938/\text{m}^3$).

Kramer (1959) reported these spores at Kansas. Meredith (1962) reported 0.7% spores in Jamaica. Ress (1964) in Brisbane recorded only two colonies from exposed Petri plates. In

India Rajan et al (1952) reported these spores from Kanpur airspora. Tilak and srinivasulu (1967) reported these spores from airspora of Aurangabad. Kulkarni (1971) recorded 0.17% spores to the total air spora over vegetable fields at Aurangabad. Other reports are of Mane (1978) 0.84% over bajra fields at Vaijapur. Bhalke (1981) 0.52%, Patil (1985) recorded 1.00%, Jogdand (1987) reported 0.27% to the total airspora over jowar fields at Aurangabad respectively. Kavishwar (1990) reported 0.32% to the total airspora over jowar fields at Dhulia. Sankaye (1989) reported 0.35% spores over sunflower fields at Latur. Ahuja (1991) recorded 0.03% and 0.001% spores during first and second Rabi Seasons over sorghum fields at Aurangabad. Thube (1992) recorded 0.37% spores in the airspora at Ahmednagar. Mali (1998) recorded 0.09% as the mean percentage contribution to the total airspora for four crop seasons over groundnut fields. Kadam (2002) reported 3.86% to the total airspora over sugarcane field. Mali (2002) reported 0.52% and 0.58% of these spores over bajra and jowar fields at Kada (Beed). Pawar (1997), Aher (1998), Thite (1998) reported different crop fields. Kshirsagar (2007) reported 0.78%, 0.22% and 0.68%, 0.25% to the total airspora over sunflower fields.

Nigrospora Zimm.: The conidia dark, one celled, globose, sub-globose or depressed globose, black and opaque, smooth, flattened, 12-23 μm in diameter. Spores of *Nigrospora* were encountered regularly throughout the period of investigations. They contributed 5.69% to the total airspora in the first and second Rabi seasons respectively. The highest mean concentration (6.52%) was observed in December, 2015 and lowest mean concentration (4.95%) in February, 2017. Maximum number of spores ($11228/\text{m}^3$) was observed in December, 2015 and minimum number of spores ($8498/\text{m}^3$) in February, 2016. Percentage contribution in the first season (6.08%) was higher than that in the second season (5.34%). Kulkarni (1971) encountered 5.45% *Nigrospora* spores. Agarwal and shivpuri (1974) reported *N.Sphaerica* from Delhi atmosphere. Shastri (1981) reported 2.85% spores over vegetable market and maize fields at Aurangabad. Bhalke (1981) reported 3.20%, Patil (1983) reported 3.29% and wankhade (1983) reported 1% over different crop fields at Aurangabad. Patil (1985) reported 2.40% conidia; Jogdand (1987) reported 0.52% over jowar fields at Aurangabad respectively.

Verma (1990) reported 2.66% contribution to the total airspora from Jabalpur. Shinde (1996) reported 6.07% at Nanded. Pawar (1997) reported 11.29% and 7.45% of these spores over bajra fields at Aurangabad. Aher (1998) reported 1.95% and 1.74% of these spores over groundnut fields. Thite (1998) reported 2.15% and 3.13% of these spores over groundnut fields. Mali (2002) reported 4.02% and 5.78% of these spores over bajra and jowar fields. Gopan (2004) reported 4.58% and 4.26% of these spores over bajra fields. Kshirsagar (2007) recorded 16.54%, 26.00% and 10.85%, 11.72% to the total airspora over sunflower fields. Patil (2008) reported 2.17% to the total airspora over black gram field. Patil et al (2015) reported 0.24% over jowar field. Patil and Mali (2017) recorded 0.44% over jowar field.

Papularia Fries: The conidia dark, one celled, ovoid, often lenticular inside view, with light band seen in edge view, 5-7.5 x 3-4 μm . They contributed 0.01% to the total airspora in the first Rabi season respectively. Percentage contribution in season (0.01%). Total number of spores in season ($42/\text{m}^3$), only observed in the first season. Kramer and Paddy (1960) reported their infrequent occurrence in the airspora at Kansas. Mishra and kamal (1971) reported it in winter at Gorakhpur. Mane (1978) observed 0.25% spores over bajra fields at Vaijapur. Other reports are of Tilak and Bhalke (1979), Bhalke (1981), Shastri (1981), Patil (1983), Wankhade (1983), Patil (1985), Jogdand (1987). reported different crop fields at Aurangabad. Patil (2008) reported 0.18% to the total airspora over black gram field. Arsule and Pande (2011) reported 0.79% over groundnut field.

Penicillium Link: Conidium hyaline or brightly colored in mass, one celled, mostly globose or ovoid, 0.8-1.52 μm in diameter. They contributed 0.28% to the total airspora in the first and second Rabi seasons respectively. Total number of spores in the first season ($644/\text{m}^3$) was lower than that in the second season ($3220/\text{m}^3$). The maximum concentration ($1120/\text{m}^3$) was found in December, 2016. Whereas the minimum concentration ($126/\text{m}^3$) in January, 2016. Percentage contribution in the first season (0.09%) was lower than that in the second season (0.45%). Daily catches showed day to day variation. Harrison (1898) and Bell (1901) reported these spores from melted water. Other reports are of Harz (1904), Brown (1930), Pady (1951) reported them from the upper air spora. Apart from these, Hyde and William (1949), Pady (1953), Gregory and

Hirst (1957), Kramer et al (1959), Davies (1961), Gregory (1961), Sreeramulu (1961), Lacey (1962), Sreeramulu and Ramlingam (1963), Tilak and srinivasulu (1967), Mishra and Srivastava (1970), Mishra and Kamal (1971) reported *Penicillium* spores from the airspora. Hyde and Williams (1949) found that the fungus formed one of the main components of the airspora, contributing 13% to the total colonies. Kramer et al (1959) reported 6.1% colonies from the air on the Petri plates. In 1960, they found that *Penicillium* preferred warm weather to cooler one. It also followed a definite seasonal trend despite a great day to day variation. Derric (1966) in Melbourne reported a large number of *Penicillium* spores during November and December. Kulkarni (1971) recorded 0.05% *Penicillium* spores from the total airspora. Agarwal and shivpuri (1974) isolated eight species of *Penicillium* which appeared in Delhi airspora. Pande (1976) reported 0.09% of these spores from Nanded over orange fields. Mane (1978) recorded 0.98% of these spores from Vaijapur over bajra fields. Other reports are of Bhalke (1981) reported 2.22%, Shastri (1981) recorded 0.33%, Patil (1983) reported 0.13%, Bhasale (1983) reported 1.14% and wankhade (1983) reported 0.44% of these spores over jowar, maize, banana, vegetable and jowar fields respectively from Aurangabad. Patil (1985) reported 0.76% to the total airspora over jowar fields at Aurangabad.

Periconia Tode ex Schew.: The conidia dark, one celled, globose, usually rough walled, often shows spiny wall, 9 -12 μm in diameter. These conidia occurred regularly through the period of investigation. They contributed 3.45% to the total airspora in the first and second Rabi seasons respectively. The highest concentration ($8400/\text{m}^3$) was recorded in November, 2016 and the lowest concentration ($2800/\text{m}^3$) in February, 2016. The total number of spores in the first season ($20314/\text{m}^3$) was lower than that in the second season ($27020/\text{m}^3$). Kulkarni (1971) reported 1.28 % of these spores from total airspora over Sugarcane fields at Aurangabad. Agarwal and shivpuri (1974) reported *P. Microspinesa* from Dheli air spora. Other reports are of Pande (1976) reported 4.74% spores over orange fields at Nanded. Mane (1978) reported 1.98% spores over bajra fields at Vaijapur. Bhalke (1981) reported 2.4%, Shastri (1981) reported 1.56%, Patil (1983) reported 5.18%, Bhasale (1983) reported 7.49%, Patil (1985) reported 4.00% and Jogdand (1987) reported 0.21% spores to the total airspora over jowar, vegetable market, banana, vegetable fields at Aurangabad respectively.

Kavishwar (1990) reported 0.77% over jowar fields at Dhulia. Patil (1992) recorded 5.84% contribution of these spores at Jalgaon over jowar fields. Thube (1992) and Aher (1993) reported these spores from Ahmednagar atmosphere. Pawar (1997) reported 2.30% and 2.08% of these spores over bajra fields at Aurangabad. Thite (1998) reported 0.80% of these spores over groundnut field. Mali (2002) reported 3.23% and 5.86% of these spores over bajra and jowar fields. Gopan (2004) reported 2.13% and 2.03% of these spores over bajra fields. Kshirsagar (2007) recorded 3.21%, 1.32% and 1.26% to the total airspora over sunflower fields. Patil (2008) recorded 5.10% to the total airspora over black gram field.

Pestalotia de Not.: The spores 5 distinct septate (false septate), 4 medium cells brown, end cells hyaline, 3-9 apical, cellular, simple or dichotomously branched appendages and 1 basal cellular simple or branched appendages, 14-23 x 5- 7µm. The spores occurred rarely during period of investigations. They contributed 0.13% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (0.14%) was higher than that in the second season (0.12%). Maximum number of spores (574/m³) was found in December, 2015 and minimum number of spores (28/m³) in February, 2017. Total number of spores in the first season (910/m³) was slightly higher than that in the second season (868/m³). Shastri (1981) reported 0.01% spores over vegetable market and Reddy (1988) reported 0.02% over sunflower fields at Aurangabad. These spores were earlier recorded by Tilak (1989) and Pole (1995) reported 0.65% and 1.13% contribution during first and second Rabi seasons over sunflower crop fields respectively. Pawar (1997) reported 0.21% and 0.05% to the total airspora over bajra fields at Aurangabad. Aher (1998) reported 1.61% and 1.32% to the total airspora over groundnut fields. Thite (1998) reported 0.35% to the total airspora over groundnut fields. Mali (2002) reported 0.08% and 0.10% to the total airspora over bajra and jowar fields. Suryawanshi (2002) reported 0.56% and 0.04% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 0.20% and 0.26% of these spores over bajra fields. Kshirsagar (2007) reported 0.40%, 0.20% and 0.48%, 0.84% to the total airspora over sunflower fields. Arsule and Pande (2011) recorded 0.42% over groundnut field. Sonawane (2013) reported 0.22% over groundnut field.

Pithomyces Berk and Br.: The conidia single, colored, doliform, mostly broadly elliptical, oblong to pyriform or irregular many celled, transversely or vertically septate 21-27 x 10-17 μm in diameter. They contributed 0.93% to the total airspora in the first and second Rabi seasons respectively. Total number of spores in the first season (5866/ m^3) was lower than that in the second season (6860/ m^3). The highest concentration (2100/ m^3) was observed in January, 2017 and lowest concentration (1260/ m^3) in November, 2015 and November, 2016. Percentage contribution in the first season (0.90%) was lower than that in the second season (0.95%). Meredith (1962) reported 0.17% spores from Jamaica. He peak between 09.00 and 16.00 hours but often the peak was defined. The peaks were of short duration and the concentration rapidly decreased to the value existing before the rains. Rees (1964) reported 0.17% of these spores from Brisbane. He observed that the spores were more prevalent during February, April and early May on several occasions in late summer and autumn a sharp increase in number followed of grasses in the immediate vicinity of crop and trap. Kulkarni (1971) recorded 0.62% spores over sugarcane fields at Nanded. Gaikwad (1974) reported 0.46% spores to the total airspora at Ahmednagar. Pande (1976) reported 0.08% spores from orange fields at Nanded. Tilak and Bhalke (1978), Sankey (1989) and Meshram (1990) recorded these spores in the airspora at various places. Patil (1985) reported 1.50% and Jogdand (1987) reported 0.11% to the total airspora over jowar fields at Aurangabad. Ramchander Rao (1987) reported 0.12% over sunflower fields at Aurangabad. Patil (1992) reported 1.58% spores to the total airspora over jowar fields at Jalgaon. Mali (2002) reported 0.86% and 1.26% to the total airspora over bajra and jowar fields. Suryawanshi (2002) reported 0.76% and 0.46% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 1.42% and 0.68% of these spores over bajra fields. Kshirsagar (2007) recorded 1.58% 1.66% and 0.97%, 1.5% to the total airspora over sunflower fields.

Pseudotorula Subram.: The spores, torulose, dark brown, elliptical to oval, usually 3septet, constricted at one or more septa, thick walled, several celled, long, slender, single or branched acropetal chains, and 12.5-24 x 5.7-9 μm . The spores were trapped in both seasons. They contributed 0.03% to the total airspora in the second Rabi season respectively. The highest concentration (0.08%) was recorded in February, 2017 and lowest concentration (0.06%) in January, 2017. The percentage contribution observed in

the second season was (0.05%).Kramer and his workers (1964) reported one colony on exposed Petri plates from Kansas air. Rees (1964) from Brisbane isolated one colony from exposed medium.Kulkarni (1971) recorded 7.08% over sugarcane fields at Aurangabad. Gaikwad (1974) reported 0.13% of these spores at Ahmedpur. Pande (1976), Mane (1978) observed 1.04% spores over bajra fields at Vaijapur. Tilak and Bhalke (1978) recorded 1.2% spores over jowar fields at Aurangabad. Kulkarni (1971) recorded 2.4%, 2.71% and 5.33% during first, second and third season respectively over vegetable fields at Aurangabad.Other reports are of Bhalke (1981), Patil (1983), Bhasale (1983) and wankhade (1983) reported the incidence of these spores over jowar and other crop fields. Patil (1985) reported 0.10% spores and Jogdand (1987) reported 0.015% spores over jowar fields at Parbhani and Aurangabad respectively to the total airspora. Thube (1992) recorded 3.23% of these spores over jowar fields at Ahmednagar. Kavishwar (1990) reported 0.04% over jowar fields at Dhulia. Pawar (1997) reported 1.03% and 1.19% of these spores over bajra fields at Aurangabad. Mali (2002) reported 3.35% and 3.35% of these spores over bajra and jowar fields. Kshirsagar (2007) reported 1.23%, 2.49% and 0.58%, 1.52% to the total airspora over sunflower fields.Kadam *et al.*, (2011) reported 0.44% over bajra field.

Tetraploa Berk and Br.: The conidia with three or four septet appendages smooth or rough, brown, 86.15 x 5.6 um in diameter. They contributed 0.60% to the total airspora. They contributed 0.60% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration (1582/m³) was encountered in December, 2015 and the minimum concentration (28/m³) in February, 2017. Total number of spores in the first season (4172/m³) was comparatively more or less equal in second season (4116/m³). Percentage contribution in the first season (0.64%) was higher than that in the second season (0.54%). Cunningham (1873) reported the occurrence of *Tetraploa* spores from the airspora of presidency and adipose jails in Calcutta Meredith (1962) reported 0.12% of these spores in Jamaica atmosphere.Rees (1964) recorded less than 1% Spores colonies from the exposed Petri plates in Brisbane. Tilak and Srinivasulu (1967) reported them from air spora of Aurangabad.Apart from this the other reports on occurrence of these spores in the air are by kulkarni (1971) at Aurangabad, Gaikwad (1974) at Ahmedpur. Pande (1976) at Nanded and Tilak and Bhalke (1976) at Aurangabad. Patil

(1985) reported 0.07% and Jogdand (1987) reported 0.0022% contribution to the total airspora over jowar fields. Other reports are of venugopalachari (1986), Ramakrishna (1987), Minhaj (1988), Reddy (1988), Meghraj (1989), Javeed (1990), Patil (1992), Thube (1992) and Zahid (1994) who reported these spores from air over different fields in Marathwada region.

Pawar (1997), Aher (1998), Thite (1998) and Mali (2002) recorded these spores from air over different fields. Gopan (2004) reported 0.04% and 0.09% of these spores over bajra fields. Kshirsagar (2007) recorded 0.05% and 0.02% to the total airspora over sunflower fields. Patil (2008) reported 0.12% to the total airspora over black gram field.

Torula Pers.: The conidia dark, present in simple or branched erect chains, unbroken chains up to 90 x 6-10 μm , apart into short length, singly, in two, in threes, in four or in groups, markedly or faintly echinulate. They contributed 0.06% to the total airspora in the first and second Rabi seasons respectively. The highest concentration ($154/\text{m}^3$) was encountered in January 2016 and lowest concentration ($42/\text{m}^3$) in November 2016. Total number of spores in the first season ($434/\text{m}^3$) was slightly higher than that in the second season ($392/\text{m}^3$). Other reports are of Lacey (1962), Kramer et al. (1963), Sreeramulu and Ramlingam (1963) reported their incidence. Tilak and Bhalke (1978) reported 1.8% spores from Aurangabad atmosphere. Mane (1978) obtained 0.13% spores over bajra fields. Apart from these other reports are by Bhalke (1981) reported 2.98% over jowar fields. Shastri (1981) reported 9.42% Spores over the vegetable market; wankhade (1983) reported 0.39% spores over jowar fields at Aurangabad. Patil (1985) reported 0.38% spores and Jogdand (1987) reported 0.17% spores to the total airspora over jowar fields. Kavishwar (1990) reported 0.16% over jowar fields at Dhulia. Patil (1992) recorded 1.12% of these spores over jowar fields at Jalgaon. Mali (2002) reported 2.67% and 2.91% of these spores over bajra and jowar fields at Kada (Beed). Suryawanshi (2002) reported 1.19% contribution to the total airspora over wheat field. Gopan (2004) reported 4.72% and 4.43% of these spores over bajra fields. Kshirsagar (2007) recorded 0.40%, 0.37% and 1.07%, 0.76% to the total airspora over sunflower fields. Patil (2008) reported 0.18% to the total airspora over black gram field.

Trichoconis Clements.:The conidia elongate fucoids with a long hyaline appendage at the tip, 3-5 septate, creamy yellow, slightly constricted at the septa, basal cells thick walled, straight, 98.5-157.5 μm long including appendages and 8.5-18.8 μm broad, rigid septate, 2-5 μm thick. They contributed 0.04% to the total airspora in the first and Jayswal (1993) second Rabi seasons respectively. The highest concentration ($140/\text{m}^3$) was observed in December, 2015 whereas the lowest concentration ($28/\text{m}^3$) in November, 2016. Total number of spores in the first season ($294/\text{m}^3$) was slightly higher than that in the second season ($252/\text{m}^3$). Percentage contribution in the first season (0.04%) was higher than that in the second season (0.03%). Sreeramulu and Sheshavataram (1962) recorded 0.44% *Trichoconis padwickii* spores over paddy fields. Kadam *et al.*, (2011) reported 0.356% over bajra field. Sonawane (2013) reported 0.48% over groundnut field.

Algal Filaments. During present investigations some algal material was trapped along with the other aero mycology. It includes one celled filamentous forms belonging to various groups of algae. All of them have been grouped in heterogeneous group. They contributed 0.65% to the total airspora in the first and second Rabi seasons respectively. Maximum number of spores ($1540/\text{m}^3$) was found in December, 2016 and minimum number of spores ($560/\text{m}^3$) in February, 2016. Total number of spores in the first season ($4130/\text{m}^3$) was lower than that in the second season ($4830/\text{m}^3$). The percentage contribution in the first season (0.63%) was lower than that in the second season (0.67%). Incidence was more during two consecutive seasons because site of sampling near the river Ehresmann and Melvinathatch (1975) studied the effect of relative humidity on survival of airborne unicellular algae and concluded that high humidity favored the longevity of airborne algae. Marathe and Reddy (1978) carried out the survey of algae airspora of Nagpur by using agar plates. They encountered 20 species which belonged to 15 different genera. Jogdand (1987) reported 0.015% contribution to the total airspora over jowar crop fields. Jayswal (1993) reported 0.48% contribution to the total airspora during two Kharif Seasons over sunflower fields. Pole (1995) reported 8.18%, Pawar (1998) recorded 6.46%, Mali *et al* (2002) reported 0.39% over bajra field and Suryawanshi (2002) recorded 0.84%, 0.38% contribution to the total airspora over sunflower and wheat fields.

Epidermal hairs: During the period of investigation different types of epidermal hairs from various tax of plant kingdom were encountered. Mainly the airborne epidermal hairs included uniseriate, multicellular hairs, trichomes and very rarely unicellular, thick double walled, straight or curved hairs which may perhaps be root hairs. Root hairs many become airborne after their separation from the dried roots of different plants. Apart from hairs of different types, occasionally epidermal tissues, sometimes sclerenchyma tissue and fibers have also been encountered, but very rarely. They have been included in this heterogeneous group. They contributed 0.36% to the total airspora in the first and second Rabi seasons respectively. The highest concentration ($1050/\text{m}^3$) was observed in February, 2017 and whereas, lowest concentration ($252/\text{m}^3$) in November, 2015. Total number of spores in the first season ($2100/\text{m}^3$) was lower than that in the second season ($2800/\text{m}^3$). The percentage contribution in the first season (0.32%) was lower than that in the second season (0.39%). Jogdand (1987) reported 0.403% contribution to the total airspora over jowar crop field. Pole (1995) recorded 0.11% and 0.09% contribution during first and second rabbi seasons over sunflower crop fields. Pawar (1998) reported 1.58% and 2.20% contribution during two winter and two summer seasons over sunflower crop fields. Suryawanshi (2002) recorded 0.41% and 0.46% to the total airspora over sunflower and wheat fields.

Hyphal Fragments: The hyphal fragments of all types (short, long, simple, branched, colored, hyaline) were occurred under this group. Whether long or short mostly dematiaceous hyphae were recorded frequently terminal portions of conidiophores were trapped. Most of the hyphal fragments were thick walled and broken. Hyaline were either less numerous or could not be recognized. Hyphal fragments occurred throughout the period of investigations. High numbers were encountered during the day time. They contributed 2.75% to the total airspora in the first and second Rabi seasons respectively. Percentage contribution in the first season (2.71%) was slightly lower than that in the second season (2.78%). maximum concentration ($5600/\text{m}^3$) was found in December, 2016 and lowest ($2800/\text{m}^3$) in November, 2015. Total number of spores in the first season ($17640/\text{m}^3$) was lower than that in the second season ($20020/\text{m}^3$). The Hyphal fragments have been reported in to over Pacific Ocean (Newman, 1948), Mediterranean Sea (Sreeramulu, 1958a), Atlantic Ocean (Pady and Kapica, 1955), England (Hamilton,

1959). Pathak and Paddy (1965) recorded them as common constituents of the airspora. Dransfield (1966) at Samru recorded 6.57% sterilia mycelia. Harvey (1970) at crdif, recorded Hyphal fragments in low concentration. Sreeramulu and Ramlingam (1963) reported high concentration during day time.

In India, Sheshavataram (1965) recorded them as common constituent of airspora. Sreeramulu and Ramlingam (1966) found that they exhibited “day time double maxia” Tilak and srinivasulu (1967) recorded 3.22% Hyphal fragments from the airspora of Aurangabad. Some of the reports from this region are of Talde (1969) at Parbhani reported 12.2%, kulkarni (1971) reported 5.14% spores at Aurangabad. Gaikwad (1974) at Ahmedpur 0.65%, Pande (1976) at Nanded reported 4.89%, Mane (1978) reported 1.77% at Vaijapur and kulkarni (1979) reported its incidence at Kolhapur.

Bhalke (1981) reported 3.42% over jowar fields. Shastri (1981) reported 8.62%, Patil (1983) reported 3.80%, Bhasale (1983) reported 2.81%, and wankhade (1983) reported 0.52% over jowar fields. Patil (1985) reported 2.65%, and Jogdand (1987) reported 3.081%, over jowar fields at Aurangabad. Apart from these reports are of Bhalke and Verma (1990) at Jabalpur, reported 3.72% mycelium. Jain and Dutta (1990) reported 5.84% fungal hyphae at Gwalior. Kavishwar (1990) reported 2.23 over jowar fields at Dhulia. Patil (1992) recorded 7.75% contribution of fungal hyphae from the jowar fields at Jalgaon.

The findings during the present investigations are fully in accordance with earlier reports. Bhagwan (1983) at Nanded 4.06%, Pillai (1983) at Aurangabad 5.12%, Minhaj (1988) at Nanded 4.85% and Meghraj (1989) 3.01%, Ahuja (1992) reported 5.83% of these fragments at Aurangabad. Pawar (1997) reported 1.13% and 1.20% of these fragments over bajra fields at Aurangabad. Aher (1998) reported 5.55% and 2.63% of these fragments over groundnut fields. Mali (2002) reported 5.98% and 4.82% of these fragments over bajra and jowar fields. Suryawanshi (2002) recorded 3.05% and 3.04% of these fragments over sunflower and Wheat fields. Gopan (2004) reported 2.73% and 2.34% of these fragments over bajra fields. Kshirsagar (2007) reported 1.93% 1.57% and 6.30%, 2.95% of these fragments over sunflower fields. Patil (2008) recorded 8.85% to the total airspora over black gram field.

Insects Scales: During the present studies insect scales, insect wings, insect skeleton and complete insects were trapped and all of these were considered under single category, insect parts. They were present in the airspora throughout and contributed 2.07% to the total airspora in the first and second Rabi seasons respectively. Total catches in the first season ($16100/\text{m}^3$) were higher than that in the second season ($12320/\text{m}^3$). The percentage contribution in the first season (2.48%) was higher than that in the second season (1.71%). Regarding second abundance and variations it can be concluded that their abundance was mainly confined to rainy periods. However, concentration declined during rainy and prolonged dry periods. High humidity coupled with low temperature enriched the insect fauna which was confirmed by abundant insects trapped during that period. However, hot, dry and windy weather enriched air-spores with insect parts i.e. enrichment of insect fauna is prior to enrichment of insect parts. Other reports are of Rees (1964) at Brisbane, reported 0.34% insect scales. He treated complete insects and groups of scales as a single unit. Sreeramulu and Ramlingam (1966) at Visakhapatnam observed eggs, hairs and scales over Paddy fields. Tilak and srinivasulu (1967) recorded 1.05% insect scales from the airspora of Aurangabad. Talde (1969) from Parbhani reported 0.76% concentration. Kulkarni (1971) at Aurangabad reported 3.5% insect scales. Bhalke (1981) reported 1.28%, Wankhade (1983) reported 0.10%, Patil (1983) reported 2.24%, and Bhagwan (1983) reported 0.75% to the total airspora at Aurangabad and Nanded respectively. Patil (1985), Venugopalachari (1986) and Jogdand (1987) also reported these insect parts over jowar fields and banana fields at Aurangabad and Nanded respectively.

Ramakrishna Reddy (1987) reported 2.66% to the total airspora of green house at Aurangabad. Minhaj (1988), Meghraj (1989), Malabade (1990) reported the insect parts in the air over different fields at Nanded, Aurangabad and Chalisgaon respectively. Pawar (1997) reported 1.47% and 1.09% of these insect parts over bajra fields at Aurangabad. Aher (1998) reported 4.80% and 3.33% of these insect parts over groundnut fields. Thite (1998) reported 0.32% and 0.32% of these insect parts over groundnut fields. Mali (2002) reported 0.87% and 0.45% of these insect parts over bajra and jowar fields. Suryawanshi (2002) reported 0.95% and 1.05% of these insect scales over sunflower and Wheat fields. Gopan (2004) recorded 0.77% and 0.75% of these insect parts over bajra fields.

Kshirsagar (2007) reported 0.02% and 0.02% of these insect parts over sunflower fields. Patil (2008) reported 5.03% of these insect parts over black gram field.

Pollen grains: All the pollen types encountered during present investigations were grouped in a single category. Pollen population in the air spora over Jowar fields was mainly dominated by *Sorghum* pollen along with this pollen many other pollen of various weeds, shrubs, trees and crop plants were also present. However, they presented very less concentration. Pollen contributed 1.89% to the total airspora in the first and second rabbi seasons respectively. The highest concentration ($5460/\text{m}^3$) was recorded in February 2017 and lowest concentration ($1120/\text{m}^3$) in January 2016. Total number of pollen in the first season ($7840/\text{m}^3$) was lower than that in the second season ($18060/\text{m}^3$).

Hamilton (1959) and Lacey (1962) reported that the locality has significant influence on the concentration and categories of pollen incidence in the air. Sreeramulu (1958) found that in Mediterranean Sea air catches, pollen grains were present with very low concentration. Talde (1969) at Parbhani reported 1.82%, pollen grains; kulkarni (1971) at Aurangabad reported 4.1% pollen grains from the total airspora over sugarcane fields. Gaikwad (1974) at Ahmedpur reported 7.61% pollen grains. Pande (1976) at Nanded reported 5.31% pollen grains from the airspora over orange field. Mane (1978) reported 6.04% Pollen to the total airspora at Vaijapur. Bhalke (1981) reported 3.73%, Shastri (1981) recorded 1.46%, Patil (1983) reported 3.80%, wankhade (1983) 0.33% Pollen over different crop fields at Aurangabad. Patil (1985) reported 0.70% and Jogdand (1987) reported 2.13% pollen over jowar fields at Aurangabad. Venugopalachari (1986) recorded these components from the airspora of Nanded. Kavishwar (1990) recorded 0.44% over jowar fields at Dhulia. Ramakrishna Reddy (1987) reported 3.11% from the airspora at Aurangabad. Patil (1992) recorded 0.66% and Thube (1992) 6.95% contribution over jowar fields at Jalgaon and Ahmednagar respectively. Suryawanshi (2002) reported 1.31% and 1.55% to the total airspora over sunflower and wheat fields. Kshirsagar (2007) reported 0.07% and 0.18% contribution over sunflower fields. Patil (2008) recorded 4.83% to the total airspora over black gram field. Arsule and Pande (2011) reported 0.47% over groundnut field. Sonawane (2013) reported 1.33% over groundnut field. Allapure (2016) reported 2.64% over sunflower field.

Protozoan cysts: The hyaline, rounded to ovoid, single celled, double walled of two sizes, 28.5-45.6µm in diameter and 95-121.6 x 87.4-121.6 µm. Their contributed 0.26% to the total airspora in the first and second Rabi seasons respectively. Maximum concentration ($672/\text{m}^3$) was observed in December, 2016 and minimum concentration ($210/\text{m}^3$) in November, 2015. Percentage contribution in the first season (0.23%) was lower than that in the second season (0.30%). Total number of spores in the first season ($1470/\text{m}^3$) was lower than that in the second season ($2184/\text{m}^3$). Miquel (1883) recorded on average 0.1% to 0.2% airborne protozoan “eggs” per cubic meter of air at Paris. Patil (1985) reported 0.17% and Jogdand (1987) recorded 0.03% cysts over jowar fields at Aurangabad. Patil (1992) recorded 3.84% contribution of spores over jowar fields at Jalgaon. Pawar (1997) reported 1.06% and 1.67% of these cysts over bajra fields at Aurangabad. Mali (2002) reported 1.53% and 0.94% of these cysts over bajra and jowar fields. Suryawanshi (2002) recorded 0.29% and 0.54% to the total airspora over sunflower and wheat fields. Gopan (2004) reported 1.50% and 2.18% of these cysts over bajra fields. Kshirsagar (2007) recorded 3.32%, 2.74% and 1.36%, 2.02% to the total airspora over Sunflower fields.

Unidentified Spores: This group is somewhat artificial comprising of one celled, two celled, three celled and many celled hyaline faint and colored spores. This group was however, dominated by one celled, round, elongate elliptic colored and hyaline spores. Though they were unidentified, their counts were found necessary to maintain the original picture of air spora. This is a heterogeneous group as such its composition and concentration changed considerably from season to season. Their contribution to the total airspora was 1.20%. Percentage contribution in the first season (1.03%) was lower than that in the second season (1.36%). Total number of spores in the first season ($6720/\text{m}^3$) was lower than that in the second season ($9786/\text{m}^3$).

Gregory and Hirst (1957) from England, reported this group as “Unclassified types” in which they placed rare forms like conidia of Entomophthoraceae, spores of Bryophytes and Pteridophytes and spores left while recording. They further observed “the fact that the group was most common during the wet weather in August merely emphasizes, how little is known of many featherless components of the damp airspora”. Ramchander Rao

(1987), reported 1.15% and 0.20%, Sankaye (1989) reported 2.50%, Pole (1995) reported 0.05% and 0.02%, Pawar (1998) reported 0.13% and 0.02% to the total airspora over sunflower fields respectively. Suryawanshi (2002) recorded, 0.37% and 0.73% to the total airspora over sunflower and wheat fields.

Fungal colonies from air by petriplates exposure:

During the air sampling simultaneously petriplates containing PDA media were exposed for 10-15 minutes each interval of 15 days in the air of jowar crop fields. Colonies were classified in to genera, more than 31 types of fungal colonies were observed. Asexual fruiting bodies and non- sporulating fungal bodies were grouped in separate group called mycelia Sterilia. 31 types of fungal colonies have been isolated from air and identified up to generic level which has been listed below under their taxonomic group.

A) ZYGOMYCOTINA: *Cunnighamella Matruchot*, *Mucor Micheli*, *Pythium*, *Pringseim*, *Rhizopus cohinii*, *Rhizopus Spp.* Ehrenb

B) ASCOMYCOTINA: *Chaetomium Kunze ex Fr.* *Neurospora Shear and Dodge*

C) DEUTEROMYCOTINA: *Alternaria Ness ex Waller*, *Alternaria alternate*, *Alternaria Solani*, *Aspergillus Flavus Link ex Fries*, *Aspergillus Niger van Tieghem*, *Aspergillus sp. Link*, *Bipolaris Shoemaker*, *Cladosporium corda*, *Curvularia lunata*, *Curvularia Boed*, *Diplodia Fr*, *Epicoccum Link ex Fr*, *Fusarium Oxysporum*, *Fusarium Link*, *Helminthosporium Link ex Fries*, *Humicola Traaen*, *Penicillium lacan*, *Penicillium notatum*, *Penicillium sp. Link*, *Pestalotia de Not*, *Phoma Desm*, *Torula Pers ex.Fr*, *Trichoconis Pers*.

D) MYCELIA STERILIA: Unclassified group.

Out of 31 fungal types 23 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina and other non- sporulating to mycelia Sterilia, Deuteromycotina fungal colonies dominated the airspora by exhibiting more concentration (79.29%). It was followed by mycelia Sterilia (14.28%), Zygomycotina (4.99%) and Ascomycotina (1.44%). Monthwise variation in the total number and percentage contribution of different fungal colonies, the air of jowar crop fields by petriplates exposure represented

in **Table 1A**. The Monthwise fungal colony counts of different fungi, the air of jowar crop fields by petriplates exposure represented in **Table 2A and 2B**. The Monthwise average percentage contribution of each fungal colonies, the air of jowar crop fields by petriplates exposure represented in **Table 3A and 3B**. The Monthwise total colonies count and average percentage contribution of each fungal group is represented in **Table 4A and 4B**. The Monthwise total colonies count and average percentage contribution of each fungal group is represented in **Table 5A and 5B**. The seasonwise total number of fungal colonies and percentage contribution of each spore group is represented in **Table 6A**.

A) ZYGOMYCOTINA:

Cunninghamella Matruchot: Colonies dry, mucoid (thick stringy and wet), moist, smooth, rough, rugose (wrinkled), or concentric rings. These spores were recorded throughout the period of investigations in air sampling and petriplates exposure method. They contributed (2.95%) to the total airspora. Whereas by Petriplate exposure (0.26%) to the total colony count. In air sampling maximum concentration ($6720/\text{m}^3$) in the month of December, 2015. While in plate exposure (1 colony) in the month of December, 2016. The Seasonwise maximum concentration ($20216/\text{m}^3$) during the first Rabi season by air sampling method. However (3 colonies) during the second Rabi season. Total (9 colonies) during the first and second Rabi seasons respectively.

Mucor Micheli: Colonies are fast growing, tall, simple, unbranched sporangiophores. Lacking basal rhizoids, non- apophysate sporangia and pigmented zygosporangial. They contributed (0.05%) to the total airspora. whereas (0.49%) to the total colony count. Maximum concentration ($210/\text{m}^3$) in the month of January, 2016. Whereas (6 colonies) in the month of February, 2017. The Seasonwise maximum concentration ($476/\text{m}^3$) during the first Rabi season. Whereas (12 colonies) during the second Rabi season. Total (17 colonies) during the first and second Rabi seasons respectively.

Pythium Pringshein: Pythium are usually coenocytic hyphae without Septation, single oospore, elongated and club shaped anthridia. Spores were reported only from Petriplate exposure. They contributed (0.09%) to the total colony count. The Seasonwise maximum

concentration (2 colonies) during the second Rabi season. Total (3 colonies) during the first and second Rabi seasons respectively.

Rhizopus cohinii: Colonies are fast growing, dense cotton growth that is a first white becoming grey or yellowish brown with sporulation, Sporangiospores are globose to ovoid one-celled, hyaline to brown and striate. They were obtained from Petriplate exposure. They contributed (3.17%) to the total colony count. Maximum concentration (30 colonies) in the month of November, 2016. The Seasonwise maximum concentration (62 colonies) during the second Rabi season. Total (110 colonies) during the first and second Rabi seasons respectively.

Rhizopus sp Ehrenb: Colonies are dark, grayish- brown, up to 10mm high producing simple rhizoids. Sporangiphores are brownish, up to 400 um high and 10 um wide, and may be produced in groups of one to four, usually in pairs. Sporangia are grayish black, spherical up to 100 um in diameter. They contributed (0.19%) to the total airspora. Whereas by Petriplate exposure (0.98 %) to the total colony count. Maximum concentration ($588/\text{m}^3$) in the month of January, 2016. Whereas (7 colonies) was recorded in the month of November, 2016. The Seasonwise maximum concentration ($1400/\text{m}^3$) during the first Rabi season. Whereas (22 colonies) during the second Rabi season. Total (34 colonies) during the first and second Rabi seasons respectively.

B) ASCOMYCOTINA:

Chaetomium Kunze ex Fr: Colonies are rapidly growing, cottony and white in colour initially, mature colonies become grey to olive in colour from the reverse the colour is tan to red or brown to black. They contributed (1.33%) to the total airspora. Whereas by Petriplate exposure (0.11%) to the total colony count. Maximum concentration ($2870/\text{m}^3$) in the month of November, 2015. Whereas (1 colony) in the month of November, December, 2016 and February, 2017. The Seasonwise maximum concentration ($9310/\text{m}^3$) during the second Rabi season. Whereas (3 colonies) during the second Rabi season. Total (4 colonies) during the first and second Rabi seasons respectively.

Neurospora shear and Dodge: Neurospora are molds with broadly spreading colonies with abundant production of ascomata. Spores were reported only from Petriplate

exposure. They contributed (1.33%) to the total colony count. Maximum concentration (17 colonies) in the month of February, 2017. Whereas (6 colonies) in the month of November, 2016. The Seasonwise maximum concentration (32 colonies) during the second Rabi season. Whereas (14 colonies) during the first Rabi season. Total (46 colonies) during the first and second Rabi seasons respectively.

C) DEUTEROMYCOTINA:

Alternaria Ness ex Waller.: Colonies at maturity orbicular, black, green and smoky, conidia dark, typically with both cross and vertical septa, variously shaped obclavate to elliptical or ovoid, frequently borne acropetally in long chains. These spores were recorded throughout the period of investigations in air sampling and petriplates exposure method. Their contribution (4.93%) to the total airspora and 4.57% to the total colony count. Maximum concentration ($12250/\text{m}^3$) in the month of February, 2017, whereas (30 colonies) in the month of November, 2016. The Seasonwise maximum concentration ($36470/\text{m}^3$) during the second Rabi season. Whereas (83 colonies) during the second Rabi season. Total (158 colonies) during the first and second Rabi season respectively.

Alternaria alternate: Colonies are fast growing, black to olivaceous-black or greyish, and are suede-like to floccose. Spores were recorded only from Petriplate exposure. They contributed (0.14%) to the total colony count. Maximum concentration (2 colonies) in the month of January, 2016. Whereas (1 colony) in the month of November, 2015 and November, December, 2016. The Seasonwise maximum concentration (3 colonies) during the first Rabi season. Whereas (2 colonies) during the second Rabi season. Total (5 colonies) during the first and second Rabi seasons.

Alternaria Solani: colonies are singly or in groups, straight or flexuous and brown to olivaceous brown conidiophores on which solitary straight or slightly flexuous, oblong or ellipsoidal conidia. Spores were reported only from Petriplate exposure. They contributed (0.33%) to the total colony count. The maximum concentration (3 colonies) in the month of February, 2016 and January, 2017. Whereas (2 colonies) in the month of November, 2015. The Seasonwise maximum concentration (6 colonies) during the first Rabi season

whereas (5 colonies) during the second Rabi season. Total (11 colonies) during the first and second Rabi seasons respectively.

Aspergillus Flavus Link ex Fries: Colonies slightly floccose at the margins of the colony due to growth of sterile hyphae, conidial areas ranging in colour from sea foam yellow, citron-green, in old colonies altered by the disappearance of the green factor, leaving shaded of yellow- brown, reverse to yellowish at first becoming brownish; conidia pyriform to almost globose, nearly colourless to definitely yellowish green, varying from 3 μ m in diameter to 3-4 x 4-5 μ m. They were recorded throughout the period of investigations from petriplates exposure. Their contribution (1.57%) to the total colony count. Maximum concentration (12 colonies) in the month of February, 2017. Whereas (10 colonies) in the month of February, 2016. The Seasonwise maximum concentration (30 colonies) during the second Rabi season. Whereas (24 colonies) during the first Rabi season. Total (54 colonies) during the first and second Rabi seasons respectively.

Aspergillus Niger van Tieghem: Colonies with abundant submerged mycelium colourless to coloured, reverse usually without coloured; conidiophores colourless to coloured, septate or non- septate, vesicle globose or subglobose thick walled. Phialides borne directly on the vesicle in certain strains on metulae; conidia globose, smooth at first, later rough or Spinulose, mostly 2-5 μ m in diameter, sometimes up to 5 μ m in diameter. They were recorded from air sampling method and petriplates exposure methods. They contributed (11.14%) to the total colony count. Maximum concentration (60 colonies) in the month of January, 2017. Whereas (55 colonies) in the month of January, 2016. The Seasonwise maximum concentration (202 colonies) during the second Rabi season. Whereas (184 colonies) during the first Rabi season. Total (386 colonies) during the first and second Rabi seasons respectively.

Aspergillus sp.Link: Vegetative mycelium composed of septate, branching hyphae, colourless or brightly coloured, forming brown sclerotic, conidiophores arising from foot cells, more or less erect, each forming a head of conidia at tip; conidia one celled globose, variously coloured when in mass, catenulate, produced basipetally. They were recorded in air sampling and petriplates exposures throughout the period of investigations. They contributed (0.84%) to the total airspora and (10.42%) to the total

colony count. Maximum concentration ($1820/\text{m}^3$) in the month of December, 2016. Whereas (55 colonies) was recorded in February, 2017. Seasonwise maximum concentration ($6230/\text{m}^3$) in the month of second Rabi season. Total (361 colonies) during the first and second Rabi seasons respectively.

Bipolaris Shoemaker.: Colonies are moderately fast growing, effuse, and grey to blackish brown, suede-like to floccose with a black reverse. Spores were reported only from Petriplate exposure methods. They contributed (0.08%) to the total colony count. The Seasonwise maximum concentration (2 colonies) during the second Rabi season. Whereas (1 colony) during the first season. Total (3 colonies) during the first and second Rabi seasons respectively.

Cladosporium Link ex Fries: The colonies were dense, often a velvety olive green, but also other shaded of brown, dark or grayish green are seen. The erect pigmented conidiophores have tree like branching, the conidia are multi - shaped and Septation, two types of spores are in lemon- shaped and another in torpedo-shaped. They were reported from air sampling and Petriplate exposure throughout the period of investigations. They contributed (15.48%) to the total airspora whereas by Petriplate exposure (35.37%) to the total colony count. Maximum concentration ($36400/\text{m}^3$) in the month of December, 2016, whereas (200 colonies) in the month of November, 2016. Seasonwise maximum concentration ($129682/\text{m}^3$) during the second Rabi season. Whereas (660 colonies) during the second Rabi season and (566 colonies) during the first Rabi season. Total (1226 colonies) during the first and second Rabi seasons respectively.

Curvularia Boed.: Colony spreading, subglobose, dark olive grey reverse bluish black, conidiophores erect, unbranched, conidia dark 3 to many celled, typically bent or curved with one or two of the central cell enlarged. They were recorded throughout the period of investigations from air sampling method and petriplates exposures method. They contributed (5.76%) to the total airspora, whereas (3.43%) to the total colony count. From air sampling maximum concentration ($12950/\text{m}^3$) in the month of December, 2016. The Seasonwise maximum concentration ($39732/\text{m}^3$) during the first Rabi season.

From Petriplate exposure maximum concentration (30 colonies) was recorded in February, 2017. The Seasonwise maximum concentration (67 colonies) during the second rabbi season. Total (119 colonies) during the first and second Rabi seasons respectively.

Curvularia Lunata: Colonies are appearing as shiny velvety-black, fluffy growth, or septate, and dematiaceous hyphae producing brown, geniculate conidiophores. Spores were reported only from Petriplate exposure. They contributed (0.14%) to the total colony count. Maximum concentration (2 colonies) in the month of January, 2016. Whereas (1 colony) in the month of November, and December, 2016. The Seasonwise maximum concentration (3 colonies) was recorded in first Rabi season. Whereas (2 colonies) was recorded in second Rabi season. Total (5 colonies) during the first and second Rabi seasons respectively.

Diplodia Fr.: Pycnidia black, single, globose, immersed, erumpent, Ostiolate; conidiophores slender, simple; conidia dark, 2-celled, ellipsoid or ovoid parasitic or saprophytic. They were reported from air sampling method and petriplates exposures method. They contributed (0.08%) to the total airspora, whereas (0.11%) to the total colony counts. Maximum concentration ($280/\text{m}^3$) in the month of December, 2016. whereas (1 colony) in the month of November, 2015, February, 2016, December, 2016 and February, 2017. The Seasonwise maximum concentration ($910/\text{m}^3$) during the first Rabi season, whereas (2 colonies) during the first and second Rabi seasons respectively. Total (4 colonies) during the first and second Rabi seasons respectively.

Epicoccum Link ex Fr.: Sporodochia, black brown, globose, usually very small conidiophores dark coloured, non-septate conidia dark one- celled or several celled. They were reported in air sampling methods and Petriplate exposure methods. They contributed (0.69%) to the total airspora and (0.14%) to the total colony count. Maximum concentration ($1554/\text{m}^3$) in the month of December, 2015. Whereas (3 colonies) in the month of January, 2017 from Petriplate exposure. Seasonwise maximum concentration ($4788/\text{m}^3$) during the first Rabi season from air. Whereas (3 colonies) during the second Rabi season. Total (5 colonies) during the first and second Rabi seasons respectively.

***Fusarium Oxysporum*:** Colonies pinkish, fluffy white growth, dark violet pigmentation, macro-conidia, micro-conidia of single celled and celled oval shape, conidiogenous cells, formation of chlamydospores, singly, or pairs. Spores were reported only from Petriplate exposure. They contributed (0.20%) to the total colony count. Maximum concentration (2 colonies) in the month of December, 2015, December, 2016 and January, 2017. Seasonwise maximum concentration (4 colonies) during the second Rabi season. Total (7 colonies) during the first and second Rabi seasons respectively.

***Fusarium Link.*:** The different species often form brightly coloured colonies, e.g., pink yellow or apricot. The genus is readily recognized by the hyaline gondola – shaped septate macro conidia, produced in cushion like masses (Sporodochia), macro conidia several celled, slightly curved or bent at the pointed ends typically cone shaped. They were observed from air sampling method and Petriplate exposure method. They contributed (2.66%) to the total colony count by Petriplate exposure. Maximum concentration (16 colonies) in the month of January, 2017. whereas (15 colonies) in the month of January, 2016. The Seasonwise maximum concentration (50 colonies) during second Rabi season. Whereas (42 colonies) during the first Rabi season. Total (92 colonies) during the first and second Rabi seasons.

***Helminthosporium Link ex Fries*:** Colonies brown to black, mycelium dark, brown, multi-septate, conidiophores erect and straight, unbranched, septate, geniculate at points below the typically containing more than three cells, cylindrical or ellipsoid, sometimes slightly curved or bent, ends rounded. The spores were observed in air by sampling method and petriplates exposure throughout the period of investigations. They contributed (1.61%) to the total airspora. whereas by Petriplate exposure (1.29%) to the total colony count. Maximum concentration ($3150/\text{m}^3$) in the month of November, 2016. Whereas (9 colonies) in the month of February, 2017. The Seasonwise maximum concentration ($11550/\text{m}^3$) during second Rabi season, whereas (27 colonies) during the second Rabi season. Total (45 colonies) during the first and second Rabi seasons respectively.

***Humicola Traaen.*:** Colonies fuscous to dark in colour, mycelium septate conidiophores sub cylindrical with single pore apically, sometimes absent; spores typically globose, first

granular and yellow brown, finally dark 1-celled, with a cell wall with an easily discernible double contour, smooth Phialides largely confined to the aerial mycelium phialospores slightly obovate, hyaline 1 celled, $3 \times 2 \mu\text{m}$. They contributed (0.28%) to the total colony count. Maximum concentration (4 colonies) in the month of January, 2016. Whereas (3 colonies) in the month of December, 2016. Seasonwise maximum concentration (6 colonies) during the second Rabi season. Whereas (4 colonies) during the first Rabi season. Total (10 colonies) during the first and second Rabi seasons

Penicillium Lecani: Colonies are fast growing, in shaded of green, sometimes white, mostly consisting of a dense felt of conidiophores. They contributed (0.14%) to the total colony count. Seasonwise Maximum concentration (3 colonies) was recorded in second Rabi season. Whereas (2 colonies) during the first Rabi season. Total (5 colonies) during the first and second Rabi seasons.

Penicillium notatum: Colonies greenish and its branching or simple conidiophores supporting Phialides in brush-like clusters. They contributed (0.17%) to the total colony count. Maximum concentration (3 colonies) in the month of November, 2015. Whereas (2 colonies) was recorded in December, 2016. The Seasonwise maximum concentration (3 colonies) during first and second Rabi seasons. Total (6 colonies) during the first and second Rabi seasons respectively.

Penicillium sp Link.: Colonies are mostly having shades of dusty green. The conidiophores have characteristic pencil-like spore bearing organ (Phialides) from which the round hyaline conidia ($2-5 \mu\text{m}$) are abundantly produced in chains. The genus is dominating in temperature soil and the spores are easily liberated and dispersed in to air. They were obtained throughout the period of investigations from air by sampling method and Petriplate exposure method. They contributed (0.28%) to the total airspora. Whereas by Petriplate exposure (5.74%) to the total colony count. From air maximum concentration ($1120/\text{m}^3$) in the month of December, 2016. Whereas from (35 colonies) in month of February, 2017. The Seasonwise maximum concentration ($3220/\text{m}^3$) was recorded from the air of second Rabi season. However from Petriplate exposure maximum concentration (108 colonies) was recorded from the air of second Rabi season. Total (199 colonies) during the first and second Rabi seasons respectively.

Pestalotia de Not.: Colonies at first white, later becoming dirty to blackish conidiophores short, simple, conidia dark, several celled, with hyaline, pointed end cells, ellipsoid to fusoid, with two or more hyaline, apical appendages. They contributed 0.13% to the total airspora and 0.69% to the total colony count. They were obtained from air by sampling method and Petriplate exposure method. Maximum concentration ($575/\text{m}^3$) was reported in December, 2015. Whereas from (10 colonies) was recorded in November, 2015 and December, 2016. Seasonwise maximum concentration ($910/\text{m}^3$) was obtained in first Rabi season. Whereas (13 colonies) was recorded in second Rabi season. Total (24 colonies) encountered in first and second Rabi seasons.

Phoma Desm.: Colonies dark brown, Pycnidia, globose or slightly lense shaped, with a small papilla at the apex; conidia small, one- celled, hyaline, ovoid to elongate, less than $15\mu\text{m}$ in length and $10\mu\text{m}$ in diameter. They contributed (0.14%) to the total colony count. They were obtained only from air by Petriplate exposure method. Maximum concentration (2 colonies) in the month of January, 2016. The Seasonwise maximum concentration (3 colonies) during the first Rabi seasons. Total (7 colonies) during the first and second Rabi seasons respectively.

Torula Pers ex Fr.: Colonies black, powdery, mycelium sub hyaline to brownish, septate, branched; conidia produced in simple or branched acropetally chains, each conidiophores with a characteristic apical Sporogenous cell, basal cell of conidiophores somewhat elongate, wide at tip, the other cells of the conidiophores sub- globose to globose or irregular in shape, arising from the swollen apex of a hypha or from a subglobose cell arising laterally from a hypha; conidia dark brown when mature, hyaline when young, markedly echinulate or smooth, mostly 2-5 septate, deeply constricted at septa, the apical cell of each conidium usually characteristically darkened and thickened like the terminal cell of the conidiophores; conidia $4-10\mu\text{m}$ wide in the widest part, conidia sometimes fragmenting into 1- celled units. They were obtained from air by air sampling and plate exposure, by air sampling they contributed (0.06%) to the total airspora, whereas by Petriplate exposure (0.11%) to the total colony count. In air sampling maximum concentration ($154/\text{m}^3$) in the month of January, 2016, while in plate exposure (1 colony) in the month of February, 2016, November, 2016, December, 2016

and January, 2017. Seasonwise maximum concentration ($434/\text{m}^3$) during the first Rabi season by air sampling method. However, in plate exposure method they were recorded (3 colonies) during the second Rabi season. Total (4 colonies) during first and second Rabi seasons respectively.

Trichoderma Pers.: colonies are fast growing, at first white and downy, later developing yellowish-green to deep green compact tufts. They contributed (0.43%) to the total colony count. Maximum concentration (5 colonies) in the month of November 2015 and November 2016. Seasonwise maximum concentration (9 colonies) during the second Rabi season. Total (15 colonies) during the first and second Rabi seasons.

D) MYCELIA STERILIA

Unclassified spores (unclassified group): One of the objects of this study was to record the total number of spores present in the air and plate exposure. All fungus spores caught on the slides except which could not be included under any of the named group were counted under this category, whereas in culture plate some of the types which could not sporulate due to their slow growth or due to inhibition by other fungi and only mycelial growth observed, such type also included under this category. The spores which were not classified because of their unsuitable orientation on the adhesive surface or because they were partially obscured by debris or other particles, were also included in this group. Thus this was a heterogenous group. They contributed (1.20%) to the total airspora, whereas by Petriplate exposure (14.28%). Maximum concentration ($2800/\text{m}^3$) in the month of December, 2016 from air, whereas from plate exposure (80 colonies) in the month of February, 2017. Seasonwise maximum concentration ($9786/\text{m}^3$) during the second Rabi season, whereas (265 colonies) during the second kharif season. Total (495 colonies) during the first and second Rabi seasons respectively.

JOWAR CROP - TABLES

Table-I: Average percentage contribution of each spore types to total airspora of two Rabi Seasons over jowar crop fields from (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 28 Feb, 2017).

Sr. No.	Spore Type	Total airspora/m ³ of air	% Contribution to the total air-spores
A)	MYXOMYCOTINA		
1.	Physarum	23212	1.69
2.	Stemonitis	11466	0.83
	Total	34678	2.53
B)	ZYGOMYCOTINA		
1.	Cunnighamella	40082	2.92
2.	Mucor	644	0.05
3.	Rhizopus	2674	0.19
4.	Sclerospora	13468	0.98
	Total	56868	4.15
C)	ASCOMYCOTINA		
1.	Ascospores	630	0.04
2.	Bitrimonospora	9058	0.66
3.	Chaetomium	18298	1.33
4.	Claviceps	7756	0.56
5.	Cucurbitaria	9352	0.68
6.	Didymosphaeria	26908	1.96
7.	Hypoxyton	1918	0.14
8.	Leptosphaeria	18480	1.35
9.	Lophiostoma	45864	3.35
10.	Massaria	154	0.01
11.	Melanospora	560	0.04
12.	Metasphaeria	3668	0.27
13.	Oothia	2016	0.15

14.	Parodiella	266	0.02
15.	Pleospora	7756	0.56
16.	Sordaria	10696	0.78
17.	Sporormia	8932	0.65
18.	Teichospora	126	0.01
	Total	172438	12.59
D)	BASIDIOMYCOTINA		
1.	Basidiospores	24990	1.82
2	Ganoderma	224	0.01
3.	Rust Spores	138796	10.13
4.	Smut Spores	134484	9.82
5.	Urediniospores	27986	2.04
	Total	326480	23.83
E)	DEUTEROMYCOTINA		
1.	Alternaria	67634	4.93
2.	Aspergillus	11508	0.84
3.	Beltraniella	6342	0.46
4.	Beltrania	6356	0.46
5.	Bispora	5306	0.39
6.	Botryodiplodia	182	0.01
7.	Cercospora	3066	0.22
8.	Cladosporium	212072	15.48
9.	Cordana	294	0.02
10.	Corynespora	1302	0.09
11.	Curvularia	78932	5.76
12.	Dictyoarthrinium	1876	0.13
13.	Diplodia	1190	0.08
14.	Drechslera	518	0.04
15.	Epicoccum	9520	0.69

16.	Fusariella	4088	0.29
17.	Haplosporella	11172	0.81
18.	Harknessia	378	0.03
19.	Heliminthosporium	22050	1.61
20.	Heterosporium	19600	1.43
21.	Lacellina	26040	1.90
22.	Lacellinospsis	7490	0.54
23.	Memnoniella	2828	0.20
24.	Nigrospora	77994	5.69
25.	Papularia	42	0.01
26.	Penicillium	3864	0.28
27.	Periconia	47334	3.45
28.	Pestalotia	1778	0.13
29.	Pithomyces	12726	0.93
30.	Pseudotorula	392	0.03
31.	Tetraploa	8288	0.60
32.	Torula	826	0.06
33.	Trichoconis	546	0.04
	Total	653534	47.70
F)	OTHER TYPES		
1.	Algal Filaments	8960	0.65
2.	Epidermal hairs	4900	0.36
3.	Hyphal Fragments	37660	2.75
4.	Insect Scales	28420	2.07
5.	Pollen grains	25900	1.89
6.	Protozoan cysts	3654	0.26
7.	Unidentified Spores	16506	1.20
	Total	126000	9.19
	Grand Total	13,69998	100.00

Table-II: Variation in the total airspora and percentage Contribution of different spore types during (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 28th Feb, 2017).

Sr. No.	Spore Types	Seasons total spores/m ³ of air		% contribution to the seasons total airspora	
		2015-2016	2016-2017	2015- 2016	2016-2017
A)	MYXOMYCOTINA				
1.	Physarum	11774	11438	1.81	1.59
2.	Stemonitis	5740	5726	0.88	0.79
	Total	17514	17164	2.69	2.38
B)	ZYGOMYCOTINA				
1.	Cunnighamella	20216	19866	3.12	2.76
2.	Mucor	476	168	0.07	0.02
3.	Rhizopus	1400	1274	0.21	0.17
4.	Sclerospora	6818	6650	1.06	0.92
	Total	28910	27958	4.45	3.88
C)	ASCOMYCOTINA				
1.	Ascospores	364	266	0.05	0.04
2.	Bitrimonospora	4592	4466	0.70	0.62
3.	Chaetomium	8988	9310	1.39	1.29
4.	Claviceps	3934	3822	0.61	0.53
5.	Cucurbitaria	4732	4620	0.74	0.64
6.	Didymosphaeria	13930	12978	2.15	1.80
7.	Hypoxyton	1022	896	0.16	0.12
8.	Leptosphaeria	8960	9520	1.39	1.32
9.	Lophiostoma	23030	22834	3.55	3.17
10.	Massaria	98	56	0.01	0.01
11.	Melanospora	350	210	0.05	0.03
12.	Metasphaeria	2058	1610	0.31	0.22
13.	Otthia	1106	910	0.17	0.13

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14.	Parodiella	154	112	0.02	0.01
15.	Pleospora	3906	3850	0.60	0.53
16.	Sordaria	5110	5586	0.78	0.77
17.	Sporormia	5012	3920	0.77	0.54
18.	Teichospora	84	42	0.01	0.01
	Total	87430	85008	13.45	11.80
D)	BASIDIOMYCOTINA				
1.	Basidiospores	9590	15400	1.47	2.14
2	Ganoderma	126	98	0.02	0.01
3.	Rust Spores	70532	68264	10.85	9.48
4.	Smut Spores	70056	64428	10.78	8.94
5.	Urediniospores	14084	13902	2.17	1.93
	Total	164388	162092	25.29	22.51
E)	DEUTEROMYCOTINA				
1.	Alternaria	31164	36470	4.79	5.06
2.	Aspergillus	5278	6230	0.81	0.87
3.	Beltraniella	3682	2660	0.56	0.37
4.	Beltrania	2716	3640	0.42	0.50
5.	Bispora	2702	2604	0.41	0.36
6.	Botryodiplodia	112	70	0.02	0.01
7.	Cercospora	1680	1386	0.26	0.19
8.	Cladosporium	82390	129682	12.68	18.01
9.	Cordana	168	126	0.02	0.02
10.	Corynespora	672	630	0.10	0.09
11.	Curvularia	39732	39200	6.12	5.44
12.	Dictyoarthrinium	966	910	0.15	0.13
13.	Diplodia	910	280	0.14	0.04
14.	Drechslera	266	252	0.04	0.03
15.	Epicoccum	4788	4732	0.73	0.66
16.	Fusariella	2072	2016	0.32	0.28

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17.	Haplosporella	6258	4914	0.96	0.68
18.	Harknessia	210	168	0.03	0.02
19.	Helminthosporium	10500	11550	1.62	1.61
20.	Heterosporium	9828	9772	1.52	1.36
21.	Lacellina	11620	14420	1.79	2.02
22.	Lacelinopsis	3766	3724	0.58	0.53
23.	Memnoniella	1890	938	0.29	0.14
24.	Nigrospora	39494	38500	6.08	5.34
25.	Papularia	42	-	0.01	-
26.	Penicillium	644	3220	0.09	0.45
27.	Periconia	20314	27020	3.13	3.75
28.	Pestalotia	910	868	0.14	0.13
29.	Pithomyces	5866	6860	0.90	0.95
30.	Pseudotorula	-	392	-	0.05
31.	Tetraploa	4172	4116	0.64	0.57
32.	Torula	434	392	0.06	0.05
33.	Trichoconis	294	252	0.04	0.03
	Total	295540	357994	45.48	49.71
F)	OTHER TYPES				
1.	Algal Filaments	4130	4830	0.63	0.68
2.	Epidermal hairs	2100	2800	0.32	0.39
3.	Hyphal Fragments	17640	20020	2.72	2.78
4.	Insect Scales	16100	12320	2.49	1.72
5.	Pollen grains	7840	18060	1.22	2.51
6.	Protozoan cysts	1470	2184	0.23	0.30
7.	Unidentified Spores	6720	9786	1.04	1.36
	Total	56000	70000	8.62	9.72
	Grand Total	649782	720216	100.00	100.00

Table-III A: The monthwise concentration and percentage contribution of each spore types to the total airspora over jowar cropfield (from: 1st Nov, 2015 to 28th Feb, 2016).

Spore type	Nov- 2015		Dec-2015		Jan-2016		Feb-2016		Total Spore Conce /m ³ of air	% Contribution to the total airspora
	Spore Conc e/m ³ of air	% Contribution	Spore Conce/ m ³ of air	% Contribution	Spore Conce /m ³ of air	% Contribution	Spore Conce/ m ³ of air	% Contribution		
MYXOMYCOTINA										
Physarum	2310	1.53	3500	2.03	3850	2.30	2114	1.32	11774	1.81
Stemonitis	1064	0.70	1386	0.80	1680	1.01	1610	1.01	5740	0.88
Total	3374	2.23	4886	2.84	5530	3.31	3724	2.33	17514	2.69
ZYGOMYCOTINA										
Cunninghamella	4256	2.81	6720	3.90	5600	3.35	3640	2.28	20216	3.11
Mucor	-	-	140	0.08	210	0.12	126	0.08	476	0.07
Rhizopus	-	-	252	0.14	588	0.35	560	0.35	1400	0.21
Sclerospora	1288	0.85	1120	0.65	2030	1.21	2380	1.49	6818	1.05
Total	5544	3.67	8232	4.78	8428	5.04	6706	4.21	28910	4.45
ASCOMYCOTINA										
Ascospores	56	0.04	70	0.04	84	0.05	154	0.09	364	0.05
Bitrimonospora	658	0.43	1372	0.79	1610	0.96	952	0.59	4592	0.70
Chaetomium	2870	1.89	2100	1.22	2408	1.44	1610	1.01	8988	1.38
Claviceps	630	0.41	840	0.49	1400	0.84	1064	0.66	3934	0.60
Cucurbitaria	1232	0.81	840	0.49	1470	0.88	1190	0.74	4732	0.73
Didymosphaeria	4200	2.78	3500	2.03	3150	1.88	3080	1.93	13930	2.14
Hypoxyton	252	0.16	420	0.24	140	0.08	210	0.13	1022	0.16
Leptosphaeria	2100	1.39	1750	1.01	2590	1.55	2520	1.58	8960	1.38
Lophiostoma	5040	3.33	7182	4.17	6356	3.80	4452	2.79	23030	3.54
Massaria	28	0.02	42	0.02	14	0.01	14	0.01	98	0.01
Melanospora	126	0.08	84	0.05	84	0.05	56	0.03	350	0.05

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Metasphaeria	700	0.46	560	0.32	504	0.30	294	0.18	2058	0.31
Othia	420	0.28	350	0.20	280	0.17	56	0.03	1106	0.17
Parodiella	56	0.04	42	0.02	56	0.03	-	-	154	0.02
Pleospora	1274	0.84	1064	0.62	728	0.43	840	0.52	3906	0.60
Sordaria	490	0.32	1680	0.97	1540	0.92	1400	0.88	5110	0.78
Sporormia	1400	0.92	2100	1.22	350	0.21	1162	0.73	5012	0.77
Teichospora	-	-	56	0.03	-	-	28	0.02	84	0.01
Total	2153 2	14.25	24052	13.97	22764	13.62	19082	11.97	87430	13.45
BASIDIOMYCOTINA										
Basidiospores	3416	2.26	3920	2.28	1400	0.84	854	0.53	9590	1.47
Ganoderma	70	0.04	-	-	56	0.03	-	-	126	0.02
Rust Spores	1695 4	11.22	15694	9.11	18270	10.93	19614	12.30	70532	10.85
Smut Spores	1460 2	9.66	14294	8.30	18200	10.89	22960	14.40	70056	10.78
Urediniospores	2954	1.95	3388	1.97	3542	2.12	4200	2.63	14084	2.17
Total	3799 6	25.14	37296	21.67	41468	24.81	47628	29.88	16438 8	25.29
DEUTEROMYCOTINA										
Alternaria	6020	3.98	7028	4.09	7336	4.39	10780	6.76	31164	4.79
Aspergillus	1414	0.93	1568	0.91	1288	0.77	1008	0.63	5278	0.81
Beltraniella	966	0.64	1106	0.64	1022	0.61	588	0.37	3682	0.56
Beltrania	238	0.6	504	0.29	1092	0.65	882	0.55	2716	0.42
Bispora	364	0.24	938	0.54	812	0.48	588	0.37	2702	0.41
Botryodiplodia	-	-	56	0.03	-	-	56	0.03	112	0.02
Cercospora	420	0.28	462	0.27	434	0.26	364	0.23	1680	0.26
Cladosporium	1890 0	12.50	22540	13.09	21280	12.73	19670	12.34	82390	12.68
Cordana	70	0.04	-	-	56	0.03	42	0.02	168	0.02
Corynespora	154	0.10	126	0.07	210	0.12	182	0.11	672	0.10
Curvularia	9660	6.39	11564	6.72	10080	6.03	8428	5.28	39732	6.11
Dictyoarthrinium	182	0.12	154	0.09	224	0.13	406	0.25	966	0.15
Diplodia	140	0.09	280	0.16	266	0.16	224	0.14	910	0.15

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Drechslera	84	0.05	84	0.05	-	-	98	0.06	266	0.04
Epicoccum	826	0.54	1554	0.90	1414	0.84	994	0.62	4788	0.73
Fusariella	378	0.25	574	0.33	602	0.36	518	0.32	2072	0.32
Haplosporella	1540	1.02	2520	1.46	1134	0.68	1064	0.67	6258	0.96
Harknessia	42	0.03	-	-	70	0.04	98	0.06	210	0.03
Heliminthosporium	3080	2.04	2800	1.62	2660	1.59	1960	1.23	10500	1.61
Heterosporium	2198	1.45	2506	1.45	2702	1.61	2422	1.52	9828	1.52
Lacellina	2240	1.48	2800	1.62	3360	2.01	3220	2.02	11620	1.79
Lacellinospsis	658	0.43	742	0.43	1344	0.80	1022	0.64	3766	0.58
Memnoniella	350	0.23	490	0.28	350	0.21	700	0.44	1890	0.29
Nigrospora	9814	6.49	11228	6.52	9954	5.96	8498	5.33	39494	6.08
Papularia	-	-	28	0.01	-	-	14	0.01	42	0.01
Penicillium	224	0.15	294	0.17	126	0.07	-	-	644	0.09
Periconia	7308	4.83	6006	3.49	4200	2.51	2800	1.75	20314	3.13
Pestalotia	294	0.19	574	0.33	-	-	42	0.02	910	0.14
Pithomyces	1260	0.83	1386	0.80	1680	1.01	1540	0.96	5866	0.90
Tetraploa	1134	0.75	1582	0.92	1414	0.84	42	0.02	4172	0.64
Torula	56	0.04	126	0.07	154	0.09	98	0.06	434	0.06
Trichoconis	42	0.03	140	0.08	70	0.04	42	0.02	294	0.04
Total	70056	46.35	81760	47.50	75334	45.08	68390	42.89	295540	45.48
OTHER TYPES										
Algal Filaments	1260	0.83	1400	0.81	910	0.54	560	0.35	4130	0.63
Epidermal hairs	252	0.16	700	0.41	420	0.25	728	0.45	2100	0.32
Hyphal Fragments	2800	1.85	4480	2.60	4900	2.93	5460	3.42	17640	2.71
Insect Scales	4200	2.78	4900	2.84	4060	2.43	2940	1.84	16100	2.48
Pollen grains	1820	1.20	2660	1.54	1120	0.67	2240	1.41	7840	1.22
Protozoan cysts	210	1.14	350	0.20	490	0.29	420	0.26	1470	0.23
Unidentified Spores	2100	1.39	1400	0.81	1680	1.00	1540	0.96	6720	1.03
Total	12642	8.36	15890	9.23	13580	8.13	13888	8.71	56000	8.62
Grand Total	151144	100.00	172116	100.00	167104	100.00	159418	100.00	649782	100.00

Table-III B: The monthwise Concentration and percentage contribution of each Spore types to the total airspora over Jowar crop field (from: 1st Nov, 2016 to 28th Feb, 2017).

Spore types	Nov- 2016		Dec-2016		Jan-2017		Feb-2017		Total Spore Conc e/m ³ of air	% Cont ribut ion to the total airsp ora
	Spore Conce /m ³ of air	% Contri bution	Spore Conce / m ³ of air	% Contri bution	Spore Conce/ m ³ of air	% Contri bution.	Spore Conce/ m ³ of air.	% Contri bution .		
MYXOMYCOTINA										
Physarum	2240	1.31	3360	1.77	3794	2.03	2044	1.18	11438	1.59
Stemonitis	1022	0.59	1400	0.74	1750	0.93	1554	0.90	5726	0.79
Total	3262	1.91	4760	2.51	5544	2.96	3598	2.08	17164	2.38
ZYGOMYCOTINA										
Cunnighamella	4200	2.46	6664	3.51	5474	2.93	3528	2.04	19866	2.76
Mucor	--	--	--	--	112	0.06	56	0.03	168	0.02
Rhizopus	--	--	224	0.12	574	0.31	476	0.27	1274	0.17
Sclerospora	1232	0.72	1064	0.56	2002	1.07	2352	1.36	6650	0.92
Total	5432	3.18	7952	4.19	8162	4.36	6412	3.71	27958	3.88
ASCOMYCOTINA										
Ascospores	56	03	84	0.04	--	--	126	0.07	266	0.04
Bitrimonospora	630	0.37	1344	0.71	1554	0.83	938	0.54	4466	0.62
Chaetomium	2800	1.64	2520	1.32	2394	1.28	1596	0.92	9310	1.29
Claviceps	616	0.36	812	0.43	1386	0.74	1008	0.58	3822	0.53
Cucurbitaria	1218	0.71	784	0.41	1442	0.77	1176	0.68	4620	0.64
Didymosphaeria	4200	2.46	3500	1.84	2800	1.49	2478	1.43	12978	1.80
Hypoxyton	224	0.13	364	0.19	168	0.08	140	0.08	896	0.12
Leptosphaeria	2100	1.23	1960	1.03	2800	1.49	2660	1.54	9520	1.32
Lophiostoma	4900	2.87	7168	3.77	6328	3.38	4438	2.57	22834	3.17
Massaria	14	0.01	--	--	42	0.02	--	--	56	0.01
Melanospora	112	0.06	--	--	56	0.03	42	0.02	210	0.03

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Metasphaeria	210	0.12	350	0.18	630	0.33	420	0.24	1610	0.22
Otthia	280	0.16	420	0.22	140	0.07	70	0.04	910	0.13
Parodiella	42	0.02	28	0.01	42	0.02	--	--	112	0.01
Pleospora	1260	0.74	1050	0.55	728	0.39	812	0.47	3850	0.53
Sordaria	700	0.41	1400	0.74	1806	0.96	1680	0.97	5586	0.77
Sporormia	994	0.58	1400	0.74	378	0.20	1148	0.66	3920	0.54
Teichospora	--	--	28	0.01	--	--	14	0.01	42	0.01
Total	20356	11.93	23212	12.22	22694	12.13	18746	10.86	85008	11.80
BASIDIOMYCOTINA										
Basidiospores	4060	2.38	3640	1.91	4200	2.24	3500	2.03	15400	2.14
Ganoderma	56	0.03	--	--	42	0.02	--	--	98	0.01
Rust Spores	16940	9.92	15680	8.25	16800	8.98	18844	10.92	68264	9.48
Smut Spores	14588	8.55	14280	7.52	14000	7.48	21560	12.49	64428	8.94
Urediniospores	2940	1.72	3374	1.77	3528	1.88	4060	2.35	13902	1.93
Total	38584	22.61	36974	19.47	38570	20.62	47964	27.79	162092	22.51
DEUTERO MYCOTINA										
Alternaria	7420	4.35	7000	3.68	9800	5.24	12250	7.09	36470	5.06
Aspergillus	1750	1.02	1820	0.96	1400	0.75	1260	0.73	6230	0.86
Beltraniella	224	0.13	504	0.26	1064	0.57	868	0.50	2660	0.37
Beltrania	952	0.56	1092	0.57	1008	0.54	588	0.34	3640	0.50
Bispora	350	0.20	910	0.48	784	0.42	560	0.32	2604	0.36
Botryodiplodia	--	--	42	0.02	--	--	28	0.02	70	0.01
Cercospora	168	0.09	448	0.23	420	0.22	350	0.20	1386	0.19
Cladosporium	35000	20.50	36400	19.16	34440	18.42	23842	13.81	129682	18.01
Cordana	56	0.03	--	--	42	0.02	28	0.02	126	0.02
Corynespora	140	0.08	112	0.06	210	0.11	168	0.09	630	0.09
Curvularia	8400	4.92	12950	6.82	10500	5.62	7350	4.26	39200	5.44
Dictyoarthrinium	168	0.09	140	0.07	210	0.11	392	0.23	910	0.13
Diplodia	--	--	98	0.05	126	0.07	56	0.03	280	0.04

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Drechslera	70	0.04	84	0.04	--	--	98	0.05	252	0.03
Epicoccum	812	0.47	1540	0.81	1400	0.75	980	0.56	4732	0.66
Fusariella	364	0.21	560	0.29	588	0.31	504	0.29	2016	0.28
Haplosporella	1344	0.79	1400	0.74	1120	0.59	1050	0.61	4914	0.68
Harknessia	28	0.01	--	--	56	0.03	84	0.05	168	0.02
Heliminthosp orium	3150	1.84	2940	1.55	2660	1.42	2800	1.62	1155 0	1.60
Heterosporiu m	2184	1.28	2492	1.31	2688	1.44	2408	1.39	9772	1.35
Lacellina	2800	1.64	3500	1.84	4200	2.24	3920	2.28	1442 0	2.01
Lacellinospsis	644	0.38	728	0.38	1344	0.72	1008	0.58	3724	0.52
Memnoniella	140	0.08	28	0.01	140	0.07	630	0.36	938	0.13
Nigrospora	9660	5.66	10500	5.53	9800	5.24	8540	4.95	3850 0	5.34
Periconia	8400	4.92	7420	3.90	7000	3.74	4200	2.43	2702 0	3.75
Pestalotia	280	0.16	560	0.29	--	--	28	0.02	868	0.12
Pithomyces	1260	0.74	1820	0.96	2100	2.41	1680	0.97	6860	0.95
Pseudotorula	--	--	140	0.07	112	0.06	140	0.08	392	0.05
Penicillium	700	0.41	1120	0.59	560	0.29	840	0.48	3220	0.45
Tetraploa	1120	0.65	1568	0.82	1400	0.75	28	0.02	4116	0.57
Torula	42	0.02	112	0.06	140	0.07	98	0.05	392	0.05
Trichoconis	28	0.01	126	0.06	56	0.03	42	0.02	252	0.03
Total	87654	51.36	98154	51.68	95368	50.99	76818	44.50	3579 94	49.7 1
OTHER TYPES										
Algal Filaments	1400	0.82	1540	0.81	980	0.52	910	0.53	4830	0.67
Epidermal hairs	280	0.16	980	0.51	490	0.26	1050	0.60	2800	0.39
Hyphal Fragments	4900	2.87	5600	2.95	4340	2.32	5180	3.00	2002 0	2.78
Insect Scales	2800	1.64	3080	1.62	2660	1.42	3780	2.19	1232 0	1.71
Pollen grains	3500	2.05	4200	2.21	4900	2.62	5460	3.16	1806 0	2.51
Protozoan cysts	280	0.16	672	0.35	644	0.34	588	0.34	2184	0.30
Unidentified Spores	2226	1.30	2800	1.47	2660	1.42	2100	1.22	9786	1.36
Total	15386	9.01	18872	9.93	16674	8.92	19068	11.05	7000 0	9.72
Grand Total	17067 4	100.00	18992 4	100.00	187012	100.00	172606	100.00	7202 16	100. 00

Table-IVA: The monthly average percentage contribution of each spore types, to the total airspora over jowar crop field (from: 1st Nov, 2015 to 28th Feb, 2016).

Sr. No	Spore type	November 2015	December 2015	January 2016	February 2016
A)	MYXOMYCOTINA				
1.	Physarum	19.62	29.73	32.69	17.96
2.	Stemonitis	18.54	24.15	29.26	28.05
	Total	19.27	27.89	31.57	21.27
B)	ZYGOMYCOTINA				
1.	Cunninghamella	21.05	33.24	27.70	18.01
2.	Mucor	-	29.41	44.12	26.47
3.	Rhizopus	-	18.00	42	40
4.	Sclerospora	18.89	16.42	29.78	34.91
	Total	19.18	28.47	29.16	23.19
C)	ASCOMYCOTINA				
1.	Ascospores	15.38	19.23	23.07	42.32
2.	Bitrimonospora	14.32	29.87	35.07	20.74
3.	Chaetomium	31.93	23.36	26.79	17.92
4.	Claviceps	16.02	21.35	35.58	27.05
5.	Cucurbitaria	26.04	17.75	31.06	25.15
6.	Didymosphaeria	30.15	25.12	22.61	22.12
7.	Hypoxyton	24.67	41.09	13.69	20.55
8.	Leptosphaeria	23.43	19.54	28.90	28.13
9.	Lophiostoma	21.88	31.19	27.59	19.34
10.	Massaria	28.57	42.85	14.29	14.29
11.	Melanospora	36	24	24	16
12.	Metasphaeria	34.01	27.22	24.48	14.29
13.	Othia	37.97	31.64	25.32	5.07

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14.	Parodiella	36.36	27.28	36.36	-
15.	Pleospora	32.62	27.24	18.63	21.51
16.	Sordaria	9.59	32.88	30.14	27.39
17.	Sporormia	27.94	41.89	6.98	13.19
18.	Teichospora	-	66.66	-	33.34
	Total	24.63	27.51	26.04	21.82
D)	BASIDIOMYCOTINA				
1.	Basidiospores	35.63	40.80	14.59	8.90
2.	Ganoderma	55.56	-	44.44	-
3.	Rust Spores	24.05	22.25	25.90	27.80
4.	Smut Spores	20.84	20.40	25.98	32.78
5.	Urediniospores	20.97	24.05	25.15	29.83
	Total	23.12	22.68	25.23	28.97
E)	DEUTEROMYCOTINA				
1.	Alternaria	19.32	22.55	23.54	34.59
2.	Aspergillus	26.79	29.71	24.41	19.09
3.	Beltraniella	26.23	30.05	27.75	15.97
4.	Beltrania	8.76	18.55	40.22	32..47
5.	Bispora	13.47	34.71	30.06	21.76
6.	Botryodiplodia	-	50	-	50
7.	Cercospora	25	27.5	25.84	21.66
8.	Cladosporium	22.94	27.36	25.83	23.87
9.	Cordana	41.67	-	33.33	25
10.	Corynespora	22.92	18.75	31.25	27.08
11.	Curvularia	24.31	29.10	25.38	21.21
12.	Dictyoarthrinium	18.84	15.94	23.19	42.03
13.	Diplodia	15.38	30.78	29.23	24.61
14.	Drechslera	31.59	31.59	-	36.82
15.	Epicoccum	17.26	32.45	29.53	20.76

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16.	Fusariella	18.24	27.70	29.06	25
17.	Haplosporella	24.61	40.27	18.12	17.00
18.	Harknessia	20	-	33.33	46.67
19.	Heliminthosporium	29.33	26.66	25.34	18.67
20.	Heterosporium	22.37	25.49	27.49	24.65
21.	Lacellina	19.28	24.09	28.92	27.71
22.	Lacellinospsis	17.47	19.70	35.69	27.14
23.	Memnoniella	18.52	25.92	18.52	37.04
24.	Nigrospora	24.85	28.43	25.20	21.52
25.	Papularia	-	66.67	-	33.33
26.	Penicillium	34.78	45.65	19.57	-
27.	Periconia	35.98	29.56	20.68	13.78
28.	Pestalotia	32.31	63.08	-	4.61
29.	Pithomyces	21.48	23.63	28.64	26.25
30.	Tetraploa	27.18	37.92	33.89	1.01
31.	Torula	12.90	29.04	35.48	22.58
32.	Trichoconis	14.28	47.62	23.82	14.28
	Total	23.70	27.67	25.49	23.14
F)	OTHER TYPES				
1.	Algal Filaments	30.52	33.89	22.03	13.56
2.	Epidermal hairs	12	33.33	20	34.67
3.	Hyphal Fragments	15.88	25.39	27.78	30.95
4.	Insect Scales	26.08	30.44	25.22	18.26
5.	Pollen grains	23.21	33.93	14.29	28.57
6.	Protozoan cysts	14.28	23.82	33.33	28.57
7.	Unidentified Spores	31.25	20.83	25	22.92
	Total	22.57	28.37	24.26	24.8

Table-IV B: The monthly average percentage contribution of each spore types, to the total airspora over jowar cropfield (from: 1st Nov, 2016 to 28th Feb, 2017).

Sr. No.	Spore Types	Nov. 2016	Dec.2016	Jan. 2017	Feb. 2017
A)	MYXOMYCOTINA				
1.	Physarum	19.58	29.37	33.17	17.88
2.	Stemonitis	17.85	24.45	30.56	27.15
	Total	19.00	27.73	32.30	20.97
B)	ZYGOMYCOTINA				
1.	Cunninghamella	21.14	33.54	27.55	17.77
2.	Mucor	-	-	66.67	33.33
3.	Rhizopus	-	17.58	45.06	37.36
4.	Sclerospora	18.53	16.0	30.10	35.37
	Total	19.43	28.44	29.19	22.94
C)	ASCOMYCOTINA				
1.	Ascospores	21.05	31.57	-	47.38
2.	Bitrimonospora	14.11	30.09	34.79	21.01
3.	Chaetomium	30.07	27.07	25.71	17.15
4.	Claviceps	16.12	21.24	36.26	26.38
5.	Cucurbitaria	26.36	16.96	31.22	25.46
6.	Didymosphaeria	32.36	26.97	21.58	19.09
7.	Hypoxylon	25	40.62	18.75	15.63
8.	Leptosphaeria	22.06	20.59	29.41	27.94
9.	Lophiostoma	21.46	31.39	27.71	19.44
10.	Massaria	25	-	75	-
11.	Melanospora	53.34	-	26.66	20
12.	Metasphaeria	13.04	21.74	39.13	26.09
13.	Othia	30.77	46.15	15.39	7.69

14.	Parodiella	37.05	25	37.05	-
15.	Pleospora	32.73	27.27	18.91	21.09
16.	Sordaria	12.53	25.06	32.33	30.08
17.	Sporormia	25.36	35.71	9.65	29.28
18.	Teichospora	-	66.66	-	33.34
	Total	23.94	27.31	26.69	22.06
D)	BASIDIOMYCOTIN A				
1.	Basidiospores	26.37	23.63	27.27	22.73
2.	Ganoderma	57.15	-	42.85	-
3.	Rust Spores	24.81	22.96	24.62	27.691
4.	Smut Spores	22.64	22.17	21.72	33.47
5.	Urediniospores	21.15	24.27	25.38	29.20
	Total	23.80	22.82	23.79	29.59
E)	DEUTEROMYCOTI NA				
1.	Alternaria	20.34	19.19	26.88	33.59
2.	Aspergillus	28.09	29.21	22.47	20.23
3.	Beltraniella	8.42	18.95	40	32.63
4.	Beltrania	26.15	30	27.69	16.16
5.	Bispora	13.44	34.94	30.12	21.50
6.	Botryodiplodia	-	60	-	40
7.	Cercospora	12.12	32.33	30.30	25.25
8.	Cladosporium	26.98	28.07	26.57	18.38
9.	Cordana	44.45	-	33.33	22.22
10.	Corynespora	22.22	17.77	33.34	26.67
11.	Curvularia	21.43	33.04	26.78	18.75
12.	Dictyoarthrinium	18.46	15.38	23.08	43.08
13.	Diplodia	-	35	45	20

14.	Drechslera	27.78	33.33	-	38.89
15.	Epicoccum	17.17	32.54	29.58	20.71
16.	Fusariella	18.06	27.77	29.17	25
17.	Haplosporella	27.35	28.49	22.79	21.37
18.	Harknessia	16.67	-	33.33	50
19.	Heliminthosporium	27.27	25.45	23.04	24.24
20.	Heterosporium	22.35	25.50	27.51	24.64
21.	Lacellina	19.42	24.27	29.12	27.19
22.	Lacellinospsis	17.29	19.55	36.09	27.07
23.	Memnoniella	14.93	2.98	14.93	67.16
24.	Nigrospora	25.09	27.27	25.45	22.19
25.	Penicillium	21.74	34.78	17.39	26.09
26.	Periconia	31.09	27.46	25.90	15.55
27.	Pestalotia	32.26	64.52	-	3.22
28.	Pithomyces	18.36	26.23	30.62	24.49
29.	Pseudotorula	-	35.71	28.58	35.71
30.	Tetraploa	27.21	38.09	34.02	0.68
31.	Torula	10.71	28.57	35.72	25
32.	Trichoconis	11.11	50	22.22	16.67
	Total	24.48	27.43	28.64	21.45
F)	OTHER TYPES				
1.	Algal Filaments	28.98	31.89	20.29	18.84
2.	Epidermal hairs	10	35	17.5	37.5
3.	Hyphal Fragments	24.47	27.97	21.69	25.87
4.	Insect Scales	22.73	25	21.59	30.68
5.	Pollen grains	19.38	23.25	27.14	30.23
6.	Protozoan cysts	12.82	30.77	29.49	26.92
7.	Unidentified Spores	22.74	28.61	27.19	21.46
	Total	23.69	26.38	25.97	23.96

Table-VA: The monthwise average percentage contribution of each spore group to the total airspora during First Rabi Season from (1st Nov, 2015 to 28th Feb, 2016).

Sr. No	Spore Group	November	December	January	February
A	Myxomycotina	2.23	2.84	3.31	2.33
B	Zygomycotina	3.67	4.78	5.04	4.21
C	Ascomycotina	14.25	13.97	13.62	11.97
D	Basidiomycotina	25.14	21.67	24.81	29.88
E	Deuteromycotina	46.35	47.50	45.08	42.89
F	Other types	8.36	9.23	8.13	8.71
	Total	100.00	100.00	100.00	100.00

Table-V B: The monthwise average percentage contribution of each spore group to the total airspora during Second Rabi Season from (1st Nov, 2016 to 28th Feb, 2017).

Sr. No	Spore Group	November	December	January	February
A	Myxomycotina	1.91	2.51	2.96	2.08
B	Zygomycotina	3.18	4.19	4.36	3.71
C	Ascomycotina	11.93	12.22	12.13	10.86
D	Basidiomycotina	22.61	19.47	20.62	27.79
E	Deuteromycotina	51.36	51.68	50.99	44.50
F	Other types	9.01	9.93	8.92	11.05
	Total	100.00	100.00	100.00	100.00

Table-VI A: The monthly average percentage contribution of each spore group to the airspora during the First Rabi Season from (1st Nov, 2015 to 28th Feb, 2016).

Sr. No	Spore Group	November	December	January	February	Total
A	Myxomycotina	19.27	27.89	31.57	21.27	100.00
B	Zygomycotina	19.18	28.47	29.16	23.19	100.00
C	Ascomycotina	24.63	27.51	26.04	21.82	100.00
D	Basidiomycotina	23.12	22.68	25.23	28.97	100.00
E	Deuteromycotina	23.70	27.67	25.49	23.14	100.00
F	Other types	22.57	28.37	24.26	24.8	100.00

Table-VI B: The monthly average percentage contribution of each spore group to the airspora during the Second Rabi Season from (1st Nov, 2016 to 28th Feb, 2017).

Sr. No	Spore Group	November	December	January	February	Total
A	Myxomycotina	19.00	27.73	32.30	20.97	100.00
B	Zygomycotina	19.43	28.44	29.19	22.94	100.00
C	Ascomycotina	23.94	27.31	26.69	22.06	100.00
D	Basidiomycotina	23.80	22.82	23.79	29.59	100.00
E	Deuteromycotina	24.48	27.43	26.64	21.45	100.00
F	Other types	21.98	26.96	23.82	27.24	100.00

Table-VII: The monthwise total Seasonal Concentration of each spore group to the total airspora in the Ist and IInd Seasons.

Spore Group	November		December		January		February	
	I	II	I	II	I	II	I	II
	2015 to 2016	2016 to 2017	2015 to 2016	2016 to 2017	2015 to 2016	2016 to 2017	2015 to 2016	2016 to 2017
Myxomycotina	3374	3262	4886	4760	5530	5544	3724	3598
Zygomycotina	5544	5432	8232	7952	8428	8162	6706	6412
Ascomycotina	21532	20356	24052	23212	22764	22694	19082	18746
Basidiomycotina	37996	38584	37296	36974	41468	38570	47628	47964
Deuteromycotina	70056	87654	81760	98154	75334	95368	68390	76818
Other types	12642	15386	15890	18872	13580	16674	13888	19068
Total	151144	170674	172116	189924	167104	187012	159418	172606

Table-VIII: Total spore concentration and percentage contribution of each spore group during Ist and IInd Season (Season I: from 1st Nov, 2015 to 28th Feb, 2016; and Season II: from 1st Nov, 2016 to 28th Feb, 2017).

Sr. No	Spore Group	Total spore Conce/m ³ of air			% contribution to the total airspora		Average % to the total airspora
		Season I	Season II	Season I and II	Season I	Season II	
A	Myxomycotina	17514	17164	34678	2.69	2.38	2.53
B	Zygomycotina	28910	27958	56868	4.45	3.88	4.15
C	Ascomycotina	87430	85008	172438	13.45	11.80	12.59
D	Basidiomycotina	164388	162092	326480	25.29	22.51	23.83
E	Deuteromycotina	295540	357994	653534	45.48	49.71	47.70
F	Other types	56000	70000	126000	8.62	9.72	9.19
	Total	649782	720216	13,69998	100.00	100.00	100.00

Table-IX:Concentration between certain pathogenic fungal sporetypes and percentage contribution during (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 28th Feb, 2017).

Sr.No	Pathogenic spore types	Seasons total spores/m ³ of air		% contribution to the total airspora		Disease
		I Season	II Season	I season	II Season	
1	Alternaria	31164	36470	4.79	5.06	Leaf spot
2	Cercospora	1680	1386	0.26	0.19	Leaf spot
3	Curvularia	39732	39200	6.12	5.44	Leaf spot
4	Heliminthosporium	10500	11550	1.62	1.61	Leaf spot
5	Periconia	20314	27020	3.13	3.75	Leaf spot
6	Rust spores	70532	68264	10.85	9.48	Rust
7	Smut spores	70056	64428	10.78	8.94	Smut

Table-1A: Variation in total number and percentage contribution of different fungal colonies, the air of Jowar crop fields by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016 and Season II: Nov, 2016 to Feb, 2017).

Sr. No	Fungal type	Total number of colonies	% contribution
A)	ZYGOMYCOTINA		
1.	Cunnighamella	09	0.26
2.	Mucor	17	0.49
3.	Pythium	03	0.09
4.	Rhizopus cohinii	110	3.17
5	Rhizopus	34	0.98
	Total	173	4.99
B)	ASCOMYCOTINA		
1	Chaetomium	04	0.11
2	Neurospora	46	1.33
	Total	50	1.44
C)	DEUTEROMYCOTINA		
1.	Alternaria	158	4.57
2.	Alternaria alternata	05	0.14
3	Alternaria solani	11	0.33
4	Aspergillus Flavus	54	1.57
5	Aspergillus Niger	386	11.14
6	Aspergillus	361	10.42
7	Bipolaris	03	0.08
8	Cladosporium	1226	35.36
9	Curvularia lunata	05	0.14
10	Curvularia	119	3.43
11	Diplodia	04	0.11
12	Epicoccum	05	0.14
13	Fusarium Oxysporum	07	0.20

14	Fusarium spp.	92	2.66
15	Helminthosporium	45	1.29
16	Humicola	10	0.28
17	Penicillium lacani	05	0.14
18	Penicillium notatum	06	0.17
19	Penicillium sp.	199	5.74
20	Pestalotia	24	0.69
21	Phoma	05	0.14
22	Torula	04	0.11
23	Trichoderma veride	15	0.43
	Total	2749	79.29
D)	MYCELIA STERILIA		
1	Unclassified group	495	14.28
	Total	495	14.28
	Grand total	3467	100

Table-2A: The monthwise fungal colony counts of different fungi, the air of Jowar crop field by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

Sr. No	Fungal type	Nov.	Dec.	Jan.	Feb.	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	01	02	--	--	03
2.	Mucor	03	02	--	--	05
3.	Pythium	--	--	--	01	01
4.	Rhizopus cohinii	25	05	15	03	48
5	Rhizopus	05	03	03	01	12
	Total	34	12	18	05	69
B)	ASCOMYCOTINA					
1	Chaetomium	01	--	--	--	01
2	Neurospora	05	04	03	02	14

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	Total	06	04	03	02	15
C)	DEUTEROMYCOTINA					
1.	Alternaria	25	15	18	17	75
2.	Alternaria alternata	01	--	02	--	03
3	Alternaria solani	02	01	--	03	06
4	Aspergillus Flavus	04	07	03	10	24
5	Aspergillus Niger	50	30	55	49	184
6	Aspergillus	45	35	42	52	174
7	Bipolaris	--	01	--	--	01
8	Cladosporium	150	155	161	100	566
9	Curvularia lunata	--	01	02	--	03
10	Curvularia	08	04	15	25	52
11	Diplodia	01	--	--	01	02
12	Epicoccum	--	--	02	--	02
13	Fusarium Oxysporum	--	02	--	01	03
14	Fusarium spp.	05	10	15	12	42
15	Helminthosporium	03	04	04	07	18
16	Humicola	--	--	04	--	04
17	Penicillium lacani	--	01	--	01	02
18	Penicillium notatum	03	--	--	--	03
19	Penicillium spp.	20	16	25	30	91
20	Pestalotia	10	--	--	01	11
21	Phoma	--	--	02	01	03
22	Torula	--	--	--	01	01
23	Trichoderma veride	05	01	--	--	06
	Total	332	283	350	311	1276
D)	MYCELIA STERILIA					
1	Unclassified group	50	45	60	75	230
	Total	50	45	60	75	230
	Grand Total	422	344	431	393	1590

Table-2B: The monthwise fungal colony counts of different fungi, the air of Jowar crop field by Petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

Sr. no	Fungal type	Nov	Dec	Jan	Feb	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	02	03	--	01	06
2.	Mucor	02	03	01	06	12
3.	Pythium	--	01	01	--	02
4.	Rhizopus Cohinii	30	07	16	09	62
5	Rhizopus	07	05	06	04	22
	Total	41	19	24	20	104
B)	ASCOMYCOTINA					
1	Chaetomium	01	01	--	01	03
2	Neurospora	06	05	04	17	32
	Total	07	06	04	18	35
C)	DEUTEROMYCOTINA					
1.	Alternaria	30	18	20	15	83
2.	Alternaria alternata	01	01	--	--	02
3	Alternaria solani	--	01	03	01	05
4	Aspergillus Flavus	05	09	04	12	30
5	Aspergillus Niger	55	35	60	52	202
6	Aspergillus	50	38	44	55	187
7	Bipolaris	--	01	01	--	02
8	Cladosporium	200	170	165	125	660
9	Curvularia lunata	01	01	--	--	02
10	Curvularia	12	07	18	30	67
11	Diplodia	--	01	--	01	02
12	Epicoccum	--	--	03	--	03
13	Fusarium Oxysporum	--	02	02	--	04

14	Fusarium spp.	07	12	16	15	50
15	Helminthosporium	05	07	06	09	27
16	Humicola	--	03	02	01	06
17	Penicillium lacani	01	01	01	--	03
18	Penicillium notatum	01	02	--	--	03
19	Penicillium spp.	25	20	28	35	108
20	Pestalotia	02	10	01	--	13
21	Phoma	01	--	01	--	02
22	Torula	01	01	01	--	03
23	Trichoderma veride	05	02	02	--	09
	Total	402	342	378	351	1473
D)	MYCELIA STERILIA					
1	Unclassified group	65	50	70	80	265
	Total	65	50	70	80	265
	Grand Total	515	417	476	469	1877

Table-3A: The monthwise average percentage contribution of fungal colonies, the air of Jowar crop field by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

Sr. No	Name of Fungal colony	Nov	Dec	Jan	Feb	Total
A)	ZYGOMYCOTINA					
1.	Cunninghamella	0.24	0.58	--	--	0.19
2.	Mucor	0.71	0.58	--	--	0.32
3.	Pythium	--	--	--	0.25	0.06
4.	Rhizopus cohinii	5.93	1.45	3.49	0.76	3.02
5	Rhizopus	1.18	0.87	0.69	0.25	0.76
	Total	8.06	3.49	4.18	1.27	4.34
B)	ASCOMYCOTINA					
1	Chaetomium	0.24	--	--	--	0.06
2	Neurospora	1.18	1.16	0.69	0.51	0.88

	Total	1.42	1.16	0.69	0.15	0.94
C)	DEUTEROMYCOTINA					
1.	Alternaria	5.93	4.36	4.17	4.32	4.72
2.	Alternaria alternate	0.24	--	0.46	--	0.19
3	Alternaria solani	0.47	0.29	--	0.77	0.38
4	Aspergillus Flavus	0.95	2.03	0.69	2.55	1.52
5	Aspergillus niger	11.85	8.73	12.77	12.48	11.58
6	Aspergillus	10.66	10.18	9.75	13.24	10.94
7	Bipolaris	--	0.29	--	--	0.06
8	Cladosporium	35.55	45.07	37.36	25.45	35.59
9	Curvularia lunata	--	0.29	0.46	--	0.19
10	Curvularia	1.89	1.16	3.48	6.37	3.28
11	Diplodia	0.24	--	--	0.25	0.12
12	Epicoccum	--	--	0.46	--	0.12
13	Fusarium Oxysporum	--	0.58	--	0.25	0.19
14	Fusarium spp.	1.18	2.91	3.48	3.05	2.64
15	Helminthosporium	0.71	1.16	0.93	1.78	1.13
16	Humicola	--	--	0.93	--	0.25
17	Penicillium lacani	--	0.29	--	0.25	0.12
18	Penicillium notatum	0.71	--	--	--	0.19
19	Penicillium spp.	4.74	4.65	5.81	7.64	5.72
20	Pestalotia	2.37	--	--	0.25	0.69
21	Phoma	--	--	0.46	0.25	0.19
22	Torula	--	--	--	0.25	0.06
23	Trichoderma veride	1.18	0.29	--	--	0.38
	Total	78.67	82.27	81.21	79.14	80.26
D)	MYCELIA STERILIA					
1	Unclassified group	11.85	13.08	13.92	19.08	14.46
	Total	11.85	13.08	13.92	19.08	14.46

Table-3B: The monthwise average percentage contribution of fungal colonies, the air of Jowar crop field by Petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

Sr. No	Name of Fungal colony	Nov	Dec	Jan	Feb	Total
A)	ZYGOMYCOTINA					
1.	Cunnighamella	0.39	0.72	--	0.21	0.32
2.	Mucor	0.39	0.72	0.21	1.28	0.64
3.	Pythium	--	0.24	0.21	--	0.11
4.	Rhizopus cohinii	5.83	1.68	3.36	1.93	3.30
5	Rhizopus	1.36	1.19	1.26	0.85	1.17
	Total	7.96	4.56	5.04	4.26	5.55
B)	ASCOMYCOTINA					
1	Chaetomium	0.19	0.24	--	0.21	0.16
2	Neurospora	1.16	1.19	0.84	3.62	1.71
	Total	1.36	1.44	0.84	3.84	1.86
C)	DEUTEROMYCOTINA					
1.	Alternaria	5.83	4.32	4.20	3.19	4.42
2.	Alternaria alternata	0.19	0.24	--	--	0.11
3	Alternaria solani	--	0.24	0.63	0.21	0.27
4	Aspergillus Flavus	0.97	2.16	0.84	2.56	1.59
5	Aspergillus niger	10.69	8.39	12.61	11.09	10.77
6	Aspergillus sp.	9.72	9.11	9.24	11.73	9.96
7	Bipolaris	--	0.24	0.21	--	0.11
8	Cladosporium	38.84	40.78	34.67	26.66	35.16
9	Curvularia lunata	0.19	0.24	--	--	0.11
10	Curvularia	2.33	1.68	3.78	6.39	3.57
11	Diplodia	--	0.24	--	0.21	0.11
12	Epicoccum	--	--	0.63	--	0.16
13	Fusarium Oxysporum	--	0.48	0.42	--	0.21

14	Fusarium spp.	1.36	2.89	3.36	3.19	2.66
15	Helminthosporium	0.97	1.68	1.26	1.93	1.44
16	Humicola	--	0.72	0.42	0.21	0.32
17	Penicillium lacani	0.19	0.24	0.21	--	0.16
18	Penicillium notatum	0.19	0.48	--	--	0.16
19	Penicillium spp.	4.86	4.79	5.89	7.47	5.75
20	Pestalotia	0.38	2.39	0.21	--	0.69
21	Phoma	0.19	--	0.21	--	0.11
22	Torula	0.19	0.24	0.21	--	0.16
23	Trichoderma veride	0.97	0.48	0.42	--	0.48
	Total	78.06	82.01	79.42	74.84	78.47
D)	MYCELIA STERILIA					
1	Unclassified group	12.62	11.99	14.70	17.06	14.12
	Total	12.62	11.99	14.70	17.06	14.12

Table-4A: The monthwise total colonies count of each fungal group, the air of Jowar crop field by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

Sr. No	Spore group	Nov	Dec	Jan	Feb	Total
A	Zygomycotina	34	12	18	05	69
B	Ascomycotina	06	04	03	02	15
C	Deuteromycotina	332	283	350	311	1276
D	Mycelia sterilia	50	45	60	75	230
	Total	422	344	431	393	1590

Table-4B: The monthwise total average percentage contributions of each fungal group, the air of Jowar crop field by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

Sr. No	Spore group	Nov	Dec	Jan	Feb	Total
A	Zygomycotina	8.06	3.49	4.18	1.27	4.34
B	Ascomycotina	1.42	1.16	0.69	0.51	0.94
C	Deuteromycotina	78.67	82.27	81.21	79.14	80.26
D	Mycelia sterilia	11.85	13.08	13.92	19.08	14.46
	Total	100.00	100.00	100.00	100.00	100.00

Table -5A: The monthwise total colonies count of each fungal group, the air of Jowar crop field by Petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

Sr. No	Spore group	Nov	Dec	Jan	Feb	Total
A	Zygomycotina	41	19	24	20	104
B	Ascomycotina	07	06	04	18	35
C	Deuteromycotina	402	342	378	351	1473
D	Mycelia sterilia	65	50	70	80	265
	Total	515	417	476	469	1877

Table-5B: The monthwise total average percentage contributions of each fungal group, the air of Jowar crop field by Petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

Sr. No	Spore group	Nov	Dec	Jan	Feb	Total
A	Zygomycotina	7.96	4.56	5.04	4.26	5.55
B	Ascomycotina	1.36	1.44	0.84	3.84	1.86
C	Deuteromycotina	78.06	82.01	79.42	74.84	78.47
D	Mycelia sterilia	12.62	11.99	14.70	17.06	14.12
	Total	100.00	100.00	100.00	100.00	100.00

Table-6A: The Seasonwise total number of fungal colonies and percentage contribution of each spore group from (Season I: Nov, 2015 to Feb, 2016 and Season II: Nov, 2016 to Feb, 2017).

Sr. No	Spore group	Total fungal colonies		Total fungal colonies	Percentage & cont.		Avg. % contribution
		Season I	Season II	Seasons I and II	Season I	Season II	
1.	Zygomycotina	69	104	173	4.34	5.55	4.99
2.	Ascomycotina	15	35	50	0.94	1.86	1.44
3.	Deuteromycotina	1276	1473	2749	80.26	78.47	79.29
4.	Mycelia sterilia	230	265	495	14.46	14.12	14.28
	Total	1590	1877	3467	100.00	100.00	100.00

PLATE - 18



View of the Jowar Field



View of the Tilak Air sampler in the Jowar Field

PLATE - 19



Rust of jowar leaf



Rust of jowar Leaf Sheath



Leaf spot of Jowar- *Helminthosporium* sp.



Smut of Jowar

JOWAR CROP – GRAPHS

Fig-I.A-F: Histograms showing monthwise concentration and percentage Contribution of each spore types to the total airspora over Jowar crop field from (Season I: 1st Nov, 2015 to 28th Feb, 2016).

Fig-I: A

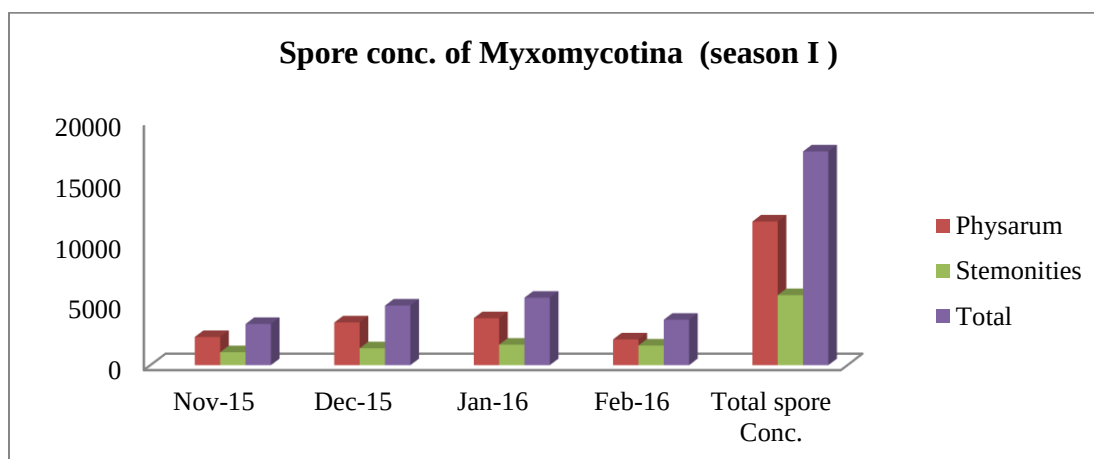
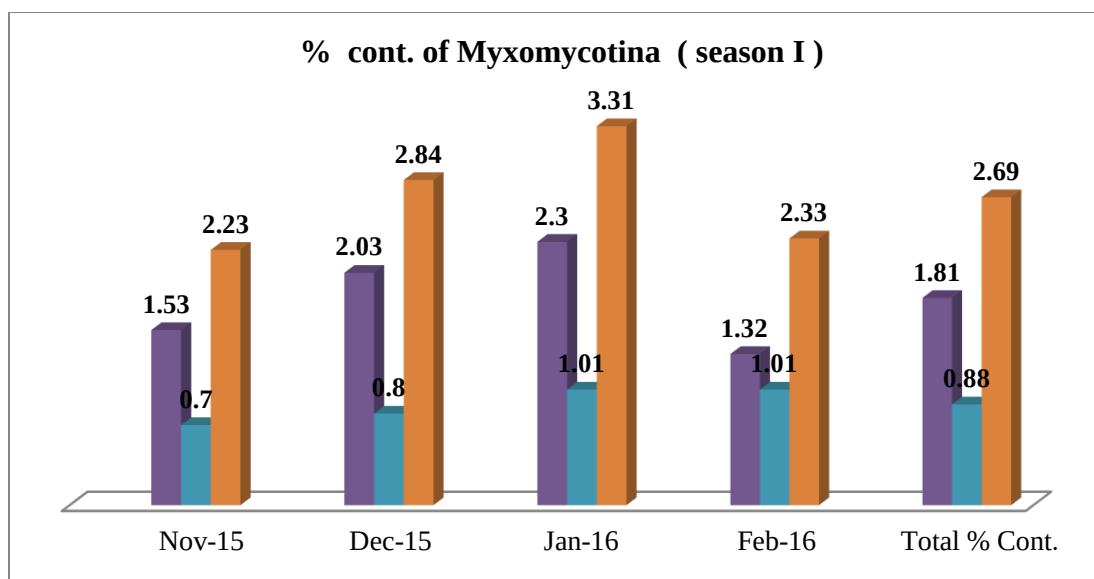


Fig-I: B

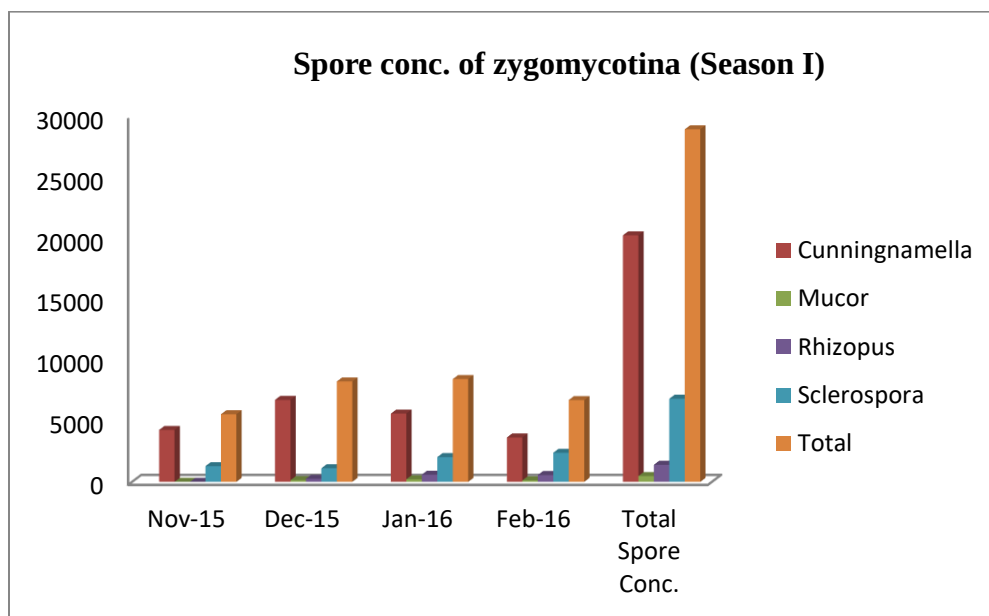
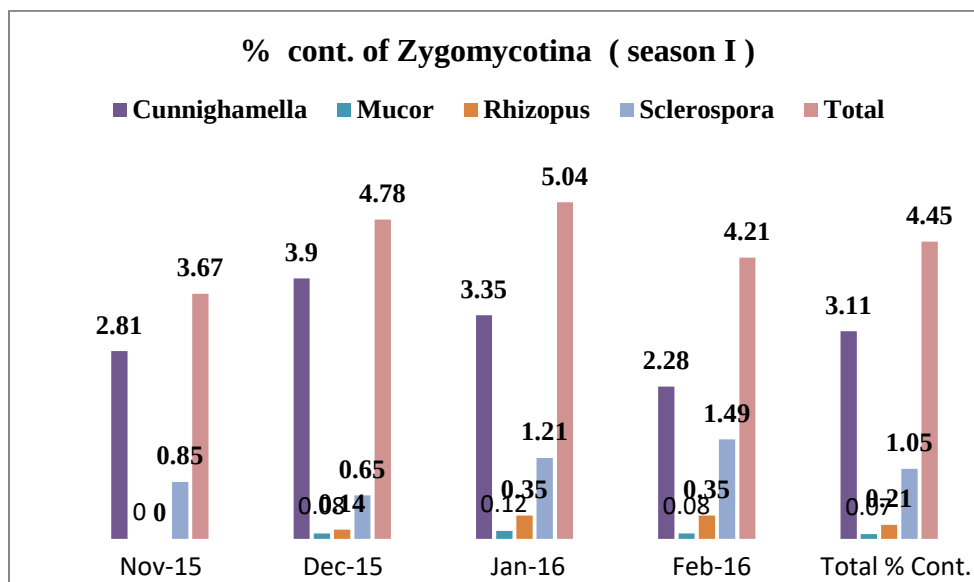


Fig-I: C

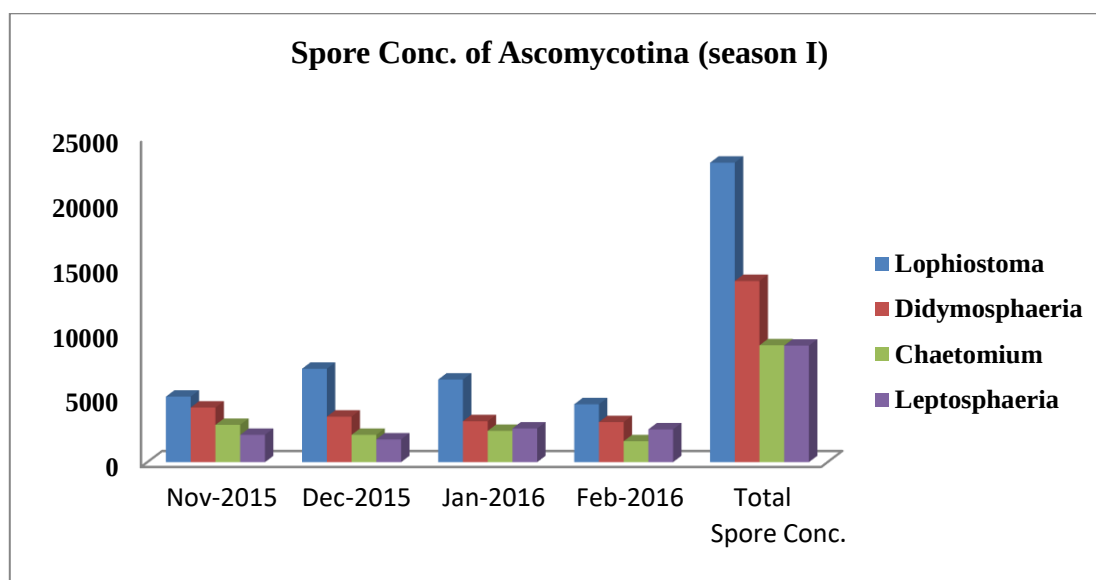
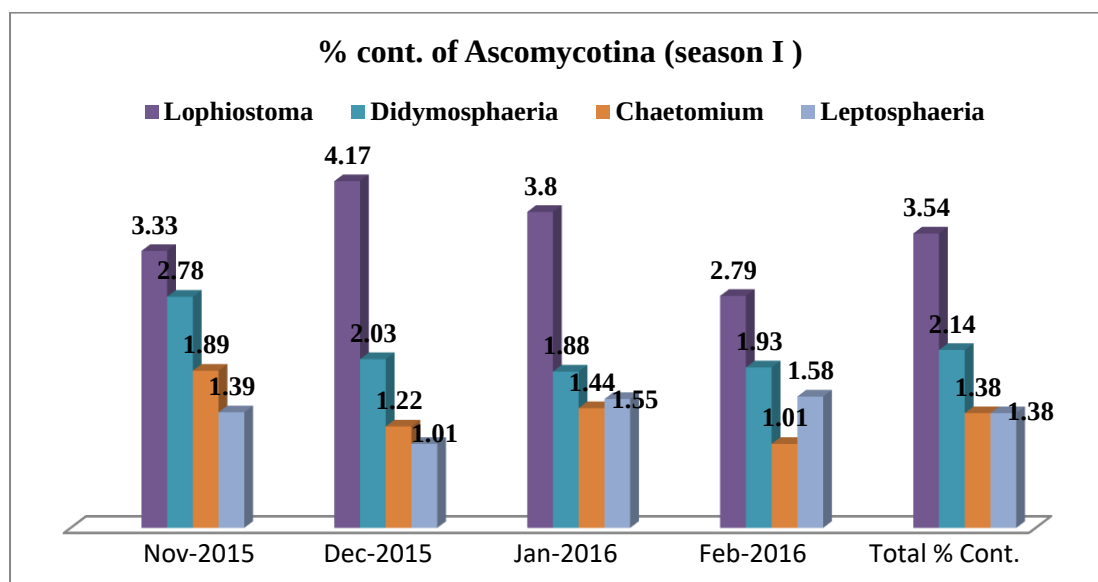


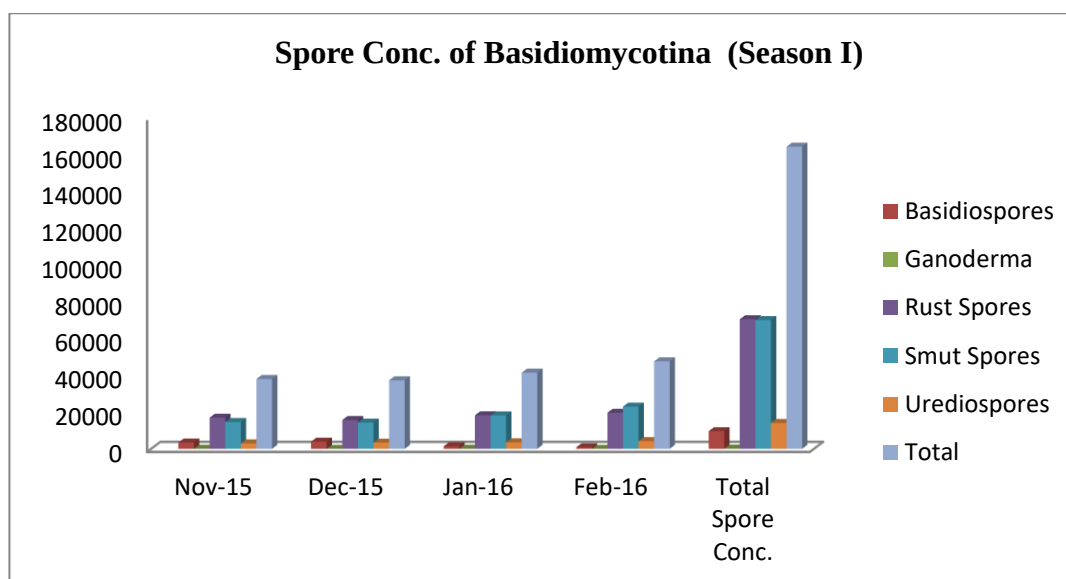
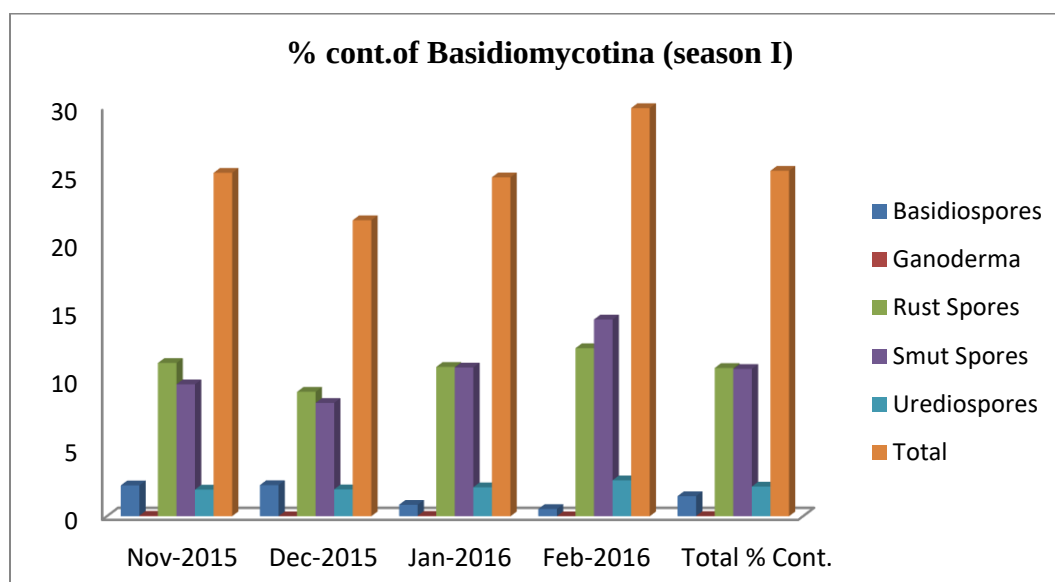
Fig-I: D

Fig-I: E

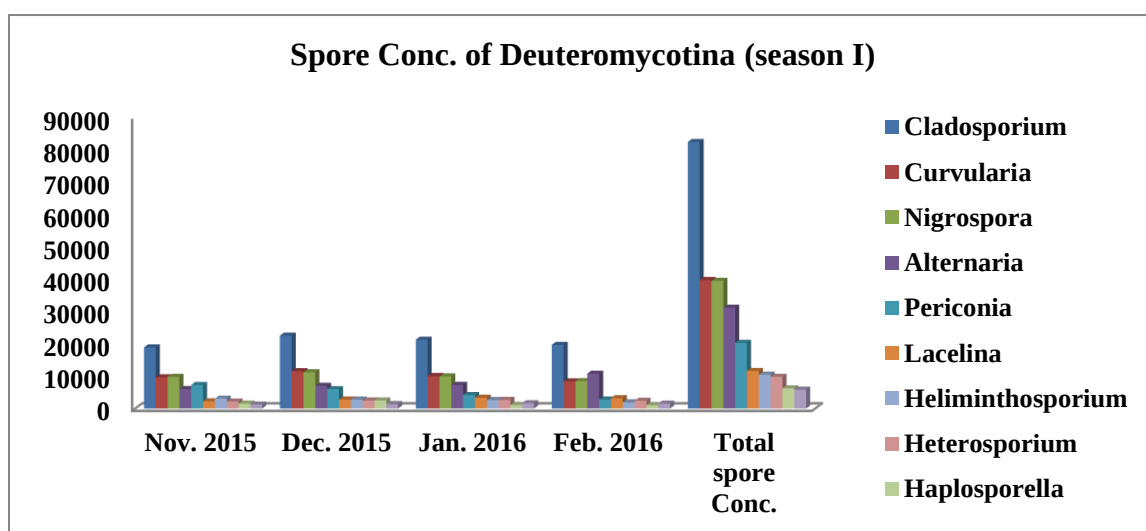
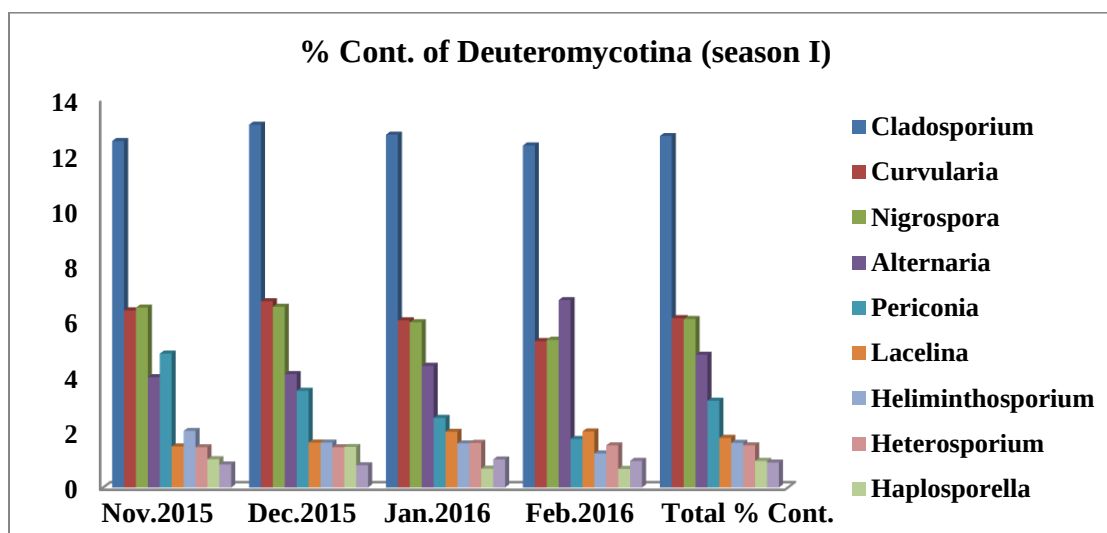


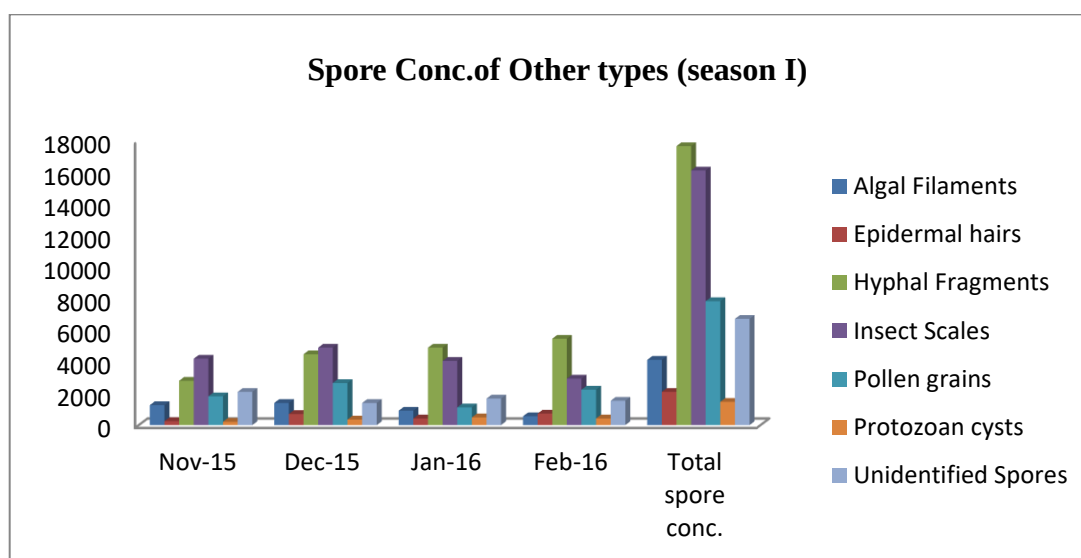
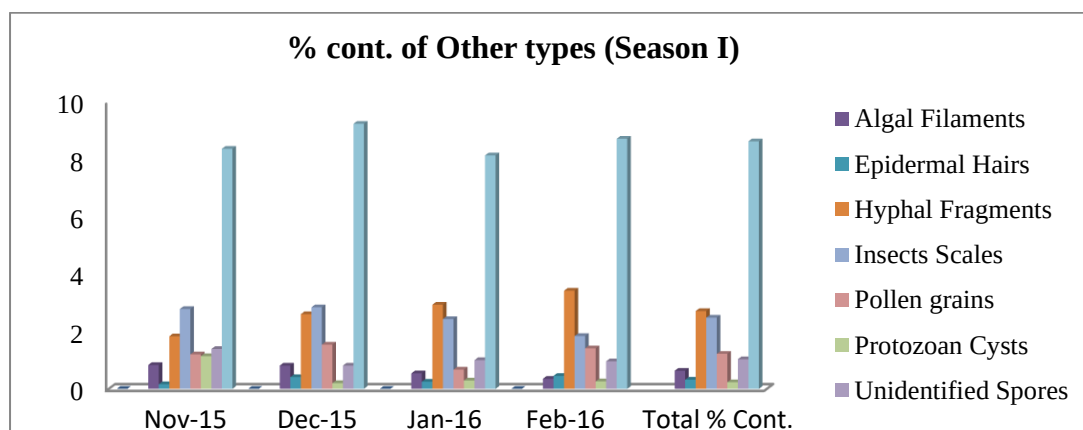
Fig-I: F

Fig-II.A-F: Histograms indicating monthwise concentration and percentage contribution of each spore types to the total airspora over Jowar crop field from (Season II: 1st Nov, 2016 to 28th Feb, 2017).

Fig-II: A

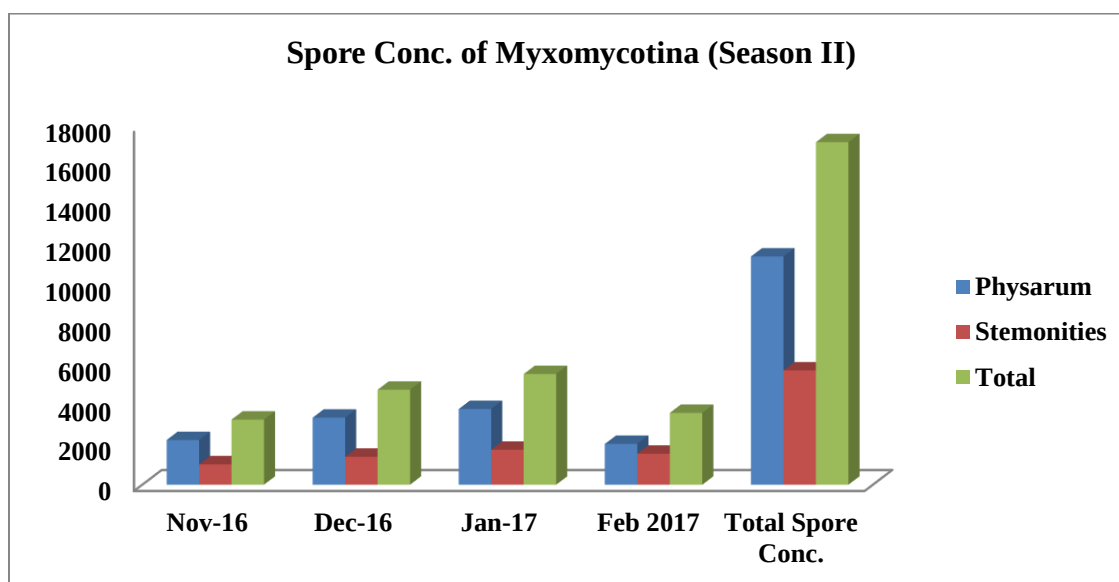
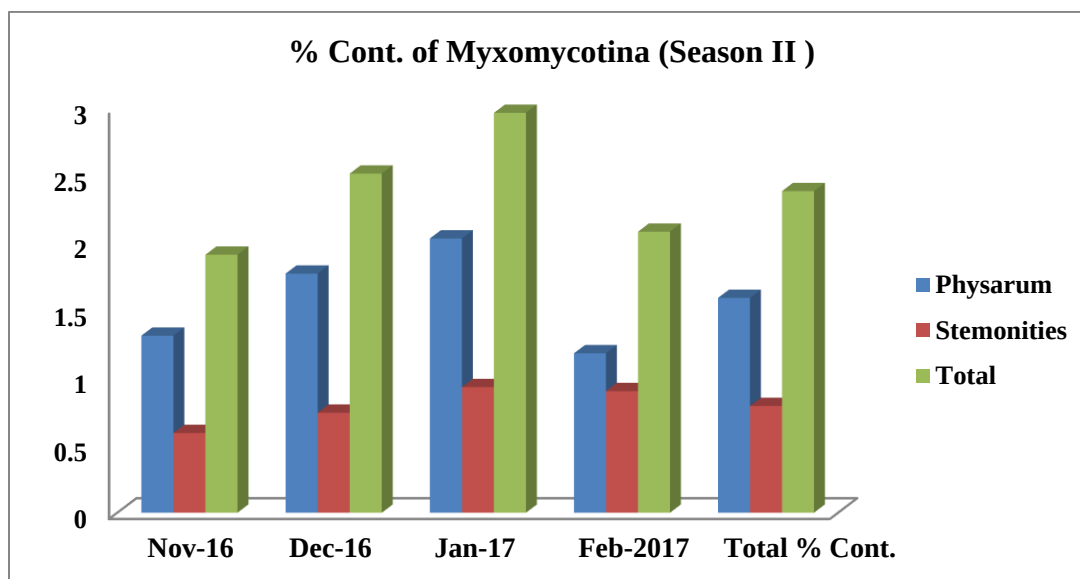


Fig-II: B

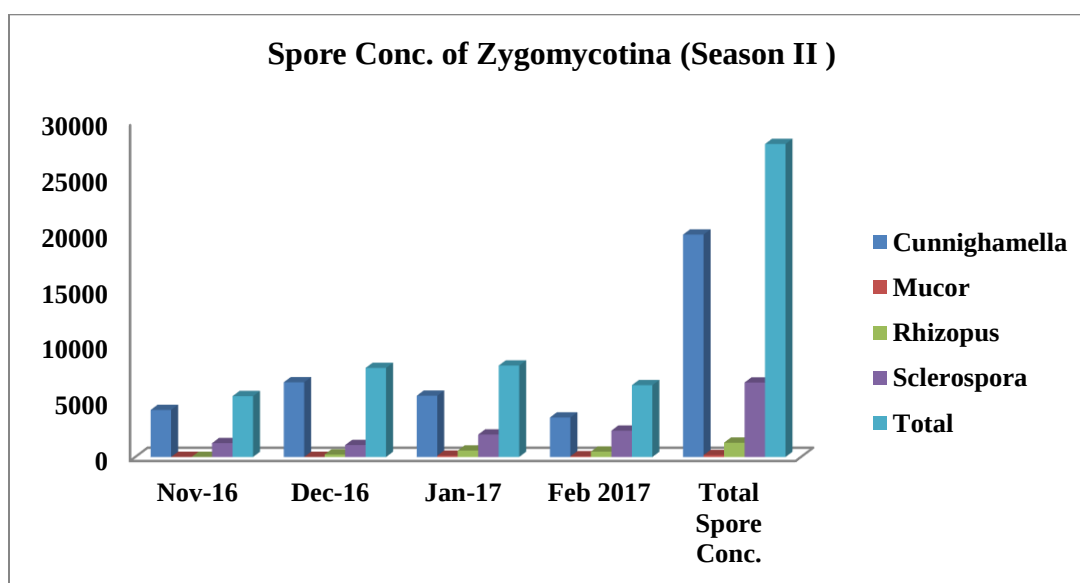
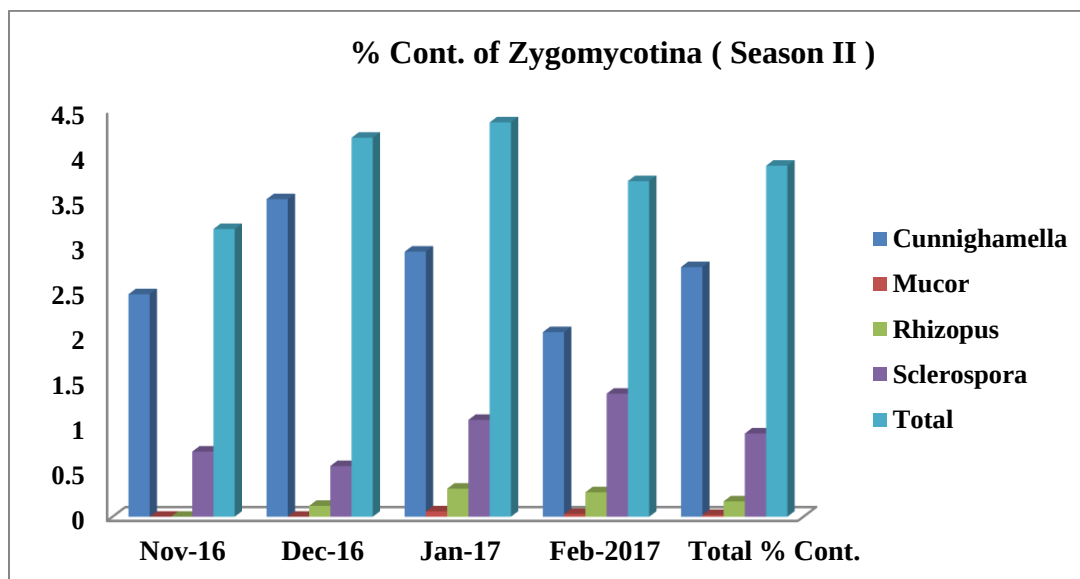


Fig-II: C

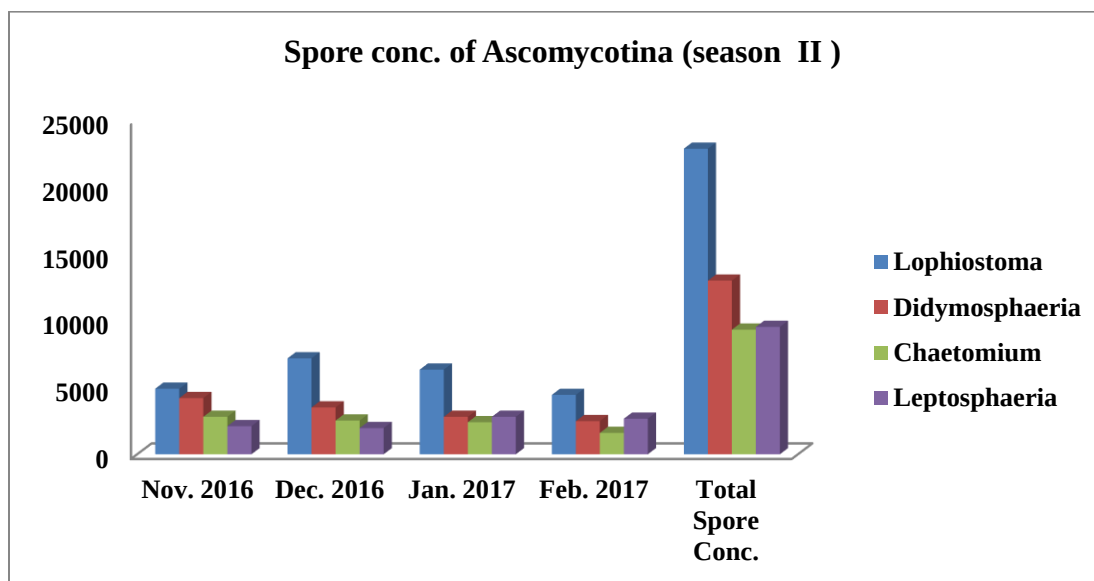
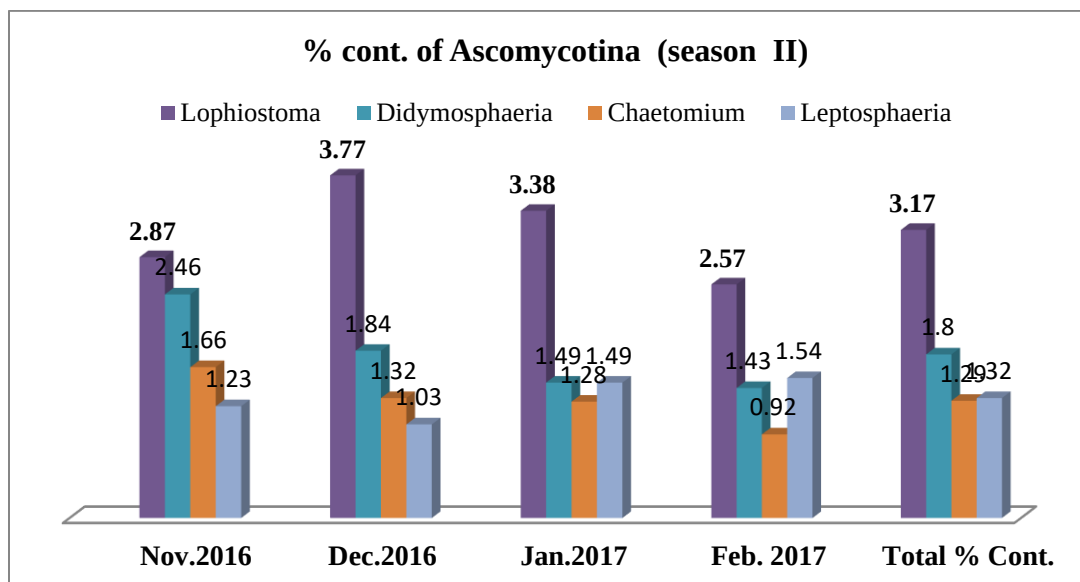


Fig-II: D

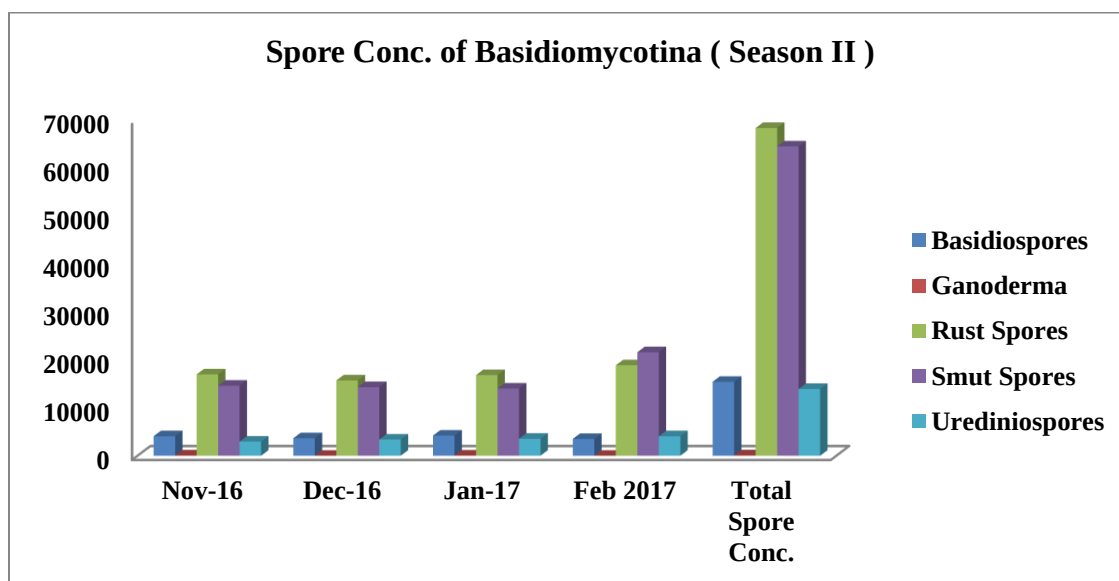
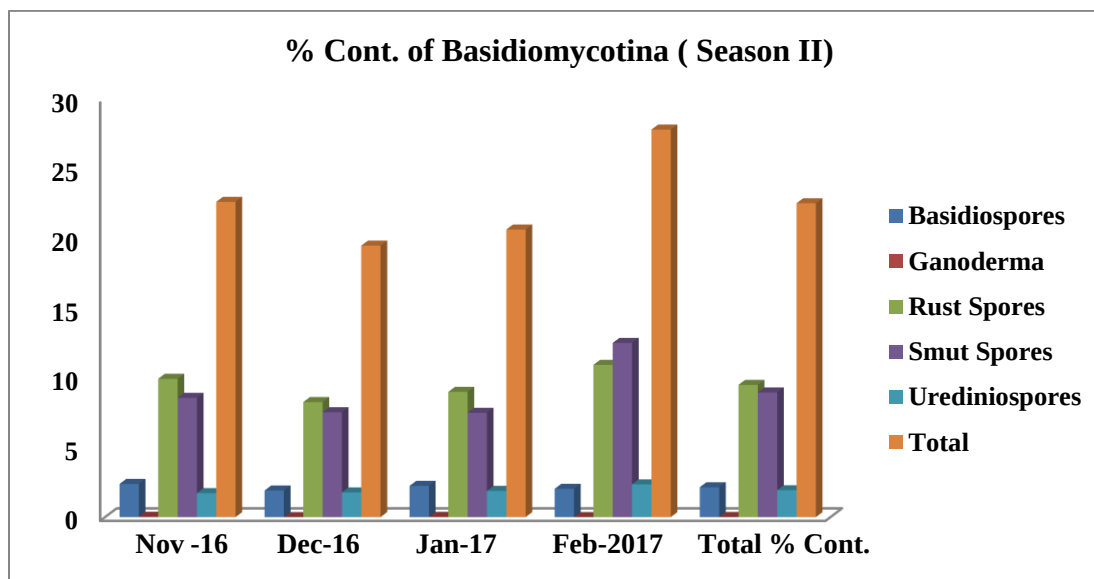


Fig-II: E

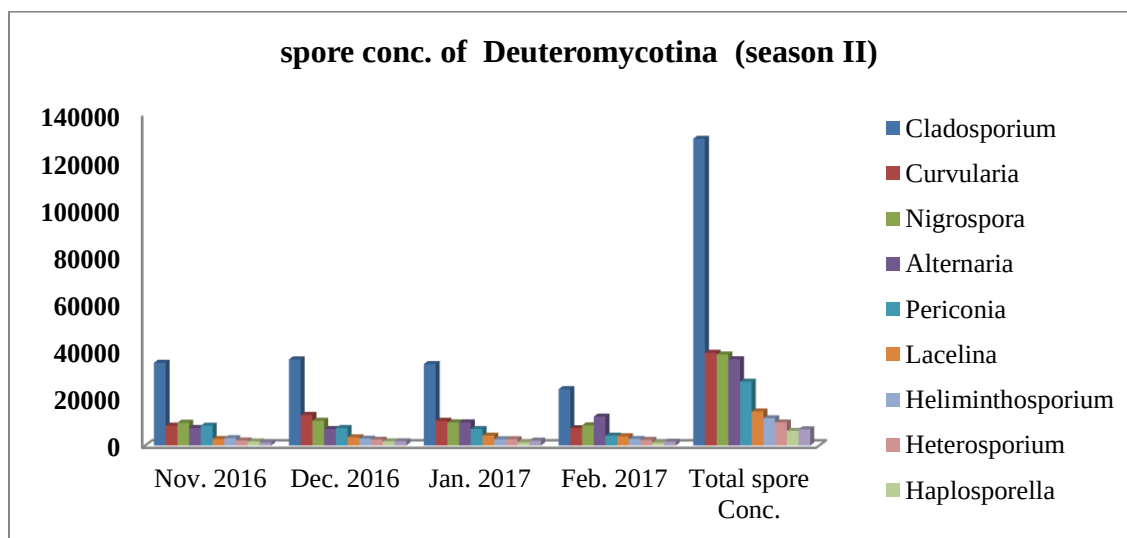
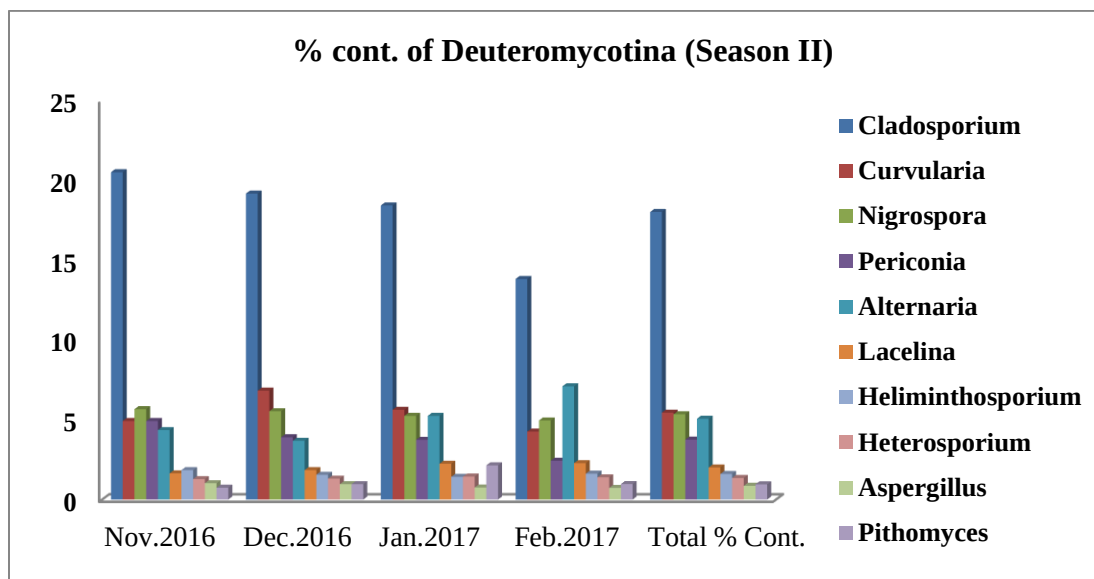


Fig-II: F

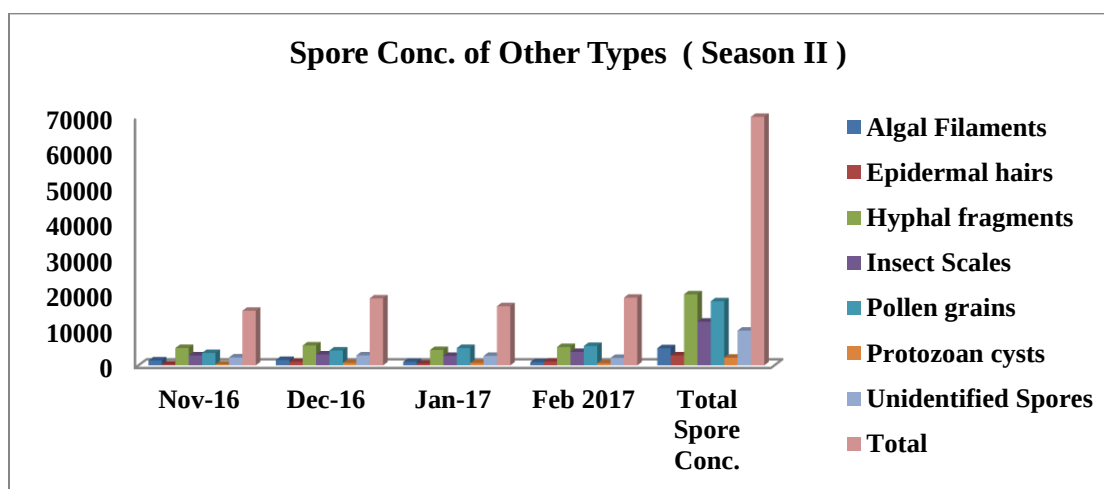
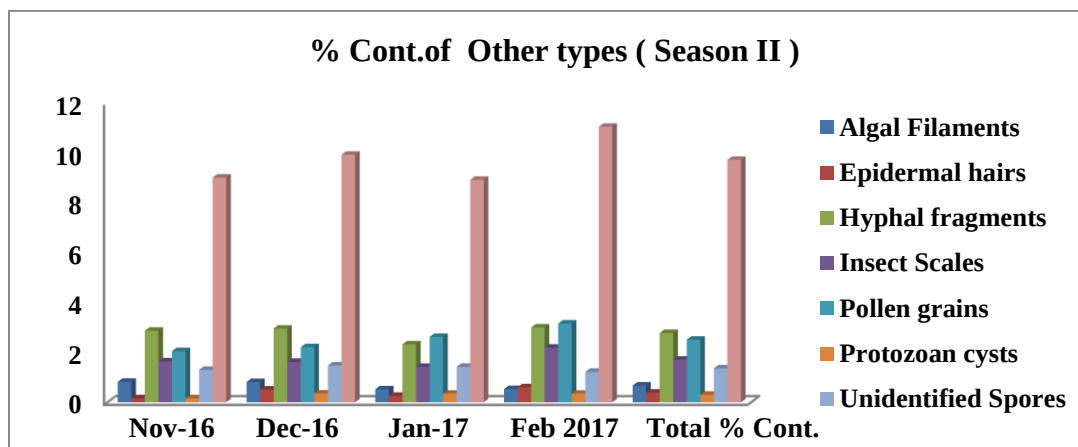


Fig-III: Histograms indicating monthwise average percentage contribution of each spore group to the total airspora from First Rabi Season (1st Nov, 2015 to 28thFeb, 2016).

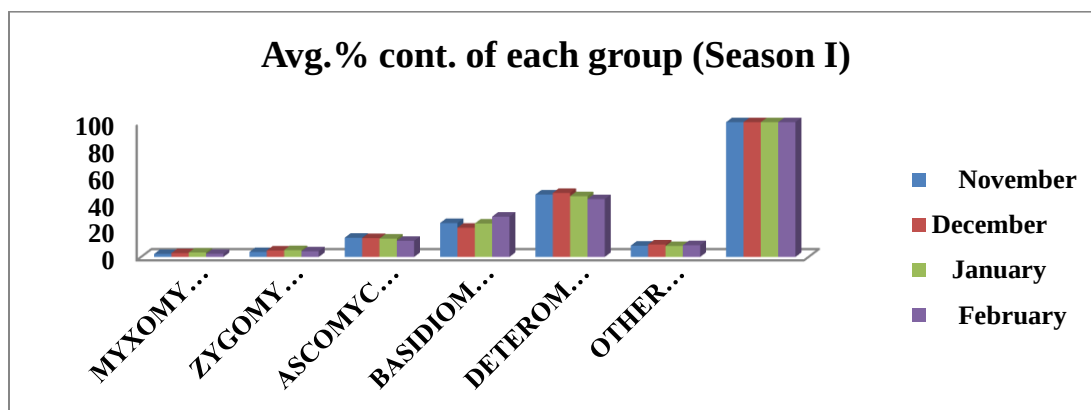


Fig-IV: Histograms indicating monthwise average percentage contribution of each spore group to the total airspora from Second Rabi Season (1st Nov, 2016 to 28th Feb, 2017).

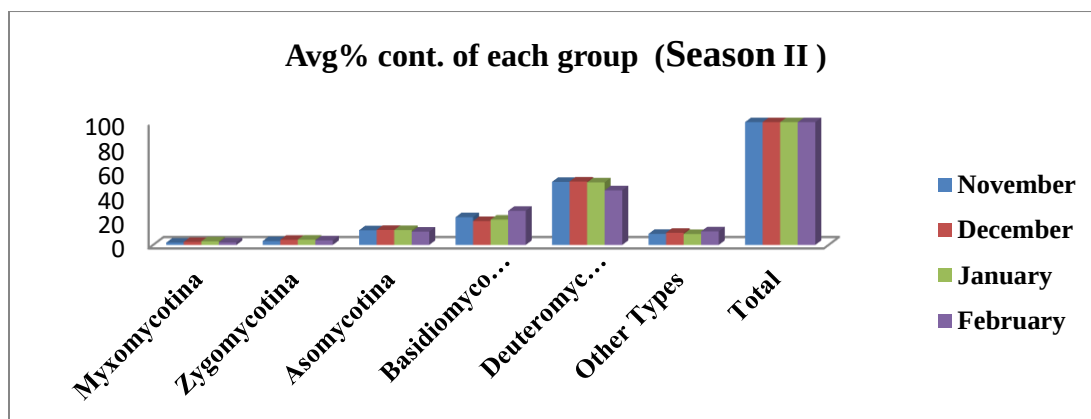


Fig-V: Histograms indicating monthly average percentage contribution of each spore group to the airspora from First Rabi Season (1st Nov, 2015 to 28th Feb, 2016).

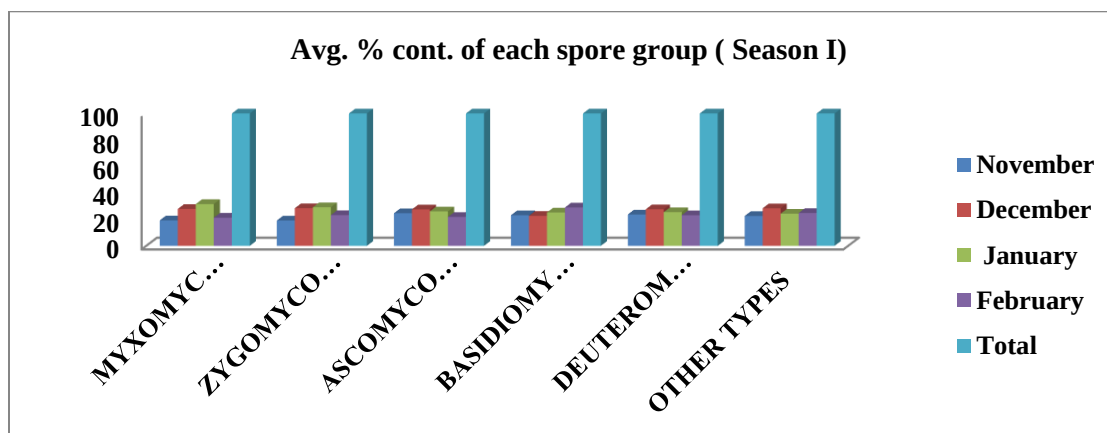


Fig-VI: Histograms indicating monthly average percentage contribution of each spore group to the airspora from Second Rabi Season (1st Nov.2016 to 28th Feb. 2017).

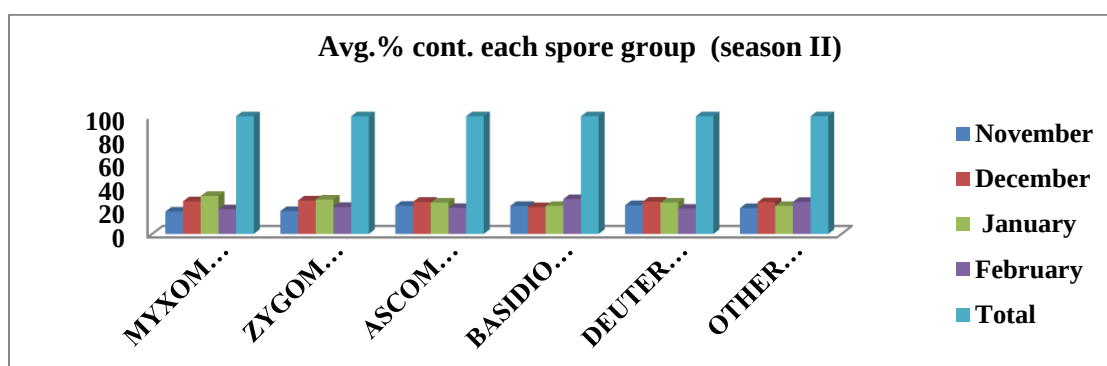


Fig-VII: Histograms indicating total percentage contribution of each spore group during Ist and IInd Season. (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 28th Feb, 2017).

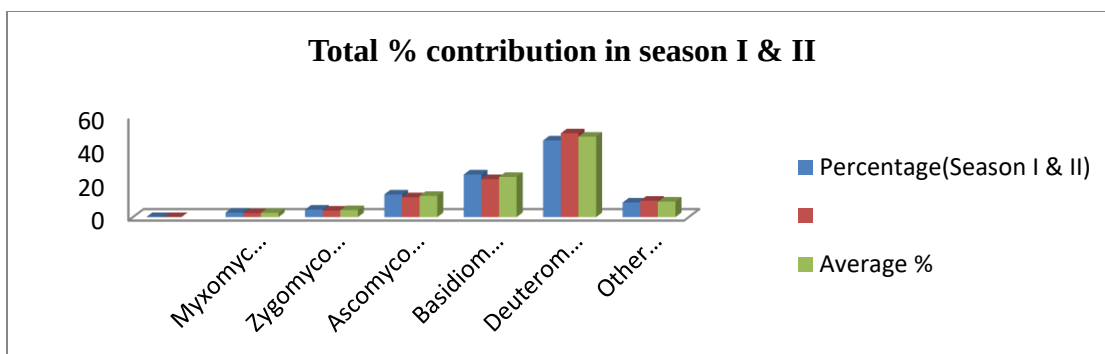


Fig-VIII: Histograms indicating total spore concentration of each spore group during 1st and IInd Season. (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 28th Feb, 2017).

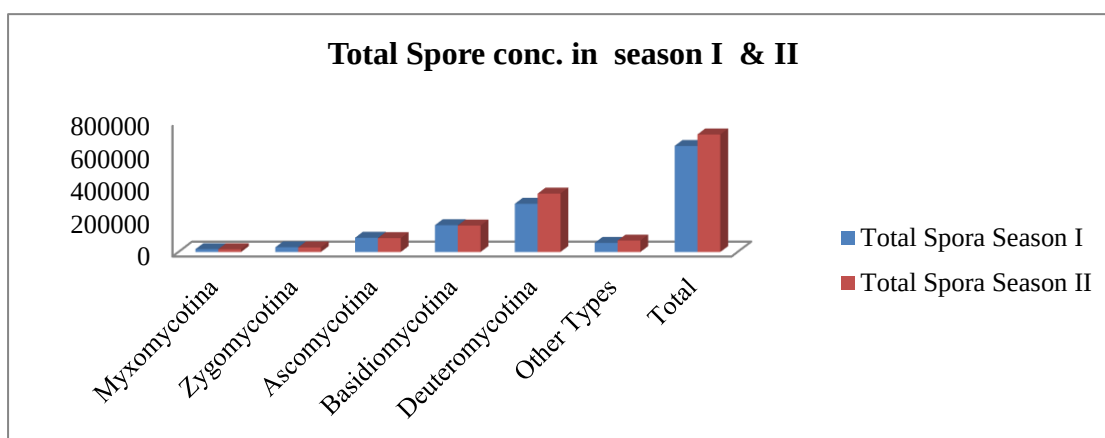


Fig-IX: Histograms showing concentration of certain pathogenic spore types during 1st and IInd Season (Season I: 1st Nov, 2015 to 28th Feb, 2016 and Season II: 1st Nov, 2016 to 31st Oct, 2017).

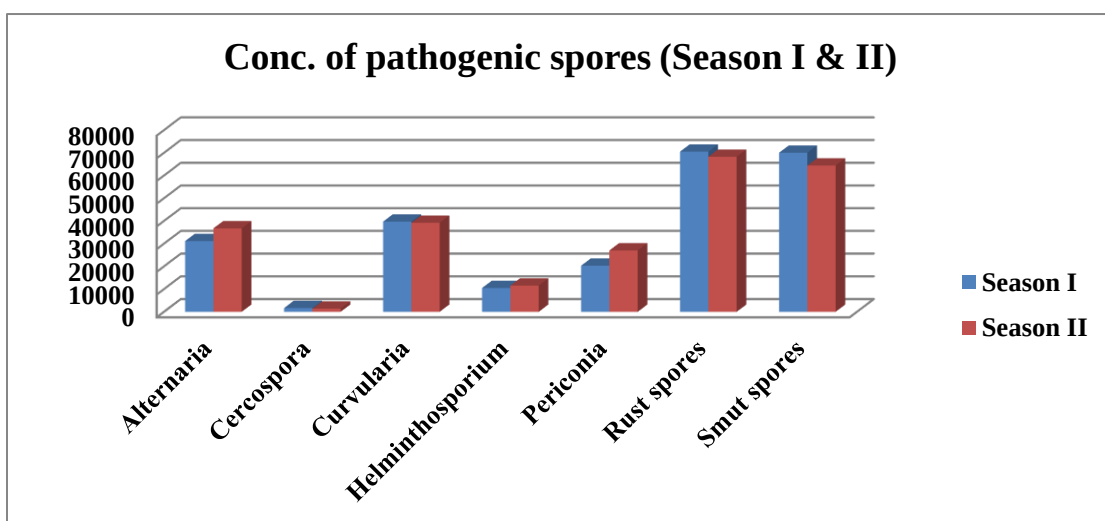


Fig-X: Histograms indicating monthwise total fungal colony counts of each fungal group of the air of Jowar crop field by petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

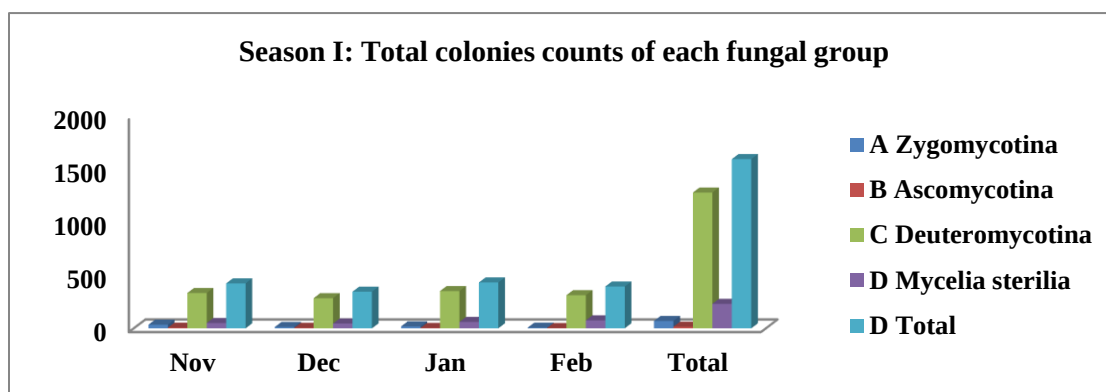


Fig-XI: Histograms indicating monthwise total average percentage contribution of each fungal group of the air of Jowar crop field by Petriplate exposure from (Season I: Nov, 2015 to Feb, 2016).

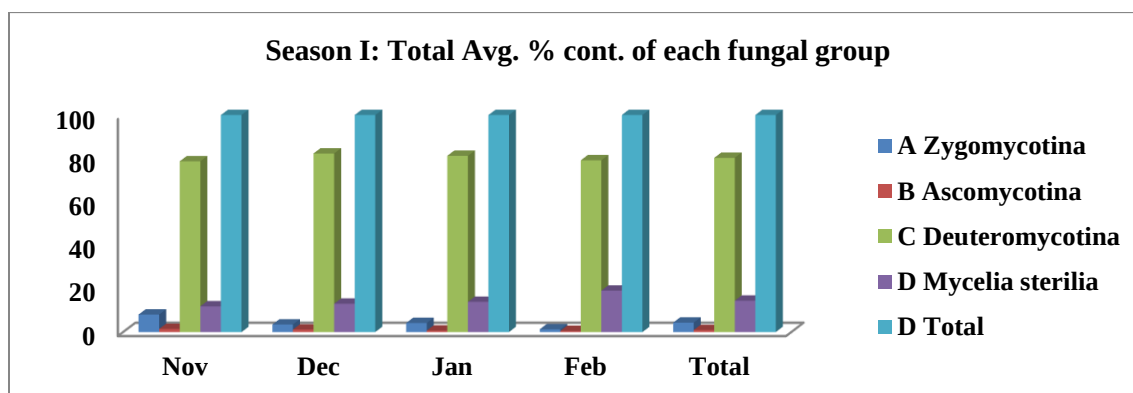


Fig-XII: Histograms indicating monthwise total fungal colony counts of each fungal groups of the air of Jowar crop field by petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

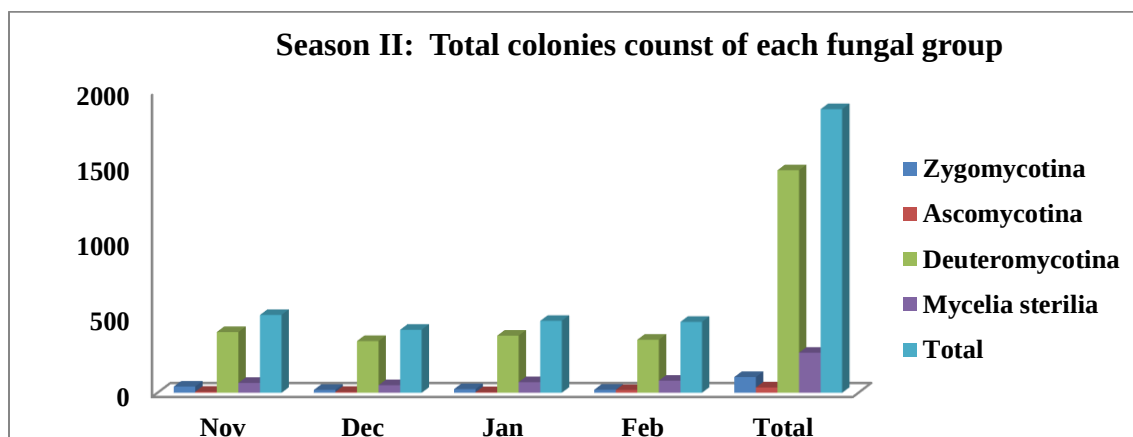


Fig-XIII: Histograms indicating monthwise total average percentage contribution of each fungal group, of the air of Jowar crop field by petriplate exposure from (Season II: Nov, 2016 to Feb, 2017).

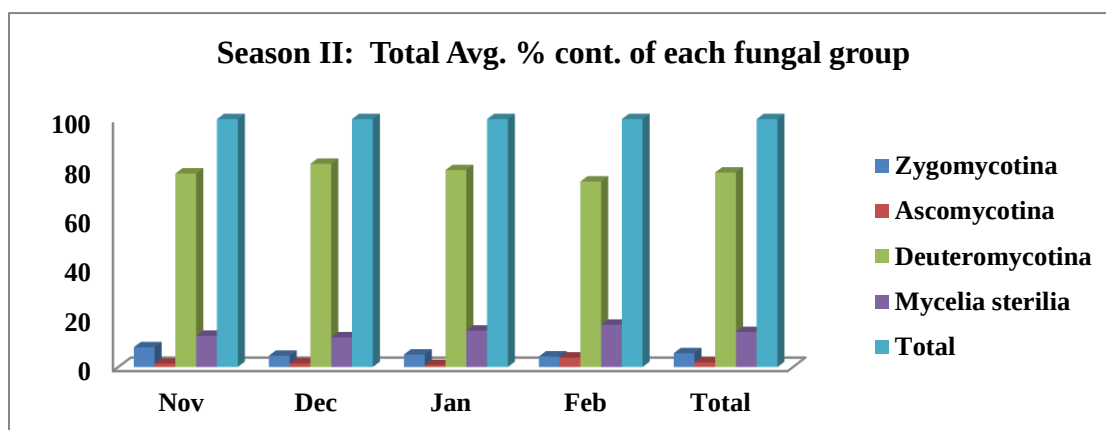


Fig-XV: Histograms showing Seasonwise total percentage contribution of each spore group, of the air of jowar crop fields from (Season I: Nov, 2015 to Feb, 2016 and Season II: Nov, 2016 to Feb, 2017).

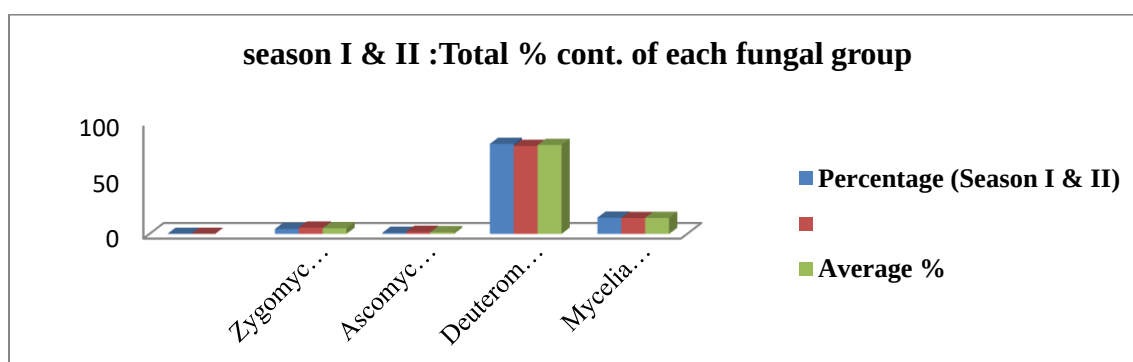


Fig-XVI: Histograms showing Seasonwise total number of fungal colony counts of each spore group in Ist and IInd seasons from (Season I: Nov, 2015 to Feb, 2016 and Season II: Nov, 2016 to Feb, 2017).

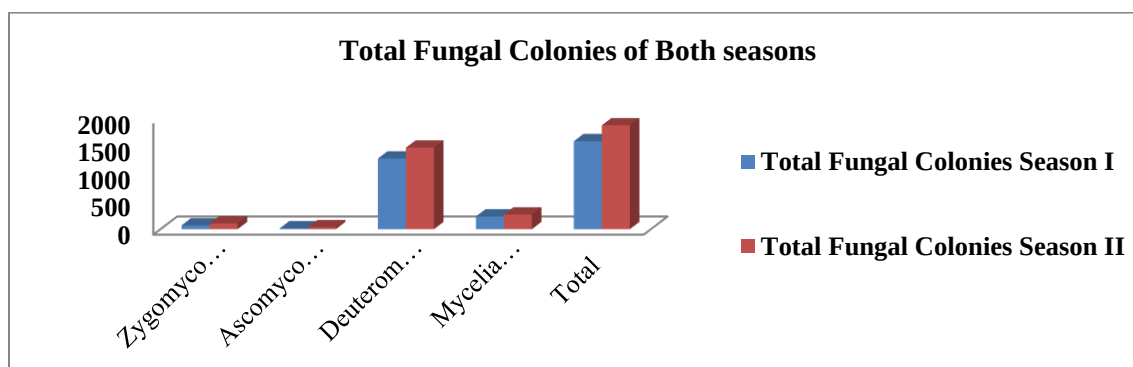


PLATE - 20

Petriplates: Fungal Colonies



PLATE - 21

Microphotographs of some isolated fungi



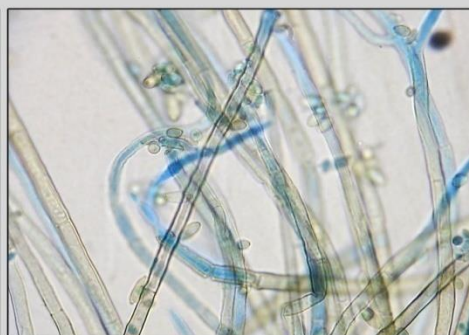
Alternaria alternata



Aspergillus flavus



Aspergillus niger



Cladosporium sp.



Fusarium oxysporum

PLATE - 22

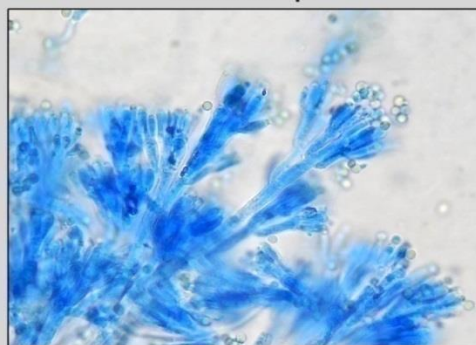
Microphotographs of some isolated fungi



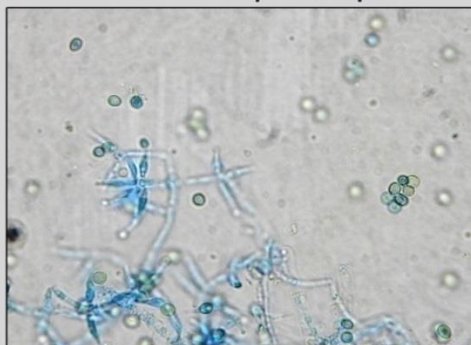
Fusarium sp.



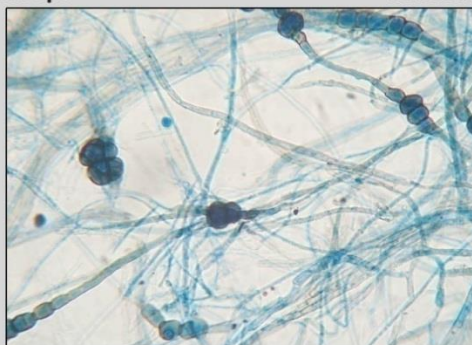
Helminthosporium sp.



Penicillium sp.



Trichoderma sp.



Torula sp.

Chapter: V

DISCUSSIONS

Soybean Crop:

The present investigation in relation to Aeromycological studies over soybean fields was carried out for two kharif seasons (Season I: 1st July, 2015 to 31st Oct, 2015 and Season II: 1st July, 2016 to 31st Oct, 2016) using continuous volumetric Tilak air sampler, in order to study the correlation between airborne microbial components, weather parameters, all the airborne fungi have been included under “spore type”. In addition, Algal filaments, epidermal hairs, hyphal fragments, pollen grains, insect scales, protozoan cysts and unidentified spores are included under the “other types” group. In the present investigation, 74 types of airborne components were reported of which 38 belonged to Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 to other types. The highest percentage was of Deuteromycotina (63.49%) followed by Basidiomycotina (12.07%), Ascomycotina (10.50%), other types (8.54%), Zygomycotina (3.24%) and Myxomycotina (2.15%). During two Kharif seasons of 2015 & 2016 Deuteromycotina contributed with highest percentage (61.49% and 65.22%), Basidiomycotina (12.66% and 11.56%), Ascomycotina (10.78% and 10.26%), other types (9.24% and 7.95%), Zygomycotina (3.52% and 2.99%) and Myxomycotina (2.31% and 2.01%) respectively. Thus, it was evident that the group Deuteromycotina dominated the total airspora. The airborne components like *Cladosporium*, *Curvularia*, *Smut* spores, *Alternaria*, *Periconia*, *Memnoniella*, *Nigrospora*, *Aspergillus*, *Lophiostoma*, *cunnighamella*, insects scales, Hyphal fragments etc. contributed significantly to the total airspora in two Kharif seasons. From Myxomycotina, two spore types i.e *Physarum* and *Stemonitis* recorded. The *Physarum* contributed (1.45%) to the total airspora (Table-I). The spores of *Physarum* encountered in all months during two Kharif seasons. They contributed (1.57% & 1.36%) during two Kharif seasons respectively (Table-II). The maximum concentration (3892/m³ and 3752/m³) was recorded in the month of September, 2015 & 2016 during two kharif seasons respectively. The seasonwise maximum concentration (11942/m³) was

recorded in the second kharif season. Similar results were recorded by Suryawanshi (2002). The *Stemonitis* contributed (0.69%) to the total airspora. Percentage contribution of *Stemonitis* to the total airspora found to be (0.75% and 0.65%) during first and second Kharif seasons respectively (Table-II). The maximum concentration ($2492/\text{m}^3$ and $2464/\text{m}^3$) was recorded in the month of September, 2015 and September, 2016 during first and second Kharif seasons respectively. The seasonwise maximum concentration ($5754/\text{m}^3$) was recorded in the second Kharif season. The concentration of Myxomycotina with respect to number of types and percentage contribution is very low in the airspora. This may be due to aquatic, semi aquatic or soil borne nature of these fungi having no special spore discharge mechanism. From Zygomycotina, four spore types i.e. *Cunninghamella*, *Mucor*, *Rhizopus* and *Sclerospora* were recorded and contributed (2.63%) (Table-I). The *Cunninghamella* contributed (2.86% and 2.43%) (Table-II). The maximum concentration ($6636/\text{m}^3$ and $6692/\text{m}^3$) was recorded in the month of September, 2015 and 2016 during two Kharif seasons respectively. The seasonwise maximum concentration ($21644/\text{m}^3$) was recorded in the first Kharif season. *Cunninghamella* group was dominant. It is indicated that the influence of weather parameter on concentration of *Cunninghamella* spore types was more as compared to second kharif season. It is clearly evident from the present observation that concentration of *Cunninghamella* was closely associated with high rainfall, low temperature and high humidity. These findings confirmed with finding of Gregory (1961) and Singh *et al.*, (1980). Similar observations were also made by Tilak and Rao (1987) and Suryawanshi (2002). *Mucor* was recorded in first and second Kharif seasons so it is confirmed that *Mucor* was rainy spores. It is found only in low temperature, high humidity and more rainfall. It is very low percentage contribution (0.03%) to the total airspora (Table-I) and contributed (0.05% and 0.02%) during first and second kharif seasons respectively (Table-II). The maximum concentration ($126/\text{m}^3$ and $84/\text{m}^3$) was recorded in the month of October, 2015 & 2016 during first and second Kharif seasons respectively. The seasonwise maximum concentration ($378/\text{m}^3$) was recorded in the first Kharif season which is having low temperature, high humidity and more rainfall was recorded during this season.

Rhizopus is a very common saprophyte and facultative parasite in the Marathwada region (Tilak and kulkarni, 1975). Its contribution to the total airspora was (0.19%) (Table-I). *Rhizopus* contributed (0.22% and 0.17%) during first and second kharif seasons respectively (Table-II). Among the Zygomycotina, *Rhizopus* spores were encountered in maximum number. Hyde and Williams (1949) and Kamal and Verma (1977) recorded high amounts in the airspora. The maximum concentration ($700/\text{m}^3$ and $672/\text{m}^3$) was observed in the month of September, 2015 and 2016 during first and second Kharif seasons respectively. The seasonwise maximum concentration ($1652/\text{m}^3$) was recorded in the first Kharif season. The source of *Rhizopus* spores was dead and decaying plant parts on the ground. Slight mechanical disturbance during weeding and other intercultural operations increased spore concentration in the airspora (Dransfield, 1966; Sreeramulu, 1967). Patil (1985) reported it as a dominant among Zygomycotina. The *Sclerospora* contributed (0.38%) to the total airspora (Table-I). They contributed (0.40% and 0.37%) during first and second Kharif seasons respectively (Table-II). The maximum concentration ($1680/\text{m}^3$ and $980/\text{m}^3$) was recorded in the month of August, 2015 and 2016 during first and second kharif seasons respectively. The Seasonwise maximum concentration ($3262/\text{m}^3$) was recorded in the second kharif season. Which is having low temperature, high humidity and more rainfall was recorded during this season. Similar observation were made by Tilak and Babu (1982), Tilak and Rao (1987), Jayswal (1993) and Suryawanshi (2002). It is concluded that, concentration of spores of Zygomycotina with respect to number of types and percentage contribution is very low, in the airspora. This may be due to aquatic, semi aquatic or soil borne nature of the fungus and no special discharge mechanism for their spore dispersal as well as size of the spores. Culture plate methods proved to be more efficient for detection and estimation of Zygomycotina and other saprophytic spore types in the airspora.

The Ascomycotina spore types ranked third in the order of dominance. In all 18 types were identified up to generic level and their percentage of occurrence ranged from 0.02% (*Massaria*) to 2.93% (*Lophiostoma*). Total contribution of the group Ascomycotina to the total airspora was (10.50%). The concentration of group Ascomycotina ($81802/\text{m}^3$ and $90272/\text{m}^3$) was recorded during first and second Kharif seasons respectively. The presence of many ascospores types reveals the abundance of parasitic and saprophytic

members of Ascomycotina forms on and around the fields. *Parodiella* is a common parasite of leguminous weeds of this region. *Sordaria* and *Sporormia* are common coprophilous fungi of this region. In both seasons maximum concentration was observed in the months of August and September. Results are similar made by Patil (1985), Jogdand (1987) and Suryawanshi (2014). The effect of rainfall on ascospores discharge was either immediate or delayed. Daily catches showed that the spores like *Didymosphaeria*, *Leptosphaeria* and *Lophiostoma* showed immediate spore release after rainfall, whereas the spore types like *Chaetomium*, *Melanospora*, *Teichospora* and *Parodiella* released the spores often long after the rains. Among Ascomycotina *Lophiostoma* was a dominant spore type and contributed (2.93%) to the total airspora (Table-I). They contributed (3.12% and 2.77%) during two kharif seasons respectively (Table-II). The maximum concentration ($9212/\text{m}^3$ and $9352/\text{m}^3$) was recorded in the month of August, 2015 and 2016 during two kharif seasons respectively. The Seasonwise maximum concentration ($24374/\text{m}^3$) was recorded in the second kharif season respectively. The *Leptosphaeria* contributed (1.36%) to the total airspora (Table-I). They contributed (1.36% and 1.35%) during first and second kharif seasons respectively (Table- II).

The maximum concentration ($3500/\text{m}^3$ and $4060/\text{m}^3$) was recorded in the month of August, 2015 and 2016 during two Kharif seasons respectively. The seasonwise maximum concentration ($11900/\text{m}^3$) recorded in the second Kharif season. The *Didymosphaeria* contributed (1.23%) to the total airspora (Table-I). They contributed (1.27% and 1.19%) during first and second Kharif seasons respectively (Table-II). The maximum concentration ($2744/\text{m}^3$ and $2940/\text{m}^3$) was recorded in the month of August, 2015 and 2016 during two Kharif seasons respectively. The seasonwise maximum concentration ($10500/\text{m}^3$) was recorded during second Kharif season. It is clear indicated that the release of spores rainfall which subsequently result in increasing higher concentration, while high humidity a moderate to low temperature are supplementary to the release of spores. The *Claviceps* contributed (1.06%) to the total airspora (Table-I). They contributed (0.98% and 1.13%) during first and second kharif seasons respectively (Table-II). The maximum concentration ($2814/\text{m}^3$ and $3360/\text{m}^3$) was recorded in the month of August, 2015 and September, 2016 during two kharif seasons

respectively. The seasonwise maximum concentration ($9982/\text{m}^3$) was recorded in the second kharif season. The *Chaetomium* contributed (0.91%) to the total airspora (Table-I). They contributed (0.97% and 0.86%) during first and second kharif seasons respectively. *Chaetomium* were found to be release long after the rains. The maximum concentration ($3248/\text{m}^3$ and $3290/\text{m}^3$) was recorded in the month of September, 2015 and September, 2016 during two seasons respectively. The seasonwise maximum concentration ($7630/\text{m}^3$) was recorded in the second kharif season. However the *Lophiostoma*, *Leptosphaeria*, *Didymosphaeria*, *Claviceps* and *Chaetomium* were recorded even during dry period and less humid condition. The present investigation clearly indicated that there is direct impact of rainfall, relative humidity and temperature to some extent over the release of ascospores in the atmosphere. According to wilcoron *et al.*, (1967) the temperature may affect the release of ascospores. Similar observations were made by Ingold (1965), Ramakrishna Reddy (1987), Malabade (1990), Kavishwar (1991) and Jayswal (1993) Suryawanshi (2002). *Hypoxylon*, *Sporormia*, *Sordaria* occurred with very insignificant concentration most probably due to non availability of required substratum for their growth and sporulation in around the fields. The spores of Basidiomycotina contributed (12.07%) to the total airspora (Table I). They contributed (12.66% and 11.56%) during first and second kharif seasons respectively (Table II). The analysis of the spore catches clearly indicated that spores of Basidiomycotina dominated the airspora i.e. second in number. The spores of Basidiomycotina i.e ; *Basidiospores*, *Ganoderma*, *Rust spores*, *smut spores*, and *Urediniospores* were recorded in high concentration for two kharif seasons. These spores were recorded regularly during the period of investigations. The seasonwise spore concentration of group Basidiomycotina was ($96012/\text{m}^3$ and $101794/\text{m}^3$) for during the first and second kharif seasons. The *Smut spores* contributed (8.33%) to the total airspora (TableI). They contributed (8.51% and 8.18%) during first and second Kharif seasons respectively (Table-II). The maximum concentration ($18928/\text{m}^3$ and $21672/\text{m}^3$) was recorded in the month of September, 2015 and 2016 during the first and second Kharif seasons respectively. The seasonwise concentration ($71974/\text{m}^3$) was recorded in the second Kharif season.

It is indicated that the *Smut spores* were third dominated spore types to the total airspora during the two Kharif seasons because of no of source material was found

around the crop fields. These spore encountered throughout the period of investigation. From the above recorded observation it is evident that the maximum concentration and *Smut spores* as compared to other spore types because very difficult to trace out the exact source of *Smut spores* in and around the crop fields. However there was a standing of hybrid, Tur near by the crop fields, varieties of grasses growing on wild land of near crop fields were found to infect by Smut diseases which probably might have served as a source.

Rees (1964) observed the *Smut spores* in dry period. Similar observations were made by Jogdand (1987) who stated that *smut spores* could be recorded in the month of October and November during first Kharif seasons and October during second Kharif seasons, when temperature was less at about 22⁰ C relative humidity was high around 75% and it was preceded by rain fall in both the kharif seasons. The *Basidiospores* contributed (1.75%) to the total airspora (Table-I). They contributed (2.17% and 1.37%) during first and second kharif seasons respectively (Table - II). The maximum concentration (6552/m³ and 6384/m³) was recorded in the month of August, 2015 and August, 2016 during first and second Kharif seasons respectively. The seasonwise maximum concentration was (16492/m³) was recorded in the first kharif season. The highest spore concentration catch (468/m³) was observed on August, 2015 when mean temp. 28⁰C mean, relative humidity 94.5% and rainfall was 102 mm recorded during first Kharif season. The highest spore catch (456/m³) was observed on August, 2016 when mean temperature 26.5⁰ c mean, relative humidity 88.5% and rainfall was 92 mm recorded during second Kharif season.

The present study revealed the correlation between the high concentration of *Basidiospores* in the atmosphere with the rainfall, high relative humidity and low temperature. Similar observation were made by Adams (1964), who reported that the *Basidiospores* concentration was highest when the weather as wet, moderately warm and relative humidity high. In general the presence or absence of *Basidiospores* in all air was directly correlated with the occurrence of rain fall. Similar observation by Patil (1985) and Jogdand (1987) source was Agaricales and Polyporales growing around the fields. The contribution was prominently more during rainy season and *Basidiospores* belonged

to “wet spora” group. High relative humidity (70-85) and lower temperature (18-22⁰ C) was favourable for their release in the air. Shastri (1981), Babu (1983), Patil (1983), Patil (1985) were some of the earlier reporters of Basidiospores in the air. During the course of investigation showed incidence of the soybean rust caused by *Phakospora Pachyrhizi*. Day to day variation in the concentration of *Urediniospores/Rust* spores of air in relation to meteorological condition during two kharif seasons revealed profound influence of meteorological parameters over the disease incidence. The rust pathogen (*Phakospora Pachyrhizi*) has been reported to cause severe losses in the quality and quantity of the yield. According to Gurudatta M. Hegde (2002) the rust disease was the most destructive and economically important of the soybean disease observed in northern Karnataka. However, aerobiological investigations have been carried out so far to trace the source of the pathogen, its transport in the atmosphere. The soybean rust caused by *Phakospora Pachyrhizi* was observed during August and September during rainy seasons. The *Urediniospores* contributed (1.71%) to the total airspora (Table-I). They contributed (1.82% and 1.62%) during first and second kharif seasons respectively (Table-II). The maximum concentration (4452/m³ and 4424/m³) was recorded in the month of September, 2015 and September, 2016 during first and second kharif seasons respectively. The Seasonwise concentration (13832/m³ and 14266/m³) was noted during first and second kharif seasons respectively. The highest spore catch was observed during second kharif season when average temperature low, moderate relative humidity and high rainfall was recorded during same season. The group Deuteromycotina was well dominated by as many as 38 spore types during the period of investigation. The grand total of Deuteromycotina spores (466368/m³ and 574000/m³). They contributed (63.49%) to the total airspora (Table-I) with (61.49% & 65.22%) during first and second kharif seasons respectively (Table-II). Among the group Deuteromycotina *Cladosporium* (16.82%), *Curvularia* (11.50%), *Alternaria* (5.82%), *Periconia* (5.16%), *Memnoniella* (4.15%), *Nigrospora* (4.02%) and *Aspergillus* (2.98%) etc. were the most dominant spore types to the total airspora for two kharif seasons. The average percentage contribution ranged from 0.01% (*Drechslera*, *Exosporium*, and *Pestalotia*) to 16.82% (*Cladosporium*). The most regularly occurring spore types which contributed in a considerable number were *Cladosporium*, *Curvularia*, *Alternaria*, *Periconia*,

Memnoniella, *Nigrospora*, *Aspergillus*, *Pseudotorula*, *Lacellina*, *Bispora*, *Tetraploa* and *Heliminthosporium* etc. From amongst all *Cladosporium* (14.10% and 19.16%), *Curvularia* (11.78% and 11.26%), *Alternaria* (5.60% and 6.01%), *Periconia* (5.24% and 5.09%), *Memnoniella* (4.82% and 3.58%), *Nigrospora* (3.86% and 4.17%), *Aspergillus* (2.73% and 3.18%), *Pseudotorula* (1.76% and 1.33%), *Lacellina* (1.44% and 1.39%), *Bispora* (1.34% and 1.22%), *Tetraploa* (1.26% and 1.33%) and *Heliminthosporium* (1.06% and 1.02%) etc. were recorded as the most dominant spore types. All of these spore types, therefore have been called as “airspora dominant” the maximum concentration of *Cladosporium*, *Curvularia*, *Alternaria*, *Periconia*, *Memnoniella*, *Nigrospora*, *Aspergillus*, *Pseudotorula*, *Lacellina*, *Bispora*, *Tetraploa* and *Heliminthosporium* etc. in the air was simply because of their Saprobiic habit, their high degree of vegetative reproduction by fragmentation, budding etc., asexual reproduction by developing conidia directly of fruiting with passive spore liberation. The gentle wind currents, natural or mechanical disturbance have been found directly or indirectly involved in liberating enormous amount of spore load in the air. Gregory (1961) also stated that the mist-pick up mechanism was rather more effective in the dispersal of *Cladosporium* spores. The obtained results are in agreement with the statement of Gregory (1961). The high frequency of occurrence of predominance during wet and dry period of observed by Cammack (1955) he also stated that various in the number of spores found dependent largely on availability of host as well as climatic factors, Reddy (1976) recorded *Cladosporium* as the dominant spore type and observed in maximum number in all months with its seasonal maxima occurring in the period between November and January. Calvo (1981) at Brisbane recorded regular recurrence of the spores of *Cladosporium* in the months of March, April and May.

Thus it may be concluded that the maximum concentration of *Cladosporium* spores could be correlated with the flowering and seed forming stages in both seasons the rain preceding days, irrigation in the season and leaf shedding might have served as pre-requisites for the copious growth and dispersal of spores in the atmosphere. Most of the spore types of Deuteromycotina have been categorized under “Dry spora” group and high incidence was observed either late after the precipitation or irrigation. The *Curvularia* spore encountered throughout the period of investigations. It is dominated spore type in

group Deuteromycotina. It is contributed (11.50%) to the total airspora (Table-I). They contributed (11.78% and 11.26%) during first and second kharif seasons respectively (Table-II). The maximum concentration ($31472/\text{m}^3$ and $34230/\text{m}^3$) was recorded in the month of August, 2015 and August, 2016 during first and second kharif seasons respectively. The Seasonwise concentration ($89334/\text{m}^3$ and $99148/\text{m}^3$) was recorded first and second kharif seasons. The highest spore catch ($2248/\text{m}^3$ and $2445/\text{m}^3$) was observed on 14th August, 2015 and 16th August, 2016 when mean temperature 25.5°C and 25°C , relative humidity 78% and 87% and rainfall 91 mm was recorded during kharif seasons.

The *Alternaria* contributed (5.82%) to the total airspora (Table-I). They contributed (5.60% and 6.01%) during first and second kharif seasons respectively (Table-II). The highest spore concentration ($13944/\text{m}^3$ and $16408/\text{m}^3$) was observed in the month of August, 2015 and August, 2016 during first and second kharif seasons respectively. The Seasonwise concentration ($42518/\text{m}^3$ and $52934/\text{m}^3$) was recorded first and second kharif seasons. The highest spore catches ($996/\text{m}^3$ and $1172/\text{m}^3$) recorded on 12th August, 2015 and 17th August, 2016 when mean temperature 24°C and 22.5°C , relative humidity 67 % and 81% and rainfall 77 mm was recorded during kharif season respectively. These whether parameters might have helped in the spore formation, liberation causing subsequent increase in the air conidial load in the air over soybean crop fields. The concentration spores were more during day time than night. Thus it was included under “day spora” group. Calvo et al (1979) reported the occurrence of *Alternaria* spores in atmosphere greatly affected by climatic condition. The spore *Periconia* encountered throughout the period of investigation. It is dominated spore type in group Deuteromycotina. It is reported (5.16%) contribution to the total airspora (Table-I). They contributed (5.24% and 5.09%) during first and second Kharif seasons respectively (Table-II). The highest spore concentration was ($11410/\text{m}^3$ and $14014/\text{m}^3$) observed in the month of August, 2015 and August, 2016 respectively. The seasonwise concentration ($39760/\text{m}^3$ and $44800/\text{m}^3$) was recorded first and second kharif seasons. The highest spore catch ($812/\text{m}^3$) was recorded on 8th August, 2015 in first Kharif season and ($1001/\text{m}^3$) of air was recorded on 11th August, 2016 in second Kharif season.

The spore type of *Nigrospora* contributed (4.02%) to the total airspora (Table-I). They contributed (3.86% and 4.17%) during first and second Kharif seasons respectively (Table-II). The highest concentration ($11816/\text{m}^3$ and $11900/\text{m}^3$) was recorded in the month of August, 2015 and August, 2016 during first and second kharif seasons. The Seasonwise concentration ($29316/\text{m}^3$ and $36610/\text{m}^3$) was recorded first and second Kharif seasons. The spores of *Nigrospora* occurred abundantly in all the months of both Kharif seasons. The spore of *Memnoniella* contributed (4.15%) to the total airspora (Table-I). They contributed (4.82% and 3.58%) during first and second seasons respectively (Table-II). The highest spore concentration ($11214/\text{m}^3$ and $11396/\text{m}^3$) was recorded in the month of August, 2015 and August, 2016 during first and second Kharif seasons respectively. The seasonwise concentration ($36554/\text{m}^3$ and $31486/\text{m}^3$) was recorded first and second Kharif seasons. The spore of *Aspergillus* contributed (2.98%) to the total airspora (Table-I). They contributed (2.73% and 3.18%) during first and second Kharif seasons respectively (Table-II). The highest spore concentration ($8652/\text{m}^3$ and $12222/\text{m}^3$) was recorded in the month of September, 2015 and September, 2016 during first and second Kharif seasons respectively. The Seasonwise concentration ($20692/\text{m}^3$ and $28042/\text{m}^3$) was recorded first and second kharif seasons. The spore of *Helminthosporium* contributed (1.04%) to the total airspora (Table-I). They contributed (1.06 % and 1.02%) during first and second kharif seasons respectively (Table-II). The maximum concentration ($2198/\text{m}^3$ and $2800/\text{m}^3$) was recorded in the month of September, 2015 and August, 2016 during first and second Kharif seasons respectively. The seasonwise concentration ($8078/\text{m}^3$ and $8960/\text{m}^3$) was recorded first and second Kharif seasons. When at temperature of 21.25 C and 18.05 C, relative humidity 43% and 48% during both the kharif seasons respectively. The spores of *Helminthosporium* occurred abundantly throughout the period of present investigation. Similar observation were also made by Jayswal (1993), Shukla (1971) isolated these spores in less concentration from the culture exposed in the forest. Kamal and Singh (1995) at Gorakhpur caught two species of *Helminthosporium* over maize fields. In general, the other spore types belonging to group Deuteromycotina like *Cladosporium*, *Curvularia*, *Alternaria*, *Nigrospora*, *Periconia*, *Tetraploa*, *Pseudotorula*, *Lacellina*, *Bispora*, showed their high incidence in air in both the kharif seasons.

Some of the spore types like, *Exosporium*, and *Pestalotia*, showed their incidence irregularly throughout the period of investigation, this may be either due to non availability of the suitable host substratum or non congenial weather conditions for their development and discharge. In addition to the scientifically formed spore groups, an artificially formed group, called “Other types” contributed a bulk concentration in first season (9.23%) and second season (7.95%). The group being heterogenous in composition comprised of Algal filaments, epidermal hairs, Hyphal fragments, Insect scales, Pollen grains, Protozoan cysts and unidentified spores. Algal filaments were trapped in all seasons from the air over soybean crop fields. They contributed (0.73% and 1.35%) during first and second Kharif seasons respectively (Table-II). The seasonwise concentration was ($5572/\text{m}^3$ and $11900/\text{m}^3$) was recorded during first and second seasons. The maximum concentration was observed during second kharif seasons, when average low temperature, average high relative humidity and high rainfall were observed during the same season. The maximum concentration ($1680/\text{m}^3$ and $3290/\text{m}^3$) was recorded in the month of September, 2015 and September, 2016. When there was a recorded of average humidity 62% and 75%. Ehresmann and Melvinathatch (1975) observed that high humidity favoured the longevity of airborne algal; Subba Reddy (1977) observed its dominance during rainy seasons and at the end. Epidermal hairs were trapped in all seasons from the air over soybean crop fields. Epidermal hairs contributed (0.21% and 0.18%) during first and second kharif seasons respectively (Table-II). The maximum concentration ($560/\text{m}^3$ and $560/\text{m}^3$) was recorded in the month of July, 2015 and July, 2016 respectively. The Seasonwise concentration was ($1610/\text{m}^3$ and $1596/\text{m}^3$) was recorded during first and second kharif seasons. The maximum concentration was observed during first kharif seasons. Hyphal fragments were encountered throughout the period of investigation continuously contributed (2.02%) to the total airspora (Table-I). They contributed (1.93% and 2.11%) during first and second kharif seasons respectively (Table II). The maximum concentration ($4900/\text{m}^3$ and $5740/\text{m}^3$) was encountered in the month of September, 2015 and August, 2016. When there was a recorded of temperature 26.80°C and 25.80°C , relative humidity was 59.41% and 81.7%. They occurred as intercalary fragments, apical fragments and conidiophores with conidia. Pady and Kramer (1960), Pady and Gregory (1963) indicated that viable Hyphal fragments are not less

important than viable spores. Harvey (1976) while studying airspora of Kansas and stated that their role in survival of pathogens is equally important as spores. Tilak and Bhalke (1981) have described and classified various Hyphal fragments. Tilak (1982) reported these as important airborne materials and their inherent ability as propagates due to their viability. Abundance of Hyphal fragments during the throughout the period of investigations. It is observed abundantly during the period of harvesting on and around soybean crop fields. It is abundantly found during dry and windy days, because their wind and rain drop contact with diseased parts.

Insect scales, parts and wings were recorded throughout the period of investigations. They contributed (2.26%) to the total airspora. They contributed (2.76% and 1.84%) during first and second kharif seasons respectively (Table-II). The highest concentration ($6160/\text{m}^3$ and $5040/\text{m}^3$) was recorded during the month of August, 2015 and September, 2016. Their incidence was high during the harvesting and high wind velocity. Tilak and Bhalke (1979) presented a report in seasonal variation of insect parts from Aurangabad. Further Tilak (1982) observed that the abundance of the insects parts is closely related with meteorological conditions, while high wind velocity also helps in discharging the insect scales in air forming a common component at airspora, Patil (1985) pointed out their peak at high around 04.00 hours and stated that powerful wind had a direct effect in the high incidence in the airspora. During the period of investigations enormous amount of Pollen grains were recorded it is considerably high concentration in the air contributing (2.07%) to the total airspora (Table-I). They contributed (2.48% and 1.72%) during first and second Kharif seasons respectively (Table-II). The incidence of Pollen concentration and variation was related to the flowering period of entire vegetation around crop. In fact during these investigation *Pollen grains* of grasses and other members beside the soybean crop fields was encountered abundance it may be just due to the weed flora growing near the boundaries at fields. Pollen grains of Access, ipomea cassia, Amaranths, grasses etc. Hamilton (1959) and Lacey (1962) reported that locality and vegetation had an influence on the concentration and categories of pollen incidence at the air. The role of Pollen in allergy is well known and is now receiving greater attention both in India and abroad.

Pollen grains were trapped throughout the period of investigations. The maximum concentration 5600/m was recorded in September, 2015. Concentration and seasonal variations in the pollen content of air had its relation with vegetation, their flowering in the area. Protozoan cysts were observed throughout the period of investigations. They contributed (0.22%) to the total airspora (Table-I). They were encountered throughout the period of investigations. They contributed (0.33% and 0.12%) during first and second Kharif seasons respectively (Table-II). Tilak and srinivasulu (1967) reported 7.56% cyst from Aurangabad. Patil (1985) reported 0.17% cyst to the total airspora. "Unidentified" spore type contributed (0.70%) to the total airspora and encountered throughout the period of investigations. They contributed (0.81% and 0.61%) during first and second kharif seasons respectively (Table-II). It is high incidence of spore was encountered in rainy season and low incidence in dry period. According to Gregory (1961) noted the fluctuations of atmosphere spore concentration with fluctuation spore concentration with in meteorological parameters. The weather parameters were also affected to unidentified spore types. During the air sampling simultaneously petriplates exposure was carried out in the air of soybean crop fields, which have revealed the presence of total 27 different fungal types of which 19 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina. Fungal types belonging to Deuteromycotina contributed with highest percentage (69.69%) it was followed by mycelia sterilia (19.47%) Zygomycotina (5.69%) and Ascomycotina (5.15%) were recorded Deuteromycotina were highest in number. During two Kharif seasons of 2015 and 2016 Deuteromycotina contributed with highest percentage (71.69% and 68.09%) to the total colony count followed by mycelia sterilia (17.69% and 20.88%), Zygomycotina (5.42% and 5.94%) and Ascomycotina (5.20% and 5.09%) respectively so in the two seasons, it was evident that the group Deuteromycotina dominated the total airspora.

From Zygomycotina, five spore types were recorded which is *Cunnighamella*, *Mucor*, *Pythium*, *Rhizopus Cohinii* and *Rhizopus*. The *Rhizopus cohinii* contributed (2.64%) to the total airspora (Table-I). The *Rhizopus cohinii* contributed (2.49% and 2.76%) to the total air during first and second kharif seasons respectively (Table 3A and 3B). The maximum number of colonies (10 colonies and 15 colonies) of air was recorded in the month of September, 2015 and September, 2016 during first and second kharif seasons

respectively. The seasonwise maximum colonies (33 colonies) of air was recorded in the second kharif season. The *Rhizopus* contributed (1.39%) to the total airspora (Table-I). The *Rhizopus* contributed (1.26% and 1.50%) during first and second Kharif seasons respectively (Table 3A and 3B). The maximum number of colonies (5 colonies and 7 colonies) was recorded in the month of October, 2015 and October, 2016 during first and second Kharif seasons. *Rhizopus cohinii* and *Rhizopus sp.* Occurred dominant spore types in comparison to other three types. From the group Ascomycotina two spore types were recorded is *Chaetomium* and *Neurospora*. The *Neurospora* was a dominant spore type. They contributed (4.91%) to the total airspora (Table-I). The *Neurospora* contributed (4.99% and 4.84%) during first and second Kharif seasons (Table 3A and 3B). The maximum number of colonies (20 colonies and 25 colonies) of air was recorded in the month of August, 2015 and August, 2016 during first and second Kharif seasons respectively. The seasonwise maximum colonies (58 colonies) was recorded in the second Kharif season.

The group Deuteromycotina was well dominated by as many as 19 spore types during the period of investigation. The grand total of Deuteromycotina fungal colonies 689 and 815 of air with (71.69% and 68.09%) were recorded in the first and second Kharif seasons. Among the group Deuteromycotina *Aspergillus Niger* (12.46%), *Aspergillus sp.* (12.28%), *Cladosporium* (12.28%), *Curvularia* (7.27%), *Penicillium sp.* (6.58%), *Alternaria* (6.35%), *Aspergillus Flavus* (3.29%), *Fusarium sp.* (2.13%) and *Helminthosporium sp.* (2.06%) etc. were the most dominant spore types for two Kharif seasons. The average percentage contribution ranged from 0.18% (*Epicoccum* and *Torula*) to 12.46% (*Aspergillus Niger*). The most regularly occurring spore types which contributed in a considerable number were *Aspergillus Niger*, *Aspergillus sp.*, *Cladosporium sp.*, *Curvularia sp.*, *Penicillium sp.*, *Alternaria*, *Aspergillus Flavus*, *Fusarium sp.* and *Helminthosporium sp.* etc. From amongst all *Aspergillus Niger* (12.49% and 12.45%), *Aspergillus sp.* (17.18% and 8.36%) *Cladosporium sp.* (10.41% and 13.78%), *Curvularia sp.* (6.97% and 7.52%), *Penicillium sp.* (5.93% and 7.10%), *Alternaria* (6.24% and 6.44%), *Aspergillus Flavus* (3.12% and 3.43%), *Fusarium sp.* (3.75% and 1.92%) and *Helminthosporium sp.* (1.67% and 2.51%) etc. were recorded

as the most dominant spore types. All of these fungal types therefore have been called as “airspora dominant”.

The *Aspergillus Niger* encountered throughout the period of investigations. It is dominated spore type in group Deuteromycotina. They contributed (12.46%) to the total airspora (Table-I). The maximum number of colonies (35 colonies and 40) colonies of air was recorded in the month of September, 2015 and August and September, 2016 during first and second kharif seasons respectively. The seasonwise maximum number of (149 colonies) was recorded second kharif seasons. The *Aspergillus* sp. recorded throughout the period of investigations. It is dominated spore type in group Deuteromycotina. They contributed (12.28%) to the total airspora (Table- I). The maximum number of colonies (30 colonies and 35) colonies of air were recorded in the month of July, 2015 and July, 2016 during first and second kharif seasons respectively. The Seasonwise maximum number of (165 colonies) was obtained first kharif seasons. The *Cladosporium* sp. encountered throughout the period of investigation. It is dominated spore type in group Deuteromycotina. It is contributed (12.28%) to the total airspora (Table-I). The maximum number of (30 colonies and 50 colonies) of air was recorded in the month of July and September, 2015 and July, 2016 during first and second Kharif seasons respectively. The seasonwise maximum number of (165 colonies) was recorded second Kharif season.

The *Curvularia* sp. contributed (7.27%) to the total airspora (TableI). The maximum number of (30 colonies and 40 colonies) of air was recorded in the month of October, 2015 and 2016 during two kharif seasons respectively. The seasonwise maximum number of (90 colonies) was observed second kharif seasons. The *Penicillium* sp. contributed (6.58%) to the total airspora (Table-I). The maximum number of 30 colonies and 40 colonies of air was recorded in the month of October, 2015 and October, 2016 during first and second kharif seasons respectively. The Seasonwise maximum number of (85 colonies) was recorded second Kharif seasons. The *Alternaria* sp. contributed (6.35%) to the total airspora (Table-I). The maximum number of (25 colonies and 30 colonies) of air was recorded in the month of October, 2015 and 2016 during two Kharif seasons respectively. The Seasonwise maximum number of (77 colonies) was reported second kharif seasons. *Aspergillus flavus* contributed (3.29%) to the total airspora (Table-I). The

maximum number (20 colonies and 25 colonies) of air were recorded in the month of October, 2015 and 2016 during two kharif seasons respectively. The Seasonwise maximum number of (41 colonies) was recorded second kharif seasons. The *Fusarium* sp. contributed (2.13%) to the total airspora (Table- I). The maximum number of (20 colonies and 12 colonies) of air was recorded in the month of October, 2015 and 2016 during first and second Kharif seasons respectively. The Seasonwise maximum number of (36 colonies) was recorded first kharif seasons. The *Helminthosporium* sp. contributed (2.06%) to the total airspora (Table-I). The maximum number of (10 colonies and 8 colonies) of air was recorded in the month of October, 2015 and 2016 during first and second kharif seasons respectively. The Seasonwise maximum number of (30 colonies) was recorded second kharif seasons. Other spore types like *Aspergillus Niger*, *Aspergillus* sp., *Cladosporium* sp., *Curvularia* sp., *Penicillium* sp., *Alternaria* sp., *Aspergillus flavus*, *Fusarium* sp. and *Helminthosporium* sp. showed their high incidence in air in both the kharif seasons. Some of the spore types like, *Diplodia*, *Epicoccum*, *Humicola*, *Helminthosporium*, *Penicillium implicatum*, *Papularia*, *Pestalotia*, *Phoma*, *Torula*, and *Trichoderma veride*, showed their incidence irregularly throughout the period of investigation, this may be either due to non availability of the suitable host substratum or non congenial weather conditions for their development and discharge.

Unidentified spore type named “Unclassified group” contributed (19.47%) to the total airspora (Table-I). They were encountered throughout the period of investigations. They contributed (17.69% and 20.88%) during first and second kharif seasons respectively (Table 3A and 3B). Maximum number of (60 colonies and 90 colonies) was recorded in the month of July, 2015 and October, 2016 during first and second kharif seasons respectively. High incidence of spore was encountered in rainy season and low incidence in dry period.

Jowar Crop:

The present investigations in relation to Aeromycological studies over Jowar fields was carried out for two Rabi seasons (season I: 01/11/2015 to 28/02/2016 and Season II: 01/11/2016 to 28/02/2017) using continuous volumetric Tilak air sampler, in order to study the correlation between airborne microbial components, weather parameters, all the

airborne fungi have been included under ‘‘ spore type’’ .In the present investigation, 69 types of airborne components were reported of which 33 belonged to Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 to other types, Deuteromycotina, dominated the airspora by exhibiting the highest percentage (47.70%), followed by Basidiomycotina (23.83%), Ascomycotina (12.58%), other types (9.19%), Zygomycotina (4.15%) and Myxomycotina (2.53%). Sufficiently high contribution by other types was due to heterogeneous of the group and high incidence of the hyphal fragments, pollen grains, insect parts, and unidentified spores which are components of the group. During two Rabi seasons of 2015 to 2016 and 2016 to 2017, Deuteromycotina contributed with highest percentage (45.48% and 49.71%) to the total airspora followed by Basidiomycotina (25.29% and 22.51%), Ascomycotina (13.45% and 11.80%), other types (8.62% and 9.72%), Zygomycotina (4.45% and 3.88%) and Myxomycotina (2.69% and 2.38%) respectively so in the two seasons, it was evident that the group Deuteromycotina dominated the total airspora. The airborne components like *Cladosporium*, *Curvularia*, *Rust spores*, *Smut spores*, *Alternaria*, *Periconia*, *Nigrospora*, *Lophiostoma*, *Cunnighamella*, Insects scales, Hyphal fragments.etc ontributed significantly to the total airspora in two Rabi seasons. From Myxomycotina, two spore types were recorded which included *Physarum* and *Stemonitis*. The *Physarum* contributed (1.69%) to the total airspora (Table-I). The spores of *Physarum* encountered in all months during two Rabi seasons. They contributed (1.81% and 1.59%) during first and second Rabi seasons respectively (Table-II). The maximum concentration ($3850/\text{m}^3$ and $3794/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017 during first and second rabbi seasons respectively. The seasonwise maximum concentration ($11774/\text{m}^3$) was recorded in the first Rabi season. The *Stemonitis* contributed (0.83%) to the total airspora. The spores of *Stemonitis* encountered in all months during two Rabi seasons. Percentage contribution of *Stemonitis* to the total airspora found to be (0.88% and 0.79%) during first and second Rabi seasons respectively (Table-II). The maximum concentration ($1680/\text{m}^3$ and $1750/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017 during first and second Rabi seasons respectively. The Seasonwise maximum concentration ($5740/\text{m}^3$) was recorded in the first Rabi season. The concentration of Myxomycotina with respect to number of types

and percentage contribution is very low in the airspora. This may be due to aquatic, semi aquatic or soil borne nature of these fungi having no special spore discharge mechanism.

From Zygomycotina group, *Cunninghamella*, *Mucor*, *Rhizopus* and *Sclerospora* (oospores) were recorded and showed their prevalence over jowar field. *Cunninghamella* spores contributed (2.92%) to the total airspora (Table I). They contributed (3.11% and 2.76%) during two Rabi seasons (Table-II). The maximum concentration of *Cunninghamella* spores ($6720/\text{m}^3$ and $6664/\text{m}^3$) was recorded in the month of December, 2015 and 2016 during two Rabi seasons respectively and found to be dominant. The seasonwise maximum concentration ($20216/\text{m}^3$) was recorded in the first Rabi season.

It is indicated that the influence of weather parameter on concentration of *Cunninghamella* spore types during this season the rainfall was more as compared to second Rabi season. It is evident from the present observation that concentration of *Cunninghamella* was closely associated with high rainfall, low temperature and high humidity. Similar observations were made by Gregory (1961), Singh *et al.*, (1980), Patil (1992), Aher (1993), Naik (1995), Shinde (1996), Garje (2000) and Suryawanshi (2002). *Mucor* spore contributed (0.05%) to the total airspora (Table- I). It is very low percentage contribution. They contributed (0.07 % and 0.02%) during first and second Rabi seasons respectively (Table-II). It is found only in low temperature, high humidity and more rainfall. It is clearly confirmed that *Mucor* was rainy spores. The maximum concentration of *Mucor* spore ($210/\text{m}^3$ and $112/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017 during first and second Rabi seasons respectively. The seasonwise maximum concentration ($476/\text{m}^3$) was recorded in the first Rabi season. The *Rhizopus* is a very common saprophyte and facultative parasite in the region (Tilak and kulkarni, 1975). Their contribution was (0.19%) to the total airspora (Table-I). The *Rhizopus* contributed (0.21% and 0.17%) to the total airspora during first and second Rabi Seasons respectively (Table-II). It also occurred with significant concentration ($588/\text{m}^3$ and $574/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017 during first and second Rabi Seasons respectively. Among the Zygomycotina, *Rhizopus* spores were encountered in maximum number. Hyde and Williams (1949), Kramer *et al.*, (1959, 1960), kamal and Verma (1977) also recorded their enormous amounts in the airspora. Moderately high

temperature (25°C to 35°C), high relative humidity favoured in release of spores of *Rhizopus* (Ingold, 1965). The seasonwise maximum concentration ($1400/\text{m}^3$) was observed in first Rabi season. The source of *Rhizopus* spores was dead and decaying plant parts on the ground. Slight mechanical disturbance during weeding and other intercultural operations increased spore concentration in the airspora (Dransfield, 1966; Sreeramulu, 1967). Patil (1985) reported it as a dominant among Zygomycotina.

The *Sclerospora* is a common parasite on jowar (*sorghum vulgare pers.*) crop of this region. They contributed (0.98%) to the total airspora for a two Rabi seasons (Table I). The *Sclerospora* contributed (1.05% and 0.92) during first and second Rabi seasons respectively (Table-II). The maximum concentration of *Sclerospora* (oospores) ($2380/\text{m}^3$ and $2352/\text{m}^3$) was recorded in the month of February, 2016 and February, 2017. The seasonwise maximum concentration ($6818/\text{m}^3$) was recorded in the first Rabi season. When there was record of low temperature, high humidity and more rainfall was recorded during this season. Similar observation were made by Mane (1978), Tilak and Babu (1982), Tilak and Rao (1987), Garje (2000) and Suryawanshi (2002). The observation concludes that the concentration of spores of Zygomycotina with respect to number of types and percentage contribution is very low, in the airspora. This may be due to aquatic, semi aquatic or soil borne nature of the fungus and no special discharge mechanism for their spore dispersal as well as size of the spores. Culture plate methods proved to be more efficient for detection and estimation of Zygomycotina and other saprophytic spore types in the airspora.

From the Ascomycotina spore types ranked third in the order of dominance. In all 18 types were identified up to generic level their percentage of occurrence ranged from 0.01% (*Massaria* and *Teichospora*) to 3.35% (*Lophiostoma*). Total contribution of Ascomycotina to the total airspora was (12.59%). The concentration of group Ascomycotina ($87430/\text{m}^3$ and $85008/\text{m}^3$) was recorded during first and second Rabi seasons respectively. The presence of many ascospores types reveals the abundance of parasitic and saprophytic members of Ascomycotina forms on and around the fields. *Parodiella* is a common parasite of leguminous weeds of this region. *Sordaria* and *Sporormia* are common coprophilous fungi of this region. In both Seasons maximum

concentration was observed in the months of November, December and January in both the Seasons, may be owing to frequent humid in these months. Many Ascomycotina showed active spore discharge mechanism (Ingold, 1965). The effect of rainfall on ascospores discharge was either immediate or delayed. Daily catches showed that the spores like *Didymosphaeria*, *Leptosphaeria* and *Lophiostoma* showed immediate spore release after rainfall, whereas the spore types like *Chaetomium*, *Melanospora*, *Teichospora* and *Parodiella* released the spores often long after the rains. Among the group Ascomycotina *Lophiostoma* was a dominant spore type. The *Lophiostoma* contributed (3.17%) to the total airspora (Table-I). They contributed (3.55% and 3.17%) during first and second Rabi Seasons respectively (Table-II). The maximum concentration ($7182/\text{m}^3$ and $7168/\text{m}^3$) was recorded in the month of December, 2015 and December, 2016 during first and second Rabi Seasons respectively. The Seasonwise maximum concentration ($23030/\text{m}^3$) was recorded during first Rabi seasons. *Didymosphaeria* was a dominant spore type and their contribution (1.96%) to the total airspora (Table-I). They contributed (2.15% and 1.80%) during first and second Rabi Seasons respectively. The maximum concentration ($4200/\text{m}^3$ and $4200/\text{m}^3$) was recorded in the month of November, 2015 and November, 2016 during first and second Rabi seasons respectively. The Seasonwise maximum concentration ($13930/\text{m}^3$) was recorded first Rabi Seasons. *Leptosphaeria* was a dominant spore type. The *Leptosphaeria* contributed (1.35%) to the total airspora (Table-I). They contributed (1.39% and 1.32%) during first and second Rabi seasons respectively (Table-II). The maximum concentration ($2590/\text{m}^3$ and $2800/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017. The Seasonwise maximum concentration ($9520/\text{m}^3$) was recorded during second Rabi Season. During course of investigations the main source of these spores are the dead crop materials and weeds are dumped near the jowar crop fields. It is clear indicated that the release of spores rainfall which subsequently result in increasing higher concentration, while high humidity a moderate to low temperature are supplementary to the release of spores.

Chaetomium was a dominant spore type. The *Chaetomium* contributed (1.33%) to the total airspora (Table-I). They contributed (1.39% and 1.29%) during first and second Rabi seasons respectively (Table-II). *Chaetomium* were found to be release long after the

rains and maximum concentration ($2870/\text{m}^3$ and $2800/\text{m}^3$) was recorded in the Month of November, 2015 and 2016. Seasonwise maximum concentration was ($9310/\text{m}^3$) during second Rabi Season. However the *Chaetomium*, *Didymosphaeria*, *Parodiella*, *Pleospora* and *Teichospora* during dry period were due to fall in temperature, increase in relative humidity and light or scattered showers of rain. The result obtained the present investigation clearly indicated that either the rainfall or high humid conditions were having their immediate impact on the spore release of Ascomycotina as has been suggested by Meredith (1961, 1962, 1963). *Hypoxylon*, *Sporormia*, *Sordaria* occurred with very insignificant concentration most probably due to non availability of required substratum for their growth and sporulation in around the fields. The spores of Basidiomycotina contributed (23.83%) to the total airspora (Table-I). They contributed (25.29% and 22.51%) during first and second Rabi Seasons respectively (Table-II). The analysis of the spore catches clearly indicated that spores of Basidiomycotina dominated the airspora i.e. Second in number. The spores of Basidiomycotina were grouped into; *Basidiospores*, *Ganoderma*, *Rust spores*, *Smut spores* and *Urediniospores* were recorded in high concentration for two Rabi Seasons. It is more significant role to the concentration of total airspora. These spores were recorded regularly during the period of investigations. The seasonwise concentration of group Basidiomycotina was ($164388/\text{m}^3$ and $162092/\text{m}^3$) was recorded during the first and second Rabi Seasons. *Rust spores* contributed (10.13%) to the total airspora (Table-I). They contributed (10.85% and 9.48%) during first and second Rabi Seasons respectively (Table-II). It is clearly indicated that the *Rust spores* was third dominated spore types to the total airspora during the two Rabi Seasons. The maximum concentration ($19614/\text{m}^3$ and $18844/\text{m}^3$) was recorded in the month February, 2016 and February, 2017 during first and second Rabi Seasons respectively. The Seasonwise maximum concentration ($70532/\text{m}^3$) was recorded in the first Rabi Season. Some earlier workers like Stakman *et al.*, (1923) studied aerial dissemination of rust inoculum with various methods. *Smut spores* contributed (9.82%) to the total airspora (Table-I). They contributed (10.78% and 8.94%) during first and second Rabi seasons respectively (Table-II). It is clearly indicated that the *Smut spores* was fourth dominated spore types to the total airspora during the two Rabi seasons because of no of source material was found around the crop fields. The maximum spore

concentration was (22960/m³ and 21560/m³) recorded in the month of February, 2016 and February, 2017 during first and second Rabi Seasons respectively. The seasonwise maximum concentration (70056 /m³) were recorded in the first Rabi season.

From the above observation it is very difficult to trace out the exact source of *Smut spores* in and around the crop fields. However there was a standing of hybrid, Tur near by the crop fields, varieties of grasses growing on wild land of near crop fields were found to infect by Smut diseases which probably might have served as a source. Rees (1964) observed the smut spores in dry period. Similar observations by Jogdand (1987) *Smut spores* was found in the month of October and November during first kharif seasons and October during second kharif Seasons, when temp was less at about 22⁰ C relative humidity was high around 75% and it was proceeded by rain fall in both the kharif seasons. The *Basidiospores* contributed (1.82%) to the total airspora (Table-I). They contributed (1.47% and 2.14%) during first and second Rabi seasons respectively (Table-II). The maximum concentration (3920/m³ and 4200/m³) was recorded in the month of December, 2015 and January, 2016 during first and second Rabi seasons respectively. The Seasonwise maximum concentration (15400/m³) was recorded in the second Rabi seasons. The highest spore catch during second Rabi season due to the more rainfall, high humidity and low temperature was affected to formation and liberation of various coloured *Basidiospores*. The present studies clearly revealed the correlation between the high concentration of *Basidiospores* in the atmosphere with the rainfall, high relative humidity and low temperature. Similar observation were made by Adams (1968), who reported that the *Basidiospores* concentration was highest when the weather as wet, moderately warm and relative humidity high.

The presence or absence of *Basidiospores* in all air was directly correlated with the occurrence of rain fall. Similar observation by Patil (1985) and Jogdand (1987) source was Agaricales and Polyporales growing around the fields. The contribution was prominently more during rainy season and *Basidiospores* belonged to “wet spora” group. High relative humidity (70-85) and lower temperature (18-22⁰c) was favourable for their release in the air. Shastri (1981), Babu (1983), Patil (1983), Patil (1985), were some of the earlier reporters of *Basidiospores* in the air. The *Urediniospores* contributed (1.71%)

to the total airspora (Table-I). They contributed (2.17% and 1.93%) during first and second Rabi seasons respectively (Table-II).

The maximum concentration ($4200/\text{m}^3$ and $4060/\text{m}^3$) was recorded in the month of February, 2016 and 2017 during two Rabi seasons respectively. The Seasonwise maximum concentration ($14084/\text{m}^3$) was noted during first Rabi season. The highest spore catch was observed during first Rabi season. When average temperature low, moderate relative humidity and high rainfall was recorded during same season. The group Deuteromycotina was well dominated by as many as 33 spore types. The grand total of Deuteromycotina spores ($295540/\text{m}^3$ and $357994/\text{m}^3$). They contributed (47.70%) to the total airspora (Table-I) with (45.48% and 49.71%) during first and second Rabi seasons respectively (Table-II). Among the group Deuteromycotina *Cladosporium* (15.48%), *Curvularia* (5.76%), *Alternaria* (4.93%), *Nigrospora* (5.69%), *Periconia* (3.45%), *Lacellina* (1.90%), *Heliminthosporium* (1.61%) and *Heterosporium* (1.43%). were the most dominant spore types to the total airspora for two Rabi seasons. The average percentage contribution ranged from 0.01% (*Botryodiplodia* and *Papularia*) to 15.48% (*Cladosporium*). The most regularly occurring spore types which contributed in a considerable number were *Cladosporium*, *Curvularia*, *Alternaria*, *Nigrospora*, *Periconia*, *Lacellina*, *Heliminthosporium*, and *Heterosporium* etc.

From amongst all *Cladosporium* (12.68% and 18.01%), *Curvularia* (6.12% and 5.44%), *Alternaria* (4.79% and 5.06%), *Nigrospora* (6.08% and 5.34%), *Periconia* (3.13% and 3.75%), *Lacellina* (1.79% and 2.02%), *Heliminthosporium* (1.62% and 1.61%) and *Heterosporium* (1.52% and 1.36%) etc. was recorded as the most dominant spore types. All of these spore types, therefore have been called as “airspora dominant” the maximum concentration of *Cladosporium*, *Curvularia*, *Alternaria*, *Periconia*, *Nigrospora*, *Lacellina*, *Heliminthosporium* and *Heterosporium* etc. in the air was simply because of their Saprobic habit, their high degree of vegetative reproduction by fragmentation, budding etc., asexual reproduction by developing conidia directly of fruiting with passive spore liberation. The gentle wind currents, natural or mechanical disturbance have been found directly or indirectly involved in liberating enormous amount of spore load in the air. Gregory (1961) also stated that the mist-pick up mechanism was rather more effective

in the dispersal of *Cladosporium* spores. The obtained results are in agreement with the statement of Gregory (1961). The high frequency of occurrence of predominance during wet and dry period of observed by Cammack (1955) he also stated that various in the number of spores found dependent largely on availability of host as well as climatic factors, Reddy (1976) recorded *Cladosporium* as the dominant spore type and observed in maximum number in all months with its seasonal maxima occurring in the period between November and January.

Thus, it may be concluded that the maximum concentration of *Cladosporium* spores could be correlated with the flowering and seed forming stages in both seasons the rain preceding days, irrigation in the season and leaf shedding might have served as pre-requisites for the copious growth and dispersal of spores in the atmosphere. Most of the spore types of Deuteromycotina have been categorized under “Dry spora” group and high incidence was observed either late after the precipitation or irrigation. Alit (1984) commented “Airborne spore” usually belong to very common fungi. Of the various leaf spot fungi like *Alternaria*, *Cercospora*, *Curvularia*, *Helminthosporium* and *Periconia* were responsible for initiating diseases of *Sorghum*. However, the disease incidence was not severe.

The *Curvularia* spore encountered throughout the period of investigations. It is dominated spore type in group Deuteromycotina. The *Curvularia* contributed (5.76%) to the total airspora (Table-I). They contributed (6.12% and 5.44%) during first and second Rabi Seasons respectively (Table-II). The maximum concentration (11564/m³ and 12950/m³) was recorded in the month of December, 2015 and 2016 during two kharif seasons respectively. The Seasonwise concentration (39732/m³ and 39200/m³) was recorded into two Rabi seasons. The highest spore catch (826/m³ and 925/m³) was observed on 6th December, 2015 and 16th December, 2016 when mean temperature 24 c and 25c, relative humidity 78% and 86% and rainfall 51 mm was recorded during Rabi seasons.

Alternaria contributed (4.93%) to the total airspora (Table-I). They contributed (4.79% and 5.06%) during first and second Rabi seasons respectively (Table-II). The highest spore concentration (10780/m³ and 12250/m³) was observed in the month of February, 2016 and February, 2017 during first and second Rabi seasons respectively. The

Seasonwise concentration ($31164/\text{m}^3$ and $36470/\text{m}^3$) was recorded first and second Rabi Seasons. The highest spore catches ($770/\text{m}^3$ and $875/\text{m}^3$) recorded on 14th February, 2016 and 18th February, 2016. when mean temperature 24^0 C and 22.5^0 C , relative humidity 71% and 78% and rainfall 67 mm was recorded during Rabi season respectively. The concentrations of spores were more during day time than night. Thus it was included under “day spora” group. Calvo et al (1979) reported the occurrence of *Alternaria* spores in atmosphere greatly affected by climatic condition. Kramer (1959) recorded these spores in the air in the month of June and July. Kramer et al (1964) observed that in many of the members of group Deuteromycotina, there was no forcible discharge which was found to be natural and dependent on rising time and windy conditions. Therefore, these members showed their peaks generally day time. The spore of *Nigrospora* contributed (5.69%) to the total airspora (Table-I). They contributed (6.08% and 5.34%) during first and second Rabi seasons respectively (Table-II). The highest concentration ($11228/\text{m}^3$ and $10500/\text{m}^3$) was recorded in the month of December, 2015 and 2016 during first and second Rabi Seasons respectively. The Seasonwise concentration ($39494/\text{m}^3$ and $38500/\text{m}^3$) was recorded two Rabi Seasons. The highest spore catch ($802/\text{m}^3$) was recorded on 8th December 2015 in first Rabi season and ($750/\text{m}^3$) was recorded on 11th December 2016 in second Rabi season. The spores of *Nigrospora* occurred abundantly in all the months of both Rabi seasons.

The spore *Periconia* encountered throughout the period of investigations. It is dominated spore type in group Deuteromycotina. The *Periconia* contributed (3.45%) to the total airspora (Table-I). They contributed (3.13% and 3.75%) during first and second Rabi seasons respectively (Table-II). The highest spore concentration was ($7308/\text{m}^3$ and $8400/\text{m}^3$) observed in the month of November, 2015 and November, 2016 respectively. The Seasonwise concentration ($20314/\text{m}^3$ and $27020/\text{m}^3$) was recorded first and second Rabi seasons. The highest spore catch ($522/\text{m}^3$) was recorded on 12th November, 2015 in first Rabi season and ($600/\text{m}^3$) was recorded on 16th November, 2016 in second Rabi season. The spore of *Lacellina* contributed (1.90%) to the total airspora (Table-I). They contributed (1.79% and 0.02%) during first and second Rabi seasons respectively (Table-II). The highest spore concentration ($3360/\text{m}^3$ and $4200/\text{m}^3$) was recorded in the month of January, 2016 and January, 2017 during first and second Rabi seasons respectively. The

Seasonwise concentration ($11620/\text{m}^3$ and $14420/\text{m}^3$) was recorded first and second Rabi seasons. The spore of *Helminthosporium* contributed (1.61%) to the total airspora (Table-I). They contributed (1.62 % and 1.61%) during first and second Rabi seasons respectively (Table-II). The maximum concentration ($3080/\text{m}^3$ and $3150/\text{m}^3$) was recorded in the month of November, 2015 and November, 2016 during first and second Rabi Seasons respectively. The Seasonwise concentration ($10500/\text{m}^3$ and $11550/\text{m}^3$) was recorded first and second Rabi seasons. When at temperature of 21.25 C and 18.05 C, relative humidity 43% and 48% during both the kharif seasons respectively. The spores of *Helminthosporium* occurred abundantly throughout the period of present investigations. Similar observation was made by Kamal and Singh (1995). The spore of *Heterosporium* contributed (1.43%) to the total airspora (Table- I). They contributed (1.52% and 1.36%) during first and second Rabi seasons respectively (Table-II). The highest spore concentration ($2702/\text{m}^3$ and $2688/\text{m}^3$) was recorded in the month of January, 2016 and January, 2016 during first and second Rabi seasons respectively. The Seasonwise concentration ($9828/\text{m}^3$ and $9772/\text{m}^3$) was recorded first and second Rabi seasons.

The “Other spore types” showed their high incidence in both the Rabi seasons. Spore types like, *Botryodiplodia*, *Cordana*, *Diplodia*, *Drechslera*, *Harknessia*, *Papularia*, *Pestalotia* and *Pseudotorula* showed their incidence irregularly. A group “Other types” contributed a bulk concentration in first season (8.62%) and second season (9.72%). The Algal filaments contributed (0.65%) to the total airspora (Table-I) and contributed (0.63% and 0.68%) during first and second Rabi seasons respectively (Table-II). The maximum concentration ($1400/\text{m}^3$ and $1540/\text{m}^3$) was recorded in the month of December, 2015 and 2016 during first and second Rabi seasons respectively. The Seasonwise maximum concentration ($4830/\text{m}^3$) was recorded second Rabi season. The maximum concentration was observed during second Rabi Seasons, when average low temperature, average high relative humidity and high rainfall were observed during the same season. When there was a recorded of average humidity 62% and 75%. Subba Reddy (1977) observed its dominance during rainy seasons and at the end. *Epidermal hairs* were trapped in all seasons from jowar crop fields. They contributed (0.36%) to the total airspora (Table-I). Epidermal hairs contributed (0.32% and 0.39%) during two seasons

respectively (Table-II). The maximum concentration ($724/\text{m}^3$ and $1050/\text{m}^3$) was recorded in the month of February, 2016 and February, 2017 during first and second Rabi seasons respectively. The Seasonwise maximum concentration ($2800/\text{m}^3$) was recorded during second Rabi season.

Hyphal fragments contributed (2.75%) to the total airspora (Table-I). They contributed (2.72% and 2.78%) during two Rabi seasons respectively (Table-II). The maximum concentration ($5460/\text{m}^3$ and $5600/\text{m}^3$) was encountered in the month of February, 2016 and December, 2016 during two Rabi seasons. Seasonwise maximum concentration ($20020/\text{m}^3$) was recorded during second Rabi season. When average temperature was 25.80°C and 24.80°C , relative humidity was 68.41% and 82.7%. There occurred as intercalary fragments, apical fragments and conidiophores with conidia. Pady and Kramer (1960), Pady and Gregory (1963) indicated that viable hyphal fragments are not less important than viable spores. Harvey (1976) while studying airspora of Kansas and stated that their role in survival of pathogens is equally important as spores. Tilak and Bhalke (1981) have described and classified various Hyphal fragments. Insect scales, parts and wings were recorded throughout the period of investigations. They contributed (2.07%) to the total airspora (Table-I). They contributed (2.49% and 1.72%) during first and second Rabi Seasons respectively (Table-II). The highest concentration ($4900/\text{m}^3$ and $3780/\text{m}^3$) was recorded during the month of December, 2015 and February, 2017 during first and second Rabi Seasons respectively. The Seasonwise maximum concentration ($16100/\text{m}^3$) was recorded first Rabi Season. Their incidence was high during the harvesting and high wind velocity. Tilak and Bhalke (1979) presented a report in seasonal variation of insect parts. Further Tilak (1982) observed that the abundance of the insects parts is closely related with meteorological conditions, while high wind velocity also helps in discharging the insect scales in air forming a common component at airspora, Patil (1985) pointed out their peak at high around 04.00 hours and stated that powerful wind had a direct effect in the high incidence in the airspora. During the period of investigation enormous amount of pollen grains were recorded contributing (1.89%) to the total airspora (Table-I). They contributed (1.22% and 1.51%) during two seasons respectively (Table-II). The maximum concentration ($2660/\text{m}^3$ and $5460/\text{m}^3$) recorded in the month of December, 2015 and February, 2017 during two Rabi seasons respectively.

The Seasonwise maximum concentration ($18060/\text{m}^3$) was recorded in second Rabi season. The incidence of Pollen concentration and variation was related to the flowering period of entire vegetation around crop. In fact during these investigation Pollen grains of grasses and other members beside the jowar crop fields was encountered in abundance. Hamilton (1959) and Lacey (1962) reported that locality and vegetation had a influence on the concentration and categories of pollen incidence at the air. Pollen grains were trapped throughout the period of investigations. The highest catch ($5460/\text{m}^3$) was recorded in February, 2017. Concentration and seasonal variations in the pollen content of air had its relation with vegetation, their flowering in the area. Protozoan cysts were observed throughout the period of investigations. They contributed (0.26%) to the total airspora (Table-I). They were encountered throughout the period of investigations. They contributed (0.23% and 0.30%) during first and second Rabi seasons respectively (Table-II). The maximum ($490/\text{m}^3$ and $672/\text{m}^3$) was recorded in the month of January, 2016 and December, 2016 during first and second Rabi seasons. The Seasonwise maximum concentration ($2184/\text{m}^3$) was recorded second Rabi season. Miquel (1967) reported 0.1% to 0.20% airborne protozoan cysts at Paris. In India, Tilak and srinivasulu (1967) reported 7.56% cysts from Aurangabad. Patil (1985) reported 0.17% cyst to the total airspora. Unidentified fungal spore type grouped under “Unidentified spore types”. They contributed (1.20%) to the total airspora (Table-I). They were encountered throughout the period of investigations. They contributed (1.04% and 1.36%) during two Rabi Seasons respectively (Table-II). The maximum concentration ($2100/\text{m}^3$ and $2800/\text{m}^3$) was recorded in the month of November, 2015 and December, 2016 during first and second Rabi Seasons. It is high incidence of spore was encountered in humid and low incidence in dry period. According to Gregory (1961) noted the fluctuations of atmosphere spore concentration with fluctuation spore concentration with in meteorological parameters. The weather parameters were also affected to unidentified spore types.

During the air sampling by applying sampler in the fields simultaneously petriplates exposure was carried out in soybean crop fields, which revealed the presence of total 31 different fungal types of which 23 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina and other non- Sporing group to mycelia sterilia as unclassified group. Fungal types belonging to Deuteromycotina contributed with highest percentage

(79.29%) it was followed by mycelia sterilia (14.28%) Zygomycotina (4.99%) and Ascomycotina (1.44%) were recorded Deuteromycotina were highest in number. During two Rabi seasons Deuteromycotina contributed with highest percentage (80.26% and 78.47%) to the total airspora followed by *mycelia sterilia* (14.46% and 14.12%), Zygomycotina (4.34% and 5.55%) and Ascomycotina (0.94% and 1.86%), respectively. Thus, it was evident that the Deuteromycotina dominated total airspora. Zygomycotina with five spore types were recorded i.e. *Cunninghamella*, *Mucor*, *Pythium*, *Rhizopus Cohinii* and *Rhizopus*. The *Rhizopus cohinii* contributed (3.17%) to the total airspora (Table-I). The *Rhizopus cohinii* contributed (3.02% and 3.30%) to the total air during first and second Rabi Seasons. (Table 3A and 3B). The maximum numbers of colonies (25 colonies and 30 colonies) was recorded in the month of November, 2015 and November, 2016 during first and second Rabi seasons respectively. The seasonwise maximum colonies (62 colonies) was recorded in the second Rabi season. The *Rhizopus* contributed (0.98%) to the total airspora (Table-I). The *Rhizopus* contributed (0.76% and 1.17%) to the total air during first and second Rabi Seasons (Table 3A and 3B). The maximum number of (5 colonies and 7 colonies) was recorded in the month of November, 2015 and November, 2016 during first and second Rabi Seasons. The seasonwise maximum of colonies (22 colonies) was recorded in the second Rabi season. *Rhizopus cohinii* and *Rhizopus sp.* Occurred dominant spore types in comparison to other three types.

From Ascomycotina two fungal spore types were recorded is *Chaetomium sp.* and *Neurospora sp.* The *Neurospora sp.* was a dominant spore type. It contributed (1.33%) to the total airspora (Table-I). The *Neurospora* contributed (0.88% and 1.71 %) to the total air during first and second Rabi seasons (Table 3A and 3B). The maximum number of (5 colonies and 17 colonies) was recorded in the month of November, 2015 and February, 2017 during first and second Kharif seasons respectively. The Seasonwise maximum colonies (32 colonies) was recorded in the second Rabi seasons. The group Deuteromycotina was well dominated by as many as 23 spore types during the period of investigation. The grand total of Deuteromycotina fungal colonies (1276 and 1473) of air with (80.26% and 78.47%) were recorded in the first and second Rabi seasons. From the group Deuteromycotina; *Cladosporium* (35.36%), *Aspergillus Niger* (11.14%), *Aspergillus sp.* (10.42%), *Penicillium sp.* (5.74%), *Alternaria* (4.57%), *Curvularia*

(3.43%), *Fusarium* sp. (2.66%) *Aspergillus Flavus* (1.57%) and *Heliminthosporium* sp. (1.29%) etc. were the most dominant fungal types. The average percentage contribution ranged from 0.08% (*Bipolaris*) to 35.36% (*Cladosporium*). From amongst all *Cladosporium* sp. (35.59% and 35.16%), *Aspergillus Niger* (11.58% and 10.77%), *Aspergillus* sp. (10.94% and 9.96%), *Penicillium* sp. (5.72% and 5.75%), *Alternaria* sp. (4.72% and 4.42%), *Curvularia* sp. (3.28% and 3.57%), *Fusarium* sp. (2.64% and 2.66%) *Aspergillus Flavus* (1.52% and 1.59%), and *Heliminthosporium* sp. (1.13% and 1.44%) etc. were recorded as the most dominant fungal spore types. All of these fungal spore types therefore have been called as “airspora dominant”.

The *Cladosporium* sp. encountered throughout the period of investigations. They contributed (35.36%) to the total airspora (Table-I). The maximum number of colonies (161 colonies and 200 colonies) was recorded in the month of January, 2016 and November, 2016 during first and second Rabi seasons respectively. The Seasonwise maximum number of colonies (660 colonies) was recorded in the second Rabi Season. The *Aspergillus Niger* encountered throughout the period of investigations. It contributed (11.14%) to the total airspora (Table-I). The maximum number of colonies (55 colonies and 60 colonies) was recorded in the month of January, 2016 and January, 2017 during first and second Rabi Seasons respectively. The seasonwise maximum number of colonies (202 colonies) was recorded in the second Rabi season. The *Aspergillus* sp. encountered throughout the period of investigations. They contributed (10.42%) to the total airspora (Table-I). The maximum number of (52 colonies and 55 colonies) was recorded in the month of February, 2016 and February, 2017 during first and second Rabi seasons respectively. The seasonwise maximum number of colonies (174 colonies and 187 colonies) was recorded first and second Rabi seasons. The *Penicillium* sp. Contributed (5.74%) to the total airspora (Table-I). The maximum number of colonies (30 colonies and 35 colonies) was recorded in the month of February, 2016 and February, 2017 during first and second Rabi Seasons respectively. The seasonwise maximum number of colonies (108 colonies) was recorded in the second Rabi season. The *Alternaria* sp. contributed (4.57%) to the total airspora (Table-I). It is dominated spore type in group Deuteromycotina. The maximum number of (25 colonies and 30 colonies) was recorded in the month of November, 2015 and November, 2016 during first and

second Rabi seasons respectively. The Seasonwise maximum number of colonies (83 colonies) was recorded in the second Rabi season. The *Curvularia* sp. Contributed (3.43%) to the total airspora (Table-I). The maximum number of (25 colonies and 30 colonies) was recorded in the month of February, 2016 and February, 2017 during first and second Rabi seasons respectively. The seasonwise maximum number of colonies (67 colonies) was recorded in the second Rabi season.

The *Fusarium* sp. contributed (2.66%) to the total airspora (Table-I). The maximum number (15 colonies and 16 colonies) was recorded in the month of January, 2016 and 2017 during first and second Rabi seasons respectively. The seasonwise maximum number of colonies (50 colonies) was recorded in the second Rabi season. The *Aspergillus Flavus* Contributed (1.57%) to the total airspora (Table-I). The maximum number of colonies (10 colonies and 12 colonies) was recorded in the month of February, 2016 and 2017 during first and second Rabi seasons respectively. The Seasonwise maximum number of colonies (30 colonies) was recorded in the second Rabi season. The *Helminthosporium* sp Contributed (1.29%) to the total airspora (Table-I). The maximum number of colonies (7 colonies and 9 colonies) was recorded in the month of February, 2016 and 2017 during first and second Rabi seasons respectively. The Seasonwise maximum number of colonies (27 colonies) was recorded in the second Rabi seasons. Similar observation were also made by jayswal (1993), Shukla (1971) isolated these spores in less concentration from the culture exposed in the forest. This fungal type showed their high incidence in air in both the Rabi seasons. All the fungal colonies which would not be identified were grouped under “Unclassified group”. They contributed (14.28%) to the total airspora (Table- I). They contributed (14.46% and 14.12%) during first and second Rabi Seasons respectively (Table 3A and 3B). Maximum number of colonies (75 colonies and 80 colonies) was recorded in the month of February, 2016 and 2017 during first and second Rabi seasons respectively. The seasonwise maximum number of colonies (265 colonies) was recorded in the second Rabi season

Chapter: VI

SUMMARY AND CONCLUSION

(*Glycine Max* L.) Soybean crop:

1. The present investigation deals with Aeromycological studies over Soybean field at Osmanabad. Air sampling was carried out by using “Tilak Air Sampler” which provided continuous spectrum of air sampler.
2. The air sampling was carried out for two Kharif Seasons over the same field i.e. (Kharif season I: 1st July, 2015 to 31st Oct,2015 and Kharif season II :1st July, 2016 to 31st oct,2016).
3. During that period of investigations, daily Meteorological parameters were maintained such as temperature, relative humidity and rainfall etc recorded for the co-relation.
4. During airspora analysis total 74 spore types, were identified of which 38 belonged to Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 to other types.
5. The Deuteromycotina dominated all other groups, in the study of both Kharif seasons and its percentage contribution was (63.49%), followed by Basidiomycotina (12.07%), Ascomycotina (10.50%), other types (8.54%), Zygomycotina (3.24%) and Myxomycotina (2.15%) to the total airspora.
6. The Myxomycotina group was represented by *Physarum* and *Stemonitis*.
7. The Zygomycotina group was represented by *Cunninghamella*, *Mucor*, *Rhizopus*, and *Sclerospora*.
8. The *Cladosporium* was found to be the most dominant spore type in the airspora and contributed (16.82%), it was followed by *Curvularia* (11.50%), Smut spores (8.33%), *Alternaria* (5.82%), *Periconia* (5.16%), *Memnoniella* (4.15%), *Nigrospora* (4.02%), *Aspergillus* (2.98%), *Lophiostoma* (2.93%) *Cunninghamella* (2.63%), *Insect scales* (2.26%), Pollen grains (2.07%) and Hyphal Fragments (2.02%) were dominant types in the total airspora over soybean crop fields.

9. 27 types of fungal colonies were reported from crop fields in plate culture method, of which 19 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina, and 1 to other non- sporulating to Mycelia Sterilia.
10. Deuteromycotina was the dominant group which contributed (69.69%) followed by Mycelia sterilia (19.47%), Zygomycotina (5.69%) and Ascomycotina (5.15%).
11. In Petri plate culture method *Aspergillus niger* alone contributed (12.46%), to the total colony count, followed by *Aspergillus sp.* (12.28%), *Cladosporium* (12.28%), *Curvularia* (7.27%), *Penicillium sp.* (6.58%), *Alternaria* (6.35%), *Neurospora* (4.91%), *Aspergillus Flavus* (3.29%), *Fusarium sp.* (2.13%), *Rhizopus cohinii* (2.64%), *Heliminthosporium* (2.06%) and *Rhizopus sp.* (1.39%) were dominant types in the total airspora over soybean crop fields.
12. The common air borne fungal pathogenic spore types like *Cladosporium*, *Aspergillus sp.*, *Penicillium sp.*, *Aspergillus Flavus*, *Alternaria*, *Curvularia*, *Neurospora*, *Phoma*, *Trichoderma* and *Heliminthosporium*.
13. Some of the pathogenic spore types like *Cercospora*, *Alternaria*, *Rust spores*, (*Phakosora Pachyrhizi*) were observed in high concentration and have been investigated in detail.
14. The Meteorological factors like temperature, relative humidity and rainfall had a pronounced effect on spore liberation and ultimately affected airspora composition qualitatively and quantitatively.
15. The concentration (in both the seasons) of many spore types was more or less same but in cases few spores it was quite different.
16. Monthwise average and monthly average percentage of individual spore and individual group was calculated separately.
17. The present air spora studies over Soybean fields, contributed in understanding the composition and components of airspora in the Kharif seasons.
18. These results would be further useful in devising the disease forecasting system for Soybean crop which would subsequently help in protecting the crops.

(*Sorghum vulgare* L.) Jowar crop:

- 19** In the present investigation deals with Aeromycological studies over jowar field at Osmanabad. Air sampling was carried out by using “Tilak Air Sampler” which provided continuous air sampler.
- 20** The observation was carried out for two Rabi Seasons over the same field.
- 21** During that period of investigations, daily Meteorological parameters were maintained such as temperature, relative humidity and rainfall etc recorded for the co-relation.
- 22** During airspora analysis 69 spore types were revealed of which 33 belonged to Deuteromycotina, 18 to Ascomycotina, 5 to Basidiomycotina, 4 to Zygomycotina, 2 to Myxomycotina and 7 to other types.
- 23** The Deuteromycotina dominated all other groups, they contributed (47.70%) followed by Basidiomycotina (23.83%), Ascomycotina (12.58%), other types (9.19%), Zygomycotina (4.15 %) and Myxomycotina (2.53%).
- 24** The Myxomycotina group was represented by *Physarum* and *Stemonitis*.
- 25** The Zygomycotina group was represented by *Cunninghamella*, *Mucor*, *Rhizopus*, and *Sclerospora*.
- 26** The *Cladosporium* was found to be the most dominant spore type in the airspora and contributed (15.48%) to the total airspora. It was followed by Rust Spores (10.13%), Smut Spores (9.82%), *Curvularia* (5.76%), *Nigrospora* (5.69%), *Alternaria* (4.93%), *Periconia* (3.45%), *Lophiostoma* (3.35%), *Cunninghamella* (2.92%), Hyphal Fragments (2.75%) and Insect scales (2.07%) were dominant types in the total airspora over Jowar crop fields.
- 27** 31 types of fungal colonies were reported from crop fields in plate culture method, of which 23 belonged to Deuteromycotina, 5 to Zygomycotina, 2 to Ascomycotina, and 1 to other non- sporulating to Mycelia Sterilia.
- 28** Deuteromycotina was the dominant group which contributed (79.29%) followed by Mycelia Sterilia (14.27%), Zygomycotina (4.99%) and Ascomycotina (1.45%).

- 29** In Petri plate culture method *Cladosporium* alone contributed (35.37%) to the total colony count, followed by *Aspergillus niger* (11.14%), *Aspergillus sp.* (10.42%), *Penicillium sp.* (5.75%), *Alternaria* (4.57%), *Curvularia* (3.43%), *Rhizopus cohinii* (3.17%), *Fusarium sp.*(2.66%), *Aspergillus flavus* (1.57%), *Neurospora* (1.33%) and *Heliminthosporium* (1.29%) were dominant types in the total airspora over Jowar crop fields.
- 30** The common air borne fungal pathogenic spore types like *Cladosporium*, *Aspergillus sp.* *Penicillium sp.*, *Aspergillus Flavus*, *Alternaria*, *Curvularia*, *Neurospora*, *Phoma*, *Trichoderma* and *Heliminthosporium*.
- 31** Some of the pathogenic spore types like *Alternaria*, *Cercospora*, *Curvularia*, *Heliminthosporium*, *Periconia*, *Puccinia* and *Sphaecelotheca* were observed in high concentration and have been investigated in detail.
- 32** The Meteorological factors like temperature, relative humidity and rainfall had a pronounced effect on spore liberation and ultimately affected airspora composition qualitatively and quantitatively.
- 33** Monthwise average and monthly average percentage of individual spore and individual group was calculated separately.
- 34** The present air spora studies over jowar fields, contributed in understanding the composition and components of airspora in the Rabi seasons.
- 35** These results would be further useful in devising the disease forecasting system for jowar crop which would subsequently help in protecting the crops.

BIBLIOGRAPHY

- Adams, K. F. (1964). Year to year variation in fungus spores content of the atmosphere. *Acta Allergol* 19:11-50.
- Agarwal, M. K. and Shivpuri, D. N. (1974). Fungal spores their role in respiratory allergy. *Adv. Pollen Res*, 1: 78- 128.
- Agashe, S. N. and Vinay, P. (1983). Aerobiological studies of Bangalore city part II Advances in pollen, spore research. 185 -193.
- Aher, S. K. Dhawale, V. P. and Baviskar, P.S. (2015). Qualitative Assessment of airborne deuterospores over pomegranate (*Punica granatum* L.) field. *Int. J of Life science special Issue*.18-20.
- Aher, S. K. (1993). An impact of environmental parameters on airborne indoor and outdoor microbes at Ahmednagar. Ph.D. Thesis Dr. B.A .M .U, Aurangabad.
- Ahire, P.P. shinde, H. P. Goswami, D. B. Kadam, V.B. (2013). Fungal Airspora over the sugarcane fields at Nasik using Tilak Air sampler *IJPRBS*. 2(2):11-15.
- Ahire, P. P. (1990). Airspora at Nashik Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Ahuja, S. R. (1991). Airspora of Aurangabad. Ph.D. Thesis Marathwada University Aurangabad.
- Ainsworth, G. C. (1952). The incidence of airborne Cladosporium in the London region, *I. Gen.Microbiol.* 7:358-361.
- Allapure, R. B. (2016). Aeromycological studies over sunflower field at udgir Region (M.S). *Int. J. of Research in Medical and Basic sciences*.2 (11).
- Alit. (1984). Identity and occurrence of venturiaceous spores in the air at Cambridge. *Trans. Brit. Mycol. Soc.* 83:431-446.

- Altikreti. S. K. Muna. A.I. Salihi and Gillard, G. E. (1980). Pollen and mould survey of Bhagded Iraq. *Ann. Allergy* 45:97.
- Ambhore, J. S. (2014). An impact of Environmental Parameters on atmospheric concentration of Cladosporium over paddy At Shrivardhan Dist. Raigad (M.S). *Bionano Frontier*. 7(1):157 -159.
- Ambhore, J. S. (2003). Aerobiological studies over some crop fields of Maharashtra Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Amber, M. P. and Vernon, J. R. (1951). Airborne mould spores. A Survey of the atmospheric spore load in Auckland city and suburban area New Zealand *J. Sci and Tech*. 33 (3):78-80.
- Arsule, C. S and Pande, B. N. (2011). Fungal Airspora over the Groundnut fields at Newasa (M.S). *Bionano Frontier*. 4 (2).
- Browne, J.G (1930). Living microorganisms in the air of the arid southwest. *Science*. 72:322-323.
- Bharat, Rai (1969). Air fungal flora of Varanasi, proc. 56th Ind. Sci.Congr. Bot.Sec.Abst. 113.
- Babu, M. (1983). Aerobiological studies at Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.
- Badge, M. and Mhatre, K. (2017). Aero mycological Studies over some paddy fields in the Ratnagiri Maharashtra state. *Int. J of current Research*. 9(6):441-444.
- Baig, M. and Fatima, S. (2016). Pathogenic and Non-pathogenic fungal flora over Sugarcane field at Aurangabad *Journal of medicinal chemistry and Drug Discovery*. 2(1):144-147.
- Bale, V. S. (1983). Aeromycological survey at Osmanabad. Proc 71st Indian Science Congress Bot. Sec.78.
- Bale, V. S. (1983). Studies in Aeromycology & taxonomy of some genera of fungi from Marathwada. Ph.D. Thesis Marathwada University, Aurangabad.

- Ban, V. G. (1997). Aerobiological studies over some oil yielding Crop. Dr. Babasaheb Marathwada University, Aurangabad.
- Bapat, A. R. (1991). Studies in Taxonomy & Aeromycology of some fungi from Marathwada region of Maharashtra. Ph.D. thesis Marathwada University Aurangabad.
- Baraskar, S.M and Patil, S. R. (2016). Investigation of Bio components over Jowar crop field at Jamkhed. *Asian Journal of Multidisciplinary Studies*. **4**(9).
- Baraskar, S.M and Patil, S. R. (2017). Aerobiological Investigation of Cladosporium spores over Jowar crop field at Jamkhed (M.S). India. **5**(8).
- Bartzokas, C. A. (1975). Relationship between the metrological conditions and the airborne fungal flora of the Athens Metropolitan area. *Mycopathologia* **57**: 35-38.
- Baviskar, R. N. and Suryawanshi, N. S. (2013). Aeromycological study of APMC. Fruit Market of Vashi, *Int. J of Life Sciences*. 52-54.
- Bembrekar, S. K and Bodke, S. S. (2013). Studies on composition and components of airspora belonging to Phycomycetes over cotton field during two consecutive kharif seasons. *Golden Research Thoughts*. **2**(9):1-7.
- Berger, R. D. (1969). Forecasting *Cercospora* blight of celery in Florida A. *Phytopathology*. **59**:1018.
- Chavan, V.S. (2011). Diversity of Fungal Spores in paddy Fields (*Oryza sativa* L.) *Indian streams Research Journal*. **1**(1):1-4.
- Bhadane, M. T. (1991). Aerobiological studies at Dhulia. Ph.D. Thesis Marathwada University Aurangabad.
- Bhalke, S. B. (1981). Air-spores over some fields. Ph.D. Thesis, Marathwada University Aurangabad, Maharashtra
- Bhasale, S. S. (1983). Studies in air- spora of Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.

- Buller, A. H. R and Low, C.W. (1911). Upon the number of microsporangiums in the air of Winnipeg Trans. *Roy. Soc. Can* **4**:41-58.
- Calvo, M. A. Guarro, T. J. Fernandez, G. S. and Ramirez, C. (1979). Airborne fungi in the air of Barcelona (Spain) - II the genus *Alternaria*. *Mycologia*. **69**(3):137-142.
- Calvo, M. A. Guarro, T. J. and Franades, G. S. (1981). Airborne fungi in the air of Barcelona (Spain) IV, the Genus *Cladosporium*. *Mycopathologia*. **69**(3):127-142.
- Cammack, R. H. (1955). Seasonal changes in three common constituents of airspora of southern Nigeria. *Nature* 176: 1270-1272.
- Cammack, R. H. (1958). Factors affecting infection gradients from a point source of *Puccinia polyspora* in plot of *Zea Mays*. *Ann. Appl. Biol.* **46**:186-197.
- Carter, M. V. and Moller, W. J. (1961). Factors affecting the Survival & dissemination of *Mycosphaerella pinodes* in south Australia irrigated pea fields. (Perk and Blox) *Vaster Aust J. Agric. Res.* **12**:878-888
- Chakraborty, P. B. Gupta, S. and Chanda, S. (2003). Aeromycoflora of an agricultural farm in west Bengal, India. *Grana*. 42:248-254.
- Chaubal, P. D. and Deodikar, G. B. (1964). Airborne spores around Poona. *Journal of University Poona*. **26**:123-136.
- Chavan, V. S. (2007). Aeromycological studies over paddy fields at Raigad in Kokan region Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Chitale, S. D. and Bajaj, A. (1973). Airspora of Nagpur at high altitudes-I. *Botanique*. 5:27-34.
- Chitale, S. D. and Bajaj, A. (1974). Airspora of Nagpur at high altitudes -II *Botanique*. **6**:59-69.
- Chitale, S. D. and Bajaj, A. (1975). Airspora of Nagpur at high altitudes -III *Botanique*. **6**:59-69.

- Chitra, A. and Arun, A. (2007). Aeromycoflora of fruit market of Baroda, India & associated diseases of certain fruits. *Aerobiologia*. 23:283-289.
- Clavo, M. A. Guarro, J. Suarez, G. and Ramirez, C. (1980). Air borne fungi in Barcelona city (Spain) *Crycopath*. 71:89-93.
- Collins, W.C. and. Best, C. A. (1955). Atmospheric mould in the country of Toranto (Canada) J.Allergy.
- Cunningham, D. D. (1873). Microscopic examinations of air Govt. printer Calcutta. 58.
- Davies, R.R. Denny, M. J. and Newton, L.W. (1963). A comparison between the summer and autumn airspora at London and Liverpool. *Acta Allergol*. 18:131-147.
- Debnath, S. and Baruah, P. K. (2008). Seasonal Variation at Aeromycoflora over Tea plantation Jorhat District. Assam. *Indian Journal of Aerobiology*. **21**(2):79-85.
- Derric, E. (1966). Air- borne pollen and spores in Melbourne. *Aust J. Bot*. 14:49-66.
- Derric, E. and Mchennan, E. I. (1963). Fungal spores found in air in Melbourne (Australia). *Acta Allergol* 18:26-43.
- Derrick, E. I. Mchennan, (1966). Air borne pollen & spores in Melbourne. *Australian J. Bot*. 14:49-66.
- Deshmukh, L. P. (2001). Aeromycological studies over some crop fields of Jalgaon District. The Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad
- Deshmukh, N. T. (1989). Study of air spora over some fields at Parli-Vaijinath. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Deshpande, (1993). Aeromycology studies over some field of Marathwada.
- Di- Meena, M. E. (1955). A quantitative study of airborne fungus spores in Dunedian, New Zealand. *Trans. Brit mycol. Soc*. 38: 119-129.
- Diez, A. Sabariego, S. Gultierrez, M. Cervigon, P. (2006). Study of airborne fungal spores Madrid (Spain). *Aerobiologia pollen*. 13:216-269.

- Donald, M. G. and Odriscoll, D. J. (1980). Aerobiology Studies based on Galway. Ireland. A comparison of pollen and spore counts over two seasons of widely differing conditions. *Clin. Allergy*. 10:211-216.
- Dransfield, M. (1966). The Fungal air- spora at samaru, N Nigeria. *Trans. Brit mycol. Soc.* 49: 121-132.
- Dye, M. H. and Vernon, T. R. (1952). Airborne mould spores, A new Zealand survey, *New Zealand J. Sci Tech.* 34:118-127.
- Edmonds, R. L. (1979). Aerobiology: the Ecological system Approach. US /IBP synthesis Series 10. Dowden, Hutchinson & Ross, Inc. Stroudsburg, Pennsylvania.
- Ehrenberg, C. G. (1872). Natchrag Zur ubersicht der organische Atmospharilien Abhandl kg. Akad, wiss. *Berlin phus.* Pp.233-275.
- Feingold, I. (1975). A two year pollen and spore survey of southeast Florida. *Ann. Allergy*. 37-41.
- Frankland, P. C. (1886). The distribution of microorganisms in air. *Proc. Roy. Soc.* 4(40):509-526.
- Frankland, P. E. (1887). A new method for the quantitative estimation of microorganisms presents in the atmosphere *phil. Trans .B* 17(8):113-152.
- Franking, H. D. (1978). Aerobiology and plant pathology international Aerobiology Newsletter, 8:16-19.
- Gadekar, S. S. (2014). Fungal Diversity, their concentration and impact over Jowar crop at Pune, India. *Research Article, Acta Biological Indica.* 3(1):605-609.
- Gadekar, S. S. (2013). Aerobiological Investigations over Jowar crop field at Rahuri. *International Journal of Life sciences.* 1:22-26.
- Gadekar, S.S. (2014). Diversity of Fungal spores over Jowar crop. *International Journal of Life sciences* 2(2): 155-159.

- Gravensen, S. (1972). Identification and quantification of indoor airborne micro fungi during 12 months from 44 Danish homes. *Acta Allergol.* 27:337-354.
- Gaikwad, Y. B. (1974). Studies in airspora and taxonomy of Pyrenomycetes Ph.D. Thesis Marathwada University, Aurangabad.
- Garje, P. M. (2002). Studies in Extramural Environmental Bio pollution Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Gopan, M. (2014). Studies in air airspora at Namalgaon phata. (Beed). Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Gregory, P. H. (1952). Fungus Spores. *Trans Brit Mycol. Soc.* 35:1-18.
- Gregory, P.H. (1954). The construction and use of a portable volumetric spore trap. *Trans.Brit. Mycol. Soc.*, 37: 390-404.
- Gregory, P. H. and Hirst, J. M. (1957). The summer airspora at Rothamsted in 1952. *J. Gen. microbiological.* 17:135-152.
- Hamilton, E.D. (1959). Studies on the airspora. *Acta Allergol. Kbh.* 13: 143-175.
- Harvey, R. (1970). Airspora at Cardiff –I. *Cladosporium*. *Trans. Brit. Mycol. Soc.*, 50: 479-495.
- Harvey, R (1970). Airspora studies at Cardiff- III. Hyphal fragments. *Trans.Brit. Mycol. Soc.*, 54: 251-254.
- Harvey, R., I.J. Hodkiss and P.N. Lewis (1969). Airspora studies at Cardiff- II. *Chaetomium*. *Trans. Brit. Mycol. Soc.*, 53: 269-278.
- Harze, C.O. (1904). Baktrilogische untersuchungender freien atmospheric mittens Luffa lions nebst Bemerkun gen uber den atmosphärischen. *Staub Jb. Disch. Luftach Vert.*, 147-170.
- Hirst, J.M (1953). Changes in atmospheric spore content diurnal periodicity and the effect of weather. *Trans. Brit. Mycol.Soc.*, 36: 375-395.

- Hudson, H.J (1969). *Aspergillus* in the air spora at Cambridge. *Trans. Brit. Mycol. Soc.*, 52:153-159
- Hyde, H. A. and Williams, D. A. (1949). A census of mould spores in the atmosphere *Nature*. 164: 668-669.
- Iva volaric, (1983). Pollen and spores studied in two side towns related to aerobiological features Croatia 2nd Int. conf. *Aerobiol. Abstr.*
- Jacobs, W. C. (1951). Aerobiology in compendium of metrology. American meteorological society, Boston, 1103- 1111.
- Jankibai, A. and Subba Reddy, (1981). The fungus airspora of Visakhapatnam. *Proc. India Nat. Acad.* 5:731-747.
- Jadhav, D. S. Patil, B.Y and Dhale, D.A. (2010). Airspora over groundnut fields at Kalamb. *Journal of phytology*. 2(12) 14-16.
- Jadhav, S. K. (1996). Aeromycoflora over rice field at Balodabazar, Raipur. Ph.D. Thesis pt. R.S University Raipur.
- Jayswal B.D (1993). Atmospheric incidence of microbial population at Dhule and relevance to environmental parameters PhD thesis Marathwada University Aurangabad
- Jagan Mohan Reddy, N. (1988). Airspora studies at Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.
- Jogdand, A. (1998). Airospora at Aurangabad. Airspora Ph.D. Thesis. 204-238.
- Jogdand, S. B. (1987). Airspora at Aurangabad. Ph.D. Thesis Marathwada University Aurangabad.
- Khan, S. K. Khan, S. and Fatima. (2014). Aeromycoflora of Vegetable and Fruit market of Beed city Maharashtra, India. *Journal of Advanced Applied sciences &Technology*. 1:30-31.
- Karnik, C. R. (1962). A Contribution to the rain water forms and airspora of Jalgaon District. *Science and culture* 28:475: 476.

- Kramer, C.L and S.M Pady (1960). Kansas Aeromycology-IX. Ascomycetes. Trans. Kansas Acad. Sci., 63: 53-60.
- Kramer, C.L., S.M. Pady, C.T. Rogerson and I.G. Ouye (1960). Kansas Aeromycology- V. Penicillium and Aspergillus. Mycologia, 52: 545-551.
- Kramer, C.L., S.M. Pady, C.T. Rogerson and I.G. Ouye (1960). Kansas Aeromycology-VIII. Phycomycetes. Trans. Kansas Acad. Sci., 63: 19-23.
- Kadam, R. M. Patil N. J. M and Birajdar, R. P. (2010). Aeromycoflora over a Sugarcane field at Ahmedpur Dist. Latur (M.S). *International Journal of plant sciences*. 5(2): 587-589.
- Kadam, R. M. Biradar, R. P. and Reddy, N .J .M. (2011). Study of airborne imperfect fungi over bajra (*Pennisetum typhoids*) fields at Ahmedpur (M.S) *Int. J. Of plant protection*. 4(1):143- 145.
- Kadam, S. S. (2012). Aerobiological investigations over sugarcane fields at Shankarnagar.
- Kale, V. S. (1983). Study of air spora over some crop field at Parli-Vaijinath. Ph.D. Thesis Marathwada University, Aurangabad.
- Kanade M. B. Awatade, A. Gulave, S. Wagh, A. Kalkute, Chandankar S. and Waghmare, A. (2018). Aeromycoflora over Jowar and pomegranate fields at Baramati Dist. Pune (M.S). *Bioscience Discovery*. 9(1): 93-96.
- Kanade, M. B. Awatade, A. Gulave, A. Wagh, S. Kalkute, A. Chandankar, S. and Waghmare, A. (2018). Aero mycoflora over Jowar and pomegranate field at Baramati Dist. Pune (M.S). *Res. J. Bioscience Discovery*. 9(1): 93-96.
- Kardule, S. R. and Jadhav, D. S. (2016). Study of Atmospheric mycoflora over Bajra crop fields at shiral Tal. Ashti Dist. Beed (M.S). India *proceeding of national conference on environment and Development*. 15-20.
- Karla, S. L. and Dumbry, (1957). Aerobiology of army medical campus, Poona. Armed forces M.ed. *J. India* 18:3-76.

- Karne, A.V. (2013). Aero mycological investigations in the Ambient Air over some crop fields in context to Pathogenic and Allergenic fungal Bio aerosols. *An int. Quarterly Scientific Journal*. **12**(4): 695 – 698.
- Kasprzyk, I. and Worek, M. (2006). Airborne fungal spores in urban & rural environments in Poland. *Aerobiology*. **22**:169-176.
- Kavishwar, A. D. (1990). Aerobiological Studies at Dhulia-I. Ph.D. Thesis Marathwada University, Aurangabad.
- Kiyusawa, S. (1972). Mathematical studies on the curve of disease incidence. A technique for forecasting epidemic development *Annual. Phytopathology Society, Japan* **38**:30-40.
- Kotwal, (1993). Aerobiological investigations at Nashik Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Kshirsagar, J .J. Dharasurkar, A.N. and Pachkore, G.L. (2016). Fungal spore of Groundnut fields in Beed District. *IJRBT*. **4**(1):161-164.
- Kshirsagar, J. J. and Pande, B. N. (2012). Prevalence of Cladosporium spores over sunflower fields at Rajuri (N). M.S India. *Science Research reporter* **2**(1):66-68.
- Kshirsagar, J. J. and Pande, B. N. (2009). Atmospheric Concentration of Alternaria spores over sunflower fields at Rajuri (N). Maharashtra. *Bioinfolet* **6**(4): 352.
- Kulkarni, R. L. (1971). Studies in airspora over some fields at Aurangabad Ph.D. Thesis Marathwada University, Aurangabad.
- Kumar, R. and Gupta, J. S. (1976). Seasonal and diurnal variations in the airspora over a potato field II. *Indian Phytopath.* **29**: 181-185.
- Kuribayashi, K and Ichikawa, H. I. (1952). Studies on forecasting of rice blast disease. Nagano Agri. Expt. Sta. Rept. **13**:1-299.
- Lakhe, D. G. (1980). Airspora studies over some fields. The Ph.D. Thesis Marathwada University, Aurangabad.

- Lacey, M.E (1962). The summer airspora of two contrasting adjacent rural sites. *J. Gen. Microbiol.*, 29: 485-501.
- Lehtimäki, A. (1997). Research on airborne fungus spores in Finland. *Grana*. 16:163-165.
- Lohare, S. D. (2016). Incidence of Airspora over soybean field at in Maharashtra state in India. Proceeding of the *IIER international conference, Paris, France*. :1-2.
- Lohare, S. and Kamble, R. (2013). Atmospheric concentration of *Cercospora* over soybean field, National conference on recent trends in plant science for rural Development.
- Long, D. L. and Kramer, C. I. (1972). Airspora of two contrasting ecological sites in Kansas.
- Louis Pasteur (1861). Memoire surless corpuscles, organizes quiexistent danstl atmosphere, Examen de la doctrine des generation Spontaneous. *Ann. Sci. Nat.* **16**:5-98.
- Mishra and kamal (1971) Aeromycological of Gorakhpur III. Seasonal variation in air fungal spora. *Mycopath*
- Malabade, H.S (1990). Aeromycological studies at Chalisgaon. Ph.D. Thesis Marathwada University Aurangabad.
- Meghraj B (1989). Airspora of Aurangabad II Ph.D thesis Marathwada university Aurangabad.
- Mali V. Sayyed, I .G. and Pathare, G. M.(2011). Fungal diversity over Green Gram field. *Bionano Frontier*.50-52.
- Mali, V. P. Pathare, G. M.. Fatima, S. Pande. B.N. (2012). Fungal Diversity in Ambient air over Bajra fields. *Bionano frontier*-154-157.
- Mali, N.S and Gaikwad, Y.B. (2011). Study in pathogenic Airspora and epidemiology of Groundnut crop at Solapur during Kharif season. *Bioscience Discovery*. **2**(1).
- Mali, V. P. (2002). Studies in Aerobiology over crop fields Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

- Mallaiah, K. V. and Rao, A. S. (1980). Aerobiology of two species of *Cercospora* pathogenic to Groundnut. *Indian National Science Academy*. 46:215-222.
- Mane, D. A. (1978). Studies in airspora over some fields Ph.D. Thesis Marathwada University, Aurangabad.
- Mehta, K.C. (1940). Further Studies on cereal rust in India. *Sci Monogr.coun. Agric. Res. India*, 18:1-368.
- Mehta, K. C. (1952). Further Studies on cereal rusts in India.PartII, *Sci. Monogr. Coun, Born Agric. Res. India*. 18:1-368.
- Meier, F. C. Stevenson J. A. and Charles, V. K. (1933). Spores in upper air. *Phytopath.* 23:23.
- Meredith, D. S. (1966). Spore Dispersal in *Alternaria Pori* on onions in Nebraska *Ann. Applied Biology*. 57: 67-73.
- Meredith, D. S. (1970). Major Banana diseases post and present status. *Rev. Plant pathology*.49: 539-554.
- Meredith, D. S. (1973). Dispersal of spores of tropical plant pathogens. Second international symposium. *Plant pathology*. (New Delhi) : 29.
- Meshram, B. M. (1990). Studies in airspora at udgir. Ph.D. Thesis Marathwada University, Aurangabad.
- Milton, D. (1966). A study of atmospheric mold spores in Tucson. *Ann. Allergy* 24:31-36.
- Mills, J.T (1967). Spore dispersal and natural infection in oat loose smut (*Ustilago avenae*). *Trans. Brit. Mycol. Soc.*, 50: 403-412.
- Mishra, R. P. and Bhandari, S. (2006). Atmospheric fungal flora of Jabalpur Madhya Pradesh India. *Journal of microbiology*. **46**(4):325-332.
- Mishra, R. R. and Srivastava, V. B. (1972). Aeromycology of Gorakhpur U. Air spora over wheat and barley fields. *Mycopath. et. Mycol. appl.*, **47**:349-355.

- Mishra, R. R. and Srivastava, U. B. (1971). Aeromycology of Gorakhpur spore content over paddy field. *Mycopath, app.***44**:283-288.
- Morales, J. Gonazaler, F. J. Minero, M. Carrasco, U. M. Orgalla, P. (2006). Airborne Basidiospores in the atmosphere of Seville (South Spain) *Aerobiologia*. **14**(1):59.
- Munde, V. R. (2016). Phycomycetes Fungal spores diversity over chili field at Parli – Vaijinath (M.S) India. *Int.J. of science Information*. **1**(5):269-272.
- Munde, V. R. (2006). Study of airspora over some fields at Parli –Vaijinath. Ph.D. Thesis, Dr. B.A.M.U, Aurangabad.
- Mushin, T. M. and Munirah, M. A. (2012). Season distribution pattern of outdoor airborne fungi in Basrah city southern Iraq. *Journal of Basrah Research (sciences)*. **38**(1):90-98.
- Mustafa, A. F. and Kamal, S. M. (1976). A study of fungal spore population in the atmosphere of Kuwait *Mycopath* 56: 29-36.
- Nagarajan, S. H. Singh, L.M. Joshi and Saari, E.E. (1976). Meteorological conditions associated with long distance dissemination and deposition of Puccinia *Triticale* Uredospore in India. *Phytopathology* **66**:198-203.
- Narpurne, S. D. (1993). Airspora at Kandhar. Ph.D. Thesis Dr .B.A.M.U Aurangabad.
- Nagia, K. N. (1994). Studies in taxonomy & Aeromycology of some fungi of state of Maharashtra Ph.D. Thesis Dr .B.A.M.U Aurangabad.
- Nair, P. K. Joshi, A. P. and Gangal, S.V. (1986). Airborne pollen spores and other plant materials of India, a survey CSIR Centre for Biochemical Delhi & National Botanical Research Institute Lucknow.
- Nanda, A. and Nayak, B. K. (2015). Studies on environmental bio-pollution by airborne fungi over a Sugarcane field. *Derpharmacia Letter*. **7**(5):245-249.
- Padmanabhan, S. Y. Ganguly, D. and Balkrishnan, M. S. (1952). Heliminthosporium diseases of Rice II. Source and development of seedling infection. Ind. *Phytopathology* **6**:96-105.

- Pady S.M. (1951). Fungi isolated from Arctic air in 1947. *Cand. J.Bot.* 29: 46-56.
- Pady S.M. (1957). Quantitative studies of fungus spores in the air. *Mycologia*, 49:339-353.
- Pady, S. M. and Kramer, C. L. (1960). Kansas Aeromycology VI Hyphal fragments. *Mycologia*. **52**:681-687.
- Pady, S. M. and Kramer, C. L. (1960). Kansas, Aeromycology X Basidiomycetes. *Trans Kansas Acad. Sci* **63**:125-135.
- Pady, S. M. and Kramer, C. L. (1960). Kansas Aeromycology-VII. Smuts. *Phytopath.* **50**:332-334.
- Pady S.M and L.Kapica (1953). Airborne fungi in the Arctic and other parts of Canada. *Cand. J.Bot*, 31.309-326.
- Pady S.M and C.D. Kelly and N. Pollunin (1953). Studies on microorganisms in Arctic air during 1949 and 1950. *Cand. J. Bot.*, 31:107-122.
- Pady, S. M. (1957). An improved silt sampler for aerobiology investigations *Trans. Kansas & Acad. Soc.* **57**: 157-163.
- Pady, S. M. (1957). Quantitative studies of fungus spores in the air. *Mycology*. **49**: 339-353.
- Pady, S. M. (1959). A continuous spore sampler. *Phytopath.* **29**:757-760.
- Panda, T. Panda, B. and Mishra, N. (2009). Seasonal incidence of Air borne fungi in coastal belt of Orissa. *Journal of Hum. Ecol.* **26**(3):205 -207.
- Pande, B.N. Dere, P. K. and Arsule, C.S. (2012). Atmospheric Fungal Diversity over the Vegetable market at Aurangabad (M.S). *Eco. Revolution*.
- Pande, B. N. (1994). Air monitoring of two species of *Cercospora* pathogens to groundnut fields Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. *J.* 27:26-29.
- Pande, B. N. (1976). Studies in airspora over some fields at Nanded. Ph.D. Thesis Marathwada University, Aurangabad.

- Pathak, V.K and S.M. Pady (1965). Numbers and viability of certain air borne fungus spores. *Mycologia*, 57: 301-310.
- Panzer, J. D. Tallis, E. C. and. Van Arsdell, E. P. (1957). A simple 24- hours slide spore collector. *Phytopath.* **47**:512-514.
- Pasteur, L. (1861). Memoir surless corpuscles organize quixistent densl atmosphere Exumen de La. Doctrine des generations spontaneous. *Ann. Sci. Mat. (Zool.)* 4.6ser.**16**:5-98.
- Pathare, G.M. and Sayyed, I.G. (2016). Studies on composition and components of Airspora Belonging to Ascomycetes over Green Gram field During Kharif season at. Kada Tal. Ashti Dist. Beed (Maharashtra) an *Int. peer Reviewed Journal. Of Multisciplinary & research.* **3** (1).
- Pathare, G. M. Mali, V. P. and Pande, B. N. (2010). Atmospheric concentration of Alternaria spores over sunflower field. *Int.J of Plant sciences.* **5**(1): 395-396.
- Patel, S. I. (2003). Studies Aeromycology over some vegetable fields of Maharashtra Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Patil, M. T. and Mali, N.S. (2017). Fungal Aerospora over the Jowar Fields. *Central European Journal of Experimental Biology.* **5**(1): 72-76.
- Patil, M.T. Kanade, M.B. and Mali, N.S. (2016). Studies on Aeromycoflora over Jowar Fields at Barshi Area during Kharif Season. *Bionano Frontier.* **9**(1):78-81.
- Patil, T. M. (2009). Studies in airspora over black gram fields. Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Patil, S.P. and Patil, B.D. (2009). Aero mycological studies on wheat field from Karad Region *Bioinfolet* **6**(2):151-152.
- Patil, A. N. (1992). Aerobiological Studies at Jalgaon & it's relative to environmental parameters. Ph.D. Thesis Marathwada University Aurangabad.
- Patil, B. Y. (1985). Aerobiology studies at Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.

- Patil, C. R. (1983). Aerobiological studies Aurangabad. Ph.D. Thesis Marathwada, Aurangabad.
- Pawar, K.D. (2013). Season wise Comparative total Deuteromycotina Flora and its percentage contribution over Groundnut field. *Indian streams Research Journal*. **3** (3).
- Pawar, S. R. (1997). Studies in airspora over some crop fields at Aurangabad. The Ph.D. Thesis Dr Babasaheb Ambedkar Marathwada University, Aurangabad.
- Pawar, K. D. (1998). Aeromycological Studies at Nanded Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Perkins, W. A. (1957). The Rotorod sampler, 2nd semifinal Rapt Aerosol Lab Dept. of Chemistry and Chem. Engg. Stanford. Univ. CML 186:66.
- Pillai, S. G. (1984). Airspora at Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.
- Proctor, B.E. (1935). The microbiology of the upper air- II. J.Bact. 30: 363-375.
- Quazi, (1985). Aerobiological approach to some crop disease Ph.D. thesis Marathwada University, Aurangabad.
- Rachie, K. O. (1970). Sorghum in Asia. In sorghum production and Utilization Eds J.S Wall and W.M Ross, West Port, Conn, U.S.A. AVI. Publishing co.328-381.
- Rajalakshmi, M.C. and. Shakila, P. (2008). An Aeromycological Survey over Groundnut field. *Nature Environmental & Pollution Technology, Techno science Publication*. **7**(1):145-146.
- Rajan, B. S. Nigam, V. and Shukla, B. K. (1952). A study of atmospheric fungal flora at Kanpur. *Proceeding of the Indian Academy of sciences*. **35**:33-37.
- Rajurkar, S. K. (1996). Aerobiological investigation at Parbhani (M.S). The Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.

- Ramakrishna Reddy, N. (1987). Airspora at Aurangabad. Ph.D. Thesis Marathwada University, Aurangabad.
- Ramchander Rao, K. S. (1987). Aerobiological studies at Aurangabad. Ph.D. Thesis Marathwada University Aurangabad.
- Ramirez, C. A Martinez, T. and Berenguer, J. (1980). Four New Species of *Penicillium* isolated from the air. *Mycopathologia*. 72:27-34.
- Rao, T. A. Shaikh, A. H. Ahmed, M. (2009). Airborne fungal flora of Karachi, Pakistan. *Pak J. Bot.* **41** (3):1421-1428.
- Ray, M. K. Mishra, P. K. and Baruah, P. K. (2015). Seasonal Variation of Air mycoflora over Some Plantation at Goalpara District of Assam during various Muga crop seasons *Int. J. pure App. Biosc.* **3**(2):128 -132.
- Reddy, N. J. M. and Kadam, S. A. (2013). Effect of Meteorological Factors on the air borne Fungi over Sugarcane (*Saccharum Officinarum*). National conference on recent trends in plant science pore rural Development. 90.
- Reddy, A. (1990). Studies in airspora at Zahirabad (A.P) Ph.D. Thesis Marathwada University, Aurangabad.
- Reddy, C. S. and. Ramakrishna, V. (1978). Vertical Profiles of spore concentration within & above sorghum crop. *Phytopathology*. 93:33-40.
- Rees, R.G. (1964). The air spora of Brisbane, *Aust. J. Bot.* 12: 185-204.
- Richards, M. (1956). A census of mould spores in the air over Britain in 1952. Trans. Brit. Mycol. Soc., 39: 431-441.
- Rogers, L.A and F.C. Meier (1936). The collection of microorganisms above 36,000 feet. Nat. Geog. Soc. Stratosphere series, 2: 146-151.
- Rooks, R. and Shapiro, R.S. (1958). The value and limitations of mould survey by the current plate method *J. Allergy*. 29:24-28.

- Sabariego, S. Diez, A. Cutierrez, M. (2007). Monitory of airborne fungi in Madrid (Spain). *Acta Bot, Croat.* **66**(2):47-126.
- Sabarigo, (2000). The effect of metrological factors on the daily variations of air borne fungal spores in Granada (South Spain).
- Sahney, M. and Purwar, A. (2007). A study on the airborne fungi at Allahabad. *Indian Journal of Aerobiology.* **20**(1&2):17-25.
- Saibaba, M. (1983). Aerobiological studies at Aurangabad Ph.D. Thesis Marathwada University. Aurangabad, Maharashtra.
- Saito, K. (1904). Untresuchgen uber die atmospheric schan: pilskeime, *I Mitt J. Coll. Sci.* Tokyo. 18:58.
- Saito, K. (1922). Untre Suchengen Uber dies atmosphari Schen Pilas keime-III. *Mitt. Jap. J. Bot* **1**:1-54.
- Sankaye, T. B. (1989). Studies in airspora at Latur. Ph.D. Thesis Marathwada University Aurangabad.
- Sengupta, C. and Chattopadhyay, S. B. (1963). Study on the prevalence of air borne conidia of *Heliminthosporium oryzae* in relation to weather conditions proc. 50th Ind. Science. Congress (Delhi) *Agricultural. Sci.*78.
- Shapiro, R.S. Ban, C. F. and Linder, W. (1965). The importance of field studies and Metrological factors in pollen & mould survey. *Ann. Allergy.* 23: 484-491.
- Shastri, S. D. (1981). Air-spores over some fields Ph.D. Thesis, Marathwada University Aurangabad, Maharashtra.
- Sharma and Pande (2000). Microbial population over groundnut fields Dr. B.A.M. Uni, *Jour. of Sci.* XXX. 7: 81-88.
- Sharma, and Narsimha, O. H. (1996). Aeromycological studies at siddhipet (A.P) Ph.D. Thesis Dr. B.A.M.U, Aurangabad.

- Sharma, G. C. and Sarma, R. (1993). Incidence of air borne fungal spores in Guwahati. *Int. J. Aerobiology*. **6**(1&2):36-40.
- Sharma, T. K. and Singh, S. (1973). Spore content of air over a sorghum field near Agra. India, *Sorghum Newsletter*. 16:96.
- Shastri, S. D. (1996). Aerobiological survey of fungal spores in two different spores over maize fields. Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Sanin, S.S., V.I.Terekhov, V.P.Chuprina and A.D.Pozdnyakova (1976). Determination of the number of rust uredospore in plant stands by their concentration in the layer of air near the ground. *S.kh. Biol.*, 11: 587-591.
- Schenck, N.C. (1968). Incidence of air borne fungus spores over watermelon fields in Florida. *Phytopathology*, 58:91.
- Shastri, S. D. (1981). Air-spores over some fields. Ph.D. Thesis Marathwada University, Aurangabad.
- Shinde, M. and. Mahajan, M. (2013). An overview of Aerobiology over Groundnut crop At Patan (M.S). *Int.J. of Life sciences* 29-30.
- Shinde, R. S. (1996). Airspora over Jowar & Sunflower Fields at Nanded. Ph.D. Thesis Dr. B.A.M.U, Aurangabad.
- Sing, (1993). Atmospheric concentration of microbes in indoor and outdoor environment Parameters at Aurangabad (M.S).Ph.D. Thesis, Marathwada University, Aurangabad.
- Sonawane, B.N Arsule, C.S. and Pande, B.N. (2017). A Survey of Bio aerosol over groundnut fields at Newasa Dist. Ahmednagar (M.S). *Int.J. of Recent scientific Research*. **8**(8):18954-18958.
- Sonawane, M. D. (2013). Aero mycological studies of groundnut field at Nasik (M.S) *IJPRBS*. **2**(6):575-583.
- Sonawane, M. N. (2004). Aeromycological studies at Nasik. Ph.D. Thesis Dr. B.A.M.U. Aurangabad.

- Sreeramulu, T. and Ramakrishna. (1971). Spore concentrations in air within above fields of sugarcane, rice, sorghum and banana. *proc. 58th Ind. Sci, Congr. Bot. Sec.*52.
- Sreeramulu, T. and Vittal, B. P. R. (1971). Periodicity in the Uredospore content of air within & above sugarcane fields. *J. Ind. Bot. Soc.* 50: 39-44.
- Sreeramulu, T. (1970). Air spora of crop fields and it application. *J. palynol.* 6:31-38.
- Sreeramulu, T. and Vittal, B. P. R. (1969). Aerobiological studies over sugarcane Smut Porc 56th *Ind.sci. Cong. Bot. Sec* Abstr. No. 53.
- Sreeramulu, T. and Vittal, B. P. R. (1966). Periodicity in the airborne spores of the rice false smut fungus *Ustilago noidea virens*. *Brit. mycol, Soc.* 49:443-499.
- Sreeramulu, T. and Ramlingam, A. (1966). A two year study of the air-spora of paddy field near Visakhapatnam. *Ind. J. Agri. sci.* 36:111-132.
- Sreeramulu, T. and Seshavataram. (1962). Spore content of air over paddy fields. I changes in a field, 1957. *Ind. phytopath.*15:61-74.
- Sreeramulu, T. and. Ramlingam, A. (1963). Spore content of air over paddy fields- II changes in the field, near Vishakhapatnam from November 1959 to January 1960. *Proc. Nat, Acad. Sci. India.B.*, 33:423-428.
- Sreeramulu, T. (1958). Spore content of air over the Mediterranean Sea *J. Ind. Bot. Soc* **37**:220-228.
- Stakman, E.C., A.W. Henry, G.C. Curran and W.N. Christopher (1923). Spores in upper air. *J. Agric. Res.*, 24:599-606.
- Stakman, E. C and Christensen, C. M. (1946). Aerobiology in relation to plant diseases. **12**:205-253.
- Stephanov, (1935). Dissemination of infective Diseases of plants by air currents. *Phytopathology* **8**:1- 68.

- Street, D. H. and Hanburger, R. N. (1976). Atmospheric pollen & spore sampling in San Diego California. *Annual Allergy*. 37: 32-40.
- Subba reddy, (1970). A comparative survey of atmospheric pollen and fungus spores at two places, twenty miles apart.
- Suryanwanshi, C. S. and Bajgire, R. S. (2014). Aerobiological survey on soybean crop fields at Naldurg Dist. Osmanabad (M.S) the *Mastics Publications*:1-2.
- Suryanwanshi, C. S. (2002). Aero microbiological investigations over different crop field like sunflower and wheat. Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Suzuki, H. (1969). Diurnal periodicity in spore discharge of rice blast fungus *Rev. pl. Prot. res* **2**:64-65.
- Talde, U. K. (1969). Air-spores at Parbhani. *Ind. J. Microbiol.* 9: 55-58.
- Thube, S. B. (1992). Airspora of Ahmednagar. Ph.D. Thesis Marathwada University, Aurangabad.
- Tilak, S. T. and Babu, M. (1982). Incidence of Cunnighamella spores in the atmosphere *Poll. Res.* **1**:55-58.
- Tilak, S.T. Saibaba, M. Shanta, G. Pillai and. Bhasale, S. S. (1982). Aeromycology at Aurangabad. *Basidiomycetes, proc. 1 Nat. conf. Env. Bio.* 45-54.
- Tilak, S.T. and Mane, D. A. (1981). Aerobiological approach to rust diseases of bajra (*Pennisetum typhoids*). *Proc.Nat. conf. Env. Bio*, Aurangabad. 247-250.
- Tilak S.T. and Bhalke, S. B. (1979). Incidence of air borne insect parts in the air-spores of Aurangabad. *Science and Environment*. **1**:167-169.
- Tilak, S. T. and Kulkarni, R. L. (1978). Rust and Smut spores content of air above sugarcane field. *Biovigyanum* **4**:103-108.

- Tilak, S. T. and Chakre, O. J. (1978). Atmospheric concentration of *Claviceps Fusiformis* over bajra fields in relation to their environmental factors-IV *Int. conf. (Palyonology)*. Lucknow, 181-182.
- Tilak, S. T. and Kulkarni, R. L. (1971). Airspora over sugarcane fields. International Symp. *Patho*: New Delhi.
- Tilak, S. T. and Srinivasulu, B. V. (1967). Airspora of Aurangabad. *Indian Journal of Microbiology*. **7**:167-170.
- Tilak, S. T. and Bhalke, S. P. (1979). Aeromycology at Aurangabad - II Ascospores. *Biovigyanam*. **5**:175-176.
- Tilak, S. T. and Bhalke, S. P. (1978). Aeromycology at Aurangabad –II Deuteromycetes. *Indian J. Bot.*, **1**:113-115.
- Tilak, S. T. and Mane, D. A. (1981). Aerobiological approach to rust disease of bajra (*Pennisetum typhoids*) *proc. Nat. Conf. Env. Bio*, Aurangabad. 247-250.
- Tilak, S. T. and Babu. (1982). Incidence of Cunnighamella spores in the atmosphere poll. *Res. I*: 55-58.
- Tilak, S. T. and Patil, C. R. (1982). Air-spores of dwelling house at Aurangabad *proc 1 Nat. conf. Env. Bio*, 215-219.
- Tilak, S. T. and Pillai, S. (1982). Components of airspora inside the library & its relevance to book deterioration *proc I Nat. Conf. Env. Bio*, 173-177.
- Tilak, S.T and Saibaba, M. (1982). Aeromycology at Aurangabad –V Basidiomycetes *proc.1. Nat. conf. Env.Bio*.45-54.
- Tilak, S. T. and Srinivasulu, B. V. (1967). Airspora of Aurangabad. *Indian Journal of Microbiology*. **7**:167-170.
- Tilak, S.T. and Kulkarni, R. L. (1970). A new air sampler. *Experimental Biol.* **26**:443.
- Tilak, S. T. (1968). The flora of Aurangabad. *Bio. Memories I*, Marathwada Univ. 1-91.

- Thite, S. V. (1998). Studies in environmental biopollution at Shrigonda. Ph.D. Thesis Marathwada University, Aurangabad.
- Tuljapurkar, D. V. (2000). Atmospheric concentration of microbes in ambient air over some crop fields. Ph.D. Thesis Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
- Turner, P. D. (1966). The fungal air-spores of Hong Kong as determined by the agar plate method. *Trans. Brit. Mycol. Soc.* 49:255-268.
- Uddin, N. (2004). Airspora studies over a rice field in rabbi season in the state of west Bengal, India *Aerobiologia*. 20:127-134.
- Vaidya, K. K. (1990). Studies airspora at Aurangabad & its relevance with environmental parameters. Ph.D. Thesis. Marathwada University, Aurangabad.
- Venugopalachari, (1986). Airspora at Nanded- I. Ph.D. Thesis Marathwada University, Aurangabad.
- Verma, A. (1979). Airspora over arhar fields at Gorakhpur. Ph.D. Thesis, Gorakhpur University Gorakhpur.
- Wankhade, J. S. (1983). Air- spora at Aurangabad. Ph.D. Thesis Marathwada University. Aurangabad.
- Yousef-AL-Dorry (1967). The fungal flora of the air near the ground in san Antonio, Texas, *Mycopath. Mycol. Appl.*, 32:313-318.
- Yousuf, A. D. Domson, J. F. and Haward, W. A. (1980). Air borne fungi and pollen of the Washington D.C metropolitan area. *Ann. Allergy*. 45:360-367.
- Zadoks, J. C. (1967). International dispersal of fungi *Netherland J. Plant path.* 73:918-923.