



## Studies on composition and components of airspora belonging to ascomycetes over *Phaseolus vulgaris* L. crop field during kharif season at Pune (M.S)

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### Abstract

A volumetric continuous tilak air sampler was employed for aerobiological study over *Phaseolus vulgaris* L. crop field for one kharif season (June-September). During the present study composition and components of airspora belonging to ascomycetes over *Phaseolus vulgaris* L. crop field in relation to weather conditions at Ganeshkhind, Pune (M.S) was studied. Analysis of spore catches during Kharif season revealed 121342 fungal spores of ascomycotina group belonging to 27 types. Maximum number of ascomycetes has been observed in the month of August. This correlates with the highest rainfall which regulate temperature and humidity.

**Keywords:** airspora, ascomycetes, *Phaseolus vulgaris* L. Pune

### Introduction

Aerobiology is a branch of biology that studies organic particles, such as bacteria, viruses, fungal spores, pollengrains, minute insects etc. and of late, the studies related to even the materials of inanimate origin affecting living organisms were also included in its fold by International Biological Programme (IBP) 1964. The study of aerobiology is mainly concerned with the source of an organism or material, their release in the atmosphere, dispersion, deposition on various surfaces and impact on plants, animals and human beings along with the key role of weather conditions in inciting the airborne diseases. Airborne infections and the resulting diseases threaten the lives and productivity of plants which cause a challenge to mankind. Standing vegetation of any place has a great influence on airspora that changes with changes in the weather. The richness of airspora was unravel through aerobiological surveys conducted in various parts of India.

*Phaseolus vulgaris* L. the common bean is grown as grain crop for its edible fruit, as a pulse and vegetable both are referred as beans. It is valued for its protein rich (23%) seeds cultivated throughout the tropics and warm regions of the world (The Wealth of India, 1969). In Maharashtra it is cultivated in Pune, Koregaon, Satara, Sangali, Kolhapur etc. Information on the nature of airspora over this legume crop is almost lacking in Maharashtra including Pune, Therefore the present detailed seasonal study has been selected to provide data on the nature of fungal airspora. belonging to ascomycetes.

### Materials and Methods

Aerobiological investigation was carried out over *Phaseolus vulgaris* L. crop field at Ganeshkhing, Pune (M.S), India. Sampling was carried by using continuous volumetric Tilak air sampler, installed at center of *Phaseolus vulgaris* L. crop field at 1.5-meter height from ground level during 18<sup>th</sup> June 2012 to 10<sup>th</sup> September 2012. Slide preparation, scanning and detailed calculations were obtained by using same method described earlier (Tilak and Srinivasulu, 1967) [58]. Identification was done by using authentic literature,

photographs, reference slides etc. Daily weather parameters were obtained from Meteorological Department, Shivajinagar, Pune (M.S) nearest place from the crop field.

### Result and Discussion

Analysis of spore catches over *Phaseolus vulgaris* L. crop field for one kharif season from June-September 2012 revealed 121342 fungal spores of ascomycotina group belonging to 27 types. Ascomycetes showed its maximum concentration (63350/m<sup>3</sup>) with 52.21% monthly percentage contribution in the month of August in presence of 26.3°C average temperature, 80.4% average relative humidity, 204.6 mm total rainfall, 1.68 m/s average wind velocity Kharif season.

The identified spores of fungi belonging to ascomycetes during kharif season have been enumerated below.

### Ascospores

Under this included heterogenous ascospores. It includes all types of ascospores hyaline or coloured, one or many celled ascospores. They were trapped highest in number during the rainy season mainly nocturnal and rarely during daytime. Their occurrence in the airspora mainly influenced by rainfall which may have an immediate or delayed effect on release of ascospores. Spores occur regularly. Its percentage contribution to the total airspora was 0.25. Its highest monthwise concentration was (840 spores/m<sup>3</sup> of air) in August 2012. Its highest spore incidence 588 spores/m<sup>3</sup> of air was recorded on 8<sup>th</sup> August 2012.

Shinde and Mahajan (2013) [46] reported 0.33% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.).

### *Bitrimonospora Sivanesan, Talde and Tilak*

Spores are one celled, spherical, dark brown to black, with a very thick outer wall, shining, 34-42 µm diameter. Spores occur sporadically. Its percentage contribution to the total airspora was 0.01. Its highest monthwise concentration was 70 spores/m<sup>3</sup> of air. Its highest spore incidence 28 spores/m<sup>3</sup> of air was recorded on 14<sup>th</sup> August 2012.

Shastri (1981) <sup>[45]</sup>, Patil (1983) <sup>[38]</sup>, Jogdand (1987) <sup>[16]</sup> recorded 0.04%, 0.006% and 0.02% spores respectively at Aurangabad. Gadekar (1990), Cholke (2007) reported 0.31% and 0.04% spores respectively over Jowar field. Kokane (2008) <sup>[18]</sup> reported 0.52% and 0.21% over Grape field at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.37% and 0.6% over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.41% over Groundnut crop field during Kharif 2011 at Patan (M.S.).

#### **Chaetomium Kunz ex. Fr.**

Spores are one celled, lemon shaped somewhat flattened in one plane, dark olive brown or greenish black and smooth 12-13 x 8-9  $\mu\text{m}$ . Spores occur regularly. Its percentage contribution to the total airspora was 0.18. Its highest monthwise concentration was 560 spores/ $\text{m}^3$  of air in September 2012. Its highest spore incidence 154 spores/ $\text{m}^3$  of air was recorded on 10<sup>th</sup> September 2012.

Kramer and Pady (1960) <sup>[20]</sup> reported species of *Chaetomium* and collected it for 36 times from Kansas air. Sreeramulu and Ramalingam (1966) reported *Chaetomium* species from paddy field near Vishakapatnam. Mishra and Kamal (1971) recorded *Chaetomium globosum* in winter only. Jogdand (1987) <sup>[16]</sup> and Gadekar (1990) observed 0.30% and 2.20% contribution over Jowar crop. Pawar (1998) <sup>[39]</sup> recorded at Nanded. Mali (2002) <sup>[25]</sup> reported 0.40% and 0.54% contribution to the total airspora over Jowar crop. Cholke (2007) reported 1.40% and 3.89% contribution of this spore type to the total airspora over Jowar crop field during two Rabi seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 1.85% and 2.04% contribution of this spore type to the total airspora over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.91% and 1.25% of this spore type to the total airspora over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.60% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 1.39% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

#### **Claviceps Tul.**

Spores elongated filiform with many transverse septa, slightly curved, hyaline 59-84 x 1-2.5  $\mu\text{m}$ . Spores occur regularly. Its percentage contribution to the total airspora was 0.74. Its highest monthwise concentration was (2786 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 322 spores/ $\text{m}^3$  of air was recorded on 27<sup>th</sup> August 2012.

Pande (1976) <sup>[35]</sup> reported 0.11% of *Claviceps* over orange fields at Nanded. Wankhade (1983) <sup>[61]</sup> reported 0.05% and 0.09% contribution of this spore type to the total airspora in the Kharif season respectively. Narsimha (1996) <sup>[33]</sup>. Pawar (1997) <sup>[40]</sup> recorded 0.01%, 1.86% spores over paddy fields at Siddipet and Bajara fields at Aurangabad, respectively. Mali (2002) <sup>[25]</sup> reported 0.24% and 0.53% of *Claviceps* spores during first and second Rabi season over Jowar fields. Cholke (2007) reported 0.60% and 0.55% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.9% and 1.08% spores over Groundnut

crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.92% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.39% spores over green gram field during kharif season at Kada (M.S.).

#### **Cucubitaria Gray ex Grev.**

Spores oblong, fusiform, yellowish brown, with five to seven transverse and one to two longitudinal septa in most segments markedly constricted at the middle septum, 24-36 x 9-16  $\mu\text{m}$ . Spores occurrence was regularly. Its percentage contribution to the total airspora was 0.21. Its highest monthwise concentration (784 spores/ $\text{m}^3$  of air) in September 2012. Its highest spore incidence 392 spores/ $\text{m}^3$  of air was recorded on 18<sup>th</sup> August 2012.

Shastri (1981) <sup>[45]</sup>, Ramakrishna Reddy (1987) <sup>[42]</sup>, Garje (2000) <sup>[13]</sup> and reported 0.009%, 0.19% and 0.04% spores at Aurangabad respectively. Thite (1998) <sup>[51]</sup> reported them from Shrigonda. Mali (2002) <sup>[25]</sup> accounted the incidence of these spores with 0.03% and 0.02% contribution during first and second Rabi season over Jowar fields. Cholke (2007) reported 0.09% and 0.10% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 0.68% and 0.52% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) recorded 0.61% and 0.68% of this spore type over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.009% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

#### **Didymosphaeria Fuck**

Spores two celled, elliptic-cylindric, slightly constricted at the septum; brown in colour, one cell tapering and slightly curved, 9-17 x 6-8  $\mu\text{m}$ . Spores occur regularly and abundantly. Its percentage contribution to the total airspora was 2.30. Its highest monthwise concentration was (7448 spores/ $\text{m}^3$  of air) in September 2012. Its highest spore incidence 1316 spores/ $\text{m}^3$  of air was recorded on 9<sup>th</sup> August 2012.

The occurrence of this spore type could be correlated with the prevailing weather parameters like rainfall and humid condition. Daily scanning records indicated that even less rain also helped in increasing the spore liberation which subsequently increased the spore load in the airspora. Similar findings were recorded by Patil (1985) <sup>[37]</sup>, Jogdand (1987) <sup>[16]</sup> and Cholke (2007). Pande (1976) <sup>[35]</sup> reported 2.41% from Nanded, Mane (1978) <sup>[26]</sup> reported 0.94% from Vaijapur, Shastri (1981) <sup>[45]</sup> reported 0.27% from vegetable markets at Aurangabad. Bhagwan (1983) and Venugopalachari (1986) reported 1.54% and 1.37% spores from Nanded respectively. Ramakrishna Reddy (1987) <sup>[42]</sup> reported 0.85% from Aurangabad. Minhaj (1988) reported 1.04% over vegetable market at Nanded. Meghraj (1989) <sup>[27]</sup> reported 1.49% over Bajra field at Aurangabad. Kavishwar (1991) <sup>[17]</sup> reported 0.16% spores at Dhule. Narsimha (1996) <sup>[33]</sup> reported at Siddipet (A.P.), Thite (1998) <sup>[51]</sup> and Pawar (1998) <sup>[39]</sup> reported this spore type at Shrigonda and Nanded respectively. Garje (2000) <sup>[13]</sup> reported 1.50% spores at Aurangabad. Cholke (2007) reported 1.44% and 1.57% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane

(2008) <sup>[18]</sup> reported 1.16% and 1.45% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.98% and 1.16% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.98% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 1.83% spores over green gram field during kharif season at Kada (M.S.).

#### ***Endoxylina Romell.***

Spores ellipsoid, two celled, rarely three celled, brown 15-27 x 4-11  $\mu\text{m}$ . Spores occur sporadically. Its percentage contribution to the total airspora was 0.13. Its highest monthwise concentration (406 spores/ $\text{m}^3$  of air) was recorded in August 2012. Its highest spore incidence 140 spores/ $\text{m}^3$  of air was recorded on 4<sup>th</sup> September 2012.

#### ***Hypoxylon Bull. ex. Fr.***

Spores one celled, elliptic to bean shaped, dark brown in colour, with distinct colourless furrow on one side, 10-16 x 6-7  $\mu\text{m}$ . Spores occurred continuously. Spores saprophytic, collected on bark of *Acacia* and *Albizia* sp. Its percentage contribution to the total airspora was 0.08. Its highest monthwise concentration was (294 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 56 spores/ $\text{m}^3$  of air was recorded on 15<sup>th</sup> August 2012.

Mane (1978) <sup>[26]</sup> reported that 0.72% spores to the total airspora at Vaijapur. Bhalke (1981) <sup>[8-57]</sup>, Babu (1983) reported 1.72% and 0.45% spores over Jowar and Banana fields at Aurangabad. Tuljapurkar (2000) <sup>[59]</sup> reported these spores from airspora at Aurangabad. Mali (2002) <sup>[25]</sup> reported 0.54% and 0.44% spores during first and second Rabi season over Jowar fields. Cholke (2007) reported 0.44% and 0.63% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 0.82% and 0.77% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.76% and 1.02% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.70% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.72% spores over green gram field during kharif season at Kada (M.S.).

#### ***Hysterium Tode. ex. Fr.***

Spores three septate, elliptic-cylindric, uniformly brown, slightly constricted at septa, 15-29 x 6.8  $\mu\text{m}$ . Spores occurred continuously and abundantly. Its percentage contribution to the total airspora was 1.69. Its highest monthwise concentration was (4312 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 588 spores/ $\text{m}^3$  of air was recorded on 9<sup>th</sup> September 2012.

Tilak and Srinivasulu (1967) <sup>[58]</sup> first time reported *Hysterium* spores from the airspora of Aurangabad. Ahuja (1991), Aher (1993) <sup>[1]</sup>, recorded 0.4%, 0.15% over Jowar, Groundnut field at Aurangabad and Ahmednagar respectively. Garje (2000) <sup>[13]</sup> reported 0.31% at Aurangabad. Mali (2002) <sup>[25]</sup> reported 0.31% and 0.24% spores during first and second Rabi season over Jowar fields. Cholke (2007) reported 0.02% and 0.03% spores over Jowar crop field during two Rabi (2004-05, 2005-06)

seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 0.53% and 0.52% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.67% and 0.86% of this spore type over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 1.57% these spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.42% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

#### ***Leptosphaeria Ces & de Not.***

Spores yellowish to yellow, elliptic to fusiform, three septate (sometime 6-7 septate), slightly constricted at septum, one at the middle cell enlarged, 15-25 x 5-7  $\mu\text{m}$ . Spores occur abundantly and continuously. Its percentage contribution to the total airspora was 5.93. Its highest monthwise concentration was (21252 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 1694 spores/ $\text{m}^3$  of air was recorded on 1<sup>st</sup> September 2012.

Kramer et.al (1959), Lacey (1962) recorded these spores in air from different places. Rees (1964) from Brisbane reported 1.6% *Leptosphaeria* spores. Meghraj (1989) <sup>[27]</sup>, Garje (2000) <sup>[13]</sup> reported 1.15%, 0.81% spores respectively over Bajra at Aurangabad. Kavishwar (1991) <sup>[17]</sup> reported 0.07% spores over Jowar fields at Dhule. Mali (2002) <sup>[25]</sup> also recorded these spores over Jowar and Bajra fields at Kada (Beed). Cholke (2007) reported 2.46% and 5.96% spores over Jowar crop field during two Rabi seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 2.65% and 2.85% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 1.07% and 1.21% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 4.70% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.52% spores over green gram field during kharif season at Kada (M.S.).

#### ***Lophiostoma Ces de Not.***

Spores fusiform, olive brown, five to seven septate, slightly constricted at septum, 18-22 x 6-7  $\mu\text{m}$ . Spores occur regularly. Its percentage contribution to the total airspora was 0.04. Its highest monthwise concentration was (168 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 70 spores/ $\text{m}^3$  of air was recorded on 14<sup>th</sup> August 2012.

Ramchander Rao (1987) <sup>[43]</sup> reported these spores from Aurangabad over different fields. Aher (1993) <sup>[1]</sup> reported this spore type from Ahmednagar, Thite (1998) <sup>[51]</sup> recorded 12.2% to the total airspora over Groundnut fields. Tuljapurkar (2000) <sup>[59]</sup> recorded these spores over Sunflower fields at Aurangabad. Mali (2002) <sup>[25]</sup> reported 0.08% and 0.02% spores over Jowar and Bajra fields respectively at Kada (Beed). Cholke (2007) reported 0.09% and 0.03% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 1.88% and 1.55% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.91% and 1.21% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.).

Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.03% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

**Massarina Sacc.**

Spores elliptic-fusiform, dark brown, 3 septate, strongly constricted at middle, septum, surrounded by thick hyaline, gelatinous sheath, 40-55 x 10-18  $\mu\text{m}$ . Spores occur sporadically. Its percentage contribution to the total airspora was 0.03. Its highest monthwise concentration was (98 spores/ $\text{m}^3$  of air) in September 2012. Its highest spore incidence 42 spores/ $\text{m}^3$  of air was recorded on 4<sup>th</sup> September 2012.

Arsule and Pande (2011) <sup>[4]</sup> recorded 0.67% and 0.97% of this spore type over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.06% spores over Groundnut crop field during Rabi (2012) season at Patan (M.S.).

**Melanospora Corda.**

Spores one celled oval, discoid often in equilateral with prominent germ spores at both ends, brown to blackish green, 13-22 x 7-14  $\mu\text{m}$ . Spores occur regularly. Its percentage contribution to the total airspora was 0.08. Its highest monthwise concentration was (224 spores/ $\text{m}^3$  of air) in July 2012. Its highest spore incidence 56 spores/ $\text{m}^3$  of air was recorded on 8<sup>th</sup> July 2012.

Mane (1978) <sup>[26]</sup> recorded 0.15% spores to the total airspora. Wankhade (1983) <sup>[61]</sup>, Ramkrishna Reddy (1987) <sup>[42]</sup>, Meghraj (1989) <sup>[27]</sup> recorded these spores over different fields at Aurangabad. Kotwal (1992) recorded 0.27% incidence of these spores over Grapevine yards at Nashik. Thite (1998) <sup>[51]</sup> and Garje (2000) <sup>[13]</sup> reported these spores over Groundnut and Jowar fields at Shrigonda and Aurangabad respectively. Mali (2002) <sup>[25]</sup> recorded 0.87% and 0.68% spores over Bajra fields at Kada. Cholke (2007) reported 0.27% and 0.37% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) <sup>[18]</sup> reported 0.44% and 0.40% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) <sup>[4]</sup> recorded 0.92% and 1.14% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.09% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.95% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

**Metasphaeria Sacc.**

Spores elliptical or slightly fusiform, hyaline, with two or more septa, one of the median cell enlarged, 15-25 x 5-8  $\mu\text{m}$ , oil globules in each cell. Spores occur regularly. Its percentage contribution to the total airspora was 0.62. Its highest monthwise concentration was (1638 spores/ $\text{m}^3$  of air) in September 2012. Its highest spore incidence 294 spores/ $\text{m}^3$  of air was recorded on 1<sup>st</sup> September 2012. Shinde and Mahajan (2013) <sup>[46]</sup> reported 1.27% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.).

**Othia Nke.**

Spores two celled, elliptical or slightly in equilateral, slightly constricted at the septum 22-26 x 10-14  $\mu\text{m}$ . Spores

occur sporadically. Its percentage contribution to the total airspora was 1.75. Its highest monthwise concentration (7504 spores/ $\text{m}^3$  of air) was recorded in August 2012. Its highest spore incidence 868 spores/ $\text{m}^3$  of air was recorded on 8<sup>th</sup> August 2012.

Arsule and Pande (2011) <sup>[4]</sup> recorded 0.47% and 0.21% of this spore type to the total airspora over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.01% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

**Parodiella (Speg.) Theiss & syd.**

Spores two celled, elliptic, distinctly striated, striations spirally converging towards end, broader and slightly constricted at septum, brown, 22-25 x 7-9  $\mu\text{m}$ . Spores occur sporadically. Its percentage contribution to the total airspora was 0.49. Its highest monthwise concentration was (1638 spores/ $\text{m}^3$  of air) in September 2012. Its highest spore incidence 280 spores/ $\text{m}^3$  of air was recorded on 31<sup>st</sup> August, 4<sup>th</sup>, 7<sup>th</sup> September 2012.

Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.09% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) <sup>[36]</sup> recorded 0.20% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

**Passerienella Berl.**

Spores elliptic – fusiform, 3 septate with brown central cells and hyaline terminal ones, slightly constricted at septum, 28-30 x 9-10  $\mu\text{m}$ . Spores occur continuously during Kharif seasons. Its percentage contribution to the total airspora was 0.13. Its highest monthwise concentration was (364 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 112 spores/ $\text{m}^3$  of air was recorded on 6<sup>th</sup> August 2012. Shinde and Mahajan (2013) <sup>[46]</sup> reported 0.07% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.).

**Pleomassaria Speg.**

Spores fusiform clavate, with 5-8 transverse septa, constricted at each septum, one or two longitudinal septa in the broader segments, golden – brown, with hyaline gelatinous sheath, 50-60 x 15 – 22  $\mu\text{m}$ . Spores occurred regularly during Kharif seasons. Its percentage contribution to the total airspora was 0.03. Its highest monthwise concentration (84 spores/ $\text{m}^3$  of air) was recorded in July 2012. Its highest spore incidence 28 spores/ $\text{m}^3$  of air was recorded on 25<sup>th</sup> July.

Arsule and Pande (2011) <sup>[4]</sup> recorded 0.74% and 1.04% of this spore type to the total airspora over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.).

**Pleospora Rabh.**

Spores oblong-fusiform or ovoid, yellowish-brown or golden brown, with several cross septa and one or usually two longitudinal septa, in most or all of the segments, upper half usually wider than lower half, always constricted at the middle septum and often slightly at the other septa, 30-38 x 13-16  $\mu\text{m}$ . spores occurred frequently and they are saprophytic on leaves and stems of *Acacia* sp., *Ocimum* sp. and *Cassia* sp. Its percentage contribution to the total

airspora was 1.81. Its highest monthwise concentration was (5936 spores/m<sup>3</sup> of air) in August 2012. Its highest spore incidence 770 spores/m<sup>3</sup> of air was recorded on 6<sup>th</sup> August 2012.

Dye & Vernon (1952) [11] reported these spores from New Zealand. Richards (1956) from England, Pady and Kapica (1956) from Canada, Davies (1969) [10] from Kuwait, Kulkarni (1971) [22] from Aurangabad and Pande (1976) [35] from Nanded, recorded these spores. Mane (1978) [26] reported 0.35% contribution and showed that the high humid conditions favoured the occurrence of these spores in the air. Jogdand (1987) [16] and Ahuja (1991) recorded these spores over *Sorghum* fields. Bhadane (1991) recorded 0.02% incidence of these spores to the total airspora over Groundnut fields at Dhule. Garje (2000) [13] recorded 0.49% occurrence of these spores over Bajra fields at Aurangabad. Mali (2002) [25] reported this spore type at Kada (Beed). Cholke (2007) reported 0.30% and 0.33% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) [18] reported 1.48% and 1.15% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) [4] recorded 0.71% and 1.04% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) [46] reported 2.33% spores over Groundnut crop field during Kharif 2011 at Patan. Pathare and Sayyed (2016) [36] recorded 0.54% spores type to the total airspora over green gram field during kharif season at Kada (M.S.).

#### ***Pringsheimia* Schultz.**

Spores hyaline, three to five septate, septa horizontal but in mature spores a vertical septum in each cell, 27-36 x 11-17  $\mu$ m. Spores were not recorded in the first Rabi season, they were rare in occurrence in second Rabi season, however they occur continuously during Kharif seasons. Its percentage contribution to the total airspora was 0.16. Its highest monthwise concentration was (532 spores/m<sup>3</sup> of air) in August 2012. Its highest spore incidence 154 spores/m<sup>3</sup> of air was recorded on 30<sup>th</sup> August 2012.

Tilak & Srinivasulu (1967) [58] reported this spore type for the first time from airspora of Aurangabad. Talde (1969) at Parbhani, Kulkarni (1971) [22] at Aurangabad, Pande (1976) [35] at Nanded, reported these spores in air occasionally. Mane (1978) [26] reported their occurrence in airspora of Bajra fields at Vaijapur with 0.55% contribution to the total airspora. Patil (1983) [38], Bhagwan (1983), Pillai (1983), Venugopalachari (1986), Ramakrishna Reddy (1987) [42], Minhaj (1988) reported 0.11%, 0.13%, 0.21% 0.24%, 0.22% and 0.13% recorded over different fields respectively. Pawar (1998) [39] reported this spore type over Sunflower fields at Nanded. Garje (2000) [13] recorded 0.18% over Bajra fields at Aurangabad. Mali (2002) [25] reported 0.21% and 0.14% spores during first and second Rabi season over Jowar field. Cholke (2007) reported 0.13% spores over Jowar crop field during first Rabi (2004-05) season at Pimpri Chinchwad area (M.S.). Kokane (2008) [18] reported 0.94% and 0.95% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) [4] recorded 1.12% and 0.48% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) [46] reported 7.75% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

#### ***Rosellinia* Ces. & de Not.**

Spores one celled, elliptical dark brown to black, flattened bearing longitudinal furrow with oil globule often with minute colourless appendages at each end ( or absent ) 17-26 x 7-9  $\mu$ m. Spores occur sporadically. Its percentage contribution to the total airspora was 0.05. Its highest monthwise concentration was (182 spores/m<sup>3</sup> of air) in September 2012. Its highest spore incidence 42 spores/m<sup>3</sup> of air was recorded on 29<sup>th</sup> August, 1<sup>st</sup>, 6<sup>th</sup> September 2012. Bhalke (1981) [8-57], Gadekar (1990) and Naik (1995) reported these spores with 0.67%, 0.52% and 0.83% contribution over Jowar fields. Cholke (2007) reported 0.09% and 0.19% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Shinde and Mahajan (2013) [46] reported 0.11% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

#### ***Sordaria* Ces. & de Not.**

Spores one celled, sub-globose to broadly elliptic with small papilla at the lower end, smooth black, enclosed in a narrow colourless gelatinous sheath, germ pore at lower end of spore, 20-30 x 13-23  $\mu$ m. Spores occur regularly. Its percentage contribution to the total airspora was 0.39. Its highest monthwise concentration was (1344 spores/m<sup>3</sup> of air) in August 2012. Its highest spore incidence 252 spores/m<sup>3</sup> of air was recorded on 6<sup>th</sup> August 2012.

Mane (1978) [26] noted 1.81% spores from Vaijapur. Tilak and Bhalke (1981) [8-57] recorded 1.13% spores over Jowar fields; Shastri (1981) [45] recorded 0.10% spores over vegetable market. Kavishwar (1991) [17], Garje (2000) [13] reported 0.13%, 0.53% spores over Jowar and Bajra fields at Dhule and Aurangabad, respectively. Mahajan (1995) [24] encountered 0.15% and 0.03% contribution over Groundnut fields. Mali (2002) [25] reported 0.04% and 0.02% occurrence during first and second Rabi seasons over Jowar fields. Cholke (2007) reported 0.02% and 0.03% spores over Jowar crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Kokane (2008) [18] reported 0.25% and 0.65% spores over Grape field during 2005 & 2006 respectively at Manjari (M.S.). Arsule and Pande (2011) [4] recorded 1.16% and 1.23% spores over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013) [46] reported 0.93% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016) [36] recorded 0.18% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

#### ***Sporormia* de not.**

Spores cylindrical, straight or slightly curved, dark brown, dull coloured, 3 septate strongly constricted at the septa and showing a tendency to break up at the septa, surrounded by hyaline gelatinous sheath, 28-40 x 7-9  $\mu$ m. Spores occur sporadically. Its percentage contribution to the total airspora was 0.17. Its highest monthwise concentration was (518 spores/m<sup>3</sup> of air) in August 2012. Its highest spore incidence 112 spores/m<sup>3</sup> of air on 15<sup>th</sup> July, 5<sup>th</sup> August 2012.

Wankhade (1983) [61] and Jogdand (1987) [16] observed 0.18% and 0.23%, 0.05% over Jowar fields. Gadekar (1990) and Mali (2002) [25] recorded 0.51% and 0.18%, 0.24% contribution over Jowar fields. Cholke (2007) reported 0.04% and 0.03% contribution of this spore type over Jowar

crop field during two Rabi (2004-05, 2005-06) seasons at Pimpri Chinchwad area (M.S.). Shinde and Mahajan (2013)<sup>[46]</sup> reported 0.09% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016)<sup>[36]</sup> recorded 0.26% of this spore type to the total airspora over green gram field during kharif season at Kada (M.S.).

#### ***Teichospora* Fuck.**

Spores oblong, fusiform, slightly clavate, yellowish brown, upto 7- transverse septa and 1-2 longitudinal septa in most of the segments, constricted at the middle septum only, 16-25 x 8-11  $\mu\text{m}$ . Spores occur sporadically. Its percentage contribution to the total airspora was 1.08. Its highest monthwise concentration was (4410 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 476 spores/ $\text{m}^3$  of air was recorded on 7<sup>th</sup> August 2012.

Shinde and Mahajan (2013)<sup>[46]</sup> reported 0.10% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016)<sup>[36]</sup> recorded 0.37% spores over green gram field during kharif season at Kada (M.S.).

#### ***Tryblidium* Speg.**

Spores broadly elliptical with thick outer wall, about 7-9 cross walls biloculate; each locule further sub divided by upto 3 longitudinal walls. 30-48 x 12-20 hyaline on yellowish. Spores occur sporadically. Its percentage contribution to the total airspora was 0.02. Its highest monthwise concentration was (98 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 28 spores/ $\text{m}^3$  of air was recorded on 29<sup>th</sup>, 30<sup>th</sup> August 2012.

Shinde and Mahajan (2013)<sup>[46]</sup> reported 0.12% contribution of this spore type to the total airspora over Groundnut crop field during Kharif 2011 at Patan (M.S.).

#### ***Valsaria* Ces. & de. Not.**

Spores two celled, broadly elliptical and strongly constricted at the septum, brown in colour, 16-18 x 9-10  $\mu\text{m}$ . in size. Spores occur infrequently. Its percentage contribution to the total airspora 0.02. Its highest monthwise concentration was (56 spores/ $\text{m}^3$  of air) in August 2012. Its highest spore incidence 42 spores/ $\text{m}^3$  of air was recorded on 31<sup>st</sup> August 2012.

Arsule and Pande (2011)<sup>[4]</sup> recorded 0.87% and 0.95% of this spore type to the total airspora over Groundnut crop field during Kharif I (2007) and Kharif II (2008) seasons respectively at Newasa (M.S.). Shinde and Mahajan (2013)<sup>[46]</sup> reported 0.04% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.). Pathare and Sayyed (2016)<sup>[36]</sup> recorded 0.45% spores over green gram field during kharif season at Kada (M.S.).

#### ***Xylaria* Hill, ex. Grev.**

Spores one celled, fusiform or bean shaped, dark brown to black, with germ silt more or less throughout the length of spore, 14-20 x 6-9  $\mu\text{m}$ . spore occurrence was not recorded during Rabi season whereas it was sporadic during Kharif seasons. Its percentage contribution to the total airspora was 0.64. Its highest monthwise concentration (2338 spores/ $\text{m}^3$  of air) was recorded in September 2012. Its highest spore incidence 476 spores/ $\text{m}^3$  of air on 7<sup>th</sup> September 2012. Narsimha (1996)<sup>[33]</sup> at Siddipet (A.P.) reported 0.01%, Thite (1998)<sup>[51]</sup> at Shrigonda reported 0.68%. Tuljapurkar (2000)<sup>[59]</sup> recorded these spores over Sunflower fields at

Aurangabad. Mali (2002)<sup>[25]</sup> reported 0.04% and 0.11% of this spore type to the total airspora during first and second Rabi season over Jowar fields. Cholke (2007) reported 0.18% contribution of this spore type to the total airspora over Jowar crop field during first Rabi (2004-05) season at Pimpri Chinchwad area (M.S.). Kokane (2008)<sup>[18]</sup> reported 0.04% spores over Grape field during 2006 at Manjari (M.S.). Shinde and Mahajan (2013)<sup>[46]</sup> reported 0.03% spores over Groundnut crop field during Kharif 2011 at Patan (M.S.).

The group Ascomycotina was represented by 27 spore types in one Kharif season. This group showed total count 121342/ $\text{m}^3$  with their contribution 19.01% the total airspora. The presence of many ascospores revealed the abundance of parasitic and saprophytic ascomycotina members in and around the fields. Along with other weather parameters rainfall plays an important role in the occurrence and release of ascospores.

Out of the total count of ascomycetes spores in kharif season 52.21% has been recorded in the month of August (63350/ $\text{m}^3$ ) in relevance to weather parameters like average temperature 26.3°C, relative humidity 80.4% and 204.6mm rainfall. All these conditions are most congenial for the rapid growth/ release of fungal spores during August. All these spore types occurred with high concentration in air only when the environmental conditions were favorable for their formation and liberation of ascospores in the atmosphere. These ascospores have reported even there was no rain this was associated with low temperature and high relative humidity. In relation to weather parameters temperature also plays an important role in the occurrence and release of ascospores in the air.

Ascospore types showed their occurrence and increase in concentration after the onset of rain and high humid conditions which have an immediate or delayed effect on release of ascospores from ascus. According to Ingold (1965)<sup>[15]</sup> dew has little effect in bringing about spore discharge, but a little rainfall of only 0.2 mm leads to abundant release of ascospores. Following rain, the majority of the ascospore types are released in the first three hours after rains (Tilak, 1989).

The dominant ascomycotina spore types in Kharif season were *Leptosphaeria* (5.93%-37818/ $\text{m}^3$ ) followed by *Didymosphaeria* (2.30%-14700/ $\text{m}^3$ ), *Pleospora* (1.81%-11578/ $\text{m}^3$ ), *Othia* (1.75%-11158/ $\text{m}^3$ ), *Hysterium* (1.69% 10794/ $\text{m}^3$ ) and *Teichospora* (1.08%-6874/ $\text{m}^3$ ) remaining ascomycetes contributed below 1% to the total airspora. Minimum percentage contribution of ascospores to the total airspora was recorded by *Bitrimonospora* (0.013%). It may be due to non-availability of suitable substratum for their growth and sporulation in and around the sampling site.

*Leptosphaeria* has been found to be dominant with total count 37818/ $\text{m}^3$  of air during kharif season. Its maximum concentration (21252/ $\text{m}^3$ ) with 56.20% monthly percentage contribution has been recorded in the month of August may be because of high humidity and associated rainfall essential for spore release. Similar findings were recorded by Tilak (1989). It clearly indicated that during these days the weather conditions like high humidity was favorable for the discharge of spores and increased the concentrations of spores in the atmosphere. Therefore, the spore type belongs to "Wet spora" group (Thakur and Jite, 2015). Gregory (1952) reported that *Leptosphaeria* spores need better condition for liberation. Their concentration increased with

increase in humidity. *Leptosphaeria* was collected on the dead plant twigs in saprophytic forms in and around the sampling site must have served as a source for increasing its concentration in air over *Phaseolus vulgaris* L. crop field. The second dominant spore *Didymosphaeria* showed total count 14700/m<sup>3</sup> with contribution 2.30%. Its maximum concentration (7448/m<sup>3</sup>) with 50.67% monthly percentage contribution has been recorded in the month of September 2012 when there was a record of 24.8°C temperature, 84.5% relative humidity, 42.4 mm rainfall, 1.08 m/s wind velocity. The occurrence of *Didymosphaeria* spore type could be correlated with the prevailing weather parameters like decrease in temperature, increase in relative humidity with even less rainfall favors their occurrence. Similar findings were recorded by Patil (1985)<sup>[37]</sup>, Jogdand (1987)<sup>[16]</sup>. Most of the ascospores typically occurred more during night time like *Didymosphaeria* and *Leptosphaeria* (Tilak and Babu, 1983; Thakur and Jite, 2015) while few occur at day time. More concentration of ascomycotina spores have been observed during Kharif seasons (121342/m<sup>3</sup>) it can be correlated with rainfall and the result of the present investigation clearly shows that the rainfall is having its immediate impact on the spore release of ascomycotina, as has been studied by Meredith (1962 and 1963). Tilak (1974, 1980 and 1989b) studied the composition of airspora over 15 years and clearly indicated the close relation between rainfall and release of ascospores. In Kharif season the ascospore's count was observed high immediately after rainfall associated with greater wind velocity. As stated by Ingold (1965)<sup>[15]</sup> high wind velocity and moderate relative humidity has profound effect on ascospore release. Weather parameters like temperature, relative humidity, rainfall and wind velocity showed a profound effect on the growth/release and dispersal of ascomycetes and ultimately affected the composition of airborne spore types qualitatively and quantitatively.

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