Studies on Seedborne Fungi of Soybean

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ABSTRACT

The present investigation was undertaken with the main objective to determine studies on seedborne fungi of soybean were conducted at DSST and Plant Pathology, College of Agriculture, Rajendranagar, Hyderabad. A total of 120 representative soybean seed samples (cv. JS - 335) from major soybean growing districts of Andhra Pradesh viz., Adilabad (60 samples) and Nizamabad (60 samples) were collected during Rainy season 2012. Total per cent incidence of seed mycoflora in Nizamabad and Adilabad districts ranged from 30 to 49.2 % and 23.6 to 45.0 % by blotter method, 14.8 to 28.1% and 11.6 to 22.1% by 2, 4 - D blotter method, 11.8 to 19.3 % and 9.5 to 16.2 % by deep freeze blotter method, 13.1 to 37% and 15.4 to 26.4 % by agar plate method, respectively. Out of nine fungal species recorded, M. phaseolina was found predominant in the samples analysed from two districts (8.5 to 28.5 %), while the occurrence of Cladosporium sp. (0.3 to 0.5%) was least. Out of four methods employed for detection of seed mycoflora, standard blotter method was found superior over other methods.

Key words: *Soybean, Fungi, Seed mycoflora and Seed samples*

INTRODUCTION

Soybean (*Glycine max* L.) Merrill) the "golden bean" is one of the fore most important oil seed crop known for its excellent protein (42-45%), oil (22%) and starch content (21%). It is good source of vitamin - B complex, thiamine and riboflavin. Soybean protein is rich in valuable amino acids like lysine (5%) in which, most of the cereals are deficient. Its oil is the largest component of the world's oils. Inspite of phenomenal increase in area and soybean production, its productivity remains low because of lack of quality seeds. Low yield and productivity of soybean in India is mainly due to various diseases and pests occurring in the field and causing yield losses. One of the major constraints in the endeavour of increasing productivity of soybean is its susceptibility to a large number of diseases caused by fungi, bacteria, viruses and nematodes. In India, although 40 fungal pathogens have been identified in soybean crop, but only a few of them are economically important [1]. Disease free quality seed production in soybean is utmost important to sustain the productivity and maintain the quality of the crop**.** The infected seeds failed to germinate or seedlings and plants developed in the field from infected seeds may escape the early infection but often may be infected at the later stages of the crop growth. Besides, pathogens can spread over a longer distance and uninfected field may be infected by the seeds in which different pathogens are present. Seed health testing methods like blotter paper method, deep freeze blotter, 2, 4 - D blotter paper method and agar plate methods have been employed for detection of internal and external seedborne mycoflora of soybean, [2], [3] and [4]. The frequency in occurrence of such potentially pathogenic fungi on soybean cultivars poses a potential threat in crop production programme. However, information on seedborne fungi associated with soybean seeds and its detection by different methods is meager. Keeping this in view, the present investigation was taken up.

MATERIALS AND METHODS

Scope of the Study

The present experiment was carried out at Department of Seed Science and Technology and Plant Pathology, Rajendranagar, Hyderabad during *rainy* season, 2012. Soybean seed samples (cv. JS - 335) collected from different soybean growing districts of Andhra Pradesh *viz.*, Nizamabad and Adilabad districts.

Collection of soybean seed samples

One hundred and twenty soybean seed samples were collected from the major soybean growing districts of Andhra Pradesh *viz.*, Adilabad (60 Nos) and Nizamabad (60 Nos) for assessment of seed mycoflora. The collected seed samples were shade dried and stored in paper bags at ambient storage temperatures of 28 ± 2 ºC for further studies.

Isolation of seed mycoflora

Four different seed health testing methods *viz.*, standard blotter method, 2, 4 -D blotter paper method and agar plate method as described by [5] and deep freeze blotter method developed by [6] were employed for estimation of seed mycoflora associated with soybean seed samples. Four hundred seeds were tested in different detection methods.

The total fungal colonies were calculated and per cent infection was assessed.

Total fungal colonies (%) =

$$\frac{\text{No of seeds colonized in each plate by a particular species}}{\text{Total no.of seed in each plate}} \times 100$$

Data analysis

The data were statistically analyzed by using Completely Randomized Design (CRD) as suggested by [7]. The data pertaining to percentage were angular transformed wherever necessary.

RESULTS AND DISCUSSION

Standard blotter method

Significant differences in occurrence of seed mycoflora were observed and the results indicated that irrespective of the locations and sources, a total of 9 fungal species *viz.*, *Macrophomina phaseolina*, *Colletotrichum dematium*, *Aspergillus flavus*, *Aspergillus niger*, *Rhizopus* sp. *Curvularia* sp. *Alternaria*, *Cladosporium* and *Fusarium* sp. belonging to eight genera were detected (Table 1). Total per cent incidence of seed mycoflora in Nizamabad and Adilabad districts ranged from 30 % to 49.2 % and 23.6 % to 45.0 %, respectively. With respect to the mean total fungal colonies, seed samples collected from Ditchpally Mandal (49.2 %) of Nizamabad district and Kubeer Mandal (45.0 %) of Adilabad district recorded more total number of fungal colonies. Out of nine fungal species recorded, the occurrence of *M. phaseolina* was found predominant in the seed samples analysed from two districts (8.5 to 28.5 %). The occurrence of *M. phaseolina* was found highest in the seed samples of Ditchpally Mandal of Nizamabad (28.5 %) and Kubeer Mandal of Adilabad district (16.5 %).

The differences in occurrence of seed mycoflora in soybean seed samples collected from different districts may be attributed to the variations in moisture content of the seed and storage conditions (Temperature, Relative humidity and Light) adopted by the farmers. Mycoflora of seed varied from place to place due to change in conditions prevailing during seed development, harvesting and storage. Seed mycoflora was highest in the seed samples of Ditchpally Mandal of Nizamabad district (49.2%) while it was least in Muthol Mandal of Adilabad district (45%). The present findings are in conformity with the earlier findings of [8] who reported that blotter method was found effective for detection of seedborne fungi in soybean. Most of the fungal species detected in the present study have been reported earlier in soybean by [9] [10] and [11] who reported the variation in the occurrence of seed samples collected from different locations, variation in incidence of seed borne fungi varied from one locality to another.

2, 4 - D blotter method

The fungal flora were similar as to that of blotter method but frequency of fungal flora were less in 2, 4 – D blotter method (Table 2). Total per cent incidence of seed mycoflora in Nizamabad and Adilabad districts ranged from (14.8 % to 28.1%) and (11.6 % to 22.1%), respectively. Out of nine fungal species recorded, the occurrence of *M. phaseolina* was found predominant (4 - 9.5 %) which was followed by *Colletotrichum* sp. (3.3 - 9 %) in both the districts. Colonies of *A. flavus* and *Cladosporium* were in Kammarpalli Mandal of Nizamabad district and Muthol Mandal of Adilabad district were not observed. Where as Colonies of *Cladosporium* was not observed in Armur Mandal of Nizamabad district and Thanur Mandal of Adilabad district. The occurrence of pathogenic fungi like *M. phaseolina* (4.0 % to 9.5 %), *A. alternata* (0.5 % to 2. 5%), *Fusarium* sp (1 to 3.3%), *Curvularia* (1% to 2.5%) and *Cladosporium* (0.3 % to 1.5 %) were observed in the tested soybean seed samples of the two districts. In the present findings also similar type of differential incidence of seed borne fungi was noticed. Similar findings were reported earlier by [4].

Deep freeze blotter method

Significant differences in occurrences of seed mycoflora were observed according to place of seed sample collected (Table 3). Fungal flora was similar but frequencies of occurrence in different detection methods were different. The percent occurrence of fungal flora were found less as compared to blotter and 2, 4 - D blotter methods. With respect to the mean total

fungal colonies, Ditchpally and Morthad Mandals of Nizamabad district (19.3 % and 15.7%) and Kubeer (16.2 %) and Ichoda Mandals (12.3%) of Adilabad district recorded more total number of fungal colonies. The occurrence of pathogenic fungi like *Colletotrichum* sp. (1.2 to 3.5%), *A. alternata* (0.5 to 2.5 %), *Fusarium* sp. (1 to 2.6 %), *Curvularia* (0.5 to 2%) and *Cladosporium* (0.3 to 2.5%) were observed. The present revealed that occurrence of seed mycoflora may varied depending up on the location and sources of collection from different farmers. The present findings are in conformity with earlier reports of [12] who reported that variation in the occurrence of seed mycoflora according to geographic location in soybean and [13] in safflower. The results are agreement with [14], [15] and [16] who observed that deep freeze blotter method was superior than standard blotter method for detection of *C. dematium* in soybean. While [17] reported that deep freeze blotter was suitable for detection of *M. phaseolina*, *C. dematium* and *Fusarium oxysporium* in infected soybean seed samples. The present study also revealed that deep freeze method yielded less number of fungal species over blotter method. Which are in conformity with findings of [18].

Agar plate method

Significant differences in occurrence of seed mycoflora in different Mandals of Nizamabad and Adilabad districts of A.P were noticed (Table 4). The fungal flora was similar as like in blotter, 2, 4 - D blotter and agar plate methods. Total per cent incidence of seed mycoflora in Nizamabad and Adilabad districts ranged from 13.1 % to 37% and 15.4 % to 26.4 %, respectively. The results revealed that percent occurrence of seedborne fungi were found less as compared to blotter method, 2, 4 - D blotter method and deep freeze method. Similar results were confirmed by [19], [20] in chickpea and [11] Ramesh *et al.* (2013) in soybean. The present study also indicated the predominant nature of *M. phaseolina* in soybean seeds. [21] also reported that PDA medium was preferable for isolation of *Macrophomina phaseolina* causing charcoal root rot of soybean.

Evaluation of different seed health detection methods

Four seed health testing methods *viz.*, blotter method, 2, 4 - D blotter, deep freeze blotter and agar plate methods were compared to know the efficacy of different detection methods (Fig 1).

The results indicated that, among the four methods employed for detection of seed mycoflora, standard blotter method was found superior and recorded maximum total fungal colonies (40.9 % and 35.7 %), followed by agar plate method (26.4 % and 20.7 %), 2, 4 - D blotter (22.3 % and 16.2 %) and deep freeze blotter (14.4 % and 11.9 %) in the seed samples analysed from Nizamabad and Adilabad districts of Andhra Pradesh (Fig 2). Whereas mean total fungal colonies of four detection methods were also found high in Nizamabad district (17.7 to 33%) followed by Adilabad district (18 to 26.4%). The results are in conformity with [4,17] who reported that differences of seed mycoflora in different safflower and castor seed samples collected from different districts of Andhra Pradesh. Similar kind of variations in occurrence of seed mycoflora in different detection methods were reported by several workers.

[22] in soybean and [19] detected more number of seed mycoflora in chick pea seed samples by blotter method followed by agar plate and deep freeze blotter method. The efficacy of agar plate method and blotter method was proved superior by various workers *viz.*, [19] and [8]. On the contrary some of the workers reported that agar plate method was found superior in isolation of more number of fungal colonies over blotter method. [2] [23] [24]

CONCLUSION

Results from the present investigation indicated that there was variation in mycoflora from one locality to another. Mycoflora of seed varied from place to place due to change in conditions prevailing during seed development, harvesting and storage. Out of four methods adopted for detection of seed mycoflora, standard blotter method was proved to be superior to other methods as the total fungal colonies was more in stand blotter method. Out of nine fungal species recorded, *M. phaseolina* was found predominant in the samples analysed from two districts.

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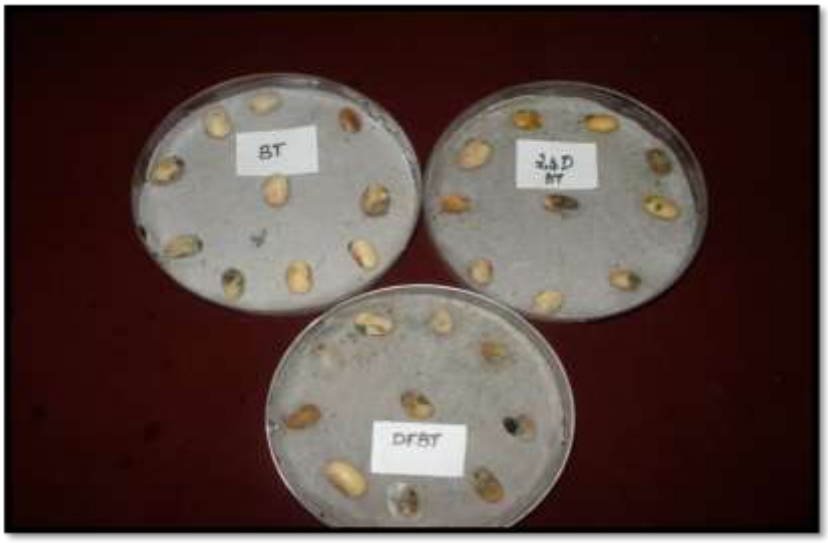

Fig 1: Seed mycoflora detected by blotter method, 2, 4-D blotter and deep freeze blotter method in seeds of soybean

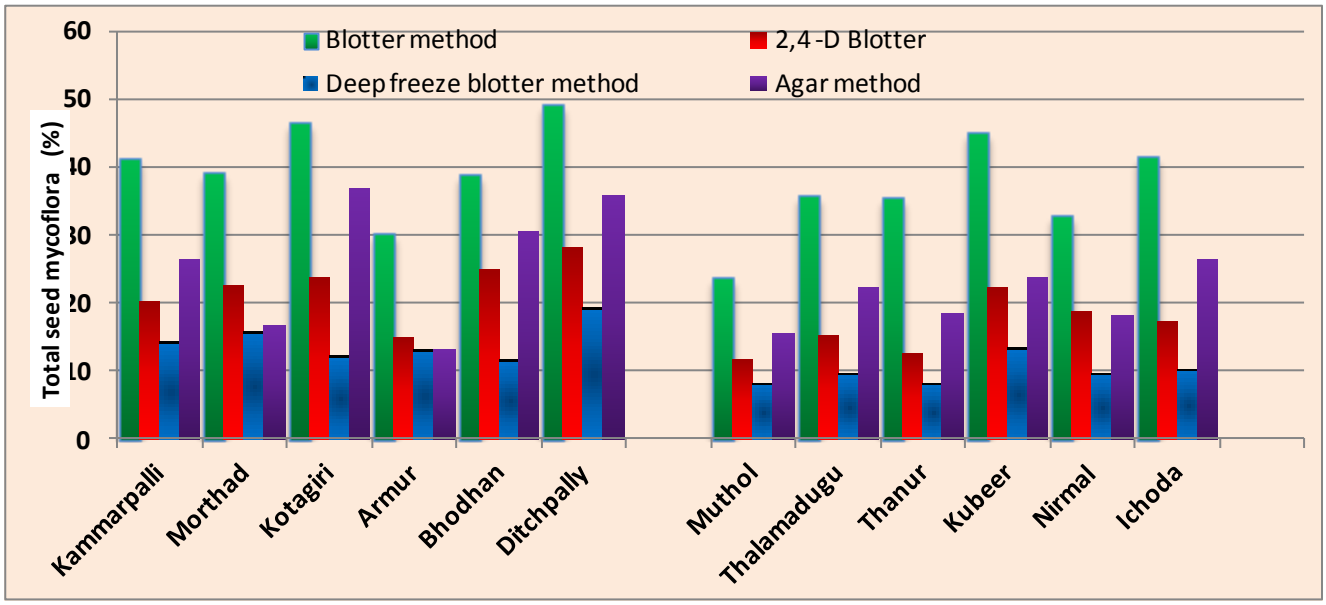

Fig 2. Total seed mycoflora detected in soybean seed samples collected from different mandals of Nizamabad and Adilabad district

Table 1. Detection of mycoflora associated with soybean seed samples collected from Nizamabad and Adilabad districts of A.P following standard blotter method.

District	S.No	Mandal	*M. phaseolina*	*Colletot-richum*	*Fusarium*	*Altern-aria*	*Curvularia*	*Rhizopus*	*A. flavus*	*A. niger*	*Cladospor-ium*	TFC (%)
NIZAMABAD	1	Kammarpalli	20.5 (27.1)	3.5 (10.7)	2.0 (8.12)	1.5 (7.03)	3.5 (10.7)	4.0 (11.5)	2.5 (9.09)	2.4 (8.91)	1.5 (7.02)	41.4
	2	Morthad	16 (23.5)	4.0 (11.5)	2.3 (8.72)	3.5 (10.7)	4 (11.5)	2.5 (9.09)	3.4 (10.6)	1.5 (7.02)	2.0 (8.12)	39.2
	3	Kotagiri	26 (30.6)	4.5 (12.2)	3.5 (10.78)	2.5 (9.08)	3.5 (10.7)	3.5 (10.78)	1.0 (5.61)	1.5 (7.03)	0.5 (4.18)	46.5
	4	Armur	14.4 (22.3)	2.0 (8.12)	2.5 (10.7)	1.5 (7.03)	1.0 (10.7)	3.5 (10.7)	1.5 (7.03)	1.3 (6.54)	2.3 (8.69)	30.0
	5	Bhodhan	24.5 (29.6)	2.5 (8.99)	1.5 (7.03)	3.0 (9.97)	2.0 (8.71)	2.3 (8.71)	1.5 (7.02)	0.5 (4.41)	1.0 (5.73)	38.8
	6	Ditchpally	28.5 (32.2)	3.5 (10.7)	3.3 (10.4)	2.5 (9.09)	3.4 (9.08)	2.5 (9.08)	1.5 (7.03)	2.5 (9.09)	1.5 (7.01)	49.2
		S.Em (±)	**0.80**	**0.44**	**0.167**	**0.165**	**0.18**	**0.18**	**0.37**	**0.21**	**0.29**	
		CD at 5%	**2.49**	**1.36**	**0.514**	**0.510**	**0.57**	**0.57**	**1.16**	**0.67**	**0.89**	
ADILABAD	1	Muthol	8.5 (16.9)	3.8 (11.2)	3.3 (10.4)	2.0 (8.12)	3.5 (10.7)	- (0.00)	1.5 (6.99)	- (0.00)	1.0 (5.73)	23.6
	2	Thalamadugu	13.2 (21.3)	3.5 (10.7)	2.5 (9.09)	2.3 (8.71)	3.1 (10.1)	4.0 (11.5)	2.5 (9.08)	4.0 (11.51)	0.5 (4.41)	35.6
	3	Thanur	9 (17.4)	4.5 (12.2)	3.4 (10.6)	4.5 (12.2)	2.5 (9.03)	4.0 (11.5)	2.5 (9.09)	2.5 (9.01)	2.5 (9.04)	35.4
	4	Kubeer	16.5 (23.9)	6.2 (14.4)	5.3 (13.3)	4.0 (11.5)	2.5 (9.09)	2.3 (8.72)	3.5 (10.7)	3.4 (10.6)	1.3 (6.53)	45
	5	Nirmal	10.5 (18.9)	4.5 (12.2)	3.0 (9.95)	3.3 (10.4)	3.3 (10.4)	2.5 (9.08)	1.5 (7.03)	3.0 (9.95)	1.3 (6.53)	32.9
	6	Ichoda	14.5 (22.3)	5.2 (13.1)	4.5 (12.4)	2.0 (8.12)	3.5 (10.7)	3.3 (10.4)	3.0 (9.97)	4.5 (12.2)	1.2 (6.28)	41.7
		S.Em (±)	**0.34**	**0.25**	**0.23**	**0.30**	**0.38**	**0.19**	**0.29**	**0.47**	**0.36**	
		CD at 5%	**1.07**	**0.77**	**0.73**	**0.94**	**1.19**	**0.59**	**0.92**	**1.47**	**1.10**	

Figures in parenthesis are angular transformed values. Mean of four replications. TFC: Total fungal colonies

Table 2. Detection of mycoflora associated with soybean seed samples collected from Nizamabad and Adilabad districts of A.P following 2, 4 - D blotter paper method.

Dist-rict	S.No	Mandal	*M. phaseolina*	*Colletotri -chum*	*Fusarium*	*Alternaria*	*Curvularia*	*Rhizopus*	*A. flavus*	*A. niger*	*Cladospo -rium*	TFC (%)
NIZAMABAD	1	Kammarpalli	5.8 (13.9)	5.8 (13.9)	3.3 (10.4)	1.0 (5.73)	1.5 (6.79)	1.3 (6.27)	- (0.00)	1.5 (7.02)	- (0.00)	20.2
	2	Morthad	5.5 (13.5)	5.0 (12.9)	1.3 (6.79)	1.8 (7.70)	1.3 (6.79)	2.2 (8.46)	2.5 (9.09)	1.3 (6.79)	1.5 (7.02)	22.4
	3	Kotagiri	8.8 (17.2)	8.5 (16.9)	1.0 (5.73)	1.5 (7.02)	1.0 (5.73)	- (0.00)	0.5 (4.18)	1.0 (5.73)	1.5 (7.02)	23.8
	4	Armur	5.0 (12.9)	3.5 (10.7)	1.5 (7.02)	1.0 (5.73)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	1.3 (6.79)	- (0.00)	14.8
	5	Bhodhan	6.8 (15.1)	6.5 (14.7)	1.3 (6.79)	1.5 (7.02)	2.5 (9.09)	3 (9.97)	0.5 (4.18)	1.5 (7.02)	1.2 (6.28)	24.8
	6	Ditchpally	9.5 (17.9)	9.0 (17.4)	1.6 (7.25)	2.5 (9.09)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	1.5 (7.02)	1.5 (7.02)	28.1
		S.Em (±)	**0.11**	**0.07**	**0.21**	**0.19**	**0.14**	**0.15**	**0.12**	**0.22**	**0.20**	
		CD at 5%	**0.35**	**0.21**	**0.65**	**0.66**	**0.46**	**0.47**	**0.39**	**0.67**	**0.62**	
ADILABAD	1	Muthol	4.0 (11.5)	3.5 (10.7)	1.0 (5.73)	0.5 (7.02)	1.0 (5.73)	0.5 (4.18)	- (0.00)	1.1 (6.00)	- (0.00)	11.6
	2	Thalamadugu	5.0 (12.9)	3.8 (11.2)	1.3 (6.53)	1.2 (6.28)	1.3 (6.53)	1.0 (5.73)	0.8 (5.12)	0.5 (4.18)	0.3 (4.05)	15.2
	3	Thanur	4.5 (12.2)	3.3 (10.4)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	0.8 (5.12)	1.0 (5.73)	0.5 (4.18)	- (0.00)	12.6
	4	Kubeer	6.8 (15.1)	5.5 (13.5)	1.5 (7.11)	2.3 (8.65)	3.0 (9.97)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	0.5 (4.18)	22.1
	5	Nirmal	6.5 (14.7)	4.5 (12.3)	1.3 (6.54)	2.1 (8.33)	1.8 (7.70)	0.7 (4.79)	0.4 (4.05)	1.0 (5.73)	0.3 (4.05)	18.6
	6	Ichoda	5.3 (13.3)	4.0 (11.5)	1.3 (6.53)	2.0 (8.12)	1.5 (7.03)	1.3 (6.54)	1.0 (5.73)	0.5 (4.18)	0.4 (4.18)	17.3
		S.Em (±)	**0.09**	**0.08**	**0.20**	**0.15**	**0.17**	**0.16**	**0.13**	**0.18**	**0.07**	
		CD at 5%	**0.28**	**0.24**	**0.63**	**0.48**	**0.54**	**0.51**	**0.41**	**0.57**	**0.22**	

Figures in parenthesis are angular transformed values. Mean of four replications. TFC: Total fungal colonies

Table 3. Detection of mycoflora associated with soybean seed samples from Nizamabad and Adilabad districts of A.P following deep freeze blotter paper method

District	S.No	Mandal	*M. phaseolina*	*Colletotr-ichum*	*Fusarium*	*Alternaria*	*Curvularia*	*Rhizopus*	*A. flavus*	*A. niger*	*Cladospo-rium*	TFC (%)
NIZAMABAD	1	Kammarpalli	3.5 (10.7)	1.5 (7.03)	1.3 (6.54)	2.5 (9.09)	1.4 (6.79)	1.3 (6.54)	1.5 (7.03)	- (0.00)	1.3 (6.54)	14.3
	2	Morthad	3.3 (10.8)	3.5 (10.7)	1.5 (7.03)	- (0.00)	- (0.00)	1.5 (7.03)	1.4 (6.54)	2.0 (8.12)	2.5 (9.09)	15.7
	3	Kotagiri	4.5 (12.2)	1.0 (5.73)	1.5 (7.03)	1.0 (5.73)	1.3 (6.54)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	0.5 (4.18)	12.3
	4	Armur	2.5 (9.09)	2.5 (9.09)	2.6 (9.27)	- (0.00)	- (0.00)	1.5 (7.03)	2.5 (9.09)	1.0 (5.73)	0.5 (4.18)	13.1
	5	Bhodhan	4.0 (11.5)	1.0 (5.73)	1.5 (7.03)	1.0 (5.73)	0.5 (4.18)	1.3 (6.54)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	11.8
	6	Ditchpally	6.5 (14.7)	1.5 (7.03)	3.0 (9.7)	2.5 (9.09)	2.0 (8.12)	1.0 (5.73)	0.5 (4.18)	1.0 (5.73)	1.3 (6.54)	19.3
		S.Em (±)	**0.14**	**0.13**	**0.12**	**0.11**	**0.10**	**0.15**	**0.13**	**0.13**	**0.13**	
		CD at 5%	**0.43**	**0.42**	**0.39**	**0.35**	**0.33**	**0.46**	**0.42**	**0.42**	**0.42**	
ADILABAD	1	Muthol	3.0 (9.96)	1.2 (6.28)	1.0 (5.73)	0.5 (4.04)	1.0 (5.73)	1.0 (5.73)	1.5 (7.03)	- (0.00)	0.3 (4.40)	9.5
	2	Thalamadugu	4.1 (11.6)	1.3 (6.54)	1.1 (6.01)	1.5 (7.03)	1.0 (5.73)	1.0 (5.73)	0.5 (4.04)	- (0.00)	0.5 (4.04)	11.1
	3	Thanur	4.0 (11.5)	1.5 (7.03)	1.0 (5.73)	0.5 (4.04)	1.0 (5.73)	0.8 (5.12)	2.5 (9.09)	- (0.00)	0.3 (3.30)	11.6
	4	Kubeer	5.1 (13.0)	1.8 (7.70)	2.3 (8.7)	2.5 (9.09)	0.5 (4.04)	1.0 (5.73)	0.5 (4.04)	1.0 (5.73)	1.5 (7.03)	16.2
	5	Nirmal	3.2 (10.3)	1.2 (6.28)	1.3 (6.54)	1.0 (5.73)	0.5 (4.04)	0.8 (5.73)	1.0 (5.73)	1.5 (7.03)	- (0.00)	10.5
	6	Ichoda	4.2 (11.8)	1.3 (6.54)	2.1 (8.3)	0.5 (4.04)	0.5 (0.00)	1.0 (0.00)	1.3 (6.54)	1.2 (6.28)	- (0.00)	12.3
		S.Em (±)	**0.08**	**0.14**	**0.18**	**0.19**	**0.18**	**0.15**	**0.17**	**0.10**	**0.45**	
		CD at 5%	**0.26**	**0.44**	**0.56**	**0.60**	**0.56**	**0.48**	**0.55**	**0.33**	**1.40**	

Figures in parenthesis are angular transformed values. Mean of four replications. TFC: Total fungal colonies

Table 4. Detection of mycoflora associated with soybean seed samples collected from Nizamabad and Adilabad districts of A.P following potato dextrose agar method

Dist-rict	S.No	Mandal	*M. phaseolina*	*Colletotri-chum*	*Fusarium*	*Alternaria*	*Curvularia*	*Rhizopus*	*A. flavus*	*A. niger*	*Cladosporium*	TFC (%)
NIZAMABAD	1	Kammarpalli	6.3 (14.5)	2.0 (8.12)	4.0 (11.4)	3.0 (9.97)	4.4 (12.0)	2.0 (8.12)	1.5 (7.02)	1.0 (5.58)	2.0 (8.12)	26.2
	2	Morthad	4.5 (12.2)	1.5 (7.03)	2.5 (9.09)	2.5 (9.08)	2.6 (9.26)	1.0 (5.58)	1.5 (7.03)	- (0.00)	1.5 (7.01)	16.6
	3	Kotagiri	12.5 (20.7)	2.5 (9.07)	6.5 (14.7)	1.5 (7.02)	5.0 (12.9)	3 (9.97)	1.5 (7.02)	2.0 (8.12)	2.5 (9.09)	37.0
	4	Armur	3.5 (10.7)	1.0 (5.67)	2.8 (9.63)	- (0.00)	4.3 (11.9)	1.0 (5.72)	0.5 (4.41)	- (0.00)	1.0 (5.73)	13.1
	5	Bhodhan	8.5 (16.9)	3.3 (10.46)	4.3 (11.9)	3.6 (10.9)	4.6 (12.3)	1.5 (7.03)	2.0 (9.09)	1.0 (5.79)	1.5 (7.02)	30.3
	6	Ditchpally	14 (24.4)	3.5 (10.7)	7.5 (15.8)	1.5 (7.03)	2.6 (9.24)	1.5 (7.02)	2.5 (9.08)	1.0 (5.72)	1.5 (6.87)	35.6
		S.Em (±)	**1.04**	**0.35**	**0.38**	**0.22**	**0.45**	**0.43**	**0.25**	**0.54**	**0.47**	
		CD at 5%	**3.23**	**1.09**	**1.19**	**0.69**	**1.41**	**1.32**	**0.78**	**1.68**	**1.47**	
ADILABAD	1	Muthol	5.5 (13.5)	1.2 (6.26)	3.5 (10.7)	1.0 (5.67)	1.2 (6.27)	1.5 (8.11)	- (0.00)	0.5 (5.72)	1.0 (8.10)	15.4
	2	Thalamadugu	8.5 (12.2)	1.3 (7.02)	5.5 (9.09)	1.3 (9.06)	1.2 (9.26)	1.0 (5.67)	1.0 (7.02)	1.3 (4.05)	1.0 (7.02)	22.1
	3	Thanur	7.8 (20.7)	1.0 (9.06)	4.0 (14.7)	1.5 (7.02)	1.0 (12.8)	0.5 (9.96)	1.0 (6.99)	1.3 (8.11)	0.4 (7.02)	18.5
	4	Kubeer	10.3 (10.7)	1.5 (5.69)	6.0 (9.58)	1.2 (4.05)	1.0 (11.9)	1.3 (5.72)	1.4 (4.51)	0.5 (4.05)	0.5 (5.67)	23.7
	5	Nirmal	6.5 (16.9)	1.3 (10.4)	4.5 (11.9)	1.2 (10.9)	0.5 (12.3)	0.8 (7.03)	1.0 (4.30)	1.2 (4.05)	1.0 (5.73)	18.0
	6	Ichoda	11.3 (19.6)	1.3 (10.7)	6.5 15.89	1.3 (6.54)	1.0 (5.73)	1.5 (7.03)	1.2 (6.28)	1.5 (7.03)	0.8 (5.73)	26.4
		S.Em (±)	**0.16**	**0.45**	**0.44**	**0.37**	**0.35**	**0.34**	**0.38**	**0.19**	**0.35**	
		CD at 5%	**0.52**	**1.41**	**1.36**	**1.14**	**1.09**	**1.05**	**1.19**	**0.59**	**1.10**	

Figures in parenthesis are angular transformed values. Mean of four replications. TFC: Total fungal colonies