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Health Status of Farmers' Saved Seed of Various Paddy Varieties in Haryana, India

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Abstract: Rice (*Oryza sativa* L.) is one of the major food crops of the world. Due to lack of awareness, the farmers do not distinguish the seed from grain and hence the quality of farmers saved seed remains below standard. This seed carries microflora which play an important role in reducing the seed viability. Among seed microflora, fungal load on the seed is very important. In this study, seed samples of different varieties of paddy were collected from farmers in different villages of Haryana from 2002 to 2012. The seed was subjected to seed health test by blotter technique and observed under stereo-binocular microscope to assess its fungal load. The per cent germination and vigour index were also evaluated by paper towel method. A total of 30 fungi belonging to different groups were recorded from the samples of farmers' saved seed. *Alternaria padwickii* (28.52%), *Curvularia lunata* (22.67%), *Alternaria alternata* (10.51%), *Rhizopus stolonifer* (8.96%), *Aspergillus flavus* (8.26%) and *Fusarium moniliforme* (7.15%) were recorded as major fungi associated with the seed. However, in breeder seed of different paddy varieties grown at this station, only 22 fungal species belonging to different groups were recorded. Out of which *Alternaria padwickii* (10.62%), *Curvularia lunata* (7.35%), *Alternaria alternata* (6.54%), *Aspergillus flavus* (6.07%) and *Rhizopus stolonifer* (5.21%) were recorded as the major fungi associated with this seed. Average per cent germination and vigour of farmers' saved seed of different paddy varieties was significantly lower than the breeder seed of different varieties of paddy grown at this station.

Key words: Farmers' saved seed, paddy, seed health and seed mycoflora

INTRODUCTION

Rice (*Oryza sativa* L.) is one of major food crops of the world. It is the staple food for more than half of the world's population. India is the one of the largest rice growing countries with an area of around 44 m ha and production of more than 100 million tonnes. Rice is grown in almost all the states of India contributing about 42% to the country's food grain production and provides livelihood for about 70% of the population. In India more than half of the population depends on rice for their food (Prasad *et al*., 2012). Seed serves as an important microcosm for saprotrophic and pathogenic microorganisms and paddy seeds are no exception to this (Agrios, 1997; Domijan *et al*., 2005). More than 50 fungal pathogens have been reported to be seed-borne in paddy (Agrawal, 1999), causing pre and post infections and considerable quality losses viz., seed abortion, seed rot, seed necrosis, reduction or elimination of germination capacity, seedling damage and loss of nutritive value (Miller, 1995; Janardhana *et al*., 1998; Kavitha *et al*., 2005). The seed replacement rate in our country is very low because farmers are used to save the seed for next crop season in different crops.

Farmer saved seed accounts for the greatest proportion of seeds used by farmers worldwide especially in low-income countries (Msuya and Stefano, 2010). In country like India, it is not possible that public and private sector can fulfil the seed requirements of farmers especially in crops which require large amount of seed to raise next season's crop like wheat, rice etc. Of the total seed requirement in the country, only less than 20% good quality certified seeds are available to the farmers and more than 80% of the requirement is met up by farmers saved seed (Raj *et al*., 2007; Atwal, 2013). Therefore, quality of farmers' saved seed is highly pertinent in this scenario. Farmers have a long experience of using their own seed saved from the previous crop harvest. Indeed, organized commercial seed supply of improved crop varieties worldwide is a very recent practice that has been in existence for less than a century. But in the maximum cases the farmers saved seed is stored in very unhygienic conditions, hence it is prone to seed inhabiting mycoflora which are capable of deteriorating seed quality. In a report it was found that more than 80% famers do not differentiate the grain from seed (Raj *et al*., 2007). This study presents a brief overview of the farmers' saved seed in Haryana with particular emphasis to seed health of different varieties of farmers' saved seed of paddy (*Oryza sativa* L.).

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MATERIALS AND METHODS

Collection of paddy seed samples: A total of 40 seed samples of different cultivars of paddy (viz., Pusa sugandh-2, Pusa sugandh-3, Pusa basmati-1, Pusa sugandh-5, PRH-10, Pusa-44, Pusa basmati-1121, Sarbati, PR-47, PR-14, CSR-30, PR-20, PR-26, PR-27, Govinda, Pusa-1460) (approximately 1.0 kg) were collected from the farmers after the harvest of the crop in different villages of state of Haryana, during the harvest seasons of 2002 to 2012. Samples were brought to the laboratory in sterile plastic bags and kept at 4°C. All the samples were subjected to seed health test using blotter technique, seed germination by paper towel method and vigour index was evaluated based on seedling length (ISTA, 1999).

Evaluation of seed for mycoflora: About 400 seeds of each collected sample were randomly picked out and were subjected to Standard blotter method as recommended by International Seed Testing Association (ISTA, 1999). The seeds were incubated for a period of 10 days 22±1°C under 12 h alternate cycles of light and darkness. After incubation fungi associated with seeds were examined under different magnifications of stereomicroscope for the occurrence of mycoflora. The fungal species observed under this study were isolated on different culture media and slides were prepared for proper identification of these fungi with the help of available literature (Thom and Raper, 1945; Barnett and Hunter, 1972; Ellis, 1976). The percent incidence of the seed mycoflora was recorded and the data were tabulated.

Evaluation of seed germination and seedling vigour: Four replicates of 100 seeds, each were incubated in wet blotter towels for a period of 14 days for germination test according to ISTA under standard conditions of light, temperature and humidity. On 15th day, the incubated towels were unrolled and the root and shoot length of the normal seedlings were measured. Percentage of seed germination was also recorded. The vigour index of the seedlings was calculated using the equation of Abdul-Baki and Anderson (1973).

RESULTS

A total of 30 fungal species belonging to different groups were recorded on samples of farmers' saved seed of different paddy varieties in Haryana. Out of which *Alternaria padwickii* (28.52%), *Curvularia lunata* (22.67%), *Alternaria alternata* (10.51%), *Rhizopus stolonifer* (8.96%), *Aspergillus flavus* (8.26%) and *Fusarium moniliforme* (7.15%) were recorded as major fungi associated with the seed (Table 1). However, in breeder seed of different paddy varieties grown at this station, only 22 fungal species belonging to different groups were recorded. Out of which *Alternaria padwickii* (10.62%), *Curvularia lunata* (7.35%), *Alternaria alternata* (6.54%), *Aspergillus flavus* (6.07%) and *Rhizopus stolonifer* (5.21%) were recorded as the major fungi associated with this seed (Table 2).

In farmers' saved seed of paddy, the incidence of maximum number of fungi (15) was less than 1%, while the incidence of 9 fungi varied between 1-5% and incidence of *Fusarium moniliforme*, *Aspergillus flavus* and *Rhizopus stolonifer* ranged between 5-10%. However, incidence of *Alternaria alternata*, *Curvularia lunata* and *Alternaria padwickii* associated with famers' saved paddy seed was greater than 10% (Table 3). Whereas, out of twenty two fungi found associated with breeder seed of paddy varieties (Table 4), the incidence of 11 fungi was less than 1% and the incidence of six fungi varied between 1-5% whereas the incidence of only two fungi *Rhizopus stolonifer* and *Aspergillus flavus* ranged

Table 1: Percent incidence of different mycoflora in farmers' saved seed of different paddy varieties in Haryana

	Percent incidence of seed mycoflora during different years of the study										
Name of fungi	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	Average incidence (%)
Alternaria alternata	12.40	7.30	27.90	0.00	5.20	10.10	17.20	16.70	5.80	2.50	10.51
Alternaria padwickii	27.90	37.20	14.90	40.00	19.30	33.40	26.50	22.60	18.50	44.90	28.52
Alternaria sp.	1.30	0.00	0.00	0.97	0.00	1.00	0.00	0.00	2.40	0.00	0.57
Arthrobotrys sp.	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.32
Aspergillus flavus	7.10	2.40	8.60	11.50	28.50	6.98	3.90	0.50	4.70	8.40	8.26
Aspergillus fumigatus	0.00	0.00	0.00	11.21	1.40	0.00	2.70	0.00	0.00	0.20	1.55
Aspergillus niger	1.20	0.00	3.30	0.19	3.80	0.00	0.34	0.30	0.20	0.90	1.02
Aspergillus terreus	3.30	0.00	0.00	1.46	1.10	0.00	0.50	0.10	0.00	0.00	0.65
Cephalosporium sp.	0.00	0.30	1.30	0.00	1.00	0.00	0.20	0.20	0.40	0.00	0.34
Cercospora sp.	0.00	0.00	0.00	0.29	0.00	0.00	3.10	0.00	0.40	0.00	0.38
Chaetomium sp	1.42	0.00	0.70	1.56	5.50	1.51	0.60	8.10	0.50	4.70	2.46
Cladosporium sp.	1.20	5.00	6.60	0.09	2.90	0.00	0.40	0.50	1.30	0.40	1.84
Curvularia lunata	12.50	28.90	4.80	10.04	9.50	31.10	34.60	31.70	34.20	29.40	22.67
Curvularia oryzae	0.80	0.00	0.20	0.19	3.20	1.16	4.10	0.00	0.60	1.10	1.14

Table 1: Continue

Name of fungi	Percent incidence of seed mycoflora during different years of the study										Average incidence (%)
	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Drechslera oryzae	5.30	7.70	4.10	3.51	6.02	2.79	3.70	5.40	3.00	0.90	4.24
Drechslera sp.	0.00	0.00	1.30	0.00	0.90	0.00	1.00	0.00	2.10	1.40	0.67
Dreschlera tetramera	0.00	0.00	0.00	1.00	0.00	0.93	0.00	1.00	0.00	0.00	0.29
Epicoccum sp.	10.10	0.00	1.50	2.24	1.40	1.63	1.20	15.50	1.90	0.20	3.57
Fusarium moniliforme	18.40	7.30	1.50	3.89	2.90	5.59	4.10	0.80	22.70	4.30	7.15
F. oxysporum	0.00	0.00	1.70	2.90	0.00	0.23	0.00	0.00	1.30	0.00	0.61
F. semitectum	0.00	0.00	1.80	1.56	0.60	1.28	1.20	1.60	1.90	1.70	1.16
Gonatobotrys sp.	0.00	0.00	0.00	0.00	0.05	0.00	0.00	1.40	1.10	0.00	0.25
Memnoniella sp.	0.00	0.43	0.00	0.09	1.60	0.35	0.00	0.40	0.20	0.10	0.32
Mucor sp.	0.00	0.00	0.00	0.00	0.60	0.00	0.00	1.70	0.00	0.10	0.24
Myrothecium sp.	0.00	0.00	0.00	0.39	0.00	0.71	0.00	0.80	0.50	0.00	0.24
Penicillium sp.	1.90	0.00	1.70	1.85	1.90	1.40	0.80	0.10	0.30	0.30	1.02
Rhizopus stolonifer	4.10	12.40	15.70	8.87	9.70	11.63	1.70	14.30	0.90	10.30	8.96
Stachybotrys sp.	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.18	0.00	0.00	0.03
Trichothecium sp.	0.00	0.50	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.10
Sterile mycelium	0.00	0.00	0.20	0.09	0.20	0.00	0.00	0.30	0.00	0.00	0.08
Average incidence (%)	3.73	3.65	3.26	3.46	3.58	3.73	3.61	4.14	3.50	3.72	–

Table 2: Percent incidence of different mycoflora in institute produced breeder seed of different paddy varieties

Name of fungi	Percent incidence of seed mycoflora during different years of the study										Average incidence (%)
	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	
Alternaria alternata	0.00	11.20	5.70	6.10	7.90	8.20	5.70	0.00	12.30	8.34	6.54
Alternaria padwickii	12.60	4.30	7.80	9.30	11.90	15.20	13.20	8.10	7.80	16.04	10.62
Aspergillus flavus	0.00	2.70	0.00	4.10	3.60	11.30	10.60	11.00	17.40	0.00	6.07
Aspergillus fumigatus	0.42	0.00	0.00	1.90	0.00	1.20	0.00	0.00	0.00	0.00	0.35
Aspergillus niger	0.00	1.00	2.10	3.20	0.00	4.10	0.00	0.00	0.00	0.00	1.04
Arthrobotrys sp.	0.00	0.00	0.00	0.30	0.00	0.00	0.00	1.20	0.00	0.22	0.17
Cephalosporium sp.	0.00	0.00	0.31	0.00	1.30	0.00	0.00	0.00	0.00	0.43	0.20
Chaetomium sp.	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.12
Cladosporium sp.	0.70	0.00	0.00	1.34	0.00	1.71	0.00	0.00	0.40	1.19	0.53
Curvularia lunata	0.00	11.70	6.30	12.40	11.62	0.00	13.20	7.43	8.34	2.52	7.35
Curvularia oryzae	0.00	0.00	0.00	0.00	1.10	0.00	0.00	0.00	1.60	0.00	0.27
Drechslera oryzae	0.00	1.80	1.40	0.00	0.00	3.70	1.90	2.60	3.20	2.10	1.67
Drechslera sp.	1.50	0.00	6.10	4.32	7.10	0.00	0.00	0.00	1.20	9.02	2.92
Epicoccum sp.	2.90	3.80	0.00	4.30	0.00	3.70	1.30	0.00	3.30	4.24	2.35
Fusarium moniliforme	1.10	2.00	0.42	0.00	6.12	9.05	1.15	7.61	1.70	5.11	3.43
F. semitectum	0.00	0.00	1.00	1.40	0.00	0.00	0.00	0.00	0.40	0.00	0.28
Gonatobotrys sp.	0.00	1.04	0.00	0.00	0.00	0.48	0.52	0.00	0.30	0.00	0.23
Penicillium sp.	0.20	0.00	0.38	5.27	2.71	1.98	0.00	3.00	2.00	0.10	1.56
Rhizopus stolonifer	1.00	2.10	0.00	1.80	3.80	5.60	9.60	7.40	10.60	10.20	5.21
Stemphylium sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.03
Trichothecium sp.	0.00	0.00	0.00	0.10	0.00	1.10	0.00	0.00	0.00	0.00	0.12
Sterile mycelium	1.45	0.00	1.30	0.00	0.00	0.00	2.12	0.00	0.10	0.65	0.56
Average incidence (%)	0.99	1.89	1.49	2.59	2.60	3.06	2.69	2.20	3.22	2.73	–

Table 3: Fungi infecting farmers' saved seed of different paddy varieties in Haryana

Infection range	Name of fungi	Total No. of fungi
<1%	*Aspergillus terreus*, *Fusarium oxysporum*, *Alternaria* sp., *Cercospora* sp., *Cladosporium* sp., *Cephalosporium* sp., *Arthrobotrys* sp., *Memnoniella* sp., *Dreschlera tetramera*, *Gonatobotrys* sp., *Mucor* sp., *Myrothecium* sp., *Trichothecium* sp., *Stachybotrys* sp. and Sterile mycelium	15
1-5%	*Curvularia oryzae*, *Fusarium semitectum*, *Aspergillus niger*, *Penicillium* sp., *Aspergillus fumigatus*, *Cladosporium* sp., *Chaetomium* sp., *Epicoccum* sp. and *Drechslera oryzae*	9
5-10%	*Fusarium moniliforme*, *Aspergillus flavus* and *Rhizopus stolonifer*	3
>10%	*Alternaria alternata*, *Curvularia lunata* and *Alternaria padwickii*	3
Total No. of fungi		30

Table 4: Fungi infecting institute produced breeder seed of different paddy varieties

Infection range	Name of fungi	Total No. of fungi
<1%	*Stemphylium* sp., *Trichothecium* sp., *Chaetomium* sp., *Arthrobotrys* sp., *Cephalosporium* sp, *Gonatobotrys* sp., *Curvularia oryzae*, *Fusarium semitectum*, *Aspergillus fumigatus*, *Cladosporium* sp. and Sterile mycelium	11
1-5%	*Aspergillus niger*, *Penicillium* sp., *Drechslera oryzae*, *Epicoccum* sp., *Drechslera* sp. and *Fusarium moniliforme*	6
5-10%	*Rhizopus stolonifer* and *Aspergillus flavus*	2
>10%	*Alternaria alternata*, *Curvularia lunata* and *Alternaria padwickii*	3
Total No. of fungi		22

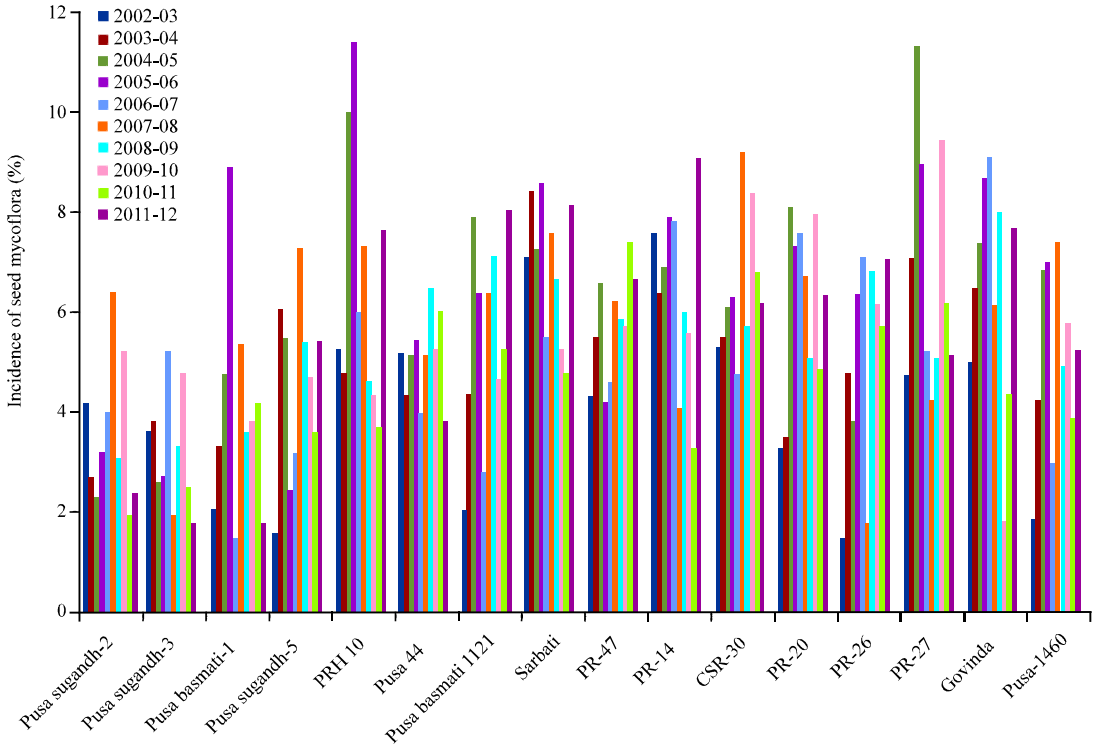

Fig. 1: Year wise per cent infection of different seed mycoflora on famers' saved seed of various paddy varieties during 2002-2012

between 5-10%. However, incidence of three fungi viz., *Alternaria alternata*, *Curvularia lunata* and *Alternaria padwickii* was greater than 10%.

At the variety level in the samples of different paddy varieties of farmers saved seed, the incidence of seed mycoflora was recorded to be varying with variety to variety. In farmers' saved seed, maximum incidence of seed mycoflora (6.93%) was recorded in Sarbati variety of paddy followed by PR-27 (6.73%) and PRH-10 (6.50%) varieties, whereas minimum incidence of seed mycoflora (3.21%) was recorded in Pusa Sugandh-3 variety during the period of 2002-2012 (Fig. 1). In case of year wise load of seed mycoflora, the percent incidence of seed mycoflora of farmers saved seed of different paddy varieties was found maximum (11.40%) during the year 2005-06 as in the seed of PRH-10 variety, whereas minimum percent incidence of seed mycoflora (1.40%) was recorded in PR-26 variety of paddy in the year 2002-2003 (Fig. 1).

The germination and vigour index of farmers saved seed of different paddy varieties were ranged between 42-89% and 870-1841, respectively during the period of study, which were comparatively lower than breeder seed of paddy (Table 5).

Table 5: Vigour index and percent germination of farmers' saved seed and breeder seed of different paddy varieties during 2002-2012

	Type of seed	
Quality parameter	Farmers' saved seed	Breeder seed
Germination (%)	42-89	72-98
Vigour index	870-1841	1378-2105

DISCUSSION

On the samples of farmers' saved seed of different paddy varieties in Haryana region, *Alternaria padwickii* (28.52%), *Curvularia lunata* (22.67%), *Alternaria alternata* (10.51%), *Rhizopus stolonifer* (8.96%), *Aspergillus flavus* (8.26%) and *Fusarium moniliforme* (7.15%) were recorded as major fungi out of total 30 fungal species associated with the seed. The higher incidence of seed mycoflora in the farmers' saved seed of various varieties of paddy in Haryana was recorded with lower percent germination and vigour index. This may be due to the unhygienic storage conditions at farmer's level. The results of present study are in agreement with those of Raj *et al.* (2007), Somda *et al.* (2008), Utobo *et al.* (2011) and Naqvi *et al.* (2013). Raj *et al.* (2007) during their studies on seed health status, reported 28 fungal genera associated with famers'

saved seed of various crops viz., paddy, sorghum, sunflower and cowpea and the prevalence of seed mycoflora varied with variety of the crop and method of storage. Icishahayo *et al.* (2009) assessed quality and health of field bean seeds collected from home-saved by smallholder farmers. The most common fungi in the area were *Fusarium oxysporum* (identified in 73.2% of seed samples tested), *Alternaria alternata* (70.7%) and *Colletotrichum lindemuthianum* (51.2%). During their study, a group of relatively minor (less frequent) fungi comprised of *Fusarium solani*, *Cercospora canescens*, *Phoma exigua*, *Macrophomina phaseolina* and *Rhizoctonia solani*, were identified in 23.2, 18.3, 13.4, 34.1 and 6.1% of tested seed samples, respectively. Seed borne pathogens on farmer-saved sorghum (*Sorghum bicolor* L.) seeds collected from various sites in Nigeria were estimated by Abdulsalaam and Shenge (2011). They identified seven fungal genera viz., *Helminthosporium* sp., *Aspergillus* sp., *Fusarium* sp., *Rhizoctonia* sp., *Penicillium* sp., *Sclerotium* sp. and *Curvularia* sp. to be growing on the farmers saved seed samples of sorghum, whereas one fungus was recorded as unidentified. Among the microflora associated with farmers saved seed, seed-borne phytopathogenic fungi can be transmitted to the seedlings (Somda *et al.,* 2008) and can cause severe yield losses to the crop. The seed-borne fungal pathogens of farmers saved seed of sorghum and groundnut were identified, documented and managed using plant extract and certain fungicides (Syed *et al.,* 2012).

The year wise load of seed mycoflora was found to be varied. The percent incidence of seed mycoflora of farmers saved seed of different paddy varieties was found maximum (11.40%) during the year 2005-06 as in the seed of PRH-10 variety, where as minimum percent incidence of seed mycoflora was recorded in PR-26 variety of paddy in the year 2002-2003. The variation in the fungal incidence during various years may be attributed to the variations in the climatic conditions during the growth/harvest of the crop, especially the environment humidity prevailing at the time of the harvest, which plays an important role in harbouring and perpetuation of seed mycoflora (Naqvi *et al.,* 2013).

Mycoflora associated with seed affect the germination of seeds. In present study the incidence of seed associated mycoflora of collected samples of farmers saved seed of different paddy varieties was comparatively higher than the institute produced breeder seed whereas percent germination and vigour index were comparatively very low in farmers saved seed of various paddy varieties. Incidence of seed associated mycoflora is negatively correlated with percent germination and vigour index of seeds (Gupta, 2003). Patharkar *et al.* (2013) reported that with the increased incidence of seed mycoflora, the percent germination of Sunflower seeds was reduced. High count of seed associated mycoflora results in low percent germination, higher number of diseased and abnormal seedlings consequently leading to lower vigour index (Haque *et al.*, 2007).

Seed samples of Sarbati variety of paddy collected from farmers recorded maximum incidence of seed mycoflora, whereas minimum incidence of seed mycoflora was recorded in Pusa Sugandh-3. The association of seed mycoflora in terms of percent load or degree of seed infection by seed mycoflora may differ from variety to variety. This may be due to their preference to particular variety for colonization of seed mycoflora (Utobo *et al.*, 2011; Archana and Prakash, 2013). *Trichoconis padwickii*, *Helminthosporium oryzae* and *Fusarium moniliforme* with varied percent incidence was recorded in rice hybrids and different local rice cultivars (Utobo *et al.*, 2011).

The inferior seed health, seed germination and seedling vigour may be improved for next generation of farmers produced seed through imparting seed producing and seed storing skills to the farmers (Haque *et al.*, 2007; Kumar *et al.*, 2013). Haque *et al.* (2007) noticed that trainings have visible effects on the efficiency of the farmers. During their studies they reported that the seed of trained farmers were significantly better than the seed of untrained famers in regard the purity, germination, vigour and seed health. They found four fungal genera viz., *Aspergillus*, *Penicillium*, *Fusarium* and *Curvularia*, associated with the six month stored rice seed samples. In case of freshly harvested rice seed, trained farmers samples yielded the lowest count of *Fusarium* sp. (2.6%), *Bipolaris oryzae* (2.9%), *Curvularia* sp. (0.9%), *Alternaria padwickii* (0.3%) and *Nigrospora oryzae* (1.6%). Hence, creating awareness through trainings/field-days etc. for the use of good quality healthy seed will have a substantial impact on sustainability of food security in the country.

CONCLUSION

In a country like India having large acerage under cultivation, the public and private seed sectors both can not fulfill the requirement of seed to raise major crops. Therefore, the use of farmers saved seed in major crops is to be continued. Training of farmers regarding production and post production activities for healthy, disease free quality seed is very crucial to sustain the food security. Availability of quality seed is very crucial for high productivity but the quality of farmers' saved seed is

below standards, hence it is essential to create awareness among farmers regarding frequent replacement of their seed with quality seed to increase their income. Hence, there is an urgent need to increase SRR for quality production.

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