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Seed Borne Mycoflora of Tribal Saved Hill Rice, *Oryza sativa* in Mizoram, Northeastern of India

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ABSTRACT

Detection of seed borne pathogens through seed health testing is a critical step in the management of diseases for healthy crop establishment. The tribal farmers of Northeastern India saved their own rice seed which remains poor quality and act as carrier of many mycoflora that hinder seed viability and crop stand. This study was carried out to assess seeds of tribal farmers' saved hill rice (twenty landraces) and improved varieties (four improved varieties) for their seed borne mycoflora collected from Mizoram, Northeastern India. The seeds were subjected to blotter, agar plate techniques and paper towel method to identify various seed borne mycoflora and their germination per cent, seed vigour index, respectively. A total of 21 fungi were recorded like *Acremoniella* sp. *Alternaria tenuis*, *Curvularia lunata, C. oryzae, Dreschslera oryzae, Fusarium moniliforme, F. oxysporum, F. semitectum, Microdochium oryzae* , *Pyricularia grisea, Rhizoctonia sp,. Saracladium oryzae, Tilletia* sp., *Trichothesiums* sp., *Stilaginoidea virens, Aspergillus flavus, A. niger, Penicillium* sp. and *Rizopus stolonifer* and among these pathogen, *Fusarium moniliforme* was pre dominant in all tested rice samples ranging from (15-35%) and (54-82.0%) of agar plate and blotter paper method, respectively. Maipum (1317.43) and Manipur Nem (1171.76) showed the better performance in terms of seed germination and seedling vigour index. Idaw, recorded the maximum number of pathogen genera (14), least germination (45.45%) and vigour index (37.42). Tribal famers' saved hill rice seeds are found to be more associated with seed borne mycoflora than the improved varieties.

1. Introduction

Rice (*Oryza sativa* L.) is the main staple food of the North Eastern Region (NER) of India and West Bengal, Uttar Pradesh, Madhya Pradesh, Punjab, Orissa and Bihar are the major rice producing states. The NER comprised of seven mountainous states (Manipur, Mizoram, Nagaland, Tripura, Meghalaya, Arunachal Pradesh and Sikkim) of Indian Territory forming 7.8% of the total land area and share about 4% of the total population of the country which dominated by tribes.

In NE region, rice is cultivated at hilly agro-ecosystem, occupying 3.51 million hectares which accounts for more than 80% of the total cultivated area of the region and 7.8 per cent of the total rice area in India. The total rice production of NER is estimated to be around 5.50 million tones with average productivity of 1.57 t/ha, which is much below the national average of 2.08 t/ha. The reason for such low productivity are several constraints in the production of rice, of which seed borne diseases caused by bacteria, fungi, viruses and nematodes are responsible for major economic losses in north east India. Agrawal (1999) reported that more than 50 fungal pathogens found to be seed-borne and it's deteriorated both quantity and quality aspects of rice (Janardhana *et al.*, 1998; Kavitha *et al.,* 2005).

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Rice seeds are infected by large number of fungi and perpetuated from one season to another through infected seeds (Zope and Thrimurty 2004). Moreover, NE region, owe to high rainfall and humidity during Kharif season exposed paddy seeds to many fungal invasions (Islam and Borthakur, 2012). In India, total seed requirement is met up 20% by certified seed and remaining 80% from farmers saved seed (Raj *et al.,* 2007; Atwal, 2013). Despite of availability of certified seeds, traditionally, tribal farmer of this region continue to produce their own local rice seed and reuse it without knowing the health status of seeds. Saved rice seeds were stored in very unhygienic conditions; hence it highly prone to seed inhabiting mycoflora which are capable of deteriorating seed quality and poor stands. In changing climate, many minor seed borne pathogens like false smut, leaf scald may act major pathogens and impart threat to tribal hill resource poor farmers. Moreover, no research has been done in Mizoram which sharing common agricultural practices with others NE states to evaluate health status of landraces rice seed from both authorized and unauthorized seed sectors. Since, every seed could play a vital role in the development of epidemics in fields, good quality and healthy seed of rice should be made available to farmers in order secure their production in increasing population. Several fungal pathogens have been isolated from rice grains and have been reported to be responsible for a number of diseases from the nursery to the field (Ibiam *et al.,* 2006). Considering the above facts, the present study were undertaken to visualize different seed borne mycoflora and incidence of tribal farmers' saved hill rice seed collected from different regions of Mizoram, Northeastern India. The result provides a database for further study to develop an effective management strategy of the pathogens.

2. Materials and Methods

Paddy seed sample collection

The study area is situated in Himalayan hill range, Mizoram, North-East India (23°28′40"N and 93°19' 44′E) with an average altitude of 1678 m (MSL). In this region, the traditional landraces of rice is widely cultivated due to its suite to food habit, high palatability (sticky) and adaptability in the prevailing climatic conditions. Topographically, maximum areas under rice are grown in Jhum (shifting cultivation) and valley (low land). Twenty landraces seed samples and four improved varieties (approximately 2 kg) (Table 1) were collected from different the hill/Jhum farmers of Mizoram during harvest season of 2012-2014. Seed samples were brought to the laboratory in sterile plastic bag and kept at 4^{o}C until the diagnosis of pathogens. All seed samples were subjected to seed health testing using blotter technique, agar plate technique, (ISTA, 1999) germination by paper towel method and vigour index was evaluated based on seedling length (ISTA, 1999 and Abdul Baki and Anderson (1972).

Detection of seed mycoflora

Seed borne fungi were detected by using the blotter test method developed by (ISTA, 1999; Mathur and Konssdal, 2003). Four hundred seeds were randomly selected from each sample and placed on three layers of moisten sterilized blotter paper at the rate of 20 seeds/ Petri plate (90 mm dia.). The seed plated were incubated at 22±1°C in an incubator for 10 days maintaining 12 h alternate cycles of light and darkness. After incubation, fungi associated with seeds were isolated by pure culture method and examined under different magnification of compound and stereomicroscope for presence of mycoflora. Identification of isolated mycoflora was done based on their morphological characters and their microscopic examination of spores with help of available literatures (Barnett and Hunter, 1972; Mathur and Kongsdal, 2003; Mew and Gonzales, 2003). The per cent incidence of the seed mycoflora was recorded in each sample and the data were tabulated for statistical analysis.

Agar plate method

Another set of experiment was also carried out on agar plate technique; four hundred seeds were tested for each sample maintaining twenty seeds per plate with 20 replications. The plated seeds were incubated for 5 days 22±1°C under 12h altering cycles of light and darkness. At the end of the incubation period, fungi growing out from the seeds on the agar medium were kept under constant examination and identification was done as mentioned above.

Testing of seed germination and seedling vigour

The method developed by Warham (1990) was followed. Three replicates of 100 seeds each were incubated in wet blotter paper towels for a period of 15 days for germination test according to ISTA under standard conditions of light, temperature and humidity. The paper towels were rolled and the ends were closed by rubber band and covered by butter paper to prevent drying up. For determination of seedlings vigour, randomly ten seedlings were selected from each paper and their individual shoot and root length was measured. Shoot length (cm) was measured from the base of the stem up to the growing point of the youngest leaf. Similarly, root length (cm) was also measured from the shoot and root juncture point to the largest available lateral root apex.

Table 1. Details information of the tribal farmer saved hill rice seed samples collected from different hilly locations of Mizoram, North eastern region of India

S. No.	Name of landraces/ varieties	Habitat Type	Seed colour and characteristics	Sources of Collection
1	Idaw	Jhum	Light brown	Farmer-saved seed-Mizoram
2	Akbuh	Jhum	Dark red with long awn	Farmer-saved seed-Mizoram
3	Zakew	Jhum	Light red with long awn	Farmer-saved seed-Mizoram
4	Saii Buh	Jhum	Light brown with long awn	Farmer-saved seed-Mizoram
5	Zaitlai	Jhum	Light brown	Farmer-saved seed-Mizoram
6	Vai buh	Jhum	Light brown	Farmer-saved seed-Mizoram
7	Zaizpuii	Jhum	Light brown with long awn	Farmer-saved seed-Mizoram
8	Fazai	Jhum	Light brown	Farmer-saved seed-Mizoram
9	Manipur (Rum)	Lowland	Light brown	Farmer-saved seed-Mizoram
10	Vuitawi	Lowland	Light brown	Farmer-saved seed-Mizoram
11	Buh tawi sang	Lowland	Light brown	Farmer-saved seed-Mizoram
12	Buh Mui	Lowland	Reddish	Farmer-saved seed-Mizoram
13	Shan buh	Lowland	Light brown	Farmer-saved seed-Mizoram
14	Sawkar Buh	Lowland	Light brown	Farmer-saved seed-Mizoram
15	Thlarau Buh	Lowland	Light brown	Farmer-saved seed-Mizoram
16	Zoro	Lowland	Light brown	Farmer-saved seed-Mizoram
17	Thingtlang vai Buh	Lowland	Light brown	Farmer-saved seed-Mizoram
18	Tauphai Buh	Lowland	Light brown	Farmer-saved seed-Mizoram
19	Manipur (Nem)	Lowland	Light brown	Farmer-saved seed-Mizoram
20	Maipuam	Lowland	Light brown	Farmer-saved seed-Mizoram
21	RC Maniphou-9	Lowland	Light brown	ICAR- Manipur Centre, Imphal
22	RC Maniphou-10	Lowland	Light brown	ICAR-Manipur Centre, Imphal
23	RC Maniphou-11	Lowland	Light brown	ICAR-Manipur Centre, Imphal
24	CAU-R-1(Tampha phou)	Lowland	Light Brown	CAU, Imphal, Manipur, India

The vigour index of the seedlings was calculated using following formula developed by Abdul Baki and Anderson (1972).

Germination (%) = (Number of seeds germinated/ Total number of seeds tested) × 100

Vigour index = (Mean of root length + Mean of shoot length) × Percentage of seed germination

The laboratory experiment was conducted by following Completely Randomized Design (CRD) and recorded data on various parameters under the present study were statistically analyzed using SAS Software Version 9.3 (SAS Institute Inc. 2011). In blotter technique, a total of 19 seed borne mycoflora were recorded like, *Acremoniella* sp. *Alternaria tenuis*, *Curvularia lunata*, *C. oryzae*, *Dreschslera oryzae*, *Fusarium moniliforme*, *F. oxysporum, F. semitectum, Microdochium oryzae, Pyricularia grisea, Rhizoctonia* sp,. *Saracladium oryzae, Tilletia* sp., *Trichothesiums* sp., *Ustilaginoidea virens*, *Aspergillus flavus, A. niger, Penicillium* sp. and *Rizopus stolonifer* (Table 2). Among the pathogens, *Fusarium moniliforme* infected the highest incidence (15-35%) on all rice seeds tested whereas, Saii Buh and Idaw, jhum rice recorded the maximum incidence of 35% & 30%, respectively. Improve rice varieties recorded less pathogen load as compared to jhum and lowland landrace rice seed. *Alternaria tenuis, Pyricularia grisea, Rhizoctonia* sp, *Saradocladium oryzae, Tilletia* sp., *Ustilagoinedea virens* and *Fusarium semectum* were not frequently occurred on all rice samples whereas *Fusarium moniliforme, Ustilaginoidea virens, Aspergillus flavus, A. niger, Penicilium* sp. and *Rhizopus stolonifer* were predominant seed mycoflora on seed tested. Among the different landraces rice, Maipum recorded the least number of pathogenic genera (5), followed by Zatlai (7), Buhmuii (7), Fazai (8) and Zakew (8).

Authentic literature on seed borne mycoflora of tribal farmer saved hill rice seed is limited, but some researchers reported on improved rice cultivars. Sharma (1987) detected 10 seed borne fungi from rice seeds where *Fusarium moniliforme, Curvularaia lunata, Aspergilus flavus* and *Rhizopus* were most common encountered. Similar finding also reported by Butt *et al.* (2011) that the highest incidence of four fungal species namely, *Fusarium moniliforme, Alternaria sp., Helminthosporium sp.* and *Curvularia sp.* from different test rice varieties of Pakistan. Ora and co workers (2011) also reported that a total of 12 pathogens when blotter method, paper towel method and agar plate method were used to identify seed borne pathogens and among pathogens, *Fusarium moniliforme Rhizopus stolonifer, Aspergillus* sp. *Bipolaris oryzae* and *Xanthomonas* spp, were pre-dominant on all tested rice varieties from Bangladesh. Habib *et al.* (2012) reported that the highest percentage infection of *Helminthosporium oryzae* and *Curvularia* spp. from Pakistan as compared with other seed borne fungi when tested by agar plate and blotter paper method. A total of 69 rice seed samples from different states of India were tested their health status and sixteen genera of fungi *viz. Acremonium, Alternaria, Aspergillus, Bipolaris, Chaetomium, Cladosporium, Curvularia, Exserohilum, Fusarium, Microdochium, Nigrospora, Phoma, Pyricularia, Rhizoctonia, Rhizopus* and *Verticillium* comprising 27 species were found to be associated with the rice seed samples (Archana and Prakash, 2013). Ahmed *et al.* (2013) detected many pre dominant fungi from 36 rice seed samples like *Fusarium oxysporum, F. moniliforme, Bipolaris oryzae, Alternaria padwickii, Curvularia lunata, Aspergillus flavus, Aspergillus niger, Penicillium* sp. and *Nigrospora oryzae.*

In another set of experiment, agar plate method, 18 and 13 seed borne mycoflora were identified associated with farmer saved hill rice seed and improved varieties, respectively. These were *Acremoniella* sp. *Alternaria padwicki, Chaetomium* sp., *Cladosporium* sp., *Curvularia lunata, C. oryzae, Dreschslera oryzae, Fusarium moniliforme, F. oxysporum, Pyricularia grisea, Rhizoctonia* sp,. *Saracladium oryzae, Tilletia* sp., *Trichothesiums* sp., *Aspergillus flavus, A. niger, Penicillium* sp. and *Rizopus stolonifer* (Table 3). The highest incidence of *Fusarium moniliforme* was observed at range of 54.0-82.0% on all farmer saved hill rice seed and the maximum incidence recorded on Vai Buh (82%) whereas, the least incidence on RCM-10 (15.00%) a improved variety. Maipum (3) and Idaw (14) were recorded the least and highest number of pathogens genera, respectively. Fusarium moniliforme was only the pre dominant seed borne pathogen recorded in all rice seed samples. Earlier workers have also reported various seed borne pathogens, *Alternaria padwickii, Curvularia oryzae, C. lunata, B. oryzae, Aspergillus niger, Fusarium moniliforme, F. semitectum, F. solani and species* of *Phoma, Cercospora, Chaetomium, Sclerotium, Penicillium* and *Myrothecium* from seeds of different varieties of rice in many parts of world (Wahid *et al.,* 2001; Khan *et al.,* 2001; Javaid *et al.,,* Nguefack *et al.,* 2007 and Utobo *et al.,* 2011). Agarwal *et al.* (1989) also reported that fungi associated with *Curvularia* and *Fusarium* species which are known to cause leaf spot, pecky rice (kernel spotting) and root rot diseases in rice. Islam and Borthakur (2012) analyzed Aijung, rice variety of Assam, India for detection seed borne fungi by blotter method and agar plate method showed that species of *Aspergillus, Fusarium, Alternaria and Curvularia* are the dominant. In case of rolled paper towel method, the highest seed germination (92.26%) was observed on Maipum and the lowest seed germination (45.45%) on Idaw (Table 4).

Table 2. Percent incidence of different seed borne mycoflora from farmer-saved rice seed of Mizoram, NE Region of India by blotter method

Pathogens	% incidence seed borne mycoflora																							
	Jhum Rice								Lowland (valley) rice														Improve cultivars			
	Idaw	Ak buh	Zakew	Saii Buh	Zaitlai	Vai buh	Zairpui	Fazai	M (Rum)	Vuitawi	Buh tawi sang	Buh Mui	Shan buh	Sawkar Buh	Thlarau Buh	Zoro	Thingtlang vai Buh	Tauphai Buh	M (Nem)	Maipum	RCM- 9	RCM- 10	RCM- 11	CAU R-1
Acremoniella sp.	0.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	2.50	0.00	3.5	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	2.00	2.20	0.10	0.20
Alternaria tenuis	3.5	0.00	0.00	0.00	7.50	0.00	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	0.0	0.00	0.00	3.50	0.00	0.00	0.00	0.00	0.00	0.00
Curvularia lunata	10	12.0	9.00	15.0	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.00	10.0	19.0	10	10.0	0.00	7.00	0.00	0.00	3.20	2.50	0.30	2.30
Curvularia oryzae	0.5	0.10	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.00	3.00	3.00	3.5	3.50	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00
Dreschslera oryzae	0.0	0.00	0.00	3.00	0.00	4.00	0.0	0.0	0.00	0.00	0.0	2.0	0.00	1.00	20	0.00	0.00	0.00	0.00	2.30	0.00	0.00	0.00	0.00
Fusarium moniforme	30.	17.0	25.0	35.0	21.0	30.0	15	15	26.0	15.0	10	30.0	15.0	10.00	16	16.0	10.0	19.0	10.0	16.3	0.30	1.50	10.0	4.25
F. oxysporum	9.0	10.0	3.00	0.50	4.00	6.00	7.5	0.0	10.0	3.00	0.0	10.3	11.0	3.00	0.0	0.00	1.50	7.00	3.50	0.00	1.75	0.75	0.50	5.00
F. semitectum	0.9	0.00	0.00	0.00	0.00	0.00	0.0	1.5	0.10	0.00	0.0	0.00	0.00	0.00	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Microdochium oryzae	3.5	0.50	7.50	3.75	10.25	3.75	6.0	12	0.00	0.00	0.0	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pyricularia grisea	0.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.00	2.00	0.0	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhizoctonia sp.	0.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.00	0.00	0.0	0.00	0.00	0.00	3.8	0.00	0.00	0.00	0.00	4.31	0.00	0.00	0.00	0.00
Saracladium oryzae	0.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.25	0.75	1.3	0.25	0.00	4.25	0.0	0.25	0.25	1.75	3.75	0.00	0.00	0.00	0.00	0.00
Tilletia sp.	0.0	0.00	0.00	0.00	0.00	0.00	3.0	5.5	0.00	0.00	0.2	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichothesiums sp.	0.0	0.00	0.00	0.00	0.00	0.00	2.0	0.0	0.00	0.00	0.1	0.00	0.00	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ustilaginoidea virens	2.1	5.00	6.00	4.00	8.00	10.00	3.0	5.0	6.00	5.00	6.0	8.00	8.00	9.00	10.	8.00	12.0	14.0	12.5	0.00	5.60	1.40	2.50	3.20
Aspergillus flavus	0.1	0.15	0.10	2.75	0.00	1.00	3.0	0.3	0.90	3.00	0.1	5.50	3.60	3.00	5.0	3.00	4.00	5.00	3.00	0.00	5.00	2.00	3.00	1.00
Aspergillus niger	3.5	7.00	7.00	3.00	9.00	8.00	7.0	6.0	1.00	0.00	10	10.0	6.50	10.30	5.0	2.50	3.50	3.25	0.75	0.56	3.15	1.75	1.00	7.25
Penicillium sp.	13.0	10.0	14.0	3.25	10.0	14.0	15.0	13.0	9.00	11.0	11	8.30	10.50	10.0	5.50	18.0	16.00	13.00	12.00	11.0	00.50	10.50	11.00	12.50
Rizopus stolonifer	5.0	3.00	0.00	3.0	0.00	5.00	3.0	0.0	5.0	3.00	0.0	1.00	0.00	1.00	2.0	1.00	0.50	0.10	0.00	0.00	3.00	1.00	3.00	3.00
No..of Genera/species	12	10	8	10	7	9	10	8	10	9	9	9	7	11	11	9	8	11	7	5	9	9	8	9

M=Manipur, RCM=Research Centre Maniphou, CAU-R=Central Agricultural University Rice

Table 3. Incidence of different seed borne mycoflora of farmer-saved hill rice seed of Mizoram, NE Region of India by Agar Plate Method

Pathogens	**% incidence seed borne mycoflora**																						
	Jhum Rice								**Lowland (valley) rice**													**Improve cultivars**			
	Idaw	Ak buh	Zakew	Saii Buh	Zaitlai	Vai buh	Zaizpui	Fazai	Manipur (Rum)	Vui tawi	Buh tawi sang	Buh Mui	Shan buh	Sawkar Buh	Thlarau Buh	Zoro	Thinglang vai Buh	*Tauphai Buh*	Manipur*(Nem)*	*Maipum*	RCM-9	RCM 10	RCM-11	CAU R-1
Acremoniella	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	0.25	1.00	0.00	0.00	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alternaria padwicki	1.50	1.00	2.50	0.25	2.50	1.30	0.25	0.18	0.25	1.26	1.35	3.21	3.50	2.00	0.25	0.75	1.25	1.45	3.10	0.00	0.15	0.00	0.00	0.00
Chaetomium sp.	0.25	1.90	1.01	0.40	2.30	1.50	0.25	1.75	2.50	0.00	0.00	0.00	0.00	2.30	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cladosporium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.10	5.15	0.00	0.00	0.00	5.25	3.25	0.00	0.00	0.0	0.00	0.00
Curvularia lunata	2.00	4.00	1.50	5.25	6.25	4.00	5.50	3.00	2.00	2.25	7.25	3.00	2.00	7.50	3.00	2.00	2.25	5.50	3.20	0.00	1.75	1.00	1.25	1.00
Curvularia oryzae	0.25	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.25	2.00	0.50	3.00	0.25	3.00	2.00	1.00	1.50	1.00	2.15	0.00	0.75	7.15	7.50	1.00
Dreschslera oryzae	2.00	3.10	2.20	3.40	2.10	1.50	0.75	1.25	1.88	1.25	0.00	3.10	2.20	1.50	1.60	1.80	1.90	2.10	3.10	0.00	0.00	0.00	0.00	0.00
Fusarium moniforme	70.0	65.0	75.0	70.0	71.0	82.0	75.0	76.0	87.0	75.0	54.0	70.0	71.50	72.0	71.0	75.0	74.0	72.0	65.0	20.5	32.0	15.0	31.0	24.0
F. oxysporum	3.50	3.10	1.50	1.30	3.50	4.50	0.25	0.10	0.25	0.30	0.40	2.50	0.00	0.00	3.10	3.00	1.75	3.00	1.50	0.23	3.30	1.75	1.25	1.00
Pyricularia grisea	2.00	1.50	1.75	0.25	1.75	1.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25	1.75	0.00	2.25	0.00	0.00	0.00	0.00	3.50
Rhizoctonia	1.01	1.80	5.60	2.30	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25	1.25	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saracladium oryzae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.25	1.50	0.00	3.75	0.00	0.00	0.00	0.00	0.00
Tilletia sp.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.90	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trichothesium sp.	7.50	7.33	5.40	1.50	0.23	0.30	0.00	0.00	0.00	3.10	2.70	3.40	0.00	0.00	4.50	1.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Aspergillus flavus	5.50	4.20	6.10	3.00	3.40	2.00	3.10	1.00	1.20	3.00	0.00	3.20	1.50	0.75	0.15	2.00	3.00	1.00	2.10	0.00	3.10	2.10	3.10	2.10
Aspergillus niger	1.25	0.25	1.50	0.00	0.25	0.00	0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	0.25	1.50	0.75	0.25	0.00	1.75	0.25	0.21	0.00
Penicillium sp.	2.15	0.00	1.50	0.00	0.00	3.00	3.25	2.75	3.25	0.00	0.00	0.00	0.75	1.50	1.25	0.75	1.25	0.45	0.70	0.00	0.50	0.15	2.10	0.15
Rhizopus stolonifer	2.10	3.90	2.00	2.50	3.10	3.40	3.60	3.25	3.50	3.75	3.30	3.50	3.10	2.50	0.75	4.25	3.15	2.00	3.10	1.02	3.12	3.15	2.15	2.00
No .of Genera/species	14	13	13	11	12	11	10	9	11	9	8	9	9	13	13	15	13	11	13	3	9	8	8	8

RCM=Research Centre Maniphou, CAU-R=Central Agricultural University Rice

Maipum and Manipur Nem showed the highest vigour index of 1314.40 and 1172.27, respectively, whereas lowest vigour index was recorded on Idaw (37.42). These findings indicate that percent seed germination was decreased due to directly associated with seed borne pathogenic infection. The inferiors seed health, seed germination and seedling vigour of tribal farmers' saved hill rice seed may be improved through skill development of farmers on seed sorting and storage practices (Haque *et al.,* 2007 and Kumar *et al.,* 2013). Haque, *et al*. (2012) reported that seedlings raised from cleaned seeds and their farmer saved seeds of the same variety results show a significantly higher grain yield in the cleaned seed than the farmer-saved seeds. Using poor quality rice seeds for planting reduces the productivity of landraces in attaining its genetic potential (Mew *et al.,* 2004).

Conclusion

From the study it can be concluded that all rice seed of hill farmers collected from Mizoram, Northeastern of India carry a heavy load of seed borne mycoflora which are responsible for loss in seed germination and seedling vigour except, Maipum. Since, rice is a staple food crop of this region; better seed health management and enhancement the seed replacement rate with quality seed is a prerequisite for successful rice cultivation by tribal peoples.

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Table 4. Seed germination and seedling vigour of farmer-saved hill rice seed of Mizoram, NE Region of India by paper towel method

Name of Localraces / Improved Varieties	Seed germination (%)	Shoot length (cm)	Root length (cm)	Vigour index
Idaw	45.45^{m}	0.66^{k}	0.17^{k}	37.42^{j}
Akbuh	76.99^{c-h}	2.59^{fg}	1.52^{h-k}	316.17^{f-i}
Zakew	71.24^{f-i}	1.10^{jk}	1.17^{h-k}	161.25^{ij}
Manipur (Rum)	86.78^{a-c}	4.84^{bc}	6.56^{bc}	988.96^{b}
Vuitawi	75.03^{e-h}	3.19^{ef}	1.79^{h-k}	373.38^{fg}
Buh tawi sang	66.31^{h-j}	4.79^{c}	5.16^{c-e}	659.77^{c}
Buh Mui	80.10^{b-h}	2.87^{fg}	2.01^{g-k}	390.35^{fg}
Shan buh	66.75^{ej}	3.89^{de}	1.33^{h-k}	348.67^{f-h}
Saii Buh	75.43^{d-h}	4.43^{cd}	3.83^{fg}	622.80^{cd}
Sawkar Buh	79.14^{b-f}	2.80^{fg}	2.82^{f-i}	444.26^{d-f}
Zaitlai	50.10^{lm}	4.11^{cd}	1.69^{h-k}	290.25^{f-i}
Vai buh	80.00^{b-f}	2.17^{g-i}	3.08^{f-i}	419.73^{e-g}
Zai pui	72.84^{f-i}	1.75^{h-j}	0.05^{i-k}	192.05^{h-j}
Fazai	73.70^{e-i}	2.42^{f-h}	0.88^{i-k}	390.35^{g-i}
Thlarau Buh	89.36^{ab}	3.20^{ef}	3.78^{e-g}	623.11^{cd}
Zoro	85.96^{a-d}	2.17^{g-i}	2.11^{g-j}	367.61^{fgh}
Thingtlang vai Buh	63.58^{ijk}	2.39^{gh}	6.19^{bc}	545.49^{f-h}
Tauphai Buh	77.20^{c-g}	1.56^{ij}	0.48^{jk}	157.49^{ij}
Manipur (Nem)	84.60^{a-e}	5.60^{b}	8.25^{ab}	1171.76^{a}
Maipum	92.26^{a}	7.41^{a}	6.87^{a}	1317.43^{a}
RC Maniphou-9	80.57^{b-f}	2.14^{g-i}	5.16^{c-e}	588.41^{c-e}
RC Maniphou-10	80.00^{b-f}	2.33^{g-i}	5.16^{cd}	599.20^{c}
RC Maniphou-11	58.92^{i-l}	2.64^{fg}	2.56^{d-f}	306.38^{e-g}
CAU R-1	54.60^{k-m}	7.68^{a}	4.65^{bc}	673.22^{b}
SEm+	5.40	0.39	0.96	90.51
CD (p = 0.05)	10.85	0.79	1.94	181.99

RCM=Research Centre Maniphou, CAU-R=Central Agricultural University Rice

Data presents the mean of three replications; Three hundred seeds were tested for each sample, Figure with common letters did not differ significantly at 5% level by LSD.

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