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# Seed Borne Mycoflora of Tribal farmers' Saved Hill Rice, *Oryza sativa* in Northeast 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 and improved varieties (twenty local landraces and four improved varieties) for their seed borne mycoflora collected from Mizoram, Northeastern India. The seeds were subjected to blotter and agar plate techniques to identify various seed borne mycoflora and their germination per cent and seed vigour index also calculated by paper towel method. 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). Rice seeds are infected by large number of fungi and perpetuated from one

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season to another through infected seeds (Zope and Thrimurty 2004). Moreover, in this region, 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, North eastern India. The result provides a database for further study to develop an effective management strategy of the pathogens.

**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-RC-NEH Region, Manipur Centre, Imphal, Manipur, India |
| 22 | RC Maniphou-10 | Lowland | Light brown | ICAR-RC-NEH Region, Manipur Centre, Imphal, Manipur, India |
| 23 | RC Maniphou-11 | Lowland | Light brown | ICAR-RC-NEH Region, Manipur Centre, Imphal, Manipur, India |
| 24 | CAU-R-1(*Tampha phou*) | Lowland | Light Brown | Central Agricultural University, Imphal, Manipur, India |

## 2. Materials and Methods

### *2.1 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; Abdul Baki and Anderson (1972).

### *2.2 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 percent incidence of the seed mycoflora was recorded in each sample and the data were tabulated for statistical analysis.

### *2.3 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.

### *2.4 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. 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 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).

## 3. Results and Discussion

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% and 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*

**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* | *Zaipui* | *Fazai* | M *(Rum)* | *Vuitawi* | *Buh tawi sang* | *Buh Mui* | *Shan buh* | *Sawkar Buh* | *Thlarau Buh* | *Zoro* | *Thingtlang vai Buh* | *Tauphai Buh* | M *(Nem)* | Laipum | RCM-9 | RCM-10 | RCM-11 | CAU R-1 |
| *Acremoniella* sp. | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.50 | 0.00 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 | 2.20 | 0.10 | 0.20 |
| *Alternaria tenuis* | 3.50 | 0.00 | 0.00 | 0.00 | 7.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Curvularia lunata* | 10.0 | 12.0 | 9.00 | 15.0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.0 | 19.0 | 10.0 | 10.0 | 0.00 | 7.00 | 0.00 | 0.00 | 3.20 | 2.50 | 0.30 | 2.30 |
| *Curvularia oryzae* | 0.50 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 | 3.00 | 3.50 | 3.50 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Dreschslera oryzae* | 0.00 | 0.00 | 0.00 | 3.00 | 0.00 | 4.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.0 | 0.00 | 1.00 | 20.0 | 0.00 | 0.00 | 0.00 | 0.00 | 2.30 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Fusarium moniforme* | 30.0 | 17.0 | 25.0 | 35.0 | 21.0 | 30.0 | 15.0 | 15.5 | 26.0 | 15.0 | 10.0 | 30.0 | 15.0 | 10.00 | 16.0 | 16.0 | 10.0 | 19.0 | 10.0 | 16.3 | 0.30 | 1.50 | 10.0 | 4.25 |
| *Fusarium oxysporum* | 9.00 | 10.0 | 3.00 | 0.50 | 4.00 | 6.00 | 7.50 | 0.00 | 10.0 | 3.00 | 0.00 | 10.3 | 11.0 | 3.00 | 0.00 | 0.00 | 1.50 | 7.00 | 3.50 | 0.00 | 1.75 | 0.75 | 0.50 | 5.00 |
| *Fusarium semitectum* | 0.9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.50 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.50 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Microdochium oryzae* | 3.50 | 0.50 | 7.50 | 3.75 | 10.25 | 3.75 | 6.00 | 12.0 | 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 | 0.00 | 0.00 | 0.00 |
| *Pyricularia grisea* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| *Rhizoctonia* 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 | 0.00 | 3.75 | 0.00 | 0.00 | 0.00 | 0.00 | 4.31 | 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 | 0.25 | 0.75 | 1.25 | 0.25 | 0.00 | 4.25 | 0.00 | 0.25 | 0.25 | 1.75 | 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 | 3.00 | 5.50 | 0.00 | 0.00 | 0.16 | 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 |
| *Trichothesiums sp.* | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.10 | 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 |
| *Ustilaginoidea virens* | 2.10 | 5.00 | 6.00 | 4.00 | 8.00 | 10.00 | 3.00 | 5.00 | 6.00 | 5.00 | 6.00 | 8.00 | 8.00 | 9.00 | 10.0 | 8.00 | 12.0 | 14.0 | 12.5 | 0.00 | 5.60 | 1.40 | 2.50 | 3.20 |
| *Aspergillus flavus* | 0.10 | 0.15 | 0.10 | 2.75 | 0.00 | 1.00 | 3.00 | 0.30 | 0.90 | 3.00 | 0.10 | 5.50 | 3.60 | 3.00 | 5.00 | 3.00 | 4.00 | 5.00 | 3.00 | 0.00 | 5.00 | 2.00 | 3.00 | 1.00 |
| *Aspergillus niger* | 3.50 | 7.00 | 7.00 | 3.00 | 9.00 | 8.00 | 7.00 | 6.00 | 1.00 | 0.00 | 10.0 | 10.0 | 6.50 | 10.30 | 5.00 | 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 | 11.0 | 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* | 5.00 | 3.00 | 0.00 | 3.00 | 0.00 | 5.00 | 3.00 | 0.00 | 5.00 | 3.00 | 0.00 | 1.00 | 0.00 | 1.00 | 2.00 | 1.00 | 0.50 | 0.10 | 0.00 | 0.00 | 3.00 | 1.00 | 3.00 | 3.00 |
| *Nos .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

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 **t**he 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. 2002; Nguefack et al. 2007; 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). *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).

## Conclusions

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 of 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.

**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* | M *(Rum)* | *Vui tawi* | *Buh tawi sang* | *Buh Mui* | *Shan buh* | *Sawkar Buh* | *Thlarau Buh* | *Zoro* | *Thinglang vai Buh* | *Tauphai Buh* | M *(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 | 72.00 | 65.0 | 20.5 | 32.0 | 15.0 | 31.0 | 24.0 |
| *Fusarium 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 |
| *Nos .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 |

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

**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 Local races / Improved Variety | Seed germination (%) | Shoot length (cm) | Root length (cm) | Vigour index |
|---|---|---|---|---|
| *Idaw* | 45.45m | 0.66k | 0.17k | 37.42j |
| *Akbuh* | 76.99c-h | 2.59fg | 1.52hijk | 316.17fghi |
| *Zakew* | 71.24f-i | 1.10jk | 1.17hijk | 161.25ij |
| *Manipur (Rum)* | 86.78abc | 4.84bc | 6.56bc | 988.96b |
| *Vuitawi* | 75.03e-h | 3.19ef | 1.79hijk | 373.38fg |
| *Buh tawi sang* | 66.31hij | 4.79c | 5.16cde | 659.77c |
| *Buh Mui* | 80.10bc-h | 2.87fg | 2.01ghijk | 390.35fg |
| *Shan buh* | 66.75ej | 3.89de | 1.33hijk | 348.67fgh |
| *Saii Buh* | 75.43d-h | 4.43cd | 3.83fg | 622.80cd |
| *Sawkar Buh* | 79.14b-f | 2.80fg | 2.82fghi | 444.26def |
| *Zaitlai* | 50.10lm | 4.11cd | 1.69hijk | 290.25fghi |
| *Vai buh* | 80.00bcdef | 2.17ghi | 3.08fgi | 419.73efg |
| *Zai pui* | 72.84fghi | 1.75hij | 0.05ijk | 192.05hij |
| *Fazai* | 73.70efghi | 2.42fgh | 0.88ijk | 390.35ghi |
| *Thlarau Buh* | 89.36ab | 3.20ef | 3.78efg | 623.11cd |
| *Zoro* | 85.96abcd | 2.17ghi | 2.11ghij | 367.61fgh |
| *Thingtlang vai Buh* | 63.58ijk | 2.39gh | 6.19bc | 545.49fgh |
| *Tauphai Buh* | 77.20cdefg | 1.56ij | 0.48jk | 157.49ij |
| *Manipur (Nem)* | 84.60abcde | 5.60b | 8.25ab | 1171.76a |
| *Maipum* | 92.26a | 7.41a | 6.87a | 1317.43a |
| RC Maniphou-9 | 80.57bcdef | 2.14ghi | 5.16cde | 588.41cde |
| RC Maniphou-10 | 80.00bcdef | 2.33ghi | 5.16cd | 599.20c |
| RC Maniphou-11 | 58.92ijkl | 2.64fg | 2.56def | 306.38efg |
| CAU R-1 | 54.60klm | 7.68a | 4.65bc | 673.22b |
| SEm+ | 5.3980 | 0.3936 | 0.9628 | 90.5094 |
| CD ($p$ = 0.05) | 10.8539 | 0.7913 | 1.9359 | 181.9911 |
| 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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