STUDY OF SEED HEALTH, GERMINATION AND SEEDLING VIGOR OF FARMERS PRODUCED RICE SEEDS

A.H.M.M. HAQUE[1], M.A.H. AKON[2], M.A. ISLAM[3], K.M. KHALEQUZZAMAN[4] AND M.A. ALI[2]

[1]Senior Scientific Officer, Pulse Research Sub-Station, BARI, Joydebpur, Gazipur, [2]Department of Plant Pathology, BAU, Mymensingh, [3]Scientific Officer, Pulse Research Centre, BARI, Ishurdi, Pabna, [4]Senior Scientific Officer, Plant Pathology Division, Regional Agricultural Research Station, BARI, Ishurdi, Pabna, Bangladesh

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ABSTRACT

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The experiment was conducted at Babugonj, Barisal; MS Laboratory of Plant Pathology Department, Bangladesh Agricultural University (BAU), Mymensingh and Seed Pathology Centre, BAU, Mymensingh during 2003-04 to investigate the health, germination and seedling vigor of the farmers produced rice seeds and to compare the health and quality of seeds produced by trained and untrained farmers. The rice seed samples cv. BR 11 were collected from 5 trained and 5 untrained farmers of Babugonj, Barisal to investigate the seed health and quality. Dry inspection, physical sorting, blotter test, germination test and seedling vigor tests were performed. Maximum pure seed (99.01%) was found in seed samples of trained farmers and minimum (96.19%) in untrained farmers. Healthy seed (67.7%) were recorded in seed samples of trained farmers and 48.41% in untrained farmer's samples. Four fungal genera were associated with the six month stored rice seed samples. The genera were *Aspergillus, Penicillium, Fusarium.* and *Curvularia.* 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%), *Nigrospora oryzae* (1.6%). Seeds of trained farmers gave maximum germination (81.5%) and also yielded maximum number of healthy seedlings (76.6%). The seeds of untrained farmers had very low germination (62.2%), highest number of diseased (6.8%), abnormal seedlings (6.75%) and lowest number of normal seedlings (48.6%). Root length, shoot and root weight of trained farmers seedlings were higher than untrained farmers. Trained farmers seeds resulted increased in seedling vigor and produced more healthy seedlings.

Key words: Seed health, germination, seedling vigor

INTRODUCTION

Rice (*Oryza sativa*) is the principal cereal crop of Bangladesh. It is a major source of calories. It covers 10.80 million hectare of land from which 25.05 million tons of rice is produced annually (Anonymous, 2002). The average yield of rice in Bangladesh is 2.14 tons/ha (Anonymous, 2001) but in many rice growing countries of the world is 3.845 tons/ha (Anonymous, 1999). Thus the production (tons/ha) of rice in Bangladesh is low. Of the total seeds requirement in the country, only 10% good quality seeds are available to the farmers and the 90% of the requirement are meet up by the farmers saved seeds (Fakir *et al*. 2002). Seed-borne diseases cause enormous losses to our crop. The infected seeds may fail to germinate, transmit disease from seed to seedling and from seedling to growing plants (Fakir *et al.*, 2002). Contaminants include weed seeds, insects, varietal mixture, partially filled grains, unfilled grains, other plant parts, inert matter and seeds of other crop species. Abnormal and diseased seeds in a seed lot also indicate poor health. Abnormal seed conditions include discolored, spotted, deformed, unfilled, partially filled, smutted and insect damaged seeds.

In order to improve the health and quality of farmers rice, Bangladesh Rice Research Institute (BRRI) conducted training and research at Babugonj, Barisal through the Seed Health Improvement sub Project (SHIP) organized by International Rice Research Institute. Farmers' participatory research and training on seed cleaning, seed health selection and proper seed storage were arranged according to the farmers produced and used clean seeds for rice production. Based on above information this research program was under taken i) to investigate the health, germination and seedling vigor of the farmers produced rice seeds and ii) to compare the health and quality of seeds produced by trained and untrained farmers.

MATERIALS AND METHODS

The experiment was conducted at Babugonj, Barisal; MS Laboratory of Plant Pathology Department, Bangladesh Agricultural University (BAU), Mymensingh and Seed Pathology Centre, BAU, Mymensingh during 2003-04. Ten farmers were randomly selected from the village Rakudia of Babuganj, Barisal. Five trained farmers and five untrained farmers were selected from Babugonj, Barisal. Each trained farmer's field was divided into two plots. One plot was used for seed production through improve technologies and in another plot traditional practices were followed for production of rice grain. Untrained farmers used traditional method only. 500g of seeds were collected from each farmer at before sowing and after harvest of BR11, and carried to BAU, Mymensingh for conducting different tests.

Forty grams of rice seeds was taken from each sample for conducting purity test. The seed was divided into three categories following ISTA rule 1976 as follows: (a) pure seeds, (b) other seeds and (c) inert matter. Four hundred seeds were randomly taken from each sample. The seeds were examined under a stereoscopic microscope. The seeds were sorted manually on a clean laboratory table into different category as (a) apparently healthy seeds (b) spotted seeds (c) discolored seeds (d) deformed seeds (e) chaffy grain and (f) insect infested seeds. Collected seeds were tested by blotter method. Three pieces of filter paper were soaked in sterilized water and were placed at the bottom of a 9 cm plastic plate. Twenty five seeds were plated in each plate. Sixteen plates were used for each sample. The petridishes containing seeds were incubated at 20 ± 2ºC under alternating cycles of 12 hours near ultraviolet (NUV) light and darkness for 7 days. After incubation the seeds were examined under stereobinocular microscope in order to record the incidence of different seed borne fungi. For proper identification of fungi, semi permanent sliders were prepared from the fungal colony and observed under compound microscope. Germination of these incubated seeds was recorded. The results were presented as percent incidence for individual pathogens.

Germination test of seed samples were done in sand. Plastic trays (18 × 9) were used for this purpose. One hundred seeds were sown in four lines in each plastic tray. For each sample, four trays were used for testing 400 seeds of each sample. Germination was recorded at 4, 7 and 14 days after sowing. Normal seedlings, abnormal seedling and dead seeds were counted separately and expressed in percentage. Rate of germination index (RGI) was calculated by the following formula:

$$RGI = \frac{\text{Number of seedlings at 7 days}}{\text{Number of seedlings at 14 days}} \times 100$$

Seedling vigor test was conducted in sand. Plastic trays (18 × 9) were used. One hundred seeds were selected at random and sown on sand in each plastic tray in four lines (25seeds/line). A total of 400 seeds were tested for each sample. International Seed Testing Association (ISTA), 1976 was followed for testing germination and seedling vigor. After 20 days, shoot and root length were measured. Fifteen seedlings from each tray were randomly selected for measurement of shoot or root length. The seedling vigor was determined following the formula of Baki and Andersen (1972) as shown below:

Vigor index = (Mean of root length + Mean of Shoot length) × Percentage of Seed germination.

Collected data of both green house and laboratory experiment were analyzed following the analysis of variance (ANOVA). Least Significant Difference (LSD) was done to determine the differences among the treatments.

RESULTS AND DISCUSSION

Purity analysis of farmers produced rice seeds

Results of three components such as pure seed, other seed and inert matter are presented in Table 1. The highest percentage of pure seed (99.1%) was found in trained farmers' sample. Untrained farmers seed samples had the lowest percentage of pure seed (96.19%). Maximum percentage of other seed (3.15%) was found in seed samples of untrained farmers and the minimum in trained farmer's seed sample. Maximum percentage of inert matter (0.66%) was found in seed samples of untrained farmer and minimum (0.41%) in seed samples of trained farmers. So, three components were differed significantly from seed samples of trained farmer to untrained farmer.

Table 1. Purity test of farmers saved rice seed cv. BR11 collected from trained and untrained farmers of Babugonj, Barisal

Sample collected from	Pure seed (%)	Other seed (%)	Inert matter (%)
Five trained farmers	99.10 a	0.49 b	0.41 b
Five untrained farmers	96.19 b	3.15 a	0.66 a
LSD (P≥ 0.05)	0.60	0.60	0.16

Total seed tested = 40 g/sample, 5 samples were tested of each treatment

Dry Inspection of trained and untrained farmers' seed samples

Results of dry inspection of farmers saved rice seed cv. BR 11 collected from trained and untrained farmers of Babugonj, Barisal are presented in Table 2. The maximum percentage of apparently healthy seed (67.74%) was recorded in the samples of trained farmer and the minimum percentage of apparently healthy seed (48.41%) was recorded the samples of untrained farmer. In case of apparently

healthy seed, statistically significant difference was found from the seed sample of trained farmers to untrained farmers. Spotted seeds was maximum (44.99%) in samples of untrained farmers and minimum (27.58%) in samples of trained farmers. Spotted seed significantly differed from trained farmers to untrained farmers. Deformed seed of trained farmers did not differ significantly from untrained farmers. The highest percentage of discolored seed (1.486%) was found in seed samples of untrained farmers and the lowest (0.946%) was found in seed samples of trained farmers. Statistically significant difference of discolored seed was found in seed samples of trained and untrained farmers. Maximum chaffy grain (0.98%) was found in seed samples of untrained farmers and minimum (0.50%) in samples of trained farmers. Statistically significant difference of chaffy grain was found in seed samples of trained and untrained farmers. Maximum percentage of insect damaged seed (0.98%) was found in seed samples of untrained farmer and minimum (0.50%) in seed samples of trained farmer. All parameters except deformed seed under dry inspection were different between the seed samples of trained farmer and untrained farmers.

Table 2. Dry inspection of farmers saved rice seed cv. BR11 collected from trained and untrained farmers of Babugonj, Barisal

Sample collected from	Apparently healthy seed (%)	Spotted seed (%)	Deformed seed (%)	Discolored seed (%)	Chaffy grain (%)	Insect damage (%)
Five trained farmers	67.744 a	27.580 b	2.732	0.946 b	0.50 b	0.378 b
Five untrained farmers	48.418 b	44.994a	3.138	1.486 a	0.98 a	0.886 a
LSD (P≥ 0.05)	7.217	7.471	NS	0.346	0.32	0.161

Total seed tested = 400 Seeds/sample, 5 samples were tested of each treatment

Health test of six month stored rice seeds (Blolter method)

A total of four fungal genera were found to be associated with the seed samples collected from trained and untrained farmers of Babugonj, Barisal (Table 3). The associated fungi were *Aspergillus* sp., *Penicillin* sp., *Fusarium* sp. and *Curvularia sp*. The predominant seed borne fungi *Bipolaris oryzae*, *Alternaria padwickii*, *Alternaria alternata* were absent in six month stored rice seed sample of trained and untrained farmers of Babugonj Thana. But two predominent fungi *Fusarium* sp and *Curvularia lunata* were identified from those samples. The prevalence of *Aspergillus* sp. (13.7%), *Penicillium* sp. (17.4%), *Fusarium* sp.(13.5%), and *Curvularia* sp. (1.25%) were the highest in seeds samples collected from untrained farmer. The incidence of the fungi *Penicillium* sp. and *Curvularia sp.* were statistically similar to seed samples collected from trained farmer (grain purpose) and untrained farmers (seed purpose) but statistically significant difference was found from the seed samples of trained farmer (seed purpose). The incidence of the fungi *Fusarium* sp. and *Aspergillus* sp. differed significantly between the seed samples of untrained farmer (seed purpose) to trained farmer (seed purpose + grain purpose). But the incidence of the fungus *Aspergillus* sp. was significantly higher in the seed sample of untrained farmer's (seed purpose) to trained farmer's (seed purpose).

Table 3. Health status of six month stored rice seed cv. BR11 collected from trained and untrained farmers of Babugonj, Barisal. (Blotter method)

Sample collected from	Percent incidence of						
	Aspergillus sp.	*Penicillium sp.*	*Fusarium sp.*	*Bipolaris oryzae*	*Curvularia lunala*	*Alternaria padwickii*	*Nigrospr oryzae*
Five trained farmers (seed purpose)	4.5 c	6.3 b	4.6 b	-	0.10 b	-	-
Five trained farmers (grain purpose)	10.2 b	14.7 a	6.5 b	-	0.75 a	-	-
Five untrained farmers (seed purpose)	13.7a	17.4 a	13.5 a	-	1.25 a	-	-
LSD (P> 0.05)	3.29	4.66	2.83	-	0.52	-	-

Five samples (200 seeds/sample) were tested of each treatment

Health test of seed samples 15 days after harvest (Blotter method)

A total of 5 fungal genera were found to be associated with the seed samples collected from trained and untrained farmers of Babugonj, Barisal. (Table 4) The associated fungi were *Fusarium* sp., *Bipolaris oryzae*, *Curvularia lunata, Alternaria padwickii* and *Nigrospora oryzae*. The predominant seed borne fungi were identified *Bipolaris oryzae*, *Fusarium* sp., *Alternaria padwickii* and *Nigrospora oryzae*. The prevalence of *Bipolaris oryzae* (8.4%) was the highest in the seed samples collected from untrained farmer (seed purpose),

which was statistically similar to that obtained in trained farmers seeds collected from untrained farmer (seed purpose) and trained farmer (grain purpose). Incidence of this pathogen was significantly lower in samples collected from trained farmers (seed purpose) to trained farmer (grain purpose) and untrained farmer (seed purpose). The prevalence of seed borne fungi *Fusarium* sp, *Curvularia lunata*, *Alternaria padwickii* and *Nigrospora oryzae* did not differ significantly from one treatment to another. The storage fungi *Aspergillus* sp. and *Penicillium* sp were fully absent in seed sample of trained and untrained farmers of Babugonj Thana collected after 15 days of harvesting.

Table 4. Health status 15 days after harvested rice seed cv. BR ll collected from trained and untrained farmers of Babugonj, Barisal

Sample collected from	Percent incidence of						
	Aspecrillus sp.	*Penicillin sp.*	*Fusarium sp.*	*Bipolaris oryzae*	*Curvularia lunala*	*Alternaria padwickii*	*Nigrospr oryzae*
Five trained farmers (grain purpose)	-	-	2.6	2.9b	0.9	0.3	1.6
Five trained farmers (seed purpose)	-	-	3.2	8.1a	1.0	0.5	2.7
Five untrained farmers (seed purpose)	-	-	4.8	8.4a	1.3	0.7	3.6
LSD (P> 0.05)	-	-	NS	3.83	NS	NS	NS

Five samples (200 seeds/sample) were tested of each treatment.

Germination and seedling health of farmers produced rice seeds

Germination and seedling health at 4, 7 and 14 days after sowing (DAS) were determined and the results are presented in Table 5. Maximum number of germinated seed (68.15%), 4 days after sowing was recorded from seed sample of trained farmer and minimum count (42.0%) was from untrained farmer. Maximum number of germinated seed (77.4%) at 7 days after sowing was recorded from seeds of trained farmer and minimum count (56.95%) was from untrained farmer. Maximum number of germinated seed (81.5%) at 14 days was recorded from seeds of trained farmer and minimum count (62.2%) was made from seeds of untrained farmer. Number of germinated seeds increased from 68.15% to 81.5% (trained farmer), and 42.0% to 62.2% (untrained farmer) respectively from 4 to 14 days. Germination percentage of different duration at 4 days and 7 days were found statistically significant difference from trained farmer to untrained farmer. In the sand using tray normal seedlings, abnormal seedlings and diseased seedlings ware observed and the results are presented in Table 5. The number of normal seedlings produced by seed samples collected from trained and untrained farmers of Babugonj varied significantly. Maximum number of normal seedling (76.62%) was found from seeds of trained farmer and minimum count (48.6%) was found from seeds of untrained farmer. Maximum number of abnormal seedling (6.75%) and diseased seedling (6.8%) were recorded from seeds of untrained farmer and minimum count of abnormal seedling (3.15%) and diseased seedling (1.8%) were made from seeds of trained farmer. Percentage of normal abnormal and diseased seedling was statistically differed from seed sample of trained farmer to untrained farmer.

Table 5. Germination and seedling health of rice cv. BR11 collected from trained and untrained farmers of Babugonj, Barisal (sand using tray method)

Sample collected from	% germination			% health of seedling		
	4 days	7 days	14 days	Normal	Abnormal	Diseased
Five trained farmers	68.15a	77.40a	81.5a	76.6a	3.15b	1.8b
Five untrained farmers	42.00b	56.95b	62.2b	48.6ab	6.75a	6.8a
LSD ($P \geq 0.05$)	7.47	7.58	7.67	8.32	1.38	1.06

Five samples (4 × 100 seeds/sample in 4 trays) were tested of each treatment.

Vigor of the seedlings raised from trained and untrained farmers seed samples

Trained and untrained farmers seed were found to differ significantly with respect to shoot length, root length, shoot weight, root weight germination and vigor index (Table 6). The root length of 15 days old seedling for all treatments ranged from 11.55 cm to 7.47 cm, while the highest value (11.55 cm) was recorded in seedling of trained farmer's seed and the lowest (7.47 cm) was found in seedling of untrained farmer's seed. In case of shoot length the highest result (4.97 cm) was observed in seedling of trained farmer's seed and the smallest length (4.55 cm) was found in seedling of untrained farmer's seed but the different was statistically insignificant. Root weight ranged from. 0.09

g to 0.20 g where the highest (0.20 g) root weight was found in seedling of trained farmers. The lowest (0.09 g) was observed in seedling of untrained farmer. Highest shoot weight (0.31g) was found in seedling of trained farmers and the lowest (0.15g) in seedling of untrained farmer. Highest germination (81.5%) was found in seed sample of trained farmers and the lowest (62.2%) germination was observed in seeds of untrained farmer. Vigor index (VI) ranged from 1356.86 to 749.71. The highest vigor index (VI) (1356.86) was found in seedling of trained farmers' seed and the lowest (749.71) was recorded in seedling of untrained farmers' seed.

Table 6. Seedling vigour of trained and untrained farmers of Babugonj, Barisal (sand using tray method)

Sample collected from	Root length (cm)	Shoot length (cm)	Root weight (g)	Shoot weight (g)	Germination (%)	Vigor index (VI)
Five trained farmers	11.550 a	4.970	0.206 a	0.316 a	81.5 a	1356.86 a
Five untrained farmers	7.476 b	7.558	0.098 b	0.156 b	62.2 b	749.72 b
LSD ($P \geq 0.05$)	1.568	NS	0.069	0.1153	7.67	234.57

Five samples (40 seedlings/sample) were tested of each treatment.

It was found that trained farmer seed samples had the highest percentage of apparently healthy seed and the lower percentage of spotted seed, discolored seed, chaffy grain and insect damaged seed. In case of six month stored seed sample, four fungal genera namely *Aspergillus, Penicillium, Fusarium and Curvularia* were associated. The predominant seed-borne fungi *Bipolaris oryzae*, *Trichoconis padwickii*, *Alternaria alternata* were absent in six month stored rice seed samples of trained and untrained farmers of Babuganj Thana. The prevalence of *Aspergillus sp*., *Penicillium sp*., *Fusarium sp* and *Curvularia lunata* was lowest in trained farmer seed samples. The efficacy of seed cleaning method (manual sorting and flotation in water) to improve the seed quality in rice cv. BRII have also been reported by a good number of workers (Rahman *et al*., 2000). In case of freshly harvested rice seed samples 5 field fungi were found to be associated. They were *Fusarium* sp. *Bipolaris oryzae*, *Alternaria padwickii*, *Nigrospora oryzae*, *Curvularia lunata*. The prevalence of *Bipolaris oryzae* was lowest in seeds of trained farmers. The association of fungi with rice seed has also been reported by quite a good number of workers (Esuruoso *et al*., 1975; Mia and Mathur, 1983; Sharma *et al*., 1987; Khan *et al*., 2000; Hossain *et al*., 2000). Germination of seed samples collected from trained and untrained farmers showed significant variation. The seed samples of trained farmers not only gave maximum germination but also yielded maximum number of healthy seedlings and minimum number of abnormal and diseased seedlings. The effect of seed cleaning and washing on germination and seedling diseases of rice and reported that farmers saved seed washed with brine solution (20% Nacl) reduced the percentage of *Bipolaris oryzae, Alternaria padwickii, Aspergillus flavus,* and *Penicilium* spp. associated with rice seeds very effectively (0.0% incidence) have also been reported by a good number of workers (Hasan *et al*., 2001). The varietal purity, germination percentage, moisture content, inert matter, weed seeds, objectionable weed seeds, other crops seeds and seed-borne pathogens affect seed quality and seed certification have also been reported by Khare (1999). In case of seedling vigor, highest value was recorded in seedling produced form trained farmers seed samples. But shoot length of trained and untrained farmers seeding were similar. The dry root and shoot weight was highest in seedlings of trained farmers.

From this study it had been clearly found that bad quality seed of untrained farmers resulted in poor germination. Quality of farmers saved seed could be improved by farmer training for seed sorting, field seed health selection, rouging, harvesting, drying and storage.

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