

MANAGEMENT OF HEALTH AND QUALITY OF HYBRID RICE SEED

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ABSTRACT

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Seed health of three hybrid rice (*Oryza sativa* L.) var. Moyna1, Moyna 2 and Moyna 3 collected from BRAC, was tested by blotter and NA method for detection of the seed-borne pathogens in the Seed Pathology Centre (SPC), Bangladesh Agricultural University, Mymensingh. Garlic extract, Vitavax 200 and *Trichoderma harzianum* were evaluated against seed borne fungi associated with those seeds. Highest percent of seed germination (88.0%) was recorded in Moyna 1 and the lowest (82.0%) germination was in Moyna 2. A total number of 318 seed-borne fungal infections were recorded in 1200 seeds obtained from three selected hybrid varieties. The highest number of total seed-borne fungal infection was recorded in Moyna 2 (123), followed by Moyna 3 (107) while the lowest total fungal infection was observed in Moyna1 (88). On the basis of total seed borne fungi, Moyna 2 was found much infected (28.5%) by the seven identified fungi followed by Moyna 3 (23.0%) and Moyna1 (19.5%) respectively. The seven fungi such

as *Alternaria padwickii*, *Bipolaris oryzae*, *Curvularia lunata*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger* and *Penicillium* sp were identified from the seed samples of all the three hybrid rice varieties. Among the recorded seven fungi, the highest seed-borne infections occurred by *Fusarium oxysporum* (5.0-8.0%), and the lowest by *Aspergillus flavus* (2.0-2.2%) followed by *Penicillium* sp (1.4-3.1%). Var. Moyna 2 contained significantly the highest percentage of all the tested seed borne fungi followed by Moyna 3 var. Variety Moyna1 had significantly the lowest seed borne infection. Vitavax 200 (@0.3%) and *Trichoderma harzianum* (@3%) were found the best treatments followed by Garlic extracts (@ 1:1 w/v) regarding seed germination and percent reduction of seed borne infection in all the tested three hybrid varieties.

Key words: Seed health, hybrid rice variety, management, seed borne fungi.

INTRODUCTION

Bangladesh is basically a rural based agricultural country. Its economy is mainly based on agricultural activities and development largely depends on its agriculture. Agriculture represents directly and indirectly almost 19.95% of Bangladesh's Gross Domestic Product (GDP) and 63.2% of its employment opportunity (BBS 2010). Rice (*Oryza sativa* L.) is the most important crop that dominates over other crops and covers 75% of the total cropped area where about 92% farmers grow rice in Bangladesh (Rekabder 2004). It is the staple food of Bangladeshi people. It covers about 75% of the total cultivable land in Bangladesh (Ahmed *et al.* 2013). Rice covers about 11533.60 ha land in Bangladesh and the production of rice is 33890 tons where 644.94 ha land is covered by hybrid rice and the production of hybrid rice is 3022 tons (BBS 2012).. The average world yield of rice is 3.84 tons/ha (Ahmed *et al.*

2013). But the average yield of rice in Bangladesh is only 2.98 tons/ha. So the average per hectare production of rice in Bangladesh is extremely low as compared to other rice growing countries of the world. By the end of 2030, the country will need 50% more rice to meet the demand of growing human population (Khush and Brar 2002). So the country has to face a challenge of producing an additional amount of food. Tropical and sub-tropical climate favors hybrid rice production. These are also favorable for its disease development. Pathogen free seed is the vital input in agriculture. The average yield in this country is low compared to other countries due to seed borne diseases. In Bangladesh, approximately 2.5 million tons of rice worth more than Tk. 12 thousand millions is lost annually due to diseases caused by seed borne pathogens (Fakir *et al.* 2003). Most of the major diseases of rice are seed borne (Fakir 2002). Rice suffers from more than 60 different diseases. In Bangladesh, 43 diseases are known to occur on the rice crop. Among these diseases, 27 are seed borne of which 14 are of major importance. Fungi are the principal organisms associated with seed in storage.

Of all the seed borne diseases of rice, 22 are caused by fungi (Fakir 2000). Without improving seed quality, the improved technology can hardly improve the production potentially. Normally farmers do not test the quality and health status of rice seed, but so many devastating diseases can be carried out by the seed and there is a great possibility to remain pathogen within the seed that causes fail to germinate, infection to seedling and diseases to growing plants. Although the seed system in Bangladesh is at a very rudimentary stage, a total of 5 lac tons of seeds including the seeds of cereals and other crops per year is required, out of which only 18% seeds are produced by different seed organizations with care but almost regardless of the health status (Hossain and Dey 2011). The rest 82% of the seeds retained by the farmers remain uncertified with unknown quality and outside the supervision of Seed Certification Agency (Rashid and Fakir 2000). Hybrid seeds are of excellent means of bumper production of rice. Here in Bangladesh huge amount of hybrid seeds of rice are being used without taking care of seed health and quality. Moreover, hybrid seeds of rice are imported and being sold without testing of health. Therefore, it is necessary to understand the problem properly which affect the seed quality and necessary steps need to be taken to overcome this huge amount of loss. On the other hand, to ensure eco-friendly disease management, *Trichoderma* and plant extracts are using instead of hazardous chemicals. BAU-Biofungicide resulted significant higher germination and plant stand, less disease incidence and higher yield of different crops (Chowdhury *et al.* 2013, Hossain and Hossain 2012). However, information about the seed health and quality status of hybrid rice (Moyna) is inadequate. So, the experiment was focused on to know health status and to find out the efficacy of *Trichoderma* and plant extracts for controlling seed borne pathogens associated with the collected three hybrid rice seed samples.

MATERIALS AND METHODS

The present investigation was carried out in the Seed Pathology Centre (SPC) and MS Laboratory, Department of Plant Pathology, Bangladesh Agricultural University (BAU), Mymensingh during 2013-2014. Seed samples of three hybrid rice varieties such as: Moyna 1, Moyna 2 and Moyna 3 were collected from BRAC, Gazipur district. Seed sampling was done according to ISTA (ISTA 2001) rules. Vitavax 200 and suspension of *Trichoderma harzianum* was collected from IPM laboratory, BAU, Mymensingh.

Inspection of dry seeds

In a clean laboratory table, the seeds of each working sample were spreaded and the seeds were separated into five categories viz. healthy seeds, discolored seeds, spotted seeds, empty seeds and inert materials.

Germination test and detection of seed borne fungi

Seed germination and health of all the seed samples were analyzed (for detection of fungi) by Blotter Method following the International rules of Seed Testing Association (ISTA 2001). Seed germination result was expressed as percentage.

Inspection of incubated seed samples and identification of fungi

Incubated seeds were observed under stereomicroscope at 16x and 25x magnification. The incidence of seed-borne fungi were detected by observing their growth characters on the incubated seeds on blotter paper following the keys outlined by Ramnath *et al.* (1970). Temporary slides were prepared from the fungal colony and observed under compound microscope. The fungi were identified with the help of keys suggested by Ellis (1971) and Kulshrestha *et al.* (1976).

Preparation of Plant extracts and treatments used

Garlic cloves (Islam 2007) were collected from K.R. Market, Bangladesh Agricultural University campus, Mymensingh. The collected cloves were washed carefully in running tap water, dried and weighed. The extract was prepared by grinding in a mortar 1:1 (100 gram of plant material mixed with 100 ml of distilled water (weight/volume) dilution ratio. The crushed materials were filtered through cheese cloth. The extracts thus obtained were kept in a refrigerator until use. A total of 5 (five) treatments were used as follows: T₀ = Control, T₁ = Garlic @ (1:1), T₂ = Vitavax 200@ 0.2%, T₃ = Vitavax 200 @0.3% and T₄ = *Trichoderma harzianum* @ 3%.

Seed treatment with Garlic extract

Hybrid rice seeds were treated in 1:1 dilution of Garlic extract. Seed samples of three hybrid rice were dipped in the Garlic extract in petridishes for an hour. Then the plant extract was drained out from the petridishes. The treated seeds were dried on blotting papers for one hour. A set of control was maintained by dipping the seeds in tap water. Three replications were maintained for each treatment for each hybrid variety. After incubating the treated seeds, the fungi yielded were observed and germination of seeds was counted.

Seed treatment with Vitavax 200 and *Trichoderma*

Hybrid rice seeds were treated with Vitavax 200 (@0.2 and 0.3% and *Trichoderma harzianum* @

3.0% (w/w). Seed samples of hybrid rice were mixed with Vitavax 200 and *Trichoderma harzianum* in petridishes for one hour. The treated seeds were then plated on blotting papers in plastic petridishes. A set of control of each was maintained with three replications in the same time for comparison.

Analysis of data

The design of experiment was CRD (Completely Randomized Design). The recorded data on various parameters under the present study were statistically analyzed using MSTAT statistical-package programme (Gomez and Gomez 1984).

RESULTS

In respect of variety the highest percentage of healthy seed was found in Moyna 1 (85.0%) and lowest was Moyna 2 (80.0%) (Table 1). Significantly the highest percentage of spotted seed (1.6%), discolored seed (6.75%), inert materials (2.25%) and crack seeds (11.4 %) were found in Moyna 2 and lowest percentage of spotted seed (1.1%) and inert matter (1.4%) found in Moyna 3 while lowest amount discolored and crack seeds (4.10% and 8.10%) were recorded in Moyna 1 (Table 1).

Identification of fungi

The incidence of major seed borne fungal pathogens associated with three hybrid Moyna varieties were analyzed and presented in Table 2. The seven fungi such as *Alternaria padwickii*, *Bipolaris oryzae*, *Curvularia lunata*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger* and *Penicillium* sp were identified from the seed samples of three hybrid rice varieties.

Germination and total number of seed-borne fungal infections

Germination and seed-borne infection of fungi varied significantly in all the tested rice varieties (Table 2). The percent seed germination also varied from 82.0 to 88.0%. Highest percent of seed germination (88.0%) was recorded in Moyna 1 and the lowest (82.0%) germination was in Moyna 2 (Table 2). A total number of 318 seed-borne fungal infections were recorded in 1200 seeds obtained from three selected varieties collected from BRAC. The total number of seed-borne fungal infection varied considerably depending on varieties. The highest number of total seed-borne fungal infection was recorded in Moyna 2 (123) followed by Moyna 3 (107) while the lowest total fungal infection was observed in Moyna 1 (88) (Table 2). On the basis of total seed borne fungi, Moyna 2 was much infected (28.5%) by the seven identified fungi followed by Moyna 3 (23.0%) and Moyna 1 (19.5%) respectively (Table 2). The percentage of total seed-borne pathogens recorded in

all the three rice varieties ranged from 1.4 to 8.0% (Table 2). Among the recorded seven fungi, the highest seed-borne infections occurred by *Fusarium oxysporum* (5.0-8.0%), and the lowest by *Aspergillus flavus* (2.0-2.2%) followed by *Penicillium* sp (1.4 to 3.1%). The percent incidence of *Bipolaris oryzae* ranged from 2.5 to 5.6%. Incidence of *Curvularia lunata* ranged from 4.0 to 6.0%, *Alternaria padwickii* 2.1 to 3.2% and *Aspergillus niger* 2.2 to 2.6% (Table 2). Moyna 2 contained significantly highest percentage of all the tested seed borne fungi except *A. niger* followed by Moyna 2 variety. Variety Moyna 1 had significantly the lowest seed borne infection. On the other hand, the highest number of seed (82) was infected by *Fusarium oxysporum* followed by *Curvularia lunata* (59), *Bipolaris oryzae* (44) *Alternaria padwickii* (40), *Aspergillus niger* (32) and the lowest number of seed infection was caused by *Aspergillus flavus* (28).

Efficacy of plant extract, Vitavax 200 and *Trichoderma harzianum* on germination and seed-borne infection of three hybrid rice variety

Effect of garlic extract (plant extract), Vitavax 200 and *Trichoderma harzianum* on the prevalence of different fungi of three hybrid rice varieties were analyzed and presented in Table 3. Almost all the treatments significantly increased percent seed germination compared to control treatment (T₀). In case of Moyna 1 variety germination was 88% recorded in non-treated treatment. In treated seeds, germination ranged from 95%-99%. The highest germination (99%) was obtained in T₄ (*Trichoderma harzianum*) where the lowest germination (94%) was obtained in T₁ (Garlic extract @ 1 :1) (Table 3). Almost the similar trend was found in case of variety Moyna 2 variety Moyna 3.

Garlic extract in dilutions @ 1:1 w/v, Vitavax 200 (0.3%) and *Trichoderma harzianum* (3%) showed significant variation on the prevalence of *Alternaria padwickii*, *Bipolaris oryzae*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger* and *Curvularia lunata*. In case of Moyna 1 variety the highest incidence of seed borne pathogens were recorded in untreated (T₀) (1.80% to 5.0%). The best result in terms of reduction of seed-borne pathogens were obtained when seeds treated with *Trichoderma harzianum* and Vitavax 200 where seed borne infection significantly ranged from 0.0-1.0% (Table 3). Seeds treated with both *Trichoderma harzianum* @3% and Vitavax 200 @ 0.3% yielded no infection of *Alternaria padwickii*, *Bipolaris oryzae*, *Curvularia lunata*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* sp. Vitavax 200 @ 0.2% yielded only 1.0% infection caused by *Fusarium*

oxysporum. Moderate reduction of seed-borne pathogens were obtained when seed was treated with 1:1 w/v dilution of Garlic clove extract. Seed treated with Garlic extract at 1:1 dilution resulted only 0.0-2.0% seed borne infections by the above mentioned pathogens where *Alternaria padwickii* was recorded 1.0%, *Bipolaris oryzae* 1.25%, *Curvularia lunata* 1.50% , *Fusarium oxysporum* 2.0% and no infection was found caused by *Aspergillus flavus*, *Aspergillus niger* and *Penicillium sp* in variety Moyna1 (Table 3). Almost the similar trend was found in case of variety Moyna 2 and variety. Moyna 3.

Effect of *Trichoderma harzianum* , Garlic extract and Vitavax 200 on the prevalence of different fungi of three hybrid rice varieties (Moyna 1 , Moyna 2 and Moyna 3) were evaluated carefully. It was observed that non-treated seeds always yielded the highest percent of seed-borne infections than the treated seeds (Figure 1). Among the treatments, Treatment T₃ and T₄ (Vitavax 200@0.3% and *Trichoderma harzianum* 3.0%) had no seed-borne infection in all the three hybrid rice varieties (Fig 1). Treatment T₁ (Garlic extract @ 1:1 dilution) yielded the lower seed-borne infections (5.75%, 7.0% and 6.0%) on variety Moyna1 followed Moyna 2 and Moyna 3. However, the second lowest effect on reduction of seed- borne fungi were observed when the seeds were treated with Treatment T₂ (Vitavax 200 @0.2%) (1.0% in variety Moyna 1, 4.0% in Moyna 2 and 3.0% in Moyna 3, respectively) (Fig. 1). Among the tested three hybrid rice variety Moyna 1 had the lowest seed borne infection followed by Moyna 3 and Moyna 2 even after when their seeds were treated with different treatments (Fig.1).

DISCUSSION

The experiment was conducted to study the health and quality of hybrid rice seed samples and their control by using Garlic extract, Vitavax 200 and *Trichoderma harzianum* to find out superior hybrid rice collected from BRAC, Gazipur District and effective treatment to control seed borne fungi in respect of health status. The seeds were sorted out in different categories. Here, germination, health status of the rice seeds and incidence of seed borne fungi with seeds were recorded. Germination percentages of the seeds by blotter method were recorded in laboratory. The results of seed germination were ranged from 82 to 88%. The highest germination was found in the var. Moyna 1 (88%) followed by Moyna 3 (86% and the lowest germination was recorded in Moyna 2 (82%). Rahman *et al.* (2003b) also recorded 86.20 to 93.39% rice germination in Rajshahi district in Bangladesh. Dry inspection of 40g of each sample was done and they were categorized in five components. The

amount of healthy seeds found in three varieties were ranged from 82-85%. Moyna 1 showed presence of highest percentage of healthy seed (85.0%). It has been found that the collected seed samples contained 4.1 - 6.75% discolored, 1.10%-1.60% spotted, 8.1% - 11.40% crack seed and 1.40 - 2.25% inert matter (Table 1). Health and quality of Moyna 2 was not good in compare to other two varieties in respect of dry inspection of seed samples, amount of percent infections, germination percentage, number of fungal infections. These results varied from variety to variety. Fakir *et al.* (2002) also recorded 91.20 to 98.89% pure seed, 0.06 to 2.73% unfilled, 1.00 to 2.54% partially tilled seed, 1.20 to 5.9 1% varietal mixture, 14.43 to 24.44% discolored seed, 33.72-37.71% spotted seed, 8.46-15.50% deformed seed in Rajshahi, Rangpur and Bogra regions of Bangladesh. The seeds of different varieties of hybrid rice were relatively good quality in terms of discolored seed, spotted seed, but low quality in terms of healthy seed. Approximately similar results were found by other different researchers such as Sharma *et al.* (1997) found 4.35 to 8.82% discolored seed, Rahman (2002) determined consistent results as 1.23 to 14.14% spotted seed and 8.51 to 10.08% discolored seed in different container used for storing.

A total number of 318 seed-borne fungal infections were recorded in 1200 seeds obtained from above mentioned three hybrid rice varieties collected from BRAC. Seven (7) fungi were found to be associated with the seeds out of which all were most common in the seed samples. The fungi detected were *Alternaria padwickii*, *Bipolaris oryzae*, *Curvularia lunata*, *Fusarium oxysporum*, *Aspergillus flavus*, *Aspergillus niger* and *Penicillium sp*. In all the rice varieties, the highest percent of fungal infection was carried out by *F. oxysporum* followed by *Curvularia lunata*, *Bipolaris oryzae*, *Alternaria padwickii*, *Aspergillus niger*, *Aspergillus flavus* and *Penicillium sp* (Table 2). Incidence of *Fusarium oxysporum* ranged from 5.0 to 8.0%, The percent incidence of *Bipolaris oryzae* ranged from 2.50 to 5.60%. *Curvularia lunata* 4.0 to 6.0%, *Alternaria padwickii* 2.10 to 3.2%, *Aspergillus flavus* 2.0 to 2.2%, *Aspergillus niger* (2.2-2.6) and the incidence of *Penicillium sp* ranged from 1.40 to 3.10% (Table 2). Var. Moyna 2 contained significantly highest percentage of *Alternaria padwickii* (3.20%), *B. oryzae* (5.00%), *Curvularia lunata* (4.00%) *F. oxysporum* (8.00%), *Aspergillus spp* (2.2%) than the other two varieties. The association of seed borne fungi of rice have also been observed by a good number of researcher (Mian and Fakir 1997; Mendoza and Molina 1980; Mia and Mather 1983; Agarwal *et al.*, 1990; Sisterna *et al.*, 1994; Purushattam *et al.* 1996; Sharma *et al.* 1997; Bicca *et al.* 1998; Fakir 2002; Naeem Khalid *et al.* 2001; Fakir *et al.* 2003).

The results indicated that, seeds of Moyna 2 was much infected and Moyna1 was less infected by the pathogens, while other was moderately infected. In order of prevalence the highest infections were caused by *F. oxysporum* followed by *Curvularia lunata* almost in all three varieties. The reason cannot be explain without knowing the field conditions of the mother plants, nature of cultivation and environmental condition during the plant growth, which, however were not considered in this experiment.

Effect of Garlic extract, Vitavax 200 and *Trichoderma harzianum* on the prevalence of different fungi on three hybrid rice seeds were evaluated carefully. Different treatment showed significant variation on the prevalence of all the seven recorded fungi. All the treatments (T₁- T₄) were found significantly effective in reducing seed-borne fungi as well as increased germination percent. In case of Variety Moyna1, among the treatment highest germination (99%) was found in T₄ (*Trichoderma harzianum*) followed by Treatment T₂ (Vitavax 200 @0.2%) and lowest (88%) was in non- treated treatment T₀ (Table 3). Significantly the similar trends were observed in case of Moyna 2 and Moyna 3. The effect of Treatment T₃ (Vitavax 200 @0.3%) and T₄ (*Trichoderma harzianum* @3%) on the seed germination (99%) and reduction of seed-borne pathogens (100%) were found significantly similar in all the three hybrid varieties. Garlic extract @ 1:1 w/v (T₁) was also found effective to control the 7 seed borne fungi significantly but its performance was not better than Treatment T₃ (Vitavax 200 @0.3%) and T₄ (*Trichoderma harzianum* @3%). Those findings were in agreement with the results of Sisterna and Bello 2007, Ahmed *et*

al. 2013, Bhuiyan *et al.* 2013, Amin *et al.* 2009 who found Garlic extract (1:1) was very much effective to control seed borne pathogens. Roy *et al.* (2011) found that the performance of garlic tablet was similar to that of Vitavax-200. A significant increase in seedling vigor was also observed over untreated control after garlic treatment. Vitavax 200 can effectively control the seed borne pathogens. This findings were supported by the findings of Bhuiyan *et al.* (2013), Kumari *et al.* (2012), Khalequzzaman *et al.* (2008) and Sultana (2003). *Trichoderma harzianum* can effectively control the seed borne fungi in different crop seeds which is supported by the findings of Debnath *et al.* (2012), Hossain and Rahman (2011) and Hossain and Naznin (2005).

In this study, among the treatments, Garlic extracts @ 1:1 w/v, Vitavax 200 (@0.3%) and *Trichoderma harzianum* (@3%) showed significant performance in controlling seed-borne fungi as well as increased seed germination of Hybrid Moyna seeds. Vitavax 200 (@0.3%) and *Trichoderma harzianum* (@3%) were found the best treatment in controlling seed borne infection where no seed borne infection was observed . As chemical is hazardous to our ecology and serious threat to our terrestrial and aquatic species of animal, use of *Trichoderma harzianum* is essential for maintaining ecofriendly environmental condition. But only this study with one season laboratory experiment is not sufficiently enough to get better findings for our farmers. This emphasizes the need of undertaking further comprehensive research with more hybrid varieties as well as field study for its confirmation.

Table 1. Dry inspection of three hybrid rice varieties collected from BRAC

Variety	Percent (%) grain under different grades of seed				
	Apparently healthy Seeds	Spotted Seeds	Discolored Seeds	Crack Seeds	Inert materials
Moyna 1	85.0 a	1.30 b	4.10 b	8.10 c	1.50 b
Moyna 2	80.0 c	1.60 a	6.75 a	11.40 a	2.25 a
Moyna 3	82.0 b	1.10 c	5.90 b	9.60 b	1.40 b
SD _(0.05)	1.988	0.141	1.936	1.247	0.322

Table 2. Frequency of fungi recorded on three varieties of Hybrid rice

Variety	% Germination	Percent (%) seed-borne infections							Total percent infection	Total pathogens
		<i>Alternaria padwickii</i>	<i>Bipolaris oryzae</i>	<i>Curvularia lunata</i>	<i>Fusarium oxysporum</i>	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Penicillium sp</i>		
Moyna1	88 b	2.1 b	2.5 c	4.0 c	5.0 c	2.0	2.50	1.40 c	19.5 c	88 c
Moyna 2	82 ab	3.2 a	4.6 a	5.0 b	8.0 a	2.2	2.20	3.10 a	28.5 a	123 a
Moyna 3	86 a	2.2 b	3.1 b	6.0	7.0 b	2.0	2.60	2.40 b	23.0 b	107 b
LSD _(0.05)	4.31	0.447	0.593	0.476	0.552	NS	NS	0.197	2.761	8.70
Level of significance	*	**	**	**	**		**		**	**

Same letter(s) in a column did not differ significantly at the 5% level of probability.

Table 3. Effect of *Trichoderma harzianum* and plant extract on germination and seed borne infection of var. Moyna-1

Treatments	% germination	Percent (%) seed-borne infections						
		<i>Alternaria padwickii</i>	<i>Bipolaris oryzae</i>	<i>Curvularia lunata</i>	<i>Fusarium oxysporum</i>	<i>Aspergillus flavus</i>	<i>Aspergillus niger</i>	<i>Penicillium sp</i>
T ₀	88.00 c	1.90 a	2.50 a	4.00 a	5.0 a	2.0 a	1.80 a	2.0 a
T ₁	94.00 b	1.00 b	1.25 b	1.50 b	2.0 b	0.0 b	0.0 b	0.0 b
T ₂	96.00 ab	0.0 c	0.0 c	0.0 c	1.0 c	0.0 b	0.0 b	0.0 b
T ₃	98.00 ab	0.0 c	0.0 c	0.0 c	0.0 d	0.0 b	0.0 b	0.0 b
T ₄	99.00 a	0.0 c	0.0 c	0.0 c	0.0 d	0.0 b	0.0 b	0.0 b
LSD _(0.05)	3.24	0.110	0.368	0.835	0.481	0.815	0.167	0.167

T₀= Control, T₁= Garlic extract (1:1), T₂= Vitavax 200 (0.2%),

T₃= Vitavax 200 (0.3%) and T₄ = *Trichoderma harzianum* (3%)

Same letter(s) in a column did not differ significantly at the 5% level of probability.

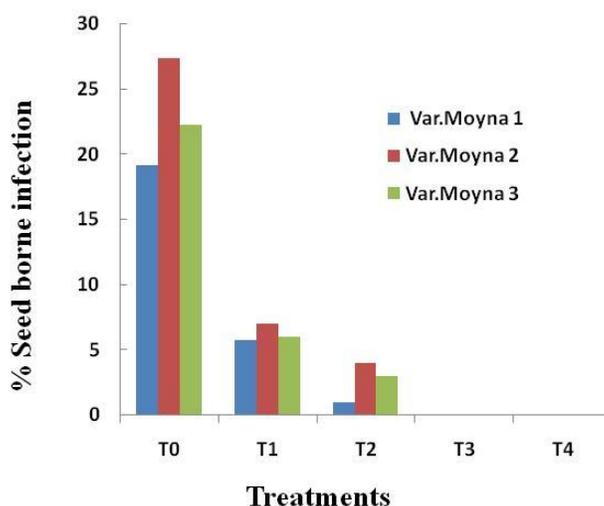


Fig. 1. Efficacy of different treatments on the prevalence of seed-borne infection of three hybrid rice varieties

T₀= Control, T₁= Garlic extract (1:1), T₂= Vitavax 200 (0.2%),

T₃= Vitavax 200 (0.3%) and T₄ = *Trichoderma harzianum* (3%)

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