Research Article
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Interaction effect among the different types of containers, used for storing seed, seed treatments and locations in jute variety O-9897 on disease incidence, seed quality and yield

Abstract

The present study was carried out with the objective was to to identify suitable seed management practices that permit maximal fiber production. The experiments were conducted in the field of Jute Agriculture Experimental Station (JAES), Manikgonj and Kishoregonj Regional Station (KRS), Kishoregonj of BJRI. The experiments were conducted during the period April 2012 to January 2013. Six different types of containers viz. tin pot, plastic pot, poly bag, gunny bag lined with polyethylene, cloth bag, and the IRRI poly bag, two different seed treatments viz. Provax-200 and BAU- Biofungicide and two locations viz. JAES and KRS were used for the present study. The highest disease incidence (10.86%) was encountered in case of interaction among plastic pot storing seeds and control condition. Interaction between different types of containers and seed treatments, the highest germination (68.17%) was recorded in interaction effect of tin pot storing seeds and BAU-Biofungicide treated seeds. The stick yield/ha (11.14ton) and fiber yield/ha (6.81ton) were recorded in interaction effect of plastic pot storing seeds and BAU- Biofungicide treated seeds. Highest seed yield/ ha (422.44kg) was observed in the interaction of tin pot storing seeds and BAU- Biofungicide treated seeds. The highest disease incidence (12.84%) was encountered in interaction effect of plastic pot storing seeds, control condition and KRS. Highest fiber yield/ha (6.81ton) and stick yield/ha (11.14ton) were recorded in interaction of plastic pot storing seeds, BAU- Biofungicide treated seeds and JAES. Highest seed yield/ ha (422.44kg) was recorded in the interaction of tin pot storing seeds, BAU- Biofungicide treated seeds and JAES. So, the following recommendation may be drawn quality of jute seeds can be maintained by treatment with BAU Biofungicide and storage in tin pots.

Keywords: interaction, containers, seed treatments, locations, disease incidence, seed quality, yield, O-9897

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Abbreviations: B, BAU-Biofungicide; P, Provax 200 WP

Introduction

Jute is one of the major cash crops of Bangladesh. Its influence on ecology and economy is so intimate that it's the effects are significantly related to the Agro-ecology and the socioeconomic life of the people. Jute crop is also cultivated in different countries. The jute crop also greatly improves the soil fertility status by incorporating organic matter to the soil through decomposition of shaded leaves and plant residues and helps in breaking plough-pans through its long taproots. Also, jute and jute goods have been recognized as being friendly to the environment. Jute is mostly grown in the Indo-Bangladesh region and in some countries of Southeast Asia. Among the jute growing countries of the world, Bangladesh was second position in respect of production.[1] The land and climatic conditions of Bangladesh are congenial for the production of high quality jute. In Bangladesh, about 0.709 million hectares of land were under jute cultivation and the total yield was 8.40 million bales.[2,3] As per Khandakar,[4] Bangladesh annually needs about 4000 metric tons of jute seeds of which only 12-15% is produced and supplied by the Bangladesh Agricultural Development Corporation (BADC). The rest of the seeds, about 85% or more of the requirements, are produced and managed by farmers'.[5] Jute suffers from more than 13 different diseases,[6] and 10 of them are seed borne. Sowing of infected seeds may cause the death of seedlings and often plants escaping early infection succumb to death due to different diseases. Seed germination decreases with the increase of the seed borne infection. The Seeds having higher seed borne infection results to significantly higher amount of disease development in the field. The rate of transmission of these pathogens from infected seeds for the growing plants and finally to the harvested seeds was relatively low.[7] Among the seed-borne fungal diseases, stem-rot, black-band, and anthracnose caused by *Macrophomina phaseolina* (Tassi, Goid), *Botryodiplodia theobromae* and *Colletotrichum corchori*,[8] respectively, are frequently transmitted through jute seeds.[9-11] *Macrophomina phaseolina* alone can cause 10% yield loss.[12] Stem rot, black band, anthracnose, foot rot and wilt (*Rhizoctonia solani*) and leaf mosaic virus are responsible for seed rot, pre and post emergence damping off seedlings, the spread of the diseases to standing crops and loss and deterioration of quality of fiber.[10-14] Soft rot, foot rot and wilt caused by *Sclerotium rolfsii* and *Rhizoctonia solani*, respectively, also cause considerable yield losses to the crop. *Cercospora* leaf spot and target spot caused by *Cercospora chorchori* and *Corynespora cassicola*, respectively, are not so important, though these two pathogens are frequently transmitted through jute seeds. The pathogens like *Fusarium* spp. (*Fusarium semitectum* and *Fusarium oxysporum*), *Curvularia lunata* and *Phomopsis* ssp., are responsible for causing germination failure and seed rot.[9] Yield loss due to seed borne diseases of jute is 8-20%, depending on the severity of jute diseases from year to year.[15] Infected jute seed fails to germinate or the young seedlings emerging from the infected seed die. Infection of jute seed causes germination failure, post emergence damping off and seedling blight.[16] Jute seedlings or growing plants produced in the field from the infected seeds and escaping early infection may often be infected at the later stages of their growth by the primary seed borne inocula grown and multiplied on the infected dead seeds and seedlings. Seed borne pathogens causing diseases on the growing jute plants in the field quite often attack the capsules or pods and subsequently infect the seed, resulting in production of infected or unhealthy seeds. Therefore, proper disease control measures should be taken for the production of quality jute seeds. Considering the above facts, the present study was carried out with the objective was to find out suitable seed management for quality jute seeds and fiber production.

Materials and methods

Experimental sites and period

The experiments were conducted in the field of Jute Agriculture Experimental Station (JAES), Manikgonj and Kishoregonj Regional Station (KRS), Kishoregonj of BJRI. The experiments were conducted during the period April 2012 to January 2013.

Varieties used

Seed of O-9897 was selected for this study.

Containers used

For this experiment six different types of storage containers were used, viz. T_1=Tin pot, T_2=Plastic pot, T_3=Poly bag having 25µm thickness, T_4=Gunny bag lined with polyethylene, T_5=Cloth bag and T_6=IRRI (International Rice Research Institute) Poly bag (Super Grain bag II Z) having 78µm thickness.

Seed Management

i. Seed treated with P (0.4% of seed weight)

ii. Seed treated with B @ 3% of seed weight [] (Hossain, 2011b)

iii. Control (Untreated)

Seed treated with Provax -200 WP

Seeds were treated with P(5,6- dihydro -2-Methyl-1, 4-oxathin-3-carboxinilide, Group: Oxathin) @ 0.4% of seed weight in a 250ml Erlenmeyer flask and shaken thoroughly for proper coating of the seeds with the fungicides.[17]

Seed treated with BAU- Biofungicide

Seeds were treated with B @ 3% of seed weight in a 250Ml Erlenmeyer flask and shaken thoroughly for proper coating of the seeds. The treated seeds were kept inside the brown paper bags so that seeds remain in dry condition till for further use.

Experimental design

The experiments were conducted following Randomized Block Design (RCBD) having three replications. The size of the unit plot was $10m^2$ (5mx2m) and the distance between plots and replications were 1.0m and 1.0m, respectively.

Soil characteristics and nutrient status

The Soil characteristics and nutrient status of the two experimental stations (JAES, Manikgonj and KRS, Kishoregonj) are shown in Table 1.

Application of fertilizers

During final land preparation Urea 60kg, Triple Super Phosphate 50kg and Muriate of Potash 25kg per hectare were applied.[18,19] After 15-20 days of seed germination first top dressing with the urea @ 60kg and again another 15 days later of first top dressing, the 2nd top dressing was given with 60kg per hectare. Top dressing of urea was done very carefully so that it will not come in contact with the plant parts. To meet sulfur and zinc deficiency, gypsum and zinc oxide @ 45kg and 5kg per hectare were applied.[18,19]

Sowing of seeds

Seeds were sown in line on 20 April, 2012 in Kishoregonj Regional Station (KRS), Kishoregonj and 2nd May, 2012 in Jute Agriculture Experimental Station (JAES), Manikgonj. Row to row and plant to plant distance were maintained as 1M and 1M, respectively. The seed rate for O-9897 was 4kg per hectare.

Data collection

Data on different parameters were collected as shown below

a) Field emergence (germination %)

b) Plant stand/ plant population

c) Incidence of diseases (%)

d) Plant height (M)

e) Base diameter (mm)

f) Fiber yield per plant (gm)

g) Fiber yield per hectare (ton)

h) Stick yield per plant (gm)

i) Stick yield per hectare (ton)

j) Average number of branch per plant

k) Average number of fruits per plant

l) Seed yield per plant (gm)

m) Seed yield per hectare (kg)

n) Weight of 1000- seeds (gm)

Some plots were kept un-harvested for seed production

Statistical analysis

Data were analyzed statistically and treatments effects were compared by Duncan's Multiple Range Test (DMRT). The relation between seed borne fungal pathogens and germination was observed with regression equations. Relationships between disease severity and seed, fiber and stick yield were also observed by linear regression lines and equations.[20]

Results

Interaction effect among the different types of containers used for storing seed and seed treatments on disease incidence, seed yield, stick yield and fiber yield following line sowing method in the field

Interaction effects of different seed treatments with different types of storage containers used for seed storing differed significantly for disease incidence, field emergence, a number of plant, plant height, base diameter, fiber yield, stick yield, number of branches, number of capsule, seed yield and 1000- seed weight (Tables 2&3). In case of JAES, Interaction effect among Tin pot and seed treated with B resulted lower disease incidence (2.95%). The highest disease incidence (10.86%) was encountered in case of interaction among plastic pot and control condition.

Interaction effects between different types of containers and seed treatments on germination were found significant (Table 2). But there was no significant differences among T_1XD_1 (68.17%), T_2XD_1 (64.33%), T_3XD_1 (66.67%), T_4XD_1 (65.17%), T_1XD_2 (68.17%) and T_3XD_2 (66.67%). Again, there was no significant variation among T_2XD_1 (64.33%), T_4XD_1 (65.17%), T_5XD_1 (61.17%), T_6XD_1 (59.67%), T_2XD_2 (62.33%), T_4XD_2 (61.00%), T_4XD_2 (61.00%), T_3XD_3 (57.67%) and T_6XD_2 (55.83%), T_1XD_3 (58.00%), T_2XD_3 (55.50%), T_3XD_3 (57.67%), T_4XD_3 (54.50%), T_5XD_3 (53.83%), T_6XD_3 (57.67%). The highest result was found in T_1XD_1 and T_3XD_1 (68.17%) followed by T_3XD_2 (66.67%). The lowest result was found in T_5XD_3 (53.83%) preceded by T_4XD_3 (54.50%).

Interaction effects between different types of containers and seed treatments on a plant stand/m^2 were found significant. But there were no significant differences among T_6XD_2, T_1XD_3 (26.60) and T_2XD_3, T_6XD_3 (23.33) The highest result was found in T_1XD_1 (40.60) followed by T_5XD_1 (37.33). The lowest result was found in T_3XD_3 (21.93) preceded by T_5XD_3 (22.40).

Interaction effects between different types of containers and seed treatments on plant height were found no significance. The highest result was found in T_2XD_1 (3.17M) followed by T_4XD_1 (3.11M). The lowest result was found in T_5XD_3 (2.75M) preceded by T_3XD_3 (2.76M). In cases of base diameter there was no significant differences among T_1XD_1 (16.14mm), T_2XD_1 (16.69mm), T_3XD_1 (16.51mm), T_4XD_1 (15.81mm), T_5XD_1 (16.39mm), T_6XD_1 (16.31mm), T_1XD_2 (16.05mm), T_2XD_2 (15.75mm), T_3XD_2 (15.76mm), T_5XD_2 (15.59mm), T_6XD_2 (15.51mm), T_1XD_3 (15.70mm), T_2XD_3 (15.34mm) and T_3XD_3 (15.46mm). Again, there was no significant variation among T_2XD_2 (15.75mm), T_3XD_2 (15.76mm), T_4XD_2 (15.13mm), T_5XD_2 (15.59mm), T_6XD_2 (15.51mm), T_1XD_3 (15.70mm), T_2XD_3 (15.34mm), T_3XD_3 (15.46mm), T_4XD_3 (15.06mm) and T_5XD_3 (15.03mm), the highest result was found in T_2XD_1 (16.69mm) and lowest result was found in T_6XD_3 (14.55mm).

Interaction effects between different types of containers and seed treatments on fiber yield/ha were found significant. But there was no significant differences among T_1XD_1 (5.64ton), T_2XD_1 (6.81ton), T_5XD_1 (6.21ton) and T_6XD_1 (6.07ton). Again, there was no significant variation among T_4XD_1 (3.69ton), T_1XD_2 (2.66ton), T_2XD_2 (3.36ton), T_3XD_2 (3.59ton), T_4XD_2 (3.17ton), T_5XD_2 (3.69ton), T_1XD_3 (3.08ton), T_2XD_3 (2.33ton), T_3XD_3 (2.19ton), T_4XD_3 (2.80ton), T_5XD_3 (3.08ton) and T_6XD_3 (2.66ton). The highest result was found in T_2XD_1 (6.81ton) followed by T_5XD_1 (6.21ton). The lowest result was found in T_3XD_3 (2.19ton) preceded by T_2XD_3 (2.33ton).

Interaction effects between different types of containers and seed treatments on stick yield/ha were found significant. But there was no significant differences among T_1XD_1 (10.76ton), T_2XD_1 (11.14ton) and T_5XD_1 (11.04ton). Again, there was no significant variation among T_1XD_3 (5.58ton), T_2XD_3 (6.14ton), T_3XD_3 (5.05ton), T_4XD_3 (4.95ton) and T_5XD_3 (5.63ton). The highest result was found in T_2XD_1 (11.14ton) followed by T_5XD_1 (11.04ton). The lowest result was found in T_4XD_3 (4.95ton) preceded by T_2XD_3 (5.05ton).

Interaction effects between different types of containers and seed treatments on seed yield/ha were found significant. But there was no significant differences among T_1XD_1 (422.44kg) and T_6XD_1 (403.12kg). Again, there was no significant variation among T_2XD_1 (356.32kg), T_5XD_1 (344.65kg), T_2XD_2 (327.67kg), T_3XD_2 (356.23kg), T_5XD_2 (335.66kg), T_6XD_2 (342.46kg), T_1XD_3 (348.75kg), T_5XD_3 (334.25kg), T_6XD_3 (337.56kg) and T_2XD_2 (327.67kg), T_4XD_2 (323.43kg), T_2XD_3 (314.34kg), T_3XD_3 (304.55kg), T_4XD_3 (313.65kg). The highest result was found in T_1XD_1 (422.44kg) followed by T_6XD_1 (403.12kg). The lowest result was found in T_3XD_3 (304.55kg) preceded by T_4XD_3 (313.65kg).

Interaction effects between different types of containers and seed treatments on 1000-seed weight were found significant. T_1XD_1 (1.49gm), T_2XD_1 (1.67gm), T_3XD_1 (1.84gm), T_4XD_1 (1.25gm), T_5XD_1 (1.56gm), T_6XD_1 (1.22gm), T_1XD_2 (1.45gm), T_2XD_2 (1.75gm), T_3XD_2 (1.67gm), T_4XD_2 (1.25gm), T_5XD_2 (1.55mm), T_1XD_3 (1.45mm) and T_2XD_3 (1.68mm). The highest result was found in T_3XD_1 (1.84gm) followed by T_2XD_2 (1.75gm). The lowest result was found in T_5XD_3 (1.12gm) preceded by T_3XD_3 (1.15gm) (Table 2). In case of KRS, Interaction effect among Tin pot and seed treated with B resulted lower disease incidence (2.35%). The highest disease incidence (12.84%) was encountered in case of interaction among plastic pot and control condition.

Interaction effects between different types of containers and seed treatments on germination were found significant (Table 3). But there was no significant differences among T_1XD_1 (68.00%), T_3XD_1 (65.50%), T_4XD_1 (65.67%), T_1XD_2 (68.00%) and T_3XD_2 (63.83%). Again, there was no significant variation among T_6XD_2 (59.67%), T_2XD_3 (56.83%), T_3XD_3 (58.50%), T_4XD_3 (55.00%) and T_6XD_3 (59.33%). The highest result was found in T_1XD_1 and T_1XD_2 (68.00%) followed by T_4XD_1 (65.67%). The lowest result was found in T_4XD_3 (55.00%) preceded by T_2XD_3 (56.83%).

Interaction effects between different types of containers and seed treatments on a plant stand/m^2 were found significance. But there were no significant differences among T_5XD_1 (25.30), T_1XD_2 (24.93), T_2XD_2 (24.20), T_3XD_2 (24.20), T_4XD_2 (23.10) and T_3XD_3 (23.10) The highest result was found in T_1XD_1 (34.83) followed by T_6XD_1 (31.53). The lowest result was found in T_6XD_3 (17.23) preceded by T_5XD_2 (17.60).

Interaction effects between different types of containers and seed treatments on plant height were found significant. But there was no significant differences among T_1XD_1 (3.14M), T_2XD_1 (3.08M), T_3XD_1 (2.89M), T_4XD_1 (2.89M), T_5XD_1 (2.78M), T_6XD_1 (2.91M), T_3XD_2 (2.79M), T_4XD_2 (2.86M), T_5XD_2 (2.83M), T_6XD_2 (2.82M) and T_4XD_3 (2.77M). Again, there was no significant variation among

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T_2XD_2 (2.73M), T_3XD_3 (2.73M), T_5XD_3 (2.76M), T_6XD_3 (2.76M) and T_1XD_2 (2.69M), T_1XD_3 (2.65M), T_2XD_3 (2.67M). The highest result was found in T_1XD_1 (3.14M) followed by T_2XD_1 (3.08M). The lowest result was found in T_1XD_3 (2.65M) preceded by T_2XD_3 (2.67M). In cases of base diameter there was no significant differences among T_1XD_1 (15.47mm), T_2XD_1 (15.23mm), T_4XD_1 (15.89mm), T_5XD_1 (15.65mm), T_1XD_2 (15.47mm), T_4XD_3 (15.31mm) and T_6XD_3 (14.35mm). Again, there was no significant variation among T_1XD_2 (13.93mm), T_2XD_2 (14.18mm), T_3XD_2 (14.25mm), T_1XD_3 (14.45mm), T_2XD_3 (13.95mm), T_1XD_3 (14.23mm) and T_5XD_3 (13.76mm). The highest result was found in T_6XD_1 (19.57mm) and lowest result was found in T_5XD_3 (13.76mm).

Interaction effects between different types of containers and seed treatments on fiber yield/ha were found significant. But there was no significant differences among T_1XD_1 (3.55ton), T_2XD_1 (3.06ton), T_3XD_1 (3.85ton), T_4XD_1 (3.09ton), T_5XD_1 (3.32ton), T_6XD_1 (3.36ton), T_1XD_2 (3.50ton), T_2XD_2 (2.88ton), T_3XD_2 (2.67ton), T_4XD_2 (3.45ton), T_5XD_2 (3.44ton), T_6XD_2 (3.77ton), T_1XD_3 (2.48ton), T_2XD_3 (2.02ton), T_3XD_3 (2.57ton) and T_4XD_3 (3.16ton). Again, there was no significant variation among T_5XD_3 (1.90ton) and T_6XD_3 (1.39ton). The highest result was found in T_3XD_1 (3.85ton) followed by T_6XD_2 (3.77ton). The lowest result was found in T_6XD_3 (1.39ton) preceded by T_5XD_3 (1.90ton).

Interaction effects between different types of containers and seed treatments on stick yield/ha were found significant. But there was no significant differences among T_1XD_1 (9.76ton) and T_6XD_1 (9.67ton). Again, there was no significant variation among T_4XD_1 (6.88ton), T_5XD_1 (7.04ton), T_3XD_2 (6.91ton), T_4XD_2 (6.62ton) and T_1XD_3 (5.18ton), T_4XD_3 (5.14ton), T_5XD_3 (4.63ton), T_6XD_3 (4.91ton). The highest result was found in T_1XD_1 (9.76ton) followed by T_6XD_1 (9.67ton). The lowest result was found in T_3XD_3 (4.33ton) preceded by T_5XD_3 (4.63ton).

Interaction effects between different types of containers and seed treatments on seed yield/ha were found significant. But there was no significant differences among T_1XD_1 (418.55kg), T_6XD_1 (403.12kg) and T_1XD_2 (406.34kg). Again, there was no significant variation among T_3XD_2 (322.55kg), T_4XD_2 (323.43kg) and T_5XD_3 (324.65kg). The highest result was found in T_1XD_1 (418.55kg) followed by T_1XD_2 (406.34kg). The lowest result was found in T_4XD_3 (313.65kg) preceded by T_3XD_2 (322.55kg).

Interaction effects between different types of containers and seed treatments on 1000-seed weight were found significant. But there was no significant differences among T_1XD_1 (1.39gm), T_2XD_1 (1.85gm), T_3XD_1 (1.78gm), T_5XD_1 (1.53gm), T_2XD_2 (1.65gm), T_4XD_2 (1.42gm) and T_1XD_3 (1.39gm). Again, there was no significant variation among T_4XD_1 (1.22gm), T_3XD_3 (1.18gm), T_4XD_3 (1.22gm), T_5XD_3 (1.23gm) and T_6XD_3 (1.22gm). The highest result was found in T_2XD_1 (1.85gm) followed by T_3XD_1 (1.78gm). The lowest result was found in T_3XD_2 (1.11gm) preceded by T_6XD_1 and T_6XD_2 (1.12gm) (Table 3).

Interaction effect among the different types of containers used for storing seed, seed treatments and locations on disease incidence, seed yield, stick yield and fiber yield following line sowing method in the field

Interaction effect of locations, different seed treatments with different types of storage containers differed significantly for disease incidence, field emergence, number of plants, plant height, base diameter, fiber yield, stick yield, number of branches, number of capsules, seed yield and 1000- seed weight (Table 4). Interaction effect among Tin pot storing seeds, seed treated with B and KRS resulted lower disease incidence (2.35%). The highest disease incidence (12.84%) was encountered in case of interaction among plastic pot storing seeds, control condition and KRS.

Interaction effects between locations and different types of containers and seed treatments on germination were found significant. But there were no significant differences among $T_1XD_1XL_1$ (68.17%), $T_2XD_1XL_1$ (64.33%), $T_3XD_1XL_1$ (66.67%), $T_4XD_1XL_1$ (65.17%), $T_1XD_2XL_1$ (68.17%), $T_3XD_2XL_1$ (66.67%), $T_1XD_1XL_2$ (68.00%), $T_3XD_1XL_2$ (65.50%), $T_4XD_1XL_2$ (65.67%) and $T_1XD_2XL_2$ (68.00%). Again, there was no significant variation among $T_2XD_1XL_1$ (64.33%), $T_5XD_1XL_1$ (61.17%), $T_6XD_1XL_1$ (59.67%), $T_2XD_2XL_1$ (62.33%), $T_4XD_2XL_1$ (61.00%), $T_5XD_2XL_1$ (61.00%), $T_5XD_1XL_2$ (60.83%), $T_2XD_2XL_2$ (62.17%), $T_3XD_2XL_2$ (63.83%), $T_4XD_2XL_2$ (61.83%) and $T_5XD_2XL_2$ (61.83%). The highest result was found in $T_1XD_1XL_1$ (68.17%) followed by $T_1XD_1XL_2$ and $T_1XD_2XL_2$ (68.00%). The lowest result was found in $T_5XD_3XL_1$ (53.83%) preceded by $T_4XD_3XL_1$ (54.50%).

Interaction effects between locations and different types of containers and seed treatments on plant stand/m^2 were found significant. But there was no significant differences among $T_2XD_1XL_2$ (25.67), $T_5XD_1XL_2$ (25.30), $T_1XD_2XL_2$ (24.93), $T_6XD_2XL_2$ (25.30) and T_2XD_3 XL_1 (23.33), T_6XD_3 XL_1 (23.33), $T_4XD_2XL_2$ (23.10), $T_3XD_3XL_2$ (23.10) The highest result was found in $T_1XD_1XL_1$ (40.50) followed by $T_5XD_1XL_1$ (37.33). The lowest result was found in $T_5XD_3XL_2$ (16.50) preceded by T_6XD_3 XL_2 (17.23). Interaction effect between locations and different types of containers and seed treatments on plant height were found no significant. The highest result was found in $T_2XD_1XL_1$ (3.17M) followed by $T_4XD_1XL_1$ (3.11M). The lowest result was found in $T_1XD_3XL_2$ (2.65M) preceded by $T_2XD_3XL_2$ (2.67M).

In cases of base diameter there was no significant differences among $T_1XD_1XL_1$ (16.14mm), $T_2XD_1XL_1$ (16.69mm), $T_3XD_1XL_1$ (16.51mm), $T_4XD_1XL_1$ (15.81mm), $T_5XD_1XL_1$ (16.39mm), $T_6XD_1XL_1$ (16.31mm), $T_1XD_2XL_1$ (16.05mm), $T_2XD_2XL_1$ (15.75mm), $T_3XD_2XL_1$ (15.76mm), $T_4XD_2XL_1$ (15.13mm), $T_5XD_2XL_1$ (15.59mm), $T_6XD_2XL_1$ (15.51mm), $T_1XD_3XL_1$ (15.70mm), $T_3XD_3XL_1$ (15.46mm), $T_4XD_3XL_1$ (15.06mm), $T_1XD_1XL_2$ (15.47mm), $T_3XD_1XL_2$ (16.10mm), $T_4XD_1XL_2$ (15.89mm), $T_5XD_1XL_2$ (15.65mm), $T_4XD_2XL_2$ (15.47mm), $T_4XD_3XL_2$ (15.31mm) and $T_6XD_3XL_1$ (14.35mm). Again, there was no significant variation among $T_6XD_3XL_1$ (14.55mm), $T_1XD_2XL_2$ (13.93mm), $T_2XD_2XL_2$ (14.18mm), $T_3XD_2XL_2$ (14.25mm), $T_1XD_3XL_2$ (14.45mm), $T_2XD_3XL_2$ (13.95mm) and $T_3XD_3XL_2$ (14.23mm). The highest result was found in $T_6XD_1XL_2$ (19.57mm) and lowest result was found in $T_5XD_3XL_2$ (13.76mm).

Interaction effect between locations and different types of containers and seed treatments on fiber yield/ha were found significant. But there was no significant differences among $T_1XD_1XL_1$ (5.46ton), $T_2XD_1XL_1$ (6.81ton), $T_5XD_1XL_1$ (6.21ton) and $T_6XD_1XL_1$ (6.07ton). Again, there was no significant variation among $T_4XD_1XL_1$ (3.69ton), $T_1XD_2XL_1$ (2.66ton), $T_2XD_2XL_1$ (3.36ton), $T_3XD_2XL_1$ (3.59ton), $T_4XD_2XL_1$ (3.17ton), $T_5XD_2XL_1$ (3.69ton), $T_1XD_3XL_1$ (3.08ton), $T_2XD_3XL_1$ (2.33ton), $T_3XD_3XL_1$ (2.19ton), $T_4XD_3XL_1$ (2.80ton), $T_5XD_3XL_1$ (3.08ton), $T_6XD_3XL_1$ (2.66ton), $T_1XD_1XL_2$ (3.55ton), $T_2XD_1XL_2$ (3.06ton), $T_4XD_1XL_2$ (3.09ton), $T_5XD_1XL_2$ (3.32ton), $T_6XD_1XL_2$ (3.36ton), $T_1XD_2XL_2$ (3.50ton), $T_2XD_2XL_2$ (2.88ton),

$T_3XD_2XL_2$ (2.67ton), $T_4XD_2XL_2$ (3.45ton), $T_5XD_2XL_2$ (3.44ton), $T_6XD_2XL_2$ (3.77ton), $T_1XD_3XL_2$ (2.48ton) and $T_4XD_3XL_2$ (3.16ton). The highest result was found in $T_2XD_1XL_1$ (6.81ton) followed by $T_5XD_1XL_1$ (6.21ton). The lowest result was found in $T_6XD_3XL_2$ (1.39ton) preceded by $T_5XD_3XL_2$ (1.90ton).

Interaction effects between locations and different types of containers and seed treatments on stick yield/ha were found significant. But, there was no significant differences among $T_1XD_1XL_1$ (10.76ton), $T_2XD_1XL_1$ (11.14ton) and $T_5XD_1XL_1$ (11.04ton). Again, there was no significant variation among $T_4XD_1XL_1$ (6.88ton), $T_3XD_2XL_1$ (6.91ton), $T_4XD_2XL_1$ (6.62ton), $T_5XD_2XL_1$ (6.44ton), $T_4XD_1XL_2$ (6.88ton), $T_5XD_1XL_2$ (7.04ton), $T_3XD_2XL_2$ (6.91ton), $T_4XD_2XL_2$ (6.62ton) and $T_5XD_2XL_2$ (6.44ton). The highest result was found in $T_2XD_1XL_1$ (11.14ton) followed by $T_5XD_1XL_1$ (11.04ton). The lowest result was found in $T_3XD_3XL_2$ (4.33ton) preceded by $T_5XD_3XL_2$ (4.63ton).

Interaction effects between different types of containers and seed treatments on seed yield/ha were found significant. But, there were no significant differences among $T_2XD_1XL_1$ (356.32kg), $T_2XD_2XL_1$ (356.23kg), $T_2XD_3XL_1$ (314.34kg), $T_4XD_3XL_1$ (313.65kg) and $T_4XD_3XL_2$ (313.65kg). The highest result was found in $T_1XD_1XL_1$ (422.44kg) followed by $T_1XD_1XL_2$ (418.55kg). The lowest result was found in $T_3XD_2XL_2$ (322.55kg) preceded by $T_4XD_2XL_2$ (323.43kg).

Interaction effects between locations and different types of containers and seed treatments on 1000-seed weight were found significant. But there was no significant differences among $T_1XD_1XL_1$ (1.49gm), $T_2XD_1XL_1$ (1.67gm), $T_3XD_1XL_1$ (1.84gm), $T_5XD_1XL_1$ (1.56gm), $T_1XD_2XL_1$ (1.45gm), $T_2XD_2XL_1$ (1.75gm), $T_3XD_2XL_1$ (1.67gm), $T_5XD_2XL_1$ (1.55gm), $T_1XD_3XL_1$ (1.45gm), $T_2XD_3XL_1$ (1.68gm), $T_1XD_1XL_2$ (1.39gm), $T_2XD_1XL_2$ (1.85gm), $T_3XD_1XL_2$ (1.78gm), $T_5XD_1XL_2$ (1.53gm), $T_1XD_2XL_2$ (1.32gm), $T_2XD_2XL_2$ (1.65gm), $T_4XD_2XL_2$ (1.42gm) and $T_1XD_3XL_2$ (1.39gm). The highest result was found in $T_2XD_1XL_1$ (1.85gm) followed by $T_3XD_1XL_1$ (1.84gm). The lowest result was found in $T_3XD_2XL_2$ (1.11gm) preceded by $T_5XD_3XL_1$, $T_6XD_1XL_2$, $T_6XD_2XL_1$ and $T_2XD_3XL_2$ (1.12gm) (Table 4).

Discussion

The experiments were conducted in the field of Jute Agriculture Experimental Station (JAES), Manikgonj and Kishoregonj Regional Station (KRS), Kishoregonj of BJRI. Six different types of containers viz., tin pot, plastic pot, poly bag, gunny bag lined with polyethylene, cloth bag, and the IRRI poly bag, two different seed treatments viz. Provax-200 and B and two locations viz. JAES and KRS were used for the present study. Effects of seed treatments with B and Provax-200 on the production of quality healthy seeds were studied. Disease incidence occurred minimum at JAES and KRS when seeds were treated with B. Be and Provax-200 have been recorded as the superior means for controlling seed borne fungi as well as field fungi with higher seed yield and better improvement of seed quality as similarly reported by Hossain,[21,22] Hossain et al.,[23] Mostafa,[24] Hossain and Sarker[25] Islam and Biswas,[26] Khan and Fakir[27] and Haque et al.[28] The present findings revealed that seed quality was comparatively better in case of using B and P treated seeds as well as seed borne infection of fungal pathogens were less in seeds produced by B and P treated seeds. Moreover, seed treatments increased germination with the decrease of total seed borne fungal pathogens. Similarly, Akanda and Fakir[29] recorded low germination of jute seeds having high seed borne fungal pathogens. Hossain (2011a)[30] reported that B (3%) was found to control the seed borne pathogens and also increased the germination percentage of seeds. A similar result was also reported by Yeasmin et al.[31], Shultana et al.,[32] and Bhuiyan et al.[33] Haque et al.[28] reported that seed germination varied significantly with respect to variety, seed category and location of seed collection. The highest disease incidence (10.86%) was encountered in case of interaction among plastic pot storing seeds and control condition. Interaction between different types of containers and seed treatments, the highest germination (68.17%) was recorded in interaction effect of tin pot storing seeds and B treated seeds. The stick yield/ha (11.14ton) and fiber yield/ha (6.81ton) were recorded in interaction effect of plastic pot storing seeds and B treated seeds. Highest seed yield/ ha (422.44kg) was observed in the interaction of tin pot storing seeds and B treated seeds. Interaction between different types of containers, seed treatments and locations, the highest disease incidence (12.84%) was encountered in interaction effect of plastic pot storing seeds, control condition and KRS. Highest fiber yield/ha (6.81ton) and stick yield/ha (11.14ton) were recorded in interaction of plastic pot storing seeds, B treated seeds and JAES. Highest seed yield/ ha (422.44kg) was recorded in interaction of seed storing in a tin pot, treated with B and JAES location.

Conclusion

Therefore, the following conclusion may be drawn for quality seed and fiber production, from the findings of this study:

A. B (3% of seed weight) can successfully be used for treating seeds to avoid P for the production of quality healthy jute seeds with higher seed and fiber yield.

B. Fiber and seed yield were found to decrease with the increase of seed borne infection of fungal pathogens.

C. Seed germination and disease incidence varied significantly with respect to storage container, seed treatment and location.

So, the following recommendation may be drawn for quality seed and fiber production, from the findings of this study:

a) Quality of jute seeds can be maintained by storage in tin pot and seed treated of B enhance the quality and yield of the jute seed and fiber in the field.

Acknowledgments

None.

Conflicts of interest

Authors declare that there is no conflict of interest.

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