Effect of Phosphorus on Different Variety in Respect of Quality Fiber Production of Jute

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Abstract: An experiment was conducted at the Agronomy Field Laboratory, Patuakhali Science and Technology University, Patuakhali from May to September 2016, with a view to investigating the effect of phosphorus and different variety on the yield of jute varieties viz. (O-795, O-9897 and O-3820) and four levels of phosphorus (0 kg, 15 kg, 20 kg and 25 kg P ha-1). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The variety had significant influence on plant height, number of internodes per plant, fiber diameter, stick diameter, green weight with and without leaves, fiber weight, fiber yield, stick weight and stick yield. The variety O-3820 produced the highest fiber yield (5.35 t ha-1) due to improved yield components. Due to effect of phosphorus the highest results of all parameter were obtained from 15 kg P ha-1. Similarly the effect of interaction of variety and level of phosphorus had significant influence on plant height, number of internodes per plant, fiber diameter, stick diameter, stick diameter, fiber diameter, green weight with and without leaves, fiber weight, fiber yield (6.52 t ha-1), stick weight and stick yield. The highest results of all characters were obtained from O-3820 with 15 kg P ha-1. The results of the present experiment showed that the O-3820 was the best among the varieties. On the other hand, 15 kg P ha-1 was proved to be better than any other lower and higher levels of phosphorus. Therefore, it can be inferred that jute can produce the highest fiber yield from a combination of variety O-3820 treated with 15 kg P ha-1 in field.

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Introduction

Jute (Corchorus capsularis and Corchorus olitorius L.) is an herbaceous annual plant from the Tiliaceae family, mostly grown in Southeast Asian countries [1]. Jute is one of the most important commercial crop of our country. Bangladesh has the second largest area under jute cultivation (1.0 million ha) with the production of nearly 100 lakh bales [2]. Jute is an annual herbaceous plant, jute is a long, soft, shiny vegetable fiber.

It is produced from plants in the genus corchorus, which has been classified in the family Tiliaceae, or more recently malvaceae. The suitable climate for growing jute (warm and wet climate) is offered by the monsoon climate during the monsoon season. Jute requires 5-8 cm of rainfall weekly and more during the sowing period.

Two species of jute Corchorus capsularis and Corchorus olitorius usually grown by the farmer. Total land area of 14.05 million hectares, total cultivated area of the country is 7.94 million hectares and its cropping intensity is about 182 percent [3] which is the highest in the world. About 80% of the total world jute is produced in Bangladesh and India. Jute is extensively used throughout the world because of its versatility, durability and fineness.

Its fibre is mainly used in manufacturing various type of industrial product such as hessian, sacking, carpet backing, cloths, mats, blankets, fabrics, packing materials, etc. Bangladesh earns about 6-7% foreign exchange through exporting raw jute and jute goods. The fibre is also used to prepare ropes and housing materials for domestic uses.
Jute sticks are used as fuel and fence. In recent years, the green jute plant are being used as raw materials for paper pulp in the paper mills. Jute is also used for partex and jute geo-textile. Jute is least expensive and most versatile textile fibers. There is an enormous contribution of jute in the economy of Bangladesh. Total demand of jute goods in the international market is 0.75 Mt [4].

Jute contributes significantly to the economy of Bangladesh, as it is the major source of foreign currency by exporting jute fibre and goods produced from it [5]. Jute plays a very important role in Bangladesh economy as the country earns about 12-13% of total foreign currency by exporting jute fibre and jute product [6]. Bangladesh, the second largest producer of jute, produces the best quality jute in the world and leads the export market [7].

Jute varieties is one of the key elements for increasing fiber and stick yield. For maximizing yield variety play a vital role. An experiment was, therefore, initiated to study the growth and yield of three varieties of *capsularis* jute and to find out superior variety for fiber yield. [8] found that the fiber yield was significantly influenced by variety.

They reported the highest fiber yield (4.65 t ha⁻¹) was obtained from O-9897 and the lowest (2.23 t ha⁻¹) from O-795. Phosphorus is one of the key elements for increasing fiber and stick yield. For maximizing yield appropriate level of phosphorus is essential. [8] reported green weight exhibited significant response to levels of P. Hence, the present study was undertaken with three important mustard varieties, O-795, O-9897 and O-3820 to find out appropriate level of phosphorus.

**Materials and Methods**

**Experimental Site**

The experimental field located at 22°37’ N latitude and 89°10’ E longitude at Ganges Tidal Floodplains and falls under Agro-ecological Zone “AEZ 13”. The study locations also lie under Ganges Tidal Floodplain AEZ (AEZ No. 13). This region occupies an extensive area of tidal floodplain land in the south–west of the country. The area lies at 0.9 to 2.1 meter above mean sea level. The study area were the location Dumki under the coastal areas of Patuakhali.

**Climate**

The experimental area falls under the subtropical climate, which is characterized by high temperature and humidity, heavy rainfall with occasional gusty winds in the Kharif season (May-September) and less rainfall associated with moderately low temperature during the rabi season (October–March).

**Test Crop**

The seeds of jute O-795, O-9897 and O-3820 (*Corchorus olitorius*) were used as the planting material in the experiment. Seeds were collected from the Bangladesh Jute Research Institute (BJRI), Dhaka. Seeds were tested for germination before sowing and it was found 95% germination.

**Experimental Treatments**

There were two sets of experimental treatments included in the study. These were as follows:

**Factor A: Variety of jute**

\[V_1 = \textit{Corchorus olitorius} \text{ (O-795)}\]

\[V_2 = \textit{Corchorus olitorius} \text{ (O-9897)}\]

\[V_3 = \textit{Corchorus olitorius} \text{ (O-3820)}\]

**Factor B: Level of phosphorus (4 levels)**

\[T_0 = 0 \text{ kg P ha}^{-1}\]

\[T_1 = 15 \text{ kgP ha}^{-1}\]

\[T_2 = 20 \text{ kgP ha}^{-1}\]

\[T_3 = 25 \text{ kgP ha}^{-1}\]

**Experimental Design and Layout**

The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The unit plot size was 3 m × 2 m. The total number of unit plots was 36. The spaces between replication and between unit plots were 1 m and 0.5 m, respectively. The treatments were randomly distributed.

**Land Preparation**

The experimental land was first opened on May 5, 2016 with a power tiller. Thereafter, the land was ploughed and cross–ploughed to obtain good tilth. Laddering was done in order to break the soil clods into small pieces followed by each ploughing.
All the weeds and stubbles were removed from the experimental field.

Application of Fertilizers and Seed Sowing

The calculated entire amount of all fertilizers was applied during final plot preparation. The applied fertilizers were mixed properly with the soil in the plot. The whole amount of MoP, Gypsum and ½ of Urea were applied as basal dose at the time of final land preparation. The remaining ½ of the urea was top dressed in splits at 45 days after sowing. Triple super phosphate was used as per treatment. The collected seeds of Jute were line sown at May 12, 2016 @ 20 g plot–1 of each cultivar, respectively for getting proper population in the plot.

Intercultural Operations

Thinning, Gap Filling, Weeding and Irrigation

Emergence of seedling was completed within 10 days after sowing. Overcrowded seedlings were thinned out two times. First thinning was done after 15 days of sowing which is done to remove unhealthy and lineless seedlings. The second thinning was done 10 days after first thinning.

Seedlings were transferred to fill in the gaps where seeds failed to germinate. The gaps were filled in within two weeks after germination of seeds. First weeding was done at 20 DAS and 2nd and 3rd weeding were done at 10 days interval to keep the plots free from weeds and to keep the soil loose and aerated. The first irrigation was done after the first weeding. After that, the irrigation was applied by observing the soil moisture condition. Irrigation was done to the plots from deep tube well in each plot during the growing period of the crop.

Harvesting, Retting, Stripping, Washing and Drying of Jute

The crop was harvested on 22 September, 2016 when the crop reached at 50% flowering stage. Before harvesting 10 sample plants were taken at random from each plot to study the yield contributing characters of jute. After harvesting the jute plants were made into small bundles and kept standing on the ground for 4 days for shedding of leaves prior to steeping.

After shedding of the leaves, the jute bundles were steeped plot-wise on 25 September in pond water for retting. The retting was completed within 20 days after steeping. In the retting process the fibers in the bark get loosened and separated from the woody stalk due to the removal of pectines, gums and other mucilaginous substances. This is usually caused by the combined action of water temperature and microorganisms.

After proper retting, the fibers were extracted by stripping and were washed thoroughly in water. The extracted fibers were dried in the sun plot-wise on bamboo bars. After drying, the fibers were weighed to get the fiber yield. After stripping, the jute sticks were dried in sun by keeping them standing against bamboo bars. The sun dried sticks were weighed to record the yield of sticks. Retting, washing and drying of the sample plants were also done in the similar way.

Statistical Analysis

Data on growth and yield parameters were compiled, tabulated and statistically analyzed using the ANOVA technique. Analysis of variance was done with the help of computer package program MSTAT according to [9] and adjudged the mean differences as Duncan’s Multiple Range Test (DMRT).

Results and Discussion

Varietal Performance

The plant height was not significantly affected by variety. The analysis of variance for plant height of two varieties showed significant variation at final stage. Table 1 showed that at final stage of harvesting the tallest plant (4.26 m) was recorded in V1 (O-795) and the shortest plant (4.17 m) was obtained in O-9897. Variation in plant height might be due to the difference in their genetic make-up [2].

There was no significant variation found among varieties regarding of number of internodes per plant. Variety O-795 produced highest numbers of internodes (94.25) per plant. The lowest number of internodes (90.7) was counted from the variety O-9897. Variation in internodes number might be due to the difference in their genetic make-up [2].
The highest green weight without leaves (3.61 kg /10 plant) was recorded in O-3820 and the lowest (3.50 kg/10 plant) O-9897, which was statistically similar to O-795 (5.54kg/10 plant). The bark diameter was significantly affected by variety.

The highest (3.18 mm) bark diameter was obtained in O-3820 and the lowest (2.63 mm) was O-9897. The stick diameter had significant variation due to different variety. The highest (14.95 mm) stick diameter obtained in O-3820 and the lowest (14.18 mm) was in O-9897 (Table 1). This result supported the result of [10]. The fibre weight was significantly affected by variety. The highest (26.78g) fibre weight was obtained in variety O-3820, and the lowest was obtained in variety O-795 (20.93 g).

The highest fibre yield (5.35 t ha⁻¹) was obtained in 3820 and the lowest (4.96) one was obtained in O-795 variety. The fresh weight of stick was significantly affected by variety. The highest (73.60 g) fresh weight of stick weight per plant was obtained in variety O-795 and the lowest (67.55) was O-9897. The highest (14.20 t ha⁻¹) stick yield per ten plants was obtained in O-3820 and the lowest stick yield was obtained in (13.18 t ha⁻¹) was O-9897. The variety O-795 was the second one in terms of stick yield (13.38 t ha⁻¹).

**Effect of Phosphorus on the Yield and Yield Attributes of Jute**

The effect of different levels of P on plant height showed significant variation at final growth stage. The plant height varied from 3.51 m to 4.62 m. Table 2 shows that at final growth stage the tallest plant (4.62 m) was recorded from 15 kg P ha⁻¹ and shortest plant (3.51 m) was obtained at control.

After 15 kg P ha⁻¹ the plant height became decline at 20 kg P ha⁻¹(307 cm). [11] recorded the maximum nutrient uptake by jute plant under the FYM+ NPK treatment. Similarly more amount of P helped in more nutrient uptake which increased the height of plant. Phosphorus application influenced number of internodes per plant positively i.e. with the application of P fertilizer number of internodes per plant increased. The highest number of internodes per plant (98.83) was counted at 25 kg P ha⁻¹, which was statistically similar to 15 kg P ha⁻¹ and the lowest number of internodes (85.03) was found at P₀ (without P) treatment, which was statistically similar to 20 kg P ha⁻¹. The highest green weight with leaves (4.28kg/10 plant) was obtained in 15 kg P ha⁻¹ but it was statistically similar to 25 kg P (4.24 kg/10 plant) and the lowest (3.50 kg/10 plant) was found from control (0 kg P ha⁻¹).

The highest green weight without leaf (3.83 kg) was obtained in 15 kg P ha⁻¹ which was statistically similar to (3.76kg) was obtained in 25 kg P ha⁻¹ and the lowest (3.07 kg) was obtained at 0 kg P ha⁻¹. The highest (3.22 mm) bark diameter was obtained at 15 kg P ha⁻¹ and the lowest (2.47 mm) was at 0 kg P ha⁻¹ where the diameter ranged from 2.47 mm to 3.22 mm. Results revealed that bark diameter increased with the level of P. Stick diameter was significant at different level of P.

The highest (14.97 mm) stick diameter was obtained in 15 kg P ha⁻¹ which was statistically similar to 25 kg P ha⁻¹ (14.95) and the lowest (13.96 mm) was in control treatment. The fibre weight exhibited significant response to level phosphorus. The highest fibre weight (29.93 g) /plant was obtained in 15 kg P ha⁻¹ and the lowest (20.90 g) was recorded at 0 kg P ha⁻¹. The fibre yield varied from 4.18 to 5.98 t ha⁻¹. The highest fibre yield (5.98 t ha⁻¹) was obtained in 15 kg P ha⁻¹ which was statistically identical with the treatment 25 kg P ha⁻¹ and the lowest (4.18 t ha⁻¹) was in 0 kg P ha⁻¹.

The trend of fiber yield increasing due to increasing fertilizer dose, after 20 kg P ha⁻¹ the yield of fiber become decline. The weight of fresh stick varied from 63.13 to 78.83 g/ plant. The highest (78.83g) fresh stick weight per plant was obtained in 15 kg P ha⁻¹ and the lowest (63.13 g) was obtained at 0 kg P ha⁻¹. Similar findings were reported by [12]. The highest (14.20 t ha⁻¹) was obtained in 15 kg P ha⁻¹ which was statistically similar to 25 kg P ha⁻¹ and the lowest (12.30 t ha⁻¹) was 0 kg P ha⁻¹. The yield of stick ranged from (12.30 to 14.20 t ha⁻¹).

**Interaction Effect of Variety and Phosphorus on the Yield and Yield Attributes of Jute**

The effect of interaction between variety and P level of plant height was significant (Table 3). The highest plant height was recorded from interaction V₁P₂₅ (4.80 m) and the lowest value (3.42 m) was found in
interaction V₃P₀. From the results (Table 4.3) it is evident that 25 kg P ha⁻¹ produced highest plant height in variety of O-795 where lowest plant height was obtained from control treatment in variety O-3820. The above findings were similar to [11].

From Table 3 the highest number of internodes per plant (103.26) was recorded in O-795 at P₂₅. The lowest number of internodes per plant (83.93) was counted from the O-9897 × P₀ (without P). The highest green weight with leaf (4.46kg/10 plant) was recorded in variety O-3820 with 15 kg P ha⁻¹ and the lowest (3.46 kg/10 plant) was obtained in O-3820 with no phosphorus application, which in turn statistically similar to O-795 at 0 kg P ha⁻¹ (3.56 kg/10plant) and O-9897 at 0 kg P ha⁻¹ (3.5 kg), respectively. The interaction of variety and level of phosphorus had a significant effect on green weight of plants without leaves. The highest (3.94kg/10plant) fresh weight of plant without leaves was recorded in variety O-3820 with 15 kg P ha⁻¹ and the lowest (3.05 kg/10plant) was in O-795 with 0 kg P ha⁻¹. The bark diameter ranged from 2.16 to 3.46mm. The highest (3.46mm) was obtained from V₃P₁₅ and lowest from control. The stick diameter ranged from 13.8 to 15.76mm. Highest value from V₃P₂₀ and lowest from V₃P₂₀ interaction. The highest (32.6 g) fiber weight was obtained in variety O-9897 with 15 kg P ha⁻¹ and the lowest (20 g) was recorded in variety O-3820 without phosphorus. The fibre yield varied from 4 to 6.52 t ha⁻¹. Highest value (6.52 t ha⁻¹) obtained from O-9897 with 15 kg P ha⁻¹ and lowest (4 t ha⁻¹) from O-3820 with control. Similar interaction effect was found by [13].

The interaction effect of variety and level of P had a significant effect on fresh stick weight (g/plant). In an combined interaction variety O-9897 with 15 kg P ha⁻¹ were obtained highest value (79g) due to high amount of P and lowest (60g) for 20kg P ha⁻¹ with variety O-9897. The Interaction effect of variety and phosphorus fertilizer varied significantly. Highest stick yield was obtained (14.76 t ha⁻¹) in O-3820 and lowest (11.26 t ha⁻¹) from O-795 with control [14,15].

**Table 1 : Effect of variety on growth and yield characteristics of jute**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Plant height (m)</th>
<th>No. of internodes Plant¹</th>
<th>Green weight with leaf (kg)</th>
<th>Green weight without leaf (kg)</th>
<th>Bark diameter (mm)</th>
<th>Stick diameter (mm)</th>
<th>Fibre weight per plant (g)</th>
<th>Fibré yield (t ha⁻¹)</th>
<th>Stick weight per plant (g)</th>
<th>Stic k yield (t ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-795</td>
<td>4.26 a</td>
<td>94.25 a</td>
<td>3.99 b</td>
<td>3.54 b</td>
<td>2.83 b</td>
<td>14.50 b</td>
<td>20.93 c</td>
<td>4.96 c</td>
<td>70.60 b</td>
<td>13.38 b</td>
</tr>
<tr>
<td>O-9897</td>
<td>4.17 c</td>
<td>90.7 c</td>
<td>3.94 c</td>
<td>3.50 c</td>
<td>2.63 c</td>
<td>14.18 c</td>
<td>26.30 b</td>
<td>5.26 c</td>
<td>67.55 c</td>
<td>13.18 c</td>
</tr>
<tr>
<td>O-3820</td>
<td>4.24 b</td>
<td>91.97 b</td>
<td>4.08 a</td>
<td>3.61 a</td>
<td>3.18 a</td>
<td>14.95 a</td>
<td>26.78 a</td>
<td>5.35 a</td>
<td>73.60 a</td>
<td>14.20 a</td>
</tr>
</tbody>
</table>

**Table 2 : Effect of phosphorus on growth and yield characteristics of jute**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (m)</th>
<th>No. of internodes per plant</th>
<th>Green weight with leaf(kg)</th>
<th>Green weight without leaf(kg)</th>
<th>Bark diameter (mm)</th>
<th>Stick diameter (mm)</th>
<th>Fibre weight per plant (g)</th>
<th>Fibré yield (t ha⁻¹)</th>
<th>Stick weight per plant (g)</th>
<th>Stic k yield (t ha⁻¹)</th>
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</thead>
<tbody>
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<td>85.03 d</td>
<td>3.30 d</td>
<td>3.07 d</td>
<td>2.47 d</td>
<td>13.96 d</td>
<td>20.90 d</td>
<td>4.18 d</td>
<td>63.13 d</td>
<td>12.30 d</td>
</tr>
<tr>
<td>P₁₅</td>
<td>4.62 a</td>
<td>97.03 b</td>
<td>4.28 a</td>
<td>3.83 a</td>
<td>3.22 a</td>
<td>14.97 a</td>
<td>29.93 a</td>
<td>5.98 a</td>
<td>78.83 a</td>
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<tr>
<td>P₁₅</td>
<td>4.24 c</td>
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<td>96.83 a</td>
<td>4.24 b</td>
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<td>5.74 b</td>
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<td>14.06 c</td>
</tr>
</tbody>
</table>

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Results

Highest and lowest values of some selected parameters under different treatments are presented in Table 3. The most important parameter, fiber yield was recorded highest with V₃P₁₅ treatment. The most important parameter, fiber yield were recorded highest with V₃P₁₅ treatment.

Table 3: Interaction effect of variety and Phosphorus (P) growth and yield characteristics of jute.

<table>
<thead>
<tr>
<th>Variety and Treatments</th>
<th>Plant height (m)</th>
<th>No. of internodes per plant</th>
<th>Green weight with leaf (kg)</th>
<th>Green weight without leaf (kg)</th>
<th>Bark diameter (mm)</th>
<th>Stick diameter (mm)</th>
<th>Fiber weight per plant (g)</th>
<th>Fiber yield (t ha⁻¹)</th>
<th>Stick weight per plant (g)</th>
<th>Stick yield (t ha⁻¹)</th>
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<td>V₃P₀</td>
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<td>20.9 c</td>
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<td>5 b</td>
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</tbody>
</table>

Level of significance: * = Significant at 1% level of probability, ** = Significant at 5% level of probability and NS = Non Significant

LSD value: 0.40 7.51 0.35 0.25 0.46 1.06 5.05 0.95 7.90 1.87

CV (%): 4.74% 4.07% 4.40% 3.55% 7.35% 3.67% 8.73% 8.72% 5.58% 6.87%

Conclusions

All the treatments of variety and phosphorus had significant impact over control on growth parameters and yield parameters and effect of combined fertilizers on them were explained by simple and multiple regression analysis. Interaction between variety and level of P showed significant variation in relation to all physical parameters. All the physical parameters were found highest from 15 kg P ha⁻¹ and the lowest in control. From the above results of the present study it may be concluded that 15 kg P ha⁻¹ individually along with recommended rate of N, K and S fertilizers significantly increased different physical parameters. Highest fiber yield was recorded from O-3820 variety. The most important parameter, fiber yield were recorded highest with V₃P₁₅ treatment.

References

8. Sarker SR, Chowdhury MAH, Mohiuddin KM and Saha BK (2012) Influence of different levels of potassium on yield and fibre strength...


