INFLUENCE OF DIFFERENT DOSES OF NITROGEN AND PHOSPHORUS ON YIELD AND QUALITY OF JUTE SEED

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CERTIFICATE

This is to certify that the thesis entitled **"INFLUENCE OF DIFFERENT DOSES OF NITROGEN AND PHOSPHORUS ON YIELD AND QUALITY OF JUTE SEED"** submitted to the **INSTITUTE OF SEED TECHNOLOGY**, Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTERS OF SCIENCE (M.S.)** in **SEED TECHNOLOGY**, embodies the result of a piece of *bona fide* research work carried out by **MD. TARIFUL ISLAM**, Registration No. **09-03485** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, as has been availed of during the course of this investigation has duly been acknowledged.

June, 2018

Dhaka, Bangladesh

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Dedicated to
My
Beloved Parents

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The Author

INFLUENCE OF DIFFERENT DOSES OF NITROGEN AND PHOSPHORUS ON YIELD AND QUALITY OF JUTE SEED

ABSTRACT

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from August to December 2017 to observe the influence of different doses of nitrogen and phosphorus on yield and quality of jute seed. Three varieties *viz*. V_1= O-9897 (Falguni Tosa pat), V_2= O-795 (BJRI Tosa pat-5) and V_3= O-3820 (BJRI Tosa pat-6) and four levels of N+P *viz*. F_0 = without N and P (control), F_1 = 25% less dose of N and P, F_2 = recommended dose of N and P and F_3 = 25% higher dose of N and P were considered for the present study. The experiment was laid out in randomized complete block design with three replications. Data on different growth, seed yield components and yield and quality of jute seed was recorded. Different variety had significant influence on different growth and seed yield parameters. The highest seed yield (2355 kg ha^{-1}) as well as yield attributes were higher with the variety V_1 (Falguni Tosa pat). Again, N+P levels also showed significant variation in results on different parameters. F_2 (recommended dose of N+P) gave the highest seed yield (2559.73 kg ha^{-1}) and other yield attributes than other fertilizer treatments. Results revealed that combined effect of variety and N+P levels showed significant difference on studied parameters and the highest number of branches $plant^{-1}$ (4.36), number of pods $plant^{-1}$ (32.74), number of seeds pod^{-1} (242.30), pod length (6.52 cm), pod diameter (2.47 cm), weight of 1000 seeds (2.49 g), seed yield (2588.85 kg ha^{-1}) and stover yield (6150.00 kg ha^{-1}) were observed from the treatment combination of V_1F_2. In terms of seed quality parameters, the lowest electric conductivity (12.25 $MScm^{-1}$), the highest seed germination (98.67%), shoot length (7.00 cm), root length (1.69 cm), seedling dry weight (52.57 g) and vigor index (686.46) were observed from the treatment combination of V_1F_2 whereas the highest electrical conductivity (19.15 ms) was found with V_2F_0. On the other hand, the lowest seed germination (86.67%), shoot length (5.72cm), root length (1.01 cm), seedling dry weight (21.93 g) and vigor index (519.64) was observed from the treatment combination of V_3F_0. So, it was evident that the variety V_1 (O-9897; Falguni Tosa pat) with F_2 (Recommended dose of N and P) showed the best performance in terms of seed yield and quality of jute.

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ABBREVIATIONS AND ACRONYMS

AEZ	=	Agro-Ecological Zone
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
CV %	=	Percent Coefficient of Variation
DAS	=	Days After Sowing
DMRT	=	Duncan's Multiple Range Test
et al.,	=	And others
e.g.	=	exempli gratia (L), for example
etc.	=	Etcetera
FAO	=	Food and Agricultural Organization
g	=	Gram (s)
i.e.	=	id est (L), that is
kg	=	Kilogram (s)
LSD	=	Least Significant Difference
m^2	=	Meter squares
ml	=	MiliLitre
M.S.	=	Master of Science
No.	=	Number
SAU	=	Sher-e-Bangla Agricultural University
var.	=	Variety
^oC	=	Degree Celceous
%	=	Percentage
NaOH	=	Sodium hydroxide
GM	=	Geometric mean
mg	=	Miligram
P	=	Phosphorus
K	=	Potassium
Ca	=	Calcium
L	=	Litre
µg	=	Microgram
USA	=	United States of America
WHO	=	World Health Organization

CHAPTER I

INTRODUCTION

Jute (*Corchorus* sp.) is the second most important fibre crop after cotton in the world and the main cash crop of Bangladesh. On an average 9.00-10.00 lakh tons (44-55 lakh bale) of jute fibre was produced annually from an average area of 4.50–5.00 lakh ha of land in Bangladesh (BBS, 2012). But the area and production was increased significantly from 2010-2011 and onwards. On an average 75-80 lakh bale jute fibre is produced from 7.00-7.50 lakh ha of land from 2010-11 and onwards due to developing more conscious about environment and stepping forward to the natural fibre by escaping from the perilous impact of synthetic fibre to the environment. As a result demand of jute fibre is being increased in the recent years both in home and abroad. Bangladesh requires about 5000-5500 tons of jute seeds every year of which nearly about 12-15% is produced and distributed by the Bangladesh Agricultural Development Corporation and the rest of the seeds are solely produced and utilized by the farmers (Saha, 2011 and Al-Mamun *et al*., 2017).

Traditionally jute seed is produced from fibre crop where seed is sown in the month of March-April and a small portion of crop is kept for seeds at the corner of the field after the harvest of fibre crop. As jute is a short day crop (Kundu *et al*., 1959), it remains in vegetative phase up to October, the seed crop faces many natural hazards in long staying in the field and produces poor quality seeds (Hossain *et al*., 1994). This problem, however, solved by adopting the late sown technology of jute seed production where seed is sown in late condition during the month of August-September aiming entirely for seed purpose. Jute seed produced in late sown condition showed unique both in quantity and qualitative attributes (Hossain *et al*., 1994). On the other hand, jute seed production areas are decreasing at an alarming rate due to unavailability of land. As a result, every year a huge amount of tossa jute and

kenaf seeds are introducing through official and unofficial trades from neighboring country.

Plant nutrients have tremendous influence on yield and quality of jute seed (Bhttacharjee *et al*., 2000). Nitrogen and phosphorus is one of the key nutrients needed for crop production; however, it is the most mobile and volatile and the most exhausted nutrients due to its ability to exist in different forms and its easy leach ability (Mucheru-Muna *et al*., 2009).

For successful jute production, high quality healthy seeds are prerequisite. Quality seeds of improved varieties itself can increase 20% yield of the crop (Hossain *et al* 1994a). But in practically presence of diseased or unhealthy seeds are common phenomena in jute seed lot. Sowing of diseased or unhealthy seed one of the major constrains responsible for low yield of jute in our country.

Considering all these facts, improvement of fiber yield seed yield and quality of jute is the prime need of Bangladesh. In this aspect, research regarding development of new high yielding variety of jute and determination of its fertilizer requirement is very important. In fact, these requirements vary within the same type of crop. For example, fertilizer demand of olitorius variety is higher than capsularis. The importance of N and P on the growth, yield and quality of fiber crops is well established. It is necessary to find a fertilizer combination which is economically profitable and at the same time gives yield very close to maximum yield potential. Therefore, much attention should be given towards the improvement of yield and quality of jute fiber to bring back the past glory of Bangladeshi jute. Considering the above facts the present study has been undertaken to observe the effects of N and P fertilizers on the growth, seed yield and seed quality of jute variety, and to find out the optimum requirement of all of these nutrients to achieve the maximum seed yield potential of new jute varieties.

Keeping the above facts under consideration present piece of the work was undertaken with the following objectives:

1) To select suitable variety (s) for achieving higher yield and quality of jute seed,
2) To evaluate the effect of N and P fertilizer levels on the yield and quality of jute seed, and
3) To find out the interaction of variety (s) and N and P levels for higher yield and quality of jute seed.

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made in this chapter to present a brief review of research in relation to growth and seed yield of jute as influenced by variety and application of nitrogen and phosphorus fertilizer. It is an established fact that balanced fertilization especially nitrogen and phosphorus which is the most important plant nutrient increases crop growth and gives higher fibre yield and seed yield as well. Some of the pertinent findings of the research with variety and application of nitrogen and phosphorus on the growth and seed yield of jute are reviewed in this chapter.

2.1 Varietal performance of jute in late sowing seed production method

Choudhury and Ali (1962) observed that plants having more vegetative growth produced more fibres but less seeds; therefore, checking of vegetative growth by late sowing was the improved device to increase the seed yields. They further suggested that to produce higher yield of better quality seeds of jute crop should be grown in June, so that the plants remain stunted in growth, induce early flowering and produce higher yield of seeds.

Joseph *et al.* (1984) carried out field trials at Barrackpur, West bengal with C. *capsularis* cv. JRC 212 and C. *olitorius* cv. JRO 632 and reported that, seed yield plant^{-1} was positively correlated with plant height, basal stem diameter, number of branches plant^{-1}, seed weight and pod number which made the greatest contribution to the yield.

Hossain *et al.* (1991) carried an experiment to investigate effect of seedling transplantation of late sown jute crop on seed yield with four cultivars (CVL-1, D-154, O- 4, and 0-9897) in 1990 at Manikgonj, Rangpur, Faridpur, Comilla and Kishoregonj regional station of BJRI. Seedlings were transplanted on

September 1, 15 and 30 to the monsoon seed bed. The interaction effect between dates of transplanting and varieties of jute indicated that all the four varieties transplanted on September 1 and 15 produced higher seed yields. Variety 0-9897 produced the highest seed yield (546 kg ha^{-1}) over the other varieties.

Hossain and Iqbal (1992) conducted an experiment at Rangpur Station of BJRI with four varieties viz. CVL-1, D-154, 0-4 and 0-9897 during 1992 to assess the feasibility of growing late jute seed crop through transplanting on three different dates viz. September 1, mid and end. Result showed that the crop transplanted on September 1 gave significantly higher seed yield than that of other transplanting dates. They also found that the variety 0-9897 gave significantly the highest seed yield (630 kg ha^{-1}) when seedlings were transplanted on 1st September.

Hossain *et al.* (1993) conducted an experiment at Manikgonj and Rangpur in 1992 with four genotypes of jute viz. Chitla , OM-I, 0-9897, and 0-4 to study the feasibility of growing sole jute seed crop in late season with different dates of sowing (August 15 & 30 and September 15). From the result it was observed that all the genotypes gave higher yield in August 15 sowing at both stations. Irrespective of dates of sowing, Variety O- 9897 gave higher yield at Manikgonj (0.98 t/ha).

Rahman *et al.* (1992) carried out an experiment at Faridpur and Kishoregonj with O- 9897 jute cultivar at four sowing dates (August 15 and 30 and September 15 and 30). Result obtained that the August 15 sowing produced significantly highest seed yield and gradually decreased with delayed sowing from August 15.

Khan and Islam (1993) carried out an experiment at Kishorergonj regional station of BJRI to find out the best time of sowing for late season seed crop of

jute (var. 0-9897). Result indicated that August 30 sowing produced significantly highest seed yield (1086 kg/ ha) followed by August 15 sowing (1033 kg/ha). The sowing of October 15 produced lowest seed yield (400 kg / ha).

Hossain *et al.* (1994b) demarcated the last time of sowing of late jute seed crop for different agro-climatic regions of Bangladesh. According to his works, sowing of late jute seed crop should not be done beyond the 1st. week of September at Rangpur, middle of September at Jessore and end of September at Faridpur, Manikgonj and Chandina (Comilla) regions.

Hossain *et al.* (1994c) conducted a research experiment on crop and seed health in Late Planting Technique at Central station and JAES, Manikgonj, of BJRI with var. CVL-1, D- 154, CC-45 and CVE-3. In this experiment, 6.89% plants of CC-45, 2.44% of CVE-3 and only 1.15% plants of D-154 were infected with leaf mosaic disease. Besides, 2.08% plants of D-154 carried soft-rot disease. At central station variety D-154 carried only 0.5% stcm-rot disease. Although 0-9897 was found free from diseases at central station but at JAES, Manikgonj, as much as 8.03% plants showed the symptom of *Cercospora* leaf spot.

Islam *et al.* (1994) conducted an experiment where the highest plant height, base diameter and the weight of dry plant were obtained din the direct seeding method (conventional method) and number of branches per plant, Seeds per pods and seed yield were maximum in the top cutting method.

Hossain *et al.* (1994d) reported that higher yield of jute seed produced in the late planting season. The author considered the planting time of jute in the late season, the corresponding temperature of their flowering period and yield, thus demarcated the last planting time of jute and stated that seed should not be planted beyond the first week of September at Rangpur, middle of September

at Jessore and end of September at Faridpur, Manikgong and Kishorcgonj; and 5 October at Comilla regions of Bangladesh.

Haque (1995) conducted an experiment with C. *capsularis* and C. *olitorius* varieties to show the varietal suitability on seed production under late planting technique. The author reported that there were significant variations in seed yield among different varieties of jute sown as late seed crop. Among *C. olitorius* cv. 0-9897, 0-4 and Chaitali produced 1044, 891 and 811 kg seeds ha^{-1}, respectively. Among *C. capsularis* varieties CVE-3 showed highest seed yield potential (509 kg^{-1}) followed by D-154 (473kg^{-1}) and CVL-1 (416 kg ha^{-1}). Although, differences in seed yield among *C.. capsularis* varieties were statistically insignificant, all the studied varieties of C. *capsularis* gave significantly lower seed yields than those of *C. olitorius* varieties.

Hossain (1999) conducted research on varietal suitability for late planting technique on seed yield productivity with C. *olitorius* (var.O-4, 0-9897 and Chaitali), *C. capsularis* (var. D-154, CV1-1 and CVE-3), *Hibiscus sabdariffa* (var. HS-24), and *H. cannabinus* (var. HC-2). It was concluded that, all the varieties of C. *capsularis* (var. D-154, CV1-1 and CVE-3), C. *olitorius* (var. 0-4, 0-9897, and Chaitali) and *H. cannabinus* (var. HC- 2) can be sown as late season seed crop. But, *H. sabdariffa* (var. HS-24) should be grown as conventional practices for seed production.

Sohel *et al.* (2002 and 2003) reported that jute seed obtained from top cutting method gave significantly higher percentage of germination and shoot length indicating its superiority over the conventional method. The variety CVE -3 gave higher percentage of germination, speed of germination, root length and dry weight of root and shoot indicating its superiority attributes among the varieties. The interaction effect of planting method and variety of different attributes differed significantly.

Islam (2005) reported that the top- cutting method gave highest seed yield of 738 kg/ha in *C. capsularis* L and 913 kg/ha in *C. olitorius* L compare to that of conventional method of 477 kg/ha in *C. capsularis* L and 529 kg/ha in *C. olitorius* L and their differences were highly significant. Late sowing method gave statistically similar yield of 715 kg/ha in C. *capsularis* and 869 kg/ha in *C. olitorius* to top cutting. Irrespective of planting method the varieties CVL-1 and CVE-3 of C. *capsularis* and 0-9897 and OM-1 of *C. olitorius* produced statistically similar yield. The interaction effect of seed production method and variety were significant for pod/plant, seed/pod, seed weight/plant, 1000 seed weight and seed yield except branch/plant. All the varieties under top cutting and late sowing methods produced much higher seed yields compared to their corresponding yields under conventional method of seed production technique.

Al-Mamun *et al*. (2017) conducted the experiment with seven varieties of jute and one variety of kenaf to find out the seed production potentiality in non-traditional areas. All varieties were sown in late July to mid August in 2009 to 2011. At hilly station white jute varieties (BJRI Deshi Pat-6, CVL-1 and BJRI Deshi Pat-5) performed better for seed production than tossa jute and kenaf varieties. At saline station (both Satkhira and Patuakhali) kenaf variety HC-95 performed better for seed yield than white and tossa jute varieties (O-9897, OM-1, BJRI Tossa Pat-4 and BJRI Tossa Pat-5). The kenaf variety (HC-95) produced the highest yield (0.86 ton/ha) in saline areas. Among the white jute varieties, BJRI Deshi Pat-5 gave the highest yield (0.66 ton/ha) and in case of tossa jute varieties, BJRI Tossa Pat-5 gave the highest seed yield (0.70 ton/ha). Therefore, BJRI Deshi Pat-5 of white jute, BJRI Tossa Pat-5 and HC-95 of kenaf are considered as the best varieties for seed production in hilly and saline areas of Bangladesh, respectively.

2.2 Effect of plant nutrients on growth and yield

Ali *et al*. (2017) conducted the present study to clarify the fertilizer requirement on the growth and yield of the variety Bangladesh Jute Research Institute Kenaf-4. Consequently the experiment was conducted in Jute Agriculture Experimental Station, Manikganj and Jute Research Regional Station, Kishoreganj of Bangladesh Jute Research Institute. The results indicated significant effect of different NPKS levels on Bangladesh Jute Research Institute (BJRI) Kenaf-4 yield and yield contributing characters over control. The highest fibre (3.14t/ha) and stick (7.65t/ha) yield were obtained by the combination dose of N100 Kg/ha with PKS 10-60-20 kg/ha at Kishoreganj. The plant height (3.14m), base diameter (19.47mm) also found highest with the same fertilizer treatment combination. By the same treatment produced higher fibre yield and yield contributing characters at Manikganj though that yield was slightly lower than Kishoreganj. Economic analysis suggested the best combination is N100P10K60S20 kg/ha. The findings of the present experiment clearly indicated a great prospect of nutrient combination of N100P10K60S20 kg/ha on the growth and yield of fibre production on the variety BJRI kenaf-4.

Khanom *et al*. (2012) conducted a field experiment at Bangladesh Jute Research Institute (BJRI) to observe the response of N, P, K and S on a pre-released white jute (*Corchorus capsularis*) var. BJC-2197. The experiment was carried out by applying N, P, K, S fertilizers in ten combinations including control. From the experiment it was observed that all the treatments had significant positive effect over control on growth, yield and quality parameters. The highest fiber yield (3.21 t/ha) and stick yield (6.58 t/ha) were recorded with N90P5K30S10 kg/ha treatment. However, the best quality fiber was found with combination of N90P15K30S10 kg/ha treatment. From the economic analysis point of view, it was found that combination of N90P5K30S10 kg/ha was higher (2.30) than N90P15K30S10 kg/ha (2.04). So the former can be

considered as the best combination for var. BJC-2197 in terms of BCR, yield and quality.

2.3 Quality of jute seed

Khandakar and Bradbeer (1983) recommended that both *Corchorus capsularis* and *C. olitorius* seeds can be stored safely for one year with a moisture content of 10 %. However, such a practice for more than a year would be harmful to C. *capsularis* seeds but would be deleterious to those of *C. olitorius* varieties.

Khatun and Sobhan (1985) reported that jute seeds with a moisture content of 4 to 7 percent maintained 85 percent viability up to 12 months at room temperature.

Talukder and Ali (1989) stated that jute seed were pyramidal shape having 4-5 faces. *C. capsularis* seeds were larger than C. *olitorius* seeds. On an average 300 C. *capsularis* seeds or 500 *C. olitorius* seeds made a gram.

Talukder and Rahaman (1989) developed jute seed purity standard and National Seed Board (NSB) of Bangladesh approved it as pure seed 96 %, inert matter 3 %, Other crop seed 0.05 %, weed seed 0.05 *%* and other variety 1%.

Mollah (2002) carried out a laboratory experiment with jute seed collected from two different seed sources viz. Bangladesh Jute Research Institute (BJRI) and farmers. He found that quality of farmers' seed deteriorated mostly during processing and storing period. Quality of farmers' seed was associated with higher content of inert matter and higher initial moisture content. Higher initial moisture in seed subsequently reduced germination and vigour of farmers' jute seed. Due to accelerated ageing test C. *olitorius* L. seed deteriorated completely by three days and *C. capsularis* L seed by seven days. They also observed that earlier deterioration of *C. olitorius* seed indicated its more vulnerability to poor storage environment.

Islam *et al.* (2002) studied different categories of jute seeds for purity, viability, vigour, green yield and dry fibre yield of varieties 0-9897 and CVL-1. Purity viability and vigour of breeder seeds were best in all respects and those of farmers' seed were poor. Moisture content was the highest in farmers' seed and lowest in breeder seed. Base diameters, green yield in dry fibre yield were influenced significantly due to seed categories. Declining trend of fibre yield was observed in breeder seed, foundation seed and farmers' seeds as well.

Islam (2007) conducted an experiment on quality of Jute seeds of different sources. He reported that the percentage of pure seeds was higher for both the species in BJRI followed by BADC seed. In CVL-1 the highest percentage of pure seed (99.58 %) was found in BJRI seeds, which was followed by BADC (97.70 %). In contrast the lowest (80.36 %) purity was observed in farmer's seeds of manikgonj. In variety 0-9897, the highest purity (99.44 %) was found in BJRI seed which was statistically similar with BADC seed (97.98 %). The percentage of inert matter also varied significantly due to different seed sources. The highest (19.57%) inert matter was found in farmers' seed of Manikgonj followed by farmers of Kishoregonj (17.88%) and local market sources (14.23%).

CHAPTER III

MATERIALS AND METHODS

In this chapter a short description of the location of the experimental site, climatic condition of the area where the plot was situated, materials used for experimental treatments, design of the experiment, method of cultivation, method of data collection, statistical analysis have been presented.

3.1 Experimental site

The research work was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 to study the influence of crop nutrition on seed yield and quality of jute during the period from August to December 2017. Experimental field was located at 90°22′ E longitude and 23°41′ N latitude and altitude of 8.2 m above the sea level. The experimental site is presented in Appendix I.

3.2 Climate

Experimental area belongs to subtropical climatic zone which is characterized by heavy rainfall, high temperature and relatively long day period during "Kharif-1" season (April-September) and scarce rainfall, low humidity, low temperature and short day period during "Rabi" season (October-March). This climate is also characterized by distinct season, *viz*. the monsoon extending from May to October, the winter or dry season from November to February and per-monsoon period or hot season from March to April (Edris *et al.*, 1979). The meteorological data in respect of temperature, rainfall, relative humidity, average sunshine and soil temperature for the entire experimental period have been shown in Appendix II.

3.3 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract in Agroecological Zone (AEZ)-28 (UNDP, 1988). It was medium high land and

the soil series was Tejgaon (FAO, 1988). The soil was having a texture of sandy loam with pH and CEC were 5.6 and 2.64 meq/100 g soil, respectively. The characteristics of the soil under the experimental plot were analyzed in the Soil Testing laboratory, SRDI, Khamarbari, Dhaka and details of the recorded soil characteristics were presented in Appendix III.

3.4 Planting materials

Three jute varieties *viz*. O-9897 (Falguni Tosa pat), O-795 (BJRI Tosa pat-5) and O-3820 (BJRI Tosa pat-6) were used in the present study. The seeds were collected from the Bangladesh Jute Research Institute (BJRI), Dhaka, Bangladesh.

3.5 Treatments of the experiment

Factor A: Variety - 3

1. V_1= O-9897 (Falguni Tosa pat)
2. V_2= O-795 (BJRI Tosa pat-5)
3. V_3= O-3820 (BJRI Tosa pat-6)

Factor B: Nitrogen (N) and phosphorus (P) - 4 levels

1. F_0 = Without N and P (control)
2. F_1 = 25% less than recommended doses of N and P
3. F_2 = Recommended doses of N and P
4. F_3 = 25% higher than recommended doses of N and P

There were 12 (3×4) treatment combinations given below:

V_1F_0, V_1F_1, V_1F_2, V_1F_3, V_2F_0, V_2F_1, V_2F_2, V_2F_3, V_3F_0, V_3F_1, V_3F_2, V_3F_3.

3.6 Design and layout of the experiment

The two factors experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. There were 12 treatment combinations.

In total 36 plots for 3 blocks were in the experiment. The size of each unit plot was (3m × 2m). The distance maintained between two replications and two plots were 1 m and 0.75 m, respectively. The layout of the experiment is shown in Appendix IV.

3.7 Preparation of the main field

The plot selected for the experiment was opened in the last week of July, 2017 with a power tiller, and was exposed to the sun for a few days, after, which the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain a good tilth. Weeds and stubble were removed and finally obtained a desirable tilth of soil for sowing. The land preparation was completed on 5 August 2017. The individual plots were made by making ridges (20 cm high) around each plot to restrict lateral runoff of irrigation water.

3.8 Application of fertilizer and manure

The following fertilizer and manure were used for the cultivation of jute under the present study as recommended doses

Name of fertilizer and manure	Doses ha^{-1}
Cowdung	10 t
Urea	80 kg
TSP	32 kg
MoP	35 kg
$ZnSO_4$	2.5 kg
B	2 kg

Source: Fertilizer Recommendation Guide, 2016

Whole amount of cowdung, TSP, MoP, $ZnSO_4$ and Boron were applied at the time of final land preparation. Urea and TSP for N and P were applied as per treatment. Half amount of urea and whole amount of TSP were applied at final land preparation and rest half of urea was applied at 15 days after sowing (DAS).

3.9 Sowing of seeds

Seeds were sown in lines maintaining line to line distance 30 cm on 7 August 2017. The seeds were sown in lines continuously and lines were covered with pulverized soil just after sowing and gently pressed with hands.

3.10 Intercultural operation

3.10.1 Thinning

Each plot contained 10 lines of seed sown. When the plants established, thinning was done to maintain 18-20 plants in each line.

3.10.2 Weeding

Weeding were done whenever it was necessary to keep the plots free from weeds and to loose the soil.

3.10.3 Plant protection

To protect from insect, at the early stage of growth (25 DAS), Malathion 57 EC was sprayed twice at the rate of 2 ml/liter at an interval of 10 days. Dithane M-45 was sprayed twice at the rate of 2 ml litre^{-1} at an interval of 7 days for the protection of damping off.

3.11 Harvesting

The ripening pods (75-80%) from central 1 m^2 area grown in different plots were harvested separately from the jute plants grown in different plots. The harvested pods were sun dried for 2 days and threshed manually by beating with the help of stick or hammer. Seeds were sun dried, cleaned and stored for further study. Seed yield data was collected from this 1 m^2 areas pod.

3.12 Collection of data

Randomly 10 representative plants were selected at random from each of unit plot to avoid border effect and tagged in the field. All the yield attributes data

were taken from those plants. The details of data recording are given below:

3.12.1 Plant parameters

1. Plant height (cm) at harvest
2. Number of branches plant^{-1} at harvest

3.12.2 Yield contributing parameters

1. Number of pods plant^{-1}
2. Number of seeds pod^{-1}
3. Pod length (cm)
4. Pod diameter (cm)
5. Weight of 1000 seeds (g)

3.12.3 Yield parameters

1. Seed yield (kg ha^{-1})
2. Stover yield (kg ha^{-1})

3.12.4 Seed quality parameters

1. Electrical conductivity (ms)
2. Seed germination of (%)
3. Shoot length (cm)
4. Root length (cm)
5. Seedling dry weight (g)
6. Vigor index

3.13 Procedure of recording data

3.13.1 Plant and yield contributing parameter

Plant height

Plant height was considered as the height from ground level to the tip of largest

leaf of the plants. The plant height was recorded at harvest. Plant height of 10 randomly sampled plants were recorded and mean was calculated in centimeter (cm).

Number of branches plant^{-1}

The number of branches of 10 randomly selected plants from each plot at harvest.

Number of pods plant^{-1}

Number of pods from 10 randomly selected plants was counted and their mean values were calculated.

Number of seeds pod^{-1}

Numbers of seeds per pod was recorded from 20 randomly selected mature pods from 10 plants and the mean value was calculated.

Pod length (cm)

Pod length was measured from randomly selected 20 pods from 10 plants with a meter scale. From base of the pod to tip was considered to measure pod length. Average length was counted as pod length and expressed in cm.

Pod diameter (cm)

Pod diameter was measured from randomly selected 20 pods from 10 plants with a slide calipers. Average diameter was counted and considered as pod length and was expressed in cm.

Thousand seed weight (g)

Thousand seeds were randomly taken from the harvest of each plot. The seeds were weighted at about 12% moisture level using an electric balance.

Seed yield (kg ha^{-1})

Seed were harvested from each unit plot and their weight was recorded and expressed in gram (g). The grain yield per plot was finally converted to yield per hectare and expressed in kilogram (kg).

Stover yield (kg ha^{-1})

To record stover yield ha^{-1}, 1 m^2 plants from center of the plot were harvest and then weighed in kg after drying. The weight was converted per ha basis and was expressed in kg as stover yield ha^{-1}.

3.13.2 Seed quality parameters

Seeds of each plot were used for taking quality parameters data in the laboratory. The following quality parameters data were taken as follows-

Percent (%) seed germination

The number of sprouted and germinated seeds was counted daily commencing. Germination was recorded at 24 hrs interval and continued up to 10th. More than 2 mm long plumule and radicle was considered as germinated seed.

The germination rate was calculated using the following formula:

$$\text{Rate of germination (\%)} = \frac{\textit{Total Number of germinated seeds}}{\textit{Total seed placed for germination}} \times 100$$

Root length (cm)

The root length of five seedlings from each sample was recorded finally at 10 DAS. Measurement was done using a meter scale and unit was expressed in centimeter (cm).

Shoot length (cm)

The shoot length of five seedlings from each sample was measured finally at 10 DAS. Measurement was done using the unit centimeter (cm) by a meter scale.

Seed vigor index

The vigor index (VI) of the seedlings can be estimated as suggested by Abdul-Baki and Anderson (1973):

$$VI = RL+SL\times GP,$$

Where

RL = root length (cm),

SL = shoot length (cm) and

GP = germination percentage.

3.14 Statistical analysis

The recorded data on different parameters were statistically analyzed using MSTAT-C computer package programme. The analysis of variance for the characters under study were performed by 'F' variance test. The differences between the pairs of treatment means was compared using least significant difference (LSD) test (Gomez and Gomez, 1984).

CHAPTER IV

RESULTS AND DISCUSSION

Results obtained from the present study regarding the influence of nitrogen (N) and phosphorus (P) effect with different varieties jute on growth, seed yield and yield attributes are presented and discussed in this chapter. After observing the field performance, further investigation was also observed on the aspect of seed quality of the obtained grain of the study. The results have been presented in Tables and Figures. Different parameters of the jute cultivars have been presented and discussed under separate heads and sub–heads as follows:

4.1 Plant parameters

4.1.1 Plant height at harvest

Effect of variety

Plant height was significantly influenced by different jute varieties (Fig. 1 and Appendix V). It was found that the tallest plant (166.91 cm) at harvest was found from variety V_1 (O-9897; Falguni Tosa pat) followed by V_2 (O-795; BJRI Tosa pat-5) where the shortest plant (129.82 cm) at harvest was found from variety V_3 (O-3820; BJRI Tosa pat-6). Similar result was also observed by Islam *et al.* (1994) and Joseph *et al.* (1984) which supported the present study.

Effect of N+P level

Significant influence was found on plant height of jute as affected by different N+P levels (Fig. 2 and Appendix V). Results revealed that the tallest plant (164.23 cm) at harvest was found from treatment F_3 (25% higher dose of N and P) which was significantly different from all other treatments followed by F_2 (Recommended dose of N and P). The shortest plant (121.43 cm) at harvest was found from the control treatment F_0 (No N and P). The result obtained from the present study was similar with the findings of Ali *et al*. (2017).

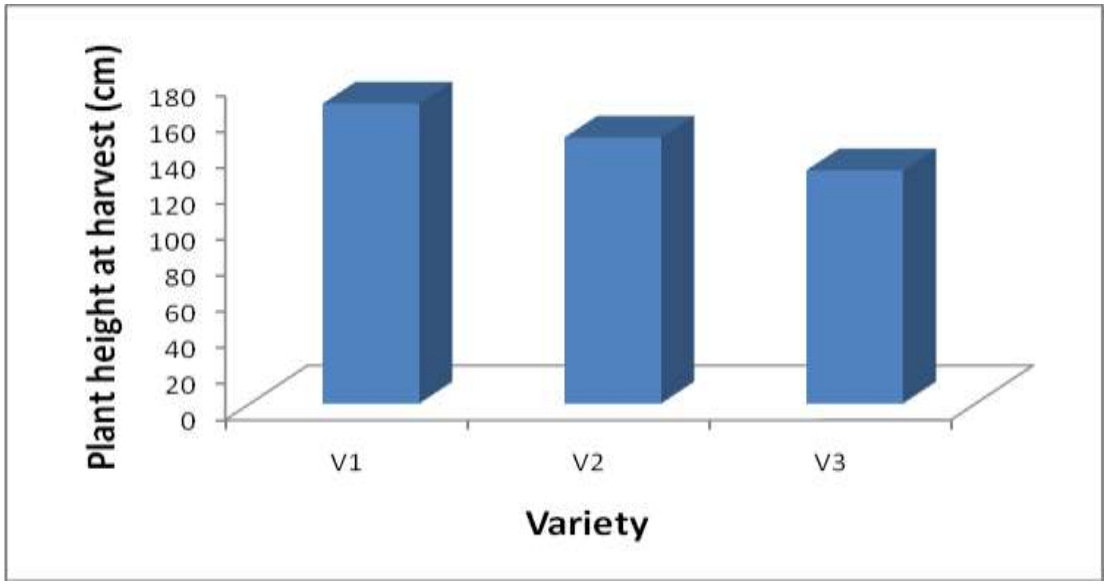

Fig. 1. Plant height of jute at harvest as influenced by variety ($LSD_{0.05}$ = 4.193)

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

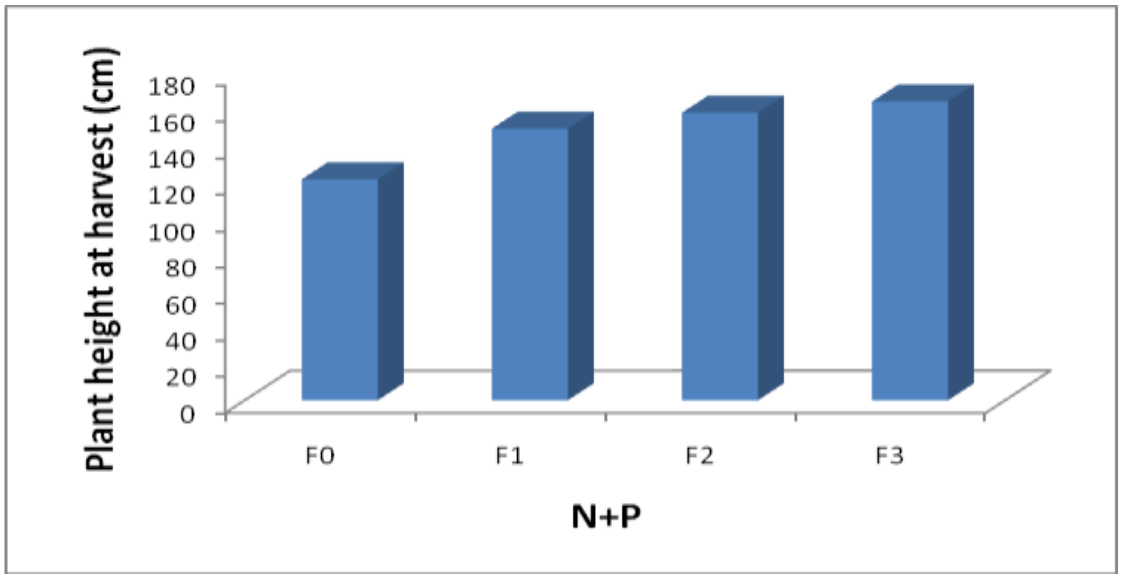

Fig. 2. Plant height of jute at harvest as influenced by N and P levels ($LSD_{0.05}$ = 4.364)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on plant height of jute (Table 1 and Appendix V). The tallest plant (185.36 cm) at harvest was observed from the treatment combination of V_1F_3 which was significantly different from all other treatment combinations followed by V_1F_2. The shortest plant (108.33 cm) at harvest was found from the treatment combination of V_3F_0 which was also significantly different from all other treatment combinations.

4.1.2 Number of branches plant^{-1} at harvest

Effect of variety

Significant variation was observed on number of branches plant^{-1} as influenced by different jute varieties (Fig. 3 and Appendix V). Results showed that the highest number of branches plant^{-1} (3.82) at harvest was found from variety V_1 (O-9897; Falguni Tosa pat) followed by V_2 (O-795; BJRI Tosa pat-5). The lowest number of branches plant^{-1} (3.30) at harvest was found from variety V_3 (O-3820; BJRI Tosa pat-6). The result obtained from the present study was similar with the findings of Islam (2005), Islam *et al.* (1994) and Joseph *et al.* (1984).

Effect of N+P level

Significant influence was found on number of branches plant^{-1} of jute as affected by different N+P levels (Fig. 4 and Appendix V). The highest number of branches plant^{-1} (3.97) at harvest was found from treatment F_2 (Recommended dose of N and P) which was statistically similar with F_1 (25% less dose of N and P) and F_3 (25% higher dose of N and P). The lowest number of branches plant^{-1} (2.66) at harvest was found from the control treatment F_0 (No N and P)

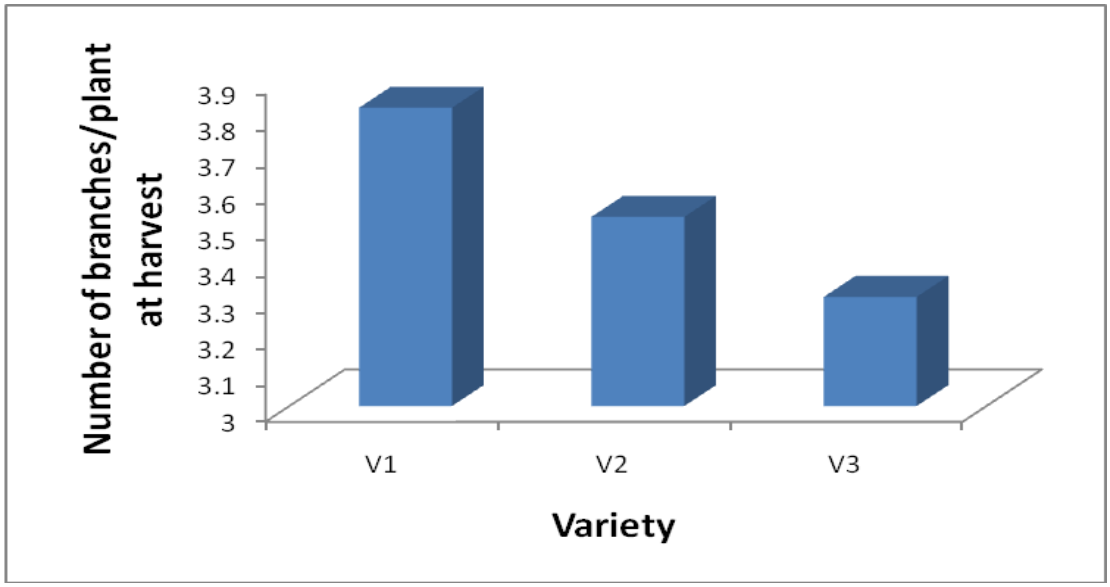

Fig. 3. Number of branches plant^{-1} of jute at harvest as influenced by variety ($LSD_{0.05}$ = 0.161)

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

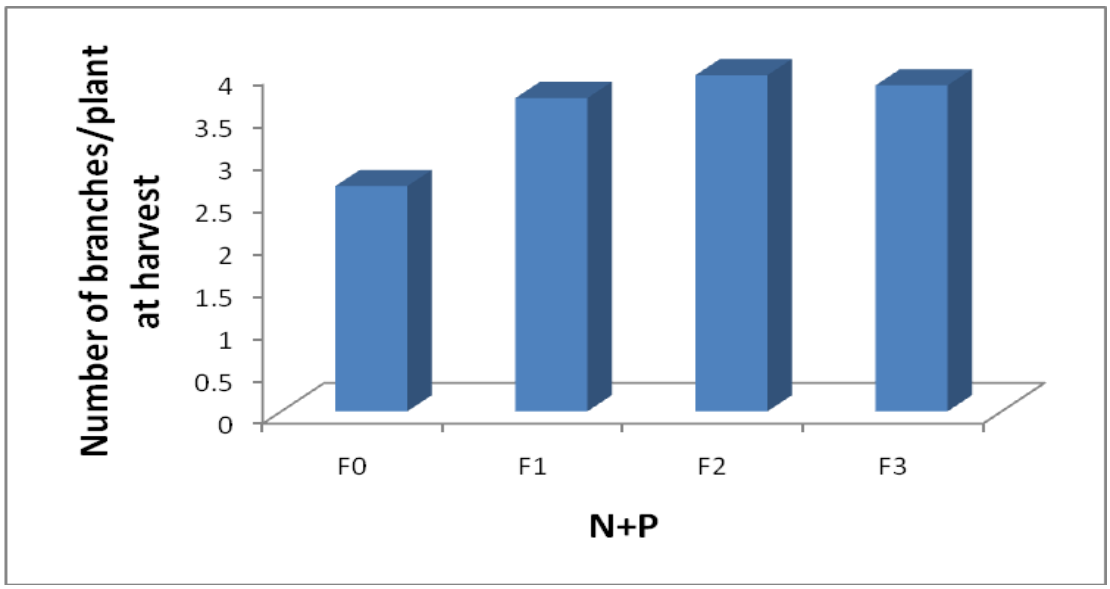

Fig. 4. Number of branches plant^{-1} of jute at harvest as influenced by N and P levels ($LSD_{0.05}$ = 0.308)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on number of branches plant^{-1} of jute (Table 1 and Appendix V). The highest number of branches plant^{-1} (4.36) at harvest was observed from the treatment combination of V_1F_2 which was statistically different from other treatment combinations followed by of V_1F_3, V_2F_1, and V_3F_2. The lowest number of branches plant^{-1} (2.52) at harvest was observed from the treatment combination of V_3F_0 which was statistically similar with V_2F_0.

Table 1. Plant height and number of branches plant^{-1} of jute at harvest as influenced by the combination of variety with N+P levels

Treatment	Plant height at harvest (cm)	Number of branches plant^{-1} at harvest
V_1F_0	133.24 g	2.88 f
V_1F_1	170.44 c	3.88 c
V_1F_2	178.60 b	4.36 a
V_1F_3	185.36 a	4.14 b
V_2F_0	122.71 i	2.58 g
V_2F_1	148.80 e	4.12 b
V_2F_2	158.71 d	3.45 d
V_2F_3	161.84 d	3.92 bc
V_3F_0	108.33 j	2.52 g
V_3F_1	128.67 h	3.11 e
V_3F_2	136.78 f	4.10 bc
V_3F_3	145.50 e	3.48 d
$LSD_{0.05}$	**3.532**	**0.217**
CV(%)	**12.502**	**6.317**

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

4.2 Yield contributing parameters

4.2.1 Number of pods plant^{-1}

Effect of variety

Significant variation was observed on number of pods plant^{-1} as influenced by different jute varieties (Table 2 and Appendix VI). The highest number of pods plant^{-1} (23.11) was found from variety V_1 (O-9897; Falguni Tosa pat) whereas the lowest number of pods plant^{-1} (22.41) was found from variety V_2 (O-795; BJRI Tosa pat-5) which was statistically similar with V_3 (O-3820; BJRI Tosa pat-6). The results obtained from the present study was similar with the findings of Islam (2005) and Joseph *et al.* (1984).

Effect of N+P level

Significant influence was found on number of pods plant^{-1} of jute as affected by different N+P levels (Table 2 and Appendix VI). The highest number of pods plant^{-1} (31.68) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments where the lowest number of pods plant^{-1} (14.73) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on number of pods plant^{-1} of jute (Table 2 and Appendix VI). Results showed that the highest number of pods plant^{-1} (32.74) was observed from the treatment combination of V_1F_2 which was statistically similar with the treatment combination of V_2F_2. The lowest number of pods plant^{-1} (14.32) was observed from the treatment combination of V_2F_0 which was statistically similar with the treatment combination of V_3F_0.

4.2.2 Number of seeds pod^{-1}

Effect of variety

Non-significant variation was observed on number of seeds pod^{-1} as influenced by different jute varieties (Table 2 and Appendix VI). However, the highest number of seeds pod^{-1} (202.58) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest number of seeds pod^{-1} (197.19) was found from variety V_2 (O-795; BJRI Tosa pat-5). Contradictory results was observed by Islam (2005) and Islam *et al.* (1994) who reported that number of seeds pod^{-1} varied significantly due to varietal difference.

Effect of N+P level

Significant influence was found on number of seeds pod^{-1} of jute as affected by different N+P levels (Table 2 and Appendix VI). The highest number of seeds pod^{-1} (236.90) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments followed by F_3 (25% higher dose of N and P). The lowest number of seeds pod^{-1} (157.34) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on number of seeds pod^{-1} of jute (Table 2 and Appendix VI). The highest number of seeds pod^{-1} (242.30) was observed from the treatment combination of V_1F_2 which was statistically similar with the treatment combination of V_2F_2. The lowest number of seeds pod^{-1} (154.12) was observed from the treatment combination of V_2F_0 which was statistically similar with the treatment combination of V_3F_0.

4.2.3 Pod length (cm)

Effect of variety

Significant variation was not observed on pod length as influenced by different jute varieties (Table 2 and Appendix VI). However, the longest pod (5.93 cm) was found from variety V_1 (O-9897; Falguni Tosa pat) and the shortest pod (5.90 cm) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant influence was found on pod length of jute as affected by different N+P levels (Table 2 and Appendix VI). Results indicated that the longest pod (6.50 cm) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments. The shortest pod (5.15 cm) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on pod length of jute (Table 2 and Appendix VI). The longest pod (6.52 cm) was observed from the treatment combination of V_1F_2 which was significantly different from all other treatment combinations followed by V_2F_2. The shortest pod (5.10 cm) was observed from the treatment combination of V_2F_0 which was statistically similar with V_3F_0 and V_1F_0.

4.2.4 Pod diameter (cm)

Effect of variety

Significant variation was not observed on pod diameter as influenced by different jute varieties (Table 2 and Appendix VI). Results indicated that the highest pod diameter (2.20 cm) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest pod diameter (2.15 cm) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Non-significant influence was found on pod diameter of jute as affected by different N+P levels (Table 2 and Appendix VI). However, the highest pod diameter (2.41 cm) was found from treatment F_2 (Recommended dose of N and P) and the lowest pod diameter (1.89 cm) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on pod diameter of jute (Table 2 and Appendix VI). The highest pod diameter (2.47 cm) was observed from the treatment combination of V_1F_2 which was statistically similar with the treatment combination of V_2F_2, V_3F_2 and V_3F_3. The lowest pod diameter (1.85 cm) was observed from the treatment combination of V_2F_0 which was statistically at par with the treatment combination of V_3F_0.

4.2.5 Weight of 1000 seeds (g)

Effect of variety

Non-significant variation was observed on weight of 1000 seeds as influenced by different jute varieties (Table 2 and Appendix VI). However, the highest weight of 1000 seeds (2.30 g) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest weight of 1000 seeds (2.25 g) was found from variety V_2 (O-795; BJRI Tosa pat-5). The result obtained from the present study was similar with the findings of Islam (2005).

Effect of N+P level

Significant influence was not found on weight of 1000 seeds of jute as affected by different N+P levels (Table 2 and Appendix VI). However, the highest weight of 1000 seeds (2.45 g) was found from treatment F_2 (Recommended dose of N and P) and the lowest weight of 1000 seeds (2.13 g) was found from the control treatment F_0 (No N and P).

Table 2. Yield contributing parameters of jute as influenced by the combination of variety and N+P levels

Treatment	Number of pods plant^{-1}	Number of seeds pod^{-1}	Pod length (cm)	Pod diameter (cm)	1000 seed weight (g)
Effect of variety					
V_1	23.11 a	202.58	5.93	2.20	2.30
V_2	22.41 b	197.19	5.90	2.15	2.25
V_3	22.55 b	200.52	5.91	2.17	2.29
$LSD_{0.05}$	**0.382**	**NS**	**NS**	**NS**	**NS**
CV(%)	**9.387**	**12.476**	**7.614**	**4.266**	**5.27**
Effect of N+P					
F_0	14.73 c	157.34 d	5.15 c	1.89	2.13
F_1	20.56 b	195.68 c	5.86 b	2.16	2.23
F_2	31.68 a	236.90 a	6.50 a	2.41	2.45
F_3	23.78 b	210.45 b	6.13 b	2.24	2.29
$LSD_{0.05}$	**4.374**	**8.692**	**0.321**	**NS**	**NS**
CV(%)	**9.387**	**12.476**	**7.614**	**4.266**	**5.27**
Combined effect of variety and N+P					
V_1F_0	15.48 h	162.63 g	5.24 f	1.95 de	2.19
V_1F_1	23.52 d	215.14 d	6.04 cd	2.20 c	2.26
V_1F_2	32.74 a	242.30 a	6.52 a	2.47 a	2.49
V_1F_3	20.70 e	190.24 e	5.92 d	2.18 c	2.22
V_2F_0	14.32 i	154.12 h	5.10 f	1.85 e	2.08
V_2F_1	19.50 f	188.50 ef	5.88 d	2.15 c	2.22
V_2F_2	32.42 a	239.78 a	6.50 a	2.44 ab	2.44
V_2F_3	23.94 d	219.67 cd	6.15 c	2.25 bc	2.27
V_3F_0	14.40 i	155.28 h	5.12 f	1.87 e	2.11
V_3F_1	18.67 g	183.40 f	5.67 e	2.12 cd	2.22
V_3F_2	29.88 b	228.62 b	6.48 ab	2.32 a-c	2.43
V_3F_3	26.70 c	221.45 c	6.32 b	2.28 a-c	2.38
$LSD_{0.05}$	**0.615**	**5.258**	**0.161**	**0.1855**	**NS**
CV(%)	**9.387**	**12.476**	**7.614**	**4.266**	**5.27**

NS = Not significant

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on weight of 1000 seeds of jute (Table 2 and Appendix VI). However, the highest weight of 1000 seeds (2.49 g) was observed from the treatment combination of V_1F_2 and the lowest weight of 1000 seeds (2.08 g) was observed from the treatment combination of V_2F_0.

4.3 Yield parameters

4.3.1 Seed yield (kg ha^{-1})

Effect of variety

Significant variation was observed on seed yield as influenced by different jute varieties (Table 3 and Appendix VII). Results indicated that the highest seed yield (2355.12 kg ha^{-1}) was found from variety V_1 (O-9897; Falguni Tosa pat) which was statistically different from with V_2 (O-795; BJRI Tosa pat-5) and V_3 (O-3820; BJRI Tosa pat-6). The lowest seed yield (2333.20 kg ha^{-1}) was found from variety V_2 (O-795; BJRI Tosa pat-5). The results obtained from the present study was similar with the findings of Al-Mamun *et al*. (2017), Islam (2005) and Islam *et al.* (1994).

Effect of N+P level

Significant influence was found on seed yield of jute as affected by different N+P levels (Table 3 and Appendix VII). The highest seed yield (2559.73 kg ha^{-1}) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments. The lowest seed yield (2049.08 kg ha^{-1}) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on seed yield of jute (Table 3 and Appendix VII). The highest seed yield (2588.85 kg ha^{-1}) was observed from the treatment combination of V_1F_2 which was

statistically similar with the treatment combination of V_2F_2 whereas the lowest seed yield (2013.88 kg ha^{-1}) was observed from the treatment combination of V_2F_0.

4.3.2 Stover yield ha^{-1} (kg)

Effect of variety

Significant variation was observed on stover yield ha^{-1} as influenced by different jute varieties (Table 3 and Appendix VII). It was noted that the highest stover yield ha^{-1} (5340 kg) was found from variety V_1 (O-9897; Falguni Tosa pat) followed by V_3 (O-3820; BJRI Tosa pat-6) whereas the lowest stover yield ha^{-1} (5087.1 kg) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant influence was found on stover yield ha^{-1} of jute as affected by different N+P levels (Table 3 and Appendix VII). The highest stover yield ha^{-1} (6048 kg) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments followed by F_3 (25% higher dose of N and P). The lowest stover yield ha^{-1} (4341.70 k g) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P level

Combined effect of variety and N+P levels showed significant influence on stover yield ha^{-1} of jute (Table 3 and Appendix VII). The highest stover yield ha^{-1} (6150 kg) was observed from the treatment combination of V_1F_2 which was significantly different from all other treatment combinations followed by V_2F_2. The lowest stover yield ha^{-1} (3925.05 kg) was observed from the treatment combination of V_2F_0 which was significantly different from all other treatment combinations followed by V_3F_0.

Table 3. Yield parameters of jute as influenced by the combination of variety and N+P levels

Treatment	Seed yield (kg ha^{-1})	Stover yield ha^{-1} (kg)
Effect of variety		
V_1	2355.12 a	5340.00 a
V_2	2333.20 c	5087.51 c
V_3	2341.05 b	5179.99 b
$LSD_{0.05}$	**7.387**	**13.74**
CV(%)	**11.798**	**12.371**
Effect of N+P		
F_0	2049.08 d	4341.70 d
F_1	2355.89 c	5028.35 c
F_2	2559.73 a	6048.30 a
F_3	2407.80 b	5391.65 b
$LSD_{0.05}$	**10.31**	**13.80**
CV(%)	**11.798**	**12.371**
Combined effect of variety and N+P		
V_1F_0	2067.69 i	4750.05 j
V_1F_1	2389.58 e	5310.00 f
V_1F_2	2588.85 a	6150.00 a
V_1F_3	2374.37 f	5149.95 g
V_2F_0	2013.88 j	3925.05 l
V_2F_1	2355.32 g	4950.00 h
V_2F_2	2587.31 a	6049.95 b
V_2F_3	2407.70 d	5425.05 e
V_3F_0	2065.68 i	4350.00 k
V_3F_1	2322.77 h	4825.05 i
V_3F_2	2503.04 b	5944.95 c
V_3F_3	2441.33 c	5599.95 d
$LSD_{0.05}$	**8.017**	**14.77**
CV(%)	**11.798**	**12.371**

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

4.4 Seed quality parameters

4.4.1 Electrical conductivity (ms)

Effect of variety

Significant variation was not found on electrical conductivity of seeds as influenced by different jute varieties (Table 4 and Appendix VIII). However, results showed that the lowest electrical conductivity (16.84 ms) was found from variety V_1 (O-9897; Falguni Tosa pat) and the highest electrical conductivity (17.55 ms) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant influence was not found on electrical conductivity of jute as affected by different N+P levels (Table 4 and Appendix VIII). However, it was observed that the lowest electrical conductivity (16.13 ms) was found from the control treatment F_2 (Recommended dose of N and P) and the highest electrical conductivity (18.61 ms) was found from treatment F_0 (No N and P). The results obtained from the present study was similar with the findings of Ali *et al*. (2017) and Khanom *et al*. (2012).

Combined effect of variety and N+P

Combined effect of variety and N+P levels showed significant influence on electrical conductivity of jute (Table 4 and Appendix VIII). Results showed that the lowest electrical conductivity (12.75 ms) was observed from the treatment combination of V_1F_2 which was followed by V_1F_3 (14.72 ms). The highest electrical conductivity (19.15 ms) was observed from the treatment combination of V_1F_2 which was statistically similar with the treatment combination of V_2F_0 significantly similar with the combinations of V_1F_1, V_2F_2 and V_3F_1 (19.04, 18.72 and 18.56 ms, respectively).

4.4.2 Seed germination (%)

Effect of variety

Non-significant variation was observed on seed germination as influenced by different jute varieties (Table 4 and Appendix VIII). However, results indicated that the highest seed germination (94.33%) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest seed germination (93.00%) was found from variety V_2 (O-795; BJRI Tosa pat-5). Similar result was also observed by Islam (2007) who reported that germination (%) varied among the inter varieties.

Effect of N+P level

Significant influence was not found on seed germination of jute as affected by different N+P levels (Table 4 and Appendix VIII). However, the highest seed germination (97.33%) was found from treatment F_2 (Recommended dose of N and P) and the lowest seed germination (88.89%) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P

Combined effect of variety and N+P levels showed significant influence on seed germination of jute (Table 4 and Appendix VIII). Results revealed that the highest seed germination (98.67%) was observed from the treatment combination of V_1F_2 which was statistically similar with the treatment combination of V_2F_2. The lowest seed germination (86.67%) was observed from the treatment combination of V_2F_0 which was significantly different from all other treatment combinations.

4.4.3 Shoot length (cm)

Effect of variety

Non-significant variation was observed on shoot length as influenced by different jute varieties (Table 4 and Appendix VIII). However, the highest

shoot length (6.58 cm) was found from variety V_1 (O-9897; Falguni Tosa pat) and The lowest shoot length (6.32 cm) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant influence was not found on shoot length of jute as affected by different N+P levels (Table 4 and Appendix VIII). However, the highest shoot length (6.84 cm) was found from treatment F_2 (Recommended dose of N and P) and the lowest shoot length (6.07 cm) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P

Combined effect of variety and N+P levels showed non-significant influence on shoot length of jute (Table 4 and Appendix VIII). However, the highest shoot length (7.00 cm) was observed from the treatment combination of V_1F_2 and the lowest shoot length (5.72cm) was observed from the treatment combination of V_2F_0.

4.4.4 Root length (cm)

Effect of variety

Significant variation was not observed on root length as influenced by different jute varieties (Table 4 and Appendix VIII). However, the highest root length (1.42 cm) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest root length (1.27 cm) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant variation was not found on root length as affected by different N+P levels (Table 4 and Appendix VIII). However, the highest root length (1.55 cm) was found from treatment F_2 (Recommended dose of N and P) and the lowest root length (1.15 cm) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P

Combined effect of variety and N+P levels had no significant influence on root length (Table 4 and Appendix VIII). However, the highest root length (1.69 cm) was observed from the treatment combination of V_1F_2 and the lowest root length (1.01 cm) was observed from the treatment combination of V_2F_0.

4.4.5 Seedling dry weight (g)

Effect of variety

Non-significant variation was observed on seedling dry weight as influenced by different jute varieties (Table 4 and Appendix VIII). However, the highest seedling dry weight (39.79 g) was found from variety V_1 (O-9897; Falguni Tosa pat) and the lowest seedling dry weight (35.47 g) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Effect of N+P level

Significant influence was found on seedling dry weight of jute as affected by different N+P levels (Table 4 and Appendix VIII). Results indicated that the highest seedling dry weight (48.83 g) was found from treatment F_2 (Recommended dose of N and P) followed by F_3 (25% higher dose of N and P) where the lowest seedling dry weight (24.98 g) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P

Combined effect of variety and N+P levels showed significant influence on seedling dry weight of jute (Table 4 and Appendix VIII). The highest seedling dry weight (52.57 g) was observed from the treatment combination of V_1F_2 which was significantly different from all other treatment combinations followed by V_3F_2. The lowest seedling dry weight (21.93 g) was observed from the treatment combination of V_2F_0 followed by V_3F_0.

4.4.6 Vigor index

Effect of variety

Significant variation was observed on vigor index as influenced by different varieties of jute (Table 4 and Appendix VIII). Results revealed that the highest vigor index (617.56) was found from variety V_1 (O-9897; Falguni Tosa pat) which was statistically similar with V_3 (O-3820; BJRI Tosa pat-6) whereas the lowest vigor index (589.85) was found from variety V_2 (O-795; BJRI Tosa pat-5). Islam *et al.* (2002) also found similar result which supported the present findings.

Effect of N+P level

Significant influence was found on vigor index as affected by different N+P levels (Table 4 and Appendix VIII). The highest vigor index (667.11) was found from treatment F_2 (Recommended dose of N and P) which was significantly different from all other treatments followed by F_3 (25% higher dose of N and P). The lowest vigor index (540.57) was found from the control treatment F_0 (No N and P).

Combined effect of variety and N+P

Combined effect of variety and N+P levels showed significant influence on vigor index (Table 4 and Appendix VIII). Results showed that the highest vigor index (686.46) was observed from the treatment combination of V_1F_2 followed by V_1F_3. The lowest vigor index (519.64) was observed from the treatment combination of V_2F_0.

Table 4. Seed quality parameters of jute as influenced by variety and N+P levels and their combinations

Treatment	Electrical conductivity (ms)	Seed germination of (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	Vigor index
Effect of variety						
V_1	16.84	94.33	6.58	1.42	39.79	617.56 a
V_2	17.55	93.00	6.32	1.27	35.47	589.85 b
V_3	16.86	93.33	6.52	1.40	36.89	613.73 a
$LSD_{0.05}$	**NS**	**NS**	**NS**	**NS**	**NS**	**7.355**
CV(%)	**7.289**	**8.374**	**6.378**	**5.287**	**6.351**	**12.63**
Effect of N+P						
F_0	18.61	88.89	6.07	1.15	24.98 d	540.57 d
F_1	16.78	92.00	6.32	1.29	35.62 c	583.21 c
F_2	16.13	97.33	6.84	1.55	48.83 a	667.11 a
F_3	16.80	95.56	6.65	1.46	40.10 b	637.29 b
$LSD_{0.05}$	**NS**	**NS**	**NS**	**NS**	**3.941**	**8.421**
CV(%)	**7.289**	**8.374**	**6.378**	**5.287**	**6.351**	**12.63**
Combined effect of variety and N+P						
V_1F_0	15.62 e	90.67 fg	6.39	1.21	27.03 g	555.03 f
V_1F_1	19.04 a	93.33 de	6.45	1.27	36.20 e	603.25 e
V_1F_2	12.75 g	98.67 a	7.00	1.69	52.57 a	686.46 a
V_1F_3	14.72 f	96.00 bc	6.94	1.41	36.53 e	673.41 b
V_2F_0	19.15 a	86.67 h	5.72	1.01	21.93 i	519.64 g
V_2F_1	17.96 c	92.00 ef	6.45	1.27	36.37 e	594.67 e
V_2F_2	18.72 ab	97.33 ab	6.91	1.39	47.23 b	673.94 b
V_2F_3	17.95 c	94.67 cd	6.52	1.52	43.20 c	618.77 d
V_3F_0	16.78 d	89.33 g	6.11	1.23	25.97 h	547.04 f
V_3F_1	18.56 ab	90.67 fg	6.07	1.34	34.30 f	551.71 f
V_3F_2	18.01 b	96.00 bc	6.66	1.57	46.70 b	640.93 c
V_3F_3	15.72 e	96.00 bc	6.44	1.46	40.57 d	619.70 d
$LSD_{0.05}$	**0.782**	**1.677**	**NS**	**NS**	**0.941**	**9.146**
CV(%)	**7.289**	**8.374**	**6.378**	**5.287**	**6.351**	**12.63**

NS = Not significant

V_1= O-9897, V_2= O-795 (BJRI Tosa pat-5), V_3= O-3820 (BJRI Tosa pat-6)

F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P, F_3 = 25% higher dose of N and P

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh during the period from August to December 2017 to study the Influence of different doses of nitrogen and phosphorus on yield and quality of Jute seed. The experiment considered of two factors. Factor A: Variety - Three varieties *viz*. V_1= O-9897 (Falguni Tosa pat), V_2= O-795 (BJRI Tosa pat-5) and V_3= O-3820 (BJRI Tosa pat-6) and Factor B- Nitrogen (N) and phosphorus (P) - 4 levels *viz*. F_0 = Without N and P (control), F_1 = 25% less dose of N and P, F_2 = Recommended dose of N and P and F_3 = 25% higher dose of N and P. The experiment was laid out in the two factors Randomized Complete Block Design (RCBD) with three replications. Data on different growth, seed yield components and yield and quality of jute seed was recorded. Different variety and N+P levels and also their combinations showed significant variation on different growth, seed yield parameters, seed yield and quality of jute.

In case of varietal performance, results revealed that the tallest plant (166.91 cm) was found from variety V_1 (O-9897; Falguni Tosa pat) where the highest number of branches plant^{-1} (3.82) at harvest was found from variety V_1 (O-9897; Falguni Tosa pat) whereas the shortest plant (129.82 cm) and number of branches plant^{-1} (3.30) at harvest was found from variety V_3 (O-3820; BJRI Tosa pat-6). In terms yield contributing parameters and seed yield, the highest number of pods plant^{-1} (23.11), number of seeds pod^{-1} (202.58), pod length (5.93 cm), pod diameter (2.20 cm), weight of 1000 seeds (2.30 g), seed yield (2355.12 kg ha^{-1}) and stover yield (5340.00 kg ha^{-1}) was found from variety V_1 (O-9897; Falguni Tosa pat). Similarly, the lowest number of pods plant^{-1} (22.41), number of seeds pod^{-1} (197.19), pod length (5.90 cm), pod diameter (2.15 cm), weight of 1000 seeds (2.25 g), seed yield (2333.20 kg ha^{-1}) and

stover yield (5087.51 kg ha^{-1}) were found from variety V_2 (O-795; BJRI Tosa pat-5).

In case of seed quality parameters, the lowest electrical conductivity (16.84 ms), seed germination (94.33%), shoot length (6.58 cm), root length (1.42 cm), seedling dry weight (39.79 g) and vigor index (617.56) was found from variety V_1 (O-9897; Falguni Tosa pat). The highest electrical conductivity (17.55 ms), seed germination (93.00%), shoot length (6.32 cm), root length (1.27 cm), seedling dry weight (35.47 g) and vigor index (589.85) was found from variety V_2 (O-795; BJRI Tosa pat-5).

Regarding, N and P levels, the highest plant height (164.23 cm) was found from treatment F_3 (25% higher dose of N and P) but the highest number of branches $plant^{-1}$ (3.97) was found from treatment F_2 (Recommended dose of N and P) whereas lowest plant height (121.43 cm) and number of branches $plant^{-1}$ (2.66) at harvest was found from the control treatment F_0 (No N and P).

In case of yield contributing parameters, the highest number of pods $plant^{-1}$ (31.68), number of seeds pod^{-1} (236.90), pod length (6.50 cm), pod diameter (2.41 cm), weight of 1000 seeds (2.45 g), seed yield (2559.73 kg ha^{-1}) and stover yield (6048.30 kg ha^{-1}) was found from treatment F_2 (Recommended dose of N and P) whereas the lowest number of pods $plant^{-1}$ (14.73), number of seeds pod^{-1} (157.34), pod length (5.15 cm), pod diameter (1.89 cm), weight of 1000 seeds (2.13 g), seed yield (2049.08 kg ha^{-1}) and stover yield (4341.70 kg ha^{-1}) was found from the control treatment F_0 (No N and P).

Regarding, seed quality parameters, affected by N and P application, the lowest electrical conductivity (16.13 ms), seed germination (97.33%), shoot length (6.84 cm), root length (1.55 cm), seedling dry weight (48.83 g) and vigor index (667.11) was found from treatment F_2 (Recommended dose of N and P) and the highest electrical conductivity (18.61 ms), seed germination (88.89%), shoot length (6.07 cm), root length (1.15 cm), seedling dry weight (24.98 g) and vigor index (540.57) was found from the control treatment F_0 (No N and P)

Different treatment combinations showed variation on different parameters. Results showed that the highest plant height (185.36 cm) at harvest was observed from the treatment combination of V_1F_3 but the highest number of branches plant^{-1} (4.36) at harvest was observed from the treatment combination of V_1F_2 whereas the lowest plant height (108.33 cm) and number of branches plant^{-1} (2.52) at harvest were observed from the treatment combination of V_3F_0.

Again, the highest number of pods plant^{-1} (32.74), number of seeds pod^{-1} (242.30), pod length (6.52 cm), pod diameter (2.47 cm), weight of 1000 seeds (2.49 g), seed yield (2588.85 kg ha^{-1}) and stover yield (6150.00 kg ha^{-1}) were observed from the treatment combination of V_1F_2 whereas the lowest number of pods plant^{-1} (14.32), number of seeds pod^{-1} (154.12), pod length (5.10 cm), pod diameter (1.85 cm), weight of 1000 seeds (2.08 g), seed yield (2013.88 kg ha^{-1}) and stover yield (3925.05 kg ha^{-1}) at harvest was observed from the treatment combination of V_2F_0

In terms of seed quality parameters, the lowest electrical conductivity (12.75 ms), seed germination (98.67%), shoot length (7.00 cm), root length (1.69 cm), seedling dry weight (52.57 g) and vigor index (686.46) were observed from the treatment combination of V_1F_2 whereas the highest electrical conductivity (19.15 ms), seed germination (86.67%), shoot length (5.72cm), root length (1.01 cm), seedling dry weight (21.93 g) and vigor index (519.64) was observed from the treatment combination of $V_3F_{0.}$

From the above results of the present study, it was found that it can be concluded that, the variety V_1 (O-9897; Falguni Tosa pat) with F_2 (Recommended dose of N and P) gave the best performance on seed yield and quality of jute. So, this treatment combination can be considered as the best treatment combination.

Considering the situation of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh to investigate regional adaptability and other performances;
2. Another level of N and P may be included in the further study;
3. Some other variety can be used including the present varieties.

REFERENCES

Ali, M.S., Gani, M.N. and Islam, M.M. (2017). Efficiency of BJRI Kenaf-4 yield under different fertilizer levels. *American J. Agric. Forestry*. **5**(5): 145-149.

Al-Mamun, M., Saha, C.K., Mostofa, M.G., Miah, A., and Hossain, M.Z. (2017). Identification of suitable varieties for seed production of jute in non-traditional areas of Bangladesh. *Bangladesh J. Pl. Breed. Genet.* **30**(1): 33-37.

BBS (Bangladesh Bureu of Statistics). (2012). Statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of Planning, Government of the Peoples Republic of Bangladesh.

Bhattacharjee, A.K., Mittra, B.N. and Mittra, P.C. (2000). Seed agronomy of jute. II. Production and quality of Corchorus olitorius seed as influenced by nutrient management. *Seed Sci. Technol*. **28**:141-154.

Chowdhury, S.D. and Ali, M.K. (1962). Studies on the line sowing and broadcasting sowing of jute. *J. Jute and Jute Fab.* **2**(6): 155- 162.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haque, A. K. M. M. (1979). Detailed Soil Survey of Bangladesh, Dept. Soil Survey, Govt. People's Republic of Bangladesh. 118 p.

FAO. (1988). Production Year Book. Food and Agricultural Organizations of the United Nations Rome, Italy. **42**: 190-193.

Gomez, K.H. and Gomez, A.A. (1984). "Statistical Procedures for Agricultural Research". *Int. Sci. Publication, Jhon wiley and Sono*, New York. p. 680.

Haque, S. (1995). Varietal suitability for late production technique on seed yield productivity, *Annual Report.* BJRI. p. 147-149.

Hossain, A., Haque, S., Sultana, K., Islam, M. and Talukder, A.L. (1994a). A survey on the constrains of quality jute seeds at farm level. MOA. *Agricultural support service project.GOV/WB.* Dhaka: BJRI.

Hossain, A., Haque, S.; Sultana, K.; Islam, M. and Talukder, A.L. (1994b). A survey on the constrains of quality jute seeds at farm level. MOA. *Agricultural support service project.GOV/WB.* Dhaka: BJRI.

Hossain, A., Haque, S., Sultana, K., Islam, M. and Talukder, A.L. (1994c). Crop and seed health in late planting technique. MOA. *Agricultural support service project.GOV/WB.* p. 16-19.

Hossain, A., Haque, S., Sultana, K., Islam, M., and Khandaker, A.L. 1994d). Varietal suitability for late planting technique on seed yield productivity: Late Jute Seed Production. Dhaka: *Seed Wing, Ministry of Agriculture,* p. 1- 5.

Hossain, M.A. (1999). Constraint of quality jute seed production and how to overcome it. *J. Jute and Jute Fab.* **25**(3): 3-5.

Hossain, M. A. and Iqbal, S. (1992). Studies on time of transplanting and age of seedling of jute on seed yield. *Annual Report.* Dhaka: BJRI.p.187-188.

Hossain, M.A., Rahman, M., Zaman,N., Isalm, R., Khan, A., Siddique, A.B. and Islam, M. (1991). Effect of transplantation of late sown jute crop on seed yield. *In Annual Report.* Dhaka: BJRI. p.183-186.

Hossain, M.A., Mannan, S.A., Sultana, M.K. and Khandakar, A.L. (1994). Survey on the constraints of quality jute seed at farm level. Ministry of Agriculture, Agricultural Support Service Project. GOB/World Bank/ODA seed technological research team, Bangladesh Jute Res. Inst. Dhaka. P. 25.

Islam, M.M. (2005). A comparative study on conventional, top cutting and late sowing seed production methods for jute seed. *J. trop. Agric.* **3**(1): 29-33.

Islam, M.M. (2007). Quality, establishment and yield of jute as affected by seeds from different sources. In *PhD thesis.* Department of Agronomy. Mymensingh: BAU.p.74.

Islam, M.M., Islam, R., Nuruzzaman, Gosh. R.K. and Alamgir, M.A. (2002). Study on seed quality status and fibre yield of different seed categories of jute. *Pakistan J. Agron.* **1**(1): 41 -43.

Islam, R.; Iqbal, S.; Rahaman, A. and Rahaman, M.L. (1994). Comparative study of four different methods of jute seed production. *Bangladesh J. Jute Fibre Res.* **19**(1): 27.

Joseph, J., Saha, A. and Kundu, T.K. (1984). Some simple correllation studies in jute concerning yield of seed and it's components. *Int. Jute bulletin.* **37**(3-4): 51.

Khan, M.A. and Islam, K.M.M. (1993). Effect of time sowing of late jute seed crop. *Annual report,* BJRI. p. 234.

Khandakar, A.L. and Bradbeer, J.W. (1983). Jute seed quality. *Bangladesh J. Agric. Res.* **10**(1): 1 -9.

Khanom, S., Hossain, S. and Hossain, S.A. (2012). Effects of N, P, K and S application on yield and quality of white jute (*Corchorus capsularis* L.) var. BJC-2197. *Dhaka Univ. J. Biol. Sci*. **21**(2): 109.

Khatun, R and Sobhan, M.A. (1985). Effect of moisture and temperature on the viability of Jute. Kenaf and Mesta seeds . *Abstract Research on jute,* BJRI. p. 221.

Kundu, B.C., Basak, K.C. and Sarker, P.B. (1959). Jute in India. The Indian Central Jute Committee. Pp. 74-136.

Mollah, F.A. (2002). Quality evaluation of jute seeds collected from two different sources. In *Agronomy Thesis.* Gazipur: BSMRAU. p. 25-35.

Mucheru-Muna, M.W., Mugendi, D., Mugwe, J., and Kungu, J. (2009). Soil mineral N dynamics in a maize crop following different soil fertility amendments in different soil fertility status in sub-humid and semi-arid regions in Central Kenya. *Res. J. Agric. Biol. Sci*. **5**(6): 978-993.

Rahaman, M.L., Prodhan, M.A. and Hossain, M.A. (1992). Viability and vigour of off-season jute seeds. Proclamation of the 6th National Botany. *Chittagong University,* p.28-29.

Saha, C. K. (2011). Jute Seed Management in Bangladesh. International Seminar on Strengthening of Collaboration for Jute, Kenaf and Allied Fibres Research and Development (held during June 8-9, 2011). International Jute Study Group (IJSG). Pp. 92-97.

Sohel, M. A.; Salim, M. and Hossain, M. A. (2002). Top cutting: An improved technique in jute seed production. *Bangladesh J. Seed Sci. Technol*. **6**(l & 2): 103-107.

Sohel, M. A.; Salim, M. and Hossain, M. A. (2003). Response of top cutting on quality Jute seed production. *Bangladesh J. Jute Fibre Res.* **24**(1-8): 65-70.

Talukder, F.A.H. and Rahaman, M.A. (1989). A step towards increase production. Compilation of porular articles on jute. Dhaka: BJRI. **3**: l6-19.

UNDP. (1988). Land Resource Apprisal of Bangladesh for Agricultural Development Report 2: Agro-ecological Regions of Bangladesh, FAO, Rome, Italy. p. 577.

APPENDICES

Appendix I. Agro-Ecological Zone of Bangladesh showing the experimental location

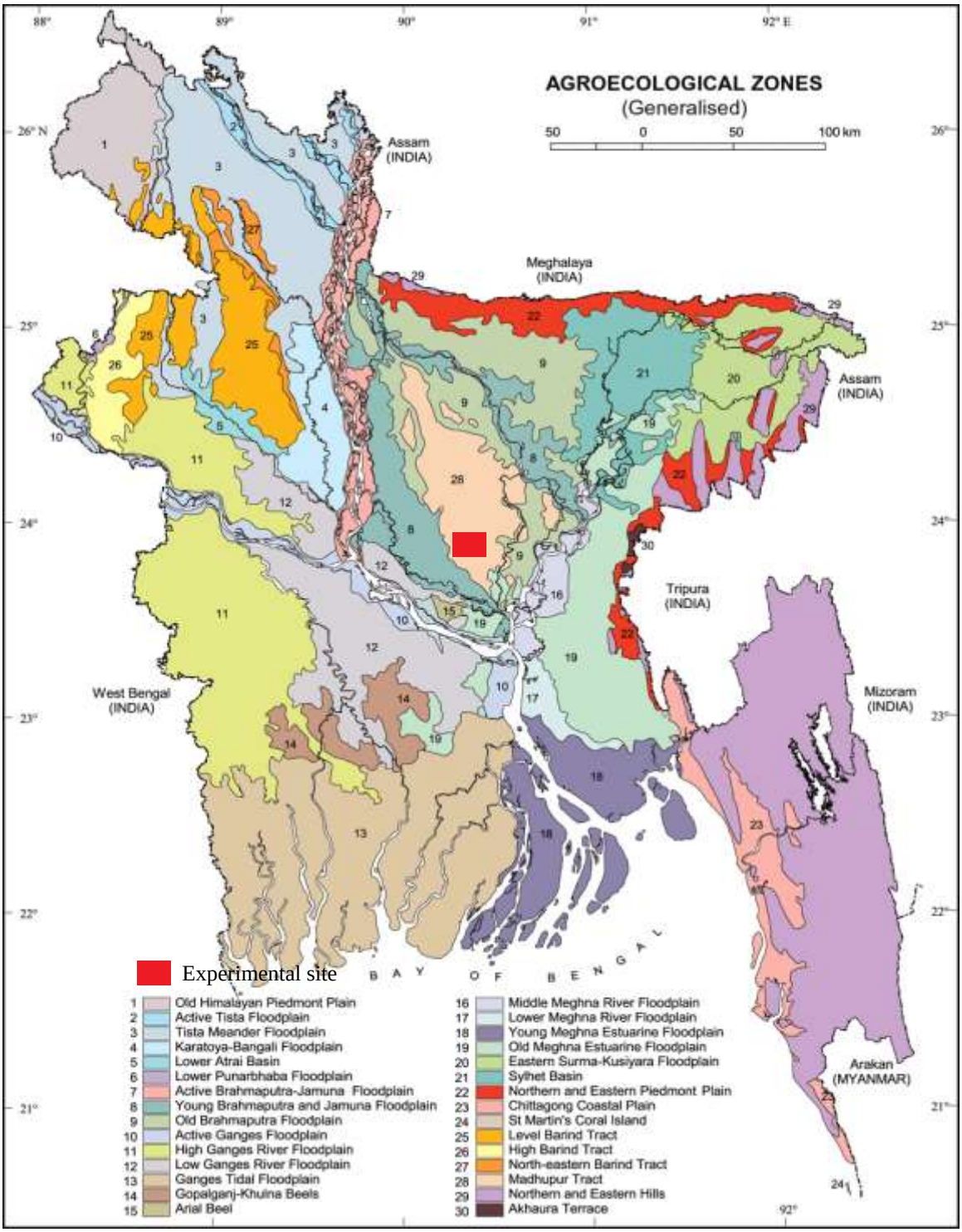

Fig. 5. Experimental site

Appendix II. Monthly records of air temperature, relative humidity and rainfall during the period from August 2017 to December 2017.

Year	Month	Air temperature (°C)			Relative humidity (%)	Rainfall (mm)
		Max	*Min*	*Mean*		
2017	August	31.00	25.60	28.30	80.00	348
2017	September	30.8	21.80	26.30	71.50	78.52
2017	October	30.42	16.24	23.33	68.48	52.60
2017	November	28.60	8.52	18.56	56.75	14.40
2017	December	25.50	6.70	16.10	54.80	0.0

Source: Bangladesh Meteorological Department (Climate division), Agargaon, Dhaka-1212.

Appendix III. Characteristics of experimental soil analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	**Characteristics**
Location	Agronomy Farm, SAU, Dhaka
AEZ	Modhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Not Applicable

Source: Soil Resource Development Institute (SRDI)

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis % Sand	27
%Silt	43
% Clay	30
Textural class	Silty Clay Loam (ISSS)
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20
Exchangeable K (me/100 g soil)	0.1
Available S (ppm)	45

Source: Soil Resource Development Institute (SRDI)

Appendix IV. Layout of the experiment field

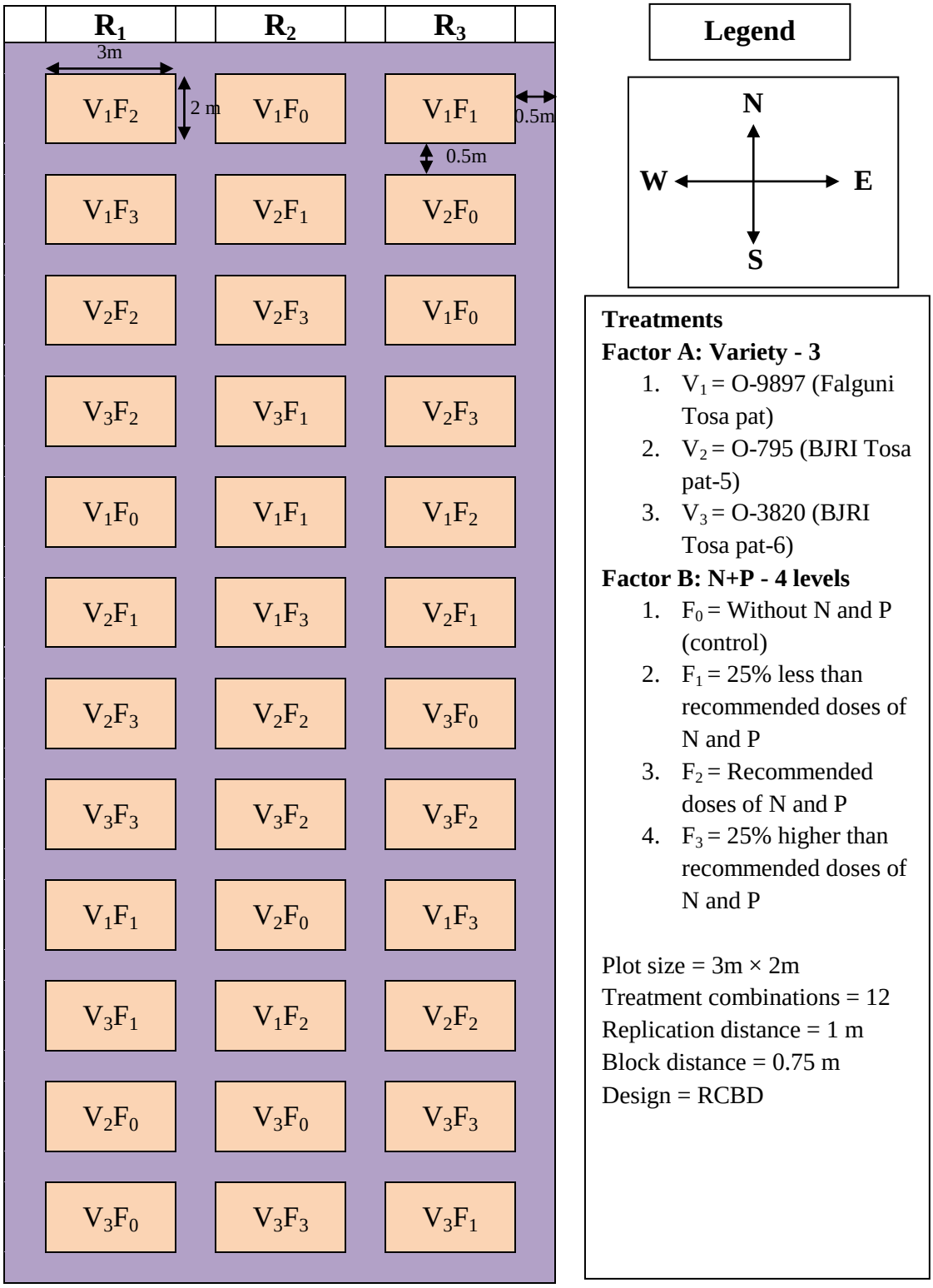

Fig. 6. Layout of the experimental plot

Appendix V. Plant height and number of branches plant-1 of jute at harvest as influenced by the combination of variety and N and P levels

Sources of variation	Degrees of freedom	Plant height (cm) at harvest	Number of branches plant^{-1} at harvest
Replication	2	2.028	1.021
Factor A	2	102.78*	11.529*
Factor B	3	399.8*	23.578*
AB	6	55.712*	3.261*
Error	22	8.144	2.13

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VI. Yield contributing parameters of jute as influenced by the combination of variety and N and P levels

Sources of variation	Degrees of freedom	Number of pods plant^{-1}	Number of seeds pod^{-1}	Pod length (cm)	Pod diameter (cm)	1000 seed weight (g)
Replication	2	1.531	8.564	2.188	0.004	0.021
Factor A	2	24.520*	NS	NS	NS	NS
Factor B	3	76.157*	286.436*	6.174*	NS	NS
AB	6	10.812*	36.089*	1.352*	0.312*	NS
Error	22	2.433	12.203	0.786	0.059	0.169

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VII. Yield parameters of jute as influenced by the combination of variety and N and P levels

Sources of variation	Degrees of freedom	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})
Replication	2	8.583	7.126
Factor A	2	906.215*	1230.62*
Factor B	3	1174.46*	1633.14*
AB	6	104.62*	102.94*
Error	22	18.71	25.37

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level

Appendix VIII. Seed quality parameters of jute as influenced by the combination of variety and N and P levels

Sources of variation	Degrees of freedom	Electrical conductivity (ms)	Seed germination of (%)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	Vigor index
Replication	2	1.814	1.444	0.028	0.002	1.002	3.961
Factor A	2	NS	NS	NS	NS	NS	166.6*
Factor B	3	NS	NS	NS	NS	16.02*	381.2*
AB	6	14.01*	10.657*	NS	NS	12.04**	9.641*
Error	22	1.413	2.323	0.270	0.007	2.031	7.963

NS = Non-significant * = Significant at 5% level ** = Significant at 1% level