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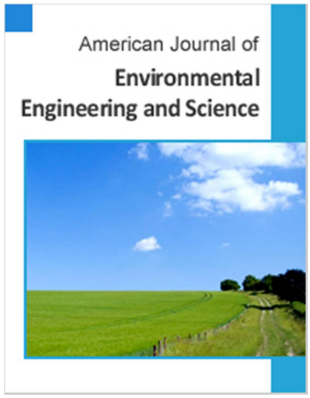

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Variation in Inorganic Fertilizer Is an Important Regulator of Yield Potential in BJRI Mesta-3

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Abstract

A field experiment was conducted to determine the effects of inorganic fertilizer on growth, yield and economic potential of BJRI Mesta-3. The results indicated significant affect of different NPKS levels on Mesta yield and yield contributing characters over control. The highest fibre (3.10t/ha) and stick (7.20t/ha) yield were obtained by the combination dose of N100 Kg/ha with PKS 10-60-20 kg/ha at Manikganj. The plant height (3.08m), base diameter (20.10mm) also found highest with the same treatment of fertilizer combination. By the same treatment produced higher fibre yield and yield contributing characters at Kishoreganj though that yield was slightly lower than that of Manikganj location. Economic analysis favored the use of 100-10-60-20 kg/ha NPKS for yield of 3.10 t/ha Mesta fibre. Therefore this combination seemed to be optimum for good growth and high potential Mesta production in Bangladesh. Application of modern fertilizer technologies on the mechanized management of Mesta will greatly increase grower profit.

1. Introduction

Mesta is one of the most important bastfibre crops grown in Bangladesh. Mesta fibre is used for making rope, twines, carpet backing etc. The productivity of Mesta is high in some areas while in others it is low. Mesta (*Hibiscus sabdariffa L.*) is a botanical species of the family Malvaceae. Probably native to tropical Central and West Africa, Mesta is mainly cultivated in tropical and subtropical regions of the world for its attractive edible calyces [1-2]. Apart from nutritional and health importance, Mesta plays an important role in income generation and subsistence among rural farmers in developing countries. The different parts of Mesta are the leaves, calyces and seeds and these have been used for different uses as vegetables, source of oils, refreshing drinks and food preserves and for medicinal and health purposes [3-4]. The tender stems, leaves and calyces are used as vegetable in the preparation of soups and sauces – calyces are specially prepared into a textural form suitable for use as meat substitute. The seed of Mesta is a valuable food resource on account of its protein (20-33%), calorie (24%), and fat (22% on dry weight basis) and also substantial amount of fibre (14%) and valuable micro-nutrients [5]. It is also an excellent source of culinary oil. The oil content in Mesta seed is also reported to be of high lysine level. The calyx which may be green, light or dark- red is used as a vegetable or for food and beverages preservation in food industries. More recently the

nutritional attributes of the vegetable and potential health benefits ofextracts from the calyx have been reported. Despite the importance of Mesta in Bangladesh, many constraints still limit its production. Yield and quality of the calyces and seeds realized on farmers' fields are usually lower than what is being reported under experimental conditions. Application of fertilizer has been documented to enhance plant growth and development [6-11]. Many research activities have reported an increase in the vegetative development of crops with fertilizer application [12-29]. However, there are contrary views on the role of fertilizer on the quality of crop produced. Improved soil nutrients could improve the quality of the minerals, vitamins and protein content of Mesta. Research efforts are therefore required to formulate and recommend fertilizer requirement for sustainable production of this crop. The nutritional requirements for jute and allied fibre crops may be different due to their variation in genetic potentialities. Judicial application of NPK and S may increase the yield of a variety. Since the varieties of a species may different in their nutritional requirements. Investigation is needed to find a suitable dose for a variety with different levels of nutrients. Present study was aimed to determine the nutritional requirements of the variety BJRI Mesta-3 (SAMU'93) for its optimum growth and yield.

2. Materials and Methods

The study was carried out at the Experimental farms of Bangladesh Jute Research Institute applying randomized complete block design (RCBD) with three replications. A total 10 treatments (T_1:$N_0P_0K_0S_0$; T_2:$N_{50}P_5K_{30}S_{10}$; T_3:$N_{50}P_{10}K_{60}S_{20}$; T_4:$N_{50}P_{15}K_{90}S_{30}$; T_5:$N_{100}P_5K_{30}S_{10}$; T_6:$N_{100}P_{10}K_{60}S_{20}$; T_7: $_{100}P_{15}K_{90}S_{30}$; T_8:$N_{150}P_5K_{30}S_{10}$; T_9:$N_{150}P_{10}K_{60}S_{20}$; T_{10}:$N_{150}P_{15}K_{90}S_{30}$) combinations along with a control were distributed randomly in each plot. The dimension of unit plots was 3.1 m × 3.1 m having 1m space between the plots, blocks and around the field. There was 20 cm deep drain around each block and plot. At the beginning of the experiment, the land was well prepared and fertilizers were applied as per treatment. Required amounts of chemical fertilizers were applied in the form of urea, TSP, MOP and gypsum. Urea was applied in two splits: half amount was applied at sowing and the rest half was top dressed at 45 days after sowing while all other fertilizers were applied at the time of sowing. Mesta seeds were broadcasted at the rate of 8 kg/ha. All cultural operations were done as and when necessary. The crop was harvested on 120 DAS. After shedding of leaves, the bundles were steeped plot−wise in pond water for 15−20 days for retting and fibre was extracted. At harvesting time, six plants were selected at random from each plot and tagged in the field to note plant height (PH), base diameter (BD), fibre yield (FY) and stick yield (SY). Statistical and economic analyses were also carried out.

3. Results and Discussion

Our research findings showed that among the ten nutrient combinations of chemical fertilizer, nutrient combination for treatment T_6 performed best for the test variety BJRI Mesta-3 yield and yield influencing factors. The growth attributes of field grown BJRI Mesta-3 (Figure 1) were significantly affected by the applied treatments like plant height (Figure 2), base diameter (Figure 3) and yield of fibre (Figure 3) and stick (Figure 4).

Figure 1. *BJRI Mesta-3 plant.*

Different levels of nitrogen @ 50, 100 and 150 kg/ha were used in the trial and increased plant growth and yield over control (Figure 2 to Figure 5). The highest dose of N150 kg/ha reduced the fibre yield (2.92t/ha) in compare to N100 kg/ha (3.1t/ha) in Manikganj (Figure 4A). Results showed that 100 kg N/ha is enough to produce BJRI Mesta-3 (Figure 4). Incremental N doses enhanced the plant height and base diameter than control (Figure 2 & Figure 3).

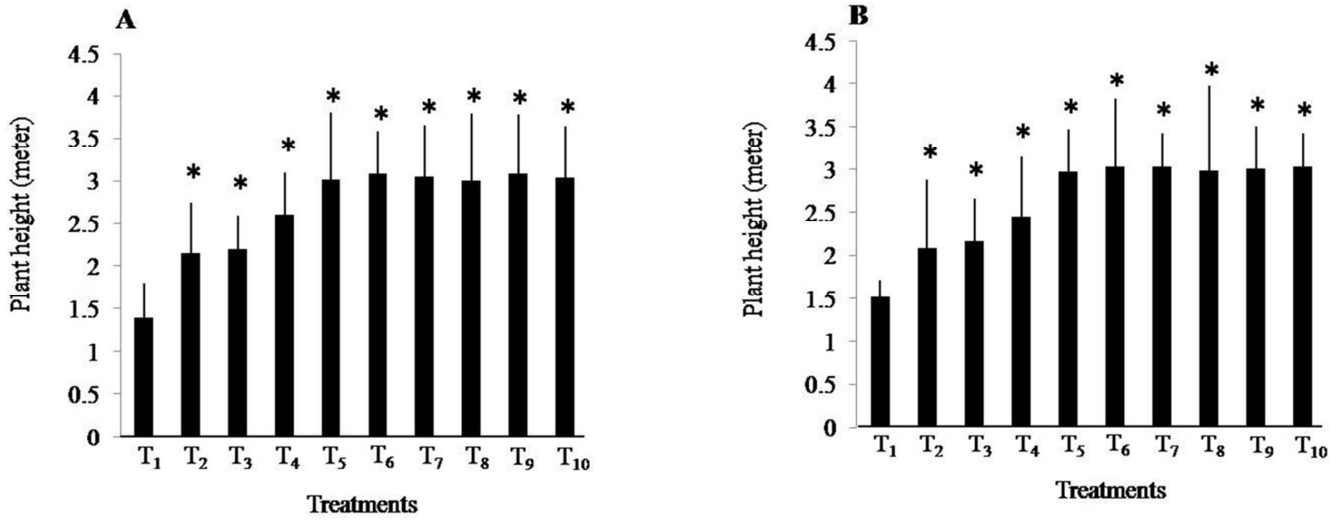

Figure 2. *Plant height of the variety BJRI Mesta-3 using different chemical fertilizer treatments. (A) level of plant height (meter) in Manikganj location, (B) level of plant height (meter) in Kishoreganj location. Each datum was calculated from three independent experiments. The results are expressed as the mean ± S.E.M. *p<0.05 significance by the Student's t-test.*

Phosphorus doses viz: 5, 10 and 15 kg/ha were used in the experiment. The dose of P 10 kg/ha contributed significantly highest yield of fibre (3.1t/ha) and stick (7.20t/ha) (Figure 4A). In Kishoreganj, the longest plant (3.03m) found with P 10Kg/ha that was statistically identical with plant height found by P15Kg/ha (Figure 2B). Significantly highest base diameter (20.0mm) found also with P 10Kg/ha (Figure 2B).

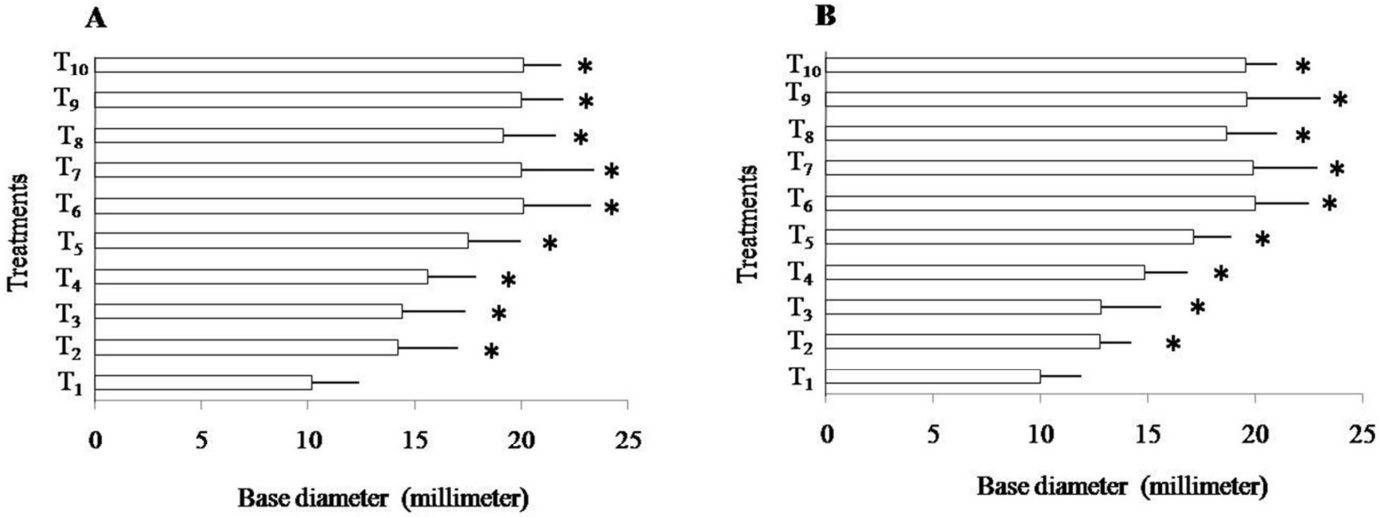

Figure 3. *Base diameter of the variety BJRI Mesta-3 using different chemical fertilizer treatments. (A) level of base diameter (meter) in Manikganj location, (B) level of base diameter (meter) in Kishoreganj location. Each datum was calculated from three independent experiments. The results are expressed as the mean ± S.E.M. *p<0.05 significance by the Student's t-test.*

Potassium was applied as 30, 60 and 90 kg/ha in the experiment. In Manikganj the rate 60 kg K/ha gave the highest plant height (3.08m), base diameter (20.10mm),) fibre (3.10t/ha) and stick (7.20t/ha) in compare to 90 Kg/ha (Figure 2A, 3A, 4A, 5A). Study noticed that BJRI Mesta-3, needs K 60 Kg/ha to produce maximum yield. High dose of K (60 kg/ha) caused highest plant height and base diameter. Some studies revealed that yield, Plant height and Base diameter increased with increasing rate of K dose [30-37].

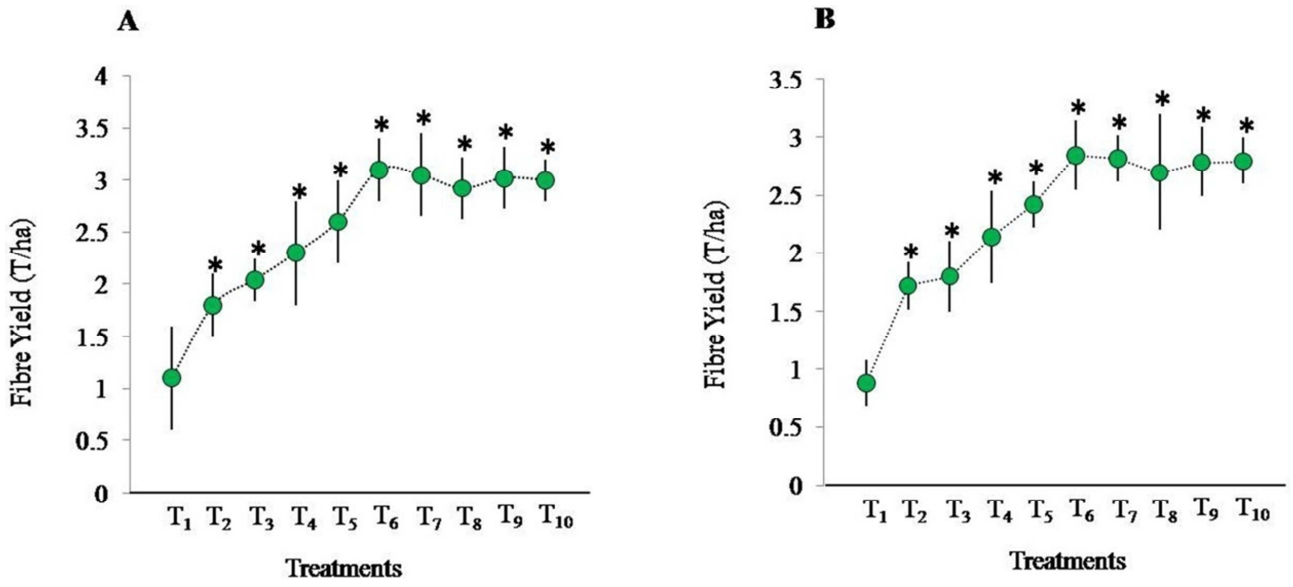

Figure 4. *Fibre yield of the variety BJRI Mesta-3 using different chemical fertilizer treatments. (A) level of fibre yield (t/ha) in Manikganj location, (B) level of fibre yield (t/ha) in Kishoreganj location. Each datum was calculated from three independent experiments. The results are expressed as the mean ± S.E.M. *p<0.05 significance by the Student's t-test.*

Sulphur was applied as 10, 20 and 30 kg S /ha in the experiment beside one control. The highest rate of S 30 kg/ha reduced the plant height (Figure 2). Maximum plant height (3.08m) observed with 20 kg S /ha (Figure 2A). Base diameter found the highest (20.10mm) with medium dose of S 20 kg S/ha (Figure 3A). Yield of fibre (3.10t/ha) and stick (7.20t/ha) achieved the highest with 20 kg S/ha (Figure 4A, 5A). Study showed that combined dose of NPK and S 100-10-60-20 Kg/ha was a suitable dose for the cultivation of BJRI Mesta-3.

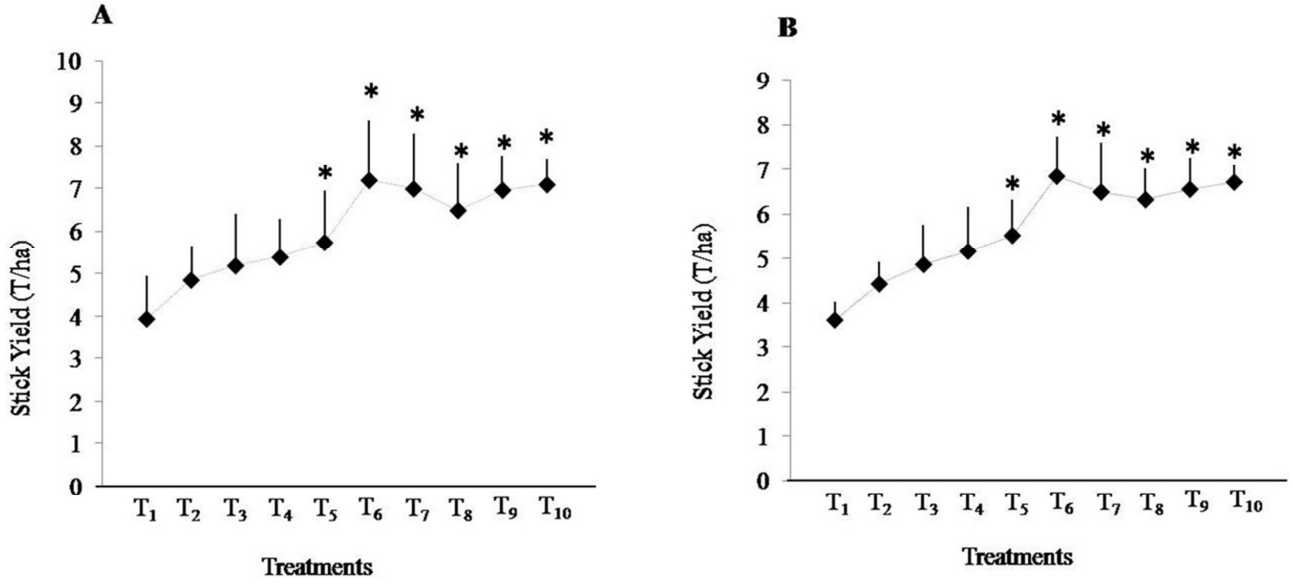

Figure 5. *Stick yield of the variety BJRI Mesta-3 using different chemical fertilizer treatments. (A) level of stick yield (t/ha) in Manikganj location, (B) level of stick yield (t/ha) in Kishoreganj location. Each datum was calculated from three independent experiments. The results are expressed as the mean ± S.E.M. *p<0.05 significance by the Student's t-test.*

Different treatments showed the statistically significant positive effect on fiber yield and stick yield of BJRI Mesta-3 (Figure 4 and Figure 5). Highest fiber yield and stick yield were recorded with T_6 ($N_{100}P_{10}K_{60}S_{20}$ kg/ha) treatment. The nutrient combination and their ratio is one of the key factors for Mesta production that is supported by previous report [38-39].

There is a great contribution of jute and allied fibre crops in Bangladesh economy. About 1.2 million farmers are still directly associated with jute and allied fibre crops cultivation. Jute sector provides about 10% of total employment in the economy [40]. Economic analysis was made considering the variable cost of fertilizers, seeds, labor and price of fibre and stick. Results reveals that T_6 ($N_{100}P_{10}K_{60}S_{20}$ kg/ha) treatment was the most cost effective treatment as it gives the highest benefit cost ratio (BCR) (Figure 6) which is highly profitable.

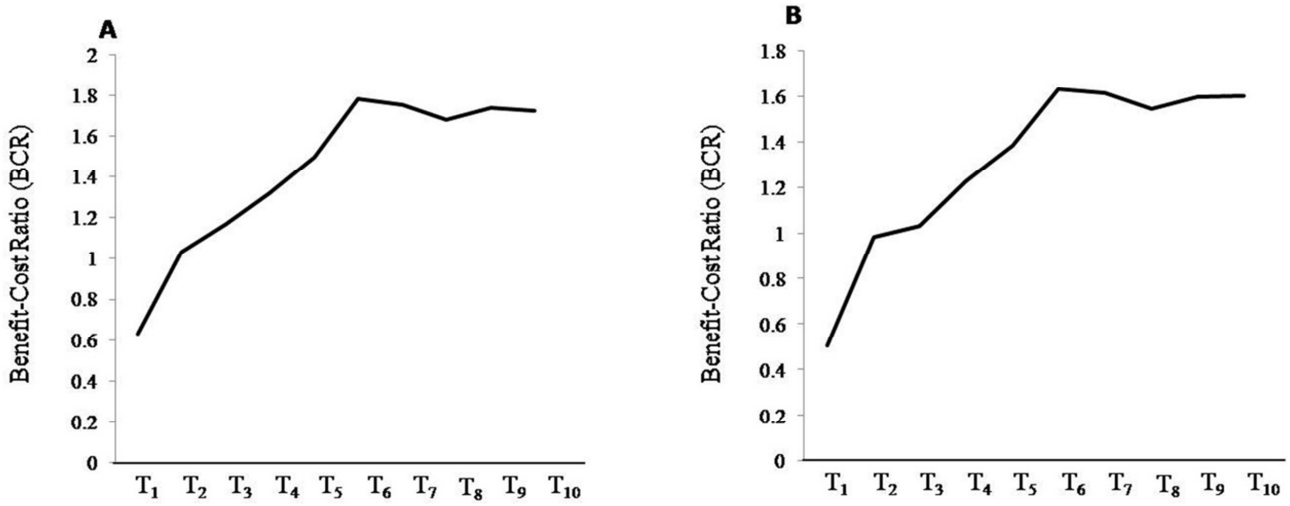

Figure 6. *Benefit-cost ratio for the production of BJRI Mesta-2. (A) Yield potential in Manikganj, (B) Yield potential at Kishoreganj.*

4. Conclusion

The overall treatments had significant positive impact over control (T_1) on growth and yield and quality parameters and effect of combined fertilizers on them were explained. The most important parameter, fibre yield (3.1 t/ha) and stick yield (7.2 t/ha), were recorded highest with T_6:$N_{100}P_{10}K_{60}S_{20}$ treatment. From the results of economic analysis, combination of $N_{100}P_{10}K_{60}S_{20}$ kg/ha showed higher BCR. Considering all these aspects, specially yield and BCR, T_6:$N_{100}P_{10}K_{60}S_{20}$ kg/ha treatment seems to be the best combination for the yield potential of the Mesta variety BJRI Mesta-3.

Significance Statement

This study discovers the economically profitable fertilizer level for BJRI Mesta-3 production that can be beneficial for farmers and farming related community. This study will help the researcher to uncover the critical areas of nutrient balance that will combine research and teaching.

Authors' Contribution

Ali, M. S. designed and performed research, analyzed data and wrote the manuscript; Hoque, M. M. analyzed data; Gani, M. N. supervised the research; and Islam, M. M., supervised and edited the first draft of the manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

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Biography

Md. Mahbubul Islam (Corresponding Author) awarded PhD in 2008 from the Department of Agronomy of Bangladesh Agricultural University especially on Jute seed quality, plant establishment and yield. He had done his M.Sc. (Agriculture) in Agronomy and B.Sc. Agriculture (Hons.) from the same University. He is working at Bangladesh Jute Research Institute (BJRI) since 1989. At present he is serving as Chief Scientific Officer & Head of Agronomy Division. He has 6 books, 67 scientific papers and more than 70 popular articles published in international and national journals, newsletters etc. He visited United Kingdom, Malaysia, India for training, seminar, workshop purpose.