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Response of BSRI Akh 42 and Soil Properties to Fertilizer Doses in Chittagong Hill Tracts of Bangladesh

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ABSTRACT

Fertilizer is crucial and one of the costliest inputs in crop production. Application of fertilizers at proper dose helps to harvest the potential productivity and improve the quality of crops and soil. A field experiment was conducted at three locations under Chittagong Hill Tracts (AEZ 29) of Bangladesh during 2013-2014 cropping season to evaluate the response of BSRI Akh 42 and soil properties to different doses of fertilizers. The experiment was laid out in a Randomized Complete Block Design with three replications having six treatments such as T_1-Control (unfertilized), T_2-Recommended Fertilizer Dose (RFD), T_3-75% of RFD, T_4-Fertilizer dose as per soil analysis, T_5-75% of fertilizer dose as per soil analysis, T_6-Fertilizer dose based on farmers practice. Yield and yield contributing components of BSRI Akh 42 responded significantly to the use of different fertilizer doses at various degrees. Maximum number of tillers, millable cane, height, girth and yield of cane were achieved from the fertilizer application as per soil analysis (T_4) followed by treatment T_2 where recommended dose of fertilizers were applied. No significant changes in soil properties due to use of different doses of fertilizers were noticed in a single year cropping cycle but unfertilized treatment showed a slight decrease in soil nutrient status.

Key words: BSRI Akh 42, soil properties, fertilizer dose, millable cane, cane yield

INTRODUCTION

Sugarcane is a food crop as well as industrial and cash crop in Bangladesh. It covers 0.11 million hectares of land with a total annual production of 4.43 million metric tons (FAOSTAT, 2013). BSRI Akh 42 (Rangbilash) is a popular chewing cane variety in Chittagong Hill Tracts due to its good yield and high market price. The soils of hill tracts are brown, permeable, friable, loamy, very strongly acidic and low in moisture holding capacity. Organic matter content and general fertility level are low to medium with very low to low status of N and P (BARC, 2012).

Plants, like all other living things, need food for their growth and development. Research has determined that plants require 17 nutrient elements, also called 'essential nutrient elements' (Marschner, 1995). There are three criteria of essential nutrient elements such as the plant cannot complete its life cycle without it, the element's function cannot be replaced by another element and the element is directly involved in the plant's

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growth and metabolism (Arnon and Stout, 1939). Among them plants obtain carbon, hydrogen, and oxygen from air and water. The remaining 14 elements are derived from the soil. When the soil cannot supply the amount of these nutrients required for adequate growth, fertilizers have to be supplemented to soil.

Sugarcane being a long duration and exhaustive crop (Paul *et al.*, 2005), is capable of producing large quantum biomass and exploiting considerable amount of nutrients from soil for its normal growth and development. A crop of 100 ton sugarcane yield may remove 140 kg N, 34 kg P and 332 kg K from soil (Dang *et al.*, 1995). The average yield of sugarcane in Bangladesh is 40.58 t ha^{-1} whereas the global yield is 70.77 t ha^{-1} (FAOSTAT, 2013). The improper use of fertilizer is largely responsible for poor sugarcane yield. To enhance farm profitability under different soil-climate conditions, it is necessary to have information on optimum fertilizer doses for crops. Fertilizers have been responsible for nearly 50% yield increases registered in recent years (Fokhrul and Haque, 1998). Stewart *et al.* (2005) also reported that 40 to 60% of crop yield can be attributed to commercial fertilizer inputs. Fertilizing with only NPK, without ensuring proper supplies of other limiting nutrients, is counter productive as it reduces the efficiency of utilization of all nutrients.

Inadequate supply and imbalanced proportions of plant nutrients lead to much greater drain of native nutrients and the soil may not be able to support high yield, anymore in the times to come. In farmers practice, fertilizer application is highly skewed in favor of N, with relatively small use of K and P, and rare use of secondary and micronutrients. Too little fertilizer leads to poor plant growth, but too much fertilizer can also reduce plant growth and quality. Crop failure through pests and diseases and also deterioration and contamination of soil, crop and water resources are the repercussions of this improper practice besides increasing input costs. Khan *et al.* (2005) recommended 128-63-70 kg NPK ha^{-1} as average fertilizer dose for sugarcane. Increasing nitrogen rate up to 225 kg ha^{-1} significantly increased the commercial cane yield, while higher N level decreased cane juice. Phosphorus enhances photosynthetic activity and increases root development, leading to increased nutrient uptake, greater tillering, and higher yield in sugarcane (Devi *et al.*, 2012). Potassium activates more than 60 enzymes and it is basic to sugarcane for synthesis and accumulation of sugar (Clements, 1980). Short leaves, shorter internodes, reduced tillering are deficiency symptoms of zinc in sugarcane whereas the primary role of boron is production and transport of sugars through membranes which is highly important for sugarcane, protein synthesis, uptake and efficient use of calcium, nitrogen, potassium and phosphorus, development of young roots and shoots. Accordingly, the experiment was implemented to evaluate the response of sugarcane and soil properties to fertilizers applied at different doses.

MATERIALS AND METHODS

The field experiment was conducted at Bandarban, Rangamati and Khagrachori under Chittagong Hill Tracts of Bangladesh during 2013-2014 cropping season. The experiment was laid out in a Randomized Complete Block Design with three replications. Six treatments comprising T_1-Control (no fertilizer), T_2-Recommended Fertilizer Dose (RFD) as per Fertilizer Recommendation Guide (FRG)' 2012, T_3-75% of RFD, T_4-Fertilizer dose as per soil analysis, T_5-75% of fertilizer dose as per soil analysis, T_6-Fertilizer dose based on farmers practice. Soil samples were collected from 0-15 cm depth before plantation and after harvesting of the crops and analyzed following standard procedures. The fertilizer requirements of sugarcane were calculated based on the analytical data of initial soil nutrients. The recommended fertilizer dose for sugarcane was $N_{165}P_{55}K_{120}S_{30}Mg_{20}Zn_{2.5}$ kg ha^{-1} (BARC, 2012). The nutrient requirement for sugarcane as per soil analysis was $N_{196}P_{55}K_{141}S_{30}Mg_{20}Zn_{2.5}B_2$, $N_{190}P_{62}K_{154}S_{30}Mg_{20}Zn_{2.5}B_2$ and $N_{177}P_{55}K_{145}S_{30}Mg_{20}Zn_{2.5}B_2$ kg ha^{-1} at Bandarban, Rangamati and Khagrachori, respectively. Besides, the amount of nutrient applied by the farmers was $N_{138}P_{30}K_{150}S_{23}$, $N_{120}P_{32}K_{130}S_{20}$ and $N_{104}P_{36}K_{101}S_{23}$ kg ha^{-1} at Bandarban, Rangamati and Khagrachori, respectively. The experimental plot size was 8m × 6m. The sugarcane variety BSRI Akh 42 (Rangbilash) was used in the experiment as a test crop. Two budded setts were planted after treating with Bavisitn 50 WP for 30 minutes. Plantation of the crop was done on 14, 15 and 16 November, 2013 at Bandarban, Rangamati and Khagrachori, respectively. Full amount of TSP, gypsum, magnesium sulphate, zinc sulphate, boric acid and one third of urea and potash were applied in the trenches before planting and thoroughly mixed with soil by spade. The rest two splits of urea and potash were applied as side dressing in 120 and 150 days after planting. Regent 3GR was applied @ 20 kg ha^{-1} during basal fertilization and Furadan 5GR was applied @ 40 kg ha^{-1} during side dressing of fertilizers. All Necessary intercultural operations were done throughout the cropping season for proper growth and development of the crop. The crops were harvested on 07, 09 and 11November, 2014 at Bandarban, Rangamati and Khagrachori, respectively. Collected data were compiled and tabulated in proper form and were subjected to statistical analysis by using the computer package Statistix 10 program for Windows Version. Computations were done by the use of Microsoft Excel 2003 program.

RESULTS AND DISCUSSION

Response of BSRI Akh 42 to fertilizer doses

Results presented in Table 1 illustrated that yield and yield attributing characters of BSRI Akh 42 responded significantly to different fertilization doses.

Germination%

Germination is a very important factor because final crop stand solely depends upon good germination. There was no significant effect on germination percentage among the fertilized treatments but they showed greater germination percentage over unfertilized treatment. However, the maximum germination percentage was obtained from treatment T_4 (63.03 and 56.61% at Bandarban and Rangamati, respectively) where fertilizers were applied as per soil analysis and from treatment T_2 (44.50% at Khagrachori) where recommended dose of fertilizers were applied. Fertilizers improve the soil temperature which ultimately helps in good germination of sugarcane setts.

Number of tillers

Tillering is the most desirable character of sugarcane from farmers' point of view. Good tillering ensures good yields and better ratoon ability of a sugarcane crop. Significant variation was monitored in comparative data pertaining number of tillers due to various fertilizer doses in sugarcane. The treatment T_4 registered maximum number of thousand tillers per hectare at Bandarban and Khagrachori (67.4 and 81.9, correspondingly) which was statistically coincident to treatment T_2 (64.3 and 76.3). In addition, statistical augmentation of tillering was noticed from treatment T_4 (69.5x10^3 ha^{-1}) at Rangamati where fertilizer application was done as per soil analysis. Similar results were recorded by Chattha *et al.* (2010) who reported that average number of tillers significantly increased with increased fertilizer doses.

Number of millable cane

Approximately similar trends of tillering were observed in production of millable cane as influenced by fertilizer doses. The maximum number of millable cane (65.7×10^3 ha^{-1}) was recorded from treatment T_4 which was identical to treatment T_2 at Bandarban. Yet fertilizers applied as per soil analysis produced differential and higher number of millable cane at Rangamati and Khagrachori (47.2×10^3 and 72.5×10^3 ha^{-1}, respectively) followed by T_2 and T_6. These results are agreed with Trevedi and Saini (1986) who obtained significantly more canes from 180 kg N than 60 kg N and control. Kamel (20[illegible]) also obtained maximum number of millable canes with maximum fertilizer levels.

Cane height

Sugarcane responded significantly to various treatments in obtaining cane height. The tallest canes were found in treatment T_4 at all locations (2.36, 3.86 and 3.53 m at Bandarban, Rangamati and Khagrachori, respectively) which was statistical identical to T_2 (2.27, 3.65 and 3.21 m). The shortest canes of 1.98, 22.83 and 2.74 m were produced at Bandarban, Rangamati and Khagrachori, respectively when no fertilizers were applied. Khan *et al.* (2005) also reported the highest plant height from fertilizer application than control.

Cane girth

The girth of sugarcane was influenced significantly by cause of various fertilizer doses. At Bandarban, fertilizer application based on soil analysis (T_4) produced the maximum cane girth (3.29 cm) which was statistically similar with all other treatments except control. The maximum cane girth at Rangamati and Khagrachori was also recorded from treatment T_4 (4.06 and 3.37 cm, respectively) followed by T_2 (3.87 and 3.22 cm). The lowest cane girth was obtained in control.

Brix%

The treatments contributed significantly in accumulating total soluble solids or brix percentage. The unfertilized treatment (control) maintained the highest value of brix% at all locations (17.2, 18.8 and 17.0% at Bandarban, Rangamati and Khagrachori, respectively). On the contrary, the lowest brix percentage was achieved from treatment T_3 and T_5 where 75% of the recommended and soil analysis based fertilizers were applied. This result is well corroborated with the findings of Kumara and Bandara (2002) who reported that sugarcane plants receiving 200 kg N ha^{-1} had lower brix% than control.

Cane yield

BSRI Akh 42 exhibited significant responses to fertilizer doses in case of cane yield. The maximal cane yield (131.5, 153.5 and 126.7 t ha^{-1} at Bandarban, Rangamati and Khagrachori, respectively) was registered from treatment T_4 where fertilizers were applied as per soil analysis and the second highest yield was obtained from treatment T_2 where fertilizers were applied at recommended dose. On the contrary, the unfertilized treatment showed the lowest yield of sugarcane (52.0, 55.1 and 48.5 t ha^{-1}, respectively). This result is at par with Lifang *et al.* (2001) who reported that yield increased as fertilizers applied increased.

Table 1. Sugarcane yield and yield attributing characters under different fertilizer doses

Location	Treatment	Germination (%)	Tiller (10^3 ha^{-1})	Millable Cane (10^3 ha^{-1})	Height (m)	Girth (cm)	Brix (%)	Yield (t ha^{-1})
Bandarban	T_1	45.45b	54.7d	52.3d	1.98d	2.83b	17.2a	52.0f
	T_2	62.26a	64.3ab	61.1ab	2.27ab	3.22a	16.3bc	121.0b
	T_3	59.24a	56.5cd	55.6bcd	2.17bc	3.13a	15.3d	94.4e
	T_4	63.02a	67.4a	65.7a	2.36a	3.29a	16.8ab	131.5a
	T_5	59.39a	56.8cd	54.3cd	2.14c	3.12a	15.2d	102.7d
	T_6	59.39a	61.3bc	59.0bc	2.16c	3.17a	15.6cd	111.7c
	CV (%)	7.92	4.99	5.5	2.54	4.27	2.9	3.91
Rangamati	T_1	43.89b	45.0e	31.1d	2.83d	3.24e	18.8a	55.1e
	T_2	52.35a	61.7b	43.5b	3.65ab	3.87b	17.9b	139.7ab
	T_3	54.85a	51.2d	33.9c	3.25c	3.50d	16.8d	98.3d
	T_4	56.61a	69.5a	47.2a	3.86a	4.06a	18.2b	153.9a
	T_5	51.63ab	53.9cd	35.8c	3.21c	3.67cd	17.0cd	114.1cd
	T_6	49.61ab	57.4bc	40.9b	3.45bc	3.71bc	17.3c	125.4bc
	CV (%)	5.65	5.88	3.69	6.04	2.66	1.11	10.02
Khagrachori	T_1	34.67b	53.5d	44.8e	2.74c	2.81e	17.0a	48.5e
	T_2	44.50a	76.3a	65.2b	3.21ab	3.22b	16.6ab	114.9b
	T_3	41.33a	59.7c	57.1d	2.80c	2.89de	15.5c	93.8d
	T_4	41.40a	81.9a	72.5a	3.53a	3.37a	16.5b	126.7a
	T_5	41.50a	64.7bc	59.9cd	3.00bc	2.96d	15.7c	94.1d
	T_6	43.17a	66.8b	64.1bc	3.03bc	3.09c	15.5c	105.5c
	CV (%)	7.79	4.90	4.78	6.39	2.27	1.70	3.07

Means followed by uncommon letters are statistically different from each other at 5% level of probability by DMRT

Chlorophyll content

Figure 1 revealed that fertilizer applications significantly increased chlorophyll concentration at 180 DAP over control. The treatment T_4 showed superiority in chlorophyll concentration (47.83, 41.43 and 47.80 SPAD reading in Bandarban, Rangamati and Khagrachori, correspondingly) over rest of the treatments and it was followed by T_2 and T_6. The least chlorophyll concentration was found from the treatment where no fertilizers were applied. Amolo *et al.* (2014) also obtained significant increase of chlorophyll content due to N and K application over control.

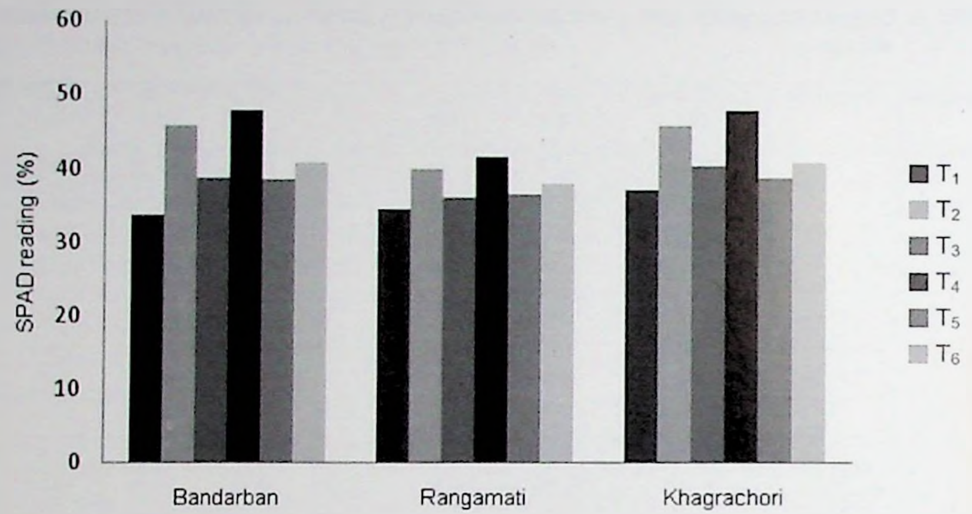

Figure 1. Chlorophyll content in leaves of BSRI akh 42 at 180 DAP influenced by different fertilizer doses

Response of soil properties to fertilizer doses

The status of soil properties including soil pH, organic carbon, total N, available P, K and S in initial as well as post-harvest soil of the experimental fields is illustrated in Table 2. There were no noticeable changes in soil properties that taken place due to the use of various fertilizer doses. But the unfertilized treatment showed the lowest value in soil OC%, N%, P (ppm), K (Cmolkg-1) and S (ppm) in all locations which was comparable to the fertilized treatments. This indicates depletion of soil nutrients due to no addition of external nutrients, and high and continual removal of internal nutrient reserves of soil to support plant growth. The soil will be very unproductive nutritionally in the long run. Therefore fertilizers should be added to soil at proper doses in order to sustain crop growth and maintain soil inherent productivity.

Table 2. Nutrient status of initial and post-harvest soil of the experimental fields

Location	Treatment	pH	OC (%)	N (%)	P (ppm)	K ($Cmolkg^{-1}$)	S (ppm)
Bandarban	Initial soil	6.45	0.46	0.050	8.0	0.15	32.5
	Post-harvest soil						
	T_1	6.40	0.40	0.040	6.0	0.13	27.0
	T_2	6.50	0.44	0.055	7.5	0.14	30.0
	T_3	6.45	0.43	0.050	7.0	0.14	28.0
	T_4	6.50	0.45	0.055	7.5	0.15	29.0
	T_5	6.45	0.42	0.050	7.0	0.14	28.5
	T_6	6.50	0.43	0.050	7.0	0.14	28.0
Rangamati	Initial	6.30	0.47	0.050	4.0	0.13	19.0
	Post-harvest						
	T_1	6.20	0.44	0.040	3.5	0.11	16.0
	T_2	6.35	0.46	0.050	4.5	0.13	18.0
	T_3	6.30	0.45	0.050	4.0	0.12	17.0
	T_4	6.35	0.46	0.055	5.0	0.14	18.0
	T_5	6.30	0.45	0.045	4.5	0.12	17.0
	T_6	6.30	0.45	0.050	4.0	0.12	17.0
Khagrachori	Initial	6.70	0.80	0.070	8.0	0.29	35.0
	Post-harvest						
	T_1	6.60	0.72	0.055	6.0	0.22	28.0
	T_2	6.65	0.75	0.065	7.5	0.27	31.0
	T_3	6.65	0.73	0.060	7.0	0.25	29.5
	T_4	6.70	0.76	0.065	7.5	0.26	30.0
	T_5	6.65	0.73	0.060	6.5	0.24	29.0
	T_6	6.60	0.74	0.060	7.0	0.24	29.0

From the above discussion it is observed that the application of fertilizer nutrients @ $N_{196}P_{55}K_{141}S_{30}Mg_{20}Zn_{2.5}B_2$, $N_{190}P_{62}K_{154}S_{30}Mg_{20}Zn_{2.5}B_2$ and $N_{177}P_{55}K_{145}S_{30}Mg_{20}Zn_{2.5}B_2$ kg ha^{-1} in Bandarban, Rangamati and Khagrachori, respectively gave maximum number of tillers, millable cane, height, girth and yield of BSRI Akh 42 and maintained soil health sound. The experiment should be repeated for the confirmation of the results.

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