Effects of Botanical Products and Nitrogen Fertilizer on the Incidence of Major Insect Pests and Yield of Sugarcane in Bangladesh

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ABSTRACT

An experiment was carried out at Regional Sugarcane Research Station, Thakurgaon of Bangladesh Sugarcane Research Institute, Ishurdi under the Old Himalayan Piedmont Plain (AEZ 1) Soils to examine the effects of botanical products viz. Biskatali plant powder (*Polygonum hydropiper*), Tobacco leaf powder (*Nicotiana tabacum*), Eucalyptus leaf extracts (*Eucalyptus macrorhyncha* F. Muell.) and Neembacidin (*Azadirachta indica* A.Juss.) and nitrogen fertilizer for obtaining lower pest infestation and higher yield of sugarcane. Among botanical products biskatali plant powder and tobacco leaf powder @ 150 kg ha^{-1} significantly reduced top shoot borer, rootstock borer and stem borer infestation and white grub population. Application of nitrogen fertilizer (N_{120} and N_{180}) with biskatali plant powder and tobacco leaf powder was found superior in controlling major pests of sugarcane and produced higher cane yield over untreated plots.

Key words: Botanical products, nitrogen fertilizer, insect pests, yield, sugarcane

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is cultivated on an area about 0.17 million hectares annually in the north-western part of the country and the only source of white sugar in Bangladesh. An average cane yields for the regions are about 41 tons ha^{-1} (BBS, 2000). Sugarcane is a long duration exhaustive crop and depletes a considerable amount of nutrients from soil. The crop is mainly grown under rainfed upland conditions. Most of the soils in Bangladesh are low in organic matter, generally containing less than 1.5% while 2.5 to 3.0% organic matter are necessary for suitable crop production (Bhander *et al.*, 1998). Fertilizers play an important role in increasing sugar production mainly because of their influence on cane yield. Most cane growers use fertilizers regularly to maintain or gain further increases in cane yields per hectare. The primary importance of nitrogen fertilizer in maintaining cane yield level has been well recognized by cane growers of the world. Appropriate dose of nitrogen fertilizer is the basic need in view of the fact that its requirement for good growth and sucrose per cent in juice after a certain level starts declining (Rana and Saini, 1989). Increased yield of sugarcane has been obtained from application of N, P, K to most soils (Tabayoyong and Robeniol, 1962). Raghavaiah and Singh (1980) obtained maximum yield with the application of 100 kg and 150 kg N ha^{-1} in Variety Co 1136 and Co 1148, respectively. Yield potentiality of a crop would not reach a maximum unless proper fertilizer management is made. A eighty five ton cane crops ha^{-1} absorbs 122 kg N, 24 kg P, 142 kg K and 48 kg S ha^{-1} from soil (Bokhtiar *et al.*, 2001). Due

to heavy depletion of soil nutrients, sugarcane soils become less fertile and fail to produce higher yield. On the other hand the continuous use of inorganic fertilizers alone for a long period causes deterioration of physical condition, lowers organic matter status of soil and reduces crop yield. Combined use of botanical products and inorganic fertilizers can improve the soil fertility and crop productivity, specially in a crop like sugarcane of high nutritional requirement. Many important soil properties are dependent to some degree on the quantity of organic matter (Black 1965). Parthasarathy (1972) reported that if a field receives adequate or optimum quantities of organic matter, such fields rarely deteriorate in productivity of any crop. Paul *et al.* (1999) observed that the use of a soil conditioner named cake-o-meal, blended organic and inorganic mineral nutrients, produced higher sugarcane yield in Old Himalayan Piedmont Plain soils of Bangladesh. In Nigeria, another organically made fertilizer named Agromax was found to increase the yield and quality of sugarcane (Oworu 1987).The objectives of this study were, therefore, to evaluate the effect of application of combined use of botanical products and nitrogen fertilizer for sustainable sugarcane production.

MATERIALS AND METHODS

Experimental Site and Soil Characteristics

The field experiments were carried out in the cropping season of 2003 - 2004 at Mohan farm under Thakurgaon Sugar Mills and other one at RSRS (Regional Sugarcane Research Station) farm, Thakurgaon to find out an economically suitable combination of some botanical products and nitrogen fertilizer for reducing lower pests infestation and high sugarcane yield. The climate of the location is tropical to sub-tropical. The soil samples (0 - 15 cm) were collected from experimental plots, air-dried and passed through 2 mm sieve. The soil was sandy loam textured with pH 4.5 to 5.0. The soil was low in organic matter (OM) ranging from 1.00 to 1.05% and very low in total N (0.07 to 0.08 %), exchangeable K(0.15 to 0.17 meq/ 100g soil) and Mg (0.11 to 0.12 meq/ 100g soil) and available P, Zn and S (9 to 11, 0.9 to 1.00 and 7 to 9 ppm) respectively.

Treatment Details and Fertilizer Application

The experiment comprised two factors, one is nitrogen as main factor with 4 level (N_0 N_{60} N_{120} N_{180} kg ha^{-1}) and the other factor is botanical products as sub-plots with 4 treatments viz. Biskatali leaf poder @ 150 kg ha^{-1}, Tobacco leaf powder @ 150 kg ha^{-1}, Eucalyptus leaf extract 3% solution and Nimbacidin @ 3 L ha^{-1} and one is without botanical product (control). The combination of treatments is 20 and the treatments were replicated three times in split plot Design. The sugarcane variety Isd 31 was used as test crop. Urea, Triple superphosphate (TSP), Muriate of potash (MOP) and gypsum were used as the source of N ,P, K and S respectively. The urea was applied in three equal splits, the first split at the settling establishment stage, the second at tiller completion stage (90 DAP) and the third at grand growth phase (180 DAP). Full amount of Triple superphosphate (TSP), Gypsum and one third of Muriate of potash (MOP) were applied in trenches and thoroughly mixed with soil prior to setts plantation. The rest amount of MOP was applied as first and second top dressing at 90 DAP and 180 DAP (days after plantation) respectively.

Planting Technique

Thirty-five- day old two eyed sugarcane settlings raised in soil bed were used in the study. The method of planting was spaced transplanting soil bed of two eyed settlings. Each plot had an area of 8m x 6m in which 6 rows of cane were planted at an interrow spacing of 1m and 0.45m interplant spacing. Block to block distance was 2m and plot to plot distance was 1m. The date of transplantation in the main field was November 2003 and the crop was harvested in January 2004. Four levels of nitrogen fertilizers was placed in main plot and five treatment of botanical products was placed in sub- plot. Pre-germinated settlings of 35-45 days were transplanted for gap-filling.

Plant Sampling

The number of tillers was counted at 120 days after transplanting (DAP) and millable cane stalks were counted during harvesting period. Sugarcane yield and its component viz. tiller, millable cane, height, girth, % brix and yield of cane are shown in the Table 1 and 2. Percent Top shoot borer, Root stock borer and Stem borer infestation and White grub population are presented in Table 3.

Assessment of sugar quality criteria

Juice quality was estimated in randomly selected ten canes from each plots. The following parameters were recorded from the extracted juice under field condition from standing canes.

Brix was measured using a hand Refractometer in the field.

Application of Botanical products:

Biskatali plant powder and tobacco leaf powder @ 150 kg ha^{-1} were applied at furrows made on both sides of cane rows and incorporated with soils with the help of spade followed by irrigation. Eucalyptus leaf extract @ 3% solution and neembacidin @ 3 L ha^{-1} were sprayed by spray machine in the selected plots. Before irrigation, soil ridges surrounding individual plots were made to protect on rush of water from one plot to another. Intercultural operations were made when necessary.

Data collection and analysis :

Data were taken thrice, May, in June and in August. The yield of canes per plot was recorded at harvest. The data obtained were statistically analyzed by using analysis of variance and finally least significant difference (LSD) test at P=0.05%.

Data on borer infestation was presented by counting total and infested canes for individual plot and the borer per cent infestation were computed by using the formula:

$$\% \text{ Infestation} = \frac{\text{Number of infested canes}}{\text{Total number of canes}} \times 100$$

RESULTS AND DISCUSSION

Effects of nitrogen fertilizer

Sugarcane yield and its component viz. tiller, millable cane, height, girth, % brix and yield of cane are shown in the Table 1 and 2. At Mohan farm the results are presented in Table 1. It is evident that the treatment N_{180} produced significantly higher number of tillers (145.93 x 10^3 ha^{-1}) followed by N_{120} (135.36 x 10^3 ha^{-1}) and they varied significantly, Significantly higher number of millable cane (81.04 x 10^3 ha^{-1}) followed by N_{60} (79.37 x 10^3 ha^{-1}) and N_{120} (77.60 x 10^3) which are statistically similar but differed from N_0 (73.86 x 10^3 ha^{-1}). Significantly higher plant height (310.53 cm) in N_{180} followed by N_{120} (309.93 cm) and N_{60} (306.00 cm) are statistically identical but differed from N_0 (296.13 cm). No significantly difference was observed in case of girth, brix and cane yield in all level of nitrogen. At RSRS farm it was observed that the treatment N_{180} produced significantly higher number of tillers (122.51 x 10^3 ha^{-1}) followed by N_{120} (116.65 x 10^3 ha^{-1}). Significantly higher number of millable cane (78.54 x 10^3 ha^{-1}) followed by N_{180} (77.06 x 10^3 ha^{-1}) and they varied significantly over N_0 level (64.74 x10^3 ha^{-1}) (Table 2). Higher plant height (320.47 cm) was observed in N_{180} (307.33 cm) followed by N_{120} (307.33 cm) and they are statistically similar but differed from N_0 level. No significant difference was observed in case of cane girth, % brix, yield of cane among the treatments. Higher number of tiller and millable cane production might be due to inorganic nutrients applied in combination with organic sources was better utilizartion than inorganic sources alone. Maximum cane yield (52.17 t ha^{-1}) was obtained from the treatment N_{180} followed by N_{60} (51.17 t ha^{-1}) at Mohan farm. On the other hand, at RSRS farm, Maximum cane yield (57.16 t ha^{-1}) was obtained from the treatment of N_{180} followed by N_{120} (55.78 t ha^{1}).

Effects of botanical product

Table 1 reveal that biskatali plant powder produced maximum tiller (147.00 x 10^3 ha^{-1}), highest millable cane (87.80 x 10^3 ha^{-1}), higher girth (2.03 cm) and highest cane yield (63.36 t ha^{-1}) followed by tobacco leaf powder that showed 145.71 x 10^3 tiller ha^{-1}, 2.02 cm cane girth and 61.70 t yield ha^{-1} at Mohan farm. No significant difference was observed between biskatali plant powder and tobacco leaf powder for girth, % brix and yield of cane but statistically superior to other treatments (Table 1).

Table 1. Yield and yield attributing characters as affected by nitrogen fertilizer levels and botanical products on sugarcane at Mohan farm, Thakurgaon Sugar Mills Ltd., 2003-2004

Treatments	Tiller (x 103 ha-1)	Millable cane (x 103 ha-1)	Height (cm)	Girth (cm)	% Brix	Yield (t ha-1)
Nitrogen fertilizer levels (kg ha-1)						
N0	113.68 c*	73.86 b	296.13 b	1.84	19.47	51.29
N60	129.68 b	79.37 a	306.00 a	1.90	19.28	55.78
N120	135.36 b	77.60 a	309.93 a	1.97	19.16	54.65
N180	145.93 a	81.04 a	310.53 a	1.97	19.53	57.16
LSD (5%)	9.23	11.85	22.84	NS	NS	NS

Insecticide: Botanical products						
A_0 : Control	114.10 c	67.64 d	207.08	1.81 c	18.73 d	45.29 b
A_1 : Biskatali plant powder @ 150 kg ha^{-1}	147.00 a	87.80 a	319.00	2.03 a	19.69ab	63.36 a
A_2 : Tobacco leaf powder @ 150 kg ha^{-1}	145.71 a	85.07 b	321.92	2.02 a	19.84 a	61.70 a
A_3 : Eucalyptus leaf extract 3% solution	125.99 b	74.65 c	300.08	1.92 b	19.25 c	51.07 b
A_4 : Neembacidin 3 L ha^{-1}	123.26 b	74.69 c	300.17	1.94 b	19.30 bc	49.70 b
LSD (5%)	6.69	3.40	NS	0.03	0.39	4.03

* In a column, means followed by the same letters are not significantly different at 0.05 level (LSD)

Table 2. Yield and yield attributing characters as affected by nitrogen fertilizer levels and botanical products on sugarcane at RSRS farm, Thakurgaon Sugar Mills Ltd., 2003-2004

Treatments	Tiller (x 10^3 ha^{-1})	Millable cane (x 10^3 ha^{-1})	Height (cm)	Girth (cm)	% Brix	Yield (t ha^{-1})
Nitrogen fertilizer levels (kg ha^{-1})						
N_0	108.64 c *	64.74 c	275.80 c	1.92	19.04	43.34
N_{60}	109.99 bc	70.04 b	295.27 bc	1.95	18.89	50.71
N_{120}	116.65 ab	78.54 a	307.33 ab	1.96	18.92	51.17
N_{180}	122.51 a	77.06 ab	320.47 a	1.97	19.73	52.17
LSD (5%)	6.69	5.83	20.79	NS	NS	NS
Insecticide :Botanical products						
A_0 : Control	100.31 c	59.92 d	273.25 c	1.83 c	18.30 d	41.16 b
A_1 : Biskatali leaf powder @ 150 kg ha^{-1}	122.73 a	78.44 b	317.25 a	2.03 a	19.71 a	58.29 a
A_2 : Tobacco leaf powder @ 150 kg ha^{-1}	126.11 a	83.20 a	321.17 a	2.03 a	19.53 ab	56.08 a
A_3 : Eucalyptus leaf extract 3% solution	110.56 b	67.68 c	296.75 b	1.94 b	18.82 cd	46.41 b
A_4 : Neembacidin 3 L ha^{-1}	109.90 b	65.61 c	290.17 b	1.92 b	19.12 bc	45.49 b
LSD (5%)	4.97	3.49	11.72	0.04	0.51	6.66

* In a column, means followed by the same letters are not significantly different at 0.05 level (LSD)

From Table 2, it was observed that tobacco leaf powder produced maximum tiller (126.11 x 10^3 ha^{-1}), highest plant height (321.17 cm), highest girth (2.03 cm) followed by biskatali plant powder that gave 122.73 x 10^3 tiller ha^{-1}, 317.25 cm height and 2.03 cm girth but no significant difference was observed between them . In case of millable cane, highest number (83.20 x 10^3 ha^{-1}) was found in tobacco leaf powder followed by biskatali plant powder (78.44 x 10^3 ha^{-1}) and they varied significantly. In case of % brix, highest brix (19.71) was found in biskatali plant powder followed by tobacco leaf powder (19.53) but they are statistically similar. In case of cane yield, highest cane yield was observed in biskatali plant powder (58.29 t ha^{-1}) followed by tobacco leaf powder (56.08 t ha^{-1}) but there was no significant difference between them.

Results in the Table 3 shows that the highest efficacy (76.87%) was observed in tobacco leaf powder followed by biskatali plant powder (69.30%) in controlling Top shoot borer at RSRS farm. At Mohan farm the highest efficacy (78.71%) was observed in biskatali plant powder followed by tobacco leaf powder (73.51%) for the same pest. Biskatali plant powder showed the highest efficacy (74.19%) followed by tobacco leaf powder (64.99%) in controlling Rootstock borer infestation at RSRS farm where as at Mohan farm biskatali plant powder showed the highest efficacy (72.67%) followed by tobacco leaf powder (64.11%) in controlling the same pest. Stem borer infestation at RSRS farm showed highest efficacy (55.967%) in biskatali plant powder followed by tobacco leaf powder (52.76%) whereas at Mohan farm the highest efficacy (55.73%) was observed in tobacco leaf powder followed by biskatali plant powder (54.16%). Biskatali plant powder treated plot reduced White grubs population at RSRS farm that showed the highest efficacy (94.99%) followed by tobacco leaf powder (93.36%). At Mohan farm biskatali plant powder treated plot also reduced White grubs population showing the highest efficacy (77.83%) followed by tobacco leaf powder (76.61%). All the treatments reduced borer infestation and white grub population significant over untreated plots.

Conclusion

Based on the results, the following conclusion can be made for sugarcane production particularly for the control of major pests like TSB, RSB, WG and SB for the pest locality.

- Application of nitrogen fertilizer 120 & 180 kg ha^{-1} is extremely important for minimizing and sustainable yield contributing parameters of sugarcane.
- Application of botanical products, biskatali plant powder and tobacco leaf powder @ 150 kg ha^{-1} is found positive effects in controlling major insect pests of sugarcane and maintaining fertility status of the soils. Considering the above results and discussion it is concluded that, biskatali plant powder and tobacco leaf powder @ 150 kg ha^{-1} kg ha^{-1} were found positives effects in controlling TSB, WG, RSB and SB of sugarcane.

Table 3. Effectiveness of botanical products in controlling some major pests of Sugarcane

Treatments	% pest infestation/ population (Mean of 3 replications)															
	TSB				RSB				SB				WG			
	RSRS		Mohan		RSRS		Mohan		RSRS		Mohan		RSRS		Mohan	
	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy	Mean	% efficacy
A_0	12.02 a*	-	13.06 a	-	14.98 a	-	20.20 a	-	12.49 a	-	15.97 a	-	11.58 a	-	13.17 a	-
A_1	3.69 cd	69.30	2.78 c	78.71	3.84 d	74.19	5.52 c	72.67	5.50 c	55.96	7.32 c	54.16	0.58 d	94.99	2.92 c	77.83
A_2	2.78 d	76.87	3.46 c	73.51	5.21 cd	64.99	7.25 bc	64.11	5.90 c	52.76	7.07 c	55.73	0.78 d	93.36	3.08 c	76.61
A_3	5.26 bc	56.24	6.12 b	53.14	8.77 b	41.06	10.22 b	49.40	8.85 b	29.14	12.34 b	22.73	5.50 c	52.50	6.92b	47.46
A_4	6.60 b	45.09	5.88 b	54.98	6.85 c	53.96	6.65 c	67.08	9.11 b	27.06	10.86 b	32.00	7.83 b	32.38	6.92 b	47.46
LSD (5%)	1.71		1.72		1.90		3.50		1.43		1.19		1.61		1.44	

TSB = Top shoot borer, SB = Stem borer, RSB = Root stock borer and WG = White grub

A_0 = Control ; A_1=Biskatali plant powder; A_2 =Tobacco leaf powder; A_3 = Eucalyptus leaf extracts and A_4= Neembacidin

* In a column, means followed by the same letters are not significantly different at 0.05 level (LSD)

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