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SCIENTIFIC NOTE

Effect of Green Manuring in Combination with N on Productivity of Sugarcane at BSRI Farm Soils

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Among all nutrients, nitrogen is the most deficient one in soils. Most soils in Bangladesh are low in organic matter (OM), generally containing less than 1-2%. Soil organic matter contents of 2.5 to 3 % are considered necessary for sustainable crop production. Because of its large biomass yield and longer growth period, sugarcane removes considerable amounts of nutrients from the soil and as a consequence the OM status of sugarcane soils has decreased over time to bellow 1%. Legumes have the unique ability to fix atmospheric N and to contribute the large quantities of N to the following crop. Green manuring (GM) crops like *Crotalaria juncea, Sesbania rostrata, Sesbania aculeata* and *Indigofera tinctoria* have been reported as potential green manuring crops to Bangladeshi farmers (Uddin *et al.*, 1996 and Alam *et al.*, 1997). The present study is therefore, made to evaluate the comparative performance of GM crops in relation to biomass production, contribution of organic N and yield productivity of subsequent cane crop.

A field experiment was conducted during cropping season of 2000-2001in Bangladesh Sugarcane Research Institute (BSRI) experimental farm at Ishurdi under High Ganges River Floodplain soils of Bangladesh (Typic Eutrocrept). Twelve treatments, considering of three rates of urea-N (N_0, N_{100} and N_{135} kg ha^{-1}) and three green manure (GM) crops viz. sunhemp (Crotalaria juncea-GM_1), mimosa (*Mimosa invisa*-GM_2) and local dhaincha (*Sesbania aculeata*-GM_3) including one control (GM_0) viz., T_1- N_0 GM_0; T_2-N_{100} GM_0; T_3-N_{135} GM_0; T_4-N_0 GM_1; T_5-N_{100} GM_1; T_6- N_{135} GM_1; T_7-N_0 GM_2; T_8- N_{100} GM_2; T_9-N_{135} GM_2; T_{10}- N_0 GM_3; T_{11}- N_{100} GM_3; T_{12}-N_{135} GM_3 were replicated four times in a randomized complete block design. The soil under experiment was calcareous in nature with pH 7.7, low in organic matter and deficient in total N. The seeds of green manure crops were sown on May 23, 2001 and ploughed down in-situ on June 26, 2001. No fertilizer was applied to green manure crops. A 35-day aged single bud sugarcane settlings (variety Isd 29) raised in small polythene bags were transplanted in December 11, 2000 and harvested on December 30, 2001. Unit plot size was 7m × 6m. Each treatment received P_{35}, K_{60}, S_{20} and Zn_3 kg ha^{-1} in the from of triple super phosphate (TSP), muriate of potash (MP), gypsum and zinc sulphate, respectively. The N fertilizers were applied in three equal splits, the first after establishment of set (20 DAP), second when the tillering was complete and third one applied at grand growth phase. Full amount of TSP, gypsum, zinc sulphate and one third of MP were applied in trenches and thoroughly mixed with soil during settling transplantation. Rest amount of potash was applied as top dressing as N fertilizer. Before transplanting sugarcane, soils samples (0-15 cm) were collected for analyzing nutrient status from each green manure crop and

also from the control plot (90 days after the incorporation of GMs). In case of analysis, two-way analysis of variance was done where the total variation and its degrees of freedom were divided according to different sources. Standard cultural practices of weeding, mulching, earthing-up, tying and disease and insect pest control methods were used.

The interaction between N and green manuring crops on millable cane stalks and recovery per cent was significantly influenced but the effect on tiller, girth, unit stalk weight and cane yield was not significant (Table 1). Result revealed that maximum number of tiller (142 x 10^3 ha^{-1}), unit stalk weight (0.91 kg) and cane yield (93.99 t ha^{-1}) was found from T_6 treatment where N_{135} kg ha^{-1} was applied and *M. invisa* were incorporated. Though maximum millable cane stalks (129 × 10^3 ha^{-1}) and cane diameter (1.61 cm) were found in T_{12} treatment that was statistically similar with T_6 treatment. From interaction Table 1 it is also indicated that in absence of N fertilizer treatment like T_1, T_4, T_7 and T_{10} produced lower cane yield of 58.3, 59.4, 65.2 and 66.4 t ha^{-1} as compared to rest treatment. Reduction in cane yield of the treatments was possibly lack of vegetative growth which attributed to the decrease in the growth parameters like number of tiller, millable cane stalks, girth, unit stalk weight and this ultimately reduced cane yield. Recovery % varied significantly and higher recovery were found in most of the treatment that did not received N fertilizer. This findings was in close agreement with Sammuels (1965) who reported that N deficiency in the early stage of growing season decreases cane yield while excess N at ripening stage reduces juice quality and sucrose content. Main effects of N and green manuring crops on yield and yield attributing parameters of sugarcane are presented in Table 2 and Table 3. Sugarcane response to applied N is significantly influenced. The highest number of tiller (129 x 10^3 ha^{-1}), millable cane (119 × 10^3 ha^{-1}), cane diameter (1.63 cm), unit stalk weight (0.88 kg) and yield (90.18 t ha^{-1}) were found from the plot that received N fertilizer @ 135 kg N ha^{-1}. But the effects of N between the plots that was fertilized by 100 kg and 135 kg N ha^{-1}, the responses in respect of tiller, millable cane, cane diameter, unit stalk weight, cane yield and recovery per cent was statistically alike. The cane yield increased over control was 38.7% and 45.2 % in N_{100} and N_{135} kg N ha^{-1} treated plots respectively. The results confirm the findings of Rahman *et al.* (1992) who also reported that in the absence of N fertilization the cane yield reduced by 33% as compared to the application of 150 kg N ha^{-1}.

A significance response of different green manuring crops on tiller and millable cane stalk was observed but the effects on cane diameter, unit stalk weight, cane yield and recovery per cent was not significant although the studied growth parameters showed only slight increasing trends over plots where GMs were not incorporated. Maximum number of tillers (121 x 10^3 ha^{-1}) was found in dhaincha incorporated plot while the lowest (115 × 10^3 ha^{-1}) was from non- green manuring plots. Increased millable cane production was found over non-incorporated plot and the effect of different green manuring crops on millable canes was statistically at par. Sathyavelu *et al.* (1991) also reported increased in number of millable cane when legumes incorporated with sugarcane. The green manure crops increased cane yield by 1.4 % only. Uddin *et al.* (1996) reported that green manuring increased cane yield by 7-25%.

In comparison to biomass production and N content, *Crotalaria juncea* added higher N to the soil than *Sesbania aculeata* and *Mimosa invisa*. It was also superior to that of other for its first growth as shown by its rapid increase in plant height. Though N content (2.50%) was higher in *S. aculeata* than *C. juncea* but N contribution to the soil was

higher in *C. Juncea* due to its higher dry matter yield. *Mimosa invisa* did not exhibit better performance as green manure crop in sugarcane due to its slow growth, bushy and spreading branching in nature, poor germination and low biomass content (Table 4). It was found that *C. juncea* performed better in producing biomass yield and subsequently added more N in soils. This finding was also in close conformity with Alam *et al.* (1997). Nitrogen content in sugarcane leaf as affected by different levels of N with different green manuring crops at four stages is presented in Table 5. This indicated that at early stage of cane growth, N concentration was higher and later the N content was gradually decreased, as the plant became mature. At mature stage (362 DAP), the maximum leaf N content (0.89%) was obtained from the treatment T_{12} where full rate of N fertilizer were applied and dhaincha were ploughed down in-situ while the minimum content of 0.65% from T_9 (full rate of N + mimosa) treatment. Such response to N content in leaf was obvious because contribution of N in soil by dhaincha was higher on the contrary *Mimosa invisa* added very negligible amount of soil N. Results also indicated that in most cases the treatments did not receive N fertilizer across the growing period showed lower N content of 0.74 to 0.96%. Due to lower uptake of N by the plant from the soils, depressed root growth affected tillering as well as millable cane and thereby resulting less cane yield. The change in total N, available P, K and S were not conspicuous though after incorporation of green manures there was slight improvement in organic matter, total N and available P over control. Little changes were observed on soil pH (Table 6). Uddin *et al.* (1996) also observed that organic C, total N, available P, S and exchangeable K status of the soil were slightly increased by green manuring.

In conclusion the study showed that green manuring crops in relation to N contribution in soil followed the trend, *C. juncea* > *S. aculeata* > *M. invisa*. Therefore, either *C. juncea* or *S. aculeata* in combination with 135 kg N ha^{-1} can help to sustain the yield levels of sugarcane.

Table 1. Interaction effects of GMs and N on yield and yield contributing parameters of sugarcane. BSRI, 2000-2001.

Treatment	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Cane diameter (cm)	Unit stalk weight (kg)	Yield (t ha^{-1})	Recovery (%)
T_1	101.81	82.77 f	1.39	0.67	58.25	10.93 a
T_2	127.39	111.45 bcd	1.55	0.79	81.55	9.40 de
T_3	118.46	114.66 bcd	1.70	0.97	90.06	9.22 e
T_4	112.75	107.16 cde	1.51	0.70	59.40	10.73 a
T_5	120.67	119.06 abc	1.61	0.94	87.32	10.45 abc
T_6	122.15	113.29 bcd	1.58	0.80	88.51	9.74 bcde
T_7	121.65	105.97 de	1.53	0.81	65.18	10.08 abcde
T_8	130.41	116.80 abcd	1.61	0.85	85.59	10.28 abcd
T_9	142.33	121.02 ab	1.60	0.91	93.99	10.32 abc
T_{10}	101.56	95.44 ef	1.57	0.73	66.37	10.58 ab
T_{11}	126.44	111.86 bcd	1.53	0.70	90.18	9.35 e
T_{12}	135.13	129.36 a	1.61	0.84	88.16	9.63 cde
LSD (0.05)	NS	12.89	NS	NS	NS	0.90

Figures accompanied by the same letter are not significantly different as per DMRT test

Table 2. Main effect of GMs on yield and yield contributing parameters of sugarcane. BSRI, 2000-2001.

Treatment	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Cane diameter (cm)	Unit stalk weight (kg)	Yield (t ha^{-1})	Recovery (%)
GM_0	115.9 b	103.0 b	1.55	0.81	76.62	9.85
GM_1	118.5 b	113.2 a	1.58	0.81	78.41	10.31
GM_2	131.4 a	114.6 a	1.58	0.86	81.56	10.23
GM_3	121.0 b	112.2 a	1.58	0.76	81.57	9.85
LSD (0.05)	9.40	7.44	NS	NS	NS	NS

Figures accompanied by the same letter are not significantly different as per DMRT test

Table 3. Main effects of N on yield and yield contributing parameters of sugarcane. BSRI, 2000-2001.

Treatment	Tiller ($\times 10^3$ ha^{-1})	Millable cane ($\times 10^3$ ha^{-1})	Cane diameter (cm)	Unit stalk weight (kg)	Yield (t ha^{-1})	Recovery (%)
N_0	109.4 b	97.83 b	1.51 b	0.73 b	62.30 b	10.58 a
N_{100}	126.2 a	114.8 a	1.58 ab	0.82 ab	86.16 a	9.87 b
N_{135}	129.5 a	119.6 a	1.63 a	0.88 a	90.18 a	9.73 b
LSD (0.05)	8.41	6.45	0.10	0.10	9.84	0.46

Figures accompanied by the same letter are not significantly different as per DMRT test

Table 4. Biomass, N-content and N-contribution in soil by different green manure (GM) crops. BSRI, 2000-2001.

GM crops	Height (cm)	Fresh biomass (t ha^{-1})	Dry biomass (t ha^{-1})	N in DM (%)	N contribution in soil (kg ha^{-1})
Crotalaria juncea	186	9.92	2.31	1.64	37.88
Sesbania aculeata	98	4.43	1.35	2.50	33.75
Mimosa invisa	44.7	0.55	0.20	1.13	2.26

Note: DM means dry matter

Table 5. Effect of GMs in combination with Nitrogen on the N content of sugarcane leaf at four- growth stage. BSRI, 2000-2001.

Treatment	130 DAP	195 DAP	290 DAP	362 DAP
T_1	0.96	0.85	1.28	0.74
T_2	1.25	1.06	1.28	0.80
T_3	1.12	1.45	1.24	0.80
T_4	0.86	0.92	1.28	0.74
T_5	1.02	1.29	1.14	0.77
T_6	1.05	1.25	0.97	0.77
T_7	1.02	1.16	1.08	0.77
T_8	1.02	1.12	1.14	0.80
T_9	1.15	1.29	1.24	0.65
T_{10}	1.22	1.22	1.14	0.83
T_{11}	1.22	0.92	1.18	0.68
T_{12}	1.12	1.35	1.21	0.89

Note: DAP means number of days after planting

Table 6. Soil nutrient status sampled after 90-day of green manure crops incorporated in sugarcane crops. BSRI, 2000-2001.

Treatment	pH	OM	Total N	Available P	Available S	Exchangeable K
		(%)		(μ g g^{-1})		(meq %)
T_1	7.8	1.14	0.06	11.0	20.0	0.21
T_2	8.0	1.14	0.07	11.0	16.0	0.20
T_3	8.0	1.14	0.07	11.0	20.0	0.19
T_4	7.8	1.42	0.08	14.0	14.0	0.23
T_5	7.6	1.23	0.08	12.0	18.0	0.21
T_6	7.6	1.30	0.08	16.0	24.0	0.19
T_7	7.6	1.14	0.08	14.0	20.0	0.19
T_8	8.0	1.42	0.06	14.0	16.0	0.21
T_9	7.8	1.14	0.07	15.0	24.0	0.19
T_{10}	7.8	1.36	0.06	12.0	22.0	0.22
T_{11}	7.7	1.14	0.06	12.0	24.0	0.19
T_{12}	7.8	1.13	0.06	11.0	18.0	0.20

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