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Effect of inter crop green manuring and nitrogen on the growth, yield and quality of sugarcane (*Saccharum offcinarum* L.)

R.C. Kabiraj, M. Shahidul Islam, M.N.A. Siddiqui[1], T. Ahamed[2] and A. Siddika[3]
Department of Soil Science, Bangladesh Sugar Crop Research Institute, Ishurdi-6620, Pabna, [1]Bangladesh Institute of Research and Training on Applied Nutrition (BIRTAN), Sech Bhaban, Manik Mia Avenue, Dhaka, [2]Faculty of Agriculture, Hajee Mohammad Danesh Science and Technology University, Dinajpur, [3]Department of Advanced Botany, Rajshahi University, Rajshahi

Abstract: A study was conducted at the Patuadangi Farm of Regional Sugarcane Research Station, Madarganj, Thakurgaon during December 2010 to December 2011 to evaluate the effect of green manuring in combination with nitrogen on the growth, yield and quality of sugarcane and on soil fertility status. The soil was sandy loam having pH 5.3, organic matter 1.90%, total nitrogen 0.080%, available P 21.0 (µg g soil^{-1}), K 0.18 (meq 100 g soil^{-1}) and available S 22.0 (µg g soil^{-1}) .The experiment was laid out in RCBD with four replications. Factor-A include four levels of nitrogen, N_1: Control, N_2: 1/3 Nitrogen as per fertilizer recommended dose, N_3 :2/3 Nitrogen, N_4: Full Nitrogen and for the factor-B include four green manuring practices GM_1: Control, GM_2: Local Dhaincha (*Sesbinia aculeata*), GM_3: Sunhemp (*Crotalaria juncea*), GM_4: African Dhaincha (*Sesbania rostrata*) were used. The highest tiller was found in the 2/3 nitrogen level i.e., 180 kg ha^{-1} (176.16 x 10^3 ha^{-1}). The highest millable cane (88.55 x 10^3 ha^{-1}), girth (1.97 cm), plant height (2.85 m), unit stalk weight (1.17 kg), cane yield (88.65 t ha^{-1}) and brix (19.5) percentage were found also in 2/3 nitrogen level i.e., 180 kg ha^{-1}. Green manuring crops incorporated in the sugarcane field performed significant results in all the parameters. Sunhemp (*Crotalaria juncea*) performed highest result in all cases. The highest number of tiller (192.83 x 10^3 ha^{-1}), number of millable cane (96.28 x 10^3 ha^{-1}), girth (1.95 cm), plant height (3.1 m), unit stalk weight (1.17 kg), cane yield (91.87 t ha^{-1}) and brix percentage (19.70) were found from Sunhemp (*Crotalaria juncea*) incorporation. A significant response of different levels of nitrogen with green manuring crops on tiller and millable cane, cane yield was observed. The highest cane yield was (73.29 t ha^{-1}) found in the sunhemp incorporated treatment with 2/3 nitrogen levels. Considering above findings 2/3 nitrogen levels with sunhemp appeared to be recommendable for cultivation of sugarcane to achieve the highest yield.

Key words: Sugarcane, nitrogen level, green manuring.

Introduction

Sugarcane is a tropical and subtropical noble herb belonging to the grass family Gramineae of the genus *Saccharum* (Deer, 1949). It is an important industrial cash crop in Bangladesh. Every year it occupies on an average 2.3% of the country's total cultivable land (BBS, 1996). It ranks second among cash crops and third among the major field crops in the country. Rabindra *et al.* (1990) reported that continuous application of farmyard manure (FYM) along with NPK fertilizer improves physico-chemical properties of soil, cane yield and juice quality. Gerardiono *et al.* (1993) found that inter cropping with *C. Juncea* as a green manure inter-crop could help to increase sugarcane yield by releasing adequate amount of N through proper mineralization. Addition of nitrogen during incorporation of green manure could hasten the release of available N from *C. juncea*. Among all the nutrients, nitrogen is the most deficient nutrient in Bangladesh soils. Legumes have the unique ability to fix atmospheric N and to contribute the large quantities of N to the following crop. Many legume species have been studied as green manure in different countries. Green manuring (GM) crops like *Crotolaria juncea*, *Sesbania rostrata* and *Sesbania aculeata* have been reported as a potential green manuring crop to Bangladeshi farmers (Uddin *et al.* 1996 and Alam *et al.* 1997). As a consequence, the present study is designed to determine the comparative study between the GM crops in relation to biomass production, contribution of organic N and yield performance of subsequent cane crop and on soil fertility status.

Materials and Methods

The experiment was conducted in the Patuadangi farm of Regional Sugarcane Research Station, Madarganj under Thakurgaon District during the period from December 2010 to December 2011. Geographically the experimental site was located at 25^{0}54' N latitude and 88^{0}18' E longitude at a height of 34.5 m from the mean sea level (Fig.1). Soil pH of the experimental field soil was 5.3 and low in organic matter as well as fertility level.

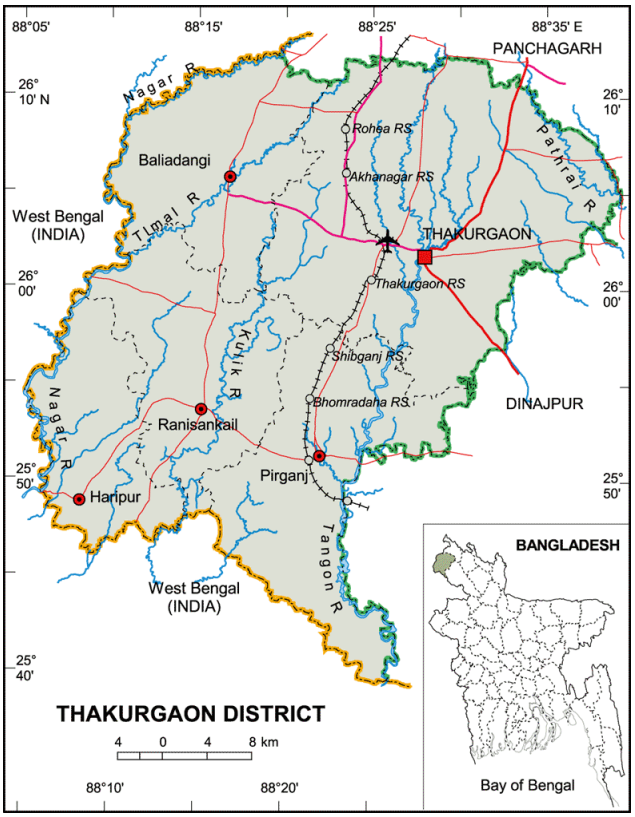
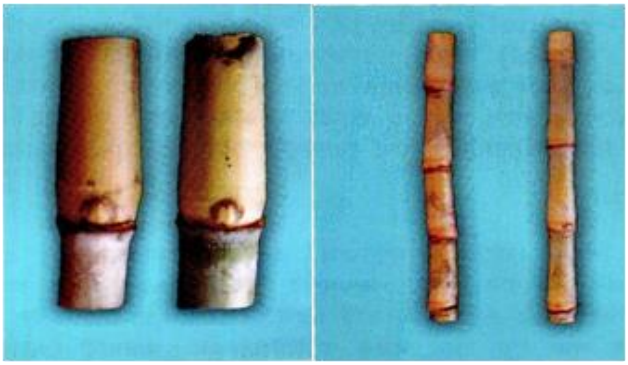


Fig. 1. Map of Thakurgaon district showing the location of experiment

Design and Treatment: The experiment was laid out following two factors Randomized Completely Block Design (RCBD) with 4 (four) replications. Total number of experimental plot was 64. The size of each unit plot was 48 m^2 (8 m x 6 m). Treatments were given below- Factor-A: Rates of Nitrogen with control.N_1: Control (No nitrogen). N_2:1/3 N as per fertilizer recommended dose. N_3:2/3 N as per fertilizer recommended doseN_4: Full doses of N. Recommended dose of N was 270 kg ha^{-1} and in all cases N was supplied as urea. Factor B: Green manure inter-cropping: GM_1: Control (No Green Manure Crops). GM_2: Local Dhaincha (*Sesbania aculeata*) GM_3: Sunhemp (*Crotalaria juncea*) GM_4: African Dhaincha (*Sesbania rostrata)*.

Materials: The test crop was sugarcane cv.-Isd32. The set of the test crop was collected from Bangladesh Sugarcane research Institute (BSRI) Ishurdi Pabna. The characteristic of sugarcane -Isd 32 stalk is long, medium and greenish yellow colour, inter node conidial shape and no growth split, corky patch and bud groove. Bud oval shaped (Fig. 2). Also high yielding, mid maturing, flood tolerant, resistant against major insect and disease pest. Data were collected on growth parameter, plant height, diameter, girth, unit stalks weight, Tiller, Millable cane and Brix percent. The data were statistically analyzed using the "Analysis of variance" (ANOVA) technique with the help of computer package MSTAT-C. The mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984.)



A **B**

Fig. 2. Sugarcane Isd 32, (A) eye, bud and growth ring (B) stalk, internodes and eye

Results and Discussion

Effect of different nitrogen levels on sugarcane: Tiller: The effect of different nitrogen levels on the number of tiller was significant (Fig. 3A). The results revealed that all the nitrogen levels produced higher number of tiller over the control. The highest (176.16 x 10^3 ha^{-1}) number of tiller was recorded for the treatment N_3 and it was statistically similar with the treatments N_4 and N_2.

Millable cane: Millable cane was significantly influenced due to different levels of nitrogen (Fig. 3B). The highest number of millable cane was observed under N_3 (88.55 x 10^3 ha^{-1}) treatment that was statistically similar to N_4 (79.76 x 10^3 ha^{-1}) treatment. Conversely the lowest number of millable cane was recorded in N_1 (51.26 x 10^3 ha^{-1}) treatment that was statistically dissimilar to all other treatments. It was very much noticeable matter that where more number of tillers was found there more number of millable canes were observed.

Girth: Girth of sugarcane was notably inclined by the reason of use of different levels of nitrogen (Fig. 3C). The maximum girth was originated from N_3 (1.97 cm) treatment that was statistically similar to N_4 treatment but superior to N_1 treatment. The minimum girth was found in N_1 (1.80 cm) treatment. Actually the girth depends upon the availability of plant nutrient in proper level. In case of nitrogen level 180 kg ha^{-1} was the appropriate because of availability and marginal use of plant nutrient in the sugarcane field especially in soil where the soil pH below 5.0 or near to 5.0.

Plant height: Plant height of sugarcane was highly significant due to different nitrogen levels (Fig. 3D). The highest plant height was observed in N_3 (2.85 m) treatment and N_4 (2.85 m) treatment and the lowest plant height was observed in N_1 (2.60 m) treatment. Moderate plant height was found in N_2 (2.78 m) treatment. The highest plant height in N_3 was probably due to higher vegetative growth. The treatments N_2, N_3 and N_4 were statistically similar to each other.

Unit stalks weight: Unit stalk weight of sugarcane was statistically insignificant (Fig. 3E). Numerically the highest unit stalk weight was recorded in N_3 (1.17 kg) treatment and the lowest unit stalk weight was observed in N_1 (0.86 kg) treatment. There were no statistically significant due to unit weight of cane in the initial nitrogen fertilizer application.

Cane yield: The effect of different levels of N on cane yield was significant (Fig. 3F). Significantly the highest cane yield was found in N_3 (88.65 t ha^{-1}) treatment which was followed by statistically similar treatment of N_4 (84.56 t ha^{-1}).The lowest cane yield was observed in N_1 (59.79 t ha^{-1}) treatment.

Brix: The brix percentage of sugarcane was influenced by the different nitrogen levels (Fig. 3G). The highest brix percentage was found in N_3 (19.5) treatment that was statistically similar to N_4 (19.0) treatment and T_2 (18.8) treatment. On the other hand the lowest brix percentage was recorded in N_1 (18.15) treatment.

Effect of green manuring crops on sugarcane: The highest plant height was observed in N_3 (2.85 m) treatment and N_4 (2.85 m) treatment and the lowest plant height was observed in N_1 (2.60 m) treatment. Numerically the highest unit stalk weight was recorded in N_3 (1.17 kg) treatment and the lowest unit stalk weight was observed in N_1 (0.86 kg) treatment. Significantly the highest cane yield was found in N_3 (88.65 t ha^{-1}) treatment which was followed by statistically similar treatment of N_4 (84.56 t ha^{-1}). The lowest cane yield was observed in N_1 (59.79 t ha^{-1}) treatment. The highest brix percentage was found in N_3 (19.5) treatment that was statistically similar to N_4 (19.0) treatment and T_2 (18.8) treatment. Tillering of sugarcane was highly influenced by the effect of inter-crop green manuring crops. The highest number of tiller was recorded in GM_3 (192.83 x 10^3 ha^{-1}) treated plot which were statistically similar to GM_4 (188.76 x 10^3 ha^{-1}) and GM_2 (180.34 x 10^3 ha^{-1}) treated plot. The highest number of millable cane was observed in GM_3 (96.28 x 10^3 ha^{-1})

treated plot that was statistically similar to GM_4 (94.43 x 10^3 ha^{-1}) treated plot. Cultivating GM with sugarcane as inter crop increase millable cane and cane yield sometimes promoting better production compare to chemical fertilizer alone (BSRI, 1996). The maximum girth was originated from GM_3 (1.95 cm) treated plot that was very close to GM_4 (1.90 cm) treated plot. The highest plant height was found in GM_3(3.1 m) treated plot and that was similar to GM_4 (3.4 m) and GM_2 (2.90 m) treated plot. The highest unit stalk was found in GM_3 (1.20 kg) treated plot which was statistically identical to GM_4 (1.17 kg) treated plot (Table 1).

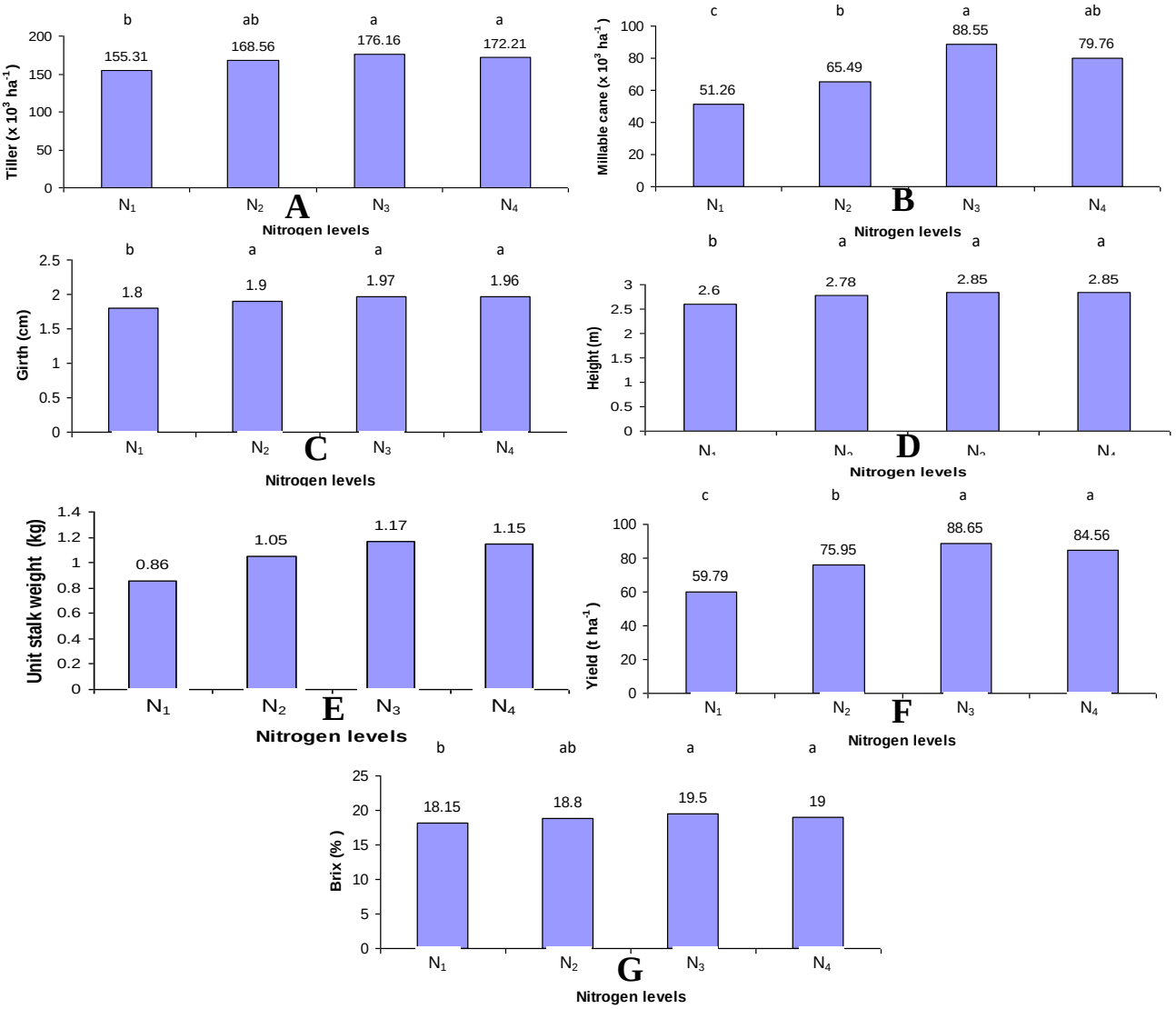


Fig. 3. Effect of nitrogen levels on (A) tiller, (B) millable cane, (C) girth, (D) plant height, (E) unit stalk weight, (F) cane yield, and (G) brix of sugarcane *cv* Isd 32

Table 1. Effect of Green manuring crops on the tiller, millable cane, girth, height, Unit stalk weight and yield of sugarcane

Treat.	Tiller (x$10^3$$ha^{-1}$)	Millable cane (x$10^3$$ha^{-1}$)	Girth (cm)	Height (m)	Unit stalk weight (kg)	Yield (ha^{-1})	Brix (%)
GM_1	170.22 b	65.51 c	1.75 b	2.78 b	0.90 c	59.11 c	18.35 b
GM_2	180.34 ab	85.64 b	183 a	2.90 a	1.08 b	78.45 b	19.0 ab
GM_3	192.83 a	96.28 a	1.95 a	3.1 a	1.20 a	91.87 a	19.7 a
GM_4	188.76 a	94.43 ab	1.90 a	3.0 a	1.17 a	86.32 a	19.02a
LSD(0.05)	9.45	7.67	NS	NS	NS	5.93	0.54

Status of initial and post harvest soil of the sugarcane experiment sites as affected by green manuring: Status of initial and post harvest soil of the sugarcane experiment sites as affected by green manuring crops and different nitrogen levels The status of soil pH, organic carbon, total N, available P, K and S in initial soil as well as post harvest soil as influenced by nitrogen levels and green manuring crops are presented in (Table 2). A change in total N, available P, K and S balance in soil were observed for different treatments. The change in total N, available P,

K and S were 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. It was also evident that the post harvest soil fertility increased against initial soil. The fertility level was found best in combination of 180 (2/3 N) kg ha^{-1} with sunhemp (Table 2).

The degree of performance of different nitrogen levels in case of cane yield ranked as -2/3 nitrogen level> full nitrogen level > 1/3 nitrogen level. The degree of performance of incorporate of green manuring crops in case of cane yield ranked as - Sunhemp (*Crotalaria juncea*) > African Dhaincha (*Sesbania rostrata)* > Local Dhaincha *(Sesbinia aculeata)*. It can be concluded that 2/3 nitrogen level with sunhemp association performed the best compared to all other treatments. Considering the situation of the present experiment, the following recommendations and suggestion may be made: Green manuring with Sunhemp along with 180 kg N ha^{-1} may be used maximizing the yield of sugarcane and Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performance.

Table 2. Status of initial and post harvest soil of the sugarcane experiment sites as affected by green manuring crops and different nitrogen levels

Treatments	Analytical value					
	pH	OM (%)	Total N (%)	Available P (µg g^{-1})	Exchangeable K (meq 100g $soil^{-1}$)	Available S (µg g $soil^{-1}$)
Initial soil	5.3	1.90	0.080	21.0	0.18	22.0
Post harvest soil						
N_1GM_1	5.3	1.80	0.080	21.0	0.17	22.0
N_1GM_2	5.3	1.85	0.076	20.5	0.17	22.0
N_1GM_3	5.3	1.85	0.076	20.5	0.17	22.0
N_1GM_4	5.3	1.85	0.076	20.5	0.17	22.0
N_2GM_1	5.3	1.81	0.078	20.5	0.17	22.0
N_2GM_2	5.4	1.92	0.070	21.0	0.19	21.0
N_2GM_3	5.0	1.93	0.075	22.0	0.18	22.0
N_2GM_4	5.1	1.82	0.081	22.0	0.17	22.0
N_3GM_1	5.1	1.92	0.081	22.0	0.19	22.0
N_3GM_2	5.0	1.94	0.080	21.0	0.20	21.0
N_3GM_3	5.5	1.95	0.085	23.0	0.20	23.0
N_3GM_4	5.0	1.92	0.075	22.0	0.19	21.0
N_4GM_1	5.1	1.82	0.081	22.0	0.17	22.0
N_4GM_2	5.2	1.93	0.080	21.0	0.18	22.0
N_4GM_3	5.3	1.92	0.080	21.0	0.19	21.0
N_4GM_4	5.4	1.93	0.075	21.0	0.19	21.0

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