

Effect of Green Manuring as Intercrop on Soils Improvement and Supplement N for Sugarcane Production under different AEZ

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ABSTRACT

An experiment was conducted during 1995-96 cropping season at Ishurdi and Sreepur under High Ganges River Floodplain and Madhupur Tract Agro-Ecological Zones (AEZ) respectively. Three different species of green manuring (GM) crops namely, dhaincha (*Sesbania aculeata* L.) sun hemp (*Crotalaria juncea* L.) and cow pea (*Vigna unguiculata* L.) were cultivated as intercrop with sugarcane. Six different treatments including intercrops GM were distributed in RCB design with 4 replications. Sugarcane seedlings were used as seed materials and transplanted in November and December, 1995 under paired row system. The distance between two cane lines was 45cm and two paired of cane lines was 135 cm. The seeds of GM crops were sown in the vacant space of 135 cm in early April and buried the biomass after 45 to 60 days of sowing the seeds. Sugarcane was harvested after one year. The GM like dhaincha, sunhemp and cowpea were grown as intercrop without hampering the main crop sugarcane. GM intercrops irrespective of species increased cane yield over non GM treated plots viz. control, farmer's practice of sugarcane cultivation and sole sugarcane with full NPKSZn. Moreover, GM intercrop treatments gave higher economic benefit. Post harvest soil analysis showed that there was slight increase in OC, total N, available P, K and S in both the locations. Uptake of plant nutrients was found to be directly co-related with the cane yield. So, higher productions of sugarcane uptake higher amount of NPKS. Among the nutrients, the crop removed the highest amount of K.

Key words : Green manuring, intercrop, sugarcane, AEZ.

INTRODUCTION

Organic matter (OM) and nitrogen (N) levels in the upland soils of Bangladesh are far below than requirement for crop growth and these are depleting day by day. Alam *et al.* (1997) reported that Bangladesh soils are deficient in nutrients and fail to give crop yields without any fertilizer. Sugarcane is long duration crop and it is grown well in the soils having abundant organic matter and sufficient level of available plant nutrients (Islam *et al.* 1995). So, to improve the soil health and for sustainable sugarcane production, addition of organic matter and plant nutrients are essential. But the availability of farm yard manure is limited due to deterioration of livestock (Mia *et al.* 1993). So, green manuring is a good option for maintaining soil health for sustainable sugarcane production. GM increases the soil NP concentrate, maintenance and renewal of organic matter and improves the soil physical and chemical conditions (Jiao, 1983). Tamhane *et al.* (1970) gave similar opinion that GM crops provide a favorable environment for many physical, chemical and biological activities. Legumes benefit the succeeding crop through symbiotic nitrogen fixation and mobilization of lesser available forms of plant nutrients, improvement of soil structure and decrease in leaching loss of nutrients (Sharma *et al.* 1988). But due to high cropping intensity, it has a limited scope to cultivate GM crops separately. At early stage of sugarcane, short duration crops can easily be grown within the vacant space of cane lines. Parthasarathy (1972) reported that cultivation of GM as intercrop with sugarcane may be done.

Many legume species have been studied as green manure in different countries, Alam *et al.* (1997) reported that dhaincha (*Sesbania aculeata*), Sunhemp (*Crotaria juncea*) are acceptable to Bangladeshi farmers cowpea (*Vigna unguiculata*) is also being cultivated in some places of Bangladesh. Therefore, a study was undertaken to see the effect of different green manures as intercrop on improvement of soils and supplement N for production of sugarcane at different AEZ conditions.

MATERIALS AND METHODS

The field experiment was conducted during 1995-96 cropping season in two different locations at Ishurdi and Sreepur. The areas fall under typical Agro-Ecological Zones namely High Ganges River Floodplain and Madhupur Tract. Six different treatments as shown in Table 1 were undertaken and were distributed in a randomized complete block design with four replications. The size of the plot was 8x6 m in both the locations. Sugarcane variety Isd 20 at Ishurdi and Misrimala at Sreepur were selected on the basis of locally available and their local performance. Sugarcane seedlings raised in polybag/soil bed were used as seed materials, and were transplanted during November-December, 1995 under paired row system. The distance between paired cane lines was 45 cm and between two paired rows was 135 cm. Under paired row system, the vacant space of 135 cm gets sufficient solar radiation and also gives opportunity for the farmers to grow 2nd intercrop.

Table 1. Fertilizers rate/ha used in the experiment on effect of different GM intercropping for sugarcane production at Ishurdi and Sreepur.

Locations	Treatments	Nutrient rate (kg/ha)					
		N	P	K	S	Zn	Rate of manures
Ishurdi	T ₀ - Control	-	-	-	-	-	-
	T ₁ - Farmer's practice	90.0	30.0	52.0	02.5	-	5400CD
	T ₂ -NPKSZn as per recom. guide-1989	160.0	48.0	124.0	40.0	10.0	-
	T ₃ - $\frac{2}{3}$ N+ Full PKSZn as per recom. guide-'89+Sunh hemp.	107.0	48.0	124.0	40.0	10.0	-
	T ₄ - $\frac{2}{3}$ N+ Full PKSZn as per recom. guide-'89+Cow pea	107.0	48.0	124.0	40.0	10.0	-
	T ₅ - $\frac{2}{3}$ N+Full PKSZn as per recom. guide-'89'+Dhaincha	107.0	48.0	124.0	40.0	10.0	-
Sreepur	T ₀ - Control	-	-	-	-	-	-
	T ₁ - Farmer's practice	41.0	36.0	32.0	2.0	-	1960CD
	T ₂ -NPKSZn as per recom.guide-1989	160.0	52.0	137.0	30.0	4.0	-
	T ₃ - $\frac{2}{3}$ N+ Full PKSZn as per recom. guide-'89'+Sunh hemp	107.0	52.0	137.0	30.0	4.0	-
	T ₄ - $\frac{2}{3}$ N+ Full PKSZn	107.0	52.0	137.0	30.0	4.0	-
	T ₅ - $\frac{2}{3}$ N+Full PKSZn '89'+Dhaincha	107.0	52.0	137.0	30.0	4.0	-

NB : CD- coddung.

Full P, S and Zn fertilizers were applied in the trenches and thoroughly mixed with the soils by spading before transplanting the seedlings $\frac{1}{2}$ N and $\frac{1}{2}$ K were applied at the both the soils of cane lines after 20-30 days of transplanting and properly incorporated the fertilizers in the soils. The rest of N and K was applied as top dressing by 1-2 installments at peak tillering stage. Three different GM crops namely dhaincha (*Sesbania aculeata*), sunhemp (*Crotalaria juncea*) and cow pea (*Vigna unguiculata*) were cultivated as intercrop at early stage of sugarcane plants. Seeds of GM crops were sown in April After 1st shower in the vacant space of 135 cm between paired rows of sugarcane and the biomass was buried after 45-60 days. No fertilizer was applied for the GM crops. Sugarcane was harvested after one year.

pH was measured in soil : water suspension at 1:2.5 by glass electrode, total N by Kjeldahl digestion and distillation method, Organic C by Walkley and Black wet-oxidation method, available P by modified Olsens method, exchangeable K (NH_4OAc -extractable) by flame photometer and available S (NH_4OAc -extractable) by turbidimetric method of Bardsley and Lancaster (Black, 1965).

Uptake of plant nutrients was calculated on the basis of nutrient removal data of sugarcane crops as mentioned in Fertilizer Recommendation Guide'97.

Data on number of tillers, number of millable cane, yield of cane, yield of by product and % brix were recorded and their interpretations were given on the basis of statistical analysis.

RESULTS AND DISCUSSION

Ishurdisite : Data on number of tillers, millable cane, yield of cane, yield of by-product (trash) and % brix are presented in Table 2. Significant effect on number of tillers, millable cane and yield of cane was found among the treatments. All parameters were significantly increased over control (T_0). However, the highest number of tillers $129.51 \times 10^3 \text{ ha}^{-1}$ and millable cane $108.55 \times 10^3 \text{ ha}^{-1}$ were produced in T_5 ($\frac{2}{3}$ N and full PKSZn +dhaincha).

Table 2. Effect of different GM crops as intercrop on yield and yield parameter of Sugarcane.

Location	Treatments	Tiller ($\times 10^3 \text{ ha}^{-1}$)	Millable cane ($\times 10^3 \text{ ha}^{-1}$)	Yield of cane (TCH)	Yield of by-product (t ha^{-1})	% Brix
Ishurdi	T_0	70.30c	58.69c	41.66c	4.16	16.83a
	T_1	93.89b	77.95b	55.98b	5.59	16.58a
	T_2	101.28b	85.13b	60.67b	6.06	16.30a
	T_3	121.64a	102.95a	70.92a	7.09	16.40a
	T_4	103.68b	86.53b	32.0 61.71b	6.17	16.57a
	T_5	129.51a	108.55a	20.0 72.17a	7.21	16.34a
	LSD 5%	11.26	10.42	22.0 7.50		
Sreepur	T_0	155.99d	60.74c	64.74d	6.47	17.41a
	T_1	177.59bc	69.00b	80.74c	8.07	17.59a
	T_2	174.05c	75.57a	118.02b	11.80	16.33a
	T_3	182.33ab	77.31a	131.73a	13.17	16.64a
	T_4	184.28a	76.49a	16.00 134.91a	13.49	16.64a
	T_5	180.81ab	76.43a	16.00 133.46a	13.34	17.64a
	LSD 5%	6.36	3.46	17.00 8.44		

* Under line figure : Green biomass of the GM crops.

The highest yield of sugarcane 72.17 TCH and by-product 7.21 t/ha were also obtained from the same treatment. These results were followed by treatment T₃ (2/3 N and full PKSZn+sunhemp). The yield and other parameters production in GM intercrop plots were found to be higher than full NPKSZn treated plot (T₂). As well as farmer's practice (T₁). In Table 4 the GM intercrop plots T₃, T₄, showed higher cane yield by 26.68%, 10.23% and 28.92% respectively than farmer's practice (T₁) and by 16.89%, 1.71% and 19.03% respectively than full NPKSZn (T₂). But in case of % brix of the sugarcane, no significant effect was found in the treatments. Data on economic analysis are shown in Table 3. It is seen in the table that GM intercrop plots gave higher net profit than sole cane with full NPKSZn (T₂) and farmers practice (T₁). However, the highest net profit of Tk. 43,404/- per hectare was obtained from T₅ (2/3 N and full PKSZn + dhaincha) followed by Tk. 42,217/- per hectare from T₃. The highest B:C 2.49 was also found in T₅.

Table 3. Effect of different GM as intercrop on cost and benefit of sugarcane production.

Treatment	Yield (TCH)	Fertilizer cost (Tk./ha)	Total variable cost (Tk./ha)	Return (Tk./ha)	Net profit (Tk./ha)	Benefit cost Ratio (BCR) B/C = R
Ishurdi						
T ₀	41.66	-	18,869/-	41,826/-	22,957/-	2.21
T ₁	55.98	6,545/-	26,188/-	56,204/-	30,016/-	2.14
T ₂	60.67	8,955/-	28,851/-	60,912/-	32,061/-	2.11
T ₃	70.92	8,537/-	28,986/-	71,203/-	42,217/-	2.45
T ₄	61.77	9,137/-	29,089/-	61,956/-	32,867/-	2.13
T ₅	72.17	8,537/-	29,054/-	72,458/-	43,404/-	2.49
Sreepur						
T ₀	64.74	-	20,115/-	64,999/-	44,884/-	3.23
T ₁	80.74	3,074/-	24,054/-	81,063/-	57,029/-	2.37
T ₂	118.02	8,483/-	31,476/-	1,18,492/-	87,016/-	3.76
T ₃	131.73	8,064/-	31,797/-	1,32,257/-	1,00,460/-	4.16
T ₄	134.91	8,664/-	32,569/-	1,35,449/-	1,02,880/-	4.16
T ₅	133.46	8,084/-	31,890/-	1,33,993/-	1,02,103/-	4.20

Initial and post harvest soil analytical data are presented in Table 5. The initial soil analytical data indicates that the soils of the experimental plot are alkaline having pH 7.8 and deficient in OM, total N, available P and moderate level of available K and S. The soils contain OC-0.69%, total N-0.065% available P-7.0 ppm, available K-0.24 meq% and available S-14.0 ppm. In post harvest soil analysis of different treatments, it was found slight increase in OC, N, P and K in GM treated plots compared to initial soils, control, farmers practice and some cases full NPKSZn plot.

Table 4 . Effect of different G.M. as intercrop on percent increase or decrease of sugarcane production.

Location	Treatments	Yield of Sugarcane (TCH)	%Yield increase over control	% Yield increase/decrease over farmer practice	% yield increase/decrease over recommended fertilizer
Ishurdi	T ₀	41.66	-	-	-
	T ₁	55.98	34.37	-	-
	T ₂	60.67	45.63	8.37	-
	T ₃	70.92	70.23	26.68	16.89
	T ₄	61.71	48.12	10.23	01.71
	T ₅	72.17	73.23	28.92	19.03
Sreepur	T ₀	64.74	-	-	-
	T ₁	80.74	24.71	-	-
	T ₂	118.02	82.29	46.17	-
	T ₃	131.73	103.47	63.15	11.61
	T ₄	134.91	108.38	67.09	14.31
	T ₅	133.46	106.14	65.29	13.08

Table 5 . Analytical data on pH, organic carbon and different nutrients of initial and post harvest soils of experiment on effect of GM for sugarcane production.

Location	Treatments	pH	O.C (%)	Total N (%)	P ppm	K (meq%)	S ppm
Ishurdi	T ₀	7.7	0.69	0.065	6.0	0.23	8.5
	T ₁	7.8	0.66	0.070	7.0	0.24	14.0
	T ₂	7.9	0.62	0.070	7.0	0.24	10.5
	T ₃	8.0	0.63	0.067	7.5	0.26	14.0
	T ₄	8.1	0.73	0.068	8.0	0.31	11.5
	T ₅	8.0	0.072	0.070	8.0	0.31	14.0
	Initial	7.8	0.69	0.065	7.0	0.24	14.0
Sreepur	T ₀	4.4	1.07	0.065	10.0	0.11	11.5
	T ₁	4.6	1.04	0.060	10.0	0.10	11.5
	T ₂	4.3	1.04	0.065	10.5	0.10	14.5
	T ₃	4.3	1.12	0.070	10.0	0.13	11.5
	T ₄	4.3	1.09	0.070	10.5	0.14	15.0
	T ₅	4.3	1.09	0.080	11.0	0.17	15.5
	Initial	5.0	1.04	0.065	9.5	0.12	12.0

Sreepur site : Data on tillers, millable cane, yield of cane and by-product and % brix are shown in Table 2. It is seen from the Table that tillers, millable and yield of cane were produced significantly over control. The highest number of tillers $184.28 \times 10^3 \text{ ha}^{-1}$ were produced in T₄ ($2/3 \text{ N}$ and full PKSZn+cowpea) but the highest number of millable cane $77.31 \times 10^3 \text{ ha}^{-1}$ was found in T₃ ($2/3 \text{ N}$ and full PKSZn + sunhemp). In the case of cane by-product yield, the highest production of cane 134.91 TCH and by-product 13.49 t/ha were obtained in T₄.

The production of yield and yield parameters were found to be higher in GM intercrop treated plots than sole cane with full NPKSZn (T_2) and farmer's practice (T_1). In spite of $2/3$ N application in the GM intercrop plots. It is indicated that GM created a favourable environment for cane production. In Table 4, the GM intercrop plots T_3 , T_4 and T_5 showed higher cane yield by 63.15%, 67.09% and 65.29% respectively over farmers practice (T_1) and by 11.61%, 14.31% and 13.08% respectively over full NPKSZn (T_2).

On economic study, it was found that the net profit and B : C were much higher in GM intercrop treatments than full NPKSZn and farmers practice treatments. The highest net profit of Tk.1,02,880/- per hectare and B : C 4.20 were found in T_4 and T_5 respectively (Table 3).

Initial and post harvest soil analytical data are presented in Table 5. Data on initial soil analysis indicated that the soils are acidic having pH 5.0 and deficient in OC, N P K and S. OC-1.04%, total N-0.065% and available P-9.5 ppm, K-0.12 meq% and S-12.0 ppm were found in the soils. The post harvest soil analysis showed that OC, N, P, K, and S were slightly increased in GM intercrop treatments than initial soil, control (T_0), farmer's practices and some cases full NPKSZn (T_2) also.

Data on nutrient uptake are shown in Table 6. The uptake of nutrients are directly correlated with production of sugarcane. So, the highest uptake of NPKS was obtained in T_4 . Among the nutrients, the crop removed the highest amount of K from the soils.

Table 6. Uptake of different nutrients of the experiment on effect of green manuring as intercrop for sugarcane production at Ishurdi and Sreepur.

Location	Treatments	Nutrient uptake (kg/ha)			
		N	P	K	S
Ishurdi	T_0	27.91	23.32	106.2	14.56
	T_1	37.50	31.35	142.7	19.59
	T_2	40.65	34.0	154.7	21.23
	T_3	47.51	39.72	180.8	24.82
	T_4	41.34	34.56	157.4	21.60
	T_5	48.35	40.41	184.0	25.26
Sreepur	T_0	43.37	36.25	165.08	22.66
	T_1	54.09	45.21	205.88	28.26
	T_2	79.07	66.09	300.95	41.30
	T_3	88.26	73.77	335.91	46.10
	T_4	90.39	75.55	344.02	47.22
	T_5	89.42	74.74	340.32	46.71

From the experiment it is revealed that GM like dhaincha, sunn hemp and cowpea were grown as intercrop without hampering the main crop-sugarcane. Parthasarathy (1972) gave similar opinion that GM cane be grown as intercrop with sugarcane GM intercrops in irrespective of species increased cane yield over non GM plots i.e. control, farmers practice and full NPKSZn treatment of sole sugarcane. It also gave higher economic benefit. The results indicated that GM has some favourable effect and supplement N for sugarcane production. Alam *et al.* (1997) supported the results that GM increased the yield of succeeding sugarcane crop with lower rate of N. Uddin *et al.* (1996) also reported that GM crops supplement N and increase subsequent cane yield.

Data on post harvest soil analysis showed that in GM intercrop plots there was slight increase in OC, total N, available P, K and S content compared to initial soil and non GM plots. The results were also supported by Uddin *et. al.* (1996) and Alam *et.al.* (1997), they reported that GM slightly increased nutrient status of the soils which help prevent the depletion of some nutrients and maintain soil fertility.

Uptake of plant nutrients was found to be directly co-related with cane yield. The highest uptake was obtained from the highest production of cane. Among the nutrient uptaken, the crop removed the highest amount of K. Anderson and Bowen (1990) reported that sugarcane has a very high demand of K.

It is concluded from the experiment that GM as intercrop with sugarcane at its early stage is possible to grow without hampering the production of sugarcane specially in High Ganges River Flood Plain and Madhupur Tract AEZ. GM intercrops increases the yield of sugarcane and economic benefit. It also improves soil conditions with slight increase of the levels of OC, total N, available P, K and S.

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