Indian Journal of Agronomy **46** (2) : 354–360 (June 2001)

Effect of concentrated organic manure, nitrogen and sulphur on the productivity and economics of sugarcane (*Saccharum officinarum*)

C.N. CHOUDHARY AND U.P. SINHA

Sugarcane Research Institute, Rajendra Agricultural University, Pusa, Bihar 848 125

Received: March 2000

ABSTRACT

An experiment was conducted during the spring season of 1995–96 and 1996–97 on sandy-loam soil of Pusa, to study the effects of different levels of concentrated organic manure, nitrogen and sulphur on growth, yield and economics of sugarcane (*Saccharum officinarum* L.). Concentrated organic manure and N fertilization significantly influenced growth parameters and yield attributes, and crop responded up to 20 q organic manure, 150 kg N/ha, respectively, for cane yield and net profit. Integration of concentrated organic manure + N further induced significant increase in cane yield and net profit over their individual application. Concentrated organic manure 20 q with 150 kg N/ha resulted in significantly higher cane yield and net profit over 200 kg N/ha alone. Sulphur fertilization did not cause significant variation in cane yield, though there was improvement in sucrose (%) in juice, but it was reduced by increase in N levels.

Key words : Concentrated organic manure, Nitrogen, Sulphur, Productivity, Economics, Sugarcane

Use of chemical fertilization in combination with an appropriate ratio of organic manure is important in sustaining the productivity of crops and soils in sugarcane-based cropping system on a long-term basis (Singh and Yadav, 1994). A large number of workers (Yaduvanshi and Yadav, 1992; Dhillon *et al.*, 1993; Singh *et al.*, 1995) reported synergistic interaction among organic manures and inorganic N which modifies the quantum of nutrient uptake by plants as their effect is not merely added up but is actually enhanced. Sulphur is becoming a limiting factor in crop production. Yadav (1993) and Singh *et al.*(1995) found increased cane yield by sulphur application. Since systematic information on these aspects is meagre in such a situation, an ex-

A part of Ph.D. thesis submitted by the senior author to Rajendra Agricultural University , Pusa, Samastipur (unpublished)

periment was conducted to find out optimum dose of concentrated organic manure, nitrogen and sulphur for increasing the productivity as well as profitability of sugarcane.

MATERIALS AND METHODS

A field experiments was conducted during the spring cropping seasons of 1995–96 and 1996–97 at Sugarcane Research Institute Farm, Pusa, Samastipur. The soil was sandy loam, having 8.3 pH, 0.47% organic C, 25.7 % free $CaCO_3$, 13.2 ppm available S, available N,P,K levels of 223,11.9 and 109 kg/ha respectively. The treatments consisted of all combinations of 3 levels of concentrated organic manure applied through castor-cake (0, 10, and 20 q/ha), 4 levels of N (50,100, 150 and 200 kg/ha) and 2 levels of sulphur (0 and 25 kg/ha). A basal dose of 85 kg phosphate and 60 kg potassium/ha was uniformly applied. Total amount of concentrated organic manure, sulphur and half of N were applied as per treatments at the time of planting, whereas remaining N was top-dressed in 2 equal splits after first irrigation and at the time of earthing up (early July) as per the N levels. The source of sulphur was phosphogypsum which contained 14 % S and 1 % phosphate while castor cake had 4.98 % N and 0.29 % S. Factorial randomized block design was adopted with 3 replications.'BO 120' sugarcane was planted on 20 February 1995 and 14 February 1996 and harvested on 10 January 1996 and 15 January 1997 respectively. Whole cane samples were taken at the time of harvest and analysed for sucrose (%) in juice (Spencer and Meade, 1955).

Economic response dose (kg N/ha)=b–R/–2c was calculated where b and c represent regression coefficients and R denotes the ratio of cost per unit of nutrient to price per unit of produce , i. e. ratio of cost per kg N to price per quintal of sugarcane .

RESULTS AND DISCUSSION

Concentrated organic manure

Application of concentrated organic manure had positive and significant influence on all the growth and yield attributes of cane. Incorporation of concentrated organic manure in furrows resulted in improved germination (%) of setts at higher levels (20 q/ha) (Table 1). Organic manure might have improved soil temperature, air-exchange capacity and reduced bulk density which are congenial for good germination. Concentrated organic manure levels differed significantly among themselves for number of tillers at 125 days after planting, leaf-area index and millable canes/ha, however, 10 and 20 q/ha concentrated organic manure were found at par but significantly superior to the control in influencing plant height, cane diameter and weight/cane. Concentrated organic manure provided balanced nutrition in addition to ameliorating physical, chemical and biological properties of soil which led to improvements in growth and yield attributes of cane and finally the yield (Table 2). The increase in cane yield by 20 and 10 q cake over no application was 33.7 and 21.9 % in 1995–96 and 42.7 and 25.7% in 1996–97 respectively. Haider *et al.* (1993) and Singh *et al.*, (1995) also reported similar results. There was no significant variation in sucrose (%) in juice by cake application. On pooled basis application of 20 q cake accrued maxi-

Table 1. Effect of concentrated organic manure, nitrogen and sulphur levels on growth attributes of sugarcane

Treatment	Germination (%) 45 days*		Final tiller count ('000/ha) 125 days*		Leaf-area index 270 days*		Plant height (cm) 270 days*		Diameter of cane (mm) 270 days*	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Concentrated organic manure (q/ha)										
0	41.34	41.17	137.78	135.64	3.281	3.253	215.5	206.9	20.6	19.9
10	43.13	42.89	154.97	152.66	3.642	3.601	225.1	215.6	21.3	20.7
20	43.91	43.59	167.58	166.10	3.884	3.830	232.6	223.3	21.5	20.8
CD (P = 0.05)	2.16	1.83	8.91	8.52	0.147	0.115	9.4	10.2	0.6	0.5
N (kg/ha)										
50	42.07	41.79	136.50	133.33	3.270	3.210	215.1	205.1	20.1	19.4
100	42.85	42.64	152.37	150.49	3.556	3.537	224.4	216.1	21.1	20.3
150	43.32	43.08	162.66	160.82	3.781	3.704	228.9	220.9	21.6	20.9
200	42.93	42.72	163.23	161.25	3.805	3.792	229.2	219.0	21.7	21.2
CD (P = 0.05)			10.29	9.84	0.179	0.132	10.9	11.8	0.7	0.7
S (kg/ha)										
0	42.79	42.55	153.40	151.19	3.556	3.596	223.5	214.7	20.9	20.3
25	42.80	42.56	153.48	151.75	3.608	3.564	225.2	215.9	21.3	20.6
CD (P = 0.05)										

*Days after planting

Table 2. Yield attributes, yield, sucrose (%) in juice and net profit of sugarcane as influenced by levels of concentrated organic manure, nitrogen and sulphur

Treatment	Millable canes ('000/ha)		Single cane weight (g)		Cane yield (tonnes/ha)		Sucrose (%) in juice		Net profit (Rs /ha)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Concentrated organic manure (q/ha)										
0	98.1	97.7	638	627	58.5	55.7	16.70	16.47	25,205	21,620
10	110.6	109.1	686	678	71.3	70.0	16.80	16.54	30,143	27,502
20	119.3	119.2	700	706	78.2	79.5	16.69	16.32	31,171	30,038
CD (P = 0.05)	6.2	5.8	32	29	3.8	4.2	NS	NS	1,458	1,640
N (kg/ha)										
50	97.2	96.0	632	633	59.2	58.5	17.08	16.63	22,488	20,353
100	108.2	107.6	674	671	68.0	66.9	16.97	16.53	28,097	25,342
150	116,3	115.5	699	690	74.5	74.1	16.62	16.38	32,187	30,091
200	117.1	115.7	695	684	75.7	74.2	16.25	16.23	32,586	29,773
CD (P = 0.05)	7.2	6.7	37	34	4.4	4.9	0.34	NS	1,684	1,894
S (kg/ha)										
0	109.5	108.6	670	668	68.8	67.7	16.62	16.26	28,661	26,252
25	109.8	108.9	680	671	69.9	69.0	16.84	16.62	29,018	26,542
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	0.25	NS	NS

mum net profit, followed by 10 q cake and both of them were significantly superior to no application which was due to significant variation in cane yield.

Nitrogen

Nitrogen @150 and 200 kg/ha were found at par but significantly superior to 50 and 100 kg N/ha in influencing tiller count at 125 days after planting, leaf-area index at 270 days after planting, plant height, cane diameter, millable canes at havest and weight/ cane (Table 1). Nitrogen induced early emergence and production of tillers which eventually resulted in higher number of mature stalks. Kapoor *et al.* (1995) reported significant increase in number of millable canes up to 150 kg N/ha. Positive improvement in all the growth and yield attributes by N fertilization led to accelerated carbohydrate production and utilization which ultimately resulted in higher tonnage (Table 2) . The increase in cane yield by 200, 150 and 100 kg N/ha over 50 kg N/ ha was 27.9, 25.8 and 14.9 % in 1995–96 and 26.8, 26.7 and 14.4 % in 1996–97 respectively.

Response to N in terms of cane yield (on pooled basis) was 0.17, 0.14 and 0.13 tonne/kg N between 50 and100, 100 and 150 and 150 and 200 kg N/ha respectively. No marked response of N beyond 150 kg N/ha might be attributed to nutrient imbalances and consequent metabolic disturbances. Kapoor *et al.* (1993) and Singh *et al.* (1995) reported that sugarcane significantly responded up to 150 kg N/ha. The pooled data of cane yield were fitted to quadratic response curve of which coefficient of determination (R^2) was found to be highly significant.

$$Y = 45.098 + 0.310 \times 0.001\ X^2\ (R^2 = 0.9939)$$

where 'Y' is the expected yield (tonnes) and 'X' is the level of N (kg/ha). Sugarcane responded significantly up to 150 kg N/ha but the economic dose calculated from the quadratic equation was 96.41 kg N/ha with a cane yield of 69.13 tonnes/ha. The increase in cane yield at economic N dose was 6.89 tonnes/ha which fetched a net return of Rs 4 892 over 50 kg N/ha (cane price @ Rs 710/tonnes and N @ Rs 8.32/ kg). It recorded a net return of Rs 12.67/ rupee investment on nitrogen.

Sulphur

Sulphur fertilization could not cause significant improvement in growth and developmental characters of cane and cane yield (Tables 1,2).This might be attributed to the fact that initial level of available sulphur was above the critical limit of 10 ppm (Tandon, 1991) besides mobilization of native soil sulphur by organic manure. Sen *et al.* (1996) also could not observe significant influence in cane yield up to 40 kg S/ha application. There was 0.22 and 0.36 unit increase in sucrose % juice during 1995–96 and 1996–97 respectively by S fertilization , however, it could reach the level of significance in 1996–97 only. Improvements in sucrose(%) in juice owing to S application might be substantiated by the fact that S exerted a favourable cellular environment, so as to forestall the inactivation of iron that is responsible for iron chlorosis. As supply of S increased , plants ability to utilize iron is positively influenced. Ghosh *et al.* (1989) reported improvement in quality indices of

Table 3. Effect of interaction between levels of concentrated organic manure and nitrogen on cane yield and net profit (pooled data of 2 years)

Concentrated organic manure (q/ha)	Cane yield (tonnes/ha) at			
	N_{50}	N_{100}	N_{150}	N_{200}
Control	49.72	55.55	60.46	62.65
10	57.06	67.74	77.40	80.15
20	69.66	78.94	84.97	81.92
CD (P = 0.05)	10.58			
	Net profit (Rs/ha)			
Control	19,041	22,556	25,488	26,568
10	20,198	27,070	33,247	34,783
20	25,025	30,634	34,683	32,185
CD (P = 0.05)		3,813		

cane by S application . Sulphur fertilization failed to influence net profit (Rs/ha) due to the fact that application of S did not improve cane yield significantly.

Interaction effects

Interaction of concentrated organic manure and nitrogen was synergistic and significant (Table 3). Nitrogen fertilization showed positive response when it was combined with 10 or 20 q cake than no application. On pooled basis, combination of 20 q cake with 150 kg N recorded the maximum cane yield, followed by 20 q cake along with 200 kg N and 100 kg N/ha;10 q cake with 150 kg N and 200 kg N/ha. Concentrated organic manure enhanced efficiency of growth and reduced the need for higher rates of N fertilization. Singh and Yadav (1992) and Singh *et al.* (1995) reported similar results.

The interaction effect of nitrogen and concentrated organic manure were also worked out by fitting quadratic production function. The pooled data on cane yields were fitted to quadratic response curve to find out optimum dose of nitrogen at 10 q (Y_1) and 20 q (Y_2) concentrated organic manure/ha respectively.

$$Y_1 = 40.988 + 0.356\,X - 0.001\,X^2 \; (R^2 = 0.994^{**})$$
$$Y_2 = 53.00 + 0.390\,X - 0.001\,X^2 \; (R^2 = 0.987^{**})$$

The nitrogen dose worked out from the above equation was 178 kg N at 10 q concentrated organic manure/ha and 195 kg N at 20 q concentrated organic manure/ha with corresponding values of optimum yields were 72.67 and 91.02 tonnes/ha respectively.

The net profit was higher in the combination of cake with nitrogen (Table 3). It was also evident that 200 kg/ha without castor cake was less profitable compared to lower doses of N (100 and 150 kg N/ha) combined with cake. Thus, combined application of concentrated organic manure and nitrogen by increasing the efficiency of production and response of sugarcane to nutrients increased net profit synergistically.

REFERENCES

Dhillon, N.S., Brar, B.S. and Vig, A.C. 1993. Ef-

fect of FYM, N,P and K on cane yield and sugar content of sugarcane. *Indian Sugar* **43** : 171–74.

Ghosh, A.K, Singh, K., Srivastava, A.K. and Saxena, Y.R. 1989. Yield of sugarcane as influenced by varying N:S ratio in fertilizers. *Journal Indian Society of Soil Science* **37** (1) : 183–85.

Haider, M.G., Samad, M.A. and Waris, M.L. 1993. Efficiency of organic amendment and carbofuran on plant parasitic nematodes, yield and juice quality of sugarcane. *Indian Sugar* **43** : 925–929.

Kapoor, M.L., Singh, Y., Singh, B. and Meelu, O.P. 1993. Effect of sources and levels of nitrogen application on the yield and quality of plant and ratoon crops of sugarcane. *Fertiliser News* **38** (11) : 27–31.

Sen, A., Singh, K.D.N., Bhogal, N.S. and Nath, R.P. 1996. Effect of sulphur on yield, juice quality and nutrient content of sugarcane. *Journal of Research, Birsa Agricultural University* **8**(2) : 119–122.

Singh, G.B. and Yadev, D.V. 1994. Critical analysis of long term manurial experiments on sugarcane in India. *Fertiliser News* **33**(10) : 27–34.

Singh, P.P., Saini, S.K. and Kumar, K. 1995. Response of sugarcane to organic sources and nitrogen. *Indian Journal of Sugarcane Technology* **10** (2) : 124–127.

Spencer, G.L. and Meade, G.P. 1955. *Cane sugar Hand Book*, pp. 611–621. John Willey & Sons, London.

Tandon, H.L.S. 1991. *Sulphur Research and Agricultural Production in India.* 140 pp. The Sulphur Institute, Washington D.C.

Yadav, D.V. 1993. Response behaviour of sugarcane to N, P, K, S and micronutrients in different parts of country. *Fertilizer News* **38** (10) : 31–33.

Yaduvanshi, N.P.S. and Yadav, D.V. 1992. Effect of direct, residual and cumulative application of pressmud with nitrogen on soil properties, yield and quality of sugarcane. *Indian Journal of Sugarcane Technology* **7**(1) : 33–39.