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Sustainability of Sugarcane Productivity in Sugarcane Plant-Ratoon Cropping System

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ABSTRACT

The sustainability of sugarcane productivity in sugarcane plant-ratoon cropping system was studied at Regional Agricultural Research Station, Anakapalle, India. Integrated use of manures with either 100% recommended NPK or 50% recommended N and full P and K resulted in higher uptake of nutrients. This led to higher cane and sugar yield of both plant and ratoon crops. Maximum cane yield, sugar and juice sucrose percent were recorded when plant crop received 10 t/ha each of cane trash and pressmud cake besides 100% recommended NPK. Similarly, cane and sugar yields as well as juice sucrose percent were the highest when ratoon crop received 100% recommended NPK besides residual effects of 10 t/ha each of pressmud cake and cane trash applied to preceeding plant crop. Maintenance of cane and sugar yields of ratoon crop at higher levels is brought out from these studies through integreted use of organic and inorganic source of nutrients, specially when level of inorganic nitrogen is reduced to 50% of recommended dose.

INTRODUCTION

Excessive use of fertilizers, pesticides and water is the bane of cultivation of crops like sugarcane for higher production. The nitrogenous fertilizers play important role in increased productivity of sugarcane till recently. Of late, the emerging deficiencies of other nutrients like, P.K.S and micronutrients limited the sugarcane production. It is well recognised that exclusive use of chemical fertilizers or organic manures cannot improve cane production besides maintaining soil health. Hence, a blend of organic manures and chemical fertilizers has to be worked out for an input intensive crop like sugarcane. Usually sugarcane plant-ratoon cropping system is followed by the farmers for achieving economic returns. Hence, the effect of integrated use of organic wastes like cane trash, pressmud cake, farm yard manure and green manure alongwith chemical fertilizers on the nutrients use efficiency, yield and quality is worth studying for sustainable sugarcane productivity in sugarcane plant-ratoon cropping system.

MATERIALS AND METHODS

Field experiments were conducted at Regional Agricultural Research Station, Anakapalle, India in sugarcane plant-ratoon cropping system during 1992-93 and 1993-94 seasons with the following treatments:

T_1 : NPK + micronutrients based on recommended doses for both crops.
T_2 : T_1 + 20 t/ha FYM (FYM to sugarcane plant crop only).
T_3 : 20 t/ha FYM (to plant crop) + 50% N + full P and K to each crop.
T_4 : T_1 + green manuring with green manure crop once in crop cycle during kharif.

T_5 : T_1 + Sulphitation Pressmud + trash @ 10 t/ha to sugarcane plant crop only.

T_6 : Green manure treatment as in T_4 + 50% N and full P and K to each crop.

T_7 : Trash + pressmud cake each @ 10 t/ha (to plant crop) + 50% N + full P and K to each crop.

T_8 : T_1 + integrated pest management to each crop.

T_9 : 50% N + full P and K to each crop.

T_{10} : Control (No NPK, micronutrients and manures).

The recommended doses of NPK and micronutrients were 112 kg N + 75 kg P_2O_5 + 120 kg K_2O + 50 kg $ZnSO_4$ per hectare for plant crop and 224 kg N + 75 kg P_2O_5 + 120 kg K_2O + 50 kg $ZnSO_4$ for ratoon crop. P, K and Zn were applied basally whereas N was applied in two splits at 45 and 90d after planting in sugarcane plant crop and at ratooning and 45d after ratooning in case of ratoon crop. The test variety was Co 7219 and treatment were tested in quadruplicate in randomised block design. The plant crop was planted in March, 1992 and ratooned in March, 1993. Uptake of N, P, K, cane yield and juice quality were recorded using standard procedures (Piper, 1967; Browne and Zerban, 1941).

The experimental soil was clay loam in texture, dark brown, moderately drained, very deep, non-calcareous, neutral in reaction (pH7.2), normal in conductivity (EC: 0.12 ds/m), low in available nitrogen (224 kg/ha), medium in available P_2O_5 (40 kg/ha) and high in available K_2O (346 kg/ha). Standard procedures were followed for determination of soil characteristics (Jackson, 1967). The farm yard manure had 1.02% N, 0.63% P_2O_5 and 1.20% K_2O. The N, P and K contents of cane trash were 0.27%, 0.55% and 0.52% respectively. The available N, P and K contents of pressmud cake were 0.24%, 0.72% and 0.19% respectively.

RESULTS AND DISCUSSION

The uptake of N, P and K, cane yield, sugar yield and juice sucrose percent of plant and ratoon crops as influenced by different levels of manures and fertilizers are presented in the Tables 1 and 2.

Uptake of NPK:

The highest uptake of NPK were recorded when crop received 100% NPK and 10t/ha each of cane trash and pressmud cake in case of plant crop and 100% NPK and residual effects of 10 t/ha each of trash and pressmud in sugarcane ratoon crop. The lowest uptake of nutrients were obtained in control plots of both plant and ratoon crops. It is interesting to note that percent utilization of applied N at 100% recommended N was higher (59.0%) than 50% N (44.1%) in case of plant crop. Similarly nitrogen utilization of ratoon crop at 100% recommended N was higher (23.9%) than 50% N (12.6%). Further, upake of N in general was higher in presence of organic manures when compared to inorganic fertilizers in both plant and ratoon crops. In the plant crop, integrated use of farm yard manures and chemical fertilizers either at 100% or 50% recommended doses of N resulted in lower nitrogen uptake possible due to immobilization of nitrogen during process of decomposition by micro-organisms. However, phosphorus and potassium uptakes by plant and ratoon crops both at 50% and 100% recommended N application, were higher due to integrated use of manures and inorganic fertilizers. Though all treatments received recommended doses of P and K; uptake of phosphorus (34.4 kg/ha) and potassium (283.2 kg/ha) at 100% recommended N to plant crop was higher than at

50% recommended N (26.5 kg/ha and 200.9 kg/ha respectively). Similarly, in case of ratoon crop, P and K uptakes at 100% recommended N i.e., 33.6 kg/ha and 286.9 kg/ha were higher than at 50% recommended N (26.24 kg/ha and 215.7 kg/ha respectively). This might be due to lower dry matter production. Thus, these uptake studies indicate beneficial effects of organic manures applied to plant crop in better utilization of applied fertilizers and their residual effects on succeeding ratoon crop when recommended doses of fertilizers were applied. Singh *et al.* (1993) observed that integrated use of fertilizers N each with green manuring in plant cane and its residues in ratoon increase N-use efficiency.

Table 1. Effects of fertilizers and manures on uptake of nutrients, yield and quality of sugarcane plant crop.

	Treatments	Uptake of nitrogen (kg/ha)	Uptake of phosphorus (kg/ha)	Uptake of potassium (kg/ha)	Cane yield (t/ha)	Sugar yield (t/ha)	Juice sucrose (%)
T_1 =	NPK + micro-nutrients based on recommended doses for both crops.	199.4	31.9	269.1	92.3	11.2	17.0
T_2 =	T_1 + 20 t/ha FYM (FYM to sugarcane plant crop only)	170.6	35.4	300.8	90.0	11.4	18.3
T_3 =	20 t/ha FYM (to plant crop)+ 50% N + Full P and K to each crop.	133.0	24.8	198.9	91.4	11.9	18.2
T_4 =	T_1 + green manuring with green manure crop once in crop cycle	200.6	32.2	279.5	89.5	11.1	17.2
T_5 =	T_1 + sulphitation pressmud and trash @ 10 t/ha to plant crop.	204.3	40.7	292.5	96.8	13.0	18.4
T_6 =	Green manure treatment as in T_4 + 50% N and full P and K to each crop.	148.3	28.5	197.7	92.6	12.0	18.0
T_7 =	Trash + Pressmud cake each @ 10 t/ha (to plant crop) + 50% N + full P and K to each crop.	146.7	30.0	213.0	86.6	11.5	18.4
T_8 =	T_1 + integrated pest management to each crop.	159.0	31.8	274.2	93.7	12.1	17.7
T_9 =	50% N + full P and K to each crop	153.5	22.8	194.0	90.7	11.4	17.5
T_{10} =	Control	120.7	24.0	184.1	77.3	9.1	16.0
	C.D. at P=0.05	--	--	--	--	1.65	1.38

Table 2. Effects of fertilizers and manures on uptake of nutrients, yield and quality of sugarcane ratoon crop.

	Treatments	Uptake of nitrogen (kg/ha)	Uptake of phosphorus/kg/ha	Uptake of potassium (kg/ha)	Cane yield (t/ha)	Sugar yield (t/ha)	Juice sucrose (%)
T_1 =	NPK + micro nutrients based on recommended doses for both crops	170.1	31.5	285.4	95.1	11.5	17.7
T_2 =	T_1 + 20 t/ha FYM (FYM to sugarcane plant crop only)	167.6	32.6	264.8	95.6	12.6	17.8
T_3 =	20 t/ha FYM (to plant crop)+ 50% N + Full P and K to each crop.	150.0	28.5	266.9	89.1	11.6	17.4
T_4 =	T_1 + green manuring with green manure crop once in crop cycle	174.7	36.2	288.4	89.5	11.2	17.4
T_5 =	T_1 + sulphitation pressmud and trash @ 10 t/ha to plant crop.	188.5	36.4	329.1	96.0	12.9	18.1
T_6 =	Green manure treatment as in T_4 + 50% N and full P and K to each crop.	159.1	27.1	212.1	81.1	10.5	17.1
T_7 =	Trash + Pressmud cake each @ 10 t/ha (to plant crop) + 50% N + full P and K to each crop.	117.5	24.2	209.2	89.2	11.9	17.3
T_8 =	T_1 + integrated pest management to each crop.	182.2	31.5	267.1	94.3	12.1	17.6
T_9 =	50% N + full P and K to each crop	122.0	25.1	174.5	76.9	9.7	17.3
T_{10} =	Control	123.0	23.1	167.6	56.2	6.7	16.6
	C.D. at P=0.05	--	--	--	16.5	2.0	0.6

Cane and Sugar Yield:

The cane and sugar yields in sugarcane plant-ratoon crops are presented in the Tables 1 and 2. The highest cane and sugar yields were obtaianed when plant crop received 10 t/ha each of cane trash and pressumud cake alongwith 100% recommended doses of NPK. Similarly, cane and sugar yields were maximum when ratoon crop received 100% recommended doses of NPK in addition to residual effects of 10 t/ha each of cane trash and PMC. The sustainability in productivity in sugarcane plant-ratoon cropping system is given in the Table 3. Higher uptake of nutrients due to integrated use of organic manures (cane trash and pressmud cake) and inorganic fertilizers (100% recommended NPK) might have helped in production of more cane and sugar. The ratoon crop yields improved slightly (1.8%) than plant crop, when both plant and ratoon crops received 100% recommended NPK. But when applied nitrogen was reduced to 50%, ratoon cane yield decreased by 6.8%. The ratoon cane yields further reduced to 16.1% when no fertilizers were applied. When integrated effects of inorganic fertilizers and manures were considered; ratoon cane yield increased by 2.8 t/ha than plant crop yields, when both plant and ratoon crops received 100% N as inorganic fertilizers alone. Such improvement was noted to be 3.8 t/ha under integrated use of fertilizers and

manures. However, when level of inorganic N was reduced by 50%, reduction in cane yields of ratoon crops was noted to be 13.8 t/ha when inorganic fertilizers alone were applied. Such decrease in ratoon yields when compared to plant crop yield was only 3.5 t/ha when integrated use of inorganic fertilizers and manures was made. Yaduvanshi and Yadav (1993) found that integrated use of 100 kg N/ha with 10 t/ha pressmud gave economy of 50 kg N/ha by producing millable cane, yield of sugarcane ratoon equal to 150 kg/ha alone. Jadhav *et al.* (1993) reported organic sources like cane trash, pressmud cake, spent waste and their compost, FYM, green manuring reduce use of chemical fertilizers.

Table 3. Sustainability of sugarcane productivity in sugarcane plant-ratoon cropping system.

Levels of fertilizer N	Cane yield (t/ha)		Sugar yield (t/ha)	
	Plant crop	Ratoon crop	Plant crop	Ratoon crop
100% N	92.4	94.1	11.8	12.1
50% N	90.2	84.1	11.7	10.9
0 N	77.3	56.2	9.1	6.7
100% N + full P and K as inorganic fertilizers	92.3	95.1	11.2	12.0
Integrated use of 100% NPK inorganic fertilizers + organic manures	92.1	95.8	11.4	11.8
50% N + full P and K as inorganic fertilizers	90.7	76.9	11.5	12.2
Integrated use of 50% N and full P and K as inorganic fertilizers + organic manures	90.0	86.5	9.7	11.3

The sugar yield of ratoon crop improved slightly (0.22 t/ha) than plant crop when 100% recommended doses of NPK alone were applied. But at 50% recommended dose of N, sugar yield of ratoon crop reduced by 0.78 t/ha. The ratoon cane yield further reduced to 2.4 t/ha when neither fertilizers nor manures were applied. When integrated effects of inorganic fertilizers and manures were considered, at 100% recommended N: ratoon crop sugar yield increased by 0.79 t/ha than plant crop sugar yield; when inorganic fertilizers alone were applied, such improvement was found to be 0.35 t/ha under integrated use of inorganic fertilizers and manures. When level of inorganic fertilizer N was reduced to 50%, ratoon sugar yield increased by 0.77 t/ha than plant crop sugar yield when inorganic fertilizers alone were applied. Under integrated use of manures and fertilizers, such improvement in ratoon sugar yield was 1.68 t/ha. Thus, higher sugar yield of ratoon due to integrated effects of inorganic and organic source of nutrients, more so at lower doses of applied N (50%) was brought out from these studies. Integrated use of FYM @ 10 t/ha and 180 kg N/ha improved sugar yield (Palchamy *et al.* 1994).

Juice Sucrose Percent:

Maximum juice sucrose percent was recorded when plant crop received 100% recommended NPK and 10 t/ha each of pressmud cake and cane trash. Similarly, juice sucrose content of ratoon crops which received 100% recommended NPK besides residual effects of 10 t/ha each of cane trash and perssmud cake. The juice sucrose percent of both plant and ratoon crops tended to depress when level of nitrogen increased from 0 to 100% recommended dose. Palchamy *et al* (1994) reported that the

juice quality was higher at lesser doses of nitrogen. When sugarcane plant-ratoon system is considered, juice surcrose percent of plant and ratoon crops which received 100% NPK were 17.0 and 17.7 respectively. But these values rose to 17.9 and 17.7 due to integrated use of 100% NPK and organic manures. Similarly at 50% recommended N level; juice sucrose values of plant and ratoon crops were 17.5 and 17.3 respectively. Such values with integrated use of manures and 50% inorganic N were 18.2 and 17.2 respectively. These results broadly indicate that integrated use of manures and fertilizers maintain juice quality at higher level when compared to use of inorganic fertilizers alone in sugarcane plant-ratoon cropping system.

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