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Effect of different sources and levels of organics on sugarcane (*Saccharurn officinarum*)

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ABSTRACT

An experiment was carried out to assess the effect of different sources and levels of organics on plant (2005-2006) and ratoon (2006-2007) sugarcane (*Saccharum officinarum* L.) on a heavy black soil. Germination, cane length, cane girth, cane and trash yields of sugarcane were significantly affected due to the different manurial treatments both in plant and ratoon crops. Crop receiving recommended dose of fertilizers (RDF *i.e.* 250 : 54.6 : 103.3 kg N:P:K/ha in plant and 300:27.3:103.3 kg N:P:K/ha in ratoon) gave significantly higher cane yield of plant (106.2 t/ha) and ratoon (94.3 t/ha), net returns (1,14,568 Rs/ha) and net B:C ratio (1.99) of sugarcane. Application of poultry manure (PM) @ 5 t/ha at planting + castor cake @ 1 t/ha at earthing up in plant crop and Bio compost (BC) @ 10 t/ha at planting + PM @ 5 t/ha at earthing up were next best treatments after RDF. The nutrient uptake (NPK) of plant cane was highest with RDF but in ratoon crop, BC (10 t/ha) + PM (5 t) recorded highest uptake values. The BC + PM treatment also resulted in highest soil fertility after plant-ratoon cropping of sugarcane.

Key words: Economics, Organic nitrogen compounds, Sugarcane, Yield

Sugarcane (*Saccharum officinarum* L.) is grown extensively in tropical and sub-tropical regions of India as cash crop and plays a pivotal role in both agricultural and industrial economy of the country. India is one of the largest producers of cane sugar sharing 13% of the world and 41% of Asia's production (Chinnasamy and Jayanthi, 2004). In India, sugarcane is grown under different agro-climatic conditions and occupies about 2.2% (4.4 m ha) of the gross cropped area with an average productivity of 68.2 t/ha. In Gujarat, it is grown only in 0.176 m ha with a productivity of 71 t/ha (NAU, 2005), mainly in South Gujarat. Despite of its long crop duration (18 months), productivity of sugarcane is relatively poor in Gujarat with narrow profit margins. Under certain situations, cost of cultivation exceeds the net realization resulting in a decline in cane area in South Gujarat, (NAU, 2003). Soil health deterioration under intensive agriculture coupled with limited or no use of organics is the major reason behind poor cane productivity. Therefore the present investigation was carried out to findout suitable nutrient management system for sugarcane under South Gujarat conditions.

MATERIALS AND METHODS

An investigation was carried out to study the sugarcane productivity and soil health under different sources and levels of organics in *Vertic Ustochrepts* of South Gujarat during 2005 - 2006 (plant) and 2006 - 2007 (ratoon) at the College Farm, Navsari Agricultural University, Navsari, Gujarat. The soil of experimental field was heavy black with 0.45% organic carbon, 245-15.4-276.9 kg/ha of available N-P-K. The seven treatments *viz.,* T_1; Biocompost (BC) @ 5 t/ha at planting + 5 t/ha at earthing up, T_2; BC @ 10 t/ha at planting +10 t/ha at earthing up, T_3; BC @ 10 t/ha at planting +castor cake (CC) @ 1 t/ha at earthing up, T_4; CC @ 1 t/ha at planting + 1 t/ha at earthing up, T_5; BC @ 10 t/ha at planting + poultry manure (PM) @ 5 t/ha at earthing up, T_6; PM @ 5 t/ha at planting and CC @ 1 t/ha at earthing up and T_7; 100 % of recommended dose of fertilizers (RDF) i.e. 250-54.6-103.3 in plant and 300-27.3-103.3 kg N:P:K/ha in ratoon) were tested in randomized block design with four replications. The sugarcane 'Co LK 8001' was planted in rows 100 cm apart using 35,000 three eye budded setts/ha. The fertilizers and manures were applied as per the treatment. The treatment receiving fertilizers i.e. N, P and K were supplied through urea, single super phosphate and muriate of potash, respectively. Green manuring with sunnhemp was done in whole field prior to plant sugarcane.

BC (1.80-1.19-1.93% N-P-K), PM (4.50-1.18-1.17% N-P-K) and CC (5.25-0.72-1.10% N-P-K) were applied as per the treatments, while uniform dose of bio fertilizers

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having 10^8 viable counts of *Aspergillus* and phosphate solubilizing bacteria [PSB (Strain NVS-1)] as well as *Acetobacter* and *Azospirillum* each @ 5 kg/ha were applied to all the treatments at the time of planting and earthing up of sugarcane, respectively in plant and ratoon crops. The crop was managed as per recommended package of practices except the treatments**.** The crop was planted during the first week of January, 2005 and harvested at first week of January, 2006. While the ratooning was done on second week of January, 2006 and harvested at second week of February, 2007. The rainfall received during the plant cane growth period was 2,427.7 mm in 52 rainy days, while for ratoon crop it was 1,613.6 mm in 42 rainy days. The mean minimum and maximum temperatures were respectively, 21.4 and 31.8 in first season (during plant crop) where as 22.0 and 32.1 ^oC in the second season (during ratoon crop). The net realization was calculated by deducting the total cost of cultivation from the gross realization for each treatment. The benefit cost ratio (BCR) was calculated as ratio of net realization to cost of cultivation.

RESULTS AND DISCUSSION

Germination and growth parameters

The treatments have significant effect on germination of sugarcane at 30 and 60 days after planting (DAP). Application of BC@ 10 t/ha at planting + PM @ 5 t/ha at earthing up resulted in highest germination followed by 20 t BC application in two equal splits at planting and at earthing up (Table 1).

The data further revealed significantly higher tillering and shoot height with application of RDF. Among the organic combinations, application of BC @ 10 t/ha at planting + PM @ 5 t/ha at earthing up (T_5) remaining at par with application of PM @ 5 t/ha at planting + CC @ 1 t/ha at earthing up proved superior to rest of the treatments, irrespective of the crop stage. Sugarcane receiving RDF produced tallest shoots being superior to T_1 and T_4 in plant and all other except T_5 in ratoon.

The results further indicated the beneficial influence of RDF on internodes/cane at harvest of plant and ratoon sugarcane but, this treatment was at par with treatment T_5 (data not given). Similarly the highest millable cane weight was recorded with RDF in both the plant (1.30 kg) and ratoon (1.14 kg) crops. While millable cane girth was arithmetically improved due to the application of BC @ 10 t/ha at planting + PM @ 5 t/ha at earthing up over RDF but, it was at par with T_7, T_6 and T_3 during plant and ratoon crops of sugarcane.

Yield, economics and nutrient uptake

Treatment receiving recommended dose of fertilizer recorded significantly higher cane yield (106.15 and 94.34 t/ha of plant and ratoon) of sugarcane. Among the organic manure treatments, BC @ 10 t/ha at planting + PM @ 5 t/ha at earthing up produced significantly higher cane yields (94.22 and 84.32 t/ha cane in plant and ratoon crop) than other organic manure treatments. However, this has recorded at par yields as that of PM @ 5 t/ha at planting + CC @ 1 t/ha at earthing up. Irrespective of treatments, the cane and trash yield of ratoon crop (Table 2) of sugarcane were less than that of the plant crop (Table 1).

Higher values of yield parameters in plant and ratoon crops in RDF treatment as compared to only organic nutrients has contributed to the greater cane yield. It is well known fact that use of organics alone is not adequate enough to meet the nutrient requirements of any crop and that is true for heavy feeder crop like sugarcane. For knowing the reasons of low yield of sugarcane with organics, periodical rate of dry matter accumulation (DMA) was calculated. In both plant and ratoon crops, the mag-

Table 1. Effect of different sources and levels of organics on growth parameters, yield attributes and yield of plant cane

Treatment	Germination (%)		Tillering (%)		Shoot height (cm)	Millable cane height (cm)	Cane girth (cm)	NMC (x 10^3 /ha)	Millable cane weight (kg)	Yield (t/ha)	
	30 DAP	60 DAP	120 DAP	180 DAP						Cane	Trash
T_1 : BC_{5t} PL + BC_{5t} EU	30.25	52.75	168	200	219.0	171.5	3.94	82.36	0.91	74.71	18.16
T_2 : BC_{10t} PL + BC_{10t} EU	33.50	58.00	176	206	227.8	178.8	4.00	81.94	1.00	81.52	21.39
T_3 : BC_{10t} PL + CC_{1t} EU	32.00	56.00	176	211	227.2	174.7	4.16	81.99	0.96	78.45	21.86
T_4 : CC_{1t} PL + CC_{1t} EU	30.50	51.50	163	190	207.7	167.2	3.82	81.52	0.82	67.11	18.31
T_5 : BC_{10t} PL + PM_{5t} EU	35.25	64.25	199	230	238.0	185.5	4.34	83.50	1.13	94.22	25.71
T_6 : PM_{5t} PL + CC_{1t} EU	32.00	56.50	190	218	230.7	178.7	4.23	81.89	1.08	88.47	23.94
T_7 : RDF	30.50	57.25	211	242	240.6	193.1	4.29	81.57	1.30	106.15	29.89
SEm±	0.89	1.21	3	4	4.9	3.4	0.06	0.34	0.04	3.40	0.91
CD(P=0.05)	2.64	3.69	10	11	14.6	10.2	0.19	NS	0.12	10.10	2.70

BC, Bio compost; PL, Planting stage; EU, Earthing up; CC, Castor cake; PM, Poultry manure; RDF, Recommended dose of fertilizer; NMC, Number of millable canes; DAP, Days after planting

Table 2. Effect of different sources and levels of organics on growth parameters, yield attributes and yield of ratoon cane

Treatment	Shoot height (cm)	Millable cane height (cm)	Cane girth (cm)	NMC (x 10^3 /ha)	Millable cane weight (kg)	Yield (t/ha)	
						Cane	Trash
T_1 : BC_{5t} PL + BC_{5t} EU	192.5	153.8	3.17	84.13	0.77	64.12	15.60
T_2 : BC_{10t} PL + BC_{10t} EU	197.0	158.2	3.27	83.87	0.85	71.61	17.61
T_3 : BC_{10t} PL + CC_{1t} EU	193.7	157.4	3.43	88.64	0.82	72.47	18.74
T_4 : CC_{1t} PL + CC_{1t} EU	189.2	150.4	3.07	88.85	0.69	61.22	14.36
T_5 : BC_{10t} PL + PM_{5t} EU	200.2	164.0	3.50	86.28	0.98	84.32	22.58
T_6 : PM_{5t} PL + CC_{1t} EU	197.5	158.7	3.36	83.95	0.93	77.89	20.37
T_7 : RDF	207.1	168.3	3.44	82.50	1.14	94.34	25.58
SEm±	2.7	2.8	0.06	2.82	0.04	2.19	0.55
CD (P=0.05)	8.0	8.3	0.19	NS	0.10	6.50	1.63

Table 3. Periodical accumulation of dry matter (kg /ha) of plant and ratoon cane

Treatment	Days after planting				Days after ratooning			
	60	120	180	Harvest	60	120	180	Harvest
T_1 : BC_{5t} PL + BC_{5t} EU	270.0	530.6	3,792	34,467	212.5	449.9	3,093	19,495
	(0.69)	(1.36)	(9.71)	(88.24)	(0.91)	(1.94)	(13.30)	(83.85)
T_2 : BC_{10t} PL + BC_{10t} EU	290.0	566.0	3,986	39,618	207.5	488.1	3,284	22,900
	(0.65)	(1.27)	(8.97)	(89.11)	(0.77)	(1.82)	(12.22)	(85.19)
T_3 : BC_{10t} PL + CC_{1t} EU	281.0	550.3	3,571	39,148	205.0	481.9	3,092	23,651
	(0.65)	(1.26)	(8.20)	(89.89)	(0.75)	(1.76)	(11.27)	(86.22)
T_4 : CC_{1t} PL + CC_{1t} EU	262.5	486.6	3,717	32,264	181.3	425.3	2,989	17,645
	(0.71)	(1.32)	(10.12)	(87.84)	(0.85)	(2.00)	(14.07)	(83.07)
T_5 : BC_{10t} PL + PM_{5t} EU	296.3	603.0	4,244	48,567	236.3	557.5	3,502	29,384
	(0.55)	(1.12)	(7.90)	(90.42)	(0.70)	(1.66)	(10.40)	(87.24)
T_6 : PM_{5t} PL + CC_{1t} EU	285.0	556.3	4,163	44,856	187.5	490.4	3,168	26,484
	(0.57)	(1.12)	(8.35)	(89.96)	(0.62)	(1.62)	(10.45)	(87.32)
T_7 : RDF	321.3	626.9	4,528	57,454	265.0	598.8	3,666	34,430
	(0.51)	(1.00)	(7.20)	(91.30)	(0.68)	(1.54)	(9.41)	(88.37)

Figure in parenthesis are per cent of total dry matter

nitude of DMA in treatment amended with organics (T_1 to T_6) was higher up to 180 DAP/DAR (days after ratooning) as compared to recommended dose of fertilizer alone. During subsequent growth period *i.e.* from 180 DAP or DAR to harvesting, recommended dose of fertilizer showed superiority with respect to DMA over rest of the treatments (Table 3). The results obtained in present study are also similar to those reported by Perumal (1999), Patel *et al.* (2002) and Patel (2006).

The results of present study clearly indicated that for meeting the nutrient requirement of plant and ratoon cane, application of recommended dose of fertilizer seems to be essential. However, the yield level achieved with recommended dose of fertilizer was 11.93 and 10.02 t/ha higher is plant and ratoon, respectively over the best organic nutrition treatment of BC 10 t/ha at planting + PM 5 t/ha at earthing up. The possible reason for this pattern might be due to the use of low C:N ratio material *viz.,* biocompost, poultry manure, castor cake and green manuring in present study. The nutrients supplied from organics persisted maximum up to 180 days and thereafter this supply failed to synchronize with nutrient demand of sugarcane. Similarly, the higher nutrient demand of sugarcane as it entered into grand growth phase might have further aggravated the situation of short supply of nutrients. In recommended dose of fertilizer treatment, where split application of fertilizers was practiced which might have maintained the perfect balance between nutrient supply and demand. Further, in present experimental field, sunnhemp green manuring was done and the possibility of its contribution towards nutrient supply can not be ruled out. The combined effect of all these factors might have resulted in higher cane yields with higher BCR value (1.99) and net realization (Rs.1,54,355/ha) with RDF treatment (Table 5) on sequential basis followed by organic manuring treatment of BC 10 t/ha + PM 5 t/ha (T_5). The results of present study are in close agreement with those reported by Kandagave (2000) and Patel (2006).

The N, P and K uptake by plant and ratoon crop (Table 4) were comparatively higher with RDF and it was closely

Table 4. Effect of different sources and levels of organics on nutrient uptake (kg/ha) of plant and ratoon sugarcane

Treatment	Plant cane						Ratoon cane					
	N		P		K		N		P		K	
	Cane	Total	Cane	Total	Cane	Total	Cane	Total	Cane	Total	Cane	Total
T_1 : BC_{5t} PL + BC_{5t} EU	63.7	145.3	18.95	36.97	80.2	158.5	52.6	75.8	15.70	22.64	75.68	96.52
T_2 : BC_{10t} PL + BC_{10t} EU	70.5	161.5	21.11	43.08	88.8	170.6	62.2	87.2	18.55	25.99	89.50	111.96
T_3 : BC_{10t} PL + CC_{1t} EU	62.3	158.6	18.58	40.73	78.4	164.9	59.0	87.4	17.62	26.13	84.75	110.28
T_4 : CC_{1t} PL + CC_{1t} EU	53.6	136.2	15.97	34.40	67.4	151.1	45.9	68.0	13.69	20.28	66.00	85.83
T_5 : BC_{10t} PL + PM_{5t} EU	68.4	174.7	20.59	47.70	86.0	186.4	68.1	102.2	20.32	30.51	97.87	128.51
T_6 : PM_{5t} PL + CC_{1t} EU	64.3	172.7	19.19	44.02	80.8	178.4	58.4	88.5	17.39	26.40	84.00	111.05
T_7 : RDF	69.6	198.4	20.73	54.22	87.6	202.2	54.2	94.8	16.10	28.22	78.02	114.55
SEm ±	5.2	7.8	1.58	2.14	6.6	9.7	3.7	4.5	1.12	1.36	5.36	6.03
CD (P=0.05)	NS	23.1	NS	6.35	NS	28.9	11.1	13.4	3.34	4.03	15.93	17.92

*Total uptake = Cane+Trash uptake

Table 5. Effect of different sources and levels of organics on available nutrient content (kg/ha) in soil and economics (x 10^3 Rs/ha) of sugarcane

Treatment	Plant crop				Ratoon crop				Economics*		
	Organic C%	N	P	K	Organic C%	N	P	K	Cost of cultivation	Net returns	Net B:C Ratio
T_1 : BC_{5t} PL + BC_{5t} EU	0.53	301	24.0	243.8	0.54	336	20.5	219.8	72.81	87.91	1.21
T_2 : BC_{10t} PL + BC_{10t} EU	0.57	373	31.9	257.9	0.59	376	23.6	244.6	82.41	94.69	1.15
T_3 : BC_{10t} PL + CC_{1t} EU	0.51	291	27.5	253.7	0.53	357	19.2	226.4	82.61	91.55	1.11
T_4 : CC_{1t} PL + CC_{1t} EU	0.50	280	22.7	239.7	0.52	353	21.4	220.7	83.01	65.16	0.79
T_5 : BC_{10t} PL + PM_{5t} EU	0.54	336	25.8	257.9	0.55	344	20.5	231.4	85.21	121.11	1.42
T_6 : PM_{5t} PL + CC_{1t} EU	0.52	298	25.3	250.4	0.53	352	19.2	218.2	77.81	114.57	1.47
T_7 : RDF	0.48	328	27.9	266.9	0.49	320	24.5	291.7	77.39	154.36	1.99
SEm ±	0.13	8	1.3	5.8	0.05	6	1.3	4.1			
CD (P=0.05)	0.04	25	3.9	16.5	0.14	18	3.5	11.6			
Initial Status	0.45	245	15.4	276.9							

Plant and ratoon cane

followed by treatment T_5 (BC @ 10 t/ha at planting + PM @ 5 t/ha at earthing up). The reasons given for treatment effects on dry matter are equally tenable here also.

Soil properties

Available nutrient status of soil at harvest revealed significant treatment differences (Table 5). Among the available nutrients studied, availability of N and P tended to improve even after harvest of ratoon crop in all the treatments in comparison to initial status. While in the case of available K, depletion was observed as compared to initial status in some of the treatments. The positive periodical balance of available N and P in soil observed in present study could be attributed to the addition of these elements through organics (T_1 to T_6) and fertilizer (T_7). This beneficial effect might be accentuated with low C: N materials viz., biocompost, poultry manure and castor cake used in present study. In other words, though the heavy feeder crop like sugarcane was grown continuously for two seasons (plant and ratoon), yet positive balance even with treatments receiving organics alone was observed. This implies that even under organic cultivation of sugarcane, available N and P status can be sustained.

From the two year study it may be concluded that recommended dose of fertilizers (250-54.6-103.3 and 300-27.3-103.3 kg N-P-K/ha in plant and ratoon cane) was best. However, application of biocompost (10 t/ha at planting) and poultry manure (5 t/ha at earthing up) if used regularly over the years, may fill up the gap in productivity and sustain the soil fertility better than use of recommended fertilizers to sugarcane.

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