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Long term effect of integrated nutrient management on productivity of sugarcane and soil fertility

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Abstract

A field experiment on Long term effect of Integrated Nutrient Management on Productivity of Sugarcane was conducted in two cycle consist of one plant cane and its successive 4 ratoon in each cycle at Central Sugarcane Research Station, Padegaon (M.S.) for ten years during 2006 to 2016 with an object of effect of integrated nutrient management on yield and quality of sugarcane, nutrient uptake and physico-chemical properties of soil. It was comprised of eight treatments viz., T₁-100% of RD through organics, T₂-100% NPK through inorganic, T₃-Fertilizer dose as per soil test (AST) with FYM & biofertilizer, T₄-75% of RD through organics + 25% RD through inorganic, T₅-50% of RD through organic & 50% of RD through inorganic, T₆-25% RD through organics +75% RD through inorganic, T₇-Use of Rishi- Krishi Tantra and T₈-Use of Jivamrut. Pooled results revealed that the treatment with 25% RD through organics + 75% RD through inorganic produced higher cane yield, CCS yield and average cane weight. The quality parameters were found non-significant. The soil pH was decreased in all the treatments except the treatment 100% NPK RD through inorganic fertilizers and lower EC was observed in the treatment rishi Krishi Tantra. The status of soil organic carbon was significantly improved over initial due to application of different organics. The same treatment having combinations of with 25% RD through organics + 75% RD through inorganic recorded higher gross monitory returns (Rs. 252290 ha⁻¹), net returns (Rs.179225 ha⁻¹) and B:C ratio (2.45). The result indicated that the application of 25% recommended dose of NPK through organics + 75% recommended dose of NPK through inorganic fertilizers for sugarcane was found beneficial in terms of yield, sustenance of soil fertility and economics.

Keywords: Integrated nutrient management, organic fertilizer, inorganic fertilizer, productivity, sugarcane

Introduction

Sugarcane is a long duration crop and it demands large amount of nutrient for their production. Indian agriculture is facing a challenge to prevent its soil degradation, nutrient mining and depletion of fertility. Plant nutrients in soil, whether naturally endowed or artificially maintained, are a major determinant of the success or failure of a crop production system. Proper soil fertility management is an importance to increase crop production. Sugarcane being a long durable exhaustive crop with heavy nutritional demand, its soils become less fertile and fails to produce higher cane yield. Balanced use of manures and fertilizers is very essential. Neither inorganic fertilizers nor organic manures can achieve the sustainability with stable soil fertility where nutrient turn over in the soil plant system is faster and larger [7]. Sugarcane is grown well in the soils having sufficient level of organic matter and available nutrients [3]. But the organic matter content in Indian soil is far below (less than 1%) than crop requirement and it is depleting day by day [6]. Nutrients replenishment through integrated use of organic manures, biofertilizers and chemical fertilizers in sugarcane soil is indispensable for sustained cane production.

With this background, the present investigation was undertaken on “Long term use of Integrated Nutrient Management on Productivity of Sugarcane” during 2006-07 to 2016-17 with the objectives effect of integrated nutrient management on yield and quality of sugarcane, nutrient uptake and physico-chemical properties of soil during preseason.

Materials and Methods

The experiment on Long term effect of Integrated Nutrient Management on Productivity of Sugarcane was conducted in two cycle in which one cycle consist of one plant cane and its successive 4 ratoon and same in second cycle at Central Sugarcane Research Station, Padegaon (M.S.) for ten years during 2006 to 2016 in Maharashtra. It was laid out in randomized block design comprising of eight treatments with three replications.

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The treatments were as: T₁- 100% of RD (400:170:170 N: P₂O₅:K₂O kg ha⁻¹) through organics, T₂ - 100% RD-NPK through inorganic, T₃ - Fertilizer dose as per soil test with FYM & biofertilizer, T₄ - 75% of RD through organics + 25% RD through inorganic, T₅ - 50% of RD through organic & 50% of RD through inorganic, T₆ - 25% RD through Organics + 75% RD through inorganic, T₇ - Use of Rishi- Krishi Tantra and T₈ - Use of Jivamrut. The organic sources for plant cane based on 100% RD NPK are sann hemp (GM) before sugarcane, FYM 21 t ha⁻¹, PMC 5 t ha⁻¹, vermicompost 2.5 t ha⁻¹ and composite culture of BF 5 kg ha⁻¹ i.e. *Azotobacter*, *Acetobacter*, *Azospirillum* and PSB and for ratoon crop it was in situ trash (7.5 t) composting, FYM 12 t ha⁻¹, PMC 5 t ha⁻¹,

vermicompost 2 t ha⁻¹ and composite culture of BF 5 kg ha⁻¹. The plant cane was planted in the month of November and the tested cane variety was Co 86032. For plant cane N was applied in 4 splits in 10:40:10:40 ratio and P and K in two equal splits at planting and at earthing up. For ratoon crop N, P and K was applied in two equal splits at ratooning and 135 days after ratooning. Data on the growth, yield and quality parameters were recorded.

The soil of the experimental field had pH of 7.81, EC 0.18 dSm⁻¹, organic carbon 0.60, available N 198 kg ha⁻¹, available P 16.0 kg ha⁻¹, available K 314 kg ha⁻¹. The name and composition of different organic sources used in study are shown in Table A and Table B.

Table A: Major nutrient composition of FYM, PMC, Vermicompost, Sunn hemp (GM), Sugarcane trash

Sr. No.	Name of organic materials	Total Nitrogen (%)	Total Phosphorus (%)	Total Potassium (%)
1	FYM	0.61	0.43	0.83
2	PMC	1.50	2.25	1.00
3	Vermicompost	0.72	0.49	0.32
4	Sunn hemp (Green Manure)	0.69	0.21	0.51
5	Sugarcane trash	0.45	0.18	0.95

Table B: Major nutrient composition of Jivamrut and Rishi- Krishi

Sr. No.	Jivamrut		Rishi Krishi	
1	pH	: 5.44	pH	: 6.03
2	EC	: 1.72 dSm ⁻¹	EC	: 1.03 dSm ⁻¹
3	Total N	: 1.56%	Total N	: 1.79%
4	Total P	: 0.013%	Total P	: 0.16%
5	Total K	: 0.16%	Total K	: 0.28%
6	Fe	: 23.22 ppm	Fe	: 12.00 ppm
7	Zn	: 4.32 ppm	Zn	: 16.00 ppm
8	Mn	: 17.70 ppm	Mn	: 24.00 ppm

Table C: The quantity of organic and inorganic fertilizer applied in this study

SN	Treatments	Sources for plant cane	Sources for ratoon
1.	100% of RD through organics	1. Sanhemp (GM) before sugarcane	1. In situ trash (7.5 t) composting
		2. Use of FYM @ 25 t ha ⁻¹	2. Use of FYM @ 12 t ha ⁻¹
		3. Use of PMC @ 5 t ha ⁻¹	3. Use of PMC @ 5 t ha ⁻¹
		4. Use of Vermicompost @ 2.5 t ha ⁻¹	4. Use of Vermicompost @ 2 t ha ⁻¹
		5. Composite culture BF @ 5 kg ha ⁻¹	5. Composite culture BF @ 5 kg ha ⁻¹
2.	100% NPK through inorganic	NPK (400:170:170)	NPK (300:140:140)
		Iron sulphate: 25 kh ha ⁻¹	Iron sulphate: 25 kh ha ⁻¹
		Zinc sulphate: 20 Kg ha ⁻¹	Zinc sulphate: 20 Kg ha ⁻¹ * without trash
3.	Fertilizer dose As per soil test (AST) with FYM & biofertilizers	1. NPK (400: 170: 128 Kg ha ⁻¹) Iron sulphate: 25 Kg ha ⁻¹ Zinc sulphate: 20 Kg ha ⁻¹	1. NPK (300:140:105 Kg ha ⁻¹) & Iron sulphate: 25 Kg ha ⁻¹ Zinc sulphate: 20 Kg ha ⁻¹
		2. Biofertilizers as seed treatment @ 5 Kg ha ⁻¹ (i.e. <i>Azotobacter</i> , <i>Acetobacter</i> , <i>Azospirillum</i> and PSB, 1.25 Kg each)	2. BF @ 5 Kg ha ⁻¹ (i.e. <i>Azotobacter</i> , <i>Acetobacter</i> , <i>Azospirillum</i> and PSB @ 1.25 Kg each)
		3. FYM @ 25 t ha ⁻¹	3. Trash mulching, fertilizer application by crow bar in two splits.
4.	75% of RD through organics + 25% RD through inorganic	1. Sunn Hemp (GM) before sugarcane	1. <i>In situ</i> trash (7.5 t) composting
		2. Use of FYM @ 15 t ha ⁻¹	2. Use of FYM @ 8 t ha ⁻¹
		3. Use of PMC @ 2 t ha ⁻¹	3. Use of PMC @ 2.5 t ha ⁻¹
		4. Use of Vermicompost @ 1 t ha ⁻¹	4. Use of Vermicompost @ 1.5 t ha ⁻¹
		5. Composite BF culture @ 5 Kg ha ⁻¹	5. Composite BF culture @ 5 kg ha ⁻¹
		6. NPK (100:43:43 Kg ha ⁻¹)	6. NPK (75:35:35 Kg ha ⁻¹)
5.	50% of RD through organic & 50% of RD through inorganics	1. Sunn Hemp (GM) before sugarcane	1. <i>In situ</i> trash (7.5 t) composting
		2. Use of FYM @ 4 t ha ⁻¹	2. Use of FYM @ 2 t ha ⁻¹
		3. Use of PMC @ 1 t ha ⁻¹	3. Use of PMC @ 1 t ha ⁻¹
		4. Use of Vermicompost @ 0.5 t ha ⁻¹	4. Use of Vermicompost @ 0.5 t ha ⁻¹
		5. Composite BF culture @ 5 kg ha ⁻¹	5. Composite BF culture @ 5 kg ha ⁻¹
		6. NPK (200:85:85 kg ha ⁻¹)	5. NPK (150:70:70 kg ha ⁻¹)
6.	25% of RD through organics + 75%	1. Sunn Hemp (GM) before sugarcane	1. <i>In situ</i> trash (7.5 t) composting
		2. Composite BF culture @ 5 kg ha ⁻¹	2. Composite BF culture @ 5 kg ha ⁻¹

	RD through inorganic	3. NPK (300:128:128 kg ha ⁻¹)	3. NPK (225:105:105 kg ha ⁻¹)
7.	Use of Rishi- Krishi Tantra	1. Angara – soil beneath banyan tree:38 kg ha ⁻¹	1. Angara – soil beneath banyan tree: 38 kg ha ⁻¹
		2. Amritpani i. Ghee of local cow: 625 g ha ⁻¹ ii. Honey: 1.25 kg ha ⁻¹ iii. Cow dung of local cow:25 Kg ha ⁻¹ iv. Water: 500 L ha ⁻¹ .	2. Amritpani i. Ghee of local cow: 625 g ha ⁻¹ ii. Honey: 1.25 Kg ha ⁻¹ iii. Cow dung of local cow: 25 Kg ha ⁻¹ iv. Water: 500 L ha ⁻¹ .
		Application of above material three times i.e. one by seed treatment and two times by fertigation.	Application of above material three times through fertigation.
8.	Use of Jivamrut	1. Dung of Indigenous cow/: 25 Kg bullock/buffalow	1. Dung of Indigenous cow/: 25 Kg bullock/buffalow/sheep
		2. Urine of indigenous cow: 12.5-25 L	2. Urine of indigenous cow: 12.5-25 L
		3. Black/ old jaggery: 2.5 Kg	3. Black/ old jaggery: 2.5 Kg
		4. Flour of any pulses: 5 Kg	4. Flour of any pulses: 5 Kg
		5. Soil from rhizosphere of: 5 Kg root zone of same crop	5. Soil from rhizosphere of: 5 Kg root zone of same crop
		6. water: 500 L	6. water: 500 L
		* Fermentation for 2-7 days	* Fermentation for 2-7 days
		* This material should applied at planting and at monthly intervals per ha up to 5 month.	*This material should be applied at monthly interval per ha up to 5 months

Results and Discussion

Yield and quality parameters

The ten year pooled data in respect of cane and CCS yield sugarcane are presented in Table 1 (a) to 1 (b). The data indicated that, the treatment T₆ receiving 25% RD NPK through organics + 75% RD NPK through inorganic fertilizers recorded significantly higher cane yield and CCS yield (112.13 t ha⁻¹ and 16.54 t ha⁻¹) which was at par with treatment T₃ receiving fertilizer application as per soil test along with FYM and biofertilizers (109.74 t ha⁻¹ and 16.07 t ha⁻¹). The ten year pooled data in respect of number of millable cane, average cane weight and juice quality of sugarcane are presented in Table 2. Significantly the highest average cane weight (1.38 kg) was observed in treatment T₆ receiving 25% RD NPK through organics + 75% RD NPK through inorganic fertilizers and it was found at par with treatment T₅, T₄, T₃ and T₂. The treatment T₃ receiving fertilizer application as per soil test along with FYM and biofertilizers recorded significantly higher number of millable canes per hectare (85.59 '000' ha⁻¹) and it was found at par with T₆ and T₂. The quality parameters viz, brix (°), sucrose (%), purity (%) and CCS (%) were found non-significant. Similar findings were reported by [1 and 2].

Soil chemical properties

The pooled data on soil chemical properties after harvest of sugarcane are presented in table 3 (a) to 3 (f) revealed that, soil pH was decreased in all the treatments over initial except the treatment T₂ receiving 100% NPK RD through inorganic fertilizers (7.84). The significantly lowest soil pH (7.53) was noticed under treatment T₁ receiving 100% NPK RD through organics. The soil EC was increased in all the treatments over initial except treatment T₇ and T₈, however, the lower EC was observed in the treatment T₇ (0.16 dSm⁻¹) and higher in the treatment T₂ (0.26 dSm⁻¹). The status of soil organic carbon was significantly improved over initial due to application of

different organics. The significantly the highest soil organic carbon was noticed in treatment T₁ receiving 100% NPK through organic (0.69%), however it was at par with all the treatments except T₂ and T₇. The available nitrogen, phosphorus and potassium content of soil after harvest of sugarcane was significantly affected by the different treatments. The significantly higher available nitrogen and phosphorus were observed in the treatment T₆ (255 and 26.11 kg ha⁻¹) and it was found at par with treatment T₃ in respect of available nitrogen and treatment T₂, T₃ and T₄ in respect of phosphorus. Significantly the highest available potassium was recorded by the treatment T₂ (348.80 kg ha⁻¹) and which was at par with treatment T₃. These results are in confirmatory with results of [15].

Total nutrient uptake

The pooled data pertaining to total nutrient uptake of sugarcane are presented in Table 4 (a) to 4 (c) indicated that, the significantly higher uptake of nitrogen and potassium was observed in the treatment T₆ receiving 25% RD NPK through organics + 75% RD NPK through inorganic fertilizers (238.32 and 290.45 kg ha⁻¹ respectively) and it was found at par with T₃ receiving Fertilizer dose as per soil test with FYM & biofertilizer in respect of total nitrogen. Significantly the highest uptake of phosphorus was noticed in the treatment T₃ receiving Fertilizer dose as per soil test with FYM & biofertilizer (33.40 kg ha⁻¹), however it was at par with T₂, T₆ and T₄.

Economics

The data on economics of different treatments are presented in Table 5 indicated that, the treatment T₆ receiving 25% RD NPK through organics + 75% RD NPK through inorganics, recorded higher gross monetary returns (Rs. 2,52,290 ha⁻¹), net returns (Rs. 1,79,225 ha⁻¹) and B:C ratio (2.45). These results are also in accordance with the findings of [14].

Table 1 (a): Effect of different treatments on cane yield

Treatments	Cane yield (t ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 Plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ : 100% NPK RD through organic	100.78	83.8	82.49	80.83	63.54	101.43	95.05	89.83	85.34	77.67	86.08
T ₂ : 100% NPK RD through inorganic	121.16	99.67	89.69	74.59	61.24	123.05	119.37	112.71	107.08	81.3	98.99
T ₃ : Fertilizer dose AST FYM & Biofertilizer	138.84	107.13	93.93	87.81	76.21	134.33	130.05	121.14	116.69	91.27	109.74
T ₄ : 75% RD organic + 25% RD inorganic	114.12	86.53	86.16	81.67	76.21	113.73	107.66	101.67	96.59	82.64	94.70
T ₅ : 50% RD organic + 50% RD inorganic	118.52	96.56	87.28	79.49	74.58	118.83	113.23	106.91	101.56	84.48	98.14
T ₆ : 25% RD organic + 75% RD inorganic	135.37	105.07	99.87	90.93	87.39	131.62	132.08	124.69	118.45	95.82	112.13
T ₇ : Rishi-Krusha Tantra	99.61	70.56	65.12	63.07	54.13	99.76	83.67	79.01	75.06	63.22	75.32
T ₈ : Jivamrut	94.82	67.36	63.65	65.61	56.47	94.43	82.56	77.96	74.06	63.27	74.02
SE _±	4.00	2.02	3.58	2.95	0.96	2.93	3.78	3.55	3.37	3.26	3.06
CD at 5%	12.16	6.14	10.86	8.93	2.91	8.87	11.47	10.76	10.22	9.78	9.27

RD: Recommended Dose, FYM: Farm Yard Manure AST: As per soil test

Table 1 (b): Effect of different treatments on CCS yield

Treatments	CCS yield (t ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ : 100% NPK RD through organic	14.96	12.23	12.27	11.89	10.99	14.02	13.06	12.78	13.08	12.13	12.78
T ₂ : 100% NPK RD through inorganic	17.95	14.38	12.94	10.79	10.56	17.12	16.88	16.52	16.9	12.7	14.64
T ₃ : Fertilizer dose AST FYM & Biofertilizer	20.69	16.1	13.21	12.50	11.96	19.28	17.6	17.24	17.63	13.94	16.07
T ₄ : 75% RD organic + 25% RD inorganic	17.08	12.65	12.51	11.65	10.96	16.16	14.77	14.46	14.79	12.27	13.78
T ₅ : 50% RD organic + 50% RD inorganic	17.72	14.25	12.59	11.36	10.85	17.3	15.25	14.92	15.26	12.73	14.28
T ₆ : 25% RD organic + 75% RD inorganic	20.3	15.34	13.99	13.45	12.19	19.84	18.81	18.41	18.83	14.26	16.54
T ₇ : Rishi-Krusha Tantra	15.29	10.14	9.45	9.14	8.46	14.32	11.53	11.28	11.54	9.58	11.20
T ₈ : Jivamrut	13.88	10.12	9.49	9.55	8.97	13.51	11.36	11.12	11.37	9.72	11.00
SE _±	0.58	0.24	0.64	0.43	0.20	0.53	0.64	0.62	0.64	0.59	0.53
CD at 5%	1.76	0.73	1.95	1.30	0.60	1.60	1.93	1.89	1.93	1.77	1.56

RD: Recommended Dose, FYM: Farm yard manure AST: As per soil test and CCS: commercial cane sugar

Table 2: Effect of different treatments on yield and quality parameters of sugarcane (Pooled 10 Year)

Treatments	NMC ('000 ha ⁻¹)	ACW (kg)	Brix (0 ^o)	Sucrose (%)	CCS (%)	Purity (%)
T ₁ :100% NPK RD through organic	72.56	1.21	21.67	20.77	14.47	98.73
T ₂ :100% NPK RD through inorganic	77.45	1.31	21.29	20.43	14.58	98.93
T ₃ : Fertilizer dose AST FYM & Biofertilizer	85.59	1.32	21.04	20.21	14.36	99.13
T ₄ :75% RD organic + 25% RD inorganic	73.52	1.34	21.92	20.99	14.37	98.58
T ₅ : 50% RD organic + 50% RD inorganic	74.16	1.37	20.28	19.53	14.39	99.06
T ₆ : 25% RD organic + 75% RD inorganic	84.49	1.38	21.78	20.86	14.75	98.66
T ₇ : Rishi-Krusha Tantra	64.84	1.19	21.81	20.89	14.45	98.64
T ₈ : Jivamrut	65.49	1.15	21.72	20.81	14.12	98.70
SE _±	3.32	0.05	0.59	0.41	0.51	0.19
CD at 5%	9.95	0.13	NS	NS	NS	NS

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test, NMC: Number of Millable Cane, ACW: Average Cane Weight and CCS: Commercial Cane Sugar

Table 3 (a): Effect of different treatments on soil pH at harvest

Treatments	Soil pH										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	7.53	7.56	7.62	7.26	7.24	7.37	7.29	7.18	7.29	7.25	7.53
T ₂ :100% NPK RD through inorganic	7.68	7.71	7.75	7.71	7.70	7.72	7.88	7.74	7.85	7.72	7.84
T ₃ : Fertilizer dose AST FYM & Biofertilizer	7.31	7.28	7.40	7.28	7.26	7.33	7.44	7.31	7.42	7.39	7.52
T ₄ :75% RD organic + 25% RD inorganic	7.41	7.36	7.63	7.36	7.35	7.45	7.46	7.42	7.53	7.47	7.62
T ₅ : 50% RD organic + 50% RD inorganic	7.48	7.53	7.55	7.41	7.36	7.44	7.49	7.38	7.49	7.45	7.60
T ₆ : 25% RD organic + 75% RD inorganic	7.61	7.59	7.64	7.58	7.55	7.59	7.68	7.54	7.65	7.62	7.74
T ₇ : Rishi-Krusha Tantra	7.31	7.24	7.51	7.29	7.26	7.35	7.44	7.38	7.49	7.44	7.55
T ₈ : Jivamrut	7.41	7.48	7.47	7.32	7.31	7.37	7.46	7.38	7.49	7.44	7.56
SE _±	0.01	0.01	0.02	0.06	0.03	0.04	0.06	0.05	0.05	0.03	0.01
CD at 5%	0.03	0.02	0.49	0.17	0.08	0.11	0.18	0.14	0.16	0.08	0.03

RD: Recommended Dose, FYM: Farm Yard Manure AST: As per soil test

Table 3 (b): Effect of different treatments on soil EC at harvest

Treatments	Soil EC (dSm ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	0.24	0.26	0.23	0.28	0.26	0.27	0.27	0.26	0.21	0.23	0.21
T ₂ :100% NPK RD through inorganic	0.14	0.15	0.16	0.30	0.37	0.32	0.33	0.28	0.27	0.29	0.26
T ₃ : Fertilizer dose AST FYM & Biofertilizer	0.17	0.14	0.13	0.29	0.34	0.28	0.30	0.25	0.24	0.26	0.24
T ₄ : 75% RD organic + 25% RD inorganic	0.16	0.15	0.15	0.28	0.33	0.29	0.30	0.27	0.30	0.26	0.24
T ₅ : 50% RD organic + 50% RD inorganic	0.13	0.12	0.19	0.28	0.36	0.3	0.31	0.27	0.29	0.27	0.25
T ₆ : 25% RD organic + 75% RD inorganic	0.15	0.15	0.13	0.29	0.29	0.27	0.28	0.22	0.27	0.24	0.22
T ₇ : Rishi-Krushu Tantra	0.11	0.10	0.11	0.19	0.25	0.16	0.20	0.15	0.13	0.16	0.16
T ₈ : Jivamrut	0.13	0.11	0.11	0.19	0.26	0.17	0.21	0.19	0.17	0.17	0.17
SE _±	0.01	0.06	0.01	0.02	0.03	0.01	0.04	0.04	0.05	0.03	0.04
CD at 5%	0.04	0.18	0.02	0.05	0.08	0.03	0.14	0.14	0.15	0.10	0.12

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 3(c): Effect of different treatments on soil organic carbon (%) at harvest

Treatments	Soil organic carbon (%)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	0.70	0.73	0.64	0.75	0.64	0.66	0.71	0.69	0.65	0.72	0.69
T ₂ :100% NPK RD through inorganic	0.66	0.68	0.58	0.54	0.57	0.59	0.57	0.64	0.67	0.59	0.61
T ₃ : Fertilizer dose AST FYM & Biofertilizer	0.66	0.67	0.65	0.74	0.64	0.59	0.56	0.66	0.62	0.63	0.64
T ₄ :75% RD organic + 25% RD inorganic	0.68	0.65	0.65	0.78	0.73	0.52	0.56	0.66	0.71	0.64	0.66
T ₅ : 50% RD organic + 50% RD inorganic	0.66	0.64	0.66	0.65	0.73	0.61	0.58	0.64	0.66	0.63	0.65
T ₆ : 25% RD organic + 75% RD inorganic	0.59	0.59	0.64	0.65	0.66	0.62	0.63	0.62	0.69	0.63	0.63
T ₇ : Rishi-Krushu Tantra	0.63	0.61	0.59	0.61	0.60	0.63	0.59	0.61	0.63	0.67	0.62
T ₈ : Jivamrut	0.64	0.66	0.63	0.59	0.61	0.66	0.64	0.61	0.63	0.64	0.63
SE _±	0.02	0.01	0.01	0.01	0.04	0.01	0.02	0.03	0.02	0.02	0.04
CD at 5%	0.06	0.04	0.04	0.04	0.11	0.04	0.06	0.10	0.07	0.08	0.06

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 3(d): Effect of different treatments on available nitrogen in soil at harvest (kg ha⁻¹)

Treatments	Soil available nitrogen (kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	222	218	207	213	225	222	259	229	242	233	227
T ₂ :100% NPK RD through inorganic	245	242	212	209	217	255	261	244	258	242	238
T ₃ : Fertilizer dose AST FYM & Biofertilizer	254	251	228	213	225	251	272	255	269	240	246
T ₄ :75% RD organic + 25% RD inorganic	217	217	205	211	216	221	246	229	242	229	223
T ₅ : 50% RD organic + 50% RD inorganic	225	222	216	202	203	221	240	223	237	225	221
T ₆ : 25% RD organic + 75% RD inorganic	262	259	224	251	263	259	263	246	260	264	255
T ₇ : Rishi-Krushu Tantra	190	186	191	181	176	189	177	160	173	201	182
T ₈ : Jivamrut	197	189	192	195	197	193	183	166	180	213	190
SE _±	3.01	2.98	2.72	1.81	2.04	2.35	10.7	5.29	7.29	4.37	4.26
CD at 5%	9.13	9.05	8.24	5.49	6.18	7.11	32.46	15.87	22.11	13.14	12.88

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 3(e): Effect of different treatments on available phosphorus in soil at harvest (kg ha⁻¹)

Treatments	Soil available phosphorus (kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	27	25	20	27	20	16	23	17	13	22	20.96
T ₂ :100% NPK RD through inorganic	28	26	24	23	24	28	25	28	27	24	25.85
T ₃ : Fertilizer dose AST FYM & Biofertilizer	27	30	28	15	18	29	27	26	21	20	24.58
T ₄ :75% RD organic + 25% RD inorganic	19	19	16	26	25	26	24	25	20	22	22.23
T ₅ : 50% RD organic + 50% RD inorganic	20	18	15	22	22	28	24	23	18	20	21.15
T ₆ : 25% RD organic + 75% RD inorganic	28	29	23	27	19	31	27	28	22	23	26.11
T ₇ : Rishi-Krushu Tantra	15	14	12	11	12	19	15	10	10	12	13.09
T ₈ : Jivamrut	16	12	14	13	11	13	14	9	8	11	12.31
SE _±	1.96	1.92	1.87	0.89	0.54	1.22	2.04	2.04	2.07	1.1	1.51
CD at 5%	5.84	5.83	5.66	2.69	1.63	3.71	6.20	6.19	6.28	3.33	4.72

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 3(f): Effect of different treatments on available potassium in soil at harvest (kg ha⁻¹)

Treatments	Soil available potassium (kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ : 100% NPK RD through organic	358	350	343	428	326	229	267	274	341	329	324.43
T ₂ : 100% NPK RD through inorganic	381	372	350	436	336	271	288	295	382	377	348.80
T ₃ : Fertilizer dose AST FYM & Biofertilizer	385	374	371	326	314	277	313	321	408	337	342.53
T ₄ : 75% RD organic + 25% RD inorganic	347	337	330	321	310	238	258	266	353	321	308.07
T ₅ : 50% RD organic + 50% RD inorganic	392	381	337	291	299	233	246	254	341	309	308.42
T ₆ : 25% RD organic + 75% RD inorganic	370	364	369	308	318	268	272	279	366	332	324.55
T ₇ : Rishi-Krusha Tantra	279	271	262	254	265	281	284	291	278	206	267.10
T ₈ : Jivamrut	262	254	252	242	238	274	271	280	267	215	255.50
SE _±	2.41	2.25	3.48	1.19	1.32	3.28	11.58	7.53	10.26	2.04	4.53
CD at 5%	7.23	6.82	10.6	3.63	4.01	9.95	35.13	22.74	30.71	6.14	13.70

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 4(a): Effect of different treatments on nitrogen uptake by sugarcane (kg ha⁻¹)

Treatments	Total nitrogen uptake(kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ : 100% NPK RD through organic	254	178	174	203	196	164	136	145	173	151	177.40
T ₂ : 100% NPK RD through inorganic	278	186	176	211	217	184	153	162	194	170	193.00
T ₃ : Fertilizer dose AST FYM & Biofertilizer	303	261	241	278	270	217	180	190	228	199	236.75
T ₄ : 75% RD organic + 25% RD inorganic	273	181	231	269	258	204	170	179	215	188	216.91
T ₅ : 50% RD organic + 50% RD inorganic	272	189	229	262	250	189	157	166	199	184	208.66
T ₆ : 25% RD organic + 75% RD inorganic	296	249	242	273	260	228	189	199	239	209	238.32
T ₇ : Rishi-Krusha Tantra	165	162	155	189	165	156	120	128	153	134	152.60
T ₈ : Jivamrut	188	149	149	181	163	155	119	127	152	133	151.60
SE _±	3.82	4.16	3.66	1.31	1.64	2.19	1.77	1.89	2.26	3.04	2.57
CD at 5%	11.48	12.6	11.09	4.02	4.97	6.66	5.38	5.72	6.87	9.13	7.79

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 4(b): Effect of different treatments on phosphorus uptake by sugarcane (kg ha⁻¹)

Treatments	Total phosphorus uptake(kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ : 100% NPK RD through organic	32.00	21.67	19.33	28.67	19.36	30.78	24.01	24.98	28.94	25.98	25.57
T ₂ : 100% NPK RD through inorganic	41.33	28.33	21.33	36.00	24.71	36.71	28.63	29.68	34.39	30.90	31.20
T ₃ : Fertilizer dose AST FYM & Biofertilizer	49.33	34.67	25.33	42.00	36.50	33.3	25.97	27.17	31.48	28.21	33.40
T ₄ : 75% RD organic + 25% RD inorganic	36.00	24.67	23.33	39.00	26.58	33.02	25.76	26.63	30.85	27.75	29.36
T ₅ : 50% RD organic + 50% RD inorganic	39.00	26.67	18.00	26.00	17.63	33.44	26.09	27.12	31.42	28.21	27.36
T ₆ : 25% RD organic + 75% RD inorganic	47.00	30.33	28.00	27.33	17.97	35.32	27.55	28.65	33.2	29.80	30.52
T ₇ : Rishi-krusha tantra	27.33	17.00	13.33	22.67	14.51	22.7	15.41	16.39	18.99	16.93	18.53
T ₈ : Jivamrut	29.00	14.67	14.00	26.00	18.09	22.71	14.41	16.38	18.97	16.59	19.08
SE _±	1.43	1.17	2.00	0.91	0.76	2.14	1.64	1.69	1.98	1.77	1.55
CD at 5%	4.28	3.56	6.17	2.72	2.3	6.51	4.98	5.14	5.95	5.36	4.70

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 4(c): Effect of different treatments on potassium uptake by sugarcane (kg ha⁻¹)

Treatments	Total potassium uptake(kg ha ⁻¹)										Mean
	I st Cycle					II nd Cycle					
	2006-07 plant	2007-08 ratoon-I	2008-09 ratoon-II	2009-10 ratoon-III	2010-11 ratoon-IV	2012-13 plant	2013-14 ratoon-I	2014-15 ratoon-II	2015-16 ratoon-III	2016-17 ratoon-IV	
T ₁ :100% NPK RD through organic	268.00	253.33	249.33	283.00	263.66	223.92	185.85	199.47	272.45	219.26	241.83
T ₂ : 100% NPK RD through inorganic	293.00	267.33	252.33	289.00	267.96	281.31	233.49	249.74	341.11	274.78	275.01
T ₃ : Fertilizer dose AST FYM & Biofertilizer	328.00	274.67	264.00	296.33	276.99	283.38	235.21	251.51	343.54	276.75	283.04
T ₄ : 75% RD organic + 25% RD inorganic	282.00	259.00	255.33	290.67	269.49	250.02	207.52	222.2	303.5	244.41	258.41
T ₅ : 50% RD organic + 50% RD inorganic	287.67	274.33	265.33	302.33	279.30	258.84	214.84	230.13	314.33	253.10	268.02
T ₆ : 25% RD organic + 75% RD inorganic	319.33	272.67	261.33	284.00	263.96	306.5	254.4	271.82	371.28	299.17	290.45
T ₇ : Rishi-krushi tantra	186.67	139.67	165.67	179.33	171.22	212.17	160.25	172.34	203.68	178.76	176.98
T ₈ : Jivamrut	194.00	137.67	169.33	186.67	179.52	204.9	154.76	166.7	207.65	176.37	177.76
SE _±	2.53	2.45	4.15	1.06	0.84	2.35	1.88	2.67	3.65	2.73	2.43
CD at 5%	7.61	7.43	12.60	3.22	2.54	7.15	5.70	8.10	11.07	8.29	7.37

RD: Recommended Dose, FYM: Farm Yard Manure AST: As Per Soil Test

Table 5: Economics of different treatments (Pooled 10 years)

Treatments	Yield (t ha ⁻¹)	Gross returns (Rs. ha ⁻¹)	Cost of Cultivation (Rs. ha ⁻¹)	Net returns (Rs. ha ⁻¹)	B: C Ratio
T ₁ : 100% NPK RD through organic	86.08	193671	85523	108148	1.26
T ₂ :100% NPK RD through inorganic	98.99	222719	76708	146011	1.90
T ₃ : Fertilizer dose AST FYM & Biofertilizer	109.74	246915	80060	166855	2.08
T ₄ : 75% RD organic + 25% RD inorganic	94.70	213071	81120	131951	1.63
T ₅ : 50% RD organic + 50% RD inorganic	98.14	220824	75876	144948	1.91
T ₆ : 25% RD organic + 75% RD inorganic	112.13	252290	73065	179225	2.45
T ₇ : Rishi-krushi tantra	75.32	169472	67874	101598	1.50
T ₈ : Jivamrut	74.02	166543	67962	98581	1.45
SE _±	3.06	--	--	--	--
CD at 5%	9.27	--	--	--	--

Conclusion

Application of 25% recommended dose of NPK through organics + 75% recommended dose of NPK through chemical fertilizers for sugarcane was found beneficial in terms of yield, sustenance of soil fertility and economics.

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