Plant Archives Vol. 24, No. 2, 2024 pp. 2641-2648 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.377

EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY OF SUGARCANE AND SOIL STATUS IN PLANT-RATOON CROPPING SYSTEM

Satendra Kumar* and S.C. Singh

UPCSR- Genda Singh Sugarcane Breeding and Research Institute, Seorahi (Kushinagar), Uttar Pradesh, India.
*Corresponding author E-mail : satendrayadav.agro@gmail.com
(Date of Receiving- 19-05-2024; Date of Acceptance-30-07-2024)

ABSTRACT

Sugarcane being a long duration, exhaustive crop removes considerably higher amount of plant nutrients from the soil. Hence it is essential to replenish the depleted soil with plant nutrients at desired levels to restore and sustain the fertility of soils and improve the cane productivity through integrated nutrient management system. A Field experiment was conducted during 2017-18, 2018-19 and 2019-20 at research farm of Genda Singh Sugarcane Breeding and Research Institute, Seorahi, Uttar Pradesh, India. The experiment consisting of nine treatments *i.e.*; T_1-No Organic + 50 per cent RDF, T_2- No organic + 100 per cent RDF, T_3- No organic + soil test basis (NPK application) T_4- application of FYM @ 20 t/ha+50 per cent RDF inorganic source,T_5- application of FYM @ 20 t/ha+100 per cent RDF inorganic source,T_6- application of FYM @ 20 t/ ha+soil test basis NPK, T_7-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter+PSB)+50 per cent RDF, T_8-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter+PSB)+100 per cent RDF, T_9-application of FYM @ 10 t/ha+biofertilizers (Azotobacter+PSB) +soil test basis NPK in plant crop but in both ratoon crops, T_1-Application of trash at 10 t/ha+50 per cent RDF,T_2-application of trash at 10 t/ha+100 per cent RDF, T_3-application of trash at 10 t/ha+soil test basis NPK , T_4-application of FYM @ 20 t/ha+50 per cent RDF inorganic source, T_5-application of FYM @ 20 t/ha+100 per cent RDF inorganic source,T_6- application of FYM @ 20 t/ha+soil test basis NPK, T_7-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter+PSB)+50 per cent RDF, T_8-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter + PSB) + 100 per cent RDF, T_9-application of FYM @ 10 t/ha+biofertilizers (Azotobacter + PSB + soil test basis NPK. Experiment was laid out in randomized block design with three replications and sugarcane variety CoSe 01434 was planted. The one third nitrogen and full dose of P and K were applied at the time of planting and remaining nitrogen was applied in two equal split doses as top dressing before the onset of monsoon season. The recommended crop management practices were followed during experimentation in plant and ratoon crops. The experimental field was medium in organic carbon, available phosphorus and low in potash with pH 8.13. Sugarcane experiment crop was planted on 25 Feb -2017 and harvested on 22 March-2018 with initiated first ratoon crop, first ratoon crop harvested on 01.04.2019 with initiated second ratoon crop and harvested on 28.03.2020. In plant crop, application of FYM@ 10 t/ha+ Bio-fertilizers (Azotobacter+ PSB)+ soil test basis NPK resulted significantly higher NMC (147.22 thousand /ha) and cane yield (98.68 t/ha) as compared to other treatments but at par with T6 and T8 treatment. Germination percent (60.76) and shoot population (196.03) were noted significantly higher in application of FYM @ 10 t/ha+ Bio-fertilizer (Azotobacter+ PSB) +100 per cent RDF treatment. In first ratoon crop, application of FYM@ 10 t/ha+ Bio-fertilizers (Azotobacter+ PSB) + soil test basis NPK application treatment produced significantly higher clump population (34.92 thousand /ha), NMC (107.54 thousand /ha) and cane yield (83.99 t/ha) compared with other rest treatments except T_8 treatment. Significantly higher shoot population (162.30 thousand /ha) was observed with application of FYM @ 10 t/ha+ Bio-fertilizer (Azotobacter+ PSB) +100 per cent RDF treatment compared with T_1, T_4 and T_7 but at par with remaining treatments. In second ratoon crop, application of FYM @ 10 t/ha+ biofertilizers (Azotobacter+ PSB) + soil test basis NPK practice (T_9) also produced significantly higher clump population (33.60 thousand /ha), shoot population (181.58 thousand per ha) and NMC (98.01 thousand per ha) than other treatments but at par with trash 10t/ha+soil test basis NPK, FYM 20 t/ha + biofertilizes+100 per cent RDF. Significantly higher cane yield (84.13 t/ha) was obtained with application of FYM @ 10 t/ha+ bio-fertilizer (Azotobacter+ PSB) + soil test basis NPK application than other remaining treatments, except application of trash 10t/ha+ soil test based NPK, FYM @20 t/ha with soil test basis NPK and FYM 10t/ha + biofertilizers with 100 per cent RDF practices. Sucrose percent was not affected significantly due to different treatments in plant and ratoon crops. Conclusion of this experiments application of FYM @ 10 t/ha+ bio-fertilizer (Azotobacter+ PSB) + soil test basis NPK was resulted significantly higher cane productivity in plant-ratoon cropping system.

Key words : Sugarcane, INM, Ratoon, Cropping system, Soil, Productivity.

Introduction

Sugarcane is the most important agro-industrial crop next to cotton, which is being cultivated in around 5.51 million hectares area with 84.0 t/ha productivity in India. Uttar Pradesh state occupies an area of 28.53 lakh hectares with an average yield of 83.95 t/ha. In the present era of energy crises, sugarcane is also coming up as a biofuel crop. Mixing ethanol by 10-15 percent has already been recommended. Hence, there is a great need to enhance sugar yield and net profit. In the present context of globalization, ways and means have to be further evolved to produce more sugar per unit area, time and input to keep pace with the population growth while preserving the soil and water resources. Increasing demand of chemical fertilizers and their adverse effect on soil physical, chemical and microbial properties and changing agro-ecosystem environment has initiated the scientist to evolve the other safer means for plant nutrition. INM involves the combined use of organic and inorganic fertilizers, ensuring a balanced supply of essential nutrients for sugarcane plants. Adequate nutrient availability supports plant growth, development, and overall productivity. Organic inputs in INM, such as farmyard manure and trash, contribute to the improvement of soil fertility. Organic matter enhances soil structure, water retention, and nutrient-holding capacity, leading to improved soil health.INM practices focus on sustainable soil management by promoting the use of organic materials, reducing reliance on chemical fertilizers. Continuous application of organic matter helps in maintaining soil structure and fertility over successive cropping cycles.INM aims to provide a balanced mix of macro and micronutrients to sugarcane plants. This balanced nutrient application reduces the risk of nutrient imbalances, ensuring optimal plant growth and yield. Organic inputs stimulate soil microbial activity, enhancing nutrient cycling and making nutrients more available to plants. Improved microbial activity contributes to better soil health and nutrient mineralization. INM practices contribute to environmental sustainability by reducing the risk of nutrient runoff and leaching into water bodies. The integration of organic inputs helps minimize environmental pollution associated with excessive use of synthetic fertilizers. Proper nutrient management through INM positively impacts the performance of ratoon crops. Ratoon crops benefit from residual nutrients in the soil, and INM practices help maintain the soil fertility necessary for successful ratoon cropping. INM practices, when optimized, can lead to higher sugarcane yields and improved quality of the harvested crop. Higher productivity can translate into economic benefits for sugarcane farmers. By promoting a balanced and sustainable approach to nutrient management, INM contributes to the long-term sustainability of sugarcane cultivation. It helps prevent soil degradation and ensures that the land remains fertile for future cropping cycles. It's important to note that the effectiveness of INM can depend on various factors such as soil types, climate conditions, and specific management practices. Local adaptation and regular monitoring through soil testing are essential for tailoring INM strategies to the specific needs of sugarcane cultivation in a given area. The choice between organic and inorganic nutrient sources should be based on factors such as soil conditions, climate, economic considerations and the overall sustainability goals of the farming operation. Implementing best management practices tailored to the specific needs of the ratoon sugarcane system can contribute to improved productivity over successive cropping cycles. The choice between organic and inorganic sources of nutrients in a plant ratoon sugarcane system can have significant effects on productivity. Ratoon cropping involves harvesting sugarcane and allowing it to regrow from the stubble without replanting. The application of 10 t FYM +biofertilizer along with 100 percent RDF provided maximum net return and resulted in gradual improvement in soil fertility with minimum ill effects of chemical fertilizer on soil and environment (Pal *et al.*, 2021). Ratooning is an important component of sugarcane based cropping systems. Its accounts over 50 per cent cane of acreage but contribute only 30-35 per cent towards total cane production. Ratoon crop ripens earlier than plant crop and gives higher sugar recovery in the early part of the crushing season. Addition of 10 t/ha FYM/compost along with inorganic fertilizers on the basis of soil test + biofertilizers (Azotobacter + PSB) @ 12.5 kg/ha each had a positive effect on sugarcane growth and yield in both plant and ratoon crops (Yadav *et al.*, 2019), however, the productivity of ratoon is far less than plant crop and is declining progressively year after year. Keeping above considerations in view, a study entitled "Effect of integrated application of organics and inorganics on productivity of sugarcane and soil status in palnt-ratoon cropping system" was planned with the objective to develop nutrient management strategy for sustaining soil health and sugarcane production.

Materials and Methods

A field experiment was conducted during 2017-18, 2018-19 and 2019-20 at research farm of Genda Singh Sugarcane Breeding and Research Institute, Seorahi, Uttar Pradesh, India. The experiment consisting of nine treatments *i.e.*; T_1-No Organic + 50 per cent RDF, T_2-No organic + 100 per cent RDF, T_3- No organic + soil test basis (NPK application) T_4- application of FYM @ 20 t/ha+50 per cent RDF inorganic source,T_5- application of FYM @ 20 t/ha+100 per cent RDF inorganic source,T_6- application of FYM @ 20 t/ha+soil test basis NPK, T_7- application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter + PSB)+50 per cent RDF, T_8-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter + PSB) + 100 per cent RDF, T_9-application of FYM @ 10 t/ha+biofertilizers (Azotobacter+PSB) + soil test basis NPK in plant crop but in both ratoon crops, T_1-Application of trash at 10 t/ha+50 per cent RDF,T_2- application of trash at 10 t/ha+100 per cent RDF, T_3-application of trash at 10 t/ha+soil test basis NPK, T_4-application of FYM @ 20 t/ha+50 per cent RDF inorganic source, T_5-application of FYM @ 20 t/ha+100 per cent RDF inorganic source, T_6- application of FYM @ 20 t/ha+soil test basis NPK, T_7-application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter+PSB)+50 per cent RDF, T_8- application of FYM @ 10 t/ha+bio-fertilizers (Azotobacter+ PSB) + 100 per cent RDF, T_9-application of FYM @ 10 t/ha+biofertilizers (Azotobacter+PSB +soil test basis NPK. Experiment was laid out in randomized block design with three replications and sugarcane variety CoSe 01434 was planted. The soil of the experiment plot was medium in organic carbon, low in available phosphorus and medium in potash with near pH 8.10. The recommended dose of fertilizer for sugarcane experiments, 180- 80-60 kg per ha N-P-K was used for field experiments. At the time of planting, the 1/3 recommended dose of N and the entire dose of P_2O_5 and K_2O were applied by placement method just before planting of the sugarcane crop. Remaining N was applied in two split doses as a top dressing @ 60kg/ha in each splits in Feb and June months. Planting of sugarcane in the conventional method with 90 cm spacing was done by a conventional furrow opener at 08 cm furrows depth and setts were planted in it. The six lines of sugarcane were maintained. Sources of nitrogen, phosphorus and potash were urea, single super phosphate and murate of potash, respectively. The improved crop management practices were followed during experimentation in all three years. In ratoon crop, clumps in central four rows were counted at 45 days of ratooning and clump population was computed in thousands per hectare. Brix value was recorded by using brix hydrometer dipped in a measuring cylinder filled with cane juice. Temperature corrections were made to correct observed brix reading by using temperature correction as described by Spencer and Meade (1955). Juice Sucrose value was recorded by Horne's dry lead Acetate Method. In this methos, about 100 ml of juice was taken in conical flask and one g lead acetate was added to it. The impurities were filtered through whatman 42 paper. Filtrate was taken in a 20 ml of polarimeter tube to recorded pol reading with the help of polarimeter following Horne's dry lead Acetate Method as described by Spencer and Meade (1955). Schmitz's table was used to calculate juice sucrose.

The sugar yield per hectare at harvesting stage was computed as follows

Sugar yield (t ha^{-1})

$$= \frac{\text{Available sugar per cent in cane}}{100} \times \text{cane yeild (t ha}^{-1}\text{)}$$

Available sugar per cent in cane juice was calculated by using the following formula (Spencer and Meade, 1955).

$$\text{Available sugar per cent} = \left[S - \{0.4(B - S)\}0.73\right]$$

Where, S = Sucrose per cent in juice

B = Corrected brix of juice

0.4 and 0.73 are constant

The cost of cultivation per hector was worked out by considering the current price of the input/commodity used. The gross return was worked out keeping in view the yields of cane and their (SAP) State advisory price of U.P. Government. Cost of cultivation was deducted from gross return to get net return per hectare. The benefit cost ratio was calculated on the basis of net returns obtained and cost of cultivation incurred. The experimental data obtained during course of investigation were subjected to statistical analysis. The techniques of analysis of variance (ANOVA) prescribed for randomized block design was used to test significance of the differences among treatments mean by the 'F' test. Cochran and Cox (1959) was used.

Results and Discussion

Effect on growth and productivity

The effect of different treatments on cane yield was significant. T_9 treatment produced significantly more cane yield (98.68 t/ha) over remaining treatments, but statistically at par with T_6 (94.18) and T_8 statistically (97.99 t/ha) in plant crop significantly higher cane yield in T_9 (83.99 and 84.13 t/ha) in the first and second ratoon crop, respectively, over remaining treatments except for T_8 in the first ratoon, but statistically at par with T_8 (81.48 t/ha), T_6 (79.10 t/ha) and T_3 (75.00 t/ha) in the second ratoon crop cycle. Sucrose percent was not affected significantly in the plant and both ratoon crops, but maximum sucrose percent was noted in T_9 (17.40) and (19.55) in the plant and ratoon crop, respectively, but in the second ratoon crop, T_6 treatment observed maximum sucrose (18.22 percent) in the second ratoon crop. T_8 treatment (60.76) produced significantly higher germination percent as compared with all the remaining treatments except T_7 (59.03) and T_8 (57.14). Significantly higher clump population (33.92 thousand/ha), (33.60 thousand/ha) were obtained in treatment T_9, followed by T_8 (34.79 thousand/ha) and (33.47 thousand/ha) over T_1, T_2, T_3 and T_7 in both the ratoon crop, respectively. A significantly lower shoot population was recovered where 50 percent RDF was applied. T_8 treatment produced a significantly higher shoot population (196.03 thousand/ha), but in the case of ratoon, first and second in T_9 treatment (162.30, 181.58 thousand/ha, respectively) as compared with T_1, T_2 and T_3 treatments. T_9 (11.87 percent) and T_8 (14 percent) treatments produced 11.87 and 14 percent more shoot populations in the second ratoon cycle than the first ratoon crop, respectively. NMC was recorded significantly higher in T_9 (107.54 thousand/ha) over the remaining treatments in the plant crop, but the same treatment produced significantly higher NMC (98.01 thousand/ha) at par with T_3 (89.55 thousand/ha), T_5 (93.78 thousand/ha), T_6 (90.08 thousand/ha) and T_9 (95.90 thousand/ha) in the second ratoon crop. The T_9 treatment also produced significantly higher NMC (107.54 thousand/ha) than all the remaining treatments. The lowest NMC count was observed in T_1 treatments (119.71, 64.55 and 71.43 thousand/ha) in the plant, ratoon

Table 1 : Impact of integrated application of organic and inorganic fertilizers on sugarcane growth and productivity.

Treatments	Germination %	Clumps (000/ha)		Shoots (000/ha)			NMC (000/ha)			Cane Yield(t/ha)			CCS t/ha		
	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II
T_1	46.06	25.00	23.81	149.87	125.26	114.38	119.71	64.55	71.43	61.90	52.64	49.07	7.49	7.10	6.04
T_2	48.38	29.89	27.78	157.27	147.35	137.31	123.68	91.93	79.50	67.72	71.69	62.04	8.13	9.20	7.15
T_3	48.96	32.80	31.35	160.18	153.30	166.25	127.78	93.52	89.55	72.35	75.92	75.00	8.49	10.00	9.19
T_4	49.07	26.45	25.26	159.26	135.84	123.49	131.61	72.75	74.60	65.87	68.91	59.26	7.40	9.12	7.39
T_5	54.86	33.60	30.69	177.38	157.41	163.25	130.02	95.24	93.78	81.88	77.78	70.10	9.57	9.94	8.42
T_6	50.23	32.94	31.75	190.61	155.55	168.07	145.63	94.58	90.08	94.18	76.06	79.10	11.08	9.53	9.93
T_7	59.03	27.51	27.51	162.17	139.42	140.96	142.99	75.53	76.59	79.36	52.78	58.20	9.39	6.82	7.26
T_8	60.76	34.79	33.47	196.03	157.93	180.61	146.56	96.29	95.90	97.75	83.20	81.48	11.65	11.00	10.08
T_9	59.14	34.92	33.60	190.87	162.30	181.58	147.22	107.54	98.01	98.68	83.99	84.13	11.33	10.28	10.23
SEm±	**1.36**	**1.37**	**1.21**	**4.25**	**7.33**	**7.75**	**2.94**	**2.57**	**5.59**	**4.46**	**2.62**	**3.23**	**0.72**	**0.39**	**0.41**
CD	**4.12**	**4.14**	**3.66**	**12.85**	**22.15**	**23.43**	**8.89**	**7.78**	**16.89**	**13.47**	**7.94**	**9.77**	**2.19**	**1.19**	**1.23**

Table 2 : Impact of integrated application of organic and inorganic fertilizers on sugarcane yield attributes.

Treatments	Single cane weight (kg)			Cane thickness (cm)			Cane lengh(cm)		
	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II
T_1	0.59	0.58	0.55	2.17	2.07	1.93	171.7	171.0	170.3
T_2	0.70	0.65	0.59	2.30	2.13	2.20	200.0	182.0	176.3
T_3	0.73	0.71	0.64	2.37	2.33	2.27	216.7	195.3	185.0
T_4	0.60	0.59	0.56	2.20	2.17	1.93	193.3	177.7	173.0
T_5	0.71	0.69	0.61	2.30	2.27	2.20	206.7	182.3	181.7
T_6	0.77	0.77	0.67	2.37	2.33	2.33	220.0	196.3	188.3
T_7	0.65	0.64	0.58	2.27	2.20	2.13	196.7	180.0	175.0
T_8	0.72	0.72	0.63	2.33	2.27	2.20	216.7	190.0	184.0
T_9	0.80	0.77	0.73	2.41	2.40	2.37	225.0	197.0	190.3
SEm±	**0.06**	**0.06**	**0.05**	**0.05**	**0.04**	**0.06**	**4.18**	**2.84**	**2.73**
CD (P=0.05)	**0.19**	**0.18**	**0.16**	**0.14**	**0.13**	**0.18**	**12.56**	**8.54**	**8.20**

Table 3 : Impact of integrated application of organic and inorganic fertilizers on sugarcane juice quality.

Treatments	CCS (%)			Sucrose (%)			Purity (%)+e			Corrected Brix		
	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II
T_1	12.04	13.47	12.30	16.61	17.98	17.88	88.52	87.69	87.40	19.65	22.31	20.46
T_2	12.01	12.81	11.55	16.64	18.63	16.80	88.36	86.60	87.36	19.65	21.34	19.26
T_3	11.73	13.18	12.27	16.95	18.96	17.84	88.49	86.29	87.36	19.15	21.24	20.42
T_4	11.23	13.24	12.49	16.29	19.29	18.13	87.73	86.98	87.45	18.57	22.17	20.69
T_5	11.71	12.77	12.01	17.03	18.60	17.51	88.48	87.01	86.20	18.14	21.37	20.16
T_6	11.76	12.51	12.53	17.17	18.30	18.22	88.13	86.26	87.35	19.32	21.21	20.86
T_7	11.78	12.90	12.50	17.08	18.80	18.15	87.86	87.02	87.56	19.44	21.61	20.72
T_8	11.87	13.20	12.39	17.36	19.24	17.97	88.28	86.85	87.20	19.44	22.14	20.46
T_9	11.48	12.26	12.14	17.40	19.55	17.68	88.27	85.77	87.10	18.82	20.94	20.29
SEm±	**0.34**	**0.30**	**0.28**	**0.42**	**0.38**	**0.39**	**1.78**	**1.04**	**0.36**	**0.51**	**0.41**	**0.43**
CD(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

I, and ratoon second crop, respectively. The data presented in table 02 showed that cane weight, cane thickness and cane length were reduced in consecutive years of ratoon crops as comparison with plant crop. T_9 treatment produced significantly higher cane weight (0.80, 0.79 and 0.73 kg per cane, consecutive both ratoon crops, respectively), cane thickness (2.41, 2.40 and 2.37 cm, consecutive both ratoon crops, respectively) and cane length (225.0, 197.0 and 190.30 cm, in plant, consecutive both ratoon crops, respectively) over 50 percent RDF treatments *i.e.*; T_1, T_4 and T_7. Lowest cane weight, length and thickness were observed in T_1 treatment followed by T_4. Application of 10t/ha FYM / compost + Inorganic fertilizers NPK on soil test basis + biofertilizers (Azotobacter + P.S.B.) @ 10 kg /ha each produced significantly higher cane yield (113 t/ha) than that of other treatments (Yadav *et al.*, 2017). Manimaran and Kalyana sundaram (2006) reported that greater availability of nitrogen through sunhemp, biofertilizers and inorganic nutrients increased the nitrogen uptake by sugarcane. Singh *et al*. (2007) also reported the higher N uptake when pressmud/ FYM was applied as source of nutrients

Effect on Juice quality

The juice quality parameters are presented in Table 3. Sucrose percent, CCS%, purity and brix were recorded more in ratoon crops as compared with plant crops. Juice quality was not affected significantly by different fertilizer treatments, but the T_1 treatment produced higher CCS, purity and brix as compared to the remaining treatments in plants and both ratoon crops. T_8 and T_9 (11.6 and 11.33), (11.0 and 10.23) and (10.08 and 10.23) produced significantly higher CCS t/ha over 50 percent RDF treatments in plants and both ratoon crops, respectively. A significantly higher CC t/ha was obtained in T_1. T_1 treatment recorded 54.92, 54.92, and 66.88 percent lower CCS t/ha over T_8 treatment in plants and both ratoon

Table 4: Impact of integrated application of organic and inorganic fertilizers economics.

Treatments	Cost of cultivation or (Rs.ii/ha)			Gross income			Net income			B:C ratio		
	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II
T_1	143629	86169	86433	216664	184257	171757	73035	98088	85324	0.51	1.14	0.99
T_2	154007	94520	94134	237034	250923	217127	83027	156403	122993	0.54	1.65	1.31
T_3	155442	95939	95902	253237	265737	262496	97795	169798	166594	0.63	1.77	1.74
T_4	151788	92263	91877	230552	241200	207405	78765	148937	115527	0.52	1.61	1.26
T_5	160017	100371	99900	286570	272219	245367	126553	171847	145467	0.79	1.71	1.46
T_6	161267	101388	101510	329625	266200	276848	168358	164812	175338	1.04	1.63	1.73
T_7	149328	88618	88835	277774	184720	203701	128447	96102	114866	0.86	1.08	1.29
T_8	157652	97424	97355	342125	291200	285181	184473	193776	187826	1.17	1.99	1.93
T_9	158939	98406	98711	345366	293977	294440	186426	195572	195729	1.17	1.99	1.98
SEm±	-	-	-	**15595**	**9184**	**11306**	**15595**	**9184**	**11306**	**0.10**	**0.10**	**0.12**
CD(P=0.05)	-	-	-	**47156**	**27771**	**34188**	**47156**	**27772**	**34188**	**0.31**	**0.30**	**0.35**

Table 5 : Impact of integrated application of organic and inorganic fertilizers on soil fertility status.

Treatments	pH			O.C.		
	Plant	Ratoon I	Ratoon II	Plant	Ratoon I	Ratoon II
T_1	8.10	8.02	8.08	0.46	0.48	0.49
T_2	8.09	8.06	7.78	0.47	0.48	0.49
T_3	8.12	8.01	7.85	0.53	0.54	0.55
T_4	8.04	8.02	7.88	0.51	0.56	0.58
T_5	8.12	8.02	8.00	0.54	0.58	0.59
T_6	7.85	7.90	7.77	0.60	0.62	0.64
T_7	8.08	8.01	7.94	0.52	0.56	0.58
T_8	7.86	7.98	7.92	0.52	0.57	0.58
T_9	7.89	7.97	7.96	0.55	0.57	0.59
Initial		8.10			0.51	
SEm±	**0.11**	**0.07**	**0.08**	**0.05**	**0.06**	**0.04**
CD(P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

crops, respectively.

Effect on economics

The cost of cultivation increased with increased inputs to the crop. T_6 treatment involved more cost of cultivation (Rs. 161267/ha) in plant and both ratoon crops (Rs 101388 and 101510 per ha in I and II ratoon crops, respectively) over the remaining treatments; it was 12.28, 17.66 and 17.44 percent more than T_1. The T_9 treatment produced significantly higher gross income in plants (Rs.345366/ha) and both ratoon crops (Rs.293977 and 294440/ha) as compared with the remaining treatments except T_8 and T_6; however, these treatments are statistically similar to T_9. 59.40, 49.79, and 24.33 percent more gross income were observed in the plant crop, whereas in the first ratoon crop 59.54, 21.88 and 59.14, and in the second ratoon crop 71.42, 41.91 and 44.54 percent more in T_9 as compared to T_1, T_4 and T_7 treatments, respectively. Net income and benefit-cost ratio were significantly affected by different treatments. The same trends were observed for gross income. T_9 treatment produced significantly higher net income (Rs.186426/ha) and benefit-cost ratio return (1.17) in the plant, however, in ratoon (Rs 195572/ha and 1.99, respectively) and consecutive ratoon (Rs155729/ ha and 1.98) and was statistically similar with T_8 and T_6 treatment in plant and consecutive ratoon crops. The benefit-cost ratio was greater in ratoon crops in comparison to plant crops.

Effect on soil status

The initial soil status of the experiment site was a pH of 8.10 and an organic carbon content of 0.51 percent. The effect of different treatments on pH was non significant, whereas the pH value decreased in FYM and trash application treatments in plants and both ratoon crops. The lowest value of pH was 7.85 in the plant crop field, whereas in consecutive ratoon crops, it was 7.90 and 7.77 in the T_6 treatment. It might be due to the application of FYM, which results in the production of organic acid upon microbial decomposition of organic manures (Gawai, 2003). Organic carbon percent in the experiment soil was slightly increased in ratoon crop fields in comparison with plant crop fields. The effect of different treatments on organic carbon percent was non-significant, whereas improvement in organic carbon percent coincided with the initial soil organic carbon status. The T_6 treatment recorded a maximum organic carbon percent of 0.60 in the plant crop; however, in consecutive ratoon crops, it was 0.62 and 0.64 percent, respectively. It might be due to increased microbial activities and aeration due to the addition of FYM.

Conclusion

Our results in the present study concluded that cane yield and return were significantly higher in the application of FYM @ 10 t/ha+ Bio-fertilizer (Azotobacter+ PSB) + soil test basis NPK application over other remaining treatments, but at par with FYM @ 10 t/ha+ Bio-fertilizer (Azotobacter+ PSB) + 100 percent RDF in plant and ratoon cropping systems. Sucrose percent was not affected significantly due to different treatments. The soil status was not significantly improved but slightly improved in comparison to the initial soil status value. The increase in net return under T_9 (FYM @ 10 t/ha+ biofertilizers (Azotobacter+ PSB) + soil test basis NPK) compared to T_1 (no organics) was Rs. 113391 in plant, Rs. 97484 in I ratoon and Rs. 110405 in second ratoon crops.

Acknowledgement

The authors express sincere thanks to the Director, U.P. Council of Sugarcane Research, Shahajanpur and Joint director, Genda Singh Sugarcane Breeding and Research Institute, Seorahi, Kushinagar for providing all the facilities timely. We are also thankful to Sri. Shakir Ali, field/lab assistant agronomy division, and Atul Kumar Srivastav, soil chemistry division, for help in lab work and sincere devoted to project work.

References

Annonymous (2017). India, Sugar annual. Global agriculture information network. USDA Foreign Agril Services, pp. 3.

Bajelan, B. and Nazir N.S. (1993). Effect of fertility variation and planting pattern on growth, yield and quality of sugarcane. *Int. J. Trop. Agricult.*, **11**, 249-254.

Banerjee, K., Puste A.M., Gunri S.K., Jana K. and Barman M. (2018). Effect of integrated nutrient management on growth, yield, quality and soil health of spring planted sugarcane (*Saccharum officinarum*) in West Bengal. *Indian J. Agron.*, **63(4)**, 41-47.

Bangar, K.S. and Sharma S.R. (1997). Role of organic manuring in improving sugarcane and sugar productivity. *Indian J. Sugar Technol.*, **12**, 59-66.

Bhaskaran, A. and Palanisami C. (2016). *Hand Book of Sugarcane*. Sugarcane Breeding Institute, Coimbatore, India. Bhatti D S and Kaur S. 2018. Package of practices for crops of Punjab–Rabi crops. Punjab Agricultural University, Ludhiana, India.

Chaudhary, C.N. and Sinha U.P. (2001). Effect of concentrated organic manure, nitrogen and sulphur on the productivity and economics of sugarcane (*Saccharum officinarum*). *Indian J. Agron.*, **46**, 354-60.

Cheema, H.S. and Singh B. (1990). *A user's manual to CPCS 1*. Punjab Agricultural University, Ludhiana. India.

Cochran, W.G. and Cox G.M. (1967). *Experimental Designs*. John Wiley Publishers. New York.

Gawai, P.P. (2003). Effect of integrated nutrient management system in sorghum-chickpea cropping sequence. *Ph D thesis*, MPKV, Rahuri, Maharashtra, India.

Gosal, S.K., Kalia A., Uppal S.K., Kumar R., Walia S.S., Singh K. and Singh H. (2012). Assessing the benefits of Azotobacter bacterization in sugarcane: A field appraisal. *Sugar Technology*, **14**, 61–67.

Keshavaiah, K.V.Y., Palled B., Shankaraiah E, Channal H.T., Nandihalli B.S. and Jagadeesha K.S. (2012). Effect of nutrient management practices on nutrient dynamics and performance of sugarcane. *Karnataka J. Agricult. Sci.*, **25(2)**, 187-192.

Kumar, M. and Prasad B. (1989). The relative contribution of natural zinc complexing agents and $ZnSO_4$ to growth and zinc nutrition of maize. *J. Nuclear Agricult. Biol.*, **18**, 29–35.

Kumar, N. (2012). Productivity, quality and nutrient balance in spring sugarcane (*Saccharum* spp. Hybrid complex) under organic and inorganic nutrition. *Indian J. Agron.*, **57(1)**, 68–73.

Lakshmi, S.R., Sreelatha T., Usha T.R., Rao S.R.K. and Naidu N.V. (2011). Effect of organic manures on soil fertility and productivity of sugarcane in north coastal zone of Andhra Pradesh. *Indian J. Agricult. Res.*, **45**, 307-313.

Meade, G.P. and Chen J.C.P. (1977). *Cane Sugar Handbook*. WilleyScience, Publication, New York.

Olsen, S.R., Coleman C.W., Watnabe F.S. and Dean L.A. (1954). Estimation of available phosphorus with sodium bicarbonate. *United States Department of Agriculture Circular,* **939**, 19.

Pal, Rajinder, Singh Omkar, Sangherara S. Gulzar and Gupta R.K. (2021). Influence of INM on sugarcane productivity and soil fertility under indo-gangetic plain. *Indian J. Agricult. Sci.*, **91(5)**, 703-707.

Ranjan, A., Jha C.K. and Kumar N. (2020). A review on effect of INM on sugarcane growth, yield and quality. *Int. J. Curr. Microbiol. Appl. Sci.*, **9(1)**, 2597-2605.

Shukla, B.S. (1991). Review of absolute sugar recovery and sugar recovery performance. (In) *Proceedings 53rd Annual Convention STAI, New Delhi*. December 24-25, pp 57-58.

Singh, H., Jalota S.K. and Singh Y. (2007). Manuring and residue management effects on physical properties of soil under rice-wheat system in Punjab, India. *Soil and Tillage Res.*, **94**, 229-238.

Singh, K.P., Suman Archana and Singh P.N. (2007). Yield and soil nutrient balance of a sugarcane plant – ratoon system with conventional and organic nutrient management in sub – tropical India. *Nutr. Cyel. Agro Ecosyst.*, **79**, 209-219.

Soomro, A.F., Shamasuddin T., Fateh C.O. and Inaitullah R. (2013). Integrated effect of inorganic and organic fertilizers on the yield and quality of sugarcane (*Saccharum officinarm* L.). *Pak. J. Bot.*, **45**, 1339-1348.

Srivastava, T.K., Singh K.P., Menhilal, Suman A. and Kumar P. (2008). Productivity and profitability of sugarcane (*Saccharum* spp. complex hybrid) in relation to organic nutrition under different cropping systems. *Indian J. Agron*., **53(4)**, 310-330.

Yadav, D.V. (2000). Organic manuring in sugarcane prospects and retrospects. *Indian Sugar*, **49**, 979-988.

Yadav, S.P., Singh S.C., Yadav Sonia and Sharma B.L. (2017). Integrated nutrient management approaches for sugarcane (*Saccharum* spp- hybrid) plant – ratoon system in North region of India. Paper accepted for International conference organized at Udon Thoni, Thailand by IAPSIT (IS 2018)

Yadav, S.P., Singh S.C. and Yadav S. (2019). Integrated Nutrient Management Approaches for Enhancing Production Potential and Sustainability of Sugarcane (*Saccharum* spp. hybrid) Plant–Ratoon System in North Region of India. *Sugar Tech*., **21**, 170–175.