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RESEARCH PAPER

Elevating the productivity of sugarcane crop with sustainable way and means

Shriprakash Yadav* **and** Sonia Yadav
Sugarcane, Research Institute, U.P. Council of Sugarcane Research, SHAHJAHANPUR (U.P.) INDIA
(Email : drshriprakashyadav@gmail.com; soinaupcsr@gmail.com)

Abstract : In northern region as well as in India, sugarcane is a major commercial crop that sustains sugar industry, the second largest next to cotton and textiles industries. India occupies better position in the world in area and production after Brazil but the cane yield/ ha is generally lower than several other countries like Australia, Brazil etc. Uttar Pradesh ranks first in the country with regards to cane area and also in sugar production in the country. Therefore, the northern states role in improving national sugarcane productivity is obvious. Now days stagnation in crop yields and decline in the factor productivity have raised a question mark over sustainability of crop yield level reached during green revolution period. While the use of mineral fertilizer is the quickest and surest way of boosting crop production, their cost and other constraints frequently deter farmers for using them in recommended quantities and in balanced proportion. With the objective to develop crop nutrient management strategies for eco-friendly sugarcane production with sustaining soil health, a field experiment in spring season during 2014-16 were conducted at the research farm of Sugarcane Research Institute, Shahjahanpur (U.P.), India. Randomized Block Design and three replications with using test variety CoS 08279 (mid late maturing) was used to conduct the experiment with nine treatments. Use of farm yard manure (FYM) @ 10t/ha as organics along with inorganic fertilizers on the basis of soil test + biofertilizers *(Azotobacter* +P.S.B.@10kg/ha each) had to positive effect on sugarcane growth and yield and gave significantly higher cane yield (113.10 t/ ha) than the other treatments, CCS% in cane was not affected significantly due to different treatments, Maximum benefit cost ratio (2.66) was also obtained under the aforesaid treatment.

Key Words : Sustainable, Sugarcane, Soil health, Eco-friendly, Productivity

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INTRODUCTION

While there have been varying notions of organic farming over the years, the growth of the industry and the introduction of standards and certification have led to a clear definition in recent years. Definition that describes organics as a viable agriculture, based on sound farming practices does not include synthetic chemicals. Certified organic agriculture can be further characterized by a set of principles that include biodiversity, integration, sustainability, natural plant nutrition, natural pest management and integrity. Declining fertilizer use efficiency and organic matter levels have been observed

*** Author for correspondence:**

in soils and increasing the area of deficiencies including KS and micronutrient like Zn and Bo (Swaroop and Ganeshamurthy, 1998).

State like Uttar Pradesh comes in subtropical zone of the country, ended the sugar season 2016-17 as the highest sugarcane producer by leading Maharashtra, ending the season at 8.75 mt, a whopping 22.13 per cent increase as compared to last year. The state also achieved an average yield of 72.37 t/ha, which is again the highest with an increase in the yield as compared to last year (during 2015-16). The sugar sector today not only has transformational opportunities that would enable it to continue to service the largest domestic markets but has also emerged as a significant carbon credit and green power producer and has potential to support ethanol blending programme of E 10 and beyond (Soloman, 2016).

MATERIAL AND METHODS

Field experiments were conducted in spring season during 2014-15 and 2015-16 at the research farm of Sugarcane Research Institute, Shahjahanpur (U.P.),India. The experimental soil was sandy loam in texture, low in organic carbon (0.37%), medium in available phosphorus (21.45 kg/ha) and potassium (160 kg/ha) with 6.80 pH level. Design was RBD with three replications using test variety CoS 08279 (mid late maturing). The 100 per cent recommendations of N, P_2O_5 and K_2O for the region were 180kg, 80 kg and 60 kg per ha, respectively and on soil test basis 200kg / ha N, 80 kg P_2O_5/ha and 40 kg/ha K_2O were applied in the experiment as per treatment. Organic manures like FYM / compost, cane trash, inorganic fertilizers and bio-fertilizers (P.S.B.+ *Azotobacter*) were applied as per treatment in both plant

Table 1: Initial soil status of the experimental field

pH	Organic carbon (g/kg)	EC (dsm^{-1})	Available							
			P_2O_5 (kg/ha)	K_2O (kg/ha)	Zn (mg/kg)	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	S (mg/kg)	BD (g/cm^2)
6.54	3.70	0.17	20.40	162	2.63	56.48	15.86	1.46	14.40	1.321

Table 2 : Nutrient status after the harvest of plant cane

Treatments	pH	O.C. (g/kg)	EC (dsm^{-1})	Available							
				P_2O_5 (kg/ha)	K_2O (kg/ha)	Fe (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	S (mg/kg)	Zn (mg/kg)	BD (g/cm^2)
T_1- No organic + 50% RDF	7.10	3.70	0.032	11.07	137.00	40.40	13.60	0.98	12.10	1.90	1.01
T_2- No organic + 100% RDF	6.89	3.80	0.020	10.00	140.67	45.30	13.80	1.02	12.35	1.98	1.22
T_3- Noorganic+ Soil test based RDF	7.08	4.70	0.022	9.73	141.35	48.35	14.10	1.20	12.80	2.10	1.05
T_4- Application of FYM/compost @ 20t/ha + 50% RDF	7.13	3.40	0.024	12.40	150.65	50.10	14.00	1.13	12.20	2.05	1.21
T_5 - Application of FYM/ compost @ 20t/ha +100% RDF	7.30	4.70	0.021	8.13	151.33	46.50	14.15	1.15	12.40	2.10	1.25
T_6 - Application of FYM/compost @ 20t/ha +soil test based RDF	7.12	4.20	0.022	9.07	158.35	43.20	14.20	1.25	13.10	2.25	1.25
T_7 - Application of FYM/ compost @ 10t/ha + 50% RDF+ biofertilizers @ 10.kg/ha each(*Azotobacter* + PSB) each	7.22	4.70	0.024	8.53	150.33	48.70	14.30	1.16	12.70	2.23	1.22
T_8- Application of FYM/ compost @ 10t/ha + 100% RDF+ biofertilizers (*Azotobacter* + PSB) @ 10. kg/ha each	6.90	4.90	0.027	9.20	152.25	50.30	13.90	1.12	12.90	2.25	1.18
T_9 - Application of FYM/ compost @ 10t/ha + soil test based RDF + biofertilizers each (*Azotobacter* + PSB) @ 10. kg/ha each	7.04	5.00	0.028	10.93	165.33	51.40	14.85	1.30	13.50	2.43	1.26

and ratoon crops. Two years data recorded and analyzed critically (Table 3). Initial and after harvest of each crop soil samples of the experimental field were collected, analyzed and presented in Table 1 and 2.

RESULTS AND DISCUSSION

Experimental data on germination, growth and yield parameters, CCS per cent and B:C ratio presented in Table 2 showed significantly higher number of shoots (174990/ha), millable canes (222920/ha and cane yield (113.10 t/ha) with highest B:C ratio (2.66) in treatment T_9 (Application of FYM@ 10t/ha + soil test based recommended dose of inorganic fertilizers+ biofertilizers (*Azotobacter* +PSB@ 10 kg/ha each). Among yield parameters T_9 gave significantly higher cane length (2.53 m) and cane diameter (2.46 cm) than other treatments. Germination and CCS per cent were not affected significantly due to integration of organic and inorganic sources as well as biofertilizers.

Effect of FYM/ compost as organic manures :

The substitution of fertilizer N requirement to 50 per cent by FYM has given yield levels nearly similar to those obtained with complete fertilization (Ranwa and Singh,1999). Munuring recommended under intercropping system is as per the individual crop requirement *i.e.* the total quantity of fertilizer nutrients applied is equal to the full requirement of sugarcane (Palaniappan and Sivaraman, 1996). A study based on bio-organic depicted that in the bio-organic cultivation with 1.0 kg of organo-decomposer/ton PMC application during cane planting resulted good impact on cane crop and increased about 5-10 per cent cane yield (Singh and Srivastava, 2007).

Perumal *et al*. (1991) and Ranwa and Singh (1999) also suggested that FYM and vermicompost are helpful to recoup the soil health deteriorated due to indiscriminate use of chemical fertilizers over the years. It also combats the ill effects of chemical fertilizers on the soil health.

Table 3 : Performance of plant crop as influenced due to nutrient management **(Mean of two years)**

Treatments	Germination (%)	No. of shoots (000/ha)	NMC (000/ha)	Cane length (m)	Cane diameter (cm)	Cane yield (t/ha)	C.C.S (%)	B:C ratio
T_1- No organic + 50% RDF	42.65	137.73	97.22	2.36	2.31	79.74	12.41	2.17
T_2- No organic + 100% RDF	41.17	148.96	102.08	2.35	3.30	82.64	12.40	2.15
T_3- No organic+ soil test based RDF	41.47	145.37	105.09	2.39	2.36	84.03	12.78	2.21
T_4- Application of FYM/compost @ 20t/ha + 50% RDF	42.86	140.51	98.61	2.43	2.41	79.86	12.56	1.99
T_5 - Application of FYM/compost @ 20t/ha +100% RDF	42.16	151.85	106.94	2.42	2.39	95.95	12.83	2.23
T_6 - Application of FYM/compost @ 20t/ha +Soil test based RDF	41.26	162.50	114.24	2.48	2.41	96.30	12.87	2.25
T_7 - Application of FYM/ compost @ 10t/ha + 50% RDF+ biofertilizers @ 10.kg/ha each(*Azotobacter* + PSB) each	45.23	151.50	106.48	2.40	2.37	87.27	12.49	2.22
T_8- Application of FYM/ compost @ 10t/ha + 100% RDF+ biofertilizers (*Azotobacter* + PSB) @ 10. kg/ha each	46.63	165.28	117.13	2.45	2.39	104.28	12.47	2.58
T_9 - Application of FYM/ compost @ 10t/ha + soil test based RDF + biofertilizers each(*Azotobacter* + PSB) @ 10. kg/ha each	43.35	174.99	122.92	2.53	2.46	113.10	12.90	2.66
S.E.±	1.85	05.17	02.95	0.02	0.03	2.26	0.10	-
C.D. (P=0.05)	NS	10.96	06.25	0.05	0.07	4.80	NS	-

NS= Non-significant

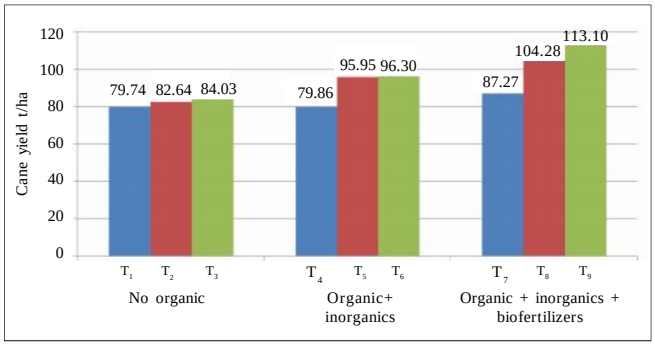

Fig. 1 : Relative expression of organic, inorganics and biofertilizers on plant cane yield

Higher levels of K_2O in vermicompost increases the turgidity of the plant cell creating problems to sucking pests while feeding on such plants (Planiappan and Siddeswaran 1995). Biological factors in FYM/ compost amended soil also contribute to increased nitrogenase activity resulting in vigorous plant growth rendering the plants to resist the attack of pathogen (Jhosi *et al*., 1984; Annonymous, 2002). Osunlaga (1990) reported increase in total aerobic bacteria with the increasing dose of compost. The presence of enzymes and other growth harmones like cytokinin and auxin in the vermicompost enhanced the nutritional quality (Alawdeen and Ismail, 1986 and Bhawalkar, 1998).

Effect of biofertilizers (*Azotobacter* and P.S.B.):

It has been reported that application of *Azotobactor* resulted 7.7–15.2 per cent more cane yield than *Azospirillum* at different N levels (Bangar and Sharma, 1997). Similar findings were observed by other workers also (Mishra and Naidu, 1990 and Durai and Manickam, 1991). It was also concluded that supplemental application of *Azotobacter* produced a marginal increase in cane and sugar yield, in addition to the saving of 75 kg N/ha irrespective of nitrogen levels. Similar finding was recorded by Bangar *et al*. (1992) confirming our results.

Bangar and Sharma (1997) reported that application of phosphate increased the yield of sugarcane and appreciable results were obtained by the use of PSB particularly at lower levels of phosphate (60 kg P_2O_5/ ha). This may be due to solubilizing of insoluble phosphate present in the soil (Kapoor *et al.*, 1989). By the use of PSB in sugarcane 20 kg P_2O_5/ha could be saved (Bangar and Sharma, 1997).

Effect of inorganic fertilizers on soil – plant system:

Studies on long term effect of cropping and manuring in 'All India Coordinated Research Project' on cropping system clearly demonstrated the role of balanced NPK fertilizers in increasing soil organic matter over unfertilized soil. Substitution of 50 per cent N through organic matter was also helpful in substantial increase in soil organic matter (Annual Report, 1999-2000). The results of Nambiar (1995) and Swaroop and Ganeshmurthy (1998) also indicated that the soil organic carbon was increased with the application of NPK + FYM continuously for 20 years compared to initial status of soil. More application of inorganic NPK has slightly lessen the carbon status as compared to NPK + FYM.

Conclusion:

Soil of the intensively cultivated areas of northern region of India specially in western part of U.P. are more prone to degradation mostly because of intensive tillage, imbalanced nutrient application and less emphasis on soil organic matter management. Our experimental results *i.e.*, application of FYM @ 10 t/ha + soil test based RDF + bio-fertilizer (*Azotobacter* + PSB @ 12.5 kg /ha each) gave significantly better plant cane yield (113.10t/ha) providing a guide line for managing soil organic matter (SOM) in intensively cropped areas and excellent tool for different agro - ecological regions by worked out threshold value of SOM.

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