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Effect of application various combination of fertilizers and manure on sugarcane production and juice quality

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ABSTRACT

An experiment was conducted during 2016-17 at Regional Research Station, Karnal of CCS Haryana Agricultural University. The experiment comprised of 10 treatments *viz*. Control (No fertilizer), 50% recommended dose (RD) of NPK, Recommended dose (RD) of NPK, Soil test based (STV) NPK, FYM@15t/ha + 50% RD NPK, FYM@15t/ha + 100% RD NPK, FYM@15t/ha + NPK based on STV, FYM@10t/ha + Bio fertilizers (BF) +50%RD NPK, FYM@10t/ha+BF+100% RD NPK, FYM@10t/ha + BF+ STV NPK. The application of 100% RD NPK or STV NPK significantly increased the cane yield and yield attributes *viz*. germination percentage (35.4 to 40.74 %), cane girth (2.08 to 2.44 cm), cane length (2.28 to 2.67 m) and cane weight (0.64 to 0.78 kg cane^{-1}), NMC (91417 to 97223), sucrose% (16.60 to 18.02%), CCS% (11.3 to 12.51%) over control. The application of FYM@15 t ha^{-1}+50% RD NPK achieved the similar cane yield as achieved by the application of 100% RD NPK. The application of FYM@15t ha^{-1}+100% RD NPK had the maximum cane yield (93.23 t ha^{-1}) and yield attributes parameters *viz*. germination percentage 44.91 %, cane girth 2.73 cm, cane length 2.97 m, cane weight 0.92 kg, NMC 101399 followed by the application of FYM@10t/ha+BF+100% RD NPK, and these treatment significantly increased cane weight and yield over RD NPK.

Key words: Bio-fertilizers, Farm yard manure, Juice quality, NPK, Sugarcane yield.

INTRODUCTION

Among the different management practices being undertaken for enhancing the productivity of sugarcane of which, soil fertility is an important one. Imbalance fertilization in sugarcane crop is mainly responsible for decline in its productivity and ultimately the profitability. Dawe *et al*. (2003) have reported that deterioration in soil health and crop productivity is associated with decline in soil-organic carbon under such farming systems. As soil organic carbon influences the physical, chemical and biological properties of the soil, thus it is necessary to device such nutrient-management practices that help to improve or maintain the organic C content of the soil. Inorganic fertilization alone cannot maintain the organic carbon status of soil. Thus integrating organic manures with inorganic fertilizer can adequately meet the nutritional requirements of sugarcane crop (Nagaraju *et al*., 2000). A balanced application of nutrients through an integrated use of organics and chemical fertilizers showed a promise in sustaining the cane productivity of soils (Kumar *et al.*, 2013 Ramesh *et al* 2004 Gopala sundaram *et al* 2012). Studies conducted in different part of India have shown that the use of different bio-fertilizers *viz*.; *Azotobacter*, *Azospirillum* and phosphorus solubilizing bacteria (*Bacillus magatherium*) alone or in combined use of these micro-organism significantly increased the sugarcane and sugar yields. The combined use of these micro-organisms always recorded increase in yields over their application alone.

Therefore experiment was conducted at Regional Research Station Karnal, to study the effect of various combinations of organic manure and bio fertilizer for sugarcane production.

MATERIALS AND METHODS

Field experiment was conducted at an research farm of Regional Research Station, CCS Haryana Agricultural University, Karnal. The physico-chemical properties of the soil of experimental field are given in Table 1. The experiment comprises of 10 treatment *viz*., T1: Control (No fertilizer), T2: 50 % recommended dose (RD) of NPK, T3: Recommended dose (RD) of NPK, T4: Soil test based NPK, T5: FYM @15 t ha^{-1} + 50 % RD NPK, T6: FYM @15 t ha^{-1} + 100 % RD NPK, T7: FYM @15 t ha^{-1} + NPK based on STV, T8: FYM @10 t ha^{-1} + Bio fertilizers (BF) + 50 % RD NPK, T9: FYM @10 t ha^{-1} + BF + 100 % RD NPK, T10: FYM @10 t ha^{-1} + BF + STV NPK. Half dose of nitrogen and full dose of P_2O_5 and K_2O (MOP) were applied at the time of sowing of the sugarcane seeds (setts). Remaining half dose of N was applied in two equal split i.e. one after 2nd irrigation and remaining after 4th irrigation. Liquid Biofertlizers (*Azotobacter chroococcum* and Phosphate solubilising bacteria) @ 2.5 litre/ha each were used to treat

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Table 1: Physico-chemical properties of soil of the experimental field.

Parameter	
Texture	Clay loam
pH (1:2:: Soil : Water)	7.87
Electrical Conductivity (dS m^{-1})	0.13
Organic carbon (%)	0.42
Available nitrogen (kg ha^{-1})	160
Available phosphorus (kg ha^{-1})	9.1
Available potassium (kg ha^{-1})	172
Cation Exchange Capacity (Cmol(p^+)/kg)	14.91

the sugarcane setts and was diluted 20 times with clean water. The setts were kept in the bio fertilizers solution for about 15-20 minutes and were dried in shade and planted on the same day. FYM was applied in the plots 20 day before sowing of crop. CoH167 variety of sugarcane was sown in furrows on 11th March 2016. CoH 167 is mid maturing variety and shows high cane yield and juice quality, tolerant to red rot, smut and frost resistant, non-lodging, solid juicy cane and thick stems.

Yield and juicy Quality observations were taken after harvesting of the crop. Following observations were taken after harvesting of the crop:

After harvesting the crop the girth of canes were recorded. Six canes from each plot were taken and their girth was recorded from top, middle and bottom. Average of these girths represented the girth of plants in the plot. The length of 6 randomly selected individual plants from each plot was measured at final harvest stage from ground to tip of the plant and expressed in centimetres; the average cane length of each plot represented the length of cane in the plot. Plant population measure by counting the germinated plants in each plot at 45 days after planting. The number of millable cane (NMC) counted per plot and NMC per ha cane yield were calculated for each treatment in each replication. The cane yield was noted for each plot and is calculated per ha for each treatment in each replication.

RESULTS AND DISCUSSION

The effect of various combination of fertilizers and organic manure on growth parameters: The application of 100% RD NPK significantly increased germination percentage (35.4 to 40.74 %), cane girth (2.08 to 2.44 cm) and cane length (2.28 to 2.67 m). The application of 100% RD NPK and STV based NPK gave the equal result in *viz.* germination percentage, cane girth and cane length. The application of FYM @ 15 t ha^{-1} + 100 % RD NPK, FYM @ 15 t ha^{-1} + NPK based on STV, FYM @10 t ha^{-1} + BF + 100 % RD NPK, FYM @ 10 t ha^{-1} + BF + STV NPK significantly increase the germination percentage, cane girth and length weight, over the control (Table 2). Further the applications of FYM @ 15 t ha^{-1} along with 100 % RD NPK significantly increased the germination percentage (40.74 to 44.91 %), cane girth (2.44 to 2.73 cm) and length (2.77 to 2.97 m) over the application of 100 % RD NPK alone. The application of FYM@15t ha^{-1}+100% RD NPK had the maximum yield attributes parameters *viz.* germination percentage 44.91 %, cane girth 2.73 cm, cane length 2.97 m and significantly increased these parameter over RD NPK application. The application of FYM@10t ha^{-1}+ BF+100%RD NPK increased the cane length 2.91m over RD NPK application.

The above results were in conformity with Dev *et al.,* (2011) recorded that application of 210 kg N ha^{-1} linearly and significantly increase number of tiller (5.48 %), number of millable cane (1.12 %), weight of millable cane (5.85 %), cane length, number of internodes cane (7.59 %), cane girth of top (4.52 %), and cane yield (5.93%), Meena *et al.*,(2015) found that variety 'CoH 06247 had higher percent germination (45.08), tillers (1, 52,000 /ha), cane length (220.40 cm), number of millable cane (1, 22,440), cane yield (97.55 t ha^{-1}) and results indicated that application of 200:60:40 kg NPK ha^{-1} was found best nutrient management practice for getting higher yield and profitability of sugarcane variety 'CoH 06247' in spring planting. Srivastava *et al.,* (2008) conducted an experiment on productivity and profitability of sugarcane in relation to organic nutrition under different cropping systems they found highest number of millable canes (82.7 and 95.2 thousands ha^{-1}) and cane length (220.8 and182.5 cm) were recorded with sulphitation pressmud (SPM) 10 t ha^{-1}+ farmyard manure

Table 2: Effect of different treatments on plant population (Germination %) cane girth and cane length.

Treatment	Plant population (Germination %)	Cane girth(cm)	Cane Length(m)
Control	35.40	2.08	2.28
50 % RD NPK	36.33	2.30	2.44
100 % RD NPK	40.74	2.44	2.67
STV based NPK	39.77	2.42	2.63
FYM @ 15 t ha^{-1}+ 50 % RD NPK	39.88	2.51	2.65
FYM @ 15 t ha^{-1} + 100 % RD NPK	44.91	2.73	2.97
FYM @ 15 t ha^{-1} + NPK based on STV	44.18	2.66	2.86
FYM @ 10 t ha^{-1} + BF + 50 % RD NPK	39.49	2.57	2.78
FYM @10 t ha^{-1}+ BF + 100 % RD NPK	43.99	2.64	2.91
FYM @ 10 t ha^{-1} + BF + STV NPK	43.57	2.61	2.90
C.D. (p=0.05)	4.12	0.21	0.10

(FYM) 10 t ha^{-1} in autumn and spring planted crops respectively. SPM 10 t ha^{-1} + FYM 10 t ha^{-1}caused the Virdia and Patel (2010) also revealed that the integrated use of FYM @25 % of recommended dose of N with RDF (250-125-125 kg N-P-K ha^{-1} and bio fertilizer (*Azotobacter* and PSB) to the main plant crop followed by 10 tonnes ha^{-1} trash incorporation with fertilizer inoculation + RDF (300-62.5-125 kg N-P-K ha^{-1}) application in ratoon crop increased the cane and commercial cane sugar yield from 13.3 to 30.6 tonn ha^{-1} and 0.5 to 1.6 tonn ha^{-1}, respectively. Nazirkar and Kamthe (2012) studied the effect of integrated nutrient management (Bio fertilizer + FYM + recommended dose of fertilizers 500:170:127: N, P_2O_5, K_2O on vertisols and observed that integrated nutrient management enhance the plant growth, total chlorophyll content and NR activity of sugarcane.

The effect of various combination of organic manure on yield attributing attributes and cane yield: The application of 50 % RD NPK increased the cane yield (66.13 t ha^{-1}) over the control (44.79 t ha^{-1} respectively). The application of 100% RD NPK significantly increased and yield attributes *viz.* cane weight (0.64 to 0.78 kg $cane^{-1}$), and NMC (91417 to 97223) and cane yield. The application of 100% RD NPK and STV based NPK gave the equal result in cane yield and yield attributes *viz.* cane weight, NMC. The application of FYM @ 15 t ha^{-1} + 100 % RD NPK, FYM @ 15 t ha^{-1} + NPK based on STV, FYM @10 t ha^{-1} + BF + 100 % RD NPK, FYM @ 10 t ha^{-1} + BF + STV NPK significantly increase the cane weight, NMC and cane yield over the control (Table 3). Further the applications of FYM @ 15 t ha^{-1} along with 100 % RD NPK significantly increased the cane weight, NMC and cane yield over the application of 100 % RD NPK alone. The application of FYM@15t ha^{-1}+100% RD NPK had the maximum cane weight 0.92 kg ha^{-1}, NMC (101399) and cane yield (93.23 t ha^{-1}) and significantly increased these parameter over RD NPK application. The application of FYM@10t ha^{-1}+ BF+100%RD NPK increased the cane weight and cane yield over RD NPK application. The application of bio fertilizer has importance for biological nitrogen fixation. So, combination of bio fertilizers with organic manure and NPK fertilizer achieves the higher yield over the 100% RD NPK.

Rakkiyappan *et al.,* (2001) revealed that combined application of organic or bio fertilizers with chemical fertilizers improved the cane yield and the effect was more pronounced at lower fertilizer level (50 % NPK) than at higher level (75 % NPK) and application of bio compost or enriched press mud or bio fertilizers along with 50 % NPK or 75 % NPK recorded yields at par with 75 % NPK and 100 % NPK as chemical fertilizers, respectively. This study indicated that through the application of 10 tonnes of bio compost or enriched press mud or *Acetobactor* + phosphobacterium (each 10 kg), 25 % chemical fertilizers could be saved without losing yield and quality besides

Table 3: Effect of different treatments on Cane weight, NMC and Cane yield.

Treatment	Cane Weight	NMC	Cane Yield (t ha^{-1})
Control	0.64	91413	44.79
50 % RD NPK	0.71	93154	66.13
100 % RD NPK	0.78	97223	75.84
STV based NPK	0.76	95772	72.78
FYM @ 15 t ha^{-1}+ 50 % RD NPK	0.78	96627	75.36
FYM @ 15 t ha^{-1} + 100 % RD NPK	0.92	101399	93.28
FYM @ 15 t ha^{-1} + NPK based on STV	0.88	100545	88.47
FYM @ 10 t ha^{-1} + BF + 50 % RD NPK	0.76	95467	72.55
FYM @10 t ha^{-1}+ BF + 100 % RD NPK	0.88	99986	87.98
FYM @ 10 t ha^{-1} + BF + STV NPK	0.85	98700	83.89
C.D. (p=0.05)	0.07	5336	8.98

Table 4: Effect of different treatments on Sucrose %, CCS % and Sugar yield.

Treatment	Sucrose %	CCS %	Sugar yield * (tonn/ha)
Control	16.60	11.37	5.1
50 % RD NPK	16.93	11.62	7.7
100 % RD NPK	18.02	12.51	9.5
STV based NPK	17. 54	12.22	8.9
FYM @ 15 t ha^{-1}+ 50 % RD NPK	17.21	11.82	8.9
FYM @ 15 t ha^{-1} + 100 % RD NPK	18.53	12.77	11.9
FYM @ 15 t ha^{-1} + NPK based on STV	18.42	12.76	11.3
FYM @ 10 t ha^{-1} + BF + 50 % RD NPK	17.97	12.58	9.1
FYM @10 t ha^{-1}+ BF + 100 % RD NPK	18.14	12.61	11.1
FYM @ 10 t ha^{-1} + BF + STV NPK	18.03	12.61	10.6
C.D. (p=0.05)	0.57	0.40	0.49

improving soil fertility. Kumar *et al.,* (2015) found that the application of Bio-fertilizer along with 75 % RDF produces the highest microbial population than alone NPK without biofertlizers and thus can compensate the application of 25 % dose of recommended nitrogen and phosphorus. Virdia and Patel (2010) revealed that the integrated use of FYM @25 % of recommended dose of N with RDF (250-125-125 kg N-P-K ha^{-1} and bio fertilizer (*Azotobacter* and PSB) to the main plant crop followed by 10 tonnes ha^{-1} trash incorporation with fertilizer inoculation + RDF (300-62.5-125 kg N-P-K ha^{-1}) application in ratoon crop increased the cane and commercial cane sugar yield from 13.3 to 30.6 tonn ha^{-1} and 0.5 to 1.6 tonn ha^{-1}, respectively.

Effect of different treatments on juice quality parameters: Different treatments have direct influence on the quality of sugarcane and showed desirable changes in quality parameters sucrose % and CCS 100% RD NPK as compared to control where no nutrient has been added (Table 4). The application of 50 % RD NPK did not increase the juice quality parameter (sucrose 16.93 % , CCS 11.62 % and sugar yield 7.7 t ha^{-1}) over the control (16.60 %, 11.37 % and 5.1 t ha^{-1} respectively) (Table 4). Addition of 100% of RD NPK resultsed in increase the sucrose % (18.02%) and CCS %. (12.51%) over the control. The value of sucrose % and CCS% obtained with the application of NPK based on soil test value were at par with the application of 100% RD NPK. The application of FYM @ 15 t ha^{-1} +50% or 100 % RD NPK or STV NPK or the application of FYM @ 10 t ha^{-1} + BF +50% or 100 % RD NPK or STV NPK resulted at par in juice quality parameter *viz.* sucrose and CCS compared with 100 % RD NPK (18.02 %) , CCS (12.51 %). However there was substantial increase in the sugar yield with application of FYM or BF with integration of NPK .The increase in the sugar yield was mainly due to increase in the cane yield. Shukla *et al.,* (2013) found that an increase in sucrose content in juice was observed by application of 12.5 t ha^{-1} of PMC over the recommended dose of NPK through fertilizer. Omollo and Abayo (2011) also recorded that application of P_2O_5 gave higher values for % Brix (20.62) and % Pol (18.81) at control plots compared to treated plots irrespective of levels of P. Soomro *et al.,* (2013) observed that % brix, pol, purity, commercial cane sugar, NPK uptake and accumulation in sugarcane were higher when three-fourth of recommended rate of NPK fertilizer (169-84-261) were applied along with + 20 tons press mud ha^{-1}. Sarwar *et al.,*(2010) reported that inorganic fertilizer increase the sugar yield 54.92 % and juice 21.95 %. Similarly when press mud was applied along with inorganic fertilizers, it resulted in increase in total soluble solid 7.83 %, sucrose10.42 % purity 2.80 %, CCS 12.06 % and sugar recovery of juice12.07 %.

Different treatments have shown influence on the yield of sugarcane. The application of 100% RD + NPK or fertilizer application base on soil test value the increased cane yield , yield parameters and juice quality as compared to control where no fertilizer. Yield parameters such as germination percentage, cane girth, cane weight, cane length, number of millable canes (NMC) and overall cane yield has been greatly influenced by the application recommended dose of fertilizer in combinations of farm yard manure, bio fertilizer and has shown maximum cane yield advantage. The application of FYM @ 15t/ha in combination 50% RDF on 50% NPK base on STV achieved the similar case yield as achieved by RDF, however the treatment combination @ 15t/ha +100% NPK future increase the case yield and yield parameters over 100% RD+ NPK application.

CONCLUSION

In this study the application of 50% RD NPK did not achieve cane yield and juice quality as obtained with the application of 100% RD NPK. However, the application of 100% RD fertilizer achieve the significantly higher cane yield over control and similar yield as achieved by the application of STV based NPK. The application of farm yard manure (FYM) @15t ha^{-1} in combination of recommended of fertilizer achieve the maximum yield and closely followed by the application of FYM@10t ha^{-1} +bio fertilizer (*Azotobacter* + PSB) +100 % RD NPK.

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