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Effect of Inorganic and Organic Fertilizers on the Yield and Quality of Sugarcane

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***Abstract*: The field experiment was conducted to evaluate the effect of inorganic and organic fertilizers on the yield and quality of sugarcane at the research block of the National Sugarcane Research Program, Jeetpur, Bara, Nepal during 2020-2020. The experiment was laid out in a randomized complete block design with three replications. A total of nine treatments (50% RDF, 100% RDF, FYM (15 t/ha) + 50 % RDF, FYM (15 t/ha) +100% RDF, FYM (7.5 t/ha) + 50% RDF + BF, FYM (7.5 t/ha) + 100% RDF + BF, 50% RDF + BF, 100% RDF +BF and no fertilizer/manure) were included in the experiment. The variety was CO 7250. The results showed that integrated application of inorganic or organic nutrient sources along with biofertilizers recorded higher cane yield and the number of millable canes. The results of the study suggest that integrated use of organic manure, chemical fertilizer, and biofertilizer [FYM @ 7.5 t/ha+100% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha) 50% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha)] is an effective and sustainable method for producing sugarcane. However, the study should be conducted over locations so that the best integrated nutrient management could be recommended for the wider area.**

***Keywords*: Sugarcane, Organic fertilizer, Inorganic fertilizer, Yield, Juice quality.**

1. Introduction

Sugarcane (*Saccharum officinarum* L.), a rich source of sucrose and ethanol, is an economically important crop worldwide. Globally, it is cultivated in 26.34 million hectares by more than 95 countries with a total production of 1859.39 million tons [1]. Sugarcane is an important industrial crop of Nepal and it is commercially cultivated in 12 districts of four provinces of Nepal. The total annual production of sugarcane in 2020/21 was 3.18 million metric tons with an average productivity of 49.48 mt/ha [2]. The sugar deficit in Nepal is about 57% and the country imports the remaining quantity from abroad to meet the national demand [3].

Sugarcane is a long-duration and nutrient-exhaustive crop which removes about 2.05, 0.24, and 2.28 kg $NP_2O_5K_2O$/t of cane production [4]. The fertilizer use in Nepal is inadequate, and imbalanced, and is in favor of N, P_2O_5, and K_2O. The inadequate and imbalanced use of chemical fertilizers is the major factor for the poor yield of sugarcane in Nepal. The soil health and chemical-based sugarcane production system is being deteriorated due to the frequent and excessive use of chemical fertilizers. The decrease in soil organic matter is a key factor for the decline of sugarcane productivity and overall factor productivity. Restoration of organic matter is thus, needed for maintaining soil health and improving productivity.

An increase in the available nitrogen with the application of bio-compost and farm yard manures (FYM) may be attributed to the incorporation of organic matter which enhances the multiplication of microbes due to the incorporation of different organic sources for the conversion of organically bound N into the organic form [5]. The available soil nitrogen is low and the addition of organic matter is not practiced in modern agriculture. Thus, improving soil organic matter and soil fertility are important factors for the sustainability of sugarcane. Sugarcane produces a large amount of foliage (40% of total biomass) and a good crop of sugarcane produces about 10 to 15 t of trash depending upon variety and growth. It contains 0.35:0.057:0.542%, $NP_2O_5K_2O$ in addition to other secondary and micronutrients [6]. Like micronutrients, FYM, vermicompost, press-mud, and biofertilizers are considered important sources of macro and micronutrients that increase crop yield. The application of organic fertilizers together with chemical fertilizers, compared to the addition of organic fertilizers alone, had a higher positive effect on microbial biomass and hence soil health [7]. The application of organic matter from such resources as animal manure, crop residues, and green manuring has been shown to replenish soil organic C and improve soil fertility [8, 9].

The addition of compost improves soil structure, texture, and tilth. Intensive cropping and imbalanced use of essential plant nutrients have reduced the organic carbon content and deterioration in physical properties. Thus, this study was conducted aiming to find out the integrated nutrient management method for the sustainability and higher productivity of sugarcane.

2. Materials and Methods

A. Experimental Site

The field experiment was carried out at the research block of

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Table 1
Details of treatments

Treatment symbol	Details
T1	50% of the recommended dose of fertilizer (75:30:20:12.5 N:P_2O_5:K_2O:$ZnSO_4$ kg/ha)
T2	100% of the recommended dose of fertilizer (150:60:40:25 N:P_2O_5:K_2O: $ZnSO_4$ kg/ha
T3	FYM @ 15 t/ha + 50% of the recommended dose of fertilizer
T4	FYM @ 15 t/ha + 100% of the recommended dose of fertilizer
T5	FYM @ 7.5 t/ha + 50% of the recommended dose of fertilizer + biofertilizer (PSB and Azotobacter @10 kg/ha)
T6	FYM @ 7.5 t/ha + 100% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha)
T7	50% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha)
T8	100% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha)
T9	No fertilizer/manure (control)

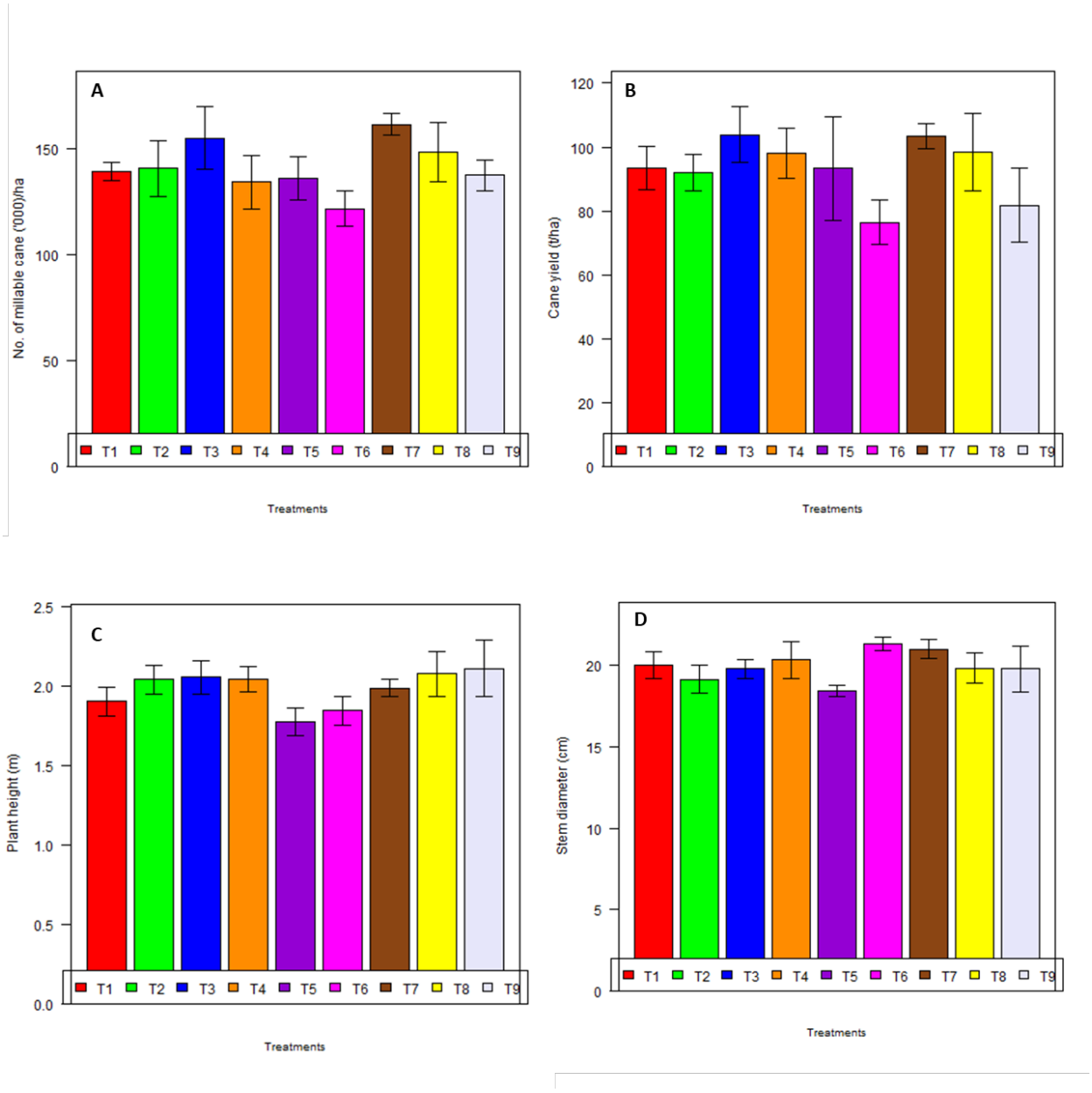

Fig. 1. Effect of different inorganic and organic fertilizers on growth and yield of sugarcane (main crop) (Bars on the graph shows ± standard error)

the National Sugarcane Research Program, Jeetpur, Bara, Nepal during 2020-2-21. The site is located at 27°06'48" N latitude, 84°57'07" E longitude, and at an elevation of 98 meters above sea level. The climate of the site is hot and humid in the summer season and cool in winter. The maximum average temperature ranges from 22.7-34.5°C and the minimum temperature ranges from 8.5-25.9°C. The average annual rainfall is 1550 mm.

B. Experimental Design and Treatment Details

The experiment was conducted in a randomized complete block design with three replications. A total of nine treatments were included in the experiment and their details are given in Table 1. The size of each plot was 22.5 m^2.

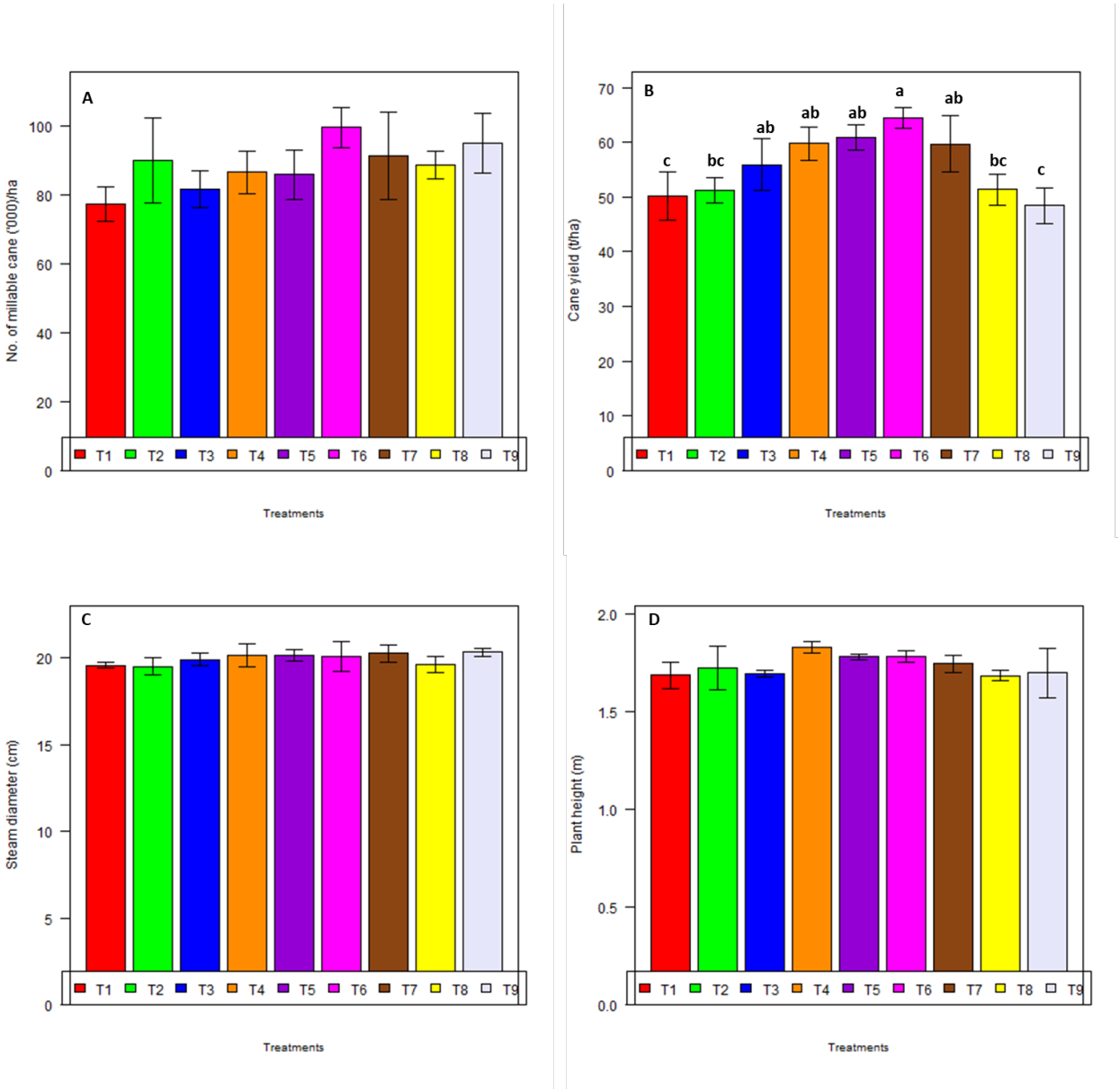

Fig. 2. Effect of different inorganic and organic fertilizers on growth and yield of sugarcane (ratoon crop) (Bars on the graph shows ± standard error and alphabets above the bar shows the significance at 5%)

C. Cultural Practices

The land was prepared with a mouldboard to remove the hard pan of the soil and then with a rotavator to obtain a fine seed bed and finally levelled. The ridges were made at a row spacing of 0.90 m and the sets having two buds of sugarcane variety Co 7250 were placed in the furrows and covered with thin layers of soil. The planting was done in the month of March. Fertilizers were applied as per treatments. Other cultural practices were done as per sugarcane production technology recommendations by the National Sugarcane Research Program, Jeetpur, Bara.

D. Observations Recorded and Data Analysis

The number of millable canes and cane yield per plot were recorded at the time of harvest after removing leaves and the top portion and converted into per hectare. Cane juice of sampled canes with a power crusher (MGT01, VED Enterprise, Rajkot, India) and juice quality was estimated as per method given by Spencer and Meade (1955).

The recorded data were subjected to analysis of variance (ANOVA) and treatment means were separated using the least significant test (LSD) at a 5% level of significance. The GenStat discovery 15th edition software was used for ANOVA and mean separation test [10].

E. Effect on Cane Yield and Other Attributes

The analysis of variance showed that the effect of treatments on cane yield and other attributes was non-significant (ANOVA is not shown) for the main crop while the effect was significant for cane yield (t/ha) for the ratoon crop. The effect of treatments on cane yield and other attributes is shown in Fig. 1. However, higher cane yield, number of millable canes ('000)/ha was recorded in T7 and T6 in the main crop and the values of cane yield (t/ha) and number of millable canes ('000)/ha were 103.39 and 161.57 in T7 and T6, respectively. There was not so much variation in plant height and stem diameter among the

Table 2
Effect of integrated application of organic and inorganic fertilizers on sugarcane juice quality

Treatments	Main crop				Ratoon crop			
	Brix	Pol%	Purity%	SR%	Brix	Pol%	Purity%	SR %
T1	21.5	20.0	93.0	14.2	19.9	18.2	91.5	13.0
T2	20.8	19.0	91.3	13.4	20.4	19.2	94.1	13.8
T3	20.4	18.5	90.3	13.0	18.9	17.7	93.4	12.7
T4	19.9	18.6	89.9	13.2	20.4	19.3	94.6	14.0
T5	21.6	19.6	90.3	13.7	19.4	17.9	92.3	12.8
T6	21.7	19.8	91.3	13.9	20.7	19.4	94.2	14.0
T7	21.3	19.5	91.2	13.7	21.2	19.9	93.9	14.3
T8	20.5	19.1	91.6	13.5	21.2	20.0	94.6	14.5
T9	20.9	18.0	91.3	12.3	19.9	18.6	93.2	13.3
Grand Mean	**21.0**	**19.1**	**91.1**	**13.4**	**20.2**	**18.9**	**93.5**	**13.6**
Max	21.7	20.0	93.0	14.2	21.2	20	94.6	14.5
Min	19.9	18.0	89.9	12.3	18.9	17.7	91.5	12.7
F-test	NS	NS	*	*	NS	NS	*	*
LSD (p≤0.05)	-	-	4.869	1.810	-	-	4.396	1.781
CV (%)	3.6	4.7	3.2	5.1	4.3	5.7	2.0	6.4

Pol = polarization, SR= sugar recovery, NS = non-significant at 5% level of significance and * significant at 5% level of significance.

treatments. The highest cane yield (64.42 t/ha) was found highest in T6 in the ratoon crop. However, it was at par with T3 (55.94 t/ha), T4 (59.76 t/ha), T5 (60.85 t/ha), and T7 (59.67 t/ha). In the main crop, there were no significant differences in yield and yield parameters. However, higher cane yield was recorded with T6 and T7 (the treatments receiving FYM + NPK+ biofertilizer) and it was significant in the ratoon crop. This could be due to the beneficial role of organic manure and sufficient fertilizer facilitating the nutrient uptake from the soil in the later years. Many authors reported that the effect of organic manure (FYM) and biofertilizers help in replenishing long-term soil fertility through biological activity in the rhizosphere [5, 11]. Our results are in agreement with the findings of [12, 13] who reported that the combination of organic manure, chemical fertilizers, and biofertilizers increased cane yield.

F. Effect on Juice Quality Parameters

The data on the effect of different organic and inorganic fertilizers on sugarcane juice quality in both main and ratoon crops are presented in Table 2. The analysis of variance showed that the effect of treatments on various quality parameters was non-significant except for purity (%) and sugar recovery (%) in both main and ratoon crops. In the main crop, purity (%) ranged from 89.9-93.0 and sugar recovery (%) ranged from 12.3 to 14.2. Similarly, purity (%) ranged from 91.5-94.6 and sugar recovery (%) ranged from 12.7 to 14.5 in the ratoon crop. In the main crop, the highest values of purity (93.0) and sugar recovery (14.2%) were recorded in T1 while the highest value of sugar recovery (14.5) was found in T8 for the ratoon crop. These two treatments were significantly different from the control treatment. In our study, many quality parameters except purity and sugar recovery percentage were not significantly different among treatments. The significantly increased sugar recovery percentage in the treatments receiving the combination of NPK, FYM, and biofertilizer might be due to a cumulative increase in other quality parameters in those treatments. Similar findings of integrated nutrient application were also reported by [4, 12].

3. Conclusion

Based on the results of the present study it can be concluded that integrated use of organic manure, chemical fertilizer, and biofertilizer [FYM @ 7.5 t/ha+100% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha) 50% RDF + biofertilizer (PSB and Azotobacter @10 kg/ha)] is an effective and sustainable method for producing sugarcane. The experiment was conducted at only one location. So, it can be suggested that the experiment should be conducted over location so that treatment performance across locations having different climatic and edaphic factors could be evaluated and verified.

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