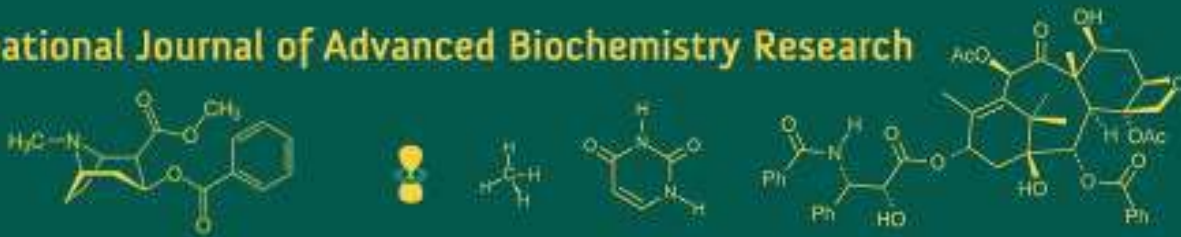


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
 ISSN Online: 2617-4707
 NAAS Rating (2026): 5.29
 IJABR 2026; SP-10(2): 304-307
www.biochemjournal.com
 Received: 21-12-2025
 Accepted: 23-01-2026

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Residual effect of different planting methods on ratoon performance of sugarcane (*Saccharum officinarum* L.)

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i2Sd.7601>

Abstract

A Field experiment was conducted at the Regional Sugarcane and Research Station, Rudrur of Professor Jayashankar Telangana Agricultural University, Telangana, India during 2023-24 to study the Performance of different planting establishment methods on growth and yield of the sugarcane ratoon crop. The experiment consists of five treatments with four Replications and was laid out in Randomized Block Design. The treatments consist of Mechanical transplanting of sugarcane seedling, Manual transplanting of sugarcane seedlings, manual planting of single bud setts, manual planting of two budded setts, manual planting of tree budded setts. Among the different treatments highest number of tillers produced at 90 DAP and 120 DAP statistically superior to the mechanical transplanting of sugarcane seedlings. The lowest tiller count was observed with manual planting of single bud setts. The number of millable canes (104.20×10^3 ha), single cane weight (1.17 kg), cane yield (122.52 t ha^{-1}) was significantly highest with the mechanical transplanting of sugarcane seedlings. Manual planting of single bud setts recorded the lowest number of millable canes ($77.30 \times 10^3 \text{ ha}^{-1}$) and cane yield (73.14 t ha^{-1}). The gross returns, Net returns and B:C ratio were recorded highly with mechanical transplanting of single node seedlings by transplanter where as lowest returns were recorded with manual planting of single bud setts.

Keywords: Sugarcane, planting methods, ratoon crop, carry-over effect, single node seedlings, sett planting, yield attributes, mechanized transplanting

Introduction

India has been cultivating sugarcane (*Saccharum officinarum* L.) since the Vedic era (1400-1000 BCE), making it one of the earliest domesticated crops ever recorded. Despite less-than-ideal agronomic conditions, sugarcane, a low-risk, high-reward cash crop, continues to play a crucial role in India's agrarian economy by providing socioeconomic stability for growers (Narendar *et al.*, 2025) [4]. In addition to numerous other byproducts, sugarcane is a multipurpose crop that yields sugar, fiber, biofuel, and manure. It is the main ingredient used to make gur and khandasari as well as to produce sugar. A crucial part of the sugarcane production system is ratooning, which gives sugarcane its distinctive character by producing multiple subsequent crops from a single planting. (Raviteja *et al.*, 2024) [5]

In India, 2.60% of the total cultivated land is used for sugarcane farming. From 2.7 million hectares in 1980-81 to 5.74 million hectares in 2023-24, the cultivated area has grown steadily. India's sugarcane industry flourishes in a variety of climates, including tropical and subtropical regions. India's sugarcane agriculture has steadily expanded over the last few decades, as seen by gains in area, productivity, production, and sugar recovery. In 2023-2024, India will produce over 34.0 million metric tonnes of sugar, or 18% of the world's total sugar production (USDA., 2024) [8]. Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Punjab, Haryana, Uttarakhand, and Bihar are the main regions where the crop is farmed. Together, Maharashtra and Uttar Pradesh make up over 69.70% of India's entire sugarcane production and almost 68.70% of the country's total sugarcane area. Despite the state's favourable growth conditions, Telangana's area is shrinking from 0.35 lakh hectares in 2017-18 to 0.27 lakh hectares in 2023-24 (Directorate of Sugarcane, G.O.I, 2024) [1].

In Telangana and other parts of the country, sugarcane productivity is often limited by high seed cane requirement, labour scarcity, and poor planting efficiency associated with conventional sett planting methods. Traditionally, farmers rely on manual planting of three-budded setts, which not only increases the seed rate but may result in uneven germination and delayed crop establishment. Modern planting techniques such as single node seedling and single bud setts have been proposed as alternatives, aiming to improve stand establishment, reduce seed rate, and optimize resource use. According to reviews, single bud and mechanized planting systems exhibit positive impacts on growth and yield metrics when compared to traditional approaches, and bud size and planting technique have a substantial impact on germination, crop vigor, and yield components in sugarcane (Varshini and Jayanthi 2021) [9].

Research on novel planting systems, including single-bud transplanting and nursery-raised seedling transplanting, suggests that these approaches can enhance early plant population and contribute to higher yield potential compared with conventional three-budded sett planting, while also offering advantages in seed cane multiplication and cost efficiency. However, performance data under specific agro-climatic conditions, such as those in Telangana, remain limited. Therefore, the present investigation was undertaken to evaluate the residual effects of different planting establishment methods including Mechanical transplanting of single node seedling with a transplanter and manual planting of seedling as well as manual planting of different sugarcane setts of single budded, two budded and three budded respectively on the growth and yield of sugarcane.

Materials and Methods

Experimental site and crop

The ratoon crop field experiment was conducted during the 2023-24 season at the experimental farm of the Regional Sugarcane and Rice Research Station, Rudrur, which is geographically situated at 18.5649°N and 77.8775°E with an altitude of 286.3 m above the mean sea level, which falls under Northern Telangana Agro-climatic zone of Telangana. Sugarcane (*Saccharum officinarum* L.) variety Co 86032, which is a medium thick cane, widely cultivated for its high yield potential for both main crop as well first and second ratoon with high quality and maintain them for longer period used for the study. The experiment was laid out in a Randomized Block Design (RBD) with five treatments and four replications. The total five treatments were randomly allotted to experimental plots to minimize the effect of soil heterogeneity. The experimental field was sandy loam in texture, neutral in reaction (7.35), Non saline (0.22 ds m⁻¹), low in organic carbon (0.52%) and available nitrogen (256 kg ha⁻¹), medium in available phosphorus (19 kg ha⁻¹) and potassium (143 kg ha⁻¹). Recommended agronomic practices were followed uniformly for all treatments throughout the crop growth period, except for the planting methods under evaluation.

The treatments comprised different sugarcane planting methods for main crop are as follows: T₁: Mechanical transplanting of Single node seedling with transplanter, T₂: Manual transplanting of single node seedlings, T₃: Manual planting of single bud setts, T₄: Manual planting of two-budded setts, T₅: Manual planting of three-budded setts (farmers' practice). Subsequently the crop was harvested and the data recorded for the ratoon crop in 2023 and 2024.

The crop was given irrigation with sub-surface drip condition. All cultural operations such as fertiliser application, weed management, and plant protection measures were adopted uniformly across treatments as per the recommended package of practices. For the ratoon crop, fertilizers were applied as per standard recommendations reported in sugarcane. The spacings adopted was 150 cm X 30 cm. The recommended dose of fertilizers (250:120:100 kg N:P₂O₅:K₂O ha⁻¹) was applied with modified scheduling. The entire dose of phosphorus (120 kg ha⁻¹) and half of potassium (50 kg ha⁻¹) were applied basally immediately after harvest. Nitrogen was applied in three splits. 85 kg ha⁻¹ immediately after harvest, 85 kg ha⁻¹ 40 days after harvest and the remaining 50 kg ha⁻¹ applied at 75 days after ratooning. The balance potassium (50 kg ha⁻¹) was applied at 60 days after ratooning.

The data recorded for different parameters like tiller count at 90 days after planting, 120 days after planting, the parameters like cane length, cane girth, number of millable canes, single cane weight, total cane yield was calculated by taking five representative cane plants from each plot. Sugarcane juice was analysed for Brix content by following standard method by Meade and Chen (1977) [3]. Analysis of variance (ANOVA) appropriate for the Randomized Block Design to test the significance of treatment effects. Treatment means were compared using the critical difference (CD) at 5% level of significance given (Gomez and Gomez 1984) [12].

Results and Discussion

Tiller production and crop stand

The growth, yield attributes and yield parameters were recorded in Table.1. The planting methods significantly influenced tiller population at both 90 and 120 DAP. Single node seedling transplanting using a seedling transplanter recorded the highest tiller count (129.55 and 146.03 ×10³ ha⁻¹ at 90 and 120 DAP, respectively), which was statistically superior to manual planting of single bud setts and comparable with manual planting of single node seedlings and three-budded setts. The lowest tiller count was observed under manual planting of single bud setts (97.60 and 111.79 ×10³ ha⁻¹), indicating poor initial establishment and reduced tiller survival. The higher tiller population under single node seedling transplanting may be attributed to uniform spacing, better root establishment, and reduced inter-plant competition, which favoured higher tiller emergence and retention. Similar trends were reported under mechanized or seedling-based planting systems, where early vigour contributes to enhanced tiller density. The results are in conformity with the results of Singh K and Gangwar (2023) [7].

Cane growth attributes

Cane length varied significantly among treatments. Single node seedling transplanting produced the longest canes (205.75 cm), which was on par with manual planting of single bud setts (204.00 cm) but significantly superior to three-budded sett planting (182.50 cm). Improved cane elongation under seedling transplanting could be linked to better canopy architecture and uninterrupted growth due to optimal plant geometry. Cane girth did not vary widely across treatments; however, manual planting of two-budded setts recorded the highest cane girth (2.74 cm), closely followed by single node seedling transplanting (2.71 cm).

This suggests that moderate plant density favoured assimilate partitioning towards individual cane thickness.

Number of millable canes and single cane weight

The number of millable canes (NMC) was significantly influenced by planting methods. Single node seedling transplanting resulted in the maximum NMC ($104.20 \times 10^3 \text{ ha}^{-1}$), which was significantly higher than single bud sett planting ($77.30 \times 10^3 \text{ ha}^{-1}$). Higher millable cane population under seedling transplanting reflects better tiller survival and conversion efficiency. Single cane weight followed a similar trend, with the highest value observed under single node seedling transplanting ($1.17 \text{ kg cane}^{-1}$), followed by two-budded sett planting ($1.12 \text{ kg cane}^{-1}$). Reduced cane weight under single bud setts ($0.95 \text{ kg cane}^{-1}$) could be attributed to poor stand establishment and suboptimal growth conditions. Similar results were obtained with Sachdeva *et al.*, (2021) [6].

Cane yield

Cane yield differed significantly among treatments and closely followed the trends observed for NMC and single cane weight. Single node seedling transplanting using a seedling transplanter produced the highest cane yield (122.52 t ha^{-1}), which was significantly superior to all other treatments. Manual planting of single node seedlings (110.30 t ha^{-1}) and two-budded setts (106.53 t ha^{-1}) were the next best treatments. The lowest cane yield (73.14 t ha^{-1}) was recorded under manual planting of single bud setts, primarily due to reduced tiller count, fewer millable canes, and lower cane weight. The superiority of seedling transplanting in terms of yield can be attributed to better crop establishment, enhanced tiller survival, and efficient utilization of resources, ultimately resulting in higher biomass accumulation (Table.1).

Juice quality (Brix %)

Brix percentage was not significantly influenced by planting methods, as indicated by the narrow range (20.23-20.60%) and low CV (3.50%). However, slightly higher Brix values were observed under two-budded sett planting (20.60%) and manual planting of single node seedlings (20.55%) (Table.1). This indicates that planting method had a marginal effect on juice quality, and yield advantages under seedling transplanting did not compromise sugar accumulation.

Economics of sugarcane production

The economic observations for ratoon crop was recorded in table.2. Gross returns varied considerably among planting

methods and closely followed the trend of cane yield. Single node seedling transplanting using a seedling transplanter recorded the highest gross returns ($\text{₹}404,303 \text{ ha}^{-1}$), owing to its superior cane yield. This was followed by manual planting of single node seedlings ($\text{₹}363,977 \text{ ha}^{-1}$) and two-budded sett planting ($\text{₹}351,543 \text{ ha}^{-1}$). The lowest gross returns ($\text{₹}241,363 \text{ ha}^{-1}$) were obtained under manual planting of single bud setts, reflecting poor crop establishment and reduced productivity. Higher gross income under seedling transplanting can be attributed to enhanced tiller population, higher number of millable canes, and increased single cane weight, which cumulatively resulted in greater marketable yield. The cost of cultivation ranged from $\text{₹}154,650$ to $\text{₹}174,450 \text{ ha}^{-1}$ across treatments. Manual planting of single node seedlings incurred the highest cost of cultivation ($\text{₹}174,450 \text{ ha}^{-1}$), mainly due to increased labour requirement for nursery raising and transplanting operations. Single node seedling transplanting using a transplanter also involved relatively higher investment ($\text{₹}172,600 \text{ ha}^{-1}$), attributed to mechanization costs and seedling production.

In contrast, manual planting of single bud setts recorded the lowest cost of cultivation ($\text{₹}154,650 \text{ ha}^{-1}$) due to reduced planting material and labour inputs. However, the lower cost did not translate into better profitability because of substantially reduced yield. Net returns differed markedly among treatments and were primarily governed by yield performance rather than cost of cultivation alone. Single node seedling transplanting using a seedling transplanter produced the maximum net returns ($\text{₹}231,703 \text{ ha}^{-1}$), which was substantially higher than all other planting methods. Manual planting of two-budded setts ($\text{₹}188,947 \text{ ha}^{-1}$) and manual planting of single node seedlings ($\text{₹}189,527 \text{ ha}^{-1}$) were the next best treatments. The minimum net returns ($\text{₹}86,713 \text{ ha}^{-1}$) were recorded under manual planting of single bud setts, indicating poor economic viability of this method despite its lower cost of cultivation. The B:C ratio clearly reflected the economic superiority of different planting methods. Single node seedling transplanting using a seedling transplanter registered the highest B:C ratio (2.34), indicating higher profitability per unit investment. This was followed by two-budded sett planting (2.16) and manual planting of single node seedlings (2.09). Manual planting of single bud setts recorded the lowest B:C ratio (1.56), highlighting its limited economic advantage. The conventional farmers' practice of three-budded sett planting achieved a moderate B:C ratio (1.97), but it remained inferior to seedling-based planting systems. The results are in line with the results of Vijayalaxmi *et al.*, (2022) [10].

Table 1: Growth, yield attributes and yield of sugarcane ratoon crop as influenced by different planting methods

Treatments	Tiller count ($\times 1000 \text{ ha}^{-1}$)		Cane length (cm)	Cane girth (cm)	NMC ($\times 1000 \text{ ha}^{-1}$)	SCW (kg cane^{-1})	Cane Yield (t ha^{-1})	Brix %
	90 DAP	120 DAP						
Mechanical transplanting of Single node seedling using transplanter	129.55	146.03	205.75	2.71	104.20	1.17	122.52	20.23
Manual transplanting of single node seedlings	125.36	139.89	185.95	2.65	102.29	1.09	110.30	20.55
Manual planting of single bud setts	97.60	111.79	204.00	2.41	77.30	0.95	73.14	20.33
Manual planting of two-budded setts	107.19	123.13	194.00	2.74	95.85	1.12	106.53	20.60
Manual planting of three-budded setts (farmers' practice)	122.43	138.11	182.50	2.64	97.91	1.04	101.39	20.23
SEM ($\pm$)	6.33	7.36	5.74	0.07	4.91	0.05	5.49	0.36
CD ($p=0.05$)	19.5	22.68	16.86	0.22	15.12	0.14	16.90	0.50

Table 2: Economic analysis of different planting methods of sugarcane on ratoon sugarcane.

Treatment	Gross Returns (Rs. ha ⁻¹)	Cost of cultivation (Rs. ha ⁻¹)	Net Returns (Rs. ha ⁻¹)	B:C Ratio
Mechanical transplanting of Single node seedling using transplanter	404303	172600	231703	2.34
Manual transplanting of single node seedlings	363977	174450	189527	2.09
Manual planting of single bud setts	241363	154650	86713	1.56
Manual planting of two-budded setts	351543	162596	188947	2.16
Manual planting of three-budded setts (farmers' practice)	334577	169750	164827	1.97

Conclusion

The results of the present study on ratoon sugarcane clearly indicated that planting methods of the main crop had a pronounced influence on ratoon growth, yield, and economics. Among the treatments, single node seedling transplanting using a seedling transplanter resulted in superior ratoon performance by recording higher tiller population, better cane growth, maximum number of millable canes, and higher single cane weight, which together contributed to the highest ratoon cane yield. The improved yield performance was achieved without adversely affecting juice quality, as Brix percentage remained comparable across treatments. From an economic perspective, ratoon crop raised from single node seedling transplanting generated the highest gross and net returns and benefit-cost ratio, despite relatively higher cultivation costs. In contrast, ratoon crop under manual planting of single bud setts showed poor productivity and economic viability. The conventional farmers' practice of three-budded sett planting exhibited moderate performance but was inferior to seedling-based planting systems.

Acknowledgement

The authors are very much thankful to the Director of Research, Professor Jayashankar Telangana Agricultural University, Hyderabad, Telangana for providing facilities for conducting the experiment and we would like to express our gratitude to everyone who contributed for the research.

Conflict of Interest

The authors declare no conflict of interest.

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