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Effect of integrated nutrient management on production potential, economics and quality of sweet corn (*Zea Mays* Var. *Saccharata* L.)

Akshay Kumar[1], Kalibavi[2], C M Kamble Anand Shankar[3], Vishwanatha S[4*]
[1] Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India
[2] Professor of agronomy, Agricultural Extension Education Centre, Hadagali, University of Agricultural Sciences, Raichur, Karnataka, India
[3] Professor of agronomy, Organic Farming Research Institute, University of Agricultural Sciences, Raichur, Karnataka, India
[4] Assistant Professor (Agro-meteorology), Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India
Corresponding Author: Vishwanatha S
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Abstract
A field experiment was conducted at the Agricultural Research Station, Siruguppa, University of Agricultural Sciences, Raichur, Karnataka, India, during the *kharif* 2025, to evaluate the effect of integrated application of the recommended dose of chemical fertilizers (RDCF), organic manures and biochar on the growth, yield, quality and economics of sweet corn (*Zea mays* var. *saccharata* L.). The experiment was laid out in a randomized complete block design with nine treatments replicated thrice, comprising RDCF alone and in combination with farmyard manure (FYM) at 7.5 t ha^{-1}, vermicompost at 2.5 t ha^{-1} and biochar at 1 t ha^{-1}, together with corresponding combinations under 75% RDCF and an absolute control. The application of RDCF + vermicompost (2.5 t ha^{-1}) + biochar (1 t ha^{-1}) recorded the significantly higher number of leaves per plant (12.53) and total dry matter production (194.25 g plant^{-1}) at harvest, fresh cob yield (13,767 kg ha^{-1}), green fodder yield (20,533 kg ha^{-1}) and net returns (Rs 1,11,614 ha^{-1}) and was statistically on par with application of RDCF + FYM (7.5 t ha^{-1}) + biochar, RDCF + vermicompost (2.5 t ha^{-1}) and RDCF + FYM (7.5 t ha^{-1}). The same treatment also recorded the significantly higher total soluble solids (TSS) (13.82 °Brix) and protein content (8.19%). The higher benefit cost (B:C) ratio (2.42) was obtained with RDCF + FYM (7.5 t ha^{-1}), owing to its lower cost of cultivation. The absolute control recorded the lower values for growth, yield and quality parameters. From this it is indicated that integration of RDCF with vermicompost and biochar is an effective nutrient management strategy for improving the productivity, quality and profitability of sweet corn under semi-arid tropical conditions.

Keywords: Sweet corn, integrated nutrient management, vermicompost, farmyard manure, biochar, total dry matter, fresh cob yield, net returns, benefit cost ratio, total soluble solids, protein content

Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops grown worldwide and serves as a major source of food, feed and industrial raw material. In India, maize occupies a considerable area and contributes substantially to national agricultural production during 2024-25, the crop occupied about 12.09 million ha with a production of 43.41 million tonnes and an average productivity of 3,590 kg ha $^{-1}$. Karnataka is one of the major maize-producing states, accounting for about 15.83% of the national maize area and 14.26% of national production.

Sweet corn (*Zea mays* var. *saccharata* L) is a specialised type of maize valued for its tender kernels, pleasant taste and increasing market demand. It is harvested at the milk stage for fresh consumption and processing and its yield and quality are strongly influenced by the availability and balanced supply of essential nutrients.

Continuous reliance on inorganic fertilizers alone may not adequately sustain soil fertility and nutrient-use efficiency over time. Organic sources such as farmyard manure (FYM) and vermicompost release nutrients gradually and add organic matter to the soil, their integrated use with inorganic fertilizers can help ensure a balanced nutrient supply and improve nutrient availability during crop growth. Several studies have reported beneficial effects of combining organic and inorganic nutrient sources on the productivity and quality of maize and sweet corn. (Ladha *et al*., 2005; Mahmood *et al*., 2017) [10, 11]

Biochar has also gained importance as a soil amendment because of its potential to improve nutrient retention and soil physicochemical properties and to enhance fertilizer-use efficiency. Its combined application with organic manures and inorganic fertilizers may further improve nutrient availability and crop productivity however, the crop response to such combinations varies with soil type, climatic conditions and the level of inorganic fertilization applied. (Coumaravel *et al*., 2015; Situmeang *et al*., 2018; Gudade *et al*., 2022) [1, 4, 25]

Judicious integration of inorganic fertilizers with FYM, vermicompost and biochar may therefore provide a suitable approach for improving the productivity and quality of sweet corn while sustaining soil fertility. The present investigation was undertaken to evaluate the effect of integrated nutrient management on the yield and quality of sweet corn (*Zea mays* var. *saccharata* L.) under the agro-climatic conditions of northern Karnataka, India.

Materials and Methods

1. Experimental Site and Season

The field experiment was conducted during the *kharif* 2025 at the Agricultural Research Station, Siruguppa, University of Agricultural Sciences, Raichur, Karnataka, India. The experimental field had a deep black clay soil.

2. Physicochemical Properties of the Experimental Soil

The experimental soil had a pH of 8.11, an electrical conductivity of 0.30 dS m^{-1}, and an organic carbon content of 0.40%. The available nitrogen, phosphorus, and potassium contents of the soil were 263.19, 28.42, and 338.68 kg ha^{-1}, respectively.

3. Treatments and Experimental Design

The experiment was laid out in a randomized complete block design (RCBD) comprising nine treatments, each replicated thrice. The recommended dose of chemical fertilizers (RDCF) was 100:50:25 kg N: P_2O_5:K_2O ha $^{-1}$. The nine treatments were as follows:

- **T_1:** RDCF + FYM 7.5 t ha $^{-1}$
- **T_2:** RDCF + Vermicompost 2.5 t ha $^{-1}$
- **T_3:** RDCF + biochar 1 t ha $^{-1}$
- **T_4:** RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$
- **T_5:** RDCF + Vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$
- **T_6:** 75% RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$
- **T_7:** 75% RDCF + Vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$
- **T_8:** RDCF alone
- **T_9:** Absolute control

The sweet corn variety Sugar-75 was sown at a spacing of 60 x 20 cm. The gross plot size was 6.0 x 4.0 m, and the net plot size was 3.6 x 3.2 m.

4. Crop Husbandry

Organic manures (FYM, Vermicompost and Biochar) were incorporated into the soil 17 days before sowing, as per the treatment schedule. The crop was sown on 20 June 2025 by hand dibbling and was harvested at 75 days after sowing (DAS), corresponding to the milk stage, which is the optimum harvest stage for fresh sweet corn cobs. (Dalvi *et al*., 2009; Singh *et al*., 2025) [2, 24]

5. Observations Recorded

Number of leaves per plant and total dry matter production (TDM, g plant $^{-1}$) were recorded at harvest. Fresh cob yield and green fodder yield were recorded from the net plot area and expressed in kg ha $^{-1}$. Quality parameters, namely total soluble solids (TSS) (°Brix determined using a hand refractometer) and protein content (%) estimated from the kernel nitrogen content, were determined at harvest. Cost of cultivation, gross returns and net returns (Rs ha $^{-1}$) were worked out for each treatment, and the benefit cost (B:C) ratio was computed.

6. Statistical Analysis

The data recorded for the various growth, yield, quality and economic parameters were subjected to analysis of variance (ANOVA) appropriate for a randomized complete block design, following standard procedures. Wherever the F-test indicated significant differences among treatments, the critical difference (C.D.) was computed at the 5% probability level for comparison of treatment means; treatments not significantly different at this level are described as being "on par" with one another.

Results and Discussion

1. Number of leaves, total dry matter production, cob length and cob girth

The application of RDCF + vermicompost @ 2.5 t ha^{-1} + biochar @ 1 t ha^{-1} recorded the significantly higher number of leaves per plant (12.53), TDM (194.25 g $plant^{-1}$), cob length (22.0 cm) and cob girth (15.4 cm), which were on par with application of RDCF + FYM @ 7.5 t ha^{-1} + biochar @ 1 t ha^{-1} (12.40 leaves, 187.91 g $plant^{-1}$, 21.3 cm and 14.6 cm), RDCF + vermicompost @ 2.5 t ha^{-1} (12.13 leaves, 182.45 g $plant^{-1}$, 20.7 cm and 14.2 cm) and RDCF + FYM @ 7.5 t ha^{-1} (12.06 leaves, 178.63 g $plant^{-1}$, 20.2 cm and 13.8 cm), respectively. The absolute control recorded the lower number of leaves per plant (9.80), TDM (114.25 g $plant^{-1}$), cob length (12.5 cm) and cob girth (8.3 cm) (**Table 1**; Figs. 1–3).

The improvement in growth and cob dimensions under integrated nutrient management may be attributed to the balanced and sustained availability of nutrients, particularly nitrogen, throughout the crop growth period. FYM and vermicompost release nutrients gradually, while biochar improves nutrient retention and the physicochemical condition of the soil, which together enhance nutrient availability and uptake. Adequate nutrient supply promotes leaf initiation and expansion, thereby increasing the photosynthetic surface and the production of assimilates, which are accumulated as dry matter and partitioned to the developing cob, favouring better cob length and girth. Similar beneficial effects of integrated nutrient management on growth, dry matter accumulation and yield attributes of sweet corn have been reported by Jayaprakash *et al.* (2003), Murmu *et al.* (2013), Pande *et al.* (2013), Rasool *et al.* (2015), Rout (2017), Singh *et al.* (2019), Kalay *et al.* (2020) and Das *et al.* (2024), Kumar *et al.* (2007), Gudade *et al.* (2022) [3, 4, 5, 7, 9, 13, 14, 20, 22, 23] and Pinnamaneni *et al.* (2023) [18]. Higher biomass production with biochar-based nutrient management in sweet corn was also noted by Suarez *et al.* (2025), while Ren *et al.* (2020) [21, 26] emphasised that proper fertilizer management enhances the accumulation and distribution of biomass in summer maize.

Table 1: Number of leaves per plant, total dry matter production (TDM), cob length and cob girth of sweet corn at harvest as influenced by integrated nutrient management

Treatment	Number of leaves per plant	TDM (g plant $^{-1}$)	Cob length (cm)	Cob girth (cm)
T_1: RDCF + FYM 7.5 t ha $^{-1}$	12.06	178.63	20.2	13.8
T_2: RDCF + Vermicompost 2.5 t ha $^{-1}$	12.13	182.45	20.7	14.2
T_3: RDCF + biochar 1 t ha $^{-1}$	10.63	155.30	17.6	11.8
T_4: RDCF + FYM 7.5 t ha $^{-1}$+ biochar 1 t ha $^{-1}$	12.40	187.91	21.3	14.6
T_5: RDCF + Vermicompost 2.5 t ha $^{-1}$	12.53	194.25	22.0	15.4

+ biochar 1 t ha $^{-1}$				
T_6: 75% RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	10.26	138.82	15.2	10.4
T_7: 75% RDCF + Vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	10.43	143.71	16.0	10.9
T_8: RDCF alone	10.56	150.00	16.7	11.4
T_9: Absolute control	9.80	114.25	12.5	8.3
S.Em. ±	0.45	7.50	0.8	0.6
C.D. at 5%	1.35	22.47	2.5	1.8

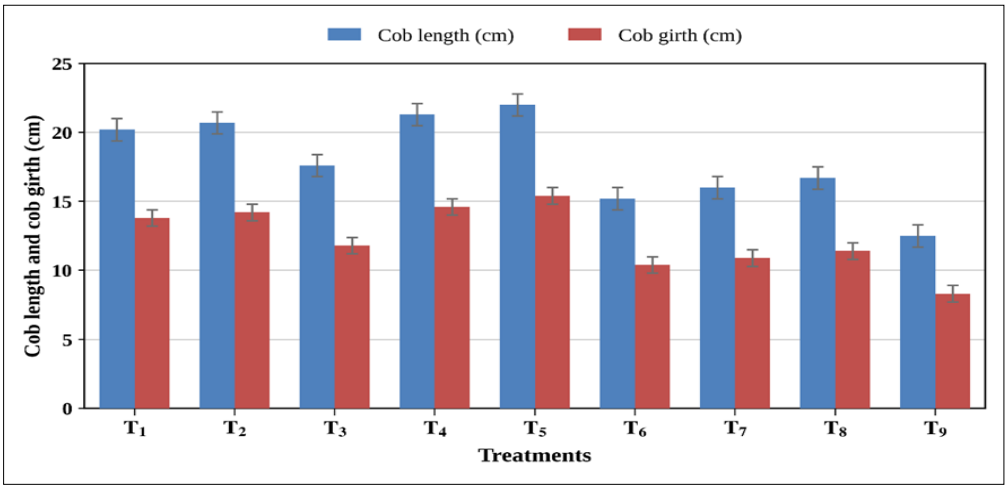


Fig 1: Effect of integrated nutrient management on cob length and cob girth of sweet corn.

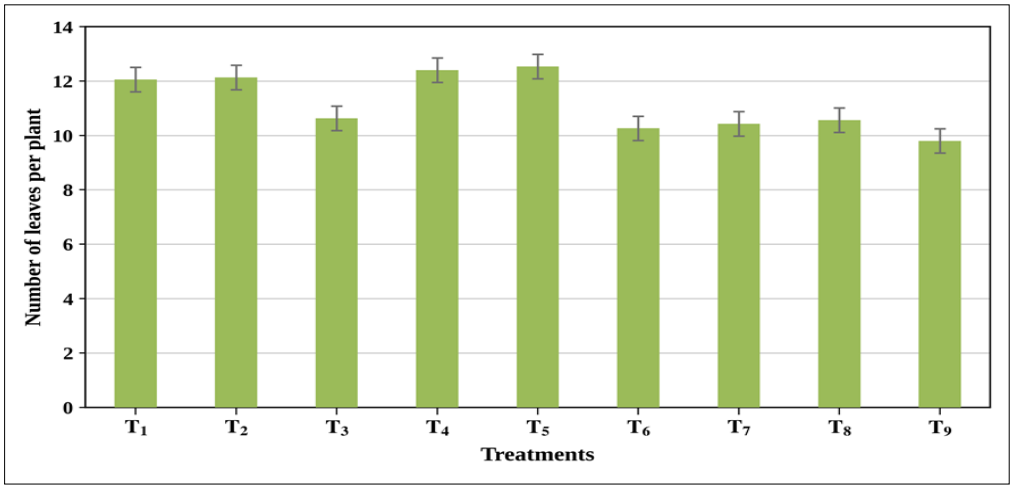


Fig 2: Effect of integrated nutrient management on number of leaves per plant of sweet corn at harvest.

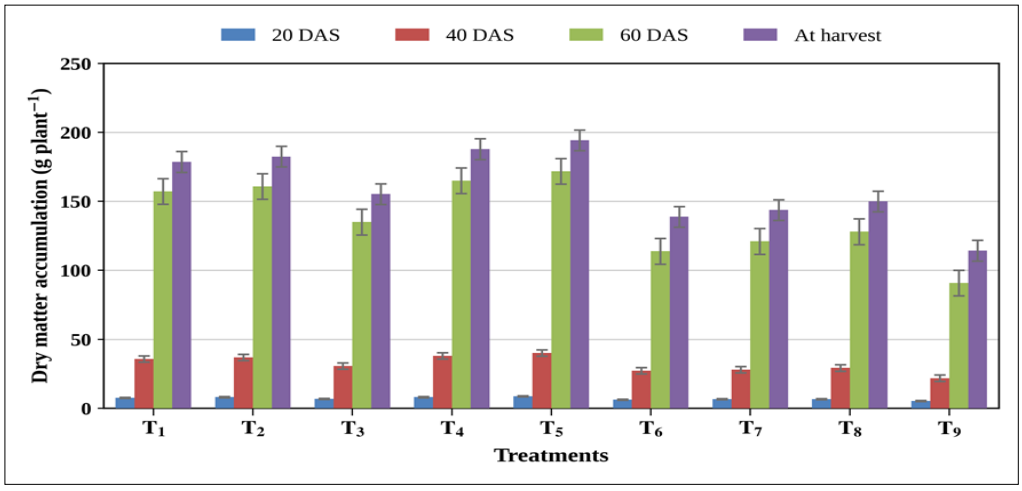


Fig 3: Effect of integrated nutrient management on dry matter accumulation (g plant^{-1}) of sweet corn at 20, 40 and 60 DAS and at harvest (total dry matter production).

2. Fresh cob yield, green fodder yield, net returns and benefit cost ratio

The significantly higher fresh cob yield (13,767 kg ha $^{-1}$), green fodder yield (20,533 kg ha $^{-1}$) and net returns (Rs 1,11,614 ha $^{-1}$) were recorded with RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) and were on par with application of RDCF + FYM (7.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) (12,758 kg ha $^{-1}$, 19,105 kg ha $^{-1}$ and Rs 1,03,668 ha $^{-1}$), RDCF + vermicompost (2.5 t ha $^{-1}$) (12,550 kg ha $^{-1}$, 18,825 kg ha $^{-1}$ and Rs 1,08,032 ha $^{-1}$), and RDCF + FYM (7.5 t ha $^{-1}$) (12,040 kg ha $^{-1}$, 18,060 kg ha $^{-1}$ and Rs 1,06,400 ha $^{-1}$), respectively. The absolute control recorded the lower fresh cob yield (6,333 kg ha $^{-1}$), green fodder yield (9,500 kg ha $^{-1}$) and net returns (Rs 45,453 ha $^{-1}$). The higher B:C ratio (2.42) was recorded with RDCF + FYM (7.5 t ha $^{-1}$), followed by RDCF + vermicompost (2.5 t ha $^{-1}$) (2.34), RDCF alone (2.28), RDCF + FYM (7.5 t ha $^{-1}$) + biochar (2.11) and RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (2.10), which were on par with one another, whereas the lower B:C ratio was recorded with 75% RDCF + FYM (7.5 t ha $^{-1}$) + biochar (1.46) and 75% RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (1.49) (Table 2; Figs. 4 and 5).

The higher yield under integrated nutrient management may be attributed to the complementary effects of inorganic fertilizers and organic sources, which ensured a better supply and utilisation of nutrients throughout crop growth. The lower yield under 75 per cent RDCF-based treatments indicates that the addition of organic manure and biochar could not completely compensate for the reduction in inorganic fertilizer dose under the conditions of the present investigation. The higher net returns with RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) and the other integrated treatments are mainly due to the higher fresh cob and green fodder yield realised under these treatments, which more than compensated for the additional expenditure on organic manures and biochar. The B:C ratio, however, was highest with RDCF + FYM (7.5 t ha $^{-1}$) and RDCF + vermicompost (2.5 t ha $^{-1}$), as these treatments had a lower cost of cultivation than the biochar-based treatments, in which the cost of biochar raised the cost of production. Similar improvement in yield and economics of sweet corn with integrated use of organic and inorganic nutrient sources has been reported by Jayaprakash *et al.* (2005), Pande *et al.* (2013), Rao *et al.* (2020), Das *et al.* (2024), Rout (2017), Singh *et al.* (2019), Karanjikar *et al.* (2020), Patel *et al.* (2021) and Patel and Painkara (2022) [3, 6, 8, 12, 14, 15, 16, 22, 23], and in maize with biochar application by Phares *et al.* (2022), Pinnamaneni *et al.* (2023) and Tadele *et al.* (2026) [17, 18, 27].

Table 2: Fresh cob yield, green fodder yield, net returns and benefit cost ratio of sweet corn as influenced by integrated nutrient management.

Treatment	Fresh cob yield (kg ha $^{-1}$)	Green fodder yield (kg ha $^{-1}$)	Net returns (Rs ha $^{-1}$)	B:C ratio
T_1: RDCF + FYM 7.5 t ha $^{-1}$	12040	18060	106400	2.42
T_2: RDCF + vermicompost 2.5 t ha $^{-1}$	12550	18825	108032	2.34
T_3: RDCF + biochar 1 t ha $^{-1}$	10072	15076	76256	1.91
T_4: RDCF + FYM 7.5 t ha $^{-1}$+ biochar 1 t ha $^{-1}$	12758	19105	103668	2.11
T_5: RDCF + vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	13767	20533	111614	2.10
T_6: 75% RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	8310	12404	47167	1.46
T_7: 75% RDCF + vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	9038	13445	51531	1.49
T_8: RDCF alone	9671	14239	82573	2.28
T_9: Absolute control	6333	9500	45453	1.84
S.Em. ±	647	948	6417	0.20
C.D. at 5%	1939	2843	19239	0.60

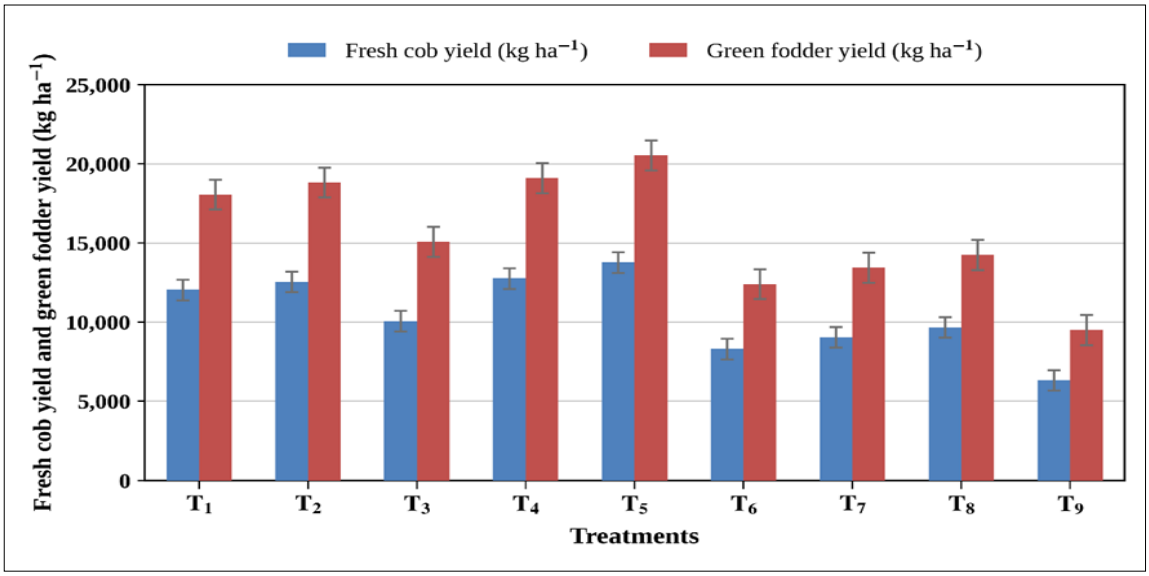


Fig 4: Effect of integrated nutrient management on fresh cob yield and green fodder yield (kg ha^{-1}) of sweet corn.

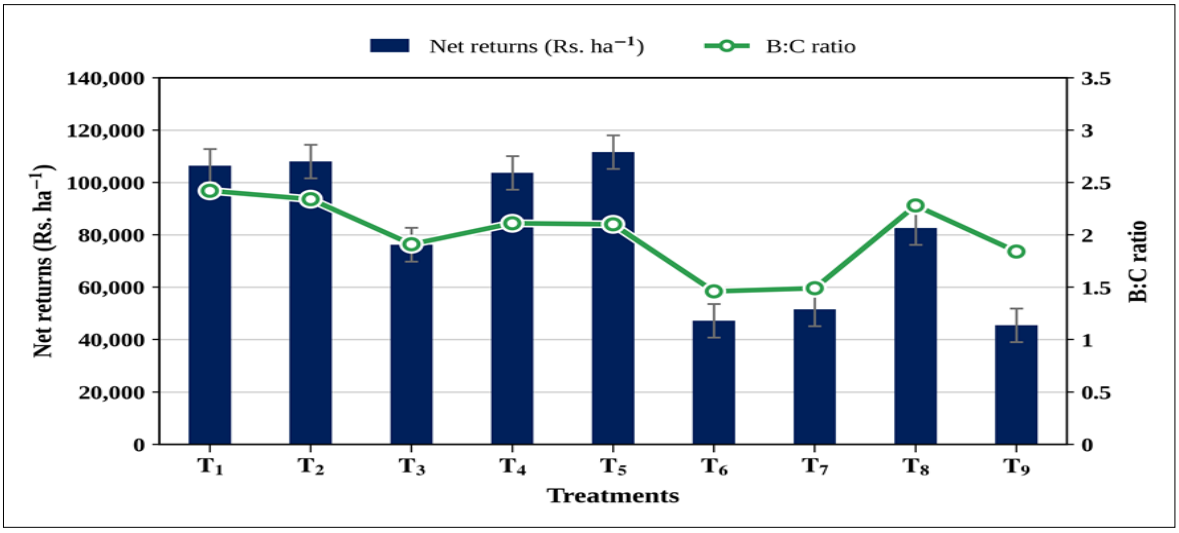


Fig 5: Effect of integrated nutrient management on net returns (Rs. ha^{-1}, bars) and benefit cost (B:C) ratio (line) of sweet corn.

3. Quality Parameters: Total Soluble Solids and Protein Content

The significantly higher TSS (13.82 °Brix) and protein content (8.19%) were recorded with RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) and were on par with application of RDCF + FYM (7.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) (13.75 °Brix and 8.00%), RDCF + vermicompost (2.5 t ha $^{-1}$) (13.67 °Brix and 7.94%), and RDCF + FYM (7.5 t ha $^{-1}$) (13.58 °Brix and 7.88%), respectively. The absolute control recorded the lower TSS (10.03 °Brix) and protein content (6.06%) (Table 3; Figs. 6 and 7).

The improvement in TSS may be attributed to the balanced and sustained nutrient supply under integrated nutrient management, which favoured assimilate production and sugar accumulation in the kernels. Higher protein content may be associated with improved nitrogen availability and assimilation resulting from the combined application of inorganic and organic nutrient sources. The findings are in conformity with those of Rasool *et al*. (2016), Dalvi *et al.* (2009) and Das *et al*. (2024) [2, 3, 19].

Table 3: Total soluble solids (TSS) and protein content of sweet corn as influenced by integrated nutrient management.

Treatment	TSS (°Brix)	Protein (%)
T_1: RDCF + FYM 7.5 t ha $^{-1}$	13.58	7.88
T_2: RDCF + Vermicompost 2.5 t ha $^{-1}$	13.67	7.94
T_3: RDCF + biochar 1 t ha $^{-1}$	12.00	7.37
T_4: RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	13.75	8.00
T_5: RDCF + Vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	13.82	8.19
T_6: 75% RDCF + FYM 7.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	11.64	6.88
T_7: 75% RDCF + Vermicompost 2.5 t ha $^{-1}$ + biochar 1 t ha $^{-1}$	11.72	7.00
T_8: RDCF alone	11.93	7.31
T_9: Absolute control	10.03	6.06
S.Em. ±	0.51	0.17
C.D. at 5%	1.54	0.50

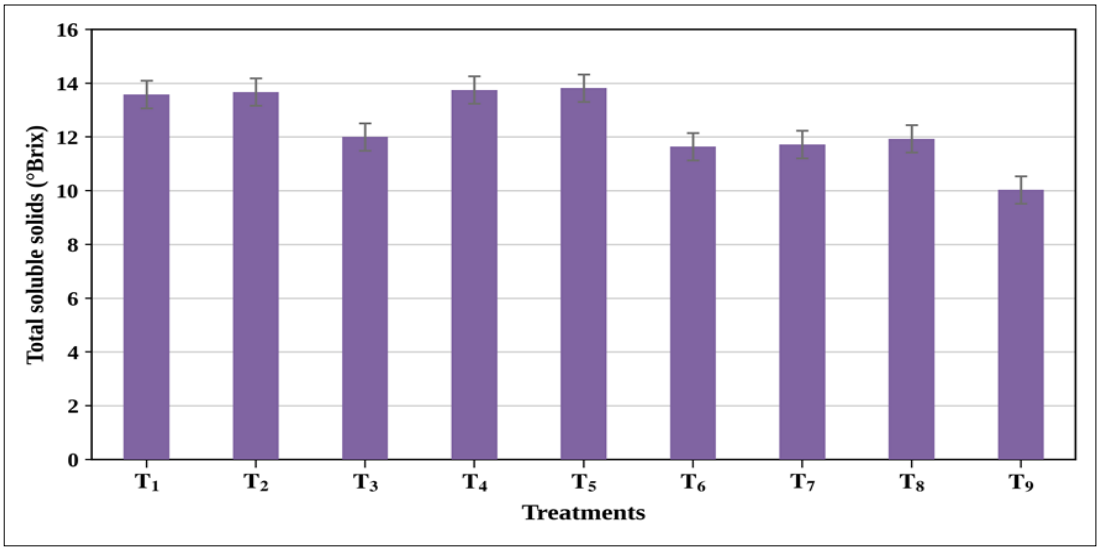


Fig 6: Effect of integrated nutrient management on total soluble solids (TSS, °Brix) of sweet corn.

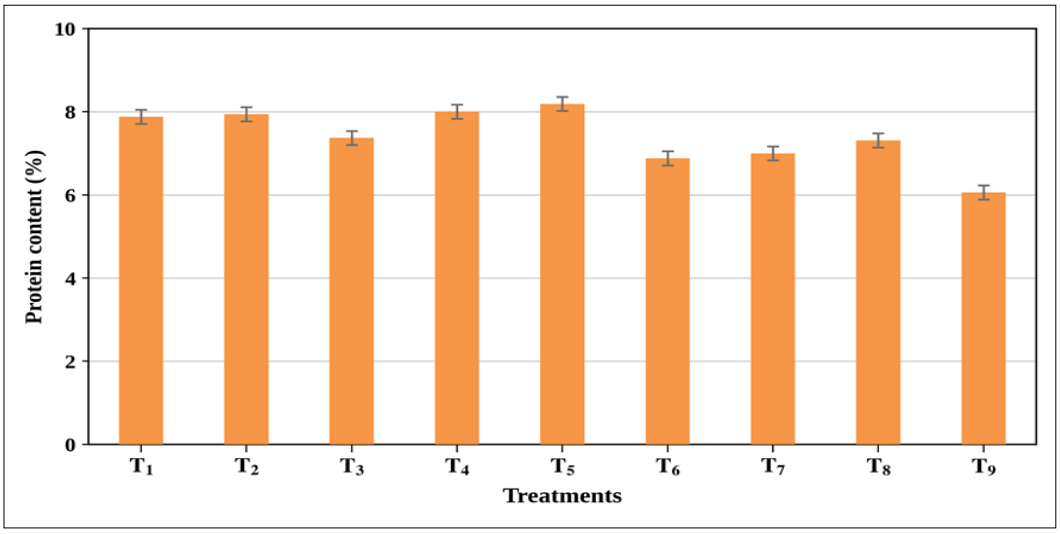


Fig 7: Effect of integrated nutrient management on protein content (%) of sweet corn.

Conclusion

From the results of the present investigation, it may be concluded that application of RDCF + vermicompost (2.5 t ha $^{-1}$) + biochar (1 t ha $^{-1}$) is the most beneficial for obtaining higher growth (number of leaves and total dry matter production), yield attributes, yield, quality and net returns of sweet corn, while RDCF + FYM (7.5 t ha $^{-1}$) recorded the highest B:C ratio. Integration of RDCF with vermicompost (2.5 t ha $^{-1}$) and biochar (1 t ha $^{-1}$) is therefore recommended as an effective strategy for improving the yield, quality and profitability of sweet corn; however, these findings are based on a single season and location, and multi-season, multi-location trials are suggested before making a broader agronomic recommendation.

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