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Influence of integrated nutrient management involving biochar, lignite and urban compost on growth, yield and dry matter production of sweet corn (*Zea mays* L. *saccharata*)

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Abstract

A field experiment was conducted during the Kharif season to evaluate the influence of integrated nutrient management involving biochar, urban compost and lignite on growth, dry matter production and yield of sweet corn (*Zea mays* L. *saccharata*). The experiment was laid out in a randomized block design with eight treatments and three replications. The treatments consisted of: T₁ (absolute control), T₂ (100% recommended dose of fertilizers, RDF: 180:60:50 kg N: P₂O₅:K₂O ha⁻¹), T₃ (100% RDF + biochar @ 5 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹), T₄ (75% RDF + biochar @ 5 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹), T₅ (100% RDF + urban compost @ 5 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹), T₆ (75% RDF + urban compost @ 5 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹), T₇ (100% RDF + lignite @ 2 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹) and T₈ (75% RDF + lignite @ 2 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹).

Growth parameters such as plant height, number of leaves, leaf area index (LAI), dry matter production and SPAD chlorophyll readings were recorded at different growth stages, along with yield attributes and yields at harvest. Integrated nutrient management treatments significantly improved growth and productivity of sweet corn over control and sole fertilizer application. Among the treatments, T₃ (100% RDF + biochar @ 5 t ha⁻¹ + microbial consortia@ 5 L ha⁻¹) consistently recorded superior growth performance, including higher LAI, dry matter production (301.8 g plant⁻¹ at harvest) and SPAD values. Yield attributes such as cob length and number of rows per cob were also higher under T₃. Consequently, T₃ produced the highest green cob yield (19.10 t ha⁻¹) and green fodder yield (45.13 t ha⁻¹), significantly outperforming other treatments. Regression analysis revealed a highly significant positive linear relationship between dry matter production at harvest and both green cob yield (R² = 0.991) and green fodder yield (R² = 0.998), highlighting the importance of biomass accumulation in determining productivity. The results indicate that integration of biochar with recommended fertilizer dose and microbial consortia is an effective strategy for enhancing sweet corn productivity under sandy loam soils with low organic carbon status.

Keywords: Sweet corn, integrated nutrient management, biochar, lignite, urban compost, dry matter production, yield

Introduction

Sweet corn (*Zea mays* L.) is an important cereal crop cultivated for fresh green cobs and fodder owing to its high market value and nutritional quality. Its productivity is highly responsive to nutrient management practices. Continuous dependence on chemical fertilizers has resulted in deterioration of soil health, reduced nutrient use efficiency and increased environmental concerns, necessitating the adoption of integrated nutrient management approaches. Integrated nutrient management aims to combine inorganic fertilizers with organic amendments and bio-

resources to ensure balanced nutrient supply, improve soil physical properties and sustain crop productivity. Biochar, a carbon-rich amendment, improves soil structure, nutrient retention and microbial activity, while lignite serves as a slow-release source of nutrients and organic carbon. Urban compost, derived from biodegradable municipal wastes, contributes to organic matter buildup and nutrient recycling. The combined use of these amendments under INM has shown promise in improving crop growth and soil fertility. However, information on the combined influence of biochar, lignite and urban compost on growth, biomass accumulation and yield of sweet corn under field conditions is limited. Therefore, the present study was undertaken to evaluate the effect of integrated nutrient management involving biochar, lignite and urban compost on growth, yield attributes, yield and dry matter production of sweet corn.

Materials and Methods

The field experiment was conducted during *Kharif season* at the Research Farm, School of Agricultural Sciences, Malla Reddy University, Hyderabad. The soil of the experimental field was sandy loam in texture, alkaline in reaction, low in organic carbon, low in available nitrogen, medium in available phosphorus and medium in available potassium. The experiment consisted of eight integrated nutrient management treatments laid out in a randomized block design with three replications.

The treatment details were as follows

- **T₁:** Absolute control
- **T₂:** 100% recommended dose of fertilizers (RDF: 180:60:50 kg N: P₂O₅:K₂O ha⁻¹)
- **T₃:** 100% RDF + biochar @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹
- **T₄:** 75% RDF (135:45:37.5 kg N:P₂O₅:K₂O ha⁻¹) + biochar @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹
- **T₅:** 100% RDF + urban compost @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹
- **T₆:** 75% RDF (135:45:37.5 kg N: P₂O₅:K₂O ha⁻¹) + urban compost @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹
- **T₇:** 100% RDF + lignite @ 2 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹
- **T₈:** 75% RDF (135:45:37.5 kg N: P₂O₅:K₂O ha⁻¹) + lignite @ 2 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹.

Biochar, urban compost and lignite were applied as basal and thoroughly incorporated into the soil prior to sowing as per treatment. Microbial consortia (Growth Sarti, Katyanani) was applied through soil drenching at 5 L ha⁻¹, corresponding to the maximum label recommended dose. Recommended doses of inorganic fertilizers were applied subsequently as per treatment schedule, followed by sowing of sweet corn. Sweet corn was sown at a spacing of 60 cm × 20 cm. All agronomic practices were followed uniformly for all treatments.

Plant height number of leaves were recorded at 25, 50, 75 DAS and at harvest. Leaf area index was recorded at 50 and 75 DAS. Dry matter production was recorded at different growth stages by oven-drying plant samples at 65 ± 2 °C until constant weight. SPAD chlorophyll readings were recorded using a SPAD meter. Yield attributes and yields were recorded at harvest.

The data were subjected to analysis of variance (ANOVA) appropriate for RBD. Treatment means were compared using critical difference (CD) at 5% level of significance. Correlation and regression analyses were performed to study the relationship

between dry matter production and yield.

Results and Discussion

Growth parameters of sweet corn were significantly influenced by the integrated nutrient management (INM) treatments at various crop growth stages (Table 1). Plant height at 50 DAS showed significant variation among treatments. Treatment T₃ (100% RDF + biochar @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹) recorded the highest plant height (128.9 cm). It was significantly superior to T₂, T₇, T₈ and the control (T₁), while remaining statistically at par with T₅ (123.6 cm) and T₄ (118.2 cm). The improvement under T₃ over sole RDF (T₂) was about 23%, indicating the positive effect of integrating biochar with recommended fertilizers. The better plant height under biochar-based treatment may be attributed to improved nutrient availability during the active vegetative phase, enhanced root growth and better soil moisture retention. Biochar is known to improve cation exchange capacity and reduce nutrient losses, thereby ensuring sustained nutrient supply during rapid growth stages (Glaser *et al*, 2002; Lehmann and Joseph, 2015) [2, 3]. The number of leaves per plant differed significantly at 50 and 75 DAS. At 75 DAS, T₃ recorded the highest number of leaves (15.68), which was significantly higher than T₂ (12.53) and the control (11.30). Treatments involving organic amendments generally produced more leaves compared to sole fertilizer application. Continuous and balanced nitrogen supply under INM promotes leaf initiation and expansion, leading to improved canopy development and photosynthetic capacity (Singh *et al*, 2018) [8]. Leaf area index at 75 DAS was significantly influenced by the treatments. T₃ recorded the highest LAI (2.36), which was significantly superior to all other treatments including T₅ (2.21). The higher LAI under T₃ indicates better leaf expansion and increased photosynthetic surface area. Improved LAI under biochar-based treatment may be due to better soil physical conditions, enhanced nutrient retention and improved soil moisture availability, which collectively favor vegetative growth (Ghosh *et al*, 2017) [1].

Dry matter production (DMP) increased significantly under INM treatments at all growth stages. At harvest, T₃ recorded the highest DMP (301.8 g plant⁻¹), followed by T₅ (282.5 g plant⁻¹) and T₄ (265.5 g plant⁻¹). The difference between T₃ and T₅ was statistically significant. Compared to sole RDF (214.7 g plant⁻¹), T₃ increased dry matter accumulation by about 41%. The higher biomass under T₃ suggests improved nutrient use efficiency and sustained nutrient availability throughout the crop growth period. Although urban compost contains comparatively higher nutrient content, biochar enhances nutrient retention and reduces leaching losses due to its porous structure and adsorption capacity. This likely improved nutrient uptake efficiency and contributed to greater biomass production (Major *et al*, 2010; Meena *et al*, 2019) [4, 5]. SPAD values at 75 DAS differed significantly among treatments. T₃ recorded the highest SPAD value (57.34), which was significantly higher than T₅ (52.94) and other treatments. Higher SPAD readings indicate better nitrogen status and chlorophyll content in plants. The improved chlorophyll content under biochar-based INM may be attributed to enhanced nitrogen retention in the root zone and gradual nutrient release, resulting in improved photosynthetic activity and biomass accumulation (Ramesh *et al*, 2018) [6].

Overall, T₃ consistently performed better in terms of growth parameters, indicating the advantage of integrating biochar with recommended fertilizer dose and microbial consortia under sandy loam soil conditions.

Yield attributes were significantly influenced by INM treatments (Table 2). Cob length was highest under T₃ (15.49 cm), followed by T₅ (14.56 cm) and T₄ (13.61 cm). Although T₃ recorded numerically higher values, it remained statistically at par with T₅ and T₄. The control treatment recorded the lowest cob length (10.93 cm). Similarly, number of rows per cob was highest under T₃ (13.89) and remained at par with T₅ (12.96), while significantly exceeding the control. The improvement in yield attributes under INM may be attributed to better assimilate production and improved source-sink relationship during the reproductive stage. Enhanced vegetative growth and higher dry matter accumulation under T₃ ensured sufficient photosynthate supply for cob development (Sharma *et al*, 2020; Yadav *et al*, 2019)^[5, 9].

Green cob yield and green fodder yield were significantly influenced by the treatments (Table 3). T₃ recorded the highest green cob yield (19.10 t ha⁻¹), which was significantly superior to all other treatments including T₅ (18.00 t ha⁻¹). The yield increase under T₃ over sole RDF (12.73 t ha⁻¹) was approximately 50%. This clearly demonstrates the synergistic effect of integrating

biochar with recommended fertilizer dose and microbial consortia. Similarly, green fodder yield was highest under T₃ (45.13 t ha⁻¹), followed by T₅ (43.23 t ha⁻¹) and T₄ (41.60 t ha⁻¹). The superior yield performance under T₃ can be attributed to improved growth parameters, higher dry matter accumulation and enhanced chlorophyll content. Although urban compost provides higher inherent nutrient content, biochar improves nutrient retention, enhances soil moisture status and increases nutrient use efficiency. Under sandy loam soil conditions with low organic carbon, these properties likely played a crucial role in improving crop productivity.

Relationship between dry matter production and yield

Dry matter production at harvest showed a strong positive relationship with both green cob yield (R² = 0.991) and green fodder yield (R² = 0.998). The strong linear association indicates that biomass accumulation is closely linked with economic yield in sweet corn. These findings suggest that treatments which enhanced vegetative growth and biomass production ultimately resulted in higher reproductive output and overall productivity.

Table 1: Effect of integrated nutrient management on growth parameters of sweet corn

Treatment	Plant height (cm) @50 DAS	Leaves plant ⁻¹ @50 DAS	Leaves plant ⁻¹ @75 DAS	LAI @75 DAS	DMP (g/plant) 75 DAS	DMP (g/plant) harvest	SPAD@ 75 DAS
T ₁	52.40	5.09	6.26	0.82	67.95	107.3	23.08
T ₂	104.6	11.36	12.53	1.85	135.9	214.7	48.49
T ₃	128.9	14.53	15.68	2.36	188.7	301.8	57.34
T ₄	118.2	12.42	13.59	2.08	167.0	265.5	51.04
T ₅	123.6	13.19	14.37	2.21	176.8	282.5	52.94
T ₆	112.7	12.01	13.22	1.98	154.8	243.8	50.22
T ₇	108.9	11.50	12.69	1.91	146.6	230.6	48.80
T ₈	101.3	10.62	11.80	1.75	129.3	205.8	46.70
SEm (±)	2.85	0.70	0.49	0.04	2.94	4.12	0.49
CD (5%)	8.52	2.10	1.48	0.12	8.75	12.25	1.48

Values are means of three replications. DAS - Days after sowing; LAI - Leaf area index; DMP - Dry matter production.

Table 2: Effect of integrated nutrient management on yield attributes of sweet corn

Treatment	Cob length (cm)	Cob girth (cm)	Cobs plant ⁻¹	Rows per cob	Grains per row
T ₁	7.93	0.65	1.26	9.43	18.70
T ₂	12.10	1.29	1.29	10.50	24.85
T ₃	15.49	1.63	1.63	13.89	32.40
T ₄	13.61	1.43	1.43	12.01	28.15
T ₅	14.56	1.55	1.55	12.96	30.05
T ₆	13.10	1.39	1.39	11.50	26.60
T ₇	12.49	1.34	1.34	10.89	25.20
T ₈	11.43	1.26	1.26	9.83	23.40
SEm (±)	0.59	0.04	0.04	0.60	0.95
CD (5%)	1.76	0.12	0.12	1.81	2.85

Values are means of three replications

Table 3: Effect of integrated nutrient management on yield of sweet corn

Treatment	Green cob yield (t ha ⁻¹)	Green fodder yield (t ha ⁻¹)
T ₁	6.73	16.23
T ₂	12.73	37.20
T ₃	19.10	45.13
T ₄	16.90	41.60
T ₅	18.00	43.23
T ₆	15.60	40.03
T ₇	14.40	38.80
T ₈	12.10	36.30
SEm (±)	0.14	0.22
CD (5%)	0.43	0.66

Values are means of three replications

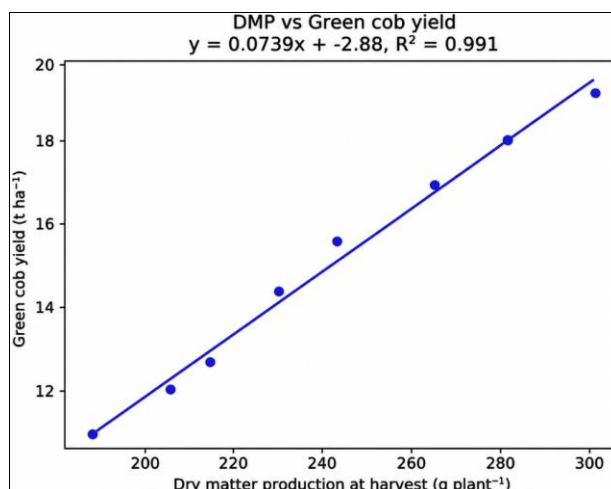


Fig 1: Relationship between dry matter production at harvest and green cob yield of sweet corn

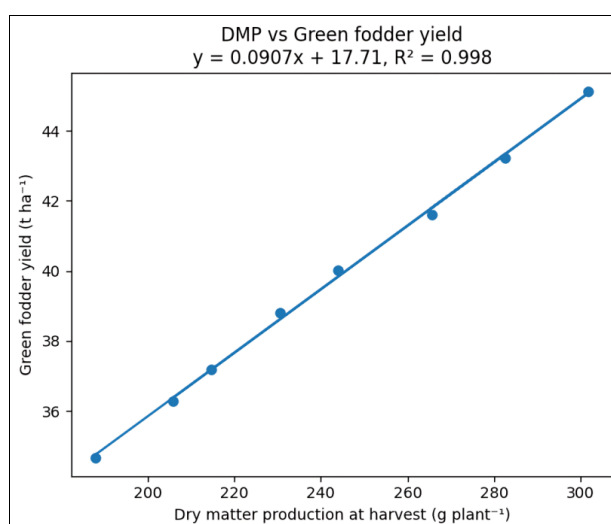


Fig 2: Relationship between dry matter production at harvest and green fodder yield of sweet corn

Conclusion

The present investigation clearly demonstrated that integrated nutrient management significantly improved growth, biomass accumulation, yield attributes and yield of sweet corn. Among the treatments evaluated, T₃ (100% RDF + biochar @ 5 t ha⁻¹ + microbial consortia @ 5 L ha⁻¹) proved superior in enhancing plant growth, dry matter production and economic yield.

The higher productivity under biochar-based INM can be attributed to improved nutrient retention, enhanced nitrogen status, better soil moisture regime and increased nutrient use efficiency. The strong positive association between dry matter production and yield further emphasizes the importance of biomass accumulation in achieving higher productivity.

Based on the findings of the study, integration of biochar with recommended fertilizer dose and microbial consortia can be considered a promising nutrient management strategy for improving sweet corn productivity under sandy loam soils with low organic carbon status.

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