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PRODUCTION POTENTIAL OF SWEET CORN AS INFLUENCED BY ORGANIC MANURES AND FOLIAR NUTRITION

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ABSTRACT

A field experiment was conducted at dryland farm of S.V. Agricultural College, Tirupati, during *kharif*, 2023 on sandy loam soils. The experiment was laid down in FRBD and replicated thrice, assessed the effects of organic manures and foliar nutrition on sweet corn (variety Tang 75). The treatments included three organic manure combinations: M_1 (Green manuring with sunhemp + 50% N through FYM + biofertilizer consortium), M_2 (Green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium), and M_3 (Green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), and three foliar sprays: F_1 (Seaweed extract @ 1%), F_2 (Waste decomposer), and F_3 (Panchagavya @ 5%). Results revealed that the application of M_2 significantly enhanced green cob and green fodder yields compared to other treatments, among the foliar sprays, F_1 achieved the highest yields, while F_3 was statistically on par to F_2. Treatment M_2 also notably improved nitrogen, phosphorus, and potassium uptake, as well as soil microbial populations (bacteria, fungi, and actinomycetes). Statistically M_1 and M_3 treatments were on parity with each other. Seaweed extract (F_1) resulted in the greatest nutrient uptake, whereas waste decomposer (F_2) and panchagavya (F_3) were comparable but less effective in nutrient enhancement compared to F_1. Post-harvest soil analysis showed that M_1 had the highest levels of available nutrients, followed by M_3 and M_2. Based on an economic analysis, M_2 had the best benefit-cost ratio, as well as the highest gross and net returns.

KEYWORDS: Sweet corn**,** Organic Manures, Foliar Sprays, Biofertilizer consortium, Green manure crop, Gross Returns, Benefit-Cost Ratio.

INTRODUCTION

Maize is known as "queen of cereals," is crucial for global agriculture due to its high productivity and versatile uses. Cultivated across 208.87 million hectares worldwide, it produces 1210.23 million tonnes, representing 37 per cent of global grain output (FAO, 2021). In India, maize is grown on 9.9 million hectares, yielding 30 million tonnes with a productivity rate of 6105 kg h^{-1} (IndiaStat, 2024). Among its varieties, sweet corn is distinguished by its elevated sugar content, a result of genetic mutations that enhance sweetness, particularly when harvested at 18 to 21 days post-pollination (Creech, 1965). Its popularity has surged due to urban demand for nutritious, sweet-tasting food. Organic farming has become a key alternative to synthetic inputs, emphasizing sustainable practices. Organic methods, such as the use of farmyard manure, poultry manure, and green manures like sunhemp, are integral to maintain the soil fertility and achieving sustainable yields. Poultry manure, rich in nitrogen, phosphorus, and potassium, and biofertilizers like Azospirillum and phosphate-solubilizing bacteria, further enhance soil health and crop growth (Mohamed *et al*., 2010; Garg and Bahla, 2008; Vamsi *et al*., 2023).

Additionally, foliar applications, including seaweed extracts, waste decomposer, and panchagavya, improve crop vigor and productivity. This study aims to evaluate the effects of various organic manures and foliar treatments on sweet corn's yield, nutrient uptake, soil microbial status, and economic returns, providing valuable insights into sustainable organic practices for sweet corn production.

MATERIAL AND METHODS

A field experiment was conducted during the *kharif* season of 2023 at the College Farm of S.V. Agricultural College, Tirupati campus, Acharya N.G. Ranga Agricultural University, Andhra Pradesh, India. The soil at the experimental site was sandy loam with a pH of 6.9, an electrical conductivity (EC) of 0.13 dS m^{-1}, and low organic carbon (0.29%). Available nitrogen, phosphorus, and potassium were 176.0, 27.2, and 259.0 kg ha^{-1}, respectively. Initial microbial counts were 21.7 × 10^6 CFU g^{-1} for bacteria, 9.5 × 10^4 CFU g^{-1} for fungi, and 9.8 × 10^3 CFU g^{-1} for actinomycetes.

The experimental design was randomized block design with factorial concept replicated thrice. Treatments were divided into two factors: organic manures and

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organic foliar sprays. Three organic maanure treatmnts *i.e.* M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium), M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium), and M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium). Four foliar spray treatments included F_1 (seaweed extract @ 1%), F_2 (waste decomposer), and F_3 (panchagavya @ 5% [260 l ha^{-1}]). Biofertilizer consortium (Azospirillum + PSB + KSB) was applied at 1.25 l ha^{-1}, and foliar sprays were administered at the knee-high stage and tassel initiation. Recommended doses of fertilizers (120-50-40 kg N, P_2O_5, and K_2O ha^{-1}) were supplied through organic manures based on equivalent nitrogen content.

Green cob yield was determined by weighing the harvested cobs from the net plot and expressing the results in kg ha^{-1}. Following the harvest of green cobs, the remaining plants were cut back to the base, and the green fodder was weighed from the net plot and also expressed in kg ha^{-1}.

Plant samples of crop were collected from all the plots at harvest and these samples were dried, ground into fine powder and used for estimation of nitrogen, phosphorus and potassium. Nutrient uptake by crop was calculated by using the formula

Nutrient uptake (kg ha^{-1}) =

$$\frac{\text{Drymatter production (kg ha}^{-1}\text{)} \times \text{Nutrient content (\%)}}{100}$$

Microbial populations in the soil were assessed using the serial dilution plate count method (Pramer and Schmidt, 1965). Bacteria were enumerated on Nutrient Agar (NA), fungi on Potato Dextrose Agar (PDA), and actinomycetes on Actinomycetes Isolate Agar (AIA). For nutrient uptake analysis, plant samples were collected at harvest, oven-dried, powdered, and analyzed for nitrogen, phosphorus, and potassium content. Nitrogen content was estimated using the micro-Kjeldahl method (AOAC, 1960), phosphorus by the vanado-molybdo phosphoric acid method (Jackson, 1973), and potassium using flame photometry (Jackson, 1973).

Soil samples were collected before planting and after harvest, air-dried, powdered, and sieved for analysis. Available nitrogen, phosphorus, and potassium were measured using methods outlined by Subbiah and Asija (1956), Olsen *et al.* (1954), and Jackson (1973), respectively.

The total cost of cultivation and gross returns were calculated based on input costs and market prices, with net returns determined by subtracting the cost of cultivation from gross returns. The benefit-cost ratio was computed to evaluate the economic viability of the treatments.

RESULTS AND DISCUSSION

Sweet corn yield, post-harvest soil nutrient status, nutrient uptake, soil microbial population and economics as influenced by different organic manures and foliar sprays are discussed under the following headings

Green Cob Yield

The green cob yield of sweet corn was significantly affected by the organic manures and foliar sprays used, although the interaction between them was not statistically significant. Among the organic manures, M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) resulted in the highest green cob yield (5634 kg ha^{-1}), which was significantly superior to all other treatments. The next best treatment was M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was comparable to M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium). The superior yield from poultry manure M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) can be attributed to the higher concentration of macro and micronutrients and a steady nutrient release throughout the crop period. Poultry manure increases humic acid production, which forms water-soluble chelated phosphorus, facilitating easier phosphorus release to the crop, enhancing green cob yield. These findings are consistent with those of Jagadeesha *et al*. (2010), Sangeetha *et al*. (2013), Prakash *et al.* (2018), Priya and Satyamoorthi (2019), Aravind *et al.* (2020). Regarding foliar sprays, the highest green cob yield was achieved with F_1 (seaweed extract @ 1%), followed by F_3 (panchagavya @ 5% [260 l ha^{-1}]) which was comparable to the F_2 (waste decomposer). Increase in green cob yield was observed with seaweed extract compared to panchagavya due to natural growth hormones, cytokinins, and auxins present in seaweed extract stimulate cell division and elongation, leading to robust plant growth and larger cobs. Additionally, seaweed extract enhances the plant's stress resistance, resulting in healthier plants and higher yields. These findings are consistent with those of Gumpula *et al*. (2022) and Simha *et al*. (2023).

Table 1. Green cob yield and green fodder yield (kg ha^{-1}) of sweet corn as influenced by organic manures and foliar sprays

Treatments	Green cob yield (kg ha^{-1})	Green fodder yield (kg ha^{-1})
Organic manures (M)		
M_1 : Green manuring with sunhemp + 50 % N through FYM + biofertilizer consortium	5634	12126
M_2 : Green manuring with sunhemp + 50 % N through poultry manure + biofertilizer consortium	6112	13161
M_3 : Green manuring with sunhemp + 25 % N through FYM + 25% N through poultry manure + biofertilizer consortium	5724	12323
SEm±	102	223.5
CD (P = 0.05)	307	670
Foliar sprays (F)		
F_1 : Seaweed extract @ 1%	6280	13521
F_2 : Waste decomposer	5562	11978
F_3 : Panchagavya @ 5% (260 l ha^{-1})	5628	12111
SEm±	102	223
CD (P = 0.05)	307	670
Organic manures (M) × Foliar sprays (F)		
SEm±	177	387
CD (P = 0.05)	NS	NS

Green fodder yield

Among the organic manures, treatment M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) produced the highest green fodder yield (12126 kg ha^{-1}), significantly surpassing all other treatments. The next best treatment was M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was comparable to M_1. The highest green fodder yield observed with M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) might be due to the better availability of NPK and beneficial micronutrients in poultry manure, enhancing plant activity and resulting in higher dry matter production, thus leading to greater green fodder yield. These findings align with those of Gawade *et al.* (2013), Pallavi *et al*. (2016), and Reddy *et al.* (2021). Additionally, the organic source's nutrient availability increased due to the release of organic acids during decomposition, aiding in the mineralization of native soil nutrients and enhancing their availability to plants. Similar results were reported by Kharche *et al.* (2020). Regarding foliar sprays, the highest green fodder yield was achieved with treatment F_1 (seaweed extract @ 1%) followed by F_3 (panchagavya @ 5% [260 l ha^{-1}]), which was comparable to F_2 (waste decomposer). The significant increase in green fodder yield associated with seaweed extract application may be attributed to enhanced nutrient uptake by the maize plant, and the presence of macro and micro-elements and plant growth regulators (especially cytokinins, IAA, and GA)

Table 2. Nutrient (NPK) uptake (kg ha^{-1}) by sweet corn at harvest as influenced by organic manures and foliar sprays

Treatments	Nitrogen	Phosphorus	Potassium
Organic manures (M)			
M_1 : Green manuring with sunhemp + 50 % N through FYM + biofertilizer consortium	140	19.0	142
M_2 : Green manuring with sunhemp + 50 % N through poultry manure + biofertilizer consortium	153	20.6	155
M_3 : Green manuring with sunhemp + 25 % N through FYM + 25% N through poultry manure + biofertilizer consortium	143	19.3	145
SEm±	2.8	0.37	2.88
CD (P = 0.05)	8.4	1.1	8.6
Foliar spray (F)			
F_1 : Seaweed extract @ 1%	157	21.2	159
F_2 : Waste decomposer	139	18.0	141
F_3 : Panchagavya @ 5% (260 l ha^{-1})	142	18.9	142
SEm±	2.8	0.4	2.9
CD (P = 0.05)	8.0	1.1	9.0
Organic manures (M) × Foliar sprays (F)			
SEm±	4.9	0.6	5.0
CD (P = 0.05)	NS	NS	NS

responsible for larger leaf area index (LAI), higher dry matter production, and ultimately higher green fodder yield. These findings are consistent with those of Gumpula *et al.* (2022) and Simha *et al.* (2023).

Nutrient (NPK) uptake at harvest

Among the organic manures, treatment M_2 resulted in the highest nutrient uptake, significantly superior to all other treatments. The next best treatments were M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium) and M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium) which were on par with each other. The higher nutrient uptake observed with poultry manure M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) can be attributed to its production of more humic acid, forming water-soluble chelated phosphorus. This helps in the gradual release of phosphorus in the rhizosphere, providing a steady supply of soluble nutrients and minimizing nutrient fixation and precipitation. Adequate nutrient supply resulted in higher nutrient uptake and better yield. These findings are consistent with Hossain *et al.* (2010), Sangeetha *et al.* (2013), Prakash *et al.* (2018), and Nayak *et al.* (2020). The application of poultry manure releases nutrients slowly into the soil solution, matching the sweet corn's absorption pattern. Devegowda (1997) also reported that poultry manure contains higher concentrations of macro and micronutrients, contributing to greater nutrient availability and uptake than farmyard manure. Among the foliar sprays, the highest nutrient uptake was observed with treatment F_1 (seaweed extract @ 1%) followed by F_3 (panchagavya @ 5% [260 l ha^{-1}]), which was comparable to F_2 (waste decomposer). The increase in nutrient uptake with seaweed extract foliar spray can

Table 3. Post-harvest soil available nitrogen, phosphorous and potassium (kg ha^{-1}) of sweet corn as influenced by organic manures and foliar sprays

Treatments	Available N	Available P_2O_5	Available K_2O
Organic manures (M)			
M_1 : Green manuring with sunhemp + 50 % N through FYM + biofertilizer consortium	241	31.6	224
M_2 : Green manuring with sunhemp + 50 % N through poultry manure + biofertilizer consortium	231	30.4	185
M_3 : Green manuring with sunhemp + 25 % N through FYM + 25% N through poultry manure + biofertilizer consortium	240	31.8	214
SEm±	3.6	0.48	3.69
CD (P = 0.05)	11	1.4	11.0
Foliar spray (F)			
F_1 : Seaweed extract @ 1%	241	31.6	219
F_2 : Waste decomposer	238	31.2	212
F_3 : Panchagavya @ 5% (260 l ha^{-1})	240	31.5	224
SEm±	3.68	0.48	3.69
CD (P = 0.05)	NS	NS	NS
Organic manures (M) × Foliar sprays (F)			
SEm±	6.3	0.8	6.4
CD (P = 0.05)	NS	NS	NS

be attributed to beneficial microorganisms and plant growth-stimulating substances in the extract, enhancing the biological efficiency of crop plants and improving the source-sink relationship. This likely contributed to greater nutrient absorption and translocation (NCOF, Ghaziabad).Higher NPK uptake might also result from the sufficient release of nutrients through mineralization at a constant level, which increased nutrient uptake under the improved soil environment created by the cumulative effect of organic sources (Nayak *et al.,* 2019).

Post-harvest soil nutrient status

Among the treatments, the highest post-harvest soil available nitrogen, phosphorus, and potassium were recorded with treatment M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium). The next best treatment was M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was comparable to M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium). The mineralization of organic manures and the release pattern of nutrients into the soil solution vary according to their sources. The enhanced nitrogen status of the soil might be due to increased rhizosphere microorganisms' activity, facilitated by the incorporation of poultry manure, which converts bound nitrogen into an inorganic form. Consequently, the application of poultry manure enhances nitrogen availability and uptake by the crop, potentially leading to lower nitrogen levels in the soil post-harvest compared to other manures. These results align with the findings of Banerjee *et al.* (2013) and Nayak *et al.* (2020). During the decomposition of organic manures, various acids are produced,

Table 4. Post-harvest soil microbial population of sweet corn as influenced by organic manures and foliar sprays

Treatments	Bacteria (No. × 10^7 CFU g^{-1})	Fungi (No. × 10^4 CFU g^{-1})	Actinomycetes (No. × 10^3 CFU g^{-1})
Organic manures (M)			
M_1 : Green manuring with sunhemp + 50 % N through FYM + biofertilizer consortium	39	18.6	15.3
M_2 : Green manuring with sunhemp + 50 % N through poultry manure + biofertilizer consortium	43	20.0	17.0
M_3 : Green manuring with sunhemp + 25 % N through FYM + 25% N through poultry manure + biofertilizer consortium	41	19.1	15.9
SEm±	0.81	0.36	0.31
CD (P = 0.05)	2.4	1.1	0.9
Foliar spray (F)			
F_1 : Seaweed extract @ 1%	45	20.8	17.2
F_2 : Waste decomposer	40	18.1	15.3
F_3 : Panchagavya @ 5% (260 l ha^{-1})	42	18.6	15.6
SEm±	0.8	0.37	0.31
CD (P = 0.05)	2.43	1.10	0.9
Organic manures (M) × Foliar sprays (F)			
SEm±	1.4	0.6	0.5
CD (P = 0.05)	NS	NS	NS

which solubilize phosphate-bearing minerals, activate phosphatase, and lower phosphorus fixation, thereby increasing phosphorus availability. This reduction in phosphorus fixation and increased availability are supported by the findings of Rana *et al.* (2015), Nayak *et al.* (2020), Chaudhary *et al.* (2021), and Ahmed and Tripathi (2022). Organic manures not only supply nutrients but also serve as food for microorganisms, encouraging their multiplication, which improves nutrient mineralization in the soil, enhancing soil fertility and productivity. Basavarajappa et al. (2002) reported similar observations, indicating that the use of organics increases both yield and soil health. In general, organic manures improve soil health by increasing the number of soil microorganisms, which in turn transform non-available plant nutrients into available forms (Yawalkar *et al.,* 1992). The results clearly indicate that wherever nutrient uptake increased, there was a corresponding decrease in the status of available nutrients in the soil post-harvest (Jagadeesha *et al.*, 2018). The influence of foliar sprays and their interactions was not statistically traceable.

Post-harvest soil microbial population

Higher post-harvest soil microbial populations, including the total count of bacteria, fungi, and actinomycetes, were recorded with treatment M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) which showed a significant difference compared to other treatments. The next best treatment was M_3 (green manuring with sunhemp +

Table 5. Gross returns, net returns (₹ ha^{-1}) and benefit-cost ratio of sweet corn cultivation as influenced by organic manures and foliar sprays

Treatments	Gross return	Net return	Benefit-cost ratio
Organic manures (M)			
M_1 : Green manuring with sunhemp + 50 % N through FYM + biofertilizer consortium	102264	40521	1.66
M_2 : Green manuring with sunhemp + 50 % N through poultry manure + biofertilizer consortium	110949	52409	1.89
M_3 : Green manuring with sunhemp + 25 % N through FYM + 25% N through poultry manure + biofertilizer consortium	103908	43517	1.72
SEm±	1864	1868	0.03
CD (P = 0.05)	5589	5599	0.10
Foliar spray (F)			
F_1 : Seaweed extract @ 1%	113993	48967	1.76
F_2 : Waste decomposer	100977	43409	1.74
F_3 : Panchagavya @ 5% (260 l ha^{-1})	102152	44071	1.75
SEm±	1864	1868	0.03
CD (P = 0.05)	5589	5599	0.1
Organic manures (M) × Foliar sprays (F)			
SEm±	3229	3235	0.06
CD (P = 0.05)	NS	NS	NS

25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was comparable to M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium). The increased microbial populations with poultry manure application are likely due to its richness in macro and micronutrients, along with plant growth-promoting substances, humus-forming microbes, and nitrogen fixers. Poultry manure enhances enzymatic and microbial activities, improving soil fertility. It also increases biological activities in the soil, thereby encouraging microbial population growth. These findings align with those of Sharma *et al.* (2017) and Ammaan *et al.* (2019). Foliar sprays such as seaweed extract, panchagavya, and waste decomposer contain beneficial microorganisms along with plant growth-stimulating substances and nutrients, promoting microbial colonization in the rhizosphere (NCOF, Ghaziabad).

Gross Returns

Significantly the highest gross returns (₹ 110949 ha^{-1}) were realized by M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) over the rest of the treatments tried. It is obvious that realization of higher gross returns was the result of higher green cob and green fodder yield. The next best treatment was green manuring with M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was on par with M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium). Among different foliar sprays, significantly the highest gross returns were recorded with application of F_1 (seaweed extract @ 1%). The next best treatment was F_3 (panchagavya @ 5% [260 l ha^{-1}]), which was on par with green manuring with F_2 (waste decomposer).

Net Returns

Significantly the highest net returns (₹ 52409 ha-1) were realized by M_2 over the rest of the treatments tried. The next best treatment was M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium), which was on par with M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium). Among different foliar sprays, significantly the highest net returns were recorded with application of F_1 (seaweed extract @ 1%). The next best treatment was F_3 (panchagavya @ 5% [260 l ha^{-1}]), which was on par with green manuring with F_2 (waste decomposer).

Benefit-Cost Ratio

Significantly the highest benefit-cost ratio (1.89) was noticed with M_2 (green manuring with sunhemp + 50% N through poultry manure + biofertilizer consortium) compared to other treatments. The next best treatments were green manuring with M_3 (green manuring with sunhemp + 25% N through FYM + 25% N through poultry manure + biofertilizer consortium) and M_1 (green manuring with sunhemp + 50% N through FYM + biofertilizer consortium) with no significant disparity between them.

Among the foliar sprays, significantly the highest benefit-cost ratio was noticed with F_1 (seaweed extract @ 1%). Treatment F_3 (panchagavya @ 5% [260 l ha^{-1}]) and F_2 (waste decomposer) were the next best treatments with no significant difference between them.

In conclusion, the present study revealed that green manuring with sunhemp + 50 per cent N through poultry manure (60 kg ha^{-1}) + soil application of *Azospirillum*+ PSB+ KSB @1.25 l ha^{-1} each along with foliar application of seaweed extract @ 1 per cent twice at knee high and tassel initiation stage was found to be the most promising and economically viable organic nutrient management practice for enhancing the productivity, uptake of nutrients as well as sustaining the soil microbial health of organic sweet corn.

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