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Sustainable fertilization strategy to enhance phosphorus availability and sweet corn productivity

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ABSTRACT

Fertilization practices are still largely dependent on chemical fertilizers to increase crop productivity; however, their excessive use has been shown to degrade soil quality, suppress soil microorganism activity, and reduce nutrient use efficiency. This challenge is even more apparent in Inceptisols that are poor in organic carbon and phosphorus, resulting in suboptimal sweet corn productivity. Meanwhile, abundant organic waste has not been fully utilized as organic fertilizer, even though it has the potential to improve the physical, chemical, and biological properties. This study aimed to increase soil phosphorus availability, while reducing the dependence on chemical fertilizers by combining the compost enriched with Korean natural farming liquid organic fertilizer (LOF KNF) with NPK fertilizer at different doses. The study using a single-factor complete randomized block design (CRBD) with 10 treatments and three replications. The treatments consisted of A0, non-fertilizer control; A1, 100% NPK; A2–A5, decreasing NPK rates (75, 50, 25, and 0%) combined with increasing proportions of market compost and KNF LOF; and A6–A9, decreasing NPK rates (75, 50, 25, and 0%) combined with increasing proportions of mixed compost and KNF LOF. Data were statistically analyzed using ANOVA, DMRT, and Pearson's correlation. The results showed that the treatment with the compost enriched with LOF KNF and the combination with NPK significantly affected all parameters observed. Combination treatment of 50% mixed compost + 50% NPK + LOF KNF (A7) was the best treatment, increasing soil available P from 8.08 ppm to 15.96 ppm (97.52%), plant tissue P concentration from 0.18% to 0.42% (133.3%), plant height from 121 cm to 163 cm (34.71%), total fresh weight from 402 g to 723.33 g (79.93%), total plant dry weight from 180.67 g to 486.33 g (169.18%), and fresh ear yield from 4.71 kg to 9.2 kg, increasing by 95.32% (15 ton/ha) compared to the unfertilized control. Pearson's correlation analysis revealed strong positive correlations between soil available P and plant P tissue (r = 0.882**), total dry weight (r = 0.700**), and fresh ear yield (r = 0.737**). These findings demonstrate that partial substitution of chemical fertilizers with the compost enriched with LOF KNF represents an effective fertilization strategy for improving Inceptisol fertility and enhancing sweet corn productivity.

Keywords: fertilization strategies, chemical fertilizers, availability of P, organic waste, compost, sweet corn.

INTRODUCTION

Sustainable fertilization strategies are an essential approach in modern farming systems to maintain a balance between increasing crop productivity, soil fertility, and environmental conservation. Chemical fertilizers, especially NPK fertilizer, remain the primary choice for farmers because they provide rapid nutrient availability, but excessive use can reduce microorganism activity, increase acidity, and worsen soil quality (Zhu et al., 2018; Zulfita et al., 2022). Several studies have reported that combining organic and inorganic fertilizers can improve nutrient efficiency and crop yields. Hou et al. (2025) demonstrated that applying a mixture of straw organic fertilizer and chemical fertilizer (SCMF) increased nitrogen fertilization efficiency by 6.39 g/g, dry plant weight by 7.82%, and sweet corn biomass accumulation by approximately 20%. Similarly, the combination of vermicompost, black soldier fly (BSF), and inorganic fertilizer significantly increased sweet corn growth and yield, with the BSF + NPK treatment producing a wet cob weight of up to 6,275.4 kg/ha, equivalent to complete NPK application (Risman et al., 2025).

The main challenge of fertilization is becoming increasingly complex on the Inceptisols that are still in the early stages of development and have low weathering levels. The characteristics of this soil indicate low fertility, with a total N content of 0.17% (low), available P of 5.68 ppm (low), total K of 0.21 mg/100 g (low), and organic C content of 1.29% (low) (Hartati et al., 2020; Septyani and Harahap, 2022). Low organic C content affects phosphorus availability, not just because soil minerals bind P, but more importantly because reduced organic matter decreases microbial activity that solubilizes P and reduces the number of binding sites that mitigate P fixation, ultimately limiting P availability for plants (Rawat et al., 2021). These conditions cause the productivity of sweet corn on Inceptisols to often be suboptimal, even though sweet corn (*Zea mays* L. var. saccharata) is a vital food commodity with a potential yield of 14–18 tons/ha, much higher than the national average productivity of only 4–5 tons/ha (Rohmaniya et al., 2023).

This significant yield gap has been attributed not only to poor soil fertility, but also to a limited access to quality seeds, inadequate farming infrastructure, inconsistent adoption of improved agronomic practices, and vulnerability to climate variability, which collectively constrain farmers' ability to achieve their potential yields. At the national level, this yield gap is associated with a trend of declining export volumes and continued dependence on imported corn as well as sweet corn products, reflecting challenges in competitiveness and domestic production sufficiency (Irawan et al., 2017); in 2023, Indonesia exported over US$2.1 million worth of frozen sweet corn to several countries, while overall maize (corn) exports declined and imports remained significant, including roughly 1.3 million tons of corn imported in 2024 to meet domestic demand (World Bank, 2023).

One alternative is the use of the compost derived from organic waste, which is rich in nutrients, especially phosphorus (Meng et al., 2017; Zhang and Sun, 2016). Organic waste-based compost is known to have a relatively high total P content, reaching 0.211% (Kurnia et al., 2017), and vegetable-based compost is reported to be even richer in phosphorus (Kaswinarni and Nugraha, 2020). In this study, two types of compost were used, namely mixed compost (household, campus, and market waste) and market compost. The added value of this compost can be increased by enriching it with liquid organic fertilizer (LOF) based on Korean natural farming (KNF). This biologically driven approach enhances soil microbial activity and nutrient cycling by using fermented plant, fruit, and microbial inputs to improve soil fertility and nutrient uptake (Cho, 2020). Studies on liquid organic fertilizers show that they can enhance the microbial diversity and nutrient availability of soil, thereby improving plant nutrient uptake across various crops. Therefore, the combination of compost, LOF KNF, and NPK is expected to improve the fertility of Inceptisol, increase phosphorus availability, and enhance sweet corn productivity. In addition, this research also contributes to reducing waste accumulation at final disposal sites through composting, thereby supporting waste management and environmental sustainability. This study aimed to evaluate the effectiveness of this fertilization strategy as a sustainable approach to improve the efficiency of chemical fertilizer use while reducing dependence on inorganic inputs.

MATERIALS AND METHODS

Research location

This research was conducted from March 2024 to December 2024 in Suruh District, Semarang Regency, Central Java, Republic of Indonesia. The experimental area is located at approximately −7.3673° S, 110.5727° E, with an average elevation of about 571 m above sea level. The region has a tropical climate with average daily temperatures generally ranging from 20–30 °C, and relative humidity of 70–85%. Sampling activities were conducted on various types of organic waste at the Magetan Regency landfill, the Gajah Putih Surakarta Waste Bank, and the UNS campus. Laboratory analysis activities were conducted at the Soil Biology and Biotechnology Laboratory and the Soil Chemistry and Fertility Laboratory of the Faculty of Agriculture, Sebelas Maret University.

Tools and materials

The tools and materials in this study included organic waste from markets, households, and campuses. The soil used for planting is an Inceptisol. Composting involved using a composter bag. Planting uses F1 hybrid Virginia sweet corn seeds. Laboratory analyses used soil samples sieved through a 2 mm mesh for chemical analysis and a 0.5 mm mesh for biological analysis, along with distilled water, $K_2Cr_2O_7$, H_2SO_4, NaOH, alcohol, $HClO_4$, a spectrophotometer, an oven, a pH meter, Erlenmeyer flasks, a distillation apparatus, and a colony counter.

Experimental design

The experiment used a single-factor completely randomized block design (CRBD) with 10 treatments and three replications, yielding 30 experimental units (Table 1).

Experimental unit, land layout, and planting method

Each experimental unit measured 3.5 × 1.75 m (6.125 m²). Plots were arranged with 0.5 m spacing between plots and 1 m spacing between blocks. Sweet corn was planted by direct seeding at a spacing of 60 × 25 cm, resulting in 33 plants per plot.

Soil and plant sampling

Initial soil samples were collected before treatment application from 0–20 cm soil depth at five random points and composited. The soil samples were collected at the maximum vegetative stage from the same depth at five points per plot. Plant samples were collected at the maximum vegetative stage by sampling the most recently fully expanded leaf (leaf blade excluding the midrib) from five representative plants per plot.

Production of local microorganisms and compost

Local microorganisms (LMO) production uses market waste and eco-enzymes from fresh fruit. LMO used as inoculum for composting. Composting was carried out with two main ingredients: market waste, which was added with LMO organic waste from the market, and organic waste mix (market, household, and campus) with LMO eco-enzyme. Composting was carried out in an 80-liter composter bag. Composting: each composter bag was made in 2 layers with the composition on each layer consisting of 500 g of dry leaves, fresh leaves 300 g, waste ½ of the capacity, leaf mold 250 g, bran 300 g, dry leaves 500 g, N fertilizer (12.5 g per 5 kg), P (8 g per 5 kg), and K (4 g per 5 kg) dissolved in water, and LMO diluted with a dilution of 1:10.

Production of liquid organic fertilizer, Korean natural farming, and Jaddam microbial solution

In this study, KNF leaf and fruit fertilizer was used to enrich compost nutrients. The KNF liquid organic fertilizer is a fermented solution made from fresh, high-quality local ingredients, including vegetables, leaves, and fruit. KNF is a fermentation method applied to Korea's natural farming system. The KNF leaf fertilizer is used

Table 1. Experimental treatments

Code	Treatments
A0	Control (no fertilizer)
A1	100% NPK (comparator)
A2	75% NPK + 25% Market Compost + 25% LOF KNF
A3	50% NPK + 50% Market Compost + 50% LOF KNF
A4	25% NPK + 75% Market Compost + 75% LOF KNF
A5	0% NPK + 100% Market Compost + 100% LOF KNF
A6	75% NPK + 25% Mixed Compost + 25% LOF KNF
A7	50% NPK + 50% Mixed Compost + 50% LOF KNF
A8	25% NPK + 75% Mixed Compost + 75% LOF KNF
A9	0% NPK + 100% Mixed Compost + 100% LOF KNF

Note: Percentages indicate substitution levels relative to the recommended NPK dose and compost application rate. LOF KNF percentages refer to the proportion of the standard LOF KNF application volume (see LOF KNF section).

together with lactic acid bacteria (LAB) serum, produced by fermenting rice-washing water with fresh milk at a 1:10 ratio for 3–5 days. LAB serum is a liquid microbial inoculant widely used in Korean natural farming and other organic farming systems.

The KNF fruit fertilizer was prepared using 1 kg total fresh fruit pulp, consisting of banana, guava, papaya, watermelon, and pineapple (200 g each, edible pulp only), mixed with 1 kg sugar (1:1 w/w) and fermented for 7 days. The nutrient composition of this mixture was not chemically analyzed and is acknowledged as a limitation. The concentrated LOF, KNF, was diluted 1:500 (v/v) before application.

Jaddam microbial solution (JMS) is a live-microorganism solution used to improve soil health, accelerate the decomposition of organic matter, and support plant growth. JMS was prepared from coarse salt, boiled potatoes, and leaf mould fermented in water for 24 hours and used within 72 hours.

Compost quality analysis

Compost quality analysis included organic C and total macronutrients (N + P_2O_5 + K_2O) in accordance with the Minister of Agriculture Decree of the Republic of Indonesia No. 261 of 2019.

Initial soil analysis

Soil sampling for initial analysis includes texture, pH, C-organic, P-available, and total soil bacteria population.

Planting and maintenance of sweet corn

Basal compost was applied at 7.5 t ha^{-1}, using the same compost type specified for each treatment (market or mixed compost). NPK fertilizer (15–15–15) was applied at a total rate of 300 kg ha^{-1}, split equally into three applications at 5, 30, and 60 days after planting. Maintenance included irrigation, weeding, replacing dead seedlings (gapping), and pest control using organic and inorganic pesticides.

Harvesting and post-harvesting

Sweet corn was harvested at 65 days after planting. Plant samples were oven-dried at 70 °C until constant weight. Dry weight included leaves and stems only; roots were excluded.

Analysis of soil and plant samples at the maximum vegetative stage

The soil samples were analyzed for pH (electrometric method), organic carbon (Walkley–Black method) (Walkley and Black, 1965), available phosphorus (Olsen method) (Olsen et al., 1954), and population of phosphate-solubilizing bacteria using the standard plate count technique. Plant parameters included tissue phosphorus concentration (wet ashing with $HClO_4$), plant height and number of leaves (direct calculation), total fresh and dry biomass of whole plants (including roots, stems, and leaves), and fresh ear yield, all determined using standard agronomic measurement procedures (BPSIP, 2023).

Data analysis

The data were analyzed using analysis of variance (ANOVA) at a 5% significance level ($p \leq 0.05$), followed by Duncan's multiple range test (DMRT). Pearson's correlation analysis was conducted among all soil, plant, and yield variables across treatments, and results were summarized in a single correlation matrix table.

RESULTS AND DISCUSSION

Initial land characteristics before compost application

The initial land characteristics are presented in Table 2. The studied Inceptisol was characterized by a clay content exceeding 40%, a crumbly structure, and a relatively loose consistency. Similar soil texture classifications for Inceptisols were reported by Suryani et al. (2021), who identified these soils as a clay texture class. The application of JMS slightly increased soil organic carbon (C), which primarily originates from plant-derived photosynthates. Soil microorganisms play a central role in regulating organic C dynamics by mediating both mineralization and accumulation (Crowther et al., 2019).

Soil available phosphorus (P) increased following JMS application, although its status remained within the low category. The low availability of P in Inceptisols is primarily attributed to limited

Table 2. Initial land characteristics before compost application

Variable observation	Non-JMS	JMS	Level
Textur %Sand %Dust %Clay	48.74 3.55 47.71		Clay
pH	5.97	6.65	Slightly acidic* – neutral*
Soil organic carbon (%)	1.02	1.16	Low* – Low*
Soil available P (ppm)	5.66	7.23	Low* –Low*
Total soil bacteria population (CFU/g)	7.63 Log	7.77 Log	

Note: * Ranking according to the soil research center of Indonesia (2023).

organic matter inputs, as soil P is derived from the weathering of P-bearing minerals, such as apatite, and from the decomposition of organic residues (Rahmi and Biantary, 2014). In addition, the high clay content typical of Inceptisols promotes strong nutrient fixation, particularly of potassium, thereby reducing its concentration in the soil solution and limiting overall nutrient availability (Putra, 2015).

Characteristics of compost quality

The compost quality analysis indicated that all compost types met the standards set by the Indonesian Minister of Agriculture Decree (2019) (Table 3). Mixed compost fertilizer has a higher organic carbon content than compost produced solely from market organic waste, due to its more diverse composition, which includes household, market, and campus organic waste. Household organic waste contributes a higher organic C content, as carbon-rich organic materials serve as a primary energy source for soil microorganisms (Krismawati and Hardini, 2014). In contrast, market organic waste generally contains higher moisture levels, which can dilute organic C concentration, as organic C is negatively correlated with moisture content (Kurnia et al., 2017). Furthermore, the mixed compost exhibited a higher C/N ratio, indicating slower decomposition rates, whereas excessively low C/N ratios indicate rapid decomposition and potential nutrient losses (Sari et al., 2020).

Soil properties following application of compost-derived organic matter

Soil pH

The soil pH analysis following treatment indicated an increase relative to pre-treatment levels, observed in both the JMS-treated and untreated samples. The increase in soil pH ranged from 2.85% to 6.61%. The combination treatment of compost fertilizer doses (market and mixed) enriched with LOF KNF, and NPK had a significant effect on soil pH ($P<0.01$). Table 4 and Figure 1 showed differences in soil pH across treatments, but all remained within the neutral range. The treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) was higher than the others, namely 7.09, with an increase of 3.6% from the control (A0) of 6.84. The application of a combination of NPK and compost treatments can increase soil pH, exchangeable base cations, P availability, and organic matter (Mi et al., 2018).

The treatment of A7 showed significant differences in all treatments, except for the treatment of 50% NPK + 50% market compost + 50% LOF KNF (A3), 25% NPK + 75% mixed compost + 75% LOF KNF (A8), and 100% mixed compost + 100% LOF KNF (A9), which showed no significant differences. The application of mixed compost fertilizer can increase the soil pH compared to market compost. The use of mixed compost fertilizer increases soil pH compared to market compost, likely because of

Table 3. Characteristics of compost quality

Treatment	C-Organic (%)	Total ($N+P_2O_5+K_2O$)	C/N Ratio
	(min 15)	(min 2%)	≤25
Market	17.15	2.45	16.11
Mixed	18.03	2.32	17.95

Note: Standard based on the Indonesian Ministry of Agriculture Decree No. 261/2019.

Table 4. Effect of treatment on Soil pH

Treatment	Soil pH
Control (no fertilizer)	6.84 ± 0.010[a]
100% NPK (comparator)	6.93 ± 0.020[b]
75% NPK + 25% market compost + 25% LOF KNF	7.04 ± 0.010[cd]
50% NPK + 50% market compost + 50% LOF KNF	7.06 ± 0.010[de]
25% NPK + 75% market compost + 75% LOF KNF	7.04 ± 0.010[cd]
0% NPK + 100% market compost + 100% LOF KNF	7.03 ± 0.015[cd]
75% NPK + 25% mixed compost + 25% LOF KNF	7.00 ± 0.043[b]
50% NPK + 50% mixed compost + 50% LOF KNF	7.09 ± 0.010[e]
25% NPK + 75% mixed compost + 75% LOF KNF	7.08 ± 0.015[de]
0% NPK + 100% mixed compost + 100% LOF KNF	7.06 ± 0.055[de]

Note: values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at P ≤ 0.05.

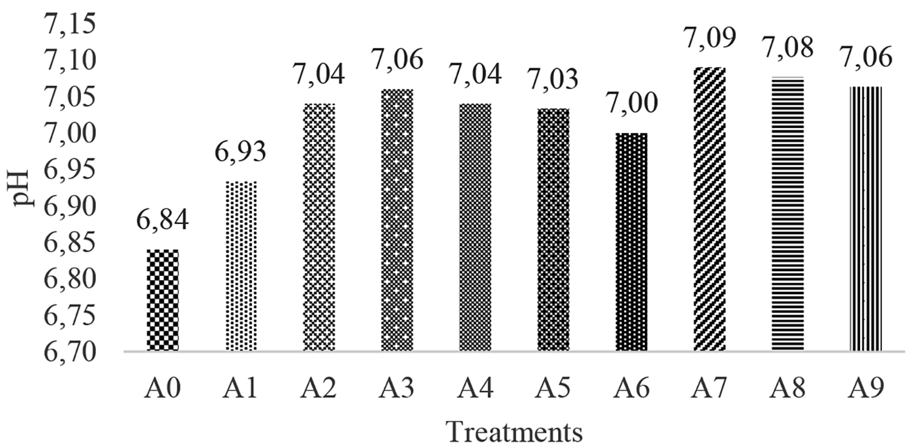

Figure 1. Effect of treatment on soil pH H_2O. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

its greater diversity of organic matter. Additionally, applying a combination of market and household waste compost can raise soil pH by 5.30% (Tampubolon et al., 2020). Soil pH determines the decomposition of organic matter by microbes and plays a vital role in its hydrolysis and oxidation (Wang and Kuzyakov, 2024). Soil pH controls mineralization by directly affecting the population and activity of soil microorganisms (Neina, 2019). Soil pH plays a vital role in biogeochemical processes, including the soil C cycle, which affects microbial activity (Malik et al., 2018).

Soil organic carbon

Soil organic carbon analysis indicated an increase in levels following treatment, regardless of the presence or absence of JMS. The increase in soil organic carbon ranged from 65.51% to 256.9%. The combination treatment of compost fertilizer doses (market and mixed) enriched with LOF KNF, and NPK had a significant effect on soil organic carbon (P<0.01). Table 5 and Figure 2, 3 showed that organic carbon increased in all treatments compared to the control. Table 5 showed that the 100% market compost + 100% LOF KNF (A5) treatment was higher than those of the other treatments, namely 4.14%, which represented an increase of 115.63% from the control (A0) of 1.92%. The application of liquid organic compost derived from market waste materials, such as vegetables, can directly increase the soil C content by 3.19% and organic

Table 5. Effect of treatment on soil organic carbon (SOC)

Treatment	SOC (%)
Control (no fertilizer)	1.92 ± 0.037^{a}
100% NPK (comparator)	1.99 ± 0.009^{a}
75% NPK + 25% market compost + 25% LOF KNF	2.25 ± 0.018^{b}
50% NPK + 50% market compost + 50% LOF KNF	2.94 ± 0.035^{d}
25% NPK + 75% market compost + 75% LOF KNF	3.82 ± 0.061^{f}
0% NPK + 100% market compost + 100% LOF KNF	4.14 ± 0.062^{g}
75% NPK + 25% mixed compost + 25% LOF KNF	2.55 ± 0.083^{c}
50% NPK + 50% mixed compost + 50% LOF KNF	3.47 ± 0.071^{e}
25% NPK + 75% mixed compost + 75% LOF KNF	3.98 ± 0.007^{f}
0% NPK + 100% mixed compost + 100% LOF KNF	4.11 ± 0.081^{g}

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

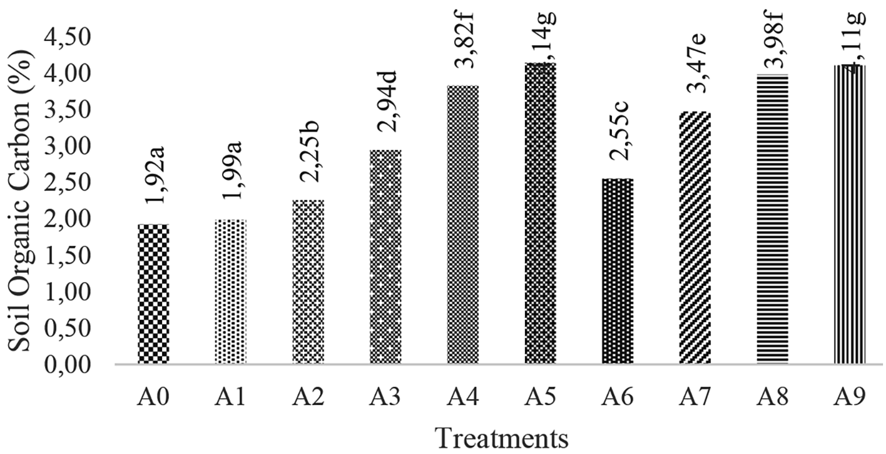

Figure 2. Effect of treatment on soil organic carbon. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

C by 7% in sweet corn plants (Muktamar et al., 2023). Table 5 showed that the treatment of 100% market compost + 100% LOF KNF (A5) differed significantly from all other treatments, except for 100% mixed compost + 100% LOF KNF (A9), which did not differ significantly. This increase reflects direct carbon inputs from organic amendments, rather than enhanced plant carbon fixation. Organic matter increases carbon storage in soil by supplying organic substrates that accumulate in soil aggregates (Benbi et al., 2015). Organic amendments improve soil aggregation and reduce organic matter losses by stabilizing carbon within macroaggregates (Six and Paustian, 2014). Soil organic carbon content is influenced by plant root exudation as a result of photosynthesis. Root exudates play an essential role in increasing microbial population and activity in the rhizosphere. Root exudates released by plant roots consist of low-molecular-weight C elements, sugars, organic acids, and amino acids that can be easily assimilated as nutrients by soil microbes (Shi et al., 2015).

On the basis of the correlation analysis (Table 14), there is a positive correlation between soil organic carbon (SOC) and phosphate-solubilizing bacteria (PSB) Population (r=0.871**) and P availability (r=0.658**). These results support the microbial energy hypothesis, which states that increased carbon availability enhances microbial growth and metabolic activity, thereby accelerating nutrient transformations such as phosphorus solubilization (Powlson et

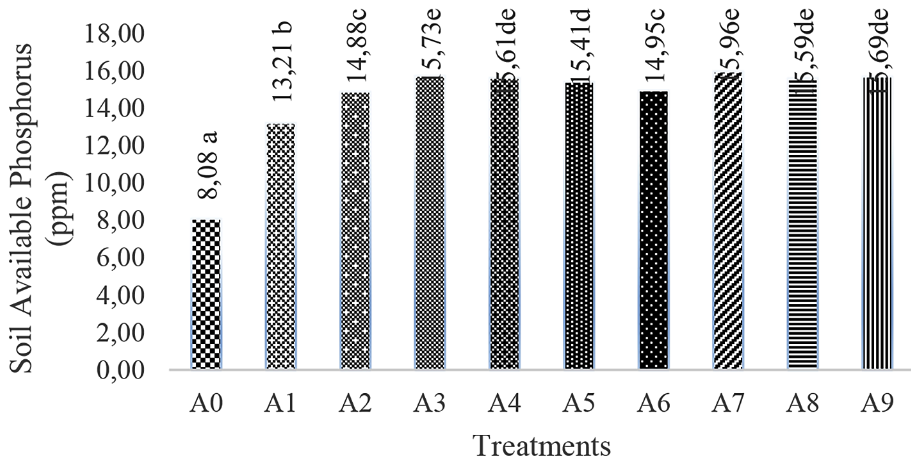

Figure 3. Effect of treatment on soil available phosporus. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

al., 2015). Luo et al. (2019) demonstrated that organic matter addition increases phosphatase activity and microbial diversity, enhancing P mineralization and availability. The strong positive correlation between soil organic carbon and PSB indicates that organic C provides an essential energy source for microbial activity in the rhizosphere. Higher organic C availability stimulates PSB proliferation and function, including the production of organic acids and indole-3-acetic acid (IAA), which enhance nutrient mobilization and root growth (Li et al., 2017). These results suggest that organic matter inputs strengthen biological phosphorus cycling and support improved plant growth.

Soil available phosphorus

Soil available phosphorus increased after treatment, regardless of whether JMS was applied. The increase in available phosphorus in the soil ranged from 11.75% to 120.74%. The combination treatment of compost fertilizer doses (market and mixed) enriched with LOF KNF, and NPK had a significant effect on soil P-Available ($P<0.01$). Table 6 showed that soil P-Available increased in all treatments compared to the control. The treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) had the highest concentration at 15.96 ppm, an increase of 97.52% from the control (8.08 ppm). This treatment differed significantly from most treatments, except A3, A4, A8, and A9.

Table 6. Effect of treatment on P-availability

Treatment	P-availability (ppm)
Control (no fertilizer)	8.08 ± 0.145^{a}
100% NPK (comparator)	13.21 ± 0.206^{b}
75% NPK + 25% market compost + 25% LOF KNF	14.88 ± 0.077^{c}
50% NPK + 50% market compost + 50% LOF KNF	15.73 ± 0.207^{e}
25% NPK + 75% market compost + 75% LOF KNF	15.61 ± 0.477^{e}
0% NPK + 100% market compost + 100% LOF KNF	15.41 ± 0.036^{d}
75% NPK + 25% mixed compost + 25% LOF KNF	14.95 ± 0.130^{c}
50% NPK + 50% mixed compost + 50% LOF KNF	15.96 ± 0.159^{e}
25% NPK + 75% mixed compost + 75% LOF KNF	15.59 ± 0.077^{e}
0% NPK + 100% mixed compost + 100% LOF KNF	15.69 ± 0.102^{e}

Note: Values are means ± standard deviation (SD) ($n = 3$). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

These results indicate that integrating organic amendments with inorganic fertilizer enhances phosphorus availability more effectively than sole fertilizer application. Organic fertilizers increase P availability through the mineralization of organic P, production of organic acids that chelate Al and Fe, and stimulation of microbial activity that mobilizes insoluble P fractions. This change is related to increased P uptake by sweet corn roots, making P available (Fahrurrozi et al., 2019). The application of organic fertilizer can increase P availability in sweet corn at 4 MST and 8 MST (Fitriatin et al., 2018). The application of a compost-NPK combination can significantly increase the P content in corn by up to 27% compared to the control (Zapałowska and Jarecki, 2024).

The correlation analysis (Table 14) indicated that soil available P was positively correlated with organic C (r=658) and harvest weight (fresh ear yield) (r=737**), suggesting that increases in soil organic matter improved P availability, thereby enhancing crop productivity. These findings support the role of organic matter not only as a nutrient source, but also as a regulator of soil chemical processes. Organic P was positively associated with soil organic matter but negatively correlated with Al and Fe contents, consistent with the findings of Noack et al. (2012). The mineralization and decomposition of organic matter released mineral P and generated organic acids such as citric and oxalic acids, which chelated Al^{3+} and Fe^{2+}, thereby increasing soil pH and reducing the pool of exchangeable Al. This mechanism facilitated the liberation of P bound to Al and Fe complexes, improving its bioavailability to plants (Pasaribu et al., 2018). Moreover, microbial activity likely contributed to this process, as phosphate-solubilizing bacteria and fungi produce organic acids and phosphatase enzymes that further accelerate P mobilization from insoluble fractions (Behera et al., 2014; Fitriatin et al., 2024). The combined chemical and biological processes promoted a more efficient soil P cycle, ultimately leading to higher harvest weights observed in this study. These results emphasize the importance of integrating organic amendments into fertilization strategies, as they enhance nutrient availability, while simultaneously reducing the dependence on inorganic P fertilizers (Figure 4).

Population of phosphate-solubilizing bacteria

The combination treatment of compost fertilizer doses (market and mix) enriched with LOF KNF, and NPK has a significant effect on the phosphate-solubilizing bacteria population ($P<0.01$). Table 7 shows an increase in the PSB population across all treatments compared to the control. The 100% mixed compost + 100% LOF KNF treatment (A9) was higher than the other treatments, at 9.44 Log CFU/ml, which was an increase of 12.91% from the control (A0) at 8.36 Log CFU/ml. Adding organic matter to soil used for sweet corn cultivation can increase the population of phosphate-solubilizing bacteria. The application of organic fertilizers can increase the activity of phosphate-solubilizing bacteria in the rhizosphere soil of corn (Patrick and Adeniyi, 2016). Organic fertilization can increase the population of phosphate-solubilizing bacteria and fungi in the soil by promoting efficient P transformation, thereby increasing P supply (Chatterjee et al., 2021).

The treatment of 100% mixed compost + 100% LOF KNF (A9) showed significant differences in all treatments, except for the treatment of 25% NPK + 75% mixed compost + 75% LOF

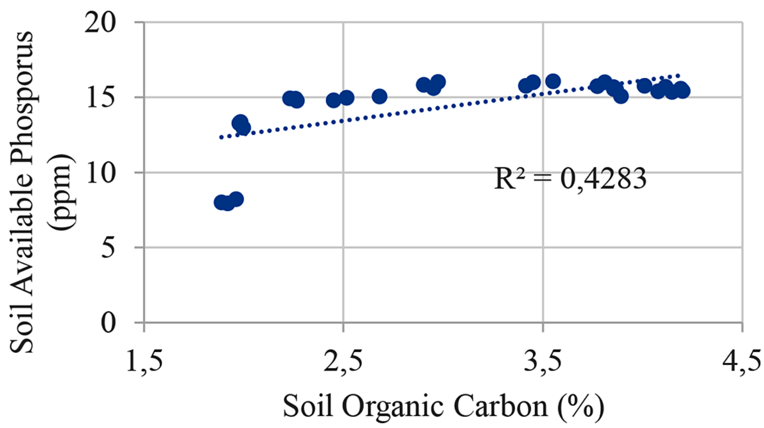

Figure 4. Graph of the relationship between P-available and C-organic

Table 7. Effect of treatment on the population of phosphate-solubilizing bacteria (PSB)

Treatment	Population of PSB (CFU/ml)
Control (no fertilizer)	8.36 ± 0.154[a]
100% NPK (comparator)	8.80 ± 0.072[b]
75% NPK + 25% market compost + 25% LOF KNF	8.86 ± 0.030[b]
50% NPK + 50% market compost + 50% LOF KNF	9.24 ± 0.044[d]
25% NPK + 75% market compost + 75% LOF KNF	9.26 ± 0.035[d]
0% NPK + 100% market compost + 100% LOF KNF	9.28 ± 0.041[d]
75% NPK + 25% mixed compost + 25% LOF KNF	9.05 ± 0.058[c]
50% NPK + 50% mixed compost + 50% LOF KNF	9.28 ± 0.037[d]
25% NPK + 75% mixed compost + 75% LOF KNF	9.33 ± 0.035[de]
0% NPK + 100% mixed compost + 100% LOF KNF	9.44 ± 0.029[e]

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

KNF (A8), which showed no significant differences. These results suggest that the greater the amount of organic material added, the greater the increase in the PSB population. This is in line with the research by Sinaga et al. (2018), which showed that applying 0 NPK + 1 organic ameliorant can increase soil PSB content by 6.08×10^9 CFU/ml. The lactic acid bacteria contained in LOF KNF can also increase the PSB population. LAB produces organic acids (such as lactate, acetate) that lower the micro-pH in the root zone, thereby improving the solubility of P bound to Al and Fe and increasing available P. Organic acids and enzymes from LAB become a source of carbon and energy for other soil microbes, including phosphate-solubilizing bacteria (Fitriatin et al., 2024).

On the basis of the correlation analysis (Table 14), there is a positive correlation between the PSB population of available P in soil (r = 0.896**) and P in plant tissue (r = 0.921**). These results suggest that an increase in the PSB population indicates higher available P in soil and P in plant tissue. Phosphate-solubilizing bacteria convert unavailable P forms into soluble forms, thereby increasing soil P availability (Behera et al., 2014). PSB can convert insoluble phosphate into a form available to plants by secreting organic acids, thereby increasing P uptake (Pande et al., 2020). A sufficiently high PSB concentration promotes the release of soil P from other bonding forms, thereby improving the soil P content (Lovitna et al., 2021) (Figure 5).

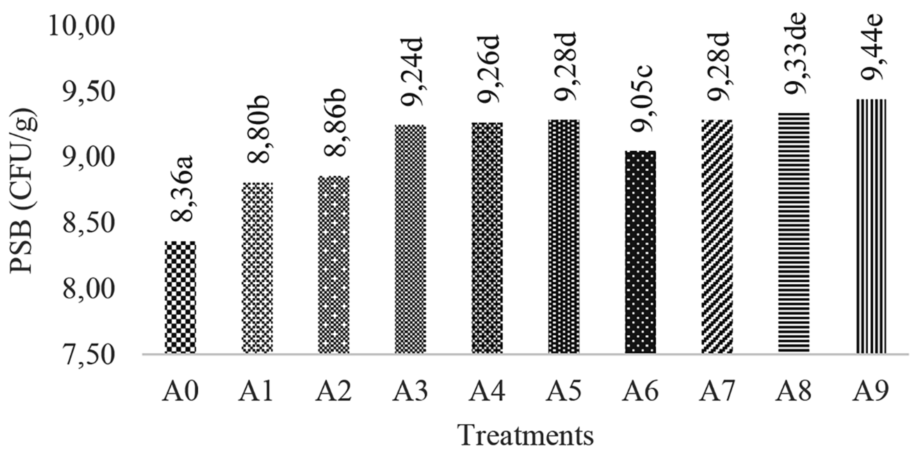

Figure 5. Effect of treatment on phosphate solubilizing bacteria. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

Plant characteristic following application of compost-derived organic matter

P-plant tissue

The combination treatment of compost fertilizer doses (market and mixed) enriched with LOF, KNF, and NPK had a significant effect on P-Plant Tissue (P<0.01). Table 8 showed that the treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) had the highest value at 0.42%, an increase of 133.3% from the control (0.18%). The mixed compost had higher Tissue P results than the market compost application. This was because the types of waste in the mixed compost were more varied, including market, household, and campus waste. The research by Akbari et al. (2022) showed that household waste could increase the P content in compost.

The treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) was significantly different from all other treatments. The addition of NPK to the soil also resulted in the highest plant tissue P levels among the treatments. This was consistent with the research by Oktaviyani et al. (2023), which showed that applying compost and 50% NPK increased plant P absorption by 17.54% compared with the control. The application of Mutiara 16-16-16 NPK fertilizer increased the availability of nitrogen, phosphorus, and potassium to plants, thereby enhancing corn growth and yield (Yani et al., 2024).

On the basis of the correlation analysis (Table 14), plant tissue P was positively correlated with available P (r = 0.882**) and PSB population (r = 0.921**). These results indicated that an increase in plant tissue P reflected the increases in available P in the soil and in the PSB population. In Susilowati's (2023) study, it was shown that an increase in soil P availability due to compost application also indicated an increase in P in plants and P uptake by plants. The application of ½ NPK + 1 organic fertilizer to corn plants showed a positive correlation between available P and P content in Inceptisol (Syamsiyah and Herdiansyah, 2022). Microorganisms reduced P deficiency by influencing plant metabolism and hormonal pathways, for example, by producing or disrupting phytohormones (Lapsansky et al., 2016).

Plant height

The combined application of compost, KNF-based liquid organic fertilizer (LOF), and NPK fertilizer had a highly significant effect (P < 0.01) on sweet corn plant height (Table 9). All treatments increased plant height compared with the control. The 50% NPK + 50% mixed compost + 50% KNF LOF (A7) treatment produced the tallest plants (163 cm), representing a 34.71% increase over the control (121 cm). The treatment A7 differed significantly from most treatments, except A3 (50% NPK + 50% market compost + 50% KNF LOF) and A9 (100% mixed compost + 100% KNF LOF), suggesting that both mixed compost and KNF LOF can partially substitute inorganic fertilizers without compromising vegetative growth. The superior performance of mixed compost treatments compared with market compost is likely related to their more diverse organic inputs, which enhance nutrient availability and soil biological activity. Increasing proportions of organic amendments, particularly compost and KNF LOF, consistently resulted in greater

Table 8. Effect of treatment on P-plant tissue

Treatment	P-Tissue (%)
Control (no fertilizer)	0.18 ± 0.004[a]
100% NPK (comparator)	0.27 ± 0.007[b]
75% NPK + 25% market compost + 25% LOF KNF	0.28 ± 0.013[b]
50% NPK + 50% market compost + 50% LOF KNF	0.39 ± 0.008[f]
25% NPK + 75% market compost + 75% LOF KNF	0.36 ± 0.010[e]
0% NPK + 100% market compost + 100% LOF KNF	0.34 ± 0.007[d]
75% NPK + 25% mixed compost + 25% LOF KNF	0.31 ± 0.008[c]
50% NPK + 50% mixed compost + 50% LOF KNF	0.42 ± 0.014[g]
25% NPK + 75% mixed compost + 75% LOF KNF	0.40 ± 0.005[f]
0% NPK + 100% mixed compost + 100% LOF KNF	0.37 ± 0.003[e]

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at P ≤ 0.05.

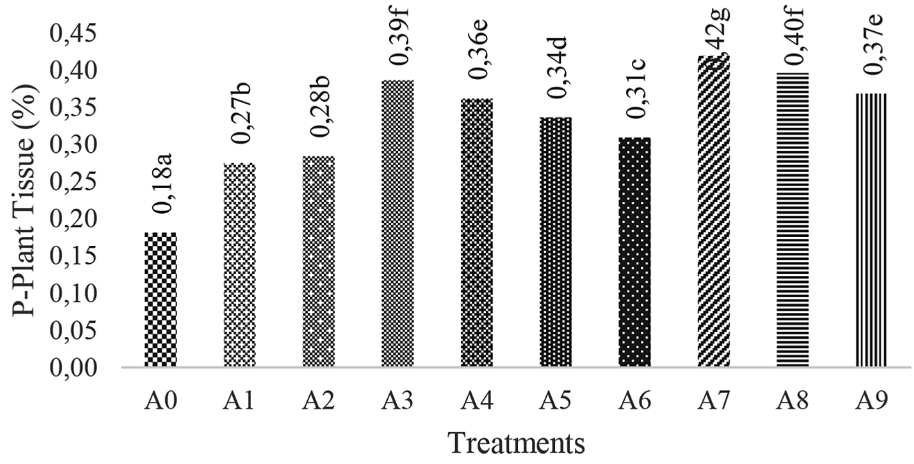

Figure 6. Effect of treatment on p-plant tissue. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF.

plant height than the treatments dominated by NPK fertilizer alone, in line with the reports by Hadiyanti et al. (2022) on the positive effects of organic fertilizers on sweet corn growth. This response is further supported by the evidence that LAB in KNF formulations stimulate root and shoot growth as well as chlorophyll biosynthesis in maize (Gajbhiye et al., 2023).

Correlation analysis (Table 14) revealed a strong positive relationship between plant height and soil-available phosphorus (r = 0.971**), indicating that increased P availability significantly promoted stem elongation and vegetative growth. High soil P availability allows more efficient nutrient uptake and supports meristematic activity, thereby increasing plant height, as reported by Harahap (2019). These results confirm that integrated fertilization using compost, KNF LOF, and reduced NPK rates effectively enhances soil P availability and sweet corn growth.

Number of leaves

The combined application of compost (market and mixed), KNF liquid organic fertilizer (LOF), and NPK significantly affected the number of leaves of sweet corn ($P < 0.01$) (Table 10). The highest mean leaf number was observed in the 100% market compost + 100% KNF LOF treatment (A5), which produced 12.4 leaves plant^{-1}, representing a 34.78% increase over the control (9.2 leaves plant^{-1}). All fertilization treatments

Table 9. Effect of treatment on plant height

Treatments	Plant height (cm)
Control (no fertilizer)	121 ± 0.200^{a}
100% NPK (comparator)	139 ± 1.665^{b}
75% NPK + 25% market compost + 25% LOF KNF	156 ± 1.700^{d}
50% NPK + 50% market compost + 50% LOF KNF	162 ± 0.808^{g}
25% NPK + 75% market compost + 75% LOF KNF	160 ± 1.222^{ef}
0% NPK + 100% market compost + 100% LOF KNF	158 ± 0.305^{d}
75% NPK + 25% mixed compost + 25% LOF KNF	152 ± 0.916^{c}
50% NPK + 50% mixed compost + 50% LOF KNF	163 ± 1.400^{g}
25% NPK + 75% mixed compost + 75% LOF KNF	158 ± 1.171^{e}
0% NPK + 100% mixed compost + 100% LOF KNF	161 ± 1.921^{g}

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

increased leaf number compared with the unfertilized control, indicating that integrated nutrient management improved vegetative growth. The positive response in leaf formation reflects enhanced phosphorus availability in the soil, as phosphorus plays a critical role in cell division, leaf initiation, and photosynthetic development during the vegetative stage.

The 100% market compost + 100% KNF LOF treatment (A5) produced the highest leaf number. This treatment differed significantly from the control and sole NPK application. Still, it was statistically similar to other combined treatments, indicating that the organic-based fertilization was more effective than mineral fertilizer alone in promoting leaf development. These results are consistent with Raksun et al. (2021), who reported that combined organic and NPK fertilization significantly increased leaf number in sweet corn due to improved availability of nitrate, phosphate, and potassium. In contrast, Fau et al. (2024) observed no significant differences in leaf number under combined compost and NPK treatments, attributed to similar nutrient availability across treatments and unfavorable climatic conditions, such as low rainfall and high temperatures (Tomasoa, 2020).

Correlation analysis (Table 14) revealed a strong positive relationship between leaf number and soil available phosphorus ($r = 0.833^{**}$), as well as with plant height and plant dry weight, indicating that phosphorus availability played a key role in leaf formation. Adequate phosphorus supply supports meristematic activity, energy transfer, and photosynthetic capacity, thereby promoting leaf initiation and expansion. Increased leaf number was closely associated with greater plant height and biomass accumulation, confirming that improved phosphorus nutrition through organic amendments contributed to enhanced vegetative growth and overall plant productivity (Pradapa et al., 2024).

Total fresh weight of the plant

The combination of compost (market and mixed) enriched with LOF, KNF, and NPK had a significant effect on sweet corn fresh plant weight ($P < 0.01$). All treatments increased fresh plant weight compared to the control (Table 11). The DMRT analysis indicated that the treatment 50% NPK + 50% mixed compost + 50% LOF KNF (A7) produced the highest fresh plant weight (723.33 g), representing a 79.93% increase over the control (402 g). This treatment differed significantly from all other treatments, except 50% NPK + 50% market compost + 50% LOF KNF (A3).

The higher fresh plant weight observed under mixed compost treatments reflects enhanced vegetative growth and biomass accumulation. Similar improvements in maize fresh biomass following compost application have been widely reported and are associated with improved nutrient availability and vegetative development (Budiyanto, 2021). The superior performance of mixed compost enriched with LOF KNF compared to market compost is consistent with previous studies showing that partial substitution of NPK with organic amendments improves soil fertility, nutrient uptake, and plant growth (Rosariastuti et al., 2025; Nuraini and Aqila, 2020).

Correlation analysis (Table 14) confirmed that fresh plant weight was strongly and positively correlated with dry weight ($r = 0.903^{**}$) and harvest weight ($r = 0.869^{**}$). These relationships

Table 10. Effect of treatment on number of leaves

Treatments	Number of leaves (leaves plant^{-1})
Control (no fertilizer)	9.20 ± 0.200^{a}
100% NPK (comparator)	10.20 ± 0.400^{b}
75% NPK + 25% market compost + 25% LOF KNF	11.33 ± 0.832^{c}
50% NPK + 50% market compost + 50% LOF KNF	12.27 ± 0.416^{c}
25% NPK + 75% market compost + 75% LOF KNF	12.33 ± 0.702^{c}
0% NPK + 100% market compost + 100% LOF KNF	12.40± 0.600^{c}
75% NPK + 25% mixed compost + 25% LOF KNF	11.47 ± 0.305^{c}
50% NPK + 50% mixed compost + 50% LOF KNF	12.00 ± 0.871^{c}
25% NPK + 75% mixed compost + 75% LOF KNF	11.93 ± 0.611^{c}
0% NPK + 100% mixed compost + 100% LOF KNF	12.27 ± 0.416^{c}

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

Table 11. Effect of treatment on fresh weight of plant

Treatments	Fresh weight of plant (g)
Control (no fertilizer)	402.00 ± 16.093[a]
100% NPK (comparator)	555.67 ± 26.102[cd]
75% NPK + 25% market compost + 25% LOF KNF	578.00 ± 35.383[d]
50% NPK + 50% market compost + 50% LOF KNF	710.33 ± 42.524[ef]
25% NPK + 75% market compost + 75% LOF KNF	581.67 ± 30.353[d]
0% NPK + 100% market compost + 100% LOF KNF	507.00 ± 38.431[c]
75% NPK + 25% mixed compost + 25% LOF KNF	497.00 ± 6.557[b]
50% NPK + 50% mixed compost + 50% LOF KNF	723.33 ± 44.523[f]
25% NPK + 75% mixed compost + 75% LOF KNF	659.67 ± 15.695[e]
0% NPK + 100% mixed compost + 100% LOF KNF	571.67 ± 24.440[d]

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

indicate that increased vegetative biomass directly contributed to greater assimilate production and yield formation, reinforcing the role of integrated organic–inorganic fertilization in improving both growth efficiency and productivity of sweet corn. Organic matter inputs enhance soil nutrient dynamics, particularly nitrogen availability, which increases chlorophyll content, stomatal conductance, and photosynthetic assimilation, ultimately promoting plant growth and biomass formation (Mohamed et al., 2018). Improved nutrient availability and physiological performance under integrated fertilization systems, therefore, play a key role in increasing fresh plant biomass.

Total dry weight of the plant

The combination of compost fertilizer doses (market and mixed) enriched with LOF, KNF, and NPK had a highly significant effect on sweet corn plant dry weight ($P < 0.01$). Table 12 showed that plant dry weight increased in all treatments compared to the control. The treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) yielded the highest average of 486.33 grams, an increase of 169.18% from the control (average of 180.67 grams). This treatment differed significantly from all other treatments, except A3 (50% NPK + 50% market compost + 50% LOF KNF).

The application of mixed compost enriched with LOF KNF resulted in higher fresh weight compared to market compost. These results were supported by the research of Rosariastuti et al. (2025), which stated that the application of 50% NPK fertilizer, 50% compost, and 50% LOF from a mixture of household waste, market waste, and leaves increased the phosphorus (P) availability, plant height, and fresh weight of bok choy plants. The application of organic fertilizer also significantly increased corn plant dry weight (Cahyani et al., 2024). In a study by Nurhidayati et al. (2024), a combination of leaf compost, FMA, a PGPR consortium, and a 50% NPK treatment produced the highest dry weight in sweet corn plants. Improved phosphorus availability enhanced root development, ATP synthesis, and meristematic activity, which promoted plant height, leaf formation, biomass accumulation, and yield. Phosphorus plays a critical role in energy transfer, photosynthate transport, and carbohydrate metabolism, thereby directly influencing dry matter production and kernel filling.

On the basis of the correlation analysis (Table 14), it was found that dry plant weight had a positive correlation with available soil phosphorus ($r = 0.700^{**}$), plant phosphorus ($r = 0.898^{**}$), and harvest weight (fresh eras yield) ($r = 0.982^{**}$). These findings indicate that phosphorus availability was a primary driver of biomass accumulation and yield formation in sweet corn. This interpretation is supported by Messiga et al. (2020), who demonstrated that higher P uptake reflects greater soil P availability and leads to increased dry matter accumulation in maize (Figure 7).

Fresh ear yield of sweet corn

The combination treatment of compost fertilizer doses (market and mixed) enriched with LOF, KNF, and NPK had a significant effect on sweet corn cob yield ($P<0.01$). Table 13 showed that yield increased in all treatments compared to the control. The DMRT results showed that the 50% NPK + 50% mixed compost + 50% LOF KNF

Table 12. Effect of treatment on dry weight of plant

Treatments	Dry weight of plant (g)
Control (no fertilizer)	180.67 ± 18.876[a]
100% NPK (comparator)	256.33 ± 3.215[b]
75% NPK + 25% market compost + 25% LOF KNF	281.33 ± 12.423[c]
50% NPK + 50% market compost + 50% LOF KNF	482.00 ± 13.453[g]
25% NPK + 75% market compost + 75% LOF KNF	380.67 ± 13.650[e]
0% NPK + 100% market compost + 100% LOF KNF	304.33 ± 6.027[d]
75% NPK + 25% mixed compost + 25% LOF KNF	262.67 ± 7.571[b]
50% NPK + 50% mixed compost + 50% LOF KNF	486.33 ± 9.018[g]
25% NPK + 75% mixed compost + 75% LOF KNF	416.00 ± 6.557[f]
0% NPK + 100% mixed compost + 100% LOF KNF	314.67 ± 6.506[d]

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

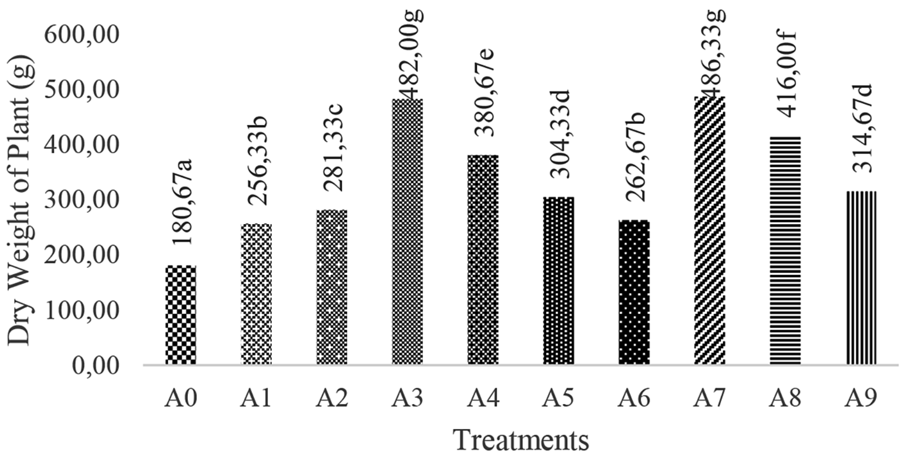

Figure 7. Effect of treatment on dry weight of plant. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

(A7) treatment was higher than the other treatments, with an average weight of 9.2 kg and a productivity of 15 ton/ha, which was an increase of 95.32% from the control (4.71 kg). The more and heavier the corn kernels formed, the heavier the cobs. The application of organic biochar fertilizer increased the soil phosphorus availability (Rosariastuti et al., 2025).

The treatment of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) showed a significant difference compared to all other treatments. The combination of organic fertilizer and NPK was most effective in increasing corn cob weight in Inceptisol, because NPK promoted vegetative growth, while organic fertilizer improved nutrient availability and soil health (Sara and Sofyan, 2024). Mixed compost produced higher yields than commercial compost, and the use of compost and LOF from organic waste achieved sweet corn productivity of up to 22.5 tons/ha (Ramadhan et al., 2022). The combination of household compost and Mutiara NPK also increased cob weight, both with and without husks (Camalia et al., 2024). Enriching compost with calcium-based KNF LOF from eggshells further supported yields, as eggshells contained 95% $CaCO_3$, P, and micronutrients (Darmawan, 2024). Calcium played an essential role in metabolism, cell division, and the formation of roots, stems, fruits, and seeds (Juliutomo et al., 2018).

Correlation analysis (Table 14) confirmed the positive relationships between harvest weight

Table 13. Effect of treatment on fresh ear yield of sweet corn

Treatments	Fresh ear yield (kg)
Control (no fertilizer)	4.71 ± 0.160[a]
100% NPK (comparator)	5.34 ± 0.116[b]
75% NPK + 25% market compost + 25% LOF KNF	6.16 ± 0.123[c]
50% NPK + 50% market compost + 50% LOF KNF	8.71 ± 0.076[h]
25% NPK + 75% market compost + 75% LOF KNF	7.89 ± 0.050[f]
0% NPK + 100% market compost + 100% LOF KNF	6.62 ± 0.044[d]
75% NPK + 25% mixed compost + 25% LOF KNF	6.14 ± 0.140[c]
50% NPK + 50% mixed compost + 50% LOF KNF	9.20 ± 0.035[i]
25% NPK + 75% mixed compost + 75% LOF KNF	8.14 ± 0.131[g]
0% NPK + 100% mixed compost + 100% LOF KNF	6.96 ± 0.116[e]

Note: Values are means ± standard deviation (SD) (n = 3). Different superscript letters within a column indicate significant differences according to DMRT at $P \leq 0.05$.

Table 14. Correlation analysis

Specification		pH	Carbon organic	P-available	PSB	P-tissue	Plant height	Number of leaves	Total fresh weight	Total dry weight	Fresh ear yield
pH	Pearson correlation	1	.809**	.852**	.851**	.848**	.815**	.822**	.841**	.857**	.810**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000
Carbon organic	Pearson correlation	.809**	1	.776**	.887**	.822**	.775**	.864**	.789**	.824**	.718**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000
P-available	Pearson correlation	.852**	.776**	1	.920**	.971**	.901**	.803**	.920**	.926**	.898**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000
PSB	Pearson correlation	.851**	.887**	.920**	1	.921**	.816**	.815**	.846**	.865**	.773**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000
P-tissue	Pearson correlation	.848**	.822**	.971**	.921**	1	.923**	.822**	.959**	.968**	.928**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
Plant height	Pearson correlation	.815**	.775**	.901**	.816**	.923**	1	.839**	.928**	.930**	.925**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000
Number of leaves	Pearson correlation	.822**	.864**	.803**	.815**	.822**	.839**	1	.828**	.857**	.798**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000
Total fresh weight	Pearson correlation	.841**	.789**	.920**	.846**	.959**	.928**	.828**	1	.988**	.982**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000
Total dry weight	Pearson correlation	.857**	.824**	.926**	.865**	.968**	.930**	.857**	.988**	1	.976**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000
Fresh ear yield	Pearson correlation	.810**	.718**	.898**	.773**	.928**	.925**	.798**	.982**	.976**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Note: ** Correlation is significant at the 0.01 level (2-tailed).

(fresh ear yield), soil available P (r=0.737**), and tissue P (r=0.928**), suggesting that P availability and uptake are key yield drivers. This aligns with Khan et al. (2021), who emphasized the role of phosphorus and potassium in seed and fruit formation, which directly determine cob weight. Nanda et al. (2017) also reported significant effects of organic fertilizer on cob weight,

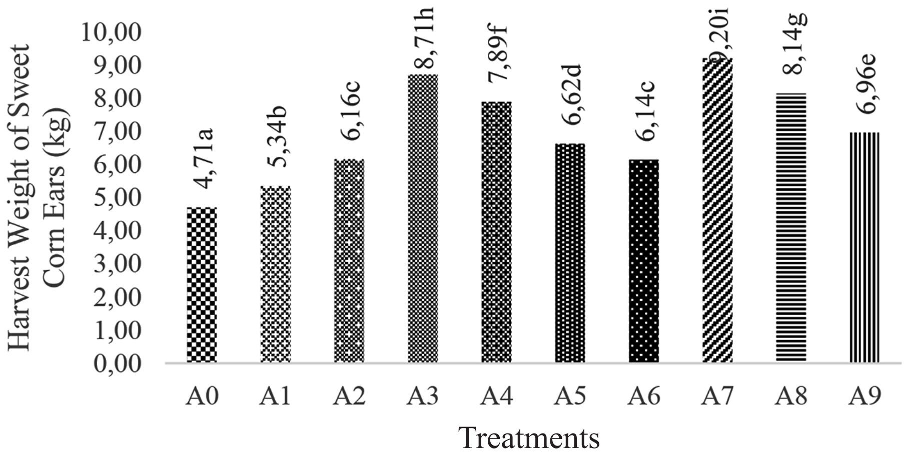

Figure 8. Harvest weight of sweet corn ears. A0: control, A1: 100% NPK, A2: 75% NPK + 25% market compost + 25% LOF KNF, A3: 50% NPK + 50% market compost + 50% LOF KNF, A4: 25% NPK + 75% market compost + 75% LOF KNF, A5: 0% NPK + 100% market compost + 100% LOF KNF, A6: 75% NPK + 25% mixed compost + 25% LOF KNF, A7: 50% NPK + 50% mixed compost + 50% LOF KNF, A8: 25% NPK + 75% mixed compost + 75% LOF KNF, and A9: 0% NPK + 100% mixed compost + 100% LOF KNF

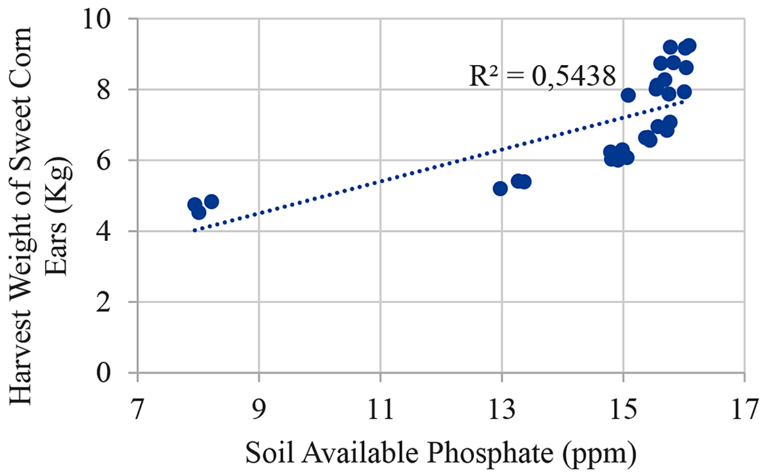

Figure 9. Graph of the relationship between corn cob yield and available phosphorus

as phosphorus is essential for flower and seed development. Long-term findings by Balboa et al. (2024) further highlighted that consistent P availability sustains maize yield across years. In addition, nutrient uptake contributes to carbohydrate, protein, and lipid accumulation in kernels, thereby enhancing cob filling and weight (Arta et al., 2023). Overall, these results confirm that phosphorus availability plays a central role in sweet corn productivity (Figures 8, 9).

CONCLUSIONS

This study demonstrated that the integrated fertilization strategy of 50% NPK + 50% mixed compost + 50% LOF KNF (A7) was the most effective treatment for improving the soil fertility and sweet corn productivity on Inceptisols. The treatment increased soil available P by 97.52% and plant tissue P by 133.3% compared to the control, while also enhancing plant height by 34.71%, plant fresh weight by 79.93%, dry weight by 169.18% and fresh ear yield by 95.32% (15 ton/ha). These results indicate that combining organic amendments with reduced inorganic fertilizer inputs can significantly improve phosphorus availability, optimize crop performance, and reduce the reliance on chemical fertilizers. Moreover, integrating compost and LOF KNF supports improved soil health and nutrient cycling, contributing to a more resilient, sustainable fertilization system. Nevertheless, this study was limited to a single growing season and a single soil type, which may limit the generalizability of the results. Further long-term and multi-site studies are recommended to confirm the consistency and scalability of this fertilization strategy. Overall, this approach shows strong potential for sustainable sweet corn production, while simultaneously promoting organic waste recycling through composting, thereby reducing environmental pollution and supporting environmentally friendly agricultural practices.

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