International Journal of Agronomy and Agricultural Research
ISSN: 2223-7054 (Print); 2225-3610 (Online) | IJAAR |
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RESEARCH PAPER
Vol. 28, Issue: 5, 2026
OPEN ACCESS

Integrated nutrient management in sweet corn (*Zea mays* L.) for production optimization

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DOI: https://dx.doi.org/10.12692/ijaar/28.5.29-37

ARTICLE INFORMATION

RESEARCH PAPER

Vol. 28, Issue: 5, p. 29-37, 2026

Int. J. Agron. Agri. Res.

Liga *et al.*

ACCEPTED: 19 May, **2026**

PUBLISHED: 24 May, **2026**

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ABSTRACT

Abstract

This study evaluated the effects of integrated nutrient management on the growth, ear characteristics, and yield performance of different sweet corn varieties under field conditions in Lakewood, Zamboanga del Sur, Philippines. The experiment was conducted using a 3 × 5 factorial arrangement in a Randomized Complete Block Design (RCBD) with three replications. Three sweet corn varieties namely Macho F1, Purple Corn, and Glutinous Corn were tested under five fertilizer treatments consisting of different combinations of vermicompost, Humus Plus, and complete fertilizer. Growth parameters such as plant height, number of leaves, and stem girth were measured at 30 and 60 days after sowing (DAS), while yield and yield components were evaluated at harvest. Results showed that both variety and fertilizer treatment significantly influenced vegetative growth, ear characteristics, and yield performance. Integrated nutrient management and vermicompost-based treatments generally produced superior plant growth compared with sole organic fertilization. Macho F1 treated with 100% vermicompost recorded the tallest plants, greatest leaf production, and superior stem development during later growth stages. Purple Corn fertilized with 100% complete fertilizer produced the highest yield at 12.69 t/ha and the heaviest ear weight per plot. In contrast, treatments relying solely on Humus Plus generally resulted in lower growth performance and reduced yield, particularly in Glutinous Corn. Ear length and ear circumference were also improved under integrated and vermicompost treatments, while the highest number and weight of marketable ears were observed in Macho F1 under vermicompost and complete fertilizer applications. The findings indicate that balanced nutrient management combining organic and inorganic fertilizers enhances nutrient availability, improves crop growth, and increases sweet corn productivity under field conditions.

Key words: Sweet corn, Integrated nutrient management, Vermicompost, Complete fertilizer, Inorganic fertilizers, *Zea mays*

INTRODUCTION

Sweet corn (*Zea mays* L.) is one of the most widely cultivated and economically important cereal crops in many parts of the world because of its high nutritional value, market demand, and adaptability to diverse agroecological conditions. Unlike field corn, sweet corn is harvested at the immature stage and is valued for its tenderness, sweetness, and palatability. It serves as an important source of carbohydrates, dietary fiber, vitamins, minerals, and antioxidants, making it highly preferred for both fresh consumption and food processing industries. In the Philippines, sweet corn production has become an important livelihood activity among smallholder farmers due to its short production cycle and attractive market value (PSA, 2023).

Despite its economic potential, sweet corn production remains constrained by declining soil fertility, poor nutrient management, increasing production costs, and environmental degradation associated with excessive use of synthetic fertilizers. Continuous cultivation and dependence on inorganic fertilizers often reduce soil organic matter and microbial activity, eventually affecting soil productivity and crop performance (Timsina, 2018). Many upland farming areas in the Philippines are characterized by nutrient-deficient soils, which further limit the productivity of corn-based farming systems. Under such conditions, the challenge is not only to increase yield but also to maintain soil health and long-term sustainability.

Integrated nutrient management (INM) has been widely promoted as a sustainable approach to improving crop productivity while minimizing environmental risks. INM involves the combined use of organic and inorganic nutrient sources to optimize nutrient availability and improve soil quality. Organic fertilizers such as vermicompost contribute to improved soil structure, water-holding capacity, microbial activity, and gradual nutrient release, while inorganic fertilizers provide readily available nutrients required for rapid crop growth (Gao *et al.*, 2024). The integration of these nutrient sources has been reported to enhance nutrient use efficiency, improve crop growth, and sustain soil fertility over time.

Among organic amendments, vermicompost has gained considerable attention because of its beneficial effects on soil biological activity and plant growth. Vermicompost contains essential macro- and micronutrients, beneficial microorganisms, and plant growth-promoting substances that enhance root development and nutrient uptake. Previous studies have shown that vermicompost application can improve vegetative growth, yield, and stress tolerance in maize and other cereal crops (Singh *et al.*, 2024). Likewise, balanced fertilization strategies have been associated with improved physiological performance and better crop resilience under field conditions (Haq and Ahmed, 2023).

Sweet corn varieties also differ in their growth behavior, nutrient requirements, and yield potential. Hybrid varieties often exhibit superior vegetative vigor and productivity, while traditional or specialty corn types may respond differently under varying nutrient conditions. Understanding the interaction between varietal performance and nutrient management is therefore important in identifying suitable production strategies for sustainable sweet corn cultivation.

Although several studies have examined fertilizer management in maize, limited information is available regarding the comparative response of different sweet corn varieties to integrated nutrient management under local field conditions in Lakewood, Zamboanga del Sur. Evaluating the combined effects of organic and inorganic fertilizers on sweet corn growth and yield could provide valuable information for improving productivity and reducing dependence on purely chemical-based fertilization practices.

Hence, this study was conducted to evaluate the effects of integrated nutrient management on the growth and yield performance of different sweet corn varieties. Specifically, the study aimed to determine the influence of organic and inorganic fertilizer combinations on vegetative growth, ear characteristics, and yield performance of sweet corn under field conditions. The findings of this study may contribute to the development of more sustainable and efficient nutrient management strategies for sweet corn production.

MATERIALS AND METHODS

Description of the study area

The study was conducted at Faustino Tambong Garden, Barangay Baking, Lakewood, Zamboanga del Sur, Philippines. The area is characterized by a tropical rainforest climate with consistently warm temperatures, high humidity, and abundant rainfall throughout the year. The soil in the experimental site was classified as mountain soil, which is generally shallow and moderately fertile, making nutrient management essential for crop productivity. The site's hilly to gently sloping terrain also provides suitable drainage conditions for corn cultivation (Fig. 1).

Fig. 1. Map of the location of Faustino Tambong Garden, Barangay Baking, Lakewood, Zamboanga del Sur

Experimental treatments and design

The experiment evaluated the response of three sweet corn varieties to different organic and inorganic fertilizer combinations. The corn varieties included Macho F1, Purple Corn, and Glutinous Corn (Waxy Corn). Five fertilizer treatments were used: F1– 50% vermicompost + 50% complete fertilizer, F2– 50% Humus Plus + 50% complete fertilizer, F3– 100% vermicompost, F4– 100% Humus Plus, and F5– 100% complete fertilizer. Urea (46-0-0) and muriate of potash (0-0-60) were applied uniformly as supplemental fertilizers during crop growth.

The study was arranged in a 3 × 5 factorial experiment using a Randomized Complete Block Design (RCBD) with three replications, resulting in fifteen treatment combinations and forty-five experimental plots. The total experimental area measured 684 m². Each plot measured 3 m × 3 m with 1-m pathways between plots and 1.5-m alleys between blocks. Treatment allocation within each block was randomized to reduce experimental bias.

Land preparation and fertilizer application

The experimental field was cleared manually before plowing and harrowing were carried out twice at one-week intervals to improve soil tilth and suppress weeds. After land preparation, the field was laid out according to the experimental design.

Fertilizer materials for each treatment were weighed separately before planting. Vermicompost was incorporated into the soil one week before sowing, while Humus Plus was applied three days before planting. Complete fertilizer was applied following the recommended treatment rates. At 28 days after sowing (DAS), all plots received side dressing applications of urea and muriate of potash to support vegetative growth and ear development.

Planting and crop management

Planting was done manually by sowing two seeds per hill at a spacing of 25 cm between hills and 70 cm between rows. Thinning was conducted ten days after emergence, leaving one healthy plant per hill.

Irrigation was provided regularly using sprinklers, particularly during dry periods. Hand weeding and shallow cultivation were carried out at 15 and 30 DAS to minimize weed competition and improve soil aeration. Hilling-up was also performed to strengthen plant anchorage. Pest and disease management were conducted as needed using botanical pesticides during light infestations and chemical pesticides when infestations became severe. Diseased plants showing severe symptoms were removed from the field to prevent further spread.

Data collection

Growth parameters

Growth observations were recorded at 30 and 60 DAS using twenty randomly selected sample plants per plot. Plant height was measured from the soil surface to the tip of the uppermost leaf using a meter stick. The number of fully expanded leaves per plant was counted manually, while stem girth was measured approximately 1 inch above the soil surface using a measuring tape.

Yield and yield components

At harvest, data were collected on ear length, ear circumference, number of marketable and non-marketable ears, weight of marketable and non-marketable ears, weight of ears per plot, number of fully developed ears, and computed yield in tons per hectare. Ear length and circumference were measured using a ruler and tape measure, respectively.

Marketable ears were classified based on acceptable ear size, proper kernel filling, and absence of insect or physical damage. Harvesting was performed at approximately 75 DAS when the ears reached market maturity.

Statistical analysis

All quantitative data were subjected to analysis of variance (ANOVA) appropriate for a factorial RCBD. Treatment means showing significant differences were compared using Duncan's Multiple Range Test (DMRT) at the 5% level of significance.

RESULTS AND DISCUSSION

Plant height

Plant height was significantly influenced by both sweet corn variety and fertilizer treatment at 30 and 60 days after sowing (DAS), indicating that nutrient availability and varietal characteristics strongly affected vegetative growth (Fig. 2). At 30 DAS, the tallest plants were observed in Glutinous Corn treated with 50% vermicompost + 50% complete fertilizer (V3F1), which attained a mean height of 93.73 cm. Purple Corn under integrated nutrient treatments also produced comparatively taller plants, while Macho F1 applied with 100% Humus Plus (V1F4) recorded the shortest plants at only 45.93 cm. These findings suggest that integrated nutrient application improved early plant growth by combining the immediate nutrient supply of inorganic fertilizer with the soil-conditioning benefits of vermicompost.

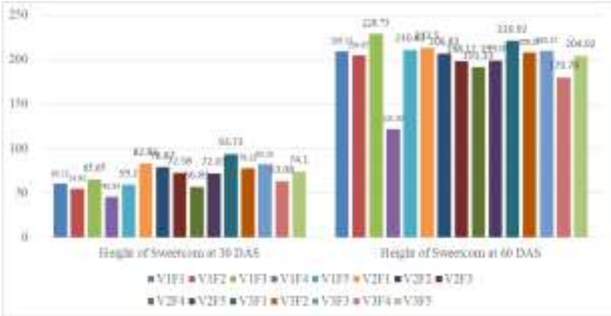

Fig. 2. Average height at 30 and 60 days after sowing (DAS) of sweet corn as affected by thevarieties of corn and ratios of inorganic and organic fertilizers

The enhanced plant height under vermicompost-based treatments may be attributed to improved nutrient mineralization, increased microbial activity, and better soil moisture retention. Vermicompost has been reported to enhance nutrient uptake efficiency and stimulate root development, thereby supporting vigorous vegetative growth in maize crops (Singh *et al.*, 2024). Similarly, Gao *et al.* (2024) emphasized that integrated use of organic and inorganic fertilizers improves nutrient synchronization and promotes sustained crop growth.

At 60 DAS, plant height increased markedly across all treatments. Macho F1 with 100% vermicompost (V1F3) produced the tallest plants with an average height of 228.73 cm, followed by V3F1 and V1F5. In contrast, V1F4 remained the poorest performer at 121.92 cm. The superior performance of vermicompost-based treatments indicates that slow and continuous nutrient release effectively sustained plant development during the active vegetative phase. Timsina (2018) explained that organic nutrient sources improve long-term soil fertility and provide a more stable nutrient supply, which is essential during periods of rapid crop growth. The results also suggest that Macho F1 had stronger nutrient utilization efficiency under balanced fertilization than the other varieties.

Number of Leaves

The number of leaves per plant was significantly affected by both fertilizer treatment and sweet corn variety at 30 and 60 DAS (Fig. 3). At 30 DAS, Purple Corn with 100% complete fertilizer (V2F5) produced the highest number of leaves with an average of 5.48 leaves per plant, followed closely by Macho F1 under V1F5 and V1F2. Conversely, Glutinous Corn under integrated and organic treatments produced fewer leaves, with V3F1 recording the lowest value at 5.00 leaves.

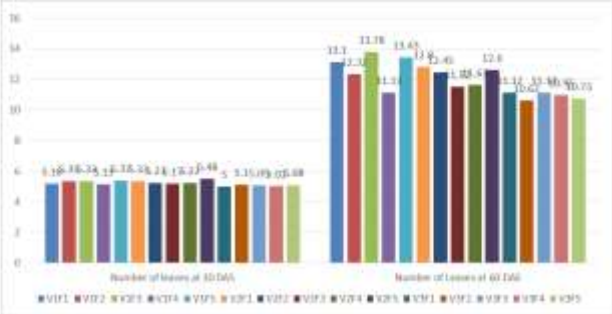

Fig. 3. Average number of leaves at 30 and 60 days after sowing (DAS) of sweet corn as affected by the varieties of corn and ratios of inorganic and organic fertilizers

The higher leaf production under complete fertilizer treatments may be linked to the rapid availability of nitrogen, which is essential for chlorophyll synthesis, cell division, and leaf expansion. Nitrogen deficiency during early growth stages can restrict leaf formation and reduce canopy development. According to Haq and Ahmed (2023), balanced nutrient availability improves physiological activity and vegetative growth in maize, particularly under field stress conditions.

At 60 DAS, the differences among treatments became more pronounced. Macho F1 treated with 100% vermicompost (V1F3) recorded the highest number of leaves with 13.78 leaves per plant, followed by V1F5 and V1F1. In contrast, V3F2 produced the fewest leaves at 10.62. The continued superiority of vermicompost-based treatments indicates that improved soil biological activity and gradual nutrient release supported sustained leaf development during the later vegetative stage. Similar observations were reported by Gao *et al.* (2024), who noted that integrated fertilization enhances photosynthetic efficiency and prolongs vegetative vigor in maize production systems.

Leaf production directly influences light interception and photosynthetic activity. Therefore, treatments that promoted greater leaf development likely contributed to better carbohydrate accumulation and improved reproductive performance later in the season.

Stem girth

Stem girth at both 30 and 60 DAS was significantly influenced by fertilizer treatment and variety (Fig. 4). At 30 DAS, Purple Corn with 100% complete fertilizer (V2F5) produced the thickest stems with an average girth of 4.90 cm. Comparable stem development was also observed in V1F3, V2F1, and V2F2. In contrast, V1F4 recorded the narrowest stem girth at 3.11 cm.

The improved stem thickness observed under integrated and vermicompost treatments may be associated with enhanced nutrient uptake and stronger root establishment. Vermicompost improves soil aeration and stimulates microbial activity, which contributes to improved nutrient absorption and stronger plant structure. Ibrahim *et al.* (2022) reported that improved nutrient availability enhances maize structural development and increases tolerance to environmental stress.

Fig. 4. Average stem girth at 30 DAS and 60 days after sowing (DAS) of corn ear of sweet corn as affected by the varieties of corn and ratios of inorganic and organic fertilizers

At 60 DAS, Macho F1 under 100% complete fertilizer (V1F5) recorded the largest stem girth at 6.93 cm, followed closely by V1F3 and V1F2. Treatments relying solely on Humus Plus consistently produced thinner stems, particularly V1F4 and V3F4. These findings indicate that while organic fertilizers improve soil quality, additional inorganic nutrients are necessary to support the high nutrient demand of sweet corn during active growth stages.

Strong stem development is particularly important in sweet corn because it reduces lodging and supports efficient nutrient translocation during ear formation. Li *et al.* (2024) further explained that integrated fertilization enhances structural resilience and improves physiological stability in maize crops.

Ear length and ear circumference

Ear length and ear circumference are important indicators of sweet corn quality and marketability. Results showed that ear length was significantly affected by variety, whereas fertilizer treatment exerted less influence (Table 1). Macho F1 consistently produced longer ears than the other varieties. The longest ears were recorded in V1F2 with an average length of 23.05 cm, followed by V1F3 at 22.28 cm. In contrast, the shortest ears were obtained from V3F4 at 18.27 cm.

Table 1. Average length of corn ears and circumference of corn ear of sweet corn as affected by inorganic and organic fertilizers

Treatment combination	Length of corn ears (cm)	Circumference of corn ears (cm)
V1F1	21.7 abc	18.88 abc
V1F2	23.05 a	18.78 abc
V1F3	22.28 ab	19.63 a
V1F4	21.83 ab	17.93 bcd
V1F5	21.53 abc	17.87 bcd
V2F1	21.32 abcd	19.18 ab
V2F2	20.73 bcdef	19.12 ab
V2F3	19.62 cdefg	18.38 abcd
V2F4	18.92 fg	17.83 bcd
V2F5	21.17 abcde	18.83 abc
V3F1	19.02 efg	17.82 bcd
V3F2	19.57 cdfg	17.47 cde
V3F3	18.87 fg	17.35 de
V3F4	18.27 g	16.20 e
V3F5	19.32 defg	17.53 cd
F-Test	**	**
CV%	5.72	0.69

Mean having the same letter are not significant different to each other. DMRT: ** Highly Significant, * Significant at 5% level only

The superior ear length observed in Macho F1 reflects its strong genetic potential for reproductive development. Although fertilizer effects were less pronounced statistically, integrated nutrient treatments generally produced longer ears than sole organic applications. This suggests that balanced nutrient availability supported improved cob formation and kernel development. Similar observations were reported by Tiwari *et al.* (2020), who found that varietal characteristics strongly influence ear morphology and market quality in maize.

Ear circumference was significantly affected by both variety and fertilizer treatment. The largest ear circumference was recorded in V1F3 at 19.63 cm, followed by V2F1 and V2F2. In contrast, V3F4 recorded the smallest ear girth at 16.20 cm. Larger ear circumference under vermicompost and integrated treatments may be associated with improved nutrient uptake and enhanced assimilate partitioning during reproductive growth. Vermicompost has been shown to improve soil fertility and support efficient kernel filling by maintaining a balanced nutrient supply throughout crop development (Singh *et al.*, 2024).

Overall, the results indicate that varietal selection strongly influenced ear size, while balanced fertilization further improved reproductive performance and market quality.

Marketable and non-marketable ears

The number and weight of marketable ears varied significantly among treatments (Table 2). The highest number of marketable ears was obtained from V1F3, V1F5, and V2F2, each producing 20 ears per plot. In contrast, V3F4 produced only 10.33 marketable ears, indicating poor performance under sole Humus Plus application.

Similarly, the heaviest marketable ears were recorded in V1F3 at 4.83 kg per plot, followed by V1F5 and V2F5. These findings indicate that both vermicompost and complete fertilizer effectively supported ear filling and commercial quality when combined with responsive varieties. According to Haq and Ahmed (2023), balanced nutrient management improves reproductive efficiency and enhances maize yield quality under field conditions.

The number and weight of non-marketable ears were highest in V3F4, which produced 9.67 non-marketable ears weighing 0.87 kg. Conversely, V1F3, V1F5, and V2F2 recorded zero non-marketable ears. The low occurrence of non-marketable ears under these treatments suggests that improved nutrient balance enhanced plant vigor and minimized poor kernel development, deformities, and pest-related damage.

The poorer performance of Glutinous Corn under organic-only fertilization indicates that this variety was less efficient in utilizing slowly available nutrients. In contrast, Macho F1 and Purple Corn responded more favorably to integrated and inorganic nutrient strategies. Tiwari *et al.* (2020) similarly reported that varietal adaptability and nutrient management strongly influence marketable ear production and postharvest quality in maize.

Fully developed ears, ear weight, and yield

The number of fully developed ears did not differ significantly among treatments, suggesting that ear formation was relatively stable regardless of fertilizer application or variety (Table 3). Most treatments produced between 18.67 and 20 fully developed ears per plot, indicating that this characteristic may be more genetically controlled than environmentally influenced. Smith and Johnson (2020) similarly noted that ear number in maize is generally less responsive to nutrient variation compared with ear weight and yield.

Table 2. Number and weight of marketable and non-marketable ears of sweet corn as affected by organic and inorganic fertilizer treatments

Treatment combination	No. of marketable corn ears	No. of non-marketable corn ears	Weight of marketable corn ears (Kg)	Weight of non-marketable corn ears (Kg)
V1F1	13.67 bc	6.33 ab	3.28 abc	0.70 ab
V1F2	18.67 ab	1.33 bc	4.50 ab	0.33 ab
V1F3	20.00 a	0.00 c	4.83 a	0.00 b
V1F4	17.67 ab	2.33 bc	3.4 abc	0.42 ab
V1F5	20.00 a	0.00 c	4.58 ab	0.00 b
V2F1	19.67 ab	0.33 bc	4.02 ab	0.08 b
V2F2	20.00 a	0.00 c	4.40 ab	0.00 b
V2F3	17.67 ab	2.33 bc	3.53 abc	0.33ab
V2F4	17.33 ab	2.67 bc	2.63 b	0.33 ab
V2F5	19.33 ab	0.67 bc	4.67 ab	0.08 b
V3F1	16.00 abc	4.00 abc	2.82 abc	0.58 ab
V3F2	16.33 ab	3.67 bc	2.82 abc	0.52 ab
V3F3	16.00 abc	4.00 abc	2.63 bc	0.55 ab
V3F4	10.33 c	9.67 a	1.53 c	0.87 a
V3F5	18.33 ab	1.67 bc	2.87 abc	0.20 ab
F-Test	**	**	**	**
CV%	18.14	121.39	28.90	110.58

Mean having the same letter are not significant different to each other. DMRT: ** Highly Significant, * Significant at 5% level only

Table 3. Number of fully developed ears, ear weight per plot, and yield (t ha^{-1}) of sweet corn as influenced by organic and inorganic fertilizers

Treatment combination	No. of full developed corn ears	Weight of corn ears per plot	Yield in Ton/Ha
V1F1	20.00	8.20 bc	9.11 bc
V1F2	20.00	7.45 bc	8.28 bc
V1F3	20.00	7.12 bc	7.91 bc
V1F4	19.33	5.87 c	6.52 c
V1F5	20.00	6.73 bc	7.48 bc
V2F1	20.00	8.73 abc	9.70 abc
V2F2	20.00	9.92 ab	11.02 ab
V2F3	19.33	9.57 ab	10.63 ab
V2F4	19.33	8.77 abc	9.74 abc
V2F5	20.00	11.42 a	12.69 a
V3F1	18.67	7.17 bc	7.96 bc
V3F2	20.00	5.90 c	6.56 c
V3F3	19.00	9.00 abc	10.00 abc
V3F4	19.33	6.33 c	7.04 c
V3F5	19.33	6.08 c	6.76 c
F-Test	ns	**	**
CV%	7.07	21.11	20.25

Mean having the same letter are not significant different to each other. DMRT: ** Highly Significant, * Significant at 5% level only

In contrast, significant differences were observed in ear weight per plot and computed yield per hectare. Purple Corn treated with 100% complete fertilizer (V2F5) produced the heaviest ears per plot at 11.42 kg and achieved the highest yield of 12.69 t/ha. This was followed by V2F2 and V2F3, which also recorded relatively high yields. These results indicate that Purple Corn responded strongly to readily available nutrients supplied through inorganic fertilization.

Meanwhile, V1F4 and V3F2 produced the lowest yields at 6.52 and 6.56 t/ha, respectively. These treatments relied heavily on Humus Plus, which may have released nutrients too slowly to satisfy the nutrient requirements of sweet corn during reproductive growth. Timsina (2018) emphasized that while organic fertilizers improve long-term soil health, they may not always provide sufficient nutrients during periods of peak crop demand unless combined with inorganic sources.

The strong yield performance of Purple Corn under complete fertilizer demonstrates its high nutrient responsiveness, whereas Macho F1 showed more stable performance under integrated nutrient strategies, particularly those involving vermicompost. Singh *et al.* (2024) further reported that integrated nutrient management enhances nutrient use efficiency and supports sustainable maize productivity.

Overall, the findings demonstrate that balanced fertilization, particularly vermicompost-based and integrated nutrient strategies, improved vegetative growth, ear quality, and yield performance in sweet corn. The results further highlight the importance of combining suitable nutrient management practices with high-performing varieties to achieve sustainable and profitable sweet corn production.

Conclusion

The study demonstrated that sweet corn growth, ear development, and yield performance were significantly influenced by both varietal characteristics and nutrient management practices. Among the varieties evaluated, Macho F1 and Purple Corn consistently showed better vegetative growth, ear quality, and yield potential than Glutinous Corn under most fertilizer treatments. Integrated nutrient management, particularly the application of vermicompost either alone or in combination with complete fertilizer, improved plant height, leaf production, stem girth, ear size, and marketable yield. These improvements were likely associated with enhanced nutrient availability, better soil physical condition, and improved biological activity in the rhizosphere.

Macho F1 treated with 100% vermicompost produced vigorous vegetative growth and high-quality ears, while Purple Corn fertilized with 100% complete fertilizer achieved the highest yield of 12.69 t/ha. In contrast, treatments relying heavily on Humus Plus alone generally resulted in weaker plant growth, lower ear quality, and reduced yield performance, particularly in Glutinous Corn. The findings indicate that sole organic fertilization may not adequately satisfy the nutrient demand of sweet corn during critical growth stages.

Overall, the results confirm that balanced fertilization using both organic and inorganic nutrient sources can enhance sweet corn productivity while supporting soil health and crop performance. The combination of high-performing varieties with appropriate nutrient management strategies offers a practical and sustainable approach for improving sweet corn production under field conditions.

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