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Research Article

Effects of mulch-based conservation tillage and nutrient management on sweet corn growth and yield under dryland conditions

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Abstract

The study aimed to examine the effect of mulch-based conservation tillage combined with different nutrient management practices on the growth and yield of sweet corn under dryland conditions. The experiment was arranged in a randomized complete block design with six treatment combinations involving tillage system, organic mulch, organic manure, and inorganic fertilizer input. Each treatment was replicated three times. Growth parameters included plant height, leaf number, and leaf color, while yield components were measured at harvest. The results showed that plant height did not differ significantly among treatments at 21 and 35 days after planting (DAP), but a significant treatment effect was detected at 49 DAP. Leaf number did not differ significantly at 21 DAP but was significantly affected at 35 and 49 DAP. This indicates that, during the initial stage, sweet corn growth was more influenced by seed reserves and plant vigor than by external treatments. However, treatment effects became clearer at the later growth stage. The integrated nutrient management treatment (P5), consisting of 50% inorganic fertilizer combined with organic manure and organic mulch, produced the best vegetative performance, with the highest plant height (178.00±06.82 cm) and leaf number (13.67±0.58 leaves per plant). P5 also produced the longest cobs (18.60±0.50 cm) while maintaining high cob weight (397±54 g) and sweetness (13.91±0.08 °Brix), both statistically comparable to full inorganic fertilization. Although full-dose inorganic fertilizer + conventional tillage treatment (P1) produced the largest cob diameter (7.36±0.11 cm), the results demonstrate that reducing inorganic fertilizer by 50% through integrated nutrient management can maintain yield quality while supporting more sustainable sweet corn production under tropical dryland conditions.

Keywords: crop productivity; dryland farming; integrated nutrient management; organic amendment; soil conservation.

Introduction

Sweet corn (*Zea mays* var. *saccharata* Sturt.) is an important horticultural crop with high economic value in many tropical countries, including Indonesia. Sweet corn farming attracts farmers because it has a relatively short growing period, high adaptability to different agroecological conditions, and strong market demand. Compared to grain corn, sweet corn is preferred by consumers due to its soft texture, fresh taste, and higher sugar content, which are key quality attributes for fresh consumption (Becerra-Sanchez & Taylor, 2021; Erenstein et al., 2022). In Indonesia, the availability of varieties with diverse agronomic characteristics provides opportunities for sweet corn cultivation across a range of growing environments (Heryanto et al., 2022). Recent studies further confirm that sweet corn has strong potential for sustainable production through genetic improvement, improved agronomic practices, and environmentally friendly cultivation systems that maintain yield stability and quality across diverse conditions (Sidahmed et al., 2025). Despite its promising potential, sweet corn production in dryland areas still faces major agronomic constraints.

Dryland farming systems are generally characterized by low soil fertility, limited organic matter content, poor soil structure, and irregular rainfall distribution. These conditions directly affect root development, nutrient uptake efficiency, vegetative growth, and final yield performance. Water scarcity also intensifies physiological stress during critical growth stages, especially tasseling and ear formation, which ultimately reduces productivity. Therefore, crop performance in dryland systems is highly dependent on effective soil and nutrient management strategies that can improve soil moisture retention and nutrient availability (Lal, 2020)

Conventional tillage, also called intensive tillage, is widely adopted by farmers because it loosens the soil, improves aeration, and supports early crop establishment. However, repeated intensive tillage practices can degrade soil structure, accelerate organic matter decomposition, increase surface evaporation, and reduce soil water-holding capacity. These negative impacts become more severe in dryland environments where water availability is limited. Over time, such practices might reduce soil quality and decrease crop productivity.

In response, conservation tillage has been introduced as a more sustainable alternative approach. Conservation tillage minimizes soil disturbance and maintains soil cover, thereby improving soil structure, reducing erosion, and enhancing soil moisture conservation (Li et al., 2020; Zhang et al., 2022; Qin et al., 2024). Several studies have also reported that conservation tillage can improve soil biological activity and stabilize crop yields, although its effectiveness depends on soil type, climate, and residue management practices (Sun et al., 2018; Chen et al., 2023; Kovács et al., 2023).

Mulching represents a key component of conservation-based agricultural systems. Mulch application reduces soil moisture evaporation, moderates soil temperature, suppresses weed growth, and protects the soil surface from erosion. These functions contribute to improved water-use efficiency and better growing conditions for crops in dryland ecosystems.

In maize-based systems, mulch has been reported to enhance soil moisture availability, improve nutrient-use efficiency, and increase yield, particularly under rainfed or water-limited conditions (Hossain et al., 2022; Das et al., 2022; Qin et al., 2024). Meta-analytical evidence also shows that both organic mulch, such as straw, and synthetic mulch, such as plastic film, significantly improve maize productivity by reducing evaporative losses and optimizing the soil microclimate (Yu et al., 2018; Gao et al., 2019; Qin et al., 2021). These effects are particularly important for sweet corn because sufficient soil moisture and nutrient availability strongly influence vegetative growth and cob formation.

In addition to soil and water management, nutrient management plays a critical role in improving sweet corn productivity in dryland systems. Inorganic fertilizers provide readily available nutrients that support rapid plant growth, but excessive use can increase production costs and contribute to environmental degradation. On the other hand, organic amendments such as manure improve soil organic matter content, enhance microbial activity, and release nutrients gradually. Integrated nutrient management, which combines organic and inorganic sources, has been shown to improve nutrient availability, enhance fertilizer-use efficiency, and support long-term soil health (Zhang et al., 2021; Martínez-Dalmau et al., 2021). Recent systematic evidence also indicates that integrating organic amendments and mineral nutrient sources can improve soil fertility, nutrient cycling, and crop productivity while reducing dependence on excessive inorganic fertilizer inputs (Sande et al., 2024). This integrated approach promotes synergistic effects between immediate nutrient supply from inorganic fertilizers and long-term soil improvement from organic inputs, leading to higher and more stable crop productivity (Abid et al., 2020; Bamboriya et al., 2023; Paramesh et al., 2023).

Although the benefits of conservation tillage, mulching, and nutrient management have been widely reported, most studies have evaluated these practices independently. Limited research has examined their combined effects, particularly under tropical dryland conditions where water and nutrient limitations occur simultaneously. This knowledge gap is critical because interactions among soil management practices may significantly influence crop responses under stress environments. Therefore, a more integrated evaluation is required to understand how these practices jointly affect sweet corn performance.

This study aimed to evaluate the effects of mulch-based conservation tillage combined with different nutrient management strategies on the growth and yield of sweet corn under dryland conditions. The study also sought to identify the most effective treatment combination for improving agronomic performance in water-limited environments. Based on previous empirical evidence and theoretical considerations, this study hypothesizes that the integration of mulch-based conservation tillage with balanced nutrient management significantly enhances sweet corn growth and yield compared to conventional tillage and suboptimal nutrient management under dryland conditions.

Materials and methods

Location and experimental period

The study was conducted at the experimental field of Politeknik Negeri Lampung, Rajabasa District, Bandar Lampung City, Lampung Province, Indonesia (5°21′11.9″ S, 105°13′40.9″ E) (Figure 1). The study was carried out from October to December 2024.

Climatic conditions during the study period, including rainfall, air humidity, soil moisture, and soil temperature, were continuously monitored using a Polinela automatic weather station (AWS) (Leakey et al., 2019). To support the classification of the site as a dryland condition, initial field characterization was conducted before planting. The initial chemical properties of the soil before the experimental plots were made were as follows: temperature (°C): 28.9; moisture (%): 25.3; conductivity (μS cm^{-1}): 55.3; pH: 6.2; N (mg kg^{-1}): 2.3; P (mg kg^{-1}): 3.3; K (mg kg^{-1}): 8.3 and fertility (mg kg^{-1}): 30.0.

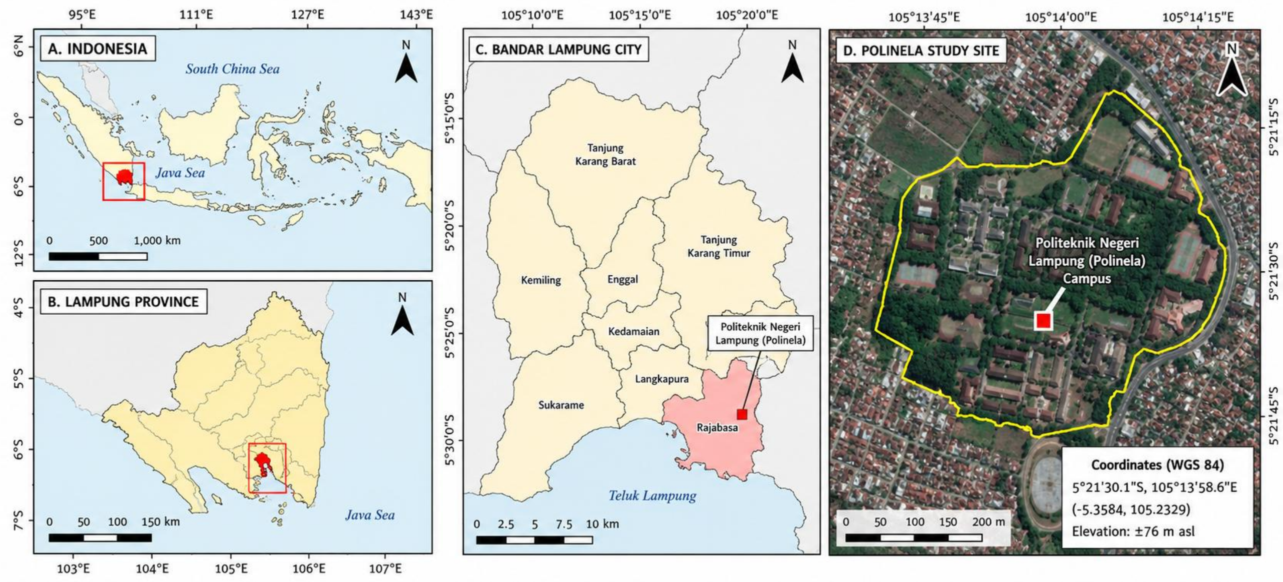

Figure 1. Map of study location

Materials and equipment

The planting material used in this study was sweet corn of Bonanza Now F1. The fertilizers used were inorganic fertilizers, namely urea at 300 kg ha^{-1}, SP-36 at 200 kg ha^{-1}, and KCl at 100 kg ha^{-1}. Organic inputs included well-decomposed cattle manure at 10 t ha^{-1} and organic mulch derived from plant residues applied to the soil surface. Agricultural lime was applied at 1 t ha^{-1} before planting to improve soil pH. Pest control was carried out using an insecticide containing emamectin benzoate to control fall armyworm (*Spodoptera frugiperda*) when pest symptoms were observed in the field.

Experimental design

The experiment was arranged in a randomized complete block design (RCBD) with six agronomic treatment combinations. Each treatment combination consisted of different management practices involving tillage system, inorganic fertilizer dose, organic manure, and organic mulch application. Therefore, the treatments were not interpreted as separate single-factor effects, but as integrated treatment combinations representing different crop management strategies.

The study consisted of six treatment combinations (P1–P6) involving variations of inorganic fertilizer, organic fertilizer, organic mulch, and tillage practices. P1: full-dose inorganic fertilizer + conventional tillage; P2: full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: organic fertilizer + organic mulch + conventional tillage; P4: organic mulch + conventional tillage; P5: half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). These treatments were designed to evaluate the effect of different nutrient management strategies and soil disturbance levels on crop performance and soil conditions.

Each treatment combination was replicated three times, resulting in a total of 18 experimental units. Each experimental unit consisted of a plot measuring 3.5 m × 4 m, with a total area of 14 m^2. The treatment combinations were randomly assigned within each block to minimize the influence of field variability.

Experimental procedures

Agricultural lime at a rate of 1 t ha^{-1} was applied uniformly before planting and incubated for seven days to improve soil pH. Cattle manure at a rate of 10 t ha^{-1} was incorporated according to the assigned treatment combinations to increase soil organic matter and enhance nutrient availability.

Conventional tillage was carried out by plowing and preparing the soil before planting, whereas the no-tillage treatment was managed with minimum soil disturbance (no soil plowing). Organic mulch was applied at a rate of 10 kg per plot according to the treatment and evenly distributed on the soil surface immediately after planting.

Sweet corn was planted at a spacing of 100 cm × 20 cm. Inorganic fertilizers were applied according to the designated treatment rates in two split applications at 7 and 30 days after planting (DAP). Crop maintenance included irrigation, weed control, and pest and disease management according to field conditions. Growth and yield observations were conducted on ten randomly selected plants from the central rows of each plot to minimize border effects.

Observed parameters

The observed parameters consisted of growth variables and yield components. Growth variables included plant height, leaf number, and leaf color. Plant height and leaf number were observed periodically at 21, 35, and 49 days after planting (DAP). Leaf color was assessed at 49 days after planting (DAP) on the middle fully expanded leaf. Leaf color was evaluated using the red, green, and blue (RGB) values captured with the RGB color detector application through a Samsung Galaxy M54 smartphone. The RGB values were used as a supporting indicator of leaf greenness.

Yield components were measured at harvest and included cob weight, cob diameter, cob length, and sweetness level. Cob diameter was measured using a caliper, cob weight was measured using a weighing scale, and sweetness level was measured in °Brix using a refractometer. Harvesting was conducted at approximately 65 days after planting, indicated by the browning of corn silk.

Data analysis

Analysis of variance (ANOVA) was performed at a significant level of α = 0.05.to determine the effect of treatment combinations on sweet corn growth and yield variables. When significant differences were detected, Tukey's honestly significant difference (HSD) test at the 5% level was applied to compare treatment means. Statistical analysis was performed using STAR software.

Results and discussion

Weather conditions during the study

Climatic conditions were monitored, including rainfall, air humidity, soil moisture, and soil temperature (Figure 2). These high-resolution measurements provided detailed temporal variability of field conditions, enabling accurate interpretation of plant–environment interactions under fluctuating weather patterns.

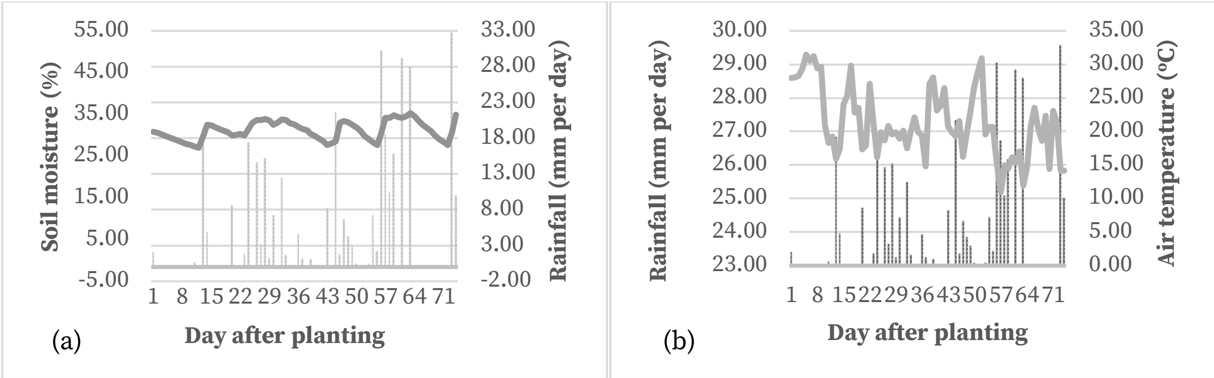

Figure 2. Dynamics of weather conditions during the study period. (a) Relationship between rainfall (mm) and soil moisture (%) across days after planting (DAP).(b) Relationship between rainfall (mm per day) and air temperature (°C) across DAP.

Growth parameters

Plant height was not significantly affected at 21 and 35 DAP but was significantly affected at 49 DAP ($p > 0.05$). At this stage, plant height increased in a relatively similar pattern across all treatments. This result indicates that early plant growth was still mainly influenced by seed reserves, seed vigor, and the genetic potential of the sweet corn variety rather than by differences in tillage, mulch, or fertilizer management. Seed vigor plays an important role in early crop establishment because it supports uniform germination and early seedling growth before the plant becomes highly dependent on external nutrient and water supply (Finch-Savage & Bassel, 2016; Erenstein et al., 2022).

Clearer treatment effects appeared after the crop entered the later vegetative stage. At 49 DAP, P5 produced the greatest plant height, showing no difference from the full inorganic treatment, P1. However, P5 was 16.34% taller than P2, which recorded the lowest plant height, indicating stronger late-stage vegetative growth under the integrated management package (Table 1).

A similar trend continued at week 6, where P5 and P1 remained among the tallest treatments, while P2 consistently showed lower plant height. This pattern suggests that the effect of soil and nutrient management became more visible as plant demand for water and nutrients increased during active vegetative growth.

The better performance of P5 may be explained by the combined effect of reduced inorganic fertilizer, organic manure, and organic mulch. Organic manure likely contributed to improving nutrient supply and soil biological activity, while mulch helped reduce soil water loss and maintain a more stable root-zone environment. Under dryland conditions, this combination is important because plant growth is often limited by irregular water availability and low soil fertility. Previous studies have also reported that conservation tillage and mulch can improve soil moisture storage, soil physical properties, and water-use efficiency, which then support better maize growth (Li et al., 2020; Zhang et al., 2022; Peng et al., 2023).

These findings show that the benefit of mulch-based conservation tillage may not appear immediately after planting. Instead, its effect develops gradually as the plant grows and becomes more dependent on soil moisture and nutrient availability. Therefore, the stronger response observed in week 5 and week 6 is reasonable, because this period represents a stage when maize plants need more water, nutrients, and root support to sustain rapid vegetative development.

Table 1. Plant height of sweet corn under mulch-based conservation tillage systems

Treatment	21 DAP	35 DAP	49 DAP
P1	52.4±0.3a	153.8±4.2a	178.0±8.6a
P2	44.5±2.3a	126.9±18.3a	153.0±11.7c
P3	57.6±2.3a	147.9±6.8a	167.0±2.5ab
P4	56.9±4.7a	144.1±3.0a	161.0±2.1bc
P5	64.6±0.5a	164.7±9.4a	178.0±6.8a
P6	56.5±1.7a	136.2±3.7a	167.0±2.60ab
CV (%)	6.85	7.92	9.47
p-value	0.254	0.096	0.011

Note: P1: Full-dose inorganic fertilizer + conventional tillage; P2: Full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: Organic fertilizer + organic mulch + conventional tillage; P4: Organic mulch + conventional tillage; P5: Half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: Half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). DAP: days after planting. Values are presented as mean ± standard deviation. Means followed by the same letter within a column are not significantly different according to Tukey's HSD test at 0.05 level.

Leaf number was not significantly affected by tillage systems at 21 DAP, but it was significantly affected by tillage systems at 35 and 49 DAP ($p > 0.05$) (Table 2). The findings indicated that early leaf formation was still mostly controlled by internal plant factors, including seed vigor and root system is still developing; the plant had not yet fully responded to differences in soil management or fertilizer input.

Treatment differences began to appear from 35 DAP. P5 showed a larger leaf number than the other treatments, reaching 12.33±0.58 leaves at 35 DAP and increasing to 13.67±0.58 leaves by 49 DAP (Table 2). This result indicates that the combination of 50% inorganic fertilizer, organic manure, and organic mulch provided a more favorable environment for vegetative growth. A higher leaf number is important because leaves are the main photosynthetic organs that produce assimilates needed for biomass accumulation and cob formation.

Table 2. Leaf number of sweet corn under mulch-based conservation tillage systems

Treatment	21 DAP	35 DAP	49 DAP
P1	8.0±0.0a	11.0±0.0ab	12.3±0.5ab
P2	8.3±0.5a	10.3±0.5b	11.6±0.5b
P3	8.3±0.5a	10.6±0.5ab	12.3±0.5ab
P4	8.3±0.5a	10.6±0.5ab	12.0±1.0ab
P5	9.0±0.0a	12.3±0.5a	13.6±0.5a
P6	8.0±1.0a	11.0±1.0ab	12.6±0.5ab
CV (%)	6.12	6.74	6.21
p-value	0.286	0.032	0.018

Note: P1: full-dose inorganic fertilizer + conventional tillage; P2: full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: organic fertilizer + organic mulch + conventional tillage; P4: organic mulch + conventional tillage; P5: half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). DAP: days after planting. Values are presented as mean ± standard deviation. Means followed by the same letter within a column are not significantly different according to Tukey's HSD test at 0.05 level.

The improved leaf number in P5 was likely related to a more balanced nutrient supply. Inorganic fertilizer provides readily available nutrients, while organic manure releases nutrients more gradually and improves soil quality. The presence of mulch may also help maintain soil moisture, allowing roots to absorb nutrients more effectively. Nitrogen availability is especially important for leaf development because it supports chlorophyll formation, cell division, and leaf expansion. Therefore, the integration of organic inputs, reduced inorganic fertilizer, and mulch may have supported more continuous leaf formation during the later vegetative stage. Similar improvements in maize growth and nutrient uptake have been reported when organic fertilizers were integrated with biological and mineral nutrient sources (Gao et al., 2020).

This result is consistent with previous studies showing that mulch-based conservation practices and integrated nutrient management can improve soil conditions and crop performance by increasing water-use efficiency, nutrient availability, and soil biological activity (Das et al., 2022; Zhang et al., 2021; Qin et al., 2024).

Leaf color (RGB)

The treatments did not significantly affect leaf color components based on red, green, and blue values ($p > 0.05$). The RGB values varied among treatments, but the variation did not show a consistent treatment-related pattern. This suggests that leaf color was not strongly influenced by tillage, mulch, or fertilizer management in this study (Table 3).

Table 3. Leaf color (RGB) of sweet corn under mulch-based conservation tillage system

Treatment	Red	Green	Blue
P1	147.3±18.5a	131.2±31.2a	142.5±38.7a
P2	143.7±35.1a	140.6±30.7a	158.9±29.9a
P3	133.0±52.1a	174.2±54.8a	139.8±4.2a
P4	116.3±7.0a	158.6±54.2a	148.9±54.1a
P5	148.7±54.7a	145.2±42.2a	119.6±22.0a
P6	127.3±28.1a	152.6±16.6a	157.8±4.5a
CV (%)	21.84	25.67	18.92
p-value	0.612	0.428	0.537

Note: P1: Full-dose inorganic fertilizer + conventional tillage; P2: Full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: Organic fertilizer + organic mulch + conventional tillage; P4: Organic mulch + conventional tillage; P5: Half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: Half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). Values are presented as mean ± standard deviation. Means followed by the same letter within a column are not significantly different according to Tukey's HSD test at 0.05 level

The absence of significant differences in RGB values may be caused by several factors. Leaf color is influenced not only by nutrient status but also by light intensity, leaf angle, water condition, plant age, and measurement conditions during image capture. Therefore, RGB-based observations may be less sensitive when used alone to detect subtle differences in plant physiological status. Although RGB measurement is useful because it is simple, low-cost, and non-destructive, it may not provide the same level of accuracy as more specific tools such as SPAD meters, NDVI, or multispectral vegetation indices for estimating chlorophyll and nitrogen status.

Leaf color parameters derived from RGB values may provide indirect information related to leaf greenness and plant nutritional status. However, RGB measurements are influenced by illumination conditions, camera characteristics, leaf orientation, and image acquisition procedures; therefore, they should be interpreted cautiously and considered as supportive indicators rather than direct measurements of chlorophyll concentration (Croft et al., 2016; Shi et al., 2021).

In this study, RGB components were not significantly affected by the treatments, indicating that possible differences in leaf greenness were small or not clearly detected using RGB measurement. Compared with SPAD, NDVI, or other vegetation indices, RGB analysis is less sensitive for estimating chlorophyll and nitrogen status (Fu et al., 2020; Zhao et al., 2021).

Yield components

Sweetness or total soluble solids of sweet corn was not significantly affected by the treatments (p > 0.05). This indicates that differences in tillage, mulch application, and fertilizer management did not cause major changes in kernel sweetness. Although slight differences in °Brix values were observed, they were not statistically significant (Table 4). The stable sweetness level may be related to the strong influence of genotype, harvest maturity, and grain-filling conditions. Since sweet corn is harvested at an immature stage, kernels usually still contain high moisture and sugar levels, so treatment differences may not strongly affect sweetness when harvest maturity is similar (Becerra-Sanchez & Taylor, 2021; Mousavi et al., 2025).

In contrast, cob diameter was significantly affected by the treatments (p < 0.05). P1 produced the largest cob diameter, reaching 7.36±0.11 cm, showing that full inorganic fertilization supplied readily available nutrients for cob enlargement. Cob development requires sufficient nutrients, photosynthetic activity, and assimilate transport during the reproductive stage. Therefore, balanced nutrient availability and soil moisture conservation under integrated management may support cob growth effectively (Qin et al., 2021; Cong et al., 2024; Zhang et al., 2024).

Table 4. Yield components of sweet corn under mulch-based conservation tillage systems

Treatment	Sweetness (°Brix)	Cob diameter (cm)	Cob weight (g)	Cob length (cm)
P1	13.92±0.02a	7.36±0.11a	374±41a	17.80±0.7ab
P2	13.78±0.08a	6.25±0.25b	265±57a	16.30±0.5b
P3	13.84±0.16a	7.15±0.26a	406±71a	17.20±1.1ab
P4	13.85±0.14a	6.54±0.57ab	339±21a	17.90±0.8ab
P5	13.91±0.08a	6.76±0.25ab	397±54a	18.60±0.5a
P6	13.88±0.11a	6.63±0.25ab	351±53a	17.80±0.3ab
CV (%)	0.62	4.45	15.82	4.14
p-value	0.239	0.011	0.104	0.046

Note: P1: full-dose inorganic fertilizer + conventional tillage; P2: full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: organic fertilizer + organic mulch + conventional tillage; P4: organic mulch + conventional tillage; P5: half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). Values are presented as mean ± standard deviation. Means followed by the same letter within a column are not significantly different according to Tukey's HSD test 0.05 level.

Cob weight was not significantly affected by the treatments (p > 0.05), although mean differences were observed. P3 produced the highest cob weight, reaching 406±71 g, while P2 showed the lowest value, 265±57 g (Table 4). This non-significant result may be caused by high variability within treatments, especially under dryland conditions where soil moisture and soil fertility are often uneven. Cob weight is influenced by many interacting factors, including cob size, kernel filling, water availability, nutrient uptake, and assimilate distribution. Therefore, the higher cob weight in treatments with organic inputs should be interpreted as a positive tendency rather than a confirmed treatment effect.

In contrast, cob length was significantly affected by the treatments (p < 0.05). P5 produced the longest cobs, reaching 18.60±0.50 cm, while P2 produced the shortest cobs, 16.30±0.50 cm. The better cob length in P5 may be related to improved soil moisture conservation, gradual nutrient release from organic manure, and available nutrients from reduced inorganic fertilizer. These conditions may support photosynthesis and assimilate allocation during cob development (Qin et al., 2021; Cong et al., 2024; Zhang et al., 2024).

Overall, mulch-based conservation tillage and nutrient management had limited effects on early sweet corn growth but became more influential at later stages. Early growth was driven by seed reserves, vigor, and genetic potential, while later growth depended on soil moisture, nutrient availability, and root-zone conditions (Finch-Savage & Bassel, 2016; Erenstein et al., 2022; Zhang et al., 2022; Niu et al., 2023). P5 showed better plant height, leaf number, and cob length, suggesting that organic manure, organic mulch, and reduced inorganic fertilizer created a favorable dryland environment. Mulch may conserve moisture and reduce evaporation, while manure improves soil structure, organic matter, microbial activity, and nutrient release.

These results are in agreement with the supporting soil analysis, which revealed that the integrated application of organic manure, organic mulch, and reduced inorganic fertilizer enhanced soil quality by increasing soil moisture, nutrient availability (N, P, and K), and the overall soil fertility index. Improved soil conditions likely promoted greater nutrient uptake and physiological activity, thereby contributing to the superior vegetative growth observed in sweet corn (Table 5).

Table 5. Effects of treatment on soil properties at the end of the experiment

Treatment	Temperature (°C)	Moisture (%)	Conductivity (µS cm^{-1})	pH	N (mg kg^{-1})	P (mg kg^{-1})	K (mg kg^{-1})	Fertility (mg kg^{-1})
P1	29.40	25.0	111	6.60	5	7	17	61
P2	29.60	56.8	245	6.50	11	16	39	134
P3	30.10	49.5	228	6.20	10	15	36	123
P4	29.90	45.2	205	6.40	8	12	30	101
P5	29.30	60.5	262	6.50	13	18	42	146
P6	28.90	58.2	250	6.40	12	17	40	139

Note: P1: full-dose inorganic fertilizer + conventional tillage; P2: full-dose inorganic fertilizer + organic mulch + conventional tillage; P3: organic fertilizer + organic mulch + conventional tillage; P4: organic mulch + conventional tillage; P5: half-dose inorganic fertilizer + organic fertilizer + organic mulch + conventional tillage; P6: half-dose inorganic fertilizer + organic fertilizer + organic mulch + no-tillage (NT). Soil physicochemical properties were determined at the end of the experiment using a digital soil tester.

Reduced inorganic fertilizer supplies available nutrients during critical stages (Li et al., 2020; Hossain et al., 2022; Das et al., 2022; Qin et al., 2024). However, responses differed among traits. Vegetative traits and cob size were more responsive than cob weight and sweetness, because °Brix is strongly affected by genotype, harvest maturity, and grain filling (Becerra-Sanchez & Taylor, 2021; Mousavi et al., 2025). Therefore, integrated mulch and nutrient management can improve selected traits without reducing quality and support sustainable dryland sweet corn production (Martínez-Dalmau et al., 2021; Paramesh et al., 2023; Abrol et al., 2024).

Conclusions

The treatment combinations did not significantly affect plant height at 21 and 35 DAP or leaf number at 21 DAP. The treatment significantly affected plant height at 49 DAP and leaf number at 35 and 49 DAP, whereas the RGB leaf-color components did not differ significantly among treatments. P5 produced one of the greatest plant heights and the highest mean leaf number at 49 DAP. This treatment produced the highest plant height (178.00±06.82 cm), and the highest leaf number (13.67±0.58 leaves). The integrated nutrient management treatment P5, consisting of 50% inorganic fertilizer combined with organic manure and organic mulch, sustained sweet corn productivity under dryland conditions. P5 produced the longest cobs (18.6±0.5 cm) while maintaining high cob weight (397±54 g) and sweetness (13.91±0.08 °Brix), both statistically comparable to the full inorganic fertilization treatment. Although P1 resulted in the largest cob diameter (7.36±0.11 cm), P5 demonstrated that reducing inorganic fertilizer by 50% can maintain yield quality while supporting a more sustainable sweet corn production system.

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