P-ISSN: 2987-7261
E-ISSN: 2987-7253

Jurnal Riset Ilmu Teknik
Journal homepage: https://jurnaljepip.com/index.php/jurit
Vol. 4, No. 3, pp. 239-248, 2026
DOI: doi.org/10.59976/jurit.399

JURIT

Changes in Soil Total Nitrogen and Available Phosphorus and Sweet Corn Growth and Yield Responses to Cattle Manure and Mycorrhizal Inoculation in Sandy Soil

Dea Enjeli[1]*, Wahyu Astiko[2], Hery Haryanto[3]
Universitas Mataram, Mataram, Indonesia
Corresponding Author: deaenjeli013@gmail.com

ABSTRACT

Sweet corn is an economically valuable crop, but its growth in sandy soil is often limited by poor water retention and low nutrient availability. This study aimed to compare soil total nitrogen and available phosphorus at 42 and 65 days after planting, describe changes in these nutrients, and examine their relationship with mycorrhizal development, plant growth, and yield. The experiment was conducted in Mataram from February to July 2025 using a randomized block design with five treatments and three replications. The treatments were an untreated control (P0), 10 metric tons per hectare of cattle manure (P1), 3 metric tons per hectare of mycorrhizae (P2), 5 metric tons per hectare of cattle manure combined with 1.5 metric tons per hectare of mycorrhizae (P3), and 10 metric tons per hectare of cattle manure combined with 3 metric tons per hectare of mycorrhizae (P4). Measurements included soil nutrients, plant height, leaf number, mycorrhizal spores, root colonization, and wet cob weight. P4 produced the highest soil total nitrogen content, reaching 0.153% at both observation times. Available phosphorus under P4 decreased from 92.30 ppm at 42 days to 46.34 ppm at 65 days, but remained higher than in the other treatments. P4 also produced plants 165.15 cm tall, root colonization of 96.66%, and wet cob weight of 7.40 kg per plot, an increase of 131.25% compared with the control. The number of mycorrhizal spores reached 5,014 per 100 g of soil under P4, compared with 1,961 in the control. Root colonization in the control indicated the presence of naturally occurring mycorrhizae. Overall, P4 performed best among the tested treatments, although its optimality remains unconfirmed. Further studies should test additional doses and compare costs to support practical nutrient management in sandy soils. The results offer useful evidence for designing practical fertilization strategies under sandy soil conditions.

Keywords: *Sweet Corn, Indigenous Mycorrhizae, Total Nitrogen, Available Phosphorus, Cattle Manure, Sandy Soil.*

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Manuscript received 15 September, 2026; revised 27 October, 2026; accepted 04 November, 2026.

INTRODUCTION

Sweet corn (*Zea mays* var. *saccharata*) is a food crop that requires sufficient water and nutrients to support growth and cob formation. However, sweet corn cultivation on sandy soils faces challenges because this soil type has a low capacity to retain water and nutrients. These conditions can cause nutrients to be more easily lost through water runoff, meaning that fertilization may not necessarily provide maximum benefits for the plants. Pradeep and Bell (2025) demonstrated that the management of organic matter and soil physical properties plays a crucial role in reducing nutrient loss in sandy soils. In their experiment, a combination of compost and clay reduced ammonium leaching by about 30% and phosphorus leaching by 30–50% compared to soil without soil amendments. These findings indicate that improving sandy soil requires more than just adding fertilizer; it is also necessary to consider the soil's ability to retain nutrients.

This issue is relevant to agricultural activities in Moncok Karya, Ampenan District, Mataram City, West Nusa Tenggara. [1] reported that the sandy soil in this area has been used for research on sweet corn cultivation using organic fertilizer and mycorrhizae. The study showed that the use of soil conditioners can support plant growth and yield. However, increases in crop yield must be understood in conjunction with nutrient status during growth. Nitrogen (N) is needed for leaf formation and to support plant growth, while phosphorus (P) plays a role in root development and the process of yield formation. Therefore, monitoring total N and available P in the soil is important for understanding nutrient status at various stages of sweet corn growth.

One way to improve sandy soil conditions is to use cattle manure. This material contains nutrients and organic matter that can support microbial activity and improve soil properties. [2], [3] found that the application of manure was associated with increased corn yields through changes in microbial activity and phosphorus availability in the soil. In addition to manure, arbuscular mycorrhizae also play a role in helping plants obtain nutrients. Mycorrhizae are fungi that live in symbiosis with plant roots and form a network of hyphae that can reach parts of the soil beyond the reach of the roots. [4], through a meta-analysis of 187 studies, reported that mycorrhizal inoculation generally increased plant biomass by 47%, nitrogen concentration by 16%, and phosphorus concentration by 27%. However, the extent of the benefits of mycorrhizae varies depending on the plant species, soil conditions, and the research environment.

Recent research also shows that the benefits of mycorrhizae are not always the same under all conditions. [5] found that mycorrhizal inoculation whether alone or in combination with the bacterium *Bacillus subtilis* enhanced the growth and phosphorus uptake of corn plants, particularly when phosphorus availability was limited. However, since this study was conducted in a greenhouse, the results still require validation under field conditions. Meanwhile, the study by [3] placed greater emphasis on the role of manure in soil phosphorus changes, while [4] demonstrated that plant response to mycorrhizae is influenced by various factors. These differing approaches demonstrate that increased plant growth cannot always be explained solely by the amount of fertilizer applied or the level of mycorrhizal colonization. Soil nutrient conditions during the growth period must also be taken into account [6], [7].

At the local level, [8] investigated the effects of cattle manure and indigenous mycorrhizae on the growth, root colonization, and yield of sweet corn in sandy soil. Another study by [1], [9] also reported the use of five treatment packages combining cattle manure and mycorrhizae at the same location. Both publications have provided evidence regarding growth response, crop yield, and mycorrhizal activity. Therefore, testing the combination of these two materials and comparing crop yields can no longer be considered a major innovation. Aspects that still require specific examination in this manuscript are the patterns of total N and available P in the soil at 42 and 65 days after planting (DAP), as well as the correlation of these patterns with mycorrhizal development, growth, and sweet corn yield. This focus can only be considered a new contribution if the data and analysis have not been reported in previous publications [10], [11].

The novelty of this study lies in the analysis of changes in total nitrogen and available phosphorus in the soil at two observation times across five treatment combinations of cattle manure and mycorrhizae, as well as a descriptive discussion of their relationship with plant response. The study not only compared treatments based on plant height or cob weight but also examined differences in soil nutrient conditions during growth. This approach provides additional information regarding which treatments yielded better nutrient conditions and crop yields in the experiment. However, because the study used a one-factor design consisting of five treatment combinations, the results cannot be used to demonstrate a statistical interaction between manure and mycorrhizae or to determine an optimal application rate.

This study aimed to compare total nitrogen (N) and available phosphorus (P) in the soil at 42 and 65 days after sowing (DAS) among five treatment combinations of cattle manure and mycorrhizae; to describe changes in these two nutrient parameters between 42 and 65 DAS under each treatment; and to evaluate the relationship between soil nutrient patterns and mycorrhizal colonization, growth, and sweet corn yield to determine the treatment with the best performance among those tested. The research results are expected to help explain soil nutrient conditions during sweet corn growth and serve as a basis for decision-making in the management of sandy soils using organic fertilizers and mycorrhizae. This information can also serve as a foundation for further research to test more efficient application rates, calculate fertilization costs, and evaluate the success of treatments at different locations and during different growing seasons.

MATERIALS AND METHODS

Time and Location of the Study

The study was conducted from February to July 2025 on farmland owned by Moncok Karya, Pajeruk Karya Village, Ampenan Subdistrict, Mataram City, West Nusa Tenggara. Analyses were performed at the Microbiology Laboratory and the Soil Physics and Chemistry Laboratory, Faculty of Agriculture, Mataram University. The study site consisted of sandy soil.

Experimental Design

The study reportedly used a one-factor randomized block design (RBD) consisting of five treatment packages with three blocks/replicates, resulting in 15 experimental plots measuring 3 × 2 m (6 m^2) [12], [13], [14]. The treatments included P0 (no addition of cattle manure or mycorrhizal inoculum), P1 (10 t/ha of cattle manure), P2 (3 t/ha of mycorrhizal inoculum), P3 (5 t/ha of cattle manure + 1.5 t/ha of mycorrhizal inoculum), and P4 (10 t/ha of cattle manure + 3 t/ha of mycorrhizal inoculum) [15], [16].

Materials and Research Procedures

The materials used were Bonanza F1 sweet corn seeds, cattle manure, and indigenous mycorrhizal inoculum from North Lombok, propagated through pot culture. In a 6 m^2 plot, doses of 5 and 10 t/ha of cow manure are equivalent to 3.0 and 6.0 kg/plot, while doses of 1.5 and 3 t/ha of mycorrhizal inoculum are equivalent to 0.9 and 1.8 kg/plot [17], [18].

Planting was carried out with a spacing of 60 × 40 cm. Manure and inoculum were applied at planting according to the treatment. The inorganic fertilizers reported were 175 kg/ha of urea and 125 kg/ha of Phonska, mathematically equivalent to 105 g and 75 g per 6 m^2 plot, applied in stages 1 and 2 weeks after planting (WAP). Harvesting was reported to occur around 9 weeks after planting (MST), while yield components were recorded at 65 days after planting (HST) [19], [20].

Parameters and Measurements

Plant height (cm) and number of leaves (sheets) were observed at 14, 28, 42, and 56 days after planting (DAP). Fresh and dry biomass of the canopy and roots, as well as the weight of the stubble, were measured at 42 and 65 DAP. If multiple plants were measured within the same plot, the results were first averaged to yield a single observation value per plot [21], [22].

Total soil nitrogen (%) and available phosphorus (ppm) were measured at 42 and 65 HST. Total N was determined according to Page et al. (1982), while available P was analyzed using the Bray–Kurtz I extraction method and spectrophotometry at a wavelength of 693 nm [23], [24].

The number of mycorrhizal spores was determined at 42 and 65 HST using the wet sieving technique (Brundrett et al., 1996). Results are expressed as the number of spores per 100 g of soil. If the total number of spores in a sample of mass m (g) is counted as N, the standardization formula is [25], [26]:

$$S_{100} = \left(\frac{N}{m}\right) \times 100 \quad (1)$$

where S_{100} = spores per 100 g of soil, N = total counted spores, and m = mass of soil analyzed (g).Root colonization by mycorrhizae was measured at 42 and 65 HST using the clearing–staining method [27], [28] and the gridline intersect method [4], [29], [30]. The colonization percentage was calculated using the formula:

$$K(\%) = \left(\frac{n_k}{n_t}\right) \times 100\% \quad (2)$$

where n_k = the number of colonized root intersection points and n_t = the total number of observed root intersection points [5], [31], [32].

Yield components at 65 HST include wet cob weight (BTB; g), dry cob weight (BTK; g), and wet cob weight per plot (BTBP; kg). The BTBP value is the total weight of wet cobs from the harvest area of the plot used. The number of sample plants/ear, the basis for ear weighing, and the effective harvest area must be determined before the yields are converted to metric tons per hectare [33], [34], [35].

RESULTS

Vegetative Growth: Plant Height and Number of Leaves

Average plant height increased across all treatments from 14 to 56 days after planting (DAP). At 14 DAP, plant height ranged from 34.23 cm (P0) to 57.06 cm (P4). At 56 DAP, P0 reached 120.52 cm, while P4 reached 165.15 cm. The difference of 44.63 cm indicates a 37.03% numerical increase in P4 compared to P0. Compared to the single applications of P1 (134.80 cm) and P2 (142.21 cm), the plant height of P4 was 22.51% and 16.13% higher, respectively. P3 reached a height of 150.98 cm; P4 was 9.39% taller than P3.

Table 1. Mean vegetative growth of sweet corn by treatment at 14–56 days after sowing. (a) Plant height (cm)

Treatment	14 DAP	28 DAP	42 DAP	56 DAP
P0	34.23	55.63	112.08	120.52
P1	41.36	63.46	126.30	134.80
P2	45.46	75.46	138.25	142.21
P3	49.13	84.83	140.86	150.98
P4	57.06	93.86	145.95	165.15
5% of net book value reported	4.042	4,444	1,437	2,076

Table 2. Average vegetative growth of sweet corn by treatment at 14–56 days after sowing. (b) Number of leaves (sheets)

Treatment	14 DAP	28 DAP	42 DAP	56 DAP
P0	3.00	5.33	7.66	9.66
P1	4.33	7.33	11.00	14.00
P2	5.33	8.66	12.66	15.00
P3	6.00	10.33	14.66	16.00
P4	6.66	12.33	16.00	18.00
5% of net income reported	0.687	1.140	0.972	0.486

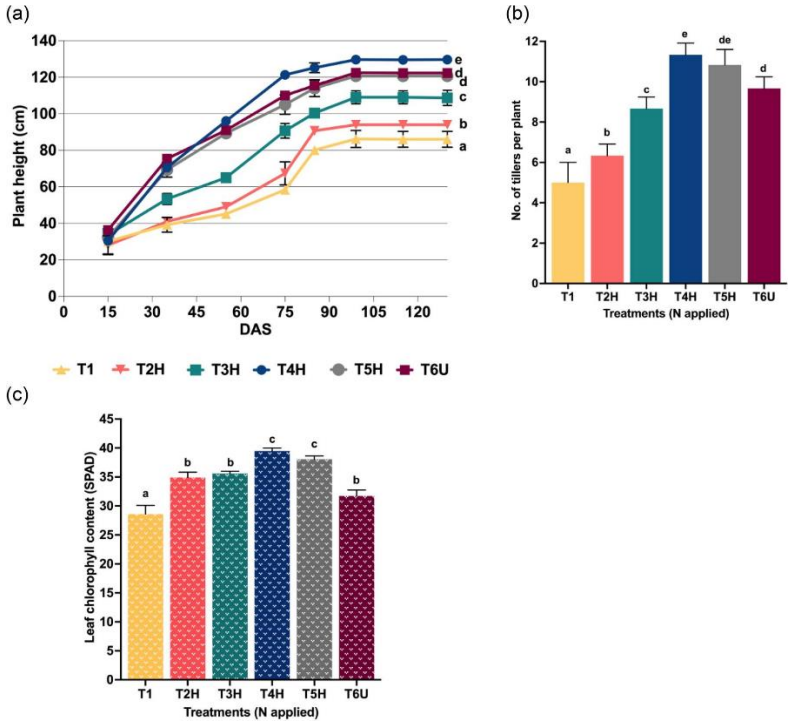


Figure 1. Development of average plant height across the five treatments during 14–56 days after sowing.

Figure 1 shows that P4 had the highest average plant height at every observation time point. The greatest increase in height for most treatments occurred between 28 and 42 days after sowing; in P4, height increased from 93.86 to 145.95 cm (a difference of 52.09 cm). However, the slope of the line only illustrates changes in the mean over time; it does not provide evidence that growth rates differ significantly among treatments. To statistically assess the interaction between treatment and time, a repeated-measures analysis or a mixed-effects model based on plot data is required.

The number of leaves showed a similar trend. At 56 HST, P4 produced 18.00 leaves, which was higher than P3 (16.00), P2 (15.00), P1 (14.00), and P0 (9.66). The increase in P4 compared to the control was 8.34 leaves, or 86.34%. This pattern is consistent with the possibility of increased nutrient availability for vegetative tissue formation. However, since P4 received the second-highest dose of both materials and the design was not factorial, the results did not demonstrate any interaction or synergy effects distinct from the effects of input quantities (Bhantana et al., 2021; Prabawardani et al., 2023).

Biomass and Bunch Weight

In the preliminary results, the wet weight of P4 pods was reported to be 8.46 g per plant and the dry weight 2.61 g per plant, while for P0 the figures were 4.23 g and 1.25 g per plant, respectively. Based on these figures, the wet biomass of P4 was twice that of P0 (a 100.0% increase), while the dry biomass was approximately 108.8% higher. This trend is consistent with plant height and leaf number, but detailed reports on canopy, root, and straw biomass by treatment and at 42 and 65 days after sowing are not available in Tables 1–4. Therefore, the claim that all biomass components differ significantly cannot yet be verified, and no biomass figures or tables that are not present in the source have been added.

Biologically, organic matter and mycorrhizae can support root development and nutrient uptake [36], [37]. However, a direct effect on cation exchange capacity, photosynthesis, and plant nutrient uptake cannot be concluded because these parameters were not reported as measurement results.

Soil Total N and Available P Concentrations

At 42 HST, the average total nitrogen content in the P4 soil was 0.153%, while that of P0 was only 0.053%. This difference of 0.100 percentage points is equivalent to a 188.68% higher value for P4 compared to P0. At the same time, available phosphorus in P4 was 92.30 ppm and in P0 was 24.42 ppm, meaning P4 was 67.88 ppm higher, or 277.97%. P1, P2, and P3 showed values between those of the two treatments, although the magnitude of the response did not always follow a simple sequence based on the amount of manure applied [38], [39].

Table 3. Mean total N and available P in the soil at 42 and 65 days after sowing.

Treatment	Total N at 42 HST (%)	Total N at 65 HST (%)	Available P at 42 HST (ppm)	Available P at 65 HST (ppm)
P0	0.053	0.013	24.42	16.02
P1	0.073	0.020	33.05	17.23
P2	0.086	0.020	40.12	17.66
P3	0.103	0.043	40.91	29.52
P4	0.153	0.153	92.30	46.34
5% of total assets reported	0.0145	0.0126	1.016	0.0854

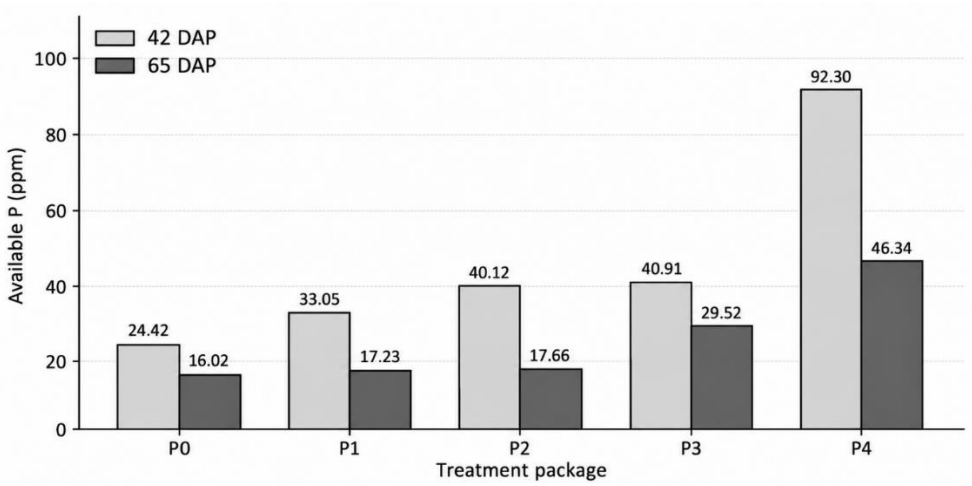


Figure 2. Comparison of mean available phosphorus in soil at 42 and 65 HST for each treatment

Supplementary Figure A shows that available P was lower at 65 HST than at 42 HST for each treatment. The decrease in P4 from 92.30 to 46.34 ppm amounted to 45.96 ppm (49.79%), while P0 decreased from 24.42 to 16.02 ppm (34.40%). Although it decreased, P4 still had the highest available P at 65 HST and exceeded P3 (29.52 ppm), P2 (17.66 ppm), P1 (17.23 ppm), and P0 (16.02 ppm). The decline over time may be related to uptake by plants, changes in the chemical form of P, or nutrient loss; however, these factors were not directly measured and therefore represent only possible explanations, not proven causes (Almeida et al., 2019; Pop Moldovan et al., 2022).

Total N in P0 decreased from 0.053% to 0.013% (a 75.47% decrease), and in P3 it decreased from 0.103% to 0.043%. In contrast, total N in P4 was recorded as exactly 0.153% at 42 and 65 HST. These identical values need to be cross-checked against the lab report to avoid possible transcription errors or rounding. Since soil property results prior to application were not available, this study only supports a comparison of concentrations among treatment packages at the two observation times and is not yet sufficient to measure changes in fertility compared to initial conditions.

Spore Count and Root Colonization by Mycorrhizae

At 42 HST, the spore count ranged from 1,069 spores per 100 g of soil (P0) to 2,325 spores per 100 g of soil (P4). However, P2 reached 2,323 spores only two spores different from P4 while P3 recorded 1,335 spores. These results indicate that the spore count did not increase monotonically in accordance with the treatment sequence. At 65 HST, the spore count for P4 increased to 5,014 per 100 g of soil and exceeded those of P3 (2,980), P2 (2,665), P1 (2,389), and P0 (1,961). Compared to P0, the spore count for P4 at 65 HST was 3,053 spores higher, or 155.69% higher.

Table 4. Mean number of mycorrhizal spores and percentage of root colonization at 42 and 65 HST.

Treatment	Spores at 42 HST (100 g soil)	Spores at 65 HST (100 g soil)	Colonization at 42 HST (%)	Colonization at 65 HST (%)

P0	1,069	1,961	48.33	58.33
P1	1,221	2,389	65.00	67.33
P2	2,323	2,665	77.33	81.33
P3	1,335	2,980	81.66	89.66
P4	2,325	5,014	91.00	96.66
5% of total assets reported	49,126	10,810	5,813	3,315

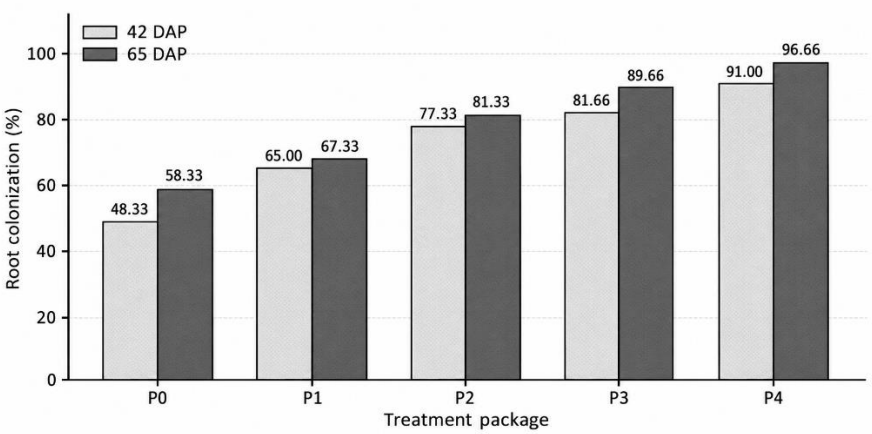


Figure 3. Comparison of root colonization percentages by mycorrhizae at 42 and 65 days after sowing

Supplementary Figure B shows that root colonization increased numerically between 42 and 65 HST across all treatment groups. The P4 value increased from 91.00% to 96.66% (an increase of 5.66 percentage points), while P0 increased from 48.33% to 58.33% (an increase of 10.00 percentage points). At 65 HST, the difference in colonization between P4 and P0 reached 38.33 percentage points. The relatively high colonization rate in the control group, despite the absence of additional inoculum, suggests the possible presence of natural arbuscular mycorrhizal fungi in the soil. The total colonization method cannot distinguish between the inoculated mycorrhizae and the natural population (Alayya & Prasetya, 2022).

Spore count and root colonization do not always correlate. For example, at 42 HST, P2 had a higher spore count than P3 (2,323 vs. 1,335), whereas P2's colonization rate was actually lower (77.33% vs. 81.66%). This indicates that spore abundance is not a direct proxy for the extent of root colonization. Researchers should also reevaluate the significance letter groups, as the difference between P2 and P4 at 42 HST was only two spores—smaller than the BNJ value of 49.126 listed in the manuscript.

Yield Components and Comparison of Sweet Corn Productivity

Treatment P4 had the highest average yield components among the five treatments tested, namely wet cob weight (BTB) of 265.00 g, dry cob weight (BTK) of 94.66 g, and wet cob weight per plot (BTBP) of 7.40 kg. In the P0 treatment, these three values were 109.66 g, 34.66 g, and 3.20 kg, respectively. Thus, P4 produced a numerical increase in BTB of 141.66%, in BTK of 173.11%, and in BTBP of 131.25% compared to the control. P3 ranked second for BTBP (6.13 kg per plot), followed by P2 (5.40 kg) and P1 (4.43 kg).

Table 5. Mean sweet corn yield components at 65 days after planting.

Treatment	BTB (g)	BTK (g)	BTBP (kg/plot)
P0	109.66	34.66	3.20
P1	134.33	44.33	4.43
P2	165.33	56.33	5.40
P3	185.33	68.33	6.13
P4	265.00	94.66	7.40
5% of net income reported	15,135	1,835	0.459

Table 5 shows a gradual increase in the average plot yield from P0 to P4. The difference between P4 and the control was 4.20 kg per plot. Compared to P1, P2, and P3, the yield of P4 was higher by approximately 67.04%, 37.04%, and 20.72%, respectively. If the effective harvest area is indeed 6 m^2, the value for P4 is equivalent to 12.33 metric tons/ha

and that for P0 is equivalent to 5.33 metric tons/ha. This conversion is merely an arithmetic illustration because the effective harvest area, the number of ears harvested, and the basis for weighing the fresh weight have not been fully reported; therefore, productivity in metric tons/ha is not considered a primary result.

The high P4 value does not prove that a dose of 10 t/ha of cattle manure and 3 t/ha of mycorrhizal material is the optimal dose. P4 used doses of each material that were twice those of P3, while the BTBP yield was only 20.72% higher than that of P3. This yield difference must be weighed against the additional costs of materials, transportation, application, and the selling price of corn cobs before making technical recommendations to farmers. Furthermore, a comparison of the five treatment packages in a one-factor RAK cannot distinguish between the effects of the total dose and the biological interaction between the two inputs.

DISCUSSION

The results of the study showed that the application of cattle manure and mycorrhizae in treatment package P4 yielded the highest growth and yield of sweet corn compared to the other four treatments. At 56 days after planting (DAP), the plant height in P4 reached 165.15 cm, while the control (P0) was only 120.52 cm. This means that plant height in the P4 treatment increased by 37.03% compared to the control. The number of leaves also increased from 9.66 in the P0 treatment to 18.00 in the P4 treatment. This increase indicates that the P4 treatment package provided conditions more conducive to plant growth during the experiment.

These findings are consistent with those of [4], who conducted a meta-analysis of 187 studies on the benefits of mycorrhizae. They reported that the application of mycorrhizae generally increased plant biomass by 47%, nitrogen concentration by 16%, and phosphorus concentration by 27%. The study explains that mycorrhizae help roots obtain nutrients from parts of the soil that are difficult for roots to reach directly. The results of this study point in a similar direction: treatment with mycorrhizae and manure at the tested doses resulted in higher growth. However, these results cannot yet prove that mycorrhizae were the sole cause of the growth increase, as the P4 treatment also received the highest dose of manure.

Further support comes from [3], who found that the use of manure can increase the availability of phosphorus forms that are more readily utilized by plants through changes in microbial activity and soil conditions. In this study, the P4 treatment yielded a wet cob weight of 265.00 g per plant and 7.40 kg per plot, while the control yielded 109.66 g per plant and 3.20 kg per plot. The fresh ear weight per plot in the P4 treatment was 131.25% higher than that of the control. The consistency of these results with those of [3] reinforces the hypothesis that the management of nutrients and organic matter plays a crucial role in supporting corn yields. However, the yield increase in this study cannot be directly attributed to the activity of specific microorganisms because those parameters were not measured.

These results expand upon the discussion by [3] , who explained that manure can influence changes in the forms of phosphorus in the soil through biological processes. Sun et al. investigated changes in phosphorus forms and microbial activity, whereas this study compared soil available phosphorus at two growth stages of sweet corn. The decrease in available phosphorus from 42 to 65 HST may be related to nutrient uptake by plants, changes in phosphorus forms in the soil, or nutrient loss. However, the primary cause cannot yet be determined because this study did not measure the amount of phosphorus absorbed by plants, leached phosphorus, or changes in phosphorus forms separately.

This explanation is also consistent with the findings of [2], who found that sandy soils have limited capacity to retain water and nutrients. In their experiment, the use of compost combined with clay material reduced the loss of ammonium and phosphorus through leaching. These findings help explain why nutrient levels in sandy soils are likely to change during the growing season. However, Pradeep and Bell's study was conducted using soil columns, not corn plants in the field. Therefore, their results are used to explain possible mechanisms of nutrient loss, not to confirm that the decrease in available phosphorus in this study was caused by leaching.

Although this study showed that P4 produced the highest growth, colonization, and yield, other studies have not always found the same benefits of mycorrhizal inoculation. [32], through a two-season field experiment on corn plants, found that the application of Rhizophagus intraradices inoculum had no significant effect on soil spore counts, root colonization rates, or corn grain yield based on their main analysis. The study also found that soils with sufficiently high natural mycorrhizal populations may show only a minor response to additional inoculation.

This difference is important because current research findings indicate that P4 exhibits the highest levels of root colonization and ear yield. However, the two studies employed different soil conditions, inoculum formulations, fertilization treatments, and crop types. The study by Buzo et al. (2023) used grain corn and a specific inoculant, whereas this study used sweet corn and an indigenous mycorrhizal inoculant. Therefore, the two sets of results should not be considered mutually exclusive. Rather, the differences indicate that the benefits of the inoculant may vary depending on experimental conditions.

Other differing findings were reported by [13] through a meta-analysis of 85 studies. They found that organic materials such as compost and manure generally support mycorrhizal colonization, but under certain conditions can actually reduce it. Such reductions were observed, among other things, in soils with a pH close to neutral and under certain soil density conditions. These findings differ from current research trends, which show the highest colonization rates in treatment plots with the highest doses of manure and mycorrhizae [40].

PRACTICAL IMPLICATIONS AND LIMITATIONS

The results of the study showed that P4 was the treatment package with the highest yield among the five treatments tested. However, P4 also used the highest doses of manure and mycorrhizae, namely 10 t/ha of cattle manure and 3 t/ha of mycorrhizal inoculant. Compared to P3, which used half the dose of both materials, P4 increased the wet cob weight per plot from 6.13 kg to 7.40 kg, or by 20.72%. This means that using more materials results in a higher yield, but does not necessarily provide greater economic benefits.

For farmers, the choice of treatment should not be based solely on crop yield, but also on the costs of purchasing materials, transportation, application, and labor. Particularly for mycorrhizal inoculants applied at a rate of 3 t/ha, it is important to clarify whether this rate refers to the total weight of the carrier material or the weight of the active inoculum. This information is essential to ensure that the treatment can be fairly compared with other fertilization technologies.

This study also has several limitations. The experiment was conducted at a single location and during a single growing season, with three replicates as described in the manuscript. In addition, the study used five treatment combinations in a one-factor design, so it could not yet prove the existence of a statistical interaction between cattle manure and mycorrhizae. Complete data on soil nutrient levels before treatment, plant nutrient uptake, production costs, and statistical test results from each replicate are not yet available. Therefore, P4 can only be identified as the treatment with the highest performance under the experimental conditions, not as the optimal dose applicable to all sandy soils.

CONCLUSION

This study shows that the application of cattle manure and mycorrhizae produces different effects on soil nutrient content, mycorrhizal development, growth, and sweet corn yield in sandy soil. Of the five treatments tested, P4 (10 metric tons/ha of cattle manure and 3 metric tons/ha of mycorrhizae) produced the highest total N and available P values in the soil at 42 and 65 days after planting (DAP). In the P4 treatment, total N remained at 0.153%, while available P decreased from 92.30 ppm to 46.34 ppm. A decrease in available P also occurred in the other treatments, indicating changes in phosphorus availability during plant growth. The P4 treatment also yielded the highest root colonization rate of 96.66%, a plant height of 165.15 cm, and a wet cob weight of 7.40 kg per plot—a 131.25% increase compared to the control. These results indicate that treatments with higher soil nutrient levels and mycorrhizal colonization also exhibited better growth and yield in descriptive terms. Thus, P4 was the best-performing treatment among the five tested, but it cannot yet be declared the optimal dose. Further research at different locations and during different seasons, as well as cost analysis, is needed to determine the most effective and economical dose for farmers.

ACKNOWLEDGMENTS

The authors would like to thank the Faculty of Agriculture, University of Mataram, for its support and for providing the laboratory facilities used in this research.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest related to this research.

DATA AVAILABILITY STATEMENT

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

FUNDING

This research received no external funding.

DECLARATION OF AI TOOL USAGE

No AI tools were used for field data collection.

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