

INTEGRATED EFFECT OF VERMICOMPOST AND CHEMICAL FERTILIZER ON STEVIA (*STEVIA REBAUDIANA*) PRODUCTION

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DOI: <https://doi.org/10.51193/IJAER.2026.12308>

Received: 22 April 2026 / Accepted: 05 May 2026 / Published: 25 May 2026

ABSTRACT

Stevia is a natural, non-caloric sweetener that has recently emerged as a promising sugar substitute for diabetes management in the Philippines. However, research on sustainable methods for producing stevia that balance high yields with soil health is lacking. The study conducted at Western Mindanao State University aimed to find out the effects of vermicompost and inorganic fertilizer (IF) on the agronomic performance of stevia. A randomized complete block design with seven treatments replicated three times was used. The treatments (T) were as follows: T1 (Control – no fertilizer applied); T2–50% Recommended Rate (RR) of vermicompost; T3-50% RR of IF; T4-100% RR of vermicompost; T5-100% RR of IF; T6-50% RR vermicompost and 50% RR IF; and T7-100% RR vermicompost and 100% RR IF. The study revealed that the application of 100% vermicompost and 100% IF (T7) resulted in the highest herbage yield (8.53 t ha⁻¹) and DMY (1.29 t ha⁻¹). Treatment 6 (50% vermicompost + 50% IF) was most successful at producing the highest percent leaf (92.98%) and lateral branching (15) while maintaining yields statistically similar to entirely IF. Therefore, to achieve the best balance of yield, leaf quality, and sustainable practices for stevia production, an integrated nutrient management approach (specifically a 50/50 mix of vermicompost and IF) is the recommended strategy.

Keywords: Stevia, organic fertilizer, inorganic fertilizer, vermicompost, integrated nutrients management

INTRODUCTION

The high prevalence of diabetes in the Philippines (14.7%), estimated to affect 4.7 million adults, or 7.5% of adults aged 20 to 79 years (IDF, 2024), underscores the importance of efficient non-

nutritive sweeteners. Stevia, a nonnutritive sweetener derived from the leaves of the *Stevia rebaudiana* plant, offers an alternative option.

Stevia has a high-intensity sweet taste due to the presence of non-caloric steviol glycosides (SGs) such as stevioside and rebaudioside A, which are approximately 100–300 times sweeter than sucrose but have no caloric value (Peteliuk et al. 2021). The pure extract is especially low in glycemic index (Orellana-Paucar, 2023). This key characteristic suggests that stevia, unlike sugar, does not cause a spike in blood glucose levels and is therefore the most recommended replacement for patients with diabetes mellitus and other associated metabolic conditions (Peteliuk et al. 2021).

The economic contribution of chemical fertilizers to increasing farm productivity sustains the world's need to feed its growing population. Chemical fertilizers have so far dominated the economic landscape, increasing farm productivity so that food is available for all people across the world, on the one hand, while farmers benefit on the other. They are a source of vital, rich nutrients (in this case, nitrogen, phosphorus, and potassium), so the yield per unit of land is substantially higher. This phenomenon is a driving force behind the success of the Green Revolution in feeding a growing human population (Tagkas et al. 2024). However, selecting these fertilizers is burdened with high environmental costs and a complicated path to economic profit (Mahankale 2023). The most immediate consequence is eutrophication, due to the overflow of nutrients dumped into surface waters (mainly rivers and lakes along the coast); we speak of nitrates and phosphates. This process leads to algal blooms, which, in turn, consume all the oxygen as they decompose, creating aquatic dead zones (ECO GARDENER 2024). Agriculture is estimated to be responsible for up to 78% of the global marine and freshwater eutrophication load (Ritchie et al., 2024). Likewise, the continual use of fertilizers is also related to numerous environmental problems, such as loss of biodiversity, heavy metal absorption, toxic effects on beneficial microorganisms, and the emission of greenhouse gases like N_2O and SO_2 , which contribute to global warming (Mahankale 2023).

There is currently growing interest among farmers in using organic fertilizers to replace or complement inorganic chemical inputs (Lestari 2014). Despite this heightened interest, organic systems have an average yield gap of 19-25% compared to conventional production. This space is highly variable and can decrease under optimal conditions or programmed control (Boschiero et al. 2023). Also, lower yields are caused by the organic additions (for example, manure and compost) inasmuch as they have a less rich and more complex nutrient content, so that these substances cannot be completely dissolved. These are not the nutrients found in chemical fertilizers that are immediately available to plants. Although these forms are not directly accessible to plants, they must be converted into inorganic forms via a biological process called mineralization (Mohamed et al., 2023a).

Integrated Nutrient Management (INM) is one of the most widely practiced and promising strategies to achieve higher production potential without harming soil health and the environment (PIDS, 2025). INM is the simultaneous use of both organic and chemical fertilizers, which have often been associated with increased crop yields and enhanced soil sustainability compared to the use of individual fertilizer types (Mohamed et al. 2023b; Song et al. 2024). In spite of the established advantages of INM, there is little research demonstrating its use in the growth of stevia (*Stevia rebaudiana*) crops. Although some related studies have been carried out, like Kumar et al. (2024) with vermicompost, farmyard manure, and NPK; Yang et al. (2013) for chemical and compost blends; and Cholid et al. (2025), who evaluated biofertilizer, organic, and nitrogen treatments for improved plant growth, there is little research available with a combination of both the inorganic and organic sources, especially for stevia. In this context, the present work evaluates the effects of organic (vermicompost) and inorganic fertilizer on the agronomic performance of stevia.

MATERIALS AND METHOD

The study was conducted at the College of Agriculture, Western Mindanao State University (WMSU). The Stevia (*Stevia rebaudiana* Bertoni) mother plants, which served as the experimental materials, were purchased from a private nursery in Cagayan de Oro City and subsequently identified by the Center of Biodiversity Research and Extension at Mindanao University, Musuan, Bukidnon. The vermicast was purchased from an agricultural store and analyzed for its nitrogen, phosphorus, and potassium content at the Soils Laboratory of the Department of Agriculture, Region IX, Zamboanga City. Soil from the study area was also analyzed for its nutrient content and texture. Other necessary research inputs, such as fertilizer and tools, were procured from local agricultural supply stores.

The study was carried out in a randomized complete block design with seven treatments, replicated three times. The following treatments were T1 (no fertilizer applied); T2 – 50% Recommended Rate (RR) of Vermicompost; T3 – 50% RR of Inorganic Fertilizer; T4 – 100% RR Organic Fertilizer; T5 – 100% RR Inorganic Fertilizer; T6 – 50% RR Organic and 50% RR Inorganic Fertilizers; and T7 – 100% RR Vermicompost and 100% RR Chemical Fertilizer. The amount of vermicast was calculated based on its nitrogen content.

Planting materials were obtained from the mother plant (Figure 1-a), which was stem-cut and grown in the seedling tray for 2 weeks prior to transplanting (Figure 1-b). Only those seedlings that had the same size, height, vigor, and number of leaves were transplanted in the field at a 20 x 20 cm distance. Figure 2 illustrates the established field study.



Figure 1: Stevia mother plant (a) and stevia seedling (b) were used in the study.



Figure 2: The field study was assessed 90 days after transplanting (DAT).

The amount of chemical and vermicompost fertilizers was based on the analysis and the soil's recommended nitrogen need, since phosphorus was found to be sufficient. Calculation of chemical fertilizer, organic fertilizer, vermicompost dry weight, and dry weight yield was performed using formulas 1-3 below.

Formula 1: Amount of Chemical Fertilizer ((Galo, 2025).

$$\text{Amount of Chemical Fertilizer} = \frac{\text{RR of fertilizer (Kg ha}^{-1}\text{)}}{\text{Analysis of chemical fertilizer}} \times 100$$

Where: Recommended Rate (RR - amount of fertilizer needed)
Fertilizer Grade = Percent of nutrient in the fertilizer

Example:

Given: RR on Chemical Fertilizer = 60 kg N ha⁻¹

Fertilizer: Ammonium Sulfate [(NH₄)₂ SO₄.] 21% N

$$\text{Amount of Chemical Fertilizer} = \frac{60 \text{ kg N ha}^{-1}}{0.21 \text{ in decimal}} = 286 \text{ kg (NH}_4\text{)}_2 \text{ SO}_4 \text{ ha}^{-1}$$

Formula 2: Dry weight of vermicast ((Galo, 2025).

Amount of vermicast in dry weight bases

Given: N Content of Vermicast: 1.58%

MC of Vermicast: 29.75%

Recommended Rate (RR) required by stevia: 60 kg N ha⁻¹

Therefore:

Require dry wight of vermicompost =

$$\begin{aligned} & (\text{RR required by stevia}) / \text{N Content of Vermicast} \\ & = (60 \text{ kg N ha}^{-1}) / (0.0158 \text{ in decimal}) \\ & = 3,797.47 \text{ kg} \end{aligned}$$

Dry matter fraction = (100% - MC) = 100% - 29.75% = 70.25 Dry Matter

$$\begin{aligned} \text{Total vermicompost amount} &= \frac{\text{Require dry wight of vermicompost}}{\text{Dry matter fraction}} = \\ &= \frac{3,797.47 \text{ kg ha}^{-1}}{0.7025 \text{ in decimal}} = 5,405.65 \text{ kg ha}^{-1} \end{aligned}$$

Formula 3: Dry matter yield (DMY) of stevia was calculated (Galo, 2025)

$$\text{DMY} = \frac{W}{GA}$$

Where: W - dry weight of either rice
GA - ground area occupied by

The exact amounts of chemical and vermicompost fertilizers were applied according to the treatment plan. The vermicompost was mixed into the soil during the last harrowing. The chemical fertilizer was applied in a split dose: the first at transplanting and the second 30 days after transplanting (DAT).

The first harvest was performed after 4 months of transplanting, when the plant reached its maximum stevioside concentration in its leaves. Thereafter, harvests were conducted biweekly for the next three months. During each harvest, young shoots and the twigs that bore leaves were carefully cut. The fresh herbage was harvested from each experimental plot and weighed on site.

To process the samples, the fresh herbage was air-dried for 4 days by spreading it on a flat, bare surface to promote rapid, even drying. Then, the entire dried herbage was weighed and subsequently threshed to sort leaves from twigs. Each separated dried leaf and twig was weighed separately. Finally, to obtain samples for analysis, the dried leaves were ground in a common blender.

The agronomic data collected include fresh herbage yield, dry matter yield (DMY), number of primary branches, leaf dry weight, and percent leaf. Stevia shoots were weighed once before and once after air drying at each harvest. Fresh herbage was air-dried for 2 days, and the combined weight of twigs with herbage comprised DMY. The recently dried leaves were removed from the twigs, and the dry weight of the leaves was measured to estimate the percent leaf. We counted the primary branches that arise directly from the plant's stem.

Data were analyzed by analysis of variance (ANOVA) to assess the effects of respective treatments. When the ANOVA results indicated a significant difference between the treatment means, post hoc mean comparisons (least significant difference) were conducted to confirm the difference.

RESULTS

Edaphic and Abiotic of Soil and Vermicompost in the Experimental Area

The study was conducted in the experimental area of Western Mindanao State University, College of Agriculture. The soil texture was clay loam. Soil analysis revealed a low organic matter content of 0.5% and a slightly alkaline pH of 7.38. The soil exhibited high levels of available phosphorus (46.80 ppm) and sufficient potassium (30.00 ppm), which suggests that supplementary P and K fertilization is not required. During the experiment, the average daily rainfall was 10.7 mm, the maximum range of solar radiation was 23.04-25.10 MJ m⁻² min⁻¹, and the air temperature ranged from 29 to 34 °C. On the other hand, the vermicompost used in the study had a moisture content of 29.75% and contained 1.58% total nitrogen (N). Its phosphorus content, expressed as P₂O₅, was 0.70% (considered negligible), and its potassium content, expressed as K₂O, was 1.04%.

Herbage Yield

The results (Table 1) for dry matter yield of stevia leaves are confirmed by the comparison with herbage, which revealed a dramatic positive relationship with both organic and inorganic fertilization. Herbage yields across all fertilized treatments show a significant increase compared to the control (T1), with the lowest value at 5.18 t ha⁻¹. The maximum numerical yield was recorded in T7 (100% Organic + 100% Inorganic) at 8.53 t ha⁻¹, followed by T5 (100% Inorganic Fertilizer) at 8.34 t ha⁻¹, which are statistically similar. These findings reveal that a high-rate nutrient addition, particularly in inorganic forms or in combination, is necessary to achieve the highest fresh biomass yield of stevia.

Understanding the categories of fertilizer, inorganic sources were more productive than organic sources when applied at equal rates. At a 50% rate, inorganic (T3) with an average tuber yield of 6.48 t ha⁻¹ was significantly higher than organic treatment (T2), which had a mean herbage yield of 5.78 t ha⁻¹ and at the 100% rate, inorganic treatment (T5) with an average fresh yield of 8.34 t ha⁻¹ was also significantly higher than the organic component (T4), which showed a mean herbage yield of 7.46 t ha⁻¹. This indicates that the rapid supply of primary nutrients (NPK) in mineral fertilizers promotes quicker vegetative growth and herbage accumulation in stevia than slower processes such as organic matter decomposition.

The combination approach was also quite effective, as T6 (50% Organic + 50% Inorganic) yielded results (8.13 t ha⁻¹) similar to those of T5. The T6 produced lower output than the T5 and T7, but showed a significant difference compared with the T4 (100% organic). This is to say that the effectiveness of Integrated Nutrient Management (INM), which combines quick-release inorganic nutrients with slow-release organic nutrients, has enabled growers to achieve equal crop yields

with a full dose of inorganic fertilizer and may represent an improvement in long-term soil management.

Dry Matter Yield

Results show that applying both organic and inorganic fertilizers greatly increases the dry matter yield (DMY) of stevia compared with the unfertilized control (Table 1). All other treatments showed a progressive increase in biomass with increasing nutrient levels, with the control treatment (T1) producing the lowest yield at 0.89 t ha⁻¹. The superiority of INM is a noteworthy trend; T7, which combined 100% organic and 100% inorganic fertilizers, produced the highest yield of 1.29 t ha⁻¹. This treatment was statistically superior to all other groups, indicating that stevia grows best in an environment that combines the immediate availability of nutrients from inorganic sources with the benefit of organic matter for soil conditioning.

Inorganic fertilizers consistently outperformed organic fertilizers when applied at equal rates. For example, the inorganic treatment (T3) produced 1.08 t ha⁻¹ at the 50% application rate, which was significantly higher than the organic treatment (T2) at 0.99 t ha⁻¹. At the 100% fertilizer rate, the difference narrowed; inorganic fertilizer (T5) had an insignificant advantage over T4. Additionally, the data emphasize the synergistic efficiency of combining nutrient sources by showing that applying half-rates of both fertilizers (T 6 at 1.23 t ha⁻¹) is more effective than applying a full dose of either fertilizer alone.

Table 1: Herbage and dry matter yield of stevia (*Stevia rebaudiana* Bertoni) as influenced by varying rates of vermicompost and inorganic fertilizers.

KINDS AND RATES OF FERTILIZERS	Herbage Yield (t ha ⁻¹)	Dry Matter Yield (t ha ⁻¹)
T1 - Control	5.18f	0.89f
T2 – 50% Organic Fertilizer	5.78e	0.99e
T3 – 50% Inorganic Fertilizer	6.48d	1.08dc
T4 – 100 % Organic Fertilizer	7.46c	1.18c
T5 – 100% Inorganic Fertilizer	8.34ab	1.20bc
T6 – 50% Organic Fertilizer + 50% Inorganic Fertilizer	8.13b	1.23b
T7 – 100% Organic Fertilizer + 100% Inorganic Fertilizer	8.53a	1.29a
LSD (0.05)	0.3554	0.0497
% CV	2.80	2.480

Primary Branches

The data in Table 2 shows that the primary branches of stevia plants responded well and significantly to the application of organic and inorganic fertilizers. The control group (T1) produced the fewest primary branches (8.33), while INM treatments showed the largest increments. T7 (100% Organic + 100% Inorganic) at 15.33 and T6 (50% Organic + 50% Inorganic) at 15.00 had the highest number of branches. Even a moderately differentiated application of each fertilizer type is able to promote lateral growth very efficiently, essentially identical to the best treatments, as these two treatments are above all others statistically (designated by the “a” suffix), but they do not significantly differ from one another.

The results also indicate that when used in isolation, inorganic fertilizers are generally more effective than organic fertilizers in promoting branching. The 100% inorganic treatment (T5) produced 12.67 branches, compared with the 100% organic treatment (T4), which produced 11.00 branches. In the same way, at 50% inorganic fertilizer (T3 9.33) was better than organic fertilizer (T2 9.00), and T2 did not statistically differ from the control. This is likely due to the immediate availability of inorganic nitrogen and other macronutrients, which encourage lateral bud growth and the formation of meristematic tissue.

Moreover, the data highlights the potential joint effects of mixing nutrient sources. T6, which used the least total nutrients among all treatments, produced substantially more branches (15.33) but did not differ significantly from T5 (15.00). This suggests that organic matter partly enhances soil physical properties and microbial activity, thereby increasing the efficiency of inorganic nutrients.

Table 2: Number of primary branches, dry weight of leaves, and percent leaves of stevia (*Stevia rebaudiana* Bertoni) as influenced by varying rates of vermicompost and inorganic fertilizers.

KINDS AND RATES OF FERTLIZERS	Number of Primary Branches	Dry Weight of Leaves (t ha ⁻¹)	Percentage Leaf
T1 - Control	8.33c	0.80f	87.25b
T2 – 50% Organic Fertilizer	9.00c	0.92e	88.89b
T3 – 50% Inorganic Fertilizer	9.33bc	1.01d	87.37b
T4 – 100 % Organic Fertilizer	11.00b	1.07c	90.21ab
T5 – 100% Inorganic Fertilizer	12.67b	1.05c	88.98b
T6 – 50% Organic Fertilizer + 50% Inorganic Fertilizer	15.00a	1.09b	92.98a
T7 – 100% Organic Fertilizer + 100% Inorganic Fertilizer	15.33a	1.13a	92.95a

LSD (0.05)	1.197	0.035	2.90
% CV	5.84	1.95	1.81

Dry Weight of Stevia Leaves

Table 2 also shows that the dry weight of stevia leaves is significantly affected by the type of fertilizer applied. T1 (control) recorded the lowest leaf dry weight of 0.80 t ha⁻¹, which clearly shows the significance of nutrients to realize higher leaf biomass. With increased fertilizer levels, dry leaf weight also increased, and the maximum yield was observed in T7 (100% organic + 100% inorganic), at 1.13 t ha⁻¹. This treatment was significantly higher than all other treatments, further demonstrating that the combined use of organic and inorganic sources can create the most beneficial environment for leaf development in stevia.

Interestingly, the results indicate that at lower application rates, inorganic fertilizer has a competitive advantage over organic fertilizer. At 50% level of fertilizer application, the yield is significantly higher (1.01 t ha⁻¹) under inorganic treatment (T3) than (0.92 t ha⁻¹) under organic fertilizer treatment (T2). However, at a 100% application rate, organic (T4 at 1.07 t ha⁻¹) and inorganic fertilizers (T5) yielded statistically the same. This implies that inorganics induce earlier leaf weight start-up, while organics can yield just as good results when applied at full rates, potentially due to better soil health and a higher nutrient release rate.

It also brought out the benefits of integrated nutrient management. The combined application of 50% organic and 50% inorganic fertilizers (T6) yielded a leaf dry weight of 1.09 t ha⁻¹, significantly higher than the full application of either fertilizer type alone.

Proportion of Stevia Leaves

Table 2 indicates that while stevia is predominantly composed of foliage, integrated fertilization enhances the leaf-to-biomass ratio. The lowest leaf percentages, ranging from 87.25% to 88.89%, were observed in the control treatment (T1) and in treatments with 50% fertilizer application (T2 and T3). Low fertilization exerted minimal influence on the allocation of resources between leaf and twig production, as these values were statistically similar. In contrast, the application of both organic and inorganic fertilizers led to a significant increase in leaf percentage.

The highest leaf percentages were recorded in T6 (50% organic + 50% inorganic) at 92.98% and in T7 (100% organic + 100% inorganic) at 92.95%. These two treatments were statistically identical and outperformed all other treatments. This finding suggests that combining organic and inorganic nutrients achieves an optimal leaf-to-stem ratio even at a 50% combined application rate (T6). In contrast, the leaf proportion in the 100% inorganic fertilizer treatment (T5) was 88.98%, which was significantly lower than in the mixed treatments. This result indicates that inorganic

nitrogen alone may promote stem elongation more strongly than balanced organic-inorganic combinations.

DISCUSSIONS

The newly harvested fresh weight of stevia is probably equivalent to the weight of nutrients spent. In the work of Kaur et al. (2025), it was found that the highest fresh leaf yield of stevia with 100% inorganic fertilizer plus a 2-ton ha⁻¹ vermicompost application was 1.965 t ha⁻¹, at a very much higher level than the nil vermicompost control (0.91t ha⁻¹). This is way below the application of 5.405 t ha⁻¹ (T4) of vermicompost, which yielded 7.46 t ha⁻¹ in the study. Shivani et al. (2024) mentioned that 100% recommended rate of vermicompost gave a fresh foliage yield and dry weight of 9.167-ton ha⁻¹ and 3.177-ton ha⁻¹ respectively while highest total fresh leaf yield and total dry foliage yield were recorded in flora under the treatment combination of 100 % recommended rate of vermicompost +100% inorganic fertilizer which was found to be 16,949-ton ha⁻¹ and 6.355-ton ha⁻¹, respectively. Paramesh et al. (2023) found that an integrated fertilization (e.g., T6 and T7) produces greater leaf to stem ratios than those obtained with pure inorganic fertilization. He explained that organic matter provides micronutrients, which also serve as triggers of photosynthesis; this explains the high yield differences observed in the given data. Singh et al. (2022) reported strong responsiveness of stevia to balanced NPK applications, with the addition of organic amendments that help retain soil moisture and prevent nutrient loss, both of which are vital for leaf-dominant crops. This can be attributed to the fact that VC and inorganic fertilizers increased soil nutrient availability, thereby enabling better nutrient absorption and uptake by the plant. Negi et al. (2022) concluded that optimum maintenance of essential elements within the shoot system enhances canopy photosynthesis by increasing both the size of the functional leaf area and the assimilation rate per unit area.

Büyük et al. (2022) observed that inorganic fertilizers have rapid nutrient release, which hastens leaf expansion, whereas organic amendments, such as vermicompost, improve soil physical properties, leading to greater dry matter accumulation over time. Similarly, Benhmimou et al. (2022) found that high doses of organic compost, such as T7, greatly enhance dry matter yield and soil fertility, noting that organic matter buffers plants against lipid quality reductions induced by excess synthetic nitrogen.

Furthermore, Kumar et al. (2024) observed that the maximum crop growth and nutrient uptake of stevia were obtained with the combined application of farmyard manure and a balanced NPK schedule. This interaction occurs because organic matter promotes the transformation of soil nutrients that are not available to the plant into readily available forms, a process that is intriguing in the context of leaf dry matter.

The higher branching under integrated nutrient management is consistent with Shivani's (2024) findings that the efficient number of primary branches in the canopy architecture of stevia was quite sensitive to the combined effects of vermicompost and NPK. They noticed that organic manures supplied essential micronutrients, which serve as cofactors for the enzymatic pathways involved in cell division and lateral shoot induction. This is also consistent with Sharma et al.'s (2022) treatment (Treatment = Vermicompost (VC) + Half Recommended Dose of Nitrogen (N₂) + Biofertilizer), which showed the highest plant height (66.17 cm), number of branches per plant (24.87), and leaves per plant (284.68).

Similarly, Büyük et al. (2022) state that during the initial shoot elongation, a "nitrogen flush" occurs with mineral fertilizers, whereas with organic fertilizers, nutrient leaching is reduced and the rhizosphere is more stable. Such stability favors more active meristems in the plant, which culminates in enhanced branching as seen in combined treatments such as T6 and T7. Furthermore, Kaur et al. (2025) showed that increased branching is the most important morphological trait for identifying high-yield potential in stevia because more branches lead to a larger total leaf area and thus a higher photosynthetic capacity.

The findings of this study align with other research, such as Sharma et al. (2022), particularly in T6, where the addition of VC containing 50% N (inorganic) resulted in the highest dry leaf yield. According to Baghat et al. (2022), vermicompost at 1.5 t ha⁻¹ combined with 30 kg N resulted in a dry leaf yield of 432 kg ha⁻¹, with higher yields across additional yield parameters. According to Büyük et al. (2022), adding organic manure to nitrogen fertilizer is ideal for reducing growth and increasing the maximum dry weight of stevia leaves. They noted that organic fertilizers improve soil moisture-holding capacity, an important factor for maintaining physiological processes that drive leaf biomass production.

Kaur et al. (2025) also noted that integrated nutrient management (INM) not only increases leaf weight but also improves the leaf-to-stem ratio. The dry weight of the leaves is the most important factor in determining the final yield of sweeteners. Büyük et al. (2022) conducted a separate study that found that organic amendments provide micronutrients, such as iron and zinc, that are often missing from conventional NPK fertilizers. These micronutrients are necessary for making chlorophyll, which is what causes dry matter to build up in the leaves.

Several recent studies support the idea that integrated fertilization can increase leaf percentage. Zaman et al. (2018) stated that mixing 7.5 t ha⁻¹ of vermicompost with 50% to 75% of the recommended chemical fertilizer dose yields the best results. Leaf yield increases by more than 500% compared to unfertilized controls. Using 100% RDF with 2 t ha⁻¹ vermicompost C made a big difference in both fresh and dry leaf yield. This indicates that a blend of inorganic fertilizers and organic amendments may constitute a sustainable strategy to enhance Stevia productivity

(Calapardo and Manigo 2024). Büyük et al. (2022) found that stevia plants treated with a mix of organic manure and NPK had a better leaf-to-stem ratio than those treated only with chemical fertilizers. They said that organic matter helps control how much nitrogen the plant takes in, preventing "luxury uptake," which occurs when the plant grows tall and stalky but lacks enough leaves.

Kumar et al. (2024) also pointed out that the leaf percentage is an important number for stevia producers because the steviol glycosides are mostly found in the leaf laminae. Their research found that integrated nutrient management (INM) improves a plant's photosynthetic capacity, leading to wider, heavier leaves. This is consistent with the findings in T6 and T7, where integrating nutrient sources optimized the vegetative yield of the plant's most economically significant component.

CONCLUSION

The fertilizer types that affect the growth and production rate of stevia (*Stevia rebaudiana*) include both organic and inorganic. The soil texture was clay loam, and sufficient phosphorus and potassium were indicated by the first test; however, nitrogen and soil conditioning were still very much needed, as evidenced by the low organic matter content (0.5%). On the other hand, for immediate herbage and dry-matter yield, inorganic fertilizers alone performed better than organic fertilizers because they made major nutrients more readily available. On the other hand, Integrated Nutrient Management (INM) showed the highest performance across all factors, including herbage yield, dry matter yield, primary branching, and leaf percentage. Thus, when considering the best mean value, the use of 100% organic and 100% inorganic fertilizers proved more favorable, with T7 once again showing an advantage; however, T6 displayed the ideal solution in terms of the effective protocol. Not only did T6 yield like that of full inorganic treatments, but it also significantly improved (92.98%) the leaf-to-stem ratio and lateral branching as well. This cooperative effect means that inorganic sourcing provides plants with the "quick-release" nutrients needed for fast growth, while the organic component improves soil physical properties and the microbial environment. Thus, the best sustainable practice for improving stevia biomass with leaf quality without disturbing soil health is to propose an integrated approach.

Acknowledgements: The author would like to express their most heartfelt gratitude and appreciation for Dr. Luella Cabahug's expertise, assistance, and guidance in the preparation and conduct of this study.

Author's Contribution: This study was solely the authors' work. The author alone is responsible for all aspects of the study, including its conceptualization, methodology, data collection, analysis, writing, and manuscript preparation.

Competing interests: This study herein is the author's idea and not duplicative of any research.
Conflict of interest: The authors declare no conflicts of interest.

Author Contributions: (Clearly define the contribution for each author in the article prior to submitting!

Data Availability: The data will be available upon a reasonable request to the corresponding author.

Ethical Considerations: The study did not involve human or animal subjects; therefore, institutional review board approval was not required. But I have followed all the precautions to ensure that this research is ethical.

Funding Source: none

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