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Research Article

Application of Various Dosages of Solid Organic Fertilizer Derived from Corn Waste on The Growth and Yield of Water Spinach (*Ipomoea reptans* Poir)

Aplikasi Berbagai Dosis Pupuk Organik Padat Limbah Jagung terhadap Pertumbuhan dan Produksi Tanaman Kangkung Darat (*Ipomoea reptans* Poir)

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Abstract: The use of solid organic fertilizers from corn waste is one of the alternatives to support sustainable agricultural systems and reduce dependence on inorganic fertilizers. This study aims to determine the application of various doses of solid organic fertilizer from corn waste to the growth and production of land kale plants and determine the dose of fertilizer that provides the best response. The study was carried out using a Group Random Design with five treatments of solid organic fertilizer doses, namely 0, 4, 6, 8, 10 kg/plot. Each combination was repeated three times so that 15 experimental units were obtained. The parameters observed included plant height, number of leaves, and fresh weight of the plant. The data was analyzed using multiple fingerprint analysis and continued with the LSD test at the level of 5% if there was a significant difference between treatments. The results showed that the application of solid organic fertilizer of corn waste provided a different response to each growth parameter of land kale plants, but did not have a real effect on the growth and production of land kale plants at the ages of 9, 12, 15, 18, and 21 DAP. The application of organic fertilizer with a fertilizer dose of 4 kg/plot (P1) tends to produce a higher plant height, while the highest number of leaves at a dose of 8 kg/plot (P3) and the highest fresh plant weight is obtained in the treatment without fertilizer (P0).

Keywords: fertilizer dosage, land spinach, organic fertilizer, corn waste

Abstrak: Pemanfaatan pupuk organik padat dari limbah jagung merupakan salah satu alternatif untuk mendukung sistem pertanian berkelanjutan dan mengurangi ketergantungan terhadap pupupk anorganik. Penelitian ini bertujuan untuk mengetahui aplikasi berbagai dosis pupuk organik padat dari limbah jagung terhadap pertumbuhan dan produksi tanaman kangkung darat serta menentukan dosis pupuk yang memberikan respon terbaik. Penelitian dilaksanakan menggunakan Rancangan Acak Kelompok dengan lima perlakuan dosis pupuk organik padat yaitu 0, 4, 6, 8, 10 kg/petak. Setiap kombinasi diulang tiga kali sehingga diperoleh 15 satuan percobaan Parameter yang diamati meliputi tinggi tanaman, jumlah daun, dan berat segar tanaman. Data dianalisis menggunakan analisis sidik ragam dan dilanjutkan uji BNT pada taraf 5% apabila terdapat perbedaan nyata antar perlakuan. Hasil penelitian menunjukkan bahwa pemberian pupuk organik padat limbah jagung memberikan respon yang berbeda pada setiap parameter pertumbuhan tanaman kangkung darat, namun tidak memberikan pengaruh yang nyata terhadap pertumbuhan dan produksi tanaman kangkung darat pada umur 9, 12, 15, 18, dan 21 DAP. Pemberian pupuk organik dengan dosis pupuk 4 kg/petak (P1) cenderung menghasilkan tinggi tanaman yang lebih tinggi, sedangkan jumlah daun terbanyak pada dosis 8 kg/petak (P3) dan berat segar tanaman tertinggi justru diperoleh pada perlakuan tanpa pupuk (P0).

Kata kunci: dosis pupuk, kangkung darat, pupuk organik, limbah jagung

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INTRODUCTION

Increasing the production of leafy vegetables, including land kale (*Ipomoea reptans* Poir.), still faces challenges in the form of declining soil fertility owing to the intensive and sustainable use of inorganic fertilizers. This terrestrial kale is a leafy vegetable with a relatively short harvest life and stable market demand. The fluctuation in kale production accompanied by high public demand demands a correct solution to this problem. To obtain optimal kale production results, it is necessary to focus on good cultivation techniques, from land cultivation to meeting plant nutritional needs (Wahiduddin *et al.*, 2025). The growth and production of land kale is greatly influenced by the availability of nutrients, especially nitrogen, which plays a role in the formation of vegetative organs such as stems and leaves. To reduce the use of inorganic fertilizers, organic fertilizers can be used. Organic fertilizers consist of natural and processed fertilizers that contain nutrients that are important for plants (Ullah *et al.*, 2023). Organic fertilizers are a sustainable solution for improving soil quality and increasing agricultural productivity. Supported by appropriate technology and education, its use can reduce soil degradation due to excessive chemical fertilization (Rachmadtullah *et al.*, 2024). In line with this, the use of organic fertilizers is more environmentally friendly to meet the nutrient needs of plants and can increase soil organic matter content and improve soil structure and soil microbial activity.

The underlying problem in this study is the high dependence of farmers on inorganic fertilizers and the very high intensity of land use, making the cultivated land more critical. Dependence on chemical fertilizers and intensive land use will make the soil nutrient-poor. Pramono (2004); Baderan *et al.* (2021) stated that intensive land use with high agrochemical inputs could cause symptoms of soil sickness. Therefore, the use of organic materials is one solution for such lands. However, there are many potential sources of organic material, one of which is agricultural waste, including corn strawberry waste. The use of corn waste as an organic fertilizer is expected to be an environmentally friendly and sustainable alternative source of nutrients. Corn waste is a potential source of organic matter because it is abundant as a by-product of agricultural activities, but its use as an organic fertilizer is still limited. The results of the study by Baderan *et al.* (2021), organic fertilizers produced from agricultural waste have C-Organic nutrient content, C/N ratio, nutrient content (N+P+K) needed by plants. Therefore, corn waste, such as stalks and cobs, has great potential to be processed into compost that can increase soil fertility and crop yields, but its use is still not widely applied by farmers even though the manufacturing process is relatively simple (Dahliana *et al.*, 2022).

Processing corn waste into organic fertilizer provides benefits, namely, reducing environmental pollution due to agricultural waste while providing organic nutrients that support increasing agricultural productivity and agricultural system sustainability (Harlina *et al.*, 2023). Research by Tamtomo and Setiawan (2016) revealed that corn waste compost, especially combined with 50% NPK fertilizer, has been proven to be effective in increasing soil organic matter, growth, nitrogen uptake, and corn production, so that it has the potential to support more sustainable nutrient management. Based on this, this study aimed to determine the application of various doses of organic fertilizer from corn waste to the growth and production of land kale plants and determine the dose of fertilizer that provides the best response.

MATERIALS AND METHODS

This study is a field experiment that aims to determine the effect of various doses of solid organic fertilizer based on corn waste on the growth and production of land kale plants (*Ipomoea reptans* Poir.). This research was carried out in East Bulotalangi Village, Bone Bolango Regency, from August to October 2025.

Tools and Materials

The tools used in this study include cultivators, shovels, hoes, wooden stakes, labels, rulers, digital scales, analytical scales, writing stationery, and cameras. The materials used in this study included land kale seeds and the manufacture of solid organic fertilizers, such as corn waste, banana stalks, coconut fiber, rice washing water, soil, AM-11, and molasses.

Solid Organic Fertilizer Manufacturing

Solid organic fertilizer is made from corn waste, banana stalks, and coconut fiber that are chopped to small sizes to accelerate the decomposition process. The ingredients were then mixed with soil, rice washing water, clean water, MA-11 activator, and molasses. The mixture of water, MA-11, and molasses is dissolved first, then evenly watered over the entire surface of the chopped material. All ingredients were stirred until homogeneous and covered using a tarp for an optimal fermentation process. Re-stirring was carried out on the third day to ensure the equal distribution of materials and oxygen supply during the composting process. The fermentation process was allowed to last for ± one month. Organic fertilizer is declared ripe when it is black, crumb-textured, and odorless.

Experimental Design

This study used a Randomized Block Design with five treatment levels and three replicates, resulting in 15 experimental units. The groups were formed based on the soil fertility conditions at the study site. The treatments consisted of different doses of corn waste fertilizer:

P0 = 0 kg/Plot

P1 = 4 kg/ Plot

P2 = 6 kg/Plot

P3 = 8 kg/ Plot

P4 = 10 kg/ Plot

Each experimental plot was 2 m^2 in size with a distance of 50 cm between the plots, and each plot consisted of 200 plants. Plant sampling was carried out diagonally in each plot for as many as 10 plant samples.

Research Implementation

The research began with land preparation, including land clearing, soil tillage, and the creation of experimental plots. Organic fertilizer was applied one week before planting according

to the level of treatment. Planting was carried out at a planting distance of 20 cm × 10 cm with 3-4 seeds per planting hole. Plant maintenance includes watering twice a day, as well as weeding weeds. Harvesting is carried out at the age of 21 days after planting by pulling the plant from the ground and then the roots of the kale plant from the soil, which is carried away during harvest. In addition, chemical analysis of organic fertilizers, including pH, N-total, P-available, K, and cation exchange capacity, was carried out.

Observation Variables

The observed variables included plant height (cm), number of leaves (strands), and fresh plant weight (g). Plant height was measured from the base of the stem to the highest leaf tip, the number of leaves was calculated from the leaves that opened perfectly, and fresh weight was measured using an analytical scale after the plant had been washed thoroughly.

Data Analysis

Data were analyzed using multiple fingerprint analysis (ANOVA) with Microsoft Excel software. If the results of the F test show a real influence, then it is followed by the Smallest Real Difference test at the level of 5%, with the following formula:

$$Yij = \mu + Ti + \varepsilon ij$$

Description:

Yij = Results of observation and treatment of the first and second repetition
μ = General middle value
Tea = Influence of the i-treatment
Eij = effect of the experimental error of the first treatment and the second test
I = Treatment 1, 2, 3, 4, 5
J = Deuteronomy 1, 2, 3

If there is a real difference, continue with the LSD Test:

$$\text{LSD } \alpha = t\alpha\ (v)\ x\ \sqrt{2\ Middle\ quadrant\ error/repeat}$$

Description:

tα = Default value found at the test level α and error-free degrees v
n = total treatment

RESULTS AND DISCUSSION

Effect of solid organic fertilizer of corn waste on vegetative growth of terrestrial kale

The results of the sample (Tables 1 and 2) showed that the application of solid organic fertilizer derived from corn waste did not have a real effect on the vegetative growth of land kale plants; therefore, no follow-up test with 5% LSD was conducted.

Plant Height

The results of variety-based fingerprinting (Table 1.) showed that the application of solid organic fertilizer of corn waste to the height of land kale plants does not have a significant effect on all plant ages. This is because the nutrients given to the plant are released slowly and the nutrients in the soil are sufficient to meet plant growth requirements. Therefore, applying large doses of organic fertilizer does not have an effect on plant height.

Table 1. Average high growth of land kale plants with the application of solid organic fertilizer from corn waste

Treatment	Plant height (cm) at the age observation				
	9 DAP	12 DAP	15 DAP	18 DAP	21 DAP
0 Kg/Friday	9.37	15.28	20.93	27.48	34.84
4 Kg/Friday	9.37	16.13	21.86	27.80	35.28
6 Kg/Friday	8.89	15.20	20.38	25.70	31.77
8 Kg/Friday	9.19	15.92	21.44	27.14	33.00
10 Kg/Friday	8.88	14.96	20.65	25.41	31.79
LSD 5%	tn	tn	tn	tn	tn

Notes : Day After Planting (DAP), tn (no significant difference), numbers followed by the same letter on the same treatment show an intangible difference in the 5% LSD test.

The height parameters of the plants at 9, 12, 15, 18, and 21 DAP increased with plant age in all treatments (Table 1). At age 9 DAP, the height of the plant was relatively uniform, and the age of 12 and 15 DAP began to be seen between treatments, where a dose of 4 kg/plot tended to provide the highest growth of the plant. This shows that nutrients from organic fertilizers support the vegetative growth of plants. Ages 18 and 21 DAP, a dose of 4 kg/plot provided the highest plant growth compared to higher doses with lower growth. It is suspected that the plant's nutrient needs are met so that too high a dose does not result in optimal growth. The provision of adequate nutrients can increase the capacity of plants to absorb essential nutrients, water, and minerals, thereby supporting the high growth of plants (Yenni *et al.*, 2025). However, the results of the analysis showed that none of the treatments was significantly different (LSD 5%). In general, a dose of 4 kg/plot can be considered the optimal dose agronomistically. The average height of the plants with the application of solid organic fertilizer is presented in Figure 1.

The height of the land kale plant increased in all treatments as the plant aged (Figure 1). The P1 treatment (4 kg/plot) consistently resulted in the highest plant height with an average of 35.28 cm compared to the other treatments, while the higher dose of P4 (10 kg/plot) showed lower growth compared to no treatment. This shows that moderate doses of organic fertilizer are more effective in supporting early plant growth than high doses. In addition to increasing the availability of nutrients, compost applications can also improve the properties of soil ficacia (Raksun *et al.*, 2020). Adnan *et al.*, (2014), the addition of 4 tons/ha of compost is able to meet the nutrient needs of land kale plants so as to support optimal growth, including increasing plant height. This is in line with Havlin *et al.* (2014), who stated that moderate dose organic fertilization

is able to provide nutrients without disturbing the biological balance of the soil. Febbriana *et al.,* (2024), the application of cashew fertilizer with a dose of 30 tons/ha tends to provide the highest plant height due to soil nutrient adequacy. Physiologically, during the initial growth phase, kale plants require a balanced and fast supply of nutrients. Organic fertilizers are released slowly; therefore, at high doses, nutrients are not fully available to plants. This is because the decomposition rate of organic fertilizer is greatly influenced by the quality of the organic fertilizer applied. Therefore, it is hoped that the nutrients needed by the plant will be available in sufficient quantities at the time of planting (Tamtomo and Setiawan, 2016). In addition, excess organic matter can trigger competition by soil microbes for available nitrogen (N immobilization), thereby inhibiting plant growth.

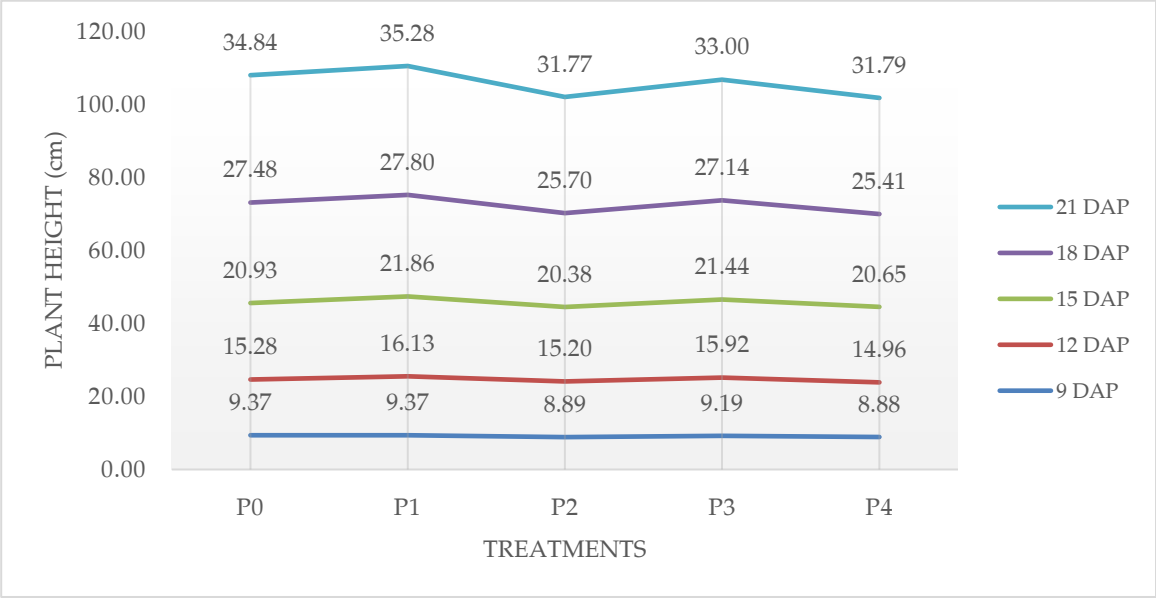

Figure 1. High Growth of Kale Plants

Number of Leaves

The results showed that the application of solid organic fertilizer from corn waste to the number of leaves of land kale plants had no noticeable effect at the 5% LSD level (Table 2). The number of leaves in each treatment varied and increased with each increase in plant life. The parameters of the number of leaves at the age of 9 DAP are more uniform with a range of 5.40 - 6.15 leaves indicating the early phase of plant growth. At 12 and 15 DAP, the number of leaves increased, with the highest number of leaves observed in the 4 and 10 kg/plot treatments. This indicates that the process of organic matter decomposition begins to provide the nutrients needed for the formation of vegetative organs, particularly leaves. Ages 18 and 21 DAP, doses of 4 kg/plot (10.33 sheets) and 8 kg/plot (10.30 sheets) provided the highest number of leaves compared to other treatments. This shows that organic fertilizers begin to make a noticeable contribution to the formation of vegetative organs after the decomposition process takes place.

Leaves are an important factor in determining the level of production (Suroso *et al.*, 2016). The variation in the number of leaves between the ages of observation is thought to be influenced by the physiological dynamics of the plant, such as the loss of old leaves, differences in the growth rate of individual plants, and the potential for sample observation errors. Overall, a dose of 8 kg/plot tended to increase the number of kale plant leaves.

Table 2. Average the number of kale leaves on land by applying solid organic fertilizer from corn waste

Treatment	Number of leaves (strands) at the age observation				
	9 DAP	12 DAP	15 DAP	18 DAP	21 DAP
0 Kg/Friday	6.15	7.56	7.07	9.02b	8.93
4 Kg/Friday	5.76	7.29	8.16	10.33a	8.93
6 Kg/Friday	5.78	6.96	7.89	9.42a	8.42
8 Kg/Friday	5.49	7.43	7.70	10.08a	10.30
10 Kg/Friday	5.40	7.13	8.18	9.78a	8.42
LSD 5%	**tn**	**tn**	**tn**	**1.13**	**tn**

Notes: Day After Planting (DAP), tn (no significant difference), numbers followed by the same letter on the same treatment show an intangible difference in the 5% LSD test.

The average number of kale leaves with the application of solid organic fertilizer can be presented in Figure 2.

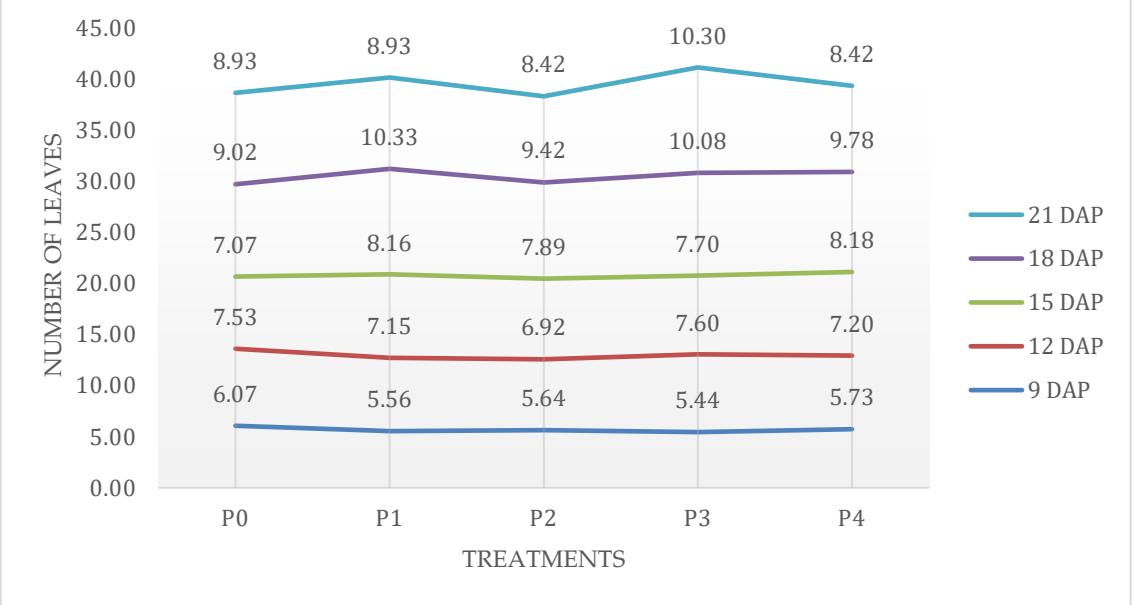

Figure 2. The Number of Leaves

The P3 treatment (8 kg/plot) provided the highest number of leaves compared to the no organic fertilizer treatment (Figure 2). This is because the dose can provide nutrients for leaf formation and vegetative growth. In line with Ediyanto *et al.* (2025), the increase in the number of leaves increases photosynthesis and photosynthate production, with the combination of biofertilizers and solid manure supporting leaf growth through the availability of nutrients N, P,

and K. This increase in the number of leaves is closely related to the availability of nitrogen, which plays an important role in cell division, chlorophyll, and leaf tissue growth. Nitrogen is the main element in the preparation of chlorophyll and proteins; therefore, its adequacy increases photosynthetic activity and encourages intensive leaf growth (Havlin *et al.*, 2014). The amount of nutrients that plants absorb from the soil plays an important role in the leaf formation process, as the formation of new cells in plants is highly dependent on their availability within the plant tissue (Adnan *et al.*, 2014).

Effect of Solid Organic Fertilizer of Corn Waste on the Fresh Weight of Land Kale Plants

The results of variety-based fingerprinting (Table 3.) showed that the application of solid organic fertilizer of corn waste had no significant effect on the fresh weight of land kale plants, using a 5% LSD test. The highest fresh plant weight was obtained in the treatment without organic fertilizer (P0), which was 7.58 grams, and the lowest in the P2 treatment (6 kg/plot) which was 5.75 grams. This is suspected to be because the soil still has sufficient nutrient reserves to support the accumulation of plant biomass. In addition, the slow release of organic fertilizers causes a significant increase in biomass in a relatively short planting cycle. Havlin *et al.*, (2014) stated that excessive or unbalanced nutrient absorption can reduce crop yields due to toxicity or disturbance of nutrient balance. Therefore, an increase in the dose of organic fertilizer is not always directly proportional to an increase in yield, especially the fresh weight of the plant. The increase in the fresh weight of plants is related to the availability of essential nutrients, especially nitrogen, phosphorus, and K. Nitrogen plays a role in the formation of new cells, phosphorus supports the activity of enzymes in photosynthesis, and potassium contributes to the development of meristem tissue, which affects leaf size (Adnan *et al.*, 2014).

Table 3. Average Fresh Weight of Kale Plants by Application of Solid Organic Fertilizer from Corn Waste

Treatment	Fresh Plant Weight (grams)
0 Kg/Friday	7.58
4 Kg/Friday	7.42
6 Kg/Friday	5.75
8 Kg/Friday	6.80
10 Kg/Friday	5.82
LSD 5%	**ns**

Notes : ns (no significant difference), numbers followed by the same letter on the same treatment show an intangible difference in the 5% LSD test.

CONCLUSIONS

The application of solid organic fertilizer of corn waste provides a different response to each growth parameter of land kale plants, but does not have a real effect on the growth and production of land kale plants at the ages of 9, 12, 15, 18, and 21 DAP. The application of organic

fertilizer at a dose of 4 kg/plot (P1) tended to produce a higher plant height, while the highest number of leaves at a dose of 8 kg/plot (P3) and the highest fresh plant weight were obtained in the treatment without fertilizer (P0). Based on the results of this study, it is recommended to provide organic fertilizer at a dose of 4-8 kg/plot for kale plants.

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