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Effect of Food Waste Digestate, Bokashi and Cow Dung Fertilizers on Soil Chemical Properties and Growth Performance of Pak Choi (*Brassica rapa* subsp. *chinensis*)

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Abstract

The misuse of chemical fertilizer has been deteriorating our soil and contaminating the environment. This study investigated the impact of cow dung fertilizer, bokashi fertilizer, and food waste digestate on the pH, electrical conductivity (EC), total carbon (TC), total nitrogen (TN), and crop growth of Pak choi (*Brassica rapa* subsp. *chinensis*). The controlled pot experiment was conducted at Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh Campus. Organic fertilizers were self-prepared and mixed with the soil before seed planting. Analysis of TC and TN of the soils was conducted on Day 0 and Day 28, while pH and EC analyses of the soils were conducted on five-day intervals i.e. 0, 7, 14, 21 and 28 days. Plant parameters measured were the height of plants and the width of leaves. Data was analyzed using one-way ANOVA. The highest plant height (11.0 cm) and maximum leaf widths (11.0 cm) were grown on soils fertilized with cow dung fertilizer. This is due to the high mineralization rate; however, the soil TC is decreased. The largest TC and TN increments (2.8595% and 0.1163%, respectively) were observed from bokashi fertilizer, indicating its great potential for sustained soil improvement, despite slow growth in plants at the initial state. Food waste digestates allowed intermediate plant growth and raised the soil pH to a slight alkaline of 7.20. In summary, cow dung fertilizer works best for short-term crop productivity and bokashi fertilizer for long-term carbon and nitrogen retention, while food waste digestates act as a balanced fertilizer. Long-term field tests for crop stability and overall improvement of soil quality should be done in future research.

1. Introduction

An important aspect of sustainable farming relates to soil health, which forms a foundation of sustainable farming itself. It influences crop growth, nutrient uptake, and overall ecological well-being. However, our prolonged practice of relying on synthetic fertilizers has stirred concerns about ecological impacts: soil can become acidic, nutrients become imbalanced, and groundwaters can be polluted [1]. These issues have prompted scientific and farming communities to consider other fertilizers, like organic fertilizers, that have positive impacts on soil and help to cut ecological risks. Organic fertilizers that include farm and food waste have

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become important because of re-cycling nutrients from waste to soil, which enhances its chemical constitution, so that farming can be carried out sustainably [2].

This study examines three common organic fertilizers, i.e. food waste digestates, bokashi fertilizer, and cow dung fertilizer. There is significant understanding that food waste digestate, with its microbial processes of anaerobic digestion, helps improve soil fertility by adding desirable macronutrients. It also has significant importance for providing a smart way to dispose of food waste [3][4]. Bokashi fertilizer, which is a bio-fertilizer that has undergone fermentation, has significant importance for improving overall soil biochemistry [5][6]. Another bio-fertilizer is cow dung fertilizer, with significant importance for improving soil fertility [7]. Despite their significant importance, their effects on the overall soil chemical composition, when grown as a pak choi *Brassica rapa* subsp. *chinensis* vegetable, remain unstudied.

Therefore, the purpose of the present study was to examine and compare the effects of the digestate of food waste, the bokashi fertilizer, and cow dung fertilizer on the chemical properties of the soil as well as the growth of pak choi within the 28-day growth period.

2. Methodology

To conduct this study, organic fertilizers were first prepared, followed by plant cultivation in controlled environments. Throughout the process, soil and plant qualities were monitored, and laboratory analyses were performed to determine soil chemical composition. Raw ingredients for organic fertilizers preparation include food scraps, bokashi bran, cow manure and organic soil. Commercial pak choi (*Brassica rapa* subsp. *chinensis*) seeds were used for planting.

2.1 Preparation of organic fertilizers

Figure 1 below shows a schematic representation of the preparation procedures for the three organic fertilizers. Food waste was combined with water and anaerobically fermented for 25 days in a sealed container to create food waste digestate (Figure 1-a). Anaerobic fermentation of organic material with bokashi bran in an airtight container for 25 days resulted in the production of bokashi fertilizer (Figure 1–b). Before applying cow dung fertilizer on soil, fresh cow dung was air- and sun-dried for 14 days to stabilize the material and lower its moisture content (Figure 1–c). Before planting seeds, each fertilizer was well mixed with the soil and allowed to stabilize for two to three days (Figure 1-d).

(a) (b) (c) (d)

Fig 1*: Preparation of organic fertilizers (a) Transformation of food waste [before] into digestate following 25 days of fermentation [after]. (b) Transformation of kitchen waste and bran [before] into Bokashi fertilizer [after] through a 25-day fermentation process.; (c) Physical transition of cow dung from a fresh state [before] to an air-dried state over 14 days [after]; (d) Soil mixed with the prepared organic fertilizers.*

2.2 Plant cultivation and periodic evaluation

Prior to growing, the pak choi seeds were soaked in water for a period of four to six hours and later potted using soil that had been treated with adequate organic fertilizer. To maintain suitable growing conditions throughout the experiment, the plants would be exposed to adequate water and favorable ambient conditions. In addition, various parameters such as the plant's height and broadness would be measured and recorded periodically on days 0, 7, 14, 21, and 28 (Figure 2-a). At this stage, soil would be collected and dried under ambient conditions for analysis purposes (Figure 2-b).

(a) (b)


***Fig 2**: Treatment and harvest system for pak choi; (a) At each interval the plant height and width were measured using a ruler; (b) Soil sample were collected.*

2.3 Laboratory Analysis of soil chemical properties

Soil samples were collected at regular intervals and processed for laboratory analysis by air-drying at room temperature to remove moisture content, followed by sieving the mixture using a 2 mm mesh sieve. To measure the soil pH, a soil-and-water suspension was created and assessed using a properly calibrated pH-meter in accordance with the guidelines provided in ISO 10390:2021 [8]. To measure electrical conductivity, a known number of soluble salts was extracted from the soil using a process specified in the guidelines of the ISO 11265:1994 standard [9]. Total carbon (TC) and total nitrogen (TN) content in the soil was analyzed using the Dumas dry combustion technique with a CHNS analyzer, where the soil undergoes high-temperature combustion for assessing elemental composition [10][11].

3. Results and Discussion

3.1 Soil Chemical Properties

Soil chemical properties analysed within the scope of this study were the soil pH, electrical conductivity (EC), total carbon (TC), and total nitrogen (TN).

3.1.1 Soil pH

Table 1 shows the soil pH for each of the organic fertilizers at five intervals from day 0, 7-, 14-, 21- and 28-day period.

Table 1 *The soil pH values at five intervals period for each of the organic fertilizers.*

Treatment	pH value Day 0 (Mean ± SD)	pH value Day 7 (Mean ± SD)	pH value Day 14 (Mean ± SD)	pH value Day 21 (Mean ± SD)	pH value Day 28 (Mean ± SD)
Control	7.80 ± 0.04	7.98 ± 0.02	7.40 ± 0.07	7.49 ± 0.06	7.57 ± 0.06
Bokashi Fertilizer	7.13 ± 0.48	8.9 ± 0.04*	7.45 ± 0.05	8.89 ± 0.21*	8.52 ± 0.05*
Food Waste Fertilizer	7.82 ± 0.04	7.75 ± 0.18	7.30 ± 0.02	7.44 ± 0.16	7.20 ± 0.12
Cow Dung Fertilizer	8.84 ± 0.35*	8.79 ± 0.15*	8.69 ± 0.27	8.83 ± 0.13*	8.64 ± 0.26*

Soil pH reacted differently in each treatment throughout the entire 28 days of growing (refer to Table 1 and Figure 3). The control soil pH remained relatively steady, declining slightly from 7.80 on day 0 to 7.57 on day 28, remaining within the slightly alkaline to neutral region. The greatest pH variation occurred in soil treated with bokashi fertilizer, which increased abruptly from 7.13 on day 0 to 8.90 on day 7, declining slightly to 7.45 on day 14, then leveling off in the alkaline region at 8.52 on day 28. Such trends heavily suggest an extremely alkalizing effect, which can be attributed to the decomposition process of organic matter, during which ammonia is also released [12]. On the other hand, food waste digestates slightly increased the soil pH to become more acidic, starting from pH 7.82 on day 0 and eventually reaching 7.20 on day 28. This may be attributed to the anticipated ammonium ion nitrification, producing protons when ammonium ions are converted into nitrate ions [13]. The cow dung fertilizer maintained the highest soil pH, which began at 8.84 and consistently remained above 8.60,

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reflecting the efficient liming effect and buffering action by its carbonate and calcium ion content [14]. Generally, these observations indicate that each organic fertilizer has distinct effects on soil pH change during pak choi growth.

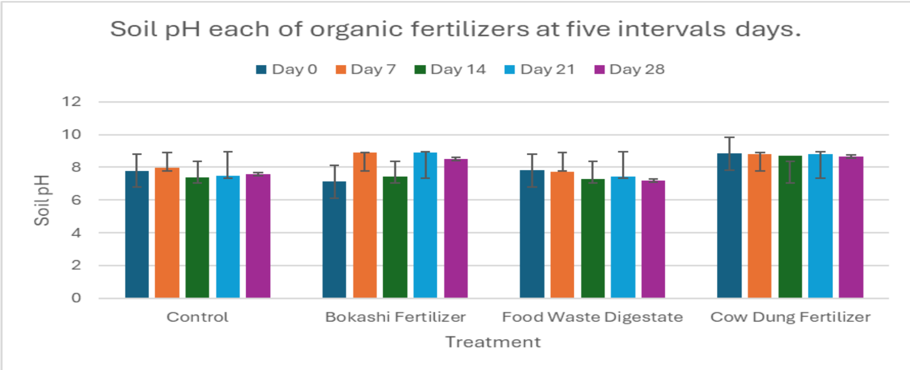


Fig 3: *Soil pH for control soils and the three organic fertilizers at five intervals over 28 days period.*

The one-way ANOVA indicated the difference between soil pH by different treatments was significant after 28 days ($p < 0.05$). Tukey's post-hoc test indicated that bokashi and cow dung amendments caused significant increase in soil pH relative to control and food waste digestate treatments (*), especially at Day 7, 14, 21 and 28. The decrease in pH with time was more progressive, induced by food waste digestate which was also significantly different from cow dung fertilizer at multiple intervals (*). These findings also demonstrate the significance of fertilizer type on soil pH status and can be used as a validation for proper selection of organic soil amendments to control soil acidity (Figure 3).

3.1.2 Electrical Conductivity

A high value of salinity (measured as electrical conductivity (EC)) is desirable in fertilizers as it typically indicates a high concentration of essential soluble nutrients and mineral salts. However, this needs to be balanced as it can adversely affect plant development due to osmotic pressure and moisture uptake restriction [15]. Table 2 below shows the electrical conductivity (EC) for control soil and each of the organic fertilizers at five intervals from day 0, 7-, 14-, 21- and 28-days period.

Table 2 *The electrical conductivity (EC) values at five intervals period for control soil and each of the organic fertilizers.*

Treatment	EC (µS/cm) Day 0 (Mean ± SD)	EC (µS/cm) Day 7 (Mean ± SD)	EC (µS/cm) Day 14 (Mean ± SD)	EC (µS/cm) Day 21 (Mean ± SD)	EC (µS/cm) Day 28 (Mean ± SD)
Control	75.9 ± 12.38	119.5 ± 2.55	105.2 ± 46.84	190.3 ± 23.16	96.8 ± 13.72
Bokashi Fertilizer	511.3 ± 29.60*	742.7 ± 13.12*	576.7 ± 94.32*	936.7 ± 54.02*	343.4 ± 162.5*
Food Waste Fertilizer	180.5 ± 33.80*	160.8 ± 62.04	364.3 ± 22.23*	279.6 ± 7.18	365.7 ± 46.15*
Cow Dung Fertilizer	307.7 ± 4.78*	417.3 ± 24.25*	329.4 ± 63.38*	594.7 ± 111.1*	351.8 ± 86.68*

The soil electrical conductivity (EC) fluctuates from day 0 to 28 of the pak choi growing process, corresponding to the variation of the soluble salts in the soil (refer to Table 2 and Figure 4). The control soil showed the lowest values in EC, indicating little movement of the soluble ions from the soil towards the soil solution and plant root zone, due to the absence of added nutrients. Meanwhile, bokashi fertilizer showed the highest increase in the value of the soil's electrical conductivity, from 511.3 to 936.7 µS/cm on day 21, then dropped to 343.4 µS/cm on day 28 of the pak choi growth process. This can be attributed to the release of nutrients from organic matter as it decomposes, followed by the uptake of the nutrients by the plants [15]. Besides, cow dung fertilizer had a moderate level of EC, which began at 307.7 µS/cm and reached a peak on day 21, suggesting a slower and progressive mineralization process of organic matter. [16]. In the meantime, food waste digestates had a progressive increase in EC, which started at 180.5 µS/cm on day 0 and reached 365.7 µS/cm on day 28, gradual replenishment of soluble ions through ongoing organic matter decomposition. This indicates a relatively steady but non-linear release of nutrients from the processed organic waste, rather than a strictly constant release [17].

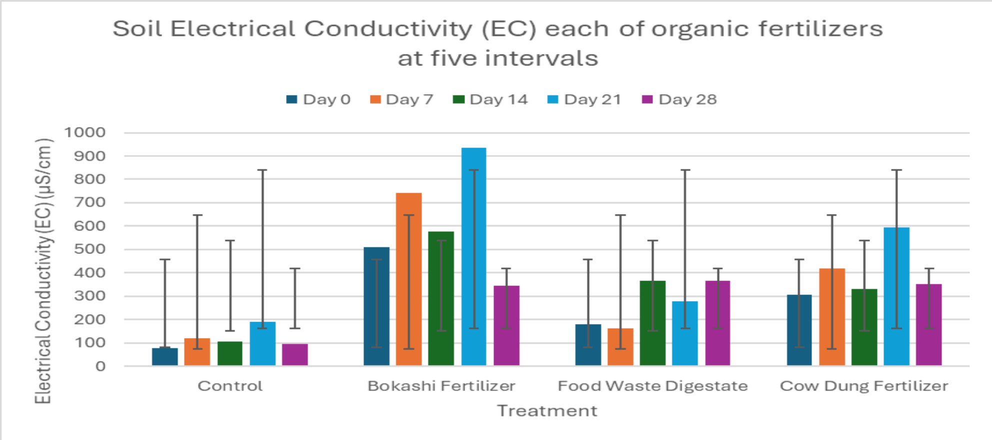


***Fig 4**: Electrical Conductivity (EC) each of the organic fertilizers at five intervals over 28 days period.*

According to one-way ANOVA, the soil EC was significantly affected by fertilization type during most sampling dates ($p < 0.05$). EC values were highest (*) in Bokashi fertilizer, followed by cow dung and food waste digestate. Higher EC in bokashi-treated soil may be due to higher nutrient and soluble salt concentration of this amendment. The changes in EC were moderate with the food waste digestate, and cow dung fertilizer (*) was higher at several intervals (*). Overall, these results provide evidence that organic fertilizers could significantly affect soil salinity which is critical for nutrient availability and plant growth.

3.1.3 Total Carbon (TC) and Total Nitrogen (TN)

Total Carbon (TC) and Total Nitrogen (TN) on day 0 and day 28 were sent to Jabatan Kimia Fakulti Sains lab, Universiti Putra Malaysia (UPM) to monitor the extent which organic fertilizers affect soil nutrients (see Table 3 and Figs. 5). For control soil, TC value is lower compared to organic fertilizer-treated soils, with no changes in TN. This is expected as the control soil received no external fertilizers, and thus any carbon within the soil will be consumed by soil microbes over time, leading to lowered TC values [18]. Total nitrogen remains unchanged or steady in the control soil due to low rate of nitrogen mineralization and the absence of volatile nitrogen loss [19].

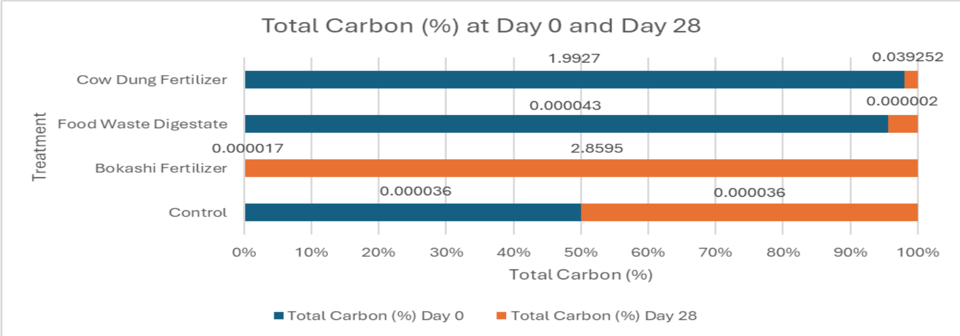
Table 3 *The total carbon (TC) and total nitrogen (TN) content on each of the treatment organic fertilizers by CHNS analysis method.*

Treatment	Total Carbon (%) Day 0	Total Carbon (%) Day 28	Total Nitrogen (%) Day 0	Total Nitrogen (%) Day 28
Control	0.000036	0.000036	0.6840	0.6840
Bokashi Fertilizer	0.000017	2.8595	0.4958	0.6121
Food Waste Digestate	0.000043	0.000002	0.5796	0.6001
Cow Dung Fertilizer	1.9927	0.039252	0.6264	0.5151

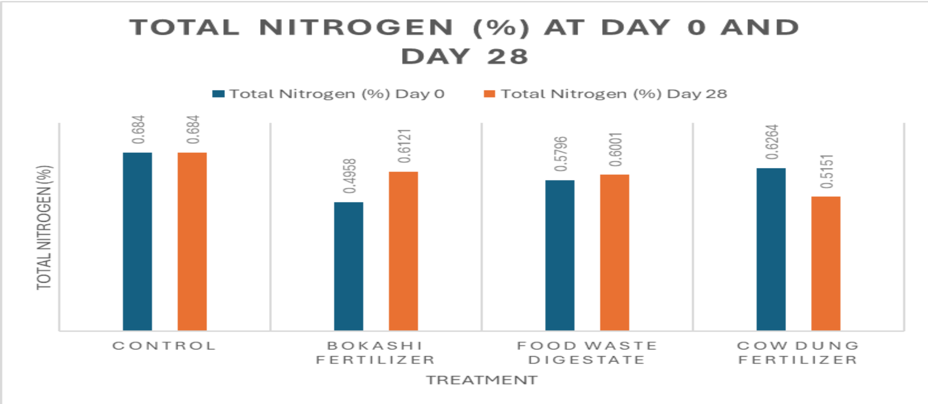
Among the treatments, the increase in TC was highest by bokashi fertilizer on day 28 (Table 3; Figure 5-a), indicating the efficient accumulation of soil organic carbon. This indicates an efficient accumulation of soil organic carbon, which is consistent with the fermented nature of bokashi fertilizer. The fermentation process produces more stable organic compounds that degrade slowly in soil, allowing carbon to be retained over time [20].

On the contrary, food waste digestates kept the lowest values of TC, as a significant portion of the carbon leaches out in the form of CO_2 and CH_4 gas in the process of anaerobic digestion [21]. Similarly, cow dung fertilizer decreased the value of TC on day 28, as carbon might have been lost due to microbial action and respiration in warm soil [22].

TN Bokashi fertilizer showed an increase in TN from day 0 to day 28, whereas cow dung fertilizer decreased TN (Table 3, Figure 5-b). The increase in TN in bokashi fertilizer can be traced to the nitrogen stabilization process during the fermentation process, which results in less ammonia volatilization or loss of soil nitrogen [23]. Although the increase in TN is small in the food waste digestate, it may experience more volatile ammonia, hence nitrogen loss via nitrification or leaching processes [24]. Alternatively, the decrease in TN of cow dung fertilizer can be linked to the volatile ammonia loss or rapid turnover of unprocessed manure nitrogen [25].



(a)



(b)

Fig 5*: Total carbon and total nitrogen percentage measured by CHNS; (a) Total carbon (%) on day 0 and day 28 contains organic fertilizers on each of the treatments; (b) Total nitrogen (%) of soil samples on day 0 and day 28.*

In a nutshell, bokashi fertilizer is most effective and efficient in increasing soil carbon and soil nitrogen content compared with other decomposes over a period of 28 days. Food waste digestate is most effective and efficient in increasing soil nitrogen content. Cow dung fertilizer had more nutrient loss, and they should be stabilizing the fertilizer before application. In this case, since there are no replicate values, descriptive analysis was employed, but results follow a similar trend as earlier studies.

3.1.4 Growth performance of Pak Choi (*Brassica rapa* subsp. *chinensis*)

The growth response of pak choi to three organic fertilizers (food waste digestate, bokashi, cow dung) and a control was determined on the basis of plant mean height and mean leaf width, combined with visual observations throughout a 28-days observation period.

Table 4 *Plant mean height of pak choi* (*Brassica rapa* subsp. *chinensis*) *at different intervals.*

Treatment	Day 0 (cm) Mean ± SD	Day 7 (cm) Mean ± SD	Day 14 (cm) Mean ± SD	Day 21 (cm) Mean ± SD	Day 28 (cm) Mean ± SD
Control	0 ± 0	1.2 ± 0.14	3.3 ± 0.14*	7.0 ± 0.28*	9.5 ± 0.28*
Bokashi Fertilizer	0 ± 0	1.2 ± 0.14	3.5 ± 0.14*	7.5 ± 0.28*	9.5 ± 0.14*
Food Waste Digestate	0 ± 0	1.8 ± 0.14	4.5 ± 0.28*	8.5 ± 0.28*	10.0 ± 0.28*
Cow Dung Fertilizer	0 ± 0	2.5 ± 0.14	5.5 ± 0,28*	9.0 ± 0.28*	11.0 ± 0.28*

Table 5 *Plant mean leaf width of pak choi* (*Brassica rapa* subsp. *chinensis*) *at different intervals.*

Treatment	Day 0 (cm) Mean ± SD	Day 7 (cm) Mean ± SD	Day 14 (cm) Mean ± SD	Day 21 (cm) Mean ± SD	Day 28 (cm) Mean ± SD
Control	0 ± 0	0.3 ± 0.14	2.0 ± 0.14*	5.0 ± 0.28*	9.0 ± 0.28*
Bokashi Fertilizer	0 ± 0	0.3 ± 0.14	2.5 ± 0.14*	5.5 ± 0,28*	9.5 ± 0,28*
Food Waste Digestate	0 ± 0	0.5 ± 0.14	3.0 ± 0.28*	6.5 ± 0.28*	10.5 ± 0,28*
Cow Dung Fertilizer	0 ± 0	0.5 ± 0.14	4.5 ± 0.28*	7.0 ± 0.28*	11.0 ± 0.28*

Mean height of pak choi at days 0, 7, 14, 21 and day 28 is presented in Table 4. Fastest and early pak choi growth was seen in soils with cow dung fertilizer (5.5 cm) on day 14, indicating the availability of nutrients. Intermediate growth was observed in soils with food waste digestate, with better performance than bokashi and control, but lower than cow dung. Bokashi fertilizer amended soil had pak choi growing the slowest or had the closest height, suggesting low early nutrient availability. Leaf width over these same intervals is shown in Table 5. Cow dung also produced the fastest initial leaf growth, with leaves that were 50% wider than those grown in digestate by day 14. Food waste digestates maintained the second-best performance, while bokashi and control were slower.

Fertilizer type had a significant effect on the overall development of pak choi (Table 4; Table 5). The differences between the means were not significant for any comparison at Day 0 and Day 7 ($p \geq 0.05$), but from Day 14 there were significant differences between plant height and leaf width among treatments ($p < 0.05$). Cow dung fertilized plants consistently were tallest and had the widest leaves followed by food waste digestate, while bokashi and control presented reduced growth. Turkey's post- hoc test indicated significant differences ($p<0.05$) between cow dung and digestate and the control. By the 28th day, all parameters were substantially different and cow dung fertilizer was overall the most efficient for pak choi growth.

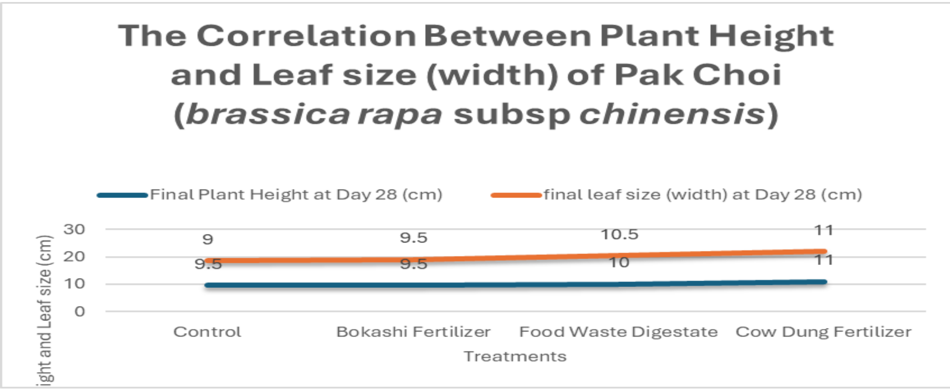


***Fig 6**: The correclation between the plant height and the leaf size (width) of pak choi* (*Brassica rapa* subsp. *chinensis*).

Plant height and leaf width increased in parallel over 28 days of development (Figure 6). The largest plants were obtained with cow dung, followed by food waste digestate and bokashi, the smallest was the control. This is indicative of the nutrient-rich composition of cow dung which contains nitrogen and other macro nutrients that boost chlorophyll, photosynthesis and cell extension [26][27]. Ammonium and soluble phosphorus/potassium from a food waste digestate application provided readily accessible nutrients thereby enhancing early growth [28]. Nutrients were slower to become available from the bokashi and this resulted in steady, moderate growth [29]. Due to lack of additional fertilizer on the control soil, therefore the smallest plants were observed.

(a)

(b)

(c) (d)

Fig 7*: Visual Observations within 28 days intervals; (a) Control without any fertilizer at five intervals cultivation; (b) Bokashi fertilizer at five intervals cultivation; (c) Food waste digestate at five intervals cultivation; (d) Cow dung fertilizer at five intervals cultivation.*

The development of growth was visually recorded at day 0, day 7, day 14, day 21 and day 28 (Fig.7). Control (Fig 7-a) shows the slow, patchy germination and overall growth was restricted due to lack of nutrients. Bokashi (Fig 7-b) shows moderately better than control, which is growing slower, early vigour limited. Food waste digestates (Fig 7-c) shows faster, more even germination and steady growth and better foliage upstand and biomass. Cow dung (Fig 7-d) shows quickest and uniform germination which is tallest and healthiest plants all over in maximum short span and the balanced nutrient offered by it supports best growth. In general, cow dung fertilizer had the highest effectiveness, followed by food waste digestate and bokashi. These findings emphasize the role of organic nutrient release that aids in the early and sustained growth of pak choi (*Brassica rapa* subsp. *Chinensis*).

3.1.5 Correlation between Soil Chemical Properties and Plant Growth of Pak Choi (*Brassica rapa* subsp. *chinensis*)

Overall, strong correlations were obtained between soil chemical properties and plant growth parameters, suggesting that differences in soil pH, nutrient content and organic matter significantly affected plant height and leaf width over the 28 days of cultivation. The plant height and leaf width was superior with cow dung fertilizer with a relatively stable and high soil pH, probably due to the liming effect of manure [30]. Prolonged alkaline conditions can hinder nutrient uptake; however, these were not prohibitive of pak choi growth in this short-term experiment. The relatively higher EC of cow dung also implies availability of soluble macronutrients for the plants that supported rapid early growth especially during transplanting up to 2 weeks after planting. High TC and TN effectively promoted nutrient mineralization, while there was enough nitrogen available for crop growth throughout the growing period. Also, the cow dung enriched organic matter, water retention and air, provide for sustained absorption of nutrients and stable vegetative growth [31].

The food waste digestates produced second highest growth and exhibited strong early growth response. The lower final soil pH (7.20) reflected nitrification of ammonium nitrogen and maintained near-neutral conditions permissive to nutrient availability. EC level steadily increased, thereby, minimizing the risk of salt stress and maintaining a consistent nutrient supply with emphasis on potassium and calcium [32]. Although TC was lower, the digestate presented relatively high easily accessible mineral nitrogen proportion for plant rapid assimilation and fast vegetative growth. Nevertheless, the low carbon percentages led to a reduced long-term stability of nutrients and can be argued that why growth was lower compared to cow dung fertilizer but higher than bokashi fertilizer [33].

However, bokashi fertilizer was moderate despite of the highest TC and TN. Soil pH fluctuations, which were maintained alkaline, may have temporarily limited the availability of micronutrients (i.e. iron and zinc) necessary for early plant growth. Moreover, the peak EC that was determined during growth indicated a risk of short-term salt stress with subsequent potential inhibition of water and nutrient uptake. Even though bokashi fertilizer conserved nutrient by means of the fermentation process and provided a slow release over time, this type of slow availability was inadequate to sustain a rapid early vegetative growth that led to final plant height and leaf width lower than when using cow dung and food waste digestate [6]. Furthermore, there were consistent trends in the different treatments which is cow dung fertilizer had plants with the highest stature and widest leaves followed by food waste digestate, bokashi fertilizer. These results are congruent with earlier research that showed better vegetative growth of leafy vegetables under the organic fertilizer because of soil fertility and nutrient availability [34].

Table 6 *Comparative effect of organic fertilizer on soil chemical properties and pak choi growth.*

Treatment	Nutrient Release Pattern	Effect on Plant Growth	Effect on Soil Health	Key Limitations
Cow dung fertilizer	Rapid nutrient mineralization	Highest short-term growth (height & leaf width)	Limited long-term carbon retention	High carbon loss, potential nutrient loss
Bokashi fertilizer	Slow and stabilized release	Moderate early growth	High carbon and nitrogen stabilization; improved long-term soil health	High EC and pH fluctuation in early stage
Food waste digestates	Moderate nutrient availability	Intermediate growth performance	Improves pH towards neutral; balanced fertility	Limited long-term carbon storage

Table 6 shown the relationship was showed that the cow dung fertilizer provided the most balance of nutrients releases for the short-term, rapid growth of the pak choi because of the immediate availability of the nutrient release during the rapid mineralization. While, for bokashi fertilizer shows the potential for long-term soil health because of the carbon and nitrogen stabilization and the nutrient was released too slowly and the highest electrical conductivity (EC) and pH fluctuations in early growth. Then, for the food waste digestate was offer a good compromise which is provided a faster mineral boost for faster vegetative responses.

4. Conclusion

In this study, the effects of cow dung fertilizer, food waste digestate, and bokashi fertilizer were compared regarding their influence on soil chemical properties (pH, EC, TC and TN) and short-term growth responses of pak choi (*Brassica rapa* subsp. *chinensis*). The findings reveal that each organic fertilizer generated a distinctive effect on the soil and plant growth, so the choice of fertilizers will rely on specific agronomical purposes like immediate yield or long-term enhancement of the soil. Plant height and leaf width (11.0 cm) were the highest with cow dung fertilizer due to rapid mineralization of nutrients and availability in early growth stage, suitable for short term productivity. Bokashi fertilizer resulted to minimal plant growth but upon application, there were the highest increments for total carbon and nitrogen indicating efficiency in terms of long-term soil carbon sequestration and nutrients immobilization. The food waste digestates served as a balanced response, yielding the second highest and adjusting soil pH towards near neutral (higher nutrient availability to ensure vegetative growth). Overall, the results prove that organic fertilizers can be a suitable choice as an effective and safe substitute for synthetic compounds. While cow dung manure is ideal for crops in the shorter term, bokashi conditioning material offers more in terms of nurturing soil for the long-term, and food waste digestate is a good middle ground between them. Further long-term and replicated studies are recommended to assess cumulative effects on soil fertility and crop performance.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Afrina Safawati Asri, 'Aisyah Mohamed Rehan;* ***data collection:*** *Afrina Safawati Asri;* ***analysis and interpretation of results:*** *Afrina Safawati Asri, 'Aisyah Mohamed Rehan;* ***draft manuscript preparation:*** *Afrina Safawati Asri, 'Aisyah Mohamed Rehan.*

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