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The impacts of the integration of onion biowaste and NPK fertiliser on okra productivity and economic profitability

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ABSTRACT

Inorganic fertilisers are effective for improving crop yields, but their overuse can lead to soil acidification, which degrades soil health and long-term plant growth. To address this issue, the integration of onion biowaste fertiliser with NPK fertiliser has been proposed as an environmentally sustainable alternative for okra cultivation. This study evaluates the influence of various combinations of onion biowaste and NPK fertilisers on the yield and economic performance of okra (*Abelmoschus esculentus*). The experiment was carried out under greenhouse conditions using a randomised complete block design (RCBD) consisting of five treatments with five replications each. The treatment levels were: T0 (control, 100% NPK fertiliser), T1 (100% onion biowaste fertiliser), T2 (50% NPK and 50% onion biowaste), T3 (30% NPK and 70% onion biowaste), and T4 (70% NPK and 30% onion biowaste). The results revealed significant differences in okra productivity and profitability across treatments. T2 (50% NPK fertiliser + 50% onion biowaste) was the most effective treatment that produced the highest fresh pods of 9250.25 kg per hectare with a gross profit margin of 62.80% and it was superior compared to all other treatment modes. Such a solution will offer the economy and the environment the best possible remedy to the fertiliser-related pollution, as well as transform household waste such as onions, into a valuable agricultural resource and a solution to the problem of fertilisers.

1. INTRODUCTION

One of the areas where chemicals have been pivotal is in agriculture, particularly in the use of nitrogen, phosphorus, and potassium (NPK) fertilisers, which are employed to enhance crop productivity. Nitrogen primarily promotes vegetative growth, whereas phosphorus contributes significantly to root growth and energy metabolism. Potassium maintains osmotic pressure and makes plants resistant to adverse environments[1]. Nonetheless, there are also significant adverse effects associated with dependence on these inputs. When overused, excessive amounts may cause soil acidification, loss of soil fertility, changes in microbial dynamics, and leaching of nitrates and phosphates into groundwater sources, contaminating these resources[2,3]. Over time, the stability of an ecosystem may be affected by the constant application of chemical fertilisers, posing a threat to the sustainability of farming systems.

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To solve these issues, there have been suggestions of integrated efforts between organic and inorganic practices. The practices would make use of organic resources and minimise chemical fertiliser usage and enhance soil structure, favourable microbial population, and accessibility to macro and micronutrients[4]. Fertiliser systems that are stronger and more ecologically stable can be developed using organic materials[5].

Among other forms of organic waste materials, onion peel waste, a material commonly found in households and food service establishments, has been recently examined as a potential compost. Essential minerals (calcium, phosphorus, potassium, sulphur) and biologically active compounds with antioxidant properties can be found in onion waste[6]. These nutritional values notwithstanding, onion peels are usually discarded, posing a waste management challenge. Waste made from onion peel, therefore, serves two purposes: it will act as a cheap source of food and an effective way to manage waste, or, more broadly, to introduce the principles of the circular economy. Despite preliminary research on the use of onion waste peel on various crops indicating its potential to promote growth and yield, fewer studies have been conducted on its use on vegetable crops such as okra.

The objectives of this study are to determine the effects of the various combinations of onion peel biowaste extract and NPK fertiliser on okra growth and their economic value. The primary goal was to determine the most effective combination to promote plant growth and production, reduce the reliance on chemical fertilisers, and reduce the cost of production. The hypothesis was as follows: the combination of organic elements (onion peel biowaste extract) and inorganic ones (NPK fertiliser) would lead to the improvement of crop performance when compared to the use of either of the inputs, since organic and inorganic elements are complements that cannot be substituted.

2. MATERIALS AND METHOD

This experiment was conducted at the Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA, Melaka, Malaysia. The geographical coordinates of the site are 2°13'45.7" N latitude and 102°27'20.1" E longitude. The study was conducted over a period of three months, from January 2023 to April 2023. Okra variety OP 1 Okra Amazon King was used throughout the study. The seed of okra variety OP 1 Okra Amazon King is of premium and high-quality, with a high germination rate. This is one of the high-yielding okra varieties with short internodes and five angled straight oily light green pods. A mixed soil medium was prepared as the growing medium for okra. Okra seeds were sown in a seedling tray containing mixed soil and allowed to grow for one week before being transplanted into polybags measuring 16 inches × 16 inches. A completed randomised blocked design (RCBD) with five treatments times five replications was used in this experiment, as shown in Table 1.

Table 1. A combination of onion peel biowaste and NPK fertiliser

Treatment	Description
T0	100% NPK fertiliser
T1	100% Onion Biowaste fertiliser
T2	50% NPK fertiliser + 50% Onion Biowaste fertiliser
T3	30% NPK fertiliser + 70% Onion Biowaste fertiliser
T4	70% NPK fertiliser + 30% Onion Biowaste fertiliser

Source: Author’s own data

An onion peel biowaste fertiliser was prepared by collecting dried onion peels and soaking them in 1 liter of distilled water inside a clean, sealable container. The mixture was kept at room temperature in a shaded area for 24 hours to allow soluble nutrients to be released. Following the extraction period, it was filtered through a fine mesh to remove solids, and the liquid extract was stored in sterilised bottles for subsequent use. For the NPK treatment, 2 mL of liquid foliar fertiliser brand AG GROGREEN water-soluble NPK foliar fertiliser (balanced NPK) was diluted in 1 L of distilled water. All fertiliser solutions were then transferred into 1.5 L plastic containers to ensure uniformity in preparation and application across all treatments. The treatments were applied on 14, 28, 60, and 75 days after sowing (DAS). Each polybag received 500 mL of the fertiliser solution, which was applied using a small watering can to ensure uniform distribution.

At the final harvest stage, yield traits were evaluated to assess the productivity and economic performance of okra under different fertiliser treatments, with pod fresh weight being recorded as the primary parameter. Gross income was calculated based on the marketable yield at RM 2.50 per kilogram. Total production costs included both variable and fixed inputs such as seeds, fertilisers, pesticides, herbicides, labour, and transportation, and were calculated based on current local market prices. Gross margin (GM) was determined by subtracting variable costs from gross income, following the method of Ifeoma et al.[7] (Eq.1)

$$GM = \text{Gross income} - \text{Variable cost} \quad (1)$$

The economic feasibility of okra cultivation was assessed using the gross profit margin (GPM) as the principal indicator of profitability. GPM, which represents the proportion of total sales revenue expressed as a percentage, was calculated using the formula presented in Eq. 2.

$$GPM = \frac{\text{Gross income - Variable cost}}{\text{Gross income}} \times 100 \quad (2)$$

The benefit-cost ratio (BCR) is represented by the following formula, as shown in Eq. 3:

$$BCR = \frac{\text{Revenue}}{\text{Total cost of production}} \quad (3)$$

Data collected were subjected to One-way Analysis of Variance (ANOVA) using the Statistical Analysis System (SAS version 9.4; SAS Institute, Cary, NC, USA). Treatment means that exhibited statistically significant differences were further compared using the Least Significant Difference (LSD).

3. RESULTS AND DISCUSSION

The results presented in Table 2 show that the okra fresh pod yield varied significantly ($P \leq 0.05$) due to different combinations of organic and inorganic fertilisers. The highest yield of okra was obtained from the combination of 50% NPK + 50% onion biowaste (T2), with 9250.25 kg ha^{-1}, and was significantly reduced ($P \leq 0.05$) when applied with only sole fertiliser. The lowest fresh pod yield was recorded in T1 (100% onion biowaste), at 4800.37 kg ha^{-1}.

Table 2. Effect of onion biowaste and NPK fertiliser on okra yield (productivity)

Treatment	Description	Fresh pod yield (kg ha^{-1})
T0	100% NPK fertiliser	5503.00^{cd}
T1	100% Onion Biowaste fertiliser	4800.37^{d}
T2	50% NPK fertiliser + 50% Onion Biowaste fertiliser	9250.25^{a}
T3	30% NPK fertiliser + 70% Onion Biowaste fertiliser	6240.76^{c}
T4	70% NPK fertiliser + 30% Onion Biowaste fertiliser	7230.74^{b}

^{abcd} Means within the same column, followed by unlike letters are statistically significant ($P \leq 0.05$)

Source: Author's own data

Organic and inorganic fertilisers both ensure balanced growth of plants[8,9]. Organic fertilisers usually consist of organic resources and minerals to stimulate the formation of roots and improve the overall health of the plant. When they are mixed, they can add fresh weight because they release nutrients into the soil faster, thus causing plants to grow and develop. Sometimes plants can develop at a slower or stunted rate when applying only one form of fertiliser[10]. It could happen because of insufficient nutrition or a deficiency of a certain nutrient at different development stages and thus produce a low fresh weight yield.

Turning onion peel waste into a useful plant biowaste product would be beneficial for both onion processing industries and crop production. Onion peel waste is rich in carbohydrates and various bioactive metabolites[11] and all of these have been shown to have beneficial effects on plant growth[12]. A study by Zhang et al.,[13] has investigated the effects of onion biowaste on various vegetables and turfgrass to explore its potential as a beneficial product for plant growth. Their study found that foliar application of onion biowaste at 1% to 2% increased yield and benefited bok choy growth.

Profitability and viability of the production strategy are influenced by the ultimate economic payoff. A comparison of profitability by economic breakdown is presented in Table 3. The combination ratio T2 was selected in the combination treatments as the most profitable with a gross margin of RM 16959.98 ha^{-1} and gross profit margin of 62.80% compared to the other treatments. The same outcome was observed in the T3 and T4 combinations, with gross margins of RM 13810.10 ha^{-1} and RM 10398.51 ha^{-1}, respectively. In the meantime, the sole fertiliser T1 (100% onion biowaste fertiliser) and T0 (100% NPK fertilisers) produced a lower gross margin than the others.

This was also indicated by the gross profit margin which reached its highest gross profit margin of T2 attained at 62.80% (Table 3) and followed by a ratio of T3 (60.60%). Nevertheless, 100% onion biowaste fertiliser (T1) had a gross profit margin (48.36%) higher than the combination ratio T4 (47.98%). Using the case of 100% NPK fertiliser (T0) itself was taken as the value with the lowest gross profit margin and this was only 29.01%.

The benefit-cost ratio amongst all the treatments was greatly varied with T2 having the highest ratio with a value of 2.67, T3 having a value of 2.54, 100% onion biowaste fertiliser (T1) having a value of 1.94 and a combination ratio of T4 having the value of 1.92, whereas the lowest ratio was a T0, combination of 100% NPK fertiliser and had a BCR of 1.41 (Table 3).

Table 3. Effect of onion biowaste and NPK fertiliser on economic analysis (profitability) of okra

Treatment	Gross Income RM ha^{-1}	Cost of Production RM ha^{-1}	Gross Margin RM ha^{-1}	Gross Profit Margin (%)	Benefit- Cost Ratio (BCR)
T0 100% NPK fertiliser	17854.25	12675.09	5179.16	29.01	1.41
T1 100% Onion Biowaste fertiliser	15300.30	7900.45	7399.85	48.36	1.94
T2 50% NPK fertiliser + 50% Onion Biowaste fertiliser	27005.20	10045.27	16959.98	62.80	2.67
T3 30% NPK fertiliser + 70% Onion Biowaste fertiliser	22789.00	8978.90	13810.10	60.60	2.54
T4 70% NPK fertiliser + 30% Onion Biowaste fertiliser	21674.74	11276.23	10398.51	47.98	1.92

Where field price 1 kg okra= RM 2.50

Source: FAMA, 2023 (Date retrieved: 25th May 2023)

The results showed that integrated fertiliser management was more cost-effective and gave more gross margins as well as gross profit margins and benefit-cost ratios compared to single-source fertiliser management. This high profitability is explained by two primary things: the maximum production takes place by the complementary application of organic and inorganic fertilisers and the efficient use and utilisation of labour and production factors and thus the production costs per unit can be-effectively managed[14–17]. It is crucial to mention that farmers combine organic and inorganic types of fertilisers with the purpose not only to earn money but also to get more income. The rate of combination of the biowaste of onions and the NPK fertiliser is very profitable and the greater the ratio of organic to inorganic components, the higher the net profit level[18].

Fertiliser mixtures, both organic and chemical have been found to be more efficient than single fertilisers. Organic composts help to enhance the soil structure and humus and offer beneficial microbes, whereas chemicals supply nutrients that enable quick growth[19]. This balance has the ability to increase yields and keep the soil healthy as well as minimise environmental damage[20]. Similar advantages would be experienced by mixing onion peel biowaste with NPK fertiliser to allow the small business farmer to obtain good harvests, lessen the dependence on chemical inputs, and safeguard their farms.

4. CONCLUSION

The results of this study revealed that the T2 treatment, which combined 50% NPK fertiliser with 50% onion biowaste fertiliser, was the most effective in improving plant growth and yield among all tested treatments. The improved performance observed under this integrated approach is likely due to the balanced supply of nutrients, which delivers essential macro and micronutrients in forms that are readily available for plant absorption. The integration of organic and inorganic nutrient sources not only improves crop yield but also lowers reliance on synthetic fertilisers, thereby supporting more environmentally sustainable agricultural practices.

In addition, the results emphasize the importance of profitability in sustaining long-term crop production systems. The balanced integration of organic and inorganic fertilisers not only enhanced crop performance but also reduced production costs by limiting reliance on costly chemical inputs. Improved nutrient use efficiency and optimised input management under this approach resulted in higher net returns and a more favourable benefit-cost ratio compared with the sole application of inorganic fertilisers.

This study highlights the importance of balancing productivity and profitability in integrated nutrient management. Such an approach enables smallholder farmers to achieve stable yields, increase income, and promote sustainable agricultural intensification. Furthermore, in line with the National Agrofood Policy 2021–2030 (NAP 2.0), which promotes sustainable and environmentally responsible agriculture, the use of onion biowaste fertiliser as part of integrated nutrient management supports nutrient recycling, reduces dependence on synthetic fertilisers, and contributes to a more resilient and sustainable agrifood production system in Malaysia.

It is recommended that future studies explore different combinations of organic and inorganic fertilisers across various crops, soil types, and agroecological conditions, and assess the long-term effects of biowaste-based fertilisers on soil health and fertility.

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6. CONFLICT OF INTEREST STATEMENT

The authors declare that there was no conflict of interest.

7. AUTHORS' CONTRIBUTIONS

Conceptualisation: S. Shampazuraini, N.H Dolhaji, N.S Abdullah
Data curation: S. Shampazuraini, W.N Wan Mohd Noor, S.S Sahmat
Methodology: S. Shampazuraini, W.N Wan Mohd Noor
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Writing (original draft): S. Shampazuraini
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Validation: S. Shampazuraini, W.N Wan Mohd Noor
Supervision: Not applicable
Funding acquisition: Not applicable

8. DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

During the preparation of this work, the author(s) used ChatGPT solely for language refinement and readability improvement. The authors carefully reviewed and edited the manuscript and take full responsibility for the content of the publication.

9. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

Data sharing is not applicable to this article as no new datasets were generated or analysed during the current study.

10. ETHICS STATEMENT

The authors declare that this research did not involve any human participants or animal subjects. All experimental procedures were conducted in accordance with the Safety, Health, and Environmental (HSE) guidelines of Universiti Teknologi MARA.

REFERENCES

1. Jiaying, M., Tingting, C., Jie, L., Weimeng, F., Baohua, F., Guangyan, L., Hubo, L., Juncai, L., Zhihai, W., Longxing, T., & Guanfu, F. (2022). Functions of nitrogen, phosphorus and potassium in energy status and their influences on rice growth and development. *Rice Science*, *29*(2), 166-178. https://doi.org/10.1016/j.rsci.2022.01.005

2. Khan, M. N., Mobin, M., Abbas, Z. K., & Alamri, S. A. (2018). Fertilisers and their contaminants in soils, surface and groundwater. In D. A. DellaSala & M. I. Goldstein (Eds.), *Encyclopedia of the Anthropocene* (Vol. 5, pp. 225–240). Elsevier. https://doi.org/10.1016/B978-0-12-809665-9.09888-8

3. Pahalvi, H. N., Rafiya, L., Rashid, S., Nisar, B., & Kamili, A. N. (2021). Chemical fertilisers and their impact on soil health. In G. H. Dar, R. A. Bhat, M. A. Mehmood, & K. R. Hakeem (Eds.), *Microbiota and biofertilisers* (Vol. 2, pp. 1–20). Springer. https://doi.org/10.1007/978-3-030-61010-4_1

4. Dhaliwal, S. S., Naresh, R. K., Mandal, A., Walia, M. K., Gupta, R. K., Singh, R., & Dhaliwal, M. K. (2019). Effect of manures and fertilisers on soil physical properties, build-up of macro and micronutrients and uptake in soil under different cropping systems: a review. *Journal of Plant Nutrition*, *42*(20), 2873–2900. https://doi.org/10.1080/01904167.2019.1659337

5. Chen, J., Lü, S., Zhang, Z., Zhao, X., Li, X., Ning, P., & Liu, M. (2018). Environmentally friendly fertilisers: A review of materials used and their effects on the environment. *Science of the Total Environment, 613–614*, 829–839. https://doi.org/10.1016/j.scitotenv.2017.09.186

6. Kumar, M., Barbhai, M. D., Hasan, M., Punia, S., Dhumal, S., Radha, Rais, N., Chandran, D., Pandiselvam, R., Kothakota, A., Senapathy, M., Anitha, T., Dey, A., Sayed, A. A. S., Gadallah, F. M., Amarowicz, R., & Mekhemar, M. (2022). Onion (*Allium cepa* L.) peels: A review on bioactive compounds and biomedical activities. *Biomedicine & Pharmacotherapy, 146*, 112498. https://doi.org/10.1016/j.biopha.2021.112498

7. Ifeoma, I. N., Iorhon, A. P., & Chioma, A. G. (2022). Profitability analysis of smallholder rice production under urea deep placement technology and conventional fertiliser application practice in North Central, Nigeria. *International Journal of Agricultural Economics, 7*(3), 108–119. https://doi.org/10.11648/j.ijae.20220703.12

8. Anisuzzaman, M., Rafii, M. Y., Jaafar, N. M., Ramlee, S. I., Ikbal, M. F., & Haque, M. A. (2021). Effect of organic and inorganic fertiliser on the growth and yield components of traditional and improved rice (*Oryza sativa* L.) genotypes in Malaysia. *Agronomy*, *11*(9), 1830. https://doi.org/10.3390/agronomy11091830

9. Gao, C., El-Sawah, A. M., Ali, D. F. I., Hamoud, Y. A., Shaghaleh, H., & Sheteiwy, M. S. (2020). The integration of bio and organic fertilisers improve plant growth, grain yield, quality and metabolism of hybrid maize (*Zea mays* L.). *Agronomy*, *10*(3), 319. https://doi.org/10.3390/agronomy10030319

10. Chandini, Kumar, R., Kumar, R., & Prakash, O. (2019). The impact of chemical fertilisers on our environment and ecosystem. In P. Sharma (Ed.), *Research trends in environmental sciences* (2nd ed., pp. 69–86). AkiNik Publications.

11. Celano, R., Docimo, T., Piccinelli, A. L., Gazzerro, P., Tucci, M., Di Sanzo, R., Carabetta, S., Campone, L., Russo, M., & Rastrelli, L. (2021). Onion peel: Turning a food waste into a resource. *Antioxidants*, *10*(2), 304. https://doi.org/10.3390/antiox10020304

12. Zenda, T., Liu, S., Dong, A., & Duan, H. (2021). Revisiting sulphur—The once neglected nutrient: It's roles in plant growth, metabolism, stress tolerance and crop production. *Agriculture*, *11*(7), 626. https://doi.org/10.3390/agriculture11070626

13. Zhang, Q., Kong, Y., Masabni, J., & Niu, G. (2024). Onion peel waste has the potential to be converted into a useful agricultural product to improve vegetable crop growth. *HortScience*, *59*(5), 578–586. https://doi.org/10.21273/HORTSCI17694-24

14. Durham, T. C., & Mizik, T. (2021). Comparative economics of conventional, organic, and alternative agricultural production systems. *Economies*, *9*(2), 64. https://doi.org/10.3390/economies9020064

15. Adane, M. (2020). Effect of combined organic and inorganic fertiliser on yield and yield components of food barley (*Hordeum vulgare* L.). *Food Science and Quality Management*, *95*(1), 1–8. https://doi.org/10.7176/FSQM/95-01 10.7176/FSQM/95-01

16. Jjagwe, J., Chelimo, K., Karungi, J., Komakech, A. J., & Lederer, J. (2020). Comparative performance of organic fertilisers in maize (*Zea mays* L.) growth, yield, and economic results. *Agronomy*, *10*(1), 69. https://doi.org/10.3390/agronomy10010069

17. Tehulie, N. S., & Tola, T. S. (2020). The effect of organic and inorganic fertilisers on growth and yield of bread wheat (*Triticum aestivum* L.). *Current Investigations in Agriculture and Current Research*, *9*(1), 1161–1166. https://doi.org/10.32474/CIACR.2020.09.000302

18. Gnanasundari, K., Srivignesh, S., Krishna, K. R., Kumar, M., & Kumar, A. R. (2022). Integrated nutrient management in onion: A review. *Ecology, Environment and Conservation, 28*, 182–192. https://doi.org/10.53550/EEC.2022.v28i07s.030

19. Hazra, G. (2016). Different types of eco-friendly fertilisers: An overview. *Sustainability in Environment*, *1*(1), 54. https://doi.org/10.22158/se.v1n1p54

20. Wato, T., Negash, T., Andualem, A., & Bitew, A. (2024). Significance of organic and inorganic fertilisers in maintaining soil fertility and increasing crop productivity in Ethiopia: a review. *Environmental Research Communications*, *6*(10), 102002. https://doi.org/10.1088/2515-7620/ad79be