AGRIVITA Journal of Agricultural Science. 2024. 46(3): 582–589

AGRIVITA
Journal of Agricultural Science
www.agrivita.ub.ac.id

The Effect Onion Biowaste and NPK Fertilizer of Combinations on Yield and Mineral Content of Mustard (*Brassica parachinensis*)

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ARTICLE INFO

Keywords:
Mustard
Mineral content
NPK fertilizer
Peel onion fertilizer
Yield

Article History:
Received: April 4, 2024
Accepted: September 1, 2024

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ABSTRACT

Recent studies have tended to reduce the added quantities of mineral fertilizers by using strategies of combination both organic and chemical. Thus, the effect of a combination of organic and chemical fertilizer was studied from March until August 2023 to investigate the growth, yield and mineral content of mustard as affected by onion biowaste and NPK fertilizer. This experiment was carried out with 5 different treatments and 4 replications, utilizing the Randomized Complete Block Design (RCBD). The treatments consisted of a control with 100% NPK fertilizer (T0), 100% peel onion fertilizer (T1), 50% NPK fertilizer + 50% peel onion (T2), 30% NPK fertilizer + 70% peel onion (T3), 70% NPK fertilizer + 30% peel onion fertilizer (T4). The parameters evaluated in this experiment included plant height, number of leaves, plant fresh weight, and NPK content in the leafy parts. The results showed that there were significantly higher in all studied parameter when using combination of 50% NPK fertilizer + 50% peel onion (T2) compared to the other combinations. Hence, it can be concluded that the combination of NPK fertilizer and peel onion fertilizer is a promising approach to reduce chemical fertilizer application and increase the quality of crops.

INTRODUCTION

The excessive use of chemical fertilizers might have detrimental effects on the environment. Improper use of these fertilizers can lead to negative environmental impacts, particularly on soil and water. It's concerning that many producers lack adequate knowledge of these potential negative effects. In fact, 66.6% of farmers are unaware of the specific soil and water impacts of nitrate pollution (Panin et al., 2019). This lack of awareness is alarming, considering that humans and other living organisms require food and nutrition to maintain health, and plants require a variety of nutrients to grow appropriately. A fertilizer is a substance used to modify the physical, chemical, or biological properties of soil to increase plant growth and crop yields (Rajput et al., 2022). The onion (*Allium cepa* L.) is the most important Alliaceae family member and one of the world's most important vegetables. The onion is a biennial herbaceous plant that is commonly grown annually for bulbs. Onions are extensively used in many culinary preparations; therefore, they command a large internal market (Jat et al., 2022). The mature bulb contains some starch as well as significant amounts of sugar, protein, and vitamins A, B, and C. According to the National Onion Association, the nutrients in onions are as follows: moisture (89%), sugar (4%), protein (1%), fibre (2%), and fat (1%) (Adeyeye et al., 2017). Onion has therapeutic properties as well. In ancient times, onion was thought to be a therapeutic herb (Rajput et al., 2022). Onion is a rich source of carbohydrates, protein, vitamin C, phosphorus, and calcium and possesses good medicinal properties (Ramesh et al., 2017). However, the effect of combination onion biowaste and NPK fertilizer used can have a distinct effect on the plant.

ISSN: 0126-0537

Cite this as: Shampazuraini, S., Dolhaji, N. H., Abdullah, N. S., & Manaf, M. H. A. (2024). The effect onion biowaste and NPK fertilizer of combinations on yield and mineral content of mustard (*Brassica parachinensis*). *AGRIVITA Journal of Agricultural Science*, *46*(3), 582–589. http://doi.org/10.17503/agrivita.v46i3.4531

In various food industries and restaurants, onions are used in multiple ways. It is estimated that more than 100,000 tons of onion trash are generated yearly in some developed countries (Sharma et al., 2016). The most common onion wastes are onion skins, two outer fleshy scales, roots created during industrial peeling, and undersized, deformed, infected, or damaged bulbs (Rodrigues et al., 2017). These wastes are an environmental concern since they are not acceptable for fodder in large concentrations due to the onion's unique aroma (Sadh et al., 2018), and they are also not suitable as an organic fertilizer due to the rapid development of phytopathogenic agents. If this bio-waste is not treated correctly, it may harm our ecosystem and living organisms (Gao et al., 2015). So, here, the dry onion peels are considered waste and have been discarded. We can take advantage of the nutrients instead of just throwing them away. Inorganic chemical fertilizers have contributed a lot to agricultural production. Unwanted wastes, such as farming and food wastes, are appealing resources in terms of green chemistry because they are abundant and have the potential to become green catalytic systems in chemical processes (Chia et al., 2019). Continuous use of inorganic or chemical fertilizers has resulted in depletion in soil fertility (Roba, 2018), pollution in surface water bodies, rapid rate of nutrient loss in different forms, and increased soil acidity with nitrification. Although using chemical fertilizers on vegetables has a quick effect on vegetables, it has long-term adverse effects on human health (Sharma & Singhvi, 2017). Therefore, this study was conducted to investigate the growth and yield of mustard as affected by onion biowaste and to analyze plant mineral content as affected by a combination of organic and inorganic fertilizers of mustard.

MATERIALS AND METHODS

Experimental Design

This research was carried out from March to August 2023 in Greenhouse No. 4 at University Teknologi MARA Melaka Branch, Jasin Campus. A Randomized Complete Block Design (RCBD) was employed with five treatments and four replications were performed. This involved soaking mustard seeds in water and then sowing them into seedling trays with potting soil. After germinating for two weeks, the seedlings were transplanted into 10" x 10" polybag bags and given water twice a day. The first treatment was executed a week after transplantation.

Peel Onion Fertilizer Preparation

The study was initiated after obtaining dried onion peels from a vendor. The peels were allowed to infuse with a liter of water inside a jar that had a lid to prevent infusion. The infusing mixture was then left in a shade for a day. Later, a stainless-steel strainer was used to separate solid portions of the peel from the infusion (Jat et al., 2022). The resulting filtrate was harvested and stored in a clean bottle to prevent contamination. Using similar planning and execution earlier, the NPK fertilizer solution was made by infusing 2 ml of liquid foliar fertilizer concentrate in a liter of water. The ratios expressed in these measurements act as a guide to lead to the final mixture that was contained in a 500 ml bottle.

The research design presupposed the usage of five different treatments to determine the effects of diverse fertilizer compositions. The first of them was the control group, T0, which involved a pure NPK solution (100% NPK). The remaining treatments explored the possible combinations of the infusion from onion peels and the regular NPK fertilizer. T1 treatment only used the onion peel fertilizer (100%). T2 treatment was a 50-50 mixture of the components in equal contribution, 50% onion peel infusion, and 50% NPK solution. T3 was in favor of infusion at a 30% contribution to NPK's 70%, while T4, on the contrary, attributed 70% to NPK and 30% onion peel fertilizer. These categories were officially recognized as follows: 100% NPK fertilizer, 100% onion peel fertilizer, 50% NPK fertilizer + 50% onion peel fertilizer, 30% NPK fertilizer + 70% onion peel fertilizer, and 70% NPK fertilizer + 30% onion peel fertilizer. It was believed that such a variety of treatments would help to determine how the type of fertilizer impacted the growth of plants.

Applying the Treatment

In the experiment, all treatments were carried out in the liquid phase, with each polybag receiving a precisely measured 40 ml of the corresponding fertilizer solution. The application was done by pouring the volume into the substrate while using a measuring cup for accuracy (Jat et al., 2022). In terms of fostering the strong development of the plants, the fertilization treatment was applied weekly. Following the transplantation, the first application was conducted on the 5th day, a measure that was intended to ensure the seedlings had acclimated

to their substrate before the introduction of the application and minimize the risk of stress. In this way, the placid transition of the young plants was intended to create the best possible conditions for their growth.

Data Collection

The two growth parameters that have been chosen to be assessed in this study are plant height. The latter was measured with transparent measuring tape, with measurements being made from the stem base to the apex of the tallest leaf. The results were expressed in centimetres (cm). The second growth parameter was leaf count, which was taken into account through the manual counting of fully expanded, green, intact leaves present on the mustard plant (Waris et al., 2021). These two measurements were taken every week, starting from the week following the quarter of the transplantation procedure. The last measurements were undertaken during the fourth final week of the study. This approach was necessary to compare changes and differences in quantitative indicators.

During the last harvest, the following data were taken into account: plant fresh weight as well as nitrogen, phosphorus, and potassium concentrations in the foliar tissues. Fresh weight plays a significant role in agricultural research activity when determining plant growth, biomass, nutrient content, crop yield, and various treatment responses. It was taken after the harvest was completed using a digital scale of two decimal plates (Waris et al., 2021). The required equipment for the materials was as follows: firstly, to analyse the leave samples for phosphorus and potassium content, it was needed to make use Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES), and secondly, a Carbon, Nitrogen, and Sulphur (CNS) analyser was used to measure the concentration of nitrogen. The results differ and are expressed as the percentage of the nutrient. The analyses were conducted by a laboratory assistant in the Soil Science Laboratory with powdered leaf samples.

Statistical Analysis

The agronomic data obtained from this study was subjected to statistical evaluation using one-way analysis of variance (ANOVA). The data was processed using IBM SPSS Statistics version 21 software and a significance level of 5%. Tukey's B test was used to compare means and differentiate between treatment effects. Microsoft Excel was used to represent the results in a graph, where the conclusion was based on the graph. These forms of analyses and graphical presentations assisted in making deductions from the gathered agronomic information.

RESULTS AND DISCUSSION

In the experiment, different fertilizer treatments significantly affected plant height ($P \leq 0.05$) as shown in Fig. 1. The combination of 50% NPK and 50% peel onion led to the tallest plants at 24.50 cm. T4 with 70% NPK and 30% peel onion followed at 16.75 cm. T3, T0, and T1 had heights of 16.25 cm, 16 cm, and 13.25 cm, respectively. These results are consistent with those found in Anggraini et al. (2021) study, indicating that the 50-50 blend of organic and inorganic fertilizers had a significant influence on plant growth. According to Sarido & Junia (2017), the proper provision of nutrients enhances the growth of plants; thus, T1 had the lowest growth because of the under-supply of nutrients. The difference could also be attributed to the high calcium content in onion skin, which contributed to an increase in mustard plant height. This indicates that the combination of onions enhanced the growth of the plants.

Leaf numbers differed significantly ($P \leq 0.05$) among treatments, as revealed in Fig. 2. T2 and T4 produced the most leaves, followed by T3. T1 and T0 resulted in the fewest leaves. Waris et al. (2021) found that organic fertilizers had a positive effect on soil and promoted the growth of mustard plants. Proper nitrogen supply is vital for the growth of stems and leaves. Cell elongation and division are related processes. T2 being superior to the others may imply that its optimal mixture for the fertilizer supplied enough nitrogen for its growth. Most fertilizers have organic components, which can be attributed to the effective supply of nutrients to the plant. This may imply that peal onion fertilizer coupled with NPK is effective in promoting plant growth (Areche et al., 2023).

There were significant differences in the fresh weight (Fig. 3) of the mustard plant recorded at $P \leq 0.05$. T2 (50% NPK + 50% peel onion) had the highest weight of 81.93 grams. T1 and T0 were the lightest at 9.47 and 13.12 grams, while T3 and T4 followed with 44.05 and 23.63 grams, respectively. Elias et al. (2016) indicated that organic fertilizers are enriched with organic matter

and micronutrients, which promote the growth of roots for a well-nourished plant. The plants also grow faster if inorganic fertilizers are used since they release nutrients quickly. As a result, they have a good effect on fresh weight due to fair growth.

From Fig. 4, it is evident that T4 had the highest % nitrogen, which stood at 0.87%. T1 was second with 0.75% nitrogen concentration and T2 with 0.64% T0 had the least nitrogen content, which was 0.50%. However, T3 was slightly higher with 0.46% nitrogen. According to the study by Sharma & Chetani (2017), the combination of mineral NPK and organic fertilizers led to high plant nitrogen. Organic fertilizers are an excellent nitrogen source that is readily usable without harming beneficial soil microbes and roots. These results indicate that the combination of fertilizers was imperative as far as the nitrogen content of mustard plants is concerned (Mpanga et al., 2019). The findings helped prove that combining onion peel fertilizer with NPK has the potential to increase mustard plant nitrogen content (Ansari et al., 2020).

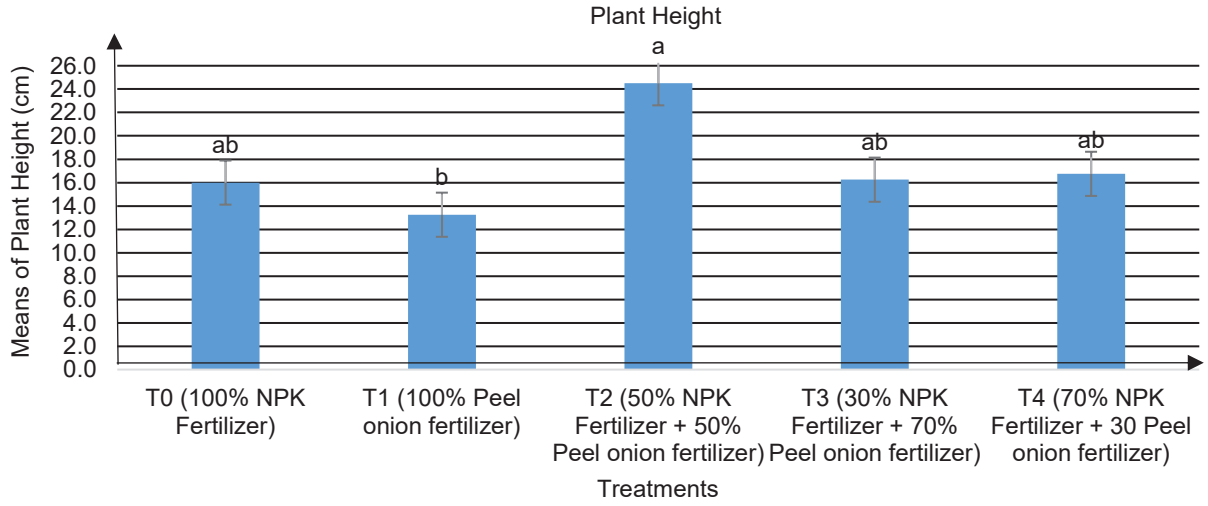

Fig. 1. Plant height as affected by combination onion biowaste and NPK fertilizer.

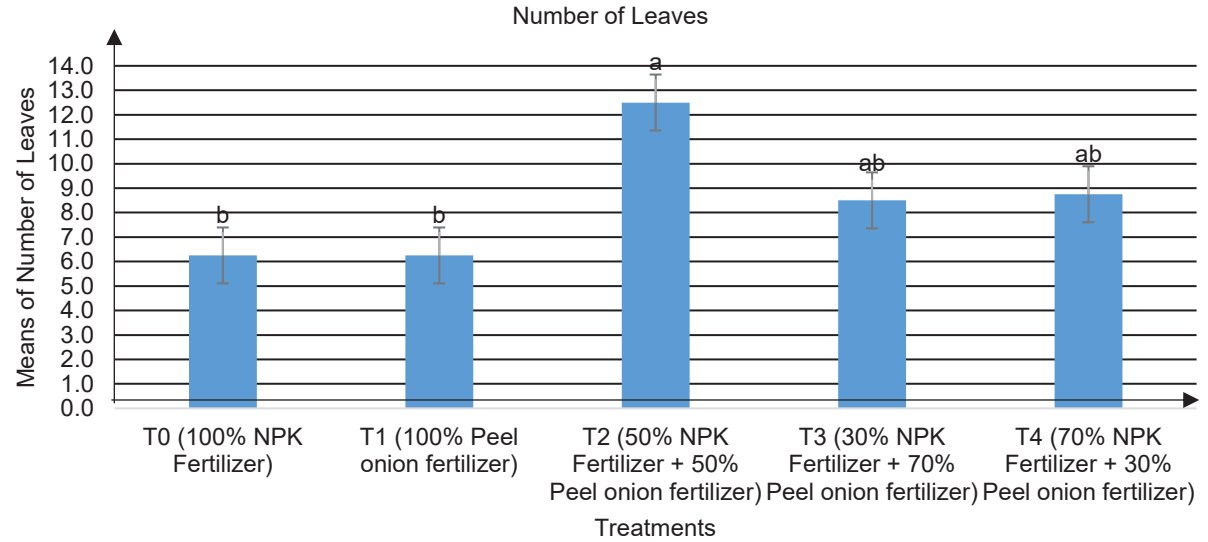

Fig. 2. Number of leaves as affected by combination onion biowaste and NPK fertilizer.

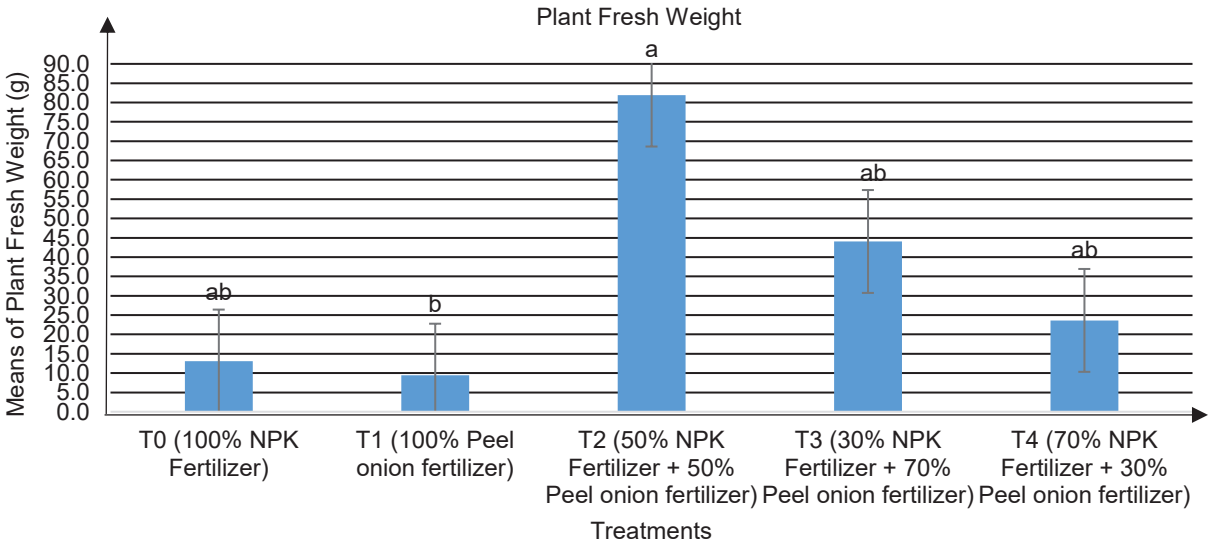

Fig. 3. Plant fresh weight as affected by combination onion biowaste and NPK fertilizer.

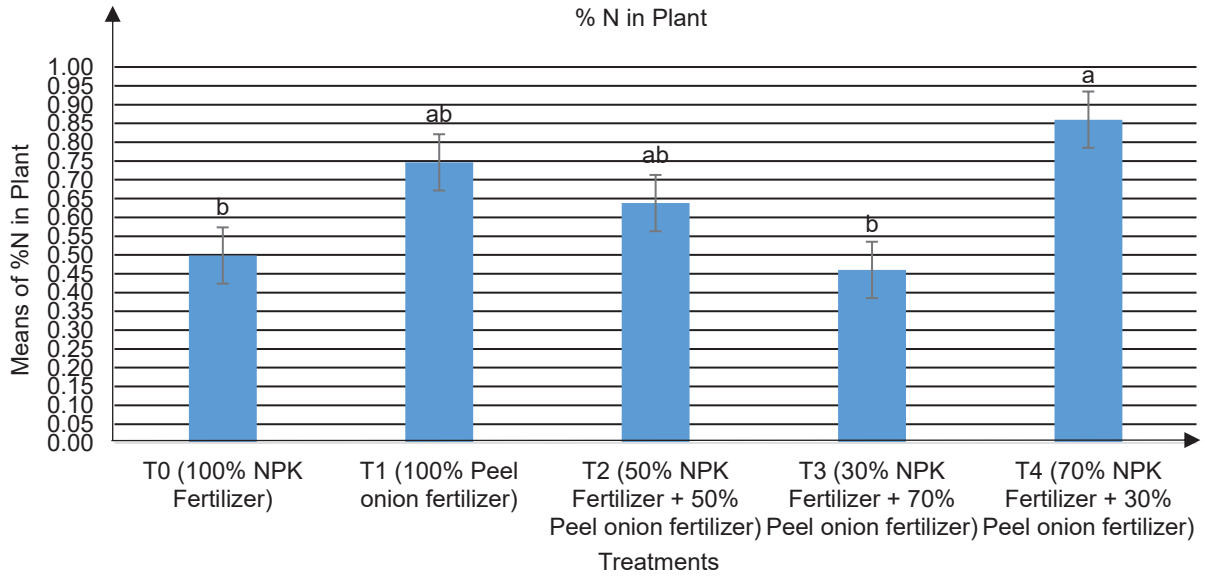

Fig. 4. % N in plant as affected by combination onion biowaste and NPK fertilizer.

There were significant differences (P≤0.05) in phosphorus content in mustard among treatments in Fig. 5. T4, which constituted 70% NPK and 30% peel onion, has the highest mean since % P = 26.23%. The lowest mean was witnessed in T3, which constituted 30% NPK and 70% peeled onion with only 19.75%. The treatments that contained the highest percentage of NPK, especially 70%, had the highest percentage of phosphorus. Mineral NPK only may not provide enough phosphorus, hence the addition of organic fertilizers like the peeled onion. The proportional combination of organic fertilizers like peel onion and mineral fertilizers like NPK also balances the nutrients in the soil (Selim, 2020). Since both fertilizers are essential for plant growth and nutrient sufficiency in plants, they need to be used proportionately to enhance soil fertility and productivity (Itelima et al., 2018).

From Fig. 6, it can be observed that there were no significant variations in potassium content among mustard plants. This means that the treatments did not significantly affect the plant's potassium levels. Bader et al. (2021) report that soil organic manure can improve potassium release, which means there were no significant variations between treatments. In general, it can be concluded that all the treatments contributed equally to the level of potassium in the plant.

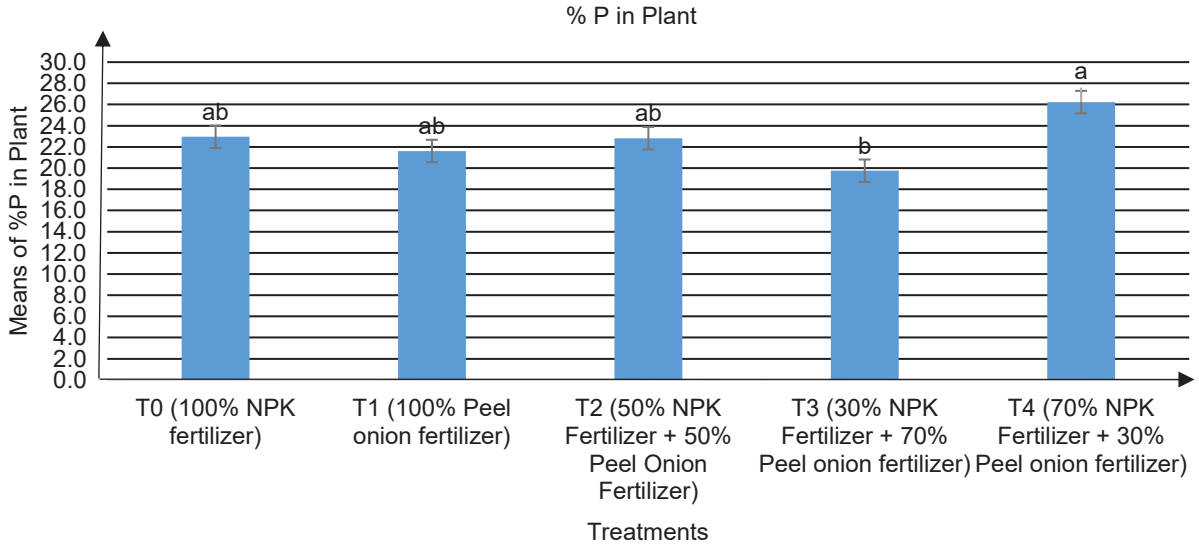

Fig. 5. % P in plant as affected by combination onion biowaste and NPK fertilizer.

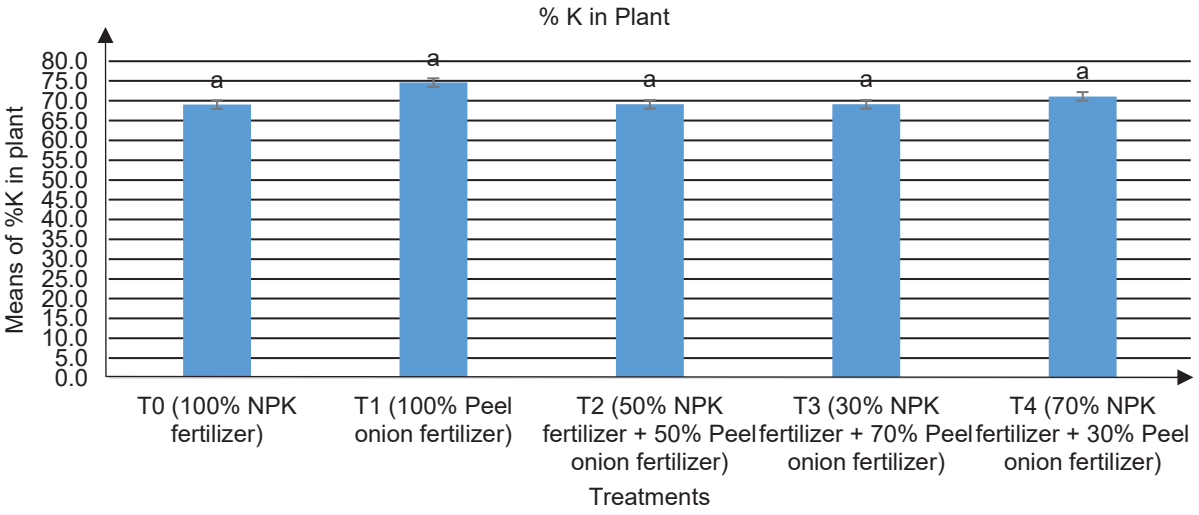

Fig. 6. % K in plant as affected by combination onion biowaste and NPK fertilizer.

CONCLUSION AND SUGGESTION

The Treatment 2, made up of 50% NPK and the other 50% peel onion fertilizer, accounted for the highest growth and best yield. It has been a double success as it had the best yield, and the treatment is beneficial because of its well-proportioned nutritional rate. This brings the opportunity to lower the usage of chemical fertilizers, which has a positive impact on the environment. Moreover, it presents the chance for smallholder farmers to reduce their costs by disposing of onion wastes in an environmentally friendly manner. Furthermore, it is also an excellent option to reduce the usage of chemical fertilizers for vegetables, which can also be applied to functional foods.

Future research in this area might focus on innovative ways of processing onion waste fertilizer in powder instead of the most popular liquid form today. This research would provide the industry with new, more convenient, and practical solutions to optimize agricultural practices. It will also contribute to more in-depth knowledge of diverse onion waste-derived fertilizers and their contribution to sustainable agriculture.

ACKNOWLEDGEMENT

This study was supported by MyRA UiTM and Faculty of Plantation and Agrotechnology, University Teknologi MARA Cawangan Melaka, Kampus Jasin, Malaysia for the opportunity, essential resources and facilities, including a well-equipped greenhouse and laboratory, played a pivotal role in ensuring the seamless execution of all project activities. We are profoundly grateful for the opportunity and infrastructure provided by the institution, which significantly contributed to the successful completion of this research endeavour.

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