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Growth Response and Production of Cabbage *(Brassica Olera Var. Capitata)* on Various Kinds of NPK and Organic Fertilizers

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Abstract: This study was conducted in Pematang Bandar district of Simalungun regency at an altitude of ±150 meters above sea level. This study investigated the growth response and production of cabbage (brassica olera var. capitata) to various types of NPK and organic fertilizers. This study used a randomized block design (RBD) with two treatment factors. The first factor was applying various types of organic fertilizers consisting of three dosage levels: P1 = 4 kg/plot cow manure; P2 = 0.8 kg/plot organic fertilizer by PETROGANIK; P3 = 1.2 kg/plot organic fertilizer by MABAR. The second factor was applying NPK fertilizer consisting of three dose levels: N1 = 3.5 g/plot; N2 = 5 g/plot; N3 = 6.5 g/plot. The parameters observed were: plant height (cm) 2.4 and 6 WAP (week after planting); total leaf (blades); crop formation speed; crop weight per plant (kg); crop weight per plot (kg). The results showed a real response in applying various types of NPK and organic fertilizers. In addition, there was a real response in applying various types of NPK and organic fertilizers to plant height, total leave, crop formation speed, crop weight per plant, and crop weight per plot on cabbage growth and production.

Keywords: Growth Response; NPK; Organic Fertilizer; Production of Cabbage

Introduction

Cabbage (Brassica oleraceae Var Capitata) has important economic value as a source of farmers' income and nutrition. These vegetables contain vitamins, minerals, proteins, carbohydrates and fats for the formation of human body tissues, as well as increasing energy for human muscle activity. Many mineral content such as potassium, calcium, phosphorus, sodium, and iron (Indrayoga et al., 2013).

Cabbage has prospects for development because of its high economic and social value. Cabbage enthusiasts have greatly increased at home and abroad. Cabbage has an important economic meaning as a source of income for farmers and a source of nutrition for the community (Indrayoga et al., 2013). The more population and income increase, the more developed the city center tourism industry and also trade liberalization. It is a potential factor in increasing the demand for horticultural products. The market potential for horticultural products has a high value, especially for cabbage. The demand for cabbage from North Sumatra as of 2017 and 2018 reached 1,728,339 quintals with a land area of 7,872 quintals/hectare.

The Statistics Indonesia for North Sumatra data of 2020 showed that the total cabbage production was 2,195,374 quintals in 2019. However, it was 2,017,698 quintals in 2020, which had decreased compared to the previous year. Several important things need to be considered in the cultivation of cabbage, such as good nutrient fertilization in plants. Fertilization is applying materials containing organic or inorganic chemical elements to improve the chemical conditions of the soil to meet the nutrients properly for plants so as to increase their productivity (Gomies et al., 2012).

The advantage of organic fertilizer compared to inorganic is its function as a granulator to improve the structure of the soil. Organic fertilizers retain more water and last longer, which makes the soil absorb water very well and greatly increases. Organic fertilizers also

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improve living conditions in the soil. Nutrients in organic fertilizers are a source of food for plants. Organic fertilizers are a source of nutrients N, P, and S (Wahyono et al., 2011).

Organic materials can be from compost, green manure, manure, crop residues (straw, stover, corn cobs, sugarcane bagasse, and coconut husks), livestock waste, industrial waste that can be used as agricultural materials, and municipal waste. Compost is the decomposition of former plant and animal waste resulting from the overhaul by fungi, actinomycetes, and earthworms. Green manure comes from all former green plant waste; it can also be from plant parts, such as remaining stems and root stumps after the green tops of plants have been used for animal feed. Manure comes from livestock manure. Livestock waste comes from slaughterhouses such as bones and blood (Helmi, 2017).

Manure derived from animals, such as cows, is an organic chemical to increase the availability of phosphorus, microelements, and reduce the harmful effects of aluminum materials. Manure derived from animals, such as cows, can also provide carbon dioxide in dense canopy plants with limited air circulation. Manure from animals, such as cows, contains a lot of nutrients needed by plants such as N, P, L, Ca, Mg, S, and Bo (Basri, 2018).

The right dose of organic fertilizer by PETROGANIK is expected to be able to optimize the soil so as to increase growth and yield. The use of organic fertilizers and the selection of the right varieties are expected to maximize yields (Abidin et al., 2017). The organic contents of the PETROGANIK can improve soil conditions so that the soil aeration content is excellent. Smooth respiration is very influential on aeration, increasing the population of microorganisms, supporting microbial activity involved in nutrient supply, increasing water absorption and storage, also facilitating water absorption of nutrients by plant roots which greatly affects plant growth (Andara, 2018).

The fertilizer by MABAR is a waste substance consisting of living things such as weathering of plant, animal and human remains. Organic fertilizers are in solid or liquid form used to improve the physical, chemical, and biological properties of the soil. Organic fertilizers contain a lot of organic matter compared to their nutrient levels. Organic materials are from compost, green manure, manure, crop residues, livestock waste, industrial waste using agricultural materials, and municipal waste (garbage). The MABAR contains macro and micro nutrients needed by plants (Siahaan, 2018).

Increasing the cabbage productivity requires adding NPK fertilizer which, in bitter melon cultivation, can increase the production at optimal doses. Nutrients N, P, and K are essential for plants. Increasing the dose of N fertilizer in the soil will directly increase protein (N) levels and crop production. Suppose only the N element is fulfilled without using P and K, then in that case, it can cause plants to fall easily, very susceptible to attack by pests and diseases, and will decrease the product quality. Several studies have shown that organic matter and inorganic fertilizers can increase soil pH, total N, available P and K in the soil, levels and absorption of plant N, P, and K nutrients, and increase crop production. NPK compound fertilizer is expected to help farmers use fertilizer according to plant needs because the composition of N, P, and K can be formulated based on soil tests (Zainullah, 2018).

Method

This research was conducted from January to April 2022 in the Pematang Bandar district of Simalungun regency, in an altitude of ±150 meters above sea level. The materials used were lowland cabbage seeds, cow manure, goat manure, NPK fertilizer, and organic fertilizers by PETROGANIK and MABAR. The instruments used are hoes, machetes, tape measure, stakes, label boards, hand sprayers, stationery, and others.

The method was carried out using a factorial Randomized Block Design (RBD) with two treatment factors: the factor for giving the type of organic fertilizer, with the notation (P), consists of three levels (P1 = cow manure = 10 tonnes/ha = 4 kg/plot, P2 = PETROGANIK organic fertilizer = 2 tons/ha = 0.8 kg/plot, P3 = MABAR organic fertilizer = 3 tonnes/ha = 1.2 kg/plot); the treatment factors for various NPK fertilizer concentrations, with the notation (N), consist of three levels (N1 : 150 kg/ha : 3.5 g/plant, N2 : 200 kg/ha : 5 g/plant, N3 : 250 kg/ha : 6.5 g/plant).

The parameters observed were plant height (in centimeter), total leaf (blades), crop formation speed (in days), crop weight per plant (in gram), and crop weight per plot (in kilogram).

Result and Discussion

Plant Height (cm)

The analysis of variance in Table 1 shows that the tallest plants with ages 14, 28, and 42 DAP (Day after Planting) were in treatment P1 (cow manure), which were 14.34 cm, 20.72 cm, and 30.47 cm, respectively. This result was significantly different from P2 (PETROGANIK) and P3 (MABAR).

The results showed that cow manure produced higher cabbage than the fertilizers by PETROGANIK and MABAR. This situation was due to the cow manure

that contained nutrients of 2.33% N, 0.61% P205, 1.58% K2O, 1.04% Ca, 0.33% Mg, and several other elements. The need for nutrients, especially nitrogen (N), could not be fully met by the growth media. Thus, applying organic fertilizers could increase the availability and absorption of N elements, which are needed in the growth of the vegetative phase of plants. As stated by Mansyur et al. (2021), that the element N serves to stimulate overall plant growth, especially the formation of stems, branches, and leaves. The N can spur the growth of cabbage height.

Table 1. Plant height (cm) at the age 14 DAP, 28 DAP, and 42 DAP, Total Leaf at the age 14 DAP, 28 DAP, and 42 DAP at Treatment On various Kinds of NPK and Organic Fertilizer.

Treatment	Plant Height			Total Leaf		
	14 DAP	28 DAP	42 DAP	14 DAP	28 DAP	42 DAP
P1	14.34a	20.72a	30.47a	9.22a	17.17a	20.58a
P2	14.14ab	20.20b	30.40a	9.03ab	16.11a	20.53a
P3	13.99b	20.12b	29.49b	8.78b	15.78b	20.17b
N1	13.94b	20.01b	29.55b	8.67b	15.64b	20.08b
N2	14.11b	20.45ab	30.36a	9.11a	16.17a	20.56a
N3	14.42a	20.59a	30.44a	9.25a	16.25a	20.64a
P1N1	14.03bc	19.90c	29.71ab	8.83b	15.50cd	20.08a
P1N2	14.17b	20.09ab	30.83a	9.25ab	16.33ab	20.58abcd
P1N3	14.83a	21.27a	30.87a	9.58a	16.67a	21.08a
P2N1	14.04bc	20.01c	30.28a	8.92b	16.00bc	20.17cde
P2N2	14.12b	20.18c	30.42a	9.00b	16.08b	20.75ab
P2N3	14.26b	20.42bc	30.49a	9.17ab	16.25ab	20.67abc
P3N1	13.75b	20.12c	28.67a	8.25c	15.42d	20.00e
P3N2	14.05bc	20.17c	29.83ab	9.08b	16.08b	20.33bcde
P3N3	14.18b	20.08c	29.97a	9.00b	15.83bcd	20.17cde

Table 1 shows that the tallest plants aged 14, 28 and 42 DAP were in the N3 treatment (NPK = 6.5g/plant), which were 14.42 cm, 20.59 cm, and 30.44 cm, respectively. It was not significantly different from N2 (5g/plant) and N1 (3.5g/plant). It shows that NPK fertilizers dan be utilized by plants because, if one is lacking, it will cause a nutrient deficiency, so that plant height and other growth will be disrupted. The nutrient content in NPK fertilizer can provide nutrients in a relatively faster time, resulting in available nutrients that are ready to be absorbed by plants, as well as a greater amount of nutrient content, especially the N element which functions to stimulate the overall vegetative growth of plants, especially the growth of roots, stems, and leaves (Hayati, 2010; Idha & Herlina, 2018; Purba, 2020). For more information, data on the average height of cabbage due to the response to various types of NPK and organic fertilizers can be seen in Figure 1.

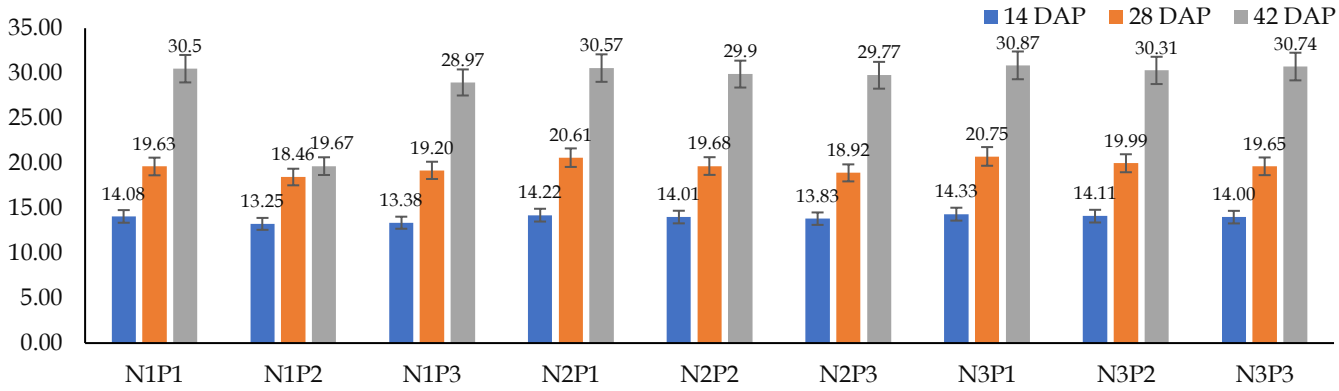

Figure 1. Histogram Average Height of Cabbage due to the response to various types of NPK and organic Fertilizer

Figure 1 shows that the tallest plants aged 14, 28 and 42 DAP in the treatment combinations were N3P1, which were 14.33 cm, 20.75 cm, and 30.87, respectively. At the age of 14 DAP, P1N3 was significantly different from P2N3, P3N3, P1N2, P2N2, P3N2, P2N1, P1N1, and P3N1. At 28 DAP, P1N3 was not significantly different from P1N2, but significantly different from P2N3, P2N2, P3N2, P3N1, P3N3, and P1N1. At 42 DAP, P1N3 was not significantly different from P1N2, P2N3, P2N2, P2N1, P3N3, P3N2, and P1NI, but significantly different from

P3N1. It shows that the combination of treatments due to the provision of various types of organic fertilizers and NPK mutually support plant growth and provide the nutrients needed by plants.

Total Leaf (blade)

The mean difference test results in Table 1 show that the highest total leaves aged 14, 28, and 42 DAP were found in treatment P1 (cow manure), which were 9.22 blades, 16.17 blades, and 20.58 blades, respectively, which was not significantly different from P2, but significantly different from P3. It shows that applying various types of organic fertilizers affects plant growth significantly so as to increase the total leaf. Zulkifli & Herman (2012); Nganji et al. (2022); Mago & Bunga (2020) stated that organic fertilizers contained low nitrogen (N), phosphorus (P), and potassium (K) nutrients, yet contained abundant microelements and needed for plant growth. Fransiska et al. (2018) stated that the treatment of different doses of organic fertilizer would cause a different number of leaves and yields, and the correct dosage would speed up the rate of leaf formation. Organic fertilizers function to bind macro nutrients, such as nitrogen, in the soil so that they will be available to plants.

Table 1 shows that the highest total leaves aged 14, 28, and 42 DAP were in the N3 treatment (NPK = 6.5 g/plant), which were 9.25 blades, 16.25 blades, and 20.64 blades, respectively. These results were not significantly different from N2 (5 g/plant), but significantly different from N1 (3.5 g/plant). This is due to the provision of NPK fertilizer can meet the needs of plant nutrients. The appropriate dose results in maximum vegetative growth, such as the number of leaves. The increase in the number of leaves occurs due to an increase in the number of cells and an increase in cell size. Nitrogen is an element that has a rapid effect on plant growth because N serves as a regulator of the use of potassium, phosphorus, and other elements in the process of photosynthesis. Plants will become stunted and root growth will be stunted if there is a shortage of N (Mutryarny & Lidar, 2018). For more details, data on the average total cabbage leaves due to the response to various types of organic fertilizers and NPK can be seen in Figure 2.

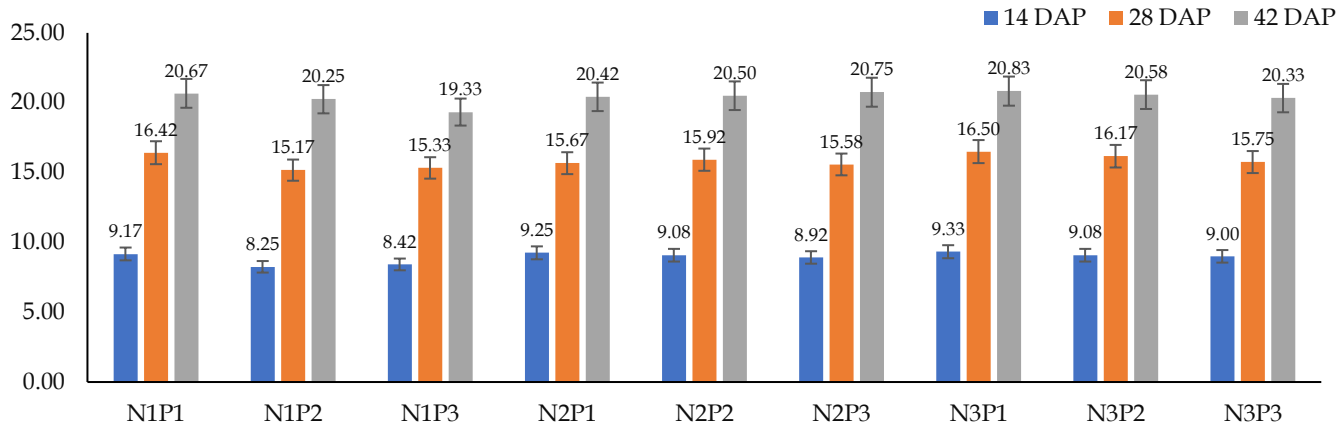

Figure 2. Histogram Average Tota Cabbage Leaves due to the response to various types of NPK and organic Fertilizer

Figure 2 shows that the highest total leaves aged 14, 28, and 42 DAP in the treatment combinations were found in N3P1 with 9.58 blades, 16.67 blades, and 21.08 blades, respectively. At 14 DAP, P1N3 was not significantly different from P1N2 and P2N3, but significantly different from P3N2, P3N3, P2N2, P2N1, P1N1, and P3N1. At 28 DAP, P1N3 was not significantly different from P1N2 and P2N3, but significantly different from P3N2, P2N2, P2N1, P3N3, P1N1, and P3N1. At 42 DAP, P1N3 was not significantly different from P2N2, P2N3, and P1N2, but significantly different from P3N2, P3N3, P2N1, P1N1, and P3N1. It is due to the provision of organic fertilizers and NPK which can be sufficient and provide nutrients in the soil so as to support plant growth. Fransiska et al. (2018) stated that in order to achieve maximum plant growth, the use of organic fertilizers should be followed by inorganic fertilizers, namely NPK, so that the two fertilizers can mutually provide nutrients for plants to achieve maximum growth, since both of them will provide each other with nutrients for plant needs and create more fertile soil and loose soil structure.

Crop Formation Speed (day)

The results of the analysis of variance in Table 2 show that the speed of crop formation was found in treatment P1 (Cow Stables), which was 56.22 days, which was not significantly different from treatment P2 (PETROGANIK, which was 56.89 days), but significantly different from treatment P3 (MABAR,

which was 57.22 days). It shows that applying organic fertilizers can meet the nutrient needs of plants, especially in applying cow manure with a higher nutrient content. Thus, it improves growth and helps the crop formation in cabbage because the better growth of plants will affect the plants in the process of forming crop. It follows Nurahmi et al. (2010) who stated that the need for macro and micro nutrients in optimal quantities will promote better plant growth and yields.

Table 2. Crop Formation Speed, Crop Weight Per Plant, Crop Weight Per plot at treatment at on various Kinds of Organic Fertilizer NPK

Treatment	Crop Formation Speed (day)	Crop Weight per plant (g)	Crop Weight per plot (kg)
P1	56.22b	0.94a	6.72a
P2	56.89a	0.75b	6.60a
P3	57.72a	0.71b	6.29b
N1	57.33a	0.66c	6.20cd
N2	56.56b	0.82b	6.63a
N3	56.44b	0.93a	6.79a
P1N1	57.00ab	0.79b	6.15cd
P1N2	56.00bc	0.88b	6.72b
P1N3	56.67abc	1.17a	7.28a
P2N1	56.67abc	0.56d	6.51bc
P2N2	57.67a	0.84b	6.61bc
P2N3	56.67abc	0.86b	6.68bc
P3N1	57.67a	0.63cd	5.93d
P3N2	57.00ab	0.74bc	6.55bc
P3N3	57.00av	0.77bc	6.40bcd

Table 2 shows that the fastest crop formation speed was produced by treatment N3 (56.44 days), which was not significantly different from treatment N2 (56.56 days) but significantly different from treatment N1 (57.33 days). It shows that applying NPK fertilizer can provide and sufficient nutrients needed by plants so that plants can utilize these nutrients. It follows Alex (2015) who stated that when nutrient needs are met, the roots will absorb nutrients properly, and supports the cell formation process or plant cell enlargement, which directly affects plant growth and production. As in the vegetative phase, plant cells are still actively dividing the plant so more nutrients are required to support crop formation. For more information on the average speed of cabbage crop formation due to the response in applying various types of organic fertilizers and NPK can be seen in Figure 3.

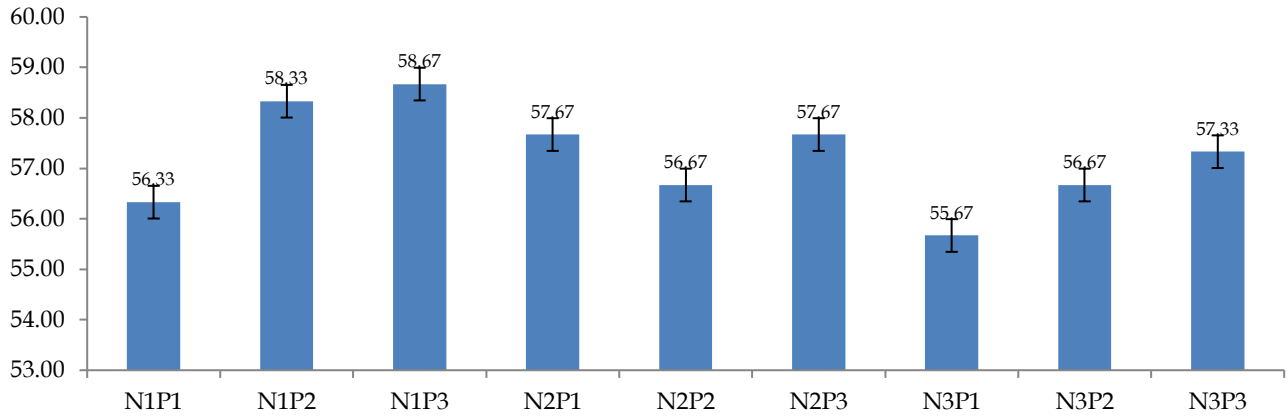

Figure 3. Crop Formation Speed of Cabbage due to the response to various types of NPK and organic Fertilizer

Figure 3 shows that the combination of treatments due to the response in applying various types of organic fertilizers and NPK was significantly different from the cabbage crop formation speed. The fastest crop formation speed was produced by the P1N3 treatment (55.67 days), which was not significantly different from the P1N2, P2N2, and P2N3 treatments but significantly different from the P3N2, P3N3, P1N1, P2N1, and P3N1 treatments. It shows that applying various types of organic fertilizers can provide nutrients to plants so that they can meet plant nutrient needs and accelerate crop formation in plants.

Crop Weight per Plant (g)

The analysis of variance in Table 2 shows that the heaviest weight was produced by P1 (cow manure), namely 0.94 kg. This result was significantly different from the P2 (PETROGANIK) treatment, which was 0.75 kg, and P3 (MABAR), which was 0.71 kg. It shows that the dosage of cow manure is better when compared to PETROGANIK and MABAR fertilizers so that cow manure produces heavier crop weights. It shows that applying cow manure can increase the availability of total nutrient, as stated by Safei et al. (2014), that applying organic fertilizer to the soil can improve physical and biological properties, so plants can grow well and can provide high production.

Table 2 shows that the heaviest weight was produced by the N3 treatment (0.93 kg), which was significantly different from the N2 treatment (0.82 kg), and the N1 treatment (0.66 kg). The difference in the crop weight occurred due to the different doses of NPK given which resulted in different nutrient content. Puspadewi et al. (2016), the nutrients contained in fertilizers are needed for plant growth, especially in stimulating plant vegetative growth. Suppose vegetative growth is maximized, then it that case, it will support optimal generative growth, where the photosynthetic results are stored in the form of food reserves. The use of nitrogen in plants can produce faster vegetative growth, increase the length of the stem, increase the size of the leaves, and give the leaves a greener color. For more details, data on the average crop weight per cabbage due to the response to various types of organic fertilizer and NPK can be seen in Figure 4.

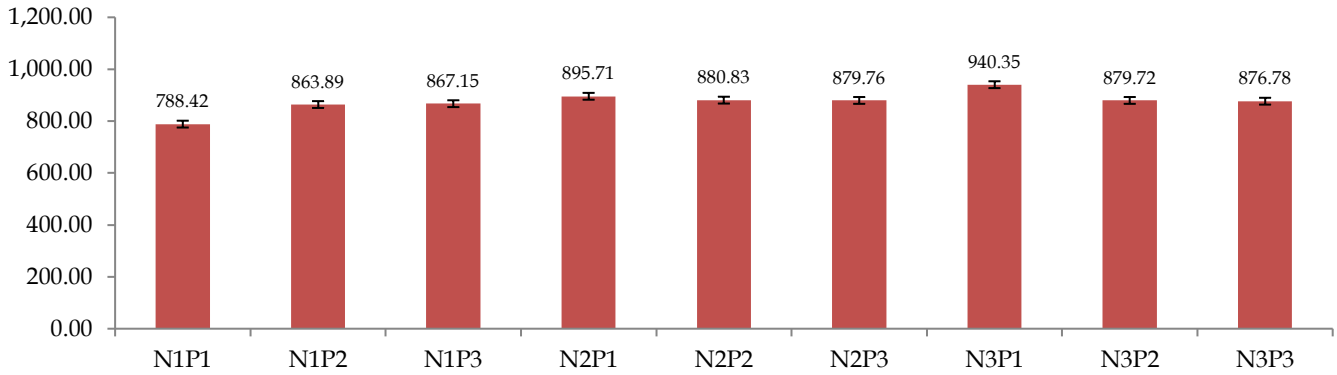

Figure 4. Crop Weight Per Plant of Cabbage due to the response to various types of NPK and organic Fertilizer.

Figure 4 shows that the combination of treatments due to applying of various types of organic fertilizers and NPK was significantly different on the crop weight per plant. Crop weight per plant tended to be higher in the P1N3 treatment, and the lowest in the P2N1 treatment. It shows that applying various types of organic fertilizers and NPK can be used by plants so that they can affect plant weight. It is also supported by P, which stimulates flower formation so that it can accelerate the harvest period.

Crop Weight per Plot (kg)

The analysis of variance in Table 2 shows that the highest crop weight per plot was produced by treatment P1 (cow manure), namely 6.72 kg, which was not significantly different from treatment P2 (PETROGANIK, which was 6.60 kg), but significantly different from treatment P3 (MABAR, which was 6.29 kg). It is because applying cow manure plays an important role in improving plant growth and increasing crop production. Following Sriyanto et al. (2015), that cow manure contains macro nutrients such as Mn, Fe, and Zn. The use of cow manure for soil physically is to increase soil porosity, and biologically increases the activity of organisms, so that the process of decomposing organic matter occurs more quickly in the soil.

Table 2 shows that the application of NPK fertilizer was significantly different on the crop weight per plot. Treatment N3 (6.79 kg) produced the highest crop weight per plot, which was not significantly different from treatment N2 (6.63 kg), but significantly different from treatment N1 (6.20 kg). Puspadewi et al. (2016), that the development of better crop yields is thought to be due to the provision of nutrients available in optimal and balanced amounts. Therefore, applying NPK fertilizer has been able to balance nutrients in plant. Plants will not give maximum results if the nutrients needed are unavailable. Fertilization can increase growth and yields qualitatively and quantitatively. It shows that the combination of treatments of various types of organic fertilizers and NPK can provide greater yields because, in addition to providing greater nutrients to be absorbed by plants, there is also an improvement in the physical, chemical, and biological structure of the soil (Fall et al., 2023; Sharada &

Sujathamma, 2018). Hence, plants can absorb nutrients more optimally so that they can increase crop yields.

Conclusion

The response of applying various types of organic fertilizers is significantly different to plant height, total leaf, crop formation speed, crop weight per plant, and crop weight per plot. The response of applying NPK fertilizer is significantly different to plant height, total leaf, crop formation speed, crop weight per plant, and crop weight per plot. The interaction of responses of applying various types of NPK and organic fertilizers significantly affects plant height, total leaf, crop formation speed, crop weight per plant, and crop weight per plot.

Author Contribution

The author of this article consists of four people. This article was completed because of the cooperation of all members from the research process to completion.

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Conflicts of Interest

The authors declare no conflict of interest.

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