

THE EFFECT OF VERMICOMPOST AND NPK FERTILIZER ON THE GROWTH OF SPINACH (*Amaranthus tricolor*)

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Abstract: Spinach is a plant usually cultivated for its leaves to be consumed as green vegetables. Spinach contains vitamins, protein, fat, carbohydrates, and minerals. Research on the effect of Vermicompost and NPK fertilizer on the growth of spinach has been carried out from July to September 2021 in Lombok, Indonesia. The objectives of the study are to determine: (1) the effect of Vermicompost on the growth of spinach, (2) the effect of NPK fertilizer on the growth of spinach, (3) the interaction effect of Vermicompost and NPK fertilizer on the growth of spinach. This research was conducted experimentally using a factorial, completely randomized design with two factors and three replications. The first factor was the dose of NPK fertilizer which consisted of 4 treatment levels, namely 0 g, 0.5 g, 1 g, and 1.5 g for each plant. The second factor is the dose of Vermicompost, which consists of 5 levels, namely 0 kg, 0.6 kg, 1.2 kg, 1.8 kg, and 2.4 kg for 1 m² of agricultural land. The vermicompost treatment was carried out ten days before planting. The NPK fertilizer treatment was carried out ten and 20 days after planting. Spinach growth parameters were stem diameter, plant height, total leaf, leaf length, and leaf width. The results of the study were: (1) the treatment of NPK fertilizer had a significant effect on the number of leaves, leaf length, leaf width, stem height, and stem diameter of spinach, (2) the application of Vermicompost had a significant effect on the number of leaves, leaf length, leaf width, and stem height but did not significantly affect the diameter of the stems, (3) the optimum dose of NPK fertilizer was 1 gram per plant, (4) treatment 1.8 kg vermicompost resulted in better growth of spinach compared to other.

Keywords: *Effect of Vermicompost and NPK fertilizer, Spinach Growth*

INTRODUCTION

Spinach is a plant usually cultivated for its leaves to be consumed as green vegetables. Spinach is characterized by its oval-shaped leaves, tapered leaf tips with clear leaf veins, erect panicle-shaped flowers, and watery stems. Spinach can grow well in a variety of environmental conditions. A good temperature for spinach plants is 160-200 C. Spinach is cultivated using its seeds. Spinach can be harvested after 25-35 days [1]. Spinach is a short-lived vegetable crop. Spinach stems are reddish or whitish. The flowers of this plant are compound. Spinach leaves are elongated, green leaves. The nutrients contained in spinach are vitamins, protein, fat, carbohydrates, and minerals. The minerals present in spinach include calcium, phosphorus, and iron [2]

Spinach growth can be stimulated by fertilization. At this time, the community depends on inorganic fertilizers because they can provide faster, more practical, and easy-to-obtain harvests. One of the most widely used inorganic fertilizers is NPK fertilizer. Inorganic fertilizers, if used simultaneously in the long term and excessively, will cause adverse impacts such as environmental pollution, damage soil structure, and reduce soil fertility [3]. This type of fertilizer should be combined with organic fertilizers to minimize the adverse effects of excessive application of inorganic fertilizers.

One of the organic fertilizers that can be used in plant cultivation is Vermicompost. Vermicompost can help provide nutrients for plants. It has the nutrients needed by plants, can hold water, can neutralize soil pH, has high macro and microelements that are useful for plant growth, and is environmentally friendly [4]. In line with this description. [5] describes that Vermicompost has a positive impact on plants, including being able to fertilize and loosen the soil so that it is suitable for use as a planting medium, stimulates root, stem, and leaf growth, stimulates flower growth, accelerates harvest, and increases plant productivity.

Several research results show that Vermicompost can stimulate plant growth. Vermicompost significantly increased the number of soybean leaves [6]. The application of Vermicompost with different doses significantly affected stem height, the number of leaves, and the leaf width of tomatoes [7]. The application of Vermicompost can increase plant height and total leaf and lettuce canopy volume [8]. The treatment of Vermicompost has a significant effect on the height growth of coffee seedlings [9]

Based on the description above, research was conducted on the effect of vermicompost and NPK fertilizers on the growth of spinach. The purpose of this research was to determine (1) the effect of Vermicompost on the growth of uproots,

(2) the effect of NPK fertilizer on the growth of spinach, (3) the interaction effect of Vermicompost and NPK fertilizer on the growth of spinach.

RESEARCH METHODS

The materials used in this study were spinach seeds, well water, woven bamboo fence, iron nails, rope, rampage 100 EC, tandem fungicide 325 SC, Furadan 3 GR, bamboo, and small-size iron wire. The tools used are a water pump, hand sprayer, hoe, push arco, machete, sickle, dipper, measuring cup, plastic bucket, and scale. This research was conducted experimentally using a factorial, completely randomized design with two factors and three replications. The first factor is the dose of NPK fertilizer (N) which consists of 4 levels of treatment and the second factor is the dose of Vermicompost (V) which consists of 5 levels of treatment. The level of vermicompost treatment consisted of 0 kg, 0.6 kg, 1.2 kg, 1.8 kg, and 2.4 kg for each m² of agricultural land. The level of NPK fertilizer treatment consists of 0 grams, 0.5 grams, 1 gram, and 1.5 grams for each plant. The vermicompost treatment was carried out ten days before planting. Furthermore, NPK fertilizer treatment was carried out twice, ten days, and 20 days after planting. Spinach growth parameters measured were stem diameter, plant height, total leaf, leaf length, and leaf width. Research data were analyzed by ANOVA [10-11]

RESULT AND DISCUSSION

Spinach Leaf Length

The spinach leaf length was observed when the plant was 27 days after planting. The data from the observation of the spinach leaf length showed variation depending on the dose of Vermicompost and NPK fertilizer. The maximum spinach leaf length was 62 mm. It was obtained using N2V3 treatment, namely 1 gram of NPK fertilizer and 1.8 kg of Vermicompost. The lowest leaf blade length of spinach is 52 mm, found in control. The results of measuring the length of spinach leaves are in table 1.

Data analysis using ANOVA showed that the application of NPK fertilizer could increase the length of spinach leaves. Vermicompost treatment had a significant effect on the length of spinach leaves. The interaction of Vermicompost and NPK fertilizer had no significant effect on spinach leaf length. The increase in spinach leaves' length due to NPK fertilizer's application is due to the nutrient content of nitrogen, phosphorus, and potassium in NPK fertilizers, which can stimulate plant vegetative growth. [12] explained that metabolic activities in plants are influenced by the availability of nutrients nitrogen, phosphorus, and potassium, especially in the vegetative growth phase of plants. Thus, treatment of NPK fertilizer up to a certain dose can stimulate an increase in plant leaf length.

The results of other studies show similar results to the results of this study. The application of NPK fertilizer had a significant effect on increasing leaf length, leaf width, leaf length, and plant height of mustard greens with an optimum dose of 2 grams per plant [13].

Table 1. The Average Length of Spinach Leaves Due to Differences in Doses NPK Fertilizer and Vermicompost at 27 days after planting

Treatment	Leaf Length (mm)	Treatment	Leaf Length (mm)
N0V0	52	N2V0	56
N0V1	53	N2V1	56
N0V2	53	N2V2	57
N0V3	54	N2V3	62
N0V4	54	N2V4	60
N1V0	52	N3V0	55
N1V1	54	N3V1	55
N1V2	54	N3V2	57
N1V3	55	N3V3	58
N1V4	55	N3V4	59

The application of Vermicompost also had a significant effect on increasing the length of spinach leaves. It is possible because Vermicompost contains organic material that can improve the soil's physical, biological and chemical properties. [14] explained that organic fertilizer produced with the help of earthworms has better chemical and biological properties than organic fertilizer produced without the help of earthworms. Vermicompost is an organic fertilizer produced with the help of earthworms. It can increase the available nutrients for plants, improve soil fertility, and add beneficial microbes. The application of various organic materials, such as compost, significantly affected the growth and production of sweet potatoes and improved soil chemical properties and uptake of potassium, nitrogen, and phosphorus in plants and tubers [15].

Spinach Leaf Width

The data collection for spinach leaf width was carried out when the plants were 27 days after planting. The spinach leaf blade width data varies, influenced by the dose of Vermicompost and NPK fertilizer applied. The highest spinach leaf width was 46 mm in the N2V3 treatment, namely the treatment of 1 gram of NPK fertilizer combined with 1.8 kg of Vermicompost. The lowest spinach leaf width data was 41 mm in the N0V0 treatment. The mean data of spinach leaf width is presented in Table 2.

Statistical analysis using ANOVA showed that NPK fertilizer treatment could increase spinach leaf width. The vermicompost treatment had a significant effect on the width of the spinach leaves. NPK fertilizer and Vermicompost

interaction had no significant effect on spinach leaf width. An increase in the width of spinach leaves due to vermicompost fertilizer treatment is possible because Vermicompost can improve the physical and chemical conditions of the soil. [16] explained that the application of Vermicompost on the soil can improve the physical properties of the soil, improve soil structure, and increase the ability to hold water, porosity, and permeability. Some advantages of Vermicompost are providing balanced and available nutrients magnesium, nitrogen, calcium, phosphorus, and potassium, increasing organic matter content, reducing the risk of pathogen infection, and increasing the ability of the soil to provide plant growth hormones. Vermicompost produced using earthworm species *Lumbricus rubellus* contained nitrogen, phosphorus, and potassium nutrients [17]. These three elements are macronutrients needed to support the formation and growth of plant leaves.

Table 2. The Average Width of Spinach Leaves Due to Differences in Doses NPK Fertilizer and Vermicompost at 27 days after planting.

Treatment	Leaf Width (mm)	Treatment	Leaf Width (mm)
NOV0	41	N2V0	42
NOV1	42	N2V1	43
NOV2	42	N2V2	43
NOV3	43	N2V3	46
NOV4	42	N2V4	44
N1V0	42	N3V0	42
N1V1	42	N3V1	42
N1V2	43	N3V2	43
N1V3	44	N3V3	44
N1V4	43	N3V4	42

The application of NPK fertilizer also had a significant effect on increasing spinach leaf width. The results of this study are similar to the results of studies on other plants. The application of NPK fertilizer had a significant effect on increasing the leaf width of sweet corn. The dose of 6 grams of NPK fertilizer for one plant gave better results than other treatments [18]. The application of NPK fertilizer had a significant effect on increasing the leaf width and height of green eggplant plants [19].

Plant Height

Spinach height was observed when the plant was 28 days after planting. The results of measuring the height of spinach vary according to the dose of NPK fertilizer and the applied Vermicompost. The highest spinach was 24 cm, observed in the N2V3 treatment, namely the treatment of 1.8 kg Vermicompost and 1 gram of NPK fertilizer. The lowest spinach was 19 cm,

observed in control. The average height of spinach can be seen in Table 3.

Table 3. The Average Height of Spinach Due to Dose Variation of NPK fertilizer and Vermicompost at 28 days after planting.

Treatment	Average plant height (cm)	Treatment	Average plant height (cm)
NOV0	19	N2V0	20
NOV1	19	N2V1	20
NOV2	20	N2V2	21
NOV3	20	N2V3	24
NOV4	20	N2V4	22
N1V0	20	N3V0	21
N1V1	20	N3V1	22
N1V2	21	N3V2	22
N1V3	21	N3V3	23
N1V4	20	N3V4	22

The data analysis using ANOVA showed that the application of Vermicompost with different doses significantly impacted spinach height. The difference in NPK fertilizer dose significantly increased the spinach's height. The interaction of Vermicompost and NPK fertilizer had no significant effect on spinach height. The increase in spinach height due to NPK fertilizer is possible because the nutrients Nitrogen, Phosphorus, and Potassium are macronutrients needed for plant growth. [20] explained that nitrogen nutrients are components of amino acids, proteins, and the formation of cell protoplasm that can function in stimulating plant growth. Phosphorus plays a role in cell division at the growing point, which affects plant height.

The results of this study were in line with the research [21] results that NPK fertilizer had a significant effect on growth in height and stem diameter of *Gmelina* seedlings. The combination treatment of 10 gr NPK and 30 gr compost gave the most significant effect and the highest growth response compared to the control. Furthermore, [22] concluded that applying NPK fertilizer could increase stem height, leaf length, leaf width, and plant height of green eggplant.

The treatment of Vermicompost can also increase the height of spinach. This study's results align with the results of research on other plants. Research on mustard showed that the application of Vermicompost significantly affected the height of mustard aged 9 to 29 days after planting. The highest plant height was 18.6 cm, obtained from the application of 60 grams of Vermicompost. In addition, the application of Vermicompost can also increase wet plant weight, plant dry weight, and root dry weight [23]. Vermicompost significantly caused an increase in lettuce height. Besides that,

the application of Vermicompost also increased the number of leaves and the volume of the lettuce canopy. The best dose of Vermicompost for lettuce is 50 grams per polybag [24]

Number of Spinach Leaves

The number of spinach leaves was calculated when the plant was 28 days after planting. The data calculating the number of spinach leaves varied according to the dose of vermicompost and NPK fertilizers in each experimental unit. The highest number of spinach leaves was eight leaves found in the N2V3 treatment, namely the treatment of 1.8 kg of Vermicompost combined with 1 gram of NPK fertilizer. The lowest number of spinach leaves was five leaves, found in the N0V0 treatment.

Table 4. Average Number of Spinach Leaves Due to Differences in Doses of Vermicompost and NPK fertilizer at 28 days after planting

Treatment	Number of Leaves	Treatment	Number of Leaves
N0V0	5	N2V0	5
N0V1	5	N2V1	6
N0V2	6	N2V2	6
N0V3	6	N2V3	8
N0V4	6	N2V4	6
N1V0	5	N3V0	5
N1V1	6	N3V1	6
N1V2	6	N3V2	6
N1V3	7	N3V3	7
N1V4	6	N3V4	6

Data analysis showed that the vermicompost application could increase the number of spinach leaves. The application of NPK fertilizer had a significant impact on the number of spinach leaves. The interaction of the application of Vermicompost and NPK fertilizer had no significant effect on the number of spinach leaves. The increase in the number of spinach leaves due to the vermicompost treatment was thought to be caused by an improvement in nutrient conditions in the growing media. The addition of Vermicompost can increase plant tissue nitrogen with the best increase obtained in the application of Vermicompost 3 tons per hectare without inorganic fertilizers, increasing available soil nitrogen with the highest increase obtained in the application of Vermicompost 3 tons per hectare [25]

The application of NPK fertilizer can increase the number of spinach leaves. In other plants, it was also found that NPK fertilizer treatment significantly affected the number of leaves, leaf area index, plant height, and the number of productive branches of eggplant plants [26]. Treatment of NPK fertilizer up to a dose of

6.0 grams per plant significantly increased the number of leaves, plant height, crown width, leaf length, fresh weight, and root length [27]. Application of NPK fertilizer can increase the number of leaves, plant height, and leaf width of bok choy [27]

CONCLUSION

Based on the results of data analysis and discussion in this study, it can be concluded: (1) NPK fertilizer had a significant effect on leaf number, leaf length, leaf width, stem height, and stem diameter of spinach, (2) vermicompost application had a significant effect on leaf number, leaf length. Leaves, leaf width, and stem height had no significant effect on spinach stem diameter, (3) The optimum dose of NPK fertilizer was 1 gram per plant, (4) treatment of 1.8 kg of Vermicompost resulted in better spinach growth compared to other treatment.

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