

# Effect of NPK fertilizer and microbial consortium to growth and production of garlic (*Allium sativum* L.)

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**Abstract.** Garlic productivity in Indonesia is relatively low due to ecological fitness, agronomic performance, and pest losses. For the reason, the research was objected to study the effect of microbial consortium and NPK fertilizer toward the growth and production of garlic. This research was conducted at the experimental field of the Indonesian Vegetable Research Institute situated at 1.300 m asl in Lembang – West Java – Indonesia from October 2018 until February 2019. The experiment was arranged in randomized block design, consisted of 6 treatments, and 3 replications. The treatments were: 1) no microbial consortium + no NPK fertilizer (negative control), 2) no microbial consortium + 50% NPK fertilizer, 3). no microbial consortium + 100% NPK recommendation, 4) application of microbial consortium + no NPK, 5) application of microbial consortium + 50% of NPK recommendation, and 6). Application of microbial consortium + 100% of NPK recommendation. The results showed that there was no significant effect of NPK fertilizer and the microbial consortium on the growth and production of garlic. However, the application of microbial consortium + 50% of NPK recommendation performed best on plant height and number of leaves, while application of microbial consortium only resulted in the best pseudostem growth and yield component of garlic.

## 1 Introduction

The economic value of garlic throughout the world in recent years has continued to increase so that increasing production and quality of garlic has become the main focus and guidance of farmers and researchers in the world [1]. China occupies the first place as the largest garlic producer in the world, which in 2016 China was able to produce garlic reaching 21,197,131 tons [2]. The high amount of production makes China can export garlic production to other countries and get huge profits. In Indonesia alone, garlic (*Allium sativum* L.) is one of the leading horticultural commodities that can be strived to become self-sufficient in the next few years. The self-sufficiency program aims to meet the needs of national garlic, reduce imports, and improve farmers' welfare.

One of the problems experienced by farmers is mainly related to the low productivity of garlic in Indonesia. One of the factors is the inaccurate method of fertilizing which will impact on soil fertility and declining yields of farmers. Fertilizer is one of the most important things, so availability is necessary for the sustainability of soil productivity and plants and food security [3]. Kalay *et al.* [4] states that fertilizer is considered to have a very big role in the crop cultivation system because it can affect the process of improving physical, chemical, and biological soil fertility so that it affects the growth and production of plants.

A fertilizer that is very commonly used by farmers is NPK fertilizer. This fertilizer is included in inorganic fertilizers that contain major nutrients such as nitrogen, phosphorus, and potassium. Chemical fertilizers do not

provide carbon compounds that contribute to the improvement of physical and biological properties of the soil, consequently if used incorrectly the soil structure is damaged and soil biological activity will be reduced so that proper and balanced fertilization is recommended to increase the efficiency of fertilizer use and improvement of physical conditions and soil biology.

The addition of biological microbes from organic fertilizer can have a positive impact on plant growth and production. The addition of biological microbes can be given in the form of a consortium. The microbial consortium is a kind of organic fertilizer consisting of a collection of microbes that work together in a group so that it has more ability to degrade an organic compound [5]. The results of the addition of the microbial consortium are the availability of nutrients for plants for metabolic processes, increased soil fertility and quality of crop yields through an increased biological activity that interacts with physical and chemical properties.

The use of microbial consortium combined with NPK fertilizer is long-term sustainable nutrient management that can be beneficial for improving the quality of soil fertility [6]. Research on the response of garlic plants to the use of NPK fertilizer and the addition of a microbial consortium has never been done, therefore this study aims to determine the effect of the use of NPK fertilizer and a microbial consortium on the growth and production of garlic.

This study discusses the use of NPK fertilizer and a microbial consortium on the growth and production of garlic

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## 2 Methods

### 2.1 Time and Place of Research

The research was carried out in the Experimental Garden of Indonesian Vegetable Research Institute at an altitude of 1,300 m asl in Lembang - West Java - Indonesia in October 2018 to February 2019.

### 2.2 Procedures

The study was arranged in a randomized block design (RBD) consisting of 6 treatments and 3 replications. The treatments tested included: 1) without a microbial consortium + without NPK fertilizer (negative control) (M0K0) 2) without a microbial consortium + NPK fertilizer 50% recommended dosage (M0K1) 3) without a microbial consortium + NPK fertilizer 100% recommended dosage (M0K2) 4) microbial consortium + without NPK (M1K0) 5) microbial consortium + NPK 50% recommended dosage (M1K1) and 6) microbial consortium + 100% NPK (M1K2). The data obtained were then analyzed by the Tukey test (BNJ).

## 3 Results and Discussion

Increased plant growth in each treatment is presented in table 1, including data on plant height, pseudo-stem length, and the number of leaves.

**Table 1.** Characteristics of plant growth at seven weeks after planting.

Treatment	Plant height	Pseudo Long Rods	Number of leaves
M0K0	50.43 <sup>ab</sup>	8.28 <sup>a</sup>	6.43 <sup>a</sup>
M0K1	45.10 <sup>b</sup>	7.37 <sup>b</sup>	6.20 <sup>a</sup>
M0K2	52.27 <sup>a</sup>	7.89 <sup>ab</sup>	6.40 <sup>a</sup>
M1K0	52.96 <sup>a</sup>	7.56 <sup>ab</sup>	6.60 <sup>a</sup>
M1K1	55.42 <sup>a</sup>	7.64 <sup>ab</sup>	6.60 <sup>a</sup>
M1K2	51.42 <sup>ab</sup>	7.71 <sup>ab</sup>	5.97 <sup>a</sup>
HSD 5%	6,83	0,75	0,75

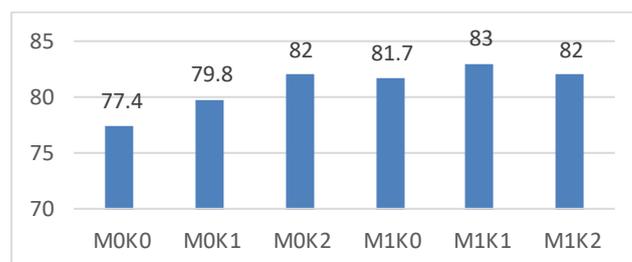
The results of this study indicate that the plant height character in the microbial treatment with NPK 50% of the recommendations (M1K1) can show the best plant height character even though the results of statistical tests do not show any differences with some other treatments, whereas the treatment without microbes with NPK 50% from the recommendation (M0K1) shows the lowest plant height and no difference with treatment without microbes and without NPK (M0K0). On the character of pseudo-stem length treatment without microbes with NPK 50% fertilizer showed the lowest pseudo-stem height, while for the

character of the number of leaves between the test treatments did not show differences.

The results of this study indicate the influence of NPK fertilizer application and the addition of biological microbes to the height characteristics of garlic plants, the addition of microbial treatment with NPK 50% of the recommendation (M1K1) can increase the growth of garlic plant height by 10 percent compared to negative control treatments (without NPK and microbes) whereas when compared with treatments without microbes with NPK 50% (M0K1) it can increase plant height growth by 22.88%.

The increase in plant height in the treatment of microbial consortia and 50% NPK fertilizer is the result of the availability of nutrients needed by the garlic plants. Even though the dose of NPK fertilizer given is only 50% of the recommended dose, the microbial consortium can compensate for the nutrient requirements that plants need for vegetative growth. Suprpto *et al.* [7] states that onion plants require the availability of macronutrients, especially nitrogen (N), phosphorus (P) and potassium (K) insufficient and balanced amounts, both from inorganic fertilizers and organic fertilizers. Fertilization with a microbial consortium can provide nutrients both macro and micro and help improve the development of soil microorganisms which then regulate nutrient availability. This is reinforced based on the results of research Kalay *et al.* [4], which states that the microbial consortium can increase plant height growth with nitrogen fixation bacterial content by providing NH<sub>3</sub> and subsequently converted to NH<sup>4+</sup> and NO<sup>3-</sup>. Nitrogen, phosphorus, and potassium nutrient needs that are fulfilled can affect the total microbial population in the soil. According to Agustian *et al.* [8], an increasing microbial population indicates that the supply of food or energy needed by microbes for survival has been fulfilled, therefore the production of phytohormones such as auxins and cytokines will increase and affect the growth of garlic plants. Increased auxin production will have an impact on performance which stimulates cell extension and stimulates the formation of flowers and seeds in plants.

The provision of microbial and NPK consortium also affects the growing ability of garlic (Figure 1), the percentage of the growing power of each test treatment is presented in the figure below.



**Figure 1.** Percentage of the growing power of garlic

The results of this study indicate the M0K0 treatment (without microbes and NPK fertilizer) showed the lowest growing power of 77.4% while the microbial treatment with 50% NPK (M1K1) showed the highest growth power of 83%, this indicated the M1K1 treatment was able to increase the ability to grow garlic and showed the best treatment compared to other treatments. One of the low growth power caused by the intensity of plant diseases, namely fusarium wilt disease. The intensity of fusarium disease in the treatment without a microbial consortium is higher than in the treatment of a microbial consortium. According to Yanti [9], 2 inhibitory mechanisms can be carried out by a microbial consortium, namely direct inhibition by inhibiting the growth of plant pathogens through antagonism mechanism, among the microbes contained in the microbial consortium some microbes are antagonistic and can produce antibiotics such as *Pseudomonas* that produce antibiotics such as phenazines, pyrrolnitrin, pyocyanin, phloroglucinol and pseudomonic acid [10]. The next mechanism is indirect inhibition, by stimulating plant growth by facilitating the uptake of nutrients in the environment such as nitrogen retention from the air or by producing growth hormones such as auxin, gibberellins, and cytokines so that plant growth is better and more resistant to disease.

Besides the presence of microbial content, the availability of macronutrients such as nitrogen (N), phosphorus (P), and potassium (K) also affect the resistance of garlic plants to the percentage of mortality. The balance of nutrients from NPK fertilizer when it is reached will have an impact on the hardness of plant tissue so that plants become stronger and more resistant to disease attacks. The effect of NPK fertilizer treatment and the addition of a microbial consortium to garlic yields is shown in Table 2.

**Table 2.** Garlic Harvest Results

Treatment	Harvest Yield (Kg)
M0K0	1.35
M0K1	1.12
M0K2	1.47
M1K0	1.78
M1K1	1.83
M1K2	1.36

The results of this study showed that treatment with the addition of microbes with NPK 50% (M1K1) gave the highest yield compared to other treatments. The addition of a microbial consortium with 50% NPK could increase the yield of garlic by 35.6% compared to yields without a microbial consortium and NPK. Razzak *et al.* [11] stated that generally the yield and yield of high garlic bulbs were due to the effects produced by non-symbiotic N<sub>2</sub> binding bacteria on the morphology or physiology of the root system. *Azotobacter* and *Azospirillum* contained in the microbial consortium produce IAA, gibberellins, and

cytokinins in sufficient quantities, as well as synthesizing some vitamins. This is in line with Zaki *et al.* [12] which states that the addition of a microbial consortium can increase the surface area and root length to increase the branching of the root hairs, then there is a major increase in the absorption of nutrients and water adsorption from the soil which ultimately results in larger plant tubers.

## 4 Conclusion

The addition of a microbial consortium and NPK fertilizer can affect the growth of plant height, the percentage of plant growth, and yield of garlic plants. The addition of a microbial consortium and the use of NPK 50% of the recommendations were able to show the best results both in terms of plant height growth, percentage of plant growth, and yield of garlic compared to other test treatments.

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