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The influence of fertilizer types on the growth of garlic in north Toraja

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Abstract

Garlic is one of the typical highland plants that is widely used for medicine and seasoning (food). The white bottom has many benefits and has been developed by cultivation by the community including in North Toraja Regency. The purpose of the study was to analyze the effect of applying fertilizers of different types on garlic plants. The research method used was an experimental method with a Complete Randomized Design Technique, consisting of 4 different types of fertilizers with an observation time of 8 and 15 weeks after planting with 2 repeats so that 16 observational data were obtained. Data analysis was carried out with a parametric statistical analysis approach with the Anova real difference test technique (Analysis of variance). The results of the study obtained that based on the number of leaves obtained a significant difference in the influence of fertilizers. Similarly, at plant height, the same conditions are obtained, namely significant differences in all types of fertilizers. Thus, it is concluded that the influence of fertilizers is very different markedly on the growth of garlic plants, both in terms of the number of leaves and the height of the plant.

Keywords: Influence; Fertilizer; Garlic; North Toraja

1. Introduction

Garlic (*Allium sativum* L.) or also known as garlic is the name of a plant from the genus Allium as well as the name of the bulbs produced (Block, 2010). Garlic has been known for a long time to be used as a seasoning in the kitchen (cooking) and as medicinal (Rivlin, 2001). A bioactive substance that acts as an antibacterial in garlic is volatile allicin with sulfur content (Harris et al., 2001); (Johnston N, 2002); (Emir et al., 2022). Garlic (*Allium sativum* L.) is one of the bulbous vegetable crops that are widely grown in various countries in the world including Indonesia (Samadi, 2000). Garlic has many other names known to the public, such as; in North Toraja it is called "lasuna moputi", in Makassar it is called "lasuna kebo" and in Java, it is called onion. Generally, people only use the tuber part, which is a spice in the kitchen (cooking) (Wibowo, 2007). The results showed that garlic has the potential as a raw material for medicines to cure various diseases(Samadi, 2000). The results of a study in the International Journal of Medical Science and Public Health in 2016 found that garlic can treat cholesterol. Researchers found the benefits as a cholesterol drug came from the content of allicin which inhibits enzymes that play a role in making cholesterol (Barnes et al., 2007). Uniquely, allicin will only be produced by garlic when the cloves are cut, ground, or crushed by chewing. According to (Amagase, 2006) that garlic is one of the plants with a high content of active compounds. These active compounds have a positive impact and are of great benefit to the body such as; allicin, protein, vitamins B_1, B_2, C, and vitamin D. Further (Meredith, 2008) states that the active compound that functions as an antioxidant in garlic is allicin. Cut or crushed garlic will cause allinase to convert alliin to allicin (diallylthiosulphinate or 2- propionyl-2-propanediol sulphinate). Allicin is unstable so it is easily decomposed. The ability of allicin to suppress the production of nitric oxide (NO) by controlling iNOS mRNA at low concentrations and controlling CAT-2 mRNA at high concentrations. Through this mechanism, can prevent reactions due to free radicals (Benkeblia, 2004). The results of other studies conducted (Ankri & Mirelman, 1999) It is proven proved he compound allicin in garlic is very effective in inhibiting the growth of penicil (Rukmana, 1995) shows

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that the allicin content in garlic extract also has antifungal activity by combining with proteins so that it will attack microbial proteins and will eventually kill these microbes (Kim et al., 2004).

The high benefits of garlic, which is not only a seasoning ingredient in cooking food but also as for various diseases, make garlic one of the main needs of society (Yunaha et al., 2008); (Kaur et al., 2021). Nowadays the production of garlic in medicine has been widely developed especially as an herb such as; Garlic (Kemper, 2000). The increasingly high need requires that the availability of garlic must be maintained. The cultivation of garlic plants is quite easy but requires fertile, loose soil, and contains a lot of organic matter, such as alluvial soil, regosol, and latosol (Santoso, 2000). Garlic growth will be better and the yield will be maximum when cultivated on loamy or light sandy soils(Samadi, 2000). Further (Sarwadana & Gunadi, 2007) that with a high clay content will inhibit the growth of garlic. In addition, garlic cultivation also requires good drainage of land conditions. Garlic can grow well at a soil pH of 5.5-7.5 with an optimal pH ranging from 6.5-7. Garlic growth that is relatively easy and does not require relative time makes garlic as on the commodities that are widely grown by farmers, including in North Toraja Regency. Garlic is suitable for cultivation in a dry climate with a temperature of 15-20 °C with precipitation of 110-200 mm per month or 800-2,000 per year. Thus, garlic cultivation will be better if it is cultivated in the highlands, which is arounare700-1000 meters above sea level. This is in by average height of North Toraja Regency, which is above the altitude between 600-2800 meters above sea level. However, garlic production in North Toraja Regency is still relatively low, which was recorded at 298 tons in 2020. This is because there are still few people who grow garlic. While the garlic center in South Sulawesi is Enrekang Regency which is a neighboring district with North Toraja Regency which also has relatively the same contours, climate, and topography as the region. According to (Wijaya et al., 2014) that garlic production in Indonesia has not been able to meet the demand for people's food needs, causing a considerable difference and gap between domestic consumption and production. Central Java and West Nusa Tenggara are the largest garlic production centers in Indonesia. Garlic production from 2014 to 2016 increased by around 3-5% annually but was still unable to meet market demand, this caused a production deficit that required the government to import to meet the consumption of the commodity y.(Wibowo, 2007). Garlic imports in 2017 reached 366,753.4 tons and it is estimated that the demand for garlic is increasing.

For this reason, it is important to continue to increase garlic production, including in the North Toraja Regency area. Efforts to increase production can be done through proper land processing or with the right fertilization system. Tillage can be carried out by plowing for bulking, as well as the land must be cleared of plant residues and weeds. Then the field is left for 10 to 2 weeks (14 days) before bulking. Take measurements of soil pH. Make sure that the pH of the soil is in neutral conditions. If the soil pH is acidic, it is necessary to add lime to increase the soil pH. The addition of lime can be carried out simultaneously with the processing of the land. At a soil pH of 5, then add lime at a dose of dolomite 5.5 tons per hectare, and at a soil pH of 5.5 add 3.1 tons per hectare, and at pH 6 add 0.75 tons per hectare. Next, make the beds and their waterways to ensure the drainage system. Beds are made with a size of about 60-80 cm in width and 40-50 cm in height, with the length adjusting the land area. After proper tillage of the land, the next important thing is to fertilize the plant. The first fertilization carried out is basic fertilization. Basic fertilization is given simultaneously with the processing of the land, by sprinkling it on the surface of the soil and then leveling. In addition, fertilization is also given to run beside the rows of plants and then closed again using the soil. The basic fertilizer applied, can be manure at a dosage of 20 tons per ha, urea 200 kg per, TSP 130 kg per ha, and ZK 200 kg per ha. Furthermore, follow-up fertilizer is applied after the plant is 15 days old (2 weeks), namely urea fertilizer as much as 100 kg per ha. The second fertilization during the planting (maintenance) period is given after the plant is 35 days old, that is, ZA fertilizer as much as 100 kg per ha. Fertilizing becomes an important thing in the cultivation of garlic. For this reason, it is necessary to know the right dose of fertilization for garlic cultivation activities in North Toraja Regency, so that production can increase.

2. Material and methods

2.1. Description of the study sites

The study was conducted in the Rantepao District, North Toraja Regency, and South Sulawesi Province. The study was conducted from May to June 2022. The Rantepao District is one of the horticultural crop centers in North Toraja Regency. The area is expected to become a fruit and vegetable center.

2.2. Method of the study

The research method used was quantitative research through an experiment. According to (Yusuf & Daris, 2018), Experiment research is a type of controlled research that can be carried out on a laboratory scale or carried out directly in the field. The study was conducted using a Complete Randomized Design with 2 factors, namely the type of fertilizer

as the main plot and plant material as the child plot. The main plot factor consists of 4 levels, namely, P_1 (ZA + TSP chemical fertilizer), P_2 (cow manure), P_3 (chicken manure), and P_4 (liquid organic fertilizer), and the plot child factor consists of 2 levels, namely bulbil and garlic cloves. There were 8 combinations of treatments with 2 observation test, so t6 data were obtained.

2.3. Method of collecting data

Observation of the effect of fertilizer application includes two important parts, namely, observation of vegetative growth and observation of yield components. Observations of vegetative growth include a) Plant height (cm), measured from soil level to the highest leaves starting from 8 MST (weeks after planting) and 15 MST. B) Number of leaves calculated is the number of whole leaves per plant from 8 MST and 15 MST.

2.4. Method of data analysis

Data processing is carried out by analyzing the real difference test with the Anova (Analysis of Variance) approach. ANOVA or also known as Anava (variance analysis) is a technique or method of parametric statistical analysis used to test the average comparative hypothesis of several samples, with interval or ratio data. In the analysis of variance known terms of the classical test normality test and homogen. Only data that meets normal data (normally distributed) and homogen data can be tested for real differences with the Anova technique. According to (Yusuf & Daris, 2018) if the data is not normally distributed and is not homogeneous, it is stated that it does not meet the prerequisites of the classical test, so data improvement must be carried out or tested with a non-parametric statistical approach. Meanwhile, to see the differences between the four treatments, a further test was carried out (Post Hoc) with Tukey HSD (Honestly Significance Difference).

3. Results and Discussion

Based on the results of soil analysis fertilizing affects the chemical elements in the soil. The results of soil chemical analysis after fertilization treatment appeared to have increased elements K_2O, P_2O_5, K-total, N-total content, KTK, and P content available. According to (Hardjowigeno, 2003) that the value of the results of the chemical analysis of the soil obtained is appropriate. Chemical fertilizer treatment ZA + TSP, and cow manure (P_1 and P_2), where the pH of the soil decreases due to the addition of organic matter and sulfur from fertilization activities. This is in line with the (Wahyudi, 2009) that the addition of organic matter can increase or decrease the pH of the soil, and depends largely on the type of organic matter being added. Meanwhile, according to (Sianturi & Ernita, 2014) that chemical fertilizers (ZA) are fertilizers that contain ammonium sulfate and provide additional nitrogen and sulfur nutrients to plants. The main use of ammonium sulfate is as a fertilizer for alkaline (alkaline) soils. Ammonium ions in the soil are released and form a small number of acids, which lower the pH of the soil. Sulfur is the fourth major plant nutrient after nitrogen, phosphorus, and potassium. It is very important for the synthesis of amino acids such as cystatin, cysteine, and methionine components of vitamin-A which, can also activate certain enzyme systems in plants. Sulfur content the can help evaporation of bioactive substances that act as antibacterial in garlic, namely allicin (Harris et al., 2001) (Johnston N, 2002). The pH of the soil in the experimental area is good enough according to what was stated by (Tisdale et al., 1985) i.e. the degree of soil acidification (pH) that garlic likes most is 5.5–7, while the pH is below 5.5 then the soil must be whitewashed.

Table 1 Results of measuring the number of leaves in 4 treatments

Fertilizer Type	Number of Leaves (strands)			
	8 MST		15 MST	
	U1	U2	U1	U2
P1 (chemical fertilizers ZA+TSP)	5.5	5.2	7.5	7.6
P2 (organic fertilizer from the cowshed)	6.0	6.1	8.7	8.5
P3 (organic fertilizer from the chicken coop)	5.8	6.0	8.3	8.0
P4 (liquid organic fertilizer)	5.6	5.7	8.4	8.2

The results of the observations showed that there was an increase in the number of leeks based on the number of days of observation. To find out whether there are noticeable differences in the results of treatment based on different types

of fertilizers to garlic growth in North Toraja Regency, an inferential analysis was carried out with the Anova real difference test approach (Analysis of Variance). The results of the Anova analysis were obtained as follows:

Table 2 ANOVA test analysis results

Dependent Variable: Number of Leaves					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	25.014[a]	7	3.573	173.260	0.000
Intercept	771.451	1	771.451	37403.667	0.000
Fertilizer	1.587	3	0.529	25.646	0.000
Time	23.281	1	23.281	1128.758	0.000
Fertilizer * Time	0.147	3	0.049	2.374	0.146
Error	0.165	8	0.021		
Total	796.630	16			
Corrected Total	25.179	15			

a. R Squared = .993 (Adjusted R Squared = .988)

The results of the different test analyses (Anova) appear that there is a difference in fertilizer application to plant growth, namely the number of leeks, where the Sign value (0.000) or very different is significant. The difference is seen in the following Tukey HSD Post Hoc test results:

Table 3 Tukey HSD advanced test results

Fertilizer Type	**N**	**Subset**		
		1	**2**	**3**
P1 (chemical fertilizers ZA+TSP)	4	6.4500		
P4 (liquid organic fertilizer)	4		6.9750	
P3 (organic fertilizer from the chicken coop)	4		7.0250	7.0250
P2 (organic fertilizer from the cowshed)	4			7.3250
Sig.		1.000	0.959	0.071

b. Alpha = .05

The results of further tests with Tukey HSD obtained that P1 (ZA + TSP chemical fertilizer) is different from the other three types of fertilizers. While the type of fertilizer P3 (chicken manure) and the type of fertilizer P4 (liquid organic fertilizer) have the same influence on the increase in the number of leaves of garlic plants. Similarly, the types of fertilizers P2 (cow manure) and P3 (chicken manure) also have the same influence. While the types of fertilizers P2 (cow manure) and P4 (liquid organic fertilizer) have a marked different influence. This shows that the application of different fertilizers has a significant effect on the growth of garlic, especially the increase in the number of leaves. This is in line with revenue (Lingga & Marsono, 2010) that the application of different fertilizers will affect the content of nutrients in the soil such as nitrogen content that is needed for plants, which serves to stimulate the growth of plants as a whole, especially branches, stems, and leaves. It is further stated that the element nitrogen is also a constituent of enzymes found in plant cells, thus affecting the formation of carbohydrates which play a very important role in plant growth. This, according to opinion (Engelstad, 1997) the role of nitrogen is very important for the vegetative growth of plants, especially the leaf part is green, can increased the ratio of root shoots affects the formation of fruits and seeds. The increase in the number of leaves is because nitrogen is one of the macro elements needed by plants as the main basis for building protein for growth.

Measurement of garlic growth with the application of different fertilizers is also carried out by measuring plant growth from the aspect of plant height. The results of the analysis of plant height measurements are obtained as follows:

Table 4 Results of plant height measurement in 4 treatments

Fertilizer Type	Plant Height (cm)			
	8 MST		15 MST	
	U1	U2	U1	U2
P1 (chemical fertilizers ZA+TSP)	31.0	30.0	36.0	36.0
P2 (organic fertilizer from the cowshed)	39.0	40.0	42.0	44.0
P3 (organic fertilizer from the chicken coop)	35.0	38.0	39.0	40.0
P4 (liquid organic fertilizer)	37.0	39.0	40.0	41.0

The results of measuring the height of garlic plants for a period of 8 and 15 weeks after the plant appeared to be different, where there was a fairly good growth of height. However, to ascertain whether there are noticeable differences between the application of different fertilizers and the timing of observations, a different test analysis was carried out with the Anova technique.

Table 5 ANOVA test analysis results

Dependent Variable: Plant Height					
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Corrected Model	196.438[a]	7	28.063	21.381	0.000
Intercept	23028.063	1	23028.063	17545.190	0.000
Fertilizer	138.688	3	46.229	35.222	0.000
Time	52.563	1	52.563	40.048	0.000
Fertilizer * Time	5.187	3	1.729	1.317	0.334
Error	10.500	8	1.313		
Total	23235.000	16			
Corrected Total	206.938	15			

a. R Squared = .949 (Adjusted R Squared = .905)

The results of the analysis of different tests (Anova) on plant growth by measuring plant height, it appears that there are differences in fertilizer application to plant growth, where the Sign value (0.000) or very different is significant. The difference is seen in the following Tukey HSD Post Hoc test results:

Table 6 Tukey HSD advanced test results

Tukey HSD				
		Subset		
Fertilizer Type	**N**	**1**	**2**	**3**
P1 (chemical fertilizers ZA+TSP)	4	33.2500		
P3 (organic fertilizer from the chicken coop)	4		38.0000	
P4 (liquid organic fertilizer)	4		39.2500	39.2500
P2 (organic fertilizer from the cowshed)	4			41.2500
Sig.		1.000	0.458	0.140

b. Alpha = .05.

The results of further tests with Tukey HSD obtained that plant growth by measuring plant height showed different influences based on the type of fertilizer. The P1 treatment (ZA +TSP chemical fertilizer) is different from the other three types of fertilizers. While the type of fertilizer P3 (chicken manure) and the type of fertilizer P4 (liquid organic fertilizer) have the same effect on the high increase of garlic plants. Similarly, the types of fertilizers P2 (cow manure) and P4 (liquid organic fertilizer) also have the same influence. While the types of fertilizers P2 (cow manure) and P3 (chicken manure) also have a noticeable different influence. This is by research (Romdoni et al., 2019) that the application of fertilizer in different doses and types will have different influences on plants.

4. Conclusion

The results of the study concluded that the different types of fertilizers used in the cultivation of garlic plants in North Toraja showed significant differences in influence both on the growth of the number of leaves and on plant height. The results of further tests were also obtained that there was a significant difference in influence between the types of chemical fertilizers, namely P1 (ZA + TSP chemical fertilizer) and the types of organic fertilizers P2 (cow manure), P3 (chicken manure) and P4 (liquid organic fertilizer).

Compliance with ethical standards

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