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2 Effect of Dose And Time of Npk Fertilizer Application on The Growth And Yield of Tomato Plants (*Lycopersicum Esculentum Mill*)

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ABSTRACT

The purpose of this study is to examine the effect of the dose and time of NPK fertilizer application on the growth and yield of tomato plants (*Lycopersicum esculentum Mill*). The study was conducted from April to July 2018 at the Experimental Garden of the Faculty of Agriculture, Merdeka University Surabaya, on Ketintang Madya VII-2 Street Surabaya, East Java with altitude of ± 5 m above sea level. The study used Factorial Randomized Block Design (RBD) consisting of two factors with three replications and two sample plants. The first factor was NPK fertilizer doses (N1 = NPK 2 gr / plant; N2 = NPK 4 gr / plant; N3 = NPK 6 gr / plant) and the second factor was the time of NPK application (W1 = day 0; W2 = day 0-14; W3 = day 0-14-28). The results shows that the combination treatment of dose and application time of NPK has a very significant effect on plant height, number of leaves, total fruit number and total fruit weight of tomato plants. The combination treatment of N3W3 (NPK 6 gr / plant and day 0-14-28) appears to produce the highest growth and yield of tomato plants though, statistically (BNT 5%), this was not significantly different from the combination treatment of N2W3 (NPK 4 gr / plants and 0-14-28 days).

Keywords: dose and time, NPK, tomato

1. INTRODUCTION

The level of Indonesian tomato production (*Lycopersicum esculentum Mill*) per hectare is 4.8 tons. This is far lower than the maximum production rate of tomatoes which can reach 16-25 tons per hectare. Tomato production per hectare can be increased by planting high yielding varieties, improving cultivation techniques and continually improving flowering.

One of the efforts to increase tomato production, according to Rikky Triyadi (2011), is to fertilize well. For good growth and yield, tomato plants need complete nutrients, both micro and macro, with a balanced composition supplied by the fertilizer. Giving too much N, for example, can cause dense leaf growth, but it can reduce the number and size of fruit. Giving sulfur (S), Calcium (Ca) and Magnesium (Mg) in tomato plants markedly increases yield, improves maturation and dissolves solids.

In reality, farmers in Indonesia only use a single fertilizer, such as Urea for source N, SP-36 for source P, and KCL for source K. They apply the fertilizer separately and without considering the composition balance of the fertilizer, which is needed by plants. This causes nutrients deficiency and low efficiency of fertilization (Hariyadi, Ali, & Pratiwi, 2018).



Fertilization that meet plant needs will increase production. At present, farmers prefer chemical fertilizers as it can provide better production results (Hariyadi & Purwanti, 2017). On the other hand, government has reduced fertilizer subsidies. This reduction causes chemical fertilizers become increasingly difficult to obtain and increasingly expensive. Therefore, those fertilizers use must be sought as efficiently as possible. Lack of fertilization, one that does not meet the needs of plants, will make production less optimal. However, excessive fertilization means waste. It can cause plants to be susceptible to attacks by pests and diseases and cause environmental pollution. The dose of NPK for Tomato plants is 175 kg Urea, 350 kg TSP, and 200 kg KCl for each hectare (Nosa Tirtajaya Pradana, Elfarsina and Rosdiana, 2013).

Indonesia, for several years, had low production of tomatoes and been trying to increase tomato production by expanding the area of tomato cultivation. However, until 2010, Indonesia still imported 10,325 tons of tomatoes from various countries both in the form of fresh fruit and in processed form. The low production of tomatoes is thought to be due to the conventional farming, the way of planting or cultivating (use of seeds, fertilizer selection and fertilization techniques), soil fertility and less climatic climate factors (Nosa Tirtajaya Pradana, Elfarsina and Rosdiana, 2013).

Furthermore, Rukmana (2002) explained that one of the important factors in cultivating plants that supports the success of plant life is fertilization. One of the common problems in fertilization is the low efficiency of nutrient absorbed by plants. The efficiency of N and K absorption is still relatively low, ranging from 30-40% and P absorption is ranging only around 15-20%.

Relying on nutrients from the ground alone will not meet the needs of plants. Therefore, plants need to be given additional nutrients from the outside, in the form of fertilizers (Prihmantoro, 2001). Efforts to increase the efficiency of fertilizer use can be achieved through right dosage, right way, right application time and balance according to the needs of plants.

Fertilizers are ingredients and food substances that are given to plants for the purpose of increasing the food substances for the soil (Hariyadi, Ali, & Nurlina, 2017). Lack of knowledge about the type and the doses of fertilizer needed by plants is one of the problems that will result in a low increase in broad unity crop production.

Land that can be used for planting purposes (cultivation) is one with soil that has sufficient nutrients for plant growth and development. That way, plants can grow and produce maximally as expected. When the land is lack of nutrients in the soil, it can be overcome by fertilizing. Fertilization is done by considering the type of fertilizer used, whether inorganic fertilizers and organic fertilizers. Inorganic fertilizers, which are fertilizers from factories, are made from a mixture of high-nutrient chemicals. On the other hand, organic fertilizers are fertilizers derived from weathering of organic



materials, in the form of plant debris, human and animal fossils, animal feces and organic rocks (Susila, 2006).

Soil fertilized with inorganic fertilizers can experience increased productivity in a short period of time. However, the land can run the risk of damage to the soil structure. On the other hand, the soil fertilized with organic fertilizer will have a good soil structure and have enough soil organic matter content, so that the ability of the soil to bind water is greater. Argued that giving optimal nitrogen can increase plant growth, protein synthesis, chlorophyll formation which causes leaf colors to become greener. This can also increase the rate of plant growth.

Shows that plant height, number of productive branches, number of leaves, and yields gives a positive response to the application of NPK fertilizer (15-15-15) at a dose of 200 kg N / ha + 100 kg P₂O₅ + 75 kg K₂O. It is significantly different from the control. The combination treatment of NPK (15-15-15) is the main plants nutrient that needs to meet the plants needs for the vegetative growth which includes leaves, stems, and roots. The dose of 200 kg N/ha + 100 kg P₂O₅/ha + 75 kg K₂O/ha can provide the highest yield or fruit weight in eggplant plants.

Furthermore, the combination of N, P and K fertilizer dose has a very significant effect on the weight of ear corn with husk and ear corn without husk per plant and also the weight of ear corn without husk per hectare. It also significantly affects plant height and ear length on 30 and 45 days after planting. However, this has no significant effect on the diameter of the ear corn. The growth and yield of corn are best found in a combination of Urea + TSP + KCl (500 + 350 + 300 kg/ha).

Compound of NPK dose is also proven to affect significantly in the height, number of leaves and weight of red spinach. The optimum dose of NPK compound fertilizer for the growth and yield of red spinach plants was achieved by compound of NPK 300 kg/ha (0.15 gr/plant). With maximum dose is compound of NPK 500 kg/ha (0.25 gr/plant), statistically, the two treatments (300 kg/ha and 500 kg/ha) are not significantly different.

Along with population growth, the demand for tomato products also continues to increase. However, the increase in demand for these commodities is not accompanied by the increase in the amount of production. One of the reasons is the low tomato productivity per plant unit and per unit area. In 2013, tomato production was only 509,380 tons.

The application (dose and time) of fertilizers originating from NPK fertilizer given in the form of a compound fertilizer is still not widely done. Research to find out the efficient and effective ways, times and doses (profitable) use of fertilizers on fruit vegetable plants, including tomato plants, is still rarely conducted. For this reason, it is necessary to further examine the use of the NPK fertilizer for tomato plant.



2. MATERIALS AND METHODS

The experiment was carried out at the Experimental Garden of the Faculty of Agriculture, Merdeka University Surabaya, on the Ketintang Madya VII-2 street in Surabaya, East Java, with altitude of ± 5 m above sea level. The research was conducted from April to July 2018. The research materials were planting soil, NPK compound fertilizer (15:15:15), and seeds of fruit tomato plants. The tools are hoes, blades, knives, polybags (8 kg media size), labels, rulers, stationery, weight gauges and electric scales as well as other laboratory equipment.

This study was a factorial study prepared using Randomized Block Design (RBD Factorial) with factor I NPK Fertilizer (3 dose levels) and factor II time of application (3 levels) with 3 replications and 2 sample plants.

To determine the effect of NPK fertilizer dose, application time and interaction between the two on growth and yield of tomato plants, the F-test with a level of 5% was used, namely the Variety Analysis Test (VAT). If from the F% Test results 5% there is a significant effect, then the T-test (Smallest Significant Difference Test) is continued with a level of 5%, in order to find out the difference between the NPK fertilizer dose and application time, so that the effectivity of the treatment is known (Adji Sastrosupardi, 1999).

3. RESULTS AND DISCUSSION

3.1. Plant height

The results of the variance analysis showed that the treatment of dose factor (N), treatment of time factor fertilization (W) and combination treatment (NW) have a very significant effect on plant height at the age of 90 days after planting. However, when plants were 30 days old and 60 days, the N factor treatment does not significantly influence, while the treatment of factor W and NW factors shows a significant effect on tomato plant height as shown in table 1.

This proves that NPK macro nutrients are useful and useful for growing tomatoes at the right time. When plants need NPK fertilizer, they are available. Application of NPK fertilizer in appropriate time and amount will increase the availability of sufficiently large nitrogen in the soil. This availability will be very useful for the subsequent process, the process of protein formation. Having the ability to produce adequate protein which is used in the process of cell division and division, rapid growth of tissue and organ growth will more likely happen. This is in accordance with the opinion of Hardjowigeno (2003) who said that the function of nitrogen as fertilizer is to improve plant vegetative growth and help the process of forming proteins.

Nitrogen (N) functions as a constituent of proteins in plant shoot growth. It also fertilizes vegetative growth, making it suitable for leafy vegetable plants, such as mustard greens, spinach, and



kale and so on. Phosphorus (P) functions as one of the constituent elements of proteins needed for the formation of flowers, fruits and seeds. These protein elements are also needed to stimulate root growth to become elongated and grow strong, so that the plant will be drought resistant. Lack of phosphorus (P) will cause plants to grow dwarf, flowering and seed formation are inhibited, and plants become weak and easily collapse. Potassium elements (K) play a role in metabolic processes such as photosynthesis and respiration which are important in plant growth (Sutejo, 2002).

Table 1. Effect of Dose and Time of NPK Fertilizer Application on the Average Height of Tomato Plants in Various Ages

Combination Treatment (Interaction) Dose and Time of NPK Fertilizer Application	Average height (cm)		
	30 days	60 days	90 days
N1W1 (NPK 2 gr/plant and 0 day)	45.33 a	58.67 a	88.67 a
N1W2 (NPK 2 gr/plant and 0-14 days)	51.67 cd	72.33 cd	102.33 c
N1W3 (NPK 2 gr/plant and 0-14-28 days)	53.33 de	73.67 d	103.67 c
N2W1 (NPK 4 gr/plant and 0 day)	46.33 b	69.33 bc	98.33 b
N2W2 (NPK 4 gr/plant and 0-14 days)	50.67 cd	72.00 cd	102.33 c
N2W3 (NPK 4 gr/plant and 0-14-28 days)	52.67 de	74.00 d	104.67 c
N3W1 (NPK 6 gr/plant and 0 day)	46.67 b	69.00 bc	99.00 b
N3W2 (NPK 6 gr/plant and 0-14 days)	52.00 cd	73.67 d	103.67 c
N3W3 (NPK 6 gr/plant and 0-14-28 days)	55.33 e	75.00 d	105.00 c
BNT 5%	3.28	3.14	3.00

Note: Means followed by same letters in same column shows no significantly differences at test of BNT 5%.

Table 1 shows that increasing the dose of NPK fertilizer and the amount of time given evenly (three times) will be followed by an increase in plant height. The highest tomato plants were achieved with a combination of dose and time of N3W3, which was 105.00 cm, although this was not statistically significant (5% BNT) with other treatments such as N3W2, N2W3, N2W2, and N1W3 and N1W2. It is presumed that the administration of doses and timing of administration of NPK fertilizers in tomato plants apparently helped increase the availability of nitrogen in the soil, so that when nitrogen is needed by plants to form tissue or organ growth, the nitrogen element is available and sufficient. So, the dose of NPK fertilizer given does not need to be increased in amount because



whatever NPK fertilizer dose is given does not indicate a significant increase in height. However, if the number of time for applying NPK fertilizer is decreased, for example applying only once at the age of 0 days, the level of nitrogen nutrient availability will also decreased. Conversely, if the number of time for applying NPK fertilizer is excessive (three times, in age 0, 14 and 28 days), it turns out that it does not guarantee that the nutrient element of nitrogen is able to be absorbed entirely by plants, so the rate of addition of growth is also not significant. Table 1 shows that the treatment of the dose and time of administration of NPK fertilizer is effective and efficient. It is the treatment of a combination of N1W2, dose of 2 gr/plant and given at age 0 day and 14 day after planting.

3.2. Number of leaves

The results of the variance analysis showed that the treatment of single factors, fertilization time (W) and combination treatment (NW) had a very significant effect on the number of leaves of tomato plants at the age of 30 days, 60 days and 90 days after planting. However, the single treatment factor (N) did not significantly affect all age observations as shown in table 2.

Table 2. Effect of Dose and Time of NPK Fertilizer Application on the Average Number of Leaves of Tomato Plants in Various Ages

Combination Treatment (Interaction) Dose and Time of NPK Fertilizer Application	Average Number of Leaves		
	30 days	60 days	90 days
N1W1 (NPK 2 gr/plant and 0 day)	18,00 a	35,67 a	54,00 a
N1W2 (NPK 2 gr/plant and 0-14 days)	18,67 a	36,67 a	56,33 abc
N1W3 (NPK 2 gr/plant and 0-14-28 days)	22,67 cd	39,33 bc	59,33 cd
N2W1 (NPK 4 gr/plant and 0 day)	21,33 bc	36,33 ab	56,33 abc
N2W2 (NPK 4 gr/plant and 0-14 days)	22,67 cd	37,67 ab	58,00 bcd
N2W3 (NPK 4 gr/plant and 0-14-28 days)	24,33 d	41,67 c	62,67 e
N3W1 (NPK 6 gr/plant and 0 day)	20,00 ab	35,33 a	55,67 ab
N3W2 (NPK 6 gr/plant and 0-14 days)	22,67 cd	38,00 ab	58,33 cd
N3W3 (NPK 6 gr/plant and 0-14-28 days)	24,00 d	39,00 b	60,00 e
BNT 5%	2,50	3,15	3,55

Note: Means followed by same letters in same column shows no significantly differences at test of BNT 5%

This result shows that the time of applying NPK fertilizer can affect the availability and the absorption of nutrients needed by plants, so that these factors can also be a limiting factor for growth and yield of tomato plants. This is in accordance with Muz Nur Apni result (2014) that argue that during the initial growth period plants should be fertilized with fertilizers with high nitrogen and phosphorus content. After growing up and approaching productive periods, fertilizers with high



potassium content and other micro elements, such as Ca, Mn, Mg, Cu, Zn, and Mb are needed. This is due to the reason that if there is a deficiency of just one of the micro elements above, the plant will experience physiological disease.

Table 2 shows that the highest number of leaves of tomato plants at the end period of growth time (90 days after transplanting) was produced by combination treatment of N2W3 (62.67 strands), although this is not statistically significantly different from the combination treatment of N3W3 (60.00 strands). The lowest number of leaves is produced by the combination treatment of N1W1 (54.00 strands) and is not statistically significantly different (5% BNT) with the combination treatment of N1W2 (56.33 strands), N2W1 (56.33 strands) and N3W1 (55.67 strands).

This shows that the time factor for administration of NPK fertilizer has a very significant effect on the growth of the number of leaves of tomato plants, regardless of the number of doses of NPK fertilizer used. But if it is only given once, the effect does not exist. If only once, when tomato plants need NPK fertilizer in the growth process, NPK fertilizer is not yet available or if available, this is not enough. Provision of NPK fertilizer at any dose will be beneficial for the tomato plant only if it is given within the period (interval) according to its growth period. This is in accordance with the opinion of Prihmantoro (2001). He stated that plants cannot rely solely on nutrients from the soil alone. Therefore, plants need to be given additional nutrients from the outside, in the form of fertilizer. Efforts to increase the efficiency of fertilizer use can be achieved through right dosage, right way, right application time and balance according to the needs of plants (Novizan, 2002).

This study corroborates the results of the Sekar Laras Putri (2016) study which showed that applying NPK fertilizer with a dose of 15 gr/plant gave the best results on variable of flower buds to appear (91.33 days), flower to bloom (24.33 days), flower arrangement (26.63 cm), overall flower length (99.03 cm), flower stem diameter (1.10 cm), and number of florets (31.5 sheets). The treatment of applying NPK fertilizer was not influenced by the Bio Max Grow bio fertilizer application on the variable length of leaves, number of leaves, width of leaves, and number of tillers of Sedap Malam (*Polianthes tuberosa L.*).

Compound of NPK dose is also proven to affect significantly in the height, number of leaves and weight of red spinach. The optimum dose of NPK compound fertilizer for the growth and yield of red spinach plants was achieved by compound of NPK 300 kg/ha (0.15 gr/plant). With maximum dose is compound of NPK 500 kg/ha (0.25 gr/plant), statistically, the two treatments (300 kg/ha and 500 kg/ha) are not significantly different.

The excess use of nitrogen fertilizer will result in damaged plants. In general, many farmers use nitrogen fertilizer in vegetable crops, such as kale, spinach and others in greater amounts than other fertilizers, because it is relatively affordable compared to other fertilizers. Nitrogen fertilizer



with a dose of 250 kg/ha will provide the best growth in plant height, number of leaves, leaf area, stem diameter and production of kale plants, spinach plants and mustard plants.

3.3. Total fruit number and total fruit weight

The results of the variance analysis shows that the treatment of fertilization time (W) and the combination treatment (NW) have a very significant effect on total number of fruit and total fruit weight for tomato plants. However, single factor (N) treatment had no significant effect as shown in table 3.

This is evidence that the time factor in applying NPK fertilizer has a very significant effect on the yield of tomato plants, regardless of the number of doses of NPK fertilizer used. However, if it is only given once, at the beginning of planting, the fertilizer will not be beneficial or influential for the plant growth.

Tomato plants are plants that require relatively large amounts of N, P and K nutrients. Nitrogen is needed for protein production, leaf growth, and supports metabolic processes such as photosynthesis (Ali & Wulan, 2018). Phosphorus plays a role in stimulating root growth and the formation of a good root system in young plants, as a constituent material for nuclei (nucleic acids), fats, and proteins. Potassium plays a role in helping the formation of proteins and carbohydrates, increasing plant resistance to pests and diseases, and improving the quality of crop yields. Soil is one of the media in giving nutrients to plants. Therefore, fertilization needs to pay attention to the nature and characteristics of the soil to obtain maximum results (Subhan, Nurtika and Gunadi, 2009). Giving fertilizers containing nitrogen into the soil can increase the fast and immediate nutrient availability for plants. Besides that, it saves time, labor and transportation costs.

Table 3. Effect of Dose and Time of NPK Fertilizer Application on the Total Fruit Number and Total Fruit Weight of Tomato Plants

Combination Treatment (Interaction) Dose and Time of NPK Fertilizer Application	Total Fruit Number	Average Total Fruit Weight (gram)
N1W1 (NPK 2 gr/plant and 0 day)	26,33 a	414,67 a
N1W2 (NPK 2 gr/plant and 0-14 days)	30,33 b	558,67 c
N1W3 (NPK 2 gr/plant and 0-14-28 days)	31,33 bcd	668,33 f
N2W1 (NPK 4 gr/plant and 0 day)	27,33 a	448,67 b
N2W2 (NPK 4 gr/plant and 0-14 days)	31,00 bc	600,00 d
N2W3 (NPK 4 gr/plant and 0-14-28 days)	33,33 d	675,00 f
N3W1 (NPK 6 gr/plant and 0 day)	28,00 a	422,67 a
N3W2 (NPK 6 gr/plant and 0-14 days)	31,00 bc	638,67 e
N3W3 (NPK 6 gr/plant and 0-14-28 days)	33,00 cd	667,33 f
BNT 5%	2,31	15,43

Note: Means followed by same letters in same column shows no significantly differences at test of BNT 5%



Table 3 shows that the lowest total fruit and fruit wet weight is indicated by the combination treatment of N1W1 (NPK 2 gr/plant and 0 day), but statistically (BNT 5%) it is not significantly different from the combination treatment of N3W1 (NPK 6gr/plant and 0 day).

This proves timing is profound. Although the amount of NPK fertilizer given is increased in number, the improper timing will make it far less beneficial for plants. Giving excessive fertilizer, which is not in the need of plants or plants are not ready to absorb and use it, will be a waste. Fertilizers will be wasted, washed away or evaporate due to warming sunlight.

Prihmantoro (2001) and Novizan (2002) state that plants cannot rely solely on nutrients from the soil alone. Therefore, plants need to be given additional nutrients from the outside, namely in the form of fertilizer. Efforts to increase the efficiency of fertilizer use can be achieved through right dosage, right way, right application time and balance according to the needs of plants

The study by Daud Saribun (2008) concluded that the application of NPK compound fertilizer 300 g/plot (300 kg/ha or about 4 gr/plant) was able to increase the yield of both mustard (*Brassica Juncea L.*) and red spinach plants (*Amaranthus tricolor L.*) to its highest level and as the best result, it produced a weight of 8.22 kg/plot equal to 6.85 tons/hectare.

In addition to, Subhan, Nurtika and Gunadi (2009) stated that the application of NPK compound fertilizer (15-15-15) at a dose of 1,000 kg/ha produced tomato plant height at the age of 60 and 75 HST, respectively 115.43 cm and 129.76 cm. The application of NPK compound fertilizer (15-15-15) at a dose of 1,000 kg/ha showed the highest results in the wet weight and dry weight of fruit and other parts, such as the roots, stems, and leaves of tomato plants and tomato products. This study also recommended NPK compound fertilizer (15-15-15) in tomato plants in Latosol soil to be 213.07 kg N/ha; 28.5075 kg P/ha and 35.69 kg K₂O/ha.

4. CONCLUSION AND RECOMMENDATION

It can be concluded that the combination treatment (interaction) between dose and time of NPK fertilizer had a significant effect on plant height, number of leaves, total fruit count and total fruit weight of tomato plants (*Lycopersicum esculentum Mill.*). The combination treatment of N3W3 (NPK 6 gr/plant and 0-14-28 days) yielded the highest per-plant and weight of tomato plants (*Lycopersicum esculentum Mill.*), although statistically (LSD 5%), it was not significantly different from the combination treatment of N2W3 fertilizer (NPK 4 gr/plant and 0-14-28 days).



For future study, it might be more helpful to conduct the similar research in the different weather, location and commodity. For who want to cultivate tomato in Surabaya and its surrounding, the best compound fertilizer is 4 gr/plant in the age of 0, 14, 28 and days after planting.

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