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# Growth and yield response in *Amaranthus tricolor* L. on various levels of urea fertilizer

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This experiment aimed to determine the effect of urea fertilizer on growth and yield of amaranthus plant. The experiment was carried out at Agrotechopark Jatikerto, Brawijaya University, from October to November 2018. The experiment was carried out using a completely randomized block design, consisted of 8 treatments namely: without urea fertilizer (N0), 25 kg ha$^{-1}$ (N1), 50 kg ha$^{-1}$ (N2), 75 kg ha$^{-1}$ (N3), 100 kg ha$^{-1}$ (N4), 125 kg ha$^{-1}$ (N5), 150 kg ha$^{-1}$ (N6), 175 kg ha$^{-1}$ (N7), and 200 kg ha$^{-1}$ (N8). Each treatment was repeated three times which resulted in 24 experimental units. The experimental data were analyzed using analysis of variance method and then followed by Honest Significantly Difference Test. The result of the research showed that the application of various dosages of urea fertilizer affected the growth and yield of amaranthus plant. Application of urea fertilizer affected leaf area, total fresh weight, and root length at 7, 14 and 21 daps. However, stem diameter and total dry weight of Amaranthus only affected by various dosages of urea fertilizer at 7 daps. Various dosages of urea fertilizer did not affect plant height and number of leaves. Application of 75 kg ha$^{-1}$ urea fertilizer considered as the optimum dosage for growth and yield of Amaranthus plant compared to other dosages.

**Keywords: nitrogen, urea, dosage, fertilization, Amaranthus**

## INTRODUCTION

Amaranthus is a leafy vegetable from the Amaranthaceae family which has high economic value. Amaranthus originate from Africa, Southeast Asia and Central America (Tubene and Mayers, 2008). In its development, amaranthus was promoted as a highly nutritious food especially in developing countries. This plant entered Indonesia through the trade route in the 29th century (Henssayon, 1985).

Amaranthus is a type of vegetable which is in demand by the community. The demand for amaranthus always increases along with increasing population and awareness of nutritional needs. The production of amaranthus is not sufficient for the needs and requirements of the community, due to the decreasing cultivation area and low productivity. Indonesian amaranthus production in 2016 was 3.69 tons ha$^{-1}$ and in 2017 was 3.65 tons ha$^{-1}$ (Central Statistics Agency, 2017).

The part of the Amaranthus which has economic value is its leaves, so the effort to increase the production generally made by stimulating the vegetative growth. This plant needs sufficient nutrients for optimal growth and development. One of the nutrients which play a vital role in its leaves development is nitrogen. Nitrogen is an essential element which increases plant growth and development. It plays an important role in the biochemical and physiological processes of plants (Leghari et al., 2016). Application of nitrogen fertilizer generally resulted in a higher number of leaves, leaf area and chlorophyll content which showed by its greener color (Wahyudi, 2010).

One source of nitrogen fertilizer widely used in Indonesia is urea. Its properties are hygroscopic

so that they are readily soluble in water, high N content (46%), and react quickly, so that roots can rapidly absorb them. The urea given to the plants will affect the growth and yield of plants (Lingga and Marsono, 2002).

Based on the description, it is necessary to apply the optimum dose of urea fertilizer in order to increase the growth and yield of amaranthus. This experiment aimed to determine the effect of various dosages of urea fertilizer on the growth and yield of amaranthus. The usefulness of the results of this experiment is expected to be information and comparison material for future studies, especially those related to the use of nitrogen fertilizers.

## MATERIALS AND METHODS

This experiment was carried out from August to October 2018, at Agrotechopark Jatikerto, Brawijaya University. It is located at an altitude of 303 m above sea level with the Alfisol soil type. The minimum temperature ranges from 18-21$^{o}$C, the maximum temperature is between 30-33$^{o}$C, rainfall is 100 mm month$^{-1}$, and soil pH is 6-6.2.

The experiment was carried out using completely randomized block design, that consisted of 8 treatments namely: without urea fertilizer (N0), 25 kg ha$^{-1}$ (N1),50 kg ha$^{-1}$ (N2), 75 kg ha$^{-1}$ (N3), 100 kg ha$^{-1}$ (N4), 125 kg ha$^{-1}$ (N5), 150 kg ha$^{-1}$ (N6), 175 kg ha$^{-1}$ (N7), and 200 kg ha$^{-1}$ (N8). Urea fertilizer is applied as basic fertilizer at 0 days after planting, by immersing it into the soil. The material used was the seed of Amaranthus var. Maestro which produced by East West seed producers.

Amaranthus were moved to beds at 20 days after sowing which had perfectly opened 3–4 leaves. The seedling was inserted into the planting hole in the middle of the surface of the prepared bed. Transplanting was done in the morning. Plants were planted with 20 x 20 cm spacing. Plant maintenance consisted of replanting, irrigation, controlling of pests and diseases. Replanting was done when plants have died or withered after planting, starting from 3 until 7 days after planting (daps). Irrigation was done once a day, especially in the initial phase of growth or adapted to soil conditions. Amaranthus was harvested at the age of 21 daps. Harvesting was done at 08.00 am. Plants were removed along with the roots. Most of the plants which suitable for harvest were those that have 15–20 leaves that have grown perfectly and had 25–30 cm height. Observations were made at the age of 7, 14 and 21 daps. Observation variables included plant height (cm), stem diameter (cm), number of leaves, leaf area per plant (cm$^2$), total fresh weight per plant (g plant$^{-1}$), total dry weight per plant (g plant$^{-1}$), and root length (cm). The experimental data were analyzed using analysis of variance method and then followed by Honest Significant Difference Test.

## RESULTS AND DISCUSSION

The soil is a medium for plant growth. In the soil, there are many nutrients needed by plants. But not all nutrients can be directly used by plants because the nutrients are not available. One of the nutrients that is not always available is Nitrogen (N). N is an essential nutrient, so its availability is vital for plant growth and development. If the amount of N in the soil cannot meet the needs of plants, then external input is needed. One of these inputs is by applying urea fertilizer.

Plant height is considered to be one of the most important morphological characters of a growing plant (Shormin and Kibria, 2018). The results of the variance analysis showed that the treatment of urea fertilizer had no significant effect on the average height of the amaranthus plant. The growth dynamics of amaranthus' plant height are shown in Figure 1.

Figure 1 showed that the average amaranthus plant height at the age of 7, 14 and 21 daps continued to increase. The highest average of amaranthus plant was obtained from treatments N1 and N3. This showed that urea 25 and 75 kg ha$^{-1}$ could supply the N element needed and can be absorbed well by plants.

The analysis of variance showed that the treatment of urea fertilizer had a significant effect on the average stem diameter of amaranthus plants at 7 days whereas no significant effect at 14 and 21 days after planting. The dynamics of growth in amaranthus' plant stem diameter can be seen in Figure 2.

Figure 2 showed that the average stem diameter of amaranthus plants at the ages of 7, 14 and 21 daps continued to increase. The highest average stem diameter of amaranthus plants was obtained from N3 treatment. Nitrogen played the most crucial role in various physiological processes. It implemented dark-green color in plants, promoted leaves, stem, and other vegetative parts' growth and development. Stem observation at 7 daps diameter showed that the application of 25 kg ha$^{-1}$ of urea resulted in a higher stem diameter compared to control, 50, 100, 125 and 200 kg ha$^{-1}$.

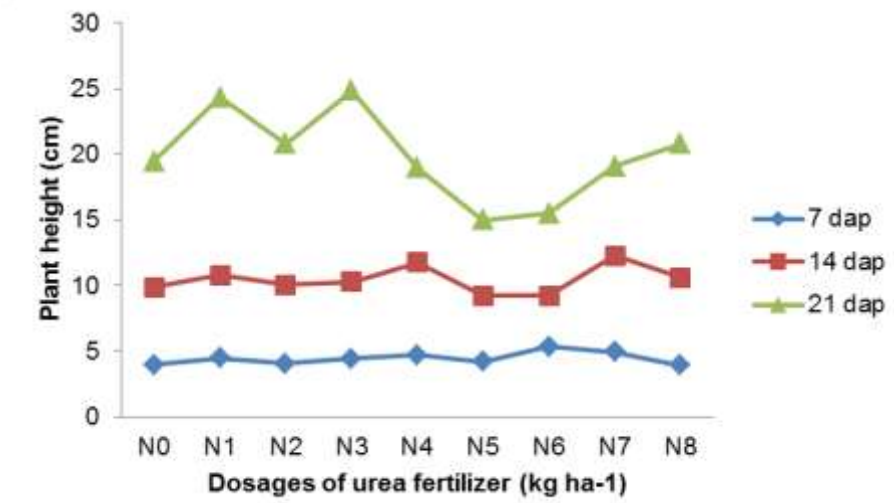


**Figure 1. Dynamics of growth in the height of the amaranthus plant.**

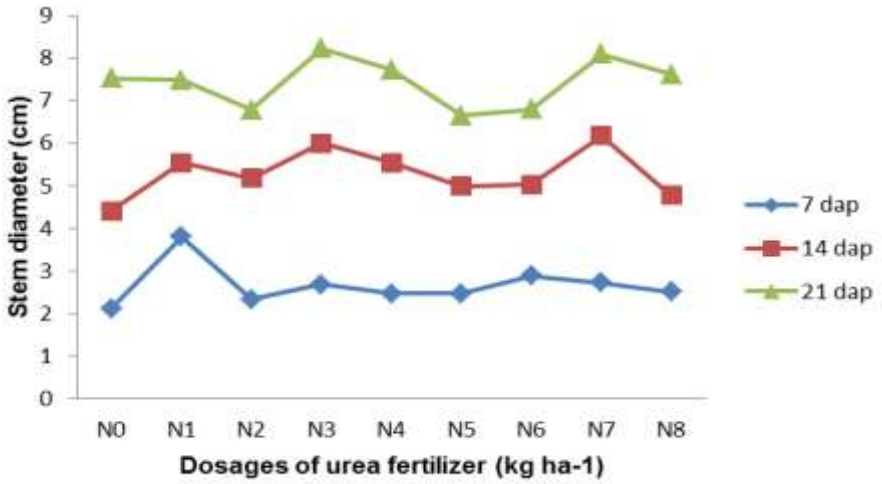


**Figure 2. Dynamics of growth in stem diameter of amaranthus plants.**

This was similar to other studies where different levels of nitrogen affected stem diameter in lavender (Yasemin et al., 2017) and tea (Pamungkas and Supijatno, 2017).

The analysis of variance showed that the treatment of urea fertilizer had no significant effect on the average number of leaves of amaranthus plants. The dynamics of growth in the number of leaves of the amaranthus plant can be seen in Figure 3.

Figure 3 showed that the average number of leaves of amaranthus plants at the ages of 7, 14 and 21 daps continued to increase. The highest average number of leaves of amaranthus plants was obtained from treatment N1. This showed that 25 kg ha$^{-1}$ urea fertilizer can supply the N element needed by amaranthus plants.

The analysis of variance showed that the treatment of urea fertilizer had a significant effect on the average leaf area of amaranthus plants. The dynamics of the growth of the leaf area of amaranthus plants can be seen in Figure 4.

Figure 4 showed that the average leaf area of amaranthus plants at 7, 14 and 21 daps continued to increase. The highest average leaf area of amaranthus plants was obtained from N3 treatment.

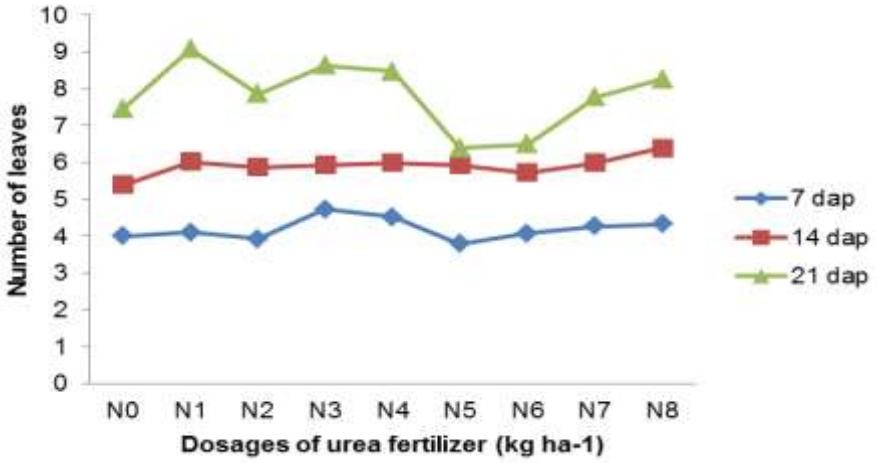


**Figure 3. Dynamics of growth in the number of leaves of amaranthus plants.**

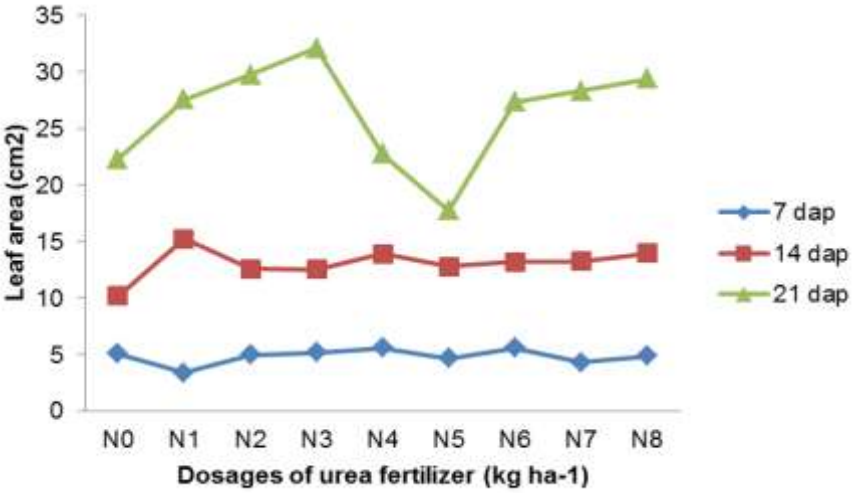


**Figure 4. Dynamics of growth in leaf area of amaranthus plants.**

This showed that 75 kg $ha^{-1}$ urea fertilizer can supply the N element needed by amaranthus plants. Increase in leaves production with higher level of N may be attributed to increased uptake of N which being the constituent of protein and component of protoplasm that might favorably affect the chlorophyll content of the leaves resulted in increasing synthesis of carbohydrates which were further utilized in building up of new cells (Shrestha and Thapa, 2018).

Nitrogen fertilizer is needed by plants to stimulate plant growth, especially vegetative parts such as leaves, stem, and branch. Nitrogen accelerated leaves growth which acts as plant growth indicator through the photosynthetic process. Sufficient light intensity received by leaves resulted in increased accumulation of assimilates which will be used to produce new vegetative organs such as leaves, stem, and branch (Napitupulu and Winarto, 2010). The analysis of variance showed that the treatment of urea fertilizer had a significant effect on the average total fresh weight of the amaranthus plant. The dynamics of the total fresh weight of the amaranthus plant can be seen in Figure 5.

Figure 5 shows that the average total fresh weight of amaranthus plants at 7, 14 and 21 daps continued to increase. The highest total fresh weight of amaranthus plants was obtained from N3 treatment.

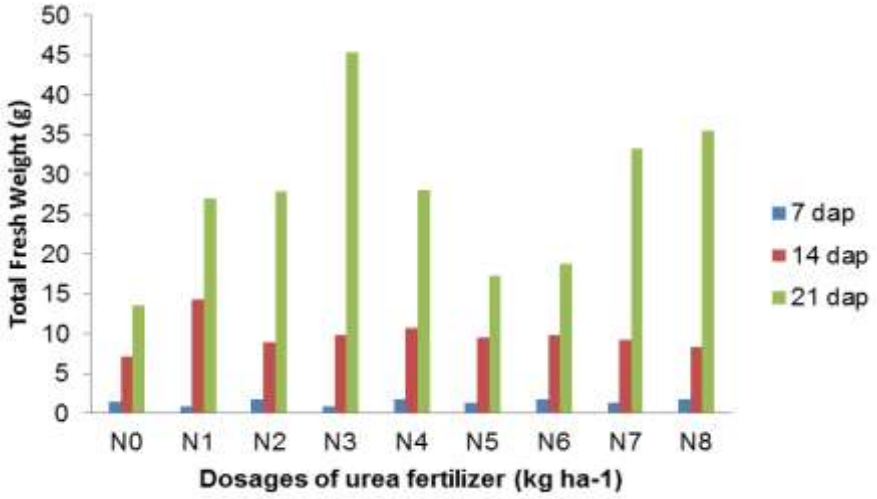


**Figure 5. Dynamics of the total fresh weight of the amaranthus plant.**

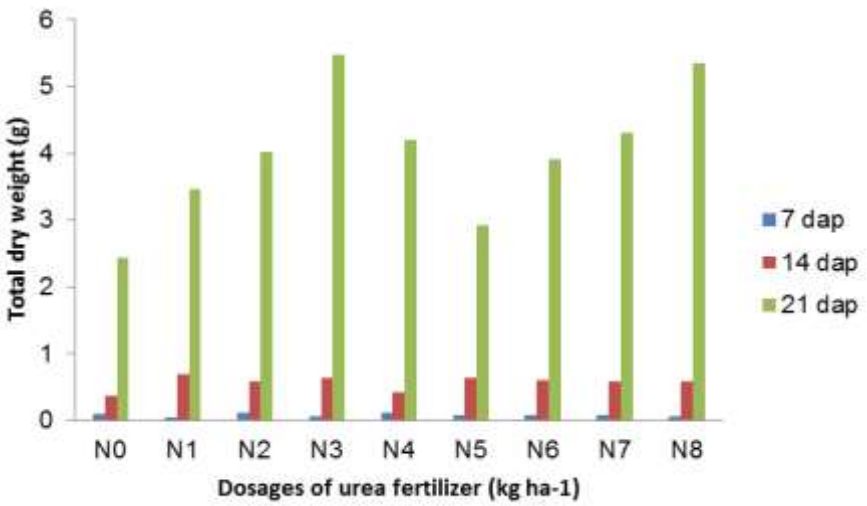


**Figure 6. Dynamics of the total dry weight of amaranthus pla**nts.

This showed that the nitrogen needed by amaranthus plants could be fulfilled from the supply of urea fertilizer. The application of nitrogen was significantly increased the total fresh weight of amaranthus. This was probably due to increased photosynthetic activity; there was an accumulation of carbohydrates in leaves, thus increasing their weight.

The analysis of variance showed that the treatment of urea fertilizer had a significant effect on the mean total dry weight of amaranthus plants on 7 daps, while at 14 and 21 daps did not show any significant difference. The total dry weight growth dynamics of the amaranthus plant can be seen in Figure 6.

Figure 6 showed that the average total dry weight of amaranthus plants at 7, 14 and 21 daps continued to increase. The highest average total dry weight of amaranthus plants was obtained from N3 treatment, and the lowest average dry weight was obtained in control. Nitrogen formed an integral part of chlorophyll and hence directly involved in dry matter accumulation through photosynthesis. Nitrogen leads to increase in the carbohydrate accumulation in the plants thus enhancing leaf/shoot fresh weight (Napitupulu and Winarto, 2010).

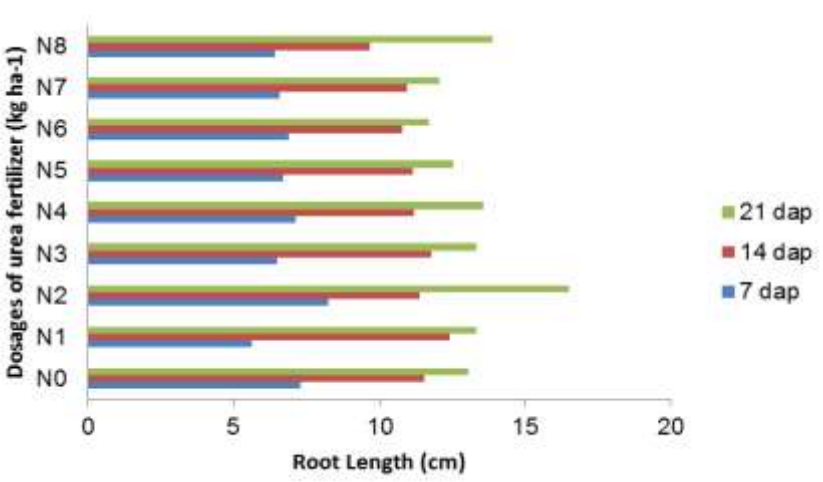


**Figure 7. Dynamics of growth in the length of the roots of the amaranthus plant**.

Mirdad (2009) reported that supplying nitrogen in urea form gave a significant mean value of all studied vegetative growth characters of amaranthus, compared with ammonium sulfate form.

Roots are complex organs made of different regions such as the root tip, root system, differentiation and integration of zones, and emerging lateral roots. The ability to compete for soil nitrogen (N) is dependent upon root morphological characteristics such as the root radius, root length, and root surface area. Plants generally respond to limiting soil nitrogen by increasing the amount of biomass allocated to roots. However, capturing belowground resources is more dependent on root length or root surface area than total root biomass (Bonifas et al., 2005; Hilbert, 1990; Reynolds and D'Antonio, 1996; Sattelmacher et al., 1990). The analysis of variance showed that the treatment of urea fertilizer had a significant effect on the mean length of amaranthus plant roots at 7, 14 and 21 daps. The growth dynamics of amaranthus plant root length can be seen in Figure 7.

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## CONCLUSION

The result of the research showed that the application of various dosages of urea fertilizer affected the growth and yield of amaranthus plant. Application of urea fertilizer affected leaf area, total fresh weight, and root length at 7, 14 and 21

daps. However, stem diameter and total dry weight of Amaranthus only affected by various dosages of urea fertilizer at 7 daps. Various dosages of urea fertilizer did not affect on plant height and number of leaves. Application of 75 kg $ha^{-1}$ urea fertilizer considered as the optimum dosage for growth and yield of Amaranthus plant compared to other dosages.

## CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

## ACKNOWLEGEMENT

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