

## Effects of Planting Distances and Organic Fertilizer Concentrations on Growth and Yield of Red Onion Plants (*Allium ascalonicum* L.)

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**Abstract.** *This study aims to determine the effect of planting distance and concentration of liquid organic fertilizer on the growth and production of shallots (*Allium ascalonicum* L.). This study used a Randomized Block Design (RAK) with two treatment factors: planting distance and concentration of liquid organic fertilizer. The treatment factors are as follows: Factor I: Planting Distance (J) consists of 3 treatment levels: J1 = 15 cm x 15 cm; J2 = 20 cm x 20 cm, and J3 = 25 cm x 25 cm. Factor II: Concentration of liquid organic fertilizer (V) consists of 4 treatment levels, namely: V1 = 2 ml / 240 ml of water; V2 = 4 ml / 240 ml of water; V3 = 6 ml / 240 ml of water and V4 = 8 ml / 240 ml of water. Data analysis was done using variance analysis and Duncan's test. The results showed that planting distance significantly affected the number of leaves, bulb diameter per sample, and fresh bulb weight per sample but had no significant effect on flowering age. POC concentration significantly affected flowering age, tuber diameter per sample, and fresh tuber weight per sample but did not significantly affect plant height and number of leaves. The interaction between planting distance and POC concentration did not significantly affect all observed parameters.*

**Keywords:** *Liquid organic fertilizer, Planting distance, Red onion*

### 1. INTRODUCTION

Shallots are one of the leading horticultural commodities and have good prospects for meeting national consumption, being a source of farmer income, and earning foreign exchange. This commodity is important not only as a flavouring related to its aroma but also for its medicinal properties due to its enzyme content, which plays a role in improving health, and its anti-inflammatory, anti-bacterial, and anti-regenerative substances (Istina 2016). To obtain good shallot production, paying attention to planting cultivation, including planting distance and the use of organic fertilizer, is necessary.

Planting distance regulation is one of the efforts that can be made to increase shallot production in the rainy season. Planting distance regulation with a specific density aims to provide growing space for each plant. Planting distance will affect the density and efficiency of light use, and competition between plants in water and nutrients will affect plant production (Silalahi and Widaryanto 2019). The closer the planting distance, the more plants will not bear fruit. Planting distance also affects competition between plants in obtaining water and nutrients, affecting the results (Vera *et al.* 2020). Plant spacing is essential so that each plant can utilize all environmental factors optimally to grow well and uniformly, ultimately producing optimal production. Plant spacing affects plant population, efficiency of light use, development of pests

and diseases, and competition between plants in water and nutrients. Determination of plant spacing is influenced by the type/variety of peanuts planted, planting patterns, soil fertility, and parts of the plant that will be used as an economic approach. Irregular plant spacing will result in competition for sunlight, water, and nutrients, and tight plant spacing will result in the nutrient absorption process becoming less efficient because the root conditions in the soil are interconnected so that competition between plants in obtaining nutrients becomes greater (Suhendrata, 2022).

In addition to planting distance, fertilizer application is needed to add nutrients for plant growth. The recommendation to use fertilizers or other organic materials is intended to reduce the problems that currently arise due to the frequent use of chemical fertilizers that can damage the soil and environment. The organic fertilizer solution that is often used is liquid organic fertilizer. Liquid organic fertilizer is a solution that results from the decomposition of organic materials originating from plant residues, agro-industrial waste, animal waste, and human waste that contain more than one nutrient. The need for liquid fertilizers, especially organic ones, is relatively high to provide some of the essential elements for plant growth and is a potential business opportunity because the procedure for making liquid organic fertilizer is relatively easy (Tanti *et al.* 2019). Liquid fertilizers are easily dissolved and contain one or more carriers of elements plants need. The use of liquid organic fertilizers can increase soil fertility that is damaged by the use of chemical fertilizers. Liquid organic fertilizers function to increase plant growth (Kurniawati *et al.* 2023). Liquid organic fertilizer has a microbiological activity to break down organic materials and has a slow availability but can be available longer in the soil than chemical fertilizers. Liquid organic fertilizer is one alternative to chemical fertilizers (Fathika *et al.* 2024). Liquid fertilizer is more easily absorbed by plants because the elements in it have been broken down. The advantage of liquid fertilizer is that its nutrient content varies, namely containing macro and micro nutrients, the absorption of nutrients is faster because it has been dissolved (Elfandari *et al.* 2022).

## **2. RESEARCH METHODS**

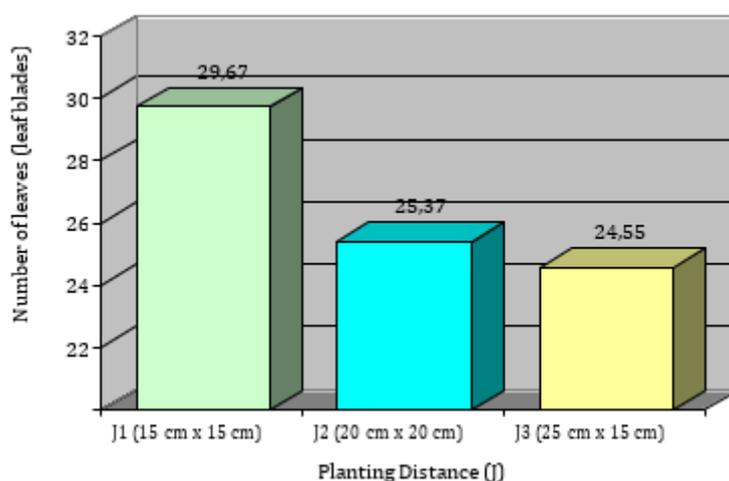
This study used a Randomized Block Design with two treatment factors: planting distance and liquid organic fertilizer concentration. The treatment factors are as follows: Factor I: Planting Distance (J) consists of 3 treatment levels: J1 = 15 cm x 15 cm; J2 = 20 cm x 20 cm, and J3 = 25 cm x 25 cm. Factor II: Liquid organic fertilizer concentration (V) consists of 4 treatment levels, namely: V1 = 2 ml / 240 ml of water; V2 = 4 ml / 240 ml of water; V3 = 6 ml / 240 ml of water and V4 = 8 ml / 240 ml of water. The quality of the tuber seeds used is

disease-free, pink in colour, round and complex tuber shape, measuring  $\pm 5$  grams. The age of the seeds used is 52-29 days after harvest. Shallot bulb seeds should be planted into the soil according to the specified planting distance, namely 15x15 cm, 20x20 cm, and 25x25 cm. Then, the shallot bulb shoots are cut by 1/3 before being planted and given fungicide treatment; the purpose of cutting the shoots is to accelerate the growth of shoots. The liquid organic fertilizer concentration is applied to shallot plants by watering the soil according to the treatment. The results of the variance analysis that show significantly different effects will be carried out by further testing, namely Duncan's multiple tests. The observed variables are the number of leaves, flowering age, bulb diameter per sample, and fresh bulb weight per sample.

### 3. RESULTS AND DISCUSSION

#### Number of Leaves (strands)

The list of variance analysis shows that planting distance has a significant effect on the number of leaves. The treatment of POC concentration and the interaction between the treatment of planting distance and POC concentration had no significant effect on the number of leaves at all observation ages. The effect of planting distance on the number of shallot leaves at the age of 5 MST can be seen in Figure 1.



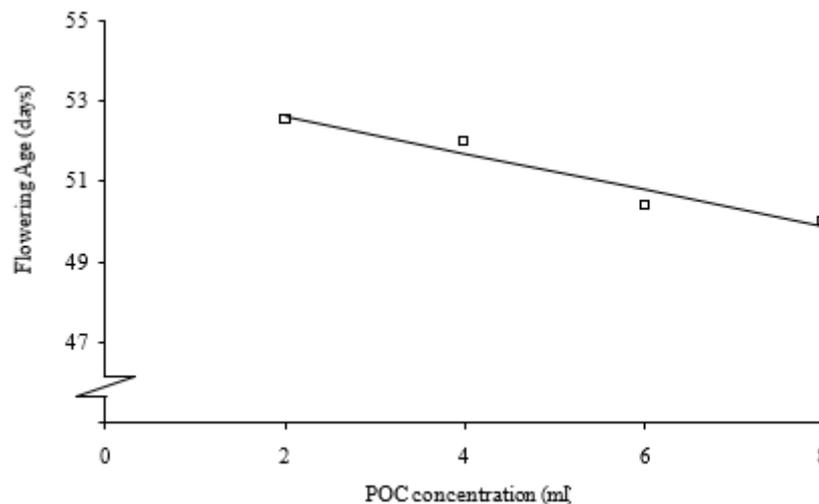
**Figure 1.** Effect of Planting Distance on the Number of Leaves of Shallots at 5 MST

Figure 2 shows that the most significant number of leaves was found in treatment J1, while the lowest number of plants was found in treatment J3. The closer the planting distance, the greater the number of shallot leaves produced. The results showed that the most significant number of plant leaves was found in treatment J1 (15 cm x 15 cm) at 29.67 strands, while the lowest number of leaves was found in treatment J3 (25 cm x 25 cm). The number of leaves provides an overview of the process and rate of photosynthesis in a plant, which is related to the formation of plant biomass (Anastasya and Sudiarso 2022). Planting distance allows plants

to grow well without experiencing competition in water, organic matter and sunlight and makes maintenance easier (Rosmawaty *et al.* 2019). Plants with close planting distances make competition between plants competing for nutrients even higher, so at close planting distances, plants will form more leaves or have longer leaves to get sunlight. The closer the planting distance, the less light the plants receive because of competition between plants in getting sunlight (Miftakhurrohmat and Septian 2019).

### Flowering Age

The analysis of variance shows that planting distance has no significant effect on plant flowering age. The POC concentration treatment has a significant effect. The interaction between the two treatments has no significant effect on flowering age. The effect of the POC concentration treatment on the flowering age of shallots can be seen in Figure 2.



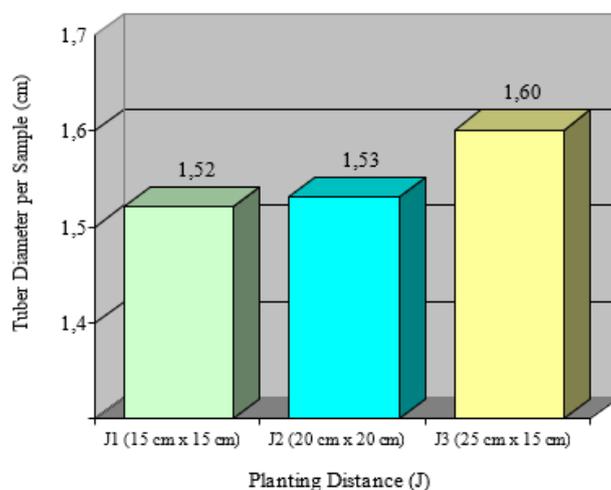
**Figure 2.** Effect of POC Concentration on Flowering Age of Shallot Plants

Figure 2 shows that the higher the concentration of POC, the shorter the flowering age of shallot plants following a negative linear regression curve. Every 2 ml increase in POC concentration can accelerate the flowering age of shallot plants by 0.46 days. The study results showed that the fastest flowering age was in the V3 treatment for 50 days. This fastest flowering age is due to POC containing macro and micro nutrients, so that providing POC will increase the supply of macro and micro nutrients in shallot plants. The availability of fertilizers containing both macro and micronutrients in sufficient conditions is a source of nutrition as a material that supplies plants in the form of important mineral elements (Arnianti *et al.* 2020).

### Tubers Diameter

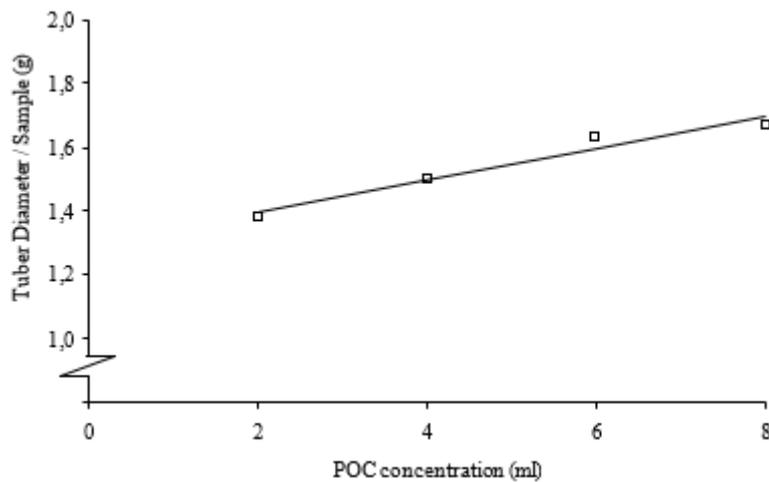
The analysis of variance shows that planting distance and POC concentration significantly affect the tuber diameter per sample, while the interaction between the two treatments does not significantly affect it. The effect of planting distance on tuber diameter per

sample can be seen in Figure 3, which shows that the largest tuber diameter per sample is in treatment J3, while the smallest plants are in treatment J1. The wider the planting distance, the greater the tuber diameter per sample produced.



**Figure 3.** Effect of Planting Distance on Bulb Diameter per Sample

The results showed that the largest bulb diameter per sample was in treatment J3 (25 cm x 25 cm) at 1.60 cm. The largest tuber diameter per sample is caused by the increasingly sparse planting distance, so the photosynthesis process takes place more intensively. Increasing the intensity of light entering the plant leaves will further increase the photosynthesis process in the plant. Increasing the rate of photosynthesis will produce photosynthesis, which is used in plant growth. The formation of better onion bulbs will follow good plant growth. Living plants use carbohydrates for their respiration. Plant growth depends on the balance of photosynthesis, which builds carbohydrates and plant materials and respiration, which breaks down carbohydrates. Growth will occur if photosynthesis exceeds respiration, as is common in growing plants. However, respiration may be the same in conditions with less light, as photosynthesis and growth will be inhibited (Manik *et al.* 2019). The effect of POC concentration treatment on tuber diameter per sample can be seen in Figure 4.

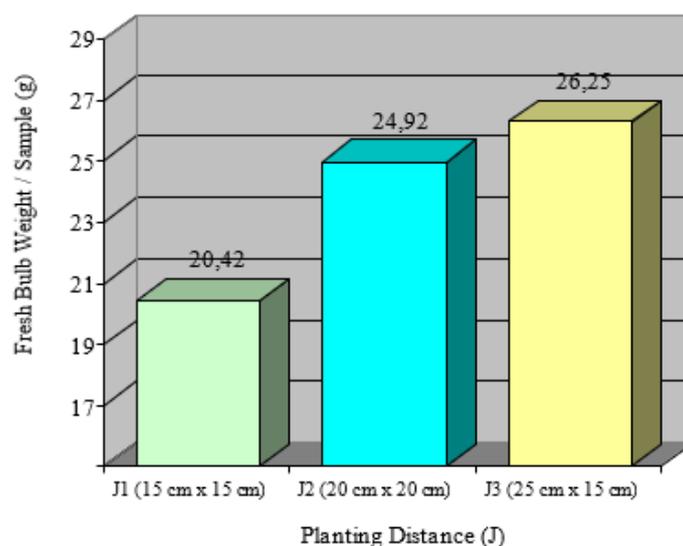


**Figure 4.** Effect of POC Concentration on Tuber Diameter per Sample

Figure 4 shows that the higher the POC concentration, the more the tuber diameter per sample increases following a positive linear regression curve. Every 2 ml increase in POC concentration can increase the tuber diameter per sample by 0.05 cm. The results showed that the highest tuber diameter per sample was found in the V3 treatment for 1.67 cm. The highest tuber diameter per sample is due to the increase in POC concentration which will increase the supply of nutrients which causes the photosynthesis process in plants to become higher. The increase in tuber size is related to the significant translocation of photosynthate into the tuber and the ability of the plant root system to absorb nutrients from the soil. The large translocation of photosynthates to the reproductive organs causes tuber formation to proceed well, so that the size of the tubers produced will be large (Ramadhan *et al.* 2018).

#### **Fresh Bulb Weight per Sample (g)**

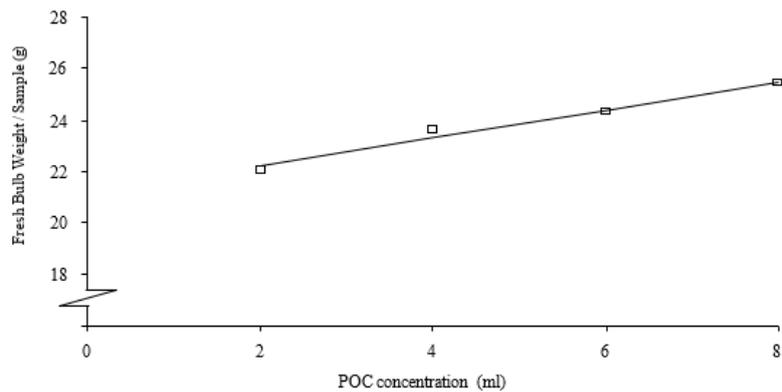
The analysis of variance shows that planting distance and POC concentration significantly affect the fresh bulb weight per sample. In contrast, the interaction between the two treatments does not significantly affect it. The fresh bulb weight per sample in treatment J2 significantly differs from J1. The effect of planting distance on the fresh bulb weight per sample can be seen in Figure 5.



**Figure 5.** Effect of Planting Distance on Fresh Bulb Weight per Sample

Figure 5 shows that the heaviest fresh bulb weight of the sample was in treatment J3, while the lightest was in treatment J1. The closer the planting distance used, the heavier the fresh bulb weight per sample produced. The results showed that the most significant fresh bulb weight per sample was in treatment J3 (25 cm x 25 cm) of 26.25 g. At a closer planting distance, there was mutual shading between the plant leaves so that the intensity received by the lower leaves decreased and subsequently reduced the weight of the bulbs; the closer the plants, the lower the plant weight. Kusumaningrum *et al.* (2024) stated that dense populations can capture much radiation. However, the radiation intensity that falls will also be reflected much, so the absorption efficiency is low. In plants with a high population, there will be a denser and rougher canopy arrangement so that the intensity of solar radiation can be received by various canopy layers directly or by reflection compared to plants planted with a low population. The lack of sunlight intensity will make the photosynthesis process even lower, where tuber formation is determined by the ratio of the weight of the stover to the weight of the tuber, which is a measure of the proportion of biological weight translocated into the harvest.

Furthermore, the treatment of planting distance turned out to have more influence on the balance of fresh tuber weight. A planting distance of 25 cm x 15 cm has the highest fresh tuber weight because more photosynthesis is produced where there are fewer leaves to shade each other. From the research results Afaf *et al.* (2024), which showed that the planting distance can affect the weight of the tubers produced. The effect of POC concentration treatment on the weight of fresh tubers per sample can be seen in Figure 6.



**Figure 6.** Effect of POC Concentration on Fresh Bulb Weight per Sample

Figure 6 shows that the higher the POC concentration, the more the fresh bulb weight per sample increases, following a positive linear regression curve. Every 2 ml increase in POC concentration can increase the fresh weight per sample by 0.55 g. The results showed that the highest fresh bulb weight per sample was found in the V3 treatment for 25.45 g. The provision of POC can improve the physical and chemical properties of the soil. POC applied to the soil can stimulate plant growth and form more root hairs so that the roots' ability to absorb nutrients from the soil is faster. Increasing plant growth can increase the photosynthetic ability of plants so that it can increase the number and size of red onion bulbs, this increase in bulb size also increases the weight of the fresh bulbs produced. Rahayu *et al.* (2024) stated that the provision of POC can increase the availability and absorption of macro and micronutrients by onion plants. POC also contains growth regulators so plants can grow well and produce high bulb weights (Anugrah *et al.* 2022). According to the opinion of Hairuddin and Ariani (2017), who state that POC with a specific concentration can increase the weight of bulbs in red onion plants.

#### 4. CONCLUSION

The study's results yield the following conclusions: Planting distance has a significant effect on the number of leaves, tuber diameter per sample, and fresh tuber weight per sample, and POC concentration has a significant effect on flowering age, tuber diameter per sample, and fresh tuber weight per sample.

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