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Optimizing the Growth and Production of Red Onion (*Allium cepa* L.) by Applying Biofertilizer and NPK Fertilizer

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ABSTRACT

This research aims to assess the impact of combining Biofertilizer with NPK fertilizer on the development and productivity of the red onion cultivars Maja Cipanas and Bima Brebes. Measurements were conducted at three time points: 3, 6, and 9 weeks after planting (MST) to assess the plant height, fruit weight per plant, and net weight. This research employed a Completely Randomized Design (CRD) to compare various combinations of Biofertilizer and NPK fertilizer treatments. Treatments included a Control group receiving no biofertilizer or NPK fertilizer, as well as treatment groups receiving 0.5 kg of both Biofertilizer and NPK fertilizer, 0.5 kg of Biofertilizer and 1 kg of NPK fertilizer, and 0.5 kg of Biofertilizer and 1.5 kg of NPK fertilizer. The second contributing factor pertains to Red Onion Variety Bima Brebes and Red Onion Variety Maja Cipanas. The findings demonstrated that the Maja Cipanas variety exhibited optimal performance across all measured parameters when treated with 0.5 kg biofertilizer and 1.5 kg NPK fertilizer. At 3 weeks after planting (WAP), the height of the plants was measured at 23.0 cm, which increased to 34.2 cm at 6 WAP and further to 44.8 cm at 9 WAP. There was a notable increase in fruit weight per plant, reaching a peak of 385.5 grams at 9 weeks after planting (WAP), and the net plant weight also reached 270.5 grams at the same time.

Keywords: *Biofertilizer; NPK Fertilizer; Onion Plants, Varieties*

1. INTRODUCTION

The onion plant, scientifically known as *Allium cepa*, is a bulbous species that has been utilized globally for culinary purposes and traditional medicinal applications (Subambhi et al., 2019) (Andriani Luta et al., 2020) (Karamina, 2022). It is a member of the Alliaceae family and is distinguished by its flat, cylindrical leaves that emerge from round or oval-shaped bulbs (Achmad, 2023) (Sari & Inayah, 2020). Onions are recognized for their unique flavor profile and potent aroma, contributing distinctive qualities to various dishes. Cultivation of onions can be achieved through seeds or shoots, and they thrive in diverse soil types, provided there is adequate drainage. The maturation period for onions typically spans 3 to 5 months, contingent upon the specific variety. This plant necessitates ample watering, particularly in its initial growth phases, while requiring soil conditions that are not overly saturated to avoid bulb damage.

Beyond their culinary applications as a spice, onions are recognized for their numerous health benefits. Rich in sulfur compounds, onions exhibit antioxidant and anti-inflammatory properties. Research has indicated that regular consumption of onions may lower the risk of cardiovascular diseases, help regulate blood pressure, and enhance immune function. Due to their adaptability and ease of cultivation, onions are a favored choice among home gardeners and agricultural producers. Individuals can reap the health advantages and unique flavors that onions offer by ensuring appropriate soil conditions, adequate watering, and diligent care.

The botanical term for the shallot plant is *Allium cepa* var. Aggregatum, commonly known as red onion, exhibits a distinct red hue on its shoots and is distinguished by a more intense and sweet flavor than white onions or shallots. Shallots are typically recognized for their tender texture and deeper hue. This botanical specimen is a member of the Alliaceae family, and its growth pattern involves the formation of clusters or aggregates of bulbs characterized by numerous interconnected small onions. Shallots can be grown from either seed or by planting a cluster of young onions in nutrient-rich soil. The period of growth for shallots is subject to variation based on climatic conditions and the specific cultivar but typically lasts approximately three to four months. Proper care of this plant requires sufficient watering, fertilization, and management of pests and diseases.

Shallots play a significant role in culinary practices by providing various dishes with a unique flavor and aroma. Furthermore, they offer health advantages akin to those of other onion varieties. The presence of allicin in shallots is noteworthy, as it exhibits antimicrobial and antioxidant properties that can enhance overall health. Globally, shallots are integral to numerous traditional cuisines, serving as a fundamental component in creating both flavorful and nutritious meals. Shallot plants can enrich home gardens and kitchens when cultivated appropriately, offering diverse flavors and health benefits. In the realm of shallot cultivation, the selection of suitable varieties is crucial for achieving optimal yields. Among the favored shallot varieties are local and international, each possessing distinct traits such as pungency, bulb size, and disease resistance. Additionally, farmers consider climatic conditions and soil quality when determining which varieties to cultivate.

Red onions are collected when their shoots and foliage wither and fall to the ground. Following the harvest, it is essential to sun-dry the red onions to ensure the outer skin is adequately dried, thereby prolonging their shelf life. Once sun-dried, red onions can be stored in a relaxed, dry environment, making them available for various culinary applications throughout the year. Beyond their culinary uses, red onions are significant in the cosmetics sector and traditional medicine. The extract derived from red onions is frequently incorporated into beauty products due to its antioxidant properties, which are beneficial for skin care. Additionally, in traditional medicine, red onions possess antibiotic and anti-inflammatory qualities that may assist in addressing various health issues.

It is crucial to emphasize that crop rotation and sustainable farming practices are essential for shallot farmers to preserve soil productivity. Through a comprehensive understanding of crop growth cycles and specific agricultural requirements, farmers can effectively and sustainably optimize yields, thereby fostering a harmonious and eco-conscious agricultural landscape. Consequently, shallots continue to be an essential crop in our culinary practices, with farmers working to uphold the sustainability and equilibrium of their agricultural environment. Datt & Kaur (2023) conducted previous research involving the application of animal manure and biofertilizers to shallot plants, while Verma et al. (2023) documented the utilization of biofertilizers and growth hormones in shallot plant cultivation. Nevertheless, there is a lack of specific data addressing the application of a blend of biofertilizers and NPK to the Bima Brebes and Maja Cipanas shallot cultivars.

This research seeks to explore the effects of NPK fertilizers and biofertilizers on the growth and yield of shallots (*Allium cepa* var. aggregatum) (Steven Cipta Putra, 2022) (Pinayungan et al., 2021). The rationale for selecting this topic stems from the necessity to enhance understanding of how NPK fertilizers and biofertilizers contribute to shallot productivity while also addressing sustainability concerns in agricultural practices (Agustin et al., 2023) (Wahyudi et al., 2016). NPK fertilizers, which consist of Nitrogen, Phosphorus, and Potassium, are widely recognized as chemical fertilizers utilized in agricultural settings (Setiawati et al., 2019) (Ortikov et al., 2023). Nitrogen is essential for promoting leaf growth and protein synthesis, phosphorus is crucial for root and flower development, and potassium is vital for maintaining water balance and enhancing plant resistance to diseases. Despite their effectiveness in boosting crop yields, the overapplication of NPK fertilizers can lead to significant environmental and soil health issues.

Meanwhile, biofertilizers are organic fertilizers that consist of living microorganisms, such as bacteria, fungi, and algae, collaborating with plants to enhance nutrient availability. Biofertilizers can improve soil health, increase plant nutrient absorption, and reduce the negative environmental impact of chemical fertilizers. This research will explore the extent to which biofertilizers can serve as a sustainable and effective alternative for enhancing the growth and yield of red onions compared to conventional NPK fertilizers. By comparing the use of NPK fertilizers and biofertilizers in red onion cultivation, this study aims to provide valuable insights for farmers and agricultural practitioners in selecting optimal fertilization methods that combine high productivity with sustainable environmental practices.

2. MATERIAL AND METHODS

The research was conducted in Jl. Kampung Banjar I Kel. Kotapinang Kec. Kota pinang Labuhanbatu Selatan Regency, located at geographical coordinates 2.1168° LU and 99.8315° BT, with an altitude of 30 meters above sea level.

In this study, the researcher will use the Randomized Block Design (RBD) (Kartika et al., 2016) (Karim et al., 2020). Randomized Block Design (RBD) is a commonly used experimental method in agricultural research to test the effects of specific treatments on plants or animals (Azizah et al., 2017) (Dwinanti & Damanhuri, 2021). In RBD, experimental units, such as plots or pieces of land, are randomly divided into blocks, and each block receives one or more identical treatments. The primary objective of RBD is to reduce variability that may arise from other uncontrolled factors. By introducing random elements, RBD enables researchers to be more confident in attributing differences in outcomes between treatment groups to the treatments themselves rather than to unknown or uncontrolled factors. RBD provides a robust statistical basis for analyzing differences among treatments, thereby allowing research results to be interpreted with greater confidence. This Randomized Block Design (RBD) will be implemented with two treatment factors.

The first factor is the application of Biofertilizer and NPK fertilizer, which consists of four levels used in the following doses: Without Biofertilizer and NPK Fertilizer (Control), 0.5 kg of Biofertilizer and 0.5 kg of NPK Fertilizer, 0.5 kg of Biofertilizer and 1 kg of NPK Fertilizer, and 0.5 kg of Biofertilizer and 1.5 kg of NPK Fertilizer. The second factor is the variety of shallot plants, comprising two levels: the Bima Brebes Variety and the Maja Cipanas Variety. The total sample size for the plants is 32 plots, with a sample of 1 plant per polybag. The spacing between polybags is 35 cm, while the spacing between repetitions is 21 days.

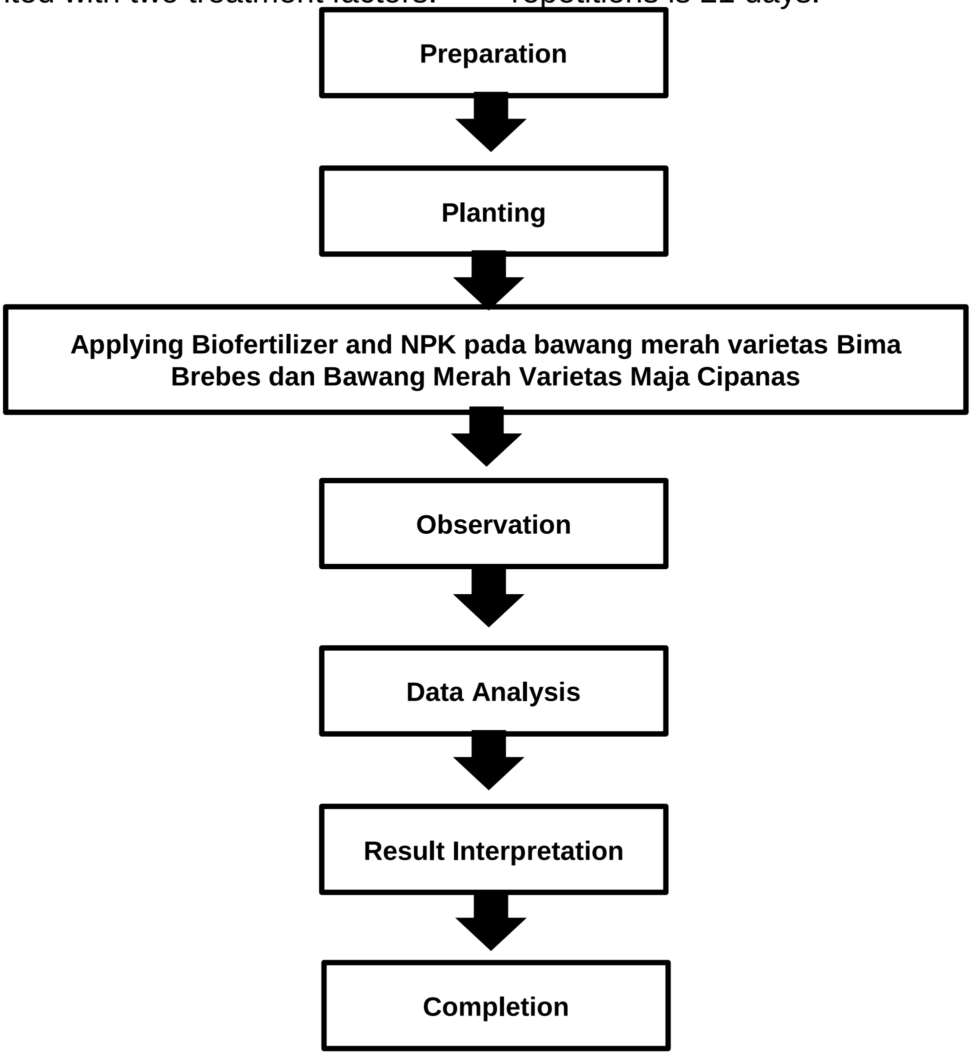

Figure 1. Research flow diagram

3. RESULT AND DISCUSSION

3.1 Plant Height

Based on the results of observations in the field, plant height results are presented in Figure 2.

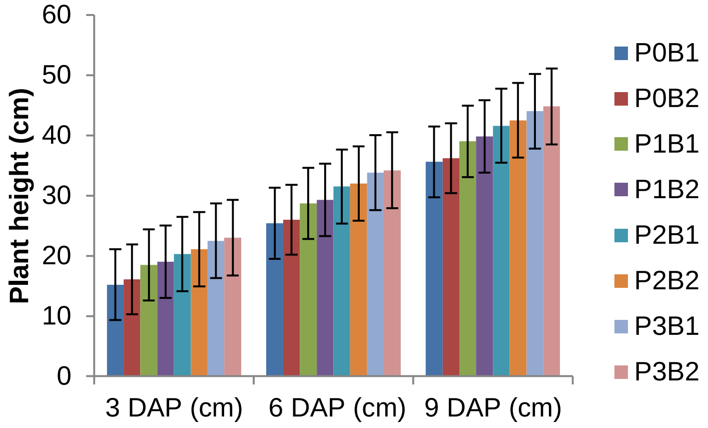

Figure 2. Average plant height, P (Biofertilizer and NPK combination treatment), B (Shallot variety) DAP (Day After Planting)

The results of the observations indicated that the combined application of P3B2, specifically utilizing 0.5 kg of Biofertilizer alongside 1.5 kg of NPK Fertilizer on the Maja Cipanas Shallot variety, yielded the greatest plant height at each measurement interval. At 3 months after sowing (MST), the height measured 30.2 cm, which increased to 38.4 cm at 6 MST and peaked at 44.8 cm by 9 MST. Conversely, the P0B1 treatment, serving as a control that excluded both Biofertilizer and NPK fertilizer on the Bima Brebes Shallot variety, consistently resulted in the shortest plant height, recording a minimum of 15.2 cm at 3 MST, 20.8 cm at 6 MST, and 26.5 cm at 9 MST. These findings suggest that the effective application of Biofertilizer and NPK fertilizer significantly enhances plant growth, particularly in the Maja Cipanas variety, compared to the control treatment, which exhibited a slower growth rate.

The supplementation of soil nutrients using Biofertilizer and NPK fertilization can address soil nutrient deficiencies, thereby supporting plant metabolism in the production of assimilates and promoting an increase in plant height (Indira & Singh, 2014). Kader et al. (2014) suggest that the increase in plant height is not only influenced by fertilization factors but also by the genetic response of plants. Different types and varieties of plants will exhibit varying growth and responses to fertilization and environmental signals.

3.2 Fruit Weight Per Plant

Based on the results of observations in the field, the results of fruit weight per plant are presented in Figure 3.

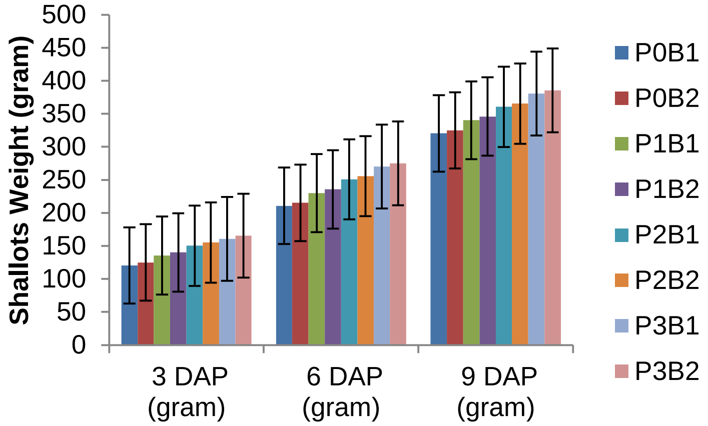

Figure 3. Average weight of bulbs per plant, P (Biofertilizer and NPK combination treatment), B (Shallot variety), DAP (Day After Planting)

Based on the provided data, the treatment combination P3B2, which involves the use of 0.5 kg of Biofertilizer and 1.5 kg of NPK fertilizer on the variety of Cipanas Red Onion (Bawang Merah Maja Cipanas), consistently resulted in the highest net plant weight at every observation stage. At 3 MST, the net plant weight reached 115.6 grams, increasing to 195.8 grams at 6 MST and achieving the peak value of 385.5 grams at 9 MST. Furthermore, this treatment also produced the most optimal bulb weight per plant, with an average bulb weight of 33.8 grams per plant at 9 MST. In contrast, the control treatment P0B1, which involved no biofertilizer or NPK fertilizer on the Bima Brebes Red Onion variety, showed the lowest net plant weight across all observation stages, with a minimum of 120.5 grams at 3 MST, 185.3 grams at 6 MST, and 245.4 grams at 9 MST. The bulb weight per plant for treatment P0B1 was also notably lower, averaging just 15.2 grams per plant at 9 MST. These results indicate that the treatment combination P3B2 yields the most optimal production compared to other treatments, particularly when compared to the control.

The mass of the tuber is intrinsically linked to the plant's sink, which arises from the transformation of nutrients and energy that the plant absorbs, facilitated by its metabolic processes. Sufficient nutrient availability is a critical determinant in the fruit development process, influencing the resulting fruit's size and weight. From a physiological perspective, fruit is derived from the plant's photosynthetic organs, specifically the leaves, where assimilates are synthesized and subsequently transported to the fruit (Kandil et al., 2011).

Different plant varieties, characterized by distinct genetic makeups, yield tubers corresponding to their specific genetic codes and the gene expressions that govern tuber growth and development. Varieties exhibiting a genetic predisposition to respond favorably to fertilization tend to demonstrate accelerated growth rates and enhanced tuber size (Khan et al., 2024).

3.3 Net Plant Weight

Based on the results of observations in the field, the net weight of plants is presented in Figure 4.

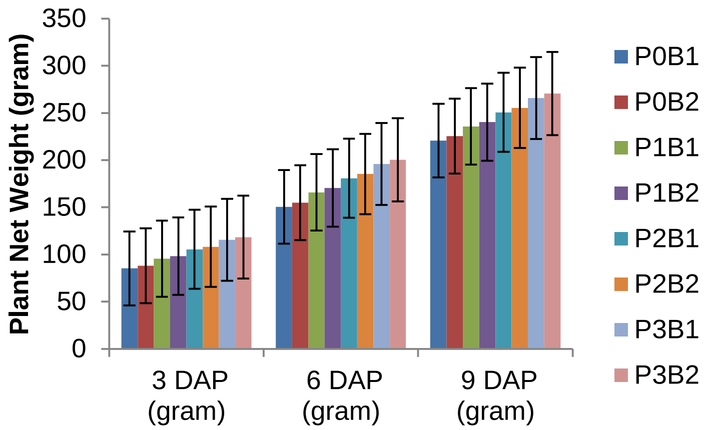

Figure 4. Average fruit weight per plant, P (Biofertilizer and NPK combination treatment), B (Shallot variety) DAP (Day After Planting)

The data analysis indicates that the treatment identified as P3B2 consistently exhibited the highest net plant weight across all observation periods, precisely 118.4 grams at 3 MST, 200.3 grams at 6 MST, and 270.5 grams at 9 MST. Conversely, the treatment labeled P0B1 recorded the lowest net plant weight, measuring 85.2 grams at 3 MST, 150.4 grams at 6 MST, and 220.6 grams at 9 MST. These findings suggest that the P3B2 treatment significantly outperformed the other treatments in promoting plant growth, whereas P0B1 resulted in the least plant weight at each measured stage.

Plant biomass represents the cumulative outcome of all physiological activities, encompassing both anabolic and catabolic processes. The availability of macro and micronutrients significantly influences the production of plant biomass. Adequate access to a comprehensive range of nutrients facilitates optimal growth throughout plant development (Mahala et al., 2018).

Furthermore, plants' physiological and morphological responses to environmental stimuli vary among different varieties. This variability is attributed to the specific arrangement of nitrogenous bases within the DNA and RNA sequences of distinct plant species, whereby the genes that encode for each genotypic characteristic play a crucial role in determining plant phenotypes (Alemu et al., 2022).

1. CONCLUSION

According to the findings from the observation, the combined treatment P3B2, which involves the application of 0.5 kg of Biofertilizer and 1.5 kg of NPK fertilizer to the Maja Cipanas Shallot variety, demonstrated superior effectiveness in promoting plant growth and yield as compared to alternate treatments. At each observation stage, the highest plant height, net plant weight, and fruit weight per plant were achieved with this treatment, resulting in a significant increase from 3 MST to 9 MST. On the other hand, the P0B1 control treatment, which did not involve the use of Biofertilizer or NPK fertilizer, consistently demonstrated the lowest results across all measured parameters in the Bima Brebes Shallot variety. The findings of this study validate the efficacy of Biofertilizer and NPK fertilizer in stimulating plant growth and yield, particularly in the case of the Maja Cipanas variety.

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