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Original Article

Growth and Production of Red Onion (*Allium ascalonicum* L) Varieties Using NPK Fertilizer Doses at Ultisol Soil

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Abstract - *Increasing red onion production is required to fulfill domestic market share requirements. One of the efforts that can be implemented is to use proper variety and NPK fertilizer application, especially on marginal land such as ultisol soil. The research objective is to determine the growth and production of several red onion varieties by applying NPK fertilizer in ultisol soil. This study used a factorial Group Randomized Design consisting of two treatments and three repeats. The first factor is red onion variety (V) covering V1: Bima Brebes Variety, V2: Tajuk (Thailand Nganjuk) Variety, V3: Sumenep Variety, V4: Bauji Variety and the second factor is NPK fertilizer (F) with doses of F1: 200kg/ha, F2: 250 kg/ha, F3: 300 kg/ha. The results showed that the treatment combination between Bima Brebes Variety and 250 kg/ha NPK fertilizer produces better growth and production than other treatments. The Bima Brebes variety showed better growth and production than other varieties. The application of 250 kg/ha NPK fertilizer, on average, produces the highest value in the growth and production of red onion.*

Keywords - *Growth and production, Red onion variety, Fertilizer dose, Ultisol soil.*

1. Introduction

Red onion (*Allium ascalonicum* L.) is a superior vegetable commodity cultivated intensively for a long time. This vegetable commodity belongs to the non-substituted spice group that functions as food seasonings and traditional medicine. This commodity is an income source and employment opportunity that contributes relatively highly to regional economic development [1]. Red onion production so far is still relatively low, so the supply quantity has not yet fulfilled community needs, which subsequently affects red onion prices. Red onion production in Indonesia frequently fluctuates and shows a supply shortage to fulfill domestic consumer needs. This is encouraging the government to increase the production of red onion in order to fulfill national red onion needs. Increasing the productivity and development of red onion can done by using marginal land such as ultisol soil. Utilizing this land for agriculture is one of the efforts to increase agricultural commodity productivity [2], although this soil is highly acidic and lacks N, P, and K nutrients [3]. Efforts to increase red onion production on this land can be made, among others, using proper variety and fertilization. Using proper variety is one of the efforts to optimize genetic potential and support increased red onion production in ultisol soil. The capability of variety to produce high yield in certain areas needs further investigation because one variety with good growth and production does not necessarily have good growth and production in other areas [4]. Farmers commonly plant local varieties such as Bima Brebes, Bauji, Keling, Maja Cipanas Ampenan, Sumenep, Kuning and Lampung. In contrast, farmers commonly plant imported varieties in Thailand, the Philippines, Vietnam, and Australia [5]. In addition to superior variety usage, crop nutrient provision through fertilization should be considered to increase the growth and production of red onion. Inorganic fertilizer can provide nutrients relatively faster, produce available nutrients readily absorbed by crops, has more nutrient content, has no pungent odor, is practical, and is easy to apply. One of the inorganic fertilizers that can applied is NPK fertilizer 16:16:16. Compound NPK fertilizer contains more than one nutrient. Compound fertilizer generally contains macro essential nutrients such as N, P2O5, K2O, MgO, and CaO, and it has easily dissolved properties so crops can absorb directly. N, P and K fertilizers are important nutrients required by crops to help the development of red onion tubers [6]. Results of the study [7] showed that applying NPK fertilizer at the dose of 1.40 grams/polybag gives the best yield for red onion crops. In contrast, applying 250 kg/ha NPK fertilizer can increase maximum red onion production [6]. In addition, Mutiara NPK compound fertilizer can benefit labor power and cost savings by applying three nutrients simultaneously: Nitrogen, Phosphorus and Potassium [7]. The research objective is to determine the growth and production of several red onion

varieties suitable for planting in ultisol soil so that red onion in this land is optimal and can be used as a reference for farmers conducting red onion cultivation.

2. Materials and Methods

This research was conducted at the experimental area of the Agricultural Faculty, Baturaja University. It was conducted from December 2023 up to 2024. Red onion varieties used in this research are Bima Brebes, Tajuk (Thailand Nganjuk), Sumenep, and Bauji. In contrast, this research uses NPK compound fertilizer (200 kg/ha, 250 kg/ha and 300 kg/ha) and goat manure. This study used a factorial Group Randomized Design consisting of two treatment factors with three replications, resulting in 36 treatment units, each containing 20 crops with 6 crops as a sample. The first factor treatment is red onion varieties consisting of V1: Bima Brebes Variety, V2: Tajuk (Thailand Nganjuk) Variety, V3: Sumenep Variety, V4: Bauji Variety, whereas the second factor treatment is NPK (P) fertilizer doses consisting of F1:200 kg/ha, F2: 250 kg/ha and F3: 300 kg/ha. The land to be used for the research location is cleaned of weeds and plant residues, followed by soil tillage and loosening, as well as plot development with a size of 100 x 100 cm and a distance between plots of 50 cm.

Soil loosened is given organic fertilizer in the form of goat manure with the magnitude of 15 tons/ha by spreading on the soil surface and then stirring until even or homogenous. Organic fertilizer is applied 7 days before planting, whereas NPK fertilizer is applied twice at 10 days after planting and 30 days after planting. Harvest is done 60 days after planting, indicated by leaves turning yellow and lying around, tubers emerging into the soil surface and tubers looking reddish. Data is analyzed using variance analysis (F test). If variance analysis results showed a significant effect, then testing was done using the HSD test [8].

3. Results and Discussion

3.1. Result

Results of variance analysis (F-Test) showed that interaction between several red onion varieties and NPK fertilizer application has no significant effect on all parameters (Table 1.) The single variety factor significantly affects the crown wet weight variable, tuber number per clump, and tuber wet weight per clump. However, it does not significantly affect crop height, crown dry weight, and consumed tuber's dry weight per clump. NPK fertilizer treatment has no significant effect on all observed variables. Table 2 shows that the Sumenep variety given 250 kg/ha NPK fertilizer (V3P2) is a treatment combination that tends to be better for red onion growth. Subsequently, treatment of Bima Brebes (V1P3) variety that is given 300 kg/ha NPK fertilizer has the highest average value for the variable of tubers wet weight per clump (66.18 g/clump) and produces the highest average value for the variable of consumed tuber dry weight per clump (51.62 g/clump).

Table 1. Variance analysis results (F-test) of average growth and production for several red onion varieties due to NPK fertilizer application

Parameters		F-count	F- table 0.05
A. Growth			
Plant Height (cm)	V	0.66^{ns}	3.05
	F	1.51^{ns}	3.44
	VF	0.70^{ns}	2.66
Crown Wet Weight (g/clump)	V	4.05^{*}	3.05
	F	1.06^{ns}	3.44
	VF	0.60^{ns}	2.66
Crown Dry Weight (g/clump)	V	0.60^{ns}	3.05
	F	1.22^{ns}	3.44
	VF	0.04^{ns}	2.66
B. Production			
Number of Tubers (piece/clump)	V	17.07^{*}	3.05
	F	1.72^{ns}	3.44
	VF	2.09^{ns}	2.66
Tubers Wet Weight (g/clump)	V	3.47^{*}	3.05
	F	0.41^{ns}	3.44
	VF	0.92^{ns}	2.66
Consumed Tubers Dry Weight (g/clump)	V	2.30^{ns}	3.05
	F	0.23^{ns}	3.44
	VF	0.52^{ns}	2.66

Remarks: * = significant effect at 5% level ns = no significant effect at 5% level. V: Varieties, F: Fertilizer, VF: Interaction

Treatment for the Bima Brebes variety is better than that of other varieties treatment because this variety is easily adapted to the environment. Table 3 shows that the Sumenep variety (V3) is significantly different from that of other varieties, and it is the best treatment for red onion growth, which can be seen from the variable of crown dry weight (1.80 g/clump). In contrast, the Bima variety and Bauji variety are not significantly different than the Bauji variety.

Table 2. Average growth and production interaction for several red onion varieties due to NPK fertilizer application for all observed parameters

Parameters	Treatment			
		F1	F2	F3
A. Growth				
Plant Height (cm)	V1	30.62	29.53	31.77
	V2	24.89	27.71	29.90
	V3	27.30	30.03	26.24
	V4	23.51	31.40	31.49
Crown Wet Weight (g/clump)	V1	8.74	9.88	13.73
	V2	7.09	9.20	9.58
	V3	16.77	26.31	15.85
	V4	11.37	15.26	10.33
Crown Dry Weight (g/clump)	V1	1.67	1.17	2.04
	V2	0.99	1.25	1.27
	V3	1.74	2.21	2.16
	V4	1.83	1.78	1.57
B. Production				

Number of Tubers (piece/clump)	V1	8.40	7.20	7.80
	V2	13.00	8.33	12.66
	V3	8.13	8.20	7.73
	V4	5.73	6.33	4.73
Tubers Wet Weight (g/clump)	V1	57.24	47.87	66.18
	V2	43.34	37.22	63.52
	V3	29.61	32.66	26.84
	V4	29.82	49.46	31.39
Consumed Tubers Dry Weight (g/clump)	V1	48.29	40.42	51.62
	V2	34.77	32.54	35.17
	V3	22.86	31.70	20.98
	V4	24.80	45.08	27.19

Remarks ; V1 = Bima Brebes variety, V2 = Tajuk variety, V3= Sumenep variety, V4 = Bauji variety. F1 = 200 kg/ha NPK fertilizer, F2 = 250 kg/ha NPK fertilizer, F3 = 300 kg/ha NPK fertilizer.

Bima Brebes variety (V1) showed relatively better results amongst the three varieties, which can be seen from the variable of tuber dry weight. However, from the four varieties above, the Tajuk variety (V2) produces a tuber dry weight close to the Bima Brebes variety (V1). Compared to the Sumenep variety (V3) and Bauji variety (V4), the Bima Brebes variety (V1) and Tajuk variety (V2) have good adaptation capability toward the environment and are drought resistant. Table 4 shows that NPK fertilizer application at 250 kg/ha (F2) can support nutrient requirements for red onion crops. This is shown from a variable of consumed tuber dry weight with a magnitude of 37.44 g per clump. A crop will grow properly if complete nutrients are available. The amount is sufficient and balanced to be absorbed by crops and subsequently will increase the growth and production of crops.

Table 3. Average result and HSD 5% test for several red onion varieties in terms of growth and production for all observed parameters.

Parameters	Treatment			
	V1	V2	V3	V4
A. Growth				
Plant Height (cm)	30.64	27.50	27.86	28.80
Crown Wet Weight (g/clump)	10.79 b	8.52 a	19.64 c	12.32 b
	HSD (0.05) = 1.75			
Crown Dry Weight (g/clump)	1.50	1.03	1.80	1.53
B. Production				
Number of Tubers (piece/clump)	7.80 b	11.33 c	8.02 b	5.60 a
	HSD (0.05) = 0.61			
Tubers Wet Weight (g/clump)	57.10 d	48.03 c	29.70 a	36.89 b
	HSD (0.05) = 4.77			
Consumed Tubers Dry Weight (g/clump)	47.78	34.16	25.18	32.36

Remarks: Numbers followed by the same notation or letter do not mean significantly different, and numbers followed by different notations or letters mean significantly different. V1 = Bima Brebes variety, V2 = Tajuk variety, V3= Sumenep variety, V4 = Bauji variety.

Table 4. Average results of NPK fertilizer application effect on growth and production of several red onion varieties for all observed parameters

Parameters	Treatment		
	F1	F2	F3
Plant Height (cm)	26.59	29.67	29.86
Crown Wet Weight (g/clump)	10.99	15.16	12.38
Crown Dry Weigh (g/clump)	1.41	1.51	1.48
Number of Tubers (piece/clump)	8.82	7.52	8.23
Tubers Wet Weight (g/clump)	40.01	41.81	46.98
Consumed Tubers Dry Weight (g/clump)	32.68	37.44	33.74

Remarks; F1 = 200 kg/ha NPK fertilizer, F2 = 250 kg/ha NPK fertilizer, F3 = 300 kg/ha NPK fertilizer

3.2. Discussion

Interaction between several red onion varieties and NPK fertilizer application has no significant effect on the growth and production of red onion, as shown in all observed variables (Table 1). This indicated that red onion varieties and NPK fertilizer application give similar responses for all variables of the growth and production of red onion. Varieties factor (Table 1) subsequently showed that varieties significantly affect crown wet weight, tuber numbers per clump and tuber wet weight per clump. Variety determines the level of crop production and is supported by environmental factors. Crops with different varieties have different growth and production levels, although planted in the same soil. Each variety has different genetic characteristics that cause it to grow and produce according to its genetics and is supported by environmental factors [9]. Each variety has different resilience; some can adapt quickly, while others require a long time to adapt to the environment. This is because each variety has different genetic potential in responding to its environment.

The environment can also cause different characteristics to emerge from a crop [10]. Treatment of NPK fertilizer doses produces a similar effect on the growth and production of red onion (Table 1). It is estimated that NPK compound fertilizer has a similar content composition of 16:16:16, which has a similar effect on the growth and production of red onion. A crop will grow properly if complete nutrients are available and the amount is sufficient and balanced to absorb by the crop, which will subsequently increase the growth and production of crops [11]. Adding N, P and K content within NPK fertilizer helps optimize red onion growth, gives balanced nutrient support, and increases overall red onion growth. NPK fertilizer is a compound fertiliser that increases soil fertility [12]. Sumenep variety and 250 kg/ha NPK fertilizer dose can increase the growth of red onion crops (Table 2). Red onion of Sumenep variety has less water content than other red onion varieties. In addition to having less water content, red onion

of the Sumenep variety also has a stronger aroma. This red onion variety is suitable for diverse weather conditions and is weather resistant [13]. Bima Brebes variety and 300 kg/ha NPK dose treatment showed better production yield amongst other varieties of red onion. Bima Brebes variety has good adaptation toward the environment and is drought resistant. Average yield and HSD 5% test for several red onion varieties in terms of growth and production for all observed variables in Table 3 showed that the Sumenep variety has the highest growth value of three other red onion varieties. This is indicated by crown dry weight. Red onion of Sumenep variety resistant to Anthracnose disease caused by Colletotichum sp fungus. Sumenep variety has fresher crown growth in this research. The growth and production of a variety will differ at every different environmental conditions due to different capabilities to absorb water and nutrients. The difference in crop growth is morphological adaptation capability that subsequently will affect its growth and production. Varieties with different growth levels also cause different growth and production potential [14].

The best red onion variety is the Bima Brebes variety. It has the maximum production yield and advantages of adapting appropriately in the dry season and is more resistant to the wet season than other red onion varieties. This is in line with research on the Bima Brebes variety, which shows that the Bima Brebes variety gives the best growth and production of red onion crops [15]. Bima Brebes variety is a red onion that originates from Brebes (Central Java) and is frequently cultivated by farmers in several provinces in Indonesia because it has good adaptation capability in several areas in Indonesia and has relatively resistant characteristics to tuber rot [16].

The Tajuk variety has tuber wet weight per clump close to the tubers wet weight per clump of the Bima Brebes variety. Red onion of Tajuk (Thailand Nganjuk) variety can adapt well during the dry season, is resistant to rain and has a pungent aroma [17]. On the other hand, the red onion of the Bauji variety can adapt well in lowland areas (6 to 80 m asl) during the dry season, and the shape of the seeds for this variety is flat, round and wrinkled [18]. The use of red onion of Tajuk (Thailand Nganjuk), Sumenep and Bauji varieties is expected to be a solution to increasing red onion production because these red onion varieties can adapt well in lowland areas [16]. In order to increase the growth and production of red onion, it is important to note nutrient provision for crops through fertilizing and the use of superior varieties. Fertilizing is the addition of organic and inorganic elements to improve soil's physical, biological, and chemical properties so that crops can grow and produce optimally. Inorganic fertilizers can provide nutrients relatively faster, provide available nutrients that are ready to be absorbed by crops, have more nutrient content, have no pungent odor, and are practical and easy to apply. One of the inorganic fertilizers that can be used is NPK16:16:16 fertilizer. Mutiara NPK compound fertilizer can benefit the labor force and save costs, providing three nutrient types in one application: nitrogen, phosphorus, and potassium [7]. Application of NPK fertilizer at the dose of 250 kg/ha can support the nutrient needs of red onion crops (Table 4). A crop will grow properly if complete nutrients are available and the amount is sufficient and balanced to absorb by the crop, which will subsequently increase the growth and production of crops. NPK Mutiara fertilizer at a dose of 250 kg/ha contains sufficient nitrogen, phosphorus, and potassium nutrients so that red onion crops can develop well and produce maximum yield [19]. Treatment of 200 kg/ha NPK fertilizer is no better than that of 250 kg/ha NPK fertilizer. 200 kg/ha NPK fertilizer is not yet optimal for the growth and production of red onion. Inorganic fertilizer can add nutrients that are not available within the soil so that it can give optimum crop yield. NPK fertilizer addition is important, especially for red onion crop cultivation in ultisol soil that lacks nutrients.

However, a lack of nutrients will impact crop production, and excessive inorganic fertilizer can cause soil and environment quality to decline. The application treatment of 300 kg/ha NPK fertilizer (F3) is not very different from that of 250 kg/ha NPK fertilizer (F2). Applying 250 kg/ha NPK fertilizer is optimal for the growth and production of red onion crops. In contrast, continued fertilizer application at high doses will cause a decrease in soil organic material and soil fertility and destroy the environment.

Excessive fertilizer application without considering proper time and dose can cause a decrease in crop growth and soil to become infertile [20]. Inorganic fertilizer application can add nutrients that are not available within the soil so that it can provide optimum crop yield. However, excessive inorganic fertilizer will decrease soil and environmental quality [21]. Production of several red onion varieties planted at ultisol soil, which is converted into a unit of ton/ha consumed dry tuber, showed that the Bima Brebes variety had the highest production with a magnitude of 11.695 ton/ha, Tajuk variety with a magnitude of 8.540 ton/ha, Bauji variety with the magnitude of 8.090 ton/ha and the lowest one is Sumenep variety with the magnitude of 6.295 ton/ha.

4. Conclusion

A treatment combination between the Bima Brebes variety and 250 kg/ha NPK fertilizer dose tends to produce better growth and red onion production than other treatments. Bima Brebes variety tends to have better growth and production than other treatments. Applying 250 kg/ha NPK fertilizer produces the highest average value in the growth and production of red onion crops.

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