Optimizing Sustainable Dryland Management for the Development of Shallots Through the Application of Good Agricultural Practices

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Abstract*—Shallot are one of the leading commodities in Central Sulawesi because shallot are the raw material for making fried onion which are widely cultivated by people in the Palu Valley. The development of shallot in Central Sulawesi often faces problems, namely: limited availability of fertile land, implementation of cultivation systems that are not yet optimal because they do not follow good agricultural practice standards for dryland shallot cultivation and pest and disease attacks. The research aims to determine the soil processing system and effective fertilizer dosage as a reference in implementing good agricultural practices for the Palu Valley variety of shallot in dryland. The research was carried out at the shallot planting center in Sigi Regency using a Split Plot Design. The main plot is the height of the bed which consists of 3 levels, namely: S1 = 10 cm, S2 = 20 cm, and S3 = 30 cm. The subplot is the fertilizer dose which consists of 3 levels, namely: P0 = no fertilizer, P1 = inorganic fertilizer according to recommendations, P2 = organic fertilizer according to recommendations. The observation variables are the growth and yield of shallot. The research results showed that the height of the bed and the type of fertilizer applied had a significant effect on the growth and yield of shallot in all parameters except the number of shallot tillers. The 20 cm bed height treatment produced higher fresh weight per plant and yield per hectare compared to other bed heights, while the inorganic fertilizer type produced higher fresh weight per plant and yield per hectare compared to other types of fertilizer but was not significantly different from organic fertilizer.*
Keywords—*bed height, cultivation of shallots, fertilizer dosage, good agricultural practices, dryland bed height, cultivation of shallots, fertilizer dosage, good agricultural practices, dryland*

I. INTRODUCTION

The increasing need for land outside the agricultural sector results in an increasing reduction in agricultural land to support superior agricultural cultivation, thus requiring optimization of the use of land resources which allows land to remain available for sustainable agriculture. One alternative that is expected to increase the potential for crop production is the utilization of dry land, because apart from being available quite widely, some of the dry land has not been exploited optimally, thus allowing opportunities for its development. Dryland is defined as an expanse of land that is never inundated or flooded with water most of the year or all the time (1). Dryland is also often associated with farming carried out by communities in the upstream part of a river basin as upper land or land found in dry areas which depends on rainwater as a water source and is never permanently flooded (2).

Constraints on dryland production are the biophysical, technological and socio-economic conditions of the land, resulting in low land productivity. Biophysical constraints include relatively shallow soil depth, frequent erosion and drought. The technological obstacle is the weak application of conservation techniques, while the socio-economic obstacle is the lack of capital to apply the recommended technology. Problems often faced by dryland farmers include low levels of productivity, which are characterized by soil with advanced weathering, thick reddish solum, high clay content, and acidic soil reactions. It is also characterized by cation exchange capacity (CEC), K, Ca, Mg, phosphorus content, soil pH and base saturation and low organic matter content, while high iron, manganese and aluminum content and sensitivity to erosion (3).

The solution to overcome this problem is to implement dryland management with a sustainable agricultural perspective for the development of horticultural crops. Dryland management technologies that can be implemented include: soil and water conservation and soil fertility management (utilization of organic materials), as well as the application of good cultivation techniques (good agricultural practices).

Good agricultural practices is a certification system for good plant cultivation practices in accordance with specified standards. In an effort to obtain quality agricultural products, farmers as producers must comply with a certification system called good agricultural practices (GAP). According to the Ministry of Agriculture of the Republic of Indonesia, good agricultural practices is a technical implementation of a certification system for agricultural production processes that uses advanced environmentally friendly and sustainable technology, so that harvest products are safe to consume, workers' welfare is cared for and farming provides economic benefits for farmers (4).

Much research has been carried out regarding the application of good agricultural practices to agricultural commodities (5–7). The research results show that the application of good agricultural practices to horticultural crops such as shallot and food crops such as rice in several regions in Indonesia is still in the low category. Thus, this research will implement improvements in shallot cultivation techniques by using doses and methods of application of liquid organic fertilizer and bed height, which is one of the key factors for optimizing the use of dryland to increase plant productivity.

The research aims to develop production technology that complies with good agricultural practices (GAP) standards to increase shallot productivity in dryland. Specifically, the research objectives are: determine the soil processing system and effective organic fertilizer dosage as a reference for implementing good agricultural practice for shallot cultivation in dryland.

II. METHODS

A. Research Implementation

The research was carried out in the form of a field experiment using a Split Plot Design. As the main plot, the height of the bed consists of 3 levels, namely: S1 = 10 cm, S2 = 20 cm, and S3 = 30 cm. As a sub plot, the type of fertilizer consists of 3 levels, namely: P0 = no fertilizer, P1 = inorganic fertilizer according to recommendations, P2 = organic fertilizer according to recommendations. From these two factors, 9 treatment combinations were obtained.

The size of the bed is 2 m wide x 4 m long. with a distance between plots of 30 cm and a depth of 20 cm. Manure compost is applied one week before planting at a dose of 5 t ha^{-1}. Shallot seeds are planted at a spacing of 15cm x 20 cm and in each hole 1 shallot seed bulb is planted which has been sterilized with a fungicide solution. Cultivation practices such as watering, weeding, maintenance, pest and disease control were carried out in the same way in all experimental plots.

B. Observation Variables

The achievement indicators that can be measured from this experiment are as follows: 1) Growth components observed in each experimental plot, consisting of: plant height, number of leaves, and number of tillers, 2) Yield components observed: fresh weight of tubers, and tuber yield per hectare.

C. Data Analysis

Data were analyzed using analysis of diversity (ANOVA) and continued with the HSD test.

III. RESULTS AND DISCUSSION

Plant growth components

The components of plant growth observed include: plant height, number of leaves and number of shallot seedlings. Data on average plant height, number of leaves and number of shallot seedlings are presented in Table 1.

The Anova results showed that there was no interaction between the bed height treatment and the type of fertilizer applied. The results of the HSD 0.05 test showed that the single treatment of bed height and type of fertilizer each had a significant difference in the variables of plant height, number of leaves and number of shallot seedlings except for the bed height treatment for the variable number of leaves of shallot plants (Table 1).

Table 1. Plant height, number of leaves and number of saplings of Palu Valley shallots in different treatments of bed height and type of fertilizer

Treatment	Plant height (cm)	Number of leaves per clump (piece)	Number of tiller per hill
Bed height			
T1	31,63 b	18,07 a	3,62 b
T2	36,82 a	20,01 a	4,93 a
T3	34,63 a	19,20 a	4,53 a
HSD 0.05	2.85	2,01	55.32
Type of fertilizer			
P0	31,24 b	17,58 b	3,28 b
P1	35,06 a	19,24 ab	4,62 a
P2	36,77 a	20,46 a	5,19 a
HSD 0.05	2.85	2,01	0,69

Note: numbers followed by the same letter in the same column are not significantly different in the 0.05 HSD test

Components of crop yields

The components of crop yield observed include: fresh weight of tubers and yield per hectare of shallot. Data on the average fresh weight of bulbs and yield per hectare of shallot are presented in Table 2.

Table 2. Fresh weight of bulbs (g) and shallot yield (ton ha^{-1}) in different treatments of bed height and type of fertilizer

Treatment	Fresh weight of tubers (g)	Yield (ton ha^{-1})
Bed height		
T1	17,05 b	4,55 a
T2	19,19 a	5,12 a
T3	17,24 a	4,60 a
HSD 0.05	2,92	2,92
Type of fertilizer		
P0	15,30 b	4,08 b
P1	18,34 a	4,89 a
P2	19,84 a	5,29 a
HSD 0.05	2,92	2,92

Note: numbers followed by the same letter in the same column are not significantly different in the 0.05 HSD test

The Anova results showed that there was no interaction between the bed height treatment and the type of fertilizer applied to the fresh weight of the bulbs and the yield of the Palu Valley shallot. The results of the HSD 0.05 test showed that the single treatment of bed height and the single treatment of fertilizer type, each had significant differences in the variables of fresh tuber weight and Palu Valley shallot yield (Table 2).

The results of the analysis of variance showed that there was no interaction between the treatment of bed height and the type of fertilizer applied to plant height, number of leaves and number of shallot seedlings. The average plant height that gave a high score in the bed height treatment was 36.82 cm, while the fertilizer type treatment was 36.77cm. The average number of leaves was the highest, namely 20.01 in the bed height treatment and 20.46 in the type of fertilizer applied, and the highest average number of tillers was 4.93 in the bed height treatment and 5.19 in the fertilizer type treatment. which is applied. The use of inorganic fertilizer and organic fertilizer provides higher yields of plants, the number of leaves and the number of tillers compared to without fertilizer, this shows that fertilizer application treatment plays an important role in increasing the growth of shallot plants. Fertilizer plays a role in preparing the nutrients needed by plants to grow and develop

Organic fertilizer plays an important role in improving soil conditions by reducing soil density so that roots can develop well and absorb water and nutrients optimally (8,9). In addition, it will contribute to increased plant growth. Availability of adequate water and nutrients can also increase the rate of photosynthesis thereby increasing photosynthate which has an impact on increasing the dry weight of plant biomass (10–12). The treatment factor for bed height can be seen that a bed height of 40 cm (T2) has soil moisture values and soil temperatures from morning to afternoon tend to be lower than lower bed heights, so that aeration in the soil will be better for root development in the process of absorbing plant nutrients. influence on plant growth. Higher beds provide more oxygen for healthy root development resulting in better aeration (13). The growth of shallot in treatment T2 had the highest yield compared to other treatments. This is caused by the influence of the height of the beds which causes the soil structure to become crumbly and absorb rainwater more quickly, thereby reducing surface runoff. Apart from that, the physical condition of the soil is good, meaning the soil is loose and there are no solid layers at the root depth (14).

The results of the analysis of variance showed that there was no interaction between the treatment of bed height on the wet weight of tubers per plant and the yield of tubers per hectare of shallot. The bed height treatment had no significant effect on increasing the wet weight of shallot bulbs. The heaviest average wet weight of tubers per plant in the bed height treatment was 19.19 g in the T2 treatment, and 19.84 g in the inorganic fertilizer treatment, and the average shallot yield was 5.12 tons per hectares at bed height T2 and the type of fertilizer is 5.29 tons per hectare, this is because the bed height can absorb water in the soil and this can soften the soil structure, allowing the circulation of water, air and temperature in the soil to be better so that the onion bulbs develop well. Apart from that, it can activate microorganisms in the soil (15).

The treatment of providing inorganic fertilizers and organic fertilizers will activate the bodies of microorganisms, thereby fertilizing and loosening the soil well, by providing these fertilizers the roots can absorb and store nutrients (16).

IV. CONCLUSION

The treatment of bed height and type of fertilizer applied each showed a significant influence on the growth and yield of shallot plants in all parameters except the number of shallot tillers. The 20 cm bed height treatment produced a higher wet weight per plant and yield per hectare compared to other bed heights, while the inorganic fertilizer type produced a higher wet weight per plant and yield per hectare compared to other types of fertilizer but was not significantly different from the application of organic fertilizer.

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