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EFFECTS OF RICE HUSK ASH AND POTASSIUM (KCL) FERTILIZER ON THE GROWTH AND PRODUCTION OF SHALLOTS (*ALLIUM ASCOLANICUM* L.)

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ABSTRACT

The extreme changes in weather which resulted in disruption of shallots growth so that the impact of declining quality and productivity of the land in shallot planting. The study aimed to determine the effect of rice husk ash and potassium fertilizer (KCl) on the growth and production of shallots. The research design used was Split Plot Design in a factorial Randomized Block Design consisting of two factors, namely the factor of rice husk ash (A) as the main plot consisting of 3 levels: 5 t/ha (A1), 10 t/ha (A2), 15 t/ha (A3) and potassium fertilizer factor (K) as subplots consisting of 4 levels: 0 kg/ha (K0), 100 kg/ha (K1), 200 kg/ha (K2), 300 kg/ha (K3). The results showed that the best dose of rice husk ash and potassium fertilizer to the growth and production maximum of shallots were 15 t/ha and 300 kg/ha, respectively. Doses of rice husk ash and potassium fertilizer have not shown the optimum dose for to the growth and production maximum of shallots.

KEYWORDS: Extreme weather, diameter of bulbs, weight of bulbs.

INTRODUCTION

The existence of global warming has resulted in erratic climate change in recent years is a threat faced in the development of shallot cultivation. The prolonged dry season has led to drought in many agricultural lands which led to crop failure due to lack of water. Likewise, extreme weather changes result in disturbed plant growth, which results in a decrease in land quality and productivity.

The occurrence of water limitations can be caused by low rainfall, especially at the beginning of the dry season and the end of the rainy season. Drought stress in dry land is caused by low soil moisture content. Therefore, research needs to be done to overcome the condition of the land due to the dry environment, because the shallot centers are dry areas such as North Sumatra.

Rice husk ash is porous, so that drainage and soil aeration change for the better. Rice husk ash contains oxygen and nitrogen, which can increase surface area and thus greatly affect plant growth.[1]

Rice husk ash can provide nutrient content in the soil and is able to meet the needs of plant nutrients. This is thought to be due to the presence of N elements in the content of rice husk ash which can contribute N needed by plants.[2] Rice husk ash is also used as biofilter filler because it can increase porosity.[3] The results of Febrinugroho.[4] showed that the addition of rice husk ash to a land can reduce the weight of land contents, increase in total pore space, fast pore drainage space, and decrease in slow drainage pore space.

Potassium fertilizer (KCl) is a source of potassium (K) for plants. Its main function of helping in plants is the formation of proteins and carbohydrates, whereas for clay soils, K that is sown is bound by soil components so

that only 1/4 to 1/3 of the dose can be absorbed by plants. In sandy soils where the pores of the soil are large enough, potassium fertilizer is easily washed and carried by the flow of water. KCl fertilizer has a volatile nature so its application must be done when the soil is still moist and not when the soil drains water because of the results of the research the evaporation rate is 30% / day.[5]

According to Setiawan,[6] in general, potassium fertilizer (KCl) has the advantage of forming and transporting carbohydrates, strengthening plant upright, activating enzymes both directly and indirectly, plant seeds can become fuller and denser, and strengthen plant roots. KCl is very suitable for plantation and horticultural crops and contains up to 60% of K_2O nutrients.

Based on this, this study aims to determine the effect of rice husk ash and potassium fertilizer (KCl) on the growth and production of shallot plants.

MATERIALS AND METHODS

The study was conducted in the dry land of farmers in Namorambe, Deli Serdang, which is located at a height of ± 25 m above sea level with flat topography, from February to May 2017.

The study used a separate plot design in a factorial randomized block design consisting of two factors, namely: Rice husk ash factor (A) as the main plot consisting of 3 levels: 5 t/ha (A1), 10 t/ha (A2), 15 t/ha (A3) and potassium fertilizer factor (K) as subplots consisting of 4 levels: 0 kg/ha (K0), 100 kg/ha (K1), 200 kg/ha (K2), 300 kg/ha (K3).

The observed variables were plant height, number of leaves, number of tillers, number of tubers, tuber diameter, tuber weight per plant, tuber weight/ha.

RESULTS AND DISCUSSION

Statistical analysis showed that the application of rice husk ash and potassium fertilizer had a significant effect, while the combination between the two treatments had no significant effect on the plant height of shallots at the age of 31 days after the plant (HST) (Table 1).

Table 1: Average plant height (cm) of shallots in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice husk ash (t/ha)			Average[1]
	5	10	15	
Kfertilizer (kg/ha)				
0	17.15	18.79	25.00	20.31d
100	19.93	25.13	34.74	26.60c
200	25.68	30.11	36.81	30.86b
300	30.28	34.43	38.59	34.43a
Average[1]	23.26c	27.11b	33.79a	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

Table 1 shows that different treatments of rice husk ash dose significantly affect the plant height of shallots at the age of 31 HST, where the highest to lowest plants were found in the treatment of rice husk ash 15 t/ha, 10 t/ha, and 5 t/ha , namely 33.79 cm, 27.11 cm and 23.26 cm, respectively. Higher shallot with the provision of rice husk ash as much as 15 t/ha due to the dose of rice husk ash is able to meet the needs of plant nutrients, because the element N contained in rice husk ash can contribute N needed for plants growth and development[2]. In addition, husk ash has high silicate content so that it can provide nutrient requirements for onion plants. According to Sumarni and Hidayat,[7] shallot is one type of plant that requires a lot of silica.

Based on the regression analysis shows that the form of the relationship between the dose of rice husk ash with the height of the onion plant is linear in the form of the equation $y = 1.053x + 17.523$ ($R^2 = 0.9765$) (Figure 1). This means that the greater the dose of rice husk ash, the higher the onion plant will increase. The determinant coefficient (R^2) value of 0.9765 means that 97.65% of rice husk ash influences the shallot plant height.

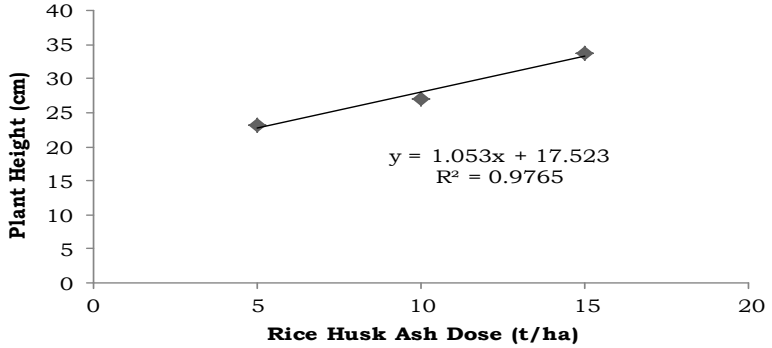

Figure 1: The form of the relationship between the dose of rice husk ash with plant height of shallot.

Potassium fertilizer dosage treatment also significantly affected the shallot plant height (Table 1), where the highest to lowest plants were treated with potassium fertilizer 300 kg/ha, 200 kg/ha, 100 kg/ha, and 0 kg/ha, i.e. respectively 34.43 cm, 30.86 cm, 26.60 cm and 20.31 cm. This is because potassium (K) is a macro nutrient that is important for plant growth and development. K has a role as an activator of several enzymes in plant metabolism. Potassium plays a role in protein and carbohydrate synthesis, and increases photosynthate translocation to all parts of the plant.[8]

Based on the regression analysis shows that the form of the relationship between the dose of rice husk ash with the height of the shallot plant is quadratic with the equation $y = -7E\text{-}05x^2 + 0.067x + 20{,}377$ ($R^2 = 0.9992$) (Figure 2). This means that the greater the dose of potassium fertilizer that is given up to the optimum dose will increase the height of the shallot plant, but if the dose of potassium fertilizer is increased beyond the optimum dose it will reduce the height of the shallot plant. Figure 2 shows that the optimum dose of potassium fertilizer has not yet been seen because the curve still shows the beginning of a decrease in plant height. The value of the determinant coefficient (R^2) of 0.9992 means that potassium fertilizer greatly influences the height of the shallot plant, which is 99.99%.

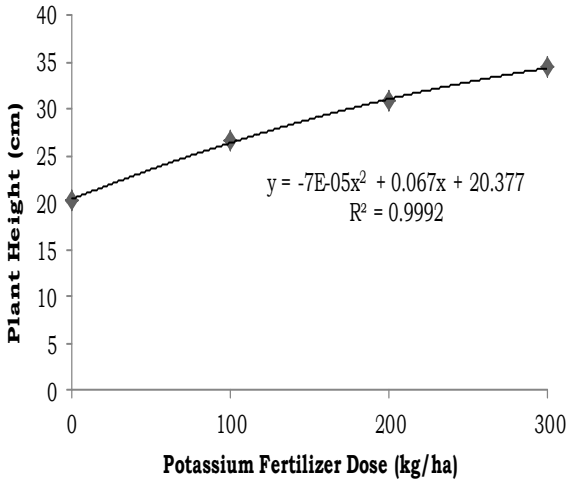

Figure 2: The form of the relationship between the dose of potassium fertilizer with plant height of shallot.

Table 1 also shows that the combination between the two treatments had no significant effect on the shallot plant height. This shows that in a single factor, rice husk ash and potassium fertilizer are able to influence the plant height of shallots, but together they have not been able to influence the plant height of shallots.

Table 2: Average leaves number of shallots in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average[1]
	5	10	15	
KFertilizer (kg/ha)				
0	11.27	9.33	11.00	10.53
100	11.00	9.80	10.73	10.51
200	12.33	9.67	10.27	10.76
300	10.73	10.27	11.67	10.89
Average[1)]	11.33	9.77	10.92	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%. [1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

The results of the statistical analysis showed that the application of rice husk ash and potassium fertilizer and the combination between the two treatments did not significantly affect the leaves number of shallot (Table 2). This is due to the general number of leaves affected by genetic factors of the plant itself, so that even if given certain treatments will not affect the number of leaves.

Based on the results of statistical analysis showed that the administration of rice husk ash significantly affected the number of tillers per shallot plant, while the dose of potassium fertilizer and the combination between the two treatments had no significant effect on the number of tillers per shallot plant (Table 3).

Table 3: Average number of tillers per shallot plant (tillers) in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average[1)]
	5	10	15	
KFertilizer (kg/ha)				
0	11.13	8.53	9.27	9.64
100	11.40	11.93	8.00	10.44
200	10.13	9.73	6.87	8.91
300	8.40	8.13	6.93	7.82
Average[1)]	10.27a	9.58b	7.77c	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

Table 3 shows that the higher the dose of rice husk ash, the number of tillers per shallot plants will decrease, ie 10.27 tillers with a dose of rice husk ash 15 t/ha, 9.58 tillers with a dose of rice husk ash 10 t/ha, and 7.77

tillers with a dose of rice husk ash 5 t/ha. This shows that the number of tillers per shallot plant will decrease if the rice husk ash dose increases. In line with the results of the study of Tarigan et al.[9] which shows that the increasing dose of rice husk ash given will reduce the number of tillers per shallot plant.

The number of tillers per plant that is not a guarantee that the shallot bulb production will be even greater. This is due to the increasing number of tillers per plant can cause competition between tillers in absorbing water, nutrients and sunlight needed in the photosynthesis process which can cause a decrease in the rate of photosynthesis, so that the photosynthate produced for bulb formation will also be reduced. This can be seen from the relationship between the number of shallots with bulb weights per plant which shows a negative linear form with the equation y = -1.7599x + 30.106 (R^2 = 0.9923) (Figure 3). This means that the greater number of shallots plants will further reduce the weight of bulbs per shallot plant, whereas if the number of tillers plants will reduce the weight of bulbs per plant.

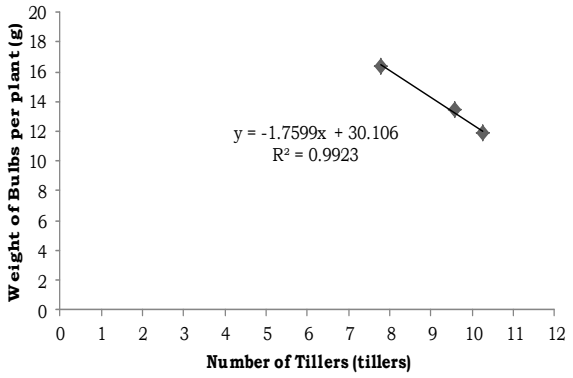

Figure 3: The relationship between the number of tillers and weights of bulbs per plant.

Table 4 shows that based on statistical analysis of rice husk ash and potassium fertilizer significantly affected the number of bulbs per plant shallot, while the combination between the two treatments had no significant effect on the number of bulbs per plant shallot.

Table 4: Average number of bulbs per plant shallot (bulbs) in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average[1)]
	5	10	15	
K Fertilizer (kg/ha)				
0	6.80	5.33	5.13	5.76b
100	8.93	7.40	5.53	7.29a
200	7.67	5.73	4.27	5.89b
300	4.53	4.60	3.73	4.29b
Average [1]	6.98a	5.77b	4.67c	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

The effect of rice husk ash on the number of bulbs per shallot plant is the same as the effect of rice husk ash on the number of tillers per shallot plant, ie the higher the dose of rice husk ash, the lower the number of bulbs per shallot plant, ie 6.98 g with a dose rice husk ash 5 t/ha, 5.77 g with a dose of rice husk ash 10 t/ha, and 4.67 g with a dose of rice husk ash 15 t/ha. This is due to rice husk ash containing only N by 1%, K by 2% but containing 87%-97% silica[10]. According to Septiani,[11] the content of rice husk ash is SiO_2 (52%), C (31%), K (0.3%), N (0.18%), F (0.08%), and calcium (0.14%). It also contains other elements such as Fe_2O_3, K_2O, MgO, CaO, MnO and Cu in small amounts and several types of organic matter.

Silica is a nutrient that is not essential for plant growth and development in general because its physiological function is unknown. According to Tisdale et al.[12], an element can be said to be essential for plant growth and development if (1) the element is involved or functioning in plant metabolism; and (2) plants cannot complete their life cycle without these elements. However, the benefits of the Si element in graminea plants, especially rice and sugar cane, are quite important and have been known for a long time.[13] This causes an increase in the dose of rice husk ash given to each onion plant, the number of tillers per shallot plant will decrease because silica is only needed by the shallot plants. In line with the results of the study by Pardede et al.[14] which showed that the application of rice husk ash by 20 t/ha further reduced the number of tillers and bulbs per shallot plant. According to Septiani,[11] high silica content can be beneficial for plants because it becomes more resistant to pests and diseases due to hardening of the tissue.

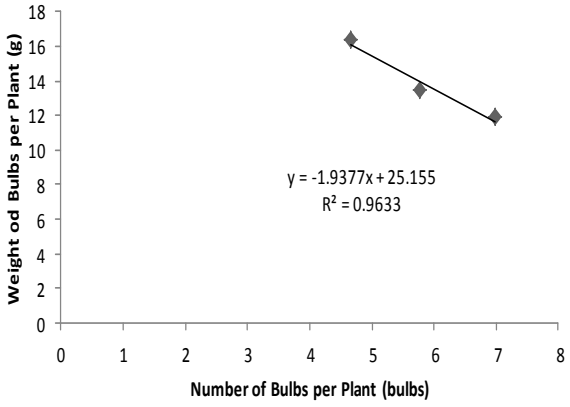

Figure 4: The relationship between the number of bulbs per plant and weights of bulbs per plant.

The number of bulbs per plant shallot that is also greater does not guarantee that the weight of the bulbs per plant produced will also be even greater. Based on the regression analysis shows that the form of the relationship between the number of bulbs per shallot plant and the bulb weight per plant of shallots is negative linearly shaped with the equation y = -1.9377x + 25.155 (R^2 = 0.9633) (Figure 4).

Figure 4 shows that the relationship between the number of bulbs per plant and the weight of bulbs per plant of shallot is negative linear, ie the more number of bulbs per plant, the less bulb weight per plant shallot will decrease. This is closely related to the competition that occurs in each shallot clump, where the more number of plants per clump will cause higher competition in fighting over the need for water, nutrients and sunlight which will affect the process of plant physiology, especially in the process of photosynthesis, water absorption and nutrient absorption. Finally it will affect the results of photosynthesis which will be used for tuber formation and enlargement.

Potassium fertilizer also has a significant effect on the number of bulbs per shallot plant (Table 4). The highest number of bulbs per shallot was found in the treatment of potassium fertilizer 100 kg/ha, which is as much as 7.29 bulbs, followed by the treatment of potassium fertilizer 200 kg/ha, which is 5.89 bulbs, the treatment of potassium fertilizer 0 kg/ha, which is 5.76 bulbs, and the treatment potassium fertilizer 300 kg/ha, which is 4.29 bulbs.

In line with the results of Ernawati's study[15] which showed that increasing the dose of potassium fertilizer given from 100 kg/ha to 300 kg/ha would reduce the number of bulbs per shallot plant. This is due to the dose of potassium fertilizer between 200-300 kg/ha has exceeded the needs of K shallot plants. According to[16] that the optimum dose of K fertilizer for growth and optimum yield of shallots was 175 kg/ha.

The application of rice husk ash and the combination between the two treatments had no significant effect on the bulb weight per plant of shallot, while potassium fertilizer significantly affected the bulb weight per plant of shallot (Table 5).

Rice husk ash has no significant effect on bulb weight per plant of shallot due to the content of element K in rice husk ash is very small, which is 2%[10] and 0.3%.[11] According to Sumarni et al.[17] the availability of K in the soil is insufficient to support important metabolic processes in plants such as translocation of sugar from leaves to tubers, enzyme activity, protein synthesis, and cell enlargement, which in turn determines the yield and quality of yield of a plant, so to meet the needs of K plants need additional K through fertilizer applications. However, if the addition of K given is not sufficient to meet the needs of the plant, the application of the fertilizer will not affect the growth and yield of the plant.

Table 5: Average bulb weights per plant of shallot (g) in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average[1)]
	5	10	15	
K Fertilizer (kg/ha)				
0	9.27	11.40	11.40	10.69b
100	10.73	10.07	11.27	10.69b
200	11.73	14.47	15.67	13.96b
300	15.73	17.93	27.13	20.27a
Average[1)]	11.87	13.47	16.37	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

Potassium fertilizer significantly affected the bulb weights per plant of shallot (Table 5). The bulb weights per plant of shallot increases with increasing dosage of potassium fertilizer given, ie 10.69 g with potassium fertilizer 0 kg/ha, 10 69 g with potassium fertilizer dose of 100 kg/ha, 13.96 g with dose of potassium fertilizer 200 kg/ha and 20.27 g with a dose of potassium fertilizer 300 kg/ha. In contrast to the results of research Sumarni et al.[17] which shows reduction in shallot bulb weights with increasing doses of potassium fertilizer exceeding 120 kg/ha. Likewise the results of research by Islam et al.[18]; El-al et al.[5] Napitupulu and Winarto[19] showed that the optimum dose of potassium fertilizer for the maximum weight of bulb per plant of shallot was 120-200 kg/ha, 144 kg/ha, and 100 kg/ha. This is thought to be caused by the status of K soil at the study site is low, so it requires additional elements of K through the application of potassium fertilizer with sufficient doses. According to Sumarni et al.[17] K-soil status factor (soil type) had more influence on the yield of shallot bulbs compared to the dose of K fertilizer applied.

Table 6 shows that the application of rice husk ash and potassium fertilizer significantly affected the bulb weights per hectare of shallot, while the combination between the two treatments had no significant effect on the bulb weights per hectare of shallot.

Increasing the dose of rice husk ash and potassium fertilizer applied also increased the bulb weights per hectare of shallot. Rice husk ash dose of 15 t/ha was able to produce the highest shallot bulb weights of 1078.88 kg/ha, followed by a dose of rice husk ash 10 t/ha with bulb weights 974.45 kg/ha, and the lowest by giving rice husk ash as much as 5 t/ha ha with a bulb weight of 814.44 kg/ha. In line with the results of Kiswondo[20] which shows an increase in yield of tomatoes with

increasing doses of husk ash given. This is due to husk ash is a solid residual combustion of organic material that does not evaporate, can increase soil pH, provide important nutrients for plants such as K, P, Ca, Mg, so as to increase crop yields.[21]

Table 6: Average bulb weights per hectare of shallot (kg) in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average[1]
	5	10	15	
K Fertilizer (kg/ha)				
0	714.09	942.22	877.02	844.44b
100	795.55	856.31	968.89	873.58b
200	814.80	1002.98	1019.24	945.67b
300	933.33	1096.31	1450.35	1160.00a
Average[1)]	814.44c	974.45b	1078.88a	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

Likewise, the application of potassium fertilizer, the more the dose of potassium fertilizer is given, the higher the weight of the shallot bulbs produced. Potassium fertilizer dosage as much as 300 kg/ha produces the heaviest bulb weight, which is 1160.00 kg/ha, followed by application of potassium fertilizer as much as 200 kg/ha with bulb weights 945.67 kg/ha, potassium fertilizer as much as 100 kg/ha with bulb weights 873.58 kg/ha and lowest bulb weights without potassium fertilizer (0 kg/ha) with bulb weights of 844.44 kg/ha. This is because K plays an important role as an activator of several enzymes in plant metabolism such as protein and carbohydrate synthesis, and increases photosynthate translocation to all parts of the plant[8,22,16] states that K can also maintain cell turgor pressure and water content in plants, increase plant resistance to disease and drought, and improve crop yield and quality. Besides that K can also affect the growth, yield and quality of shallot bulbs[23]. Nutrient balance, especially K in the soil, plays a role in the synthesis of carbohydrates and proteins so that it can enlarge the shallot bulbs.[24]

Shallot bulb diameter is one of the analyzes that shows the quality of shallots because the shallot bulbs that are favored on the market are shallot bulbs with a larger diameter. Based on statistical analysis showed that rice husk ash and potassium fertilizer significantly affected the shallot bulb diameter, while the combination between the two treatments had no significant effect on the shallot bulb diameter (Table 7).

Table 7: Average bulb diameter of shallot (mm) in the treatment of rice husk ash and potassium fertilizer doses.

Treatments	Rice Husk Ash (t/ha)			Average [1]
	5	10	15	
K Fertilizer (kg/ha)				
0	10.65	12.24	11.32	11.40b
100	11.02	10.31	12.27	11.20b
200	11.07	14.64	16.05	13.92b
300	14.86	18.04	19.35	17.42a
Average[1]	11.90c	13.81b	14.75a	

Note: The average value of treatment without being followed by letters in the same column and row shows no significant difference based on Duncan's multiple range test at the 5%.[1] Different letters in the same column and row show significantly different based on Duncan's multiple range test at the 5%.

Increasing the dose of rice husk ash and potassium fertilizer dosage further increases the diameter of the shallot bulbs. The diameter of the largest shallot bulbs with the application of rice husk ash is 15 t/ha, followed by the application of rice husk ash 10 t/ha, and 5 t/ha, ie respectively 14.75 mm, 13.81 mm, and 11.90 mm. This is because one of the important roles of rice husk ash is to be able to improve soil structure, increase absorption and water retention ability, so as to maintain soil structure and humidity of the microenvironment around plantations[25]. Goldsworthy and Fisher[26] further stated that the addition of rice husk ash can increase overall plant growth continuously and indirectly increase root growth at all depths of normal roots and even encourage better tuber formation.

The higher the dose of potassium fertilizer applied, the greater the diameter of the shallot bulbs produced (Table 7). This is due to the shallot planting, K can provide better bulb yields, higher quality and shelf life of bulbss, and the bulbs remain solid even though they are stored for a long time[27]. The low diameter of shallot bulbs

obtained with the lower dosage of potassium fertilizer given due to K nutrient deficiency will inhibit translocation and storage of assimilates, thereby reducing the size, number and yield of bulbsper plant[5]. Furthermore[28,16] states that the K requirement increases with increasing crop yields, because the K function is related to photosynthesis.

CONCLUSION

The best dose of rice husk ash and potassium fertilizer to produce maximum growth and production of shallot plants are 15 t/ha and 300 kg/ha, respectively.

The optimum dose of rice husk ash and potassium fertilizer has not yet been obtained for maximum growth and production of shallots because the relationship between the dose of rice husk ash and potassium fertilizer with growth and production of shallots is still linear.

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