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The effect of Dolomite and Potassium to growth and yield of shallots in peatland

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The expansions of shallots have expanded in all provinces, mainly caused by adaptability that large. The big potension region for developing shallots is short peatland that have been old. Central Borneo has shallow peat land that has potension to development shallots. Amelioration have function to improving fertility of peatland there are to improve root environment for plant growth through increasing of pH, to improving nutrient availability, decreasing organic acid and toxin. Giving dolomite can increase of soil pH and activation fertilizer absorption (N, P and K). The research aim is knowing of effect dolomite and potassium to growth and yield of shallots in peatland. This research was conducted at peat land Palangkaraya City, Central Borneo Province on July-December 2017. This research use method of Randomized Block Design (RBD) with two factors there are dolomite and potassium. The treatment of dolomite and potassium resulted in a real interaction on the parameters of plant length, number of leaves, number of tillers, chlorophyll content, stomatal density and shallots yields.

Keywords: Shallots, Peatland, Dolomite and Potassium

INTRODUCTION

The expansion of shallots have expanded in all province, mainly caused by adaptability that large. The shallots can grow in low area to high area at height 0-100 masl, on padi fields of irrigation and dry field, with temperature 24-32^{0}C and humidity among 80-90%. The big potension region for developing shallots is shallow peatland that have been old. Central Borneo has shallow peat lands that have potension to development shallots. According classification of marshland vegetables plant and horticulture suitable for cultivation on marshland and alluvial peatland (Widjaja et al., 1993). According suitability class for crops and horticulture, the peat land is marginal suitability (S3) with limiting factor of soil pH is low and low fertility level.

Amelioration have a function to improve peat land fertilizer there are improving root environment to plant growth through increased of pH, increasing of nutrient availability, decreasing of organic acid and toxin ions. One of amelioration to improving of fertilizer is agricultural lime. The giving of lime can increase of soil pH and can adsorbing nutrient N, P and K. Giving of dolomite 4 t ha^{-1} can increase soil pH, Mg and Ca, decreasing Mn and Cu in soil (Palliyaguru et al., 2013). Liming with level 4-5 t ha^{-1} agricultural lime effective to increase fertilizer of peatland. On peat land that usage as intensive the lime is given among 1-2 t ha^{-1}, then peat land that has degradated among 2-5 t ha^{-1} (Maftu'ah et al., 2014). Growth and development shallots is needing the nutrient that have most important function on growth and yield of shallots. The shallots yield is determined by interaction among plant and environment, technology and social-economic farmer problem. The height shallots yield can reach if all of factor plant growth is available in optimum condition (Saud et al., 2013).

The height soil diversity and environment in Indonesia causing different fertilizer needed from

location to other location. The problem that faced to determine the right location specific fertilizer needed on shallots is unknown of information result of research as simultaneous. One of the nutrients that are classified as the main macro nutrient needed for plant growth is potassium. Potassium is essential nutrients that shallots needed on plant metabolism process. Potassium have function as photosynthesis process, as plant growth stimulant, strengthen stem and reduce decay result. Potassium on shallots give result of tuber is belter, quality and long storability. Potassium have an important function to maintenance of cell water potential to set up open and close stomata (De Resende et al., 2014). Potassium also has function as facilitator to water absorption by root and reduce transpiration on the plant.

MATERIALS AND METHODS

The research was conducted at peat land of Palangka Raya Central Borneo Province, on July to December 2017. This research use Randomized Block Design (RBD) with 2 factors there are:

D Factor is dolomite there are:

D2 = Dolomite 2 t ha^{-1}

D4 = Dolomite 4 t ha^{-1}

D6 = Dolomite 6 t ha^{-1}

D8 = Dolomite 8 t ha^{-1}

K Factor is treatment of potassium nutrient there are:

K0 = Without potassium (control)

K1 = 60 kg ha^{-1} K_2O

K2 = 120 kg ha^{-1} K_2O

K3 = 180 kg ha^{-1} K_2O

K4 = 240 kg ha^{-1} K_2O

The 2 factor are repeated three times, so there are 60 combination.

Data Analysis

Data of experience result was analized by ANOVA using F test. If the results are significantly different (F Hit > F Table 5%) then it will continue using the least significant difference Test (LSD) with 5% level.

RESULTS AND DISCUSSION

Effect of dolomite and potassium to plant growth

Efforts to increase the pH and productivity of peatlands are by providing ameliorants and inorganic fertilizers needed by plants. Giving ameliorant in the form of dolomite can increase soil pH and soil nutrient availability which can be absorbed by plants. The results of research showed an initial soil pH of 3.92 and an increase in soil pH to 5.94 (34.01%), 6.06 (35.31%), 6.59 (40.52%) and 6.63 (40.87%), each with treatment of 2, 4, 6 and 8 t ha^{-1} dolomite compared to the pH of the initial soil. This is caused by the process of decomposition of peat soils which produce organic acids and nutrients. The administration of dolomite increases soil pH due to increased OH^- and decreases in H^+ in the soil, increases Ca^+ and Mg^+, a nutrient balance occurs so that it is available to plants. Adding dolomite to the right dose increases the number of cations that play a role in the elongation of organic acids (maftu'ah et al., 2013).

Treatment of dolomite and potassium increases the number of plant leaves. Interaction of dolomite and potassium administration increases plant length and number of plant leaves (Table 1). Increased nutrient uptake by plants will increase the number and size of cells so as to increase the length and amount of plant leaves in line with the increase in plant age until the maximum subsequent decline will occur. Increasing the length and number of plant leaves will improve photosynthesis. If the nutrient content of the plant is mainly increased, photosynthate will increase. Nitrogen improves the green color of leaves and promotes the growth of plant stems and leaves (Marschner, 2012).

Interaction of dolomite and potassium treatments increased the number of plant tillers (Table 1). Increased pH and potassium fertilization cause increased availability of soil K which can be absorbed by plants. Increased uptake of K by plants will improve the development of meristem tissue so as to increase shoot formation and then develop into tillers.

Treatment of dolomite and potassium showed an increase in levels of chlorophyll a, chlorophyll b and total chlorophyll. Increased chlorophyll levels are in line with increasing doses of dolomite and potassium. Interaction of dolomite and potassium treatments increased chlorophyll a, chlorophyll b and total chlorophyll (Table 2). Chlorophyll as the main pigment of plants, plays a role in photosynthesis which produces carbohydrates and provides energy. Increased levels of chlorophyll will increase photosynthesis, then the assimilate is translocated to plant organs for growth and development.

Treatment of dolomite and potassium causes a significant increase in plant growth. Interaction of dolomite and potassium treatment increases

plant growth.

Table 1. Effect of dolomite and potassium on plant growth

Parameter	Age (DAP)	Treatment	K0	K60	K120	K180	K240
Length Plant	42	**D2**	33,33 a A	34,53 ab A	36,53 ab A	39,47 b A	40,60 b A
		D4	35,33 a AB	35,33 a A	41,33 b B	44,27 b B	40,67 b A
		D6	37,27 a B	41,53 b B	42,13 b B	42,27 b AB	39,60 ab A
		D8	39,53 a B	40,53 a B	40,73 a B	40,68 a AB	39,33 a A
		LSD 5%	3,57				
		CV	5,50%				
Number of Leaf	42	**D2**	25,16 a A	25,71 ab A	25,75 ab A	32,32 b AB	33,38 b A
		D4	25,85 a A	29,10 ab AB	34,96 cd B	37,96 d B	32,30 bc A
		D6	27,58 a A	32,71 b B	35,79 b B	34,67 b B	32,42 ab A
		D8	28,80 a A	31,29 a B	31,17 a B	31,49 a A	29,56 a A
		LSD 5%	4,94				
		CV	9.68%				
Number of Tillers	42	**D2**	6,17 a A	6,83 ab AB	6,48 ab A	7,08 ab A	8,07 b A
		D4	6,18 a A	6,41 a A	7,96 b B	9,00 b B	8,31 b A
		D6	6,39 a A	7,17 ab AB	8,22 b B	8,34 b B	8,06 b A
		D8	7,30 a A	8,34 a B	7,99 a B	7,92 a AB	7,78 a A
		LSD 5%	1,16				
		CV	9,37%				

Note: The numbers followed by the same uppercase letters in the same column and the same lowercase letters on the same line show no significant difference based on the LSD test at the 5% level; DAP= Day After Planting; LSD = Least Significant Different; D2= 2 t ha^{-1} Dolomite; D4= 4 t ha^{-1} Dolomite; D6= 6 t ha^{-1} Dolomite; D8= 8 t ha^{-1} Dolomite; K0= Control; K60= 60 kg ha^{-1} K_2O; K120= 120 kg ha^{-1} K_2O; K180= 180 kg ha^{-1} K_2O; K240= 240 kg ha^{-1} K_2O.

Table 2. Effect of dolomite and potassium to number of chlorophyll

Parameter	Age (DAP)	Treatment	K0	K60	K120	K180	K240
Chlorophyll A	14	D2	2,44 a A	2,49 a A	2,47 a A	3,48 b A	4,00 b A
		D4	2,67 a A	2,69 a A	3,31 bc B	3,66 c B	3,91 b A
		D6	2,39 a A	2,69 a A	3,71 b B	4,83 c B	3,95 b A
		D8	2,76 a A	3,74 ab B	4,12 b B	4,76 b A	3,87 b A
		LSD 5%	0,75				
		CV	13,28%				
Chlorophyll B	14	D2	4,50 a A	4,44 a A	4,58 a A	5,84 b A	6,12 b A
		D4	4,01 a A	4,69 a A	4,81 a A	6,92 b B	6,46 b A
		D6	4,62 a A	4,67 a A	5,76 b B	6,73 c B	6,92 c A
		D8	4,59 a A	5,22 a A	6,71 b C	6,39 b AB	6,72 b A
		LSD 5%	0,82				
		CV	8,93%				
Chlorophyll Total	14	D2	6,94 a A	6,93 a A	7,05 a A	9,33 b A	10,12 b A
		D4	6,68 a A	7,38 ab AB	8,12 b A	10,58 c B	10,37 c A
		D6	7,01 a A	7,36 a AB	9,48 b B	11,55 c B	10,86 c A
		D8	7,36 a A	8,96 b B	10,83 c C	11,15 c B	10,59 c A
		LSD 5%	1,15				
		CV	7,80%				

Note: The numbers followed by the same uppercase letters in the same column and the same lowercase letters on the same line show no significant difference based on the LSD test at the 5% level; DAP= Day After Planting; LSD = Least Significant Different; D2= 2 t ha^{-1} Dolomite; D4= 4 t ha^{-1} Dolomite; D6= 6 t ha^{-1} Dolomite; D8= 8 t ha^{-1} Dolomite; K0= Control; K60= 60 kg ha^{-1} K_2O; K120= 120 kg ha^{-1} K_2O; K180= 180 kg ha^{-1} K_2O; K240= 240 kg ha^{-1} K_2O.

Plant growth increased with increasing doses of dolomite and potassium. The administration of dolomite increases soil pH and the availability of nutrients N, P and K that can be absorbed by plants for growth. Dolomite contains Ca and Mg to support plant growth. Potassium plays a role in the process of protein synthesis, water balance, chlorophyll compiler, opening and closing stomata, and development of plant meristems, enzyme activators and plant metabolism, enhancing photosynthetic translocation throughout plant organs so as to increase plant growth. Phosphorus plays a role in root growth and is a component of nucleic acid, phospholipids, ATP and several enzymes. Increasing uptake of N, P and K maximally increases photosynthesis.

Effect dolomite and potassium to yield of shallots

Interaction of dolomite and potassium treatments increased the weight of wet, dry weight and dry weight of plant tuber (Table 3). Interaction did not occur between dolomite and potassium treatment on tuber weight loss (Table 4).

Table 3. The effect dolomite and potassium to yield of shallots

Parameter	Treatment	K0	K60	K120	K180	K240
Wet Weight	**D2**	8,70 a A	9,63 ab A	10,30 b A	12,02 c A	13,77 d B
	D4	10,20 a A	10,66 a AB	10,74 a A	14,77 c B	13,39 b AB
	D6	9,60 a AB	11,21 b B	11,63 b B	14,62 c B	13,18 b AB
	D8	11,20 a B	12,32 a B	13,71 b B	14,27 b B	12,06 a A
	LSD 5%	1,38				
	CV	7,03%				
Dry Weight	**D2**	6,13 a A	7,14 ab A	7,74 b A	9,40 c A	10,29 c B
	D4	7,31 a B	7,85 a A	8,21 a AB	10,46 b B	9,79 b B
	D6	7,00 a AB	7,97 ab A	8,59 b AB	10,49 c B	9,52 bc AB
	D8	8,05 a B	9,07 ab B	9,15 b B	10,34 c AB	8,64 ab A
	LSD 5%	1,05				
	CV	7,35%				
Weight Of Dry Tubers	**D2**	5,56 a A	6,44 ab A	7,13 b A	8,54 c A	9,25 c B
	D4	6,53 a AB	7,15 a AB	7,46 a A	9,61 b B	9,00 b AB
	D6	6,41 a AB	7,46 b BC	7,89 bc AB	9,56 d B	8,76 cd AB
	D8	7,27 a B	8,33 b C	8,56 bc B	9,88 c B	8,02 ab A
	LSD 5%	1,01				
	CV	7,72%				

Note: The numbers followed by the same uppercase letters in the same column and the same lowercase letters on the same line show no significant difference based on the LSD test at the 5% level; DAP= Day After Planting; LSD = Least Significant Different; D2= 2 t ha^{-1} Dolomite; D4= 4 t ha^{-1} Dolomite; D6= 6 t ha^{-1} Dolomite; D8= 8 t ha^{-1} Dolomite; K0= Control; K60= 60 kg ha^{-1} K_2O; K120= 120 kg ha^{-1} K_2O; K180= 180 kg ha^{-1} K_2O; K240= 240 kg ha^{-1} K_2O.

Table 4. Effect of dolomite and potassium nutrient to decreasing of weight

Treatment	Decreasing Of Weight			
	14 DAP (t ha^{-1})	28 DAP (t ha^{-1})	42 DAP (t ha^{-1})	56 DAP (t ha^{-1})
D2	6,92 a	6,42 a	6,06 a	5,80 a
D4	7,44 ab	6,89 ab	6,59 ab	6,34 ab
D6	7,51 b	6,99 b	6,72 b	6,48 b
D8	7,88 b	7,42 b	7,17 b	6,97 b
LSD 5%	0,55	0,56	0,57	0,60
K0	5,84 a	5,37 a	5,11 a	4,89 a
K60	6,77 b	6,27 b	5,97 b	5,75 b
K120	7,25 b	6,77 b	6,47 b	6,24 b
K180	8,95 c	8,35 c	8,03 c	7,76 c
K240	8,37 c	7,90 c	7,60 c	7,35 c
LSD 5%	0,61	0,63	0,64	0,67
CV	10,00%	11,01%	11,70%	12,61%

Note: The numbers followed by the same uppercase letters in the same column and the same lowercase letters on the same line show no significant difference based on the LSD test at the 5% level; DAP= Day After Planting; LSD = Least Significant Different; D2= 2 t ha^{-1} Dolomite; D4= 4 t ha^{-1} Dolomite; D6= 6 t ha^{-1} Dolomite; D8= 8 t ha^{-1} Dolomite; K0= Control; K60= 60 kg ha^{-1} K_2O; K120= 120 kg ha^{-1} K_2O; K180= 180 kg ha^{-1} K_2O; K240= 240 kg ha^{-1} K_2O.

Increased doses of dolomite and potassium significantly reduce tuber weight loss. The administration of dolomite and potassium increases pH and soil K so that it can be absorbed by plants that play a role in photosynthesis, translocation and storage of assimilates, increase in size, amount and yield of tubers per plant, increase tuber density and reduce the rate of decay results (Abd El-Al et al., 2010).

Giving potassium 180 kg ha^{-1} is a sufficient dose for plant needs. At this dose showed that when growth and filling of tubers the availability of K was not a limiting factor so photosynthetic translocation of the leaves to plant organs and tubers was not inhibited. According Abd. EL-AL et al., (2010), giving of K fertilizer in the form of K sulfate at a dose of 144 kg ha-1 K_2O can increase plant growth, quality and yield of tubers. The application of K fertilizer as much as 100 kg ha-1 K_2O is the best for onion plants on Ultisol soil with low K soil status (Napitupulu dan Winarto, 2010). According Sumarni et al., (2012), the relationship between the results of onion Bangkok or Yellow varieties with K fertilizer dosage on all K-soil status was quadratic, whereas the results of tuber and Bangkok and Yellow varieties on high K-soil status were significantly higher than those in low and medium K-soil status.

Excessive giving of K will cause K to be antagonistic because it inhibits absorption of other nutrients such as Ca and Mg which inhibits growth and decreases crop yields. Excessive administration of dolomite and K will cause increased cations of Mg, Ca and K. Cation will become an inhibitor of Mg and Ca, whereas Ca and Mg cations have the same valence so that competition occurs.

CONCLUSION

The treatment of dolomite and potassium resulted in a real interaction on the parameters of plant length, number of leaves, number of tillers, chlorophyll content, stomatal density, and shallots yields, ie wet Stover weight, dry Stover weight and dry tuber weight.

CONFLICT OF INTEREST

Resolves of plant problems on peatlands, especially shallots.

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AUTHOR CONTRIBUTIONS

Suparman is the author who conducts research in the field

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