Available online freely at www.isisn.org
Bioscience Research
Print ISSN: 1811-9506 Online ISSN: 2218-3973
Journal by Innovative Scientific Information & Services Network
RESEARCH ARTICLE BIOSCIENCE RESEARCH, 2019 16(2): 929-935. **OPEN ACCESS**

The effect of dolomite and potassium to uptake of NPK and tuber weight loss of shallots in peatland

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Peatland is marginal land that potential as development of shallots. Improvement productivity of peatland is giving ameliorant and an organic fertilizer. The aim of this research is known the effect of dolomite and potassium to uptake of macro nutrient (NPK) and tuber weight loss of shallots in peatland. This research was conducted in peat land, Sebagau District, Palangkaraya City, Central Borneo Province, on July to December 2017. This research used Randomized Block Design (RBD) with 2 factor and 3 replication. Dolomite factor consist from 4 level there are: 2 t ha^{-1} dolomite, 4 t ha^{-1} dolomite, 6 t ha^{-1} dolomite and 8 t ha^{-1} dolomite. Potassium factor consist from 5 level there are without potassium fertilizer (control), 60 kg ha^{-1} K_2O, 120 kg ha^{-1} K_2O, 180 kg ha^{-1} K_2O and 240 kg ha^{-1} K_2O. The result shown there are interaction both dolomite and potassium to length of plant, stomata density dry tuber weight, uptake of NPK, and potassium soil residue, while on tuber weight loss, residue of N and P there are no interaction. Giving of dolomite 4 t ha^{-1} and potassium 180 Kg ha^{-1} increase of plant length stomata density, dry tuber weight, potassium soil residue and uptake of NPK on plant. Giving dose of potassium 180 kg ha^{-1} decrease tuber weight loss.

Keywords: Shallots, Peatland, Dolomite and Potassium

INTRODUCTION

Peatlands are composed of remnants of vegetation that accumulate for a long time and form peat soil. Peat soils are irriversible drying, subsidence, low bearing capacity of the land to pressure, low nutrient content and nutrient and limited number of microorganisms (noor et al., 2014). Peatlands are marginal land for agriculture because of their low fertility, are very acidic, high cation exchange capacity, low base saturation, Ca, Mg and micro elements such as (Cu, Zn, Mn, B) are also low, phosphorus availability (P) and potassium (K) in low soils and high P-absorption, the amount of K on peat soil is lower than K mineral soil and nitrogen (N) is volatile, due to leaching, volatility and denitrification. (Noza et al., 2014; Aryanti et al., 2016).

Improvement of soil acidity and low nutrient status on peat soil is done by adding dolomite and fertilizer. Giving dolomite can increase soil pH, increase nutrient availability, streamline nutrient uptake by plants, increase soil adsorption ability. Giving dolomite on peatlands is a source of elements of Ca and Mg, increasing the power of storing P, increasing the fertility of peat soils and increasing crop yields. Lime can increase the pH and nutrients of peat soil (Salsi, 2011).

Fertilization is one of the determining factors in an effort to improve crop yields. The impact of fertilization not only increases yield per unit area but is also efficient in using fertilizers. The application of fertilizers to soil with low nutrient availability can increase the growth and yield of shallots. Potassium (K) is one of the macro nutrients that is important for plant growth and development. Giving K significantly increases the yield and quality of shallot bulbs (Deshpande et al., 2013). Potassium acts as an activator for several enzymes in plant metabolism, protein and carbohydrate synthesis and increases photosynthate translocation to all parts of the plant. Potassium can also maintain cell turgor pressure and water content in plants, increase plant resistance to disease and drought and improve crop yield and quality. In shallots, potassium administration increases growth, yield and quality of nutrient uptake (Atanda and Olaniyi. 2016)

Availability of K in rare earths is sufficient to support the process of assimilate transport from leaves to tubers, enzyme activity, protein synthesis, and cell enlargement that determines yield and quality of results. One way to overcome this is by adding sufficient K fertilizer. Provision of sufficient K fertilizer into the soil increases growth, nutrient uptake, yield and quality of shallots. K-soil status has a significant effect on the weight of tubers. The higher the K-soil status, the higher the yield of plant tuber weight. The optimum shallot tuber yield obtained by administering 100 kg ha-1 K_2O and administering K fertilizer over this dose did not increase yield (Deshpande et al., 2013).

The purpose of this study was to determine the effect of dolomite and potassium on NPK uptake of plants and shrinking the weight of shallot tubers on peatland.

MATERIALS AND METHODS

This research was conducted at peatland, Sebagau District, Palangkaraya City, Central Borneo Province on July-December 2017. The shallots used bauji variety. This research used Randomized Block Design (RBD) with 2 factor and 3 replication. Dolomite factor consist of 4 level there are 2 t ha^{-1} dolomit, 4 t ha^{-1} dolomit, 6 t ha^{-1} dolomit dan 8 t ha^{-1} dolomit. Potassium factor consist of 5 level there are: without potassium (control), 60 kg ha^{-1} K_2O, 120 kg ha^{-1} K_2O, 180 kg ha^{-1} K_2O dan 240 kg ha^{-1} K_2O.

Parameter on this research are plant length, density of stomata, dry tuber weight, loss tuber weight. NPK soil residue and NPK uptake. Data of research was analysed with analysis covarian (ANOVA). If the results of the analysis show F count > from F table, then proceed with the LSD (Smallest Real Difference) test of 5%.

RESULTS

The results of the initial soil analysis showed low soil fertility and were very acidic, with a pH of 3.92 (very acidic), 6.91% organic C (very high), 2.03% N (very high), 95.60 ppm P_2O_5 bray (very high) and 0.02 me g^{-1} K-add (very low) (Table 1).

Soil Acidity

The result showed dolomite effort increased soil pH (Table 1). Improvement soil pH is in line with increased dose of dolomite. On the week 2-7 giving of dolomite until dose of 6 t ha^{-1} is significantly to improvement soil pH, while giving dose of dolomite 8 t ha^{-1} are not significantly to dose of 6 t ha^{-1}. On the week 8-9 giving dolomite to 8 t ha^{-1} are significantly improvement of soil pH.

Dolomite is a source of Ca and Mg which plays a role in increasing soil pH. Addition of dolomite in ameliorants can reduce the acidity of the soil, improve nutrient balance so that nutrients can be absorbed by plants (Brown et al., 2007). Chalk provides an OH^- supply to the soil solution which reacts with H^+ to water and causes H^+ levels to decrease so that the pH of the soil increases (Maftu'ah et al., 2013).

The interaction between dolomite and potassium on plant length, stomata density and dry tuber weight increased significantly (Table 2). Dolomite and potassium treatments significantly increased plant length, stomata density and dry tuber weight until the combination of dolomite treatment 4 t ha^{-1} with potassium 180 kg ha^{-1}. This is because the administration of dolomite and potassium increases soil pH and nutrients, especially Ca, Mg, N, P and K which can be absorbed by plants for the growth process. The stomata density affects the opening and closing of the stomata and cell turgor. The process of opening and closing stomata plays an important role in the process of assimilating CO_2 and plant water balance. Uptake of K and Ca by plants will increase cell turgor which affects the opening of the stomata. The higher the absorption of K and Ca, the stomata will open wider. Giving dolomite and potassium increases soil pH and K so that plants can be absorbed which play a role for photosynthesis, translocation and assimilate storage, increase in size, amount and yield of tubers per plant, increase tuber density and reduce the speed of decay results (Abd El-Al et al., 2010). Giving K will cause K to be antagonistic because it inhibits the absorption of other nutrients such as Ca and Mg which inhibits growth and decreases crop yield. Excessive administration of dolomite and K will cause an increase in the cations of Mg, Ca and K. Cation K will be an inhibitor of Mg and Ca, while the Ca and

Mg cations have the same valence so that competition occurs. Potassium has significant effect on tuber weight loss, while dolomite has no significant effect. Decreasing weight loss significantly occurred until the treatment of potassium doses 180 kg ha^{-1} (Table 3). This is due to the availability of K nutrients that can be absorbed by plants that are responsible for photosynthesis.

Table 1. The effect dose of dolomite to peatland pH

Dolomite (t ha^{-1})	Time of Observation (Weeks)							
	2	3	4	5	6	7	8	9
2	5,63 a	5,77 a	5,71 a	5,78 a	5,94 a	5,53 a	5,70 a	5,68 a
4	5,79 a	5,80 a	5,94 b	6,00 a	6,04 a	5,99 b	5,98 b	6,06 b
6	6,13 b	5,99 ab	6,22 c	6,57 b	6,59 b	6,32 c	6,23 c	6,28 b
8	6,31 b	6,13 b	6,44 c	6,63 b	6,64 b	6,52 c	6,49 d	6,59 c
LSD 5%	0,22	0,26	0,22	0,26	0,22	0,28	0,24	0,27
CV	4,88%	6,04%	4,80%	5,60%	4,81%	6,31%	5,40%	5,99%

Note: the numbers followed by the same letters in the same column show no significant difference based on the 5% LSD test.

Table 2. Dolomite interaction with potassium fertilizer on plant length, stomata density and dry tuber weight

Parameter	Dolomite (t ha^{-1})	Potassium (kg ha^{-1})				
		0	60	120	180	240
Length plant	2	29,17 a A	29,00 ab A	29,00 ab A	32,87 b A	33,27 b A
	4	29,33 a A	30,20 ab AB	34,20 b B	35,73 b B	33,07 b A
	6	29,53 a A	33,70 b B	33,80 b B	34,40 b B	31,80 ab A
	8	29,80 a A	33,20 b B	33,07 b B	33,40 b B	31,00 b A
	LSD 5%	3,08				
	CV	5,83%				
Stomata Density	**2**	14,67 a A	14,83 ab A	15,50 ab A	16,17 b A	17,50 c B
	4	14,33 a A	15,67 b AB	17,33 c B	17,83 c B	17,50 c B
	6	14,67 a A	15,17 a AB	17,00 b B	17,33 b AB	17,83 b B
	8	14,67a A	16,83 bc B	17,50 c B	16,83 bc AB	16,17 b A
	LSD 5%	1,24				
	CV	4,60%				
Dry tuber weight	**2**	5,39 a A	6,28 ab A	6,98 b A	8,42 c A	9,20 c B
	4	6,35 a AB	6,98 a A	7,33 a A	9,48 b AB	8,88 b AB
	6	6,24 a AB	7,28 ab AB	7,75 b AB	9,42 c AB	8,67 bc AB
	8	7,11 a B	8,17 b B	8,40 bc B	9,73 c B	7,90 ab A
	LSD 5%	1,05				
	CV	8,13%				

Note: The numbers followed by the same uppercase letters in the same column and the same lowercase letters on the same row show no significant difference based on the 5% LSD test.

Table 3. Effect of Dolomite and Potassium Fertilizers on Weight Loss of tubbers (%)

Treatment	Weight loss (days)			
	14	28	42	56
	(%)			
Dolomite (t ha^{-1})				
2	6,89	13,89	18,72	22,29
4	6,80	13,88	17,80	21,09
6	6,53	13,13	16,53	19,50
8	6,33	11,99	15,05	17,44
LSD 5%	ns	ns	ns	ns
Potassium (kg ha^{-1})				
0	9,41 c	17,03 b	21,14 b	24,50 b
60	7,94 bc	15,04 b	19,04 b	22,16 b
120	6,57 b	12,87 ab	16,80 ab	19,81 ab
180	4,72 a	11,22 a	14,66 a	17,59 a
240	4,54 a	9,96 a	13,48 a	16,33 a
LSD 5%	1,59	2,97	4,10	4,56
CV	29,04	26,97	29,11	27,47

note: The numbers followed by the same letters indicate not significantly different based on the 5% LSD test.

Photosynthate is then trans located to tubers to improve the quality of the tuber. Giving K fertilizer in the form of K sulfate with a dose of 144 kg ha-1 K_2O can increase plant growth, quality and yield of tuber (Abd. EL-AL et al., 2010). Giving of 100 kg of K fertilizer ha^{-1} K_2O is the best for shallots on Ultisol soil with low K land status (Napitupulu dan Winarto, 2010).

Nutrient Absorption of Plant Leaves

The leaf N content showed a significant increase in leaf N content. This is due to an increase in soil pH so that N can be absorbed by plants. Interactions occur at the age of 30 days due to N being used for vegetative growth while the age of 60 days the shallots plants are in the filling phase and tuber aging (Table 4).

The leaf P content increases with increasing doses of dolomite and potassium at the age of 30 and 60 days after birth. This is because the administration of dolomite increases the pH and availability of P so that it can be absorbed by plants. P uptake will be disturbed in acidic conditions because P is not a car, causing root growth and function to be disrupted (maftu'ah et al., 2013).

The interaction of dolomite and potassium treatment showed an increase in leaf K with increasing doses of dolomite and potassium. This is because the administration of dolomite and potassium increases soil pH and the availability of soil K, resulting in an increase in K uptake by plants. On soils with high K land status, the highest K uptake of Bangkok varieties was obtained by giving K a dose of 180 kg ha^{-1} K_2O, while the highest nutrient uptake of K plant variety Yellow was found in K fertilizer 120 kg ha^{-1} K_2O (Sumarni et al., 2012).

Nutrient Residue N, P and K

Dolomite treatment showed a significant increase in the availability of soil N, while the potassium treatment did not increase significantly. Significant increase in soil N to dolomite 4 t ha^{-1} at age 30 days and 6 t ha^{-1} at age 60 days (Table 5). The increase in soil N is due to the administration of dolomite which causes an increase in soil pH. Increased levels of bases that can be exchanged in the oxidation process cause nitrification to occur quickly, thereby increasing the availability of N soil. At the age of 30 and 60 days there is a decrease in soil N. This is because N is absorbed by plants for the growth process so that the N content of the soil decreases.

Dolomite treatment significantly increases the availability of P soil, while the potassium treatment does not increase significantly. Significant increases in soil P occur until doses of dolomite 6 t ha^{-1} at the age of 30 days and 4 t ha^{-1} at the age of 60 days. Increased soil P caused by administration of dolomite causes P to be available to plants. According to Lahuddin et al., (2010) administration of dolomite will increase Ca-dd and decrease Al-dd in the soil and administration of dolomite to 50 g / 5 kg of soil increasing P available in the soil. At the age of 30 days there is an increase in soil P, while at the age of 60 days there is a decrease in soil P. This is because P is used for plant growth.

Table 4. Interaction between dolomite and potassium to NPK uptake

Treathment of Dolomit - Potassium (t ha^{-1})	(kg ha^{-1})	Nutrient uptake of plant N (%) 30 DAP	P (ppm) 30 DAP	P (ppm) 60 DAP	K (ppm) 30 DAP	K (ppm) 60 DAP
2	0	1,59 a A	323,91 a A	397,94 a A	9.535,22 a A	9.117,31 a A
	60	1,67 a A	318,91 a A	431,12 a A	10.422,93 ab A	10.523,62 a A
	120	1,67 a A	327,93 a A	431,29 a A	10.798,03 ab A	12.590,08 b A
	180	1,65 a A	374,66 b A	412,37 b A	11.418,04 b A	14.612,09 c A
	240	2,01 b C	408,86 b A	517,15 b B	11.848,04 b A	14.646,62 c A
4	0	1,53 a A	346,56 a AB	463,59 a AB	10.514,76 a AB	10.248,07 a AB
	60	1,69 ab AB	379,96 ab B	508,13 ab AB	10.041,63 a A	11.897,22 a AB
	120	1,71 b AB	383,67 ab B	536,73 ab B	11.236,15 a A	14.325,83 b A
	180	1,84 bc B	421,68 b B	554,64 b B	13.748,19 b B	17.533,65 c BC
	240	1,91 c B	388,96 ab A	442,93 ab AB	11.418,22 a A	14.797,11 b A
6	0	1,74 ab B	347,83 a AB	500,50 a B	10.451,10 a AB	11.315,00 a B
	60	1,84 b B	392,23 b B	540,55 b B	10.632,62 a A	13.697,46 b B
	120	1,85 b B	414,19 b B	515,17 b B	13.642,33 b B	13.209,65 b A
	180	1,81 b AB	401,94 b AB	551,74 b B	11.442,47 ab A	18.442,05 c C
	240	1,62 a A	373,79 ab A	415,59 ab A	12.663,90 b A	14.050,92 b A
8	0	1,77 ab B	375,46 a B	491,21 a B	10.928,47 a B	11.024,81 a B
	60	1,80 ab B	374,49 a B	491,34 a AB	10.999,36 a A	13.219,45 b B
	120	1,87 b B	404,70 a B	486,66 a AB	11.660,97 a A	17.560,96 d B
	180	1,99 b B	410,09 a AB	489,43 a AB	11.604,91 a A	15.059,52 c AB
	240	1,67 a A	377,68 a A	431,65 a AB	11.764,68 a A	13.054,35 b A
	LSD 5%	0,17	44,19	88,31	1.275,20	1.812,50
	CV	5,78%	7,08%	11,12%	6,80%	8,09%

note: The numbers followed by the same letters indicate not significantly different based on the 5% BNT test.

Table 5. Impact of dolomite and potassium to residue of soil N and P

Treatment		N-Total Soil (%)			P_2O_5 bray (ppm)	
		30 DAP	60 DAP		30 DAP	60 DAP
Dolomite ($t\ ha^{-1}$)	2	1,41 a	1,33 a		581,82 a	410,45 a
	4	1,66 b	1,56 ab		647,66 a	571,13 b
	6	1,78 b	1,63 b		714,39 b	586,26 b
	8	1,79 b	1,67 b		750,20 b	633,39 b
	LSD 5%	0,23	0,24		111,91	65,53
potassium (kg ha-1)	0	1,44	1,37		593,36	497,53
	60	1,62	1,59		646,62	582,65
	120	1,72	1,66		648,65	548,76
	180	1,79	1,66		734,47	563,29
	240	1,73	1,47		744,49	559,33
	LSD 5%	ns	ns		ns	ns
	CV	18,43%	20,82%		22,48%	16,11%

Note: The numbers followed by the same letters indicate not significantly different based on the 5% BNT test.

Table 6. Interaction between dolomite and potassium to residue of soil K ($me\ 100^{-1}\ g$).

Age (DAP)	Dolomite ($t\ ha^{-1}$)	Potassium ($kg\ ha^{-1}$)				
		0	60	120	180	240
30	2	0,58 a A	0,68 ab A	0,76 b A	0,97 c A	1,07 c A
	4	0,75 a B	0,87 ab B	1,00 bc BC	1,06 c AB	1,09 c A
	6	0,76 a B	0,97 b B	1,09 bc C	1,17 c B	1,06 bc A
	8	0,91 a C	0,92 ab B	0,94 ab B	1,26 c B	1,08 b A
	LSD 5%	0,14				
	CV	9,21%				
60	2	0,56 a A	0,69 ab A	0,72 b A	0,74 b A	0,90 c A
	4	0,55 a A	0,73 b A	0,75 b A	0,98 c B	0,91 c A
	6	0,76 a B	0,93 b B	0,92 b B	1,00 b B	0,90 ab A
	8	0,90 a B	0,91 a B	0,96 a B	0,95 a B	0,89 a A
	LSD 5%	0,15				
	CV	11,01%				

Note: The numbers followed by the same letters indicate not significantly different based on the 5% LSD test.

The interaction of the treatment of dolomite with potassium caused an increase in the availability of soil K at the age of 30 and 60 days (Table 6). Treatment of dolomite 4 $t\ ha^{-1}$ and potassium dose 180 $kg\ ha^{-1}$ significantly increased K soil. This is because the administration of dolomite and potassium fertilizer causes an increase in soil pH and availability of soil K due to the addition of potassium fertilizer. At the age of 60 days, a decrease in soil K is caused by K being absorbed by plants for filling tubers.

CONCLUSION

There was an interaction between dolomite and potassium on growth, tuber weight and NPK uptake of shallots, whereas the shrinkage of tuber bulb potassium showed a significantly different effect.

Dolomite dosage 4 $t\ ha^{-1}$ and potassium dose 180 $kg\ ha^{-1}$ produced dried tubers higher by 9.48 $t\ ha^{-1}$, lower weight losses by 17, 59% and higher plant NPK uptake, respectively. at 1.84%, 551.64 ppm and 17,533.65 ppm.

CONFLICT OF INTEREST

Resolves of plant problems on peatlands, especially shallots.

ACKNOWLEGEMENT

The research has been successly done with the help from others, so the authors thank to Prof. Dr. Ir. Mudji Santosa, MS and Prof. Dr. Ir. Moch Dawam Maghfoer, MS for their contribution in this research.

AUTHOR CONTRIBUTIONS

Suparman is the lead author who conducts research in the field, Prof. Dr. Ir. Mudji Santosa, MS is the second author and lead counselor and designs research and drafts then Prof. Dr. Ir. Moch Dawam Maghfoer MS is the third author and as the second guide in reviewing the manuscript

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