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Increasing Production of Potato (*Solanum tuberosum* L.) Var. Nadia at Medium Land Through Application of Compost Goat Manure and Potassium

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ABSTRACT

Potato production in the highlands is decreasing, therefore it is necessary to increase the yield. This research aims to obtain the interaction between doses of KCl and compost on the growth and yield of potato variety Nadia. The Nadia variety is one of the potato which is tolerate to high temperature and medium land. The research conducted on February until May 2016 in Klino, Bojonegoro, 750 m asl. The research method was using randomized block design that consist with two factors; organic and inorganic fertilization. There are two levels of compost fertilization: 10 ton ha^{-1} (K1), 20 ton ha^{-1} (K2) and KCl fertilizer consist of four levels; 100 kg KCl ha^{-1} (P0), 150 kg KCl ha^{-1} (P1), 200 kg KCl ha^{-1} (P2), 250 kg KCl ha^{-1} (P4). There were eight combinations with four replication. The results showed that there were interaction between the dose of KCl and compost on the parameters: number of leaves, number of stems, height of plant, leaf area, total content of chlorophyll, total number of tubers per plant, weight of tuber per plant, weight tuber per plot, and total harvest. The results showed combination of doses compost 20 ton ha^{-1} and dosage of KCl 150 kg ha^{-1} had the optimum result of total yield potato.

Keywords: Potato, Compost, KCl, Dose, Growth, Yield

INTRODUCTION

The potato (*Solanum tuberosum* L.) is one of commodities horticulture which we can consume the tuber. Potato tubers containing carbohydrates even less 16 % and also containing protein 1.9 % and fibers 2.5 % and fat 0.1% so it can supports the diversification food program (Gunadi, 2009). Based on BPS data, Potato production in Indonesia are cultivated in the highland aproximately 750 meter above sea levels. In the period 2009-2013 the productivity was in the range of 15.94 - 17 tons ha^{-1}. Based on these conditions potato cultivations in the medium land 300-750 meter above sea levels are continued to be planting. Therefore, the produce of potato nowdays in aproximately 27-35 tons ha^{-1} (Prabaningrum et al., 2014).

Potatos cultivation in the medium land had low productivity and the price of the tubers is still expensive and easy attacked by diseases (Basuki et al., 2009). Planting potato in the medium land will allow some changes in the morphological that caused by the difference metabolic processes that occurs because of the different environment condition on growing potatos.

Application potassium (K) can be used to increase yields of potato tubers because potassium is needed for carbohydrates metabolism, the activity of enzyme, the efficient of water usage, nitrogen absorption, synthesis protein and assimilates translocation. Potassium also has role to reduce disease attack in certain plants and improving the quality of the potato yield (Charloq, 2009; Gunadi, 2009). Organic matter has some function such as a platform for supplies water in the rooting, keep the availability of potassium element, keep structure granule soil and to improve of the soil quality Grumusol type. Therefore, the soil will suitable for the growth of tubers potato plants (La Habi et al., 2014). Compost as organic matter able to improve the structure of the soil become granule while element potassium serves to improve the survival of plants to high temperatures and help the forming leaves in the process photosynthesis. If compost and potassium

could have mutual interaction, it will help the growth and the productivity of potato will increase (Nainggolan, 2009; Pauly and McKenzie, 2013).

There are real impact of application compost on the growth and yield of potatoes. Nainggolan (2009) stated that there a real difference between the provision of compost with without the provision of compost in the potato plants. Every addition of measure doses which include the 10 tons ha^{-1}, 15 tons of ha^{-1} and 20 tons ha^{-1} gave significant impact to plant height, the number of tubers and tubers weight. The research of Luthfyrakhman and Susila (2013) showed that the treatment organic and inorganic fertilizers had influential on the growth of plant height of tomatoes (*Lycopersicon esculentum* Mill. Solanaceae) in the 2 until 6 weeks after planting.

MATERIAL AND METHODSD

This study was conducted on February until May 2016 in the Klino Village, District Sekar, Bojonegoro, East Java on 750 m above sea level. Equipments that used in this research are; scale, ph meters, watering can, ruler, digital camera, stationery. Materials that used are potato tubers seeds variety Nadia with average weights 20 - 30 grams per tubers, compost taken from UPT Compost Brawijaya University, Fertilizer ZA (N 21%) 430 kg ha^{-1}, fertilizer SP 36 (P_2O_5 36%) 420 kg ha^{-1} and fertilizer KCl (K_2O 60%) according to the treatment.

The research method was using randomized block design that consist with two factors; organic and inorganic fertilization. There are two levels of compost fertilization; 10 ton ha^{-1} (K1), 20 ton ha^{-1} (K2) and KCl fertilizer consist of four levels; 100 kg KCl ha^{-1} (P0), 150 kg KCl ha^{-1} (P1), 200 kg KCl ha^{-1} (P2), 250 kg KCl ha^{-1} (P4). There were eight combination of treatment, each combination repeated four times. The data will be analyzed with analysis of variant in probably 5 % and continued with Least Significant Different (LSD) in probably 5%.

RESULTS AND DISCUSSION

Component of Growth

The research showed the interactions of the parameter the number of stems to doses fertilizer KCl and dosage of compost. The optimum result obtained at doses compost 10 tons of doses ha-1 fertilizer KCl 250 kg ha^{-1} but it was not significantly different in doses compost 20 tons ha^{-1} with fertilizer KCl 150 kg of ha^{-1} that were able to produce optimum number of stems (Table 1).

Potato stem provide a way for nutrient that taken from the soil into the leaves for photosynthesis process and distribute the assimilates from leaves to the others part of plant (Soelarso, 1997).

Therefore, the number of stems will accelerate assimilates translocation from *source* to *sink*. Kalium fertilizer will increase translocation system that helps the growth of potato stems will be optimum. Adding organic matter such as compost which has macro and micro nutrient could decreased the needs of anorganic fertilizer such as KCl fertilizer. The result showed that doses compost 20 tons ha^{-1} combine doses fertilizer KCl 150 kg ha^{-1} were able to produce optimum number of potato stems.

Luthfyrakhman and Susila (2013) showed on tomatoes (*Lycopersicon esculentum* Mill. Solanaceae) were having interaction between organic and inorganic fertilizers on the parameter of plant height that occur in 8 weeks after planting which is 56 day after planting, this research in line with the interactions of potato plant height at the age of 56 and 70 day after planting.

Gunadi (2009) stated that fertilizer organic base dosage 25 tons ha^{-1}, in the treatment fertilizer KCl showed the highest potato plants with doses 100 kg K_2O ha^{-1} ≈ 150 kg of KCl ha^{-1}. Therefore, with decreasing the doses of compost, it will increase the use of fertilizer inorganic in order to meet nutritional needs of plants. The results showed that the fertilizer KCl and compost were significant different on leaf area. This interaction happened at the age of 56 and 70 day after planting (Table 2) with the highest leaf area was in the treatment of compost 20 tons ha^{-1} combine with KCl 150 kg of ha^{-1}

Table 1. Data of the number of stems from the interaction between variant dose KCl fertilizer combine with compost at age observation 56, 70, and 84 day after planting.

Planting age (dap)	KCl Doses (kg ha^{-1})	Compost Doses	
		K1 (10 ton ha^{-1})	K2 (20 ton ha^{-1})
56	P0 (100)	2.55 a	2.35 a
	P1 (150)	2.45 ab	3.05 d
	P2 (200)	2.55 ab	2.65 bc
	P3 (250)	3.00 d	2.90 cd
LSD 5%		0.25	
KK(%)		6.57	
70	P0 (100)	2.75 ab	2.60 a
	P1 (150)	2.80 ab	3.20 c
	P2 (200)	2.85 ab	2.85 ab
	P3 (250)	3.15 C	2.95 bc
LSD 5%		0.26	
KK(%)		6.15	
84	P0 (100)	2.85 a	2.75 a
	P1 (150)	2.75 a	3.25 c
	P2 (200)	2.80 a	2.85 a
	P3 (250)	3.15 bc	2.95 ab
LSD 5%		0.28	
KK(%)		6.62	

Remarks : Numbers followed by the same letter in rows and columns in each age observation showed no significant differences based on LSD at 5% level.

Table 2. Data of the average leaf area (cm^2) due to the interaction between variant dose KCl fertilizer and compost at the age of observation 56 and 70 day after planting

Planting age (dap)	KCl Doses (kg ha^{-1})	Compost Doses	
		K1 (10 ton ha^{-1})	K2 (20 ton ha^{-1})
56	P0 (100)	212.83 a	254.63 b
	P1 (150)	275.23 bc	308.80 d
	P2 (200)	207.32 a	278.25 bc
	P3 (250)	301.15 cd	304.11 cd
LSD 5%		29.11	
KK(%)		7.39	
70	P0 (100)	219.40 a	294.15 b
	P1 (150)	307.53 bc	342.77 C0
	P2 (200)	228.60 a	297.64 b
	P3 (250)	341.97 c	336.44 bc
LSD 5%		43.34	
KK(%)		9.95	

Remarks : Numbers followed by the same letter in rows and columns in each age observation showed no significant differences based on LSD at 5% level.

The nature characteristic of KCl which affects when the plants start to generative phase and supported from compost slow release so it can increase the absorption of nutrients in plants. According to Marschner (1995), the potassium element will be a buffer nutrient availability to plants when the addition of organic matter. Likewise, the presence of organic material would be a buffer for the availability of potassium. Asandhi and Rosliani (2005) obtained values potassium uptake in potato plants ranged from 1.78 mg g^{-1} up to 4:00 mg g^{-1} with the average measurement 2.77 mg g^{-1}. The research of Charloq (2009) stated that the element potassium have less influence on potato vegetative growth, and it had large effect on the enlargement of the leaves, leaf thickness and the strength of the leaves as well as in the amount of chlorophyll. Potassium is to push the increasing number of chlorophyll. This is consistent with the results of this study that the leaf area parameters had a significant different (Table

2) which is treatment compost 20 ton ha^{-1} (K2) combine with KCl 150 kg ha^{-1} had the highest leaf area, the wider leaf area made the total chlorophyll significantly increased. This was not only potassium element that contributed in the increasing leaf area, but also compost has some of the nutrient content that supports in raising levels of chlorophyll because nitrogen element has a role in the chlorophyll formation where happens in the leaves which are useful in the process of photosynthesis (Novizan, 2002).

Table 3 Data number of tubers per plant from the interaction between variant dose KCl fertilizer and compost dose

Data Observation	KCl Doses (kg ha^{-1})	Compost Doses	
		K1 (10 ton ha^{-1})	K2 (20 ton ha^{-1})
Number of tubers	P0 (100)	12.40 ab	12.75 abc
	P1 (150)	12.30 a	13.25 c
	P2 (200)	12.65 abc	12.25 a
	P3 (250)	13.15 c	12.95 bc
LSD 5%		0.63	
KK(%)		3.40	

Remarks: Numbers followed by the same letter in rows and columns in each age observation showed no significant differences based on LSD at 5% level.

Table 4. Data weight of tubers per plant from the interaction between variant dose of KCl fertilizer and compost dose

Data Observation	KCl Doses (kg ha^{-1})	Compost Doses	
		K1 (10 ton ha^{-1})	K2 (20 ton ha^{-1})
Weight of tuber (g)	P0 (100)	293.69 a	297.85 a
	P1 (150)	300.40 ab	347.26 d
	P2 (200)	308.24 ab	331.42 cd
	P3 (250)	320.45 bc	336.36 cd
LSD 5%		20.9	
KK(%)		4.49	

Remarks : Numbers followed by the same letter in rows and columns in each age observation showed no significant differences based on LSD at 5% level.

Table 5 Results of potato tuber per plot (kg per 8.16 m2) and potato tuber yield (ton ha-1) from the interaction between variant doses of KCl fertilizer and compost doses

Data observation	KCl Doses (kg ha^{-1})	Compost Doses	
		K1 (10 ton ha^{-1})	K2 (20 ton ha^{-1})
Hasil umbi per petak (kg per 8.16 m^2)	P0 (100)	10.27 a	10.42 a
	P1 (150)	10.51 ab	12.15 d
	P2 (200)	10.78 ab	11.59 cd
	P3 (250)	11.21 bc	11.77 cd
LSD 5%		0.73	
Hasil umbi ton ha^{-1}	P0 (100)	12.59 a	12.77 a
	P1 (150)	12.88 ab	14.89 d
	P2 (200)	13.22 ab	14.21 cd
	P3 (250)	13.74 bc	14.42 cd
LSD 5%		0.89	
KK (%)		4.49	

Remarks : Numbers followed by the same letter in rows and columns in each age observation showed no significant differences based on LSD at 5% level.

Result Component

Based on data, there were a significant difference in the parameter number of tubers per plant, tuber weight per plant and weight of tuber per hectare (Tables 3, 4 and 5). This interactions showed if using dose of compost 10 tons ha^{-1} then KCl fertilizer has to be increased 250 kg ha^{-1} although the weight of tuber per plant and per hectare had no significant difference at another dose of KCl. In conclusion, the dose of compost 20 tons ha^{-1}, combine with dose of KCl 150 kg ha^{-1} was sufficient to meet the needs of plants. The growth of the potato plants are characterized by increasing the number of stem and leaf area. In here, the role of nutrients potassium and compost had an interaction to the potato growth and yield. Potassium elements role in regulating the availability of water in the cells and transfer of cations across the membrane, and the increased weight of tubers affected by the effectiveness of the process of photosynthesis and photosyntat where is translocated to the tubers. According to Charloq (2009) one of the factors that affect the number of tubers is determined by the number of stolon that will be grow as potato tubers. Moreover, the growing number of stolon will also inhibit the formation of tubers. Charloq (2009) stated that potassium has important role in the initiation phase to the growth and yield of potato plants. By giving the right doses of potassium fertilizer, it would increase of potato tuber weight. The data results of this study on the potato tuber yield per plot and per ton as below.

Increasing the dosage of KCl fertilizer increase the tuber yield, but it only applied to the dose of compost 10 tons ha^{-1}, compared with a dose of compost 20 tons ha^{-1} combine with dose of fertilizer KCl 150 kg ha^{-1} had the better results than to the other treatments (Table 5). The yield increased was also due to the provision of compost to improve soil fertility and increase the efficiency of use of inorganic fertilizers, Hayati et al. (2012) stated that in general organic fertilizer can improve soil and increase the efficiency of the use of inorganic fertilizers, therefore it could accelerating the growth of plants.

CONCLUSION

The results shows that there is interaction on number of stem effected by KCl and composts dosages. The highest average obtain on 10 ton / ha of compost and 250 kg / ha KCl (Tabel 1). Regarding of the interaction between number of tuber per plant, the weight of tuber per plant as well as the wight of tuber per hectare. Meanwhile the increasing of KCl reached about 250 kg per hectare add to 10 ton com post per hectare does not significantly different to 150 kg KCl addt o 20 ton per hectare. Based on the photosynthetically activities of potato plants the rate of growth is steadily increase following of the function of potassium on the water and nutrient regulation inside cell. Thereby, the number of tuber strongly depicts of the number of stolon per plants. However, while the tuber development which required much photosyntate, the the growth of vegetative stolon inhibits the tuber filling. The general results on growth and yield of potato, that the slightly increase the KCl application higher that the farmer commonly application that the combination of compost 20 ton per hectare and 150 kg KCl per hectare. The increasing of compost as the organic matter application until 20 ton per hectare obtain the yield reached 14,7 ton per hectare while this is combined by the KCl fertilizer 150 kg per hectare.

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