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Growth and yield of shallot using KCl fertilizer at peatlands in Central Kalimantan, Indonesia

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Abstract. In order to develop horticultural commodities, especially for shallots (*Allium ascalonicum* L), Central Kalimantan province attempts to develop the areas as new agricultural centers on sub-optimal lands. Peatlands have been recognized as potential land for agriculture and shallot development has been carried out since 2013. For shallot, KCl fertilizer plays role in facilitating photosynthesis process, growth plant at the starting level, strengthen the stem and reduce yield decay. The objective of this study was to determine the effect of addition of KCL fertilizer on growth and productivity of shallots (*Allium ascalonicum* L) in peatlands. This study was conducted in Palangka Raya starting from August 2019 to December 2019. Statistical approach used randomized block design (RBD) with 5 treatments and 4 replications. The treatments given involved without fertilization K0 = 0 kg/ha, K1 = 50 kg/ha, K2 = 100 kg/ha, K3 = 150 kg/ha, K4 = 200 kg/ha. Several parameters observed included plant height, number of leaves, number of tillers, weight of wet biomass, dry biomass and bulb weight. The results showed that the application with addition of KCl with dosage of 150 kg/ha showed a higher yield and it was significantly different from other KCl dosage treatments.

1 Introduction

Shallots (*Allium ascalonicum* L), classified into Aggregatum group, is plant that can be used for spice for various dishes in various countries, especially in Indonesia. The plant part that most widely used include bulb. However, leaves and flower stalks can also be used as seasoning for cooking. In Indonesia, this plant is included as the ten prime horticultural commodities and the production need to be increased in order to fulfil demand in line with the increasing population. Shallots is also considered as high-value commodity category, so that many farmers cultivate this plant as a source of income while at the same time contribute to regional economic development.

Shallots can be cultivated at dry climates with high temperatures and duration of sunshine more than 12 hours. Shallots can also grow both in lowlands and highlands (0-900 meters above sea level) with rainfall of 300-2500 mm/year and temperatures of 25^{o}C - 32^{o}C [1]. Based on growth requirements in Central Kalimantan, especially in Palangka Raya, which

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has an average annual temperature between 19.6oC-35.9oC with rainfall of 2326.4mm/year and altitude 35 meters above sea level, this plant can then be cultivated and have fairly good yields [2].

Central Kalimantan, which has various agroecosystems and one of them is peatlands that have prospect for agricultural development [3]. The efforts to manage peatlands for horticultural development has been conducted by local Government of Central Kalimantan. This effort also includes degraded peatlands management in order to prevent land fires.

Peatlands as suboptimal land for agriculture can be managed using appropriate technology. In this study, the input of technology through fertilizing was assessed for shallot cultivation at peatlands. In addition to overcome acidic soil at peatlands using lime or dolomite treatment, additional of KCl was also given as a source of potassium to increase carbohydrate metabolism and stomatal behaviour. Previous study has shown that potassium is an essential nutrient required by shallot for metabolic process. For shallots, furthermore, potassium can provide optimum bulb yield, higher quality, and higher storage capacity of bulb so that it can be stored for a long time [4, 5]. The objective of this study was to determine the effect of addition of KCl fertilizer on the growth and productivity of shallots in peatlands.

2 Methodology

This study was conducted at peatland located in Sebangau, Palangka Raya on August to December 2019. Statistically, this study used a randomized block design (RBD) with 5 treatments and 4 replications. The treatments used involve application of K0 = 0 kg/ha, K1 = 50 kg/ha, K2 = 100 kg/ha, K3 = 150 kg/ha, K4 = 200 kg/ha. Selected shallot used in this study was Bauji variety as existing plant which has been cultivated by local farmers.

The basic fertilizers used involve manure 5 ton/ha, dolomite 2 ton/ha, while for urea is 200 kg/ha and SP-36, 200 kg/ha. Chicken manure and dolomite were applied 7 days before planting, and urea was given at the age of 10 day after planting (DAS) and SP-36 at the time of planting. The size of the experimental plots was 1x2 meter and between the plots was made a trench measuring 40 cm with a depth of 25 cm. Irrigation was implemented by operating pump in the morning and evening when there is no rain.

Periodically, observation was conducted to measure the growth of plant at 14 days after planting (DAP), 28 DAP, 42 DAP. Parameters observed include plant height, number of leaves, number of tillers, weight of wet biomass, dry biomass and bulb weight. The data were further analysed using Analysis of Variance (ANOVA). If there is a significant difference, then further test using the LSD 5% test.

3 Results and discussion

3.1 Biophysical characteristics of peatlands

The main characteristic of peat soil includes fiber content, high organic content with brown to black in color. Peat soil has a small density so that it is very light. Generally, peat soil has the properties as a strong colloid which is able to bind water so that the peat soil has the ability to absorb a lot of water. Peatlands located in Palangka Raya where the study take place, has a fairly high-water content of 134.70%. With slightly absorbent category, this peat soil has the ability to store and absorb water less than 300% [6].

Palangka Raya with total areas of 247,121 hectares consisted of two land typologies i.e., drylands and wetlands. Dryland's areas are dominated with mineral soil. While for wetlands, they are mainly dominated by peat soils. Especially for peat soils, they are classified into soil orders of Histosols with great group of Haplohemists [7]. Geographically, peatlands areas distribution in Palangka Raya is represented at Figure 1.

Based on spatial analysis, peatlands areas cover 41,873 hectares or 16.94% of total areas for Palangka Raya. peatlands areas. With appropriate land management, these peatland areas are potential for crop cultivation ranges from low to high depending on limiting factors for specific crop requirements especially for horticulture commodities [8].

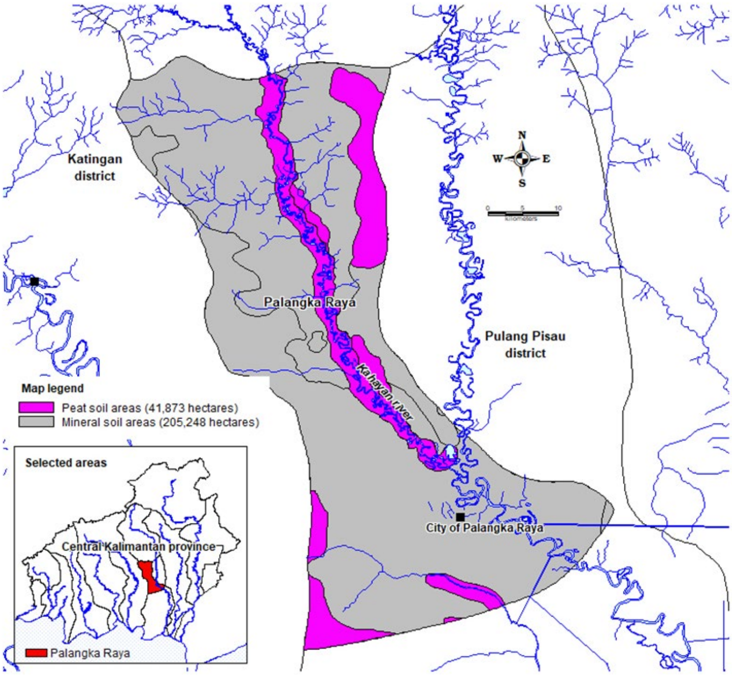

Fig 1. Spatial distribution map of peatlands in Palangka Raya (Source : BBSDLP, 2016).

3.2 Plant height

The growth of plant height was observed by measuring plant height (cm), which was conducted 3 times during observation starting from 14 days after planting (DAP), 28 DAP, 42 DAP with 14 days intervals. The result of data measurement was provided at Table 1.

Table 1. The Average of plant height growth for shallots with KCl fertilizer treatment.

KCl treatment	14 DAP (cm)	28 DAP (cm)	42 DAP (cm)
Control	18,49 a	29,17 a	33,33 a
50 kg/ha	18,97 ab	29,00 a	34,53 a
100 kg/ha	19,67 bc	29,00 a	36,53 b
150 kg/ha	20,00 c	32,87 b	39,47 c
200 kg/ha	23,20 d	33,27 b	40,60 c

Note: Number followed by the same letter show insignificant differences at level of 5%.

Table 1 showed that the treatment of KCl fertilizer application on shallot at the age of 42 DAP with K4 treatment (200 kg/ha) showed the highest average plant height of 40.60 cm and this is not different with application of 150 kg/ ha of KCl with an average of 39.47 cm, but significantly different with control treatment, 50 kg/ha KCl and 100 kg/ha. Although the dosage of 200 kg/ha numerically resulted in the highest plant height, it was not signicantly different with dosage of 150 kg/ha. For optimum and efficient fertilizing application this indicated that dosage of 150 kg/ha KCl is a better than other treatments.

3.3 Number of leaves

The number of plant leaves was also observed 3 times at the age of 14, 28 and 42 DAP. Data obtained was provided at Table 2. The existence of leaves has closely relative with bulb size of shallot. Large seed bulbs will grow more vigor, produces longer leaves, larger leaf area resulting high number of tubers and total yield [9]. Statistically, this also indicate that dosage of KCl 150 kg/ha was more optimum than other treatments.

Table 2. The Average of number of leaves for shallots with KCl fertilizer treatment

KCl treatment	14 DAP (leaf)	28 DAP (leaf)	42 DAP (leaf)
Control	12,08 a	17,44 a	26,16 a
50 kg/ha	12,71 ab	20,95 b	25,71 a
100 kg/ha	13,65 bc	21,97 bc	25,75 a
150 kg/ha	15,01 c	22,68 c	32,32 b
200 kg/ha	14,75 c	22,90 c	33,38 b

Note: Number followed by the same letter show in-significant differences at level of 5%.

3.4 Number of tillers

The increase of number of tillers indicated weight of bulb become increasing [5]. The result of data analysis based on Table 3 for tillers growth of plant showed that the treatment of KCl 200 kg/ha produced highest number of leaves and it was different from dosage of control, 50, 100 and 150 kg/ha.

Table 3. The average of number of tillers for shallots with KCl fertilizer treatment

KCl treatment	14 DAP (tillers)	28 DAP (tillers)	42 DAP (tillers)
Control	3,56 a	5,12 a	6,17 a
50 kg/ha	3,95 b	5,36 ab	6,83 b
100 kg/ha	4,01 b	5,75 b	6,48 ab
150 kg/ha	4,69 c	6,53 c	7,08 b
200 kg/ha	4,90 c	7,07 d	8,07 c

Note: Number followed by the same letter show in-significant differences at level of 5%.

Increasing the dosage of potassium significantly affected to plant height and number of leaves. The application of dosage of KCl 150 kg/ha resulted in a higher length and number of plant leaves. This is due to increase in K available in the soil that can be absorbed by plants. The increase of K nutrient uptake by plants will increase number and size of cells thus increasing the length and number of leaves in accordance with plant ages. The application of Kalium with dosage of K2O 150 kg/ha can significantly increase both height and number of shallots [10]. The nutrient of K increases rate of photosynthesis and it will work optimally [11, 12]. Furthermore, the increase in K uptake by plants will also increase the development of meristem tissue, thereby increasing shoots formation and then developing into tillers. The K nutrient is a catalyst in converting protein into amino acids and composing carbohydrates and bulb formation [13].

3.5 Wet and dry bulb biomass and bulb weight

The application of potassium in the form of KCl fertilizer showed an increase in the yield of shallots and this is in line with increasing in dossage of potassium (Table 4). Treatment with a dosage of KCl 200 kg/ha provide higher yields on wet biomass weight (13.77 ton/ha) and dry biomass weight (10.29 ton/ha) and this is significantly different from other KCl dosage treatments. The weight of bulb showed higher yields for application of KCl 150 kg/ha (9.17 ton/ha) and significantly different from the control, KCl 50 and 100 kg/ha, but not significantly different with KCl 200 kg/ha.

Table 4. Weight of wet bulb biomass, dry bulb biomass, and bulb weight for shallots with KCl fertilizer treatment

KCl treatment	Wet biomass weight (ton/ha)	Dry biomass weight (ton/ha)	Bulb weight (ton/ha)
Control	8,70 a	6,13 a	5,56 a
50 kg/ha	9,63 b	7,14 b	6,44 b
100 kg/ha	10,30 c	7,74 c	7,13 c
150 kg/ha	12,02 d	9,83 d	9,17 d
200 kg/ha	13,77 e	10,29 e	9,25 d

Note: Number followed by the same letter show in-significant differences at level of 5%.

The optimum production of shallot occurs with application of KCl 150 kg/ha comparing to other KCl fertilization dosages. KCl fertilization in peatlands with dosage of KCl 150 kg/ha is sufficient for crop growth requirement of shallots. With this dosage, it showed that during the growth and filling of bulbs. The K availability is not a limiting factor so that the translocation of photosynthate from leaves to plant organs and bulb is not inhibited.

The addition of potassium fertilizer increases K available in the soil so that it can be absorbed by plants which play a role in photosynthesis process, translocation and storage of assimilates, increasing the size, number and yield of bulb per plant, increasing bulb density and reducing the rate of rotting yield. Based on several studies that have been conducted at drylands showed that the application of potassium as KCl 180 kg/ha is a dosage that is sufficient for plants and the application of K fertilizer in the form of K sulfate with dosage of K2O 144 kg/ha K2O can increase plant growth, quality and bulb yield [14]. The application of K fertilizer with dosage of K2O 100 kg/ha showed the best performance for shallot plants cultivated in Ultisols that has low soil K status [15]. The relationship between shallot bulb yield and K fertilizer dosage to all soil K status is quadratic, while bulb yields on high soil K status are significantly higher than those with low and medium K-soil status [16]. This study was then conducted at wetlands that dominated in order to know the important of potassium for crop growth in peatlands environment. Potassium is a nutrient that is easily leached, especially in tropical areas with high rainfall and in root crop zones, it can be absorbed by plants in large enough quantities, even though available potassium is limited [17]. Potassium has many functions, some of which are maintaining plant water status and cell turgor pressure, regulating stomata and regulating the accumulation and translocation of newly formed carbohydrates. Application of potassium to shallots affects the growth, yield and quality of bulb [18].

4 Conclusion

KCl fertilization affects plant growth and productivity of shallots in peatlands. Because of not significantly with dosage of 200 kg/ha, for optimum and efficient fertilizing application, KCl fertilizer with dosage of 150 kg/ha can be implemented for farming practices and it can increase the yield of shallots which is higher by 9.17 ton/ha.

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