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Improved cassava (*Manihot esculenta* Crantz) growth and production by application of potassium

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Improved cassava (*Manihot esculenta* Crantz) growth and production by application of potassium

Sungkono[1], Kukuh Setiawan[2*], Latif Nurul Fatah[1], Dadang Rieswanto[1], Muhammad Syamsoel Hadi[2], and Ardian[2]

[1]Agrotechnology Department, Surya Dharma Agriculture University, Bandar Lampung, Indonesia
[2]Agronomy and Horticulture Department, Faculty of Agriculture, University of Lampung, Lampung, Indonesia

*Corresponding author email: kukuhsetiawan38@gmail.com

Abstract. Indonesia is the fifth countries in term of cassava production in the world. The biggest cassava area in Indonesia is Lampung. One of the important nutrient fertilizers to improve cassava production is potassium. Consequently, the objective of this study was to evaluate distribution of photoassimilate by determining cassava growth and production under different potassium dosages. Treatment was arranged by factorial (2x3) in randomized complete block design (RCBD) with two reps. The first factor was two cassava clones, UJ3 and UJ5 and the second factor was three potassium (KCl) dosages, 0, 150, and 300 kg/ha. The variables observed in this study were plant height, stem diameter, fresh weight and dry weight of leaf, total root number and swollen root number, distribution of root number, root length, root distribution, and root weight. The result showed that under fertilizer of 300 kg KCl/ha, stem dry weight of UJ3 and UJ5 was not significantly different however root fresh weight of UJ3 seemed higher compared to that of UJ5. It seems that UJ3 cassava clone is more responsive to potassium fertilizer than UJ5 cassava clone.

Keywords: photoassimilate, root weight, stem weight

1. Introduction

Lampung has the biggest cassava areas in Indonesia which is the fifth countries in term of cassava production in the world. Cassava (*Manihot esculenta* Crantz) is grown throughout the tropics, where it is the fourth most important staple food crop in terms of energy source. It supports approximately more than 60% of farming households in Lampung (about 2 million people) and is a major crop on 55 % of all agricultural land, approximately119.000 hectares [1]. In Lampung, cassava production is decreasing mainly due to two problems, conversion of areas from cassava to other food crops, as corn; and low macro fertilizer input, as potassium.In general, farmers in Lampung are very rare to fertilize macro nutrient with standard application for macro fertilizer as 100 kg urea/ha (45% N), 100 kg SP36 (36% P_2O_5), and 150 kg KCl/ha (60% K_2O). In South India as a comparison, standard macro fertilizer recommendation per ha for optimum cassava production would be 100 kg N, 50 kg P_2O_5, and 100 kg K_2O [2].

The cassava productivity in Lampung was around 26 tons/ha, this was classified as low yield because the potential cassava productivity could be around 40-60 tons/ha. It is well known that one of macro nutrients to increase root weight in cassava is potassium. However, Howeler [3] stated that the application of fertilizer for cassava in Thailand and Vietnam tended to be more P than N and K. The increasing potassium application on cassava was able to improve tuber yield up to 7.59% compared tom control [4]. The harvested cassava roots would contain large amounts of K in the NPK ratio in the roots being 5:1:10 compared to the ratio of 7:1:7 as in other crops [5]. It seems that increasing potassium fertilizer could improve cassava productivity. Consequently, the objective of this study was to evaluate distribution of photoassimilate by determining cassava growth and production under different potassium dosages.

2. Methods

2.1 Place and planting materials

This study was conducted in dry land of Pesawaran, Lampung with soil type of sandy loam with pH of 6.24 and 0.10 me K-dd/100 g from November 2019 to December 2020. The population of cassava plants was 12,500 plants/ha with planting distance of 80 x 100 cm. Approximately, 20 cm cutting stem length or 4-5 buds was used in this study. The macro nutrient used in this study was urea (45% N), SP36 (36% P2O5), KCl (60% K2O) and 10 ton cattle manure/ha. The cattle manure was applied at one week before planting (WBP).

2.2 Variables and data analysis

Variables observed in this study were plant height, stem diameter, fresh weight and dry weight of leaf, total root number and swollen root number, root length, root distribution, and root weight. Shoot parts as leaf number, plant height, stem diameter were recorded from 2 until 10 months after planting (MAP). At harvest age approximately 10 MAP, root weight was measured and weighed after cleaning from soil.

Treatment was arranged by factorial (2x3) in RCBD with three reps. First factor were two cassava clones, UJ3 (originally selected from Thailand) and UJ5 (originally selected from Kasetsart) whereas second factor were three KCl dosages as 0, 150, and 300 kg KCl/ha. Data was analyzed by analysis variance then continued to LSD at difference level of 5%. Fertilizer of 100 kg SP36/ha was applied once at 1 MAP, yet that of urea was applied twice as a half dosage or 50 kg/ha at 1 MAP then the remnant of 50 kg/ha was applied at 3 MAP. The same as urea, KCl was applied twice as a half dosage at 1 MAP then the remnant was applied at 3 MAP. The application of KCl was based on the different dosage treatments.

3. Result and discussion

The effect of potassium fertilizer on plant height was significant at 2 and 10 MAP, however between 3-9 MAP the plant height was not significant (Table 1). This probably means that there is such an additional growth of plant height after potassium fertilizer at 3 MAP then plant height be stagnant from 4-9 MAP. The stagnancy of plant height was probably due to translocation photoassimilate from leaves to stem and roots at 3-9 MAP. This condition was supported by data of stem diameter that showed significant differences at 7, 8 and 9 MAP. The result of Ramanujam and Biradar [6] was concomitant with this study that photoassimilate would accumulated in stem and root parts. The stagnancy of plant height was compensated through stem diameter (Table 2). It means that there is a photoassimilate translocation from leaves to stem resulted in enlarging stem as stem diameter. Clone of UJ5 was more responsive to potassium fertilizer that was proven by plant height and stem diameter than that of UJ3 in the same potassium dosage of 150 kg/ha. The stem diameter of UJ3 clone (22.4 mm) under 150 kg KCl/ha was smaller than that of UJ5 (30.9 mm) in the same potassium dosage at 7 MAP. Such condition was still the same at 8 and 9 MAP.

The variation of leaf weight both fresh and dry condition was in Table 3. Application of 150 kg potassium /ha, LFW and LDW of UJ5 clone was heavier than that of UJ3 clone. Such condition was still the same as 6 and 8 MAP. Interestingly, when potassium application increased from 150 kg/ha to

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300 kg/ha, LFW and LDW of UJ3 was heavier than that of UJ5. It seems the fact that UJ3 clone was more responsive than UJ5 clone in increasing potassium application. The photoassimilate of UJ3 clone was not translocated to stem because stem diameter of UJ3 was smaller than that of UJ5 clone at 7-9 MAP under both dosages of potassium, 150 and 300 kg/ha. Photoassimilate translocation of UJ5 clone from leaf parts to stem enlarged stem diameter and increased plant height of UJ5. The results showed that the photoassimilate translocation to the storage roots occurred during 7-9 MAP. This condition was similar to the results that was studied by Janket *et al.* [7].

Table 1. The variation of plant height means of cassava due to different potassium fertilizers and clones.

Clone	KCl (kg/ha)	2 MAP (cm)	10 MAP(cm)
UJ-3	0	88.2 bc	369.6 ab
UJ-3	150	88.3 bc	336.6 b
UJ-3	300	99.4 a	339.9 b
UJ-5	0	88.7 bc	385.0 b
UJ-5	150	91.0 b	431.0 a
UJ-5	300	83.9 c	408.0 ab
BNT 0.05		6.15	46.2

Means followed by the same letter in the same column showed not significantly different with LSD 0.05.

Table 2. The variation of stem diameter means of cassava due to different potassium fertilizers and clones.

Clone	KCl (kg/ha)	7 MAP (mm)	8 MAP (mm)	9 MAP (mm)
UJ-3	0	21.0 d	22.0 c	23.0 c
UJ-3	150	22.4 d	23.5 c	24.4 c
UJ-3	300	25.0 c	26.7 b	27.5 b
UJ-5	0	28.5 bc	29.6 a	30.5 ab
UJ-5	150	30.9 b	31.8 a	32.9 a
UJ-5	300	27.0 c	29.0 ab	30.0 ab
BNT 0.05		3.46	2.98	3.02

Means followed by the same letter in the same column showed not significantly different with LSD 0.05.

Under application of 150 kg potassium/ha, root characters as TRN, TSR, RN, DRD, and RL of both clones UJ3 and UJ5 were the same (Table 4). This condition probably caused root weight of UJ3 and UJ5 was the same. However, when the application of potassium increased to 300 kg/ha, the RW of UJ3 was heavier than that of UJ5. This was supported by Akari *et al.* [8] who conducted research in sweet potato applied by 150 kg potassium fertilizer /ha. They reported that fresh tubers weight, tubers weight marketable, and tubers productivity was significantly higher than that of control (50 kg potassium/ha). In Nigeria, Uwah *et al.* [9] reported that application of 120 kg potassium fertilizer/ha on cassava improved tubers weight and tubers productivity around 48% and 36%, respectively. The heavier RW of UJ3 was supported by the increase in TRN, RN, DRD, and RL. It seems that the increase in RW was concomitant with the increase in TRN, RN, DRD, and RL. Under application of 150 kg potassium/ha, the lower LFW and LDW of UJ3 was probably caused by translocation assimilate from leaves to root parts more than that of stem. Because of that, UJ3 clone produced RW which was the same as UJ5. On the contrary, UJ5 clone applied by 150 kg potassium/ha showed higher LFW and LDW than UJ3 clone. This induced photoassimilate to be translocated from leaves to stem and root parts, because of that RW of UJ3 and UJ5 were not significantly different. Fernandes *et al.* [10] concluded that application of 150 kg KCl/ha could enhanced the root weight and starch content approximately 36-49%.

Table 3. The variation of fresh weight and dry weight of leaf mean of cassava do to different potassium fertilizers and clones at 6 MAP and 8 MAP.

Clone	KCl (kg/Ha)	LFW (g/ plant)	LDW (g/ plant)	LFW (g/ plant)	LDW (g/ plant)
		6 MAP		8 MAP	
UJ-3	0	253.1 b	37.5 b	231.2 c	17.0 cd
UJ-3	150	221.3 b	32.7 b	217.3 c	15.8 d
UJ-3	300	359.4 a	52.1 a	303.3 b	26.9 a
UJ-5	0	333.5 a	49.6 a	303.9 b	22.3 b
UJ-5	150	376.1 a	56.0 a	389.2 a	28.7 a
UJ-5	300	257.3 b	38.1 b	277.5 b	20.3 bc
BNT 0.05		58.2	6.87	30.8	3.99

Means followed by the same letter in the same column showed not significantly different with LSD 0.05.

Table 4. The variation of yield component mean of cassava do to different potassium fertilizers and clones at 10 MAP.

Clone	KCl (kg/Ha)	TRN[a] (no/plant)	TSR[b] (no/plant)	RN[c] (no/plant)	DRD[d] (cm)	RL[e] (cm)	RW[f] (kg/ plant)
UJ-3	0	23.9 b	15.2 b	13.4 c	70.0 b	30.6 b	3.410 b
UJ-3	150	24.8 b	19.5 ab	16.5 bc	70.5 b	32.2 b	4.452 b
UJ-3	300	30.4 a	22.6 a	22.0 a	93.2 a	46.9 a	6.743 a
UJ-5	0	25.3 b	16.9 b	14.3 c	73.0 b	33.4 b	2.789 c
UJ-5	150	25.1 b	17.8 a	14.3 c	67.4 b	32.6 b	4.373 b
UJ-5	300	24.2 b	18.4 a	15.2 c	70.4 b	33.6 b	4.600 b
BNT 0.05		4.13	5.02	4.88	10.8	12.4	1.240

[a]TRN: Total root number.
[b]TSR: Total swollen root.
[c]RN: Root number.
[d]DRD: Distribution of root diameter.
[e]RL: Root length.
[f]RW: Root weight.

Under application of 300 kg potassium/ha, LDW of UJ3 was heavier than that of UJ5 at 8 MAP. Moreover, stem diameter and plant height of UJ3 was the same as that of UJ5 which was applied by 300 kg potassium/ha. However, application of 300 kg potassium/kg increased significantly RW of UJ3 compared to that of UJ5. It could be explained that application of 300 kg potassium/kg could induced UJ3 clone to produce strong photoassimilate as a source and also had strong sink as root parts.

This means that response of growth could be influenced by clone. Based on this information, UJ3 clone was more responsive to increasing potassium application than UJ5 clone. The increasing potassium application from 0-300 kg KCl/ha in Tulungagung, Jawa Indonesia, could increase fresh tuber yield from 19-35 ton/ha [11]. The evidence obtained from this study would greatly facilitate more efficient adoption of precision agriculture in cassava production by applying recommended fertilizer.

4. Conclusion

Photoassimilate translocation from leaves to roots on cassava was probably influenced by potassium fertilizer and clone. Application of 150 kg KCl/ha could increase LDW of UJ3 clone higher than that of UJ5 clone led to the same RW. Additionally, application of 300 kg KCl/ha enhanced LDW of UJ3 more than that of UJ5 with RW was heavier in UJ3 than in UJ5. Strong source as photoassimilate and strong sink of UJ3 proved to increase RW by increasing root components as TRN, RN, RL. It was recommended that high storage root yield of cassava could be applied by 300 kg KCl/ha.

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