

Research Article

The effect of weeding with two kinds of fertilizers on sweet potato (*Ipomoea batatas* L.) growth and yield

Husni Thamrin Sebayang^{*}, Wiwin Sumiya Dwi Yamika, Lidia Kartika Mulyani

Agronomy Department, Faculty of Agriculture, Brawijaya University, Jl. Veteran, Malang 65145, Indonesia

^{*} corresponding author: husni_thsby@yahoo.co.id

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Abstract: Sweet potato is the main food resources for human life besides that of rice. An experiment to find out the effect of weeding with two kinds of fertilizer on the growth of yield sweet potato (*Ipomoea batatas* L.) was conducted at UB Agro Techno Park, Jatikerto, Kromengan, Malang, East Java, from April until to 2017. The experiment used a randomized block design with six treatments consisting of G1 (organic fertilizer + weeding 15 days after planting = DAP), G2 (inorganic fertilizer + weeding at 15 DAP), G3 (organic fertilizer + weeding at 15 and 30 DAP), G4 (inorganic fertilizer + weeding at 15 and 30 DAP), G5 (organic fertilizer + weeding 15, 30 and 45 DAP), G6 (inorganic fertilizer + weeding at 15, 30 and 45 DAP) with three replications. The results showed that weeding three times (15, 30 and 45 DAP) significantly reduced the dry weight of weeds, improved the growth and yield of sweet potato with two kinds of fertilizers.

Keywords: *inorganic fertilizer, organic fertilizer, sweet potato, weed*

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Introduction

Sweet potatoes (*Ipomoea batatas* L.) are carbohydrate-producing plants other than rice that is important as alternative food sources for human life (Data Centers and Agricultural Information System, 2016). Various efforts have been conducted to increase the yield of sweet potatoes such as using a suitable variety, improving soil fertility and plant maintenance methods, especially in the application of fertilizer and weed control. The availability of nutrients and control of plant-disturbing organisms are critical environmental factors for plant growth (Kastono, 2005). Nutrient availability can be increased through fertilization. Among these are organic and inorganic fertilizers. The application of the organic fertilizer from manure can improve environmental conditions for plant growth such as soil texture, soil structure, also increases absorption of water by soil, thereby increasing crop yield (Andayani and La Sarido, 2013). For

soybean, cow manure is a kind of organic fertilizer which can increase the growth and yield of soybean plant (Sudarsono et al., 2013). Even so, manure fertilizer can increase the growth of weeds in agricultural field (Mayadewi, 2007). Weed compete with the crops for nutrients, water, light and other environmental factors (Anggeraini et al., 2016). Kilkoda et al. (2015) state that weeds cause a decrease in the quantity and quality of crops. Workayehu et al. (2011) reported that many alternatives are available for weed control in sweet potatoes such as tillage, hand weeding and multiple cropping systems. This experiment aimed to find out the effect of weeding with two kinds of fertilizers on the growth and yield of sweet potatoes (*Ipomoea batatas* L.).

Materials and Methods

The experiment was conducted at UB Agrotechno Park, in Jatikerto Village, Kromengan Sub-district, Malang Regency from April 2017 to July

2017. The experiment used a randomized block design with six treatments consisting of G1 (organic fertilizer + weeding at 15 days after planting = DAP), G2 (inorganic fertilizer + weeding at 15 DAP), G3 (organic fertilizer + weeding at 15 and 30 DAP), G4 (inorganic fertilizer + weeding at 15 and 30 DAP), G5 (organic fertilizer + weeding at 15, 30 and 45 DAP), G6 (inorganic fertilizer + weeding at 15, 30 and 45 DAP) replicated 4 times. Land treatment was done two times with hoe at a depth of 5 - 10 cm so that the soil becomes loose. Then, experimental plots were made with a size of 4.9 m x 3 m. Sweet potato cuttings of Beta 1 variety with a length of 25 cm were planted with a plant spacing of 30 cm in the rows and 70 cm between row. The treatment of inorganic fertilizers used urea fertilizer at a dose of 200 kg/ha, SP36 at a dose of 100 kg/ha, and KCl at a dose of 100 kg/ha. One-third doses of urea and KCl fertilizers and all dose SP36 were given at planting time, while 2/3 doses of urea and KCl fertilizer were given at 45 days after planting. The treatment of organic fertilizer using cow manure of a quantity of 5 t/ha was given simultaneously with soil tillage. Weeding treatment was done using hoes at 15 DAP for weeding once, at 15 and 30 DAP for weeding two times and at 15, 30 and 45 DAP for weeding three times. Plant maintenance was done following the recommendations. The observation of sweet potato was done on the dry weight of

weed, plant length, leaf number, leaf area, fresh weight and dry weight of the plant, tuber number, fresh weight of tuber, tuber dry weight and tuber yield of sweet potato. Data analysis used variance analysis (F test) at 5% level. The result of the significant variance analysis was continued with the Least Significant Difference (LSD) test at 5% level.

Results and Discussion

Weed dry weight

Application of types of fertilizers and weeding affected growth of weeds as seen in weed dry weight. The results presented in Table 1 showed that weed dry weight for weeding once (15 DAP), weeding twice (15 and 30 DAP), and weeding three times (15, 30 and 45 DAP) with both organic fertilizer was significantly higher than other treatments observed at 15 DAP. Weed dry weight observed at 30 and 45 DAP was lower for treatment of weeding two times (15 and 30 DAP) and weeding three times (15,30 and 45 DAP) with organic and inorganic fertilizers. Weed dry weight at harvest was not significantly different in all treatments. Intensive weeding of weeds during the growth period of sweet potato and the increasing growth of sweet potatoes could suppress the growth of weeds. Andriyani (2006) stated that weeding is an attempt to suppress weed growth.

Table 1. Average weed dry weight with the type of fertilizer and weeding at different times of observation.

Treatments	Average Weed Dry Weight (g/0.25 m ²)			
	15 DAP	30 DAP	45 DAP	Harvest
Organic fertilizer + weeding 15 DAP	12.97 b	8.47b b	8.40 c	4.27
Inorganic fertilizer + weeding 15 DAP	7.90 a	5.03 a	6.43 b	4.20
Organic fertilizer + weeding 15, 30 DAP	12.33 b	5.57 a	5.63 ab	3.97
Inorganic fertilizer + weeding 15, 30 DAP	6.47 a	4.90 a	5.10 a	3.67
Organic fertilizer + weeding 15, 30, 45 DAP	9.27 ab	4.83 a	4.60 a	3.37
Inorganic fertilizer +weeding 15, 30, 45 DAP	6.43 a	4.30 a	4.67 a	2.90
LSD 5%	3.42	1.43	1.65	NS
CV (%)	21.30	10.81	16.35	14.80

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Plant growth

Plant length

Weeding treatment increased plant length of sweet potato (Table 2). In observations at 75 DAP, plant length was significantly higher in the treatment of organic and inorganic fertilizer respectively for weeding three times (15, 30 and 45 DAP) and

significantly different to the treatments of weeding once (15 DAP) and weeding two times (15 and 30 DAP) with two types of fertilizer. In observation 90 and 105 DAP, plant length was not significantly different from the treatment of weeding twice (15 and 30 DAP) and weeding three times (15, 30, and 45 DAP) with both types of fertilizer. Meanwhile, the treatment of weeding

one time (15 DAP) plant length was lower with both types of fertilizers in observations of 75, 90 and 105 DAP. Weeding done in the critical period of plant significantly improves plant growth. If weeds were not controlled, the growth of sweet

potato was inhibited compared to sweet potatoes growth that weeds were controlled. Prachand et al.(2014) stated that weed control should be done during the first six week after planting due to weed competition occurs during this period.

Table 2. The average length of the sweet potato plant in the application of two types of fertilizer and weeding at different times of observation.

Treatments	Length of plant (cm)							
	60 DAP		75 DAP		90 DAP		105 DAP	
Organic fertilizer + weeding 15 DAP	41.75	47.25	a	45.75	a	47.50	a	
Inorganic fertilizer + weeding 15 DAP	47.75	48.00	a	49.25	ab	48.25	a	
Organic fertilizer + weeding 15, 30 DAP	49.25	49.50	ab	56.75	bc	57.25	ab	
Inorganic fertilizer + weeding 15, 30 DAP	54.00	51.75	ab	57.50	c	59.75	ab	
Organic fertilizer + weeding 15, 30, 45 DAP	53.75	56.75	bc	58.25	c	66.75	b	
Inorganic fertilizer +weeding 15, 30, 45 DAP	56.25	59.75	c	59.25	c	67.50	b	
LSD 5%	NS	7.95		8.23		16.46		
CV (%)	14.58	10.12		10.03		19.49		

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Leaf number and leaf area

Leaves are essential plant organs that function as a place of photosynthesis takes place in plants. From Tables 3 and 4, the number of leaves in the observation of 75 DAP, significantly higher with the treatment of organic and inorganic fertilizer for weeding three times (15, 30 and 45 DAP) and significantly different for treatment of weeding one time (15 DAP). In observations 90 DAP and 105 DAP, the number of leaves was not significantly different in the treatment of weeding twice (15 and 30 DAP) with inorganic fertilizer and weeding three times (15, 30 and 45 DAP) in both types of fertilizer, while the treatment of

weeding one time (15 DAP) showed a significantly lower leaf number with both types of fertilizer. Leaf area observations did not show any difference for weeding twice (15 and 30 DAP) and weeding three times (15, 30 and 45 DAP) with both types of fertilizer at 75, 90 and 100 DAP, while the treatment of weeding one time (15 DAP) showed a lower leaf area. Application of the type of fertilizer and weeding is essential to support the optimal growth of leaf. Silva et al. (2004) reported that an important factor that determines dry matter accumulation in the leaf area.

Table 3. The average number of leaves with the application of types of fertilizer and weeding at different times of observation.

Treatments	Number of leave per plant							
	60 DAP		75 DAP		90 DAP		105 DAP	
Organic fertilizer + weeding 15 DAP	39.75	39.50	a	36.50	a	36.50	a	
Inorganic fertilizer + weeding 15 DAP	40.00	39.75	a	39.25	ab	37.25	a	
Organic fertilizer + weeding 15, 30 DAP	42.75	40.50	ab	46.50	bc	47.00	abc	
Inorganic fertilizer + weeding 15, 30 DAP	43.25	41.00	ab	47.50	bc	48.25	abc	
Organic fertilizer + weeding 15, 30, 45 DAP	44.25	47.50	bc	48.00	bc	54.25	bc	
Inorganic fertilizer +weeding 15, 30, 45 DAP	49.50	49.50	c	49.25	c	58.80	c	
LSD 5%	NS	6.88		9.23		12.73		
CV (%)	17.67	10.63		13.90		17.62		

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Table 4. The average leaf area with the application of two types of fertilizer and weeding at a different time of observation.

Treatments	Leaf Area (cm ²)				
	60 DAP	75 DAP	90 DAP	105 DAP	
Organic fertilizer + weeding 15 DAP	107.23	103.90 a	113.70 a	116.45 a	
Inorganic fertilizer + weeding 15 DAP	106.70	109.15 a	114.75 a	117.20 a	
Organic fertilizer + weeding 15, 30 DAP	110.95	113.63 ab	120.40 ab	136.88 ab	
Inorganic fertilizer + weeding 15, 30 DAP	111.05	117.48 ab	121.18 ab	138.98 an	
Organic fertilizer + weeding 15, 30, 45 DAP	116.88	126.38 b	126.90 b	148.20 b	
Inorganic fertilizer +weeding 15, 30, 45 DAP	119.18	127.78 b	130.58 b	149.75 b	
LSD 5%	NS	16.55	10.34	24.40	
CV (%)	7.67	9.47	5.66	12.30	

Notes: Numbers with the same letters in the same columns shows no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant

The fresh and dry weight of the plant

Application of organic and inorganic fertilizer followed by weeding affected the fresh and dry weight of plant (Tables 5 and 6). In observation of 90 DAP and at harvest time, the fresh and dry weight of plant were significantly higher in the treatment of weeding three times (15, 30 and 45 DAP) with both types of fertilizer compared to the treatments of weeding twice (15 and 30 DAP) and weeding one time (15 DAP). At observation 105 DAP, the fresh and dry weights of the plants were

not different for treatment of weeding twice (15 and 30 DAP) and weeding three times (15, 30, and 45 DAP) with both types of fertilizer. For the weeding treatment of one time (15 DAP) the fresh and dry weight of plants are lower. Abadi et al. (2013) stated that the presence of weeds gave a significant effect of decreasing plant growth and yields. Weed control on sweet potato plants with an oxyfluorfen herbicide dose of 1 L/ha followed by weeding of 40 days after planting effectively controlled weeds and increased plant growth.

Table 5. The average fresh weight of plants with the application of two types of fertilizer and weeding at a different time of observation.

Treatment	Fresh Weight Per Plant (g/plant)				
	60 DAP	75 DAP	90 DAP	105 DAP	Harvest
Organic fertilizer + weeding 15 DAP	50.98	55.30	66.55 a	72.78 a	123.10 a
Inorganic fertilizer + weeding 15 DAP	54.33	57.00	67.95 ab	78.48 ab	129.25 a
Organic fertilizer + weeding 15, 30 DAP	56.33	57.53	70.45 ab	80.43 abc	130.73 ab
Inorganic fertilizer + weeding 15, 30 DAP	56.65	58.55	77.73 b	84.15 abc	134.43 b
Organic fertilizer + weeding 15, 30, 45 DAP	58.50	58.75	102.80 c	98.78 bc	150.78 c
Inorganic fertilizer +weeding 15, 30, 45 DAP	58.75	59.00	103.45 c	102.85 c	152.92 c
LSD 5%	NS	NS	11.15	21.04	10.41
CV (%)	7.67	5.18	9.08	16.13	5.05

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Yields component of sweet potato

The presence of weeds in sweet potato plants inhibits growth and decreases sweet potato yields. The results showed that the treatment of two types of fertilizer followed by weeding affected the yield of sweet potato (Table 7). For the number of tubers and dry weight of tuber per plot, the treatment of weeding three times (15, 30, and 45 DAP) and weeding two times (15 and 30 DAP) showed no significant difference with organic and inorganic fertilizers. The fresh weight of tubers per plot and fresh weight of

tubers per ha were higher for the treatment of weeding three times (15, 30 and 45 DAP) with the treatment of two types of fertilizer, and were not significantly different with the treatment of weeding two times (15 and 30 DAP) with inorganic fertilizer. Gomes (2014) stated that weeding at the appropriate time would reduce the growing of weeds and reduced competition, and thus growth and the harvest of the plant will increase. Glaze et al. (1990) stated that sweet potato competes with weed, reducing yields and causing problems during harvest.

Table 6. The average dry weight of plants with application of two types of fertilizer and weeding at a different time of observation.

Treatment	Dry Weight Per Plant (g/plant)				
	60 DAP	75 DAP	90 DAP	105 DAP	Harvest
Organic fertilizer + weeding 15 DAP	25.25	26.58	26.95 a	27.78 a	35.58 a
Inorganic fertilizer + weeding 15 DAP	25.30	27.33	27.70 a	28.70 ab	36.23 a
Organic fertilizer + weeding 15, 30 DAP	26.95	27.23	28.08 a	29.73 ab	38.38 a
Inorganic fertilizer + weeding 15, 30 DAP	26.53	28.63	29.58 ab	30.03 ab	39.03 a
Organic fertilizer + weeding 15, 30, 45 DAP	27.88	29.15	33.53 bc	32.35 b	41.63 ab
Inorganic fertilizer + weeding 15, 30, 45 DAP	28.55	29.90	36.48 c	35.50 b	45.85 b
LSD 5%	NS	NS	4.29	6.89	6.21
CV (%)	16.65	9.30	9.33	14.88	11.08

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Table 7. The average yield of crops consisting of numbers of tubers, fresh weight of tubers, dry weight of tubers and fresh weight of tubers with application two types of fertilizers and weeding.

Treatment	Yield Components			
	Number of tubers per plot	Fresh weight of tuber per plot (g)	Dry weight of tuber per plot (g)	Fresh weight of tuber (t/ha)
Organic fertilizer + weeding 15 DAP	47.75 a	107.40 a	33.40 a	12.79 a
Inorganic fertilizer + weeding 15 DAP	48.50 a	111.43 a	35.25 ab	13.03 a
Organic fertilizer + weeding 15, 30 DAP	56.25 ab	113.38 a	38.00 ab	13.80 ab
Inorganic fertilizer + weeding 15, 30 DAP	58.75 b	115.88 a	39.95 ab	14.74 bc
Organic fertilizer + weeding 15, 30, 45 DAP	60.50 b	128.70 b	40.30 ab	15.78 c
Inorganic fertilizer + weeding 15, 30, 45 DAP	65.25 b	130.60 b	41.73 b	16.32 c
LSD 5%	9.37	12.03	8.29	1.62
CV (%)	11.07	6.77	9.47	7.43

Notes: Numbers with the same letters in the same columns show no significant difference based on the LSD (Least Significant Difference) test of 5% level. DAP: Day After Planting. CV: Coefficients of Variation. NS: Not Significant.

Conclusion

Application of organic fertilizer and inorganic fertilizer must be followed by weeding to increase the growth and yield of sweet potato. Weeding one time showed lower growth and yield of sweet potato compared to weeding two or three times. Weeding two and three-time increase the growth and yield of sweet potato with organic fertilizer and inorganic fertilizers.

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