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The Effect of the Length of Cuttings and the Dose of Rabbit Manure on the Growth and Yield of Purple Sweet Potato (*Ipomoea Batatas L.* Poiret)

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Abstract
This study aims to determine the effect of the length of cuttings and the dose of rabbit manure on the growth and yield of purple sweet potato, which was carried out in Banjar Uma Kepuh, Buduk Village, Mengwi District, Badung Regency, Bali Province. The implementation time of the research starts from March - July 2021. The design used in this experimental design is a Randomized Block Design (RDB). The first factor was the length of the cuttings: S1 (40 cm), S2 (50 cm), and S3 (60 cm). The second factor was the dose of rabbit manure K0 (without fertilizer), K1 (5 tons/ha), and K2 (10 tons/ha). Observation variables included stem length per plant, number of shoots per plant, number of leaves per plant, tuber diameter per plant, number of tubers per plant, fresh weight of tuber per plant, fresh weight of tuber per plant, the weight of oven tuber per plant, dry weight number of ovens per plant and harvest index. The results showed that the length of the cuttings had a significant to a very significant effect on the observed variables except for the largest tuber diameter per plant, tuber fresh weight per plant, and tuber fresh weight per plant had no significant effect. The results of this study indicate that the best cutting length is 50 cm. The dose treatment of rabbit manure had a significant to a very significant effect on the observed variables except for the number of tubers per plant, which had no significant effect. The kind of dose of rabbit manure that gives the best economic results is without rabbit manure. There was an interaction between the length of cuttings and the dose of rabbit manure which had a very significant effect on the observed variables except for the number of shoots per plant, the number of tubers per plant, and fresh weight per plant. The best combination obtained in this study was treatment with cuttings length of 50cm and without a dose of rabbit manure.

Keyword: *Purple sweet potato; length of cuttings; rabbit manure.*

1. Introduction

Food is the main factor to maintain the stability of a country, if a country experiences a shortage of food, the country is on the verge of collapse. The staple food of a commodity, such as rice, has a considerable risk if one day the crop commodity experiences a decline in production or crop failure, this must be an alternative to root-based foodstuffs, such as sweet potatoes to maintain a country's food security.

Sweet potato (*Ipomoea batatas L.*) is one of the largest sources of carbohydrates after rice, corn, and cassava. In addition, sweet potatoes have an important role in the supply of food raw materials, industrial raw materials, medicinal ingredients, and animal feed ingredients [1]. Purple sweet potatoes have various health benefits, including being useful as antioxidants to prevent cancer and various cardiovascular diseases, and purple sweet potatoes have the necessary content for the body, such as carbohydrates, beta-carotene, vitamins E, C, and minerals [2].

Sweet potato production in Indonesia is still relatively low compared to other countries, such as China 51.9 million tons, Malawi 5.9 million tons, Nigeria 4.1 million tons, Tanzania 3.9 million tons, Uganda 1.9 million tons [3]. One of the efforts to increase the productivity of sweet potato cultivation is to determine the length of good cuttings and the type of fertilizer used.

The method of plant propagation using cuttings is a method of plant development that is carried out by taking parts of the plant, especially the stem [4]. The propagation technique through cuttings is a simple and easy way to be applied by farmers. Through this propagation technique, it is hoped that the perfect sweet potato plant can be obtained, namely, a plant that has roots stems, and leaves in a relatively short time. The best use of cuttings length is to use cuttings length of 50 cm [5]. The length of the cuttings affects the formation of roots and shoots, therefore the longer the cuttings, the greater the carbohydrate content, so that more roots are produced. The purpose of cuttings is so that plant parts can form roots [6].

Fertilizer is a material that is organic or inorganic, when added to the soil can add nutrients and can improve the physical, chemical, and biological properties of the soil. Manure is a natural fertilizer so it does not pollute and damage the environment and soil conditions. In addition, manure can also provide macro and micronutrients [7]. Rabbit manure is a solid organic fertilizer, which can add nutrients to the soil, can also add humus, improve soil aggregates and encourage the life of soil microorganisms [8]. Based on research conducted by the Animal Research Agency in Ciawi, Bogor Regency, in 2005, rabbit droppings contained elements of N, P, K which were 2.72%, 1.1%, and 0.5% higher, respectively, compared to other livestock manure such as cows, buffaloes, sheep, horses, pigs, and even chickens.

Provision of 10-15 tons of compost per hectare can improve soil fertility and crop yields [9,10,11]. Rabbit manure treatment significantly affected root fresh weight by giving rabbit manure 20-30 tons per ha to increase plant growth [12,13].The use of rabbit manure as organic fertilizer in sweet potato cultivation has a role in improving soil physical properties, increasing plant nutrition, and being safe for consumption [14].

2. Materials and Methods

This research was conducted in Banjar Uma Kepuh, Buduk village, Mengwi sub-district, Badung district, Bali province, with an altitude of ± 65 m above sea level, and an average temperature of 24˚C - 31˚C. The time of conducting the research started from March - July 2021. The materials used in this study were purple sweet potato cuttings and rabbit manure. While the tools needed are a hoe, raffia rope, bamboo, ruler, scales, scissors, camera, stationery, research label, sprayer, and other cultivation equipment.

The design used in this experiment was a randomized block design which consisted of two treatments. The first factor was the length of the cuttings (40 cm, 50 cm, and 60 cm), while the second factor was the dose of rabbit manure (without fertilizer, 5 tons/ha, and 10 tons/ha). Observation variables included stem length per plant, number of shoots per plant, number of leaves per plant, the diameter of the largest tuber per plant, number of tubers per plant, fresh weight of tuber per plant, fresh weight of tuber per plant, the weight of oven tuber per plant, oven-dry weight. Thus, 9 combination treatments were obtained and each treatment combination was repeated 3 times, so a total of 27 combination treatment plots were obtained.

The results of observations of each observed variable were analyzed by analysis of variance. If the analysis of variance has a significant to very significant effect, then it is continued with the analysis of the significant difference test at the 5% level in the single treatment, and Duncan analysis at the 5% level on the interaction effect.

3. Results and Discussion

Based on the results of statistical analysis, it was found that there was a significant effect of cutting length (S) and rabbit manure dose (K), as well as interactions (SxK) on the observed variables (Table 1).

Based on Table 1, shows that the treatment of cuttings length (S) showed a significant effect ($P<0.05$) to very significant ($P<0.01$) on the observed variables except for tuber diameter per plant, tuber fresh weight per plant, and fresh weight per plant had no significant effect ($P\geq0.05$). The dose of rabbit manure (K) had a significant ($P<0.05$) to very significant ($P<0.01$) effect on the observed variables except for the number of tubers per plant had no significant effect ($P\geq0.05$). The interaction between the treatment length of cuttings and the dose of rabbit manure had a very

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significant effect (P<0.01) on the observed variables except for the number of shoots per plant, the number of tubers per plant, and fresh weight per plant had no significant effect (P≥0.05).

Tabel 1. Significance of the effect of cutting length (S) and dose of rabbit manure (K) and their interaction on the observed variables

No.	Variable	Perlakuan		
		Cutting length (S)	Rabbit Fertilizer Dose (K)	Interaction (SxK)
1.	Stem length per plant (cm)	**	**	**
2.	Number of shoots per plant (strands)	*	**	ns
3.	Number of leaves per plant (strands)	**	**	**
4.	Bulb diameter per plant (cm)	ns	**	**
5.	Number of tubers per plant (fruit)	**	ns	ns
6.	Bulb fresh weight per plant (g)	ns	**	**
7.	Fresh weight per plant (g)	ns	**	ns
8.	Oven dry weight of tubers per plant (g)	**	**	**
9.	Oven dry weight per plant (g)	**	**	**
10.	Harvest index (%)	**	*	**

* = significant effect (P<0.05), **= very significant effect (P<0.01), ns= not significant (P≥0.05)

3.1 Stem length per plant (cm)

The interaction of cuttings length treatment and rabbit manure dosage had a very significant effect on stem length per plant, the highest value was shown in S3K2 which was 210.00 cm and significantly different from the interaction in the combination treatment of each level on the cutting length factor and rabbit manure dose (Tabel 2).

Tabel 2. The average stem length per purple sweet potato plant was due to the interaction effect of cutting length treatment and rabbit manure (SxK) dose.

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	77.50 cd	95.33 cd	104.50 bcd
S2	80.67 cd	107.00 bc	172.50 bc
S3	96.83cd	133.67 bc	210.00 a

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

3.2. Number of shoots (strands)

The effect of cutting length and dose of rabbit manure showed that the average number of shoots per plant was highest in the S3 cutting length treatment, with the number of shoots 24.89 strands, not significantly different from the other cutting length treatments except S1. In the treatment with doses of rabbit manure, the highest average value of the number of shoots per plant in the treatment dose of rabbit manure K2 with 33.50 strands, was significantly different from other manure doses (Tabel 9).

3.3. Number of leaves per plant (strands)

The interaction of cuttings length treatment and rabbit manure dosage had a very significant effect on the number of leaves per plant, the highest value was shown in S3K2 which was 210.00 strands and significantly different from the interaction in the combination treatment of each level on the cutting length factor and rabbit manure dose (Tabel 3).

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3.4. Bulb diameter per plant (cm)

The interaction of treatment cuttings length and dose of rabbit manure has a very significant effect on tuber diameter per plant, the highest value is shown at S3K0 which is 4.78 cm and is significantly different from the interaction in the combination treatment of each level on the factor of cutting length and dose of rabbit manure (Tabel 4).

Tabel 3. The average number of leaves per purple sweet potato plant, the effect of interaction between cuttings length and dose of rabbit manure (SxK)

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	46.00 f	116.17 de	190.83 c
S2	59.17 ef	118.50 de	237.17 bc
S3	72.50 e	136.00 d	282.00 a

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

Tabel 4. The average tuber diameter per plant was influenced by the interaction of cutting length and dose of rabbit manure (SxK).

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	3.51 bc	2.06 ef	2.27 d
S2	3.35 c	2.24 d	2.22 d
S3	4.78 a	2.73 d	1.55 f

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

3.5. Number of tubers per plant (result)

The effect of cutting length and dose of rabbit manure showed the highest average number of tubers per plant in the S2 cutting length treatment, with 1.72 tubers, not significantly different from other cutting length treatments. In the treatment with the dose of rabbit manure, the highest average value of the number of tubers per plant in the treatment dose of rabbit manure K2 with the number of shoots 1.57 fruit, was significantly different from the treatment of other manure doses (Tabel 9).

3.6. Fresh weight of tubers per plant (g)

The interaction of cuttings length treatment and rabbit manure dosage had a very significant effect on the fresh weight of tubers per plant, the highest value was shown at S3K0 which was 388.98 grams and significantly different from the interaction in the combination treatment of each level on the cutting length factor and rabbit manure dose except S2K0 (Tabel 5).

Tabel 5. Average fresh weight of tubers per plant due to the interaction effect of treatment length of purple sweet potato cuttings and dose of rabbit manure (SxK)

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	215.97 cd	221.21 bcd	233.17 bcd
S2	310.11 ab	261.34 bc	217.49 bcd
S3	388.98 a	197.45 cd	158.71 d

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

3.7. Fresh weight per plant (g)

The effect of cutting length and dose of rabbit manure showed the highest average fresh weight per plant for cuttings length treatment S3, weighing 1605.56 grams, was not significantly

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different from other cutting length treatments except S1. In the treatment of rabbit manure dose type, the highest average value of fresh weight per plant in the treatment dose of rabbit manure K2 with a weight of 1724.44 grams, was significantly different from other manure dosage treatments (Tabel 9).

3.8. Oven dry weight of tubers per plant (g)

The interaction of cutting length treatment and rabbit manure dose had a very significant effect on the oven-dry weight of tubers per plant, the highest value was shown at S2K0 which was 102.09 grams and significantly different from the interaction in the combination treatment of each level on cutting length factor and rabbit manure dose. except S1K2, S3K0, and S3K1 (Tabel 6).

Tabel 6. The average maximum oven-dry weight of purple sweet potato tubers was due to the interaction effect of cutting length and dose of rabbit manure (SxK).

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	43.94 d	78.72 b	89.58 ab
S2	102.09 a	34.41 de	24.99 e
S3	89.48 ab	87.94 ab	52.98 c

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncant's Test.

3.9. Oven dry weight per plant (g)

The interaction of cuttings length treatment and rabbit manure dosage had a very significant effect on the oven-dry weight of the stovetop per plant, the highest value was shown in S3K2 which was 656.67 grams and was significantly different from the interaction in the combination treatment of each level on the factor of cutting length and dose of rabbit manure (Tabel 7).

Tabel 7. The average oven-dry weight of the stovetop per purple sweet potato plant is due to the interaction effect of cutting length and dose of rabbit manure treatment (SxK).

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	261.98 ef	377.05 bc	379.90 b
S2	295.47 cde	241.13 ef	340.33 bcd
S3	254.33 ef	202.17 f	656.67 a

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

3.10. Harvest index (%)

The interaction of cutting length treatment and rabbit manure dosage had a very significant effect on the harvest index, the highest value was shown at S2K0 which was 21.84% and significantly different from the interaction in the combination treatment of each level on the cutting length factor and rabbit manure dose (Tabel 8).

Tabel 8. Average harvest index % of maximum purple sweet potato plants due to the interaction effect of cuttings length and dose of rabbit manure (SxK)

Treatment cutting length	Dosage of rabbit manure		
	K0	K1	K2
S1	13.99 cd	12.78 cd	12.74 cd
S2	21.84 a	15.83 cd	13.32 cd
S3	21.80 bc	12.43 cd	7.24 d

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Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

Tabel 9. The average variables observed in the treatment of cuttings length (S) and rabbit manure dose (K)

Treatment	Number of shoots (strands)	Number of tubers (result)	The fresh weight of the stove (g)
Cutting length (S)			
S1	19.78 b	1.47 b	1516.67 b
S2	24.33 a	1.72 ab	1309.26 ab
S3	24.89 a	1.35 a	1605.56 a
LSD 5%	3.81	0.27	242.20
Dosage of rabbit manure (K)			
K0	13.11 c	1.46 a	1279.26 b
K1	22.39 b	1.57 a	1427.78 b
K2	33.50 a	1.52 a	1724.44 a
LSD 5%	3.81	-	242.20

Note: The numbers followed by the same letter on the same factor mean that they are not significantly different in Duncan's Test.

The interaction of giving various lengths of cuttings and various doses of rabbit manure resulted in the highest oven-dry weight found at cuttings length of 50 cm and without doses of rabbit manure. Possibly caused by the content of food reserves in cuttings 50 cm more likely in plant growth. The content of food reserves (carbohydrates) is a component that greatly influences the formation of roots on cuttings. Root growth and development are influenced by the content of the cutting material used, especially the supply of carbohydrates. Cuttings that contain high carbohydrates will be sufficient to form roots and shoots. The longer the cuttings used, the better the growth of root length because more food reserves are used to support root growth [15]. There is a contribution related to cutting length, namely differences in carbohydrate accumulation at the bottom of the cuttings and the amount will be optimal for root formation on long cuttings compared to short cuttings [16]. Each segment of the stem grows roots [17]. Roots that grow on cuttings will become tubers based on the growth phase of the plant [18].

4. Conclusion

Treatment of cuttings length had a significant to very significant effect on the observed variables except tuber diameter per plant, tuber fresh weight per plant, and fresh weight per plant had no significant effect. The dose of rabbit manure had a significant to very significant effect on the observed variables except for the number of tubers per plant which had no significant effect. The interaction between cuttings treatment length and dose of rabbit manure had a very significant effect on the observed variables except the number of shoots per plant, number of tubers per plant, and fresh weight per plant had no significant effect. The interaction of cuttings length treatment and rabbit manure dosage had a very significant effect on oven dry weight of tubers per plant, the highest value was found in the interaction between cuttings length of 50 cm and without rabbit fertilizer compared to other interaction treatments.

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