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Growth Response and Yield Level Thai Sweet Potato Cultivar Regarding under Staking

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ABSTRACT

Sweet potatoes are a local food source with the potential to support food diversification in Indonesia, primarily due to their carbohydrate, vitamin, and mineral content. However, national sweet potato productivity continues to fluctuate due to reduced harvested area. One method to increase yields is by providing stakes. Stakes help plants grow vertically, thus optimizing sunlight absorption. This study aimed to determine the effect of staking on the yield of Thai sweet potato cultivars. This study was conducted in Sigerongan Village, Lingsar District, West Lombok, from August to December 2024 using a non-factorial Completely Randomized Design (CRD) with two levels: with and without stakes, with nine replications each. The parameters observed were stem length, number of leaves, number of tubers, tuber weight, tuber diameter, tuber length, and the percentage of marketable tubers. The results showed that the staking treatment had a significant effect on stem length and tuber weight with an average of 821.22 g, higher than the treatment without stakes, while the parameters of the number of leaves, number of tubers, tuber diameter, tuber length and percentage of marketable tubers showed non-significant results. The conclusion of this study is that the staking treatment can increase growth in the stem length parameter by 51.5%, while in the tuber weight parameter, the provision of stakes can increase the weight of the tuber spread by 13.56%.

INTRODUCTION

Food is a primary need for humans to survive, so the availability of sufficient food for every individual is a basic right that must be fulfilled (Sutrisno et al., 2022). Rice is the main food source for 96.95% of the Indonesian population in 2021 (Sabarella et al., 2021). As the population increases, the need for food increases, making it increasingly difficult to provide food (Sabarella et al., 2024).

Food security must be supported by the availability of food, affordable prices, quality, nutritious food, and safe for consumption. Continuous population growth, accompanied by the conversion of agricultural land into residential or industrial areas, poses a major challenge to national food self-sufficiency. This condition makes food availability increasingly difficult to meet, while demand continues to increase. Food security factors include availability, distribution, and consumption. Food availability ensures that community needs are met in terms of quality, quantity, diversity, and safety. Effective and efficient food distribution ensures public access to food in sufficient quantity, quality, sustainability, and affordable prices. Meanwhile, food consumption includes utilization in accordance with the principles of nutrition, quality, diversity, safety, and halal (Sutrisno et al., 2022).

One strategy to reduce dependence on rice is food diversification, by utilizing local food sources such as cassava, sweet potatoes, corn or sago which have long been known and widely consumed (Sabarella et al., 2021). Sweet potatoes have high nutritional value, their carbohydrate content (percent dry weight) is starch 46.2%, sugar 22.4%, hemicellulose 3.6%, cellulose 2.7% and pectin 0.47%. Sweet potatoes when harvested contain 16-40% dry matter, of which 75-90% is carbohydrate (Meyer, 1982; Haryuni et al., 2021). Pectin, cellulose, and hemicellulose are among the dietary fibers that are good for health because they can reduce

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the risk of developing several diseases, such as cancer, colon cancer, diabetes, liver disease, and digestive tract diseases. Sweet potatoes also contain vitamins such as carotene (pro-vitamin A) and vitamin C (ascorbic acid). Sweet potatoes also contain minerals such as K, Na, P, Ca, Mg, Fe, S, and other minerals, but in low amounts. Sweet potatoes are very popular among Indonesians as a food ingredient. Sweet potatoes are a staple food for people in eastern Indonesia (Haryuni et al., 2021). Sweet potatoes can be processed into various products such as: boiled sweet potatoes, fried sweet potatoes, sweet potato flour and various types of traditional foods (Saati et al., 2024).

Sweet potato production fluctuates from year to year, reaching 1.42 million tons in 2021, increasing to 1.51 million tons in 2022, and decreasing by 5.34% to 1.43 million tons in 2023. This decline is due to land conversion and unfavorable environmental conditions. In West Nusa Tenggara (NTB), sweet potato productivity decreased from 18.61 tons/ha in 2022 to 11.70 tons/ha in 2023, with harvested areas decreasing from 705 ha to 520 ha. (Directorate General of Food Crops, 2023). This demonstrates the need for efforts to increase productivity through the application of cultivation technology.

One cultivation technique that has the potential to increase sweet potato yields is the use of stakes or trellises as a climbing medium. Allowing sweet potato plants to grow along the ground causes them to overlap, reducing the efficiency of sunlight capture. The use of stakes can help plants grow vertically and receive more sunlight, resulting in better vegetative and generative growth (Syahputra et al., 2022). Vertically growing sweet potato plants can prevent the plant stem from coming into direct contact with the soil, thus preventing the formation of secondary tubers (Gultom, 2004; Soplanit et al.., 2020). Based on the research results of Rahawarin. (2023), sweet potato cultivation using the triangular staking technique can increase crop production. Plants with triangular staking have better vegetative growth in terms of tendril length, number of leaves and number of branches, as well as in generative growth, the number of tubers and tuber weight are higher.

Based on these problems, this study was conducted with the title Growth Response and Yild Level Thai Sweet Potato Cultivars Regarding Under Staking. The purpose of this study was to determine the response of Thai sweet potato cultivars to staking. This research is expected to contribute to the development of sweet potato cultivation technology in limited land, particularly through staking treatments to increase plant productivity, as well as serve as a reference in efforts to support food diversification.

MATERIALS AND METHODS

This research was conducted from August to December 2024 in Sigerongan Village, Lingsar District, West Lombok Regency. The method used was an experimental method with direct field observation. The experimental design used was a non-factorial Completely Randomized Design (CRD) with two levels: stakes (A) and no stakes (control) (K). Each level was repeated nine times, resulting in 18 experimental units.

The tools used in this study included stationery, hoes, sickles, cable ties, stakes (150 cm), digital calipers (15 cm), cloth tape (150 cm), knives, analytical scales (0.01 grams) and buckets. The materials used included 72 cuttings of Thai sweet potato cultivars, NPK 16-16-16 fertilizer, furadan and label paper.

The research implementation includes land preparation, seed preparation, planting, fertilization, pest control (OPT), replanting, irrigation, turning the plant stems, installing stakes, installing treatment boards and harvesting. Land preparation is done by clearing the planting area of weeds, loosening the soil and making ridges with a hoe. The ridges made are 110 cm long, 50 cm wide, 25 cm high and the distance between ridges is 30 cm. Seed preparation is done by selecting sweet potato plants that are free from pests and diseases. Cuttings are taken from mother plants that are at least two months old. The cuttings used are shoot cuttings with a length of 30 cm. Planting is done in the morning, sweet potato cuttings are planted by immersing 2/3 of the cutting stem into the soil. In one ridge, 4 cuttings are planted with a distance between plants of 30 cm and a distance of 10 cm between the plants and the tip of the ridge.

Fertilization is carried out twice during cultivation: the first application seven days after planting and the second two months after planting. The fertilizer used is NPK 16-16-16 at a dose of 40 grams per mound. Weed control is carried out at 1, 2, and 3 months, depending on the number of weeds growing in the planting area. Pest control is carried out if the intensity of pest attacks exceeds the threshold. Control can be carried out mechanically or with chemicals. Replanting is carried out a week after planting. Replanting involves replacing dead or abnormally growing sweet potato plants with healthy sweet potato seedlings. Irrigation is

carried out at the beginning of planting, after fertilization, and when the soil is dry. If sweet potato cultivation is carried out during the rainy season, irrigation can be provided by rainwater. Stem turning is carried out at the age of 6 weeks after planting (wp) with an interval of once every two weeks. Staking is done at 6 months after planting, coinciding with the turning of the sweet potato stems. Harvesting occurs at 3 to 5 months, when the leaves begin to yellow and dry.

Growth observations were conducted when the plants were 6 weeks after planting (WAP), observations were conducted six times with two-week intervals. The growth variables observed were stem length (cm) and number of leaves (strands). Harvest yield observations were conducted once at 121-123 days after planting (DAP), the observed yield variables were the number of tubers (fruit), tuber weight (grams), tuber length (cm), tuber diameter (cm) and the percentage of marketable tubers (%) based on consumption suitability and tuber size. The number of tubers per plant was calculated by selecting small, medium, and large tubers. Very small tubers were not counted. The tubers are weighed one by one to find out the weight of the tuber per plant, then all the tubers per plant are weighed to get the tuber weight value per plant. Observations of tuber length were carried out by measuring the length of the tuber from the base to the tip of the tuber using a vernier caliper. If the tuber length exceeded 15 cm, the measurement was carried out using a cloth tape measure. Observation of tuber diameter was carried out by measuring the diameter of the largest tuber using a vernier caliper. Marketable tubers are sorted based on quality (physical condition) and tuber size (tuber length and diameter).

Observational data were analyzed using a t-test (equal variances) to determine significant differences between treatments (A and K). The analysis was performed using Microsoft Excel software.

1. Data Focus

Tabel 1. Data Tabulation

No	K	A	K^2	A^2
1				
2				
Σ				
$\bar{K}/\bar{A}$				

Information:

K = First sample data (control)

A = Second sample data (Pengajiran)

Σ = Total data

$\bar{K}/\bar{A}$ = Average of the first and second samples

2. Determining the combined standard deviation value (σ)

   Data homogeneous: $\sigma \frac{\sqrt{(n_1-1)K^2+(n_1-1)A^2}}{n_1+n_{2-2}}$

3. T-value calculation

   Data omogeneous:

   T count = $\frac{\bar{K}-\bar{A}}{\sigma\sqrt{\frac{1}{n1}+\frac{1}{n2}}}$

4. Finding the T-value of the table

5. Drawing conclusions

   If $t_{count} < t_{table}$ it can be concluded that there is no difference

   If $t_{count} > t_{table}$ it can be concluded that there is a significant difference

RESULTS AND DISCUSSION

Plants go through two phases to complete their life cycle: vegetative (growth) and generative (yield level); these two phases are interrelated. Research on cultivating Thai sweet potato cultivars using stakes involved observations in both phases. According to Paiman (2022), external factors significantly influence plant growth. Differences in external factors such as light, temperature, humidity, soil aeration, oxygen, and plant-disturbing organisms can cause differences in plant growth. These differences can affect plant yield levels.

1. Growth of Thai Cultivar Sweet Potato Plants

Table 2. Average Growth Rate of Thai Sweet Potato Cultivars

Criteria	Without Stakes	Wit Stakes	T count	T table	Information
Stem Length (cm)	32,79	55,52	5,8621	2,1788	S
Number of Leaves (pieces)	91,84	104,80	2,0755	2,1199	NS

The average stem length in the treatment without stakes showed a stem length of 32.79 cm, while in the treatment with stakes, the stem length was 55.52 cm. The difference in stem length reached 22.73 cm, and statistically this difference in length showed significant results. This means that the provision of stakes can increase the length of plant stems. Plant stems in the treatment without stakes experienced death, this is what caused the average stem length of plants in the treatment without stakes to be lower than the treatment with stakes. Plants in the treatment without stakes had stems overlapping each other, so the environment was more humid. High humidity can cause plant stems to rot. The provision of stakes can prevent plants from shading each other so that in the treatment with stakes, no plant stems died. According to Richana (2024), sweet potato cultivation from October to March (the rainy season) can cause rot in the stems and leaves of sweet potato plants.

The average number of leaves in the unstake treatment was 91.84, which was lower than the staking treatment. The staking treatment had 104.80 leaves. The difference in the number of leaves between the unstake treatment and the staking treatment was 12.96. This difference was non-significant, meaning that without staking, the number of leaves in the Thai sweet potato cultivar was relatively high. The lower number of leaves in the unstake treatment was due to the death of the stems and shoots of the plants, which caused the leaves growing on the stems to die. In addition, the branches of the plants also died, so that the leaves growing on the branching system also died. The results of this study are in contrast to the results of Rahawarin's (2023) study, where plants that were not given stakes showed a higher average number of leaves compared to plants that were staked.

1.1. Growth in Stem Length of Thai Cultivar Sweet Potato Plants

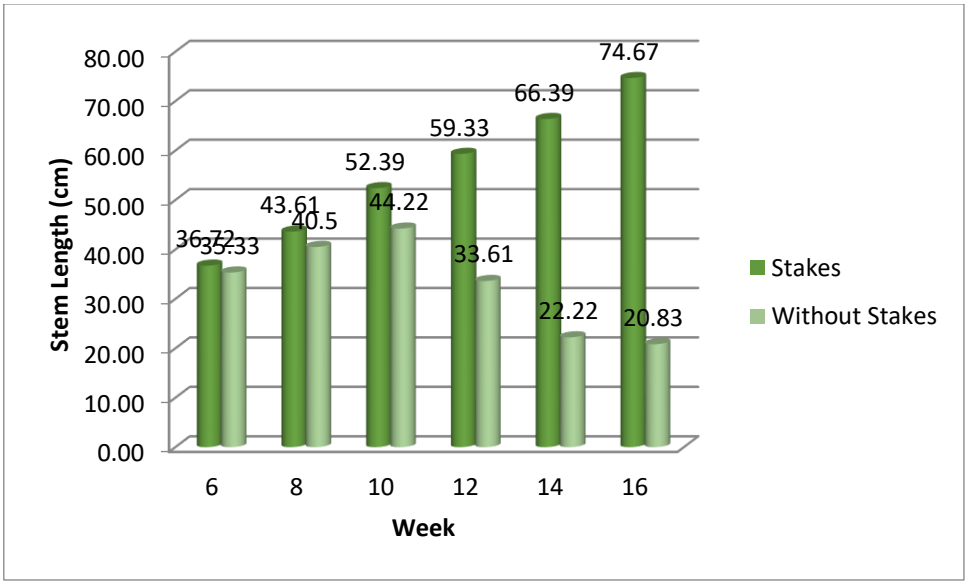

Figure 1. Growth in stem length of Thai cultivar sweet potato plants at various observation ages

The average growth of stem length of Thai sweet potato cultivars in each observation showed that the treatment of providing stakes could increase the length of plant stems consistently from each observation. Sweet potato plants without the provision of stakes showed an increase in plant stem length in weeks 6 to 10, and experienced a decrease in stem length in weeks 12 to 16. The reduction in the average length of plant stems in the treatment without stakes was caused by rotting of the stems and shoots of the plants, so that stem growth stopped and the plants were more focused on growing plant branches.

1.2. Growth in the Number of Leaves of Sweet Potato Plants of Thai Cultivars

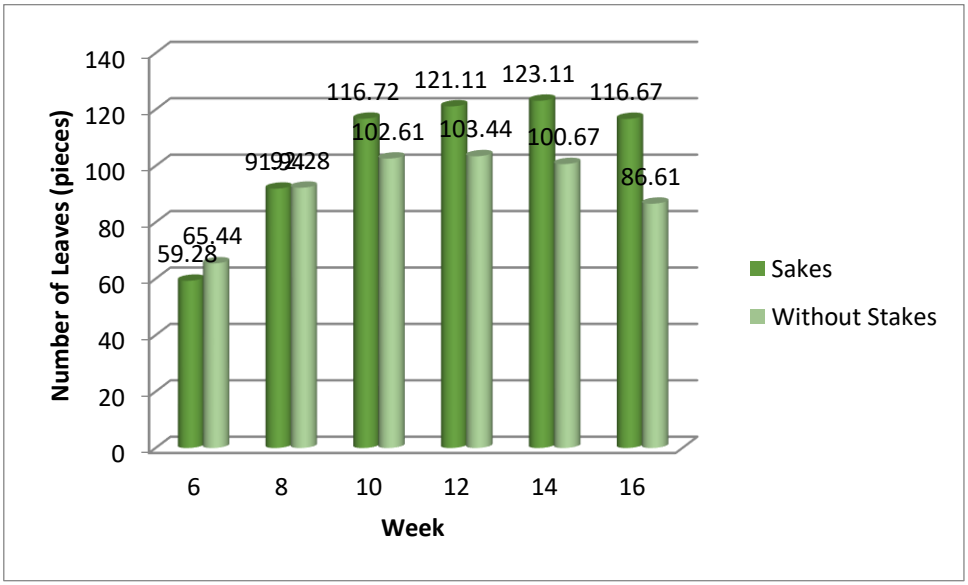

Figure 2. Growth in the number of leaves of Thai cultivar sweet potato plants at various observation ages

The average number of leaves of the Thai sweet potato cultivar showed no significant difference in each observation. The number of leaves in the staking treatment was higher than in the unstaking treatment. From the first to fifth observations, the number of leaves in the staked plants continued to increase, with a slight decrease in the sixth observation. The number of leaves in the unstaking treatment continued to increase from the first to fourth observations, with a decrease in the fifth and sixth observations. This decrease in leaf number was caused by the death of the plant stem, which also caused the leaves growing on the stem to die. According to Harnowo & Joko (2020) in Hozyo*et* al. (1986), leaf fall that is not balanced with new leaf growth causes a decrease in the number of leaves. The death of the main stem and the branching system of the plant is the cause of the high number of dead leaves.

2. Yield Level of Thai Sweet Potato Cultivars

Table 3. Average Yield Level of Sweet Potato Cultivars of Thai

Criteria	Without Satkes	Stakes	T count	T table	Information
Number of Bulbs	6,55	7,05	0,5147	2,1199	NS
Bulb Weight (grams)	716,88	821,22	2,5102	2,1199	S
Tuber Diameter (cm)	3,83	4,14	1,0891	2,1199	NS
Tuber Length (cm)	12,39	13,01	1,2172	2,1199	NS
Percentage of Marketable Tubers	0,85	0,76	0,8705	2,1199	NS

Based on the data analysis in Table 3, the staking treatment significantly affected tuber weight. However, the parameters of tuber number, tuber diameter, tuber length, and marketable tuber percentage were not significantly different compared to the unstaking treatment. This indicates that staking plays a greater role in increasing tuber weight, although several parameters, such as tuber number, tuber diameter, and tuber length, tended to yield better results compared to the unstaking treatment.

2.1. Yield Level of Thai Sweet Potato Cultivars Based on the Number of Tuber Parameters

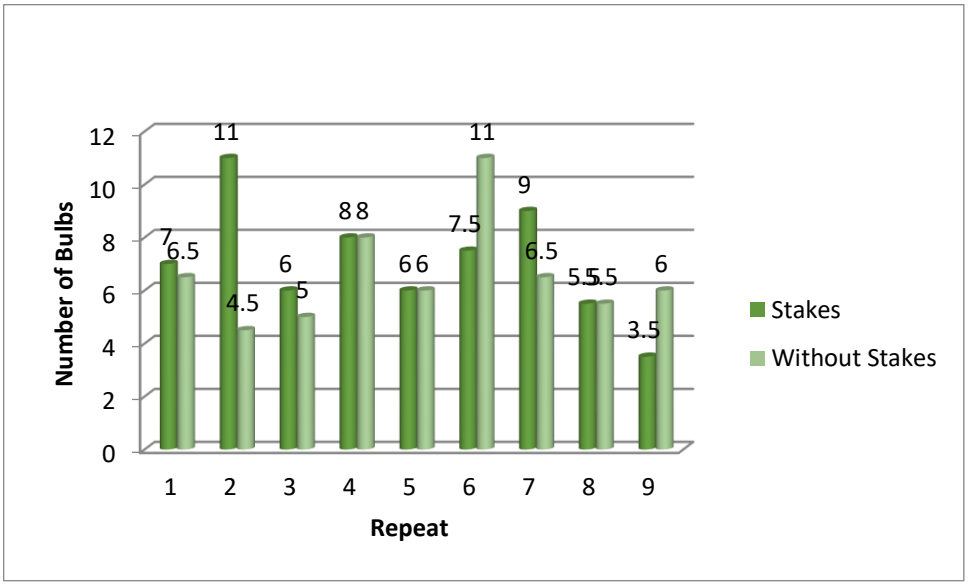

Figure 3. Yield level of Thai sweet potato cultivars based on the number of tubers per plant

The average number of tubers from plants with stakes in Table 3 was 7.05 per plant, higher than the 6.55 tubers per plant for plants without stakes. Although the difference was not statistically significant, this trend indicates the benefits of staking. In several replications (Figure 3), the number of tubers from plants with stakes was higher than that from the unstaked treatment, such as in the first, second, third, and seventh replications. However, in the sixth and ninth replications, the number of tubers in the unstaked treatment was higher, while in the fourth, fifth, and eighth replications, the results were similar. This indicates that although the average number of tubers in the staking treatment was higher, variation between replications still occurred, so the difference in tuber number was not large enough to be considered significant. The results of this study are in line with Rahawarin's (2023) study, where plants with stakes showed a higher number of tubers (4.28 tubers) than those without stakes (3.48 tubers).

The higher number of tubers in the staking treatment may be due to more optimal plant growth conditions. In plants without stakes, some plant tendrils die, followed by the death of branches and leaves. This condition can reduce the photosynthetic area, thus reducing photosynthate for tuber formation. Furthermore, plant tendrils in the unstaked treatment grow creeping above the soil surface, so that the plant stem segments that come into direct contact with the soil cause the formation of secondary tubers. The resulting photosynthate distribution causes tuber formation to occur not only in the adventitious root zone. Plants that are staked grow vertically so that the leaves do not cover each other. Staking plants are able to utilize sunlight more optimally. According to Adnan (2022), the provision of stakes helps plant leaves receive optimal sunlight. Sunlight is an important factor in the process of photosynthesis and can affect plant production.

2.2. Yield Level of Thai Sweet Potato Cultivars Based on Tuber Weight Parameters

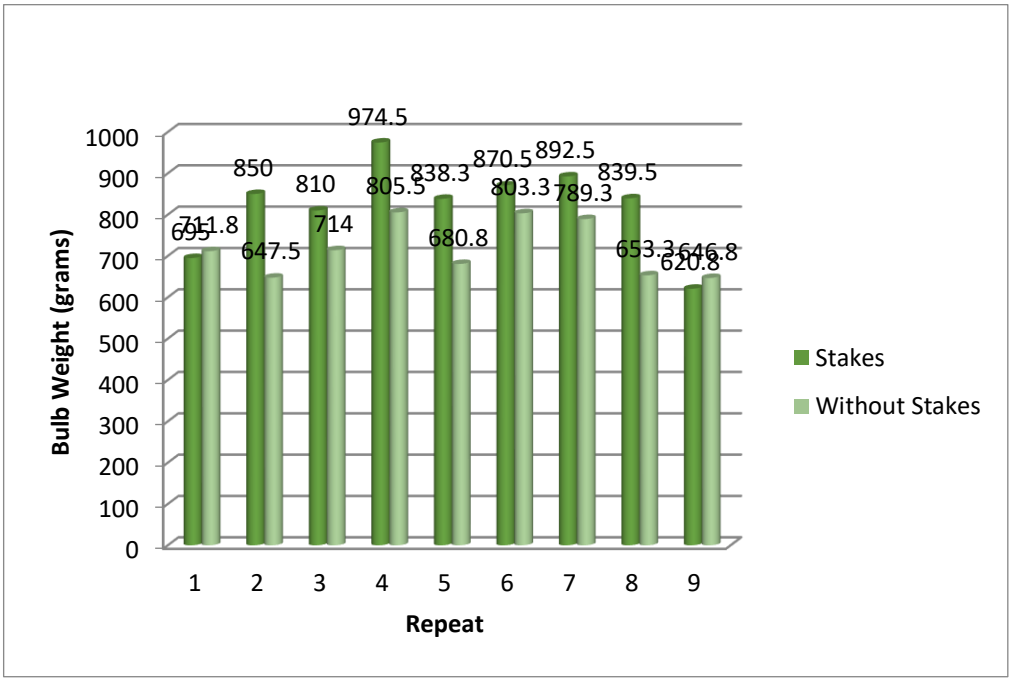

Figure 4. Yield level of Thai sweet potato cultivars based on tuber weight per plant

The tuber weight parameters in Table 3 show that the tuber weight in the staking treatment was higher, at 821.22 grams per plant, while in the unstaking treatment the tuber weight was 716.88 grams per plant. Statistically, the staking treatment showed better results than the unstaking treatment. The average tuber weight (Figure 4) in the second to eighth replications showed that the staking treatment had a higher tuber weight, with a range of 810 grams to 974.50 grams per plant.

Figure 4 shows the average tuber weight per replication. In the second to eighth replications, the tuber weight in the staking treatment was higher than the unstaking treatment, with tuber weights per replication ranging from 810 grams to 974.50 grams. The unstaking treatment showed higher tuber weights in the first and ninth replications. Table 3 shows that the staking treatment significantly affected the tuber weight of the plants, with the staked plants having a tuber weight of 821.22 grams, while the unstaking treatment produced a tuber weight of 716.88 grams. The results of the Ummah research et al. (2025) showed that Thai sweet potato cultivars that were not staked had a tuber weight per plant of 0.69 kg (690 grams). This tuber weight per plant was lower than that of the staking treatment.

Other parameters showed non-significant results. This is likely due to the lower tuber weight of unstaked plants because most tubers were attacked by boleng pests and rats, which caused tuber rot and reduced weight. Unstaked plants experienced overlapping tendril growth, creating a humid environment and making tubers more susceptible to rot. This condition can affect tuber weight. Tuber weight can be influenced by the number of tubers, tuber length, and tuber diameter. Although statistically these parameters did not show a significant difference, the treatment with stakes showed higher figures than the treatment without stakes. Furthermore, unstaked plants experienced less than optimal growth because some of the stems died. This resulted in less favorable plant growth for crop yields, especially during the generative phase.

2.3. Yield Level of Thai Sweet Potato Cultivars Based on Tuber Diameter Parameters

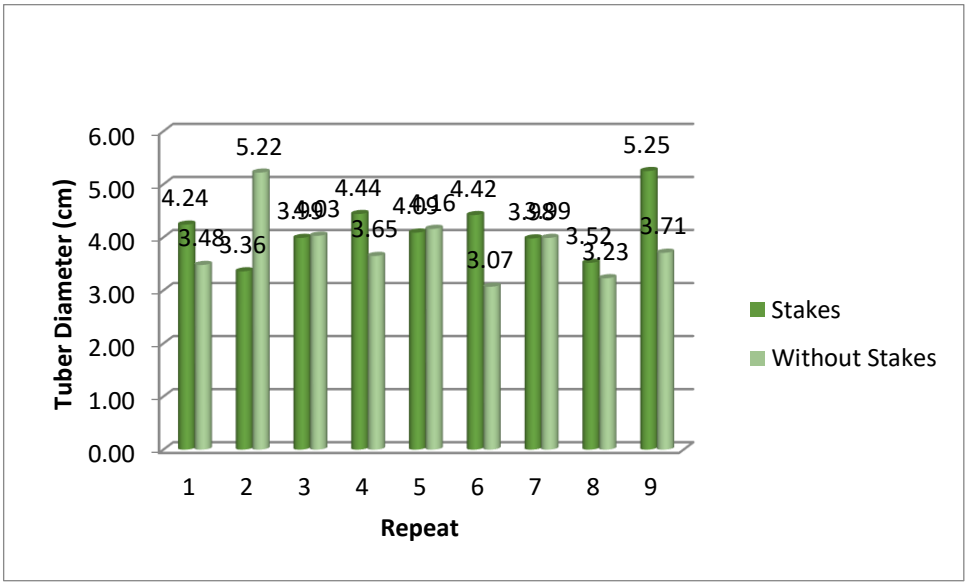

Figure 5. Yield level of Thai sweet potato cultivars based on tuber diameter per plant

The average tuber diameter in the staking treatment was higher than in the unstaking treatment, although the difference was relatively small. In replications 1, 4, 6, 8, and 9, the staking treatment showed better tuber diameter, while in replications 2, 3, 5, and 7, the unstaking treatment showed better tuber diameter. Based on Table 3, the provision of stakes did not have a significant effect on tuber diameter. The average tuber diameter in the staking treatment was 4.14 cm, while in the unstaking treatment it was 3.83 cm. Tuber length also showed non-significant results (Table 3), indicating that the provision of stakes did not affect the length of the plant tubers. Tuber diameter and length are influenced by genotype characteristics (Hasan et al., 2019), so that different treatments do not always produce significant differences in these two parameters. Although statistically, tuber diameter and length were not significantly different between the staking and control treatments, the staking treatment showed a larger average tuber size. Thus, the provision of stakes still showed a positive trend towards increasing tuber size compared to the unstaking treatment.

2.4. Yield Level of Thai Sweet Potato Cultivars Based on Tuber Length Parameters

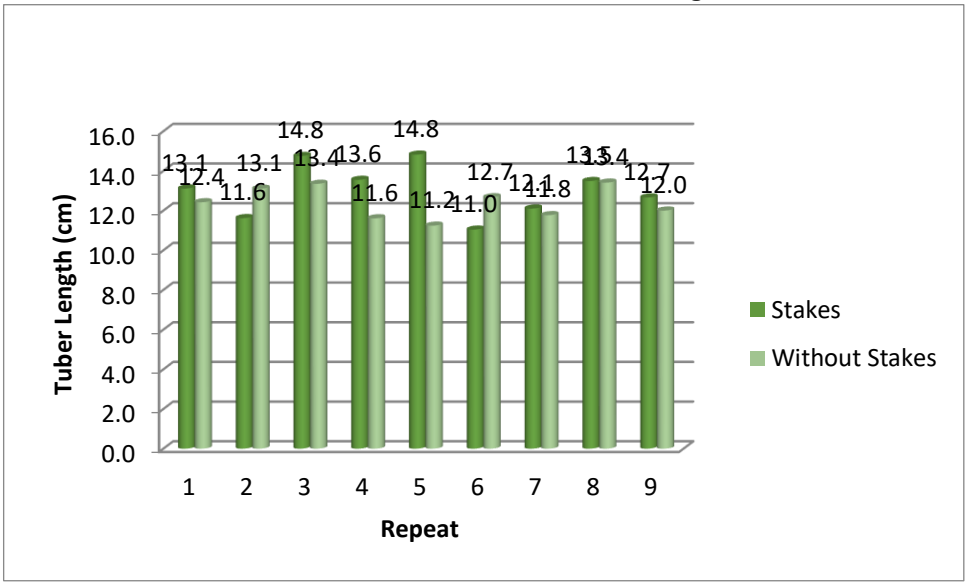

Figure 6. Yield level of Thai sweet potato cultivars based on tuber length per plant

Tuber length (Figure 6) shows that in replications 1, 3, 4, 5, 7, 8, and 9, the staking treatment had a higher tuber length compared to the unstaking treatment. However, the difference in tuber length was relatively small. The average tuber diameter in the staking treatment was 4.14 cm, while in the unstaking treatment it

was 3.83 cm. The analysis results in Table 3 show that tuber length did not differ significantly between the staking treatment and the control. This indicates that staking did not significantly affect tuber length. Although tuber length was not significant, the staking treatment still showed a higher average tuber size (diameter and length) compared to the unstaking treatment. Thus, staking still had a positive trend towards increasing tuber size in general (Manikomen et al., 2021).

2.5. Yield Level of Thai Sweet Potato Cultivars Based on the Percentage of Marketable Tubers Parameter

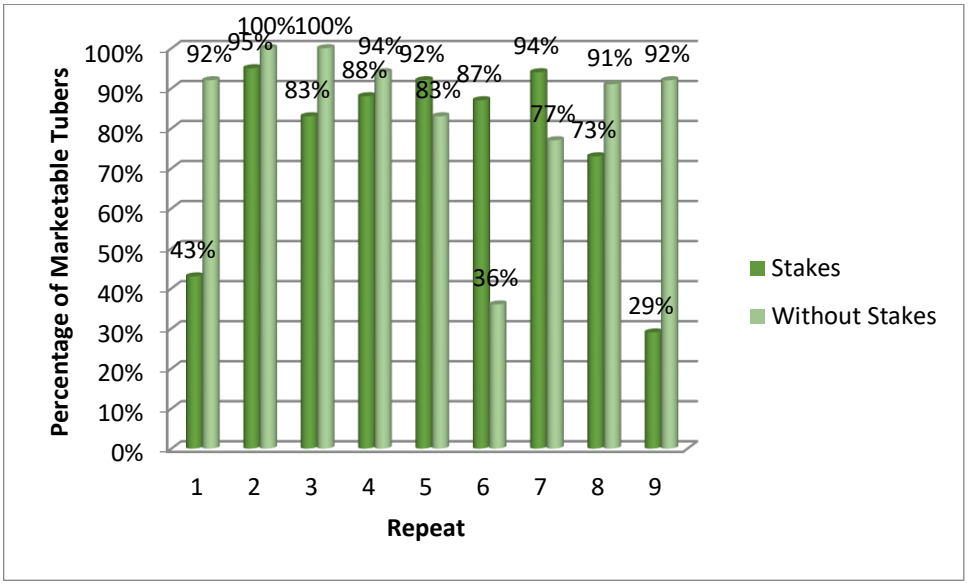

Figure 7. Yield levels of Thai sweet potato cultivars based on the percentage of marketable tubers.

The percentage of marketable tubers based on their consumption suitability indicates that the unstaking treatment tends to have a higher percentage than the staking treatment. Based on Table 3, the percentage of marketable tubers shows non-significant results. This indicates that the staking treatment does not significantly affect the percentage of marketable tubers. The criteria for marketable tubers are based on size, quality, and weight. In terms of quality, marketable tubers are those that are free from pests and diseases, have no rotting parts, and are intact.

Enter the value (*Cylas formicarius*) is a pest that attacks sweet potato tubers. This pest attack causes changes in the shape of the tubers and makes them taste bitter. This pest attack causes a decrease in the quality and quantity of the tubers (Manikomen et al., 2021). The percentage of marketable tubers based on quality is determined by several criteria, including: no rotting parts of the tuber, no black spots on the tuber, and no strong odor. The pest that often attacks tubers is the boleng pest. The characteristics of tubers attacked by this pest are the presence of brown spots on the tuber and the presence of small holes when cut. This pest attack causes the tubers to taste bitter and unpleasant, making them unfit for marketing. Tubers that rot due to rat attacks, especially at the base of the tuber, are also unfit for market because they are unfit for consumption. In addition to these pests, tubers are also attacked by gayas pests, this pest attack only on the outside of the tuber and does not affect the taste of the tuber so it is still marketable.

CONCLUSIONS

The conclusion of this study is that staking has a positive effect on plant growth in terms of stem length, while staking has a positive effect on yield of Thai sweet potato cultivars in terms of tuber weight. Staking can increase tuber weight by 104.34 grams, or 13.56%.

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