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Response of Growth and Production of Sweet Potato *(Ipomea Batatas L.)* Due to The Application of TSP Fertilizer and Cow Manure

Wahyunita Sitinjak[1*]

[1] Fakultas Pertanian, Universitas Simalungun, Pematangsiantar, Indonesia.

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Corresponding Author:
Wahyunita Sitinjak
lucy88sitinjak@gmail.com

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Abstract: The purpose of this study was to determine the response of growth and production of sweet potatoes (Ipomea batatas L.) due to the application of TSP fertilizer and cow manure, carried out in Huta I Silau Bayu, Gunung Maligas District, Simalungun Regency, North Sumatra, from May to August 2024. The study used a factorial Randomized Block Design (RAK), with 2 factors. The first factor is TSP fertilizer with 4 levels, namely P1 = 20.4g / plot, P2 = 40.8g / plot, P3 = 61.2g / plot, P4 = 81.6g / plot. The second factor is Cow Manure with 4 levels, namely: S0 = No Treatment, S1 = 5.1kg / plot, S2 = 10.2kg / plot, S3 = 15.3kg / plot. Observed parameters were Tendrils Length (cm) at 3 and 5 MST, Number of Bulbs Per Plant (fruit), Number of Bulbs Per Plot (bulbs), Bulb Weight Per Plant (g) and Bulb Weight Per Plot (kg). The results showed that TSP fertilizer application significantly affected Tendrils Length (cm) at 3 and 5 MST, Number of Bulbs Per Plant (bulbs), Number of Bulbs Per Plot (bulbs), Bulb Weight Per Plant (g) and Bulb Weight Per Plot (kg). The best dose of TSP fertilizer was found in the treatment of 30 tons/ha: 15.3 kg/plot. Cow Manure treatment significantly affected Tendrils Length (cm) at 3 and 5 MST, Number of Bulbs Per Plant (bulbs), Number of Bulbs Per Plot (bulbs), Bulb Weight Per Plant (g) and Bulb Weight Per Plot (kg). The best dose of cow manure was found in the treatment of 160 kg/ha: 81.6 g/plot. The interaction treatment of TSP fertilizer and Cow Manure fertilizer significantly affected the Length of Tendrils (cm) at the age of 3 and 5 MST, Number of Bulbs Per Plant (bulbs), Number of Bulbs Per Plot (bulbs), and Bulb Weight Per Plot (kg). It had no significant effect on Bulb Weight Per Plant (g). The best interaction treatment was in the TSP treatment (30 tons/ha: 15.3 kg/plot) with cow manure (160 kg/ha: 81.6 g/plot).

Keywords: Cow Manure; Sweet Potato; TSP Fertilizer.

Introduction

Sweet potatoes or also known as Ipomoea batatas L in Latin are one type of tuber that has many advantages compared to other tubers. Sweet potatoes are the fourth largest source of carbohydrates in Indonesia after rice, corn, and cassava (Noer & Wijaya, 2017). Sweet potatoes are a food source that contains nutrients such as carbohydrates, vitamins, and minerals. Sweet potatoes can also be used as a substitute for rice as a staple food (Claudia et al., 2015). Sweet potatoes contain many nutrients that are often beneficial for body health (Nguyen et al., 2021; Tedesco et al., 2023).

Another advantage is that they can grow in varying soil conditions. Therefore, it is very strategic if developed as a supporter of food diversification in various regions in Indonesia (Ginting et al., 2017). Based on data (Central Statistics Agency, 2022), North

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Sumatra's sweet potato production in 2021 was 80,144.00 tons and decreased in 2022, namely production of 77,498.00 tons. Sweet potato production must continue to be increased considering the benefits generated from sweet potatoes. Sweet potato production can be increased by providing the right fertilizer, both in composition and application time (Djalil & Jahja, 2004).

Sweet potato productivity has not reached its optimal level because it is planted on dry land with low organic matter in the soil, so efforts are made to add organic matter (Agbede & Oyewumi, 2022; Nyarko et al., 2022). Providing manure is one way to add organic matter to the soil. Organic matter in compost will improve the physical, chemical, and biological properties of the soil, making the soil looser, thus helping the root system (Lingga, 2001).

Fertilization needs to be done using a combination of organic and inorganic fertilizers, including organic fertilizers before planting and inorganic fertilizers at the time of planting. Inorganic fertilizers generally used are N fertilizer (urea), P fertilizer (TSP), K fertilizer (KCL) and organic fertilizers generally used are compost, manure and green fertilizer (Purwa, 2007). Providing cow manure will also provide nutrients to plants and increase the plant's ability to absorb nutrients. Providing cow manure can also improve the physical properties of the soil and increase the humus content of the soil (Wigati et al., 2006).

According to Hanafiah (2005), the P content in the soil is influenced by the initial soil material, soil reaction (pH), soil organic C and soil structure. Plants absorb phosphorus from the soil solution in the form of primary orthophosphate ions (H2PO4-) and secondary orthophosphate ions ($HPO4^{2-}$). Because the ability to utilize P in the soil, especially in acidic soils, is limited, it is necessary to add chemical P fertilizers to increase the ability to utilize P in the soil. Compared to several other inorganic P source fertilizers, TSP (Triple Super Phosphate) fertilizer has a higher P2O5 content, reaching 43-45%, best used to increase the P nutrient content in soil with low phosphorus nutrient content.

Method

This research was conducted in May - August in Huta I Silau Bayu, Gunung Maligas District, Simalungun Regency, North Sumatra, with an altitude of 250 meters above sea level. The materials used in this study were Taiwan variety sweet potato seeds, Cow Manure fertilizer, TSP fertilizer, Urea fertilizer, Decis EC 25 insecticide. The tools used in this study were hoes, machetes, meters, hand sprayer plastic ropes, watering cans, pH meters, label boards, and stationery.

This study used a factorial Randomized Block Design (RAK) using two factors, namely: Factor I: TSP fertilizer application consisting of 4 dose levels, namely: P1 = 40 kg / ha = 20.4 g / plot, P2 = 80 kg / ha = 40.8 g / plot, P3 = 120 kg / ha = 61.2 g / plot, and P4 = 160 kg / ha = 81.6 g / plot. Factor II: provision of cow manure consisting of 4 dosage levels, namely: S0 = No treatment, S1 = 10 tons/ha = 5.1 kg/plot, S2 = 20 tons/ha = 10.2 kg/plot, and S3 = 30 tons/ha = 15.3 kg/plot, so that 16 treatment combinations were obtained. The parameters observed were Main Stem Length (cm), Number of Bulbs Per Plant, Number of Bulbs Per Plot, Bulb Weight Per Plant, Bulb Weight Per Plot.

Result and Discussion

Main Stem Length (cm)

The results of the analysis of variance of the main stem length at 3 and 5 MST showed that the effect of TSP fertilizer, cow manure and the interaction of TSP fertilizer and cow manure had a significant effect.

Table 1 shows that the provision of TSP fertilizer had a significant effect, for the length of the main stem at the age of 3 MST the highest was P4, namely (33.71 cm), which was significantly different from other treatments. The length of the main stem at the age of 5 MST the highest was P4, namely (59.02 cm), which was significantly different from other treatments. TSP fertilizer has a significant effect on the growth of sweet potato plants, especially in increasing the length of the main stem. The use of this fertilizer can accelerate vegetative growth, which contributes to an increase in the length of the main stem.

According to Kumala et al. (2023), Phosphorus encourages better root development, which is important for the absorption of nutrients and water. Healthy roots allow plants to grow taller and stronger. To determine the differences between treatments, the smallest significant difference test was carried out at the 5% level which is shown in Table 1.

Table 1. Results of the Average Difference Test for Main Stem Length (cm) Due to the Administration of TSP Fertilizer and Cow Manure at 3 and 5 MST

Treatment	Main Stem Length (cm)		Number of Bulbs Per Plant (Tubers)
	3 MST	5 MST	
P_1	31.81 c	56.81 c	2.06 c
P_2	32.56 bc	57.67 bc	2.27 bc
P_3	32.96 ab	57.96 ab	2.44 b

Treatment	Main Stem Length (cm)		Number of Bulbs Per Plant (Tubers)
	3 MST	5 MST	
P_4	33.71 a	59.02 a	2.96 a
BNT 5%	0.99	1.06	0.37
S_0	31.73 c	56.73 c	1.73 c
S_1	32.48 bc	57.48 bc	2.33 bc
S_2	32.79 ab	58.23 ab	2.46 b
S_3	33.73 a	58.94 a	3.21 a
BNT 5%	0.99	1.06	0.37
P_1S_0	28.92 d	53.92 d	1.42 d
P_1S_1	32.67 b	57.67 b	2.08 c
P_1S_2	31.92 bc	58.25 b	2.50 bc
P_1S_3	33.75 b	57.42 b	2.25 c
P_2S_0	32.25 b	57.25 bc	1.75 d
P_2S_1	32.42 b	57.42 b	2.25 c
P_2S_2	32.67 b	57.67 b	2.08 c
P_2S_3	32.92 b	58.33 b	3.00 b
P_3S_0	33.08 b	58.08 b	1.92 c
P_3S_1	32.33 b	57.33 b	3.00 b
P_3S_2	33.00 b	58.00 b	1.92 c
P_3S_3	33.42 b	58.42 b	2.92 b
P_4S_0	32.58 b	57.67 b	1.83 cd
P_4S_1	32.50 b	57.50 b	2.50 bc
P_4S_2	33.58 b	59.00 b	2.83 b
P_4S_3	36.17 a	61.92 a	4.67 a
BNT 5%	1.99	2.12	0.74

Note: Numbers followed by different letter notations in the same column indicate significant differences at the 5% level.

Table 1 shows that the effect of cow manure has a significant effect on the length of the main stem at the age of 3 and 5 MST, the highest is S3, respectively (33.73 cm), and (58.94 cm) which is significantly different from other treatments. In this study, it can be seen that the effect of cow manure shows significant results for the length of the main stem of sweet potato plants.

According to Darwis et al. (2021), the organic matter content in cow manure helps improve soil looseness and increase the capacity of the soil to store water and air, such as the percentage of pore formation in the soil that can be occupied by air and water compared to soil volume. This is very important for healthy and optimal root growth which can affect the length of the main stem of sweet potato plants.

Table 1 shows that the interaction of TSP fertilizer and P4S3 cow manure shows the highest main stem length at the age of 3 and at the age of 5 MST, respectively, namely (36.17 cm) and (61.92 cm) which are significantly different from other treatments. This is due to the significant interaction of the two treatments when combined together. Organic fertilizers provide scope for good growth by improving the texture to be looser while TSP fertilizers help supply nutrients in the form of Phosphate. TSP fertilizers help accelerate the development of the root system, which is important for increasing the absorption of water and nutrients by plants (Fertahi et al., 2019).

Number of Bulbs Per Plant (tubers)

Analysis of variance for the number of bulbs per plant shows that the provision of TSP fertilizer, cow manure and the interaction due to the combination of TSP fertilizer and cow manure have a significant effect. To determine the difference between treatments, the smallest significant difference test was carried out at the 5% level which is shown in table 1.

The interaction of TSP fertilizer and cow manure for the number of bulbs per plant has a significant effect (Table 1). The largest number of bulbs was found in the P4S3 treatment (4.67 bulbs) which was significantly different from other treatments. This is due to the significant interaction between the combination of TSP fertilizer and cow manure. The interaction between TSP fertilizer and cow manure shows varying results in increasing the growth and yield of sweet potatoes.

In accordance with the opinion of Purba et al. (2017) stated that TSP fertilizer functions to increase the availability of phosphorus in the soil, which is essential for tuber growth. Meanwhile, cow manure increases soil pH, organic carbon, and the availability of other nutrients, thus creating a better environment for plant growth.

Table 1 shows that the administration of TSP fertilizer for the highest number of tubers per plant was in the P4 treatment with a number (2.96 tubers) which was significantly different from other treatments. This is

because TSP fertilizer plays a role in tuber formation and increases the number of tubers produced by plants.

Hakim et al. (2019) said that the phosphorus contained in TSP fertilizer plays an important role in the biochemical processes of plants, which support the development of roots and tubers. The availability of sufficient phosphorus helps increase the growth and production of sweet potato tubers.

Table 1 shows that the treatment of cow manure on the number of tubers per plant is the highest in treatment S3, namely (3.21 tubers) which is significantly different from other treatments. This is because cow manure helps increase the organic matter content in the soil. This organic matter is important for maintaining soil health and increasing soil microbial activity. Soil microbes play a role in decomposing organic matter and releasing nutrients that can be absorbed by plants (Li et al., 2022; Yuniarti et al., 2012)

Number of Tubers Per Plot (Tubers)

Analysis of variance for the number of tubers per plot shows that the provision of TSP fertilizer, cow manure and the interaction due to the combination of TSP fertilizer and cow manure have a significant effect. To determine the difference between treatments, the smallest significant difference test was carried out at the 5% level which is shown in Table 2.

Table 2. Results of the Average Difference Test for the Number of Bulbs Per Plot (Bulbs) Due to the Provision of TSP Fertilizer and the Provision of Cow Manure

Treatment	Number of tubers per plot (tuber)	Weight of tubers per planting (g)
P_1	31.92 cd	527.29 cd
P_2	32.25 c	584.79 bc
P_3	33.58 ab	622.09 ab
P_4	33.83 a	699.77 a
BNT 5%	0.68	58.69
S_0	31.25 cd	445.01 d
S_1	32.83 c	530.15 c
S_2	33.67 ab	670.33 b
S_3	34.00 a	788.45 a
BNT 5%	0.68	58.69
P_1S_0	30.00 e	369.80
P_1S_1	32.67 c	483.29
P_1S_2	34.33 b	572.49
P_1S_3	31.33 de	683.58
P_2S_0	30.00 e	447.02
P_2S_1	31.67 cd	504.66
P_2S_2	33.67 b	641.24
P_2S_3	33.67 b	746.24
P_3S_0	32.67 c	462.06
P_3S_1	34.33 b	532.67
P_3S_2	33.67 b	693.72
P_3S_3	33.67 b	799.91
P_4S_0	32.33 c	501.15
P_4S_1	32.67 c	599.97
P_4S_2	33.00 bc	773.89
P_4S_3	37.33 a	924.08
BNT 5%	1.37	

Note: Numbers followed by different letter notations in the same column indicate significant differences at the 5% level.

Table 2 shows that the provision of TSP fertilizer for the highest number of tubers per plot is in treatment P4, namely (33.83 tubers) which is significantly different from other treatments. This is because the higher the dose of fertilizer given, the more tubers are produced by the plant. Phosphorus from TSP plays an important role in stimulating flowering and tuber development. Research shows that meeting phosphorus needs in the generative phase can increase overall fruit yield and quality (Agustian & Baharuddin, 2023).

Table 2 shows that the provision of cow manure for the highest number of tubers per plot was in the S3 treatment, namely (34.00 tubers) which was significantly different from other treatments. This is because cow manure can improve the physical properties of the soil which can help maximize the quality of tubers. In accordance with the opinion of Lubis et al. (2022), organic fertilizers improve soil structure, such as facilitating aeration and drainage which makes the soil have enough water and good circulation so that there is no stagnant water.

Table 2 shows that the interaction between the provision of TSP fertilizer and the provision of cow manure for the number of tubers per plot had a significant effect. The highest number of tubers was in the P4S3 treatment (37.33 tubers) which was significantly different from other treatments. This is because there is a significant interaction between the combination of TSP fertilizer and cow manure. As in the Tangkasiang (2023) noted that the combination of cow manure with TSP and other fertilizers can increase the availability of nutrients in the soil, which contributes to better growth. Cow manure serves to improve the physical and chemical properties of the soil, while TSP provides phosphorus which is important for root development and flowering.

Weight of tubers per planting (g)

Analysis of variance of tuber weight per planting showed that the provision of TSP fertilizer and cow manure had a significant effect, while the interaction of TSP fertilizer and cow manure had no significant effect on tuber weight per planting. To determine the differences between treatments, the smallest significant difference test was carried out at the 5% level which is shown in Table 2.

Table 2 shows that the provision of TSP fertilizer for the heaviest tuber weight per planting was in the P4 treatment with a weight (699.77 g) which was significantly different from the other treatments. This is because the effect of TSP fertilizer provides a significant response to the weight of tubers per plot.

Agustian & Baharuddin (2023) stated that phosphorus in TSP plays an important role in the process of photosynthesis and energy transfer, which supports tuber growth. Phosphorus also helps in better root formation, thus supporting optimal nutrient absorption and increasing tuber weight.

Table 2 shows that the provision of cow manure for the heaviest tuber weight per planting was in the S3 treatment with a weight (788.45 g) which was significantly different from the other treatments. The provision of cow manure significantly affects the weight of sweet potato tubers because it increases aeration and drainage capacity. This allows plant roots to grow better and reduces the risk of root damage due to waterlogging (Daniel & Hartman, 2024).

Table 2 shows that the interaction between the provision of TSP fertilizer and the provision of cow manure for the weight of tubers per plant has no significant effect. The heaviest tuber weight per plant was in the P4S3 treatment (927.08 g) which was not significantly different from other treatments. This is because there has been no significant interaction between the combination of TSP fertilizer and cow manure. Fidiansyah et al. (2021), said that these two fertilizers provide optimal nutrition, which encourages the growth of larger and heavier tubers. However, research shows that they cannot be combined simultaneously.

Tuber Weight Per Plot (kg)

Analysis of variance of dry tuber weight per plot shows that the provision of TSP fertilizer and cow manure as well as the interaction due to the combination of TSP fertilizer and cow manure have a significant effect on the weight of tubers per plot. To determine the differences between treatments, a test of the smallest real difference at the 5% level was carried out, which is shown in Table 3.

Table 3 shows that the administration of TSP fertilizer for the heaviest tuber weight per plot was in the P4 treatment with a weight (8.69 kg) which was significantly different from other treatments. This is because the higher the dose of TSP fertilizer given, the heavier the tubers produced.

Hakim et al. (2019), also stated that the administration of TSP with the right dose can increase the weight of sweet potato tubers. The study showed the best results, where the total tuber weight increased significantly compared to the treatment without fertilizer or a lower dose.

Table 3 shows that the administration of cow manure for the heaviest tuber weight per plot was in the S3 treatment with a weight (8.70 kg) which was significantly different from other treatments. This is because cow manure improves soil structure, making it looser and easier to absorb water, increasing the soil's ability to store water and nutrients, which is very important for plant growth. Good soil structure can help the nutrient absorption mechanism because the roots of the plants that grow and can easily penetrate reach more soil areas, thus increasing the possibility of meeting available nutrients so as to maximize the weight of the sweet potato tubers.

Table 3. Results of the Average Difference Test of Tuber Weight Per Plot (kg) Due to the Application of TSP Fertilizer and Cow Manure

Treatment	Weight of tubers per plot	Conversion Results (Ton/Ha)
P_1	8.26 c	16.20
P_2	8.37 b	16.41
P_3	8.37 b	16.42
P_4	8.69 a	17.04
BNT 5% P	0.08	
S_0	8.28 cd	16.23
S_1	8.29 c	16.25
S_2	8.43 b	16.54
S_3	8.70 a	17.05
BNT 5%	0.08	
P_1S_0	7.22 d	14.16
P_1S_1	8.44 bc	16.54
P_1S_2	8.71 b	17.08
P_1S_3	8.68 b	17.02
P_2S_0	8.56 b	16.78
P_2S_1	8.14 c	15.95
P_2S_2	8.22 c	16.11
P_2S_3	8.57 b	16.80
P_3S_0	8.89 b	17.43
P_3S_1	8.33 c	16.34
P_3S_2	8.28 c	16.23
P_3S_3	7.99 cd	15.67
P_4S_0	8.44 bc	16.54
P_4S_1	8.25 c	16.17
P_4S_2	8.53 b	16.72
P_4S_3	9.55 a	18.72
BNT 5%	0.53	

Note: Numbers followed by different letter notations in the same column indicate significant differences at the 5% level.

The results of Widodo & Kusuma (2018), good soil structure, including porosity (Porosity is the percentage of total pores in the soil occupied by water and air, compared to the total volume of soil) and aggregate stability (the ability of the soil to regulate the movement and storage of air and water), contribute to the ability of

plant roots to absorb water and nutrients, with stable aggregates and good porosity allowing more efficient movement of water and nutrients, thereby increasing nutrient absorption by plants. Table 6 shows that the interaction of TSP fertilizer and cow manure fertilizer for fruit weight per plot has a significant effect. The heaviest tuber weight was in the P4S3 treatment (9.55 kg) which was significantly different from other treatments. Sunaldi & Fitriani (2020) said that the combination of TSP and cow manure also showed good results. Research shows that the interaction between these two types of fertilizers can improve soil quality and nutrient availability, which contributes to increased tuber weight.

Conclusion

The application of TSP fertilizer significantly affected the length of tendrils at 3 and 5 WAP, the number of tubers per planting, the number of tubers per plot, the weight of tubers per planting, and the weight of tubers per plot. The best dose was at 30 tons/ha: 15.3 kg/plot. The application of cow manure significantly affected the length of tendrils at 3 and 5 WAP, the number of tubers per planting, the number of tubers per plot, and the weight of tubers per plot. It had no significant effect on the weight of tubers per planting. The best dose was at 160 kg/ha: 81.6 g/plot. The interaction due to the combination of TSP fertilizer and cow manure significantly affected the length of tendrils at 3 and 5 WAP, the number of tubers per planting, the number of tubers per plot, the weight of tubers per planting, and the weight of tubers per plot. The best dose was at 30 tons/ha: 15.3 kg/plot and 160 kg/ha: 81.6 g/plot.

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