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Growth and production of sweet corn (*Zea mays saccharata* Sturt.) as an intercrop in immature oil palm plantations (TBM 2) on dystrudepts soil given MB green manure (*Mucuna bracteata*) and NPK fertilizer

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Abstract

This research aims to examine the interaction, the main effects of *Mucuna bracteata* green fertilizer, NPK and obtain a combination that produces the highest production of sweet corn. The research was carried out in Kembang Damai Village, Pagaran Tapah Darussalam District, Rokan Hulu Regency from April to July 2023. The research was carried out experimentally using a factorial randomized block design, where factor I was the provision of *Mucuna bracteata* green fertilizer consisting of 3 levels, namely 4.18 . t.ha -1 , 8.36 t.ha -1 and 12.54 t.ha -1 . Factor II is the provision of NPK which consists of 3 levels, namely 0.1 t.ha -1 , 0, 2 t.ha -1 and 0.3 t.ha -1 , so there are 9 treatment combinations and they are repeated 3 times, so there are 27 experimental units. The parameters observed were the amount of chlorophyll, photosynthesis rate, transpiration rate, stomatal conductivity, and CO_2 concentration in cells, plant height, time when female flowers appeared, harvest age, weight of cobs with husks, and weight of cobs without husks. The variance data was further tested using Duncan's multiple distance test at the 5% level. The results of the research showed that there was an interaction between *Mucuna bracteata* and NPK green manure treatment on the parameters of female flower emergence time, harvest age and husk ear weight, but not on other parameters . The application of *Mucuna bracteata* green fertilizer had a significant effect on the time the female flowers appeared, the age of harvest, and the weight of the husk cobs. NPK fertilizer has a significant effect on harvest age and husk cob weight. Providing *Mucuna bracteata* green fertilizer 12.5 t.ha -1 and NPK 0.2 t.ha -1 is a combination that provides higher production results in the weight parameter of husk cobs, namely 527,833 g per plant.

Keywords: Sweet corn; fertilizer; *Mucuna bracteata;* NPK; Palm oil

1. Introduction

Oil palm is a plantation crop that is widely cultivated by the people of Riau, including Rokan Hulu Regency. [1] Oil palm planting has increased in the last two years, where in 2020 the planting area was 264,942.00 ha, while in 2021 the planting area was 267,791.00 ha. Simultaneous planting of oil palm plantations can result in the same replanting period , this will create an unstable economic cycle for the community due to waiting quite a long time for the harvest after planting. Land utilization can be done by planting other plants in between oil palm plantations during the TBM 2 period. Plants in the second year are 13 to 24 months old, where the vegetative growth of plants such as leaves does not hinder the growth of intercropped plants either from the growing space or sunlight. . Intermediate crops that can be cultivated are sweet corn .

Sweet corn (*Zea mays saccharata* Sturt.) is a food plant that produces seeds as a source of carbohydrates apart from rice and wheat. [2] Sweet corn production in 2021 is targeted at 36,016.8 tons, but sweet corn production is only 19,144.2 tons. This shows that sweet corn needs efforts to increase production. Increasing sweet corn production can

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be done by intensification and extensification. Extensification has great potential to be implemented in Riau Province because many oil palm plantations are undergoing a replanting process. Farmers need money for the replanting process, so to support the farmer's economy by utilizing the replanted land by planting intercrops. One of the intercrops that can be cultivated is sweet corn . The land that is widely cultivated for oil palm plants is the Dystrudepts type.

Dystrudepts soil has an acidic acidity level (pH), cation exchange capacity (CEC) is moderate, base saturation (KB) is very low, base cations such as Na, Ca, Mg and K are low to very low and the elements N, P and K are classified as very low to medium. Based on the constraints on Dystrudepts' soil, a solution is needed to improve soil fertility and meet plant nutrient needs, namely by adding green manure and NPK fertilizer [3].

Green fertilizer that can be used is *legume cover crop* (LCC) such as *Mucuna bracteata*. Green fertilizer is fertilizer that comes from green plants which can be directly embedded in the planting medium. The *Mucuna bracteata* plant can be used as green manure because it can bind nitrogen resulting from the symbiosis of *rhizobium bacteria* so it has a higher N content than other plants [4]. Adding organic matter to the soil has a stronger effect on improving soil properties and not just increasing nutrients in the soil. Returning plant residues will improve the biological, chemical and physical properties of the soil, increase its ability to absorb water, increase ease of management and increase soil fertility [5]. In good soil conditions, sweet corn can be planted in general, but the availability of nutrients is not enough just to come from the soil and the green fertilizer given, so it is necessary to add macro nutrients in the form of NPK fertilizer.

NPK fertilizer is a fertilizer that contains macro nutrients, namely N, P and K, which function to support plant growth and development. [6] The research results of Karim *et all.* showed that administering NPK fertilizer (15:15:15) at a dose of 6 g per plant gave the highest cob weight, namely 208.38 g compared to other treatments. [7] Rahmandari's research results showed that administering NPK fertilizer at a dose of 300 kg.ha $^{1-}$ gave the highest yield on cob weight of sweet corn plants, namely 4.15 kg per plot compared to other treatments.

Mucuna bracteata and NPK green fertilizer can be expected to increase sweet corn production , but the interaction cannot yet be known so research needs to be carried out with the title "Growth and Production of Sweet Corn (*Zea mays saccharata* Sturt.) as an Intercrop in TBM 2 Oil Palm Plantations on Dystrudepts Soil Applying MB Green Fertilizer (*Mucuna bracteata*) and NPK Fertilizer.

2. Materials and Methods

2.1. Research Place

This research was carried out on a smallholder oil palm plantation located in Kembang Damai Village, Pagaran Tapah Darussalam District, Rokan Hulu Regency , Riau Province, Indonesia .

2.2. Research Materials and Tools

The materials used in this research were sweet corn seeds of the Bonanza F1 variety, *Mucuna bracteata* plants , pearl NPK fertilizer 16:16:16, Furadan and Prevathon 50 SC insecticide. The tools used in this research were Chlorophyl meter, LI-COR LI-6400XT Portable Photosynthesis System, digital scales, machete, hoe, bucket, hose, sprayer, raffia rope, scissors, gembor, stakes, labels, stationery, tape measure, and Vernier calipers

2.3. Research Methods

This research is a factorial experiment arranged according to a randomized block design (RAK), while the factors in this research consist of 2 factors, namely the factor I dose of *Mucuna bracteata* (P) green fertilizer consisting of 3 (three) levels: P1 = *Mucuna bracteata* green manure 4.18 t.ha -1 equivalent to 2 kg per plot , P2 = *Mucuna bracteata* green manure 8.36 t.ha -1 equivalent to 4 kg per plot , P3 = *Mucuna bracteata* green manure 12, 54 t.ha -1 is equivalent to 6 kg per plot , while f actor II: NPK fertilizer dose consisting of 3 levels , namely : N1 = NPK fertilizer 0, 1 t .ha -1 equivalent to 48 g per plot , N_2 = NPK fertilizer 0.2 kg.ha -1 is equivalent to 96 g per plot , N3 = NPK fertilizer 0.3 kg.ha -1 is equivalent to 144 g per plot . The two factors were combined, 9 treatment combinations were obtained and each treatment was repeated 3 times, so there were 27 experimental units. Each experimental unit consisted of 20 plants, 6 of which were used as sample plants. Sample plants were taken randomly from 20 plants that were not located on the edge of the bed.

The parameters observed were the amount of chlorophyll, photosynthesis rate, transpiration rate, stomatal conductivity, and CO_2 concentration in cells, plant height, time when female flowers appeared, harvest age, weight of cobs with husks, and weight of cobs without husks. The data obtained was analyzed statistically, namely analysis of variance (ANOVA). The variance results that had a significant effect were tested with Duncan 5%. Data analysis using the SAS 9.1 program.

3. Results

Table 1 Chlorophyll Content of Sweet Corn Plant Leaves (μmol m-2) when Application of *Mucuna bracteata* and NPK Fertilizer

***Mucuna bracteata* dosage ($t.ha^{-1}$)**	**NPK dosaget.ha^{-1})**			**Average**
	0.1	**0.2**	**0.3**	
4,18	47,017	54,283	55,067	52.122
8,36	43,467	48,483	53,567	48,506
12,54	47,150	56.183	49,950	51,094
Average	45,878	52,983	52,861	

Table 2 Photosynthesis Rate of Sweet Corn Plant Leaves (μmol $\mathbf{CO_2}$ m-2 s-1) on Application of *Mucuna bracteata* and NPK Fertilizer

***Mucuna bracteata* dosage ($t.ha^{-1}$)**	**NPK dosage($t.ha^{-1}$)**			**Average**
	0.1	**0.2**	**0.3**	
4.18	42,768	42,633	43,285	42,895
8.36	43,689	44.103	42,440	43,411
12.54	43,730	43,003	40,579	42,437
Average	43,395	43,246	42.102	

Table 3 Transpiration Rate of Sweet Corn Plant Leaves (mmol H2O m-2 s-1) on Application of *Mucuna bracteata* and NPK Fertilizer

***Mucuna bracteata* dosage ($t.ha^{-1}$)**	**NPK dosage ($t.ha^{-1}$)**			**Average**
	0.1	**0.2**	**0.3**	
4,18	1,7040	1.6440	1.5170	1.6217
8.36	1,8397	1.9330	1.8887	1.8871
12.54	1.5867	1,5087	1.8030	1.6328
Average	1.7101	1,6952	1.7362	

Table 4 Stomatal Conductivity of Sweet Corn Plant Leaves (mol H2O m-2 s-1) on Application of *Mucuna bracteata* and NPK Green Fertilizer

***Mucuna bracteata* dosage ($t.ha^{-1}$)**	**NPK dosage($t.ha^{-1}$)**			**Average**
	0.1	**0.2**	**0.3**	
4.18	0.82067	0.78033	0.74367	0.78156
8.36	0.83767	0.85767	0.84700	0.84744
12.54	0.77067	0.75067	0.81233	0.77789
Average	0.80967	0.79622	0.80100	

Table 5 CO 2 Concentration in Sweet Corn Plant Leaf Cells (μmol **CO_2** mol-1) on the application of *Mucuna bracteata* and NPK fertilizer

***Mucuna bracteata* dosage (t.ha^{-1})**	**NPK dosage (t.ha^{-1})**			**Average**
	0.1	**0.2**	**0.3**	
4.18	427.5	248.1	203.3	292.9
8.36	339.1	287.7	285.1	303.9
12.54	396.4	191.8	327.8	305.3
Average	387.7	242.5	272.0	

Table 6 Height of sweet corn plants (cm) when given *Mucuna bracteata* and NPK fertilizer

***Mucuna bracteata* dosage (t.ha^{-1})**	**NPK dosage (t.ha^{-1})**			**Average**
	0.1	**0.2**	**0.3**	
4,18	166.67	214.67	215.17	198.83
8,36	200.00	195.83	203.83	199.89
12,54	193.33	217.83	192.50	201.22
Average	186.67	209.44	203.83	

Table 7 Time of Appearance of Female Flowers (DAP) on Application of *Mucuna bracteata* and NPK Fertilizer

***Mucuna bracteata* dosage (t.ha^{-1})**	**NPK dosage (t.ha^{-1})**			**Average**
	0.1	**0.2**	**0.3**	
4.18	$54,666^{c}$	$52,333^{b}$	$52,000^{b}$	$53,000^{B}$
8.36	$52,666^{b}$	$54,000^{c}$	$52,666^{b}$	53.111^{B}
12.54	$50,000^{a}$	$52,000^{b}$	$52,333^{b}$	$51,444^{A}$
Average	$52,444^{A}$	$52,777^{A}$	52.333^{A}	

The numbers in the coloumns and rows by the same uppercase and lowercase letters were significantly different according to Duncan's multiple range test at the 5% level.

Table 8 Harvest Age (DAP) when applying *Mucuna bracteata* and NPK Fertilizer

***Mucuna bracteata* dosage (t.ha^{-1})**	**NPK dosage (t.ha^{-1})**			**Average**
	0,1	**0,2**	**0,3**	
4,18	74.666^{d}	71.666^{c}	67.666^{a}	71.3333^{B}
8,36	69.000^{ab}	71.333^{c}	69.333^{b}	69.888^{A}
12,54	69.333^{b}	71.333^{c}	69.333^{b}	70.000^{A}
Average	71.444^{B}	71.000^{B}	68.777^{A}	

The numbers in the coloumns and rows by the same uppercase and lowercase letters were significantly different according to Duncan's multiple range test at the 5% level.

Table 9 Weight of Loose Cobs (g) when Applying *Mucuna bracteata* and NPK Fertilizer

Mucuna bracteata dosage ($t.ha^{-1}$)	NPK dosage ($t.ha^{-1}$)			Average
	0.1	0.2	0.3	
4.18	419,833^{g}	466,500^{f}	520,000^{b}	468,778^{C}
8.36	480,500^{e}	503,333^{c}	519,333^{b}	501,056^{B}
12.54	492,667^{d}	527,833^{a}	527,500^{a}	516,000^{A}
Average	464,333^{C}	499,222^{B}	522,278^{A}	

The numbers in the coloumns and rows by the same uppercase and lowercase letters were significantly different according to Duncan's multiple range test at the 5% level.

Table 10 Cob weight without husks (g) when applying *Mucuna bracteata* and NPK fertilizer

***Mucuna bracteata* dosage ($t.ha^{-1}$)**	**NPK dosage ($t.ha^{-1}$)**			**Average**
	0.1	**0.2**	**0.3**	
4.18	296,500^{ab}	243,500^{b}	382,670^{a}	307.56^{B}
8.36	350,330^{ab}	380,000^{a}	389,500^{a}	373.28^{A}
12.54	370,170^{a}	397,330^{a}	389,830^{a}	385.78^{A}
Average	339.00^{A}	340.28^{A}	387.33^{A}	

The numbers in the coloumns and rows by the same uppercase and lowercase letters were significantly different according to Duncan's multiple range test at the 5% level.

4. Discussion

4.1. Chlorophyll content (µmol m-2)

Table 1 shows that the provision of green fertilizer *Mucuna bracteata* and NPK and their combination produce The chlorophyll content of sweet corn plant leaves was not significantly different . This is influenced by environmental conditions, especially the availability of sunlight. Chlorophyll is formed in leaves which has a role in capturing sunlight. Chlorophyll formation is influenced by several factors such as light, sugar, water, temperature and nutrients. This research was conducted on a smallholder plantation with oil palm plants aged 2 years and 3 months [8]. In general, the canopy of immature oil palm plants does not hinder the entry of light into the research location so that the light requirement is sufficient for the growth of sweet corn plants . However, the placement of the research plot was divided into two areas so that the plant plot in the middle of the location received more light than the edge of the research location.

Chlorophyll is the main pigment in plants. Chlorophyll has the main function in photosynthesis, namely utilizing solar energy, triggering CO_2 fixation to produce carbohydrates and providing energy. Higher chlorophyll content is usually found in dark green leaves [9]. The results of the study showed that the application of *Mucuna bracteata* green fertilizer tended to give the plant leaves relatively the same color . [10] The results of Dharmadewi's research show that the morphology of cassava leaves is dark green while lettuce leaves are light green, so the chlorophyll content in cassava leaves is higher than lettuce leaves. The leaf thickness factor can also affect the chlorophyll content, because thin leaves generally wilt when picked so that the chlorophyll is easily degraded.

4.2. Photosynthesis Rate (µmol CO_2 m-2 s-1)

Table 2 shows that the application of *Mucuna bracteata* and NPK green fertilizer as well the combination produces an unreal difference in the photosynthesis rate of sweet corn plant leaves . This is thought to occur because the value of chlorophyll content produced in sweet corn plants given treatment tends to be the same so that the rate of plant photosynthesis tends to be the same in each treatment given. Chlorophyll content is one of the factors that influences the rate of photosynthesis because this parameter is closely related to plant photosynthesis [11]. The chlorophyll content is directly proportional to the rate of plant photosynthesis. Chlorophyll content and photosynthesis rate have a strong correlation [12].

Environmental factors also influence the rate of plant photosynthesis, namely light intensity. [13] The rate of photosynthesis is influenced by light intensity. An increase in the rate of photosynthesis occurs when light intensity increases. When light intensity is low, the rate of photosynthesis decreases. Each plant has an optimal light intensity range for the photosynthesis process to increase growth and production. Optimal light intensity during the growing period is important for plant growth and development. [14] The rate of photosynthesis is influenced by the intensity of sunlight because the photosynthesis process will only occur if there is light and through the green pigment chlorophyll which is located in the cytoplasmic organelle, namely chloroplasts.

Another thing that causes the photosynthesis rate to be the same in each treatment is the influence of the TBM oil palm canopy and the leaves of the sweet corn plant. Plants that grow in the shade and under a canopy will experience chlorophyll packaging by providing a wider distance in the stroma than plants exposed to direct sunlight . [15] The factors that influence photosynthesis include light and nutrients where plants live. Plants that grow in an environment exposed to direct sunlight will perfectly affect plant growth, thus light greatly influences the photosynthesis process.

4.3. Transpiration Rate (mmol H2O m-2 s-1)

Table 3 shows that the application of *Mucuna bracteata* and NPK green fertilizer and their interaction resulted in significantly different leaf transpiration rates of sweet corn plants. This is thought to be due to the environmental conditions of sweet corn plants which are protected by the canopy or canopy of oil palm plants. The canopy of oil palm plants allows the plants to be protected from sunlight so that humidity is high in the research environmental conditions. [16] The rate of transpiration and stomatal conductivity appear to be directly related to the water content and humidity of the soil.

Soil moisture has a strong influence on transpiration rate, stomatal index and stomatal conductivity. During the day water transpires faster than it is absorbed from the soil. If the water content decreases, the movement of water through the soil into the roots becomes slower. This tends to increase the water deficit in the leaves. As a result, the water potential decreases, the opening of the stomata decreases and the rate of transpiration also decreases. In addition, the availability of water affects the presentation of the epidermal cells and the presentation of the epidermal cells will result in the number of stomata being seen less, while in a water deficit condition the epidermal cells do not stretch so that the number of stomata will be seen more.

[17] Transpiration rate is a momentary response to environmental conditions, its nature is dynamic or fluctuating. Most transpiration occurs through the stomata, although it can also occur through the cuticular. Stomata that are more open will increase their conductivity, resulting in faster transpiration. [18] If the CO 2 absorption capacity increases , the transpiration activity of the leaves will also increase, likewise, the value of the amount of transpiration is influenced by the size of the stomata opening on the plant leaves.

4.4. Stomatal Transmission Power (mol H2O m-2 s-1)

Table 4 shows that the application of *Mucuna bracteata* and NPK green fertilizer and their interaction resulted in significant differences in the stomata conductivity of sweet corn plant leaves. This is thought to be due to the influence of the canopy of oil palm plants which affects the environmental conditions of the research plants. The research environment is protected by the canopy of oil palm plants resulting in quite high air humidity around the research location. [19] plants that have tall canopies are better able to reduce temperature and increase air humidity. Air humidity affects stomatal response. Stomata are very sensitive to changes in environmental conditions.

Mucuna bracteata green fertilizer as an organic material has not been able to influence the increase in the stomata conductivity of sweet corn plant leaves , while the growing environment greatly influences plant growth. [20] The growing environment, especially soil moisture, pH, light intensity and air temperature have a significant effect on the size and number of stomata. Stomata are the main door for the entry of CO_2 into the leaves, which in turn will affect the plants' photosynthetic capacity. In the process of CO_2 diffusion into leaf tissue, stomata that open smaller, CO_2 diffusion is lower than in leaves whose stomata open larger. Wide stomata pore openings can produce high production.

[21] The length and width of the stomata are closely related to the size of the stomatal pore. The larger the size of the stomata, the larger the stomatal pore will be . This results in a high transpiration rate because more water comes out, which increases the uptake of nutrients from the soil. The nutrients absorbed will be used for the photosynthesis process which causes an increase in the rate of photosynthesis which will have an effect on increasing plant growth and

development. The results of this research show that there is no increase in transpiration due to the small number of stomata openings so that there is no increase in nutrient uptake in the soil, whereas in this process plants need nutrients such as N, P and K.

4.5. CO_2 concentration in cells (µmol CO_2 mol-1)

Table 5 shows that the application of *Mucuna bracteata* and NPK green fertilizer and their interaction resulted in CO_2 concentrations in sweet corn plant leaf cells that were not significantly different. CO_2 concentration is closely related to stomata. The conductivity of the stomta does not increase, so the CO_2 concentration also does not increase. [22] that stomata have a function as a gateway for the entry of CO_2 and the exit of water vapor from the leaves. The size of the stomata opening is the most important regulation carried out by plants, where plants try to take in as much CO_2 as possible but emit as little H2O as possible to achieve high growth efficiency. The high binding capacity of CO_2 in C4 plants causes the ratio between CO_2 intake and stomatal conductivity (the ability of the stomata to channel H2O per unit time) to be optimal. The main physiological effect of increasing CO_2 is an increase in the rate of assimilation (the rate of binding of CO_2 to form carbohydrates, photosynthesis) in the leaves. The efficiency of using other growth factors : solar radiation, water and nutrients will also increase. Providing *Mucuna bracteata* and NPK green fertilizer has not had a significant effect on increasing CO_2 concentrations in cells, in fact plants need nutrients in the process of increasing CO_2 concentrations in cells. The nutrients needed such as N, P and K are interrelated.

[23] The research results of Ibanez et all. showed that a mixture of legume cereals containing nitrogen did not significantly increase the increase in CO_2 absorption and photosynthesis during the day[24] The number of moles of CO_2 gas that react will be greater if the concentration of the potassium carbonate solution (K_2CO_3) bigger. [25] That CO_2 capture efficiency is influenced by pressure, the higher the pressure difference , the better the resulting CO_2 capture efficiency . The high pressure difference causes the contact between the solvent (K_2CO_3) and CO_2 gas to take place well. [26] Plant dry weight is influenced by the optimal photosynthesis process. Photosynthesis results in an increase in plant dry weight due to CO_2 uptake . Plant dry weight can be said to be the net accumulation of CO_2 assimilation during the growth period which is significantly influenced by the presence of P.

4.6. Plant Height (cm)

Table 6 shows that the provision of green fertilizer *Mucuna bracteata* and NPK and their interactions resulted in significantly different sweet corn plant heights . Providing green fertilizer *Mucuna bracteata* and NPK in sweet corn plants in this study show a lower range of sweet corn plant height compared to the plant height in the description of the Bonanza F1 corn variety, namely 220 – 250 cm (Appendix 1). Environmental conditions are thought to be less than optimal to support the growth of Bonanza F1 sweet corn varieties. [27] This is supported by the opinion of Mehran et all. which states that the gene potential of a plant will be maximized if it is supported by optimal environmental factors.

Mucuna bracteata green fertilizer cannot provide optimal growing environmental conditions, whereas plants require fertile environmental conditions for their growth. Meanwhile, NPK is expected to be able to meet plant nutrient needs optimally, but research results show that there is no significant increase in plant height. The land used as a growing medium is marginal land. This soil has a relatively acidic pH so there will be a decrease in the binding of nutrients such as N, even though the addition of nutrients in the form of fertilizer, plants are not able to absorb them completely. Fertile soil is one of the results of the presence of available organic material.

4.7. Female Flower Appearance Time (DAP)

Table 7 shows that the provision of green fertilizer *Mucuna bracteata* 12.54 t.ha-1 and NPK 0.1 t.ha-1 significantly accelerated the time for female flowers to appear on sweet corn plants compared to other combinations . Providing *Mucuna bracteata* green fertilizer at a dose of 12.54 t.ha-1 significantly accelerated the time for female flowers to appear on sweet corn plants compared to doses of 4.18 t.ha-1 and 8.36 t.ha-1 . Application of NPK fertilizer 0.1 – 0.3 t.ha -1 resulted in the appearance of female flowers on sweet corn plants which was not significantly different. Providing organic fertilizer can increase agricultural production both in quality and quantity, reduce environmental pollution and improve land quality in a sustainable manner. The combination of *Mucuna bracteata* green fertilizer combined with NPK can accelerate the flowering of sweet corn plants . The appearance of female flowers on sweet corn plants of the Bonanza variety ranges from 55-60 DAP, but the research results show that the fastest increase in the appearance of female flowers occurs at 50 DAP. This happens because the nutrient requirements for corn plants have been met, especially the P element which plays a role in flowering. [28] the increase in yield was due to the combined use of organic and inorganic fertilizers which complement each other.

[29] The nutrients that plays a role in flowering is phosphorus. [30] the addition of organic material (compost) has a positive influence on soil P availability. [31] That apart from releasing P elements, the breakdown of organic materials also produces organic acids, such as oxalate and citric. Anions from these organic acids can become competitors for phosphate ions, thereby reducing P fixation and increasing availability. [32] that most of the N and P are carried to growing points, stems, leaves and male flowers and then transferred to seeds.

4.8. Age of Harvest (DAP)

Table 8 shows that the combination of green manure application *Mucuna bracteata* 4.18 t.ha-1 and 0.3 t.ha-1 NPK significantly accelerated the harvest of sweet corn plants compared to other combinations except by administering *Mucuna bracteata* 8.36 t.ha -1 and 0.1 t.ha - 1 NPK. Providing *Mucuna bracteata* green fertilizer at a dose of 8.36 t.ha -1 accelerated the harvest of sweet corn plants compared to a dose of 4.18 t.ha -1 . Giving NPK 0.3 t.ha -1 accelerated the harvest compared to giving NPK 0.1 t.ha -1 and 0.2 t.ha -1 . The harvest age for corn plants ranges from 67,666-74,666 DAP, which is faster than the harvest age in the description of sweet corn plants , namely 82-84 DAP.

Harvest age indicates maturity of the seeds. [33] That earlier flowering and ripening was caused by relatively higher air temperatures and solar radiation, which accelerated the process of flowering and ripening of plants (physiological maturity). Apart from that, the role of fertilizer also influences the fruit ripening process. The nutrient element that plays a role in the formation of seeds until they can reach harvest is the element P. The nutrient P will be absorbed by the plant continuously until the seeds are close to ripening [34]. [35] The P element absorbed by plants affects plant photosynthesis so that if there is a lack of this element, photosynthate translocation will be less than optimal and will have an impact on seed filling and harvest time. Photosynthate produced in leaves and other photosynthetic cells must be transported to other organs or tissues so that they can be utilized by those organs and tissues for growth or stored as food reserves.

Green manure is an organic material that contains several essential nutrients that are useful for plants, including the elements N, P and K for plant growth and soil fertility. Green manure *Mucuna bracteata* is more aimed at soil improvement, because the nutrients produced are not necessarily available in full for plants, so the nutrients are supplemented with the addition of NPK fertilizer. [36] That organic materials, apart from improving soil properties, can also make the soil loose and the soil structure more crumbly, can store water and can improve the chemical properties of the soil by contributing nutrients to the soil. [37] Plant metabolic processes are largely determined by the availability of nutrients in plants, especially the nutrients N, P and K in sufficient quantities, while plant generative growth requires the elements P and K which are more dominant.

4.9. Weight of Loose Cobs (g)

Table 9 shows that the combination of green manure application *Mucuna bracteata* 12.54 t.ha-1 with 0.2 t.ha-1 NPK produces heavier cob weights than other combinations except for the combination of *Mucuna bracteata* 12.54 t.ha -1 and 0.2 t.ha- 1 NPK. The application of *Mucuna bracteata* green fertilizer at a dose of 12.54 t.ha-1 had a significant effect on increasing the weight of husked cobs of sweet corn plants compared to doses of 4.18 t.ha-1 and 8.36 t.ha-1 . Giving NPK 0.3 t .ha-1 had a significant effect on increasing the weight of husked cobs compared to giving a dose of NPK 0.1 t .ha-1 and 0.2 t .ha-1 .

Mucuna bracteata green fertilizer gave quite good results on the weight of the husked cobs of sweet corn plants . The results of the research showed that the higher the dose of green manure, the heavier the weight of the corn cobs. [38] According to the research results of Kartana and Miyanus, 100 g of *Mucuna bracteata* compost contains the nutrients N (3.93 %), P_2O_5 (0.58%), K_2O (1.29%) and B_2O_3 (22.33%). The P content in *Mucuna bracteata* green manure combined with NPK can provide P elements for sweet corn plants . The nutrient P greatly influences the formation of corn cobs. If the P element is well available, ATP formation will ensure the availability of energy for growth so that the formation of assimilate and transportation to the storage area can run well.

4.10. Cob Weight Without Lobs (g)

Table 10 shows that all combinations produced heavier cob weights without husks except for the treatment combination of *Mucuna bracteata* 4.18 t.ha-1 with NPK 0.2 t.ha-1 . Application of *Mucuna bracteata* green fertilizer at a dose of 8.36 t.ha-1 resulted in a heavier cob weight without husks of sweet corn plants compared to the 4.18 t.ha-1 *Mucuna bracteata* treatment , but not significantly different from the 12.54 t.ha-1 . NPK 0.1 – 0.3 t .ha-1 produces not different weight of cobs without husks.

The higher the dose of NPK and *Mucuna bracteata* green fertilizer given, the more nutrients will be available in the soil for plants. The formation of corn cobs is greatly influenced by the nutrients absorbed by plant roots in the soil through fertilization. The weight of the cobs without husks is heavier because the seeds are completely filled and this is closely related to pollination or fertilization. [39] Fertilization will run smoothly if the pollen and egg cell nuclei are healthy and fertile. Pollen must have high growth capacity, while the stigma must be a good medium for germination and further growth of pollen.

Sweet corn cobs is also caused by plants being able to utilize nutrients in the soil. The nutrients available in the soil are also a contribution from gifts green fertilizer *Mucuna bracteata* and NPK. Nutrient elements that play a role in fertilization and seed formation are elements P and K. [40] The role of P is very necessary in fertilization, such as ear formation and ear quality.

[41] P element is very necessary for corn plants in the generative growth phase in the formation of cobs and if there is a lack of the P element, it causes imperfect cob development and causes the seeds to be uneven and not ripe. [42] Standard fertilizer treatment and a combination with organic fertilizer have a significant effect on the average weight of cobs with husks and stover weight. [43] Fertilizer dosage had a significant effect on the length and weight of sweet corn cobs .

5. Conclusion

- *Mucuna bracteata* and NPK fertilizer provided an interaction on the time female flowers appeared, harvest age and husk ear weight, but did not provide an interaction on other observations.
- Providing *Mucuna bracteata* green fertilizer can speed up the appearance of female flowers, harvest time, and increase the weight of husked cobs . Meanwhile, NPK can speed up the maturity of harvest and the weight of husked cobs , but not in other observations.
- *Mucuna bracteata* green fertilizer 12.5 t.ha-1 and NPK 0.2 t.ha-1 resulted in higher production of husk sweet corn compared to other treatments, namely 527,833 g per plant .

Compliance with ethical standards

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Disclosure of conflict of interest

All authors declare there is no conflict of interest in this paper.

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