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THE EFFECT OF SPACING PLANT AND WEEDS AS ORGANIC MULCH ON THE GROWTH AND RESULTS OF SWEET CORN (*ZEA MAYS SACCHARATA* STURT)

Yenni Asbur [1]*
Yayuk Purwaningrum [2]
Murni Sari Rahayu [3]
Bambang Nurdiansyah [4]

Program Study Agrotechnology, Faculty of Agriculture Universitas Islam Sumatera Utara, Medan, Indonesia
Email: yenni.asbur@fp.uisu.ac.id
*Corresponding Author
Program Study Agrotechnology, Faculty of Agriculture Universitas Islam Sumatera Utara, Medan, Indonesia
Email: yayuk.purwaningrum@fp.uisu.ac.id
Program Study Agrotechnology, Faculty of Agriculture Universitas Islam Sumatera Utara, Medan, Indonesia
Email: murni.rahayu@fp.uisu.ac.id
Student of Program study Magister Agrotechnology, Faculty of Agriculture Universitas Islam Sumatera Utara, Medan, Indonesia

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Abstract: *Sweet corn (Zea mays saccharate Stuart) is the most popular plant in Indonesia at the moment because it tastes sweet and can be processed into various kinds of food, from corn, grilled, corn on the cob, corn fritters, corn cakes and also as a mixture of salads and preparations. other vegetables. However, the ever-increasing demand for sweet corn has not been matched by an ever-increasing yield. The purpose of this study was to determine the optimum plant spacing and the best type of mulch for the growth and yield of sweet corn. The research was conducted in the experimental field of the Faculty of Agriculture, Universitas Islam Sumatera Utara, Gedung Johor, Medan (3°31'23" N 98°39'51" E) with a flat topography and an altitude of ± 25 masl. The study was designed using a two-factor randomized block design. The first factor is the spacing (S), namely 25 cm x 50 cm (S1), 25 cm x 75 cm (S2), and 25 cm x 100 cm (S3). The second factor was the type of weeds used as organic mulch (M), namely A. gangetica (M1), N. biserrata (M2), and P. conjugatum (M3). The dose of mulch used was 5 tons/ha and all treatments were repeated three times. The results showed that the optimum spacing for the best growth of sweet corn was 25 cm x 75 cm and 25 cm x 100 cm and the best organic mulch for the growth and yield of sweet corn was P. conjugatum and A. gangetica*

Keywords: *Weed, Asystasia gangetica, Nephrolepis biserrata, Paspalum conjugatum*

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Introduction
Sweet corn (*Zea mays saccharata* Stuart) is the most popular crop in Indonesia at the moment because it tastes sweet and can be processed into various kinds of food, from corn, grilled, corn on the cob, corn fritters, corn cakes and also as a mixture of salads and preparations. other vegetables. However, the ever-increasing demand for sweet corn has not been matched by an ever-increasing yield. Muhsanati et al. (2006) stated that the productivity of sweet corn in Indonesia averaged 8.31 tons/ha, while the yield potential of sweet corn could reach 14-18 tons/ha.

One way to increase sweet corn production is to provide an optimal growing environment for its growth so that it develops well, namely by creating a growing space that suits the needs of sweet corn plants through spacing and also using organic mulch. The results of research by Probowati et al. (2014) showed that the use of spacing that is too narrow causes the leaves of other plants to shade each other, which delays plant growth and increases plant height, and there is also very strong competition between plants for nutrients, light, and water. Spacing that is too wide is also not good to apply because this will provide opportunities for weeds to thrive, causing a decrease in corn yields and can also reduce the effectiveness of land use. One way to create an optimal growing environment for plants is by mulching. Mulching is a way to regulate soil air conditioning and the availability of groundwater for plant growth and development (Novayana et al., 2015). In addition, giving mulch can also protect the soil surface from high intensity direct radiation of sunlight and can prevent the evaporation process so that evaporation is only through transpiration by plants (Gustanti et al., 2014)

Generally, the mulch used comes from plant residues. However, in this study the mulch used came from weeds that grew a lot in the study area. The weeds used as mulch were *Asystasia gangetica* (L.) T. Anderson, *Nephrolepis biserrata*, and *Paspalum conjugatum*. The results of research by Asbur et al. (2018a) showed that the use of *A. gangetica*, *N. biserrata* and P. *conjugatum* as cover crops has been able to improve soil chemical properties in oil palm plantations, but their use as organic mulches on annual crops, especially sweet corn, has never been carried out. Based on this, the purpose of this study was to determine the optimum plant spacing and the best type of mulch for the growth and yield of sweet corn.

Methods and Material
The research was conducted in the experimental garden of the Faculty of Agriculture, Universitas Islam Sumatera Utara, Gedung Johor, Medan (3°31'23" N 98°39'51" E) with a flat topography and an altitude of ± 25 masl. Research implementation begins in February 2022 until May 2023.

The materials used in this study consisted of sweet corn seeds of the Bonanza F1 variety, basic fertilizer (NPK Phonska), nylon thread, plastic rope, bamboo stakes, organic mulch consisting of A. gangetica, N. bisserata, and P. conjugatum , Dithane M-45 fungicide and other materials deemed necessary for this research.

The tools used in this study consisted of hoes, machetes, gembor, tape measure, analytical scales, stationery, standard stakes, handsprayer, oven, and other supporting tools.

The study was designed using a two-factor randomized block design. The first factor is the spacing (S), namely 25 cm x 50 cm (S1), 25 cm x 75 cm (S2), and 25 cm x 100 cm (S3). The second factor was the type of weeds used as organic mulch (M), namely *A. gangetica* (M1), *N.*

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biserrata (M2), and *P. conjugatum* (M3). The dose of mulch used was 5 tons/ha and all treatments were repeated three times.

Prior to the start of the research, land clearing was carried out and a trial plot of 2 m x 2 m was made with a distance between experimental plots of 50 cm and between replicates of 100 cm. Then, the Bonanza F1 variety of sweet corn was planted in tugal with spacing according to the treatment and NPK fertilizer was given at a dose of 200 kg/ha. Application of organic mulch according to treatment is carried out after planting is complete. Organic mulch that is applied to the field is still fresh.

Variables observed were plant height 9cm), number of leaves (strands), cob length with husks (cm), cob weight with husks (cm), and soil chemical properties, namely C-organic (Walkey and Black method), N-total (Kjeldhal method), P-total and K-total (25% HCl extract), P-available and K-available (Bray method).

The data obtained were analyzed using ANOVA and F-test. If there is a significant difference in the treatment, continue using the Duncan test at the 5% level. Data analysis was performed using SAS software.

Results and Discussion

Soil Chemical Properties at the Research Location

Based on the results of soil analysis prior to the study, it indicated that the soil at the study site was acidic (pH 5.2). More complete soil chemical properties before and after the study are presented in Tables 1 and 2.

Table 1: Soil Chemical Properties at the Study Site Before Treatment

Parameter	Value	Dignity(*)
pH H_2O	5.2	Acid
C-organic (%)	0.03	Very low
N-total (%)	0.19	Very low
C/N	0.16	Very low
P-available (ppm)	21.96	Medium
K-available (me/100 g)	0.45	Medium
P-total (ppm)	164.62	Very high
K-total (ppm)	69.17	Very high

(*): Award based on Soil Research Institute (2005). Source: Department of Soil, Faculty of Agriculture, UGM (2011)

Table 2 : Soil Chemical Properties at the Research Site After Treatment

Interaction Treatment	pH H_2O	C-org (%)	N-total (%)	C/N	P-available (ppm)	K-available (me/100 g)	P-total (ppm)	K-total (ppm)
S1M1	5.61b	1.67b	0.19b	8.79d	17.81d	0.25a	492c	1200a
S1M2	5.75a	1.96a	0.22a	8.91c	18.27b	0.18c	540b	700d2.41%,
S1M3	5.43d	1.61d	0.18b	8.94c	19.27a	0.21b	611a	801c
S2M1	5.55c	1.68b	0.20b	8.40f	17.84c	0.28a	491c	1199a
S2M2	5.76a	1.96a	0.21a	9.19b	18.28	0.19c	542b	701d

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S2M3	**5.44d**	**1.62c**	**0.19b**	**8.58e**	**19.28a**	**0.22b**	**610a**	**802c**
S3M1	**5.62b**	**1.63c**	**0.19b**	**8.57f**	**17.82d**	**0.27a**	**489d**	**1197b**
S3M2	**5.75a**	**1.97a**	**0.23a**	**8.57f**	**18.26b**	**0.19c**	**541b**	**701d**
S3M3	**5.43d**	**1.62c**	**0.17c**	**9.53a**	**19.29a**	**0.22b**	**612a**	**800c**

Note: Numbers followed by unequal letters in the same treatment group are significantly different at the 5% level based on Duncan's test
S1: 25 cm x 50 cm; S2: 25 cm x 75 cm; S3: 25 cm x 100 cm; M1: *A. gangetica*, M2: *N. biserrata*; M3: *P. conjugatum*

Prior to the study, the state of organic matter in the soil at the study site was very low, which was illustrated by a very low C-organic value (0.03%). After the research, the soil organic matter content significantly affected the interaction between the treatments and increased to 1.96%-1.97% in the Interaction plot of spacing and *N. biserrata*, 1.63%-1.68% in the Interaction plot of spacing and *A. gangetica*, and 1.61%-1.62% in Interaction plot of spacing and *P. conjugatum* treatment. This is due to the presence of weeds as organic mulch capable of increasing soil organic matter. According to Shofiyati et al. (2010), soil organic matter will be higher in the presence of cover crops because soil organic matter content is affected by the physical properties of the soil (especially bulk density), as well as the type of vegetation that grows on it.

The highest C-organic content was found in the interaction of *N. biserrata* organic mulch treatment and the spacing of 25 cm x 50 cm (S1M2), 25 cm x 75 cm (S2M2) and 25 cm x 100 cm (S3M2) and the lowest in the interaction of the treatment spacing of 25 cm x 50 cm and *P. conjugatum* organic mulch. Likewise the results of research by Asbur et al (2015) which showed that the presence of *A. gangetica* and *N. biserrata* as biomulch can increase soil organic matter in oil palm plantations.

The content of N total in the soil before the study was very low (0.19%) and increased after the application of organic mulch *N. biserrata*, *A. gangetica*, and *P. conjugatum*, which respectively became 0.21%-0.237%, 0.19%-0.20%, and 0.17%-0.19% (Table 2). In Table 2 it can be seen that the interaction of the treatment with spacing and organic mulch also significantly affected the total N-content of the soil, where the highest N-total soil content was found in the interaction of the organic mulch treatment of *N. biserrata* with a spacing of 25 cm x 50 cm (S1M2), 25 cm x 50 cm (S2M2), and 25 cm x 100 cm (S3M2). Meanwhile, the lowest N-total soil content was found in the interaction between the treatment spacing of 25 cm x 100 cm with organic mulch *P. conjugatum* (S3M3).

The highest N-total soil content was found in plots with organic mulch *N. biserrata* mulch, followed by plots with *A. gangetica* as organic mulch and *P. conjugatum* as organic mulch. The higher N-total content in the plots with organic mulch *N. biserrata* was due to the higher organic matter content in the plots with *N. Biserrata* as organic mulch compared to the plots with *A. gangetica* and *P. conjugatum* as organic mulch (Table 2). This was also found in the study of Singh et al. (2007) where the soil N content is higher in the presence of organic mulch due to increased soil microorganism activity and soil organic matter content.

There was a change in the C/N ratio before and after the study, from 0.16 to 8.57-9.19 in plots with organic mulch *N. biserrata*, 8.40-8.79 in plots with organic mulch *A. gangetica*, and 8.58-9.53 in plots with organic mulch *P. conjugatum*. The C/N ratio was also significantly affected by the interaction between the spacing and organic mulch treatment (Table 2), where the highest C/N ratio was found in the interaction between the spacing of 25 cm x 100 cm and *P.*

conjugatum (S3M3) and the spacing of 25 cm x 50 cm and *N. biserrata* (S2M2), while the lowest C/N ratio was found in the treatment with a spacing of 25 cm x 100 cm with organic mulch of *A. gangetica* (S3M1) and *N. biserrata* (S3M2).

Overall, the C/N ratio in the results of this study is in the low category. The low C/N ratio in plots with organic mulches of *A. gangetica*, *N. biserrata*, and *P. conjugatum* indicates that organic matter is more available and easily absorbed by plants. In accordance with the results of Sullivan's research (2012) that if the C/N ratio is less than 20 then the nutrients will decompose quickly, whereas if it is more than 25 then the nutrients will decompose more slowly.

The content of P-available before and after the study was medium. There was a decrease in the content of P-available after research on plots with organic mulch of *N. biserrata*, *A. gangetica*, and *P. conjugatum*, which were 18.26-18-28 ppm, 17.81-17.84 ppm, and 19.27-19.29 ppm, respectively. This decrease was due to P being absorbed by plants. Leiwakabessy et al. (2003) stated that the loss of P in the soil occurs through harvesting, washing, erosion and evaporation. Furthermore, Hardjowigeno (2010) states that the low available P is also caused by low soil pH so that the P fixed by Al and Fe is greater than the available P in the soil.

Table 2 shows that soil of P-available was significantly affected by the interaction of spacing and organic mulch treatment. The highest content of P-available was found in the interaction of *P. conjugatum* organic mulch treatment and spacing of 25 cm x 50 cm (S1M3), 25 cm x 75 cm (S2M3), and 25 cm x 100 cm (S3M3) and the lowest was in the organic mulch treatment *A. gangetica* and spacing of 25 cm x 50 cm (S1M1), 25 cm x 75 cm (S2M1), and 25 cm x 100 cm (S3M1). Based on the research results of Asbur et al. (2018a), *P. conjugatum* has a higher P content in its plant tissues compared to *N. biserrata* and *A. gangetica*, namely 0.31%, 0.27% and 0.22%, respectively.

The content of P-total before and after the study was classified as very high and there was an increase in P-total after the study on plots with organic mulches of *N. biserrata*, *A. gangetica*, and *P. conjugatum*, which respectively became 540-542 ppm, 489-492 ppm, and 610-612 ppm. The increase in P-total content is thought to be partly due to the decomposition of organic matter from the organic mulch applied. Tisdale & Nelson (1975) stated that P in the soil comes from organic matter and primary minerals. P from organic matter is broken down by decomposers into inorganic P which dissolves in the soil. Yuwono (2008) also states that the overhaul of organic matter contributes 20% -80% of the total P in the soil.

The P-total content of the soil was also significantly affected by the interaction of spacing and organic mulch treatment (Table 2). The highest P-total content was obtained in the interaction of *P. conjugatum* organic mulch treatment and spacing of 25 cm x 50 cm (S1M3), 25 cm x 75 cm (S2M3), and 25 cm x 100 cm (S3M3) and the lowest was in the organic mulch treatment *A. gangetica* and spacing of 25 cm x 50 cm (S1M1), 25 cm x 75 cm (S2M1), and 25 cm x 100 cm (S3M1). This result is the same as the available P content because the P content in *P. conjugatum* plant tissues plant tissue is more than the P content in *N. biserrata* and *A. gangetica* plant tissues (Asbur et al., 2018a)

There was a decrease in content of K-available after the study, from 0.45 me/100 g to 0.18-0.19 me/100 g in plots with organic mulch *N. biserrata*, 0.25-0.28 me/100 g in plots with organic mulch *A. gangetica*, and 0.21-0.22 me/100 g on plots with *P. Conjugatum* organic mulch. In accordance with the statement of Havlin et al. (2005), the biggest loss of K is through washing, and harvesting because K is easily soluble and tends to be absorbed by plants in much greater amounts than the needs of plants.

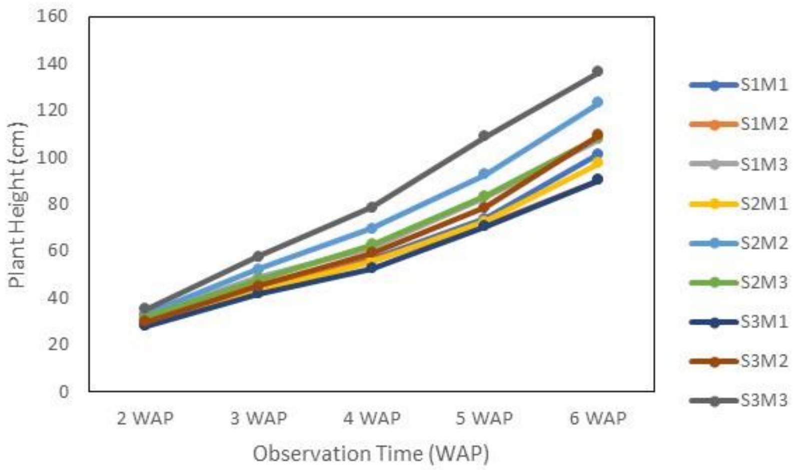
Table 2 also shows that the interaction of spacing and organic mulch treatment has a significant effect on the K-total content of the soil. The highest K-total content was found in the *A. gangetica* treatment with spacing of 25 cm x 50 cm (S1M1), 25 cm x 75 cm (S2M1), and 25 cm x 100 cm (S3M1). Meanwhile, the lowest K-total content was seen in the interaction of *N. biserrata* treatments with spacing of 25 cm x 50 cm (S1M2), 25 cm x 75 cm (S2M2), and 25 cm x 100 cm (S3M2). This is because the K content in *A. gangetica* tissue is higher than the K content in *P. conjugatum* and *N. biserrata* tissue, namely 2.41%. 1.83%, and 1.21% (Asbur et al., 2018a).

There was an increase in the K-total content in the soil in the plots with organic mulch of *N. biserrata*, *A. gangetica*, and *P. Conjugatum*, namely to 700-701 ppm, 1197-1200 ppm, and 800-802 ppm, respectively. The highest K-total content was found in plots with *A. gangetica* organic mulch, followed by plots with *P. conjugatum* organic mulch and *N. biserrata* plots. The higher K-total content in plots with *A. gangetica* organic mulch is thought to be due to the higher K nutrient content in *A. gangetica* plant tissues (Asbur et al., 2016; 2018a; 2018b; 2021) compared to other weeds. Leiwakabessy et al., (2003) stated that the K nutrient in the soil comes from the decomposition of plant tissues and the mineralization of potassium minerals in the soil.

Sweet Corn Growth and Yield

The results of ANOVA showed that the treatment of spacing and organic mulch and the interaction between the two treatments had no significant effect on plant height and number of sweet corn leaves.

Plant height and number of sweet corn leaves were observed at the age of 2 weeks after planting (WAP) to 6 WAP with an observation interval of once a week. Although the treatment given had no significant effect on plant height and number of sweet corn leaves, it was seen that the older the sweet corn, the higher the plant height and number of sweet corn leaves (Figure 1 and Figure 2).



Note: S1: 25 cm x 50 cm; S2: 25 cm x 75 cm; S3: 25 cm x 100 cm; M1: *A. gangetica*, M2: *N. biserrata*; M3: *P. conjugatum*

Figure 1: Increase in plant height (cm) of sweet corn treated with plant spacing and organic mulch

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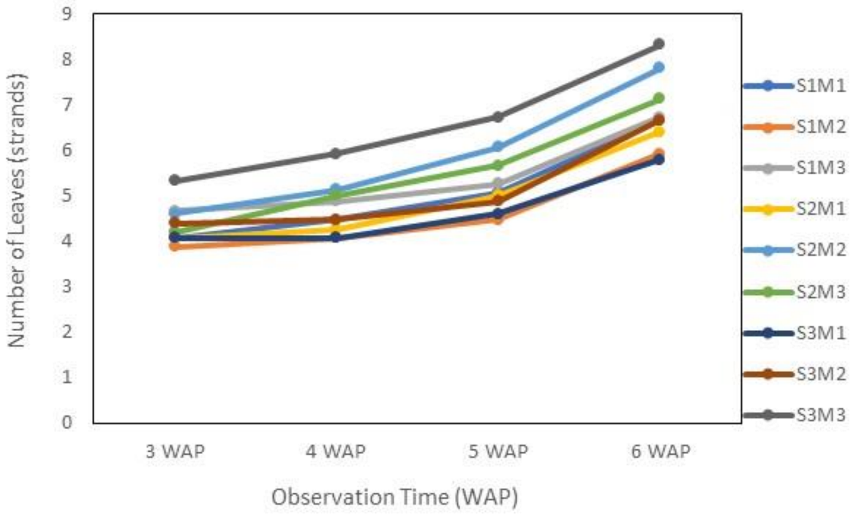

Note: S1: 25 cm x 50 cm; S2: 25 cm x 75 cm; S3: 25 cm x 100 cm; M1: *A. gangetica*, M2: *N. biserrata*; M3: *P. conjugatum*

Figure 2: Increase in the number of leaves (strands) of sweet corn with the treatment of plant spacing and organic mulch

Figure 1 shows that the increase in plant height and number of sweet corn leaves increased with increasing plant age, but the organic mulch treatment and spacing had no statistically significant effect. This is because the provision of organic mulch can minimize evaporation, increase water holding capacity, increase soil organic matter so that it has a good effect on improving the physical and chemical properties of the soil which will ultimately increase plant growth (Harsono, 2012).

The length of sweet corn cobs with husks was not significantly affected by the organic mulch treatment (Table 3). Multazam et al. (2014) stated that the use of mulch in plant cultivation is intended to maintain the microclimate around plants such as temperature and humidity so that plants can grow optimally. In addition, it is also thought to be due to the influence of corn plant competition with organic mulch given in nutrient extraction. The organic mulch given was in the form of fresh forage from several weeds that are often found in oil palm plantations, namely *A. gangetica*, *N. biserrata*, and *P. conjugatum*. This is in accordance with Puspita's research (2014) which showed that there was competition between Oyong plants and *Arachis pintoi* (as biomulch) in nutrient uptake, so that Oyong growth was suppressed

Table 3: Average Length of Sweet Corn Cobs with Husks (cm) in Organic Mulch Treatment and Plant Spacing at 11 WAP

Treatments	Spacing			Average
	25 cm x 50 cm	25 cm x 75 cm	25 cm x 100 cm	
Organic Mulchs				
A. gangetica	25.15	24.89	23.45	24.50
N. biserrata	21.10	26.07	23.98	23.72
P. conjugatum	25.11	26.02	27.35	26.16
Average	23.79	25.66	24.93	

Note: Numbers followed by unequal letters in the same treatment group are significantly different at the 5% level based on Duncan's test, while those without annotations are not significantly different at the 5% level based on Duncan's test.

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In contrast to cob length, sweet corn cob weight was significantly affected by spacing and organic mulch treatment (Table 4).

Table 4: Average Weight of Sweet Corn Cobs with Husks (g) in Organic Mulch and Plant Spacing Treatment at 11 WAP

Treatments	Spacing			Average
	25 cm x 50 cm	25 cm x 75 cm	25 cm x 100 cm	
Organic Mulchs				
A. gangetica	183.33bcd	176.87bcd	146.67cd	168.96b
N. biserrata	117.33d	278.67ab	154.67cd	183.56b
P. conjugatum	187.27bcd	226.00abc	316.67a	243.31a
Average	162.64b	227.18a	206.00ab	

Note: Numbers followed by unequal letters in the same treatment group are significantly different at the 5% level based on Duncan's test, while those without annotations are not significantly different at the 5% level based on Duncan's test.

Spacing has a significant effect on the weight of cobs and corn cobs, where the optimum spacing that produces heavier cob weights is a spacing of 25 cm x 75 cm which is not significantly different from a spacing of 25 cm x 100 cm. This shows that good vegetative growth will also affect good generative growth. From the results of the study it can be seen that although the spacing did not significantly affect the vegetative growth of sweet corn plants, the highest values for all vegetative growth variables were found in the treatment of spacing of 25 cm x 75 cm and 25 cm x 100 cm. In line with the research of Probowati et al. (2014) on corn plants which showed that the wider the distance between rows of corn plants, the heavier the cob weight with and without husks. In accordance with the results of Herlina's research (2011) which showed that dense spacing led to competition in extracting nutrients, water, CO_2 and sunlight so that organic matter accumulated in cob weight was lower. The increase in cob weight is also closely related to the amount of photosynthates distributed to the cobs, if the photosynthate transport to the cobs is high, the cobs produced will also be bigger. In this case, what plays a role in increasing plant yields is the result of photosynthesis in the leaves and stems which is transferred when filling the seeds. So that if the yield of photosynthate stored in the leaves and stems is high, then the photosynthate transferred when filling the seeds will also be higher. In addition, spacing affects plant population and light use coefficient, spacing also affects competition between plants in using water and nutrients, thereby affecting yields. Plant density affects the appearance and production of plants, mainly due to the coefficient of light use (Febriyono et al., 2017).

Organic mulch had a significant effect on cob weight with cobs, where the optimum organic mulch that produced heavier cob weight was *P. conjugatum* mulch which was not significantly different from *A. gangetica* mulch. This shows that vegetative growth which is not good will also affect generative growth. From the results of the study it can be seen that although organic mulch had no significant effect on the vegetative growth of sweet corn plants, it had a significant effect on generative growth and had the highest value for all vegetative growth variables in *P. conjugatum* mulch, in line with research by Asbur et al. (2021) that the use of organic mulch can increase nutrients and nutrient uptake by plants thereby improving the vegetative properties of plants. The use of mulch as organic matter in good doses will increase plant growth and soil fertility. Increased cob weight is also associated with plant photosynthesis. if the photosynthate stored in the leaves and stems is high, the process of filling the seeds will be higher so that the cobs of the plants will be bigger and the weight of the corn cobs will be heavier.

Conclusion

Based on the results of the study it can be concluded that the optimum spacing for the best growth of sweet corn yields is a spacing of 25 cm x 75 cm and 25 cm x 100 cm and the best organic mulch for the growth and yield of sweet corn is *P. conjugatum* and *A. gangetica*.

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