DOI :https://doi.org/10.36378/juatika.v4i1.1874
JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL.4 NO. 1 January 2022
eissn 2656-1727
pissn 2684-785X
Hal : 224 – 233

The Effect Of Planting Distance On The Growth And Yield Of Cabbage (Brassica oleracea L.) In The Lowland's Klamalu Village, Mariat District, Sorong Regency

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ABSTRACT

The decline in production of cabbage in Indonesia is due to the lack of intensive and traditional cultivation of this plant, ie without the use of spacing and frequency that is not appropriate, resulting in a seizure of nutrients from the soil by plants and organ cover of the cabbage plant itself which inhibits the photosynthesis process. So this research was conducted to know the effect of effective spacing that can increase the growth and production of cabbage plants. This study used a single factor randomized block design consisting of 4 levels of treatment, namely 1) Without Planting Distance; 2) Planting distance 35 cm x 35 cm; 3) Distance to plant 45 cm x 45 cm; and 4) Planting distance 55 cm x 55 cm. Each treatment was repeated 3 times to obtain 12 experimental units. The plant spacing factor on cabbage had a significant effect on the observation of plant height, the number of leaves, and leaf length. While the results of observations on the fresh weight of cabbage buds did not have a significant effect on the spacing treatment. The planting distance at 25 cm x 55cm gave the best effect on the growth and production of cabbage (*Brassica oleraceae* L.*).*

Keywords*: Cabbage, planting_distance, lowland*

1. INTRODUCTION

Cabbage (Brassica oleraceae L.) is one type of vegetable plant originating from subtropical areas that have important economic significance, which includes species that produce leaf vegetables, buds, flowers, stems. According to its origins, the cabbage plant cultivated to date comes from wild cabbage that grows along the Mediterranean coast, England, and northern western France, as well as the coast of Glamorgan. Cabbage (Brassica oleracea L.) is a type of vegetable plant from the Brassicaceae family. This plant has the potential to be cultivated because it has a very high nutritional content and also has economic value(Erwin et al., 2015). In Indonesia, the development of flower cabbage cultivation is still limited, when compared to other countries in ASEAN, the average productivity of flower cabbage in Indonesia per hectare is still low at 8-10 tons/ha.

while Thailand and Vietnam average productivity have reached 15 to 20 tons. /hectare (Revelation, (2013) in(Laksono, 2016)).

The decline in cabbage production in Indonesia is due to the lack of intensive and traditional cultivation of this plant, ie without the use of spacing and the frequency of which is not appropriate, resulting in ineffective land use. From the results of a field survey on cabbage cultivation in Sorong Regency, it is known that farmers grow cabbage with an average spacing of 30 cm x 30 cm, some are even closer, namely 25 cm x 30 cm so that the resulting product is not much and if calculated with input issued, it is known that the profit obtained by farmers is less. Therefore, many farmers have instead switched to planting other horticultural crops.According to(Fajeriana M & Wijaya, 2020), the existing land does not only discuss its characteristics to support sustainability, but nutrient status is also a major factor that cannot be ruled out. This is because, the availability of nutrients in the soil can be used by plants in their growth and development. Spacing arrangements greatly affect the growth and yield of cabbage, especially during the crop formation period, which varies greatly between ovoid, flattened, and conical in shape. Thus, plant spacing is shown to utilize light effectively and distribute nutrients evenly (Rukmana, 2005, in(Erwin et al., 2015)). Cabbage cultivation was initially only planted in highland areas. In its development, now cabbage is starting to be widely planted in the middle plains and even in the lowlands (Pracaya, 2001 in(Ridwan et al., 2013)). According to(Pesireron et al., 2020), that highland horticultural crops are currently susceptible to environmental damage because new land clearing does not pay attention to conservation aspects. It does not matter in which plains cabbage is cultivated as long as the land and land management is carried out properly.

In a crop, there is often competition between plants for nutrients, water, sunlight, and space to grow. One of the efforts that can overcome this is by adjusting the spacing. Planting distances that are too narrow will give less than optimal results because of the competition between the plants themselves. in(Dewanti et al., 2019) research for cabbage plants, the optimal spacing should be at a spacing of 30 x 40 cm, but in (Mulyani et al., 2019)research it is known that the best spacing for cabbage plants is 60 cm x 60 cm. Therefore, optimal spacing is needed to obtain maximum yields. Based on this description, this research was conducted to know the effect of effective spacing that can increase the growth and production of cabbage plants..

2. RESEARCH METHOD

This research was conducted in Klamalu Village, Mariat District, Sorong Regency. It takes place from September to December 2018. The materials used are cabbage seeds of the Sehati F1 Cap Merah variety, manure (as basic fertilizer), pearl fertilizer, ponska. The tools used are: hoe, machete, tape measure, saw, hammer, nails, wood, camera (for documentation), scales, and writing tools.

The number of plants in this study used a single factor with a randomized block design consisting of 4 treatment levels. Each treatment was repeated 3 times to obtain 12 experimental units.

Each treatment consists of 18, 13, 10 plants. Thus the total population is 165 plants. The sample plants for each plot were randomly selected with 5 plants, thus the total sample size was 60. The treatments in this study were: 1) Without Planting Distance; 2) Planting distance 35 cm x 35 cm; 3) Distance to plant 45 cm x 45 cm; and 4) Planting distance 55 cm x 55 cm.

Research implementation

Land Preparation

The research area located in the lowlands with a slope of 5% was first cleared of wild plants or weeds, followed by tillage using a hoe as deep as 40 cm. The type of soil in the research area is Alfisol with loamy loam texture and deep soil solum. The purpose of this tillage is to turn the soil aggregate and leave it for 1 week before the second tillage. The second tillage is carried out to loosen the soil and at the same time make planting beds. By planting a planting of 1 x 1.5 meters in size, along with making this planting, then giving 3 kg of cow dung manure for each bed by sowing, the beds are then mixed with soil with a hoe so that the fertilizer is evenly mixed with the soil. According to(Harahap et al., 2021)providing manure fertilizer can have soil properties, increase the ability of the soil to hold air, increase soil aggregates, increase soil humus content, thus forming a planting condition desired by plants.

Seedling

Cabbage seed sowing is carried out in 1x1 meter beds that are shaded. At the time of making the same bed, 2 kg of cow dung fertilizer was given and mixed evenly with the soil of the bed. The seeding is carried out until the cabbage seedlings are 3-4 leaves and then transferred to the planting beds by planting them in the prepared planting holes by planting them with the size of the spacing according to the treatment being tested.

Planting Distance Setting

The planting distance for cabbage plants was made based on the spacing used in the treatment, namely, 1) Without Planting Distance; 2) Planting distance 35 cm x 35 cm; 3) Distance to plant 45 cm x 45 cm; and 4) Planting distance 55 cm x 55 cm. This spacing is different for each planter because it is done based on the spacing treatment in each bed. The purpose of setting the spacing is to get a good growing space for plant growth to avoid competition for nutrients and sunlight, knowing this amount is treated and making it easier to maintain, especially in weeding. Spacing can affect yields because different plant populations will produce different plant growth. Increasing the spacing to a certain level, the yield per unit area can increase while the yield of each plant can decrease, the recommended spacing depends on the type of plant,

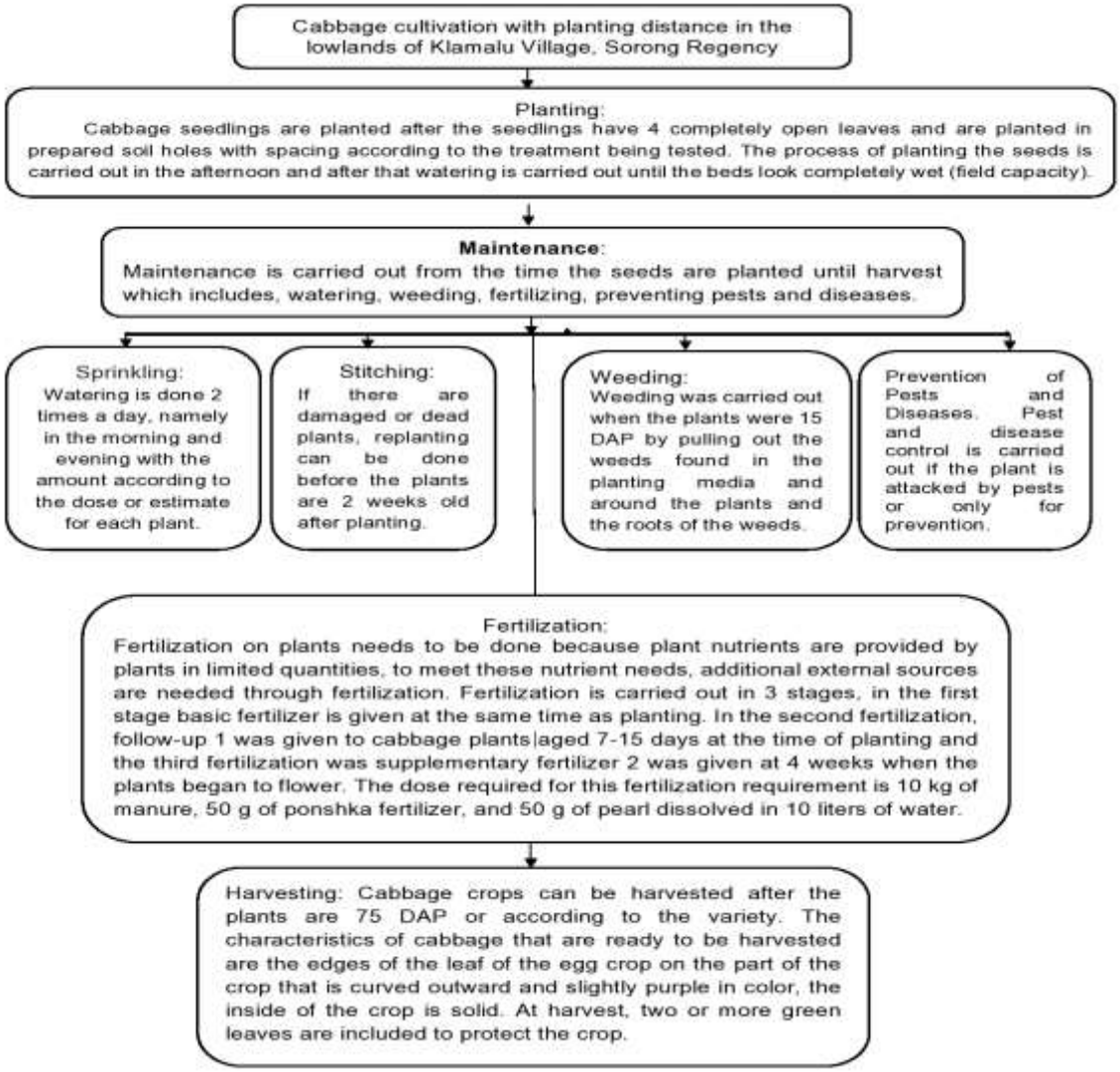

Figure 1: Flowchart of Research Implementation

Observation Variable

Plant height (cm)

Plant height was measured using a rope meter that was placed above the soil surface, namely at the base of the plant to the highest part of the plant. Measurements were made at the age of 1 MST to 5 MST.

Number of Leaves (Strand)

The number of leaves was done by counting the leaves that were not damaged and fully opened at the age of 1, 2, 3, 4, 5 MST, counting from the lowest leaf to the top leaf.

Leaf Length

Leaf length was measured using a rope meter that was carried under the base of the plant to the tip of the plant leaf. Measurements were made at the ages of 1, 2, 3, 4, 5 MST.

Fresh Weight of Cabbage Crops (gr)

Weighing is done at the time of harvest by weighing the clean crop (without leaves) using a scale in grams and calculated at post-harvest. The measurement of the diameter of the crop is carried out at harvest by measuring the circumference of the crop by using a rope meter unit cm, after which the measurement results are recorded.

Data Analysis

The data from the research were then analyzed using analysis of variance, if the perpetrator had a significant effect, then the The HSD (Honestly Significant Defferences) test was carried out at a 5% confidence level.

3. RESULTS AND DISCUSSION

Cabbage Plant Height

The results of the analysis of variance showed that differences in plant spacing did not have a significant effect on plant height growth. The average yield of cabbage plant height is presented in table 1 below.

Table 1. Cabbage plant height at the time of observation 1-5 WAP.

Treatment	Week After Planting (cm)				
	1	2	3	4	5
Without Planting Distance	36.4 b	46.93 b	48.2 ab	48.66 cd	49.2c
Planting distance 35 cm x 35 cm	47.6 a	53.06 a	55.0 a	57.93 bc	56.4b
Planting distance 45 cm x 45 cm	49.06 a	53.93 a	50.06 a	58.4 b	62.26a
Planting distance 55 cm x 55 cm	50.2 a	52.33 a	56.4 a	63.86 a	64.13a
HSD 0.05	3.1	3.5	8.5	4.0	4.9

Noted: The same letter in one column shows no significant difference at the 0.05 level.

The highest mean yield of cabbage plant height at the age of 5 weeks after planting (MST) was obtained in the Planting distance 55 cm x 55 cm treatment as high as 64.13 cm then followed by Planting distance 45 cm x 45 cm treatment at the age of 62.26cm, followed by the Planting distance 35 cm x 35 cm treatment 56.4 cm and the lowest in the without planting distance treatment as high as 49.2 cm. Based on the results of the BNJ test at the 0.05% level (Table 1), it shows that the Planting distance 55 cm x 55 cm treatment was not significantly different from the Planting distance 45 cm x 45 cm treatment but significantly different from the Planting distance 35 cm x 35 cm treatment and significantly different from the control (without planting distance). From the results of observations of cabbage plant height gave a significant effect on plant height.(Friday, 2017) said that plants that lack N elements cause plant growth and development to be disrupted and yields decline due to disruption of the formation of chlorophyll which is very important for the photosynthesis process.

The results of the 5 WAP observations, the highest plant height at Planting distance 55 cm x 55 cm the highest average was 64.13 cm and the lowest plant average was at a plant spacing without treatment an average of 49.20 cm. The spacing of 55 x 55 cm has wider spacing between rows. This is in accordance with the opinion of, which states that a wider spacing or a less frequent population allows greater sunlight so as to increase the efficiency of photosynthesis so that the reception of sunlight is higher in this case helping

plants grow. The plant height is an illustration of the environmental influence on plant growth, in this case, the effect of plant spacing, where plants generally will change morphological properties including changes in plant height.

The lowest plant growth in the treatment without spacing is 49.20 cm, this spacing is closer than the previous distance. So that it has an effect in competing with the growing space and available nutrients. In accordance with the opinion of (Kriswantoro et al., 2017) also found that denser spacing or denser populations inhibit growth in plant height, this is influenced by plants taking nutrients so that competition occurs which causes plant growth to be disrupted at its growth rate.

Number of Cabbage Plant Leaves

Based on the results of the variance of the number of cabbage leaves at the age of 1, 2, 3, 4, and 5 weeks after planting, it showed that the spacing treatment had a significant effect on the growth of the number of cabbage leaves .

Table 2. Number of Leaves of Cabbage Plants at Observation Time 1-5 WAP

Treatment	Week After Planting (strand)				
	1	2	3	4	5
Without Planting Distance	2.70bc	4.67bc	5.7ab	9.1b	11.1ab
Planting distance 35 cm x 35 cm	2.80b	4.77b	5.8ab	9.2a	11.2b
Planting distance 45 cm x 45 cm	3.27a	4.83b	6.2a	9.3a	11.9a
Planting distance 55 cm x 55 cm	3.30a	4.87a	6.8a	9.4a	12.2a
HSD 0.05	0.2	0.1	0.7	0.2	0.4

Note: The same letter in one column shows no significant difference at the 0.05 level.

The average yield of the highest number of cabbage leaves at the age of 5 weeks after planting was obtained in the Planting distance 55 cm x 55 cm treatment, which was 12.2, then followed by the Planting distance 45 cm x 45 cm treatment, which was 11.9, followed by the Planting distance 35 cm x 35 cm treatment, which was 11.2 and the lowest was in the Wiithout Planting Distance treatment, 11.1. Based on the results of the BNJ test at a level of 0.05% (Table 2), it shows that the Planting distance 55 cm x 55 cm spacing treatment is not significantly different from the Planting distance 45 cm x 45 cm treatment but is significantly different from the Planting distance 35 cm x 35 cm treatment and is different very real with control (Without Planting Distance). Similarly, the observation of the number of leaves showed that there was a significant difference of 5 WAP. The highest number of leaves was in the treatment distance of 55 cm x 55 cm 12.2 leaves and the lowest average number of leaves at the spacing without treatment 11.1 strands. Spacing of 55 x 55 cm aims to provide good conditions where this spacing provides conditions for plants, especially to increase the capture of sunlight, nutrients,(Rahmawati et al., 2015).While

the spacing without treatment according to (Alfandi & Soedomo, 2006)**,**is influenced by plants competing for nutrients and the air environment, light, wind circulation that carries oxygen, nitrogen, and carbon dioxide, air humidity, and others. this has an impact on the number of leaves formed. According to(Kriswantoro et al., 2017), that the wide plant spacing causes the plant leaves to not overlap each other so that the plants get sunlight evenly and allow the humidity to drop so it doesn't make it easier for plant growth to be disturbed and leaf growth is low. Irawati (2015) in(Luthfiana et al., 2019) states that the regulation of plant populations through the spacing of plants will affect the efficiency of plants in utilizing sunlight, nutrients, and water which in turn affects the growth and yield of these plants. Smaller competition can be used by plants in making maximum use of growing space. Optimal growing space so that the photosynthesis process can run optimally. The results of photosynthesis are transmitted through the phloem tissue from the leaves to the flower organs in plants, which are in the form of C6H12O6 so that the flowers experience an increase in diameter (the process of growth and development).

Cabbage Plant Leaf Length

Based on the results of the leaf length variance of cabbage at the age of 1, 2, 3, 4, and 5 weeks after planting, it showed that the spacing treatment did not significantly affect the growth of cabbage leaf length.

Table 3. Cabbage leaf length, observation time 1-5 WAP.

Treatment	Week After Planting (cm)				
	1	2	3	4	5
Without Planting Distance	33.03a	27.2bc	27.72cd	28.5cd	28.96cd
Planting distance 35 cm x 35 cm	34.78a	36.02b	38.7b	40.45b	57.88b
Planting distance 45 cm x 45 cm	33.66a	36.13a	38.22a	43.13b	58.24b
Planting distance 55 cm x 55 cm	34.45a	34.86a	38,50a	47.33a	59.02a
HSD 0.05	not real	1.4	1.2	11.1	11.9

Noted: The same letter in one column shows no significant difference at the 0.05 level.

The highest mean leaf length of cabbage at the age of 5 weeks after planting was obtained in the Planting distance 55 cm x 55 cm treatment which was 59.02 cm, then followed by the Planting distance 45 cm x 45 cm treatment 58.24 cm, followed by the Planting distance 35 cm x 35 cm treatment 57.88 cm, and the lowest in the without planting distance treatment 28.96.2. Based on the results of the BNJ test at a level of 0.05% (Table 3.) it shows that the treatment of spacing Planting distance 55 cm x 55 cm is not significantly different from the Planting distance 45 cm x 45 cm but significantly different from the Planting distance 35 cm x 35 cm treatment and different. very

real with control (without planting distance). Based on the results of the variance from observations of 5 WAP, it showed that leaf length had a significant effect on the spacing treatment. The best leaf length was at the 55 x 55 spacing at 5 WAP, which was 59. Sunlight contributes to leaf length because it is related to relatively the same photosynthetic activity of each plant. In addition, the availability of nutrients in the soil and air temperature affects the transpiration process, where each plant receives relatively the same climatic and environmental conditions Sunlight contributes to leaf length because it is related to relatively the same photosynthetic activity of each plant. In addition, the availability of nutrients in the soil and air temperature affects the transpiration process, where each plant receives relatively the same climatic and environmental conditions(Kriswantoro et al., 2017). Added again(Fajeriana et al., 2013)To utilize solar radiation efficiently, plants must be able to absorb some of the solar radiation with their green photosynthetic network. At the beginning of growth, plants invest most of the early growth in the form of increasing leaf area, for efficient utilization of solar radiation in the photosynthesis process. Leaf area initially increased with an exponential growth rate, were at the beginning of the growth of small leaf area, a few days after the vegetative phase there was a rapid increase in leaf length with a linear rate. This rate begins to decrease entering the generative phase because most of the proportion of biomass sharing is accumulated in the generative process. Entering the physiological mature phase, there was no increase in leaf length and even a decrease. in addition, optimal spacing not only causes the struggle for nutrients in the soil but also the distribution of sunlight to plant organs more efficiently, due to the absence of plants whose leaves cover each other, because in addition to ILD not only explains the ratio of land cover to a land area by plants, but also explains the magnitude of light interception by plants even though the stem also intercepts light, but the activity is more effective in the leaves. The light captured by the leaves is then used in the process of photosynthesis, so the ILD reflects the area of the leaves that carry out photosynthesis. Therefore, the higher the ILD value of the plant, the higher the crop production.

Cabbage Plant Fresh Weight

Based on the results of the variance of the fruit weight of cabbage plants, it was shown that the spacing treatment did not have a significant effect on the growth of cabbage fruit weight.

Table 4. Fruit Weight of Cabbage Plants

Treatment	The average weight of cabbage
Without Planting Distance	1.27a
Planting distance 35 cm x 35 cm	2.05a
Planting distance 45 cm x 45 cm	1.64a
Planting distance 55 cm x 55 cm	2.08a
HSD 0.05	not real

Note: The same letter in one column shows no significant difference at the 0.05 level.

The results of the analysis of variance obtained, it can be seen that the application of spacing does not have a significant effect on the fruit weight of cabbage plants. The results showed that the heaviest cabbage weight was in the 55 x 55 spacing treatment, which was 2.08 gr. This is because the treatment creates a good growing medium so that nutrients can be absorbed by plants optimally. According to(Syakur et al., 2016)five factors support plant growth,

especially the process of flowering and fruiting, namely temperature, light intensity, air humidity, rainfall, and soil fertility. The same thing was also stated by Weiss et. al. (1991) in(Fajeriana et al., 2013)that the leaf area index data affects the effectiveness and efficiency in utilizing light energy which will later become plant biomass. Leaves that have a high chlorophyll content are more efficient at capturing sunlight energy for photosynthesis. Greener leaves have higher chlorophyll content and wider leaf surfaces contain more chlorophyll. The investment of photosynthetic results in vegetative organs greatly determines productivity at the next level of development, namely generative and crop yields.

4. CONCLUSION

The plant spacing factor on cabbage had a significant effect on the observation of plant height, the number of leaves, and leaf length. While the results of observations on fruit weight did not have a significant effect on the spacing treatment. Planting distance (55 cm x 55 cm) gave the best effect on the growth and production of cabbage (Brassica oleraceae L.)

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