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Differences in seedling age in several lowland varieties of cauliflower (*Brassica oleraceae* L.) for cultivation development efforts in Kabupaten Karawang

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Abstract

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In Indonesia, cauliflower is generally grown in the highlands (mountainous areas). However, with advanced agricultural technology, the lowland varieties of cauliflower have now been found. This study aims to find the best combination of seedling age and varieties of cauliflower (*Brassica oleraceae* L.) for the development of cultivation techniques in the lowlands. The research method used was an experimental method with a single factor randomized block design (RBD) with 8 treatments and repeated 4 times, so that there were 32 experimental units. The treatments were as follows: A (seedling age of 21 days after sowing (das) and PM126 F1 variety), B (seedling age of 28 das and PM126 F1 variety), C (seedling age of 21 das and Mona F1 variety), D (seedling age of 28 das and Mona F1 variety), E (seedling age of 21 das and Bima 45 variety), F (seedling age of 28 das and Bima 45 variety), G (seedling age of 21 das and Diamond variety), H (seedling age 28 das and variety Diamond). Based on the experimental results, the Bima 45 variety with a seedling age of 28 das (treatment F) showed the highest growth in plant height and stem diameter compared to other treatments, while the PM 126 F1 variety with 21 das seedling age (treatment A) showed the highest yield at each weight. Interest per plant (221.46 grams), production per plot (2.66 kg) and production per ha (12.66 tonnes/ha).

Keywords: seedling age; variety; weight of curd; lowland

Introduction

Cauliflower (*Brassica oleraceae* L.) is a type of vegetable that belongs to the Cruciferae family. The Cauliflower plant originated from Europe and was first discovered in Cyprus, southern Italy and the Mediterranean. Quiros & Farnham (2011) stated that Italy is the origin of broccoli and cauliflower. This plant comes from sub-tropical areas, the temperature range for growing cauliflower is a minimum of 15.5–18°C and a maximum of 24°C. The optimum humidity for this plant is between 80–90%. With new cultivars that are resistant to high temperatures, cabbage cultivation can also be carried out in the lowlands (0–200 m asl) and medium (200–700 m asl). Susila (2006) stated that this plant can grow well in all types of soil in the lowlands, but the most suitable soil for planting Cauliflower is sandy

loam, loam or clayey clay, which is fertile soil with good nutrients.

Cauliflower is generally grown in the highlands (mountainous areas), namely at an altitude of 1000-2000m above sea level, such as in West Java (Lembang, Cianjur, Garut, Subang, Cisarua, Cibodas), Central Java (Kopeng), and Bali (Bedugul) (Ministry of Agriculture, 2017). However, with advanced agricultural technology, lowland varieties of Cauliflower have now been found. Several cultivated varieties of lowland Cauliflower, including PM 126 F1, Mona F1, Bima 45, Diamond and Larisa.

Research on Cauliflower using lowland tolerant varieties has been carried out, such as in the research of Haryanti et al. (2019). According to Salisbury and Ross (1995), each variety has different resistance, some plants can adapt quickly, but on the other hand, there are plants that take a long time to adapt to their environment. Gomies et al. (2018) added that each variety has a difference in terms of its ability to sustain individual life and growth from different climates. Plant genetic factors and their adaptation to the environment produce different growths, it can be seen that varieties have a significant effect on the growth and yield of cauliflower.

In order to maximize the yield of cauliflower, it is necessary to make more appropriate cultivation methods, including using the right age of the seedling. A good seedling age for transplanting is important so that the plant can accelerate the adaptation of plants to the environment. Therefore, the plant growth is not hampered and produces better vegetative parts (Widiatningrum, 2010). If the seedling age is not right or too old, then the plant does not have enough time to complete its vegetative growth, the plant will age faster and enter the generative stage quickly (Ainy et al., 2019). Amin (2018) states that the age of the seedling that is good for transplanting is 4 weeks after sowing, with the PM 126 F1 variety. However, according to research by Fridayati (2015), it is stated that the age of the seedlings for transplanting is at the age of 29 days after sowing, so it is necessary to re-examine the age of these seeds according to their respective regions.

In general, seedling of vegetable plants that are good for transplanting is 15-30 days after sowing (DAS). Transfering of seedling to the field is carried out when the seedling has strong roots and has 3-6 strands and is not affected by pests and diseases so that the growth and yields obtained from these plants are better (Susila, 2006). In addition to determining the age of seedlings to grow and produce high yields, it is necessary to pay attention to determining the types of plants, cultivars, and the environmental conditions of the transplanted plants and their cultivation techniques. According to Erwin et al. (2015), plant growth is not only influenced by internal factors but also by external factors. This indicates that proper cultivation is needed to support the growth and yield of cauliflower in the lowlands. Determination of the most proper age of the seedling and varieties of lowland cauliflower will result in high production.

Materials and Method

This research was carried out in July 2020 – October 2020 at the experimental land of the Faculty of Agriculture, Singaperbangsa Karawang University, which is located in Pasirjengkol Village, Majalaya District, Karawang Regency. The results of the initial soil analysis in the experimental field showed that the C-Organic content was low with a yield of 1.80%, an acidic pH of 5.55, a N nutrient content of 0.15%, a P of 44.32 ppm, and a K of 91, 37 ppm. The daily temperature during the experiment ranged from 22.9°C – 38.9°C with an average temperature of 30.9°C, while the humidity ranged from 40.2% – 98.4% with an average air humidity of 40.2%.

The stages of cauliflower (*Brassica oleraceae* L.) cultivation in this research include land preparation including land clearing, soil loosening, experimental plots making, and basic fertilizer application. The land was cleared of weeds and the remains of plant roots. Soil loosening was done by hoeing the soil with a depth of approximately 40–50 cm to loosen the land, so that air exchange in the soil is good, oxygen gases can enter the soil, gases that poison plant roots can be oxidized, and acids can get off the ground. The size of the experimental plot was 300 cm × 75 cm. The height of the beds was 35 cm and the distance between the plots was 50 cm. Cauliflower was planted with a spacing of 50 × 50 cm in the morning.

The experimental design used was a single factor randomized block design (RBD) with 8 treatment combinations and was repeated 4 times so that there were 32 experimental units. Each experimental unit consisted of 12 plants, for a total of 384 plants. Each experimental unit observed was 6 plants, so a total of 192 plants to be observed. The respective treatments for seedling age were 21 das and 28 das. The treatments for the varieties of cauliflower were PM 126 F1, Mona F1, Bima 45 and Diamond. The combination treatment of seedling age and varieties of Cauliflower is presented in (Table 1).

The data obtained from the results of the observations of each variable were tested using the F test at the 5% level using the ANOVA method. If there is a significant difference, then a further test is carried out to find out which treatment combination gives the best results, data analysis is further tested using the multiple distance test or the Duncan Multiple Range Test (DMRT) advanced test at the 5% level. The data obtained from the results of the observations of each

Table 1. Combination treatment of seedling age and cauliflower (*Brassica oleraceae* L.) varieties

No.	Treatment	Seedling age	Cauliflower varieties
1	A	21 das	PM 126 F1
2	B	28 das	PM 126 F1
3	C	21 das	Mona F1
4	D	28 das	Mona F1
5	E	21 das	Bima 45
6	F	28 das	Bima 45
7	G	21 das	Diamond
8	H	28 das	Diamond

variable were tested using the F test at the 5% level using the ANOVA method. If there is a significant difference, then a further test is carried out to find out which treatment combination gives the best results, data analysis is further tested using the multiple distance test or the Duncan Multiple Range Test (DMRT) advanced test at the 5% level.

Results and Discussion

Plant height

Plant height is one aspect of plant vegetative growth. Height is the growth of the plant vertically and changes every day. According to Haryanti et al. (2019) the vegetative character and yield of Cauliflower in the lowlands are higher than the highlands. The results of the analysis of variance (Table 2) showed that the treatment F (seedling age of 28 das Bima 45 variety) gave the best results at 1 week after plant height and was significantly different from the other treatments. At 7 weeks after plant, treatment F (seedling age of 28 das Bima 45 variety) and treatment A (seedling age of 21 das PM 126 F1 variety) gave the best results and was significantly different from treatment H (seedling age 28 of das Diamond variety), but not significantly different from treatment B (seedling age 28 of das PM 126 F1 variety), treatment C (seedling age of 21 das Mona F1 variety), treatment D (seed age of 28 das Mona F1 variety), treatment E (seed age of 21 das Bima 45 variety) and treatment G (seedling age of 21 das Diamond variety).

Stem diameter

Based on the results of the analysis of variance (Table 3), it shows that the treatment F (seedling age of 28 das Bima 45 variety) gave the best results at 1 week after plant stem diameter, which was significantly different from treatment A (seedling age of 21 das PM 126 F1 variety), treatment C (seedling age of 21 das Mona F1 variety), treatment D (seedling age of 28 das Mona F1 variety), treatment E (seedling age of 21 das of Bima 45 variety), treatment G (seedling age of 21 das of Diamond variety) and treatment H (seedling age of 28 das Diamond variety), but not significantly different from treatment B (seedling age of 28 das PM 126 F1 variety). At 3, 4, 5, 6 and 7 week after plant, all treatments did not show any significant effect on stem diameter.

Transplanting will produce a sturdy plant if root recovery is good. Salisbury & Ross (1995) stated that the stem is a medium for transporting nutrients from the soil and the photosynthetic product of the plant itself. With good photosynthetic activity, the growth of the stems to the side is also faster so that the stem diameter is larger. It is hoped that the transportation system in the plant will run well so that the plants can grow stronger in unfavorable field conditions. At the beginning of growth, treatment F (seedling age of 28 das Bima 45 variety) showed the highest plant height and stem diameter compared to other treatments. According to Firmansyah (2020), each variety has its own specifications and depends on genetic factors. Newly transplanted plants need time to recover due to transplanting so that the roots do not actively absorb nutrients for growth, while at the age of 5 and 6 weeks the seedlings have already a strong root system. This is what causes the age of 28 das seedlings to grow better than 21 das in the Bima 45 variety.

Table 2. Average plant height (cm) of cauliflower (*Brassica oleraceae* L.)

Treatment	Plant age (week after planting)						
	1	2	3	4	5	6	7
A	8.62 bc	9.25 bc	11.39 ab	15.64 a	18.87 ab	22.04 ab	23.82 a
B	9.42 b	10.18 ab	12.76 a	16.31 a	19.18 a	21.33 abc	23.47 ab
C	7.86 c	8.54 c	11.28 ab	14.98 ab	18.19 abc	21.27 abc	22.78 ab
D	9.47 b	9.87 abc	12.14 a	15.46 a	18.71 ab	21.21 abc	22.28 ab
E	7.82 c	8.45 c	11.37 ab	15.96 a	18.80 ab	21.35 abc	23.29 ab
F	10.60 a	11.19 a	13.13 a	17.32 a	19.63 a	22.65 a	24.11 a
G	5.12 d	6.04 d	8.62 b	14.02 ab	15.82 c	19.05 bc	20.84 ab
H	8.22 c	8.82 bc	11.03 ab	12.03 b	16.17 bc	18.33 c	20.23 b
CV (%)	9.09	10.84	17.16	14.04	9.41	9.26	9.51

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test

Table 3. Average stem diameter (cm) of Cauliflower (*Brassica oleraceae* L.)

Treatment	Plant age (week after planting)						
	1	2	3	4	5	6	7
A	1.79 c	2.21 bc	2.78 a	4.01 a	5.23 a	7.10 a	9.38 a
B	2.27 a	2.61 a	3.27 a	4.37 a	5.78 a	7.59 a	9.53 a
C	1.63 cd	2.12 bc	2.88 a	4.12 a	5.63 a	7.39 a	9.35 a
D	2.06 b	2.40 ab	3.11 a	4.26 a	5.50 a	6.97 a	9.05 a
E	1.79 c	2.19 bc	2.87 a	4.19 a	5.64 a	7.68 a	9.51 a
F	2.36 a	2.66 a	3.27 a	4.32 a	5.65 a	7.50 a	9.36 a
G	1.51 d	1.90 c	2.68 a	3.97 a	5.57 a	7.27 a	9.19 a
H	2.01 b	2.29 b	2.97 a	4.24 a	5.28 a	7.16 a	8.77 a
CV (%)	6.88	8.52	14.55	16.19	12.06	11.76	7.30

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test

Number of leaves and leaf area

Based on the analysis of variance (Table 4), all treatments did not show significant differences in the number of leaves of the cauliflower. Meanwhile, the leaf area showed that treatment E (seedling age of 21 das Bima 45 variety) had the highest leaf area significantly different from treatment G (seedling age of 21 das Diamond variety) and treatment H (seedling age of 28 das Diamond variety). But it was not significantly different from treatment A (seedling age of 21 das PM 126 F1 variety), treatment B (seedling age of 28 das PM 126 F1 variety), treatment C (seedling age of 21 das Mona F1 variety), treatment D (seedling age of 28 das Mona F1 variety) and treatment F (seedlings age of 28 das Bima 45 variety).

The taller the plant, the more the number of leaves will be. The number of leaves of a plant will greatly affect the photosynthesis process that occurs in plants. In relation to photosynthesis and transpiration, apart from the number of leaves, the size of each leaf must also be considered. This will determine the leaf area of each plant. In general, with the increasing number of leaves and leaf area of a plant, the photosynthetic activity will also increase. The older the seedling, the more leaves will be and the leaf surface area will also increase. Based on the research of Marliah et al. (2013) varieties have a significant effect on plant height, number of leaves, and net flower weight per plant. The results tend to be better for the PM 126 F1 variety.

***Wet and dry weight of cauliflower (Brassica oleraceae* L.)**

The results of the analysis of variance (Table 5) showed that treatment A (seedling age of 21 das PM 126 F1 variety) and treatment B (seedling age of 28 das PM 126 F1 variety) gave the highest wet weight significantly different from treatment H (seedling age of 28 das Diamond variety), but not significantly different from treatment C (seedling age of 21 das Mona F1 variety), treatment D (seedling age of 28 das Mona F1 variety), treatment E (seedling age of 21 das Bima 45 variety), treatment F (seedling age of 28 das Bima 45 variety) and G treatment (seedling age of 21 das Diamond variety).

Based on the analysis of variance (Table 5) treatment C (seedling age of 21 das Mona F1 variety), treatment D (seedling age of 28 das Mona F1 variety), treatment E (seedling

Table 4. The average number of leaves and leaf area of cauliflower (*Brassica oleraceae* L.)

Treatment	Number of leaves	Leaf area, cm^2
A	14.79 a	155.04 ab
B	15.42 a	183.22 ab
C	14.50 a	178.07 ab
D	15.13 a	158.83 ab
E	12.75 a	214.98 a
F	13.42 a	182.36 ab
G	14.63 a	136.69 bc
H	15.67 a	88.59 c
CV (%)	13.28	23.12

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test

Table 5. Average wet and dry weight of Cauliflower (*Brassica oleraceae* L.)

Treatment	Wet eight per plant, g	Dry weight per plant, g
A	466.84 a	10.97 ab
B	470.42 a	10.78 ab
C	395.75 ab	12.44 a
D	409.92 ab	11.54 a
E	425.58 ab	12.02 a
F	405.71 ab	12.31 a
G	341.38 ab	9.40 b
H	281.92 b	9.39 b
CV (%)	23.50	10.53

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test

age of 21 das Bima 45 variety) and treatment F (seedling age of 28 das Bima 45 variety) gave the highest dry weight yield, which was significantly different from treatment G (seedling age of 21 das for Diamond variety) and treatment H (seedling age of 28 das Diamond variety), but not significantly different from treatment A (seedling age of 21 das PM 126 F1 variety) and treatment B (seedling age of 28 das PM 126 F1 variety).

Sitompul & Guritno (1995) stated that calculating plant dry weight is important because dry weight represents the plant metabolite. Dry weight gain is also used as an indicator of plant growth because dry weight reflects the accumulation of organic compounds that plants have successfully synthesized from inorganic compounds, namely water and CO_2. According to Larcher (1995) plant dry weight is the result of the accumulation of net results of CO_2 assimilation during plant growth and development. The growth of the plant itself can be considered as an increase in fresh weight and an accumulation of dry matter. So the better plant growth, the better dry weight.

Increasing the photosynthetic process will also increase the results of photosynthesis in the form of organic compounds which will be translocated to all plant organs and have an effect on plant dry weight. The yield of dry weight is a balance between photosynthesis and respiration. Photosynthesis will increase the dry weight due to CO_2 uptake while respiration results in a decrease in dry weight due to the release of CO_2. If respiration is greater than plant photosynthesis, the dry weight will be reduced and vice versa (Salisbury and Ross, 1995).

Curd Diameter

Based on the analysis of variance (Table 6) shows that treatment A (seedling age 21 das variety PM 126 F1), treatment B (seedling age of 28 das PM 126 F1 variety), treatment G (seedling age of 21 das variety Diamond variety) and treatment H (seedling age of 28 das of Diamond variety) had the highest flower diameter, significantly different from treatment C (seedling age of 21 das Mona F1 variety), treatment E (seedling age of 21 das Bima 45 variety) and treatment F (seedling age of 28 das Bima 45 variety) but not significantly different from treatment D (seedlings age of 28 das of Mona F1 variety). PM 126 F1 varieties with 21 das and 28 das and Diamond varieties with 21 das and 28 das had the highest curd diameter, but physically the curd of PM 126 F1 variety was tighter than the Diamond variety, which had slightly tenuous curd. Farmers and field sellers prefer tight curd diameters to market the Cauliflower.

Table 6. Average curd diameter of Cauliflower (*Brassica oleraceae* L.)

Treatment	Curd diameter, mm
A	114.17 a
B	110.86 a
C	89.34 b
D	101.44 ab
E	89.23 b
F	91.19 b
G	114.94 a
H	111.89 a
CV (%)	12.02

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test.

Curd Weight per Plant, Production per Plot and Production per Ha

Based on the analysis of variance (Table 7), it shows that treatment A (seedling age of 21 das PM 126 F1 variety) and treatment B (seedling age of 28 das PM 126 F1 variety) gave different weight of curd per plant, production per plot and production per hectare. significantly with C treatment (seedling age of 21 das Mona F1 variety), E treatment (seedling age of 21 das of Bima 45 variety) and treatment F (seedling age of 28 das Bima 45 variety), but not significantly different from treatment D (seedling age of 28 das Mona F1 variety), treatment G (seedling age of 21 das Diamond variety) and treatment H (seedling age of 28 das Diamond variety). This is in line with the research of Marliah et al. (2013) stated that the PM 126 F1 variety of Cauliflower has advantages with high production and productivity compared to other cauliflower varieties. Meriyanto et al. (2017) stated that planting of PM 126 F1 in polybags reached 104.05 grams per plant. Likewise with Oktaviania & Usmadia's (2019) research, the production of PM 126 F1 reached 270 g per plant.

Based on its curd weight, PM 126 F1 varieties with 21 das and 28 das seedlings age had heavier curd weights compared to other varieties, although in the curd diameter, they were not significantly different from the Diamond varieties with 21 das and 28 das seedling age. For farmers and sellers, the weight is more important than the diameter of the curd. If the scale is heavy it will be more profitable. Rovi'ati et al. (2019) stated that Mona and PM 126 varieties produced higher crop weight than Diamond in hydroponic cultivation in the lowlands. The high production of a variety is because these varieties quickly adapt to the environment. This is because although other varieties have good production potential genetically but because they require a long time of adaptation it will produce lower production than it should be (Hayati et al., 2012).

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Table 7. Average curd weight per plant, production per plot and production per ha

Treatment	Curd weight per plant, g	Production per plot, kg	Production, ton ha^{-1}
A	221.46 a	2.66 a	12.66 a
B	213.92 a	2.57 a	12.22 a
C	126.37 b	1.52 b	7.22 b
D	155.54 ab	1.87 ab	8.90 ab
E	125.04 b	1.50 b	7.15 b
F	129.59 b	1.56 b	7.41 b
G	172.33 ab	2.07 ab	9.85 ab
H	155.34 ab	1.86 ab	8.88 ab
CV (%)	25.53	25.58	25.52

Note: The number followed by the same letter in the same column shows that it is not significantly different in the 5% Duncan Test

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Conclusion

Based on the experimental results, the Bima 45 variety with a seedling age of 28 das (treatment F) showed the highest growth in plant height and stem diameter compared to other treatments. Meanwhile, the PM 126 F1 variety of 21 das seedling age (treatment A) showed the highest yield for each curd weight per plant (221.46 grams), production per plot (2.66 kg) and production per ha (12.66 tonnes/ha).

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