



Original Paper

# The Effect of Differences in Variety and POC on The Growth and Production of Sunflowers (*Helianthus Annuus. L*)

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**Abstract**—This study used a completely randomized block design (CRBD) consisting of two factors. Factor I included the Kanigara variety (V1), the Helina variety (V2), and the BM1 variety (V3). Factor II consists of control POC concentration (P1), POC concentration of 9 ml/L (P2), POC concentration of 12 ml/L (P3), and POC concentration of 15 ml/L (P4). The parameters observed for plant growth were plant height (cm), number of leaves (sheets), stem diameter (cm), leaf area (cm<sup>2</sup>), and flowering age (DAP). The parameters observed for production were flower diameter (cm), harvest age (DAP), total seed weight per plant (g), weight of 100 seeds (g), wet husk weight (g), and dry husk weight (g). The Kanigara variety was the best in terms of plant height, leaf area, flower diameter, and seed weight per plant. The Helina variety was the best in terms of number of leaves, flowering age, and harvest age, while the BM1 variety was the best in terms of stem diameter, weight of 100 seeds, and wet and dry husk weight. POC at 0 ml/L had a significant effect on all growth and production parameters. A significant interaction between variety and POC was found in wet and dry seed weight, with the highest results observed in the BM1 variety at 0 ml/L POC.

**Keywords**— BM1 variety, Helina variety, Liquid organic fertilizer, Kanigara variety, Sunflower

## I. INTRODUCTION

Sunflowers (*Helianthus annuus L.*), members of the Asteraceae family, are annual plants native to Eastern North America [1,2]. In Indonesia, sunflowers were first introduced in 1907 by Dutch agricultural experts [3] and are now cultivated for various purposes, including as ornamental plants, vegetable oil production, and as industrial raw materials [4]. Sunflower seeds, which are rich in healthy fats, protein, and vitamin E, are also widely consumed as a nutritious snack [5]. Despite these benefits, Indonesia still faces significant challenges in meeting its domestic vegetable oil demand. In 2023, the global export value of sunflower oil reached approximately Rp300 trillion, with Ukraine, Russia, and Argentina as the main producers [6]. In addition, raw

sunflower seeds contribute significantly to international trade, with an annual value exceeding Rp45 trillion. However, Indonesia is still heavily dependent on vegetable oil imports from these countries. This dependence is exacerbated by the fact that domestic vegetable oil consumption increased by 12% in 2023, while local production was only able to meet about 3% of total national demand [6].

Therefore, choosing the right variety is a key factor in improving the growth and yield of sunflowers. Sunflowers need sufficient nutrients to support their growth, which can be supplied through fertilization. Fertilization plays an important role in improving plant quality and soil fertility, thereby promoting healthy plant development and maximizing crop yields. Organic fertilizers are generally available in two forms: solid and liquid. Liquid organic fertilizer (LOF) is produced through the fermentation of organic materials [7]. According to [8], LOF derived from organic waste is highly effective for a wide variety of plants, including vegetables, fruits, ornamental plants, rice, and secondary crops. It supports photosynthesis and accelerates fruit ripening, thereby increasing productivity [8]. POC is usually applied by spraying the solution directly onto parts of the plant such as leaves (both surfaces), stems, and branches until it is evenly distributed throughout the plant. Research conducted on Dramaga Yellow Kenikir [9] shows that POC at a concentration of 9 ml/L can accelerate flowering, while a concentration of 12 ml/L increases growth and yield. These findings highlight the potential of POC in optimizing the vegetative and generative phases of plants, including sunflowers, thereby contributing to increased domestic production.

## II. MATERIAL AND METHODS

### A. Description of Study Area

This study was conducted from January 31 to May 28, 2025, at UG Carte Technopark, located on Jalan Desa Jamali Mulyasari, Mande District, Cianjur Regency, West Java Province. The research location is 392 meters above sea level (masl). The soil type used in this study is classified as ultisol. In the morning, light intensity ranged from 631 to 695 Lux, then increased at noon to 812 to 891 Lux, and decreased in the afternoon to a range of 712 to 767 Lux. The average air

temperature in the morning was recorded at 28.1 °C with a relative humidity of 67.5%. At noon, the temperature increased to an average of 31.1 °C with a humidity of 69.4%. In the afternoon, the temperature decreased to an average of 25.6 °C with a relative humidity of around 67.5%.

### B. Experimental Materials

The tools used in this study were a 7-in-1 sensor-based soil test kit, imaje g, 40 x 40 cm polybags, trays, shovels, rulers, measuring cups, sprayers, watering cans, and scales. The materials used in this study were Kanigara sunflower seeds, Helina sunflower seeds, BM1 sunflower seeds, soil, water, POC, and compound NPK fertilizer.

### C. Experimental Design

The experiment employed a Randomized Complete Block Design (RCBD) with two factors. Factor I consisted of three sunflower varieties: Kanigara (V1), Helina (V2), and BM1 (V3). Factor II consisted of four fertilization treatments: control (NPK 5 g/plant + 0 ml/L POC) (P1), 9 ml/L POC (P2), 12 ml/L POC (P3), and 15 ml/L POC (P4). In total, 12 treatment combinations were tested with three replications, resulting in 36 experimental units and a total of 108 plants. The growth parameters observed were plant height (cm), number of leaves, leaf area (cm<sup>2</sup>), and stem diameter (cm). Production parameters included flower diameter (cm), flowering age (days after planting), harvest age (days after planting), seed weight per plant (g), and 100-seed weight (g). In addition, soil and environmental analyses were also conducted.

### D. Data Collection and Analysis

The data obtained were first tested for normality and then analyzed using the SAS System for Windows version 9.0 with the Analysis of Variance (ANOVA) method. If the F-calculated value exceeded the F-table value, or if a significant effect was detected, further testing was carried out using Duncan's Multiple Range Test (DMRT) at the 5% significance level ( $\alpha = 0.05$ ).

## III. RESULT AND DISCUSSION

### A. General Condition

TABLE I. AVERAGE SOIL ANALYSIS TEST

Parameter	Before		After	
	Nilai	Kriteria	Nilai	Kriteria
Ph	8.29	Sufficiently Basic	7.06	Neutral
Ec (µS/cm)	924.58	High	195.91	Moderate
Temperature(°C)	35.06	High	31.16	Optimal
Humidity (%)	33.40	Fairly High	27.49	Fair
N (ppm)	61.33	High	14.25	Moderate
P (ppm)	93.7	High	14.66	Moderate
K (ppm)	216.50	High	40.33	Moderate
Eh (mV)	0.06	Low	0.10	Normal

\*[10]

Soil testing using a 7-in-1 sensor-based tester provides important information about soil conditions that can affect plant growth, especially sunflowers (*Helianthus annuus*.L.). The measurement results show that the soil pH ranges from 6.9 to 8.2. The ideal soil pH for sunflower growth is between 6.0 and

7.5. Therefore, soil pH within this range can be considered adequate, although higher pH values (above 7.5) may affect the availability of certain nutrients, such as phosphorus (P) and iron (Fe) [11]. The measured electrical conductivity (EC) values ranged from 279 to 587.6 µS/cm.

High EC can indicate salinity, which can affect plant growth. For sunflowers, the ideal EC value should not exceed 1.5 mS/cm (1500 µS/cm) [12]. Therefore, the measured EC values are still within safe limits for sunflower growth. The recorded soil temperature, between 20.8 and 30.7 degrees Celsius, is also an important factor. Sunflowers grow optimally at temperatures between 20 and 30 degrees Celsius. Temperatures higher than 30 degrees Celsius can cause stress on the plants, which can reduce crop yields [13]. The nitrogen (N), phosphorus (P), and potassium (K) content in the soil ranges from 20-53.6, 18-69.6, and 27.6-188.3 mg/kg, respectively. These three nutrients are essential for sunflower growth.

Nitrogen plays a role in vegetative growth, phosphorus supports root development and flowering, and potassium contributes to plant resistance to stress [14]. Thus, the measured N, P, and K content indicates that the soil has good potential to support sunflower growth. The soil's redox potential (Eh) value in the range of 0.065–0.127 V indicates good aeration. This condition is important for root growth and nutrient availability [15].

### B. The Growth of Sunflower

Different varieties had a significant effect on sunflower plant height. Treatment with fertilizer concentration (POC) also had a significant effect on this parameter. The interaction between variety and POC concentration did not have a significant effect on plant height. Treatment with different varieties and POC concentrations can affect the rate of plant height growth starting from 2 weeks after planting (WAP).

TABLE II. PLANT HEIGHT OF SUNFLOWER (CM)

Treatment	Plant Age (Week After Planting/WAP)				
	2	4	6	8	10
V1 (Kanigara)	34.79a	63.66a	95.20a	153.59a	160.32a
V2 (Helina)	26.83b	47.52b	70.67b	106.04b	134.91b
V3 (BM1)	7.04b2	18.41b	68.53b	96.04b	122.01c
P1 (0 ml/L)	32.78a	71.23a	103.75a	144.74a	164.20a
P2 (9 ml/L)	28.58b	47.53b	69.26b	102.00b	133.87b
P3 (12 ml/L)	28.13b	46.72b	69.53b	104.34b	127.67b
P4 (15 ml/L)	28.71b	47.32b	70.00b	103.91b	130.58b
Interaction	Nr	Nr	Nr	Nr	Nr

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

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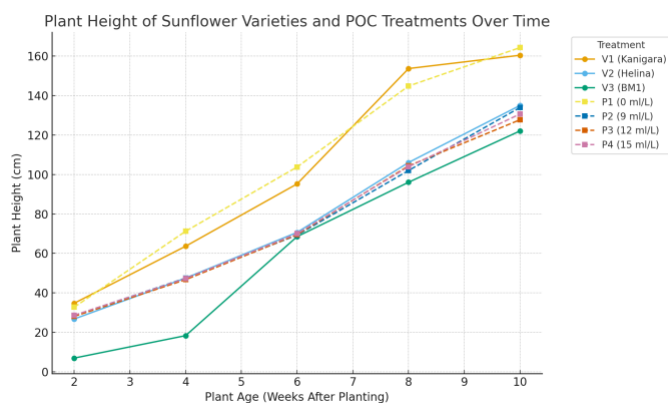


Fig. 1. Plant height of sunflower varieties and POC treatments over time

The treatment of different varieties and various concentrations of organic fertilizer (POC) significantly affected plant height. This effect began to appear as early as 2 weeks after planting (WAP), indicating that plants responded to POC treatment and varieties early on. This early response indicates that combining varieties with the appropriate POC concentration can accelerate the vegetative growth phase of plants. This is likely due to the availability of nutrients from POC, which are absorbed more quickly by plants, especially compared to inorganic fertilizers, which tend to release nutrients gradually. This study disagrees with the results of [16], which stated that a significant effect on plant height was only seen 4 weeks after planting when using compound NPK fertilizer.

In that study, the early vegetative phase did not show a significant growth response until the plants received 75% of the total fertilizer dose 4 weeks after planting. This difference is likely due to the type of fertilizer used and the speed at which plants respond to available nutrients. Based on the results of the study, the Kanigara (V1) variety showed the highest plant growth rate at 10 weeks after planting (WAP), which was 160.32 cm (Table 2). This was due to the genetic factors of this variety, which was less responsive to fertilizer treatment compared to the Kanigara variety. Research by [17] shows that different varieties can affect plant height growth, which is related to environmental adaptability.

Referring to the variety description, Kanigara has a plant height range of 115-280 cm, while the BM1 variety ranges from 171-200 cm [18]. These results support the suitability between the descriptive data of the varieties and the research results. The treatment without POC 0 ml/L (P1) with the application of compound NPK fertilizer produced the highest plant height of 164.20 (Table 2). This shows that inorganic fertilizers with the right dosage can provide macro nutrients more quickly and efficiently, especially in the early stages of plant growth.

TABLE III. NUMBER OF LEAVES SUNFLOWER (BLADE)

Treatment	Plant Age (Week After Planting/WAP)				
	2	4	6	8	10
V1 (Kanigara)	12.88a	24.58a	28.80ab	31.83b	29.55b
V2 (Helina)	11.03b	21.84b	33.90a	46.00a	39.54a
V3 (BM1)	11.08b	23.05ab	27.27b	31.22b	28.14b
P1 (Npk 5 g/plant)	13.00a	44.87a	51.20a	55.87a	47.58a
P2 (9 ml/L)	11.74ab	16.74b	24.77b	31.40b	34.33b
P3 (12 ml/L)	11.29b	17.00b	24.33b	30.63b	26.63bc
P4 (15 ml/L)	10.85b	16.59b	21.59b	28.59b	22.00c
Interaction	Nr	Nr	Nr	Nr	Nr

Description : The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

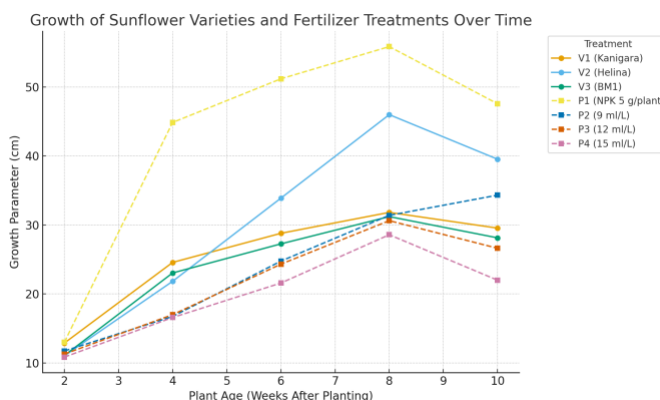


Fig. 2. Growth of sunflower varieties and fertilizer treatments over time

Differences in varieties and concentrations of liquid organic fertilizer (POC) have a significant impact on plant growth, especially the number of leaves. The results showed that the Helina (V2) variety had the highest leaf growth rate at 10 weeks after planting (WAP), with 39.54 leaves, while the BM1 (V3) variety showed the lowest leaf growth rate of 28.14 leaves (Table 3). This indicates that the genetic potential of a variety significantly determines the physiological performance of plants, including leaf canopy formation. The number of leaves is an important indicator of light absorption for photosynthesis. Varieties with greater leaf growth tend to have higher photosynthetic capacity, which impacts overall plant productivity [19]. Therefore, selecting superior varieties such as Helina can be an effective agronomic strategy to increase crop yields.

The treatment without POC (P1), but with the application of 5 grams of compound NPK fertilizer per plant, actually produced the highest leaf number, at 47.58 leaves (Table 3). This shows that inorganic NPK fertilizer can provide macronutrients that are directly available and easily absorbed by plants, such as nitrogen (N), phosphorus (P), and potassium (K), which play a significant role in vegetative growth [20]. In contrast, the application of POC with a concentration of 15 ml/L (P4) given every two weeks resulted in the lowest number of leaves, namely 22.00 strands (Table 3). This decrease is likely caused by the excessively high dose of POC, which can cause nutritional

imbalances or even toxicity to certain microorganisms contained in the POC. In addition, POC generally takes longer to decompose and provide nutrients, so in the initial or vegetative growth phase, its effectiveness can be lower than inorganic fertilizers.

TABLE IV. STEAM DIAMETER OF SUNFLOWER (MM)

Treatment	Plant Age (Week After Planting/WAP)				
	2	4	6	8	10
V1 (Kanigara)	4.79a	9.10a	12.06a	14.30	15.81ab
V2 (Helina)	4.02b	7.81b	10.23c	13.28	14.78b
V3 (BM1)	4.51a	8.67a	11.15b	14.18	15.97a
P1 (Npk 5 g/plant)	4.92a	12.67a	14.24a	17.64a	18.72a
P2 (9 ml/L)	4.39b	7.35b	9.84b	12.93b	14.67b
P3 (12 ml/L)	4.28b	7.26b	9.81b	12.83b	14.71b
P4 (15 ml/L)	4.17b	6.82b	9.13b	12.39b	13.96b
Interaction	Nr	Nr	Nr	Nr	Nr

Description : The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

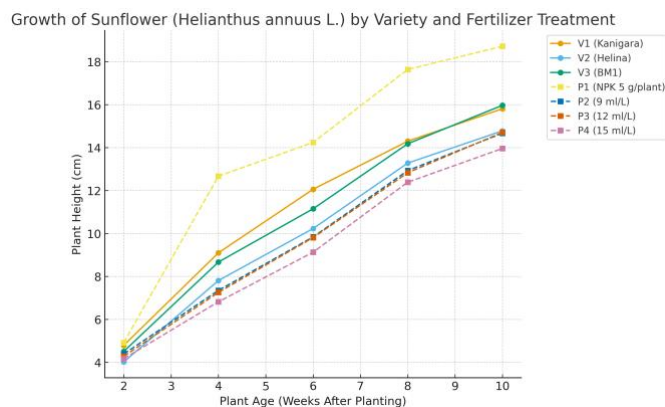


Fig. 3. Growth of sunflower (*Heliantus annus L.*) by variety and fertilizer treatment

Treatment of different varieties and various concentrations of organic fertilizer (POC) significantly affected stem diameter. This effect was evident as early as 2 weeks after planting (WAP), indicating that plants responded to POC treatment and variety earlier. This early response indicates that combining varieties with the appropriate POC concentration can accelerate the vegetative growth phase of plants. This is likely due to the availability of nutrients from POC, which are absorbed more quickly by plants, especially compared to inorganic fertilizers, which tend to release nutrients gradually. This study disagrees with the results of [16], which stated that a significant effect on stem diameter was only seen 4 weeks after planting when using compound NPK fertilizer.

In that study, the early vegetative phase did not show a significant growth response until the plants received 75% of the total fertilizer dose 4 weeks after planting. This difference is likely due to the type of fertilizer used and the speed at which plants respond to available nutrients. Variety BM1 (V3) showed

the highest stem diameter growth rate at 10 weeks after planting (WAP) with a value of 15.97 mm (Table 4), indicating superior genetic potential to support vegetative growth, as stated by [21] that the genetic characteristics of a variety greatly determine the morphological capacity of a plant. The treatment without POC (P1), which only used 5 g of NPK fertilizer per plant, produced the best results in terms of stem diameter, namely 18.72 mm (Table 4). This is in line with research by [22], which states that compound NPK fertilization can efficiently meet the macro nutrient requirements of plants during the early vegetative phase. Environmental factors such as light intensity, temperature, and humidity also affect plant physiology.

The optimal daytime temperature of 31.1°C (Table 1) and sufficiently high light intensity of 812-891 Lux (Table 1) support maximum photosynthesis, consistent with the results of a study [23] stating that (*Helianthus annuus L.*) has the highest photosynthetic efficiency at temperatures of 28–32°C and light intensity >800 Lux. Soil conditions at the research site were quite good, with a neutral to slightly alkaline pH of 6.9–8.2 (Table 1), moderate to high nitrogen, phosphorus, and potassium content, and redox potential values that support soil microbial activity. [24] states that the redox potential ranges from 0.06–0.13, indicating an ideal aerobic soil environment for the absorption of macro nutrients by plant roots.

TABLE V. LEAF AREA OF SUNFLOWER (CM<sup>2</sup>)

Treatment	Leaf Area (cm <sup>2</sup> )
V1 (Kanigara)	17.03a
V2 (Helina)	12.88
V3 (BM1)	15.11b
P1 (Npk 5 g/plant)	16.28a
P2 (9 ml/L)	14.31b
P3 (12 ml/L)	14.74b
P4 (15 ml/L)	14.70b
Interaction	Nr

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Leaf area growth parameters were significantly influenced by variety treatment and fertilizer application concentration. The Kanigara variety (V1) showed the largest average leaf area, namely 17.03 cm<sup>2</sup> (Table 5), reflecting its genetic potential to form a wider canopy and support more efficient photosynthesis. The Helina variety (V2) had the smallest leaf area, 12.88 cm<sup>2</sup> (Table 5), possibly due to its lower morphological or physiological capacity [25]. The treatment without fertilizer (P1), using only 5 grams of NPK compound fertilizer per plant, produced the largest leaf area, namely 16.28 cm<sup>2</sup> (Table 5). This may be due to the availability of macro nutrients (N, P, and K), which are more quickly absorbed by plants, thereby supporting maximum leaf growth. Fertilizer application at a concentration of 9 ml/L (P2) actually showed a decrease in leaf area, namely 14.31 cm<sup>2</sup> (Table 5). The decrease in leaf area was caused by an imbalance in the composition of organic matter in POC or

suboptimal microorganism activity in supporting nutrient absorption.

TABLE VI. FLOWERING AGE OF THE SUNFLOWER (DAP)

Treatment	Flowering (Dap)
V1 (Kanigara)	63.18b
V2 (Helina)	63.12b
V3 (BM1)	80.70a
P1 (Npk 5 g/plant)	62.91a
P2 (9 ml/L)	67.68b
P3 (12 ml/L)	68.64b
P4 (15 ml/L)	72.90b
Interaction	Nr

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

The Helina (V2) variety recorded the fastest flowering time, with an average of 63.12 days, followed by the BM1 (V3) variety, with the longest average flowering time of 80.70 days (Table 6). These results indicate that genetic factors in varieties play an important role in regulating the early reproductive phase of plants. The Kanigara variety appears to have a faster physiological response to the growing environment in initiating flowering. These findings are in line with research [29] which found that sunflower varieties show significant differences in flowering time. Treatment without POC (P1), which relied solely on compound NPK fertilizer, produced the fastest flowering time, with a value of 62.91 days (Table 6). This is in line with the results of study [30], which stated that the application of chemical fertilizers can accelerate the vegetative phase to the generative phase because NPK elements are available to plants.

Conversely, the application of 15 ml/L POC every two weeks showed the longest flowering time, with a value of 72.90 days (Table 6). POC takes longer to decompose and become available to plants, and its hormone content (auxin, cytokinin) can trigger longer vegetative growth before entering the generative phase. Environmental conditions also play a role. Moderate to high light intensity (812–891 Lux) during the day supports optimal photosynthesis, but relatively high daytime temperatures (31.1 °C) can stimulate earlier flowering. As explained by [31], the optimum temperature for sunflower flowering is between 25–30 °C. Relatively stable relative humidity, around 67–69%, also supports plant physiological activity.

Soil test results show a neutral to slightly alkaline pH, namely 6.9–8.2, which is still optimal for sunflower growth [32]. Soil nutrient content, such as nitrogen (20–53.6%), phosphorus (18–69.6%), and potassium (27.6–188.3%), indicates moderate to high fertility. Abundant nutrient content combined with POC application can prolong the vegetative phase, thereby delaying flowering.

### C. The Production of Sunflower

TABLE VII. FLOWER DIAMETER OF SUNFLOWER (MM)

Treatment	Flower Diameter (mm)
V1 (Kanigara)	25.02a
V2 (Helina)	21.18c
V3 (BM1)	22.95b
P1 (Npk 5 g/plant)	26.46a
P2 (9 ml/L)	22.02b
P3 (12 ml/L)	21.87b
P4 (15 ml/L)	21.81b
Interaction	Nr

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Flower diameter parameters were significantly influenced by variety differences and POC concentration. Kanigara (V1) consistently produced larger flowers, at 25.02 mm (Table 7). The smallest average flower diameter was found in Helina (V2), at 21.18 mm (Table 7). This is in line with previous studies showing that the genetic characteristics of a variety play an important role in determining the morphology and size of plant organs, including flowers [26]. Genetic differences between varieties can affect photosynthetic efficiency, nutrient allocation, and environmental responses, which ultimately manifest in flower size. The treatment without POC (P1), which was only given 5 grams of compound NPK fertilizer per plant at 15 days after planting (DAP), showed the largest average flower diameter, at 26.46 mm (Table 7).

Meanwhile, the application of POC at a concentration of 15 ml/L, given every two weeks, showed a decrease in flower diameter to 21.81 mm (Table 7). At a concentration of 15 ml/L, POC may be phytotoxic or cause nutritional imbalance in plants, thereby inhibiting generative growth. On the other hand, NPK compound fertilizer alone is sufficient to meet the nutritional needs of plants for optimal flower diameter under these conditions, and the addition of POC may be excessive or even disruptive [27]. A relatively neutral to slightly alkaline soil pH range (6.9–8.2) generally supports nutrient availability for most plants. The available EC, N, P, and K values indicate varying macro nutrient availability, which will certainly affect overall plant growth, including flower formation [28]. Adequate light intensity in the morning, afternoon, and evening supports photosynthesis, which is the basis for biomass production and generative organ formation.

TABLE VIII. HARVEST AGE OF SUNFLOWER (DAP)

Treatment	Flowering (Dap)
V1 (Kanigara)	77.79b
V2 (Helina)	77.76b
V3 (BM1)	95.88a
P1 (Npk 5 g/plant)	77.46a
P2 (9 ml/L)	81.75b
P3 (12 ml/L)	83.70b
P4 (15 ml/L)	87.90b
Interaction	Nr

Description : The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Based on the data, the Helina (V2) variety showed the highest growth rate at harvest, namely 77.76 days (Table 8). The longest harvest time was found in the BM1 (V3) variety, namely 95.88 days (Table 8). The Helina (V2) variety has the fastest growth rate, indicating genetic characteristics that allow this plant to reach the generative phase earlier than other varieties, such as BM1 (V3), which shows the lowest growth rate and longest harvest time. This study is consistent with existing literature, which states that genotype differences between varieties significantly affect the length of the plant life cycle, including the vegetative and generative phases, which ultimately determine the harvest time [33]. Varieties with fast growth rates tend to have shorter flowering periods, thereby accelerating harvest time.

The POC concentration treatment of 0 ml/L (P1), which relied solely on compound NPK fertilizer, produced the fastest harvest time, namely 77.46 days (Table 8), which indicates the fastest average harvest time. This shows that a single dose of 5 grams of NPK fertilizer per plant may be sufficient to meet the nutritional needs of sunflowers to reach maturity quickly. The lowest average growth rate was obtained at a POC concentration of 15 ml/L (P4), which was 87.90 days (Table 8). This result is important to note, as it contradicts the common assumption that POC always has a positive effect. It is possible that at a concentration of 15 ml/L, POC can cause nutritional imbalance or even phytotoxicity, which then inhibits plant growth and prolongs the time needed to reach maturity.

Research by [34] shows that inappropriate POC doses can disrupt soil microbial activity and nutrient uptake, thereby affecting plant growth and development. Excessively high POC concentrations can cause the accumulation of salts or certain organic compounds that inhibit plant metabolism, delay the generative phase, and prolong the harvest period. Environmental conditions such as light intensity, air temperature, humidity, and soil characteristics (pH, EC, soil temperature, N, P, K, Eh) also play an important role in sunflower growth. Adequate light intensity supports optimal photosynthesis, which is important for biomass accumulation and generative development [35]. Air temperature varies throughout the day within a range that generally supports tropical plant growth. Variations in soil nutrient content, such as nitrogen (N), phosphorus (P), and

potassium (K), indicate the availability of macro nutrients that are essential for plant growth and development.

TABLE IX. SEED WEIGHT PER PLANT OF SUNFLOWER (G)

Treatment	Seed Weight (g)
V1 (Kanigara)	24.55a
V2 (Helina)	18.98b
V3 (BM1)	21.02ab
P1 (Npk 5 g/plant)	31.57a
P2 (9ml/L)	17.39b
P3 (12 ml/L)	18.70b
P4 (15 ml/L)	18.41b
Interaction	Nr

Description : The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Variety differences have a significant effect on sunflower seed weight. Based on the data, the Kanigara (V1) variety showed the highest seed weight growth rate per plant, namely 24.55 g (Table 9). This is in line with study [36], which states that variety differences affect seed formation and filling due to physiological variations and photosynthetic efficiency of each genotype. The lowest growth rate was observed in the Helina (V2) variety, with a value of 18.98 g (Table 9), due to the less efficient accumulation of photosynthates from the variety into the seeds. In addition to genetic factors, environmental factors and fertilization treatments also play a significant role. The treatment without POC (P1), which only used compound NPK fertilizer, produced the heaviest seed weight, namely 31.57 g (Table 9).

Compound NPK is readily available and immediately utilized by plants during the seed filling phase. Nitrogen and potassium are very important for seed formation because they support protein formation and photosynthate translocation. The application of 9 ml/L POC every two weeks actually resulted in the lightest seed weight, namely 17.39 g (Table 9). This was due to the slow decomposition of liquid organic matter, so that its nutrients were not readily available during the critical seed filling period.

TABLE X. 100-SEED WEIGHT OF SUNFLOWER (G)

Treatment	100-Seed Weight (g)
V1 (Kanigara)	5.33
V2 (Helina)	5.68
V3 (BM1)	5.81
P1 (Npk 5 g/plant)	6.09a
P2 (9ml/L)	4.91b
P3 (12 ml/L)	5.84a
P4 (15 ml/L)	5.60a
Interaction	Nr

Description : The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Based on the data, the average weight of 100 seeds was highest in the BM1 (V3) variety with a value of 5.81 g (Table 10). The average weight of 100 seeds was lightest in the Kanigara (V1) variety, with a value of 5.33 g (Table 10). The treatment without POC 0 ml/L (P1), with only the application of 5 g/plant of compound NPK fertilizer, produced the highest seed weight of 6.09 g, while the application of high-concentration POC 9 ml/L (P2) produced the lightest average weight of 100 seeds with a value of 4.91 g (Table 10). This indicates that excessively high POC doses can cause nutrient imbalance or ion competition, which negatively impacts seed filling. Research by [38] also states that excess liquid organic matter can reduce macronutrient absorption efficiency.

TABLE XI. WET WEIGHT STOVER OF SUNFLOWER (G)

Treatment	Wet Weight Stover (g)
V1 (Kanigara)	237.50c
V2 (Helina)	248.75b
V3 (BM1)	405.00a
0 ml/L (P1)	402.33a
9 ml/L (P2)	167.66d
P3 (12 ml/L)	275.33c
P4 (15 ml/L)	343.00b
Interaction	R

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Based on the data, the BM1 (V3) variety showed the heaviest wet weight of 405.00 g (Table 11). The lightest wet weight was found in the Kanigara (V1) variety with a value of 237.50 g (Table 11). This finding is in line with research by [39], which states that variety genetics have a significant effect on plant vigor and photosynthetic efficiency, which in turn affect plant biomass. The treatment without POC (P1), using only 5 grams/plant of compound NPK fertilizer, produced the heaviest wet weight of 402.33 g (Table 11). The lowest average was

obtained at a POC concentration of 9 ml/L (P2), with a value of 167.66 g (Table 11). This indicates that the use of POC at inappropriate concentrations can cause nutrient imbalance, thereby reducing plant metabolic efficiency [40].

TABLE XII. DRY WEIGHT STOVER OF SUNFLOWER (G)

Treatment	Dry Weight Stover (g)
V1 (Kanigara)	64.18b
V2 (Helina)	60.85c
V3 (BM1)	88.80a
0 ml/L (P1)	89.87a
9 ml/L (P2)	49.00d
P3 (12 ml/L)	64.37c
P4 (15 ml/L)	81.87b
Interaction	R

Description: The Numbers in the same column followed by the same letter are not significantly different at the DMRT test level  $\alpha = 5\%$ .

Based on the data, the BM1 (V3) variety showed the heaviest average dry weight of the cobs, namely 88.80 g (Table 12). The average value for the Helina (V2) variety was 60.85 g (Table 12). This finding is in line with research by [39], which states that variety genetics significantly affect plant vigor and photosynthetic efficiency, which in turn affect plant biomass. The treatment without POC (P1), which only used 5 grams of compound NPK fertilizer per plant, produced the heaviest dry weight of straw, namely 89.87 g (Table 12). The lightest average value was obtained at a POC concentration of 9 ml/L (P2), with a value of 49.00 g (Table 12).

This indicates that the use of POC at inappropriate concentrations can cause nutrient imbalance, thereby reducing plant metabolic efficiency [40]. Environmental conditions during the study were favorable, with optimal light intensity for photosynthesis (812–891 Lux during the day), air temperature between 25–31 °C, and stable humidity (67–69%). These ideal temperature and humidity conditions are important in supporting plant physiological processes, such as enzyme activity and transpiration rate. Soil conditions also showed fairly good fertility. Neutral to slightly alkaline soil pH (6.9–8.2) supported phosphorus availability, while soil EC values (279–587.6  $\mu\text{S}/\text{cm}$ ) were still within the optimal range for plant growth without causing salinity stress.

#### IV. CONCLUSION AND SUGGESTION

##### A. Conclusion

Growth parameters in variety differences have a significant effect from 2 WAP plant age. Production parameters in variety differences have a significant effect. The best parameters in the Kanigara variety are plant height, leaf area, flower diameter, and total seed weight per crop. The best parameters for the Helina variety are number of leaves, flowering age, and harvest age. The best parameters for the BM1 variety are stem diameter,

weight of 100 seeds, wet weight of husks, and dry weight of husks.

Production parameters for the application of several concentrations of POC have no significant effect but have a significant effect on NPK fertilizer. Growth parameters had a significant effect on the NPK 5 g/plant treatment, namely plant height, number of leaves, stem diameter, leaf area, and flowering age. Production parameters had a significant effect on the NPK 5 g/plant treatment, namely flower diameter, harvest age, total seed weight per plant, weight of 100 seeds, wet husk weight, and dry husk weight.

Significant interaction effects between variety and POC were obtained in production results, namely variety BM1 and POC at 0 ml/L in wet husk weight and dry husk weight.

### B. Suggestion

POC nutrition should be administered more intensively at intervals of less than two weeks per application until harvest time. However, based on the results, the use of POC alone does not provide optimal results for seed or oil-producing plants. Therefore, POC should be combined with compound NPK fertilizer so that macro nutrient requirements can be met in a balanced manner.

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