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Increasing Cucumber Plant (*Cucumis sativus* L.) Growth and Production by Providing NPK Phonska and Gibberellin (GA3)

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Abstract

Cucumber (*Cucumis sativus* L.) is a plant that has various advantages, one of which is a relatively short harvest period. This study was conducted to determine the most effective dose of NPK Phonska fertilizer and the optimal concentration of gibberellin growth regulator (GA3) to increase the growth and productivity of cucumber (*Cucumis sativus* L.) plants. This study was conducted from May to August 2025 at the Puri Serang Hijau, Serang City, Banten. The experiment was designed as a randomized block design with two treatment factors: the dose of NPK Phonska fertilizer (0, 350, 400, and 450 kg/ha) and the concentration of GA3 (0, 150, 175, and 200 ppm). The results showed that a single application of NPK Phonska fertilizer at a dose of 400 kg/ha gave the best effect on the growth and productivity of cucumber. This was reflected in greater plant height and more leaves, compared to other doses. The application of a single GA3 at a concentration of 200 ppm improved plant reproductive characteristics, such as accelerated flowering time. This study highlights the age of flower emergence and harvest age according to the varieties used as research objects.

Keywords: 200 ppm, 400 kg/ha, Doses, Flowering Time, Fruit Length

1. Introduction

Cucumber (*Cucumis sativus* L.) is a vegetable crop belonging to the Cucurbitaceae family and is widely cultivated and consumed in many countries. Cucumbers are popular not only because of their ease of preparation but also due to their high nutritional value. 100 g of cucumber contains approximately 15 kcal of energy, 0.8 g protein, and 3 g carbohydrates, as well as various vitamins and minerals, including phosphorus, iron, thiamine, riboflavin, and ascorbic acid (Gustianty, 2016). The low caloric content and high water composition make cucumber a rich source of vitamin C and flavonoids, which function as antioxidants (Christine *et al*., 2021).

In addition to its nutritional value, cucumber has considerable economic importance and is widely used as a fresh vegetable, processed food product, and raw material in pharmaceutical and cosmetic industries. Increasing population growth, improved living standards, higher educational levels, and greater public awareness of nutritional benefits have contributed to the rising demand for cucumbers. Despite this demand, cucumber productivity in Indonesia remains relatively low, although the crop has strong potential for development due to its adaptability to diverse climatic conditions (Zain *et al*., 2023).

The Central Statistics Agency (2023) noted that cucumber harvested area fluctuated, but tended to decline. Furthermore, cucumber production and productivity in Indonesia also declined year-on-year between 2021 and 2023. This also occurred in cucumber production in Banten Province, where, from 2021 to 2023, cucumber production decreased by 19,325 tons, 17,857 tons, and 7,872 tons, respectively (BPS Banten, 2023). This decline in cucumber production significantly impacts the community's demand for cucumbers. This can be anticipated by improving production through technical plant cultivation, one of which is fertilization

Cucumber production in Indonesia remains relatively low despite substantial development potential. The plant adapts readily to various climatic conditions, facilitating cultivation. Appropriate cultural practices, particularly optimal fertilization, can enhance growth and productivity. Nutrients serve as building blocks and energy sources for

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plant metabolism. NPK fertilizer supplies nitrogen (N), which is crucial for vegetative growth, especially root, stem, branch, and leaf development (Nursayuti, 2021). Phosphorus (P) promotes cell division, accelerating stem, leaf, and root growth (Kartina *et al*., 2018). Potassium (K) contributes to cell wall formation, stem strengthening, optimal nutrient uptake, and regulation of stomatal opening and closure (Uliyah *et al*., 2017).

Compound fertilizers are highly effective inorganic fertilizers for improving the availability of macronutrients, particularly N, P, and K. They serve as alternatives to single-component fertilizers such as urea, SP-36, and KCl, which are often limited in supply and expensive. Compound fertilizers also ensure more uniform nutrient distribution to plants (Idha & Herlina, 2018).

Research by Fauzi *et al*. (2024) demonstrated that NPK Phonska application at 400 kg/ha enhanced cucumber productivity, considered the optimal dose. This treatment yielded the longest vine length (average 132.667 cm), highest leaf number (average 56.333 leaves), and greatest fruit weight (average 338.833 g).

In addition to fertilization, imbalance between male and female flowers is a common issue in cucumber cultivation. Plants typically produce more male flowers, which develop earlier than female ones. However, abundant harvests require more female flowers Kartikasari *et al*. (2016). Flowering is strongly influenced by environmental conditions, potentially leading to low yields, poor fruit quality, unfavorable sex ratios, and reduced production. Thus, interventions to promote flowering, particularly through gibberellin application—a plant growth regulator—are necessary (Zein, 2016).

Gibberellin is one of the most widely used plant growth regulators in agriculture, playing a key role in regulating physiological processes. Its efficacy depends on application timing and concentration, adjusted to plant growth rates. Dose, variety, and developmental stage also influence responses to growth regulators. According to Widiwurjani *et al*. (2020), gibberellin promotes vegetative and reproductive growth, stimulating seed germination, stem elongation, and fruit formation.

Exogenous gibberellin application significantly affected leaf area, fruit weight per plant, and average fruit weight in cucumber (Santoso & Maghfoer, 2022). Treatment at 200 ppm produced the highest average fruit weight, significantly differing from untreated controls. This is attributed to enhanced transport and accumulation of photosynthetic products in fruit organs, along with stimulated cell division, increasing fruit size and weight (El-Shereif *et al*., 2017).

Based on research by Anggraini *et al*. (2025) on cucumber cultivation carried out using NPK Mutiara (16:16:16) with a content of 16% Nitrogen (N), 16% Phosphate (P_2O_5), and 16% Potassium (K_2O) with doses (100, 400, 500, and 600 kg/ha) and also gibberellin concentrations (0, 100, 200, 300 ppm). In this study, NPK Phonska (15:15:15) was used with a content of 15% N, 15% P_2O_5, 15% K_2O, 10% sulfur (S) at doses (0, 350, 400, and 450 kg/ha) and gibberellin concentrations (0, 150, 175, and 200 ppm).

2. Material and Methods

This experimental study was conducted in Puri Serang Hijau, Cipocok Jaya Subdistrict, Serang City. The location used has an altitude of 37 meters above sea level with longitude coordinates 106.1788883 and latitude coordinates -6.1448597, from May to August 2025. Tools used included shovels, hoes, stakes, measuring tapes, raffia strings, seed trays, 30 cm × 30 cm polybags, hoses, labels, stationery, cameras, scissors, TDS meters, droppers, and analytical scales. Materials comprised Erina F1 cucumber seeds, NPK Phonska fertilizer (15:15:15), husk charcoal, animal manure, soil, water, gibberellin (GA3), Furadan 3G, and garlic. The parameters observed in this study encompassed plant height, number of leaves, age at first flower emergenceage, and fruit length.

The experiment employed a randomized block design with two treatment factors. The first factor was NPK Phonska dose: P0 (control, 0 kg/ha), P1 (350 kg/ha, equivalent to 1.00 g/polybag), P2 (400 kg/ha, equivalent to 1.15 g/polybag), and P3 (450 kg/ha, equivalent to 1.30 g/polybag). The second factor was GA3 concentration: G0 (control, 0 ppm), G1 (150 ppm, equivalent to 3.75 ml/polybag), G2 (175 ppm, equivalent to 4.37 ml/polybag), and G3 (200 ppm, equivalent to 5 ml/polybag). The 16 treatment combinations were replicated three times, yielding 48 experimental units. Each unit contained two plants, totaling 96 plants. Observational data were analyzed using analysis of variance (ANOVA). Significant differences were followed by Duncan's Multiple Range Test (DMRT) at the 5% significance level. Processed using the DSAASTAT ver. 1.514 application.

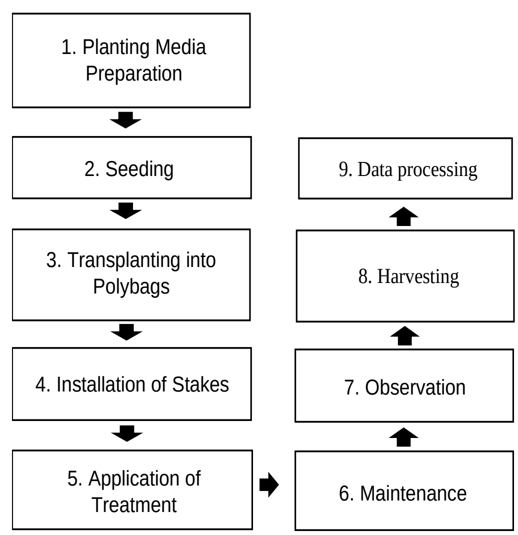

Figure 1. Research flow diagram

3. Results and Discussion

3.1. Plant Height

Analysis of variance revealed that NPK Phonska fertilizer significantly affected cucumber plant height at 7–35 days after planting (DAP). In contrast, gibberellin application showed no significant effect on plant height. No interaction occurred between NPK Phonska and gibberellin. Average plant heights from 7–35 DAP are presented in Table 1.

Table 1. Average plant height (cm) of cucumber plants aged 7-35 days after planting in various NPK fertilizer doses and GA3 concentrations.

NPK Dosage (kg/ha)	GA3 Concentration				Average
	0 ppm	150 ppm	175 ppm	200 ppm	
	..........................cm..........................				
7 DAP					
0	11,37 ± 0,53	10,70 ± 1,20	10,62 ± 0,54	11,43 ± 1,07	11,03 ± 0,85 b
350	11,50 ± 0,88	10,67 ± 0,14	10,50 ± 1,10	11,43 ± 0,45	11,03 ± 0,79 b
400	11,78 ± 1,41	12,43 ± 0,40	11,82 ± 0,58	13,27 ± 1,73	12,33 ± 1,18 a
450	11,50 ± 0,71	12,02 ± 0,23	11,45 ± 0,97	11,13 ± 0,80	11,53 ± 0,70 b
Average	11,54 ± 0,82	11,45 ± 0,99	11,10 ± 0,92	11,82 ± 1,30	
21 DAP					
0	57,28 ± 14,82	65,83 ± 12,74	48,12 ± 3,51	55,88 ± 9,34	56,78 ± 11,43 c
350	70,60 ± 11,66	74,48 ± 9,63	78,03 ± 12,80	81,02 ± 8,65	76,03 ± 10,08 b
400	86,10 ± 8,96	82,03 ± 9,11	84,02 ± 12,37	87,17 ± 12,04	84,83 ± 9,39 a
450	81,75 ± 12,73	68,82 ± 7,64	84,97 ± 5,73	86,92 ± 9,07	80,61 ± 10,74 ab
Average	73,93 ± 15,63	72,79 ± 10,66	73,78 ± 17,69	77,75 ± 15,85	
35 DAP					
0	155,52 ± 12,03	162,10 ± 7,45	148,13 ± 3,04	155,68 ± 9,55	155,36 ± 9,02 b
350	171,90 ± 8,49	176,78 ± 14,07	177,80 ± 12,75	180,93 ± 8,81	176,85 ± 10,21 a
400	179,33 ± 2,46	171,73 ± 18,17	178,90 ± 7,43	183,35 ± 8,37	178,33 ± 10,15 a
450	178,23 ± 11,28	163,68 ± 2,27	174,73 ± 2,83	180,05 ± 2,64	174,18 ± 8,41 a
Average	171,25 ± 12,74	168,57 ± 12,09	169,89 ± 14,75	175,00 ± 13,49	

Note: Numbers followed by the same letter in the same row or column indicate no significant difference based on the DMRT test at the 5% level.

Observations presented in Table 1 indicate that the standalone application of NPK Phonska fertilizer exerted a highly significant effect, yielding the highest values under the P2 treatment at a dose of 400 kg/ha. This treatment resulted in average plant heights of 12,33 ± 1,18 a cm at 7 days after planting (DAP), 84,83 ± 9,39 a cm at 21 DAP, and 178,33 ± 10,15 a cm at 35 DAP. These findings suggest that the growing medium provided sufficient nitrogen supply. This indicates sufficient nitrogen availability in the growing medium for plant growth. Nitrogen is an essential macronutrient critical for vegetative activity (Sihaloho *et al*., 2021).

Research Karamina *et al*., (2020) shows that the application of NPK fertilizer with a dose of 200 kg/ha when the plant is 10 DAP (5.66 cm) and 15 DAP (10.07 cm) is able to provide the best plant height results, while when the plant is 20 DAP (18.79 cm) and 25 DAP (52.26 cm), the best plant height is when the NPK application dose is 400 kg/ha.

The application of gibberellin growth regulator (GA_3) at 7, 21, and 35 days after transplanting exhibited no significant effect on plant height. This lack of significance is attributed to the potential inefficiency of GA_3 foliar application under extreme environmental conditions. According to Auli *et al*. (2022) on foliar nutrient and growth regulator uptake, climatic factors play a critical role in application efficacy. Rainfall can wash off the sprayed solution, thereby reducing absorption efficiency. Additionally, spraying during periods of high air temperature accelerates evaporation, rapidly increasing solution concentration on leaf surfaces and potentially causing leaf scorch or phytotoxicity.

In addition, optimal soil pH is also required for the growth of cucumber plants. Research by Septyan *et al*., (2025) shows soil pH results that are not suitable for growth. Based on the analysis of soil chemical properties, it was found that the soil had a pH of 4.96, which is classified as acidic, potentially inhibiting the availability of specific nutrients.

3.2. Number of Leaves

Analysis of variance revealed that the NPK Phonska significantly influenced leaf number at 21 and 35 DAP, while gibberellin had no significant effect. No interaction was observed. Average leaf numbers are shown in Table 2. In general, leaf number at 21 DAP was significantly influenced by NPK fertilization, whereas plant response to gibberellin application exhibited no clear enhancement. The highest average leaf number at 21 DAP was achieved with an NPK fertilization rate of 450 kg/ha. This indicates that cucumber plants require higher levels of macronutrients—such as nitrogen, phosphorus, and potassium—during the early growth stage to support vegetative development. Nitrogen plays a pivotal role in leaf formation and vegetative tissue development; consequently, higher NPK concentrations are associated with increased leaf numbers. These findings align with Lakitan (2018), who stated that nitrogen promotes chlorophyll synthesis and the development of photosynthetic organs during the vegetative phase.

Table 2. Average number of leaves (count) of cucumber plants aged 21-35 days after planting in various NPK fertilizer doses and GA3 concentrations.

NPK Dosage (kg/ha)	GA3 Concentration				Average
	0 ppm	150 ppm	175 ppm	200 pm	
	..........................count..........................				
21 DAP					
0	10,00 ± 1,32	10,33 ± 0,29	8,33 ± 1,15	10,17 ± 1,26	9,71 ± 1,25 b
350	12,17 ± 0,29	12,00 ± 0,87	11,33 ± 1,26	12,83 ± 0,76	12,08 ± 0,93 a
400	12,33 ± 0,58	11,17 ± 2,25	12,83 ± 1,53	11,67 ± 0,58	12,00 ± 1,38 a
450	12,67 ± 1,53	11,50 ± 2,29	12,50 ± 1,73	13,00 ± 2,18	12,42 ± 1,77 a
Average	11,79 ± 1,42	11,25 ± 1,56	11,25 ± 2,22	11,92 ± 1,65	
35 DAP					
0	38,00 ± 4,09	43,17 ± 3,55	38,17 ± 4,80	36,67 ± 1,53	39,00 ± 4,08 b
350	54,67 ± 5,97	50,33 ± 7,15	44,00 ± 6,14	50,50 ± 3,50	49,88 ± 6,38 a
400	53,00 ± 4,44	56,50 ± 6,26	52,67 ± 8,08	51,67 ± 3,79	53,46 ± 5,37 a
450	48,50 ± 1,73	55,33 ± 3,75	54,33 ± 10,25	54,17 ± 3,33	53,08 ± 5,66 a
Average	48,54 ± 7,72	51,33 ± 7,17	47,29 ± 9,44	48,25 ± 7,61	

Note: Numbers followed by the same letter in the same row or column indicate no significant difference based on the DMRT test at the 5% level.

In the study by Khoirimah *et al.*, (2024), a concentration of 200 ppm 14 DAP (12,24 cm) and 21 DAP (25,16 cm) tended to provide higher results compared to other concentrations. This was because the concentration was neither too large nor too small so that it could provide optimal results for plants.

The increase in leaf number at 35 DAP underscores the critical role of nutrient availability in the substrate for plant photosynthesis. Vegetative growth is highly dependent on sufficient nitrogen and phosphorus supplies, which stimulate cell division and differentiation. Nitrogen is directly involved in chlorophyll formation, imparting the characteristic green coloration to plants and being essential for photosynthesis. This is consistent with the findings of Amin *et al.* (2024), who demonstrated that optimal photosynthesis leads to elevated concentrations of photosynthetic enzymes. These enzymes are translocated to vegetative organs, thereby promoting the formation of new structures, including leaves.

3.3. Age at First Flower Emergence

Analysis of variance revealed that NPK Phonska fertilizer treatment and gibberellin (GA_3) application individually exerted highly significant effects on the age at first flower emergence in cucumber plants, whereas no significant interaction was observed between the two treatments. The mean values for the age at first flower emergence are presented in Table 3.

Table 3. Average age at first flower emergence (days) in cucumber plants under different NPK fertilizer doses and GA3 concentrations.

NPK Dosage (kg/ha)	GA3 Concentration				Average
	0 ppm	150 ppm	175 ppm	200 pm	
	..........................days..........................				
0	29,17 ±	28,33 ±	28,67 ±	27,17 ±	28,33 ± 1,40 c
350	28,50 ±	27,00 ±	26,00 ±	25,33 ±	26,71 ± 1,74 b
400	24,67 ±	23,83 ±	24,17 ±	24,83 ±	24,38 ± 0,83 a
450	25,17 ±	25,00 ±	24,00 ±	23,33 ±	24,38 ± 0,98 a
Average	26,88 ± 2,19 b	26,04 ± 2,13 ab	25,71 ± 2,20 a	25,17 ± 1,75 a	

Note: Numbers followed by the same letter in the same row or column indicate no significant difference based on the DMRT test at the 5% level.

Observations presented in Table 3 indicate that NPK fertilization at rates of 400 and 450 kg/ha exerted a significant effect, yielding the highest mean values for age at first flower emergence. These results demonstrate that increasing NPK fertilization up to a certain threshold can accelerate flowering. According to Iftikhar *et al.* (2024), the timing of flower emergence is influenced by both internal and external factors, including nutrient availability. Similarly, Solihat *et al.* (2025) emphasized that adequate NPK fertilization is essential for plant metabolism and tissue formation.

Table 3 further reveals that gibberellin (GA_3) application at concentrations of 175 and 200 ppm resulted in the earliest (optimal) age at first flowering, although the differences were not statistically significant. Gibberellin, as a plant growth hormone, stimulates cell elongation, shoot growth, and flowering. Exogenous gibberellin application can hasten the transition from the vegetative to the reproductive phase, thereby inducing earlier flowering. These findings are supported by Iftitah *et al*. (2025), who reported that appropriate gibberellin concentrations influence various physiological processes in plants, including acceleration of flowering, stimulation of shoot formation, and promotion of both vegetative and reproductive growth.

The study by Anggraini *et al*., (2025) found that a 200 ppm gibberellin concentration and 400 kg of Phonska NPK resulted in the fastest flowering time. Gibberellin 200 ppm (22.13 days) and NPK Phonska 400 kg (22.48 days)

3.4. Fruit Length

The analysis of variance revealed that the application of NPK Phonska fertilizer and the plant growth regulator exerted highly significant effects on cucumber fruit length, with no significant interaction observed between the two treatments. The mean cucumber fruit lengths are presented in Table 4.

Table 4. Average fruit length (cm) in cucumber plants under different NPK fertilizer doses and GA3 concentrations.

Dosis NPK (kg/ha)	Konsentrasi GA3				Rata-rata
	0 ppm	150 ppm	175 ppm	200 pm	
	..........................cm..........................				
0	14,24 ± 3,03	13,73 ± 2,16	14,53 ± 0,75	13,13 ± 2,29	13,91 ± 1,97
350	13,03 ± 1,66	13,23 ± 1,88	14,63 ± 1,75	14,77 ± 2,06	13,92 ± 1,77
400	14,53 ± 2,59	14,77 ± 1,19	13,40 ± 2,50	14,67 ± 0,78	14,34 ± 1,75
450	15,80 ± 1,76	15,30 ± 2,95	15,07 ± 2,17	14,90 ± 1,73	15,27 ± 1,92
Rata-rata	14,40 ± 2,24	14,26 ± 2,01	14,41 ± 1,75	14,37 ± 1,72	

Note: Numbers followed by the same letter in the same row or column indicate no significant difference based on the DMRT test at the 5% level.

Based on the fruit length observations presented in Table 4, no treatment combination exerted a significant effect on fruit length. This suggests that fruit length is predominantly determined by the genetic makeup of the plant rather than by nutrient supply or hormonal application. For example, Tripathy *et al*. (2020) demonstrated that genetics plays a pivotal role in determining fruit size and accounts for characteristic differences among varieties. In addition to genetic factors, environmental conditions also influence overall plant productivity.

The lack of a significant effect of NPK fertilizer on fruit length can be explained by the plant's nutritional needs, which are likely sufficient to support fruit formation even without increasing fertilizer doses. GA3 treatment also had no significant effect on cucumber fruit length, although gibberellins theoretically play a role in cell elongation.

Thus, it can be concluded that in this experiment, fruit length was more controlled by genetic factors and was not responsive to variations in the dose of NPK fertilizer or gibberellin. According to Oja *et al*. (2024) these differences are influenced by genetic factors that contribute to significant diversity. Specific genes have been identified that influence floral organ formation, cell division, and cell cycle regulation.

The results Anggraini *et al*. (2025) showed that gibberellin concentration treatment affected fruit length. The lowest average response value for gibberellin concentration on fruit length was found in G0 with a value of 13.25 cm. The highest average value was found in G3 (200 ppm) with a value of 13.76 cm. This is thought to be due to the effect of gibberellin at a concentration of 200 ppm, the maximum concentration that can be absorbed by cucumber plants, and plants tend to grow taller than other concentrations.

Figure 2. Research documentation

4. Conclusion

Based on the results and discussion, the results obtained are that the interaction between NPK Phonska fertilizer and gibberellin did not result in yield increases in all four observed parameters. NPK Phonska treatment alone increased plant height, leaf number, and age at first flowering. Gibberellin alone only increased age at first flowering.

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