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Original Article

Effect paclobutrazol and NPK fertilizer on generative fase and clorophyll content of soybean (*Glicine max L.*) variety Anjasmoro

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Abstract

Soybean (Glycine max) is a popular food ingredient due to its high protein content. Despite soybean cultivation in Indonesia, it is not yet at its best and requires further enhancement. Paclobutrazol (PBZ) is a plant growth regulator (PGPR) that can increase production by suppressing the vegetative phase and increasing the generative phase whereas, the use of NPK fertilizers can improve the yield quality of soybeans. The objective of this study is to investigate how different concentrations of PBZ and NPK fertilizers impact the growth and yield of soybean plants. This research was carried out from May to August 2024 in Semolowaru, a neighborhood in Surabaya, East Java. This research used the split plots design (SPD) method, in this study testing the concentration of paclobutrazol (0 ppm, 50 ppm, 100 ppm, and 150 ppm) and the dose of NPK fertilizer (150 kg/ha, 200 kg/ha, 250 kg/ha, and 300 kg/ha). Paclobutrazol concentration of 150 ppm and NPK fertilizer dose of 300 kg/ha showed the best results in the parameters of plant height, number of flowers, number of seeds, and chlorophyll content.

Keywords: soybean, paclobutrazol,fertilizer, NPK, production

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Introduction

Soybeans (*Glycine max L.*) represent a significant component of the Indonesian food supply. This is due to the fact that soybeans contain protein, carbohydrates, and fat. The soybean is a crop with a high market value in Indonesia. Soybeans represent a cost-effective source of vegetable protein and are utilized as the primary ingredient in a multitude of food products (Widoretno, 2011). As reported by the Central Bureau of Statistics (2022), Indonesia imports approximately 2.32 million tons of soybeans annually. Despite the fact that soybean production in Indonesia is capable of producing 594.6 thousand tons, this suggests that the level of soybean commodity production in Indonesia is considerably below the level of consumer demand. Improved cultivation systems and methods are necessary, including the use of active ZPT and proper fertilization. Paclobutrazol is a growth inhibitor that can inhibit gibberellin synthesis in soybean plants by inhibiting the oxidation of kaurene to kaurenoic acid, which can result in a reduction in the speed of cell division during vegetative growth (Marshel et al., 2015). Compared to single fertilization, NPK fertilizer demonstrates superior efficiency in nutrient delivery. NPK fertilizer is advantageous for the healthy growth of soybean plants, as it provides three vital elements (N, P, and K) that are essential for the development and nourishment of soybeans. The nitrogen element is involved in the creation of amino acids, which are crucial for the healthy development of soybean plants. The element P acts as a conduit for plant metabolism, influencing growth, promoting the development of soybean flowers, and bolstering disease resistance. Element K plays a crucial role in the absorption of water and nutrients by the soil, which in turn affects the growth and development of pods and soybean seeds (Hendri et al., 2015). Therefore, it is crucial to investigate the impact of paclobutrazol concentration and NPK fertilizer dosage on the growth and yield of different soybean varieties.

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Methods

This research was conducted in March to May 2024 on agricultural land in Surabaya City, East Java. The area has an altitude of 3 - 6 meters above sea level, an average temperature of 23.6 - 33.8 ºC, and an average rainfall of 200 mm/year.

The tools used in this research were a meter or ruler, polybag size 30 x 30 cm, trowel, scissors, hand sprayer, stationeries, digital scale, vernier, dropping pipette, and measuring cup. The materials used in this research were soybean seeds of anjasmoro variety, paclobutrazol pgr, planting medium (combination of soil with compost in 50:50 ratio), NPK fertilizer (15:15:15) by Phonska®, KNO_3 fertilizer, Starban 585 EC® insecticide.

This research was arranged based on a split-plot design (SPD) with two treatments of paclobutrazol concentration as subplots and NPK fertilizer dosage as the main plot. Paclobutrazol concentration (P) consisted of 4 treatment levels and NPK fertilizer (N) consisted of 4 treatment levels. The concentration of PBZ were as follows P0 = 0 ppm, P1 = 50 ppm, P2 = 100 ppm and P3 = 150 ppm. Whereas, NPK fertilizer concentration were N1 = 150 kg/ha, N2 = 200 kg/ha, N3 = 250 kg/ha, N4 = 300 kg/ha. From the combination of these 2 factors, 16 combinations were obtained and 3 replications were carried out, so there are 48 experimental units, then carried out further tests followed the method of Tukey (1953).

Plant height parameters were measured using a tape measure, and the parameters of number of flowers and number of pods of soybean plants were calculated manually. Calculation of chlorophyll content followed the method described by Harborne (1987) using a spectrophotometer at wavelengths of 646 nm and 663 nm. Leaves sampling was carried out at the age of 40 day after planting (DAP) on the 3rd and 4th nodes (Figure 1.).

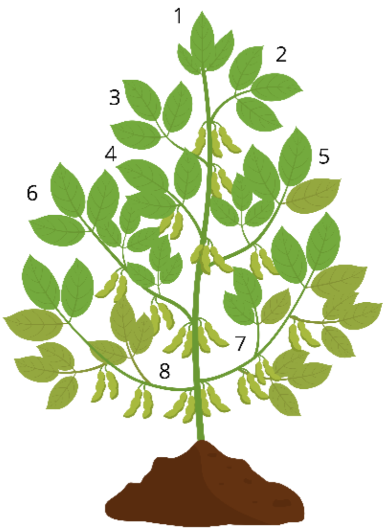

Figure 1. Ilustration Plant Nodes

Results

The findings of this study indicated that there were notable discrepancies in several parameters. These included plant height, the number of flowers, the number of pods, and chlorophyll content. Paclobutrazol has the capacity to impede the growth of plants while simultaneously stimulating flowering, which in turn gives rise to differences in a multitude of parameters.

The growth rate of the Anjasmoro soybean varieties differed significantly in the P0, P1, P2, and P3 treatments. Figure 2. illustrates that the paclobutrazol concentration of P2 (100 ppm) yielded the lowest height, yet no interaction was observed between paclobutrazol concentration and NPK fertilizer. The 150 ppm (P3) concentration should have yielded the lowest height, but the 100 ppm (P2) concentration proved more effective than the 150 ppm (P3) concentration.

Paclobutrazol at 150 ppm (P3) resulted in the highest average number of flowers per plant (115.17), in comparison to the concentrations of 100 ppm (P2), 50 ppm (P1), and 0 ppm (P0) which produced 101.92, 83.58, and 64.17 respectively (Table 1).

The analysis of variance on the number of pods revealed that the concentration of paclobutrazol at 150 ppm (P3) exhibited the highest pod count, with an average of 48.33 pods per plant. This was followed by the concentration of paclobutrazol at 100 ppm (P2), 50 ppm (P1), and 0 ppm (P0) which demonstrated a mean pod count of 47.00, 45.25, and 35.75 per plant respectively (Table 2). This is consistent with the number of flowers that soybean plants typically produce.

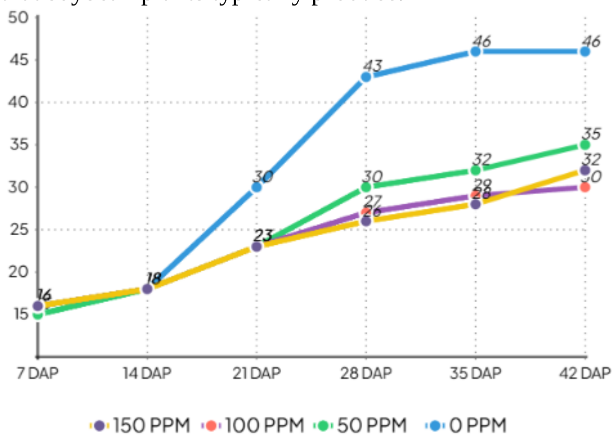

Figure 2. Plant Height Chart

Table 1. Number of Flowers Per Plant of Soybean Variety Anjasmoro

Treatment Paclobutrazol Concentration (ppm)	Number of Flower
P0 (0)	64.17
P1 (50)	83.58
P2 (100)	101.92
P3 (150)	115.17
Tukey 5%	12.02

Table 2. Number of Pods Per Plant of Soybean Variety Anjasmoro

Treatment Paclobutrazol Concentration (ppm)	Number Of Pods
P0 (0)	35.75
P1 (50)	45.25
P2 (100)	47.00
P3 (150)	48.33
Tukey 5%	9.42

Chlorophyll test results for Anjasmoro soybean varieties showed striking differences among the various treatment groups. The application with paclobutrazol concentration of 150 ppm (P3) and nitrogen, phosphorus and potassium fertilizers at 300 kg/ha (N4) had the highest chlorophyll yield with a concentration of 53.87 mg/L. The application of paclobutrazol concentration of 150 ppm (P3) and 150 kg/ha (N1) and nitrogen, phosphorus and potassium fertilizers concentration of 50.50 mg/L. Using paclobutrazol concentration of 50 ppm (N4), 33.81 mg/L NPK obtained from 150 kg/ha (N1), 36.57 mg/L from NPK 200 kg/ha (N2) and 36.57 mg/L from NPK 200 kg/ha/48.44 mg ha (N2) dose, 29.43 mg/L at 250 kg/ha and 29.43 mg/L at 300 kg/ha (N4). Using 100 ppm Paclobutrazol.

NPK dose of 150 kg/ha the obtained concentration (N4) is 40.86 mg/L (N1), at a NPK dose of 200 kg/ha the result at the NPK dose is 50.18 mg/L (N2). The result is 44.06 mg/L at 250 kg/ha and 46.26 mg/L at 300 kg/ha (N4). When a paclobutrazol concentration of 150 ppm (N4) was used, 50.50 mg/L was obtained at a NPK dose of 150 kg/ha (N1), 43.79 mg/L at a NPK dose of 200 kg/ha (N2), and 47.86 mg/L at a NPK dose of 200 kg/ha (N2). mg NPK dosage is 53.87 /L at 250 kg/ha and 53.87 /L at 300 kg/ha (N4) dosage (Table 3).

Table 3. Chlorophyll Content of Soybean Plants of Anjasmoro Variety

No	Treatment	ABS		Total Chlorophyll
		646	663	
1	P0N1	1.334	2.053	37.82
2	P0N2	1.551	1.191	35.38
3	P0N3	0.759	1.759	25.76
4	P0N4	1.592	2.063	42.35
5	P1N1	1.098	2.064	33.81
6	P1N2	1.977	2.270	36.57
7	P1N3	1.905	2.156	48.44
8	P1N4	0.890	1.954	29.43
9	P2N1	1.494	2.091	40.86
10	P2N2	1.899	2.413	50.18
11	P2N3	1.608	2.262	44.06
12	P2N4	1.763	2.195	46.26
13	P3N1	1.221	2.151	50.50
14	P3N2	1.578	2.297	43.79
15	P3N3	1.732	2.493	47.86
16	P3N4	2.193	2.219	53.87

Discussion

Paclobutrazol is a growth regulator that can increase crop yield by inhibiting the vegetative phase and increasing the growth rate. This is consistent with Harpitaningrum et al. (2014) who said that the presence of PGR paclobutrazol will inhibit the growth of plants and promote flowering. Paclobutrazol is a chemical compound, therefore the appropriate concentration is essential to achieve optimal efficacy while minimizing the risk of plant poisoning due to excessive doses. According to Roostika et al. (2009), the use of paclobutrazol at higher levels can lead to poisoning of tissues and plant death.

Figure 1 illustrates the plant height. The data in Figure 1 demonstrate that at the age of 28 DAP, the growth of soybean plants of the Anjasmoro variety exhibited a decline in rate. This outcome can be attributed to the application of paclobutrazol at the age of 25 DAP. The mechanism of action of paclobutrazol has been elucidated by Marshal et al. (2015). In brief, paclobutrazol inhibits gibberellin production by impeding the oxidation of kaurene to kaurenic acid. This, in turn, can result in a reduction in the speed of cell division and a decline in vegetative growth.

The treatment with a paclobutrazol concentration of 150 ppm exhibited the highest number of total flowers, in comparison to the other treatments. This can be attributed to the inhibitory effects of retardant substances on gibberellin synthesis. This finding is in accordance with the research conducted by Ardigusa and Sukma (2015), which elucidates that retardants can effectively regulate plant growth, preventing excessive growth and ensuring optimal lodging resistance. The Anjasmoro soybean variety has more flowers than other soybean varieties (Sumarmi, et al., 2014). Retardants have the capacity to impede gibberellin synthesis, expedite flowering, augment the number of flowers. It can be reasonably assumed that as the number of flowers on a plant increases, so too does the number of fruit or pods. The findings of Zamzami et al. (2015) demonstrate a correlation between an increase in floral abundance and a corresponding increase in fruit formation.

The application of paclobutrazol at a concentration of 150 ppm has been observed to result in the highest average chlorophyll content, which plays a pivotal role in facilitating the photosynthesis process in plants. The data demonstrate that paclobutrazol can enhance the chlorophyll content in Anjasmoro soybean plants. Cahyani et al. (2022) corroborate this finding by asserting that paclobutrazol administration to plants can augment chlorophyll levels in leaves, thereby facilitating enhanced photosynthesis and assimilation, and ultimately, increased plant productivity. The presence of chlorophyll is of great significance to plants, as this pigment plays a pivotal role in the process of photosynthesis. The process of photosynthesis is beneficial for the conversion of nutrients in the soil into carbohydrates, which are utilized by plants. This is consistent with the findings of Song (2012), who asserts that photosynthesis is the synthesis of carbohydrates from inorganic materials (CO2 and H2O) in pigmented plants with the assistance of solar energy.

The application of NPK fertilizers has been demonstrated to influence the accumulation of chlorophyll in soybean plants. This phenomenon can be attributed to the N element present in NPK, which serves as a vital nutrient in the synthesis of chlorophyll. This assertion is corroborated by the findings of Lingga and Marsono (2006) who stated that the N nutrient is an essential nutrient that functions as a building block for amino acids, proteins and chlorophyll which are important in the process of photosynthesis, N also plays a role in the process of flowering and ripening seeds.

Conclusion

The results of the above research indicate that the application of paclobutrazol at a concentration of 150 ppm elicits the most favorable outcomes with respect to the parameters of flower count, pod count, and chlorophyll content. The application of paclobutrazol has the potential to inhibit plant growth and promote the generative phase, resulting in plants treated with paclobutrazol having a reduced height. The application of NPK fertilizer at 150 kg/ha has been found to exert the most favorable average influence on soybean varieties Anjasmoro.

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