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Study of the growth and yield of mung bean plants (*Vigna radiata* L.) on the inhibitory power of ZPT Paclobutrazol

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Abstract:
The decline in productivity of mung beans (*Vigna radiata* L.) in Indonesia requires strategic efforts to increase yields. One approach studied in this study is the use of plant ZPT Paclobutrazol as a compound that inhibits vegetative growth, especially in the formation of branches that play an important role in plant yields. The purpose of this study was to determine the effect and magnitude of the inhibitory power of Paclobutrazol on the growth and yield of mung beans. The study was conducted in July–October 2024 in Sumbersari District, Jember Regency with an altitude of 160 meters above sea level. The design used was a Randomized Block Design (RBD) with five concentration treatments (0 ppm, 50 ppm, 100 ppm, 150 ppm, and 200 ppm) and five replications. The results showed that a concentration of 200 ppm Paclobutrazol gave the most significant inhibitory effect, reducing plant height by 33% compared to the control and producing fewer branches. However, yield variables such as biomass weight, pod weight, seed weight, and number of pods did not show significant differences between treatments. This indicates that Paclobutrazol is more dominant in inhibiting vegetative growth without providing a significant increase in the generative phase. This study concluded that the application of Paclobutrazol at high concentrations significantly inhibited the growth of mung beans but did not significantly affect the yield.

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INTRODUCTION

Mung beans (*Vigna radiata* L.) are an important food crop widely consumed in Indonesia after soybeans and peanuts (Ruhan, 2023). However, the trend in mung bean production shows a decline from 588,522 tons/ha in 2021 to 512,467 tons/ha in 2022, below the RPJMN target of 0.58 million tons (Directorate General of Food Crops, 2022).

Mung bean productivity is greatly influenced by the number of branches, which is directly correlated with the number of pods. Branch formation is influenced by endogenous hormones such as auxin and abscisic acid (ABA). ABA dominance can suppress branch formation, while auxin stimulates cell elongation, which also has a negative impact on lateral branch growth (Asra et al., 2020). To regulate this hormonal balance, the application of ZPT, such as Paclobutrazol, can be used.

Paclobutrazol works by inhibiting gibberellin biosynthesis through blocking kaurenoate formation, thereby inhibiting stem and branch elongation (Gusmawan, 2019; Santosa et al., 2024). This inhibition of vegetative growth can divert energy to the generative phase, but risks reducing yields if not used properly (Fathurrahman, 2020; Ulivia, 2023). Therefore, this study aims to examine

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the effect of Paclobutrazol on the growth and yield of green beans, especially in branch formation and seed productivity.

METHOD

This research was conducted from July to October 2024 in agricultural land located in Sumber Pak Environment, Kebonsari Village, Sumbersari District, Jember Regency, East Java Province, at an altitude of 160 meters above sea level, with an average temperature of 23°C and air humidity of around 95%. The research location is at coordinates -8.189495° South Latitude and 113.714758° East Longitude.

The research design used was a Randomized Block Design (RBD) with five treatments of Paclobutrazol plant growth regulator (PGR) concentrations, namely 0 ppm (control), 50 ppm, 100 ppm, 150 ppm, and 200 ppm, each of which was repeated five times. Vima 5 green bean seeds were planted with a spacing of 40 × 30 cm in a 2 × 1 meter plot, using a tugal planting system, two seeds per planting hole. Paclobutrazol application was carried out twice, namely at the ages of 25 and 30 days after planting (DAP), by spraying the solution over all parts of the plant in the morning.

Plant maintenance is carried out intensively, including replanting, weeding, hilling, watering, and fertilization. Fertilization is given twice, using urea, SP-36, and KCl, namely at the age of 7 HST at 75% of the total dose, and the rest at the age of 30 HST.

Observations were made on growth and yield variables, including plant height at 28 and 42 HST, dry biomass weight per sample, fresh and dry pod weight per sample, number of filled and empty pods, dry seed weight per sample and per plot, weight of 100 seeds, and flower emergence time. All observation data were analyzed using analysis of variance (ANOVA). If there was a significant difference between treatments, then we continued with Dunnett's test at the 5% level to compare the treatment with the control. To determine the tendency of plant response to increasing Paclobutrazol concentration, a quadratic polynomial test was used.

RESULT

Plant Height

Observations on plant height at 42 days after planting (DAP) showed that the administration of Paclobutrazol ZPT at a concentration of 200 ppm resulted in a significant decrease in plant height, which only reached 23.46 cm, compared to the control ZPT, which reached 31.32 cm. This decrease reached 33%, indicating the strong inhibition of Paclobutrazol on stem elongation. The following graph illustrates the difference in plant height in each treatment:

These results are in accordance with the findings of Gusmawan (2019) and Santosa et al. (2024), which stated that Paclobutrazol inhibits the formation of gibberellin, a hormone that plays a role in cell elongation, thereby reducing plant height growth.

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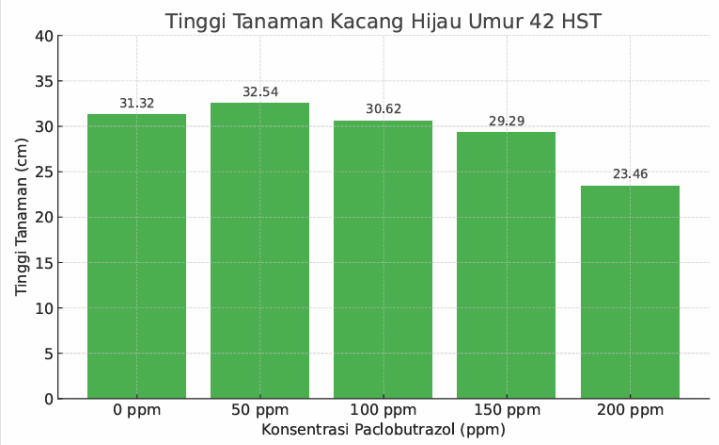

Figure 1. Plant Height

Number and Weight of Pods

The highest average number of filled pods was found in the treatment without Paclobutrazol (25.57 pods), while the 200-ppm treatment only produced 18.71 pods. This indicates that excessive use of Paclobutrazol can reduce plant productivity. Fresh and dry pod weights also showed a similar pattern, with the highest values in the 0 and 150 ppm treatments, while 200 ppm showed a decrease.

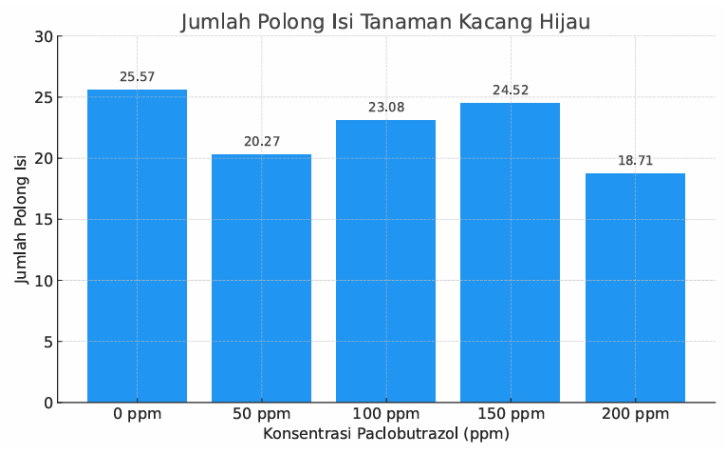

Figure 1. Number of Pods

Below is a bar graph showing the fresh pod weight per sample at various concentrations of Paclobutrazol. The graph shows that the 150-ppm treatment resulted in the highest pod weight, while the 200-ppm concentration resulted in the lowest pod weight. This shows that the effectiveness of Paclobutrazol ZPT is highly influenced by concentration, and high doses can reduce yield potential.

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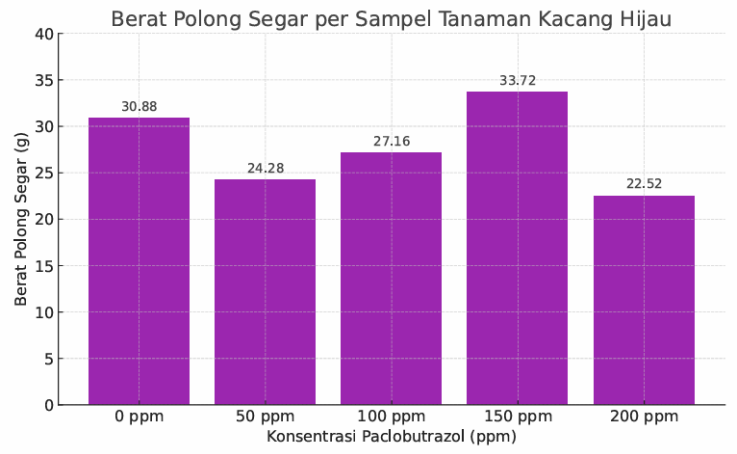

Bar Figure 3. Pod Weight

Dry Seed Weight and 100 Seed Weight

The highest dry seed weight per sample was obtained at a concentration of 150 ppm (17.44 g), while the lowest value was recorded at a concentration of 200 ppm (14.00 g). Meanwhile, the highest 100 seed weight was found in the 50-ppm treatment (6.42 g), and the lowest was at 200-ppm (6.24 g). This shows that the effect of Paclobutrazol on yield parameters is not always linear, and high concentrations tend to reduce yield.

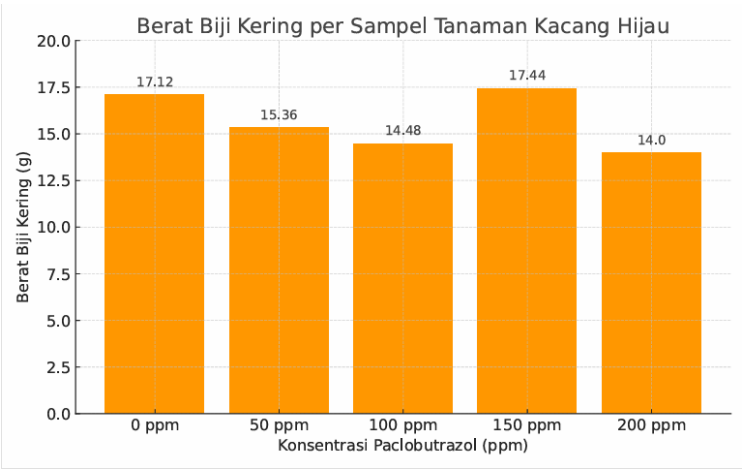

Figure 4. Dry Bean Weight

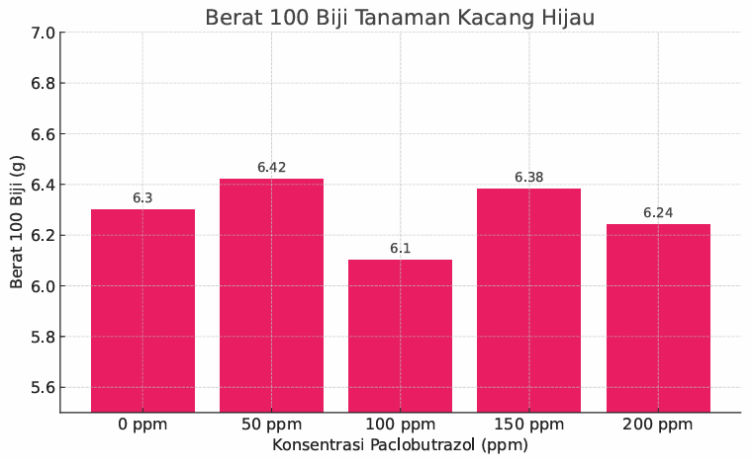

Figure 5. Weight of 100 Seeds

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Flowering Time

The flowering time in the Paclobutrazol treatment (50, 150, and 200 ppm) was relatively uniform, namely at 35 HST, while the control and 100 ppm treatment appeared at 36 HST. This difference is not significant but indicates a tendency for acceleration of the generative phase by PGR at certain doses (Sakanti et al., 2024).

DISCUSSION

The results showed that the application of Paclobutrazol had a significant effect on suppressing the vegetative growth of mung bean plants, especially on plant height. A concentration of 200 ppm reduced plant height by 33%, in line with the mechanism of action of Paclobutrazol, which inhibits gibberellin biosynthesis (Gusmawan, 2019; Santosa et al., 2024). However, this decrease in growth was not followed by a significant increase in generative results such as the number of pods, seed weight, and weight of 100 seeds. In fact, at high concentrations, the number of filled pods and seed weight tended to decrease.

These findings support previous studies (Kusumawardani & Hariyono, 2020; Moko et al., 2018), which showed that Paclobutrazol can inhibit growth without always increasing yield. The novelty of this study is the focus on the effects of inhibiting branching and pods on the Vima 5 mung bean variety, which has not been widely reported.

These results provide practical contributions to mung bean cultivation, especially in the management of ZPT to prevent excessive growth without sacrificing yield. However, this study was limited to one location and a certain dose range. Further research needs to evaluate higher concentrations and other environmental factors to obtain broader and more applicable recommendations in agricultural systems.

CONCLUSION

This study concluded that the application of Paclobutrazol PGR on green bean plants of the Vima 5 variety had a significant effect on vegetative growth, especially plant height. A concentration of 200 ppm significantly reduced plant height by 33% compared to the control. However, the effect on yield components such as the number of pods, seed weight, and weight of 100 seeds was not significant, and even tended to decrease at the highest concentration.

Thus, the use of Paclobutrazol needs to be adjusted so as not to inhibit branch formation and overall plant productivity. The optimal dose still needs to be studied further to maximize yield potential without excessively disrupting vegetative growth. Further research is recommended to evaluate the effects on different growing environments and wider concentration variations.

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