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Development and yield of cormels gladiolus plant stimulated with paclobutrazol

F Iriani*, R Sitawati, A Rahmawati

Agrotechnologi Department, Universitas Insan Cendekia Mandiri, Jalan Pasir Kaliki 199, Sukabungah, Sukajadi, Bandung. 40162. Indonesia

*Email: farida.iriani52@gmail.com

Abstract. The application of paclobutrazol compounds in several types of horticultural crops is effective in stimulation the growth and development of tubers. Gladiolus plant (*Gladiolus hybridus*) is one of the ornamental plants that produce bulbs or corm and cormels as reproductive organs. The development of corm and cormels gladiolus plants has been stimulated by the concentration of paclobutrazol compounds through soil surface flushing after flowers are harvested, namely at the age of 66 days after planting. Using the single factor Randomized Block Design method with four concentration levels of paclobutrazol compounds as treatment, namely, 0 mgL⁻¹, 50 mgL⁻¹, 100 mgL⁻¹, and 150 mgL⁻¹. Corm and cormels development was observed destructively in sample plants at regular intervals of five days as many as eight times, starting after a week of watering consisting of variable responses to the development of the corm diameter, the development of the number of cormels, the development of the diameter of the cormels, and the development of the plant root ratio. The data obtained are suspected according to regression fingerprints, and the curves obtained are compared with squeeze and alignment tests. The results showed that the diameter of the corm, the diameter of the cormels, and development of the plant root ratio treated with paclobutrazol compounds were better than without treatment, but the application of paclobutrazol treatment had no effect on the number of cormels. Obtained cormels with a diameter of > 1.5 cm is the desired final goal in this study, because the cormels have economic value as planting material to produce larger corm, then the next can be used as planting material to produce flowering corms.

1. Introduction

Gladiolus hybridus L. from the Iridaceae family is one of the targets of Indonesian floriculture production in the period 2020-2024 [1], with the production organs used are flowers along with stalks and cormels. Indonesia's domestic consumer demand from year to year continues to increase, averaging 2-7% over the past five years. Production of are⁻¹ each gladiolus harvest period at the level of highland farmers in Indonesia averages 169,189 flower stalks, and cormels of 136,406 pieces, while domestic consumer demand averages 127,200 flower stalks per week [2].

The reproductive apparatus of gladiolus plants for the purpose of flower production is through the corm which is a modification of stem tissue composed by dense layers of leaf flesh [3]. In corm stored food reserves consisting of protein and hemicellulose needed during the dormancy period, then these substances will be converted into sugar as an energy source for the emergence of leaf buds and flower buds through the corm growing point. The diameter of the corm for the purpose of flower production is > 1.0 inches while the diameter of the corm $\geq 0.4 \leq 1.0$ inches is used to produce the corm back [4].



Efforts to produce quality corm gladiolus can be done by utilizing appropriate technology, especially retardants that can stimulate the productivity of harvesting organs. The compound paclobutrazol (PBZ) is a member of the triazole group of compounds containing chlorophenyl, dimethyl triazole and pentanol groups and as a whole is able to act as a growth regulator [5]. To carry out its role as a retardant, PBZ works by inhibiting the synthesis of gibberellene (GA) and abscisic acid (ABA), and vice versa increasing the synthesis of cytokinins (CK) [6, 7, 5]. Changes in the balance of hormone levels in the plant body will certainly have an effect on growth and development attitudes. Some experts have analyzed that PBZ has an effect on reducing stem elongation of the *Phaseolus vulgaris* plant [6], increasing root growth and stimulating root formation from calluses of cotyledon origin [8], as well as increasing production, tuber size and dry biomass of tubers [9, 10, 11].

According to Desta and Amare (2021) [5] that PBZ compounds are more effective when applied to planting media than if applied through leaves, because it will give longer time for plant roots to absorb the PBZ active ingredients. PBZ active ingredient residues are still detected in the soil for up to 120 days after application, and are still able to have an effect on increasing the number of taro plant saplings [12]. Application of PBZ at a concentration of 150 mgL⁻¹ in *Capsicum anuum* plants obtained the highest results compared to concentrations of 30, 60, 90, or 120 mgL⁻¹ [13].

2. Materials and methods

2.1. Place, preparation of planting media, and research materials

The experiment has been carried out at an altitude of 1,250 masl, Andosol soil type, soil pH 5.5 and average daily temperature 22 - 27 °C located in Parongpong village, West Bandung Regency, West Java Province, Indonesia. The planting media consists of a mixture of soil and chicken manure dose of 30 tons.acre⁻¹ stored in a wooden box measuring 100x100x30 cm and the bottom of the box is in direct contact with the land media. Planting material is corm *Gladiolus hybridus* L. variety Priscilla, colour of white goddess with 5 cm in diameter, healthy condition, pest-free disease, and totaling 648 pcs. Application of retardant compounds with PBZ active ingredients is carried out by watering the soil surface on the 66th day after planting, that is, one day after the flower stalks are harvested.

2.2. Response Design

The trial was conducted using a single-factor Randomized Block Design, consisting of four treatments and six blocks. The treatment is the concentration of PBZ active ingredients with treatment levels of 0, 50, 100, and 150 mg L⁻¹ which is poured onto the soil surface.

2.3. Variables and Response Analysis

The response variables observed included corm diameter, cormels diameter, number of cormels, and shoot and root ratio, each of which was measured periodically five days eight times, starting from days 73, 78, 83, 88, 93, 98, 103, and 108 after planting. The four response variable data obtained were analyzed by regression fingerprints according to Draper and Smith (1998) [14], and presented in the form of curves. The curve obtained is further tested to be compared with alignment and tightness tests.

The combined regression equations displayed in each observed response variable analysis result, each consisting of four regression equations with one predictor variable so that it will be guessed by the following model:

$$Y = \beta_0 + \beta_i X_i \quad (1)$$

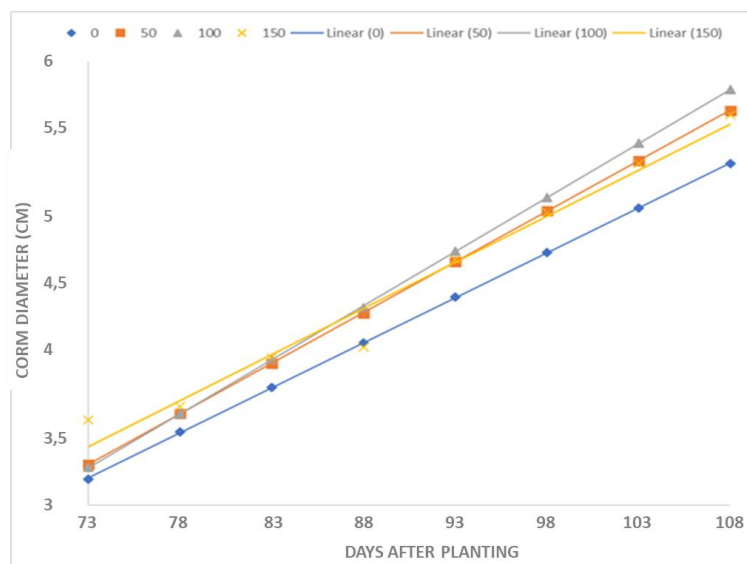
3. Result and Discussion

Based on the results of statistical analysis of Group Random Design, it was found that the development of corm diameter, development of cormels diameter and root extinction ratio was significant at the test level of 0.05 while the development of the number of cormels was not tested

significantly at the test level of 0.05. The four results of the response variable analysis are presented in the form of curves as in Figure 1, Figure 2, Figure 3, and Figure 4.

The development of the diameter of corm the five-day period Gladiolus

Figure 1 informs that the three curve lines that are the application treatment of PBZ compounds, and any degree of concentration are squeezed together while those without PBZ treatment are parallel to the other three lines. The analysis data means that treatment without PBZ application will not compete with the magnitude of corm diameter development value in treatment that gets PBZ application. The fastest corm diameter development value is obtained at a concentration of 100 mgL⁻¹ PBZ, and the higher the PBZ concentration (150mgL⁻¹) it appears that the corm diameter development decreases and coincides with the PBZ concentration curve line of 50 mgL⁻¹. The results of this experiment support the opinion of Zhan *et al.* (2014)[10] that the application of PBZ compounds can be increase the size of *Ophiopogon japonicus* tubers.



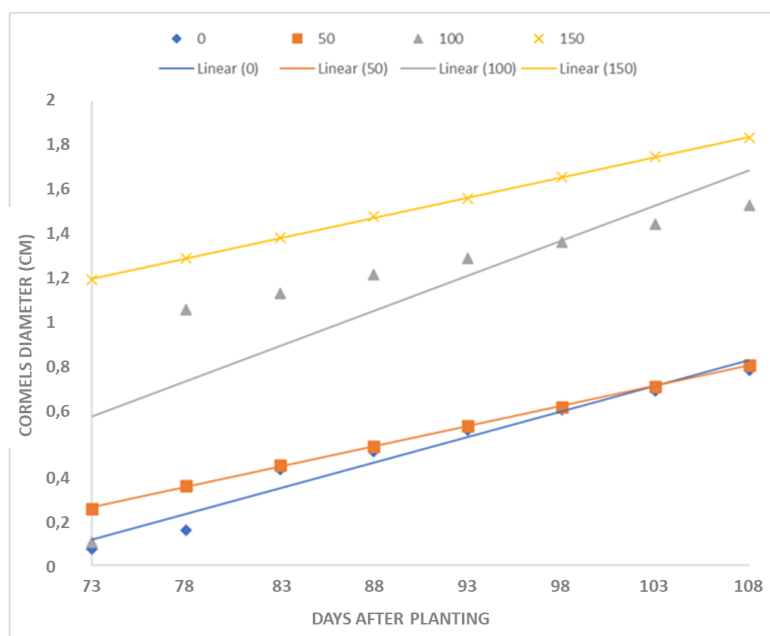
Concentration treatment mgL ⁻¹	Regression equation (y)	Value R ²
0	y = 0.0607x - 1.2421	0.9999
50	y = 0.0684x - 1.7135	1
100	y = 0.073x - 2.0706	1
150	y = 0.0623x - 1.146	0.9736

Figure 1. Development of the diameter of the corm *Gladiolus*

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The development of the diameter cormels of the five-day period Gladiolus

Figure 2 informs that the development of cormels diameter is cyclical due to the application of PBZ compounds. It appears that the higher the concentration of PBZ compounds, the development of cormels diameter increases, and the best value is obtained at a PBZ concentration of 150 mgL⁻¹. The larger the diameter of the cormels obtained be rate the greater the number of cormels that can be replanted to produce corm [4]. The activity of PBZ active ingredients in the soil, appears to have a positive effect up to 37 days after treatment, even based on the linearity of the curve is predicted to continue to increase due to the application of PBZ concentration of 150 mgL⁻¹, very different results from the treatment of PBZ concentration of 50 mgL⁻¹. Thus these data support that the application of PBZ compounds by flushing the soil surface is effective because the active ingredients of PBZ can still be absorbed by the roots to spur the development of tuber diameter [5] or cormels. Jiang *et al.* (2019)[12] suggest that PBZ active ingredient compounds in the soil are slowly dehydrated, and residues remain detected up to the 120th day after application, and are still able to have an effect on stem elongation inhibition.



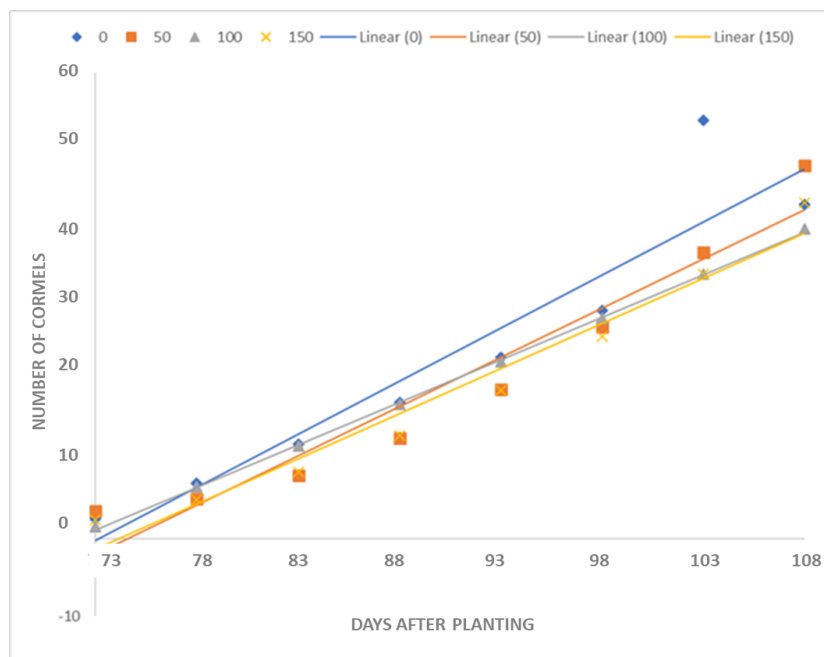
Concentration treatment mgL ⁻¹	Regression equation (y)	Value R ²
0	y = 0.0220x - 1.5003	0.9652
50	y = 0.0175x - 1.0257	0.9995
100	y = 0.0303x - 1.5743	0.6600
150	y = 0.0175x - 0.0407	0.9998

Figure 2. Development of the diameter of the cormels *Gladiolus*

The development of number of the cormels five-day period Gladiolus

The following Figure 3 presents the results of regression analysis of the development of the number of five-day *Gladiolus* cormels, starting from day 73 to day 108 after planting. The results of regression fingerprints showed that there was no significant difference in the development of the number of cormels, both treated with PBZ compounds (regardless of concentration), and without PBZ compounds. It is suspected that the number of cormels has not been a focus for *Gladiolus* plants to

spur the number of yields, but rather focused on increasing the size of corms and / or cormels, and at the same time to increase the biomass of corms and or cormels. Economically, this is more profitable than increasing the number of cormels that are small ($> 0.5 \leq 0.75$ inch) to very small (≤ 0.4 inch), and have no economic value [4].



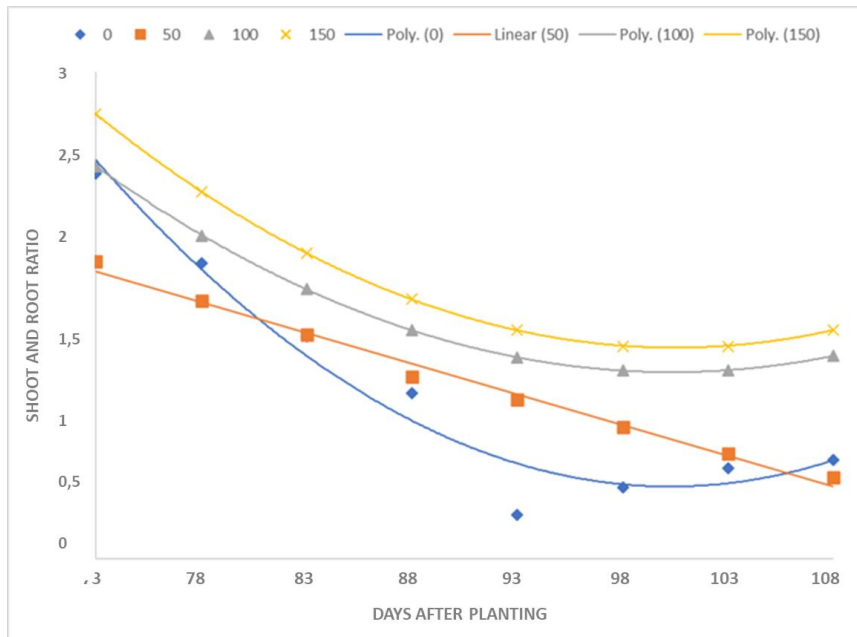
Concentration treatment mgL ⁻¹	Regression equation (y)	Value R ²
0	y = 1.3668x - 100.09	0.8892
50	y = 1.2694x - 94.761	0.9385
100	y = 1.0946x - 78.786	0.9996
150	y = 1.1621x - 86.235	0.9648

Figure 3. Development of number of the cormels Gladiolus five-day period

Development shoot and root ratio of the five-day period Gladiolus plant

Based on the results of the shoot and root ratio calculation as presented in Figure 4 below, data were obtained that the development of fresh weight of plants decreases with increasing plant age, and vice versa followed by the increase in weight of the lower part of plants, namely corms and cormels. The four regression lines as presented in Figure 4 show that the linear line is only caused by the application of the compound PBZ 50 mgL⁻¹ meaning that as we get older after PBZ treatment, the fresh weight of the upper part of the plant decreases and is replaced by the fresh weight of the root part which increases. Near the age of corm harvest or towards the end of the senescent of Gladiolus plants it appears that photosynthetic activity decreases which is represented by a decrease in the fresh weight of the plant, but instead photosynthetes accumulate in the final crop of corms, and / or cormels.

Figure 4 informs that the higher the concentration of PBZ compounds applied to the soil surface, causing the longer the photosynthetic activity period of plants, senescence delayed, and active photosynthetes translocated to the subsurface of the soil i.e. in corms and or cormels. The experimental results of the application of PBZ compounds concentrations of 100 mgL⁻¹ and 150 mgL⁻¹ as presented in Figure 4 support the opinion of Xia *et al.* (2018) [15] that PBZ is able to significantly increase the rate of photosynthesis in the leaves of peony plants with more concentrated green color characteristics and higher chlorophyll levels compared to control.



Concentration treatment mgL ⁻¹	Regression equation (y)	Value R ²
0	$y = 0.0027x^2 - 0.5423x + 27.63$	0.9582
50	$y = -0.0378x + 4.525$	0.9900
100	$y = 0.0017x^2 - 0.3406x + 18.236$	1
150	$y = 0.0019x^2 - 0.3828x + 20.529$	1

Figure 4. Development of shoot and root ratio Gladiolus five-day period

Presented in Figure 5 is sample the yield of corm and cormels after each receiving PBZ treatment at different concentrations at 108th. The widest of sample corm diameter due to PBZ 150 mgL⁻¹ treatment was 6.9 cm while the widest corm diameter without treatment only reached 5.5 cm. The widest average diameter of cormels was obtained at 150 mgL⁻¹ PBZ treatment, but the highest number of cormels was without PBZ treatment despite the small size of the cormels.

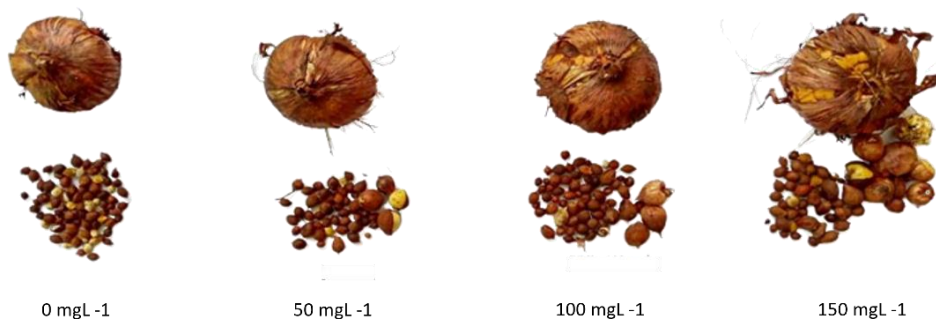


Figure 5. Examples of corms and cormels at the time of harvest 108th days after planting due to PBZ treatment (concentration 0, 50, 100, 150 mgL⁻¹).

4. Conclusion

Efforts to increase one of the yields of Gladiolus plants, namely in the form of corm products and or cormels can be stimulated by the application of PBZ compounds at a concentration of 150 mgL⁻¹ through watering the soil surface after the flower products are harvested.

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