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The effect of triacontanol on the flowering of *Gladiolus* (*Gladiolus hybridus*)

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Abstract. *Gladiolus* plant is one of the ornamental flower plants that is used as cut flowers. The economic value of cut flowers depends on the length of the stalk along the stalk, the brightness of the color of the petals, and the length of time the flowers are vase life. Triacontanol compounds (TA) are long-chain alcohol compounds, and are generally able to stimulate the flowering process and fruit enlargement. The study used a one-factor randomized block design, including four treatments and six blocks. *Gladiolus* plants aged 15 days after planting have been applied with TA compounds at concentration levels of 15 g⁴.L⁻¹, 30g⁴.L⁻¹, and 45 g⁴.L⁻¹ through above soils surface, apparently giving different effects on the quality of *gladiolus* cut flowers. The comes about appeared that TA fertilization at a concentration of 45 g⁴.L⁻¹ was the best depending on the age of flower bud appearance, flower harvest age, flower stem length, flower diameter and and 5-day Relative Growth Rate. This study aimed to examine the effects of TA compounds at different concentrations on flowering of *gladiolus*. TA compounds had a better effect when given in a concentration of 45g⁴.L⁻¹ for all observed response variables.

1. Introduction

Gladiolus (*Gladiolus hybridus*) is an annual herbaceous plant whose end products are flowers and stems used as cut flowers for a variety of ornamentals, and which produces tubers used as reproductive materials [1]. *Gladiolus* plants belong to the *Iridaceae* family, numbering approximately 255 species, sword-shaped leaves, trumpet-shaped flowers with thin crown sheets, consisting of various colors, and grow well in medium to high altitude areas with average daily temperatures ranging from 20-25°C [2]. *Gladiolus* flowers have relatively good economic value, quite popular in almost all parts of the world, and occupies the fifth position in international floriculture trade [3]. Besides being used as a decorative material, *gladiolus* flowers are now starting to be used as cosmetic raw materials, especially for skin and hair health because it contains antioxidant, anti-inflammatory, and anticancer compounds [4, 5]. The application of natural and synthetic growth regulators externally, is currently commonly used as an effort to increase plant productivity. Triacontanol (TA) organic compounds are one of the long-chain alcohol compounds that are quite consistent in spurring the process of flowering, fruit development, or ripening of other reproductive organs in some species [6]. Triacontanol is a relatively new regulatory compound that plays a role in regulating various physiological and biochemical processes that lead to the control to the regulation of the adverse effects of salinity on plants [7]. Application of TA in low concentrations is more effective than high concentrations, but in very low concentrations it sometimes does not work as a booster [7, 8]. Furthermore, it was observed that TA spray treatment substantially increased the N,



P and K content in the leaves of *Coriandrum sativum* L. and *Cymbopogon flexuosus*. It was also obtained that TA treatment caused changes in the composition of plants, affecting the nutrient content [9, 10]. Various efforts have been made to understand the mechanisms of TA activity in hypersaline soils condition [11], but some plant physiologists agreed that the specific internal hormone that drives the flowering process of plants is florigen [12]. That one organic compound release was declared into the group of plant hormones in the era of 2000th after enough positive recommendations on physiological response of flowering, and stimulation of a plant [13]. The florigen that has been agreed to be a special hormone for flowering part of the auxin hormone, but it still takes a lot of experiments to support this statement. Sometime that the mechanism of action of TA organic compounds in influencing plant growth and development is not fully understood, but many plant physiological agree on that responses point to a mechanism similar to the hormone auxin especially in terms of increasing the growth of rice, maize, and tomato plants [14].

This is known that the physiological response of plants to the addition of external synthetic hormones is different, depending on internal factors such as the responsiveness of substrates that carry RNA transformation genes in each species, the type of hormone, and the amount of hormone concentration applied [15]. In addition, it is also influenced by external factors such as the way and time of application, temperature and humidity of micro air, as well as the presence or absence of light and rainfall that falls shortly after the application of the hormone [13]. Plant hormones play important roles in controlling all aspects of plant growth, development, and metabolism. We are interested in understanding the hormonal regulation of flower opening in *Gladiolus* plants. How the flowering of *Gladiolus* plants responds to external of TA compounds when plants are still in the vegetative growth phase with different levels of concentration, is the purpose of this study.

2. Material and Methods

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

The experiment was conducted at an altitude of 1,250 m above sea level, and average daily temperature located in Parongpong village, West Bandung Regency, West Java, Indonesia, where the average daily temperature ranges from 22°C to 27 °C. *Gladiolus* plants grown through the reproductive apparatus of cormels, grown in pots consist of sand planting media, Aluvial soil, and organic fertilizer of chicken manure with a ratio of 1:1:1 each. The *gladiolus* plant used is the Priscilla variety with colour white of flower petals. Bulbs with a diameter of 4.5 cm were planted according to the placement of Randomized Block Design with single factor, consisting of six blocks and four treatments. The surface of the planting medium was watered with TA compounds at four level concentrations of 0 g.L⁻¹ (Y0), 15 g⁴.L⁻¹(Y1), 30 g⁴.L⁻¹(Y2), and 45 g⁴.L⁻¹ (Y4) respectively at 15 days after planting (DAP) with a watering volume of 150 mL.plant⁻¹, and at that time the leaf primordia had appeared above the soil surface.

2.2. Response Design

The trial was conducted using a single-factor Randomized Block Design, consisting of four treatments and six blocks. One week after the plants were treated with TA compounds, the total dry weight of the plants began to be observed, the leaf area taken destructively amounted to eight plants. Meanwhile, non-destructive plant residues were used to observe the variables of flower bud appearance age response, flower harvest age, flower stalk length, and flower diameter.

2.3. Variables and Response Analysis

The response variables observed included of the growth dynamics, namely the Relative Growth Rate (RGR) every 5-day period, namely on the 22 DAP, 27 DAP, 32 DAP, 37 DAP, 42 DAP, 47 DAP, 52 DAP, and 57 DAP so that the total destructive activities of the plants were carried out eight times. For eight periods of time in five days, the total dry weight of *Gladiolus* plants was measured so that seven number observation were obtained, then calculated according to the formula of Relative Growth Rate.

The growth dynamics of Gladiolus plants represented by the 5-day RGR parameter are calculated using the following formula as stated by [16]:

$$RGR = \frac{\ln W_2 - \ln W_1}{t_2 - t_1} \text{ g. day}^{-1} \quad (1)$$

W_2 = total dry weight of plants at t_2 time

W_1 = total dry weight of plants at t_1 time

t_2 = 2nd observation time

t_1 = 1st observation time

The results of the analysis of the RGR formula are presented in the form of regression lines on the X and Y axis curves and then tested further with the alignment and tightness test [16]. The response variables of flower bud appearance age response, flower harvest age, flower stalk length, and flower diameter, then ANOVA diversity was analyzed according to the Randomized Block Design, as presented in the following formula [17]:

$$X_{ij} = \mu + \beta_i + \tau_j + \varepsilon_{ij} \quad (2)$$

X_{ij} = is the dependent variable score for the subject in block i that receives treatment j

μ = is the population mean

β_i = is the effect of block i

τ_j = is the effect of treatment j

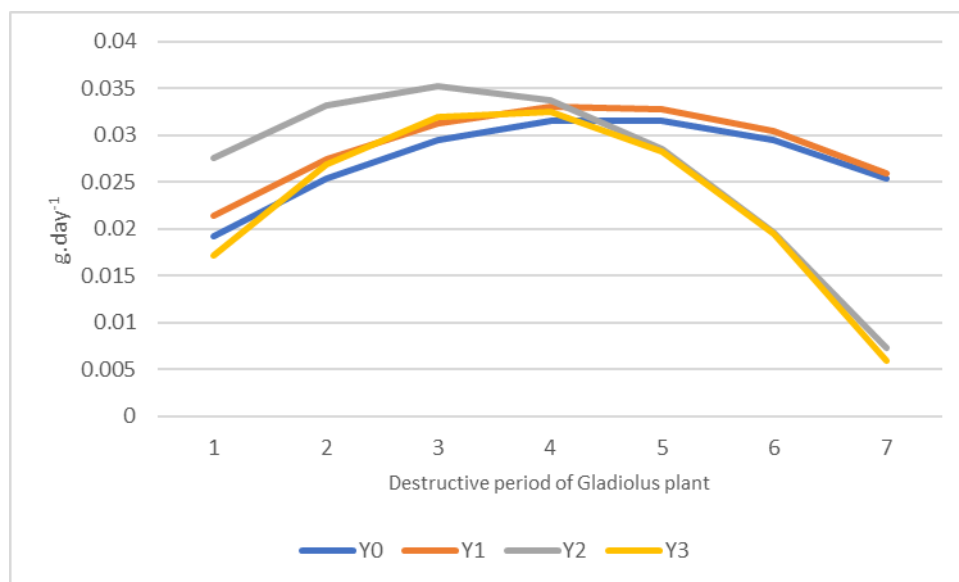
ε_{ij} = is the experimental error

Calculate the difference between treatments, the results of the ANOVA analysis were compared with the Duncann test [17], and presented in Table form.

3. Result and Discussion

The growth dynamics of Gladiolus plants observed through the RGR activity in each 5-day period are presented in the following Figure 1. The analysis of varians of different treatment TA concentrations for response variables of flower bud appearance age response, flower harvest age, flower stalk length, and flower diameter are presented Table 1.

Based on Figure 1 above it appears that the growth dynamics pattern of Gladiolus plants has a normal shape, namely forming hyperbolic lines as following the normal pattern of the Sigmoid curve. The RGR of Gladiolus plants was slow at the beginning of observation periods 1 and 2 then increased in observation period 4 and decreased again in observation periods 5, 6, and 7. The average value of the relative growth rate due to the application effect of TA organic compounds was above the relative growth rate without TA application. The application of TA at the lowest concentration ($15 \text{ g}^{-4} \cdot \text{L}^{-1}$) formed a parallel line to no TA treatment, while the application of TA at concentrations of $30 \text{ g}^{-4} \cdot \text{L}^{-1}$ and $45 \text{ g}^{-4} \cdot \text{L}^{-1}$ formed a squeezing line which meant that there was 'nt significant difference in outcome between the two treatments. Based on the results of the regression analysis, there was an acceleration towards the reproductive phase of Gladiolus plants due to the application of TA compounds represented by a sharp decrease in the results of the regression analysis, there was an acceleration towards the reproductive phase of Gladiolus plants due to the application of TA compounds represented by a sharp decrease in the relative growth rate value until the end of the observation period (periods 5, 6, 7).



RGR regression equation:

$$Y_0 = 0,011127 + 0,009188X - 0,001021X^2$$

$$Y_1 = 0,013419 + 0,009099X - 0,001043X^2$$

$$Y_2 = 0,018290 + 0,011101X - 0,001811X^2$$

$$Y_3 = 0,002766 + 0,016724X - 0,002323X^2$$

Figure 1. Relative Growth Rate of Gladiolus plants 5-day period.

The decrease in the relative growth rate value is identical to the reduction of growth activity and the nutrients absorbed will be utilized to meet cell development and differentiation activities. The experiment Rojek et orci (2018) [18], when in vitro culture media is added steroid hormones such as estrone, androsterone, progesterone, and epibrassinolide, it turns out to be able to act as a stimulant for endosperm cell division and at the same time add nutrients.

Table 1. Variants analysis results of various 4 parameters observed.

Treatment: Concentration TA (mgL ⁻¹)	Age of flower buds (Day After Plant) (N= 23; df = 3)	Flower stalk length (cm) (N= 23; df = 3)	Flower harvest age (Day After Plant) (N= 23; df = 3)	Flower diameter (cm)
Y0 = 0	63.20 a	74.95 a	68.12 a	12.43 a
Y1 = 1.5	61.80 a	76.88 a	66.82 a	12.59 a
Y2 = 3.0	60.90 ab	77.52 b	66.01 ab	13.19 b
Y3 = 4.5	60.49 b	80.59 b	64.64 b	13.40 b

Information: The number followed by the letter notation horizontally states that there is no difference in the Duncann's test standard at 5%

Based on Table 1 above, TA compounds applied in the vegetative phase are effective against the 4 variables observed, and it appears that the higher the concentration of TA given, the more responsive it is to the physiological changes of gladiolus plants observed through the variables of flower bud appearance, flower stalk length, flower harvest age, and flower diameter, although it does not affect the total number of flower buds. TA compounds with C₃₀H₆₂O chemical formula have a long carbon chain structure, are able to work easily on membrane cells, change the composition and structure of cell membranes, promote material movement, accelerate plant growth, and delay aging [12,14,19]. The results of Qianqian Pang et orci (2020) [20] research show that TA has a positive effect on increasing

the development and ripening of strawberries when applied when approaching the generative phase. Triacantanol was effected on flower quality of floriculture, and has been used for many years to increase the quality of chrysanthemum [21].

This experiment following image shows the Gladiolus flower due to the application of TA organic compounds at some concentration level on Figure 2.



Figure 2. Gladiolus flower appearance due to the application of TA compound.

4. Conclusions and sugestions

TA coumpound stimulates plants growth tolerance at low temperatures and has a positive effect on the content of Relative Growth Rate. This TA compound can also be used at concentrations (4.5 mgL⁻¹) or more to increase flowering hormones, especially through soil flushing techniques, because very low concentrations TA it does not effected.

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