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The Effect of Giving Paklobutrasol and Calcitor Fertilixer on The Yield of Siamese Citrus

I Komang Juniarta[1*], Ni Putu Anom Sulistiawati[1], Ni Komang Alit Astiari[1]

[1] Agrotechnology Study Program, Faculty of Agriculture, Warmadewa University

*Corresponding author. Email: juniarta360@gmail.com

Abstract

The research of this study was to determine the effect of giving paklobutrasol and calcitor fertilizer and their interaction on the yield of Siamese orange (Citrus nobillis var microcarva L.) conducted in Bayung Gede Village, Kintamani District, Bangli Regency from December 2021 to July 2022. This study using a randomized block design (RAK) with 2 factors arranged in a factorial manner. The first factor that was tried was the administration of Paklobutrazole (P) which consisted of 4 levels, namely: P^o 0 ml.L^{-1}, P^1 5 ml.L^{-1}, P^2 10 ml.L^{-1}, P^3 15 ml.L^{-1} while the second factor is the application of calcitor fertilizer (K) which consists of 4 levels, namely: K^0 0 ml/L^{-1}, K^1 3 ml/L^{-1}, K^2 6 ml/L^{-1}, K^3 9 ml/L^{-1}. Thus, there were 16 combination treatments, each of which was repeated 3 times so that 48 citrus trees were needed. The results showed that the interaction between the administration of Paklobutrasol and Kalsitor Fertilizer (PxK) had no significant effect on all observed variables. The highest harvested fruit weight per tree was obtained in the treatment with Paklobutrasol 15cc/tree, which was 7.77 kg or an increase of 78.21% when compared to the treatment without Paklobutrasol, which was 4.36 kg, while the highest harvested fruit weight per tree was obtained in the treatment with Calcitor Fertilizer 9cc/tree, which was 6.90 kg or an increase of 28.49% compared to the treatment without the application of calcitor fertilizer, namely 5.37 kg.

Keywords: Paklobutrasol, dosage, Siamese orange, concentration, Calcitor Fertilizer

1. Introduction

Orange is one type of fruit horticultural plant that has high economic value because it is in great demand by the public [1]. Siamese oranges are the most widely cultivated citrus species in Indonesia [2]. Oranges contain vitamin C which is very useful for the human body because it has many benefits such as lowering blood pressure, preventing cancer, preventing skin damage and treating canker sores. [3]. Fertilization plays an important role so that oranges can produce and get good fruit quality, it is necessary to provide complete and balanced nutrients such as organic and inorganic fertilizers containing N, P, K, Ca and Mg nutrients [4].

The province of Bali is one of the centers of citrus production in Indonesia. Bangli Regency is one of the potential developments of Siamese citrus. For Bali, especially in Kintamani Banglli, the Siamese orange is one of the leading commodities [5]. Siamese citrus production in Bangli Regency continues to increase based on data from the Central Statistic [6] namely in a row from 2017 (101,238 tons); in 2018 (102,051 tons) and in 2019 (168,476 tons). Oranges need loose and fertile soil, containing a lot of air (oxygen), organic matter, and water in the soil with a pH of 4-7.8 and an altitude of 1100-1500 meters above sea level. Optimum rainfall is 1,500 mm/year with optimal temperature between 250-3000C. Citrus plants also need a lot of sunlight which is about 50-70% [7]. Siamese citrus planting at an altitude of more than 900 m above sea level causes the taste of citrus fruits to become slightly sour [8].

The nutritional content in 100 g of fresh Siamese oranges are: calories 44.00 kcal, protein 0.80 grams, fat 0.30 grams, carbohydrates 10.90 grams, phosphorus 23.00 mg, calcium 33.00 mg, iron 0.40 mg, vitamin A 420.00 S.I, vitamin B1 0.07 mg, vitamin C 31.00 mg, water 87.30 grams [9]. Uneven harvest of citrus fruits (still seasonal) which causes price spikes when there are few fruits (not in season) and low prices when there are many fruits, namely during the main harvest [10]. Meeting the needs of Siamese oranges is still difficult, this is due to the (seasonal) harvest. According to the natural phenology of Siamese oranges, from December to July there is a scarcity of citrus fruit production in Bali [11]. Therefore, to support the increase in productivity, cultivation techniques are needed that are accompanied by effective and sustainable pest and disease control and optimal garden maintenance, including cultivation technology through fertilization and the provision of growth regulators as flower inducers. [12]. Fruit plants can produce well if fertilized with the right type of fertilizer and the right dose and time of application, at least with fertilizers containing N, P, and K nutrients [13].

Fertilization is one of the efforts to suffice nutrients into the soil so that the genetic potential of plants can be achieved to the maximum [14]. The use of appropriate fertilizers causes plants to grow healthier and more balanced [15]. Fertilizers containing calcium (Ca) and magnesium (Mg) have a very important role in plant growth and development [16-17].The element of calcium (Ca) is very dominant, especially at the growing points of plants such as young shoots and root tips [18].The recommended dose of use for citrus plants is 4-6 cc/L of water [19]. Application of calcitor fertilizer with a concentration of 6 cc/l gave the number of fruits (106.44 pieces) and weight per fruit (114.08 g) compared to the control, namely 83.44 pieces and 106.08 g [20].

Growth regulators (PGR) are chemical compounds produced synthetically that function to regulate and control plant growth [21]. Paklobutrasol is a PGR from the retardant group that is used to inhibit the biosynthesis of gibberellins [22]. Paklobutrasol can be applied to plants through leaves or soil [23]. Paklobutrasol can be absorbed by plants through stem, root and leaf tissue [24]. The recommendation for the use of paklobutrasol for fruit plants is a dose of 5-10 cc of paklobutrasol and put it in 1 liter of water [25]. The results of Darmayasa's research [26] found that the highest number of fruit formed per tree was obtained in the 6 cc/L paklobutrasol treatment of water/tree, which was 183.78 fruit.

Due to the scarcity of research results on the use of Paklobutrasol and special calcitor fertilizers on Siamese citrus plants, the authors wanted to examine the administration of Paklobutasol in combination with the application of Calsitor Fertilizer.

2. Material and Methods

This research was conducted in Banjar Bayung Gede, Bayung Gede Village, Kintamanai District, Bangli Regency. The altitude is between 800–900 meters above sea level, with a sloping to hilly topography, a slope of 20-40%, temperatures between 13.6–25.1^{o}C. The temperature is cool and the rainfall is quite high between 125-200 mm. This research was carried out from December 2021 to July 2022. The materials used in this study were Siamese citrus plants, Paklobutrazol, Calcitor Fertilizer, water and chemical solution materials for analysis in the laboratory.

The tools used in this research are nylon rope, spait, zinc (plate), permanent marker, paper, hoe, pruning shears, bamboo, bucket, scale, stationery, oven, sprayer, camera, plastic, aluminum foil , small ice flask (coolbox), scissors, hand refractor and ice mold. This study used a Randomized Block Design (RAK) with 2 factors arranged in a factorial manner. The first factor tested was paklobutrazole (P) which consisted of 4 levels, namely: P^0 = 0 ml.L^{-1}, P^1 = 5 ml.L^{-1}, P^2 = 10 ml.L^{-1} P^3 = 15 ml.L^{-1}. While the second factor tested was calcitor fertilizer (K) which consisted of 4 levels, namely: K^0 = 0 ml.L^{-1}, K^1 = 3 ml.L^{-1}, K^2 = 6 ml.L^{-1}, K^3 = 9 ml.L^{-1}. Thus, 16 combination treatments were obtained, each of which was repeated 3 times so that 48 Siamese citrus trees were needed.

The variables observed in this study were: number of flowers formed per tree (bud), number of fruit formed per tree (fruit), percentage of fallen fruit per tree (%), relative water content (KAR) of leaves (%), number of fruit harvested per tree. tree (fruit), weight per fruit (g), fruit diameter (cm), fruit weight harvested per tree (kg) and total dissolved solids (^{o}Brix).

Siamese citrus plants used in this study were 4 years old, with a spacing of 3 x 3 meters, 48 uniform plants were selected based on plant age, plant height ranged from 220 - 270 cm, stem diameter ranged from 6.5 - 8.5 cm and healthy plant conditions.

The treatment of paclobutrazole was carried out in the morning, with doses according to treatment (0, 5, 10 and 15 ml), given 3 times during the study. How to give paklobutrazole: measure the appropriate dose of paklobutrazole, put it in 1 liter of water. Make a 10 cm deep trench in a circle around the tree at a distance of 50 cm from the base of the tree and then pour the solution evenly into the trench. The first administration was given in early January, the second administration was given at an interval of 2 weeks after the first administration and the third administration was given at an interval of 2 weeks after the second administration with the same dose each time. Calcitor fertilizer was also given 3 times during the study with the appropriate concentration of treatment (0, 3, 6 and 9 ml) dissolved in 1 liter of water and then sprayed evenly over the leaves of citrus plants. The first administration was given a day after the administration of paclobutrazole, the second administration with an interval of 1 month after the first administration and the third administration also at an interval of 1 month after the second administration with the same concentration for each administration.

Observational data were tabulated, then statistically analyzed using analysis of variance in accordance with the design used. First, a diversity test was conducted to obtain a variance fingerprint. If the treatment has a significant effect, then the analysis is continued to find a single effect of each factor with the BNT test at 5%.

3. Results and Discussion

Based on the results of statistical analysis, it was obtained that there was a significant effect of giving paklobutrasol (P) and calcitoring fertilizer (K) as well as their interaction (PxK) on all observed variables, which are presented in Table 1. The average variables observed were due to the effect of giving paklobutrasol (P) and calcitor fertilizer (PxK). K) are presented in Tables 2a and 2b, while the correlations between variables due to the effect of giving paklobutrasol and calcitoring fertilizers are presented in Tables 3 and 4.

Table 1
Significant effect of treatment with Paklobutrasol and Calcitor Fertilizer and their interactions on the observed variables

No	Variables observed	Treatment		
		P	K	P x K
1	Number of flowers formed on tree	**	**	ns
2	Number of fruit formed on the tree (fruit)	**	**	ns
3	Percentage of deciduous fruit on the tree (%)	**	**	ns
4	Relative Moisture Content (CAR) of leaves (%)	**	ns	ns
5	Number of harvested fruit on the tree (fruit)	**	**	ns
6	Weight per fruit (g)	**	**	ns
7	Fruit diameter harvested fruit (cm)	**	*	ns
8	Weight of harvested fruit on the tree (kg)	**	**	ns
9	Total dissolved solids (^{0}Brix)	**	*	ns

Description: ns = Not significant (P> 0.05)
* = Significantly influential (P<0.05)
** = very significant effect (P<0.01)

Based on Table 1, it shows that the interaction of giving paklobutrasol and calcitor fertilizer (PxK) had no significant effect (P>0.05) on all observed variables. Treatment with paclobutrasol had a very significant effect (P<0.01) on all observed variables. Meanwhile, the effect of applying calcitor fertilizer had a significant (P<0.05) to very significant (P<0.01) effect on all observed variables except for the leaf relative water content (KAR) variable that had no significant effect (P>0.05).

Paklobutrasol treatment at a concentration of P^3 15 ml.L^{-1} gave the highest fruit weight per tree, which was 7.77 kg or an increase of 78.21% when compared to the control (P^0) which was only 4.36 kg (Table 2b). The increase in harvested fruit weight per tree in P^3 treatment was supported by the number of harvested fruits per tree (r = 0.977**), weight per fruit (r = 0.998**), and fruit diameter (r = 0.998**). The highest number of harvested fruit per tree was obtained in P3 treatment, which was 71.17 fruit or an increase of 37.52% compared to P^0 which was only 51.75 fruit (Table 2b). The highest weight per fruit and fruit diameter were obtained in P^3 treatment, namely 106.92 g and 7.03 cm, an increase of 31.14% and 8.32% compared to P^0 which was 83.59 g and 6.49 cm (Table 2b). The increase in the number of fruits harvested in the P^3 treatment was also supported by the increase in the number of flowers per tree (r = 0.998**) and the number of fruits formed per tree (r = 0.998**). The highest number of flowers per tree was obtained in treatment P_3 which was 83.17 buds, an increase of 29.95% when compared to P_0 which was only 64.00 buds (Table 2b) so that it could support the increase in the number of fruit formed per tree in P^3 (r = 0.999**), which was the highest at 74.00, an increase of 30.58% compared to P_0 which was only 56.67 (Table 2b).

The number of flowers and the number of fruit formed was higher in the treatment of calcitor fertilizer with the given concentration increasing, closely related to the increase in the value of the relative water content (KAR) of the leaves. The highest leaf CAR was obtained at (P^3) which was 98.14% compared to P^0 which was only 79.99% (Table 2a). It can be said that the administration of paklobutrasol can increase the water status in the tissue as indicated by the increase in leaf CAR, which causes the plant's metabolic processes to increase so that the formation of carbohydrates produced increases, which can be proven in the variable percentage of deciduous fruit per tree and total dissolved solids. The lowest percentage of deciduous fruit per tree was obtained at P^3 which was 3.51% and the highest was at P^0 which was 11.96%. Meanwhile, the highest total dissolved solids was obtained at P^3 which was 8.83 ^{0}Brix compared to P^0 which was 7.88 ^{o}Brix. The higher the TPT produced, the higher the sugar content in the fruit and the sweeter the fruit tastes. Supported by Hartini's [24] statement which states that paklobutrasol can be absorbed by plants through stem, root, and leaf tissues. The substance is then transported through the xylem to the growing point. The active compound that reaches the sub-apical inhibits the production of gibberellins by inhibiting the oxidation of kaurene to kaurenic acid. This causes a reduction in the speed of cell division, thereby directly reducing the vegetative growth of plants. The reduction in vegetative growth causes most of the assimilate to be allocated for flower bud formation, fruit formation and growth.

The concentration treatment of calcitor fertilizer (K) gave the highest harvested fruit weight per tree obtained at a concentration of 9 ml.L^{-1} (K^3) which was 6.90 kg, an increase of 28.49% compared to K^0 treatment which was only 5.37 kg (Table 2b). The increase in the weight of harvested fruit per tree in the K^3 treatment was supported by the increase in the number of harvested fruit per tree (r = 0.990**), weight per fruit (r = 0.997**) and fruit diameter (r = 0.955**), namely the highest was 68.58 and 99.90 and 6.87 cm or increased by 25.08%; 22.39% and 3.62% compared to K_0 which was only 54.83 pieces and 81.62 g (Table 2b).

Table 2a.
Average of all the variables observed in the treatment of paclobutrasol and calcitor fertilizer

Treatment	Number of flowers formed on tree	Number of fruit formed on the tree (fruit)	Percentage of deciduous fruit on the tree (%)	Relative Moisture Content (CAR) of leaves (%)
Paclobutrazol (P)				
P0	64.00	56.67	11.96	79.99
P1	75.83	67.33	7.42	86.36
P2	79.58	71.33	5.50	92.63
P3	83.17	74.00	3.51	98.14
BNT 0,05	2.76	2.38	1.95	3.99
Calcitoring Fertilizer (K)				
K0	71.83	64.25	9.46	87.10
K1	75.50	66.00	7.04	88.52
K2	76.83	68.83	6.13	89.67
K3	78.42	70.5	5.77	91.82
BNT 0,05	2,76	2.38	1.95	3.99

Note: The mean value followed by the letter with the same treatment and the same column means that it is not significantly different at the 5% BNT test level.

Table 2b.
Average of all the variables observed in the treatment of paclobutrasol and calcitor fertilizer

Treatment	Number of harvested fruit on the tree (fruit)	Weight per fruit (g)	Fruit diameter harvested fruit (cm)	Weight of harvested fruit on the tree (kg)	Total dissolved solids (^{0}Brix)
Paclobutrazol (P)					
P0	51.75	83.59	6.49	4.36	7.88
P1	62.67	93.13	6.70	5.66	8.17
P2	67.42	98.45	6.83	6.67	8.38
P3	71.17	106.92	7.03	7.77	8.83
BNT 0,05	2.33	4.67	0.19	0.41	0.40
Calcitoring Fertilizer (K)					
K0	59.83	91.62	6.63	5.37	8.17
K1	61.67	93.63	6.70	5.84	8.21
K2	64.92	96.93	6.85	6.34	8.38
K3	66.58	99.90	6.87	6.90	8.50
BNT 0,05	2.33	4.67	0.19	0.41	0.40

Note: The mean value followed by the letter with the same treatment and the same column means that it is not significantly different at the 5% BNT test level.

The increase in the number of fruits harvested per tree was supported by an increase in the number of flowers formed per tree (r = 0.950**) and the number of fruits formed per tree (r = 1,000**). The number of flowers per tree and the number of fruit formed per tree were higher in the calcitor treatment supported by the increase in the relative water content (KAR) of the leaves. The highest leaf CAR was obtained in the K_3 treatment, which was 91.82% compared to the K_0 treatment, which was 87.10% (Table 2a). In this study, by observing directly in the field, the application of calcitor fertilizer can prevent flower and fruit loss, improve plant health, it is proven that plants are not attacked by pests and diseases. This is probably due to the addition of calcitors can stimulate the growth and

development of roots properly so that the absorption of nutrients in the soil is maximized. With the increase in the relative water content (KAR) of the leaves in the treatment of higher calcitor fertilizers, it can cause the plant's metabolic process to increase compared to without the treatment of calcitor fertilizers.

In this study it can be said that in plants treated with calcitor fertilizer at higher doses, plant metabolism processes, especially photosynthesis, were better as evidenced by the lower percentage of fallen fruit per tree, namely 5.77% in K^3 treatment compared to K^0 which reached 9.46% (Table2a). The low percentage of deciduous fruit per tree at higher concentrations is due to the fact that more photosynthate is produced so that there is less competition between fruits than without calcitoring fertilizers, thereby supporting an increase in the number of harvested fruits per tree and can increase the sugar content of the fruit, which in turn will increase the number of fruits harvested per tree. reflected by the increase in total dissolved solids (TPT). In the calcitor treatment with a concentration of 9 ml.L-1 (K^3), the highest TPT was 8.50 ^{0}Brix and the lowest was at K^0 of 7.17 ^{o}Brix (Table 2b). Calsitor fertilizer is a liquid calcium fertilizer containing Ca (35%), Mg (15%) and B (5%) . Supported by the opinion [16-17] which states that calcium (Ca) can function to assist the translocation and distribution of starch and phosphorus in plants which play a role in fruit formation and fruit weight, can stimulate the formation and increase growth. flowers, it is very appropriate to prevent flower and fruit loss, can stimulate root growth so that it causes maximum absorption of nutrients in the soil, and stimulates growth and improves plant health so that it is not susceptible to pests and diseases, while magnesium (Mg) functions in the photosynthesis process (because it helps the formation of chlorophyll which is important in photosynthesis) also supports plant permeability so that it helps the respiration process; increases plant resistance or immunity against pests and diseases; formation of nutrients in plants (sugars, carbohydrates, fats, proteins and oils); increases plant productivity because it can prevent the fall b flowers and fruit. Stated that boron (B) is one of the micro elements that is needed in small amounts but if it is deficient it will affect the production and survival of plants [27]. Boron functions to strengthen cell walls, increase protein synthesis and improve fruit quality.

4. Conclusion

Based on the results of the study, it can be concluded that the interaction between the treatment of giving paclobutrazol and calcitor fertilizer had no significant effect on all observed variables. The treatment of giving paklobutrasol gave the highest harvested fruit weight per tree obtained in the treatment of giving paclobutrazol 15 ml.L^{-1}, which was 7.77 kg or an increase of 78.21% when compared to the treatment without giving paclobutrazol which was 4.36 kg. The treatment with calcitor fertilizer obtained the highest harvested fruit weight per tree in the treatment of 9 ml.L^{-1} calcitor fertilizer, which was 6.90 kg or an increase of 28.49% compared to the treatment without calcitor fertilizer, which was 5.37 kg.

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