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Effect of fertilization and flower bud dormancy breaker on yield and fruit quality of crystal guava (*Psidium guajava L.)*

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Abstract

Guava (*Psidium guajava* L.) crystal variety or often called crystal guava is a type of fruit that has recently become increasingly popular in the community and is highly favored by consumers. The advantages of this guava compared to other guavas are fast fruiting (8 months after planting has started production), small habitus so that the population per hectare is high, the fruit is large with thick pulp, tastes good, fresh, and crunchy, very few seeds only 4-6 per fruit, even many are seedless (seddless), and the appearance of the fruit is attractive. With its various advantages, the crystal guava population in Bali has grown very rapidly since the last 5 years, but farmers complain that although certified superior seeds are used, the production, quality and continuity of the fruit produced are not as expected. The continuity of fruit harvest is not sustainable because many naturally induced flower buds do not develop into flowers due to dormancy. The aim of this study was to increase the production and quality of crystal guava fruit through fertilization and the application of flower bud dormancy breakers.

The research was conducted in Semanik Village, Petang District, Badung from January to July 2024. The experiment was arranged in a 2-factor factorial with 9 replications, using a group randomized design. The first factor was fertilization consisting of 3 levels; fertilization as the farmer's way/control (P1), fertilization with N, P, K, and Ca (P2), and fertilization with N, P, K, Ca and microfertilizers Zn, and Cu (P3), while the second factor was the application of flower bud dormancy breaker type consisting of 3 levels; without dormancy breaker/control (Dt), Ethreel dormancy breaker (De), and KNO_3 dormancy breaker (Dk). The results showed that fertilization level P2, namely the provision of urea, TSP, KCl and calcium fertilizer in the form of gypsum ($CaSO_4.2H_2O$) at a dose of 250 g, 300 g, 300 g, and 1,250 g/plant respectively and fertilization level P3, namely the provision of urea, TSP, KCl and gypsum at a dose of 250 g, 300 g, 300 g, and 1,250 g/plant coupled with the provision of micro-fertilizers $ZnSO_4$ and $CuSO_4$ tend to increase the growth, production and quality of crystal guava fruit. Similarly, the application of Ethreel and KNO_3 flower bud dormancy breakers tended to increase the number of new buds per plant, number of fruits per plant, weight of fruits per plant and percentage of grade A fruits.

Keywords: Crystal guava; Dormancy breaking agent; N, P, K, Ca, Cu and Zn fertilizers; Ethepon; KNO_3

1. Introduction

Guava (*Psidium guajava* L.) was originally an underestimated fruit by the Indonesian people, because the fruit is small, has many seeds, little pulp, hard texture, bad taste, astringent, and thick skin. However, lately this fruit has become increasingly popular and is highly favored by consumers so that the selling price is high, both for eating sgar and as juice or other processed ingredients. Crystal guava is one of the varieties that has been widely cultivated by fruit producers lately.

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The prominent advantages of this guava compared to other guavas such as local guava, Bangkok guava, red brittle guava, Australian guava, or Sukun guava, are fast fruiting (8 months after planting has started production), small habitus so that it can be planted with a tight planting distance with a high population per hectare, large fruit with an attractive appearance, thick pulp, good taste, crispy and slightly sweet, and very few seeds and even many are seedless (seddless) (Anon., 2012).

The obstacle faced by crystal guava farmers is that the quantity and quality of production produced is not as expected. Production per tree at productive age (4 years old) is still low, only an average of 20 kg/year and the fruit produced is mostly small, on average less than 400 g/fruit (Rai et al., 2016), whereas according to Abdurahman (2012) the potential production of crystal guava reaches 40-60 kg/tree/year with an average fruit size of 300-400 g/fruit. Under such conditions, most of the fruit produced is only marketed in traditional markets while self-service, fruit outlets/shops, and tourism markets (hotels and restaurants) that require fruit with grade A quality (smooth fruit, no defects, slightly flattened round fruit shape, and weighing > 300 g/fruit) are very limited. This is due to inadequate maintenance, especially fertilization that is not in accordance with the recommendations, both regarding the type of fertilizer, time and method. Fertilization is done only once a year with organic fertilizers and compound fertilizers at a modest dose (Rai et al., 2015). According to Anon. (2012) and Abdurahman (2012), crystal guava can produce well if fertilized with the right type of fertilizer and with the right dose and time of application as well, at least with organic fertilizers and fertilizers containing nutrients N, P, and K. But according to Mandal et al. (2010) and Godage et al. (2013), in addition to N, P, and K fertilizers, to increase fruit production and quality, guava needs to be fertilized with Ca fertilizer. While Yadav et al. (2014) and Yadav and Solanki (2015) mentioned that micro-fertilizers especially those containing zinc (Zn) and copper (Cu) are also very important to be applied to guava, papaya, banana, grapes and various other tropical and sub-tropical fruits to improve fruit quality, extend shelf life, and reduce damage during storage.

Other constraints faced by crystal guava farmers from the research results of Rai et al. (2015) are low harvest frequency and unsustainable production continuity. In general, the critical point to be able to produce tropical fruits continuously lies in the flowering process, especially the success in regulating the occurrence of flower induction, so that tropical fruits not only produce fruit during the season (on-season), but also can produce off-season and it causes the supply of fruit to occur continuously (Bernier et al., 1985; Wang and Faust, 1990; Hempel et al., 2000; Rouse, 2002; Thirugnanavel et al., 2007; Hanke et al., 2010). However, unlike other tropical fruit crops, the problem of continuous fruit production in crystal guava does not lie in the need to induce flowers, as crystal guava naturally (without any treatment) has induced flowers in its buds throughout the year. However, the problem is that the induced flower buds experience dormancy, which can be caused by physiological (internal) and/or environmental (external) factors (Lang et al., 1997; Naor et al., 2003; Lu et al., 2006). To overcome this, it is necessary to spray a substance that breaks the dormancy of flower buds. According to Poerwanto et al. (1996), KNO_3 with a concentration of 40 g/l and ethepon 0.40 g/l are effective in breaking induced dormant flower buds. Based on the above description, this research was conducted with the aim of finding a package of fertilization technology and breaking flower bud dormancy to increase production, continuity and quality of crystal guava fruit.

2. Research methods

The research was conducted in crystal guava production centers in farmer-owned plantations in Semanik Village, Petang Subdistrict, Badung Regency, from January to July 2024. The study used a 2-factor factorial cluster randomized design; The first factor was fertilization consisting of 3 levels, namely fertilization following the farmer's method/control (P1), fertilization with N, P, K, and Ca (P2), and fertilization with N, P, K, Ca and microfertilizers Zn, and Cu (P3), while the second factor was the application of flower bud dormancy breaker consisting of 3 levels, namely without application of flower bud dormancy breaker/control (Dt), application of Ethrel dormancy breaker (De), and application of KNO_3 dormancy breaker (Dk). Thus there were 9 treatment combinations and each was repeated 6 times so that 54 sample plant trees were needed.

Sample plants for the study were selected that were already in production with relatively uniform tree size, about 4 years old, located in the same ownership (one owner) assuming the same maintenance history. All plants used for the study were fertilized with 10 kg/tree of manure. Fertilization level P1 (farmer/control method) was done by applying organic fertilizer (compost) 5 kg/tree, applied once during the study, i.e. after pruning. Fertilization level P2 is done by giving urea, TSP, KCl and calcium fertilizer in the form of gypsum ($CaSO4.2H_2O$) at a dose of 250 g, 300 g, 300 g, and 1,250 g/plant, respectively. Urea, TSP and KCl fertilizers were applied 3 times, namely 1/3 dose after pruning, followed by 1/3 dose before flowering, and 1/3 dose during fruit enlargement, while gypsum fertilizer was applied once during the first stage of urea, TSP and KCl fertilizers. Fertilization level P3 is similar to level P2, namely the application of urea, TSP, KCl and gypsum at the same dose and time, but added with the application of micro-fertilizers ZnSO4 and $CuSO_4$ each concentration of 0.5%, given by spraying through the leaves 3 times, namely after pruning, before flowering, during fruit enlargement. Manure, urea, TSP, KCl and gypsum are applied by making circular holes, 20 cm deep, 20 cm wide, at a distance of 30 m from the base of the tree. Fertilizers are spread evenly, stirred until well mixed, then covered again with soil. The application of ethepon and KNO_3 dormancy breakers was carried out 3 times, the first application 2 weeks after the plants started flowering, while the second and third applications were 4 and 6 weeks after the plants started flowering, respectively. The application concentration was Ethrel 0.40 g/l and KNO_3 300 mg/l (300 ppm), by spraying through the leaves until the crown of the plant was evenly sprayed.

During the research, the plants were properly and correctly maintained following the guidelines of the Standard Operating Procedures (SPO) of Guava Cultivation (Directorate of Fruit Crops, 2009), so that the growth and development of plants are optimal and avoid the disturbance of plant disrupting organisms (OPT). The types of maintenance carried out are pruning, weeding, fruit packing, and pest and disease control. Pruning is done on dead branches/branches, attacked by pests and diseases and water levers while weeding is done by cleaning weeds that grow around the crown. Young fruits that are the size of marbles are wrapped using plastic to avoid pest and disease attacks. Before wrapping, the plants were sprayed using pesticides (Samite, Dursban, Sorento, Wendry) with a concentration of Samite 1 ml + Dursban 1 ml + Sorrento 0.5 ml + Wendry 1 Gr / liter of water with the intention of controlling pests and diseases that attack plants.

Variables observed included the number of new shoots per plant, chlorophyll content of leaves measured by Chlorophyll Meter SPAD-502, Relative Water Content (KAR) of leaves measured 3 times, namely before flowering, during flowering, and during fruit enlargement then averaged, the number of fruits per plant, fruit weight per plant, weight per fruit, fruit diameter, percentage of grade A, B, and C fruits per plant, and fruit hardness. Observation data were tabulated, then statistically analyzed using analysis of variance (anova) in accordance with the design used. If the interaction effect was real or very real then to compare the mean value of the combination treatment was tested by Duncan's test, while if the interaction effect was not real then to compare the mean value of the single factor of fertilization and flower bud dormancy breaking agent was tested by BNT test.

3. Results and discussion

The results of statistical analysis of the observed variables showed that the interaction between fertilization and application of dormancy breakers and the effect of a single factor of dormancy breakers had no significant effect on all observed variables. The single factor of fertilization only significantly affects fruit hardness. Table 1 shows that fertilization levels P1 and P2 tend to give higher leaf moisture content and leaf calorophyll content than the P0 level although statistically not significantly different. Similarly, Table 2 and Table 3 respectively show the weight per fruit and fruit weight per plant at P1 and P2 tended to be higher than the P0 level although statistically not significantly different. Furthermore, fruit hardness in P1 and P2 was significantly higher than the P0 level. This means that fertilization causes reduced fruit softness so that it is physically more resistant to piercing or rubbing and becomes more resistant to storage. However, this data shows that the application of fertilizers to Crystal guava from April to October has not shown a significant difference compared to the control.

Table 1 Effect of fertilization treatment and flower bud dormancy breaking agent application on leaf moisture content, chlorophyll content, number of flowers per plant, and number of new buds

Treatment	Leaf moisture content (%)	Chlorophyll content (SPAD)	Number of flowers per plant (fruit)	Number of new shoots (fruit)
Fertilization				
P_0	73,2117 a	54,8111 a	38,8333 a	38,0000 a
P_1	76,1300 a	56,9694 a	75,5000 a	35,2222 a
P_2	76,6822 a	57,5833 a	79,2222 a	33,1667 a
Flower Bud Dormancy Breaker				
D_t	76,3144 a	55,9833 a	72,7222 a	35,8889 a
D_e	76,3661 a	56,8500 a	84,8330 a	38,1667 a
D_k	73,3433 a	56,5300 a	86,0000 a	39,3333 a

Notes: Numbers followed by the same letter in the same column show no significant difference, based on Duncan test at 5% level.

Table 2 Effect of fertilization treatment and flower bud dormancy breaking agent application on fruit diameter, number of fruits per plant, weight per fruit, and percentage of grade A fruits

Treatment	Fruit diameter (cm)	Number of fruit per plant (fruit)	Weight per fruit (g)	Percentage of fruit grade A (%)
Fertilization				
P_0	7,7928 a	44,2778 a	212,9717 a	22,6833 a
P_1	7,7744 a	42,1667 a	230,6628 a	24,5944 a
P_2	7,7728 a	39,1111 a	231,5767 a	16,0072 a
Flower Bud Dormancy Breaker				
D_t	7,7311 a	41,7222 a	227,9883 a	18,1644 a
D_e	7,8322 a	41,7222 a	225,9883 a	19,3011 a
D_k	7,7767 a	42,1111 a	241,2345 a	25,8194 a

Notes: Numbers followed by the same letter in the same column indicate no significant difference, based on Duncan test at 5% level.

Table 3 Effect of fertilization treatment and flower bud dormancy breaking agent application on percentage of grade B fruit, percentage of grade C fruit, fruit weight per plant and fruit hardness

Treatment	Fruit percentage grade B (%)	Percentage of fruit grade C (%)	Fruit weight per plant (g)	Fruit hardness
Fertilization				
P_0	34,0767 a	41,6328 a	9740,2625 a	7,7900 c
P_1	43,3556 a	31,2183 a	9741,8027 a	8,9306 bc
P_2	37,1794 a	39,6333 a	9047,6836 a	9,3750 a
Flower Bud Dormancy Breaker				
D_t	37,2806 a	40,9783 a	9161,5195 a	8,6544 a
D_e	44,7867 a	38,8067 a	9457,7227 a	8,7389 a
D_k	32,5444 a	32,6994 a	9970,5117 a	8,6972 a

Notes: Numbers followed by the same letter in the same column show no significant difference, based on Duncan test at 5% level.

The application factor of breaking flower bud dormancy until the October observation results gave a similar effect as the fertilization factor. However, although statistically not significantly different, the application of dormancy breaking agents Ethreel (D¬e) and KNO_3 (Dk) tended to give a higher number of new shoots, number of flowers per plant and chlorophyll content (Table 1), number of fruits per plant, weight per fruit and percentage of grade A fruits (Table 2), fruit weight per plant and fruit hardness (Table 3) compared to no application of flower bud dormancy breaking agents (Dt). This data shows that the research results are in accordance with the opinion of Poerwanto et al. (1996) that ethepon and KNO_3 are effective dormancy breakers in overcoming the dormancy of generative buds of mango which is indicated by the induced flower buds can develop further to produce flowers. Ethylene functions in breaking the dormancy of flower buds because it can increase the synthesis of amylase enzymes, cellulase enzymes, PEP carboxylase and induce mRNA synthesis (Subhadrabandu and Tongumpai, 1991). While the ability of KNO_3 in breaking the dormancy of flower buds according to Marschner (1997) is related to the role of K + ions in increasing sucrose translocation, increasing the rate of sucrose transportation in the apoplast of leaf mesophyll cells, increasing loading on the phloem and direct influence of increased osmosis pressure. KNO_3 application with essential nutrients, namely potassium (K) and nitrogen (N), was reported by Poerwanto et al. (1997) that the substance can be used to stimulate off-season fruit production in mango because it can break the dormancy of flower buds. According to Mandal et al. (2012) the application of KNO_3 to guava at a concentration of 1.5% by spraying through the leaves during the fruit enlargement phase has a significant effect in improving fruit quality as indicated by the increase in vitamin C content, total soluble solids, length of storage, and the level of fruit damage.

4. Conclusions

Based on the results of this study, the following conclusions can be drawn:

- Fertilization level P2 is the provision of urea, TSP, KCl and calcium fertilizer in the form of gypsum ($CaSO4.2H_2O$) each at a dose of 250 g, 300 g, 300 g, and 1,250 g/plant and fertilization level P3 is the provision of urea, TSP, KCl and gypsum at a dose of 250 g, 300 g, 300 g, and 1,250 g/plant coupled with the provision of micro fertilizers $ZnSO_4$ and $CuSO_4$ tend to increase the growth, production and quality of crystal guava fruit.
- Application of flower bud dormancy breakers Ethreel and KNO_3 also tended to increase the number of new buds per plant, number of fruits per plant, weight of fruits per plant and percentage of grade A fruits.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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