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The Effect of Probiotic Fertilizer Concentrations and Pruning on Kristal Guava (*Psidium guajava* L. cv. Kristal) in the Off-Season Production

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ABSTRACT: Kristal guava is one of the horticultural commodities that is in demand by the public at large amount and can grow well in Indonesia. The low production of Kristal guava in the off-season is one of the causes of not fulfilling the demand for the fruit. The research was conducted in Semanik Village, Badung, Bali, Indonesia from January to July 2023. This study aimed to increase the growth and production of Kristal guava in the off-season through fertilization with probiotic fertilizer and pruning. This experiment used a factorial Randomized Block Design consisting of 2 factors and 3 replications. The first factor was fertilization with probiotic fertilizer consisting of 4 concentration levels, i.e., control (C_0), 10% (C_1), 20% (C_2) and 30% (C_3). While the second factor was pruning, namely: P_t (no pruning) and P_1 (pruning 2-3 segments of twig ends + dead twigs + twigs infested with pests). The results showed that the interaction between fertilization with probiotic fertilizer and pruning had no significant effect in off-season production of Kristal guava. The 30% probiotic fertilizer concentration (C_3) was able to increase the growth as indicated by the variable number of new shoots per tree (2.17 shoots) and the number of leaves of new shoots per tree (2.67 leaves) and the off-season production of Kristal guava, reflected in the increase in the number of flowers formed per tree (103.50 flowers), the number of harvested fruits (3.50 fruits) and the weight per fruit (49.72 g) or an increase of 93.46%; 40% and 114.31%, respectively, compared to C_0 which was 53.50 flowers; 2.50 fruits and 23.20 g. The P_1 treatment increased the growth as indicated by the variables of leaf chlorophyll content (69.55 SPAD) and leaf relative water content (59.58%) and the off-season production of Kristal guava as reflected by the number of flowers formed per tree (91.25 flowers), the number of fruits formed per tree (8.83 fruits) and the weight of fruit per tree (163.22 g) or an increase of 39.85%; 103.93% and 123.28%, respectively, compared to P_t which was 65.25 flowers; 4.33 fruits and 73.10 g.

KEYWORDS: Kristal Guava, Off-Season, Probiotic Fertilizer, Pruning.

I. INTRODUCTION

Guava (*Psidium guajava* L.) is a tropical fruit that is commonly cultivated in Indonesia. This is because Indonesia has a suitable climate for the growth of these plants. According to [1], guava production increased from 2017 to 2021. Guava production in Indonesia is 422,491 tons in 2021 and 200,487 tons in 2017. This shows that guava production increased by 222,004 tons in 5 years, but the production is still seasonal. There are several guava cultivars that grow well in Indonesia, including Kristal guava. Kristal guava was officially released by the Ministry of Agriculture through the Decree of the Minister of Agriculture Number 540/Kpts/SR.120/9/2007. Some of the advantages of Kristal guava are that it has a waxy layer and thick fruit flesh, almost seedless and the texture of the fruit is very crunchy. The fruit also contains various vitamins such as A and C, unsaturated fatty acids, dietary fiber, polyphenols, carotenoids, Omega-3, and Omega-6 [2]. The high potential utilization of Kristal guava has led to high demand in the market, but it is known that production has not been able to meet this demand [3]. The cause of the inability to fulfill the demand for Kristal guava fruit occurs due to the lack of production produced by farmers and the cultivation technology used is still not appropriate. Kristal guava plants are different from other plants, the obstacle to producing fruit continuously is not caused by the induction of flowering, because naturally the flowers of this plant have been induced in the bud throughout the year. But the obstacle lies in the induced flower buds experiencing dormancy which can be caused by various factors such as physiological or environmental [4]. To overcome this, it is necessary to apply appropriate cultivation techniques or known as Good Agricultural Practices (GAP), such as fertilizing and pruning.

According to [5], fertilization involves the use of fertilizers on plants. Kristal guava can produce good fruit if fertilized with the right type and concentration of fertilizer, such as organic fertilizer or fertilizer containing macro and micro nutrients. The addition of

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probiotics to organic fertilizers in Kristal guava plants is considered to increase the nutrient content needed by soil and plants. Probiotics is a term that refers to beneficial microorganisms where the addition of probiotics is used to decompose and ferment organic matter [6]. The use of probiotic fertilizers can also reduce production costs and increase crop productivity [7].

In addition to the lack of nutrients, Kristal guava production cannot meet consumer demand because in some guava plants the growth of the stem tip dominates over the growth of other parts so that the formation of lateral branches is inhibited or better known as apical dominance. The strong apical dominance at the tip of the plant spurs the plant to continue growing upwards and one way to break the apical dominance is by pruning [8]. Pruning is useful for reducing unimportant plant parts and optimizing plant parts that are important for growth and production [9]. Pruning also plays a role in increasing the C/N ratio in plants. A high C/N ratio indicates a buildup of carbohydrates that can stimulate flower and fruit formation in plants [10]. Increasing production and continuity of Kristal guava fruit availability by accelerating the flowering and fruit formation phases will fulfill the balance between supply and demand over a longer period of time. This can be done by developing off-season fruit production technology so that not all trees bear fruit at the same time.

II. RESEARCH METHODOLOGY

The research was conducted in Semanik Village, Badung, Bali, Indonesia for treatment application and sampling of Kristal guava fruit. Kristal guava leaf contents analysis were conducted at the Soil Science Laboratory, Faculty of Agriculture, Udayana University and the Food Analysis Laboratory, Faculty of Agricultural Technology, Udayana University. This research was conducted from January to July 2023. The experiment used a factorial Randomized Block Design consisting of 2 factors and 3 replications. The first factor is fertilization with probiotic fertilizer consisting of 4 concentration levels, namely control (C_0), 10% (C_1), 20% (C_2) and 30% (C_3). While the second factor is pruning, namely: P_t (no pruning) and P_l (pruning 2-3 twig end segments + dead twigs + pest infested twigs). The variables observed in this study were number of new shoots per tree, number of leaves of new shoots per tree, number of flowers formed per tree, number of fruits formed per tree, chlorophyll content of leaves, number of fruits harvested, weight per fruit, relative water content of leaves, N nutrient content of leaves, P nutrient content of leaves and total sugar content of leaves. Data were analysed using analysis of variance. If the interaction between the fertilization with probiotic and pruning had a significant effect, it was continued with the Duncan's Multiple Range Test at the 5% level, but if the interaction had no significant effect, then the single factor influence was tested with the Low Significant Difference Test at the 5% level.

III. RESULTS AND DISCUSSION

A. Significance of Treatment on Observation Variable

The results of analysis of variance showed that the interaction between probiotic fertilizer concentration (C) and pruning method (P) had a very significant effect on the total sugar content in leaves but had no significant effect on other variables. Fertilization concentration (C) as a single factor gave a very significant effect on leaf chlorophyll content and total leaf sugar content, while significantly affecting the number of new shoots per tree and the number of flowers formed per tree. The single factor pruning method (P) had a significant effect on the number of fruits formed per tree and the N nutrient content of the leaves (Table 1).

Table 1. Significance of Probiotic Fertilizer Concentration (C) and Pruning Method (P) on Observation Variables

No.	Variables	Treatment		Interaction
		C	P	
1	Number of new shoots per tree (buds)	*	ns	ns
2	Number of new shoot leaves per tree (leaf)	ns	ns	ns
3	Number of flowers formed per tree (flowers)	*	ns	ns
4	Number of fruits formed per tree (fruit)	ns	*	ns
5	Leaf chlorophyll content (SPAD)	**	ns	ns
6	Number of fruits harvested (fruit)	ns	ns	ns
7	Weight per fruit (g)	ns	ns	ns

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8	Relative water content of leaves (%)	ns	ns	ns
9	Leaf N nutrient content (%)	ns	*	ns
10	Leaf P nutrient content (%)	ns	ns	ns
11	Total sugar content (%)	**	ns	**

Description: ns: not significantly effect (P<0,05); *: significant effect (P>0,05);
**: very significant effect (P>0,01).

B. Treatment Interaction on Total Sugar Content

Total sugar content showed the highest result in the combination of probiotic fertilization C_0 concentration and pruning method P_1 (C_0P_1) with a value of 14.69% and the lowest in the treatment combination of probiotic fertilization C_3 concentration and pruning method P_1 (C_3P_1) with a value of 10.41% (Table 2).

Table 2. Interaction Of Probiotic Fertilizer Concentration (C) And Pruning Method (P) on Total Sugar Content

Treatment	C_0	C_1	C_2	C_3
P_t	12.65 abc	12.17 bcd	14.48 a	10.66 d
P_l	14.69 a	13.82 ab	11.63 cd	10.41 d

Description: Numbers followed by different letters in the same treatment and column indicate significant differences in Duncan's multiple range test (DMRT) at the 5% level.

C. Effect of Probiotic Fertilizer Concentration and Pruning Method on Observed Variables

Probiotic fertilization treatment with a concentration of 30% (C_3) gave the highest value on the variable number of flowers formed (103.50 flowers) or an increase of 93.46% from the lowest number of flowers formed at C_0 (53.50 flowers) (Table 3). The increase in the number of flowers formed caused by probiotic fertilization was also supported by the high chlorophyll content of the leaves (75.41 SPAD). The more leaf chlorophyll content, the more it will affect the photosynthesis results in plants and be able to increase the yield of Kristal guava plants, such as the number of flowers formed which is significantly positively correlated with leaf chlorophyll content supported by the correlation value (r = 0.78*). The value of leaf Relative Water Content (RWC) at C_3 is quite high at 59.34%, this indicates that probiotic fertilization is able to overcome drought stress conditions in Kristal guava plants. The high RWC value of leaves is a plant defense mechanism against drought stress [11]. The leaf P nutrient content obtained the highest value in the C_3 concentration fertilization which amounted to 0.28% compared to C_0 which was 0.25% (Table 3). This shows that P nutrients given in probiotic fertilizer can be absorbed by Kristal guava plants well at a concentration of 30%. P nutrients in plants spur the growth and development of plant parts (roots, stems, twigs and leaves), flowering and fruit ripening [12], while the percentage of leaf N nutrient content in C_1 was higher than C_0 or an increase of 7.55%. However, probiotic fertilization did not show significant differences in leaf N nutrient content in this study. In the results of this study, the number of flowers formed per tree is inversely proportional to the value of total sugar content, this is in accordance with the results of [13] which stated that some plants with higher sugar concentrations in their leaves show a late flowering phenotype. The low total sugar content indicates that the photosynthate formed is directly translocated to flowers in Kristal guava plants, so that when the total sugar content increases, the number of flowers formed will decrease (r = -0.56).

The C_3 treatment also showed a tendency for the number of harvested fruits to be higher than C_0, this is supported by the positive correlation value between the number of harvested fruits and leaf chlorophyll content (r = 0.46) and in line with the research of [14] which states that the lower the leaf chlorophyll content, the lower the plant development including fruit formation. The number of harvested fruits increased by 40% after fertilization with 30% concentration (Table 3). The application of probiotic fertilizer resulted in a higher number of harvested fruits compared to those without probiotic fertilizer. This is because the probiotic fertilizers used in this research contain macro nutrients such as N and P as well as micro nutrients (laboratory analysis results not shown) needed by plants in the process of flower and fruit formation. While the number of harvested fruits is inversely proportional to the total sugar content, this is contrary to the research conducted by [15] which states that low total sugar content of leaves correlates with low fruit formation in Salak plants. The components of growth and production that have not increased optimally through fertilization

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treatment with probiotic fertilizer compared to the treatment without fertilization are due to the content of probiotic fertilizer in this study has not reached the Standard Operating Procedures (SOP) set by the Ministry of Agriculture based on the Decree of the Minister of Agriculture of the Republic of Indonesia number 261/KPTS/SR.310/M/4/2019 concerning minimum technical requirements for organic fertilizers, biological fertilizers and soil improvement.

Table 3. Effect of Probiotic Fertilizer Concentration and Pruning Method on Observed Variables

No.	Variables	Probiotic Fertilizer Concentration				LSD	Pruning Method		LSD
		C_0	C_1	C_2	C_3	5%	P_t	P_l	5%
1	Number of new shoots per tree	1.36 b	1.75 ab	1.53 ab	2.17 a	0.67	1.85 a	1.55 a	0.47
2	Number of new shoot leaves per tree	2.17 a	2.51 a	1.95 a	2.67 a	0.89	2.59 a	2.06 a	0.63
3	Number of flowers formed per tree	53.50 b	81.83 ab	74.17 ab	103.50 a	37.48	65.25 a	91.25 a	26.51
4	Number of fruits formed per tree	6.17 a	11.00 a	6.33 a	5.50 a	7.54	4.33 a	8.83 a	5.33
5	Leaf chlorophyll content	55.36 b	71.10 a	68.97 a	75.41 a	9.92	65.87 a	69.55 a	7.01
6	Number of fruits harvested	2.50 a	2.50 a	1.83 a	3.50 a	4.86	2.42 a	2.75 a	3.44
7	Weight per fruit	23.20 a	14.88 a	18.80 a	49.72 a	41.88	29.25 a	24.05 a	29.62
8	Relative water content of leaves	60.07 a	58.70 a	56.49 a	59.34 a	6.61	57.72 a	59.58 a	4.67
9	Leaf N nutrient content	1.59 a	1.71 a	1.54 a	1.36 a	0.46	1.38 b	1.71 a	0.33
10	Leaf P nutrient content	0.25 a	0.26 a	0.26 a	0.28 a	0.04	0.27 a	0.26 a	0.03
11	Total sugar content	13.67 a	13.00 a	13.05 a	10.53 b	1.31	12.49 a	12.64 a	0.93

Description: Numbers followed by the same letter in the same row and treatment show no significant difference in the 5% level of low significant difference test (LSD).

The treatment of pruning method (P) with complete pruning (P_l) gave the highest value on the variable number of flowers formed per tree, number of fruits formed per tree, leaf chlorophyll content, number of fruits harvested, RWC and leaf N nutrient content than those of no pruning (P_t). The high value of the number of fruits formed per tree due to pruning in this study is also due to the high number of flowers formed per tree with the same treatment, proving that the percentage of flowers into fruit by pruning treatment is very high. The correlation value (r = 0.37) between the number of flowers formed per tree and the number of fruits formed per tree shows that when the number of flowers formed per tree increases, it will be followed by an increase in the number of fruits formed per tree. The yield components of Kristal guava plants such as the number of flowers formed per tree, the number of fruits formed per tree and the number of harvested fruits that have higher values in the P_l treatment compared to P_t are one of the effects of the high chlorophyll content of leaves in the pruning treatment which is 69.55 SPAD. Although not significantly different, the higher value of leaf chlorophyll content in pruned plants indicates that plants with fewer leaves due to pruning get more effective light in carrying out the photosynthesis process and produce more assimilate to be used properly in the process of flower and fruit development [16].

IV. CONCLUSION

The treatment of probiotic fertilizer with a concentration of 30% (C_3) gave the highest value on the number of new shoots per tree (2.17 shoots), the number of leaves of new shoots per tree (2.67 leaves), the number of flowers formed per tree (103.50 flowers), the number of harvested fruits (3.50 fruits), weight per fruit (49.72 g) and leaf chlorophyll content (75.41 SPAD). The pruning 2-3 twig end segments + dead twigs + pest infested twigs (P_l) gave the highest values in the number of flowers formed per tree (91.25 florets), number of fruits formed per tree (8.83 fruits), number of harvested fruits (2.75 fruits), leaf chlorophyll content (69.55 SPAD) and leaf relative water content (59.58%) compared to no pruning (P_t). There was an increase of 103.93% and 123.28% in

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the number of fruits formed per tree and fruit weight per tree, respectively. The interaction between probiotic fertilizer concentration and pruning method had no significant effect on the growth and production of Kristal guava plants in the off-season.

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