



## Pruning to Improve Flowering and Fruiting of 'Crystal' Guava

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### ARTICLE INFO

#### Keywords:

Fruit quality  
 Fruit set  
 Generative shoots  
 Vegetative shoots

#### Article History:

Received: 17 July, 2018

Accepted: 8 January, 2019

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### ABSTRACT

Pruning is one of the techniques to improve plant growth and production. The aim of this research was to determine the effect of pruning on vegetative and generative growth, and fruit quality of 'Crystal' guava. The experiment was conducted from September 2016 to April 2017 at Cikabayan Research Station of Bogor Agricultural University, Dramaga, Bogor, Indonesia (-6.550780, 106.714531). The experiment used completely randomized design with six replications. There were three treatments i.e. a) pruning by leaving 4 pairs of leaves, b) pruning by leaving 8 pairs of leaves, and c) control (without pruning). Pruning was applied after shoot leaves grew fully. The result showed that pruning significantly increased the total number of shoots and generative shoots. Pruned plants produced more flower and fruit than un-pruned ones. Pruning by leaving 4 pairs of leaves tended to produce higher number of flower and fruit than those by leaving 8 pairs of leaves. Fruit weight and internal fruit quality were not affected by pruning.

### INTRODUCTION

Guava (*Psidium guajava* L.) is one of the Indonesian superior fruits which contains high nutritional value and has potential to compete in the global market. Guava contains remarkable antioxidants and high dietary fiber (Jiménez-Escrig, Rincón, Pulido, & Saura-Calixto, 2001). A high antioxidant activity in guava was also reported by Fu, Lu, & Zhou (2016) and Hassimotto, Genovese, & Lajolo (2005). Vitamin C content in guava is much higher than that of other fruit such as pummelo (Kalsum, Susanto, & Junaedi, 2015; Romalasari, Susanto, Melati, & Junaedi, 2017). Guava leaf extract is also potential to alleviate the symptoms of diabetes (Jayachandran, Vinayagam, Ambati, Xu, & Chung, 2018).

Guava is a fruit plant originating from the American tropics (Nakasone & Paull, 1998). Guava in Indonesia has many varieties including Red Guava, Wijaya Merah, Deli, and Crystal. The shape, size, taste and color of guava fruit flesh vary depending on the variety. Guava generally has a large number of seeds and having soft flesh when ripened. The superiority of Crystal guava is to have a very few

seeds (less than 3 % parts of fruit or even seedless), fresh sweet fruit flavors, and crisp fruit texture. Crystal guava is an introduced fruit plant from Taiwan. Its variety was released by the Ministry of Agriculture in 2007 (Direktorat Perbenihan Hortikultura, 2007).

Crystal guava cultivation is very prospective to be developed commercially because it can produce fruit 2-3 times a year, contains high vitamin C, and has a potential substitute as an imported fruit. Along with the increase of public awareness related to the importance of fresh fruit consumption for health, the market demand for fresh fruit is also expected to increase. Furthermore, as population and income per capita increase, it is estimated that the domestic needs for Crystal guava will continue to increase.

However, though at present Crystal guava has been cultivated in some areas in Indonesia, especially in Java and Sumatera islands, there are still some problems related to its productivity and quality to meet the market demand. The farmers crops still vary in its productivity and quality. Therefore, the cultivation techniques should be developed to improve Crystal guava fruit performance and production.

**ISSN: 0126-0537 Accredited First Grade** by Ministry of Research, Technology and Higher Education of The Republic of Indonesia, Decree No: 30/E/KPT/2018

**Cite this as:** Susanto, S., Melati, M., & Aziz, S. A. (2019). Pruning to improve flowering and fruiting of 'Crystal' guava. *AGRIVITA Journal of Agricultural Science*, 41(1), 48-54. <https://doi.org/10.17503/agrivita.v41i1.1954>

Slamet Susanto *et al.*: *Pruning to Improve Flowering and Fruiting of 'Crystal' Guava* .....

Plants with vigorous growth produce only few flowers and fruit (Susanto, Sugeru, & Minten, 2010). Flowering can be arranged and improved through manipulation of plant growth. The arrangement of plant canopy is directed to improve sunlight penetration, thus it can improve the photosynthesis process (Taiz & Zieger, 2010), and resulting more fruiting shoots (Willaume, Lauri, & Sinoquet, 2004). Pruning is one of the cultivation techniques that aimed to form and arrange plant canopy to effectively produce flowers and fruit (Santoso, 2012).

Pruning is the modification of plant architecture with the aim of regulating growth and flowering (Fumey, Lauri, Guédon, Godin, & Costes, 2011). According to Kinet (1977) a proper pruning can be used to regulate the balance of vegetative and reproductive growth. Sunlight received by pruned plants will increase so that it can stimulate the growth of productive new shoots (Willaume, Lauri, & Sinoquet, 2004). Pruning on the shoots (apical buds) will encourage the growth of lateral shoots hence branching will increase (Shimizu-Sato & Mori, 2001). The more number of productive shoots, the more fruit will be produced.

Pruning is useful to control growth so that the leaf architecture becomes more compact and the distance from source to sink becomes shorter. Source is an organ (leaf) and all photosynthetic plant tissues, whereas sinks are all parts of plants that do not photosynthesize or it photosynthesizes but not maximum, so that some of their carbohydrate needs are provided by the sources (Taiz & Zieger, 2010). The shorter distance between source and sink will cause the use of assimilation to be more effective and the translocation will be smoothly (Ainsworth & Bush, 2011).

Researches related to pruning to various plants have been reported by several researchers. Pruning application can significantly improve the fruit yield and quality of peach (Kumar, Rawat, Rawat, & Tomar, 2010), fruit yield of sweet cherries (Bennewitz, Fredes, Losak, Martinez, & Hlusek, 2011), fruit yield of lemon (Ghosh, Dey, Bhowmick, Medda, & Ghosh, 2016). Dhaliwal, Banke, Sharma, & Bali (2014) showed that pruning can accelerate and increase shoot numbers on 'Kinnow' mandarin. Pruning which applied with different intensity to guava plants increased the number of buds and fruits (Lakpathi, Rajkumar, & Chandrasekhar, 2013; Mohammed, Sharma, Kumar, Gupta, & Singh, 2006). Moreover, da Silva, Tecchio, Domiciano,

Leonel, & Balestrero (2016) stated that the time of pruning significantly improved fruit yield but did not affect fruit sweetness of guava.

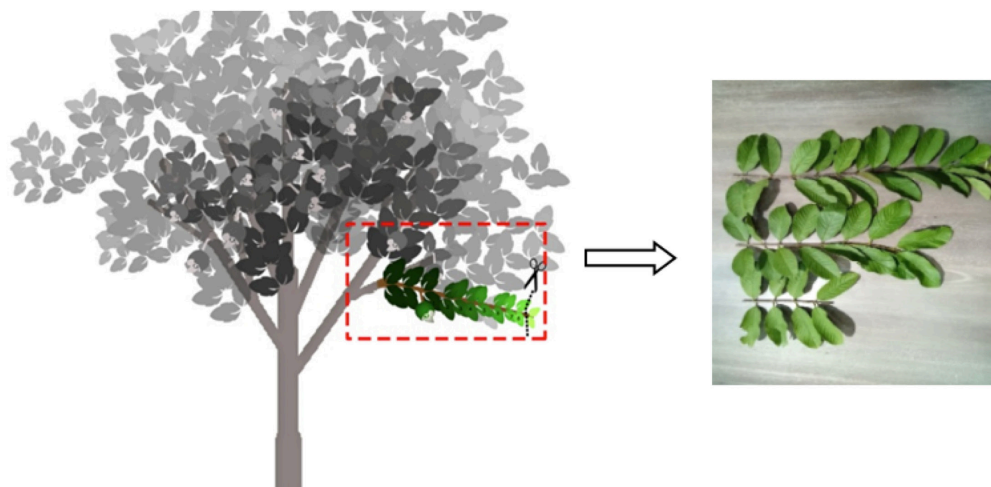
Guava's growers in Indonesia, in general, prune plants after harvest by cutting weak and unhealthy branches, reducing the excessive branches or pruned only a small portion of the shoots by leaving more pairs of leaves. However, appropriate pruning methods, as guidance for improving growth and production of guava, are not available yet for them. This study aimed to determine the effect of pruning applied to apically growing shoots on the growth, production and quality of Crystal guava.

## MATERIALS AND METHODS

The experiment was conducted from September 2016 to April 2017 in Cikabayan Research Station of Bogor Agricultural University, Dramaga, Bogor (-6.550780, 106.714531) at 264 m above sea level. The analysis of fruit quality was conducted in the Postharvest Laboratory of Agronomy and Horticulture Department and Center for Tropical Horticulture Research Laboratory, Bogor Agricultural University.

The 3-years-old 'Crystal' guava plants originated from air layered seedling were subjected to this experiment. The plants were planted with spacing of 4 x 3 m. The fertilization was done by providing organic and inorganic fertilizers. The organic fertilizer in the form of manure was applied once in September 2016 as much as 10 kg per plant. The inorganic fertilizer was applied twice in September 2016 and January 2017, each was 0.5 kg NPK (21-21-21) per plant. Weeding was done manually and the pests and diseases control was done with pesticides if necessary. Irrigation was not applied due to the condition of rainy season with rainfall was 195-439 mm per month and rainy days number was 12-18 days per month during the experiment period.

The experiment used a Completely Randomized Design with single factor. There were three treatments, namely pruning of shoots by leaving 4 pairs of leaves, pruning of shoots by leaving 8 pairs of leaves and without pruning as control (Fig. 1). Each treatment was repeated 6 times, so there were 18 experimental units. Each experimental unit used 2 plants. The observation was done to 20 randomly selected shoots per plant



**Fig. 1.** Pruning application by leaving 8 and 4 pairs of leaves and control

In every new shoot appeared as a result of pruning treatment was maintained only one fruit and the remaining fruits were removed. Each fruit was then bagged with foam net and transparent plastic to protect fruit from insect attack. The vegetative and generative variables observed were 1) vegetative shoot number, 2) generative shoot number, 3) flower number, 4) fruit number, and 5) fruit sets. Fruit set was calculated by comparing the number of fruit formed with the number of flowers.

The fruit quality variables observed were: 1) fruit diameter, 2) fruit weight, 3) fruit volume, 4) fruit softness, 5) total soluble solids, 6) titratable acidity, and 7) organoleptic test. The fruit volume was measured using archimedes principle. The fruit softness was measured based on the electric pneumatometer needle penetration at the middle of the fruit, with a puncture for five seconds and a load of 50 g. The total of soluble solids was measured by placing juices of fruit on the Atago DATA-PSH 03 reactive hand refractory lens. Titratable acidity was measured using titration method with 0.1 N NaOH solutions. The vitamin C was measured using titration method with iodine solution 0.01 N. While the organoleptic test with score range of 1 (the lowest) – 5 (the highest) was performed by providing a questionnaire sheet of 10 trained panelists, using 10 fruit per plant.

The observed data were analyzed by multiform analysis (F test). If the treatment showed a significant difference, then it would be continued with the Least Significance Different (LSD) test at  $\alpha$  5 % level.

## RESULTS AND DISCUSSION

Generally, farmers prune the weak, unhealthy, and excessive branches or small portion of the shoots by leaving around 8 pairs of leaves or more. Pruning a small portion of shoots may leave apical dominance effect that can suppress initiation of axial buds. Suppressing of axial buds by terminal shoots has been stated by previous researchers (Cline, 1997; Shimizu-Sato & Mori, 2001). More severe pruning needs to be performed to release apical dominance therefore more axial buds will emerge. In this experiment, the application of severe pruning by leaving 4 pairs of leaves, light pruning by leaving 8 pairs of leaves and un-pruned shoots as the control have been investigated to get a better pruning technique that is appropriate for guava plants.

The plants, in general, grew normally during the experiment period. The vegetative and generative shoots appeared around 2-4 weeks after pruning. The flowers appear along with the appearance of new shoots with the number of 1-4 flowers per new generative shoot. Only one fruit was kept in each new shoot. The fruit peel performance was relatively smooth as fruit was bagged with plastic and foam net at the beginning of the fruit formation. Fruit was harvested when the fruit peel reached yellowish green color at the age of 116-120 days after blooming.

### Vegetative and Generative Growth

Pruned plants produced total new shoots and generative shoots more than the un-pruned plants. The plants pruned by leaving 4 and 8 pairs of leaves increased the total shoot number by 32.55 % and

18.04 %, and generative shoot number by 71.63 % and 47.52 % respectively per plant as compared to the control plants that produced only 25.4 total shoots and 14.1 generative shoots per plant. The vegetative shoot number ranged from 9.6-11.4 shoots per plant, showing no significant difference among treatments (Table 1). The pruning application has caused the loss of apical dominance resulting in the emergence of both vegetative and generative shoots. The increased generative shoots due to pruning application was also reported in previous studies (Mohammed, Sharma, Kumar, Gupta, & Singh, 2006; Pilia, Shukla, Mahawer, Sharma, & Bairwa, 2010).

The effect of pruning on the number of flowers, fruit set and number of fruits is shown in Table 2. The result showed that pruning by leaving 4 and 8 pairs of leaves increased flower number by 95.98 % and 65.90 % respectively, as compared to the control plants which produced only 52.2 flowers per plant. The results of the study of Singh, Singh, & Rajan (2001) also showed that pruning application has increased the amount of flower of 'Sardar' guava by 70 % and 'Allahabad Safeda' guava by 73 %.

Pruning causes sunlight received by more branches of plant and can stimulate shoot and flower formation (Willaume, Lauri, & Sinoquet, 2004).

Pruning by leaving 4 and 8 pairs of leaves increased the fruit number by 85.22 % and 50.74 %, respectively as compared to the control plants that only produced 20.3 fruit per plant. Fruit set was in the range of 35.3 to 38.9 %, showed no significant difference among treatments (Table 2). Sahar & Abdel-Hameed (2014) reported that pruning applied to guava at 10 cm from the base of the branch resulted 253.0 fruits per tree in the first season and 251.8 fruits per tree in the second season, while in control plants only produced 208.8 per tree in the first season and 188.5 fruits per tree in the second season. According to Kumar, Rawat, Rawat, & Tomar (2010) in the pruned plants, more assimilates was used for the formation of buds or fruits. The number of flowers and fruits in the pruned plants by leaving 4 pairs of leaves tended to be higher than those produced by plant pruned leaving 8 pairs of leaves. It may be due to the difference on the number of new generative shoot produced

**Table 1.** Effect of pruning to the number of vegetative and generative shoots

Pruning Treatment	Number of Vegetative Shoots	Number of Generative Shoots	Total Shoots
Leaving 4 pairs of leaves	9.6 a	24.2 a	33.8 a
Leaving 8 pairs of leaves	9.3 a	20.8 a	30.1 a
Control	11.4 a	14.1 b	25.5 b

Remarks: Values followed by different letters in the same column show significant difference based on the LSD at 5 % level

**Table 2.** Effect of pruning to the flower number and fruit set

Pruning Treatment	Number of Flowers	Fruit set (%)	Fruit Number
Leaving 4 pairs of leaves	102.3 a	36.8 a	37.6 a
Leaving 8 pairs of leaves	86.6 ab	35.3 a	30.6 ab
Control	52.2 b	38.9 a	20.3 b

Remarks: Values followed by different letters in the same column show significant difference based on the LSD at 5 % level

**Table 3.** Effect of pruning to the external fruit quality

Pruning Treatment	Fruit Diameter (mm)	Fruit Volume (ml)	Fruit Weight (g)	Fruit Softness (mm/50 g/5 sec)	Peel Color
Leaving 4 pairs of leaves	75.8 a	222.3 a	210.3 a	81.3 a	Yellowish Green
Leaving 8 pairs of leaves	82.8 a	251.5 a	241.2 a	84.1 a	Yellowish Green
Control	81.7 a	253.2 a	249.2 a	83.6 a	Yellowish Green

Remarks: Values followed by different letters in the same column show significant difference based on the LSD at 5 % level

**Table 4.** Effect of pruning to the internal fruit quality

Pruning Treatment	TSS (°Brix)	TA (%)	Vitamin C (mg/100 g)
Leaving 4 pairs of leaves	8.3 a	0.42 a	131.6 a
Leaving 8 pairs of leaves	8.1 a	0.51 a	128.2 a
Control	8.3 a	0.44 a	127.3 a

Remarks: Values followed by different letters in the same column show significant difference based on the LSD at 5 % level



### Fruit Quality

The external and internal quality of fruit are presented in Table 3 and Table 4. There are no significant differences in the diameter, volume, and weight of fruit among treatments (Table 3). The fruit diameter, fruit volume and fruit weight ranged between 75.8 – 82.8 mm, 222.3 – 253.2 ml and 210.3 – 249.2 g, respectively for all treatments. The fruit growth of each treatment during the experiment period is presented in Fig. 2, while fruit performance is presented in Fig. 3. The control plants tended to bear bigger fruit may be due to the less fruit produced, resulted higher assimilates allocation per fruit. A positive correlation between leaf number and fruit size has been found in a previous experiment (Lakpathi, Rajkumar, & Chandrasekhar, 2013). There were also no significant differences on the fruit softness and peel color among treatments. Fruit softness ranged between 81.3 – 84.1 mm/50 g/5 sec. The pruned plants as well as the control plants produced similar color of yellowish green fruit.

There were no significant differences among treatments in the total of soluble solids (TSS), titratable acidity (TA), and vitamin C contents in fruit juice (Table 4). TSS, TA and vitamin C contents were in the range of 8.1-8.3 %, 0.42-0.51 %, and 127.3-131.6 mg/100 g, respectively for all treatments. The similar results indicating no significant difference in internal quality due to pruning treatment has been reported by Lakpathi, Rajkumar, & Chandrasekhar (2013) and da Silva, Tecchio, Domiciano, Leonel, & Balestrero (2016) in guava, Ghosh, Dey, Bhowmick, Medda, & Ghosh (2016) in lemon and Bennewitz, Fredes, Losak, Martinez, & Hlusek (2011) in sweet cherries.

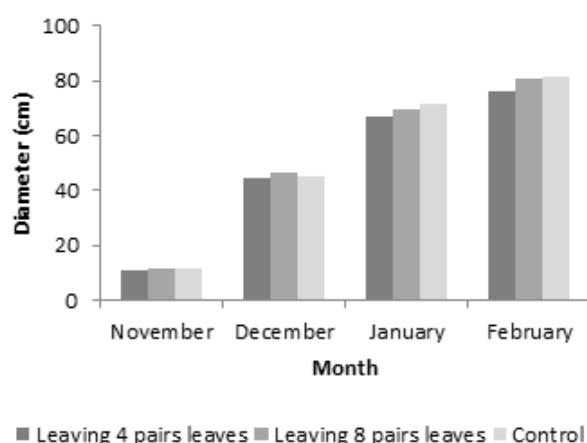
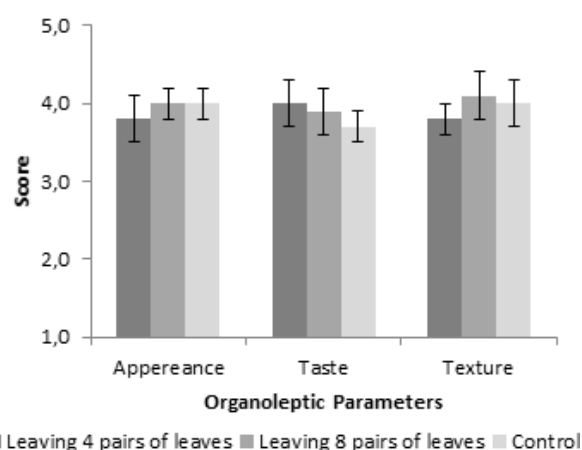


Fig. 2. Effect of pruning to the fruit growth



Fig. 3. Effect of pruning to the fruit performance

Fig. 4 showed organoleptic test results among treatments. There were no difference among treatments on the fruit appearance, taste and texture. Fruit from the pruned plants as well as control plants were favored by panelists due to its sweet fresh taste with crisp texture. The insignificant difference on organoleptic test in this study might have been contributed by insignificant difference on fruit weight among treatments. In the previous study, Kalsum, Susanto, & Junaedi (2015) reported that the smaller fruit of pummelo tended to have better taste as shown by higher sugar/acid content as compared with those of bigger ones.



Remarks: Score 1 = very dislike, 2 = dislike, 3 = rather like, 4 = like, 5 = very like

Fig. 4. Effect of pruning to the organoleptic test

## CONCLUSION

Pruning had significant effect to the increase of total number of shoots and generative shoots. Pruned plants produced more flower and fruit than un-pruned ones. Pruning by leaving 4 pairs of leaves tended to have higher number of flower and fruit than by leaving 8 pairs of leaves. Fruit weight and its quality were not affected by pruning.

## ACKNOWLEDGEMENT

The authors express our gratitude to Ministry of Research, Technology and Higher Education for funding this research through National Strategic Research Scheme 2016-2017. Our thankful is addressed to Mr Dadang Hermansah for assistance in data collection and analysis.

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Slamet Susanto *et al.*: *Pruning to Improve Flowering and Fruiting of 'Crystal' Guava* .....

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