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Studies on flowering and fruiting rhythms of 'Cristal' Guava (*Psidium guajava* L.) at three different Locations, Indonesia

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ABSTRACT

The purpose of this study was to explain the relationship between agroclimate variables with flowering and harvesting pattern of 'Cristal' guava plants at three locations namely Lampung (5p12'7"S, 105p46'13"E), Bogor (6p3'27"S, 106p43'54"E) and Sukabumi (7p0'7"S, 107p1'6"E). The lowest temperature, the highest relative humidity and rainfall were found in Sukabumi. Lampung and Bogor were relatively similar in term of temperature and relative humidity, although the rainfall was higher in Bogor than Lampung. The research was conducted through survey method since May 2016 to November 2017 in the mentioned sites. Flowering period happened in May to July, November to January, and back to May to July on the next year. Fruiting period was September to October, March to April, and back to September to October on the next year. The numbers of day required from flower bud emerge to harvest varied among locations, i.e 127 days in Lampung, 131 days in Bogor and 144 days in Sukabumi. Plant in Lampung and Bogor showed almost similar flowering and fruiting time, while in Sukabumi showed those periods two weeks later. The variation of both periods was associated with the variation of agroclimate among the locations. The higher temperature, the lower relative humidity and the lower rainfall intensity such in Lampung accelerated the flowering and harvesting of guava, along with the improvement of flower and fruit production.

Key words : *Agroclimate, Flowering pattern, Production center, Production cycle.*

Introduction

Guava (*Psidium guajava L.*) is one of the plants belonging to the family Myrtaceae originating from the tropical regions of America. In Indonesia, guava is very popular with the community because of its delicacy and high nutritional value, resulting in the demand for this commodity as fresh fruit or processed products is quite large (de Souza *et al.,* 2016). The magnitude of the demand is an opportunity that must be met through cultivation.

Guava cultivation requires a basic understanding of the life cycle or phenology of the plant; phenology is a study of the response of living things to climate change and seasons that occur in the surrounding environment (Huang *et al.,* 2009). In plants, phenology can also be interpreted as recording the pattern of planting, flowering and

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harvesting related to changes in the agro-climate component of the cultivation environment. Agroclimate is weather elements around cultivated land which probably affect the success of crop cultivation (Suharta *et al.*, 2003).

Guava cultivation is carried out in a broad growing environment so that it has diverse agro-climatic conditions. This condition is strongly influenced by the rainfall and altitude factors. Based on altitude, an area is included in the highlands if the altitude of more than 1000 meters above sea level (m a.s.l), while the lowlands are generally at an altitude of fewer than 500 m a.s.l. Different agro-climatic conditions in the highlands and lowlands have a strong influence on the production of guava plants. This condition also happens related to differences in rainfall level. Therefore, this study aimed to explain the relationship between agro-climate and flowering and harvesting of guava which are cultivated in three different production centers in Lampung, Bogor, and Sukabumi regency.

Materials and Methods

The study was conducted in three production centers of guava, namely Lampung, Bogor and Sukabumi, from May 2016 to November 2017. A total of 30 'Cristal' guava plants in the same production phasewere used as observation materials at each production center. Uniformity of plants includes plant age (3-3.5 years), plant height (1.7-2.4 m) and canopy diameter (1.5-2.2 m). Agroclimate including air temperature, relative humidity, rainfall intensity and the number of rainy days in the three sites were obtained from the Indonesian Meteorology, Climatology and Geophysics Agency (BMKG). Observation was carried out weekly. Plant height was measured from the base of the stem to the tip of the highest growth point using a meter. The number of shoots is calculated using a hand counter. Flowering until harvesting time was calculated based on the level of flower development such as buds, anthesis until the fruit was harvested. The number of flowers was calculated as a whole using a hand counter. The number of harvested fruits per tree was calculated using a hand counter. Flowering patterns are arranged based on the number of flowers every week observation. The harvesting pattern was arranged based on the number of fruits harvested every week. The chemical properties of fruit after harvest is observed based on relative sugar content (RSC) and total titrated acid (TTA).

Results and Discussion

Agroclimate

Agroclimate conditions such as air temperature, air humidity and rainfall in the three production centers of guava are relatively different (Figure 1), so do the altitude of the locations. The altitude of ob-

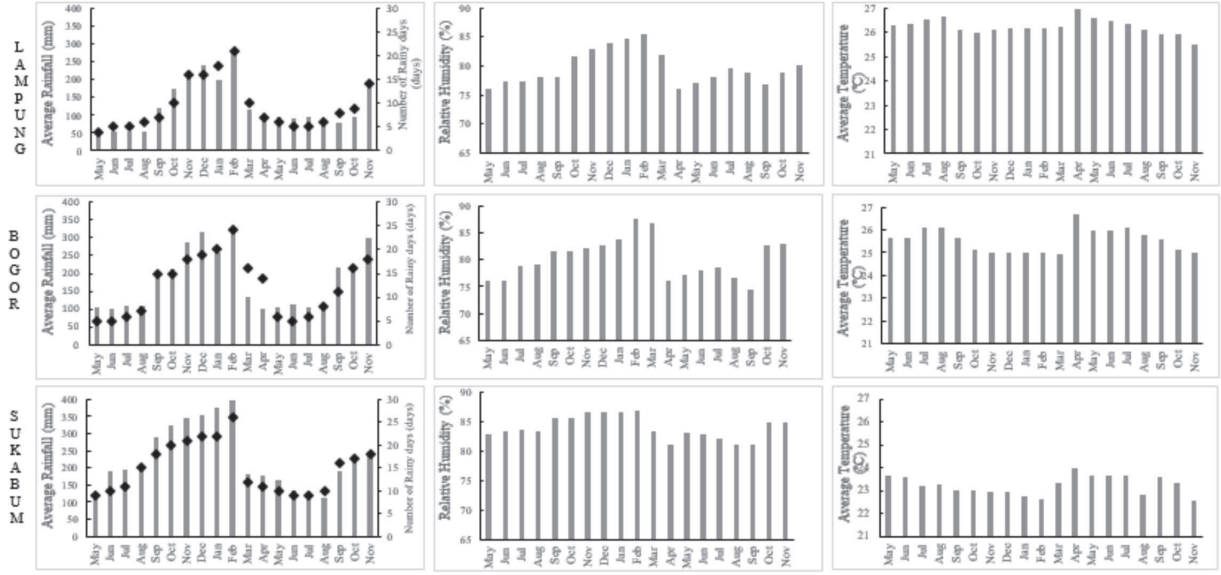

Fig. 1. Average rainfall, number of rainy days, relative air humidity and temperature in Lampung, Bogor, and Sukabumi from May 2016-November 2017 (BMKG 2018)

served locations are 24 m asl for Lampung, 197 m asl for Bogor and 956 m asl for Sukabumi. During the study period (May 2016 - June 2017), the average temperature of Lampung, Bogor and Sukabumi were 26.6 °C, 25.8 °C, and 23.2 °C, respectively. The high relative humidity found in Sukabumi with an average of 84.34%, compared to Lampung and Bogor which only ranged of 80.63% and 79.83%. The intensity of rainfall might be related to variations of the relative humidity at the study site. Lampung tends to have the lowest rainfall with an average of 1 131.32 mm / year, while Sukabumi has the highest rainfall of 4 229.54 mm/year. The average rainfall in Bogor was 3 417.30 mm/year. In general, the highest rainfall during the study period was observed in the middle of the rainy season in February 2017 in all study sites. The lowest rainfall was found in the dry season from June to September, depending on the location.

Flowering

Flowering time of guava was different in the three study sites (Figure 2). A flowering phase of guava is generally divided into 3 stages, that are the emergence of flower buds, flower blooms and enlargement of the ovary, then followed by enlargement of the fruit until it is ready for harvest. The flowering ofguava in Lampung showed the fastest and lowest in Sukabumi. Overall, the time taken by guava from flower buds emerge to harvests phases in Lampung, Bogor, and Sukabumi was 127, 131 and 144 days, respectively..

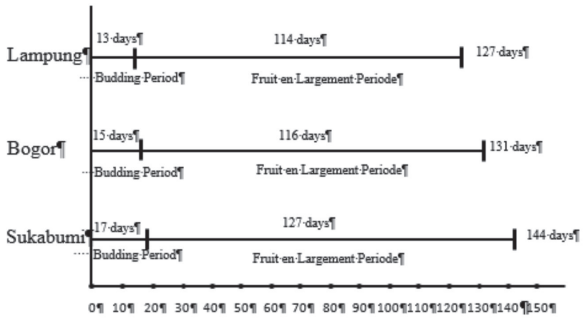

Fig. 2. Number of days taken by 'Cristal' guava from flower buds emerge to harvests phases in the three study sites.

Generally, guava plants in the three study sites flowered three times, the first period in May-July 2016, the second in November 2016-January 2017 and the third in May-July 2017. The period of May-July was occurred in the dry season, while the period November-January during the rainy season. This indicated that flowering of guava in Sukabumi was 16 days shorter than Lampung and Bogor. The same pattern was also shown in the second and third flowering periods. In addition, there are differences in the number of flowers in the three study sites and among the observation periods (Figure 3). The total number of flowers for the three study periods in Lampung, Bogor, and Sukabumi was 406, 352 and 287, respectively.

Fruiting

There are three fruiting period of guava plant, i.e September-November 2016, March-April 2017, and September-November 2017 (Figure 4). The harvesting period of guava in Sukabumi was 24 days shorter than Lampung and also 30 days shorther than Bogor. The same pattern was also shown in the second and third harvest periods. The highest number of fruits found in Lampung, then followed by Bogor and Sukabumi during the three periods. Overall, the total fruit during the three study periods in Lampung, Bogor, and Sukabumi was 158, 149 and 130 respectively.

Chemical Quality of Fruit

Relative sugar content (RSC) and total titrated acid (TTA) were measured to know the chemical quality of guava fruit. The RSC of guavaobtained during first harvesting period in Lampung, Bogor and Sukabumi were 8.29 Brix, 8.25 Brix and 7.95 Brix, respectively. In the second period, the RSC of guava from Lampung, Bogor, and Sukabumi were 8.35 Brix, 8.31 Brix and 8.03 Brix, respectively. In the third period, the RSC of guava from Lampung, Bogor, and Sukabumi were 8.20 Brix, 8.07 Brix and 7.71 Brix, respectively. The TTA of guava obtained during first harvesting period in Lampung, Bogor and Sukabumiwere 0.22%, 0.23% and 0.24%, respectively. In the second period, the TTA of guava from Lampung, Bogor, and Sukabumi were 0.21%, 0.22% and 0.23%, respectively. In the second period, the TTA of guava from Lampung, Bogor, and Sukabumi were 0.24%, 0.22%, 0.23%, respectively.

Discussion

The flowering response is basically the result of interactions between genetic and environmental factors including agro-climates. Microclimate factor

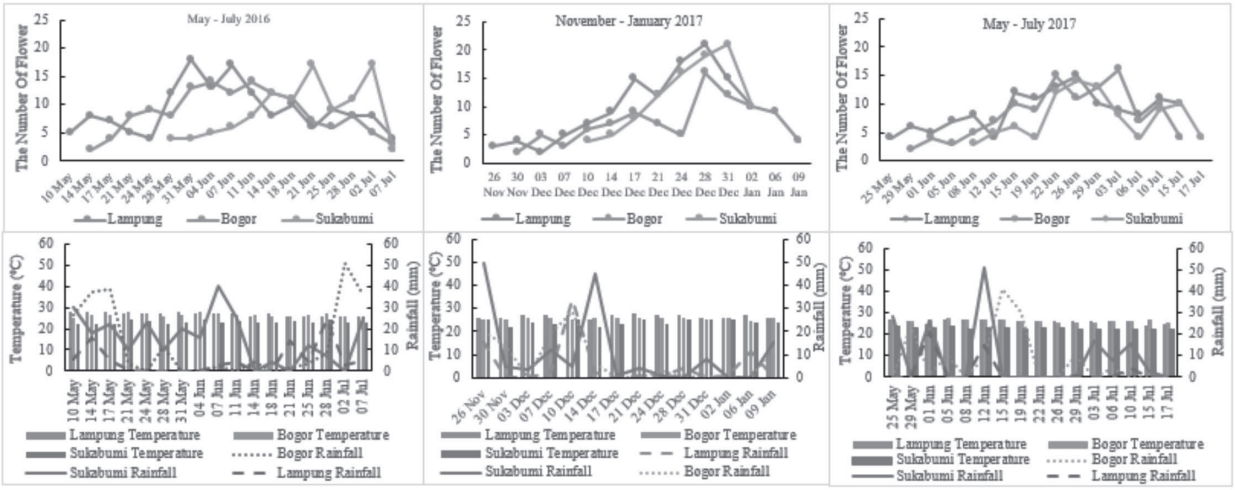

Fig. 3. Flowering pattern of 'Cristal' guava, the average temperature and rainfall intensity for three periods in three study sites

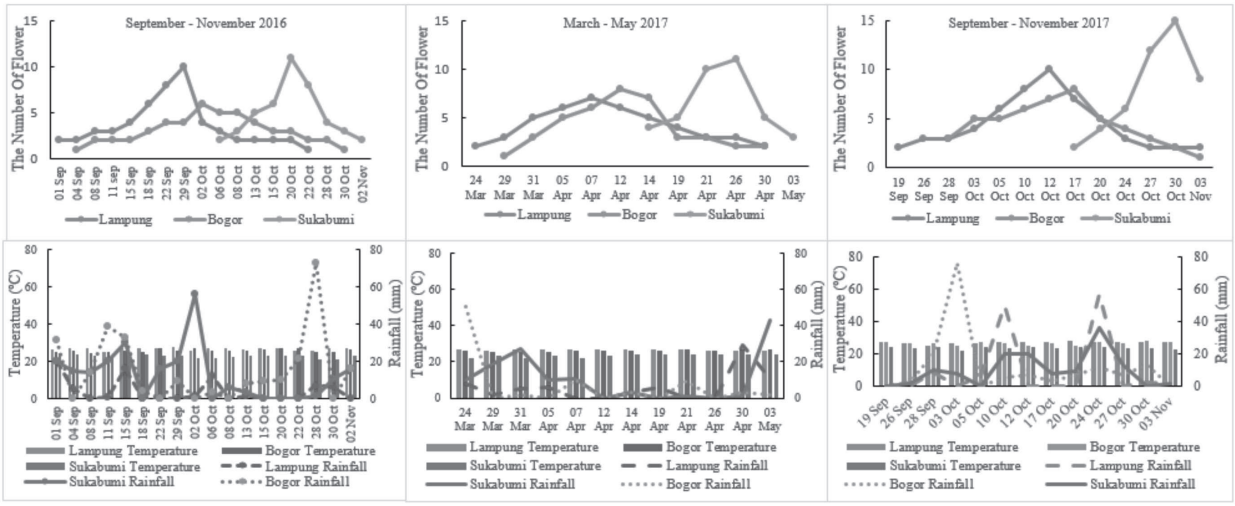

Fig. 4. Fruiting pattern of 'Cristal' guava, the average temperature and rainfall intensity during three periods at three study sites

could affect the carbohydrate translocation and plant growth (Yildiz *et al.*, 2013). The increasing temperature in the optimum growing temperature range could promote the plant growth through activation of certain enzymes (Taiz and Zeiger, 2010). The generative growth of guava is better in the lowlands than the highlands. It is evidenced by the high proportion of generative shoots which are more dominant in the lowlands such Lampung (77%) and Bogor (73%), compared to Sukabumi (64%).

There are differences in the flowering period that lead to the difference in the harvesing periods amongthe study sites. The harvesting period of guava ranged from 122 - 142 days. Similar result by Patel *et al.*, (2015) that showed 110 to 120 days depending on the guava cultivar. It could be caused by the differences growing conditions. Growing locations with higher daily temperatures support faster growth, it might be due to differences in the speed of accumulation of heat units. The accumulation of heat units is one concept involving measurement of the difference in daily temperature with the plant base temperature to monitor plant growth and development (Syakur, 2012).

The failure and delay in the flowering period may reduce the fruit production and later disrupt

the production cycle. The increase of rainfall intensity and the number of rainy days in the second flowering period (November 2016 - January 2017) proved to be associated with the decrease of the number of flowers by 25% and harvested fruits by 14% during the period, especially in Sukabumi. The high intensity of rainfall may cause the drop of guava flowers (Mariati, 2013).

The RSC and TTA of guava fruit in this study were seemed to be similar among various study sites. The RSC and TTA of the fruit could be affected by internal or external factors. The most influenced internal factors is the fruit maturity level (Bakshi *et al.*, 2007). During the ripening process, the starch is hydrolyzed into sugar so it can improve the RSC (Yahia *et al.*, 2012). While TTA decrease as the consequences of fruit ripening process due to organic acids is used as energy for fruit respiration (Silalahi *et al.*, 2007). The external factors such microclimate manipulation. Fruit bagging, one of microclimate manipulation technique, tended to increase the RSC/TTA ratio by increasing the RSC and reducing the TTA, as the consequances of the improvement of micro-temperature surrounding the fruit (Susanto and Pribad, 2004).

Conclusion

In general, the flowering period of the 'Cristal' guavahappened 3 times, i.e May-July 2016, November 2016-January 2017and May-July 2017. The harvesting period of 'Cristal' guava were September-October 2016, March-April 2017 and September-October 2017. The number of days taken by the 'Cristal' guava from flower bud emerge to harvest varied depending on the study sites, i.e 127 days in Lampung, 131 days in Bogor and 144 days in Sukabumi. The flowers emergence until the 'Cristal' guava harvest period in Lampung is relatively similar to Bogor, while both are different to Sukabumi that is two weeks slower. This difference is related to differences in agro-climate conditions, especially rainfall and temperature. Higher temperatures and lower rainfall intensity increase the number of flowers and guava fruit harvested in Lampung compared to those in Bogor and Sukabumi.

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