The impact of micro climate on flowers development in Siam orange plant (*Citrus nobilis* var. *microcarpa*. L)

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**Abstract.** Constraints that can affect the occurrence of induction and flowering development of Siamese citrus plants are endogenous and exogenous factors. Exogenous factors include microclimate. Microclimate, especially extreme humidity, is one of the factors that can determine the physiological process of flowering of Siamese citrus plants. Siam oranges require 6-9 wet months (rainy season) and 3-6 dry months (dry) and need enough water especially in July-August (dry season). The purpose of this study was to examine and determine the role of microclimate on the phenology of flowering Siam oranges in Badung, Bangli and Gianyar. The assessment method was observed in citrus centers from 2014 to August 2018. The results showed high rainfall occurring throughout 2014, a flowering phenology disorder that had previously flowered Siamese citrus plants 1 to 3 times a year to 4 to 6 times a year. The number of flowering periods is not supported by the number of flowers formed because the flower miscarried before the fruit-set formed, the height of the deciduous flower is supported by the large number of leaves formed at the location of the garden whose height is less than 1000 meters above sea level. Location of citrus orchards which applies an integrated management system to. New potentials are good for cultivating conjoined oranges, namely dry land or dry fields and sandy soil when compared to oranges planted in faddy fields.

1. **Introduction**

Indonesia is still dominated by 80% by Siamese oranges due to productivity [1]. Siam orange can be grown of and cultivar by fanners in the lowlands to the highlands with different varieties [2] and can be consumed vy low-income to high-income people/ Most of citrus fruits produced from all production centers are traded and consumed in fresh form. The formation of the flower of the conjoined orange plant is largely determined by the number of shoots that grow and develop because the shoot is a place for flowering induction [3].

The regencies of Badung, Bangli and Gianyar are the largest centers of production of tangerines in Bali with a total land area of 7500 ha [4]. This is because the soil conditions are very suitable for citrus cultivation, especially Siam. The growth of fruit plants and their quality is not only influenced by the quality of seedlings, soil [5] is also influenced by growth requirements including climate [6]. Requirements for growing climate, fruit plants need 6-9 months wet (rainy season), rainfall 1000-2000 mm / year evenly throughout the year, need enough water especially in July-August. The optimal temperature needed is between 25-30 °C with optimum humidity around 70-80% [7]. Wind speed is not result more than 40% (because if more than 40% will shed flowers and fruit). Tropical fruit plants need direct sunlight (do not like a place that is protected from sunlight). Suitable soil types are andosols and latosols with a degree of soil acidity (soil pH) 5.5-6.5 with a salt content of 10%. Depth of ground water
150-200 cm below ground level. In the dry season the water depth is 150 cm and in the rainy season 50 cm. Altitude, oranges can grow from 0-1.200 meters above sea level [8].

Bali region began from the last five years there were extreme climate deviations, which affected agronomic growth, productivity and quality of oranges which were quite serious about the occurrence of flowering phenology changes, changes in population dynamics and increased potential outbreaks of plant pests [9]. This condition justifies the importance of assessing and developing strategies to minimize the risk of failure and to optimize the positive effects of extreme climate change on the productivity and quality of Siamese oranges. The Siem Kinta mani orange plant is one of the horticultural plants that are the leading commodities in Bali. The cultivation of citrus Siem Kintamani has long been done in the province of Bali. The citrus center of Siem Kintamani Province of Bali is in the Bangli Regency region [10].

Bangli regency, followed by Gianyar Regency and Badung Regency were regions with the highest citrus production at 119,030 tons per year. The national citrus production in 2013 amounted to 1,548,401 which could not meet the needs of oranges in Indonesia, this was evidenced by the volume of citrus fruit imports reaching 2,594,825 tons in December 2013 [11]. The import volume can be said to be still high, therefore Indonesia needs to increase the production of fresh oranges. Meeting the needs of conjoined oranges is still difficult, this is caused by uneven harvest (seasonal). September to October is the development of the vegetative phase of citrus.

Naturally Siam fruit blooms between November to December. Eight to nine months after flowering oranges can be harvested, between July and August which is the peak harvest of conjoined oranges [12]. According to the natural phenology of Siamese from December to July, there is a scarcity of citrus fruit production in Bali.

Flowering in fruit crops such as manga and oranges is a very complex process, namely: covering many stages of development. Because of its perennial nature, trees must interact with environmental conditions at all times of the year, and flowering is usually associated with climate change. Constraints that can affect the occurrence of induction and flowering development of mango fruit are endogenous and exogenous factors. Exogenous factors include microclimate. Microclimate is a climate in a specific region within a wider area [13]. Microclimate can be influenced by various factors such as the slope of a plain, wind speed, humidity, irrigation and others [14].

The flowering process of fruit plants is basically an interaction of the influence of two major factors, namely external (environmental) and internal (endogenous) factors. External factors (environment) Temperature, Light, Humidity, Nutrients and internal factors include phytohormones and genetics [15]. External factors such as temperature in cold temperate species, relatively high temperatures in summer and early fall seem to stimulate flower initiation. The function of temperature here is to break bud dormancy [16]. Humidity, water stress can stimulate flower initiation, especially in tropical and subtropical tree plants such as lychees, mangoes and oranges. Abundant flowering in the tropical wood species of the genus Shorea has also been linked to the occurrence of drought in the previous period. However, opposite results have been observed in temperate climate species such as pine, apple and olive [17]. Most flowering in the tropics occurs during the transition from the rainy season to the dry season. In the rainy season the plants do their maximum activity to absorb nutrients and water, so they can accumulate food reserves and store as much energy as possible so that vegetative growth is more.

Rainfall, humidity, water stress can stimulate flower initiation, especially in tropical and subtropical tree plants such as lychees, mangoes and oranges. Abundant flowering in the tropical wood species of the genus Shorea has also been linked to the occurrence of drought in the previous period. However, opposite results have been observed in temperate climate species such as pine, apple and olive [17]. Most flowering in the tropics occurs during the transition from the rainy season to the dry season. In the rainy season the plants do their maximum activity to absorb nutrients and water, so they can accumulate food reserves and store as much energy as possible so that vegetative growth is more dominant.

Transition to drought is associated with increased light intensity, irradiation time and air temperature causing increased metabolic activity in plants [18]. Flowering in the tropics is a response to the decline
in the status of water in the soil, abundant water and nitrogen causing active apical growing points so that vegetative growth is dominant [19]. As the water content decreases, the temperature in the soil increases so that apical meristem activity decreases, energy mobilization and food reserves occur to form lateral meristems [20]. This study aims to examine the development of flowering Siamese citrus plants due to the role of its niceoclimate in three research locations in Bangli, Gianyar and Badung Regency in Bali Province.

2. Methodology

2.1. Research place and time
The study was conducted in Bali Province three locations namely: Banjar Belancan, Belancan Village. Kintamani District Bangli Regency. Banjar Seming, Kerta Village, Payangan District. Gianyar Regency and Banjar Murtisari Petang Village, Petang District, Badung Regency. The study was conducted in March 2018-August 2019.

2.2. Research methods
This research was conducted with a study method with secondary data processing and a field survey with orange farmer respondents in the field extension staff in each region based on a random sampling. Citrus plants based on plant age data from 6 years to 12 years.

2.3. Variables observed
In this study the variables observed included:
- rainfall record from 2014-2017.
- the frequency of flowering of conjoined citrus plants from 2018-1019, Production of Siam orange at Badung, Bangli and Gianyar regencies. The number of flowers and the number of fruits formed per plants, calculated cumulatively throughout the study.
- Number of fruit harvested per plant, weight of fruit harvested per plant, weight per fruit, diameter fruit, and the percentage of fruit per plant. Number of fruit harvested and weight of fruit harvested per the plants are calculated cumulatively throughout the study. Every fruit is harvested weighed.
- The total dissolved solids of the fruit, measured using a hand refractometer, to know the sweetness of Siam oranges as a result of the research.

2.4. Data analysis
Data were analyzed qualitatively from primary data and secondary data were carried out according to the needs and explanations of respondents who were equipped with observations in the field, when the data was assessed from 2014-2019.

3. Result and discussion
In the phenomenon in the field is always related to climate conditions, which can be grouped into several phenomena, namely increasing temperature, increasing rainfall, increasing rainfall in the wet season will have an impact on the state of the soil where the plant is cultivated. When the rainfall is too high, namely in December – April (Table 1).
Table 1. Data on average rainfall in three observation locations from 2014-2017 climate data at experimental locations. Total month rainfall (mm).

| Year  | Location of Orange plant cultivation | January | February | March | April | May | June | July | August | September | October | November | December |
|-------|--------------------------------------|---------|----------|-------|-------|-----|------|------|--------|-----------|---------|----------|----------|
| 2014  | Banjar Belancan (Belancan)            | 200     | 239      | 227   | 194   | 157 | -    | -    | -      | -         | 19      | 259      |
| 2015  | Banjar Belancan (Belancan)            | 227     | 212      | 299   | 362   | -   | -    | -    | -      | 85        | 99      | 467      |
| 2016  | Banjar Belancan (Belancan)            | 434     | 214      | 207   | 334   | 98  | -    | -    | -      | -         | -       | 438      |
| 2017  | Banjar Belancan (Belancan)            | 138     | 269      | 1348  | 230   | 60  | -    | -    | -      | -         | 102     | -        | 30       |
| 2014  | Banjar Belancan (Seming)              | 231.5   | 727      | 271.5 | 83.5  | 67.5| 51.5 | -    | -      | 27        | 29      | 156      |
| 2015  | Banjar Belancan (Seming)              | 682.5   | 902      | 242.5 | 223   | 291 | -    | -    | -      | 14        | 95      | 77       |
| 2016  | Banjar Belancan (Seming)              | 572     | 225      | 278   | 238   | 269 | 49   | 47   | 42     | 33        | 26      | 153      |
| 2017  | Banjar Belancan (Seming)              | 584.5   | 466      | 389   | 327   | 223 | -    | -    | 23     | 27        | 72      | 305      |
| 2014  | Banjar Belancan (Sekamukti)           | 657     | 812      | 341.1 | 208   | 79  | -    | -    | 52     | 42        | 116     | 134      |
| 2015  | Banjar Belancan (Sekamukti)           | 719     | 920      | 540   | 245   | 235 | 100  | 30   | 45     | 43        | 157     | 392      |
| 2016  | Banjar Belancan (Petang)              | 579     | 586      | 576   | 228   | 225 | 21.4 | 36   | 6.71   | 16        | 127     | 213      |
| 2017  | Banjar Belancan (Petang)              | 672     | 543      | 421   | 232   | 235 | 23   | 12   | 5.14   | 15.6      | 75      | 146      |

Source: BMKG Denpasar monthly rainfall data in Banjar Seming, Banjar Belancan and Banjar Sekamukti.

Observation of rainfall data is taken from secondary data, namely data from BMKG Denpasar the results of the record from Banjar Belancan, Belancan Village, Kintamani District, Bangli Regency, Banjar Seming, Kerta Village, Payangan District, Gianyar Regency and Banjar Sekamukti, Petang Village, Petang District, Badung regency. High rainfall occurred in December-May (Table 3.1) in the three study sites and the highest average rainfall in the evening, so that plant growth is more towards vegetative parts, so flowering is less. which is 215 poles per plant. The transition from dry to rain then began the flowering induction occurred most at the Belancan Banjar research location as many as 589 buds per tree followed by 458 buds per tree in Banjar Belancan (Table 3.2). In the growth of citrus plants there are two important stages namely the initiation stage where this stage is the initial stage of bud growth.

Furthermore, there will be an induction stage where at this stage will determine the shape of the growth of shoots either vegetative or generative shoots. The estimation of fruit plants, especially mango fruit plants, is a reproductive event which is the main key in fruit production [12]. Good growth conditions, time and intensity of flowering will greatly determine when and how fruit is produced in certain seasons [14]. Many factors affect the flowering process in fruit plants. Plant development, especially flowering depends on several environmental and internal factors of fruit plants cultivated. Environmental temperature and drought stress [15]. Environmental factors that influence in general are due to temperature or environmental stress. In subtropical regions, temperature is an environmental factor that influences the process of development and flowering of fruit plants.

Table 2. The average variable number of flowers blooming, deciduous, and the number of flowers formed/plants (buds), the percentage of fruit-set formed/plants on Siam fruit on-season and off-season.

| Variable                  | Flowering and fruiting of Siam orange plant |
|---------------------------|--------------------------------------------|
|                           | Banjar Belancan | Banjar Seming | Banjar Sekamukti |
| Blooming Flower           | 570            | 350           | 224             |
| Autumn Flower             | 96             | 85            | 89              |
| Flower is Formed          | 474            | 265           | 135             |

Note: Sources of data from field observation in three research locations.

Observation in Banjar Belancan Village, Kintamani District, Bangli Regency, with population of 788,459 ha or 7,885 km2 with the shape extending to the south. Banjar Belancan is located at 80°8'32 "LS-8015! .8" with altitude between 1,000-1,200 meters above sea level with sloping to hilly topography, a slope of 20 to 40% including with parent rocks derived from volcanic ash, with regosil, the texture of sandy loam soil. Average rainfall of 2800 mm / year with wet months between October-April and dry months...
between April 2014–October 2017. Soil acidity (pH) is 5-6, average humidity 90%, average temperature daily from 15 °C to 30°C and has poor drainage [2].

Kerta Village has an area of 1.332 Ha stretching from south to north with territorial boundaries as follows:
- North side: Banua Village (Bordered by Bangli Regency)
- West side: Ayung River (Bordered by Buahan Badung Village)
- South: Puhu Village
- Taro side: Taro Village *Bordering Taro*

Administratively, the Kerta Village area is divided into 8 (eight) Banjar Dinas, namely: 1). Banjar Dinas Kerta 2). Banjar Penbangan Office 3). Banjar Dinas Margetenga 4). Banjar Dinas Saren 5). Banjar Dinas Pilan 6). Banjar Dinas Seming 7). Banjar Dinas Bunteh 8). Banjar Dinas Mawang. The Seming office plans include Kerta Village, Payangan Sub district, Gianyar Regency with an area of 14.42 km², Total population of 4,940 people (2014), population density of 366 people / km² (2010) [3].

The size of the fruit is influenced by the environment in each season of the harvest period. The highest fruit weight was obtained from the study location of the Banjar Belancan in the first harvest during the on-season period with an average weight of 89.5 grams per fruit. The lowest average fruit weight was obtained in the off-season harvest, which was 45.6 grams (Table 3.3).

Likewise, with fruit diameter variables. widest also in the first harvest on-season period, which is 6.59 mm, and the smallest in the third harvest, which is 5.12 mm (Table 3.3). Fruit size increase which includes fruit weight, fruit diameter is strongly influenced by water availability. High rainfall can induce shoot growth, number of leaves, leaf surface area, photosynthesis, and transpiration, so as to increase overall plant production [21]. water for plants has an important role in increasing nutrient content and quality of plants. Lack of water can cause plants to experience stress and even death. Increased water availability in tomatoes, causes fruit skin color to be more attractive, fruit weight and total acid increase [22], but decreases the value of total dissolved solids (TDS) [23].

| Variable         | Flowering and fruiting of Siam orange plant |
|------------------|--------------------------------------------|
|                  | Banjar Belancan | Banjar Seming | Banjar Simekerti |
|                  | I  | II | III | I  | II | III | I  | II | III |
| Fruit weight     | 89.5 | 55.4 | 20.4 | 45.6 | 34.5 | 31.1 | 41.2 | 3.13 | 2.67 |
| Diameter of fruit| 6.15 | 5.98 | 5.12 | 5.01 | 4.8 | 4.01 | 3.51 | 3.05 | 2.45 |
| TDS              | 5.98 | 5.23 | 5.00 | 4.59 | 4.16 | 4.02 | 3.41 | 3.02 | 2.47 |

Sources of data from field observations in three research locations.

The highest average value of total dissolved solids (TDS) was found in the first harvest of the Banjar Belancan, which was 5.98 ° briks, and the lowest during the Banjar Simekerti harvest period, which was 4.02 ° briks (Table 3.3). The first harvest in the on-season period takes place at the end of the dry season, so the plants may experience drought stress. Whereas in the on-season harvest period, the harvest takes place when the intensity of the rain is high. According to some research results, drought stress can increase the value of TDS in fruit, the results of the study explained that melon plants which were gripped by drought had a higher sugar content than plants that received sufficient irrigation.

4. Conclusion

The flowering process of Siam orange is influenced by environmental factors and each of these factor can influence one another. There are environmental factors with temperatures around 18 effect in tingerin flowering, Environmental factor that influence in subtropical generally are higher environmental temperatures followed by humidity. And Low whereas in the tropics, drought stress triggers the flowering of Siam oranges
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