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### The effect of climate to the fruit set of nutmeg plant

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#### A B S T R A C T

Nutmeg is dioecious, the success of the fruit set is affected by the climate, and the pollination is assisted by insects and wind. The purpose of this study was to assess the effect of climate to the fruit set of nutmeg plants. The research was conducted in Ambon island. 20 trees of nutmeg plants was selected purposively. 30-50 flowers marked with plastic straps on each tree. The fruit set is calculated were the amount of fruit formed, divided by the number of flower and multiplied by 100. Climate correlation analysis with the fruit set used correlation pearson. The results were obtained by high rainfall, rainy days and high humidity which lowers the fruit set. Whereas of air temperature and solar radiation increase the fruit set. The average of air temperature was 26-27.8 ° C, maximum temperature was 30-31 ° C and solar radiation was 60-80% provides of the fruit set of highest.

### Introduction

Plant growth and development are strictly influenced by environment. Flowering plants were influenced by several internal factors, such as genetics, hormones and nutrients, also influenced by external factors (environment) such as water, light and temperature. The environmental changes can alter the response of flowering in plants. Every species of plant has different flowering response to the environment (Moss, 1976; Thomas, 1993). The qualitative and quantitative temperature effected on the development of flowers.

High temperatures increase the growth rate resulting in early anthesis but in a small reproductive structure. The high temperatures also induced flower abortion in some species. the temperature of the main environmental factors regulate the time of flowering and low temperatures caused delays flowering time (Ausin et al., 2005). The temperature limits of plant growth is a major determining factor in the distribution of plants in different environments (Mittler, 2006). Weather plays an important role in spring-blooming fruit crops due to the

combined effects on bee activity, flower opening, pollen germination, and fertilization (Tuell and Isaacs, 2010).

Global climate change resulting temperature rise daily, seasonal and annual temperature will be experienced by plants. In addition, climate change will increase the intensity, frequency, and duration of abnormal temperatures, both low and high temperatures (Wagner, 1996; Tebaldi et al., 2006; Christensen et al., 2007). Climate change also resulted in rainfall in some regions increased and in other regions affected by drought (Boer et al., 2009). Increased temperatures lead to increased intensity of evaporation resulting in changes in humidity, the result could be more frequent rainfall in certain areas or otherwise elsewhere infrequent rains (Chen et al., 2011; Cheng et al., 2011). All of these changes will affect the development of plant. Plants can not avoid the environmental conditions which in favorable, the plant's ability to resist or adapt to a changing environment variations is essential for survival.

Nutmeg (*Myristica fragrans* Houtt) generally is dioecious (male and female flowers are on different plants) but sometimes encountered monocious, male and female flowers located on the same tree (Flach, 1966; Hadad, 1990; Arrijani, 2005; Anandaraj et al., 2005; Krishnamoorthy, 2013). Observations in the forest of nutmeg in the provinces of Maluku and North Maluku (Marzuki, 2007), found that based on the location of the flowers, there are three types: male plants (have male flowers), female plants (having female flowers), and plant hermaphrodite (having male and female flowers). Krishnamoorthy (2013) said it has identified there are five types of the nutmeg tree, which is a purely male, pure women, bisexual men, bisexual

women, and hermaphrodites. Male trees do not bear fruit, while the female trees need a male tree as a source of pollen. Male trees do not bear fruit, while the female trees need a male tree as a source of pollen. every 10 female trees needed one male tree (Hadad et al., 1996). Because it is dioecious, nutmeg plants cross-pollinated and pollination assisted by wind and insects. The chief agent of pollinators are wind (Thangaselvabai et al. (2011). Insect pollination is dominant on ants, bees, butterflies, and flies. And the diversity of pollinating insect species are affected by air temperature, air humidity and the intensity of the radiation (Masfufah, (2010). Thus, climate determines the success of the fruit set on nutmeg plant.

### **Material and Methods**

The study was conducted in Ambon island located in Salahutu District of Central Maluku-Indonesia (3°35'57 South latitude and 128°21'11 East longitude) at altitude 46 m above sea level. 20 tree of *Myristica fragrans* Houtt, selected purposively as a plant sample. The selected tree was actually indicated the female trees. Each tree was marked 30-50 flowers form on any part of the lower branches. Observations were done during of four times flowering period in 2013-2014. Climatic data of blooming flowers were obtained from meteorological and climatological stations Pattimura - Ambon. The fruit set was obtained by dividing the amount of fruit that is formed by the total amount of interest that marked multiplied by 100. To view the climate variable relationship with fruit set used correlation person analysis.

### **Results and Discussion**

Climate variables on average during the blooming flowers are rainfall ranging between 117-384 mm/month, rainy days

between 12-29 days, temperatures average between 25.5 - 27.1°C, maximum temperatures between 28.7 - 31°C, minimum temperature between 23 - 24.2°C, relative humidity between 82-88%, solar radiation between 26 - 85.2%, and the wind speed between 7.4 - 9:26 km/h, respectively.

The success of the fruit set an average of 22.6-47.5% (Table 1). The result showed that the time required from the female flower buds to bloom for 28-32 days, and from blooming to the fruit set was 7-12 days.

**Table.1** The variables of climate and fruit set in different period of flowering

| Variabel                 | Flowering period |      |      |      |
|--------------------------|------------------|------|------|------|
|                          | I                | II   | III  | IV   |
| Fruit set success (%)    | 47.5             | 39.9 | 22.6 | 26.1 |
| Rainfall (mm/month)      | 129              | 170  | 386  | 177  |
| Rainy days (days)        | 12               | 15   | 29   | 12   |
| Average temperature (°C) | 26.8             | 27.1 | 26.1 | 25.5 |
| Maximum temperature (°C) | 30.1             | 31.0 | 28.9 | 28.7 |
| Minimum temperature (°C) | 24.2             | 24.0 | 24.1 | 23.0 |
| Relatif humadity (%)     | 83               | 80   | 89   | 84   |
| Solar radiasi (%)        | 85.5             | 63.0 | 26.0 | 61.0 |
| Winds (km/h)             | 7.4              | 9.3  | 7.4  | 9.3  |

**Table.2** Value correlation of relationship between the climate variables and fruit set

| Climate variable    | r      |
|---------------------|--------|
| Rainfall            | -0.583 |
| Rainy days          | -0.62  |
| Relatif humidity    | -0.502 |
| Average temperature | 0.797  |
| Max tempertaure     | 0.796  |
| Min. temperature    | 0.486  |
| Solar radiation     | 0.86   |
| Wind                | -0.101 |

**Fig.1** Curve relationship between rainfall and fruit set in different period of flowering

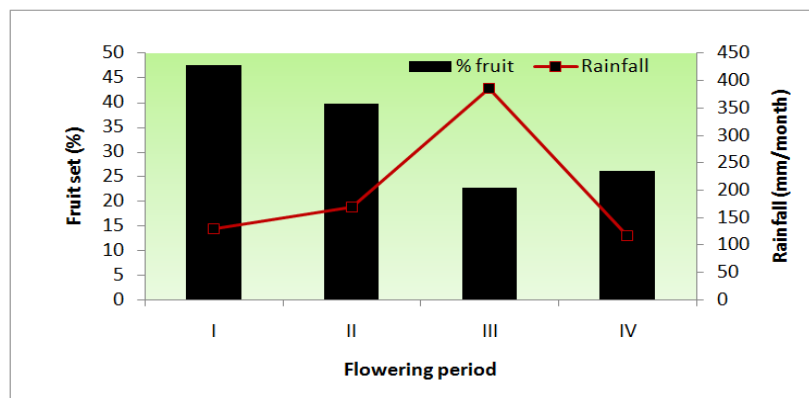


Fig.2 Curve relationship between rainy days and fruit set in different period of flowering

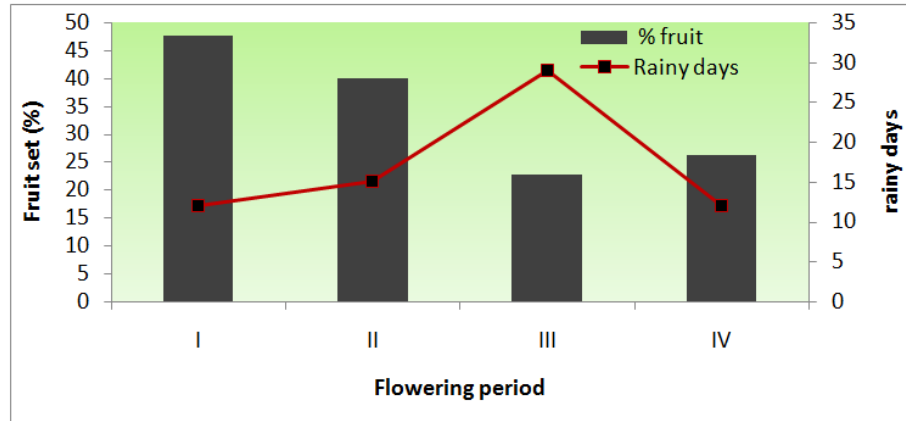


Fig.3 Curve relationship between temperature average, maximum, minimum with fruit percentage and fruit set in different period of flowering

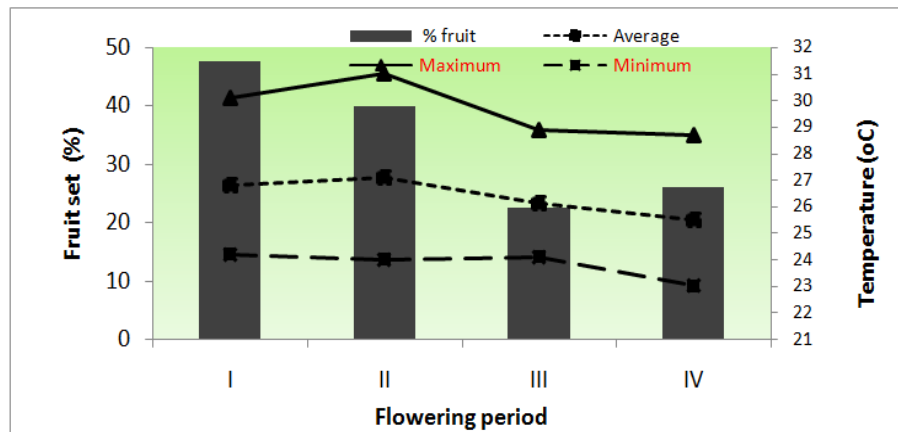
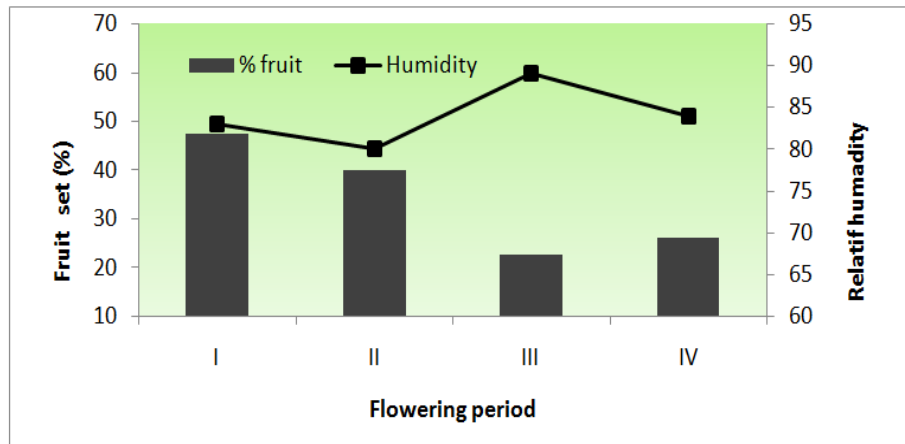
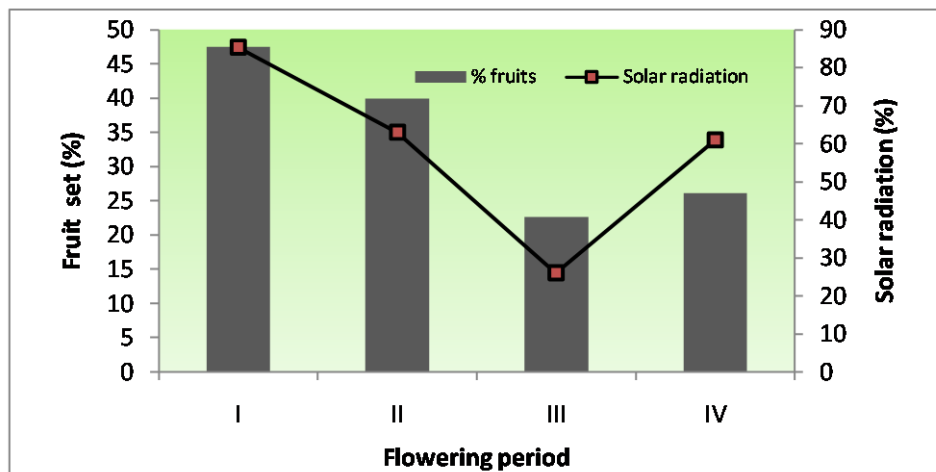


Fig.4 Curve relationship between relative humidity and fruit set in different period of flowering



**Fig.5** Curve relationship between solar radiations and fruit set in different period of flowering



The fruit set of highest obtained on climatic conditions when flowers bloom were rainfall between 129-177 mm/month, the rainy days 12-15 days, the maximum temperature of 30-31 ° C, the average temperature of 26.8 -27 ° C, and solar radiation of 63-85%, while rainfall is smaller 120 mm/month and larger 200 mm / month, rainy days > 25 days, the maximum temperature of < 29°C, the average temperature < 26.1° C and solar radiation < 30% gives of low the fruit success (Table 1). The high rainfall and rainy days resulted in lower fruit set, because inhibit the spread of pollen from the male flowers by wind or insects, because of wetness and pollination did not occur. Hadiati et al., (1997) states that the flowering of annual plants usually associated with rainfall and the percentage flowering shoots of *nephelium* plants will be lower in if high rainfall.

The results showed that despite the low rainfall (117 mm / month), rainy day for 12 days, and solar radiation 61%, but the average temperature of ≤ 26.1 ° C, resulting in lower of fruit set (Fig 1, 2, 3 and 5). It indicated that the low temperature inhibits the fertilization process. The low air temperatures result in lower photosynthesis process of photosynthesis resulted allocated

for the development of flowers to be low, thereby affecting the process of fertilization. This result was slightly different from that proposed by Hadad (1990; 1991), for the best temperature nutmeg plant growth between 25°C - 30°C.

Analysis of the correlation between climate variables and fruit set shows that rainfall, rainy days, relative humidity, air temperature and solar radiation was strongly correlated to the percentage of fruit set. The higher rainfall, rainy day, and humidity will decrease the percentage of fruit set. Otherwise the increase in air temperature and solar radiation will increase the percentage of fruit set. The results were obtained 22.6-47.5% fruit set . Different with Haldankar et al., (2004) in India 2% - 41%, and Masfufah (2010) in Bogor, Indonesia amounted to 21.8% -31%. This is allegedly due to climatic differences of each region. Masfufah (2010) low temperature is also believed to inhibit the activity of pollinating insects.

### Conclusion

The success of the fruit set was affected by rainfall, rainy days, average temperature, maximum temperature, and solar radiation.

The high of rainfall, rainy days and humidity result lowers the fruit set, while the increase in air temperature and solar radiation increase of the fruit set. The highest of fruit set was in rainfall 129-177 mm/month, rainy days 12-15 days, average air temperature 26-27.8°C, maximum temperature 30-31°C and 60-80% of solar radiation.

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