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FLOWERING AND FRUITING PHENOLOGY OF *RUBUS* SPP. IN CIBODAS BOTANICAL GARDEN, INDONESIA

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ABSTRACT

Flowering and fruiting phenology were studied in five species of *Rubus* spp (*Rubus ellipticus, Rubus fraxinifolius, Rubus lineatus, Rubus moluccanus,* and *Rubus pyrifolius*) collected from Cibodas Botanical Garden from April 2009 to March 2010. Flowers and flower buds were produced every month by *Rubus* spp., in different amount except *Rubus pyrifolius*. Furthermore, each species had a different response to the environment factors. Correlation analysis shows that maximum temperature and relative humidity influenced flower and fruit production. *Rubus fraxinifolius* and *Rubus lineatus* had more economic value due to its ability to produce fruit throughout the year.

Keywords: *Rubus*, Phenology, Cibodas Botanical Garden

INTRODUCTION

Cibodas Botanical Garden is an institute of *ex situ* conservation located in forest complex of Mounts Gede Pangrango, Cianjur, West Java, Indonesia. A garden that has a wide area 84,99 hectare was established on 1852. This garden has hilly and undulating topography with an altitude around 1300 – 1425 m above sea level. *Rubus* spp is one of genera collected from Cibodas Botanical Garden.

Rubus, a member of raspberries that also include trailing brambles such as blackberry and loganberry, is distributed from the low land tropics to subarctic region and also found on all continents except Antarctica (Focke, 1910, 1911, 1914; Thompson, 1995; Menzies, 2002; Yang and Pak, 2006). In Malesia Region, there are 46 species of *Rubus*, and 25 of them are found in Indonesia (Kalkman, 1993). Currently, Cibodas Botanical Garden has been collecting eight species, such as *R. alpestris, R. chrysophyllus, R. ellipticus, R. fraxinifolius*, *R. lineatus, R. molaccanus, R. pyrifolius,* and *R. rosifolius*, some of which were collected from mountains of Indonesia (Surya, 2009).

Phenology is the study of the timing of recurring biological events, the causes of their timing with regard to biotic and abiotic forces, and the interrelation among phases of the same or different species (Lieth, 1974), and it is one of interesting topic in the tropical. The phase may be first flowering date, bud break, unfolding of first leaf, etc. Factors influencing phenology vary by species, but include photoperiod, soil moisture, soil temperature, air temperature, solar illumination (Reed *et al.* 1994).

This research was aimed to observe the phenology of flowering and fruiting of *Rubus* spp. collected from Cibodas Botanical Garden.

MATERIALS AND METHODS

Flowering and fruiting phenology was observed on five species of *Rubus* spp. collected from Cibodas Botanical Garden. There are *Rubus ellipticus* (I.J.20), *Rubus fraxinifolius* (I.A non-collection), *Rubus lineatus* (I.J.29-29a), *Rubus moluccanus* (I.J.28-28a-28b), and *Rubus pyrifolius* (I.J.30,31) (Widyatmoko *et al.* 2010).

This research was done in Cibodas Botanical Garden, West Java – Indonesia, from April 2009 to March 2010. Phenological data were recorded weekly. A rank scale was used to observe the abundance of flower buds, flowers and fruits. Scores were: 0 = absent, 1 = low (less than 25% of canopy), 3 = medium (25 – 50 % of canopy), and 5 = high (more than 50% of canopy). The value scale of phenological

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events (in months) was calculated by the average of scale each week for all events and species. Others data such as temperature and relative humidity were obtained from the data of Cibodas Botanical Garden. Spearman correlation analysis (Gomez and Gomez, 1995) was conducted to determine whether there was a relationship between environment (temperature and relative humidity) and the average scale of phenological events.

RESULTS AND DISCUSSION

Reproductive phenology was observed on five species of *Rubus* spp. Generally, the results showed that each species had different phenological cycles. Production of flower buds on *Rubus ellipticus* occurred every months and the maximum production was obtained on October to November (Figure 1). This period was as long as that of the maximum fruit production.

Rubus fraxinifolius that is called 'Arben' has different reproductive event comparing to *Rubus ellipticus*, which is the maximum of fruit production occurring from January to March. Moreover, flower buds and flowers production were obtained on June and January. These phenomena might be related to the environment factor where each species had different response. Using the correlation analysis, the result showed that flowering and fruiting event of *Rubus fraxinifolius* had a positive correlation with relative humidity (0.552* and 0.894**) (Table 1). It means that the increase of relative humidity was followed by flower and fruit productions.

Table 1. Correlation value of *Rubus* spp. between reproductive events, temperatures and relative humidity

Variables		Max. Temp.	Min. Temp.	Average Temp.	Relative Humidity
R. ellipticus	Flower buds	-0.391	-0.212	-0.302	0.006
	Flowering	-0.048	0.236	-0.010	0.037
	Fruting	-0.419	0.012	-0.316	-0.065
R. fraxinifolius	Flower buds	0.328	0.132	0.226	0.077
	Flowering	0.227	0.464	0.171	0.552*
	Fruting	-0.163	0.265	-0.177	0.894**
R. lineatus	Flower buds	-0.079	-0.345	-0.171	-0.227
	Flowering	0.638*	0.289	0.608*	-0.247
	Fruting	0.559*	0.448	0.583*	-0.200
R. moluccanus	Flower buds	-0.372	-0.284	-0.348	-0.094
	Flowering	0.190	0.207	0.257	-0.078
	Fruting	0.099	-0.013	0.010	0.607*
R. pyrifolius	Flower buds	-0.200	-0.421	-0.354	0.490
	Flowering	-0.515	-0.067	-0.406	0.450
	Fruting	-0.253	0.306	-0.206	0.455

Remarks : *= significant at the 0.05 level ; **= significant at the 0.01 level

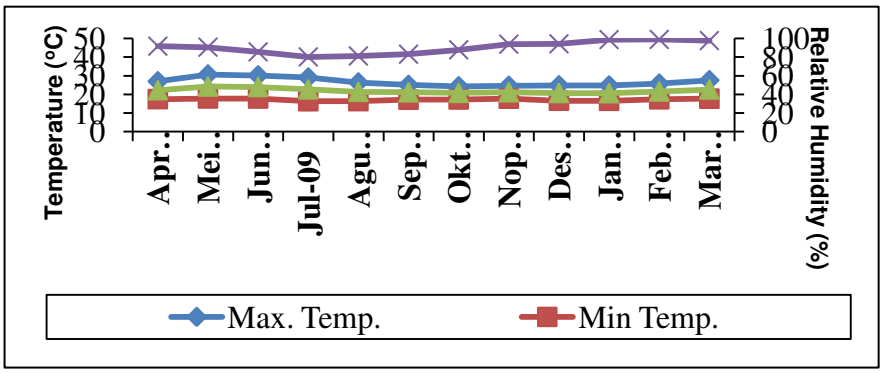

Figure 1. Monthly relative humidity, minimum and maximum temperatures from Cibodas Botanical Garden

Rubus lineatus is a species that is able to produce fruit throughout the year. The results showed that the maximum production of fruit occurred in June while the maximum temperature was around 30°C. This species might be similar to other tropical trees as reported by Tutin and Fernandez (1993) and Chapman *et al.* (1999) where the temperature may act directly to fruiting phenology. Moreover, spearman correlation analysis also supported this result where fruiting event had a positive correlation with a maximum temperature (0.559*). Furthermore, the maximum production of flower buds was obtained on August. On the other hand, correlation analysis showed that flowering events also had positive correlation with maximum temperature (0.638*). Figures 1 and 2 (*Rubus lineatus*) showed clearly that the maximum production of flowers and fruits occurred in July and June when the temperature was high.

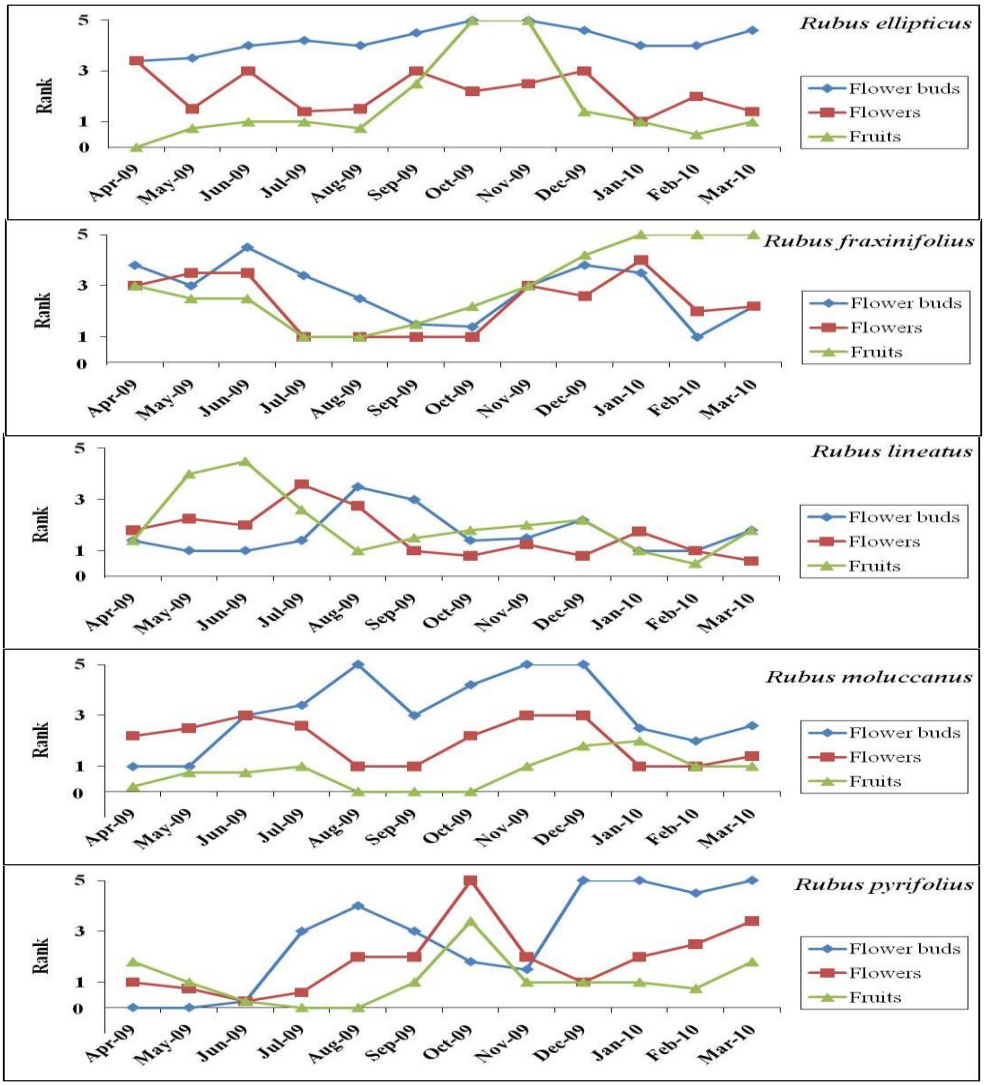

Figure 2. Phenology of reproductive events of *Rubus* spp. at Cibodas Botanical Garden

Flower buds and flowers production of *Rubus moluccanus* occured simultaneously. The maximum production of flower buds occurred in August, November, and December, and for flowers, it occurred in June, November and December. Correlation analysis showed that relative humidity had a positive correlation (0.607*) with fruiting time. Fruits production of *Rubus moluccanus* did not occur throughout the year. Figure 2 showed that fruit production was obtained from November to March and continued from May to July. The maximum of fruit production occurred in January. Compared to the other species, this species had the lowest fruit production. Furthermore, the graph for *Rubus moluccanus* on figure 2 showed that not all flower buds became flowers and also not all flowers turned into fruits. This phenomenon is similar to *Rubus ellipticus.* Other environmental factors such as pollinator, rain fall, or fertilizer might have influence in this species. Bown and Mcneil (2009) reported that seed set and also fruit production of *Rubus* was influenced by insect. Pollination by insects is common, and Hippa and Koponen (1976) have identified pollinators in *Rubus*.

Rubus pyrifolius is one of species that does not produce fruit throughout the year. The maximum production occurred in October. From July to August this species did not produce any fruit. Furthermore, the maximum production of flowers occurred in the same months like a fruit production. Even though the time of maximum production was the same, but there was no zero production of flowers like the fruits. Production of flowers occured simultaneously throughout the year. This phenomenon indicated that this species might have other factors influencing the fruiting phenology. On the other hand, Table one showed that flower buds and flowering event had a negative correlation with temperature. Moreover, the maximum production of flower buds and flowers was obtained in December to January, and October.

Flowering and fruiting phenology is important in the fruit production. In some country, like Russia, Poland, Serbia and United State, where central production of raspberries is located, the fruits are not produced continuously every month. Usually, the production occurs in August to October (Bolda *et al*., 2005; FAO, 2010) due to environmental factors. Furthermore, the results showed that two species, *Rubus fraxinifolius* and *Rubus lineatus*, had more economic value due their ability to produce fruit throughout the year.

CONCLUSIONS

Almost all of the species, except *Rubus pyrifolius*, production of flower buds and flowers occurred throughout year. Moreover, *Rubus fraxinifolius* and *Rubus lineatus* were able to produce flower buds, flowers and also fruits throughout the year. Relative humidity was an environmental factor that influenced a fruiting phenology in *Rubus fraxinifolius* and *Rubus moluccanus.* Furthermore, temperature influences a reproductive event in *Rubus lineatus.*

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