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Climatic variables study on generative characters of some types of durian (*Durio zibethinus* Murr.)

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Durian (*Durio zibethinus* Murr.) is a tropical fruit that has a unique taste and flavor. Some problems and constraints in agribusiness of durian commodity is the supply of fruit that is not continuous because the characteristic of durian is seasonal bearing. The phenomenon is influenced by the environmental factors, especially microclimate and plant endogenous factors. This study was conducted to determine the difference of phenological character of vegetative and generative growth on some varieties of durian. This research was conducted in June 2016 until January 2017 at Durian Garden of Mendalan Wangi Village, Wagir District, Malang, East Java. The research method was using descriptive survey. The results showed that vegetative and generative growth pattern on four durian varieties such as Monthong, Sunan, D24 and Matahari were significant difference between each other varieties. The blooming of flowers on varieties Monthong, Sunan and D24 was srtrongly influenced by the air temperature. The fruit formation on varieties Monthong, Sunan and D24 is strongly influenced by the intensity of rainfall and humidity. While the fruit formation on variety of Matahari was influenced by humidity.

Keywords: Durian, D24, Phenology, Matahari, Monthong, Sunan

INTRODUCTION

Indonesia is a tropical zones that has a lot of diversity of plant species, including durian (*Durio zibethinus* Murr.). Durian is include to seasonal fruit and known as the king of fruit in Indonesia. There are many varieties of durian that have not been cultivated commercially, only a few species are already known as commercial crops. *Durio zibethinus* and *Durio kutejensis* as well as the offspring of both varieties that have been widely grown as a commercially cultivated plant (Salafsky, 1995). Basically commercial durian are endemic and pandemic. Durian with endemic types is describing specific environmental conditions (climate, soil, and other natural resources), which is the quality and quantity of durian fruit produced has a significant interaction with the environment. Thus, the environmental changes will produce different quality and quantity of characteristic durian. Establishment of endemic durian through adaptation to specific growth environments for a relatively long time, such as on air temperature, both of maximum temperature, minimum temperature and also cardinal temperature (Hariyono, 2013). The interaction between air temperature and the growth of durian at various altitude, causing changes in the quality and quantity durian fruit of *zibethinus* species. In each different altitude with the changing elements of climate, such as air temperatures, the durian will produce fruits with different quality of flavors, colors, texture of fruit flesh, aromas, and different performance even though in the same type, which is known as local durian. Durian pandemic have a high adaptability to new environments, even on the different soil types (with neutral to slightly acidic pH) and altitude from zero to 800 meters above sea level (Hariyono, 2013). In a diverse

environment, pandemic durian are still able to produce fruits with the same relative quality and quantity of the same plant species.

Durian growth patterns occur periodically as well as the other annual crops. Environmental conditions that support durian vegetative growth, that consist of leaf shoots, stem, branches and root growth will make durian not generate the generative growth (flowers/fruit), and vice versa. The response of durian plant growth to the environmental conditions (especially to climates and soil types) was not the same between endemic and pandemic plants (Borchert et al, 2002). The respons of changes in plant growth patterns were shown from the existence of time changes (late growth or accelerate) that could emergence the vegetative and generative growth In suitable environmental conditions, Durian plants will spur their vegetative and generative growth of flowers and fruit. In unsuitable environmental conditions (soil pH is too acidic and rainfall is high), durian will had vegetative phase without followed by generative growth (flower and fruit formation). Likewise, there is a failure in the development of leaf shoots (flush) into leaves due to the low availability of nutrients in the soil especially the element of Nitrogen (Hariyono et al, 2012).

The main problem of the pattern durian plant growth is still being controlled by environmental conditions, especially climate. Thus, durian could produce their fruit in accordance with the season. This could make a fluctuations in the quantity of fruit produced in each season. In the unstable air temperature and the high intensity of rainfall causes the failure in the formation of flowers into fruit set. The main obstacle is the short period of effective pollination (Effective Pollination Period, EPP) in durian (Honso et al, 2006). Plant phenology of durian was different from one type to another, even though in one stratum on the same environment. Based on these problems, the information about the relationship of various biotic factors (climatic factors) and the phenology of some types of durian were used as the basic reference to make a new cultivation practice for the optimum growth of durian.

This study were conducted to determine the relationship between climatic factors with vegetative and generative growth on some durian. In addition, to know the climatic factors that influence to the emergence of character on durian plant growth.

MATERIALS AND METHODS

The research was conducted in June 2016 until January 2017 at Durian Garden of Mendalan Wangi Village, Wagir District, Malang, East Java. This research was using descriptive survey method that intended to collect information about the status of an existing symptom according to field research without any treatment. Determination of sample plants by selecting 4 durian trees in each variety, so the total number of tree samples as many as 16 durian trees.

The data collecting is done by collecting 2 primary data source which is the period of flowering and number of fruit. The secondary data include climate data in the form of rainfall, humidity and daily air temperature in the period of June 2016-January 2017. Data analysis of observations using descriptive analysis based on primary data and secondary data which will be tested on correlation and regression test with SPSS program.

RESULTS

Correlation of Climate Variables with Blooming and Number of Fruits

Based on the observations of durian varieties of Monthong, Sunan, D24 and Matahari which includes blooming time, number of fruits and climate variables including rainfall, air temperature and humidity that obtained by the calculation of correlation coefficient between variables. The correlation coefficient test on the number of blooming and number of fruits that associated with the climate variables were presented in Table 1.

Monthong variety showed that some observation variables on monthong varieties had a significant correlation. Rainfall variable has a significant negative correlation to the number of fruit with correlation coefficient value of 0.54. On the variable of air temperature were having significant positive correlation on blooming with a correlation value of 0.59.

Sunan variety had significant different correlation values on each observation variable. Rainfall variable had a significant negative correlation with blooming and number of fruits with coefficient values of 0.47 and 0.50. The humidity had a significant positive correlation to the number of fruit with the coefficient value of 0.68. Humidity had a significant negative correlation to the number of flower with coefficient of 0.40.

Table 1. Matrix of correlation between rainfall, air temperature, humidity on the number of flowers and number of fruit Durian varieties of Monthong, Sunan, D24 and Matahari

Variable	Monthong Variety		Sunan Variety		D24 Variety		Matahari Variety	
	Blooming	Number of Fruits	Blooming	Number of Fruits	Blooming	Number of Fruits	Blooming	Number of Fruits
Rainfall Intensity (mm)	-0.08	-0.54**	-0.47**	-0.50**	-0.40*	-0.53**	-0.25	-0.29
Air Temperature (^oC)	0.59**	0.06	0.20	-0.06	0.38*	0.13	0.07	0.23
Humidity (%)	-0.25	0.69**	-0.40*	0.68**	0.18	0.63**	-0.44*	0.43*

Description: Numbers followed by an asterisk (*) has a significant different of 5%, while the numbers followed by asterisk (**) has a significant different of 1% level and numbers were not followed by an asterisk is not significant different.

D24 variety, rainfall had a significant negative correlation with the number of fruits with coefficient value of 0.53 and had a significant negative correlation to the number of flowers with coefficient value of 0.40. Air temperature had a significant positive correlation to the number of flowers with coefficient value of 0.38. Humidity had a significant positive correlation with the number of fruits with the correlation coefficient of 0.63.

Matahari variety, humidity had a significant positive correlation on the number of fruit with coefficient value of 0.43 and the humidity had a significant negative correlation with on number of flowers with a correlation value of 0.44.

Climatic Variables that Influencing Flowering Period (Blooming) on Varieties of Monthong, Sunan, D24 and Matahari

The influence of independent variable which is rainfall (X1), air temperature (X2) and humidity (X3) to dependent variable which is the number of flowers in Monthong, Sunan, D24 and Matahari varieties were known by regression multiple linear analysis. Based on the analysis of regression coefficients on the Table 2 until Table 4, it shows that climatic variables such as rainfall, air temperature and humidity had a very close relationship to the flower buds formation. It can be known from the value of correlation coefficient (R) were near to number 1, except on the Matahari variety that had a low correlation coefficient (R) value of 0.475 which shows that climatic variables had no significant effect to Matahari variety on flower buds formation. The result of regression analysis of flowering on monthong, variety obtained *Adjusted R Square* value of 0.296 which means that 29.6% of the total numbers of flowers formation were influenced by climatic variables such as rainfall, air temperature and humidity. Sunan variety had *Adjusted R Square* value of 0.283 and D24 variety had *Adjusted R Square* value of 0.271, which means on the Sunan variety of 28.3% and D24 variety with value 27.1%. of the total numbers of flowers formation influenced by climatic variables. While the varieties of Matahari is the lowest varieties that influenced by climatic variables in the formation of flowers with *Adjusted R Square* value of only 0.142 or only 14.2%.

Table 2. Multiple Linear Regression Analysis During Flowering Period of Durian Variety of Monthong

Variabel Climate	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-34.634		-1.437	0.162	
X_1	0.378	0.245	1.156	0.257	ns
X_2	31.819	0.520	2.959	0.006	s
X_3	-5.141	-0.180	-0.767	0.450	ns

R = 0.603
R^2 = 0.364
X_1 = Rainfall Intensity (mm)
X_2 = Air Temperature (^oC)
X_3 = Humidity (%)

Table 3. Multiple Linear Regression Analysis During Flowering Period of Durian Variety of Sunan

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-54.663		-2.414	0.023	
X_1	0.30	0.208	0.976	0.338	ns
X_2	23.153	0.407	2.293	0.030	s
X_3	11.696	0.439	1.857	0.074	ns
R = 0.594 R^2 = 0.352 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 4. Multiple Linear Regression Analysis During Flowering Period Durian Variety of D24

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-51.611		-2.044	0.050	
X_1	0.526	0.331	1.536	0.136	ns
X_2	30.080	0.478	2.671	0.012	s
X_3	4.976	0.169	0.708	0.485	ns
R = 0.585 R^2 = 0.342 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 5. Multiple Linear Regression Analysis During Flowering Period Durian Variety of Matahari

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-48.290		-1.882	0.070	
X_1	-0.228	-0.153	-0.653	0.519	ns
X_2	11.256	0.191	0.984	0.334	ns
X_3	-17.280	-0.626	-2.421	0.022	s
R = 0.475 R^2 = 0.225 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 6. Multiple Linear Regression Analysis on Fertilization Period of Durian Variety of Monthong

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	TStatistics	Level of Significant	Descriptions
Constant	-113.350		-4.701	0.000	
X_1	-36.001	-0.448	-3.348	0.002	s
X_2	0.011	0.006	0.035	0.973	ns
X_3	-33.303	-0.886	-4.966	0.000	s
R = 0.795 R^2 = 0.632 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 7. Multiple Linear Regression Analysis on Fertilization Period of Durian Variety of Sunan

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-86.174		-3.429	0.002	
X_1	-22.266	-0.299	-1.987	0.047	s
X_2	0.059	0.032	0.174	0.863	ns
X_3	-29.104	-0.834	-4.164	0.000	s
R = 0.732 R^2 = 0.535 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 8. Multiple Linear Regression Analysis on Fertilization Period of Durian Variety of D24

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-118.246		-4.732	0.000	
X_1	-41.028	-0.507	-3.681	0.001	s
X_2	0.013	0.006	0.039	0.969	ns
X_3	-32.193	-0.850	-4.632	0.000	s
R = 0.781 R^2 = 0.610 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Table 9. Multiple Linear Regression Analysis on Fertilization Period of Durian Variety of Matahari

Climatic Variables	Unstandardized B	Standard coefficient (Beta)	T Statistics	Level of Significant	Descriptions
Constant	-10.922		-0.592	0.559	
X_1	0.021	0.020	0.082	0.935	ns
X_2	-2.457	-0.059	-0.298	0.768	ns
X_3	-7.598	-0.392	-1.480	0.015	s
R = 0.434 R^2 = 0.188 X_1 = Rainfall Intensity (mm) X_2 = Air Temperature (^oC) X_3 = Humidity (%)					

Climatic Variables that Influencing Number of Fruits on the Durian Varieties of Monthong, Sunan, D24 and Matahari

Multiple linear regression analysis is used to know how big influence of independent variable (i.e rainfall (X1), air temperature (X2) and humidity (X3) to dependent variable that was number of fruit on varieties of Monthong, Sunan, D24 and Matahari. Data from Table 6 until Table 9 shows that the Monthong variety has the highest *Adjusted R Square* value 0.592 compared to other varieties, which means that as much as 59.2% of fruit formation or number of fruits that was affected by climatic variables such as rainfall, and humidity. While, Sunan and D24 varieties had *Adjusted R Square* value of 0.485 and 0.568, respectively, which means that as much as 48.5% on Sunan variety and 56.8% on D24 variety, fruit formation was affected by rainfall, air temperature and humidity. While the varieties of Matahari are the lowest varieties influenced by rainfall, air temperature and humidity in the formation of fruit with *Adjusted R Square* value of 0.101 or equal to

10.1%.

DISCUSSION

High intensity of rainfall had a direct influence on flowering and also the process of pollination on durian. Based on the data that has been obtained, showed that rainfall has a significant negative correlation to the number of flowers and the number of fruits. It can be interpreted that the higher rainfall, the lower number of flowers and the number of fruits that were formed. Ashari (2004), explained that pistillate receptivity of flowers is determined by rainfall conditions. If there were raining at a time, it will having poor pollination process because when the flowering time were having high temperature, low humidity, and the plant were not enough water, then the flowers will fall. It also happens when low temperatures, high humidity and high rainfall the flowers and fruit were fall too. Durian flower buds will usually continue to develop into flowers, although it was not pollinated. The candidate of the fruit will unable develop because the seeds can not be formed (Ihsan et al, 2012). The research of Nurtjahjaningsih (2012), showed that the flowering process was influenced by internal factors such as genetic and fitohormon, and environmental factors such as the intensity of sunlight and nutrients. The correlation between number of flowers and number of fruits on Sunan, D24 and Matahari varieties had a significant positive correlation, while on monthong variety there was no significant correlation because the durian monthong variety is a type of durian that can produce fruit continuously due to the emergence of flowers will be followed by the emergence of fruit. Tremblay et al. (2005), stated that low fruit formation in various plants is caused by the limited number of pollinators and incompatible plants because there will be flower loss after fertilization, so that the fruit can not develop properly. Ashraf et al. (2010), also stated when dry months exceeding 3 months, it will have adverse effects on the growth of flowers and fruits which is severe flowers and fruits will be aborted. The lack of nutrients in the soil also can cause the fall of flowers and fruit. Durian requires climatic conditions, where there is a clear distinction between rainy season and dry season. Dry season is necessary for the formation of primordial flowers. In general, during the dry season there was a drought stress and temperature increase in the plant canopy area. Both of the above conditions encourage the formation and accumulation of the "florigen" hormone that stimulates flower formation.

Temperature data during the development flowers of durian Monthong, Sunan, D24 and the Matahari varieties showed that high temperatures will inhibit the flowers to bloom. Mukminatin and Harisudin (2012), durian is suitable on daily temperature of 20-30^{o}C. In the 15^{o}C temperature, durian can grow but the growth is not optimal and the leaves will dry when the temperature reaches 35^{o}C. While, Sunan variety indicate that the air temperature also greatly affect the formation of flowers. It can be seen that the formation of flowers on the Sunan variety occurred in October the third week with a high temperature condition of 25.5^{o}C. In the D24 and Matahari varieties it is also seen that the formation of flowers occurs when the air temperature begins to increase from the previous air temperature. Larcher (2006), stated that the temperature effect on flower induction, flowering phase, inflorescence, blooming flowers, emergence of pollen, seed formation and seed ripening. Observation of the flowering phenology is crucial for determining the development of fruits and seeds, the conservation of flower fertilization systems are important, so that the population diversity can be maintained (Kukade and Tidke, 2013).

The humidity directly affects the number of flowers on the Sunan and Matahari varieties. It can be seen from the correlation coefficient test that has been done. Correlation coefficient test showed that the humidity has a negative correlation with the number of flowers. Humidity directly affect the flowering period because humidity is strongly influenced by the intensity of rainfall in the area. In Monthong and D24 varieties showed that the humidity was not affect the number of flowers that were formed, but the humidity was greatly affects the number of fruits. Based on the correlation coefficient test showed that the humidity affect the number of fruit in all varieties. The plant growth increases as the temperature increases and the humidity decreases, and vice versa (Wijayanto and Nurunnajah, 2012). It is associated with rainfall contained in the area, if during flowering there were a high intensity rain, then the flowering process will be disrupted. The pollen becomes rotten and not have a good viability and the flower pistils were also rotten because of high humidity. In addition, the activity of pollinating insects will also decrease during high humidity. If the pollen and flower pistils are rotten, it means the pollination has been failed and for fruit formation are waiting for the following year (Tabla and

Vargas, 2004).

CONCLUSION

Based on the research that has been carried out can be concluded that the flowering on varieties of Monthong, Sunan and D24 was strongly influenced by the air temperature. The formation of fruit on varieties of Monthong, Sunan and D24 was strongly influenced by the intensity of rainfall and humidity. While on the varieties of the Matahari, the formation of fruit was only influenced by humidity.

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CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest".

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AUTHOR CONTRIBUTIONS

DH designed and performleed the experiments and also wrote the manuscript. .

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