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Climate matching of endemic orchid (*Phalaenopsis amabilis* L.) Blume Forma Pelaihari) in South kalimantan

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Abstract

This study was aimed to make and evaluate climate matching for assessing region suitability for endemic orchid (*Phaleonopsis amabilis*- Pelaihari) in South Kalimantan. The study was conducted at three locations that have different region and climate conditions. Characteristics of orchids likes flowering and fruits data were collected based on interview with farmer and field observation. The correlation between flower and fruit orchids and climate was analysed with stepwise regression method. Then, temperature-Humidity Index (THI) as one of climate matching method is expressed in function climate element (CE) that is correlation to flowering orchid characteristic (FC). Temperature and relative humidity was found as climatic elements that has high correlation with characteristic of orchid. Sum of flowers (SF) and sum of fruits (SFr) were affected by temperature and relative humidity, respectively. The analysis shows temperature and humidity can be expressed as function, i.e.: THI for SF = -298.369 + 2.42215 T + 2.92066 RH and THI for SFr = 118.162 - 4.36413 T + 0.05475 RH. The first differential equation will get optimum value of temperature and humidity index for SF and SFr that are 4.9 and 0.8 respectively. Air temperature and relative humidity can determined the other suitable for development. The suitable region for optimal SF and SFr are the region that average temperature between 27.5 – 27.9°C and average relative humidity between 77.5 – 85.9%. The temperature and humidity index can be followed up as effective indicator to estimate suitable region for development orchid.

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Introduction

Chan *et al.* (1944) was written more than 1,400 orchids in a place in Kalimantan. There are 41 kinds of orchid in South Kalimantan, and 11 kinds of those present at Kentawan's Mountain, in Meratus's Mountains area, and were identified by *Bureau of Natural Resources Conservation* (BNRC) of South Kalimantan (Sumedi and Noor, 1998). Rodinah *et al.* (2000) reported, there are 27 kinds of orchid at Natural Preserve of Kentawan's mountain.

The natural orchid that present at Meratus's Mountain in example is moon orchids "mountain's Meratus" (*Phalaenopsis amabilis*). *Phalaenopsis amabilis* have high value economic because it is one of orchid kinds that much be desired by people. So, sustainable development of orchid can be hold.

Climate is one of environment variable that very significant to growth and development of orchids. At the equator the widespread flowering trigger of day length is often not applicable, as there is little day length variation throughout the year in equatorial regions. Generally, most orchids prefer indirect or filtered light. The rule of thumb is to provide as much light as the leaves can take without burning, usually 50% shading. Orchid plants which receive enough light have short, plump stems with bright green leathery leaves.

Those receiving too much sunlight are yellowish, stunted, and even scorched. Those under too much shade have darker green, soft and succulent leaves with thin, spindly stems.

There are 3 temperature categories of orchids: Warm species prefer day temperatures up to 90°F (32.22°C) and 65°F (18.33°C) for a minimum night temperature. Intermediate species prefer 80°F (26.67°C) days and 60°F (15.56°C) nights. Cool species prefer 75°F days (23.89°C) and 55°F (12.78°C) nights.

Most orchids, however, require a lower night temperature for both strong growth and often to initiate bloom. Most require high humidity or daily misting for proper water intake.

Low humidity can cause buds to become stuck in sheaths and prevent vegetative leads from emerging, causing wrinkled leaves. Contrarily, fresh air and good circulation are also vital for orchid production. Leaves should move gently in a light breeze.

Because of comfort environment condition will influence on orchid flowering, the using climate matching as indicator for determination environment is comfort or not for orchids need to study. Temperature Humidity Index (THI) for example is one of climate matching methods that often used to calculate level of environment comfort.

The climate index value can be used to determine suitable environment to development orchid. This research have goals and objectives, that are (i) correlation between flower and fruit of orchid and (ii) arranging climate matching in relation with orchid agronomy characteristic. The result research can be used as guide to development orchid at the other place.

Materials and methods

Site plan

The Meratus's mountain has long about ± 600 km² from southeast and turn around to north until East Kalimantan border-side. Mountain high is about 600 meter from sea surface level. In geography, Meratus's region has lied between 115°38'00" until 115°52'00" longitude and 2°28'00" until 2°54'00" latitude.

Research location from the Meratus's mountain is divided into two regions based on climatic zone, the one at southeast (Pelaihari Site conservation has 7,500 ha) and the other one at west region (Loksado site/Gunung Kentawan site has 250 ha.).

Method

Data is collected based on interview with farmer and field survey. Kind of orchids that are observed consist of "moon orchid" (amabilis) and the other *Phaleonopsis's*. The agronomy characteristic is (1) flower quantity per plant and (2) mature fruit.

The other data is collected from orchid farmers. Some of climatic data is collected based on direct measurement in site.

Some instruments are used in this research like Global Positioning Survey (GPS), point solar-meter, wet and dry bulb thermometer. The climatic data are radiation intensity and duration radiation, air temperature and relative humidity.

The rainfall and rainfall's day was get from Hulu Sungai Selatan (HSS), Pelaihari (Tala) and Banjarmasin in figure.

The correlation between orchids flowering characteristic and climate elements are analysis with stepwise model-building techniques for regression designs with a single dependent variable are described in numerous sources (Mayers and Forgy, 1963; Draper and Smith, 1981;).

The basic procedures involve (1) identifying an initial model, (2) iteratively "stepping," that is, repeatedly altering the model at the previous step by adding or removing a predictor variable in accordance with the "stepping criteria," and (3) terminating the search when stepping is no longer possible given the stepping criteria, or when a specified maximum number of steps has been reached.

The following provide details on the use of stepwise model-building procedures. The initial model is designated the model at Step 0.

The initial model always includes the regression intercept (unless the No intercept option has been specified.). For the backward stepwise and backward removal methods, the initial model also includes all effects specified to be included in the design for the analysis.

The initial model for these methods is therefore the whole model. Then, Temperature-Humidity Index (THI) for one of climate matching method is expressed in function climate elements (CE) that is correlation to orchids flowering characteristic (FC).
Correlation between THI and FC are:

$$FC = a_0" + \sum_{i=1}^{n} b_i THI^i$$

$$THI = \sum_{i=1}^{m} c_i CE_i$$

a_o is constant , b_i and c_i are estimated in according with simultaneous with iteration method. The final selection the best candidate models are performed using s (error) and R^2 criterion (Mayers and Forgy, 1963). The analysis involved several steps (Fig. 1).

Results and discussion

Correlation between Climate Elements with Reproductive Characteristic

Based on step wise regression analysis the both temperature and relative humidity have high correlation with the characteristic of agronomic so this factor always was used to analysis (in **Error! Reference source not found.** and Table 2).

Table 1. Regession sum of flower with climatic element.

1. Descriptive statistic

Descriptive Statistics			
Sum of flowers	Mean	Std. Deviation	N
	12.60	23.734	5
Rainfall	2351.83	76.855	5
day of rain	123.06	19.307	5
Temperature	27.63	.382	5
Moisture	83.56	8.226	5
Duration of Sunshine	44.83	15.385	5

2. Model summary

Model Summary[b]

Model		R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
						R Square Change	F Change	df1	df2	Sig. F Change	
dimensiono	1	.960[a]	.922	.896	7.66718	.922	35.329	1	3	.010	.976

a. Predictors: (Constant), Temperature

b. Dependent Variable: Sum Flowers

3. Analysis of variance

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2076.843	1	2076.843	35.329	.010[a]
	Residual	176.357	3	58.786		
	Total	2253.200	4			

a. Predictors: (Constant), Temperature

b. Dependent Variable: Sum Flowers

4. Coefficients of regression

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1934.333	323.334		5.982	.009	905.340	2963.326					
	Temperature	-69.122	11.629	-.960	-5.944	.010	-106.132	-32.113	-.960	-.960	-.960	1.000	1.000

a. Dependent Variable: Sum Flowers

In Fig. 3, air temperature has high correlation with sum of flowers and also correlation with sum of fruits. The equation is non linear. The-other research also shows most orchids, however, require temperature for both strong growth and often to initiate bloom. Then, orchids most require high humidity for production. A similar response to temperature has been observed in Phalaenopsis orchid. As temperature increase from 14 to 26°C, the rate of leaf, and flower development increased linearly in several hybrids (Robinson, 2002).

Arranging Climate Matching in Relation with Orchid Agronomy Characteristic

Characteristic of orchid that was affected by temperature and relative humidity are sum of flowers (SF) and sum of fruits (SFr). So, the next analysis use temperature and humidity to get climate matching that can be expressed as function, i.e.:

Temperature and Humidity Index for SF = 1508.96 - 61.6620 T + 2.7314 RH

Temperature and Humidity Index for SFr = 118.162 - 4.36413 T + 0.05475 RH

T is average temperature and RH is average relative humidity. If the temperature is 27.63°C and relative humidity is 83.56 (data in **Error! Reference source not found.**) then sum of flowers and fruits are 34.3 units and 2.2 units, respectively. The correlation between temperature and humidity with sum of flowers and fruits are non-linear (Fig. 4). The first differential from equation will get optimum value of temperature and humidity index for SF and SFr that are 4.9 and 0.8, respectively.

Table 2. Regression sum of fruits with climatic elements.

1. Descriptive statistic

Descriptive Statistics

	Mean	Std. Deviation	N
Sum_Fruit	1.20	1.643	5
Rainfall	2432.19	234.476	5
Days_Rainfall	128.20	18.780	5
Temperature	27.80	.330	5
RH	79.60	1.817	5
Sun_Duration	44.60	16.103	5

2. Model Summary

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.906[a]	.820	.760	.805	.820	13.665	1	3	.034	1.884

a. Predictors: (Constant), Temperature

b. Dependent Variable: Sum_Fruit

3. Analysis of varians

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.856	1	8.856	13.665	.034[a]
	Residual	1.944	3	.648		
	Total	10.800	4			

a. Predictors: (Constant), Temperature

b. Dependent Variable: Sum_Fruit

4. Regession coefficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	126.689	33.949		3.732	.034					
	Temperature	-4.514	1.221	-.906	-3.697	.034	-.906	-.906	-.906	1.000	1.000

a. Dependent Variable: Sum_Fruit

The analysis showed that region potential to orchid development can be made based on temperature and relative humidity data.

Generally, the analysis showed that Pelaihari's orchid was suitable with room climatic. The analysis showed that SF and SFr optimal are 4.9 and 0.8 respectively.

The use temperature and humidity index can determine the other suitable for development. The suitable region for optimal SF and SFr are the region that has average temperature between 27.5 – 27.9 °C or 18.50 – 27.90 °F. The average relative humidity is between 77.5 – 85.9%. So, moon orchid's Pelaihari is intermediate species categories.

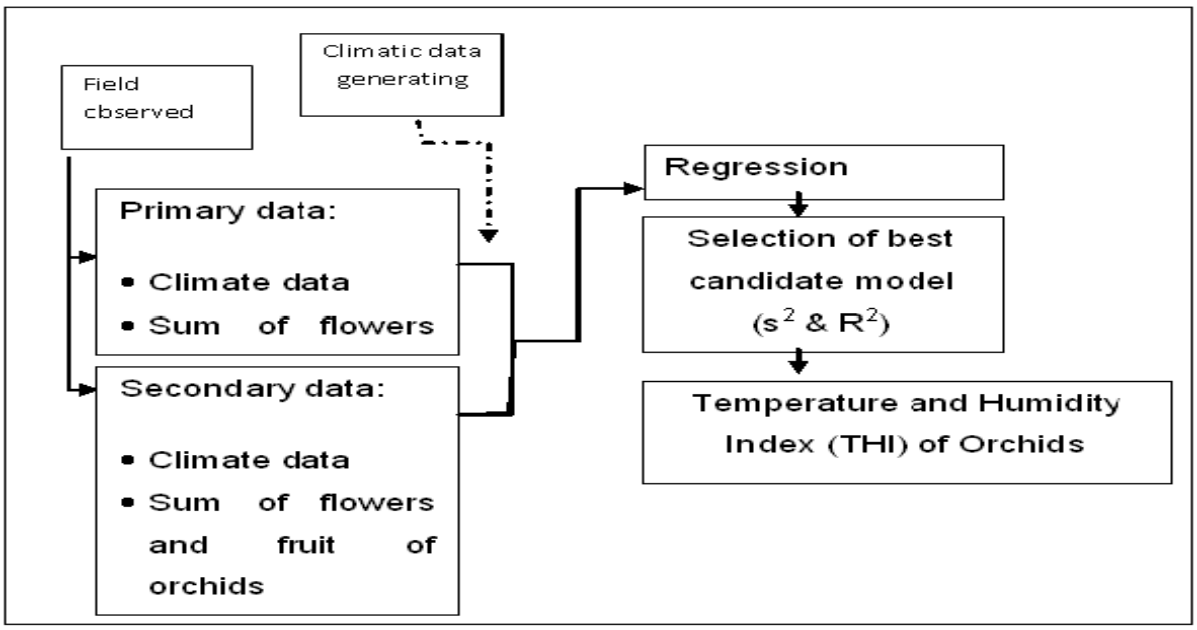

Fig. 1. Research steps the comfort index of orchids.

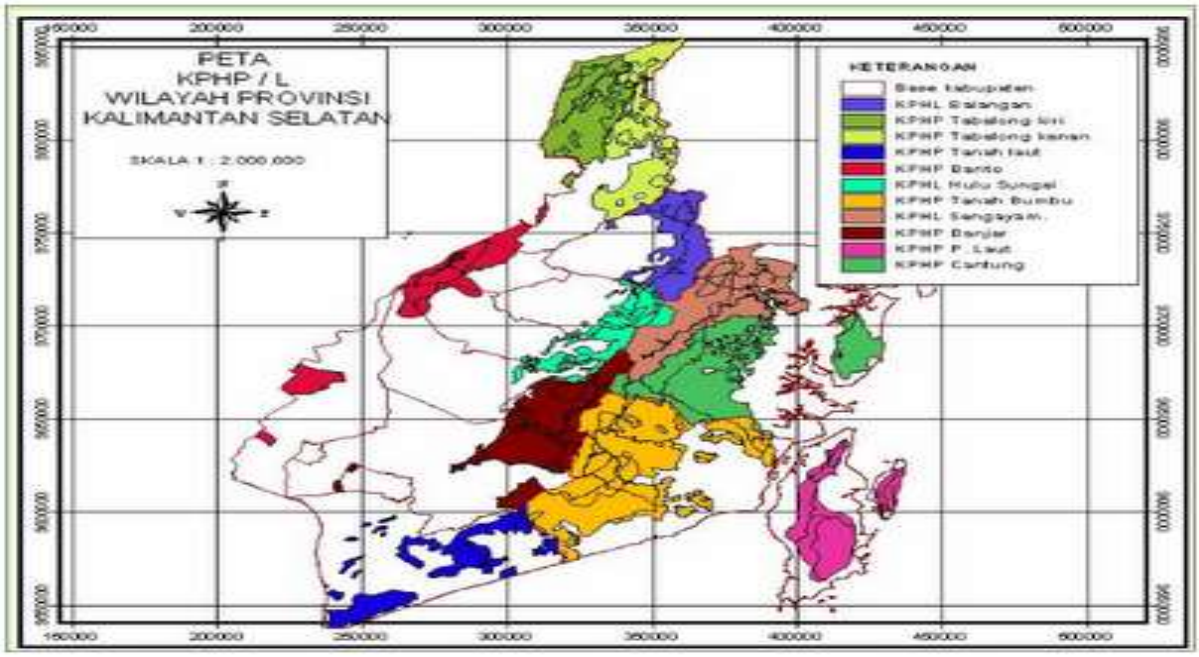

Fig. 2. Research location in Pelaihari (Tala), Loksado (HSS) and Banjarmasin districts.

Sum of flowers is affected by temperature and sum of fruits by relative humidity. The pattern low temperature and high relative humidity will be increasing sum of flower and fruits, respectively. The temperature and humidity index can be used as effective indicator to estimate suitable region for development orchid. The my research agree with the others research that are flower induction in

Phalaenopsis follows exposure to temperatures below 28 °C and may be promoted by short days (Sakanishi *et al.*, 1980; Wang and Lee, 1994). The optimal temperature for growth of Phalaenopsis, which is native to tropical and subtropical areas of the South Pacific and Asia, appeared to be 26°C (Robinson, 2002).

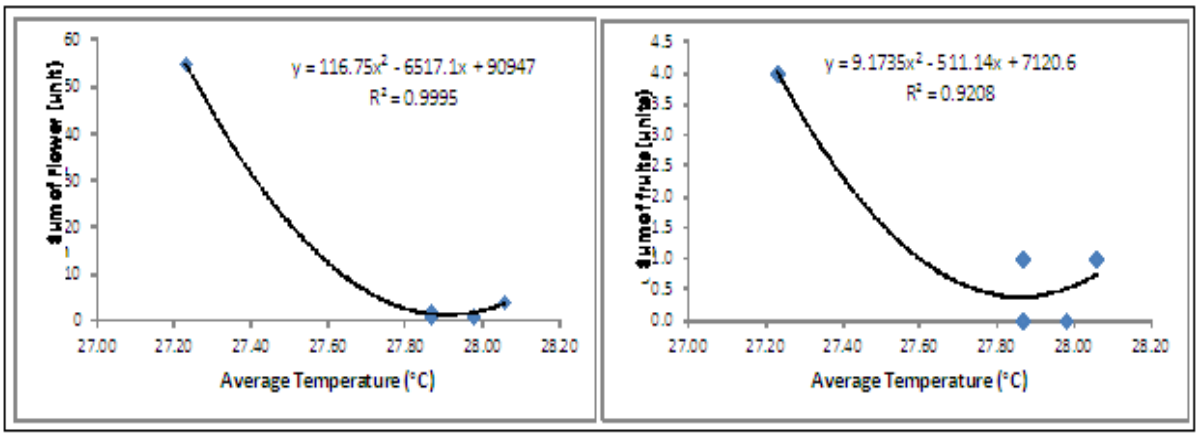

Fig. 3. Correlation between characteristic of orchid and climatic (temperat and relative humidity).

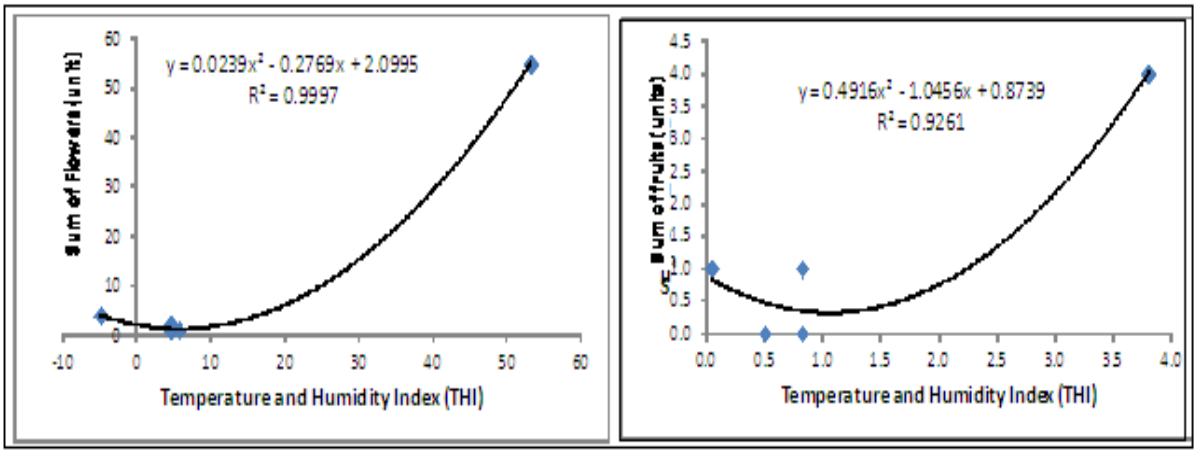

Fig. 4. The correlation between THI and sum of flowers and fruits.

Because of *Phalaenopsis amabilis* (L.) Blume Forma Pelaihari orchids is among the most valuable potted flowering crops commercially produced throughout the world, that their long flower life and ease of crop scheduling to meet specific market dates, so the some triggers to blossom are needed to next research.

Acknowledgment

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