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Jurnal Agroteknologi
Journal homepage: https://jaet.usu.ac.id

The Influence of Climate on Tea Crop Productivity (Camellia sinensis L.) in the Bah Butong plantation 2000 - 2004

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ARTICLE INFO

Article history:
Received: 05 June 2023
Revised : 10 Oktober 2023
Accepted : 15 November 2023
Available online: 05 January 2024

E-ISSN: 2963-2013
P-ISSN: 2337-6597

http://doi.org/10.32734/ja.v12i1.18758

ABSTRACT

Several climate components influence the decline and rise in tea plant productivity. This research aims to determine the influence of climate elements on the productivity of tea plants in the Bah Butong PTPN IV plantation. The hypothesis in this research is that there is a real influence of rainfall, rainy days, amount of sunlight, temperature, and humidity partially or simultaneously and their correlation on tea productivity. This research was carried out from September 2023 to December 2023 using data collection methods through field surveys with secondary data collection at related agencies. The data taken includes rainfall data, rainy days, amount of sunlight, temperature and humidity as well as tea production. The analysis method used is multiple linear regression analysis and correlation analysis using SPSS.v.22 for Windows. The results of the partial t-regression analysis show that rainfall and temperature have a significant effect, while rainy days, amount of sunlight, and humidity have no significant effect and simultaneously rainfall, rainy days, amount of sunlight, temperature and humidity has no significant impact on increasing tea production. The correlation of rainfall, rainy days, amount of sunlight, temperature and humidity on tea plants has a weak and very weak influence on the interpretation of the r value in achieving tea productivity.
Keywords: Climate, Tea Productivity, Tea

ABSTRAK

Beberapa komponen iklim mempengaruhi penurunan dan peningkatan produktivitas tanaman teh. Penelitian ini bertujuan untuk mengetahui pengaruh unsur iklim terhadap produktivitas tanaman teh di perkebunan Bah Butong PTPN IV. Hipotesis dalam penelitian ini adalah terdapat pengaruh nyata curah hujan, hari hujan, jumlah sinar matahari, suhu, dan kelembaban udara secara parsial maupun simultan serta korelasinya terhadap produktivitas teh. Penelitian ini dilaksanakan pada bulan September 2023 sampai dengan Desember 2023 dengan menggunakan metode pengumpulan data melalui survei lapangan dengan pengumpulan data sekunder pada instansi terkait. Data yang diambil meliputi data curah hujan, hari hujan, jumlah penyinaran matahari, suhu dan kelembaban udara serta produksi teh. Metode analisis yang digunakan adalah analisis regresi linier berganda dan analisis korelasi dengan menggunakan SPSS.v.22 for Windows. Hasil analisis regresi t parsial menunjukkan bahwa curah hujan dan suhu berpengaruh nyata, sedangkan hari hujan, jumlah sinar matahari, dan kelembaban udara tidak berpengaruh nyata dan secara simultan curah hujan, hari hujan, jumlah sinar matahari, suhu dan kelembaban udara tidak berpengaruh nyata. berdampak pada peningkatan produksi teh. Korelasi curah hujan, hari hujan, jumlah sinar matahari, suhu dan kelembaban pada tanaman teh mempunyai pengaruh yang lemah dan sangat lemah terhadap interpretasi nilai r dalam mencapai produktivitas teh.
Kata Kunci : Iklim, Produktivitas Teh, Teh

1. INTRODUCTION

The tea plant (Camellia sinensis L.) is a tree-shaped plant that can reach tens of meters in height. For plantation purposes, the height of the tea plant is maintained at around 1.5 m so that the shape is like a shrub. This plant has high economic value so it is widely cultivated in many regions in Indonesia (Pamungkas and Supijatno, 2017).

The growth and shoot production of tea plants is strongly influenced by climate components. Global climate change has affected the intensity and patterns of rainfall, rainy days, amount of sunlight, temperature and humidity. The impact of climate change on tea plantations greatly influences tea growth and production (Dalimoente et al., 2016).

The problem currently being faced in tea cultivation in Indonesia is tea productivity which is decreasing as a result of climate change and less than optimal plantation management. The distribution of tea yields during the season depends on many factors, one of which plays a significant role is the microclimate. Variations in yield between regions indicate a major influence of soil and climate on yield (Bhagat et al., 2010).

Tea plant production in 2000 was 123.12 tonnes. In 2001, it was 126.71 tonnes. In 2002, tea production decreased to 120.42 tons. Furthermore, in 2003 there was an increase to 127.52 tons. In the following year, 2004, in line with unfavorable climatic conditions, the amount of tea production was less than satisfactory with a decrease in productivity, namely 125.21. The fluctuations in production produced by tea plants are related to climate conditions (BPS, 2023).

High air temperatures have various effects on plant physiology and biochemistry. This is because at higher temperatures plant metabolism runs faster, so shoot growth is slower. Therefore, the speed of plant metabolism, such as photosynthesis, transpiration and respiration, which occurs at high air temperatures must be balanced with the optimal availability of raw materials in the form of CO2, H2O, enzymes and hormones involved (Bita and Gerats, 2013).

North Sumatra as one of the tea producing provinces is Simalungun Regency. PTPN IV has three tea gardens in the Simalungun highlands, namely the Bah-Butong, Sidamanik and Toba Sari gardens. These three gardens are located close to each other. However, people generally know the tea products from these three gardens as sidamanik tea. This is of course because the three gardens were previously located in Sidamanik District, Simalungun Regency.

According to Utomo et al., (2018) stated that partially and simultaneously climate elements had an insignificant effect at the 95% confidence level in North Sumatra and had a weak relationship with increasing tea productivity for 7 years (2010-2016) in PT's Sidamanik plantation. Perkebunan Nusantara IV, Simalungun Regency, North Sumatra.

According to Harahap et al., (2021) stated that partially and simultaneously climate elements have an insignificant effect at the 95% confidence level in North Sumatra and have a sufficient relationship to increasing tea productivity over 10 years (2011-2020) in PT Tobasari plantations. Perkebunan Nusantara IV, Simalungun Regency, North Sumatra.

Based on the climate problems experienced on tea plantations, production has decreased from year to year. This is due, among other things, to the conversion of tea plantation areas and the influence of natural phenomena which have an impact on reducing the productivity of tea plants.

2. MATERIALS AND METHODS

This research was carried out in the Bah-butong plantation of PT. Perkebunan Nusantara IV, Pematang Sidamanik District, Simalungun Regency, Sumatra Province, precisely at the coordinates 20 51' 34.5" N - 980 54' 17.7" E and an altitude of 910 meters above sea level, with a land area of 1,884,526 Ha. This research was carried out from September 2023 to December 2023.

The analytical method used in this research is multiple linear regression analysis and correlation. Multiple linear regression analysis techniques are used to determine the functional influence of two or more independent variables on the dependent variable, and correlation analysis is useful for seeing the strength and weakness of the relationship between the independent and dependent variables. The dependent variable is a variable whose existence is influenced by the independent variable and is denoted by Y. The dependent variable in this study is tea productivity, while the independent variable is the variable that influences or is the cause of the change in the dependent variable and is denoted by X. The independent variable in this study is monthly rainfall and rainy days, amount of sunlight, temperature and humidity. Data processing was assisted by SPSS.v.22 for Windows software.

The functional influence of rainfall, monthly rainy days, amount of sunlight, temperature and humidity on tea productivity using the following equation model:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \varepsilon$$

Keterangan :

Y	: Tea productivity	X_4	: Temperature
a	: Intercept and line on the Y axis	X_5	: Humidity
b	: Linear regression coefficients	ε	: error
X_1	: Rainfall		
X_2	: monthly rainy days		
X_3	: amount of sunlight		

The observed variables tested are secondary data in the form of data at the Bah-butong plantation office of PT. Perkebunan Nusantara IV, Pematang Sidamanik District, Simalungun Regency, North Sumatra Province.

3. RESULTS AND DISCUSSION

Tabel 1. Average tea productivity (kg/ha), average rainfall (mm), and average rainy days (days), average amount of sunlight (hours), average temperature (°C), average humidity (%) in tea plants for 5 years (2000-2004).

Bulan	Average					
	Rainfall (mm)	rainy days (days)	amount of sunlight (hours)	Temperature(°C)	Humidity (%)	Production (kg/ha/bulan)
januari	314,2	15,6	258	21,98	87,8	1.603.405
Februari	246,2	12,8	285,6	22,24	86,6	1.721.717
Maret	259,2	15	313,2	22,8	85,4	1.519.401
April	280,6	14,8	288	22,98	87,2	1.293.170
Mei	164,4	9,2	326,4	23,56	82,4	1.208.048
Juni	212	9,2	312	23,14	83,2	1.559.685
Juli	248,6	12,6	309,6	22,86	83	1.571.374
Agustus	203,6	9,4	321,6	22,82	83,2	1.784.640
September	376,8	18,2	285,6	22,54	86,8	1.638.533
Oktober	277	15,4	253,2	22,26	87	1.522.269
November	318,6	16	241,2	22,34	88,6	1.677.720
Desember	192,8	12,6	235,2	22,1	88,2	1.390.591
Total	3094	160,8	3429,6	271,62	1029,41	18.520.591
Rataan	257,83	13,4	285,8	22,63	79,117	1.543.405

From table 1 it shows that the total average productivity of tea for the 2000-2004 period was 18,520,591 kg/ha, the total average rainfall was 3,094 mm, the total average number of rainy days was 160.8 days, the total average amount of sunlight was 114.32 hours, the total average temperature is 271.62 and the total average humidity is 1,029.41. The highest average tea productivity kg/ha/month for 5 years (2000-2004) was in August, namely 1,784,640 (kg/ha/month) and the lowest was in May, namely 1,208,048 kg/ha/month. The highest average rainfall (mm) for the 2000-2004 period was in September, namely 376.8 mm/month and the lowest average was in May, namely 164.4 mm/month. The highest average of rainy days (days) for the 2000-2004 period was in September at 18.2 days/month and the lowest was in June at 9.2 days/month. The highest average amount of sunlight (hours) for the 2000-2004 period was in May, namely 3326.4 hours/month and the lowest average was in December, namely 235.2 hours/month. The highest average temperature (°C) for the 2000-2004 period was in May, namely 23.56°C/month and the lowest average was in January, namely 21.98°C/month. The highest average humidity (%) for the 2000-20004 period was in October, namely 88.6%/month and the lowest average was in May, namely 82.4%/month.

3.1 Multiple Linear Regression Analysis

Tabel 2. Coefficient values of multiple linear regression equations on tea plants. for 5 years (2000-2004)

Model	Coefficient Value		
	R	R^2	Adjusted R Square
1	.855[a]	.784	.603

The coefficient value of the multiple linear regression equation on tea plants for 5 years shows that the coefficient value (r) is 85.5%, the coefficient of determination (R^2) is 78.4% and the corrected coefficient of determination (Adjusted R^2) is 60.3%. The coefficient value (r) of 85.5% shows that the magnitude of the variable's relationship to tea plant productivity is sufficient (can be seen in Appendix 10). The coefficient of determination (R^2) indicates that 78.4% of the variation in tea productivity can be explained by variations in the variables rainfall, rainy days, amount of sunlight, temperature and humidity and the remaining 21.6% is explained by other variables not included in model.

Tabel 3. Partial t test of climate elements on tea plants for 5 years (2000-2004).

Observation Variables	5 Tahun	
	t-hitung	Sig.
Rainfall	2.541	.044
Rainy day	-2.009	.091
Length of Sunlight	1.131	.301
Temperature	-3.412	.014
Humidity	-.286	.785

The partial t test shows that the significance value of the rainfall variable on tea plants for 5 years is smaller than alpha 5% (sig < α 0.05), namely 0.044 < 0.05, and the calculated t value > t table value, namely 2.541 > 2.201. So it can be concluded that the calculated t has a real effect at the 95% confidence level (H0 is rejected, Ha is accepted). Thus, the rainfall variable partially has a significant effect in increasing tea productivity.

The partial t test shows that the significance value of the variable rainy days on tea plants for 5 years is greater than alpha 5% (sig > α 0.05), namely 0.091 > 0.05, and the calculated t value < t table value, namely -2.009 < 2.201 . So it can be concluded that the t count is not significantly different at the 95% confidence level (H0 is accepted, Ha is rejected). Thus, the rainy day variable is not significantly different in increasing tea productivity.

The partial t test shows that the significance value of the variable amount of sunlight on tea plants for 5 years is greater than alpha 5% (sig > α 0.05), namely 0.301 > 0.05, and the calculated t value < t table value, namely 1.131 < 2.201 . So it can be concluded that the different t counts are not real at the 95% confidence level (H0 is accepted, Ha is rejected). Thus, the variable amount of sunlight is not significantly different in increasing tea productivity.

The partial t test shows that the significance value of the temperature variable in tea plants for 5 years is smaller than alpha 5% (sig < α 0.05), namely 0.014 < 0.05, and the calculated t value > t table value, namely -3.412 > 2.201. So it can be concluded that the calculated t has a real effect at the 95% confidence level (H0 is rejected, Ha is accepted). Thus, the temperature variable partially has a significant effect in increasing tea productivity.

The partial t test shows that the significance value of the humidity variable in tea plants for 5 years is greater than alpha 5% (sig > α 0.05), namely 0.785 > 0.05, and the calculated t value < t table value, namely -0.286 < 2.201. So it can be concluded that the t count is not significantly different at the 95% confidence level (H0 is accepted, Ha is rejected). Thus, the Humidity variable is not significantly different in increasing tea productivity.

Tabel 4. Trace the various multiple linear regression equations on tea plants for 5 years (2000-2004).

Source Diversity	Degrees Freedom	Sum Squares	Middle Square	F Count	Sig.
Regression	5	2.51	5.03	4,345	.0051 [b]
Residual	6	6.33	1.15		
Total	11	2.57			

Based on the productivity model estimates for tea plants in 2000-2004, the calculated F value < F Table was obtained, namely 4.345 < 4.387 with a significance value in the F test greater than alpha 5% (Sig > α 5%) namely 0.051 > 0.05. So it can be concluded that the calculated F difference is not significant at the 95% confidence level (H0 is accepted, Ha is rejected). This means that the variables rainfall, rainy days, amount of sunlight, temperature and humidity in the regression model simultaneously (simultaneously) have no significant effect on tea productivity in the Bah-butong PT plantation. Perkebunan Nusantara IV for 5 years (2000-2004).

Tabel 5. Multiple linear regression analysis testing model on tea plants for 5 years (2000-2004)

Model	coefficient
Constant	11841096.190
Rainfall	3647.194
Rainy day	-72795.693
Amount of Sunlight	3166.749
Temperature	-443375.970
Humidity	-13223.600

Based on the results of the analysis, a regression equation can be formed which is produced by the variables rainfall, rainy days, amount of sunlight, temperature and humidity in predicting tea productivity over the following 5 years:

Y = 11841096.190 + 3647.194 (Curah Hujan) - 72795.693 (Hari Hujan) + 3166.749 (Jumlah Sinar Matahari) – 443375.970 (Suhu) – 13223.600 (Kelembapan) + ε

3.2. Correlation Analysis

Tabel 6. Analisis korelasi pada tanaman teh selama 5 tahun (2000-2004)

Variabel	Test Statistic	Variabel					
		Rainfall	Rainy Days	Amount Sunlight	Temperature	Humidity	Productivity of Tea
Rainfall	r (koefisien)	1	.913**	-.408	-.471	.598*	.369
	Sig.		.000	.188	.123	.040	.238
Rainy Days	r (koefisien)	.913**	1	-.574	-.582*	.760**	.158
	Sig.	.000		.051	.047	.004	.625
Amount Sunlight	r (koefisien)	-.408	-.574	1	.833**	-.900**	-.073
	Sig.	.188	.051		.001	.000	.822
Temperature	r (koefisien)	-.471	-.582*	.833**	1	-.807**	-.462
	Sig.	.123	.047	.001		.001	.130
Humidity	r (koefisien)	.598*	.760**	-.900**	-.807**	1	.093
	Sig.	.040	.004	.000	.001		.774
Produktivity Tea	r (koefisien)	.369	.158	-.073	-.462	.093	1
	Sig.	.238	.625	.822	.130	.774	

Note: ** = very significantly different at the 1% test level
* = significantly different at the 5% test level

Correlation analysis on tea plants during 2000-2004 shows that the variables rainfall and rainy days have a strong correlation, namely 0.913. This can be seen from the significance value being smaller than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variables rainfall and amount of sunlight have an r value of -0.408 with a significance value of greater than 5% (Sig > α 0.05), which means they have a rather weak correlation. Correlation analysis on tea plants during the 2000-2004 period shows that the rainfall and temperature variables have an r value of -0.471 with a significance value greater than 5% (Sig > α 0.05), which means they have a rather weak correlation. Correlation analysis on tea

plants during the 2000-2004 period shows that the rainfall and humidity variables have an r value of 0.598 with a significance value of less than 5% (Sig < α 0.05), which means they have a rather weak correlation. Correlation analysis on tea plants during the 2000-2004 period shows that the rainfall and tea productivity variables have an r value of 0.369 with a significance value of greater than 5% (Sig > α 0.05), which means they have a weak correlation. Correlation analysis on tea plants during the 2000-2004 period shows that the variables of rainy days and amount of sunlight have a very weak correlation, namely -0.574. This can be seen from the significance value greater than 5% (Sig > α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variables of rainy days and temperature have a rather weak relationship, namely -0.582. This can be seen from the significance value being smaller than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variables rainy days and humidity have sufficient correlation, namely 0.760. This can be seen from the significance value of less than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variable rainy days and tea productivity have a weak relationship, namely 0.158. This can be seen from the significance value greater than 5% (Sig > α 0.05).

Correlation analysis on tea plants during the 2000-2004 period shows that the variables of amount of sunlight and temperature have a strong correlation, namely 0.833. This can be seen from the significance value of less than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variables of the amount of sunlight and humidity have a strong correlation, namely -0.900. This can be seen from the significance value of less than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variable amount of sunlight and tea productivity have a very weak relationship, namely -0.073. This can be seen from the significance value greater than 5% (Sig > α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the temperature and humidity variables have a strong correlation, namely -0.807. This can be seen from the significance value of less than 5% (Sig < α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the variables of temperature and tea productivity have a rather weak relationship, namely -0.462. This can be seen from the significance value greater than 5% (Sig > α 0.05). Correlation analysis on tea plants during the 2000-2004 period shows that the humidity and productivity variables have a very weak relationship, namely 0.093. This can be seen from the large significance value of 5% (Sig > α 0.05).

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

1. Rainfall and temperature partially have a significant effect at the 95% confidence level, while rainy days, amount of sunlight and humidity do not have a significant effect at the 95% confidence level on increasing tea productivity.
2. Rainfall, rainy days, amount of sunlight, temperature and humidity simultaneously (together) have no significant effect at the 95% confidence level on increasing tea productivity.
3. The variables rainfall, rainy days, amount of sunlight, temperature and humidity have a rather weak relationship with the achievement of tea productivity. Tea productivity can be explained by climate elements by 78.4%.

4.2. Recommendations

Further research needs to be carried out using other agroclimatological factors and aspects of agronomic actions. In addition, the data used must come from a longer period of time so that analysis results can be obtained accurately.

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