Ilmu Pertanian, Vol.7 No.1, 2000 : 22-26

TEA SHOOT PRODUCTION IN RELATION TO RAINFALL, SOLAR RADIATION, AND TEMPERATURE IN PAGILARAN TEA ESTATE, BATANG

PRODUKSI PUCUK TEH, HUBUNGANNYA DENGAN CURAH HUJAN, PANJANG PENYINARAN MATAHARI DAN SUHU DI KEBUN TEH PEGILARAN

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INTISARI

Suatu penelitian telah dilakukan di kebun PT Pagilaran, Batang, untuk mengkaji pola produk pucuk teh yang diperkirakan dipengaruhi oleh faktor-faktor iklim seperti curah hujan, panjang penyinara matahari, dan suhu sehingga terjadi fluktuasi produksi.

Kebun teh PT Pagilaran terletak pada ketinggian 700 m – 1500 m di atas permukaan laut, memilik suhu pada kisaran 15°C – 30°C dan curah hujan yang tinggi yakni 4500 mm – 7000 mm per tahur Sayangnya, lokasi ini juga memiliki bulan kering antara dua sampai tiga bulan hampir setiap 3 tahun.

Pada penelitian dengan metoda survai ini, data sekunder yang dikumpulkan mencakup produk pucuk teh, curah hujan, panjang penyinaran matahari, dan suhu. Data yang diperoleh dianalisis denga metode analisis korelasi, regresi, dan juga uji-t.

Hasil penelitian menunjukkan bahwa pola produksi pucuk pada tiga bagian kebun yang ad (Kayulandak, Pagilaran, dan Andongsili) tidak berbeda, yakni produksi meningkat pada bulan Oktober Desember dan kembali menurun pada bulan Januari-Februari. Fluktuasi produksi pada bagian kebu Kayulandak dan Andongsili lebih kecil, kemungkinan disebabkan ketersediaan air tanah yang lebih bai pada masa bulan kering karena kebun ini berbatasan langsung dengan hutan lindung di atasnya.

Produksi pucuk teh memiliki korelasi dengan jumlah curah hujan (r = -0,3771), hari huja (r = -0,3512), suhu maksimum (r = 0,3502), suhu minimum (r = -0,2786), dan panjang penyinara matahari (r = 0,6607) pada bulan yang sama. Perhitungan data pada bagian kebun Pagilaran menunjukka bahwa produksi pucuk terutama ditentukan oleh curah hujan dan panjang penyinaran matahari seper tercermin dalam persamaan $y_i = 759{,}5616 - 0{,}1802\ x_{i-1} + 0{,}1057\ x_{i-2} + 0{,}5239\ z_{i-1}$ (R^2=0,3398), diman y_i = produksi pucuk, x_i = mm curah hujan, z_i = panjang penyinaran matahari, dan $_i$ mengacu ke suatu bulan.

Kata kunci : produksi teh, curah hujan, panjang penyinaran matahari, suhu

ABSTRACT

Tea shoot production pattern in PT Pagilaran tea estate, Batang, is studied in relation to rainfall solar radiation, and temperature. Pagilaran tea estate is located at 700 – 1,500 m above the sea level, witl temperature of 15 – 30°C and rainfall ranging from 4,500 mm to 7,000 mm per year. However, the area i also characterized by two up to three dry month for every three years.

Monthly data of rainfall, solar radiation, and temperature were collected and were related to tea shoot production using correlation and regression analysis.

The results indicated that there was no significant different pattern of tea shoot production form the three estate units (Kayulandak, Pagilaran, and Andongsili). Monthly shoots production increases during October up to December, and then goes down in January up to February. It fluctuated at a lesser degree ir the upper units (Kayulandak and Andongsili) which might be attributed to better soil moisture available in the area. They are right below a forests area which understandably serves as rainfall catchment area and maintains soil moisture of the area below in a better condition.

Weak to moderate correlation was obtained when monthly tea shoot production was correlated to amount of rainfall (r=-0.3771), days of rainfall (r=-0.3512), maximum temperature (r=0.3502), minimum temperature (r=-0.2786), and solar radiation (r=0.6607) of the same month. On regressing monthly tea shoot production to those variables, rainfall and duration of solar radiation turned out to be the two significant factors through the following equation $y = 759.5616 - 0.1802\ x_{i-1} + 0.1057\ x_{i-2} + 0.5239\ z_{i-1}$ (R^2=0.3398), where y = tea shoots production, x = amount of monthly rainfall, z = duration of solar radiation, and $_i$ refer to month.

Key words : shoot production fluctuation, rainfall, solar radiation, temperature

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INTRODUCTION

Tea is a crop of wide adaptability and grows in a great range of climates and soil types in various parts of the world (Watson, 1986). However, high quality tea comes from plantations with temperature range of 15°C – 25°C (Eden, 1976). Such requirement is found from sea side to the highland in Srilanka, India, China and Japan. In other tropical area, particularly Indonesia, only areas with attitude of 700 m or more meet the requirement. Elevation of Pagilaran tea estate ranges from 700 m to 1,500 m above se level.

Yield of tea is optimum when annual rainfall of the area is 2,500 mm to 3,000 mm. More important than total rainfall is rainfall distribution in a year. An even distribution without any marked seasonally is ideal. Minimum monthly rainfall requirement has been quoted as 50 mm, though it varies depending on temperature, soil water holding capacity, evapotranspiration, and water table of the area (Watson, 1986).

Pagilaran tea estate is characterized by temperature ranging from 15°C to 30°C, annual rainfall as high as 4,500 mm to 7,000 mm with a few dry months per three years. Relative humidity ranges from 60% to 95%, and the solar radiation is about 135 minutes – 325 minutes per day (Anonymous, 1988-1997)

Soil on which tea plants are grown very widely, both in origin as well as morphology. A slightly acid soil with pH of 4.5 – 5.5 is ideal. It has deep sohum, high permeability, and well drained (Watson, 1986). These requirements are met in Pagilaran tea estate, Batang.

According to Williams (1971), drought stress lowers growth rate due to low cell turgor, photosynthetic activity, cell growth, and plant development. On the other hand, solar radiation affects photosynthetic process directly, and eventually plant growth (Siv Raj, 1978). Duration and intensity of solar radiation is affected by duration of cloudy condition and rainfall frequency. Morning fog encountered in dry season lower both intensity and duration of solar radiation.

Pagilaran tea estate consists of three units : Kayulandak (218 ha), Andongsili (312 ha), and Pagilaran (387 ha) with elevation of range of 1,200 m – 1,450 m, 1,200 m – 1,500 m, and 700 m – 1,200 m above sea level, respectively.

Research objective is to find out how tea shoot production in Pagilaran tea estate relates to climatic factors, assuming that they the only factors affecting tea production, as production management is set similar for all units within the estate.

MATERIALS AND METHODS

Pagilaran tea estate covers an area of 1311 hectares. The effective area is approximately 938 hectares, administratively divided into three units : Kayulandak, Andongsili, and Pagilaran.

Data is taken from Pagilaran Annual Reports since the year of 1988 up to 1997 complemented with data from research section of Pagilaran tea estate. An access the author enjoys as a staff in Pagilaran tea company. The data includes tea shoot yield, rainfall, air temperatures, and solar radiation.

Data is subjected to correlation and regression analysis where current and lag-time data is also considered to find out what climatic factor(s) can be attributed for the fluctuating monthly tea shoot production in Pagilaran tea estate.

RESULT AND DISCUSSIONS

The percentages of monthly tea shoot production for the three estate units Kayulandak, Pagilaran, and Andongsili for 10 year period (1988-1997) are presented in Table 1.

Correlation analysis showed a considerable high correlation of tea shoot production percentage among the three units with coefficient of 0.88, 0.88, and 0,95 for Pagilaran-Andongsili, Pagilaran-Kayulandak, and Andongsili-Kayulandak, respectively. It indicated that tea shoot production in the three units, in terms of percentage total production of the estate, shows similar pattern with respect to time. Higher production is noted in October up to December, and smaller one in January and February every year. Rainy season normally starts on September-October with peaks in January-February.

Tabel 1. Percentage od monthly tea shoot production in Kayulandak, Pagilaran, and Andongsili unit for ten years (1988-1997)

MONTH	ESTATE UNIT			TOTAL	CUMULATIVE
	Kayulandak	Pagilaran	Andongsili		
January	1.88	2.81	2.34	7.03	7.03
February	1.24	2.34	1.74	5.32	12.35
March	1.91	3.49	2.64	8.04	20.39
April	2.07	3.56	2.74	8.37	28.76
May	2.03	3.95	2.52	8.50	37.26
June	2.25	3.79	2.79	8.83	46.09
July	2.07	3.60	2.60	8.27	54.36
August	2.13	3.71	2.71	8.55	62.91
September	2.29	3.64	2.93	8.86	71.77
October	2.34	3.91	3.15	9.40	81.17
November	2.23	4.08	3.15	9.46	90.63
December	2.33	3.84	2.91	9.08	99.70*
SUM	24.77	42.72	32.22	99.70*	
AVERAGE	2.06	3.58	2.68		
SD	0.2890	0.4798	0.3658		

Source: PT Pagilaran, computerized from secondary data

*) Deviation from the supposedly 100 is due rounding error.

Relatively more stable production in Kayulandak and Andongsili units in comparison to Pagilaran unit is probably partly due to their position. The first two units are just right below forested area intended as rainfall catchment area, and thus making water availability over a year in the units better.

Monthly percentage of rainfall and number of rainy days in Pagilaran Tea Estate during 1988-1997 is presented in Table 2.

Tabel 2. Monthly percentages of amount of rainfall and number of rainy days in Pagilaran Tea Estate over 10 years period (1988-1977).

MONTH	KAYULANDAK		PAGILARAN		ANDONGSILI	
	Amount	No. of days	Amount	No. of days	Amount	No. of days
January	4.73	4.67	5.15	4.32	4.82	3.96
February	4.23	3.72	3.99	3.88	4.23	3.20
March	3.26	1.11	4.03	4.22	4.26	2.93
April	3.52	3.74	3.12	3.77	3.12	3.75
May	2.42	2.89	2.53	3.08	2.44	2.38
June	1.92	2.46	1.78	2.01	1.82	1.56
July	1.04	1.29	0.92	1.19	0.69	0.86
August	0.99	1.17	0.76	1.27	1.01	0.86
September	1.11	1.34	1.06	1.25	1.33	1.24
October	2.11	2.70	2.26	2.86	2.11	2.31
November	4.00	3.82	3.15	4.05	3.55	3.55
December	4.01	3.77	3.72	4.05	4.09	3.55
SUM	33.34	32.68	32.47	35.95	33.14	29.04
AVERAGE	2.77	2.72	2.70	2.99	2.76	2.42
SD	1.2917	1.1250	1.3435	1.1951	1.3697	1.0374

Source : PT Pagilaran, computed from secondary data.

Using t-test (α = 5%), it was found that there was no significant difference among estate units with respects to amount of rainfall as well as number of rainy days. Coupled with the significantly high value of correlation between amount of rainfall and number of rainy days of the three units (Table 3), they suggested that rainfall in the three units is more or less similar.

Table 3. Correlation of mm rainfall (upper diagonal) and number of rainy days (lower diagonal) in the three estate units of PT Pagilaran.

	Kayulandak	Pagilaran	Andongsili
Kayulandak		0.9560	0.9625
Pagilaran	0.7130		0.9796
Andongsili	0.8071	0.9363	

Uninterrupted data over sufficiently long period, particularly for temperature and solar radiation, were hard to find due to incidental breakdown of measuring equipment's. Table 4. Presents shoot yield in a given month and its corresponding record on climate elements in Pagilaran from 1990 up to 1993.

It was shown that shoot yield was affected by climate, particularly for temperature and solar radiation and rainfall. Effect of temperature was undetected, as it fluctuated in a smaller range in addition to smaller data which was available for analysis due to missing values. As expected, effects of the elements of climate on tea shoot yield were not direct. Understandably, tea shoot harvested today is a result of climatic conditions experimented some time in the past. Amount of rainfall in the last two months affects tea shoot harvested today. Higher rainfall and greater number of rainy days in a given month had a detrimental effect on next month shoot production. but in the case of total rainfall, it had a positive effects on next two months tea shoot production. High amount and frequency of rainfall is usually accompanied with heavy cloud days, resulting in a shorter duration and lower intensity of solar radiation. Such conditions are unfavorable to plant metabolism, mainly photosynthesis and absorption of plant nutrition from the soil.

It seem that large amount of and greater number of days of rainfall are similarly detrimental to tea shoot production as severe drought stress occurred in 1991.

Relationship of tea shoot production on climatic elements is depicted in the following equation : $y_i = 759.5616 - 0.1802x_{i-1} + 0.1057x_{i-2} + 0.5239\ z_{i-1}$ with R2 = 0.3398 where y_i = tea shoot production (kg), x = rainfall (mm), z = solar radiation, and the subscript *i* refer to month.

CONCLUSION

Based on the data analysis, it can be concluded that :

1. Pattern of tea shoot production in all three estate units of Pagilaran Tea Estate are more or less similar with the production of the upper units, i.e. Kayulandak and Andongsili, are more stable than that of Pagilaran unit.
2. Amount and frequency of rainfall at the three units are not significantly different.
3. Tea shoot production is shown to be affected by solar radiation and rainfall, but the effect occurs in the next month, and for rainfall the effect extends to next two month.

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Table 4. Tea shoot yield (kg/ha, A) rainfall (mm, B), days of rainfall (days, C), maximum (°C, D) and minimum temperature (°C, E), and solar radiation (F) during 1990-1993 over the estate unit of Pagilaran.

NO.	YEAR	MONTH	CLIMATE ELEMENTS					
			A	B	C	D	E	F
1	1990	January	597.09	1207	28	23.2	18.2	98.18
2	1990	February	525.84	774	22	24.3	17.4	151.79
3	1990	March	1051.81	1272	23	25.6	20.5	234.33
4	1990	April	677.21	803	23	24.5	28.5	166.10
5	1990	May	1186.13	883	23	21.3	24.7	176.43
6	1990	June	721.94	570	15	18.3	11.0	204.11
7	1990	July	874.77	230	13	18.6	11.0	245.81
8	1990	August	810.81	229	14	19.7	12.3	211.32
9	1990	September	908.87	231	10	20.0	12.3	272.32
10	1990	October	1012.39	124	11	21.4	13.2	374.35
11	1990	November	1163.70	235	16	20.6	12.6	304.30
12	1990	December	996.14	711	29	18.6	12.5	206.61
13	1991	January	680.77	838	28	18.9	11.4	190.32
14	1991	February	531.00	773	26	18.6	12.6	178.93
15	1991	March	731.49	323	19	21.6	11.6	271.29
16	1991	April	1018.63	406	25	22.0	11.7	228.30
17	1991	May	808.83	115	12	23.7	12.7	326.77
18	1991	June	964.42	11	2	23.6	13.1	369.17
19	1991	July	971.14	60	7	24.2	14.4	293.55
20	1991	August	786.15	4	2	24.4	14.9	326.93
21	1991	September	941.26	66	4	25.0	13.7	284.83
22	1991	October	722.73	67	6	23.9	15.7	357.26
23	1991	November	878.63	728	23	20.6	12.6	151.89
24	1991	December	873.05	707	21	18.5	12.6	207.74
25	1992	January	786.19	499	16	na	na	143.00
26	1992	February	659.43	584	20	na	na	77.61
27	1992	March	824.97	963	23	na	na	124.74
28	1992	April	801.05	433	19	26.0	15.2	125.25
29	1992	May	803.51	584	26	25.5	19.5	161.22
30	1992	June	773.93	238	12	na	na	178.68
31	1992	July	805.99	243	24	25.3	14.8	151.98
32	1992	August	836.01	107	12	na	na	158.98
33	1992	September	877.44	610	12	27.1	18.6	137.33
34	1992	October	781.20	957	26	25.8	18.0	115.48
35	1992	November	803.93	564	23	24.7	17.9	111.08
36	1992	December	744.97	206	12	23.3	17.4	109.33
37	1993	January	691.15	1588	24	23.0	17.0	128.23
38	1993	February	451.49	572	14	24.2	17.9	295.00
39	1993	March	864.47	655	24	24.0	17.8	277.26
40	1993	April	900.77	533	22	26.7	18.0	241.17
41	1993	May	742.98	231	15	24.6	17.8	307.74
42	1993	June	901.67	431	13	24.7	17.8	276.00
43	1993	July	826.39	80	9	24.3	16.3	282.58
44	1993	August	801.21	118	10	24.4	16.8	245.81
45	1993	September	874.97	98	9	25.4	17.7	281.43
46	1993	October	1030.68	192	15	26.0	18.0	285.32
47	1993	November	959.55	524	23	27.5	20.5	196.00
48	1993	December	877.66	827	31	26.5	19.1	133.25

Source: PT Pagilaran, Estate Division, computed from secondary data.
na = not available due to breakdown of measuring equipments.