

Daily and Seasonal Variation in Evapotranspiration on Tea Field

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It is believed that tea is a crop which likes mild climate with copious rainfall and the region with an average temperature per year of above 13°C and an annual total amount of precipitation of above 1,400 mm is suitable to cultivate tea.

Practically, however, in the region where tea is cultivated the amount of precipitation is not always distributed equally, even if an annual total amount is sufficient.

Most regions are divided into the rainy season with high frequency of rainfall and the dry season with extremely low frequency of rainfall.

As the moisture of the soil is extremely insufficient in the dry season, a plan to introduce an irrigation equipment into the tea field is attempted in various places, and the elimination of damage by blight and noxious insects due to sprinkler, the fertilizing and the prevention of climatic damage, etc. are being tried to save labor for managing operation.

In introducing such irrigation technique, it is necessary to investigate the rainfall characteristic at each region and the consumption trait of water of the crop. Then, the characteristics of evapotranspiration on the tea field such as the daily and seasonal variation in the amount of evapotranspiration, etc. have been investigated³⁾ since 1967 using the chamber method^{1,2)} (a method by measuring humidity using transpiration chamber), of which an outline is given in this report.

Daily variation in the amount of evapotranspiration on tea field

As shown in Fig. 1, the daily variation in the amount of evapotranspiration on the tea field begins at sunrise; the amount of evapotranspiration keeps increasing rapidly and reaches the vast amount in the daytime (9:00-15:00), while after that it decreases gradually towards sunset and it is extremely small in quantity during the night.

Compared with the transpiration of tea plant with the evaporation from the surface of the soil, the evaporation is little that of about 30 per cent of transpiration on the mature tea field, while the numerical value of the evaporation reaches to 80-90 per cent of that of transpiration on the young tea field.

The consumption of water per day per area of the tea field is mostly the transpiration of tea plant on the mature tea field where the

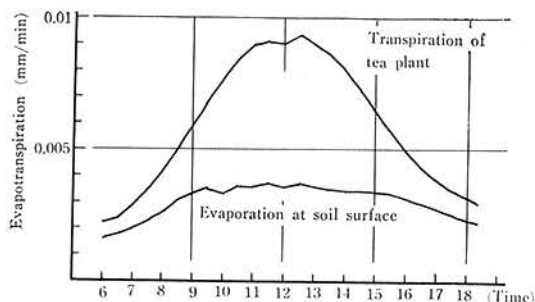


Fig. 1. Daily variations in the transpiration of tea plant and the evaporation from the surface of the soil (Nov. 11)

exposed surface of soil is very small since it is mostly covered with tea bushes, while on the young tea field where the proportion of the exposed surface of the soil is large, the consumption of water is the amount which the transpiration of tea plant is added to the evaporation from the surface of the soil according to the proportion of the area which each part occupies.

The major factor which decides the daily variation in the amount of evapotranspiration is in the atmospheric condition; the daily variation is large on a fine day, while it is small on a cloudy or rainy day and the daily amount of evapotranspiration is small as shown in Fig. 2.

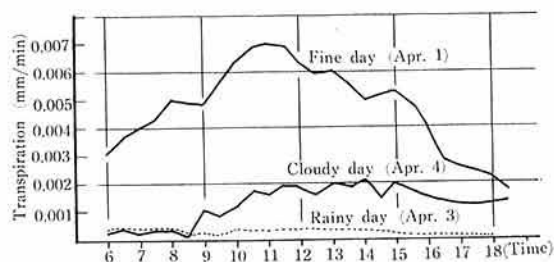


Fig. 2. Daily variations in the transpiration on several weather phenomena

The daily variation in the transpiration of tea plant and that of each climatic factor are indicated hourly in Fig. 3, where the variation in the transpiration is closely related to that in the amount of insolation and also to those in the temperature and the saturation

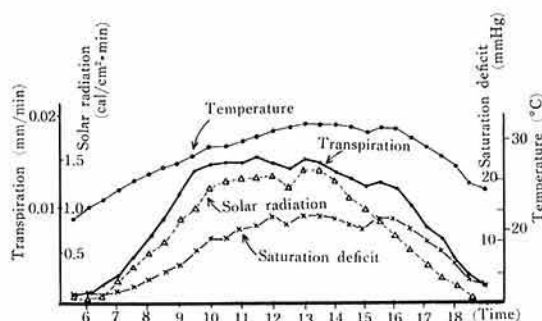


Fig. 3. Daily variations in the transpiration of tea plant and climatic factors (Aug. 3)

deficit and in every case, the relationship shows a high correlation.

It is closely related to the variation in the velocity of the wind, which will remain for another occasion, since it cannot be clarified by the measurement method accomplished by the authors.

Seasonal variation in evapotranspiration on tea field

The seasonal variations in the transpiration of tea plant and the evaporation from the surface of the soil are indicated in Fig. 4, where the transpiration of tea plant changes remarkably large with a change in the season; the transpiration in winter is at its

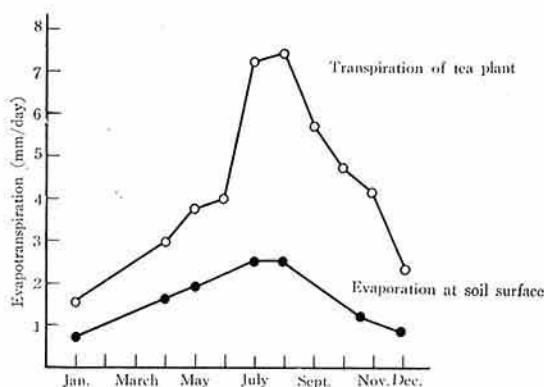


Fig. 4. Comparison of the transpiration of tea plant and evaporation from the surface of the soil in each season

smallest each day from December to March; it shows the intermediate value between the two in spring and autumn.

The evaporation from the surface of the soil shows the same seasonal variation with that in the transpiration of tea plant where it is small in winter and reaches the largest in summer while the degree of the variation is exceedingly low compared with that in the transpiration of tea plant.

The major factor of such seasonal variations is considered to be a climatic factor as well as in the case of daily variations, and

as shown in Fig. 5, the variation in the transpiration is highly correlated with the amount of insolation, the temperature and the evaporation measured by evaporation gauge.

If the relationship between the transpiration and the climatic factors is examined in detail as indicated in Fig. 6, the regression coefficient of each factor changes largely with each season and as shown in Fig. 5, the transpiration has a tendency to increase rapidly when the temperature at 9 a.m. reaches

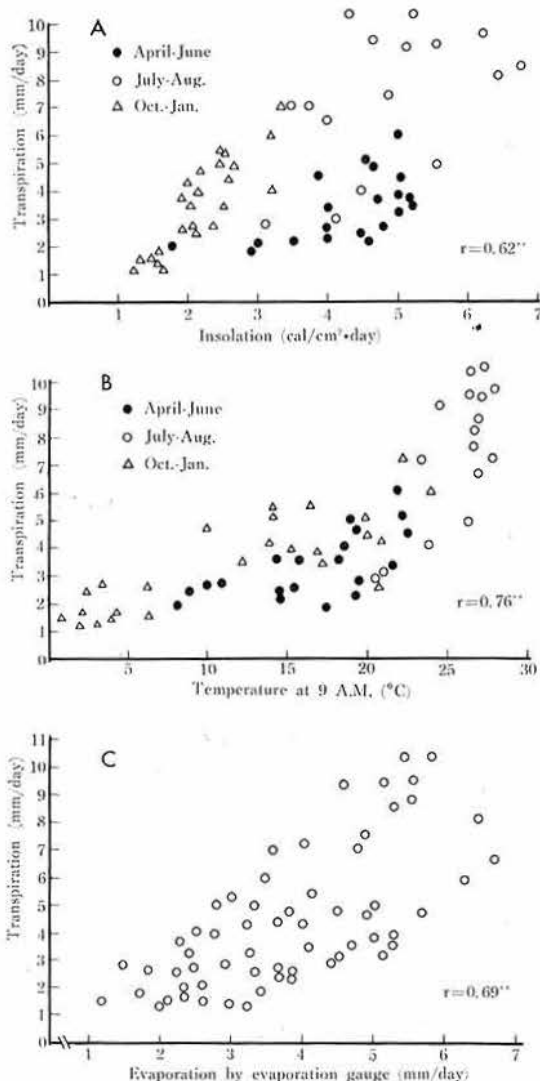


Fig. 5. Relationship between daily transpiration and climatic factors in each season

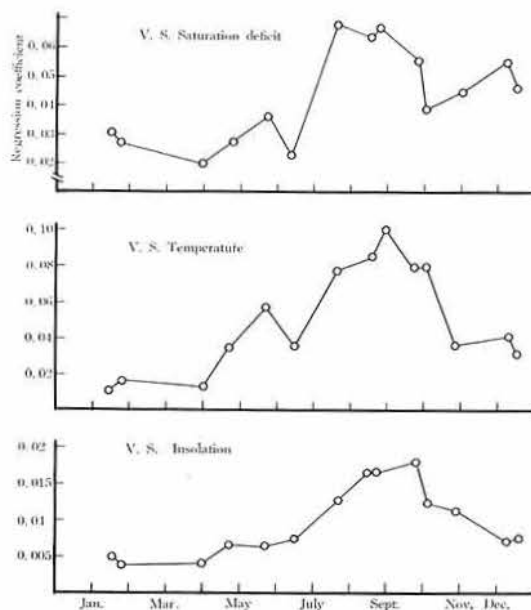


Fig. 6. Monthly variations of regression coefficient in transpiration and climatic factors in single regression

above 25°C.

Consequently, the seasonal variation in the evapotranspiration on the tea field is the result of the variation in the faculty of transpiration of tea plant which is influenced by some change in the climatic factor of each season.

Factors which decide the faculty of transpiration of tea plant

If the evapotranspiration rate (transpiration/evaporation measured by evaporation gauge) is obtained as an index to show the faculty of transpiration of tea plant, the numerical value is also small in winter and large in summer.

Moreover, even in the same season, the value of early growing time of new shoots is much different from that in the plucking time, and there is a tendency that the faculty of transpiration increases remarkably in and just after the plucking time.

The variation in the transpiration due to

the growing degree of new shoots is considered to be closely related to the leaf area index and the character of leaf, especially the function of stomata.

The relationship between the daily transpiration and the leaf area index is shown in Fig. 7, where the transpiration rises so far as 3-4 in the leaf area index, while it increases a little above that value. Consequently, it does not decrease when the index is above 5, even if most of new shoots are plucked away.

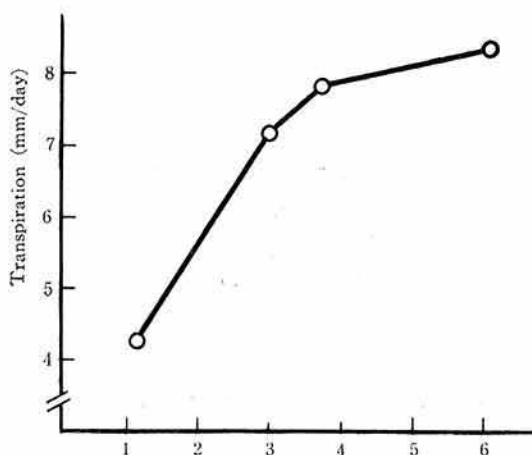


Fig. 7. Relationship between leaf area index and amount of transpiration

Meanwhile, the relationship between the daily transpiration and the function of stomata, which is being examined, is considered in that the transpiration is small since the stomata of a new leaf is not yet grown numerically and functionally in the early growing time of new shoots and most of stomata's new leaves are completed in or after the plucking time when the faculty of transpiration is increased.

Moreover, the transpiration of tea plant differs a little with a clone whose large leaf is apt to have a great amount of transpiration and the clone with a small or lustrous leaf is likely to have a small amount.

Annual consumption of water on tea field

In order to estimate the yearly consumption of water on the tea field, the evapotranspiration on the mature tea field is obtained every 10 days by multiplying the evapotranspiration rate by the average evaporation which has been measured for 10 years at Kanaya, Shizuoka Prefecture, in Japan with which the rainfall characteristic in each period is compared as indicated in Fig. 8.

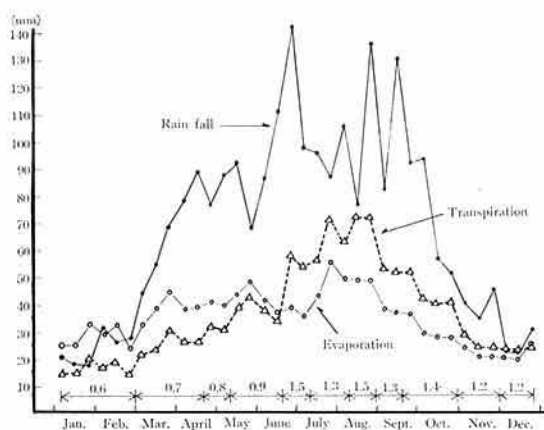


Fig. 8. Rainfall, evaporation and transpiration obtained every ten days at Kanya, Shizuoka Pref.

If the evapotranspiration per day in each season on the mature tea field is obtained on a basis of such estimated values, it is 1.5-2.5 mm in winter, 6-7 mm in summer and 3-4 mm in spring and autumn. If the consumption of water from the sprouting of new shoots in each crop season to the plucking time is calculated, it is about 120 mm at the first, second and third crop seasons respectively.

The annual total consumption of water on the tea field is about 1,300 mm which coincides with the former theory that an amount of rainfall of above 1,400 mm is required as a condition suitable for the cultivation of tea.