14年生ヒノキ林分における1日の蒸散量

誌名	日本林學會誌 = Journal of the Japanese Forestry Society
ISSN	0021485X
著者	森川, 靖
巻/号	53巻10号
掲載ページ	p. 337-339
発行年月	1971年10月

農林水産省 農林水産技術会議事務局筑波産学連携支援センター
Tsukuba Business-Academia Cooperation Support Center, Agriculture, Forestry and Fisheries Research Council Secretariat

短　報

Daily transpiration of a 14-year-old *Chamaecyparis obtusa* stand

Yasushi MORIKAWA*

14年生ヒノキ林分における1日の蒸散量

森　川　靖*

Estimations of transpiration of a stand have been made mainly by multiplying the total leaf biomass of a stand by the single average transpiration rate per unit leaf obtained with samples arbitrarily chosen[1~3]. A weakness in these estimations mentioned above may be the disregard for differences in the transpiration rate among different positions, heights and/or directions in the crown. In this study the transpiration of a stand of Hinoki (*Chamaecyparis obtusa*), an important forest tree species in Japan, was estimated paying attention to the above mentioned weakness.

The estimation was made in a 14-year-old Hinoki plantation, having 4,283 trees/ha in density and 8.3 cm in average diameter breast high, on the southwest-facing slope with a gradient at of 22° in Compartment 25 of University Forest in Tiba.

Measurement of transpiration. After measuring diameter at breast hight of each tree in the stand, the sample trees near the average diameter were selected. Diurnal trends of transpiration was followed at intervals of about 90 minutes for the period from the time when the morning-dew on the leaves had completely evaporated until the early evening. Leaf samples of about 3 g in fresh weight each were detached from the upper part, higher than 3 m above the ground, and from the lower part of the crown of each sample tree respectively. Weight loss in 4 minutes after detaching was measured by a torsion balance placed near the forest floor. Six samples were used each time. Since the saturation deficit in the air, by which transpiration rate is remarkably affected, differs with heights in the stand, corrections of the obtained values are required to estimate the transpiration rates in each part of the crown. These corrections were made by the readings of wet- and dry-bulbs in screen boxes placed respectively at the height of upper and of lower part of the crown and on forest floor. Using the diurnal trends of transpiration the daily transpiration per unit leaf in each part of the crown was calculated.

The measurements were carried out for the period from May to August in 1968, choosing clear days for obtaining the even measuring conditions to make a comparison easy with the results of isolated young Hinoki trees in Tanashi[4].

Estimation of biomass and net production of the stand. Eight trees in the stand having various diameter breast high, 5.6 cm to 9.8 cm, were cut, and

Table 1. Dry matter and dry matter production in 14-year-old Hinoki stand

	Method*	Stem	Branch	Leaf** F-1	Leaf** F-2	Leaf** F-1+F-2	Above ground
Biomass (t/ha)	1	33.39	10.21	8.01	6.39	14.40	58.00
	2	37.77	10.98			14.18	62.93
Net production (t/ha)	1	6.07	3.96			7.11	17.14
	2	6.68	4.93			6.72	18.33

* Estimations of biomass and production were made with the two methods: method 1 was the multiplication of the weight of each part of sample trees by the ratio of cross sectional area of sample trees to the basal area of the stand, and the method 2 was the sum of values calculated applying the following allometric relations to each diameter breast high of stand trees

Equations:
$$\log W_S = 2.8355 \log D - 1.6600$$
$$\log W_B = 2.8626 \log D - 2.2268$$
$$\log W_L = 1.8799 \log D - 1.1919$$
$$\log \triangle W_S = 2.8842 \log D - 2.4659$$
$$\log \triangle W_B = 3.9412 \log D - 3.6015$$
$$\log \triangle W_L = 1.8100 \log D - 1.4437$$

where W_S, W_B and W_L are dry weight (kg) of stem, branch and leaf, $\triangle W_S$, $\triangle W_B$ and $\triangle W_L$ the each annual dry weight increment (kg) and D (cm) the diameter breast high

** F-1 is leaf biomass of the upper crown higher than 3.3m above the ground, and F-2 that of the lower crown

* 東京大学農学部 Fac. of Agr., Univ. of Tokyo, Tokyo

Table 2a. Daily transpiration of 14-year-old Hinoki stand

Date	Tr	Tr*	TrF-1	Tr*F-2	TrF-1+Tr*F-2	TrF	Tr*F
May 15, 1968	2.426	1.573	19.43	10.05	29.48	34.93	22.65
Jun. 6	2.018	1.230	16.16	7.86	24.02	29.06	17.71
Jul. 24	2.698	1.692	21.61	10.81	32.42	38.85	24.36
Aug. 19	2.909	1.206	23.30	7.71	31.01	41.89	17.37

Tr: Daily transpiration (g water loss/g dry weight/day) of the leaf in the upper crown
Tr*: Daily transpiration of the leaf in the lower crown
TrF-1: Daily transpiration of the upper crown (t/ha/day) estimated by multiplying Tr by leaf biomass of the upper crown in Table 1 (F-1)
Tr*F-2: Daily transpiration of the lower crown (t/ha/day) estimated by multiplying Tr* by leaf biomass of the lower crown in Table 1 (F-2)
TrF-1+Tr*F-2: Daily transpiration of the stand (t/ha/day)
TrF: Daily transpiration of the stand (t/ha/day) estimated by multiplying Tr by total leaf biomass in Table 1 (F-1+F-2)
Tr*F: Daily transpiration of the stand (t/ha/day) estimated by multiplying Tr* by total leaf biomass in Table 1 (F-1+F-2)

Table 2b. Daily transpiration of 8-year-old Hinoki and expected daily transpiration of the stand

Date	Tr	TrF
Jul. 4, 1967	2.633	37.92
26	3.140	45.22
Aug. 16	3.428	49.36
Sep. 28	1.573	22.65
Oct. 12	1.639	23.60
31	1.350	19.44
Nov. 16	1.220	17.57
22	0.550	7.92
Dec. 7	0.732	10.54
12	0.183	2.64
Jan. 8, 1968	0.219	3.15
16	0.101	1.45
Feb. 26	0.091	1.31
Apr. 2	1.283	18.48
17	1.464	21.08
May 1	1.651	23.77
24	2.508	36.12
Jun. 12	1.994	28.71

Tr: Daily transpiration (g water loss/g dry weight/day) of the leaf. Data is the same as the previous paper[1)]
TrF: Expected daily transpiration of the stand (t/ha/day) estimated by multiplying Tr by total leaf biomass in Table 1 (F-1+F-2)

the total amount and the current year growth of stem, branch and leaf were measured respectively with a modified stratified clip method in November in 1968, nearly at the end of the growing season. Since the difference in needle colour between current and older leaves becomes not distinct in late fall, the borders of current and older leaves were marked previously with paint in August on the two branches attached to the stem at 3, 4 and 5 m distant from the base of sample tree respectively. Estimations of biomass and net production per unit area were made with the two methods, method 1 and 2, as given in the foot notes of Table 1. The net production of leaf was calculated by multiplying the ratio of current leaves to total ones of the sample branches by the total biomass of leaf. The estimation of leaf biomass in the upper and in the lower crown was made only with method 1. As shown in Table 1, the estimates calculated with both methods did not differ obviously from each other. In this study only the leaf biomass was used for the calculation of the transpiration of the stand. The estimates of the biomass of other parts and of the net production, however, may be available not only for the comparison of primary productivity with other stands but also for estimation of the transpiration from stems and branches, and of the transpiration of the stand using a transpiratory coefficient in the future.

Daily transpiration per unit leaf. Although the rate of transpiration in the upper and lower part of the crown did not differ distinctly from each other under the same saturation deficit in the air, the rates of the upper crown were higher than those of the lower one under saturation deficit at corresponding height, i.e. the latter was about 60%, with an exception of 40% on Aug. 19, of the former (Table 2a). These differences in transpiration may be caused by the difference in evaporation rate increasing with the height in the stand[5)].

Daily transpiration of the stand. The daily transpiration of the stand was estimated as the sum of TrF-1, daily transpiration per unit leaf in the upper crown (Tr) multiplied by leaf biomass of the upper crown (F-1), and Tr* F-2, daily transpiration per unit leaf in the lower crown (Tr*) multiplied by leaf biomass of the lower crown (F-2). As shown in Table 2a, the daily transpiration of the stand on clear days in summer amounted to about 30 t/ha. These estimates may be more accurate in comparison with those calculated as TrF disregarding the difference among different heights of the crown and multiplying the single average transpiration per unit leaf (Tr) by the total leaf biomass of the stand (F). The application of the daily transpiration per unit leaf in the upper crown to the entire crown resulted in an overestimation at about 20%, with an exception of 40% on Aug. 19, and the application of that in the lower crown to the entire crown an underestimation at about 25%, with an exception of 45% on Aug. 19. As there was no remarkable difference in the daily transpiratiration per unit leaf between the isolated young Hinoki in Tanashi and that in the upper crown of this stand, an expected seasonal variation in transpiration of the stand was calculated using the rate of isolated young trees in Table 2b. But the values in Table 2b may be an overestimation at about 20 to 40%.

The method of estimation in this study was not perfect because the differences in transpiration among different sides of the crown[6] and those between the sun- and shade-leaf[5] were ignored. However, there are many difficulties in practice to measure simultaneously the transpiration of many sample leaves detached from various position by means of cut-leaf method, and to estimate the leaf biomass of each position of the tree crown of a stand. And other methods, e.g. measuring the rate of sap flux in tree trunk improved recently by LADEFOGED[7], may be expected as means for the estimating transpiration of a stand.

Literature

1) POLSTER, H.: Die Physiologischen Grundlagen über Assimilation Respiration, und Transpiration unserer Hauptholzarten. Bayerischer Landwirtshaftverlag Gmbh. München. 1950
2) SATOO, T.: (In Japanese). Kagaku. **28**: 205, 1958
3) SCHUBERT, A.: Untersuchungen über den Transpirationsstrom der Nadelhölzer und den Wasserbedarf von Fichte und Lärche. Thar. Forstl. Jb. **90**: 821~883, 1940
4) MORIKAWA, Y.: Seasonal variation in transpiration of *Chamaecyparis obtusa* on clear days. J. Jap. For. Soc. **52**: 259~262, 1970
5) PISEK, A. u. TRANQUILLINI, W.: Transpiration und Wasserhaushalt der Fichte (*Picea excelsa*) bei zunehmender Luft- und Bodentrockenheit. Physiol. Plant. **4**: 1~27, 1951
6) PARKER, J.: The cut-leaf method and estimations of diurnal trends in transpiration from different heights and sides of an oak and a pine. Bot. Gaz. **119**: 93~101, 1957
7) LADEFOGED, K.: Transpiration of forest trees in closed stands. Physiol. Plant. **16**: 378~414, 1963

(Received 7 May, 1971)