当年生および1年生ヒノキ苗の比葉面積の季節変化

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短　報

Seasonal Change in Specific Leaf Area of Hinoki (*Chamaecyparis obtusa*) Seedlings during the First Two-Years*

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I. Introduction

Some tree species pass several distinct leaf-stages after germination; cotyledons are followed by primary leaves and eventually by secondary or foliage leaves. These leaf types differ physiologically as well as morphologically. When the photosynthetic rate is based on a leaf weight, the cotyledons or primary leaves are photosynthetically more efficient than foliage leaves (BORMANN, 1956; BOURDEAU, and MERGEN, 1959; WRIGHT, 1970; SORENSEN, and FERRELL, 1973; NEGISI, 1986).

LINDER (1985) reported that in eucalyptus there appeared a pronounced difference in leaf morphology between primary leaves and foliage leaves, and as a result, there was a drastic change in specific leaf area during the sapling stage. Thus, it is questionable whether the photosynthetic rate on a leaf-area basis shows the same tendency as that on a leaf-weight basis. When comparing the photosynthetic rate at different growth stages, it is necessary to clarify the changes in specific leaf area with plant growth.

In our study, we examined the seasonal changes in the specific leaf area of hinoki [*Chamaecyparis obtusa* (S. et Z.) ENDL.] seedlings under nursery conditions during the first two-years after germination. Furthermore, we investigated the photosynthetic difference between cotyledons-primary leaves and foliage leaves. Here we used the net assimilation rate (NAR) because it can be considered as an index of the photosynthetic activity of the leaves (EVANS, 1972).

II. Materials and Methods

The study was conducted from April 1984 to March 1986 on hinoki seedlings growing at the Midorigaoka Nursery, Gifu District Forest Office, at Minokamo, Gifu Prefecture. Seeds were sown on March 29, 1984. Germination was almost completed by mid-June, and the seedling density was 1,382 m^{-2}. The seedlings were transplanted at a density of 60 m^{-2} during the period of late March to early April 1985.

For the first-year seedlings, sampling began on April 27, 1984 and ended on March 14, 1985, totaling 18 occasions. The sampling was made at semimonthly intervals from May to October, whereas it was made at monthly intervals from November to March. Thirty seedlings were harvested in each sampling. For the second-year seedlings, 25 seedlings were harvested at monthly intervals between April 25, 1985 and March 28, 1986 for a total of 12 samplings.

In each harvesting period, leaf area was measured with an area meter (AAC-100, HAYASHI), and the leaf dry-weight was measured to determine the seasonal course of specific leaf area. In the period of April to May when the first-year seedlings were in the leaf stage of cotyledons-primary leaves, the dry weights of other parts (stems, branches, and roots) were measured to evaluate the NARs on a leaf-weight basis and on a leaf-area basis. The NAR was computed by the following equation:

$$\mathrm{NAR}=\frac{1}{u}\frac{dw}{dt}=\frac{d\ln u}{du}\frac{dw}{dt}$$
$$\doteqdot\frac{\Delta\ln u}{\Delta u}\frac{\Delta w}{\Delta t}=\frac{\ln u_2-\ln u_1}{u_2-u_1}\frac{w_2-w_1}{t_2-t_1}.$$

Here, t_1 and t_2 ($t_2>t_1$) are time; w_1 and w_2 are mean seedling dry-weight, and u_1 and u_2 are mean leaf dry-weight or mean leaf-area at time t_1 and t_2, respectively. NAR on a leaf weight basis is equal to the

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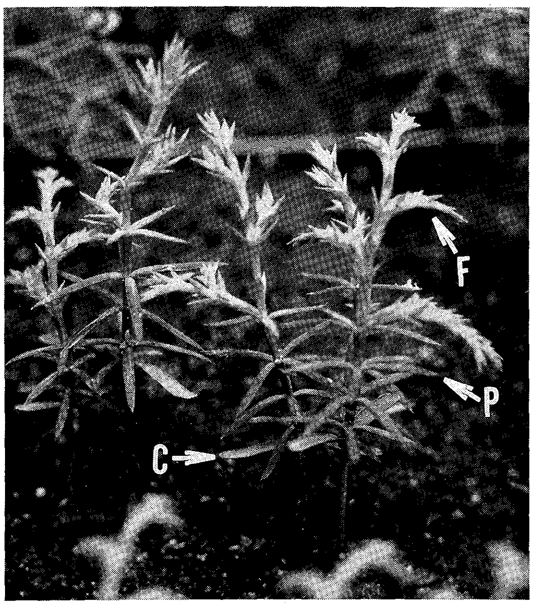

Fig. 1. Appearance of the seedlings with cotyledons (C), primary leaves (P), and foliage leaves (F) in late June of the first year

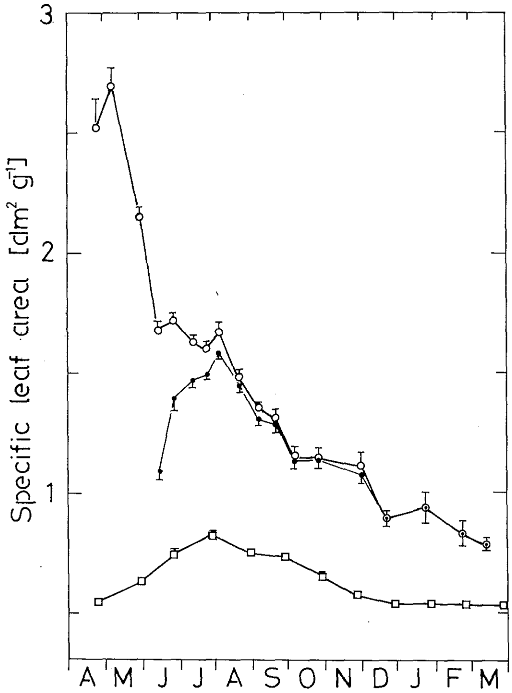

Fig. 2. Seasonal course of specific leaf area on a dry-weight basis during the first two-years

○, First year, □, Second year; ●, Foliage leaves alone during the first year. Vertical bars indicate the standard errors.

product of the NAR on a leaf-area basis and the specific leaf area.

III. Results

1. Progress of leaf stages

Figure 1 shows seedlings with cotyledons, primary leaves, and foliage leaves in late June of the first year. The primary and foliage leaves first were visible in early May and mid-June, respectively. Most of the cotyledons and primary leaves died in the autumn of the first year.

2. Seasonal changes in specific leaf area

Figure 2 shows that the seasonal changes in specific leaf area differed conspicuously between the first- and the second-year seedlings. For the former, the specific leaf area, ranging from 0.79 to 2.69 $dm^2\ g^{-1}$, tended to decrease with the progress of the seasons. For the latter, the specific leaf area was between 0.53 and 0.82 $dm^2\ g^{-1}$ reaching a single peak during the year.

The first-year seedlings had a single peak in the seasonal course of the specific leaf area of foliage leaves, which also was observed in the second-year seedlings. A single peak during the seasonal changes of the specific leaf area was reported by KURACHI *et al*. (1983) for a *Larix leptolepis* GORD. tree with foliage leaves.

IV. Discussion

Several workers (BORMANN, 1956; BOURDEAU, and MERGEN, 1959; WRIGHT, 1970; SORENSEN, and FERRELL, 1973) showed a greater photosynthetic efficiency in cotyledons or primary leaves than in foliage leaves when the photosynthetic rate was calculated on a leaf-weight basis. NEGISI (1986) also reported that for six coniferous species, including *C. obtusa*, the photosynthetic capacity was greater in the first-year seedlings with mainly cotyledons as the photosynthetic organs than in the second-year seedlings with mainly foliage leaves.

In the period of late April to late May when the leaves of the first-year seedlings were composed of cotyledons and primary leaves, we obtained the same tendency in the photosynthetic difference between leaf types; the NAR on a leaf-weight basis was 0.090 g g^{-1} day^{-1} in the first-year seedlings and 0.018 g g^{-1} day^{-1} in the second-year seedlings, being five times greater in the first-year seedlings than in the second-year seedlings.

On the other hand, the NAR on a leaf-area basis was 0.038 g dm^{-2} day^{-1} in the first-year seedlings and 0.034 g dm^{-2} day^{-1} in the second-year seedlings, not a marked difference between the two different stages. Therefore, the difference in NAR on a leaf-weight basis was caused mainly by the difference in specific leaf area. In fact, the specific leaf area of the first-year seedlings was four times on average larger than that of the second-year seedlings during the period of late April to late May.

From these results, it is concluded that, in hinoki seedlings under nursery conditions, the photosynthetic capacity in the leaf stage of cotyledons-primary leaves is similar to that during the leaf stage of foliage leaves. In addition, the seedlings are under conditions favorable for obtaining light in the leaf stage of cotyledons-primary leaves, or immediately after germination because of their large specific leaf areas.

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