Photoperiodic Response to Continuous Illumination in Vegetative Growth of Current-Year *Cryptomeria* Seedlings*

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Abstract : This experiment was carried out in order to clear the photoperiodism in current-year *Cryptomeria japonica* seedlings. The seedlings were exposed to continuous illumination and natural day-length in the phytotron, in which the seedlings were kept at 25°C and 15°C in the night from September to next March in 1976. The stem length and the top of the oven dry weight were strikingly increaed by continuous illumination. The oven dry weight of the root also largely increased by continuous illumination. Allometric relationship between the oven dry weight of whole plant and the product of the square of diameter at base by the stem length was expressed with a single regression line. Relationships between the stem length and the diameter at base, the weight of the top and the root, and the stem length and the branch number were apparently separated. From these results, it seemed that the distribution of the photosynthate differed from continuous illumination and control ones. The continuous illumination made slime the shape of the stem length and influenced on the branch differentiation.

Introduction

There are few reported on the vegetative growth of current-year *Cryptomeria japonica* seedlings to photoperiod. So far investigated[1,2], it is found that long days stimulate the elongation of stem length and short days inhibit the growth. The oven dry weight of the top has also become weighter under long days than under short days. As these results, however, were made under the natural environment condition, this study was carried out in order to clear the growth, development and morphogenesis of the seedlings to continuous illumination and natural day-length in the phytotron.

Materials and Methods

In 1974, the seeds of *Cryptomeria* were collected from the *Cryptomeria* natural stand of about 200 years old at Yanase, Kochi Prefecture. On August 28, 1975, the seeds were sown on quartz sand in small Petri dishes kept at a constant temperature 24°C in a incubator. When the seedlings elongated their roots 5 – 10 mm in length, they were transplanted to Wager's pots filled with a mixture of vermiculite and soil. The pots, contained 20 – 25 seedlings in each, were put in the net house under natural day-length. On October, 2 – 4 weeks after the cotyledons expanded fully, the pots were transferred into a room in the phytotron, in which the temperature was maintained at 25°C in the daytime and 15°C in the night. The test seedlings were exposed to the daylight in the daytime and illuminated with the 20 W standard cool white fluorescent lamps in the night. The light intensity in the night was 100 – 200 lux on the soil surface. The non test seedlings as control were grown under natural daylength condition in the same phytotron. The experiment in the

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phytotron was continued until March 6, 1976. The seedlings were occasionally watered and fertilized at intervals of 2 weeks.

The measurements were made on the mean stem length, diameter at base and number of lateral branch at intervals of 2 – 4 weeks for each plant of these samples throughout the experiment period. Together with these measurements, sometimes, the measurements of the oven dry weight of the top and the root of about 30 seedlings sampled at each time were separately made both in the test and the control one.

Results and Discussion

Natural Day-Length during the Experiment Period (Fig. 1)

The day-length was about 11.5 hours at the beginning of the treatment, shortened with the lapse of time, reached the minimum, became shorter than 10 hours at the middle of the experiment period, and then lengthened again. The day-length at the end of treatment was nearly the same length as that of the beginning. As the plants are sensitive to both the morning and the evening twilight, the effective light period for the photoperiodic response maybe about 1 hour longer than given in Fig. 1, i.e. 12.5 hours at the biginning and the end, and 11 hours at the middle of the experiment period.

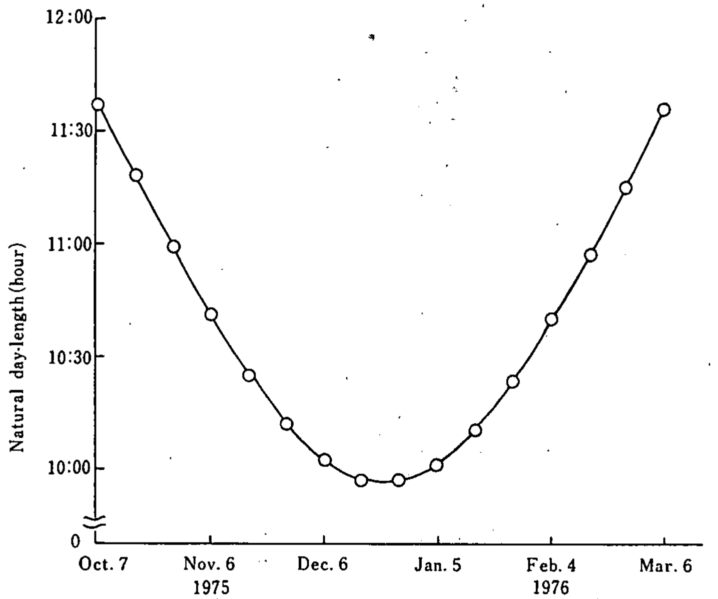

Fig. 1. Natural day-length during the experiment period. (Kochi : 33°33′N)

Though the natural day-length contained the twilight in this experiment period has showed the extent from 12.5 to 11 hours below and changed it day by day, it may be justifiable to regard as short day-length condition.

Elongation of Stem Length (Fig. 2)

The stem length was 2 mm on the average at the beginning of photoperiodic treatment

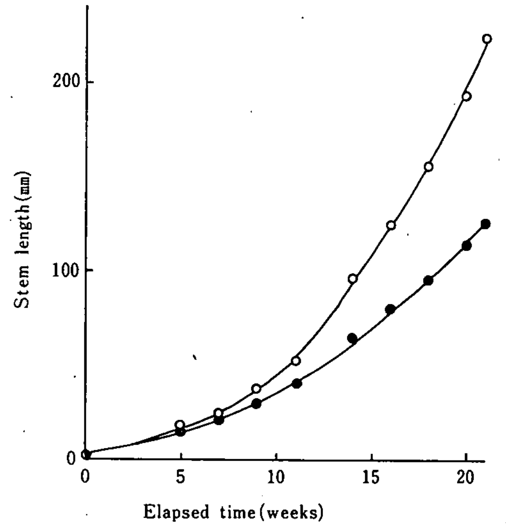

Fig. 2. Elongation of the stem under natural day-length (closed circles) and continuous illumination (open circles).

and increased with time. The elongation was strikingly stimulated with the continuous illumination. The mean stem length was 224 mm in the test seedlings and 127 mm in the control ones respectively at the end of treatment. The former was 1.76 times as long as the later. The increased elongation by continuous illumination showed the same results as those obtained by TAKAHARA et al[2]. and MAKISAKA et al[1].

Increase in the Oven Dry Weight of Top, Root and Whole Plant, and Change in T/R Ratio (Fig. 3 and Table 1)

Also the oven dry weight growth for each part was rapid in the test seedlings as compared

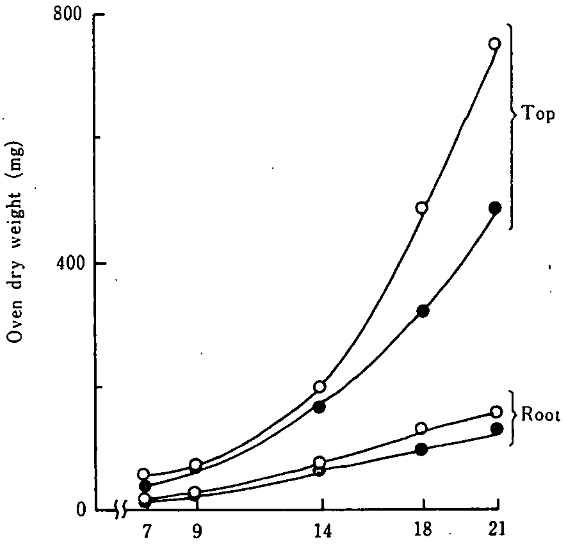

Fig. 3. Increase in oven dry weight of the top and the root. Symbols as in Fig. 2.

Table 1. *Oven dry weight of seedling under natural day-length (Nat) and continuous illumination (24hl)*

Date of sampling	Treatment	Time elapsed after the start of treatment (weeks)	No. of plant	Oven dry weight per individual (mg)*			Top/Root
				Top	Root	Whole plant	
Nov. 29	Nat	7	31	35.4 ± 3.3	10.1 ± 0.4	45.6 ± 3.3	3.50
〃	24hl	7	29	48.7 ± 5.1	12.3 ± 0.6	61.0 ± 5.6	3.96
Dec. 13	Nat	9	31	48.6 ± 4.4	16.9 ± 0.9	65.5 ± 5.1	2.77
〃	24hl	9	30	62.4 ± 7.8	17.4 ± 1.0	79.9 ± 8.5	3.59
Jan. 17	Nat	14	31	164.8 ± 19.6	59.3 ± 5.2	224.1 ± 24.7	2.78
〃	24hl	14	27	200.2 ± 18.4	70.5 ± 4.4	270.7 ± 21.5	2.83
Feb. 14	Nat	18	32	320.6 ± 30.5	94.5 ± 7.8	415.1 ± 37.9	3.39
〃	24hl	18	24	488.7 ± 44.1	124.4 ± 10.7	613.1 ± 54.0	3.93
March 6	Nat	21	31	490.9 ± 45.5	129.9 ± 11.7	620.8 ± 56.6	3.78
〃	24hl	21	28	749.4 ± 79.9	157.3 ± 14.9	906.7 ± 93.8	4.76

* mean±standard error.

with that of the control ones. The oven dry weight of the test seedlings was 1.53 times in the top and 1.21 times in the root as heavy as the control ones at the of treatment. The top root ratio of the test seedlings was higher than that of control ones throughout the experiment period.

Number of Lateral Branch

The beginning of development of lateral branch was observed during the 6th week after the start of treatment both in the test seedlings and the control ones. The average number of lateral branch was 9.7 in the test seedlings and 8.4 in the control ones at the end of experiment period respectively. It seemed that continuous illumination stimulated the branch differentiation.

Allometric Relationships at the End of Experiment Period on Log-Log Coordinate

Relationship between the dry weight of whole plant and the product of the square of diameter at base by the stem length (Fig. 4) : The difference between the test and the control ones was not apparent. The relation was expressed with a single regression line.

Relationship between the stem length and the diameter at base (Fig. 5) : The regression line of the test seedlings was obviously separated from the control ones. The stem length corresponding to the same diameter was longer in the test seedlings than the control ones. Therefore the stem of the test seedlings was slender in shape as compared with the control ones.

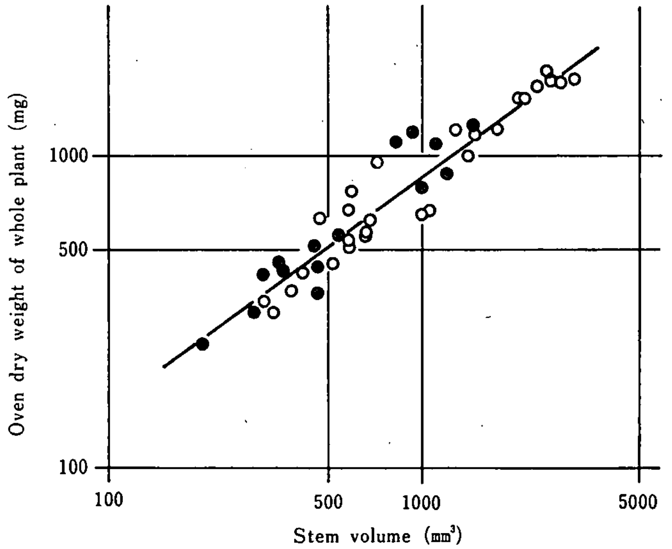

Fig. 4. Relation between the oven dry weight of whole plant and the stem volume expressed as a product of the square of diameter at base by the stem length. Symbols as in Fig. 2.

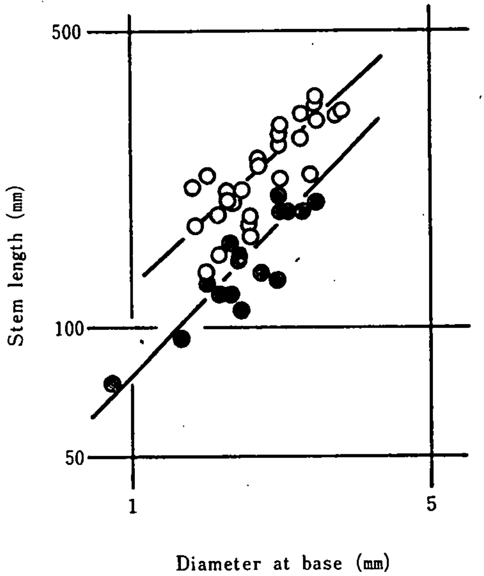

Fig. 5. Relation between the stem length and the diameter at base. Symbols as in Fig. 2.

Relationship between the top and the root weight (Fig. 6) : The regression line of the test seedlings run a higher level as compared with the control ones. The distribution ratio of dry matter accumulation to the top was higher in the test than the control ones.

Relationship between the stem length and the branch number (Fig. 7) : The regression line of the test seedlings was apparently separated from the control ones. The number of branch per unit stem length was larger in the control than the test seedlings.

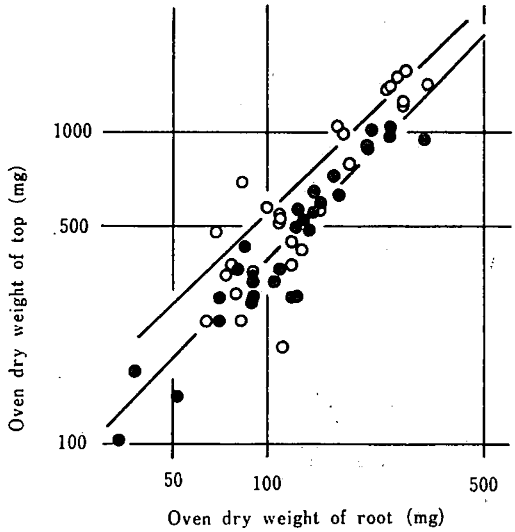

Fig. 6. Relation between the top weight and the root weight. Symbols as in Fig. 2.

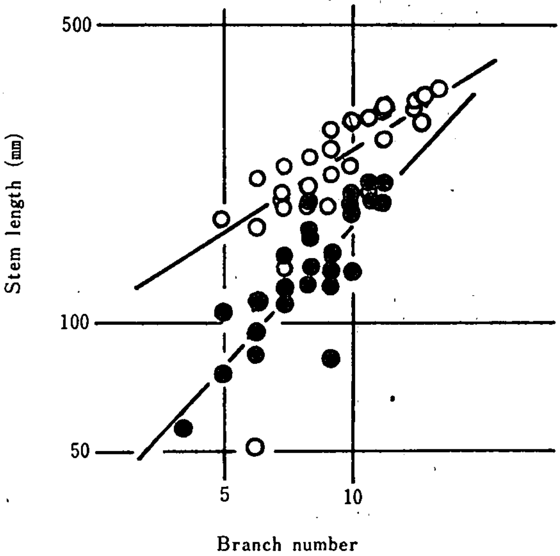

Fig. 7. Relation between the stem length and the branch number. Symbols as in Fig. 2.

As mentioned above, both the rate of vegetative growth and the ratio distribution of the oven dry matter increment were affected by the continuous illumination in current-year seedlings of *Cryptomeria*. The continuous illumination stimulated the stem elongation and the oven dry matter accumulation especially in the top, made slim the shape of stem and had influence on the branch differntiation. Since the light intensity supplemented in the night, 100 - 200 lux, was too low for active photosynthetic production, the stimulated increase of dry matter under continuous illumination may resulted from the photoperiodic response.

References

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