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Effect of soil moisture upon radial diameter and cell-wall thickness of tracheids in 1-year old plants of *Larix decidua* Mill.

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INTRODUCTION

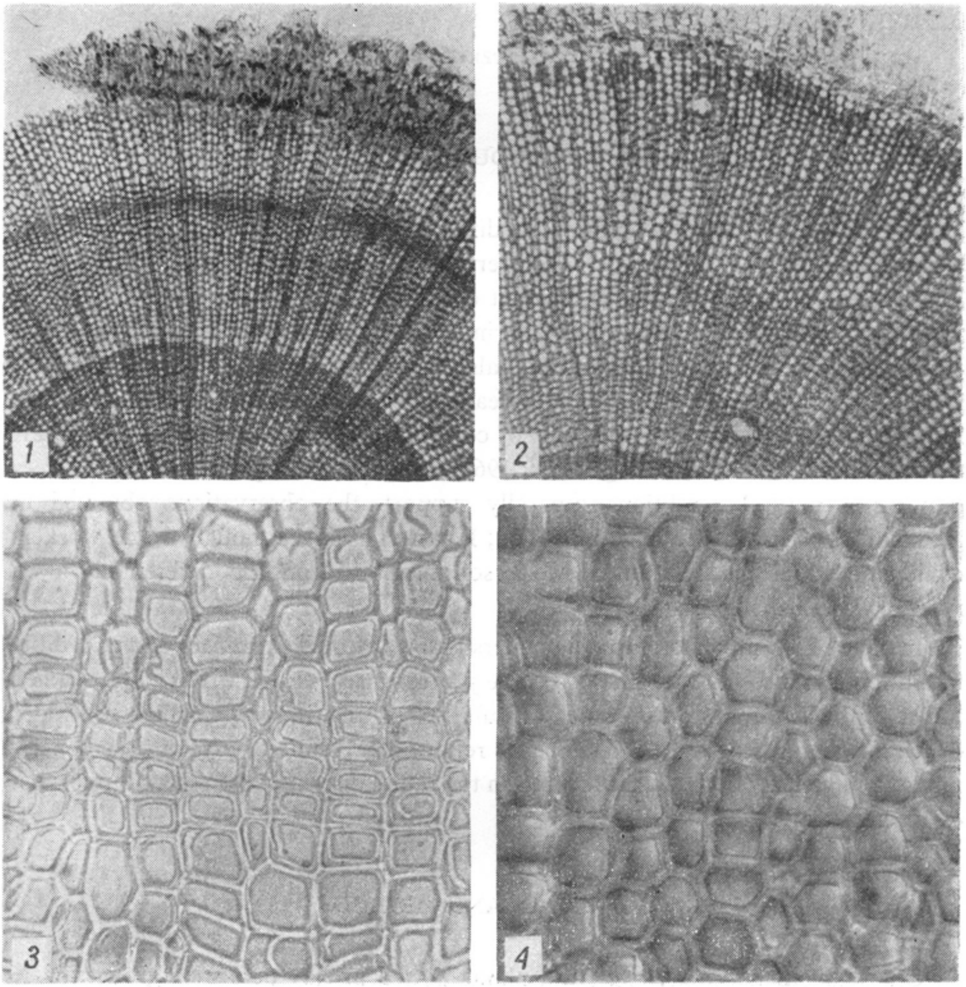
The influence of drought upon wood differentiation in Conifers has been studied by several authors. Larson (1963) observed that 5-year-old *Pinus resinosa* trees submitted to drought periods of different duration in greenhouse formed tracheids with a reduced radial diameter. Rewatering of the plants produced an increase in tracheids size resulting in formation of „false rings". Production of narrow-diameter tracheids has also been observed in 6-year-old *Pinus taeda* and 20-year-old *Pinus resinosa* trees growing in conditions of controlled soil moisture deficit (Zahner, 1962; Zahner, Lotan, Baughman 1964). Experiments performed with trees growing in natural conditions generally support the observations obtained in greenhouses (Glock 1955; Zahner 1963; Kramer 1964), although, some workers could not establish a relation between soil moisture and the differentiation of xylem (Van Buijtenen 1958).

In spite of its importance for the understanding of the mechanism of wood differentiation and also for wood industry, the problem has been relatively little studied under controlled conditions where the influence of other factors than the soil water deficit can be greatly limited. This paper reports the results of experiments concerning the influence of soil moisture level on the radial diameter and cell wall thickness of tracheids in larch.

MATERIALS AND METHODS

One-year-old *Larix decidua* Mill, plants potted in clay pots were grown for 76 days under favourable soil moisture conditions (60% of soil capillary capacity) in greenhouse since January 25, 1965. After that period the plants were divided into five groups of six plants each. Three groups were not watered for a varying number of successive days; this resulting in a decrease of soil moisture to a different degree: 8 days — 20% soil capillary capacity, 11 days — 10% and 20 days wilting point. The three levels of soil moisture were maintained during the following 21 days and then the plants were watered sufficiently to regain the original 60% of soil capillary capacity for another period of 21 days, harvested and the stem was preserved in 96% ethanol for microscopic wood examination. Two other groups of plants serving as controls (60% of soil capillary capacity) were collected at two different dates during the experiment.

Soil moisture content was determined on the basis of the weight of the pot with plant and soil.



Figs. 1—4. Effect of soil moisture upon radial diameter and cell wall thickness of tracheids in larch. Fig. 1. In the second season the seedling was grown for 76 days under 60% of soil capillary capacity, then was subjected to drought (10% of the capacity) for 21 days followed by 21 days of the initial moisture prior to harvest. Fig. 3. Portion of the xylem with the band of flattened tracheids produced during the drought. Fig. 2. The seedling was grown continuously under 60% of soil capacity for 132 days of the second season. Fig. 4. Portion of the xylem produced by the control plant when the drought was applied to the experimental plants.

All plants were exposed to long-day conditions (20 hours) for the entire growth period in greenhouse. Additional illumination, about 5000 lux, was provided by two high-pressure mercury vapour lamps. Mean daily minimum and maximum temperatures ranged from 12.5°C to 25.5°C and analogous relative air humidity from 64% to 97%.

Free-hand transverse sections of wood were cut 5 mm below the first node, stained with safranine and light-green SF, and mounted in Canada balsam after Wodzicki (1960). The radial diameter and lumen of tracheids were measured under an optical microscope (magnification 1200×) on two transverse sections of each examined plant. Cell wall thickness was calculated as the difference between radial diameter and lumen of tracheid.

All tracheids were measured along two radial files perpendicular to each other in the region of wood formed during the plant growth in greenhouse.

Mean tracheid diameters and mean cell wall thickness were calculated from six plants of each groups. The significance of differences was tested by Student's t-test.

RESULTS

Microscopic examination of the transverse sections of wood revealed a few layers of tracheids with greatly reduced radial diameter in each plant of the groups submitted to reduced soil moisture (Fig. 1). Wider and more remarkable (although statistically not significant) bands of flattened tracheids were observed in plants exposed to the lowest levels of soil moisture (Table 1). Rewatering of these plants and further growth under favourable soil moisture conditions resulted in the production of tracheids with large diameters. No bands of narrow-diameter tracheids could be observed in the control plants growing all the time under favourable soil moisture conditions (Fig. 2). The mean diameter of tracheids of control plants was significantly greater than that of plants growing under reduced soil moisture.

No significant difference in cell wall thickness between control plants and those submitted to reduced soil moisture could be observed (Fig. 3 and 4, Table 1).

Table 1

Effect of soil moisture upon radial diameter and cell wall thickness of tracheids in 1-year-old larch plants. Means of six plants

Experimental treatment	Number of days*	Radial diameter	Cell wall thickness
		microns	
60% of soil capillary capacity			
(Control 1)	56	18.5	3.8
(Control 2)	62	18.6	3.8
20% of soil capillary capacity	50	16.9	3.7
10% of soil capillary capacity	53	16.0	3.6
wilting point	62	16.3	3.6
$\mu \cdot t$ 0.95	—	1.5	0.3

* Number of days from the beginning of experiment until collection of plants.

DISCUSSION

The results of the experiments are similar to those reported by Larson (1963). The influence of reduced soil moisture level upon the radial diameter of tracheids was clearly demonstrated. The greater and longer the soil water deficit the more pronounced the effect upon xylem differentiation.

Observations concerning cell wall thickness support the results of Van Buijtenen's (1958) experiments, however, this question requires further investigation, especially, from the point of view represented by Zahner (1963).

The results concerning wood differentiation obtained with very young tree plants easily responding to any change of environment and deeply affected by critical conditions must be interpreted with great caution. The response to growth-limiting factor in these plants may produce the effect of tissue differentiation, although the physiological mechanism controlling a similar morphological response in natural conditions is different.

SUMMARY

Investigations on the reduced soil moisture effect on wood differentiation were performed on 1-year-old *Larix decidua* plants growing in greenhouse under controlled long-day conditions.

Microscopic examination revealed a band of narrow-diameter tracheids in the plants submitted to each of tree levels of reduced soil moisture: 20 and 10% of soil capillary capacity, and wilting point. Plants recovered from the drought effect in the subsequent period of growth under favourable moisture conditions.

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Wpływ wilgotności gleby na średnicę promieniową i grubość ściany komórkowej cewek u 1-rocznych roślin Larix decidua Mill.

STRESZCZENIE

Badania nad wpływem obniżonej wilgotności gleby na różnicowanie się drewna przeprowadzono na 1-rocznych sadzonkach *Larix decidua* rosnących w szklarni w kontrolowanych warunkach długiego dnia.

Obserwacje mikroskopowe wykazały, że u sadzonek rosnących w glebie o obniżonej wilgotności (20, 10% pojemności kapilarnej oraz punkt więdnięcia) wytworzyła się strefa cewek o wyraźnie zmniejszonych średnicach promieniowych. Po zwiększeniu wilgotności gleby do 60% pojemności kapilarnej sadzonki tworzyły cewki o dużyych średnicach promieniowych.