



Title	VARIATION IN MOISTURE CONTENT AND REDUCING SUGAR CONCENTRATION IN HARDENING PROCESS OF TODOMATSU ( <i>Abies sachalinensis</i> MAST.) SEEDLING WITH LAMMAS SHOOT
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VARIATION IN MOISTURE CONTENT AND REDUCING SUGAR CONCENTRATION IN HARDENING PROCESS OF TODOMATSU  
(*Abies sachalinensis* MAST.) SEEDLING  
WITH LAMMAS SHOOT

By

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トドマツ 2 次生長苗の硬化過程における  
含水量と還元糖含量の変化

玉利長三郎

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INTRODUCTION

The seedling with lammas shoot of Todomatsu (*Abies sachalinensis* MAST.) takes bad forms, because its lateral buds open, nevertheless its terminal bud remains closed in the time of the bud-opening; also they are often damaged by abnormal climate. In the writer's preceding observations on the so-called "cold-damage" of Todomatsu, such seedlings were worse damaged than the normal seedlings.

Length of growing season, which the seedling with lammas shoot has, is longer than that which the normal one has. Accordingly, the period of preparation for (winter) dormancy; i. e. hardening period of the former is shorter than that of the latter. Especially the hardening period of the lammas shoot is very short. As a matter of fact, the seedlings are covered with snow (in the

nursery where the snow falls to the depth of seedling height), therefore the importance of this problem is in the hardening process until the snow falls. The writer has experimented on the variations in moisture contents and reducing sugar concentrations, which indicate the grade of hardiness throughout this hardening process, in comparison with the normal seedling.

#### MATERIALS AND METHODS

Samples were taken in 1961 from 5 year seedlings in the Sapporo Nursery of the College Experimental Forest. Length of the lammas shoots varied, but, in this experiment, 5 malformed seedlings without terminal shoot and 5 normal seedlings were selected at random. The lateral shoots which were removed by razor from each seedling, were placed immediately in the tarred weighing bottles in the field; their fresh weights were measured on a chemical balance in the laboratory; they were put it in the oven (2 hrs at 110°C). After determinations of dry weights and moisture contents were expressed on a fresh weight basis. Samples were taken generally at 10 days interval with several exceptions, as exact weighing can not be expected on a wet-leaf condition. Fresh weights were determined in the period from 14:00 to 15:00.

This procedure was performed at approximately 20 days interval for the comparison of moisture contents between the lammas shoots and the normal shoots of the same seedlings.

The whole of the lateral shoots which were taken at random for the determination of reducing sugar concentrations was placed in an oven (1 hr at 100°C) and then in another oven (24 hrs at 60°C). Determination of reducing sugar concentrations was performed by OKAZAKI's method, and expressed as a ratio on the base of the values which residue was taken away from a dry or a fresh weight.

#### RESULTS AND DISCUSSION

In hardening process, with the development of cold resistant structure in cell from autumn to winter, there occur increases in cell sap concentration and then water reservation availability for the dehydration goes up. Therefore, moisture content decreases with the advancing hardiness. On the other hand, it is well known that the increase in sugar concentration of cell accompanies with the increase in hardiness.

Many investigators reported: the seasonal cycles of tree moisture contents, in general, increase in the vigorous growing stage and decrease from autumn to winter. OKAZAKI found that, in Sugi (*Cryptomeria japonica* D. DON), moisture content of a one year shoot was much higher than that of a two year shoot till late autumn, but there was little difference from late autumn to winter. In the studies in Kuwa (*Morus bombycis* KOIDZ.) and Cha (*Thea sinensis* L.), the decreasing of each respective moisture content with the differentiation of the tissues followed the ceasing of its growth. According to this, the more the ceasing of growth delays, the slower the decreasing time of moisture contents becomes.

The cessation of growth of lammas shoots of Todomatsu comes later than that of normal shoots, too. In this investigation from late Sept. to the season of snow fall, the lammas shoots were always much higher in moisture contents than the normal shoots, and also than the normal shoots in the same seedling (Fig. 1). Respective values did not trace a smooth decreasing curve and also

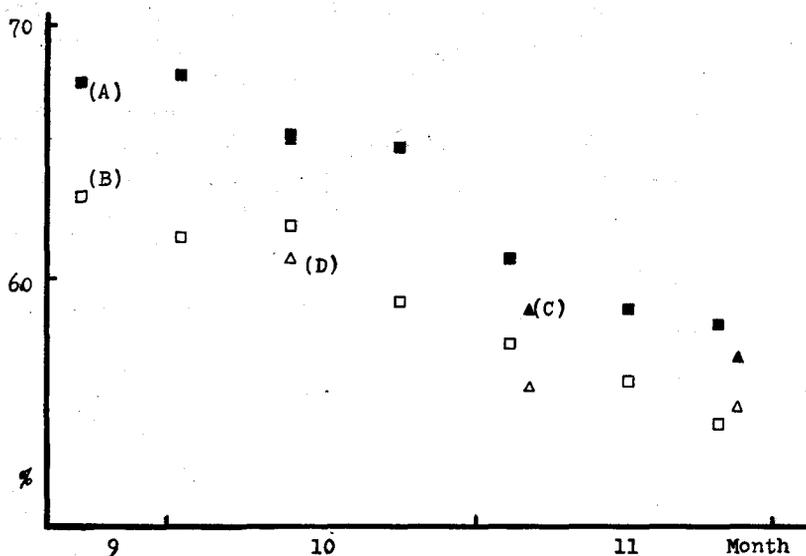


Fig. 1. Variation in moisture content of the lammas shoot (A), (C) and of the normal shoot (B) in TODOMATSU (*Abies sachalinensis* MAST.) seedling on a Fresh weight basis. (D) shows the value of the normal shoot in the same seedling with lamwas shoot as (C).

the differences varied within the range of 2.9 to 6.4 percent. It was considered that this was influenced mainly by differences in soil and weather conditions. The differences showed a tendency to decrease, but they remained even in the time when the seedlings were covered with snow. This decreasing tendency was recognized clearly in the differences of both sorts of shoots in the same seedling.

The writer thinks that the differences between the normal shoots of seedlings with lammas shoot and those of normal seedlings correspond with the stage of cessation of their growth.

It was reported by many investigators that sugar concentration of seedlings increases with the advancing hardiness. On the sugar concentration of Todomatsu, OKAZAKI studied in comparison with Ezomatsu (*Picea jezoensis* CARR.) and Akazomatsu (*P. Glehnii* MAST.), and SAKAI determined the former precisely. According to OKAZAKI, the sugar concentration in Todomatsu increased more remarkably in winter than in summer, and especially mono-saccharide concentration was much higher in winter. On the other hand, SAKAI established three funda-

mental types; viz. reducing sugar type, sucrose type and intermediate type according to the ratio of the carbohydrate constitution to the woody plants in winter; he found that Todomatsu belongs to the sucrose type, but he recognized no intimate correlation between the rate of sugar composition in leaves and their frost hardiness. As the purpose of this study was to trace the hardening process of seedlings with lammas shoot, merely the variations of reducing sugar concentrations were taken into consideration. The values on a dry weight basis from late Sept. to the season of snow laying kept increasing and they were always lower in the lammas shoots than in normal shoots which differences between the two types of shoots continued to exist. Concerning the term from late Sept. to late Nov., the difference was constant from late Sept. to early Oct.. And became much higher from mid-Oct. to mid-Nov. and thereafter showed a decreasing tendency (Fig. 2 (B)). These differences were expressed more distinctly on a dry

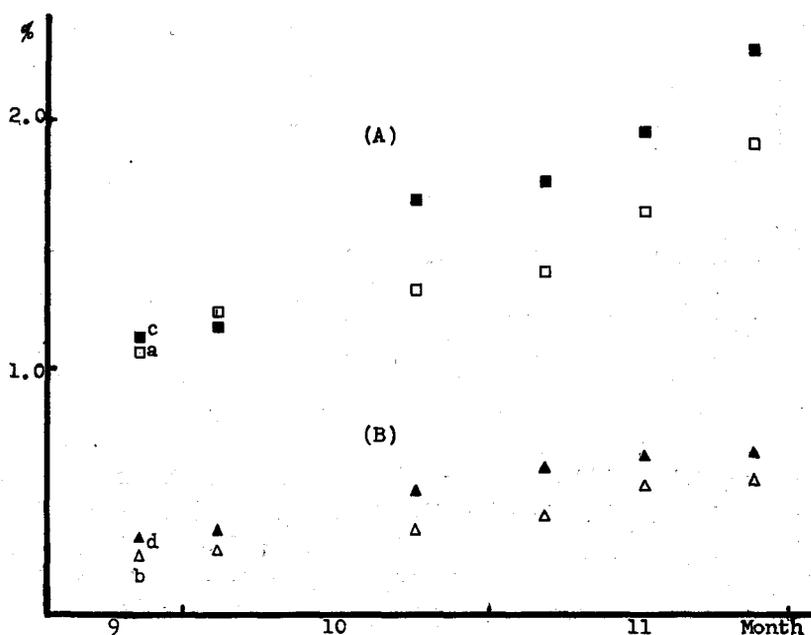


Fig. 2. Variation in reducing sugar concentration of the lammas shoot (a, b) and of the normal shoot (c, d) in TODOMATSU (*Abies sachalinensis* MAST.) on a dry (A) and a wet weight basis (B).

weight basis. The opposite result on early Oct. in Fig. 2 (A) shows that little difference between the two sorts of shoots occurred in the term from late Sept. to mid-Oct.. In another study of SAKAI, the reducing sugar concentrations in Kuwa (*Morus bombysis* KOIDZ.) showed a slightly increasing tendency from late Sept. to mid-Oct. with no variation thereafter. It was considered that the disagreement between Todomatsu and Kuwa comes from the tree species.

These results indirectly show that the grade of hardiness in the seedlings with lammas shoot is lower than that in the normal seedlings of Todomatsu, and that the later the ceasing of growth in this species, the lower is the grade of hardiness attained before the coming of winter snow.

#### SUMMARY

In order to clarify the hardening process of the seedlings with lammas shoot of Todomatsu, the variation in moisture contents and reducing sugar concentrations were investigated on the lammas shoots in comparison with the normal shoots from late Sept. to the season of the snow laying. The results are summarized as follows:

1. The moisture contents of the former is always higher than that of the latter, and the differences show a tendency to become less, but keep remaining even during the time of the snow laying.
2. The reducing sugar concentrations increases gradually and the former is always lower than the latter. The differences grow larger from mid-Oct. to early Nov. and thereafter they shows a tendency to lessen, but they continue to exist.

The writer wishes to express deep appreciation to Emeritus Professor K. KONDA for his suggestions and encouragement throughout the course of this work, to Professor Y. SAITO and Assist. Professor K. MUTO for their continued guidance and cordial revision and to Assist. Professor A. SAKAI, Research Institute of Low Temperature Science, who gave him kind leading in the determination of reducing sugar concentration.

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### 要 約

1. 成長休止期のおそいトドマツ 2 次成長苗が、正常に育った苗木よりも短い硬化期間にどのような硬化過程をとるかを知らるために、硬化度を間接的にしめす含水量と還元糖の含量の変化をしらべた。資料は 2 次成長部分だけをつかい、すべて 2 次成長しない苗木の 1 年生側枝と比較してしめた。

2. 減少傾向にある含水量は、9 月末から積雪するまでの期間中どの測定時でも 2 次成長部分が、平均して 3~6% 多かった。この差はすくなくなる傾向は見られたが、積雪期に入る頃でも両者の含水量はひとしくならなかった。

3. 還元糖含量は両者とも徐々に増加したが、常に 2 次成長部はすくなくかった。10 月はじめから 11 月はじめにかけて両者の差はひろがり、その後この差はすくなくなった。しかし含水量とおなじように差は残っていた。