

ANDRZEJ LEWANDOWSKI, GRZEGORZ KOSIŃSKI

## Spring frost damage of European larch flowers

### Abstract

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Late spring frost injury on European larch (*Larix decidua* Mill.) flowers was observed. On the average from 10% to 100% female flowers and from 42% to 100% male flowers were damaged on different clones. A significant correlation of female and male flower damages on the investigated grafts has been found. Also significant differences have been found in the degree of damages on grafts in different parts of the seed orchard.

*Additional key words:* late frost, flowers, *Larix decidua*.

*Address:* A. Lewandowski, G. Kosiński, Institute of Dendrology, 62-035 Kórnik, Poland.

### INTRODUCTION

It is generally observed that larches are highly tolerant of thermal conditions (Olaczek 1986). Simultaneously it is well known that especially European larch from Alps and Japanese larch are susceptible to late spring frost (Rubner 1960, Ellenberg 1963, 1974 cited by Olaczek 1986, Fujii and Kaijo 1965, Sakai 1968). Also a negative effect of low temperature on viable pollen formation has been observed (Eriksson 1968, Ekberg and Eriksson 1967). However so far we did not find any detailed reports on the late frost damages of generative organs in larch. During our earlier observations, we have occasionally met flowers that had been damaged, especially within the zone 1-2 m above the ground. In 1986 late frost took place during flower bud bursting. It was a good occasion for more detailed observation of the late frost damages of generative buds in the seed orchard conditions.

## MATERIALS AND METHODS

The observations were conducted at the end of April 1986 on 14 clones of European larch growing in the Kórnik seed orchard. For every clone 3 flowering grafts, distributed in different parts of seed orchard have been selected. On these grafts 5 - 34 female flowers and 22 - 79 male flowers were observed on branches about 2 - 4 m above the ground. The percentage of frost bitten flowers has been calculated. The percentage values were converted by the arcsine transformation for variance analysis.

The temperature conditions during the phase of flower development were collected from the Kórnik meteorological station.

## RESULTS

A period of specially low daily temperatures occurred in mid April 1986. The lowest measured temperature was about  $-5^{\circ}\text{C}$  (Fig. 1).

The percentage of damaged flowers on the observed grafts varied from 6.3% to 100% for female flowers and from 27.7% to 100% for male flowers. As a mean for 14 selected clones the frost injury varied

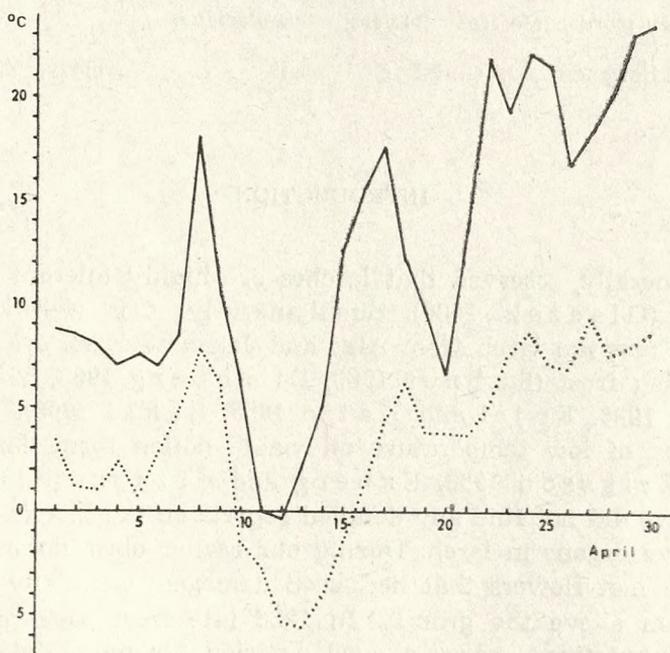


Fig. 1. Maximum (continuous line) and minimum (dotted line) daily temperature in April 1986 in Kórnik

Table 1

Mean percentage frost damages of female and male flowers on selected clones. Values with the same letter are not significantly different in the Newman-Keuls test

No. clones	% frost damage	
	female	male
K-10-01	100.0 a	95.5 ab
K-15-17	99.4 a	100.0 a
K-02-19	99.0 a	94.5 ab
K-15-88	76.2 b	88.9 abc
K-10-20	61.2 bc	59.5 bc
K-15-19	59.5 bc	94.8 ab
K-02-10	53.1 bcd	72.7 bc
K-10-27	40.6 bcd	80.1 abc
K-10-05	40.1 bcd	77.7 abc
K-10-17	40.1 bcd	42.0 c
K-02-12	19.8 cd	65.6 bc
K-15-16	18.7 cd	71.3 bc
K-02-17	18.0 cd	58.2 bc
K-15-64	10.0 d	67.6 bc

10 - 100% for female and 42 - 100% for male flowers (Tab. 1). The injuries to female and male flowers were correlated significantly ( $r = 0.65^{**}$ ). In both cases interclonal differences were statistically significant (Tab. 2).

Table 2

Variance analysis for percentage of frost damaged flowers on selected clones (after arcsine transformation)

Source of variation	d.f.	female		male	
		M.S.	F	M.S.	F
Total	41	620.60		265.77	
Clones	13	1674.18	12.74*	555.12	4.22*
Residual	28	131.45		131.43	

\* - significant at 0.01 level

A different degree of injury has been observed on grafts growing in the four blocks of the seed orchard (Fig. 2 and 3). As a mean the damages varied from about 48% to 63% for female and from 69% to 87% for male flowers (Tab. 3). For three grafts of every clone (in different blocks of the seed orchard) a deviation from the clonal mean has been calculated. On this basis a variance analysis between the four blocks has been carried out, showing statistically significant differences of the mean damages of flowers (Tab. 4).

#### DISCUSSION

The problem of late frost injury on European larch seems to be very important from the point of view of an abundant seed crop in a seed orchard. Frost damages of flowers on the lower branches have

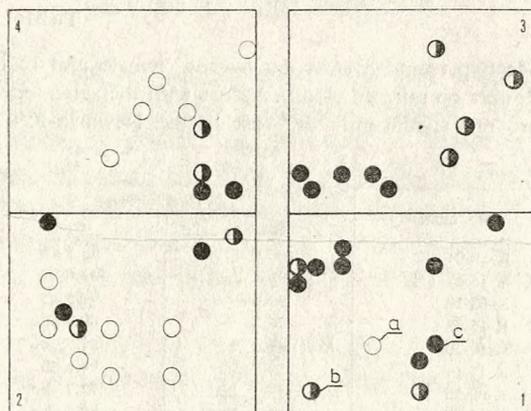


Fig. 2. Distribution of observed grafts with frost damaged female flowers. Degree of damages for the three grafts of every clone: unshaded — least (a), half shaded circle — medium (b), shaded circle — most (c). Excess of shaded circles due to the fact that 100% damaged flowers occurred on two or three grafts of one clone

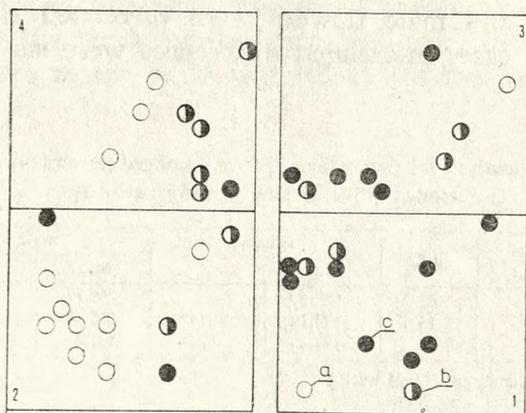


Fig. 3. Distribution of observed grafts with frost damaged male flowers. Legend as in Fig. 2

been observed from time to time. But in the middle of April 1986 particularly low daily temperatures caused freezing of generative organs during bud bursting also in the higher parts of the crowns. Male flowers have been damaged a little more in relation to the female flowers — about 75% and 50% respectively. The significant correlation between both sexes on investigated grafts, suggests a similar tolerance of clones to both female and male flower frost injury. For both sexes significant interclonal differences have been observed. These differences seem to be independent to the origin of clone. Clones of larch from the Sudety Mts. (e.g. K-15-16, K-15-64), from north Poland (e.g. K-02-19, K-02-17) and

Table 3

Mean percentage frost damages of female and male flowers in four blocks of the seed orchard. Values with the same letter are not significantly different in the Newman-Keuls test

No. of block	% frost damage	
	female	male
3	66.3 a	85.1 ab
1	63.6 a	87.0 a
4	48.9 b	75.2 bc
2	47.7 b	69.3 c

Table 4

Variance analysis for percentage of frost damaged flowers in four blocks of the seed orchard (after arcsine transformation)

Source of variation	d.f.	female		male	
		M.S.	F	M.S.	F
Total	41	89.66		89.76	
Blocks	3	328.09	4.63*	396.37	6.05*
Residual	38	70.84		65.55	

\* - significant at 0.01 level

the so called Polish larch from Świętokrzyskie Mts. (e.g. K-10-01, K-10-17) have been damaged much or little (Tab. 1).

In most cases some differences in the degree of frost injury on different grafts of one clone have been observed. These seem to be related with the distribution of grafts in the seed orchard (Fig. 2 and 3). When analysing the grafts from four blocks, significant differences have been observed. This seems to be an effect of some microclimatic differences within the investigated seed orchard.

The above results suggest some possibilities for the selection of more tolerant clones to late frost injury and the establishment of seed orchards on frost free sites to preserve the strobiles.

#### SUMMARY

Observation carried out on 14 clones of European larch of different origin growing in the Kórnik seed orchard have shown significant interclonal differences in late frost injury on female and male flowers. Also significant differences have been found in the damages on grafts growing in different parts of the seed orchard, probably due to differences in microclimatic conditions.

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## Uszkodzenia kwiatów modrzewia europejskiego przez wiosenne przymrozki

## Streszczenie

Obserwacje przeprowadzone na 14 klonach modrzewia europejskiego różnych pochodzeń, rosnących na plantacji nasiennej w Kórniku, wykazały istotne międzyklonalne zróżnicowanie w odporności kwiatów żeńskich i męskich na wiosenne przymrozki. Stwierdzono istotne różnice w uszkodzeniach kwiatów na szczepach rosnących w różnych miejscach na plantacji nasiennej. Prawdopodobnie było to związane ze zróżnicowanymi warunkami mikroklimatycznymi.

## Повреждение цветков лиственницы европейской весенними заморозками\*

## Резюме

Наблюдения, проведенные на 14 клонках лиственницы европейской разного происхождения, растущих на семенной плантации в Курнике, показали существенную межклоновую дифференциацию в устойчивости женских и мужских цветков к весенним заморозкам. Установлены существенные различия в повреждении цветков на привитых растениях растущих в разных местах семенной плантации. Вероятно это было связано с различными микроклиматическими условиями.

\* Авторы: А. Левандовски, Г. Косиński.