Population and Individual Variation in the Process of Seed Release by Cones of European Larch

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Abstract

Cones collected from 20 trees of European larch (*Larix decidua* Mill.) from two Sudetian populations were subjected to eight wetting-drying cycles to cause the extraction of all seeds. We recorded a great variation between trees in weight and volume of seeds released from cones in successive cycles.

Key words: Larix decidua, seed extraction, ecology.

Introduction

Classification within the genus *Larix* is based to a large extent on features of female cones (RUBNER and SVOBODA, 1944; BOBROV, 1978; DYLIS, 1961; MILYUTIN et al., 2002; PUTENIKHIN, 2002). Despite numerous studies, the systematic position of many taxa has not been established yet. On the one hand, this results from the close relations between them and their easy crossing, and on the other hand, from a great intraspecific variation, concerning also cone morphology. This is the case in European larch (*Larix decidua* Mill.) too. In Poland, research on its variation and on the possibility to identify provenance on the basis of cone structure, was conducted by BALUT (1969a, 1969b, 1969c), MALIŃSKI (1993), DANIELEWICZ and MALIŃSKI (1999), and other authors. In the present work, we focused on intraspecific variation in the course of seed release by female cones of European larch. When seeds of this species started to be collected on a large scale, it was noticed that the cones released only some seeds, even if they were completely dry. The next portions of seeds were released in successive wetting-drying cycles (TYSZKIEWICZ, 1949). There are many reports published on practical tests aiming at improving the methods of larch cone collection and seed extraction (for review see SUSZKA, 1986). One of the latest studies on this subject has been conducted by ZALEŞKI (2000). However, we did not find any publications describing the process of seed release and its variation in European larch. For this reason, after collection of larch seeds for a provenance test, we carried out the experiment presented here, to see if there exists any variability in the process of seed release by cones from individual trees.

Material and Methods

Material for this study was collected in two permanent plots of plus larch stands in the Sudeten Mts in SW Poland:

– Śnieżka Forest District, compartment 245b (latitude 50°47'N, longitude 15°49'E, altitude 570 m)

– Prudnik Forest District, compartment 235j (latitude 50°17'N, longitude 17°24'E, altitude 450 m)

In each forest stand, 10 trees were randomly selected and durably marked in 1998. In late December 1998 and early January 1999 cones were collected from each tree and placed in separate linen bags. After transport to the laboratory, the material collected from each tree was weighed and divided into portions of 2–3 kg each, and was placed in bags made of a fine nylon mesh. The bags with cones were then soaked in tap

Table 1. – Number and weight of larch cones, and volume and weight of seeds released from the cones after 1–8 successive wetting-drying cycles. The cones were collected in 1998 from two provenances: Śnieżka (S) and Prudnik (P).

Tree No	Cones			Cycle I		Cycle II		Cycle III		Cycle IV		Cycle V		Cycle VI		Cycle VII		Cycle VIII	
	Number	Dry weight before seed release	Mean weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight	Seed vol.	Seed weight
		g	g	cm^3	g	cm^3	g	cm^3	g	cm^3	g	cm^3	g	cm^3	g	cm^3	g	cm^3	g
P1	114	698.7	6.13	45	15.35	21	3.67	10	1.50	8	1.48	2	0.46	6	1.22	3	0.74	4	0.98
P2	198	844.4	4.26	74	14.28	31	4.33	19	2.85	14	1.91	20	3.33	22	3.52	17	2.60	16	2.54
P3	131	579.5	4.42	18	3.42	9	1.46	11	1.93	10	1.94	2	0.50	6	1.45	6	1.33	8	1.64
P4	290	700.4	2.41	30	6.31	28	6.09	23	4.43	20	4.54	6	1.19	17	3.65	14	3.18	8	1.68
P5	315	737.3	2.34	27	4.65	29	5.31	18	3.46	20	3.82	10	1.70	20	3.91	21	4.37	11	2.15
P6	150	687.8	4.58	23	3.82	9	1.51	8	1.48	7	1.22	5	0.95	4	1.02	4	1.09	4	1.04
P7	100	704.2	7.04	14	2.22	15	2.32	23	4.00	27	5.04	13	2.10	19	3.53	18	3.74	16	2.93
P8	136	700.6	5.15	17	2.92	10	1.89	11	1.89	11	2.02	12	2.37	16	3.53	18	3.92	15	3.51
P9	131	766.0	5.85	33	6.54	15	2.48	11	2.13	8	1.55	9	1.52	9	1.77	6	1.39	5	1.07
P10	104	667.5	6.42	61	12.55	16	2.80	10	1.64	12	2.04	1	0.35	3	0.70	7	1.46	5	1.05
Σ	1669	7130.4	48.6	342	72.06	183	31.86	144	25.31	137	25,56	80	14.47	122	24.30	114	23.82	92	17.59
S1	613	1890.5	3.08	232	60.74	44	10.41	88	21.53	76	20.62	38	10.39	35	10.84	29	8.09	15	3.50
S2	895	1853.9	2.07	87	20.14	69	16,57	68	13,54	48	10.30	34	7.74	53	13.84	28	7.26	33	7.90
S3	560	1145.5	2.05	66	16.16	57	14.23	38	9.77	39	10.99	14	3.33	25	7.26	18	4.27	12	2.72
S4	1018	1685.0	1.65	272	66.79	47	12.26	26	5.62	13	2.75	18	4.57	12	3.02	13	3.30	11	2.49
S5	694	1947.3	2.80	128	34.75	80	20.68	106	28.15	37	10.07	45	12.99	43	13.14	23	5.78	15	3.83
S6	716	1721.4	2.40	56	12.38	48	10.44	46	9.96	20	3.73	29	6.44	37	8.60	36	8.47	24	5.17
S7	604	1739.1	2.88	78	18.54	27	6.18	41	8.74	16	3.30	34	8.47	30	8.49	24	6.18	22	5.33
S8	794	1892.7	2.38	110	29.70	86	22.68	85	22.35	45	13.60	69	21.00	71	23.63	38	12.79	23	6.36
S9	732	2104.9	2.87	122	34.82	87	26.74	103	28.69	78	23.94	43	13.16	65	22.40	42	13.50	27	7.65
S10	797	1703.4	2.14	86	25.24	62	16.95	99	26.83	81	23.07	64	20.44	61	20.90	46	14.63	27	7.70
Σ	7423	17683.7	24.32	1237	252.47	607	157.14	700	175.18	453	121.37	388	108.53	432	132.12	297	84.27	209	52.65

water for 2 hours, resulting in complete closing of cone scales. After draining off the excess of water, the bags with cones were placed in a seed extraction kiln, where they were dried by an air current at the constant temperature of 30 °C and humidity of 28% for 48 hours. Next, the open cones were shaken manually in the bags for 30 seconds. Then, the cones were placed in another bag, while the remaining seeds were weighed and their volume was measured in a glass cylinder. This wetting-drying cycle was repeated 8 times.

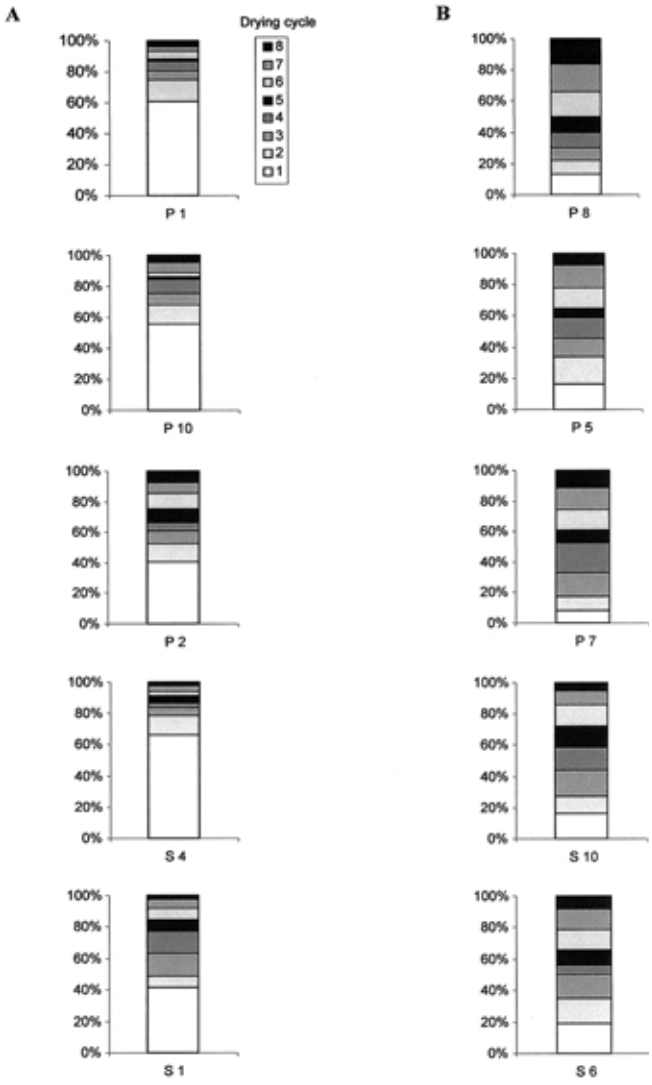

Figure 1. – Percentage distribution of weight of seeds released from larch cones (collected in the winter of 1998/1999) from different trees (of two provenances: Śnieżka, S, and Prudnik, P) in successive wetting-drying cycles. A and B = two different types of trees in respect of pattern of seed release from cones.

To observe seed germinability after each wetting-drying cycle, the seeds released from cones of single trees from Śnieżka (S4) and Prudnik (P10) were subjected to a germination test for two weeks in the Jacobsen germinator (in 3 replicates of 50 seeds each).

Collection of seeds from the marked trees was repeated in successive years, but because of poor yields, sufficient amounts of cones were collected only in the winter of 2000/2001 from some trees of the Śnieżka provenance. The differences between individuals in distribution of seed weight extracted from cones in successive cycles were analysed by the χ^2 test.

Results and Discussion

Number and weight of cones collected in the winter of 1998/1999 from individual trees (provenances Śnieżka and Prudnik) and both volume and weight of seeds released from the cones in successive wetting-drying cycles are presented in *Table 1. Figure 2* shows the percentage distribution of weight of seeds released from cones (collected in the winter of 1998/1999) in successive wetting-drying cycles. The presented data indicate that most trees released seeds from cones in several cycles, so that the first 50% of seeds were extracted during at least 3 cycles (*Table 1, Fig. 1b*). Nevertheless, some trees released the majority (> 50%) of seeds in the first (e.g. *Fig. 1a,* trees: P 1, P 10, S 4) or the first 2–3 cycles (e.g. *Fig. 2a,* trees S 1, P 2). The differences between distributions of seed weight extracted from cones in successive cycles, presented on *Fig. 1a* and *Fig. 1b,* are statistically significant ($p \leq 0.05$).

In successive years there is some variation in this respect, but the general trend for each tree is maintained (*Fig. 2*). The differences between distributions for cones collected from the same trees in the winter of 1998/1999 and 2000/2001 are not significant.

Differences between individual years may result from uneven cone size and number of scales, as was noticed during our earlier observations (Filipiak unpubl. data). Differences in size of cones produced by the same tree in successive years were mentioned also by BALUT (1969a). Data presented in *Figure 3* prove that the level of germinability of seeds released from cones in successive cycles was similar. The odds are that the repeatedly applied wetting-drying cycle of larch seed extraction is profitable.

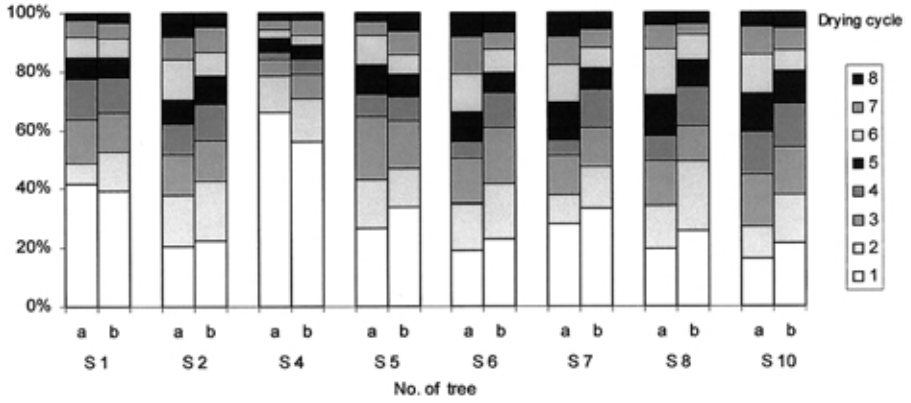

Figure 2. – Percentage distribution of weight of seeds released from larch cones in successive wetting-drying cycles – comparison of data for cones collected from the same trees (Śnieżka provenance) in the winter of 1998/1999 (a) and 2000/2001 (b).

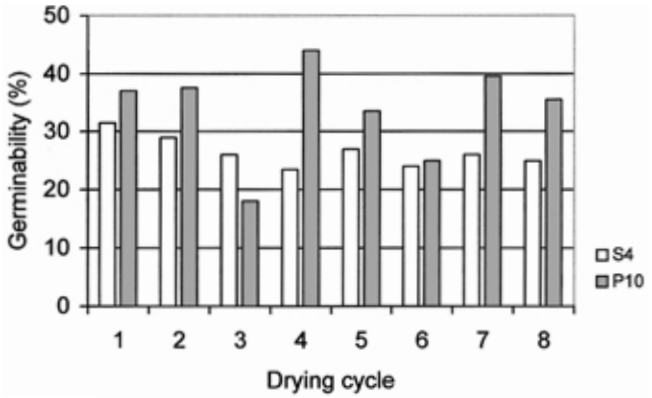

Figure 3. – Germinability of seeds released from cones of two trees (S4 and P10), with different patterns of release, after 1–8 wetting-drying cycles.

The differences observed in the course of seed release by cones may be partly due to the fact that seeds of the Sudetian variety of European larch were used in the experiment. BAŁUT (1969c) put forward a hypothesis that this geographical variety derives from crosses between larch trees originating from the Alps and from the Carpathians or the Polish lowlands (the Polish variety of European larch). That hypothesis is based on his earlier observations of great differences in cone morphology between individuals (BAŁUT, 1969b). It is noteworthy that in our study large differences in cone weight (*Table 1*) were observed between individual trees (e.g. P 5 = 2.34 g and P 7 = 7.04 g). This applies primarily to larch trees from Prudnik. As reported by ZALEŞKI (1995), the slower release of seeds is most common in lowland races of European larch, which dominate in Poland. European larch (*Larix decidua* Mill.), as a pioneer species, is characterized by intensive natural regeneration after natural disasters (avalanches, forest fires, windstorms) and after forest clearance by man (felling). Its natural regeneration is easier if there are gaps in the forest canopy and the upper layer of mineral soil is exposed (e.g. under uprooted trees). In a beech forest of the lower montane zone and in oak-hornbeam forests of uplands, where larch trees of Sudetian and Polish varieties are most common, natural disasters destroying forest are not frequent, and a destroyed soil cover is quickly regenerated. Thus, favourable conditions for regeneration of larch stands occur sporadically and only for a short time. Perhaps, the gradual release of seeds from cones is one of the factors that enables their self-perpetuation under such conditions. This interesting phenomenon and the problem of intrapopulational and interpopulational variation in seed release deserve to be studied in detail. However, such investigations are not only difficult because of the necessity to collect cones from standing trees, but are also time-consuming, as larch trees do not give high cone yields every year.

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