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Thermal conditions for the after-ripening and germination of Cornelian cherry (*Cornus mas* L.) seeds

Abstract

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Thermal conditions for after-ripening of Cornelian cherry seeds were studied immediately after collection (28.4–32.8% of moisture content in fresh weight) or after drying (12.6–14.2%). Dormancy of seeds was overcome most effectively by warm-followed-by-cold stratification, when the warm phase was ran 18 weeks at alternating temperatures 15° ~ 25°C or 20° ~ 30°C (24 + 24 hours/cycle) and when the cold phase at 3°C lasted 15–18 weeks i.e. until the seeds started to germinate. Most energetic germination was observed when after the cold phase of stratification an alternating temperature of 3° ~ 15°C or 3° ~ 20°C (16 + 8 hours/cycle) was applied after the first seeds started to germinate. Drying of stones after collection increased germinative capacity of seeds to 49.5–65.5% while non-dried seeds germinated 18.0–39.5% in the same thermal conditions.

It appeares that the course of weather conditions of the last 2 months (July and August) preceding collection of ripe fruits, affects the dormancy of seeds. A hot and dry summer created favourable conditions for deep dormancy in seeds of Cornelian cherry in contrast to a cold and moist one.

Additional keywords: stratification, dormancy, alternating temperature, drying.

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INTRODUCTION

Cornelian cherry is a shrub or small tree with a wide crown. Its decorative value – early and aboundant flowering – is equally important as its usefulness for first spring honey produced by bees and in the autumn for edible fruits, which are house processed and used up in the food industry (Kovaleva, 1950; Šajtan et. al. 1987).

Difficulties to obtain plants of this species are associated among other things with the considerable mechanical resistance of thick stones sorrounding one, two or three seeds and with their deep physiological dormancy

(Nikolaeva et al. 1985). In Cornelian cherry seeds growth regulators were found in amounts sufficient to inhibit germination (Nikolaeva and Poljakova, 1978).

Many discrepancies in literature concerning optimal, thermal conditions for after-ripening of Cornelian cherry seeds (Tyszkiewicz, 1949; Ploščakova, 1960; Nazarenko, 1962; Heit, 1968; Gordon and Rowe, 1982; Terpiński, 1984; Klimenko and Zholtonoga, 1987) induced me to undertake the investigations on this problem.

MATERIALS AND METHODS

Investigations were carried out with seeds from fully ripened fruits collected in 1988 and 1989 (Table 1).

Table 1

Cornus mas L. Provenance, date of seed collection, start of experiments and moisture content (in fresh weight) of stones

Exp. No	Collection site	Collection date	Start of experiments	Moisture content %
Exp. I	Arbor. Kórnickie	15.09.1988	15.09.1988	32.8
Exp. II	Arbor. Kórnickie	31.08.1989	31.08.1989	31.4
			14.09.1989	14.2
Exp. III	Poznań	1.09.1989	1.09.1989	28.4
			27.09.1989	12.6

Thermal conditions of the experiments are presented schematically (Fig. 1). The experiments on seeds collected in 1988 were pilot studies aimed at recognizing the thermal conditions for after-ripening (exp. I), whereas two others (exp. II and III) were carried out to find optimal conditions, using seeds from two different provenances collected in 1989. In experiment II having considerable amounts of stones they were used immediately after cleaning from fruits (31.4% of moisture content) and after drying at room temperature to 14.2% (exp. II) and 12.6% (exp. III) as shown in Table 1.

The moisture content of stones was estimated after drying at 105°C for 24 hours and referred to fresh weight.

Stones were stratified in a moist mixture of peat mull and fine-grained sand, 1:1 by vol. The humidity of the stratification medium with stones was checked and moistened if necessary at regular time intervals every week during the warm phase and biweekly during the cold phase. During the warm phase an alternating temperature two-day cycle was applied i.e. 24 hours of action at the lower temperature and 24 hours at the higher temperature.

The germination tests were carried out at a constant temperature of 3°C or at alternating temperatures 3°∼15°C and 3°∼20°C (16+8 hours/cycle).

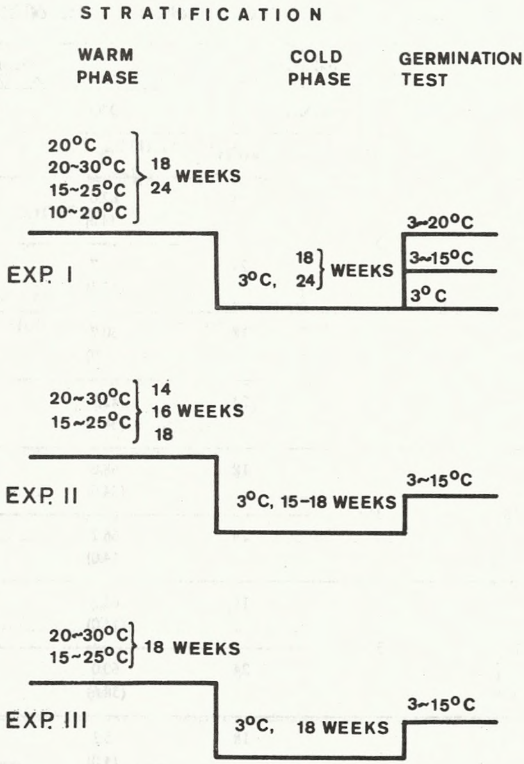

Fig. 1. Scheme of experiments (I, II and III)

Each experimental variant was represented by 3 replicates with 25 stones (exp. I) or 4 replicates with 50 stones (exp. II and III).

Germination was scored per stones regardless of the number of seeds it contained.

RESULTS

Using a constant temperature 20°C during the warm phase of the warm-followed-by-cold stratification 20°/3°C, irrespective of its duration (18 or 24 weeks) with the same length of the cold period did not help overcome dormancy of the seeds (Table 2).

Table 2

Cornus mas L. Germination capacity (in %) of seeds at 3°, 3°~15° and 3°~20°C after warm-followed-by-cold stratification. Warm stratification phase ran at alternating temperatures (10°~20°, 15°~25° or 20°~30°C, 24/24 hours/cycle) and cold phase at 3°C. In brackets percentage of germinating seeds has been given during the cold phase of stratification. Exp. I

Warm phase of stratification		Cold phase of stratification		Germination tests		
				3°C	3°~15°C	3°~20°C
°C	weeks	°C	weeks	%	%	%
20°~30°	18	3°	18	62.6 (8.0)	66.6 (8.0)	66.6 (8.0)
			24	54.7 (53.3)	61.3 (58.6)	56.0 (49.3)
	24	3°	18	50.7 (8.0)	48.0 (8.0)	50.7 (8.0)
			24	42.7 (36.0)	46.7 (38.7)	37.3 (32.0)
15°~25°	18	3°	18	68.0 (24.0)	69.3 (24.0)	64.0 (24.0)
			24	66.7 (64.0)	69.3 (65.3)	65.3 (60.0)
	24	3°	18	65.3 (16.0)	58.7 (16.0)	– –
			24	60.0 (58.6)	62.7 (54.6)	66.7 (61.3)
10°~20°	18	3°	18	5.3 (4.0)	5.3 (4.0)	5.3 (4.0)
			24	0.0 (0.0)	1.3 (0.0)	1.3 (0.0)
	24	3°	18	8.0 (4.0)	8.0 (4.0)	9.3 (4.0)
			24	8.0 (5.3)	8.0 (8.0)	6.7 (6.7)
20°	18	3°	18	0.0	0.0	0.0
			24	0.0	0.0	0.0
	24	3°	18	0.0	0.0	0.0
			24	0.0	0.0	0.0

When an alternating temperature of 10°~20°C was applied during the warm phase of stratification only an insignificant part of the seeds germinated, below 10%. Most effective proved to be the alternating temperatures

15° ~ 25°C and 20° ~ 30°C during warm phase, because germinative capacity of seeds reached above 60%, irrespective of the germination test temperatures (Table 2). The germination capacity of seeds dried after collection was markedly higher than that of non-dried ones (Table 3 and 4).

Extension of the warm phase beyond 18 weeks did not influence the germination capacity of seeds (Table 2). Shortening of this phase to 16 or 14 weeks caused a decrease of germination capacity (Table 3). Inception of seed germination started 15–18 weeks after changing the stratification temperature from alternating to constantly cold (3°C).

Table 3

Cornus mas L. Germination capacity (in %) of seeds at 3° ~ 15°C. Stones were subjected to warm-followed-by-cold stratification, with the warm phase at alternating temperatures, immediately after collection without drying (31.4% of moisture content, fresh seeds) or after drying (14.2%). Exp. II

Warm phase of stratification		Cold phase stratification (3°C) of seeds		Germination test	Germination capacity of seeds	
		fresh	dried		fresh	dried
°C	weeks	weeks	weeks	°C	%	%
15°~25°	14	18	16	3°~15°	21.5	46.0
	16	17	15		28.0	58.0
	18	15	15		21.5	65.5
20°~30°	14	18	16	3°~15°	18.0	46.5
	16	17	15		28.0	61.5
	18	16	15		27.5	63.0
Overall mean					24.1	56.7

Table 4

Cornus mas L. Germination capacity (in %) of seeds at 3° ~ 15°C. Stones were subjected to warm-followed-by-cold stratification, with the warm phase at alternating temperatures, immediately after collection without drying (28.4% of moisture content, fresh seeds) or after drying (12.6%) Exp. III

Warm phase of stratification		Cold phase of stratification		Germination test	Germination capacity of	
					fresh seeds	dried seeds
°C	weeks	°C	weeks	°C	%	%
15°~25°	18	3°	18	3°~15°	39.5	53.0
20°~30°					39.5	49.5
Overall mean					39.5	51.2

From experiment II (Table 3) one may see that there exists a dependence between extensions of the warm phase of stratification and the length of the cold one, especially in the case of fresh seeds. When the warm phase was short

(14 weeks) a longer period of the cold phase (18 weeks) was needed to start germination while after a longer warm phase (18 weeks) a shorter (15–16 weeks) period of the cold phase was needed.

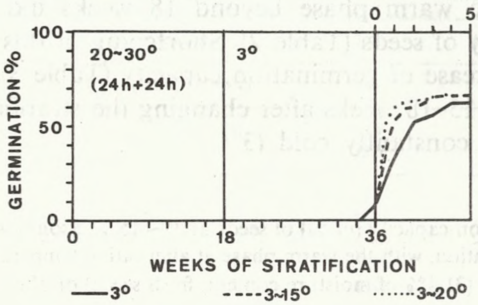

Fig. 2. *Cornus mas* L. Course of seed germination at 3°, 3° ~ 15° and 3° ~ 20°C (8+16 hours cycle/day) after warm-followed-by-cold stratification

Extension of the cold phase of stratification (3°C) led to slow germination at this temperature. Seeds germinated most energetically during germination tests at 3° ~ 20°C or 3° ~ 15°C, attaining maximal levels after 3 and 4 weeks respectively. At 3°C the germination was extended for up to 8 weeks (Fig. 2).

The remaining, non germinated seeds were submitted to a cutting test after termination of germination tests. They did not show any decaying.

It is worth noting that only from stones cracked during stratification did seeds germinate in the germination test.

DISCUSSION

The methods of dormancy breaking of Cornelian cherry seeds applied in nursery practice consist in immediate sowing of stones following cleaning from red flesh. Tyszkiewicz (1949) recommends to sow stones already at the end of August to obtain more equal seedling emergence in the spring of next year. This method seems to be prone to failure considering the thermal conditions in the nursery after sowing compared to those needed for after-ripening of seeds. Klimenko and Zholtonoga (1987) have found that after summer sowing of freshly collected seeds, mass seedling emergence appeared at best after 18 months i.e. in the second spring. On the other hand, Nazarenko (1962) belives that autumn sowing of stones pressed into 5 cm furrows, without covering, was fully satisfactory for seedling emergence already the next spring. It must be pointed out that this experiment was conducted in Odessa (southern Ukraina) with unreported weather conditions after sowing.

Ploščakova (1960) stratified early collected seeds in Bulgaria, in a cellar, first at an alternating temperature 10°~16°C (accidental variability) for 190 days and then at 0–5°C, and she obtained 29% germinating seeds. This result is closely to mine after treating seeds with an alternating temperature 10°~20°C in a two-day cycle. Application of the alternating temperatures at a higher level (15°~25°C or 20°~30°C, with the same amplitude of 10°C) appeared more effective for dormancy breaking of both, fresh and dried but not stored seeds.

Table 5

Comparison of mean July and August temperatures, precipitations and germinative capacities of seeds collected from the same provenance (in Kórnik) in 1988 and 1989. Meteorological data obtained from Mrs. U. Przybył from the Meteorological Station in Kórnik

Month/Year		Mean monthly temperature °C	Precipitations mm		Germinative capacity %
July	1988	18.8°	118.6	171.4	>60.0
August	1988	17.4°	52.8		
July	1989	20.4°	29.0	85.5	23.7
August	1989	19.5°	35.4		

In my experiments the constant temperature 20°C applied during warm phase followed by cold 3°C was completely uneffective in contrast to the Gordon and Rowe (1980) recommendations from Great Britain. Probably an important role is played here by the provenance of seeds and connected with this – the pattern of weather conditions during ripening of seeds. This suggestion is confirmed by an analysis of weather conditions in July and August of the two consecutive years 1988 and 1989 preceding collection of Cornelian cherry seeds from the same provenance (Table 5). From this it appears that during a hot and dry 2-months period preceding harvest of fruits, seed dormancy increase and conversly cool and moist weather decreases dormancy. Similar observations were made on *Quercus borealis* acorns by Tylkowski and Wrześniewski (1986).

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Warunki cieplne ustępowania spoczynku i kiełkowania nasion derenia właściwego (*Cornus mas* L.).

Streszczenie

Badano optymalne układy cieplne ustępowania spoczynku nasion derenia właściwego bezpośrednio po zbiorze (wilg. 28,4–32,8%) lub po podsuszeniu (wilg. 12,6–14,2%). Spoczynek nasion przezwyciężany był najskuteczniej podczas stratyfikacji ciepło-chłodnej, gdy ciepła faza stratyfikacji przebiegała w temperaturze cyklicznie zmiennej 15°∼25°C lub 20°∼30°C (24+24 godz.) przez 18 tygodni, a faza chłodna w temperaturze 3°C przez 15–18 tygodni, aż do rozpoczęcia kiełkowania. Najbardziej energicznie kiełkowały nasiona po zmianie temperatury w początkowym okresie kiełkowania ze stałej 3°C na cykliczną 3°∼15°C lub 3°∼20°C (16+8 godz.). Podsuszenie nasion po zbiorze wywarło korzystny wpływ na ich późniejszą zdolność kiełkowania: 49,5–65,5%. Nasiona niepodsuszone kiełkowały w 18,0–39,5%.

Wydaje się, że przebieg warunków pogodowych 2 miesięcy poprzedzających zbiór nasion (lipiec i sierpień) wywiera wpływ na głębokość spoczynku nasion. Upalne i suche lato sprzyja pogłębianiu spoczynku w nasionach derenia właściwego.

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