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ENDOZOOCHORY ENHANCES SEED GERMINATION AND SEEDLINGS GROWTH OF BLACK CHERRY

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Abstract

The fruits of the black cherry are food for a variety of different species of animals. Therefore, animals have an important role in the spread of black cherries by zoochory. The aim of this study was to determine how the digested black cherry seeds by the badger (*Meles meles*) digestive system affects the germination efficiency of these seeds after voiding in the badger's faeces. It was hypothesized that seeds of black cherries collected from badger faeces will show greater germination efficiency in the first year after sowing than non-stratified seeds, stratified seeds and seeds with an exocarp. Black cherry seeds were collected in autumn 2018 at the Forest Arboretum in Zielonka from badger faeces, which comprised the first treatment group of the experiment and from standing trees, and among these seeds there were further variants of treatment. Seeds collected from standing trees were: without pericarp (treatment group), without pericarp and stratified, not cleaned but stratified and seeds untreated (control sample). The first seedlings to emerge were from seeds collected from badger faeces (206 days after sowing). The seeds with intact pericarp had the longest period of emergence, germinating 221 days after sowing. The highest seed germination capacity was noted for seeds from badger faeces (66.4 %), and the lowest one was observed for seeds sown with intact pericarp (15.2 %). Pericarp inhibits seed germination in the first year after sowing.

Key words: germination, invasive species, *Meles meles*, *Prunus serotina*, zoochory.

Introduction

One of the most invasive species in forest ecosystems in Europa is the black cherry (*Prunus serotina* Ehrh.) (Halarewicz 2011, Danielewicz and Wiatrowska 2014, Jagodziński et al. 2019). Its fruits serve as a food for a large range of birds and mammals (Starfinger 1997). The role of animals in the spread of black cherry should not be overlooked (Kurek 2011). The aim of this study was to determine the germination capacity of black cherry seeds collected from badger's faeces.

Material and Methods

In the summer of 2018 at the Forest Arboretum in Zielonka (17.10941 E 52.553975 N), the badgers (*Meles meles* L.) were observed to feed under black cherries. Numerous intact seeds of black cherries were found in the faeces of these animals, and these were used for this research.

Black cherry seeds were collected in the autumn 2018. In each experiment variant, the sample consisted of 500 seeds. Seeds were collected from badger faeces (i), which comprised the first treatment group of the experiment, and from standing trees, which seeds were used for the other variants of treatment. Seeds collected from standing trees were: without pericarp and stratified (ii), without pericarp (treatment group) (iii), not cleaned but stratified and seeds untreated (control sample; iv). Seeds were subjected to stratification (ii) by hot-cold treatment according to Krüssmann's (1978) recommendations consisting of 4 weeks at 20 ºC followed by 18 weeks in 3 ºC in the laboratory. Seeds from each treatment group were weighed before sowing. Then the seeds were sown in the autumn (3.10.2019) into cassettes (Alonet peat substrate) in the nursery of the Experimental Forestry Plant Murowana Goślina, 500 for each treatment group, except for the seeds subjected to stratification, which were placed in sand on that day. Stratified seeds were sown in early spring (18.03.2019).

The time of emergence of seedlings was observed in spring (beginning of May), and the number of emerging seedlings was counted once every three weeks (Table 1). Seedlings were removed and subjected to drying twice for eight hours at 60°C. Observations were carried out until September 2019. Seed cassettes were watered from June 2019 according to the Guidelines for irrigation of forest nurseries in open areas (Pierzgalski et al. 2002).

Results

The mean weight of 500 black cherry seeds ranged from 41 to 43 g (Table 1). The seeds with pericarp weighed 338 g/1000 pcs. The lowest weight was found in black cherry seeds obtained from badger faeces – 82 g/1000 pcs (Table 1). Results indicate that black cherry seeds did not differ in terms of the average weight. The lack of significant difference in weight concerned the seeds without pericarp.

Similar to the seed weight, there was no significant difference in the weight of seedlings. A single seedling weighed on average from 0.041 g (non-stratified seeds, treatment groups i and ii) to 0.052 g (stratified seeds, treatment groups iii and iv). Seedlings grown from badger faeces, similarly to seedlings with intact pericarps, had a mass similar to the average for the experiment (0.045 g).

The first emergence of black cherry seeds collected from badger faeces was observed on April 26, 2019 (Table 1) and the time that elapsed from sowing these seeds until the first seedlings appeared was 206 days. The first emergence of seeds with intact pericarps was not observed until May 11, 2019 (Table 1), 221 days after sowing these seeds. Hence, the seeds with pericarps were distinguished by the longest period of germination.

The seeds obtained from badger faeces showed the highest germination capacity. On May 21, 63.8 % of the seeds sown from this treatment group germinated, while by the last day of observation the germination capacity of these seeds in the growing season was 66.4 %. In contrast, the seeds sown with intact pericarps had the lowest germination capacity – 15.2 % of the seeds germinated (Table 1, Fig. 1).

Table 1. Observation results.

Variant	I badger		II stratified		III nonstratified		IV with a pericarp and stratified	
Date of observation (2019)	Total weight (seedlings), g	Total number (seedlings), pcs	Total weight (seedlings), g	Total number (seedlings), pcs	Total weight (seedlings), g	Total number (seedlings), pcs	Total weight (seedlings), g	Total number (seedlings), pcs
21.05	14.38	319	14.17	278	8.93	205	1.6	51
11.06	0.25	8	0.69	10	0.73	19	1.78	19
02.07	0.01	1	0.36	3	0.1	12	0.01	3
23.07	0	0	0	0	0.04	1	0.09	2
13.08	0	0	0	0	0	0	0	0
03.09	0.12	4	0	1	0.01	0	0.01	1
Weight of individual seedlings, g*	0.0445		0.0521		0.04134		0.0459	
First germination, date	26.04		16.05		29.04		11.05	
Mass of collected seeds, g	41		43		42		42 (169**)	

Note: pcs – pieces; * – average weight of seedlings 0.04597 (±SEM 0.00451); ** – mass of seeds harvested with pericarp.

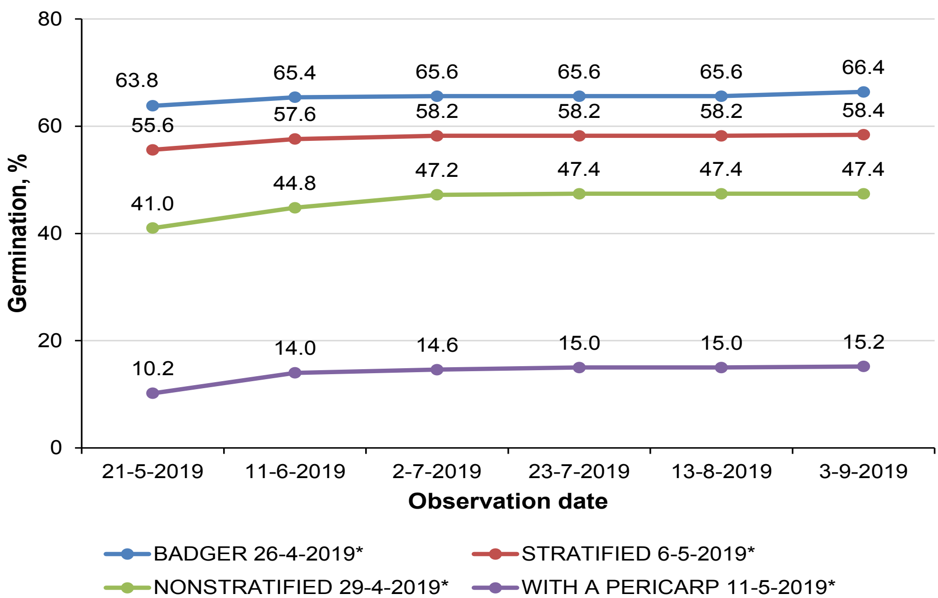

Fig. 1. Germination energy of black cherry seeds with observation date.
Note: * – date of first appearance of seedlings.

Discussion

This study showed that black cherry seeds collected from badger faeces (with destroyed pericarp) were characterized by greater germination capacity than untreated, as well as stratified seeds. Our results indicate that the process of germination of black cherry seeds is characterized by high violence at the initial stage, regardless of the variant. The vast majority of seeds (96 % badger, 95 % stratified, 86 % non-stratified, 67 % with pericarp) germinated one month after the appearance of the first seedlings. The acceleration of germination of seeds that have passed through the gastrointestinal tract of birds has been demonstrated in previous studies, which have also shown lower germination capacity of stratified seeds compared with seeds not subjected to digestion by passing through bird intestines (Krefting and Roe 1949, Smith 1975).

Various mammals also contribute to the spread of berry plants, including Black cherries, thereby increasing the effectiveness of their spread and invasive capacity in environments in which they are not normally distributed (Gosper et al. 2005, Deckers et al. 2008). The share of berries in the diet of forest mammals increases during the year (summer and autumn) (Baltrūnaitė 2001, Kurek 2011). Near the badgers' burrows, a range of different species of fruit trees and shrubs appear, facilitated by habitat conditions and badger endozoochory. Although the disturbance of habitats caused by these mammals is not extensive on a forest scale, they nevertheless directly increase forest community diversity locally and on a broader scale (Kurek et al. 2014). Therefore, the role of badgers in transforming plant communities should not be underestimated. Seeds transmitted by mammals germinate in the form of characteristic clumps (clusters) often composed of up to several dozen seedlings (Kurek 2011), and this was confirmed in our observations during the current work.

Black cherry seeds require stratification. In nature, they are subject to stratification on the forest floor during winter (Marquis 1990) and they may show delayed germination extending up to 3 years after being deposited (Marquis 1975). According to Krüssmann (1978) the germination capacity of seeds of the *Prunus* genus is 1–2 years, which is consistent with our finding that only a relatively small number of seeds with intact pericarps germinated (just over 10 %) whereas germination was 41 % in non-stratified black cherry seeds cleaned of pericarp.

Breaking of seed germination is an adaptation that allows plants to withstand the adverse environmental conditions (Starfinger 1991) and resume development when more favourable conditions return. Delayed germination results in the retention of significant amounts of seeds in the forest floor. It is estimated that hundreds or even thousands of black cherry seeds accumulate in the soil in any given year (Marquis 1975) and only about half germinate each spring (Uchytil 1991). The above reports are consistent with our findings, however, the mechanisms involved in the inhibition of germination of black cherry seeds are still largely unexplained and remain to be resolved by future research.

Some species of the *Prunus* genus require long periods of ripening, hot-cold stratification even before autumn sowing or they can be sown immediately after harvest (Grisez et al. 2008). Stratified seeds can be sown as early as possible in the spring, because high temperatures and drought can reduce the germination of black cherry (Huntzinger 1971). According to Hrynkiewicz-Sudnik et al. (2001) black cherry seeds should be sown in September or November after prior mixing of the seeds with sand and thereafter keeping them at low positive temperatures. This type of treatment according to Hrynkiewicz-Sudnik et al. (2001) is necessary because storing seeds without stratification until spring and followed by subsequent stratification, results in poor emergence.

Conclusions

Our findings show that endozoochory increases the germination capacity of black cherry seeds and contributes to their more effective germination. The pericarp inhibits the germination of black cherry seeds in the first year after sowing. Further observations will allow assessment of the ability of black cherry seeds with pericarp to germinate in the following years after sowing. Monitoring of badgers population and their participation in the spread of black cherry would be recommended.

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