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Seed dormancy of safflower – Do we have to worry about it?

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Abstract
Safflower (*Carthamus tinctorius*) varieties and genotypes often showed low emergence rates in previous experiments. Since no apparent seed damage was observed which could have reduced the germinability, dormancy was supposed to be the reason for the low germination. Aim of the current study was to determine innate seed dormancy of several safflower genotypes (*C. tinctorius*) and its weedy relative, saffron thistle (*C. lanatus*). 6–8 genotypes were grown at the experimental station Ihinger Hof, University of Hohenheim, SW Germany. Developing seeds were harvested at regular intervals in the years 2006 and 2007 and were then tested immediately for germinability, dormancy and water content by the standard methods of the institute. Seeds of *C. tinctorius* became germinable approximately four weeks after bloom. The maxima of germinability for all *C. tinctorius* genotypes ranged between 21% and 89% (2006) and 16–75% (2007). *C. lanatus* had a maximum germinability of 71% (2006) and 82% (2007). Depending on genotype, a maximum of 40% (year 2006) or 70% (2007) of seeds did not germinate and was rated as dormant at maturity. The ascertained genotypic variation in dormancy allows a selection for low dormancy in further breeding approaches in order to improve seedling emergence on the field.

Keywords: Seed - innate dormancy - germination

Introduction

Seed dormancy is a required trait as long as the seeds are developing on the flower head. This innate dormancy prevents seeds from pre-harvest sprouting and from deterioration in quality. At the time of sowing, seeds of cultivated plants have to be released from dormancy to guarantee high germination rates. If not, germination rates would be low, and seeds from harvesting loss could enter the soil seed bank and volunteer plants could germinate in following crops. Transgenic volunteers would contribute to unwanted seed admixtures and gene escape. Seeds of wild plants, for instance *C. lanatus*, often persist in the soil in the state of dormancy over several years and later germinate in other crops as weeds (Grace et al. 2002). Since low germination rates were observed from freshly harvested, apparently healthy safflower seeds, innate dormancy was supposed to be the reason. The development of innate dormancy on the flower head should be observed by harvesting seeds in intervals from flowering to maturing, associated by an immediate germination test. The hypotheses were 1. there is some innate dormancy left in the seeds at the time of harvesting, and 2. there is a genotypic variation in innate seed dormancy of safflower.

Materials and Methods

Six to eight genotypes of *C. tinctorius* and one accession of the wild relative *C. lanatus* were grown in plots (2 × 5m) in the years 2006 and 2007 at the experimental station of the University of Hohenheim, SW Germany. Flowers were tagged (2006: 25 July, 2007: 7 August), and 15 flower heads per genotype with developing seeds were harvested in weekly intervals beginning four weeks after flowering. A part of the seeds was then weighted, dried and re-weighted to determine the water content and with this the stage of maturity. For the germination test, 4 × 50 seeds from each genotype were placed on Petri dishes with 8 ml of water and germinated for two weeks under light at 20°C in a germination cabinet. Non-germinated seeds were treated with alternating light and temperature conditions (3°C/30°C; darkness/light; 12 hrs/12 hrs) for seven days at the end of the germination test to break dormancy. The method followed the standard dormancy test for oilseed rape of the University of Hohenheim. The data were evaluated by the SAS programme, using the procedure “mixed”.

Results

Seeds became germinable about four weeks after flowering. The germinability of *C. tinctorius* increased genotype-specific to a maximum of 21–89% in the year 2006, and to 16–75% in 2007 (Table 1). The seed moisture declined over the period of observation, depending on the genotype, from 48–74 to 5–15% (2006), and from 32–60% to 9–20% (2007).

Table 1. Development of germinability in safflower (*C. tinctorius, C. lanatus*) seeds during ripening in two growing seasons 2006 and 2007 (presented in selected intervals)

	2006					2007				
Date	23/08	06/09	20/09			11/09	02/10	16/10		
No.[1]	% Germinability			% un-germ. [2]	% seed moisture[3]	% Germinability			% un-germ. [2]	% seed moisture [3]
1	0	28	71 [c]	29 [b]	15	0	14	82 [a]	16 [b]	20
8	10	80	76 [b]	11 [c]	5	23	75	46 [b]	19 [b]	10
10	5	21	n.d.	n.d.	n.d.	1	16	2 [d]	70 [a]	14
16	11	63	85 [a]	11 [c]	7	24	51	50 [b]	23 [b]	10
17	23	66	68 [c]	17 [bc]	6	33	29	58 [b]	17 [b]	10
18	23	83	77 [b]	17 [c]	6	n.d.	n.d.	n.d.	n.d	n.d.
19	18	89	86 [a]	11 [c]	5	n.d.	n.d.	n.d.	n.d	n.d
20	36	57	53 [d]	40 [a]	5	8	24	13 [c]	8 [c]	9

[1] 1: *C. lanatus*; 8–20: *C. tinctorius* (16: Sabina, 17 Saffire, others: breeding lines); [2] % ungerminated seeds at final harvesting, apparently healthy, possibly dormant; [3] gravimetric, at the final harvesting date. No significant differences between values with same numbers, $p < 0.05$, significance given only for final date of harvesting; n.d.: not determined

Nearly no seeds germinated during the dormancy breaking treatment. Non-germinated, apparently healthy and hard seeds accounted for up to 40% (2006) or 70% (2007). The genotypes differed significantly, though non consistently over the two experimental years.

Discussion

Germinability of the seed samples differed significantly; the commercial varieties Sabina and Saffire had comparatively satisfactory germination rates. The dormancy breaking treatment which is usually highly effective to break oilseed rape (*Brassica napus)* dormancy (Gruber et al. 2004) can probably not be used for safflower. It is supposed that the non-germinated, healthy seeds were dormant and thus the reason for low germinability and emergence of sown safflower on the fields. There was a clear genotypic variation in the number of dormant seeds which should be considered in further breeding approaches. The high germinability of seeds even quite early after flowering indicates that there might exist the risk of open or hidden pre-harvest sprouting and deterioration of seed quality. The wild relative *C. lanatus* had germination rates similar to *C. tinctorius*.

Conclusions

A method for dormancy testing should be developed, specifically adapted to safflower, to release seeds from dormancy to clearly proof the viability of the non-germinated seeds. In regions with wet conditions, safflower could be harvested earlier to avoid the risk of pre-harvest sprouting and fungal diseases. Low germination and emergence rates can result from dormancy which is variety-specific. Safflower varieties should be tested and selected for low dormancy.

References

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