



Outcrossing rate of safflower (*Carthamus tinctorius* L.) genotypes under the agro climatic conditions of Northern Germany

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Abstract

Safflower oil is considered to be one of the highest quality vegetable oils for human nutrition, containing up to 90% linoleic acid. The cultivation of safflower would enlarge the number of species to increase biodiversity and widen crop rotation. Very little effort on safflower breeding has been done in Germany. The knowledge of the pollination system is a prerequisite of efficiently designing future breeding programmes. The cross pollination rate between and within plots was investigated in Göttingen (Latitude: 51° 32' North and Longitude: 9° 57' East) in 2004 and 2005. A plot of 10 m² of non-spiny plants was surrounded by plots of spiny plants. Ten non-spiny plants each of the border rows and of the core were harvested individually. The rate of cross pollination was calculated as the ratio of spiny to non-spiny offsprings. The average cross pollination was 6.5% (core), 9.7% (border no.1) and 18.1% (border no. 2). In a second experiment the rate of cross pollination within plots was estimated from non-spiny plants grown in mixture with spiny plants. The outcrossing rate was about 63% in 2004, but about 30% in 2005. Isolating or covering flowers by bags or cloth should be considered in pedigree breeding.

Key words: cross pollination rate

Introduction

In Germany oil crops are cultivated only on 2% of the organic farming area though there is a great demand for highly valuable oils for human consumption produced organically. Since rapeseed grown organically suffers hard under the pressure of a range of insects and other pests, safflower is considered to be of interest to dry areas of Germany. Very little effort on safflower breeding has been done in Germany. The knowledge of the pollination system of safflower is a prerequisite of efficiently designing future breeding programmes. Safflower is described as a self-pollinator with outcrossing rate of less than 10% (Knowles 1969) although Dajue and Mündel (1996) stated that environmental conditions may result in outcrossing exceeding 50%. Bees of several genera are attracted to safflower for pollen and nectar. Wind pollination is not the major factor in cross-pollination in safflower (Dajue and Mündel 1996). The objective of this study was to determine the outcrossing rate under the conditions of our breeding program in Göttingen, Northern Germany.

Materials and Methods

Selfed seeds of the variety 'Sabina' (non-spiny) and the spiny genotype CR1 (derived from a single plant with many spines found within the variety 'Sabina') were used, both with yellow flower colour. According to Pahlavani (2004) it was assumed that the trait 'spiny' is completely dominant over 'non-spiny'. In 2004, one plot of 10 m² of non-spiny 'Sabina' was planted with 40 achenes/m² surrounded by eight plots of 10 m² each with spiny plants. Ten non-spiny plants each of the border rows and of the core were harvested individually to calculate the outcrossing rate between plots. Border row no. 1 was next to a safflower field. To calculate the outcrossing rate within a plot 35 achenes of a selfed 'non-spiny' plant were sown in mixture with 315 achenes of the 'spiny' genotype in a second experiment in two years. Ten 'non-spiny' plants were harvested randomly. 500 offspring (50 per single plant from harvest 2004) were sown in



the greenhouse, 1350 offspring (135 per single plant from harvest 2005). For more details see Rudolphi (2007).

Results

The average outcrossing rate between plots was 6.5 % (core), 9.7% (border no.1) and 18.1% (border no. 2). Border no. 1 next to a safflower field showed less outcrossing than the border no. 2 (table 1).

Table 1. Outcrossing rate (%) between plots in 2004

	Number of offspring	'spiny' offspring	Outcrossing (%)	Range (%)
Border no. 1	353	33	9.7	5.7-17.1
Core	382	25	6.5	0.0-11.5
Border no. 2	259	47	18.1	8.3-33.3

The outcrossing rate within a 10m² plot was much larger than between plots. The outcrossing rate was influenced by the environmental conditions in both years. In 2004 outcrossing rate was for most plants between 50% and 65%, in 2005 average outcrossing rate was less 30% (table 2).

Table 2: Outcrossing rate (%) within plots of 10m²each in 2004 and 2005

	Number of offsprings	'spiny' offsprings	Outcrossing (%)	Range (%)
2004	372	219	63.1	39.8-87.1
2005	728	172	29.9	17.4-43.7

Discussion

Our investigations on outcrossing rate were limited to one location and one or two years only. The outcrossing rate within a plot differed remarkably in the two experimental years. Different environmental conditions in these two years may have caused these differences of more than 30%. Further investigations in coming years should take into consideration the influence of different genotypes, flower colour, and capitula position.

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