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RESEARCH ABOUT SEXUAL REPRODUCTION CYCLE OF CANADIAN THISTLE (*CIRSIUM ARVENSE*) WEED

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Abstract

Although the efficiency of the sexed reproduction of the species Cirsium arvense is situated at well-balanced to low levels despite its spread and gaining in light of new habitats, it is constantly growing. It is possible that the seed-set flower head (S-S FH), able to spread, may succeed in doing this if it has got a large range of information, as a result of an outcrossing and by the seedling' stamina which derives from morphologically well-selected seeds, that is bigger, fuller and heavier. Morphological variability of the S-S FH from the female capitula provides information over the possibility of their formation on the one hand, numerically speaking and their setting up or not of seed-set from male capitula which shows the structure of the clones' type by their number on the other hand. In the present study, the morphological variability of the S-S FH from the female capitula is analyzed according to their prolific location within the big inflorescence. The big and heavy seeds were formed on the first ramifications. Between the number of formed seed and their total weight, a negative correlation was found. The obtained data proved that only small seed-sets had an absolutely big absolutely weight. In this correlation, one might find an explanation in favor of natural and genetic formation of less but heavier seeds as a guarantee for the seedling's success in various habitats.

INTRODUCTION

Canadian thistle - *Cirsium arvense* L./Scop. is a widespread species in the Temperate Zone. Being a perennial plant, it insures its reproduction through vegetative propagation and sexual one. Its spreading takes place on the micro-level through its under-ground roots and on the macro-level through its seeds of type achene [2]. The seeds are being formed within a complex sexual system (Figure 1). The system is of dioecious mating type [5]. This requires the existence of female and male plants. The respective plants form offshoot stems named clones. Female clones are pollinated compulsory by the male ones [6, 7, 3]. This pollen carries out important genetic information and varied. Seed-sets from FH of female clones are variable and generally speaking reduced because of multiple causes. Among the most important factors which adjust the seed-sets, one can mention: genetic factor and pollination agents' mobility = insects. Important factors are: sexual differences they can be enclosed or remoted, the seed-predators and the degree of filling up

with endosperm. The less important factor is sexual rate, which can be equal, of 3 to 1 or more [8]. The male clones are genetically varied [5].

<table>
<tr><td colspan="6">THE MATING DIOECIOUS SYSTEM</td></tr>
<tr><td rowspan="4">THE FEMALE PART</td><td>Female plants</td><td><u>Pollination</u></td><td colspan="2">Male plants</td><td rowspan="4">THE MALE PART</td></tr>
<tr><td>Morphologically hermaphrodites</td><td></td><td colspan="2">Morphologically hermaphrodites</td></tr>
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Fig. 1. Sexual cycle structure of *Cirsium arvense* weed (original)

The male clones also form seed-sets and according to their number per set they can be defined as: hermaphrodites with sets of over 10 seeds a FH, subhermaphrodites with reduced sets, 1-10 per FH and clone only with pollen, that is without seeds. Among various types of clones, there are also large hybridizytions outcrossing. As a result of the female flower fecundation, seed-sets should contain genetic information as varied as possible. The question one would ask is: which of the formed seeds and spread, are successful in forming viable seedlings? The answer may be found in studies regarding variability of seed-sets formed in a couple of diverse populations of *Cirsium arvense*. In the present study, variability was obtained from the diversity of populations, diversity of sex-differences, diversity of FH depending on their location on floriferous branches.

MATERIAL AND METHODS

In order to determine the seed-production of *Cirsium arvense,* a few populations from extended specific spreading area from Arges county were chosen.

a) <u>Selecting ecotypes</u>: every population registered a good growth on a large area, measuring over 100 sq.m. each, with high densities of stems/clones. Both female and male plant populations developed in tilled fields.

b) Taking samples: they went in a zigzag direction that crossed the respective population, without trying a stationing-positioning right in front of a certain plant. A stationing was done at every 2 steps and FH were harvested out of the clone. Every referred clone was planned to be well grown and developed with big inflorescence. The FH were harvested separately from every 3 different levels, out of the first 1-3 floriferous branches, then from 4-6th branch and the third category out of 7-11th branch. This procedure was repeated 50 times, separately on the 3 types of floriferous branches.

c) The analysis of seed-sets: the flower-head (FH), one by one, according to ramifications' category and clone FH were harvested after stems within 12 days after its full flourishing on July. They considered that achenes were already formed and developed accordingly [1]. The samples were put to dry in lab conditions for 4-5 days. The FH were weighed according to categories of floriferous ramifications, seed-sets from every FH have been counted separately and also weighed. The sterile FH had been recorded separately. Estimation was made with the help of ordinary methods: Anova test, correlations and regressions by Excel program.

RESULTS AND DISCUSSION

The analysis of *Cirsium arvense*' population emphasized a specific variability.

i) The variability of seed-sets and of sterility. In the case of female clones, achene-sets varied both as interval (min to max) but also as location in inflorescence. On the harvested capitula from 1st-3rd branch, seed-sets were between 1-62 (F_3) and 1-74 (F_1). On the 4th to 6th branch, sees-sets varied between 1-63 (F_1) and 1-75 (F_2), and on the 7-11th branch between 1-54 (F_1) and 2-76 (F_2) (table 1). On the male clones, the M_1 ecotype had no seed-set; M_2 ecotype formed 6 achenes in only one FH on the 1-3 branch and 1-7 achenes in 2 FH on the 4-6th branch. The 3rd ecotype, M_3 formed achenes, only in 2 capitula with 1-6 seeds on the 1st-3rd branch. The FH' sterility has been extremely different. On the female clones the 1st-3rd branch had 9-34 percent sterility; the 4-6th branch had 17-51 sterility, and 7-11th branch between 40-73 percent without seeds. On the male clones, the sterility was between 84-100 %, which shows the prevalence of the pollen type versus subhermaphrodites type (1-7 seed-sets). As for sexual differences, the seed-sets were between 1-84, 1-71 and 1-67 on a middling-average distance from the male clones : between 2-83, 1-78 and 2-87 on the enclosed clones and in between 1-62, 1-58 and 1-72 at a great distance from the pollination agent. At first sight, one couldnot clearly divide any influence of the capitulum's branch location and of the sexual differences over seed-production. It was emphasized the growth of sterility percentage towards the base branches and through distance increase versus pollination agent.

Table 1

Seed-set number limits and sterile flowers in female and male clones of *Cirsium arvense*

Ecotype*	Seed-set number limits			Sterile flowers, %		
	branch no.			branch no.		
	1-3	4-6	7-11	1-3	4-6	7-11
F_1	1-74	1-63	1-54	33	51	73
F_2	2-69	1-75	2-76	9	17	40
F_3	1-62	1-68	1-72	34	30	44
M_1	0	0	0	100	100	100
M_2	6	1-7	0	88	84	100
M_3	1-6	0	0	86	100	100

*F-female, M-male

ii) The variability of capitula' morphology and seed-sets per FH. The female clones formed different fertile flower heads (FFH) according to their location on the floral branches (Table 2). The average degree of fertility registered higher value on the 1^{st}-3^{rd} branch, particularly 77%; the 4-6^{th} ramifications had FFH of about 67% and on the 7-11^{th} of only 45% fertility. The conclusion is that the analyzed Canadian thistle populations, 3/4 of the capitula from the 1^{st}-3^{rd} branch form seed-sets; 2/3 of middle capitula are fertile but those from the base form only 1/2 of capitula, seeds. The FH' weight was considerably equal, as well the populations' variability and its shows a good ecotypes' constancy. As for absolute values the FH' weight was in between 0.21- 0.22 gr. The average number of seeds showed values in between 26.3 on the 1^{st}-3^{rd} level; 24.8 seeds/FH on the 4-6^{th} level and 25.5 seeds/FH on the 7-11^{th} level. Achenes-set had an average total weight in between 0.0195 gr. on the first ramifications, 0.0150 gr. on the middle and 0.0149 gr. on the ground ramifications. The one thousand grains weight (TGW) was between in 0.76 gr. from 1^{st}-3^{rd} branch; 0.60 gr. on the 4-6^{th} branch and 0.59 gr. on the 7-11^{th} branch.

iii) Correlation between various morphologic characters. According to the increase of the FFH' percentage seed-sets production was positive. The estimation showed a growing rate of 2.7 seed at every 10% fertility growth. The correlation showed a favorable tendency of *Cirsium arvense* population to form more seeds by increasing the number of FFH (Figure 2). The correlation between FFH-% and TGW seemed to be initially almost null or close to 0 value. The estimation established a light increase, although recording a low correlation coefficient and therefore non-significant. The function showed that at every 10% rise of fertility percentage, TGW increased with 0.01 grams.

Table 2

Fertile female flower head and seed-set per capitulum variability

Branch position	FFH	FFH weight	Seed-set	Seed-set weight	TGW
	%	g.	no.	g.	g.
1-3	77	0.22	26.3	0.0195	0.76
4-6	67	0.22	24.8	0.0150	0.60
7-11	45	0.21	25.5	0.0149	0.59

The formed seeds had absolute weight a little influenced by the degree of FH' fertility. The correlation between number of seeds and their total weight (TGW) was negative and statistically not insured.

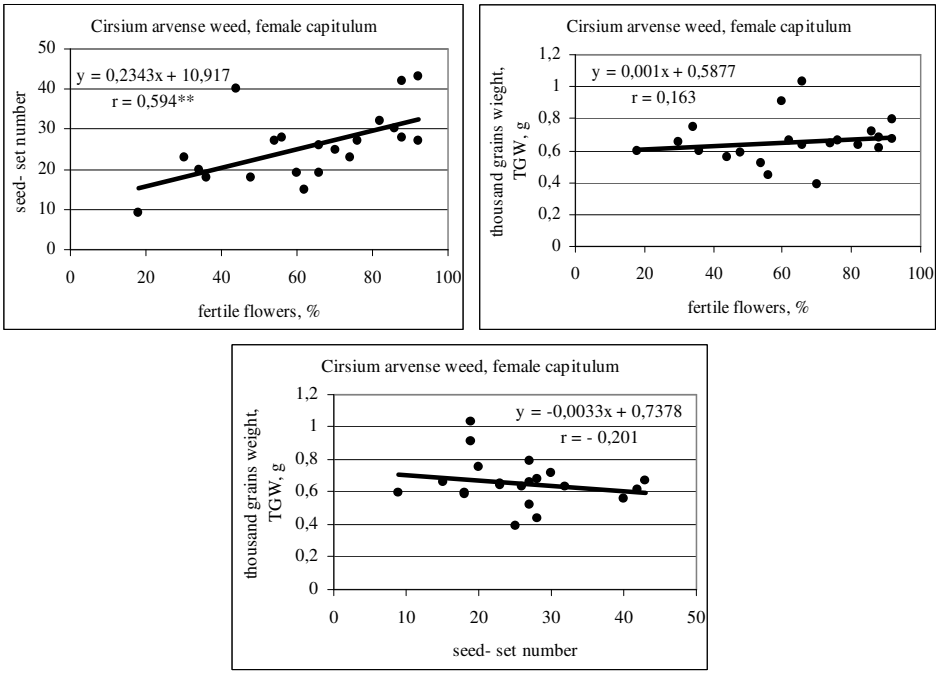

Fig. 2. Correlations between *C. arvense* fertile female flowers and morphological seed-sets characteristics

Out of the antagonism of the two morphologic characters resulted in a diminished value of TGW at every 10 achenes additionally formed. A smaller number of seeds brought about the increase of their absolute weight. The correlation might explain the inefficiency of sexed reproduction on *Cirsium arvense* through a smaller number of seeds as they were heavier.

CONCLUSIONS

1. The analysis of the seed-sets that the plant produces brings in some momentary information over the morphological diversity of populations within a specific zone. As part of female ecotypes, sterility recorded 9-73% and within FFH the seed-set was up to 1-76 pieces, with less obvious variations among the group of female plants. The reference material shows a great diversity in estimating FFH [6, 4, 8] but it displayed no variability according to location on the floriferous branches.
2. The seeds were formed either into the female clones' flowers or into the male ones. The sets in a reduced number proved a more advenced and evolutionary stage.
3. Achene-set per FH and TGW showed a very important negative connection that was the tendency of forming less numbered achene-sets but having a bigger weight.

REFERENCES

1. Derscheid L.A. & R.E. Schultz, 1960. *Achene development of Canada thistle and perennial sowthistle.* Weeds, vol. 8 (pp. 55-62).
2. Heimann B. & G.W. Cussans, 1996. *The importance of seeds and sexual reproduction in the population biology of Cirsium arvense- a literature review.* Weed Research, vol. 36 (pp. 493-503).
3. Kay Q.O.N., 1985. *Hermaphrodites and subhermaphrodites in a reputedly dioecious plant, Cirsium arvense (L)Scop.* New Phytologist, vol. 100 (pp. 457-472).
4. Lloyd D.C., 1976. *The transmission of genes via pollen and ovules in gynodioecious angiosperms.* Theor. Population Biology, vol. 9 (pp. 299-316).
5. Lloyd D.G. & A.J. Myall, 1976. *Sexual dimorphism in Cirsium arvense (L)Scop.* Annals of Botany, vol 40 (pp. 115-123).
6. Moore R.J., 1975. *The biology of Canadian weeds.13.Cirsium arvense (L)Scop.* Canadian Journal of Plant Science, vol. 55 (pp.1033-1048).
7. Sagar G.R. & H.M. Rawson, 1964. *The biology of Cirsium arvense (L)Scop.* Proceedings 7th British Weed Control Conference, Brighton UK (pp. 553-561).
8. Van Leeuwen B.H., 1987. *An explorative and comparative study on the population biology of the thistles C.Arvense, C.palustre and C.vulgare in a coastal sand- dune area.* Ph.D. Thesis, Rijksuniversiteit Leiden, The Netherlands (pp. 149).