

MATING DIOECIOUS SYSTEM OF *CIRSIIUM ARVENSE* (L.) SCOP. WEED

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Abstract

The species has an important presence in crops (Everitt et al., 2007). It occurs in- micro (asexually) by forming clones with different densities (Donald, 1994), and in-macro (sexually) by fruits with conquering new lands. The sexed propagation type is dioecious, with the presence of both female plants and those male. To express existent ecotype weed in the Southern Highlands area, they have made some determinations of variability. Thus, the male heads had in flourished time average size 14.6-15.1 mm / 7.0-7.5 mm, with or without fruits (achenes). Females flowerhead (capitula) were 25.4 mm / 8.8 mm and formed 22 achenes. Female clones had fruits 2.29 mm length, thickness 0.65 mm and 20.5 mm pappus. Some correlations obtained were positive and significant: between flowerhead dimensions $r = 0.375^{***}$ and 0.265^{**} in male populations and $r = 0.278^{*}$ the female population. Negative correlation was obtained between the sizes of the female clones fruits, $r = -0.037$. The present study demonstrated cross-type structure evolved in these conditions and wide possibilities that it has spread throughout the agricultural field.

Keywords: achenes, *C. arvense*, diversity, flowerheads/ capitula, male and female clones.

1. INTRODUCTION

Cirsium arvense (L.) Scop. (Pro syn. *Cnicus arvensis* Hoffm., *Serratula arvensis* L, Canadian thistle, perennial thistle, field thistle, CIRAR- Bayer code) is a perennial dicotyledonous (Moore, 1975; Gustavsson, 1994; American Flora, 2006), dioecious with male and female flowers, which are formed on different plants (Lloyd & Myall, 1976; Lalonde & Roitberg, 1994). The female flowers (pistillate) differ from the male (staminate) by the absence of pollen [abundant in male flowers (Kenneth, 1972)], the distinct smell of vanilla and smaller dimensions of corolla lobes- 2.8 mm vs 4.8 mm. The female flowers have larger pappus: 23 mm vs 11 mm, and larger involucre: 19 mm vs 13 mm. Male flowers rich in pollen evolved from an initial gynodioic population and exist in three forms (Kay, 1985): some with pollen and without fruits, other subhermaphrodites with small fruit sets (1-10), and the third hermaphrodites with greater than 10 fruit sets (Figure 1). From the recent research it has been found that the hermaphrodite clone (have male and female flowers on the same plant) is about 26% of male plants, capable of producing achenes. In the UK 15% of male flowers are hermaphrodites and produce 2-10 achenes/ flowerhead. The hermaphrodites resemble with typical male flowers. The incidence of hermaphroditism varies by location. Clones and individual strains can be also imperfectly dioecious. Except hermaphrodites, *C. arvense* flowers are

obliged out-crossers (Bureš, 2010). The flowers are by the way exclusively insect-pollinated (Ellis & Ellis-Adam, 1992). Of the 350 species of the *Cirsium* genus, insects prefer *C. arvense* due to the “accessibility of its copious nectar” (Van Der Kooi et al, 2015). Chromosome number for all *Cirsium arvense* varieties is $2n = 34$.

Flowerhead looks specific with flowers- corolla pink or purple. Flowers (florets) from a flowerhead are similar. Small flowers are closed in heads/ capitula, which is 1.0-1.5 cm in diameter and 1.3-1.5 cm tall. Flower color varies from lavender to pink or white. Flowers lasts for a long enough period. Stigmata are receptive for 3-8 days when pollen is abundant and 5 other days when pollen availability is lower. Achene fruit set depend on pollen (Ionescu and Ionescu, 2012). In addition the male and female plants are close, pollination is high and decreases when the distance is over 50 m. The fruits (achene type) were 2.5-3.2 mm length and of 1.0 mm in diameter. Their color is brown shades. Achenes weight depends on ecotype, being 0.67-1.52 mg/ seed, with an average of 1.08 mg. After training achenes still need 8-10 days to become sufficient mature to be able to germinate.

In recent years there has been a quantitative analysis on the structure of existing ecotype. It took into account the morphological characteristics of the reproductive organs of the plant *C. arvense* scattered in different crops. Determinations took place in two periods. At flowering were measured length and width of the heads. At maturity analyzed the number of achenes formed in each flowerhead, along with achenes dimensions (length and width). In female flowerhead measured pappus length.

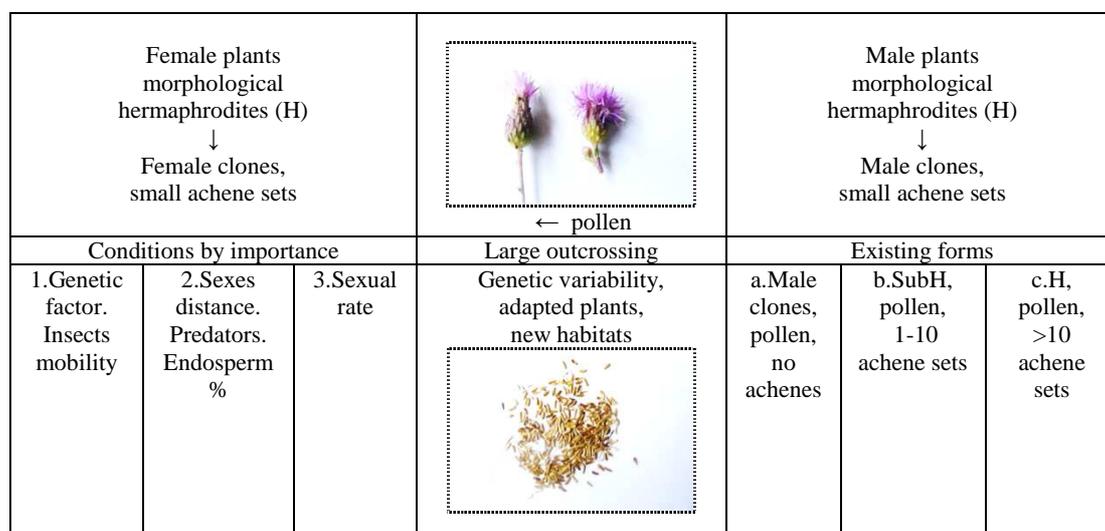


Figure 1. Mating Dioecious System (MDS) of *Cirsium arvense* weed

2. MATERIALS AND METHODS

Measurements were carried out in July last two years (2016-2018). *C. arvense* plants analyzed were found in different areas of local farms with natural weeding. Studied area was located in the perimeter of Albota, Argeş County. In flowering stage were measured with ruler the *C. arvense* flowerhead by length and width both male and female clones. After three weeks after flowering, were harvested mature heads. The method consisted by passing in zig-zag through large fireplaces, developed weed without a guided positioning. Thus they were collected by 100 heads each of two male populations and 100 heads of female population. The distance between populations was from close to 50 m. The samples were brought to the laboratory for maturing and determinations. After

15 days of harvest was considered that the fruits were swept and were measured the number of achenes/ male heads. The female heads were measured achene no., achene length and width, and pappus length. The data shown represents the average of the measurements made.

Measured morphological characters were analyzed by three directions. The first direction was the establishment of morphological variability, with the model of polygons frequency (%), or histograms. The method allows the expression in several ways: i) modal values (highest frequencies), ii) trends and extremes characters, iii) the specifics of each character expressed. Among the analyzed characters were established some correlations, by which they could observe and study their tendencies within ecotype. The expressions values was used Excel. Another direction was variance analysis of data obtained from measurements. Statistical parameters used were: i) $\bar{a} = \frac{\sum x}{n}$, where \bar{a} = media, x = values, ii) S^2 (variance) = $\frac{1}{n-1} \left[\sum x^2 - \frac{(\sum x)^2}{n} \right]$, iii) S (standard error) = $\sqrt{S^2}$ and iv) S % (variation coefficient) = $\frac{S}{\bar{a}} \cdot 100$. Finally it has developed a comparative study synthesis of flowers and fruits characters variability of *C. arvense*.

3. RESULTS AND DISCUSSIONS

Size variability of *C. arvense* flowerheads. The heads male clones lengths were between 12 and 18 mm (a population) (figure 2).

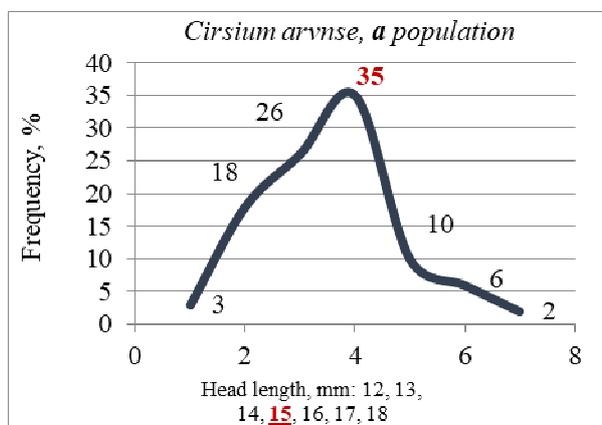


Figure 2. Length frequencies of *C. arvense* male capitula, a population

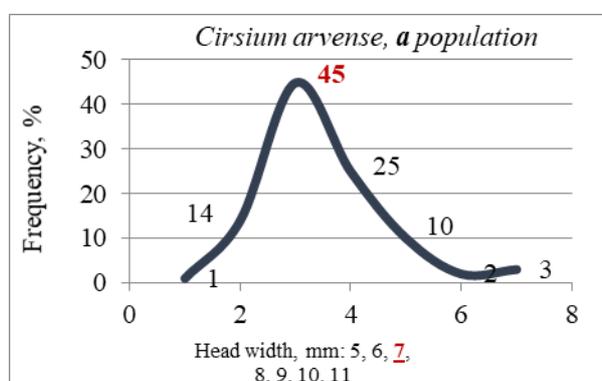


Figure 3. Thickness frequencies of *C. arvense* male capitula, a population

The highest frequencies were 15 mm (35%), followed by the 14 mm (26%) and 13 mm (18%). Extreme lengths represented 5% of the total. The width of the heads was scored between 5 and 11 mm. The highest frequency was 7 mm (45%), followed by the 8 mm (25%). Heads of 5 mm width was only 1% (figure 3).

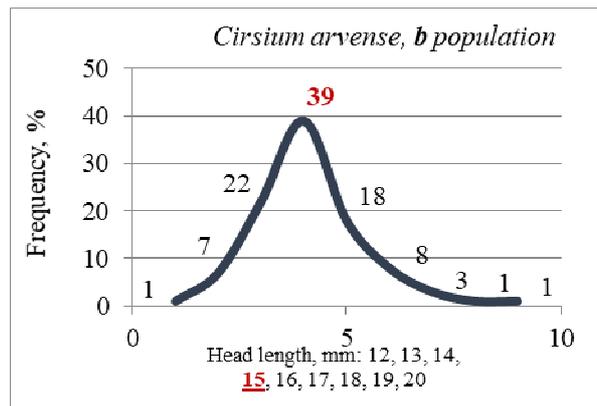


Figure 4. Length frequencies of *C. arvensis* male capitula, *b* population

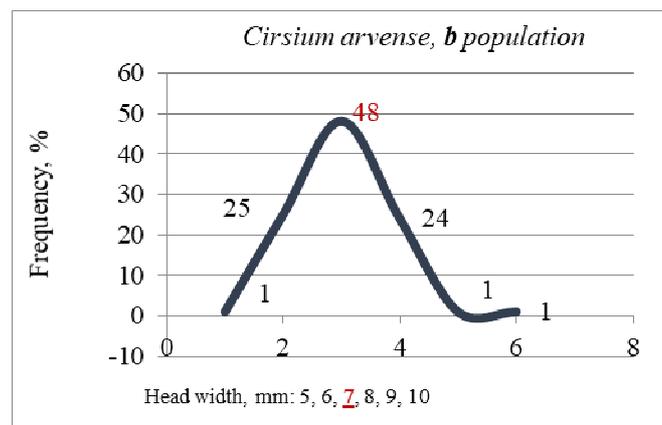


Figure 5. Thickness frequencies of *C. arvensis* male capitula, *b* population

Male clones of *b* population have had the heads between 12 and 20 mm, with greater frequency to 15 mm (39%). Extremes accounted for 5% (figure 4). Head width was 5-10 mm with the modal value of 7 mm (48%), and the measurements of extremes represented 3% of the total (figure 5).

Flowering takes place in long day conditions (figures 6 and 7). With some exceptions the ecotypes are necessary between 14-16 hours of light during the day. For 14 hour light is needed a daily temperature little higher. In our conditions, in July is 14 to 15 hours day light, with an average of temperature of 21°C.

Correlations between the two dimensions obtained show positive result, upwards. Thus, the *a* population the provision of statistical point of view was clearly evident, $r = 0.375^{***}$ (figure 8). Data for *b* population were similar, increasing and distinct significant, $r = 0.265^{***}$. Variability of *a* population was slightly higher, while the *b* population was grouped. The relationships obtained show that under the existing conditions weeds that produced the longest heads had larger thickness (figure 9).



Figure 6. Male flowers, staminate



Figure 7. Capitula from male clones of *C. arvense* weed

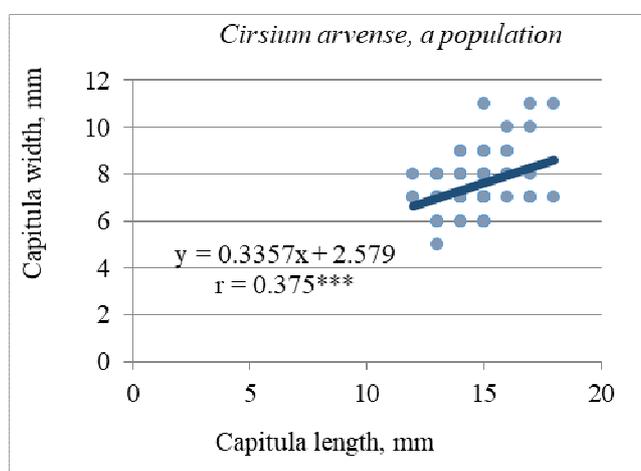


Figure 8. Correlation between male capitula dimensions of *C. arvense*, population *a*

Size of the female heads variability was different and specific (figure 10). Thus the heads length was between 18 and 36 mm, with the highest frequency from 27 to 29 mm (43%). This was followed by the lengths of 30-32 mm at a rate of 23% and 19% of 24 to 26 mm. The extremes were only 2 %. Head width ranged from 6 to 13 mm. Greater frequencies of capitulas had a 10 mm (26%), followed by the 9 mm (23%) (figure 11).

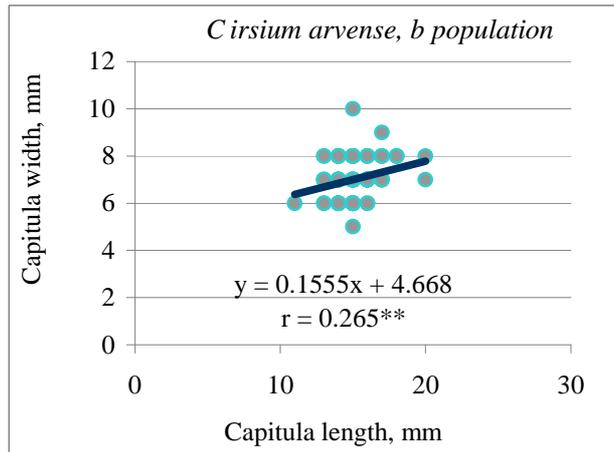


Figure 9. Correlation between male capitula dimensions of *C. arvense*, population *b*

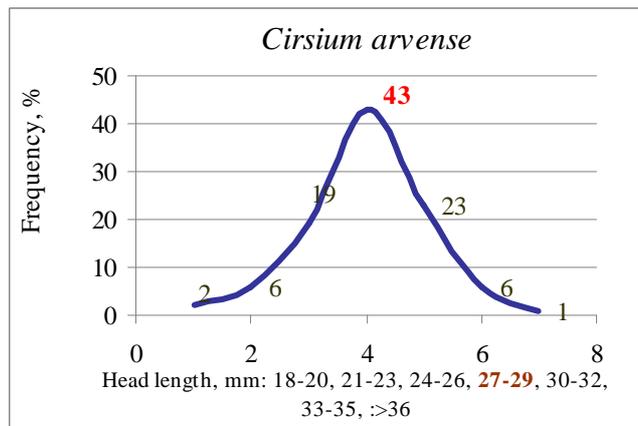


Figure 10. Length frequencies of *C. arvense* female capitula

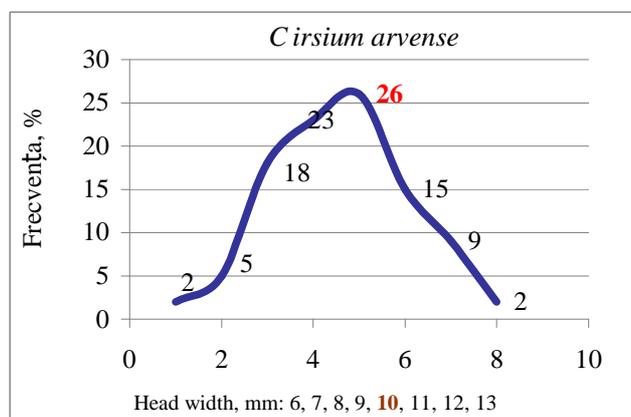


Figure 11. Thickness frequencies of *C. arvense* female capitula

Number of flowers (florets) in every head varies by clone. This can form between 100-4 30 and even 1120 into a capitula. Appearance of the blooming heads of female clones showing some morphological differences, visible in the field. Generally their flowering period is identical to that of male clones (figures 12 and 13).



Figure 12. Female flowers, pistillate.



Figure 13. Capitula from female clones of C.arvensis weed

Achene structure sets of *C. arvensis* male clones. Among the populations analyzed was chosen two different structural characters. Thus, the first population which 99 % of heads were formed only pollen, and 1 % of heads formed two achenes, like subhermaphrodite (table 1). Second population structure was more complex. 78 % were producing pollen, 21 % formed 1-9 subhermaphrodites achenes, in 1 % of heads were 13 achenes as hermaphrodites.

Table 1. Structure of achene sets from male clones (%)

Clones type	No. achenes	Population A, %	Population B, %
Pollen, no achene	0	99	78
Subhermafrodites, pollen, achene 1-10 sets	1	-	8
	2	1	3
	3	-	4
	4	-	1
	6	-	4
	9	-	1
Hermafrodites, polen, achene >10 sets	13	-	1

Variability of *C. arvense* female clones achenes. The heads of the female clones produce fruits like achenes type in a variable number (figure 14). In terms of field grown on average 59 may be formed/ head. Values obtained show limits between 3 and 72 pieces/ head. The highest frequency was obtained from 13 to 22 fruits/ head (29%), followed by one with 23-32 fruits/ head (25%), and 3-12 fruits/ head (22%). The set with 72 pieces/ head accounted for 1 % of the total. Achenes aspect is specific (figure 15).

Achenes had specific size variability. So long it had limits between 2.0 mm and 3.3 mm. Frequency distribution was discontinuous (figure 16). Thus the maximum values were in the 2.4-2.5 mm (24%) and 2.8-2.9 mm (24%). Values of over 3.0 mm of the length of the achenes were only 5 %. The width of the fruits followed the same uneven distribution curve. The amount of modal was obtained as 0.6 mm (26%) and 0.8 mm (26%). Fruit with 0.4 mm was only 1 % (figure 17). Pappus length of female heads is considered somewhat long as that of male flowers. Pappus from female heads ranged between 17 mm and 31 mm (figure 18). High frequencies of pappus had flowers of 20-22 mm (41%) and 23-25 mm (46%). The longest pappus with 29-31 mm accounted for only 1 %. Into the field female flowerheads are expressed by a compact mass whitish falls off by the wind (figure 19). Male pappus remains common between dry petals.

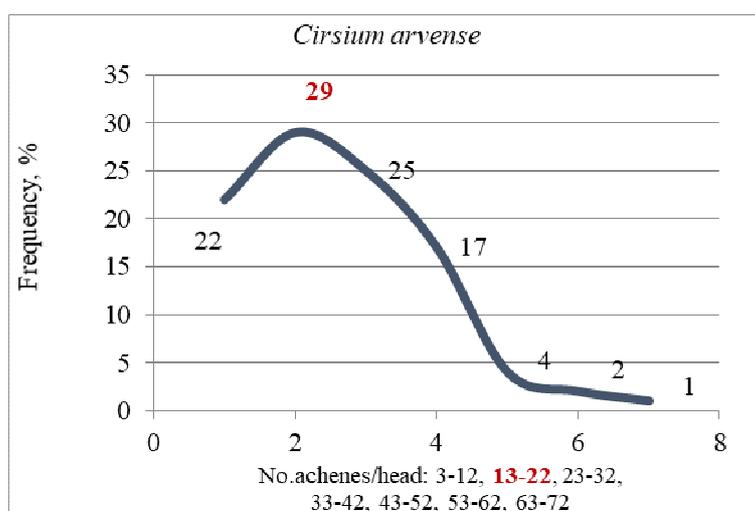


Figure 14. Frequencies of achene no. from female capitula



Figure 15. Fruits/ achenes of female head, general aspect

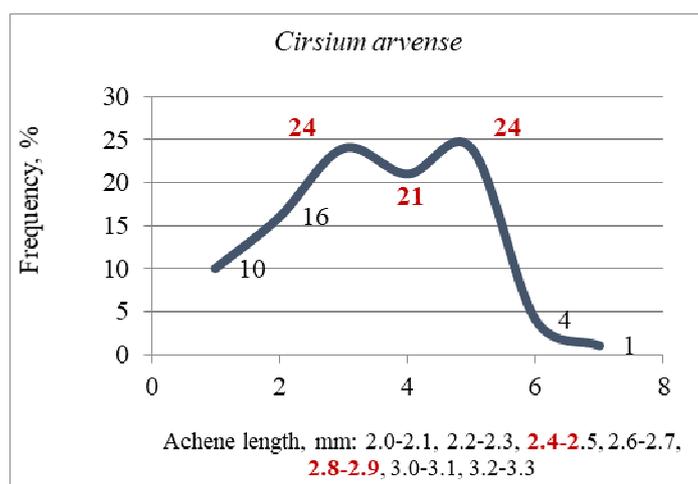


Figure 16. Frequencies of achene length from female fruits, *C. arvense* weed

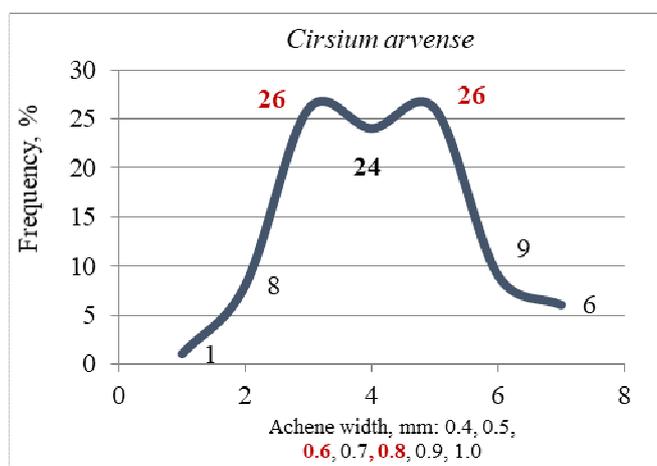


Figure 17. Frequencies of achene width from female fruits, *C. arvense* weed

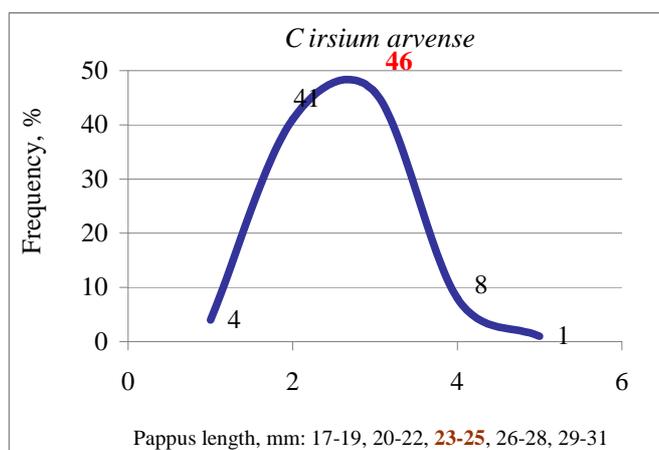


Figure 18. Frequencies of female pappus length.



Figure 19. The pappus from female capitulum

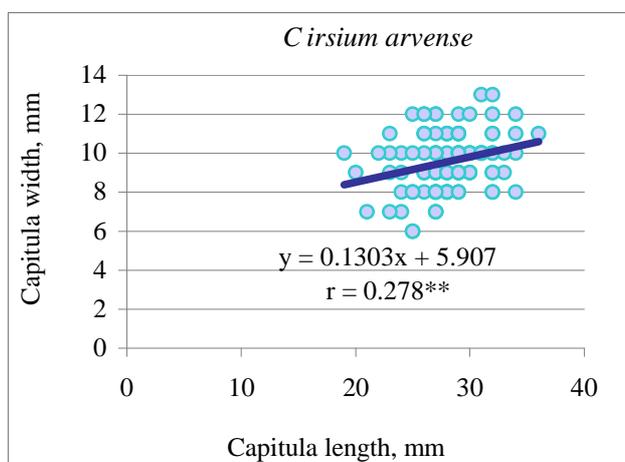


Figure 20. Correlations between capitula dimensions, female heads

Correlations obtained between female characters showed different aspects (Figure 20). Between length and width of head obtained a positive and positive correlation with $r = 0.278^{**}$. Between length and width of achenes correlation shows negative trend ($r = -0.037$), insignificant. It follows that the length of the achenes was less dependent on the width, it being possible for the two sizes to be practically independent (figure 21).

Between a number of achenes from a head and length were obtained positive and significant correlation, $r = 0.226^*$. If the heads formed more fruits, so their length was greater (figure 22). The cause may be the environment that living conditions were more favorable.

The correlation between the pappus length and achene length has negative trend, $r = -0.0023$, close to zero. Conclusion: pappus is formed regardless of the achene length.

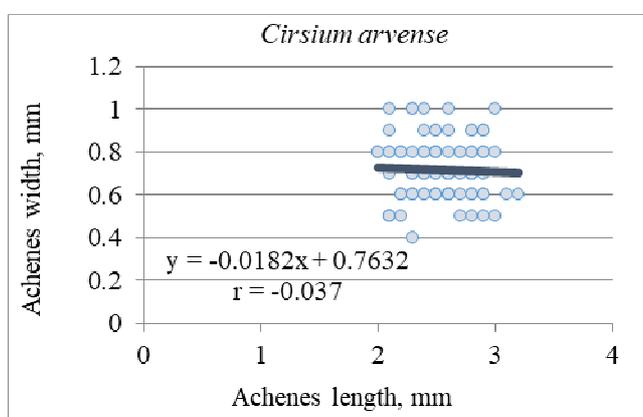


Figure 21. Correlations between achenes dimensions, female heads

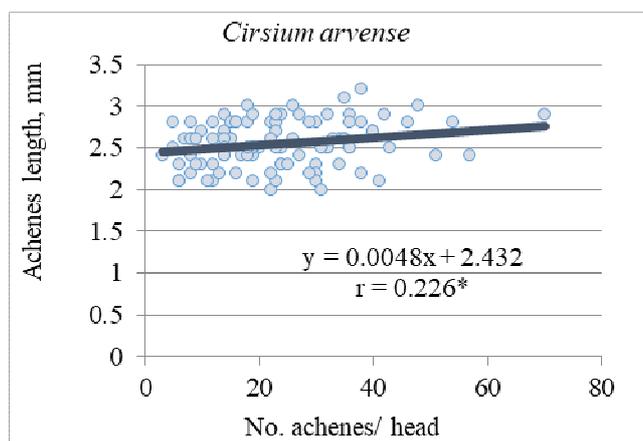


Figure 22. Correlations between no.achenes/capitula with achene length

In general, the whole situation emerged very favourable correlations between the capitula length with pappus length ($r = 0.368^{***}$) and between capitula width with total number of achenes ($r = 0.412^{***}$) (table 2). Negative correlation were reached between achene dimensions ($r = -0.037$), and between achene length and pappus length ($r = -0.0023$).

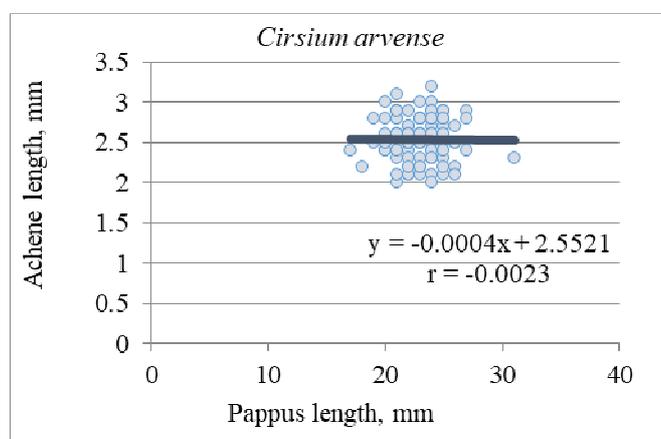


Figure 23. Correlations between pappus length with achene length

Table 2. Correlations between female fruits character of C.arvense

Character	Capitula length	Capitula width	No. achenes	Achene length	Achene width	Pappus length
Capitula length	1	0.278**	0.254**	0.014	0.175	0.368***
Capitula width		1	0.412***	0.162	0.256**	0.071
No. achenes			1	0.226*	0.079	0.167
Achene length				1	-0.037	-0.0023
Achene width					1	0.006
Pappus length						1

LSD 5 % = 0.19 LSD 1 % = 0.25 LSD 0.1 % = 0.32

Statistical analysis of the flowerhead and fruits characters. Data obtained that could express the specific way in which weed was adapted in agricultural field of the South, may be typical. Thus, the length of male heads was 14-15 mm with a width of 7 mm. Female capitula were 25 mm in length and 8-9 mm in width (table 3 and 4). Achene number of female head was 21-22, with length average of 2.3 mm and 0.6-0.7 mm width. Pappus had 20-21 mm length.

Table 3. Statistic indices of Cirsium arvense (L)Scop. fruits. A. Male capitula

Indices	Male heads, population a		Male heads, population b	
	Length, mm	Width, mm	Length, mm	Width, mm
Mean, \bar{a}	14.57	7.47	15.13	7.02
Variance, s^2	1.601	1.282	1.932	0.666
Standard error, s	1.265	1.132	1.3901	0.8162
Variation coef., %	8.68	15.15	8.65	11.63

Table 4. Statistic indices of Cirsium arvense (L)Scop. fruits. B. Female capitula

Indices	Heads/ capitula		Fruits/ achene			Pappus length, mm
	Length, mm	Width, mm	No./head	Length, mm	Width, mm	
Mean, \bar{a}	25.41	8.77	21.61	2.292	0.651	20.48
Variance, s^2	156.78	17.39	257.49	1.306	0.109	110.635
Standard error, s	12.521	4.170	16.047	1.143	0.331	10.518
Variation coef., %	49.28	47.55	74.26	49.87	50.84	51.36

The variation coefficient (VC,%) was low: 8-15 % for male head dimensions, and big- bigger for all female parameters (head and fruit achene type). In general, the diversity of flowers and fruits of C.

arvense characters dressed specific issues, possibly by adapting on this type of soil from southern territory.

4. CONCLUSIONS

A common species that cause significant damage of crops is *C.arvense* (*L*) *Scop*. The weed is widespread in the southern territory, because this ecotype may be well adapted by its special biology. In order to control through proper management is good to know as it's special reproduction system and as many characters. It was found that a species expressing widest variability may find it easier means of control and stop eventually. Morphological variability, especially reproductive, being less known, could express eco-existing type here.

Table 5. Mean values of *Cirsium arvense* (*L*) *Scop*. weed fruits characters

Fruits characters		Literature	Research
Headflower length, mm	male	13 – 15	12 - 18
	female	13 – 15	19 - 36
Headflower width, mm	male	10 – 15	5 – 11
	female	10 - 15	6 - 13
No.achenes/ headflower	male	4 - 6	0 - 13
	female	40 - 59	3 - 70
Achene length, mm		2.5 – 3.2	2.0 – 3.2
Achene width, mm		0.9 – 1.0	0.4 – 1.0
Achene weight, mg		0.67- 1.52	-
Female pappus length/ mm		-	17 - 31

We have had *C. arvense* capitula a little longer length, and a little short width (table 5). Another determined characters were: male achenes no./capitulul express 1% subhermaphrodite by 99% without fruits for population a, and 1% hermaphrodites, 21% sufhermaphrodites, 78% without fruits by population b. From female capitulul the achenes were with dimensions little shorter, and the papus length with 17-31 mm.

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