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ASPECTS OF Linaria vulgaris Mill. WEED FRUITS VARIABILITY

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ABSTRACT

A common species here too is Linaria vulgaris Mill. The plant grows in small, dense clumps around and within various agricultural soils. Recently, there has been an increase in the spread of this weed, especially in the area of poor soils in the south of the territory. Morphological characters have shown a continuous evolution, depending on the existing ecotype at a given time. Thus, the raceme measured 13 cm long and weighed approx. 240 mg. 7.2 seed capsules formed on one raceme. The capsules had a length of 8 cm, a width of 4.7 cm and a mass of 115 mg. 90 seeds were formed on one raceme, the average diameter of which was 2 mm. Significant positive correlations were obtained between most determined characters. Negative correlations were only between seed fin width with the other characters. The determinations made demonstrated the increased adaptability of the weed to the current ecological conditions of the albic luvic soil from South part of country.

INTRODUCTION

The adaptation of the weed to the current ecological conditions can also be ascertained by studying the aspects of the variability of some morphological characters. A species that expresses the greatest variability of reproductive characters, manages to adapt much better to the conditions in a crop or any other plant area. A well-known weed in agricultural fields is also *Linaria vulgaris* L. (pro syn *L. acutiloba* Fisch. ex Rchb., *L. glaucophylla* Schur., *L. vulgaris- glandulosa* Lej., common toadflax, yellow toadflax, butter-and-eggs, LINVU in Bayer code). The name *Linaria* indicates the resemblance of the leaves to those of flax (of the genus *Linum*). The plant is a perennial herb that has traditionally been placed in the *Scrophulariaceae* family. However, following the phylogenetic analysis (Mazuecos et al. 2013) the plant was introduced into the new *Plantaginaceae* family. This new family also includes genera such as *Antirrhium*, *Cymbalaria*, or *Nuttallanthus* (this being recently separated from *Linaria* of American origin). The plant is native to the temperate regions of Europe, North Africa and Asia. The multitude of species (of the order of tens) of the genus *Linaria* have experienced an obvious spread around the Mediterranean Sea (Sing & Peterson 2011). In our country, LINVU grows throughout the country and is found in the spontaneous flora of the plains and hills, but also on uncultivated land, through orchards, fodder crops, vineyards and the edges of gardens. In our country it has only one variety, *glabra*. It prefers diverse soils, from slightly acidic to neutral, poor in humus, loose, predominantly without calcium, as are those in the resort. The plant stands out for its short high (30-60 cm), simple stem and linear-lanceolate leaves. The flowers are arranged in terminal racemes, yellow in color, with the zygomorphic configuration, being visited by bees and a multitude of other insects. Apart from the fact that the plant is melliferous (Van Der Kooi et al. 2015), its younger parts can be used for culinary purposes. From a medicinal point of view (Foster & Duke 2000) the plant contains alkaloids of the linarine type (*pegaine*), flavonoids, flavonoglycosides (*aurones*), organic acids: arthric, formic, citric, malic, tannic, sugars, pectins, fats and various salts minerals.

The main properties of the plant are: emollient, depurative, laxative, diuretic, anti-hemorrhoidal, sudorific, cleans the liver and urinary tract, vermifuge and helps to increase potency. Flowers are used in phytotherapy.

From a genetic point of view, the plant has 2n= 12. The plant forms cylindrical-elongated poricidal capsules (with pores), which emerge from the calyx. The thickness of the capsules is approx. ½ of their length. Many flattened, round seeds with a diameter of 0.2 mm are formed in the capsules. The seeds have an external area in the form of a fin. To define some morphological characters of the fruits of this species, the following were measured: the length and weight of the raceme, the number of capsules on the raceme, the length and thickness of the capsules, the number of seeds in a raceme, the diameter of the seeds and the width of the seed fin (figure 1 and figure 2).

Figure 1. Flowering shoots of *L. vulgaris*

Figure 2. Capsules on the raceme

MATERIALS AND METHODS

The determinations were carried out during October on the mature shoots of *Linaria vulgaris*, in the last two years. Plants were chosen from the hearths located ruderal and segetal within the resort. Thus, 100 shoots of *L. vulgaris* were harvested, by cutting from the base of the raceme, from several hearts, by crossing in the zigzag system. The racemes were brought to the laboratory, kept for a while to dry, after which each one was analyzed separately. Measurements and determinations were as follows: length and weight of raceme, number, length, width and weight of capsules per raceme, number, weight and diameter of seeds, width of outer fin of seeds. Because of the very small mass of seeds on one plant, the weight of one thousand seeds was made at the level of 100 racemes. The study of the morphological characters in the *Linaria vulgaris* species was done in three directions. Thus, analyzes were made on the data sets obtained, namely by the method of frequency polygons (of histograms). Class intervals were used in the method. The histograms present, on the one hand, the mode values (highest frequencies), then the limits of the variability intervals of the studied characters, as well as the specificity of each character of the plant ecotype in the analyzed area. On the other hand, simple correlations were established between the analyzed characters, with the help of which their trends could also be observed within the studied ecotype. The Excel program was used to express the values. The obtained data were compared with the theoretical values of the transgression probabilities for 5%, 1% and 0.1%. Thirdly, for the statistical calculation of all the determined characters, the analysis of variance (anova test) was used, namely on the variation strings. Statistical parameters were calculated using the formulas: $\bar{a} = \Sigma x/n$, where $\bar{a}$ = the average of the determinations, and x = the determined values, S^2 (variance) $= 1/(n-1)\ [\Sigma x^2 - (\Sigma x)^2/n]$, S (standard error) $= \sqrt{(S^2)}$ and S % (coefficient of variation) $= S/\bar{a}100$.

RESULTS AND DISCUSSIONS

Morphological variability of racemes, capsules and seeds. There was competition between the plants in the different agricultural locations and those of the weed. In this interaction the weed formed plants with specific morphological characters. Thus, the length of the raceme on an average shoot was between 8 and over 22 cm (figure 3). Of these, those with 12-14 cm dominated (29-28%). Close to them were the racemes that measured 16 cm (12 %), 18-10 cm (9-8 %) and 20 cm (7 %), respectively. From these data it follows that within the hearth the species had a relatively small waist, specific, from the rather high density of the productive shoots within the respective hearth.

The biomass of a raceme ranged from 100 mg to over 500 mg. (figure 4). Dominant were the racemes with weights of 150 mg (23 %). Those with 200 mg represented 19%, and those with 250-300 mg, 13%. Plants with 350-400 mg each represented 10-8% of the total. Racemes with biomass of 100 mg and 450 mg each contributed 5% of the total. A fragment of the mature raceme of the weed is shown in Figure 6.

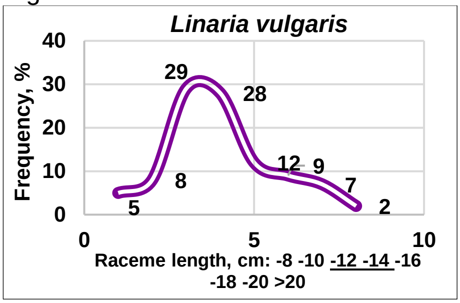

Figure 3. Frequencies of raceme length

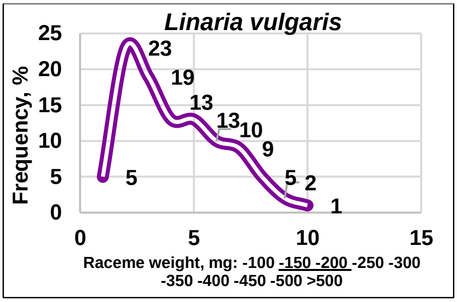

Figure 4. Frequencies of raceme weight

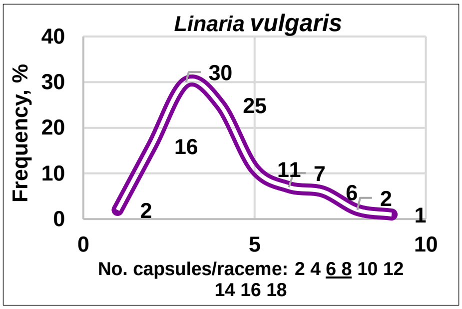

Figure 5. Frequencies of no. capsules/raceme

Figure 6. Raceme of *Linaria vulgaris*

Between 2 and 18 seed-filled capsules were formed on a medium raceme (figure 5). Racemes with 6 capsules dominated (30 %). These were followed by those with 8 capsules (25%), by those with 4 (16%) and those with 10 capsules (11%). Racemes with 12-14 capsules constituted 7% and 6% respectively of the total. A single raceme produced 18 capsules filled with normal seeds. The appearance of capsules on a raceme is shown in figure 6.

The dimensions of the capsules expressed by length and thickness demonstrated specific aspects. Thus, their length fell between 6 and 10 mm (figure 7). 8 mm long capsules dominated (28 %).

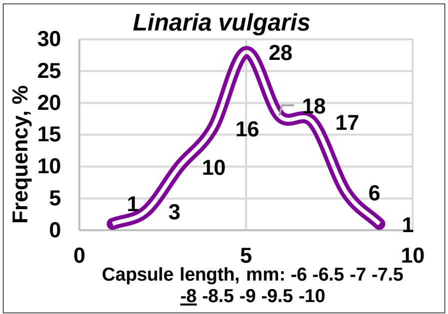

Figure 7. Frequencies of capsule length

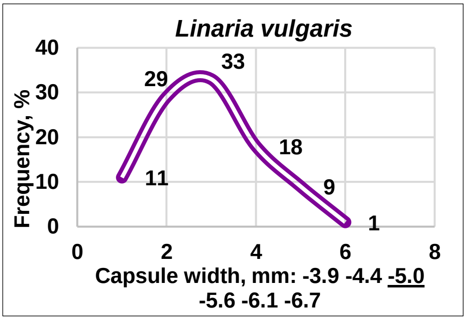

Figure 8. Frequencies of capsule width

Capsules with lengths between 7.5 mm (16 %), 8.5 mm (18 %) and 9 mm (17 %) followed. The length extremes of the capsules constituted one unit of the total. Regarding the thickness of these capsules, the dimensions were between 3.9 mm and 6.7 mm (figure 8). Capsules with a thickness of 5 mm (32 %) were dominant, followed by those with a thickness of 4.4 mm (29 %). Fruits with 5.6 mm (18 %) and 3.9 mm (11 %) followed. Capsules with larger thicknesses constituted only 10% of the total.

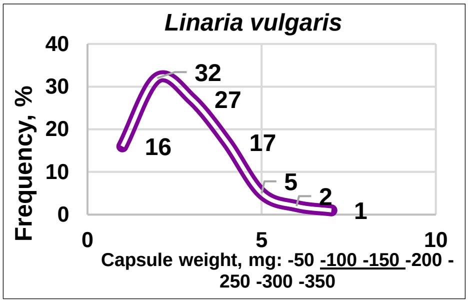

Figure 9. Frequencies of capsule weight

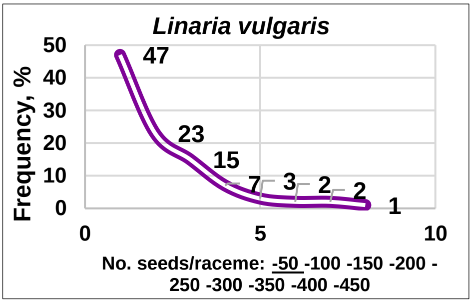

Figure 10. Frequencies of no.seeds /raceme

Regarding the biomass of these capsules, the values obtained show limits between 50 mg and 350 mg (figure 9). Dominant were the weights of 100 mg (32 %) and 150 mg (27 %). Capsules with weights of 50 mg and 200 mg respectively constituted 16 % and 17 % respectively. Heavier capsules between 250 mg and 350 g accounted for a total of 8%. The number of seeds on a raceme was very fluctuating mostly due to the specific fruiting, as well as significant attack by insects, which feed on the formed seeds. The obtained values ranged between 50 and 450 seeds per raceme (figure 10). The average values of 50 seeds/raceme (47%) dominated, after which the values followed rather steep decreases, so that at 250-300-400-450 seeds/head they represented only 8% of the total. Figure 11 shows the arrangement of the seeds in the capsule, and figure 12 shows the appearance of the seeds together with one of the predators (a *Curculionidae*).

Figure 11. Capsules with seeds

Figure 12. Seeds with an insect which eat it

The seeds formed by L. vulgaris have a circular appearance, flattened and with a small depression through which they are attached to the inner wall of the capsule. Their color is black when mature. The size of these seeds, respectively the diameter, was variable, namely between 1.7 mm and 2.5 mm (figure 13). Sizes of 2.0-2.1 mm dominated (27% and 29%, respectively). They were followed by those with a diameter of 2.2 mm (17%), while the other sizes had percentages below 10%.

In the general appearance of the seed of this plant, it is found that between the germs formed in the central portion- as a thickening and the edge, there is a flattened portion in the form of a fin (figure 12). From the determinations made on its width, values between 0.1 mm and 0.5 mm were found (figure 14). Fins with a width of 0.2 mm dominated (43 %), followed by those with a width of 0.3 mm (34 %). Fins with a width of 0.1 mm constituted 13%, and those with a width of 0.4-0.5 mm were at the level of 10%.

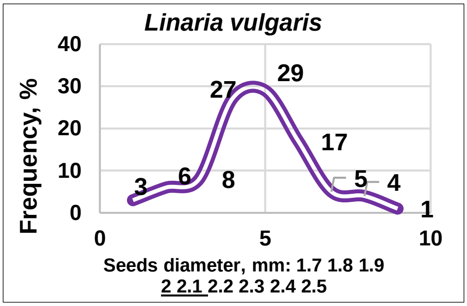

Figure 13. Frequencies of seed diameter

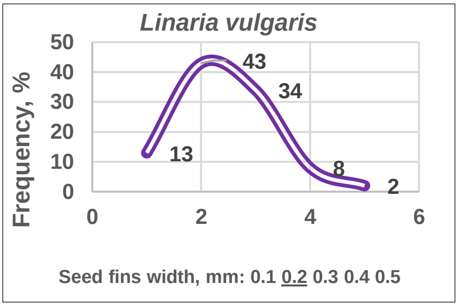

Figure 14. Frequencies of seed fins width

<u>Correlations between the main characters</u>. Simple correlations were established between the morphological characters of the weed fruits. The aim was to observe their manifestation tendencies in the researched area. Except for seed fin width with negative correlations with most other characters, among all other determinations the correlations were positive and mostly significant (table 1). Among

all the links obtained, one with a positive and significant trend and one positive, but insignificant, will be presented. Thus, the correlation between the number of capsules per raceme and the number of seeds/racemes was distinctly positive (r = 0.251**) (figure 15). The graph shows the large scatter of the data, which demonstrates, on the one hand, the less controlled variability of seed formation, or the existence of factors that could reduce the normal number of seeds in a chapter, such as predator attack. Between raceme length and the number of seeds/racemes, the correlation was positive, but without statistical assurance (r = 0.169). The graph shows a very large dispersion of the number according to the length of the raceme (figure 16). This aspect demonstrates a less obvious dependence between the two characters, which sometimes does not imply causality.

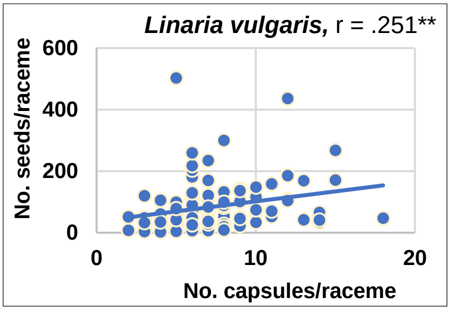

Figure 15. Correlation no.capsules x no.seeds

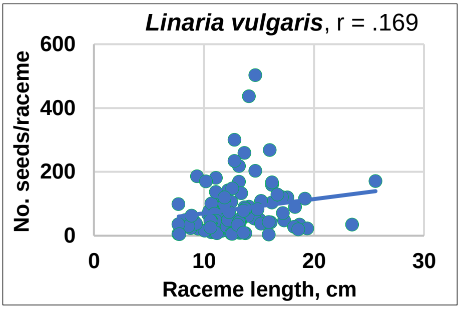

Figure 16. Correlation no.seeds x seeds diameter

Table 1.

Correlations between *Linaria vulgaris* the main morphological fruits characters

Indices	Raceme weight mg	No. caps/ raceme	Caps length mm	Caps width mm	Capsule weight, mg	No, seeds/ raceme	Ø seeds, mm	Fins width, mm
Raceme length	**.728**	**.473**	.136	**.221**	**.519**	.169	.032	-.068
Raceme weight	1	**.589**	**.305**	**.587**	**.773**	**.404**	.157	-.069
No. capsules		1	.137	.177	**.847**	**.251**	**.222**	**-.222**
Capsule length			**1**	**.401**	**.376**	**.341**	.055	.176
Capsule width				**1**	**.388**	**.343**	.056	-.048
Capsule weight					**1**	**.332**	.156	-.168
No. seeds						**1**	.028	.007
Ø seeds							**1**	**.245**
	LSD 5 % = .190		LSD 1 % = .250		LSD 0.1 % = .320			

<u>Statistical analysis of the variability of morphological characters</u>. The mean (ā), the variance (s2), the standard error of the mean (s) and the coefficient of variation (CV, %) were calculated for each analyzed character. The statistical estimates made highlighted characteristic values of the Linaria vulgaris ecotype from

different researched areas. However, the values obtained were characteristic. Thus, the raceme measured 13.06 cm and weighed 238.4 mg. 7.24 capsules were formed per raceme, weighing 114.7 mg. The length of the capsule measured 7.94 mm, and the thickness of the capsule was 4.70 mm (Table 2). 89.9 seeds were formed on one raceme, with a diameter of 2.08 mm and the width of the seed fin of 0.25 mm. In general, the variability of the characters was high: the number of seeds per raceme, the weight of the capsules, the number of capsules/racemes, as well as the weight of the racemes, due to the morphological characteristics that the weed exhibits in different agricultural conditions.

Table 2.

Statistical indices of *Linaria vulgaris* plant fruits

Indices	Raceme length, cm	Raceme weight, mg	No. capsules/ raceme	Capsule length, mm	Capsule width, mm	Caps. weight mg	No, seeds/ racem	Ø seed mm	Seed fins, mm
Mean ā	**13.06**	**238.4**	**7.24**	**7.94**	**4.70**	**114.7**	**89.90**	**2.08**	**0.25**
Var. S^2	10.49	11.52	10.61	0.693	0.556	4.689	7583	0.036	0.012
Std. dev. S	2.239	10.73	3.257	0.833	0.746	68.47	87.08	0.19	0.11
Var. coef. VC, %	**24.8**	**45.0**	**45.0**	**10.5**	**15.9**	**59.7**	**96.9**	**9.2**	**44.4**

CONCLUSIONS

a) A common species present in various agricultural areas is Linaria vulgaris Mill. The weed is spread here, through eco-types that are increasingly adapted through specific biology.

b) In order to control it through your own management, it is good to know as many morphological characters as possible. From the observations it was found that a weed species, which expresses the widest possible variability of morphological characters, demonstrates greater degrees of adaptability, and complex control measures will be more extensive.

c) The morphological variability, especially the reproductive one, being less known in detail, could bring some new information within the existing eco-type under the conditions of the low fertility soils existing in the resort.

d) High variability was found in the number of seeds in the raceme (97 %), the weight of the capsules (60 %), the number of capsules/raceme and the biomass of the raceme (both with 45.0 %). Seed diameter and capsule length had low variability.

e) They actually express the degrees of adaptability of the species through the hearths they form in this agricultural area.

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