ANALYSIS IN THE MORPHOLOGICAL ASPECT AND THE PHENOTYPE WITHIN FLOWERING SPECIES VARIABILITY *ANGELICA ARCHANGELICA* L.

ANALIZA SUB ASPECTUL MORFOLOGIC ŞI AL VARIABILITĂŢII FENOTIPICE A INFLORESCENŢEI ÎN CADRUL SPECIEI *ANGELICA ARCHANGELICA* L.

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Abstract. *This paper examines the variability of the main components of the inflorescence for the selection of forms with high performance in terms of seed production at Angelica archangelica L.. Researches were conducted in the experimental field of Lucian Blaga University in Sibiu, in the period 2009-2010, using morphological description of the plant method. The results revealed a wide variability the number of stems per plant floriferous, umbels diameter, number of umbels, average seed mass per plant (MMS) and thousand grain weight (MMB) based on the following statistical indicators: mean, variance, standard deviation and variability coefficient.*

Key words: *Angelica archangelica*, variability, umbel, MMS, MMB

Rezumat. *Lucrarea de faţă analizează gradul de variabilitate a principalelor componente din inflorescenţă în vederea selecţionării unor forme cu performanţe ridicate sub aspectul producerii de sămânţă la Angelica archangelica L. Cercetările au fost realizate în câmpul experimental al Universităţii Lucian Blaga din Sibiu, în perioada anilor 2009-2010, folosind metoda descrierii morfologice a plantelor. Rezultatele au scos în evidenţă marea variabilitate a numărului de tulpini florifere pe plantă, diametrului umbelelor, a numărului de umbelule, a masei medii de sămânţă pe plantă (MMS) şi a masei a o mie de boabe (MMB) pe baza următorilor indicatori statistici: media, varianţa, abaterea standard şi coeficientului de variabilitate.*

Cuvinte cheie: *Angelica archangelica*, variabilitate, umbelă, MMS, MMB

INTRODUCTION

Angelica archangelica L. species is used as medicinal species, since long time ago, due to its many therapeutic qualities (Bobiţ et al., 2002). Over time, there have been proven, based on the aromatic characteristics, different usages in the preparation of confectionery and distilled alcohol beverages, such as vermouth and liqueurs (Lazurcă, 1995). The literature emphasizes that species finds its utility in veterinary medicine or as a honey plant and though the volatile oil extracted from the rhizomes and seed in the cosmetics industry (Pop, 2005).

The species mentioned is a robust plant with erect stems with an height of 150-200 cm, on which are inserted pinnate leaves with lengths up to 90 cm, the

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flowers, grouped in inflorescence globes, are light white-yellow-green (Muntean et al., 2007).

From a biological perspective is a biennial or perennial species pollinated entomofilă cross-fertilized; after flowering aerial parts of the plant die.

Various studies on the development of new policies on dynamic application of the action plans in agriculture, according to environmental factors, the impact of climate change and the degree of tolerance of different local varieties, may lead to increase productivity (Antofie et al., 2010). Is an important to realization a model of sustainable agriculture at the level of the farm in order to obtain healthy vegetal products through applying crop technologies specific for each species, bring a contribut to the maintenance and improvement of soil characteristics (Iagăru, 2010).

Thus, the populations of *Angelica archangelica* L. are composed of numerous biotypes that show a high degree of heterogeneity in all aspects, including the inflorescence one, which, depending on size and degree of branching, can strongly influence seed quality (Pop, 2005). For this reason it is interesting to analyze the variability of flowers and inflorescence, taking into account measurements of the number of branches on flowering stem, number and diameter umbels per plant, depending on the degree of branching.

MATERIAL AND METHOD

The biological material was provided by National Research Institute for Potato and Sugar Beet, Laboratory of Medicinal Plants, Brasov, in the form of seed. This material belongs to the local Christian population, where 10 selections were chosen. These selections differentiated from a phonetically point of view, under several quantitative characters. Sowing was carried out in autumn, and in the spring of the first vegetation year, thinning was carried out after the first two true leaves appeared. The distances chosen were 60 cm between rows and 40 cm between plants per row, up to a density of 42,000 plants / hectare.In the first year were carried out maintenance work consisting of hoeing and weeding, so, in August, the ground was well covered by the aerial parts of the plant.In the spring of second vegetation year, there were also applied 1-2 mechanical weeding and a manual weeding, the land was quickly covered the entire surface, the aerial parts of the plant. In June, the plants flourished, each strain showing flowering branches which are terminated by a globular inflorescence, umbel type, composed of several umbels. On each flowering stem was formed a primary inflorescence, and based on the degree of branching, there might appear some secondary and even tertiary. In June and July were carried out observations on the flowering process and determinations on the following quantitative characters: the number of branches of the floriferous stem, number of secondary umbels / plant, number of tertiary umbels / plant, primary umbel diameter (cm), secondary umbel diameter (cm), tertiary umbel diameter (cm), average mass seed / plant - MMS (g / pl), the mass of 1000 seeds - MMB (g).

Based on the results obtained from measurements there was calculated the degree of variability of characters analyzed, based on the following statistical indicators: mean, variance and standard deviation ($\bar{x}$, s^2, s) and coefficient of variability - (s%) (Arden, 2006) - summarized in tabular form.

The coefficient of variation was interpreted based on indications of literature data, considering that the frequency distributions that have a coefficient of variation less than 10% have a low variability, medium is for those who have a coefficient of 10-20% and those with a ratio of over 20% have a higher variability (Ardelean, Sestraş, 1996)

RESULTS AND DISCUSSIONS

The values of morphological characters studied in the 10 selections identified in the field of choice of the population is Christian, are presented in table 1 and table 2. Data represent results centralized at the end of second year results of vegetation, in the months of June-July 2010. Data from the field measurements were used to calculate several statistical indicators (table 3).

Table 1

Results on the morphological characteristics of floriferous organs at *Angelica archangelica* L. selections

No.	Selection	Number of branches / flowering stem	Number secondary umbels / plant	Number tertiary umbels / plant	MMS (g / pl.)	MMB (g)
1.	**G-1**	5	4	7	65	4,8
2.	**G-2**	6	5	6	95	4,2
3.	**G-3**	4	3	5	53	6,3
4.	**G-4**	6	5	7	80	3,9
5.	**G-5**	5	4	6	28	5,1
6.	**G-6**	4	3	3	50	5,9
7.	**G-7**	5	4	6	35	5,2
8.	**G-8**	4	3	6	26	6,2
9.	**G-9**	3	2	2	32	6,9
10.	**G-10**	3	2	2	29	7,3

From measurements made results that the number of branches of the floriferous stem presented a wide range, from 3-6, being highlighted the G_2 and G_4 selections, with the highest values, followed by G_1, G_5 and G_7. Analysis of tables 1 and 2 show that the number branches of the floriferous stem positively influence the number of secondary and tertiary umbels. This is confirmed by the large number of secondary and tertiary umbels obtained at the same number of selections at which the number of branched of the floriferous stem was the highest.

On the opposite side we can notice the negative influence of the number of branches of the floriferous stem on the primary umbel diameter. The highest values of primary umbel diameter were recorded at G_9 and G_{10} selections with 19 cm and 20 cm. The negative influence of the number of branches of the floriferous stem largely occurs also at the secondary and tertiary umbels diameter, the highest value being recorded at G_9 selection. The values recorded in the measurement of all types of umbels diameter ranged between 2,3 cm and 20 cm.

The analysis in table 2 shows a fairly wide range of values of the average seed mass per plant (MMS). These values range from lows of 26, 29 and 32 g per plant, recorded at the G_8, G_{10}, G_9 and highs of 95 and 80 g per plant, recorded G_2 and G_4

selections. Instead, the analysis of the values of MMB the highest levels are achieved at G_{10} and G_9 selections, with 7.3 and 6.9 g, and lowest at G_4 and G_2 selections with 3,9 respectively 4,2 g.

Table 2

Results on the morphological characteristics of floriferous organs at *Angelica archangelica* L. selections

No.	Selection	Primary umbels diameter (cm)	Secondary umbels diameter (cm)	Tertiary umbels diameter (cm)
1.	**G-1**	15	13	3,8
2.	**G-2**	14	10	2,1
3.	**G-3**	19	16	3,2
4.	**G-4**	15	9	1,9
5.	**G-5**	17	17	2,5
6.	**G-6**	16	16	3,7
7.	**G-7**	16	14	2,3
8.	**G-8**	17	12	4,2
9.	**G-9**	19	17	5,7
10.	**G-10**	20	16	4,4

From these data it is very easy to notice that where the amount of seed per plant is high, the seeds are small. Moreover, we stress the positive influence of the size primary umbel diameter and the number of negative influence of the ramifications of floriferous strain on MMB. Thus our results are consistent with those obtained by Galambosi (1994) and Dachler and Pelzmann (1999) which stated that in their studies conducted on *Angelica archangelica* L., the largest seed, with the best quality is given by the primary umbel.

To see the chance to improve the characteristics discussed above for creating seed forms with higher MMB and a flowering with a low degree of branching, was calculated the coefficient of variability (table 3).

Table 3

Statistical indicators calculated on the ten *Angelica archangelica* L. selections studied

Character	Variance s^2	Standard deviation s	Mean $\bar{x}$	Coefficient of variability s%
Number of branches / flowering stem	1,17	1,08	4,5	24
Number secondary umbels / plant	1,17	1,08	3,5	30,86
Number tertiary umbels / plant	3,78	1,94	5	38,87
Primary umbels diameter (cm)	3,96	1,99	16,8	11,84
Secondary umbels diameter (cm)	8,44	2,91	14	20,76
Tertiary umbels diameter (cm)	1,46	1,21	3,38	35,80
MMS (g / pl.)	578,23	24,05	49,3	48,78
MMB (g)	1,27	1,13	5,58	20,18

All characters analyzed**,** except the diameter of the primary umbel and the number of umbels in the primary umbel, have a large variability with a coefficient of variability greater than 20%. The diameter of the primary umbel and the number of umbels of primary umbel have a medium variability, with values ranging between 10% and 20%.

Based on the observations made during the flowering period, we noticed that each flowering stem has a main umbel. This will bloom more quickly due to the earlier appearance on the plant. Analyzing the flower openness we note that this is protandru type through a earlier maturation of the anthers than the stigma. This makes the primary umbel flowers pollination to be in high percentage cross-fertilized. The flowers belonging to the secondary and tertiary umbels, due to later openness, on the extent of their occurrence, could not benefit of a high percentage of cross-fertilized pollination. Due to the fact that so far there wasn't found other mechanism to ensure cross-fertilized at *Angelica archangelica* L. Species, other that the protandria described above, it can be assumed that the flowers of secondary and tertiary umbels are exposed to some degree on pollinating pollination. This phenomenon may explain the smaller size of the seed formed in secondary and tertiary umbels. This idea is supported by low values of the MMB at selections with many umbels. Smaller seeds may also have a low germination capacity, leading to problems encountered by the emergence of plants.

CONCLUSIONS

1. For the production of good seeds we have to use selections with a small number of branches of the floriferous stem, such as G_9 and G_{10} for the highest recorded values of MMB, 6,9 g and 7,3 g. The values of the coefficient of variability for both the number of branches and for MMB floriferous stems are large (24% and 20.18% respectively), which gives a chance for selection work to improve these characters.

2. To obtain forms with a large number of both secondary and tertiary umbels we can use the selections with a higher number of branches of the floriferous stems, such as G_2 and G_4. The large number of umbels enhances the aesthetic quality of the flowers. The values of coefficient of variability for the number of secondary and tertiary umbels is very high 30,86% and 38,87%, which shows possibilities to improve these characters through selection.

3. The coefficient of variability calculated for both diameter of the secondary and tertiary umbel has high values 20,76% and 35,80%. This increases the chance of the selection of works to improve these characteristics.

4. The 10 selections from the Christian population are characterized by a pronounced polymorphism. The general analysis of the data presented in this study highlight a variability that can be correlated with the possibility of applying a high selection pressure for improvement in future works of this species.

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