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Studies Analyzing the Number of Elements in the Composition of Inflorescence and Seed Quality Parameters in the Species of *Angelica archangelica* L.

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Abstract. The multiple usages of *Angelica archangelica* L. species are given by its medicinal properties due to high content of essential oils and also, aromatization capacity which makes it useful in the food industry to flavor their various additives or alcoholic beverages, its habitus is highly appreciated for its ornamental value. The major problem of this species is that the number of individuals from spontaneous flora decrease dramatically in the past 40 years, being included on the red list of protected species. Thus, we consider important at this stage any study action to improve the conservation methods *in situ* and *ex situ* and to enrichment the collection of genetic resources in order to broaden them. For these reasons this paper presents analysis of the principal components of the inflorescence, in order to select some high performing genotypes, either in terms of decor can be encouraged to spread their green spaces, whether in terms of seed production to increase cultivated areas.

Keywords: *Angelica archangelica* L., umbels, umbellules, MMS, MMB

INTRODUCTION

Extracts from *Angelica archangelica* L. stimulate salivary, gastric and intestinal secretions. Is highly appreciated because it generates hunger and cures bloating, indigestion, flatulence, fevers, and heartburn, by inhibiting the activity of the *Helicobacter pylori* bacterium in human stomach tissue (Hensel, 2007). The species is also recommended for central nervous system diseases, the therapeutic treatment including the use of angelica essential oil together with essential oils of marjoram, lavender, rosemary, mint, pine, thyme, hyssop, pine (Bojor and Popescu, 2009). The medicines with angelica increase sweating and increase the amount of urine eliminated over time (Nie *et al.*, 2009). Over time, based on its aromatic properties there were detected different uses in the preparation of confectionery and preparation of distilled from alcohol, vermouth and liqueurs (Greer, 2008).

The literature emphasizes that species finds its utility in veterinary medicine or as honey plant, and through the volatile oil extracted from the rhizomes and seeds, in the cosmetics industry (Pop, 2008).

The species mentioned is like a robust plant with erect stems with a height of 150-200 cm, on which pinnate leaves with lengths up to 90 cm are inserted and the flowers, grouped in globular inflorescence, are flower white-yellow-green (Wesenberg, 2001).

Angelica archangelica L. is a biennial or perennial species that dies after flowering and pollination is cross-fertilized (Hanelt, 2001).

In recent years, the species is faced with a drastic decrease in the number of individuals (Lazurca, 1995). In addition, seeds lose quickly the germination faculty or have low yields after sowing (Vandelook *et al.*, 2007). This requires an increase of the cultivated areas, which involves the selection of varieties with good performance in terms of seed production.

The effectiveness in improving the heritability of the characters given, which can identify the chemical composition, earliness, etc. is important to be pursued in a process of improvement (Savatti *et al.*, 2004).

Different types of integrated studies on the development of new policies under dynamic 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). Thus populations of *Angelica archangelica* L., are composed of numerous biotypes that show a high degree of heterogeneity in all aspects, including the inflorescence which depending on the degree of branching and number of components can strongly influence seed quality (Pop, 2008). It is therefore interesting to analyze the influence of organs responsible for seeds production, taking in the study measurements of the umbels number per plant.

MATERIALS AND METHODS

The biological material was provided by National Institute of Research and Development for Potato and Sugar Beet - Laboratory of Medicinal Plants, Braşov, in the form of seed. This material belongs to the local population, "De Cristian", in which 10 genotypes were selected, that were phenotypical differentiated in terms of several quantitative characters. Sowing was carried out in autumn, and in the spring of first year of vegetation was carried out the plant thinning after the first two true leaves (Bobiţ *et al.*, 2002). The distances chosen were 60 cm between rows and 40 cm between plants per row, up to a density of 42,000 plants per hectare, as recommended in the literature (Muntean *et al.*, 2007). This year there were performed maintenance work, consisting of hoeing and weeding, thus in August the ground was well covered by the aerial parts of the plant. In the spring of the second year of vegetation were also applied 1-2 mechanical weeding and a hand weeding, the land being quickly covered on its entire surface, by its aerial parts. In June and July were carried out observations of how flowering was evolving. Also then there were done observations the mode of flowering, determinations and measurements of the number of umbellules and umbels per plant. After harvesting there have been weighing on the on the average weight of seed per plant (MMS) and 1000 grain weight (MMB).

The experiment was monofactorial and was organized by randomized blocks method. The data was recorded in a table to be subject to interpretation by statistical analysis of variance of the umbelule and umbels number per plant, and MMB MMS obtained. Interpretations were reported in averages recorded by "De Cristian" population.

Establishing the significance of differences by comparing the differences between variants and control limit values differences (denoted by DL) calculated the probabilities of transgression of 5%, 1% and 0.1%, for 18 degrees of freedom of error (Ardelean, 2006). We are note in Table 1, the significance of differences, with the sign from the literature (Ardelean and Sestraş, 1996).

RESULTS AND DISCUSSION

Following the observations done in June, the plants have flowered and on every flowering stems were present branch in different degrees, forming the top one inflorescence globular, type umbel, composed of several umbellules. Each flowering stem formed a primary inflorescence and based on the degree of branching could occur some secondary or even tertiary. After the measurements were determined the number of umbellules and umbels per plant at all the 10 genotypes identified in the field of choice from “De Cristian” population. These data is presented in Tab. 1. Data represents the centralized results at the end of second year of vegetation, that in the months from June -July.

Tab. 1

Results on the number of umbels and umbellules per plant at selected *Angelica archangelica* L. genotypes

No. crt.	Genotype / source	Umbels Number / plant			Umbelulas Number / plant		
		Pcs.	Difference	Significance	Pcs.	Difference	Significance
1.	F-l	18	8	**	35	5	-
2.	F-2	20	10	***	44	14	***
3.	F-3	8	-2	-	34	4	-
4.	F-4	16	6 6	*	38	10	***
5.	F-5	7	-2	-	30	0	-
6.	F-6	12	2	-	39	9	**
7.	F-7	14	4	-	36	6	*
8.	F-8	9	-1	-	33	3	-
9.	F-9	6	-4	-	35	5	-
10.	F-10	5	-5	-	32	2	-
11.	“De Cristian” (Mt)	10	-	-	30	-	-
	DL 5% DL1% DL 0.1%		5.29 7.25 9.86			5.09 6.98 9.50	

Note: DL (Differences limit values calculated the probabilities of transgression of 5%, 1% and 0.1%, for 18 degrees of freedom of error); * (difference is real significant);
** (difference is real distict significant);
*** (difference is real and very significant); ns (difference is neither significant or real); 0 (difference is negative).

It is shown that in terms of number of umbels, it was achieved a fairly wide range of shapes. F_9 and F_{10} genotypes had the lowest number, six and five umbels, while F_2 genotype had 20 umbels, noticing a large amplitude of this character.

The high values which are highlighted in the data analysis, are those recorded in F_2 genotype with a very significant positive difference, F_1 distinctly significant and positive difference in genotype F_4 with a significant positive difference. All comparisons were made against the average population obtained from “De Cristian”. In what concerns the number of umbellules to all 10 genotypes studied, they had higher values compared with "De Cristian" population (over 32 umbellules per plant). Very significant positive difference compared to "De Cristian" population we find at genotypes F_2 and F_4, being highlighted a positive influence of umbels number on this character. Harvested seeds were weighed thus determine the average weight per plant and weight of 1000 seeds of *Angelica archangelica* L. selected genotypes. The analysis of Tab. 2 shows a fairly wide range of values of the average weight of seed per plant (MMS). These values range from lows of 26, 29 and 32 g per plant and highs of 95 and 80 g per plant.

Tab. 2

Results on average mass of seeds per plant and 1000 seeds weight to the selected genotypes of *Angelica archangelica* L.

No. crt.	Genotype / source	The average weight of seed per plant (MMS) (g / plant)			MMB (g)		
		Production	Difference	Significance	Production	Difference	Significance
1.	F-l	65	20	**	4.8	-0.2	-
2.	F-2	95	50	***	4	-1	0
3.	F-3	53	8	-	6.3	1.3	*
4.	F-4	80	45	***	3.9	-1.1	0
5.	F-5	28	-17	º	5.1	0.1	-
6.	F-6	50	5	-	5.9	0.9	-
7.	F-7	35	-10	º	5.2	0.2	-
8.	F-8	26	-19	ºº	6.2	1.2	-
9.	F-9	32	-13	º	6.9	1.9	***
10.	F-10	29	-16	º	7.3	2.3	***
11.	"De Cristian" (Mt)	45	-	-	5	-	-
	DL 5% DL1% DL 0.1%		5.29 7.25 9.86			5.09 6.98 9.50	

Note: DL (Differences limit values calculated the probabilities of transgression of 5%, 1% and 0.1%, for 18 degrees of freedom of error); * (difference is real significant);** (difference is real distict significant); *** (difference is real and very significant); ns (difference is neither significant or real); 0 (difference is negative)

Very significant positive differences compared to the average of "De Cristian" population were recorded at genotypes F_2 and F_4, at F_8 genotype the differences were distinctly significant negative, and at F_9 and F_{10} genotypes were significantly negative. In contrast, analysis of values of MMB show the highest levels, with significant positive differences were at genotypes F_9, F_{10} 7.3 g and 6.9 g. The differences were significant negative were at F_4 genotype with 3.9 g and at F_2 genotype with 4g.

CONCLUSIONS

The wide range of umbels number obtained in our experimental variants, in conjunction with the large number of umbellules that compose the umbels, enables the use of the species in composition of landscapes as stated above by Pârvu (2004). Umbellules numbers per plant are responsible of the umbel size, being subject to their ramifications. Taking into account the height reached by the time of flowering, and the large size of the leaves, we suggest the idea of combining species of *Angelica archangelica* L. with other high floral species such as *Canna*, *Dahlia*, *Rudbekia*. Promoting within urban green spaces the medicinal and aromatic plants, such as the one in this study, we can be helpful in raising public awareness and education in different programs. This was affirmed also by Bogdan *et al.* (2010) and will contribute to fostering ecosanogeneza fields, eco-education, bio-economy, eco-economy for food safety and educational counseling on issues of plant biology.

In parallel, if you want to highlight the aesthetic qualities of plant, biotypes with a greater number and umbellules and umbels are desirable, because they generate a greater aesthetic force. Numerical oscillations of these characters show that the selection work can improve their chances for success.

In what concerns the seed, previous literature reports for MMB several variants, or a range between 2.08 to 8.49 g given by Heeger (1989), or one between 2.1 to 5.4 g described by Bomme (1997). After analyzing the values obtained by us with a range between 3.9 to 7.3 g we can appreciate that this parameter can be influenced by factors not related to species (climate, annual rainfall, geographical location). However, our data show that where the amount of seed per plant is high, the seeds are small. Furthermore, we can stress the positive influence of the small number of umbels and umbellules on MMB. Similar studies reported by Galambosi (1994, 2002) and Pelzmann Dachler (1999), affirmed that in their cases at the species *Angelica archangelica* L. the largest and the most qualitative seed is given by the main umbel. Lower values of MMB for some genotypes may be a cause of low seed germination. This limits the natural reproduction of the species and its conservation *in situ* is not effective. In a similar situation in at the species of *Angelica glauca* in the Himalayan, Vashistha (2009) recommends finding ways to *ex situ* cultivation, including some treatments for raising seed germination. In our case, we recommend either the selection of genotypes with less number of umbellules and umbels, capable of producing seed with a high cultural value, or remove by cutting work of some juvenile umbels competing in an early stage.

By viewing all the data obtained, it is shown that the starting biological material, the “De Cristian" population and selected genotypes of *Angelica archangelica* L. are characterized by an increased phenotypic polymorphism in terms of features comprising the bloom. Using in the selection the original material has enabled the phenotypic and genetic differentiation, in terms of quantity and quality of some valuable genotype *Angelica archangelica* L. Thus, there were noted for the production of seed genotypes F_{10} and F_9, and for use in green spaces were noted in particular the genotypes F_2 and F_4. These valuable genotypes can be recommended for approval.

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