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A STUDY ON THE GERMINATIVE CAPACITY AND HERBA YIELD OF *Hyssopus officinalis* L.

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Abstract

Hyssopus officinalis L. has a long and rich history as a medicinal plant due to the health benefits transmitted from generation to generation of usage as a carminative, antiseptic, and cough reliever. These benefits have drawn the attention of the researchers, whom, in the last years, have started to fundament scientifical elements of the hyssops crop technology. This study aims to follow and report the germinative capacity and both fresh and dry herba yield of three hyssops varieties (white, blue and pink). The assessing of herba yield, was done at SCDA Lovrin and the germinative capacity of the studied varieties was determined in the Laboratory for Seed Quality from the Faculty of Agriculture from Timisoara. The results are highlighting significant differences between the varieties regarding germinative capacity, the mass of 1000 grains and both dry and fresh herba yield.

Key words*: hyssop, herba yield, medicinal plants, germinative capacity.*

INTRODUCTION

Hyssopus, originating from the Mediterranean and Central Asia, is mentioned in the Bible and in the works of Theophrastus, Dioscorides, Columella, and Pliny. It is cultivated as a medicinal plant with expectorant, antiseptic, and digestive functions stimulating properties (Dragland et al., 2003; Jung, 2004; Lugasi et al., 2006, Imbrea, 2016). Additionally, hyssopus is used as a honey plant, spice, and ornamental plant (Kapelev, 1986; Păun, 1986; Verzea, 2002). According to the Flora României, vol. VIII, the cultivated species is *Hyssopus officinalis* L., with subspecies *officinalis* Briq and *canescens* (DC) Briq. *Officinalis* subspecies includes 3 varieties (*vulgari*s Benth, *decussatus* Pers., and *angustifolius* (Bieb) Benth). Additionally, within the *vulgaris* Benth. variety, plants with blue-violet flowers (f. *cyaneus* Alef.), red-carmine flowers (f. *ruber* (Mill) Alef.), or white flowers (f. *albus* Alef.) can be found (Fleischer, 1988; Mechraz, 1989; Muntean, 2007; Roman, 2008).

MATERIALS AND METHODS

The study was conducted on three colour varieties, namely pink, blue, and white, obtained from the collection of the Phytotechnics discipline within the Faculty of Agriculture in Timisoara, from three years of cultivation. Germination capacity testing was carried out in the Laboratory for Testing Seed Quality and Plant Material within the Faculty of Agriculture. For the processing and interpretation of the experimental results, the following programs were used: for analysis of variance - statistics [ANOVA], MSTATC; for correlations and regressions - statistics - Regressions and Graphs; procedures with formulas on factor contribution and DLs - in EXCEL; Cluster Analysis.

RESULTS AND DISCUSSIONS

Thousand grain weight (TGW) is an indicator that shows the size of the seeds, provides information on their quality and cultivation method, expressing their potential as a multiplication material. Table 1 and Figure 1 present the results regarding the thousand seed weight depending on the colour variety. Compared to the experience average, which recorded a value of 0.894 g, only the white colour variety recorded a higher value (1.001 g), statistically significant. In the case of the pink colour variety, the smallest value of the thousand seed weight was obtained (0.739 g),

respectively a difference of 0.155 g, statistically significant in a negative sense. For the blue colour variety, the values of the thousand seed weight were very close to the field average (0.943 g), the difference of 0.049 g was not statistically assured.

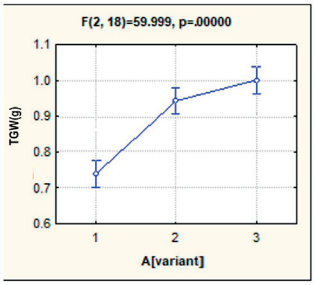

Figure 1. TGW variation in the 3 varieties

Table 1. TGW variation depending on colour variety

Factor A - colour variety	TGW [g]	Difference [g]	Significance
a1 - v1	0.739	-0.155	000
a2 - v2	0.943	0.049	ns
a3 - v3	1.001	0.106	***
Average	0.894	mt	
DL 5% = 0.053 g; DL 1% = 0.072; DL 0.1% = 0.098			

The variation of TGW in the three colour varieties under study shows an increasing trend. The values of TGW ranged from 0.74 g in the pink variety to approximately 1.0 g in the white variety. The differences between the varieties are highly significant ($p<0.001$). The results regarding the evolution of TGW according to the colour variety and year of culture are presented in Tables 1 and 2, and Figures 1 and 2.

Table 2. TGW variation depending on cultivation year

Factor B - cultivation year	TGW [g]	Difference [g]	Significance
b1	0.946	0.051	ns
b2	0.911	0.017	ns
b3	0.826	-0.068	0
Average	0.894	mt	
DL 5% = 0.053 g; DL 1% = 0.072; DL 0.1% = 0.098			

The obtained data show that compared to the field average, the seeds obtained from the crops in the first, second, and third year do not present significant differences for the first and second year, only for the third year of culture, the difference of 0.068 g of the mass of 1000 grains is statistically significant in a negative sense. It should also be noted that, of the three experimental years, in terms of precipitation deficit during the growing season, the year 2022 had the highest deficit and the highest values of monthly average temperatures.

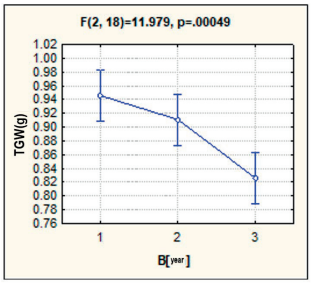

Figure 2. TGW variation depending on cultivation year

The values of the 1000 grain weight decrease with the year of cultivation, with the highest value obtained in the first year of vegetation of 0.95 g, followed by the second year of vegetation with 0.91 g, and the lowest value was obtained in the third year of vegetation.

The interaction between colour variety of hyssop and the crop year on the 1000 seed weight is presented in Table 3 and Figure 3.

Table 3. Results on interaction of colour variety and cultivation year on TGW

			Factor B [cultivation year]			
			B1	B2	B3	Average
Factor A [colour variety]	A1 - pink	TGW [g]	0.801	0.798	0.619	0.894
		Dif[g]	-0.094	-0.096	-0.275	
		Sig	0	0	000	
	A2 - blue	TGW [g]	1.014	0.937	0.878	
		Dif [g]	0.12	0.04	-0.01	
		Sig	*	ns	ns	
	A3 - white	TGW [g]	1.022	0.998	0.982	
		Dif [g]	0.128	0.103	0.088	
		Sig	**	*	ns	
DL 5% = 0.091 g DL 1% = 0.125; DL 0.1% = 0.170						

Compared to the control, the average interaction between year and colour variety was expressed as follows:

For the pink variety [v1], all differences obtained in the three years were statistically significant (highly significant in b3 - year 3, significant in b2 - year 2, and b1 - year 1), but in a negative sense.

For the blue variety [v2], only in the first year was an interaction recorded expressed by a statistically significant positive difference, while for the II and III years, the differences are

insignificant, and the values of the 1000 seed weight are close to the field average.
For the white variety [v3], the interaction between factors was expressed by statistically significant positive differences (distinctly significant in b1 [year 1], significant in b2 [year 2]) and insignificant in b3 [year 3].

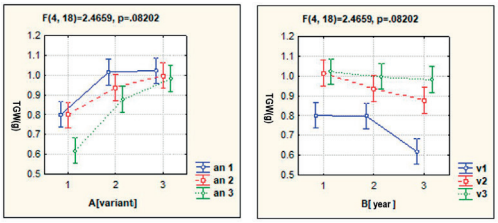

Figure 3. The variation of the 1000 grain weight depending on the interaction between cultivation year and color variety [A x B]

Over the three years of cultivation, the 1000 seed weight shows an upward trend with respect to color variety. The highest 1000 seed weight is obtained in a3 [blue variety], while the lowest is obtained in a1 [pink variety]. Comparing the years, it can be deduced that the highest value for 1000 seed weight was obtained in year 1 of cultivation, while the lowest was obtained in year 3 of cultivation. Figure 4 shows the contribution of the experimental factors (colour variety, crop year, and their interaction) to the realization of the TGW.

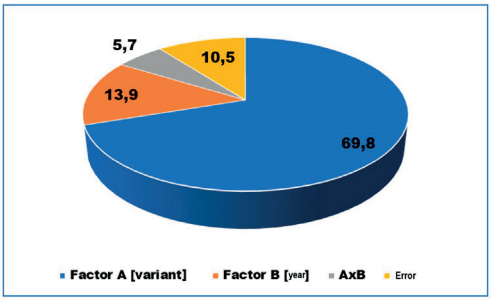

Figure 4. The contribution of the A [colour variety], B [crop year], and the A x B interaction factors

The A [colour variety] factor contributes 69.8% to the realization of the TGW, the B [crop year] factor contributes 13.9%, and the A x B interaction contributes 5.7%. Therefore, the colour variety factor has the highest contribution, followed by the B [crop year] factor and the A x B interaction. Cluster analysis is a multivariate analysis technique that includes a number of algorithms for classifying objects [elements or individuals] into homogeneous groups. A dendrogram is one of the methods of representing the clustering and can provide a summary of the classification.
Figure 5 shows the dendrogram of the TGW based on the nine combinations (three colour varieties and three crop years).

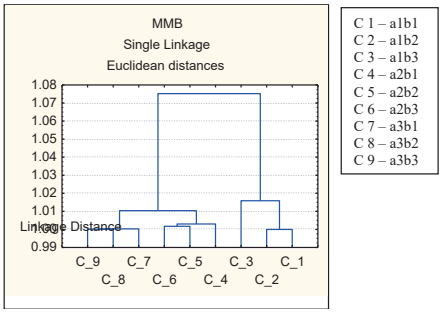

Figure 5. TGW dendrogram of the nine AXB combinations

The highest value of TGW 1.02 g is obtained from the combination a3b1 - class A, which differs significantly from all other combinations that do not contain the letter A. Other combinations belonging to class A include: a2b1, a3b2, and a3b3. Therefore, all four combinations yield approximately the same value of TGW at around 1 g. The four combinations [white in all three years of cultivation and blue in the first year of cultivation] are not significantly different from each other, but are significantly different from a2b3, a1b1, a1b2, and a1b3.
The lowest value of TGW 0.62 g - class D is obtained from a1b3, which differs significantly from all other combinations.
In conclusion, the expression of the weight of 1000 seeds is a character influenced by colour variety, and depending on the year of cultivation, with hyssop being a perennial plant, the highest value of the TGW is obtained in the first year of growth, followed by a reduction in subsequent years. Based on this finding, it is recommended that seeds harvested in the first year of growth be used for the production of hyssop seedlings.
For hyssop, which is a plant with small seeds and propagated by seedlings, seed germination

is a crucial process influenced by their quality. Table 4 and Figure 6 show seed germination according to colour variety.

Table 4. Seed germination depending on colour variety and cultivation year

Factor A [color variety]	Germination [%]	Difference [%]	Significance
a1	90.35	4.00	***
a2	93.66	7.31	***
a3	75.02	-11.32	000
Average	86.34	mt	
DL 5% = 0.048 %; DL 1% = 0.066; DL 0.1% = 0.091			

The results obtained show a very significant effect of the hyssop colour form, meaning that there are very significant differences in germination between the three colour variants studied in the experiment. Compared to the control - the experiment's average, very significant increases were obtained for all three-colour variants, noting that for variant 3 (white), the increase was negative, meaning that the germination rate for white hyssop was below the experiment's average. The germination percentage increases from variant 1 (pink) to variant 2 (blue), after which it decreases. Therefore, we have an upward trend from v1 to v2 and a downward trend from v2 to v3. The germination rates obtained for the three variants were 90% for v1 (pink), 94% for variant 2 (blue), and 75% for variant 3 (white).

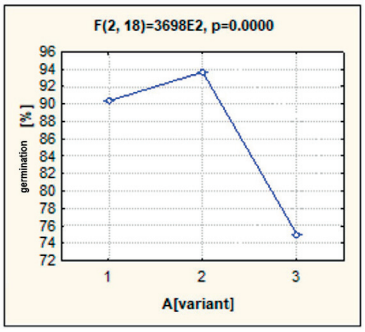

Figure 6. Germination variation of the three colour Hyssopus variety

Table 5. Percentage of germination by cultivation year

Factor B [year of cultivation]	Germination [%]	Difference [%]	Significance
b1 – an 1	91.37	5.03	***
b2 – an 2	88.31	1.97	***
b3 – an 3	79.35	-6.99	000
Average	86.34	mt	
DL 5% = 0.048 %; DL 1% = 0.066; DL 0.1% = 0.091			

The highest germination percentage was obtained from the seeds harvested in the first year (91.37%). Compared to the control - the experience mean (86.34%), statistically significant differences were obtained in all three years of production, noting that in the third year, the difference was negative, meaning that the germination rate was below the experience mean. The germination percentage decreased from year 1 to year 3, indicating a decreasing trend depending on the year of culture. The values of the germination percentage varied between 91% (year 1) and 79% (year 3). The differences between the years are highly significant ($p<0.001$).

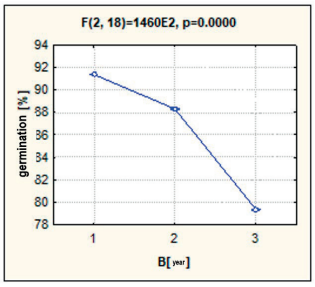

Figure 7. Germination variation during the three cultivation years

It should be noted that the germination percentage obtained in the first and second year of cultivation exceeds the value of 85%, which recommends their use as material for multiplication.

The germination percentage obtained for the interaction of color variety and year of cultivation [AXB] is presented in Table 6 and Figure 8.

Table 6. Percentage of germination obtained at the interaction of colour variety and cultivation year

			Factor B [cultivation year]			
			b1	b2	b3	Average
Factor A [colour variety]	a1	Germination	96.03	93.99	81.02	86.34
		Diff [%]	9.69	7.65	-5.32	
		Sig	***	***	000	
	a2	Germination	98.07	95.93	86.98	
		Diff [%]	11.72	9.59	0.63	
		Sig	***	***	***	
	a3	Germination	80.01	75.01	70.05	
		Diff [%]	-6.33	-11.34	-16.29	
		Sig	000	000	000	
DL 5% = 0.091 g DL 1% = 0.125; DL 0.1% = 0.170						

The highest germination percentage was obtained in the first year for blue hyssop

(98.07%), followed by pink hyssop (96.03%). Values over 90% germination were also obtained in the second year of cultivation for the same color varieties (95.93% for blue and 93.99% for pink). It is worth noting that for white hyssop, where the highest 1000 seed mass was obtained, the germination percentage ranged from 70.05% in the third year of cultivation to 80.01% in the first year of cultivation, values much lower than the experience average (86.34%).

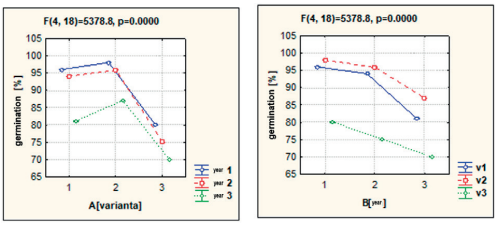

Figure 8. Germination variation [AxB interaction]

In the 3 years of cultivation, germination shows a decreasing trend regardless of the variant. The highest germination value is obtained for v2 [blue isop], while the lowest is for v3 [white isop]. Comparing the years, it can be deduced that the highest germination value was obtained in year 1 of cultivation, while the lowest was in year 3 of cultivation. The contribution of factors A [color variety], B [cultivation year], and the interaction of A x B, is presented in Figure 9.

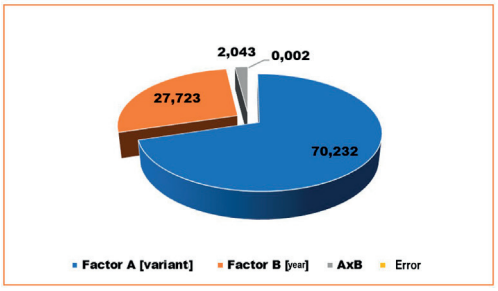

Figure 9. The contribution of factors A [color variety], B [cultivation year], and the interaction A x B

Factor A [color variety] contributes to the germination achievement in proportion of 70.23%, factor B [crop year] contributes with 27.7%, interaction A x B with 2.043%. The CLUSTER analysis and germination dendrogram is presented in figure 10.

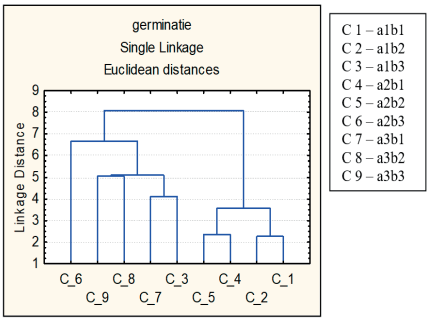

Figure 10. Dendrogram of the 9 AxB interactions

Each combination belongs to a different homogeneity class. Therefore, any combination differs from all other combinations. The highest germination value of 98.07% is obtained for combination a2b1 - class A, significantly different from all other combinations. The lowest germination value of 70.05% - class I is obtained for a3b3, significantly different from all other combinations.

CONCLUSIONS

The research conducted on the TGW and germination of three color varieties of hyssop (pink, blue, and white) provides information that contributes to improving the knowledge related to the technology of this species, which, although known since biblical times, is little known in our country and in Europe.

The TGW is a character influenced by the color variety, and depending on the year of cultivation, hyssop being a perennial plant, the highest value of the TGW is obtained in the first year of vegetation, with the value decreasing in the following years. Based on this observation, it is recommended to use seeds harvested in the first year of vegetation for the production of hyssop seedlings.

Analyzing the contribution of experimental factors to the realization of the TGW, the results show that the color variety contributes to the realization of TGW by 69.8%, the year of cultivation contributes by 13.9%, and the interaction of the two factors by 5.7%. Therefore, the color variety factor has the greatest contribution, followed by the year of cultivation factor and their interaction.

Regarding the germination percentage, the highest values were obtained in the first year of

cultivation for blue hyssop (98.07%), followed by pink hyssop (96.03%). Values of over 90% germination were also obtained in the second year of cultivation, for the same color varieties (95.93% for blue and 93.99% for pink). It should be noted that for white hyssop, where the highest TGW was obtained, the germination percentage ranged from 70.05% in the third year of cultivation to 80.01% in the first year of cultivation, values much lower than the experience average (86.34%).

Factor A [color variety] contributes to germination by 70.23%, factor B [year of cultivation] contributes by 27.7%, and the interaction of A x B by 2.043%.

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