RESEARCH ON THE EFFECT OF APPLYING DIFFERENT DOSES OF BIOSTIMULATORS ON THE MONOECIOUS HEMP AGROPRODUCTIVE CAPACITY

CERCETĂRI PRIVIND EFECTUL APLICĂRII UNOR DOZE DIFERITE DE BIOSTIMULATORI ASUPRA CAPACITĂŢII AGROPRODUCTIVE LA CÂNEPA MONOICĂ

POPA Diana[1], ISTICIOAIA Simona[1], TELIBAN G.[2], VLĂDUŢ V.[3], NEDELCU Ancuţa[3], MÎRZAN Oana[1], PINTILIE Paula[1], MATEI Gh.[4], PANDA Anca[5], MELUCĂ Cristina[6], AGAPIE Alina[5]*
*Corresponding author e-mail: alinamartinig@yahoo.com

Abstract*. The paper aims to highlight the singular and combined effects of the cuttings application and three types of biostimulators, in different doses, on the seed production of the Secuieni - Jubileu monoecious hemp variety. The research was carried out in the technological field of SCDA Secuieni, during the year 2020. The results revealed the highest seed yields (2022 kg·ha^{-1}), supported at a very significant statistical level, in the case of the application of two cuttings. At the same time, the biggest influence was determined by the use of the biostimulatorAsfac BCO - 4, at a dose of 1.5 l·ha^{-1}, the registered yield increase (790 kg·ha^{-1}) being very significant, compared to the control variant (unfertilized). The combined influence of the studied factors determined the highest yield increase (1420 kg·ha^{-1}) in the case of the variant on which two cuttings and Asfac BCO-4 were applied, at a dose of 1.5 l·ha^{-1}.*

Key words: cuttings, biostimulators, monoecious hemp, agroproductive capacity

Rezumat*. Lucrarea îşi propune să evidenţieze efectul singular şi combinat dintre aplicarea retezărilor şi a trei tipuri de biostimulatori, în doze diferite, asupra producţiei de sămânţă la soiul de cânepă monoică Secuieni – Jubileu. Cercetările au fost derulate în câmpul tehnologic al SCDA Secuieni, la nivelul anului 2020. Rezultatele au relevat cele mai ridicate producţii de sămânţă (2022 kg·ha^{-1}), asigurate la nivel statistic foarte semnificativ, în cazul aplicării a două retezări. Totodată, influenţa cea mai mare a avut-o utilizarea biostimulatorului Asfac BCO – 4, la doza de 1,5 l·ha^{-1}, sporul de producţie înregistrat (790 kg·ha^{-1}) fiind foarte semnificativ, comparativ cu varianta martor (nefertilizată). Influenţa combinată a factorilor studiaţi a determinat cel mai ridicat spor de producţie (1420 kg·ha^{-1}) în cazul variantei la care au fost aplicate două retezări împreună cu biostimulatorul Asfac BCO-4, în doză de 1,5 l·ha^{-1}.*

[1]Agricultural Research and Development Station Secuieni Neamţ, Romania
[2]University of Agricultural Sciences and Veterinary Medicine Iasi, Romania
[3]The National Institute of Research – Development for Machines and Installations Designed for Agriculture and Food Industry Bucharest
[4]University of Craiova, Romania
[5]Agricultural Research and Development Station Lovrin, Romania
[6]Agricultural Research and Development Station Teleorman, Romania

Cuvinte cheie: retezări, biostimulatori, cânepă monoică, capacitate agroproductivă

INTRODUCERE

Hemp crops for seed production are needed to meet the demand in the technical, food and cosmetics industries, as well as for fodder availability.Hemp seeds contain about 30% oil, 80% of which consists of polyunsaturated essential fatty acids that are not synthesized by the human body and 31% easily digestible proteins that can supplement or replace other protein sources (Sirițanu and Sirițanu, 2007).

Hemp can be considered a superfood, due to its rich content of essential amino acids, unsaturated fats, proteins, dietary fiber, vitamins, essential phytonutrients, its versatility of use (vegetarian, vegan, raw, paleo or clean diets), the absence of allergenic components, gluten and GMOs, but also due to the suitability for organic and/or sustainable farming systems (EIHA Conference, 2016 – 2019; Trotuş *et al*., 2020).

Hemp seeds are very healthy and have benefited in recent years from such an expansion that can be found today in almost all European supermarkets; there are no barriers or limits to a constantly growing market demand. In this regard, the combined influence between the application of biostimulants, in different doses, and cuttings, was tested in order to increase seed yield and align with the European trend.

MATERIAL AND METHOD

The experiment was carried out in the experimental field of the Agricultural Research and Development Station Secuieni-Neamț , in 2020, being of a bifactorial type, in the form of subdivided plots. The experimental factors studied were the following: A = the type of cutting with three graduations (a_1 = uncut, a_2 = one cutting, a_3 = two cuttings); B = the biostimulant dose applied with ten graduations (b_1 = unfertilized (M), b_2 = Aminosol1 l·ha^{-1}, b_3 = Aminosol 2 l·ha^{-1}, b_4 = Aminosol 3l·ha^{-1}, b_5 = TerraSorb Complex 1 l·ha^{-1}, b_6 = TerraSorb Complex 1.5 l·ha^{-1}, b_7 = TerraSorb Complex 2 l·ha^{-1}, b_8 = Asfac BCO-4 0.5 l·ha^{-1}, b_9 = Asfac BCO-4 1l·ha^{-1}, b_{10} = Asfac BCO-4 1.5 l·ha^{-1}).

The biological material used was represented by the genotype of monoecious hemp Secuieni – Jubileu, a variety with specificity for seed, an early variety (vegetation period is 90 - 110 days), having a THC content well below the legal limit of 0.2%.

In autumn, after harvesting the preceding plant (wheat), plowing was performed at a depth of 25 cm and in spring, when preparing the germination bed, followed a round with the cultivator.

Hemp is a demanding species in terms of nutrient content in the soil, therefore, when preparing the germination bed, complex fertilizers were administered, N:P:K 20:20:0, in an amount of 250 kg·ha^{-1}.

The sowing was carried out in the first decade of April, followed by an application of herbicide with Aloha at a dose of 1.5 l·ha^{-1}. The sowing rate was 6 kg·ha^{-1}, at a distance of 70 cm between plant rows. The seedling emergence was done in stages, the phenophase density of 6-8 leaves being of 20 pl·m^{-2}.

The “Secuieni method” used in the experiment involves performing a cut above the third node with opposite leaves, when the plant reaches 50 – 60 cm; thus, from the insertion of the leaves, 2 – 6 lateral shoots will develop. The second cutting is performed 15 – 20 cm above the first cut, when the shoots have developed enough.

The shoots from the first cutting will form from the leaf insertion nodes, after the second cutting, new shoots which, depending on the plants density, will be able to make 8 – 14 shoots/plant, which will ensure the formation of generative organs for the formation of production (Popa *et al*., 2015; Leonte *et al*., 2016).

The first cutting was applied 40 days after seedling emergence, on 26.05.2020, for T1 (the variant with one cutting) and T2 (the variant with two cuttings), at a height of 27 cm. The second cutting was made at a height of 43 cm, for T2, on 11.06.2020 (it was performed earlier due to the imminence of rains, being confronted with the risk of missing the phenophase).

During the vegetation period, on different phenophases, three biostimulants were applied (Popa *et al*., 2019), in different doses, these aspects being detailed in the table below.

Table 1

Biostimulants used in the experiment

Biostimulants	Description	Dose used l·ha^{-1}	Time of application
Aminosol	Organic foliar fertilizer containing 9.4% total N; 1.1% potassium oxide; 0.25% total S; 1.28% total Na; 66.3% organic substance	A1 = 1.0 A2 = 2.0 A3 = 3.0	at the beginning of flowering in the middle of flowering at the beginning of seed maturation
TerraSorb Complex	Biostimulant containing 20% L-amino acids; 5.5% total N; 5.0% organic N; 0.8% Mg (MgO); 1.5% B; 1.0% Fe; 0.1% Mn; 0.1 Zn; 0.001 Mo; 25.0 organic matter	B1 = 1.0 B2 = 1.5 B3 = 2.0	at the beginning of flowering in the middle of flowering at the beginning of seed maturation
Asfac-BCO4	Biostimulant with the following components: chlorosulfonic acid - 0.05%, potassium hydroxide - 0.016%; 2-(dimethylamino)-ethanol - 0.02%	C1 = 0.5 C2 = 1.0 C3 = 1.5	at the beginning of flowering in the middle of flowering at the beginning of seed maturation

The meteorological conditions during the experiments are presented in table 2.

Table 2

Temperatures and rainfall recorded at A.R.D.S. Secuieni weather station in 2020

Specification		Months						Veg. period average/ sum	Veg. period charact.
		IV	V	VI	VII	VIII	IX		
Temp. (°C)	2020	10.0	13.9	20.0	20.9	22.2	17.2	17.4	normal
	multiannual average	9.5	15.4	18.8	20.4	19.5	15.0	16.4	-
	deviation	0.5	-1.5	1.2	0.5	2.7	2.2	1.0	-
Rainfalls (mm)	2020	1.2	69.6	72.6	39.0	51.2	12.0	245.6	excessively dry
	multiannual average	46.9	65.7	85.0	82.3	60.2	45.7	385.8	-
	deviation	-45.7	3.9	-12.4	-43.3	-9.0	-33.7	-140.2	-

The samples were collected manually, in the second decade of August, the experimental data obtained being statistically processed by methods specific to

bifactorial experiments. The recorded yield differences were assessed using the calculation of limit differences (Jităreanu, 1999).

RESULTS AND DISSCUTIONS

In 2020, the cutting factor influenced the seed production obtained, ranging from 1317 kg·ha^{-1} (NT) to 2022 kg·ha^{-1}(T2). The variant to which two cuttings were applied resulted in very significant production increases (705.0 kg·ha^{-1}), whereas the variant with only one cutting applied showed distinctly significant differences (244.0 kg·ha^{-1}) compared to the control (NT), as seen in the table below.

Table 3

The cutting influence on seed production in 2020

No.	Cutting	Seed production			Differences significance
		kg·ha^{-1}	% vs control	differences from control	
1.	NT	1317.0	100.00	0	Ct
2.	T1	1561.0	118.53	244.0	**
3.	T2	2022.0	153.53	705.0	***

DL 5% = 54.7 kg·ha^{-1}; DL 1% = 102.2kg·ha^{-1}; DL 0.1% = 264.0kg·ha^{-1}

In 2020, the yield results obtained from the use of three types of biostimulants, in different doses, revealed statistically significant increases for the variants to which Aminosol and Asfac BCO-4 were applied, for each of the doses used. Very significant yield differences were also registered in the case of the variant to which TerraSorb Complex was applied, in a dose of 2.0 l·ha^{-1}. Compared to the unfertilized control variant, the application of the other two doses of TerraSorb Complex generated distinctly significant (dose of 1.5 l·ha^{-1}), respectively significant (dose of 1.0 l·ha^{-1}) yield differences.

Table 4

The influence of biostimulant dose on seed production in 2020

No.	Biostimulant	Seed production			Differences significance
		kg·ha^{-1}	% vs control	differences from control	
1.	M	1173.3	100.00	0	Ct
2.	A1	1606.7	136.93	433.3	***
3.	A2	1690.0	144.03	516.7	***
4.	A3	1840.0	156.82	666.7	***
5.	B1	1383.3	117.90	210.0	*
6.	B2	1546.7	131.82	373.3	**
7.	B3	1660.0	141.48	486.7	***
8.	C1	1703.3	145.17	530.0	***
9.	C2	1766.7	150.57	593.3	***
10.	C3	1963.3	167.33	790.0	***

DL 5% = 149.1kg·ha^{-1}; DL 1% = 214.1kg·ha^{-1}; DL 0.1% = 391.8kg·ha^{-1}

In 2020, following the combination of the two factors studied, cutting x biostimulant dose, yield increases with different statistical significance were achieved.

The two cuttings made in combination with the application of different doses of biostimulants generated yields with very significant positive differences compared to the control variant of the NT x NF experiment. Also, very significant yield increases were obtained for the variants with only one cutting applied, with the exception of the non-fertilized version, as well as the one to which TerraSorbComplex was applied in a dose of 1.0l·ha^{-1}. In the case of the variants to which no cuttings were applied, yield differences supported at a very significant statistical level were obtained, following the application of the maximum doses of the Aminosol and Asfac BCO-4 biostimulants. Distinctly significant positive differences were achieved by the variant where two cuttings were applied, this being non-fertilized, as well as the variants treated with Asfac BCO4 1.0 l·ha^{-1} and Aminosol 2.0 l·ha^{-1}, even if no cuttings were applied. These variants were followed by those uncut and treated with the minimum doses of Aminosol and Asfac BCO-4, but also by the variant T1 x TerraSorb Complex 1.0 l·ha^{-1}, with significant positive differences compared to the control variant.

Table 5

Combined influence of cutting x biostimulant dose on seed production in 2020

No.	Variant		Seed production			Differences significance
			kg·ha^{-1}	% vs control	differences from control	
1.	NT	M	1020.0	100.00	0	Ct
2.	NT	Aminosol 1.0 l	1290.0	126.47	270.0	*
3.	NT	Aminosol 2.0 l	1360.0	133.33	340.0	**
4.	NT	Aminosol 3.0 l	1590.0	155.88	570.0	***
5.	NT	TerraSorb Complex 1.0 l	1050.0	102.94	30.0	-
6.	NT	TerraSorb Complex 1.5 l	1150.0	112.75	130.0	-
7.	NT	TerraSorb Complex 2.0 l	1270.0	124.51	250.0	-
8.	NT	Asfac BCO-4 0.5 l	1330.0	130.39	310.0	*
9.	NT	Asfac BCO-4 1.0 l	1400.0	137.25	380.0	**
10.	NT	Asfac BCO-4 1.5 l	1710.0	167.65	690.0	***
11.	T1	M	1090.0	106.86	70.0	-
12.	T1	Aminosol 1.0 l	1500.0	147.06	480.0	***
13.	T1	Aminosol 2.0 l	1600.0	156.86	580.0	***
14.	T1	Aminosol 3.0 l	1790.0	175.49	770.0	***
15.	T1	TerraSorb Complex 1.0 l	1340.0	131.37	320.0	*
16.	T1	TerraSorb Complex 1.5 l	1690.0	165.69	670.0	***
17.	T1	TerraSorb Complex 2.0 l	1760.0	172.55	740.0	***
18.	T1	Asfac BCO-4 0.5 l	1510.0	148.04	490.0	***
19.	T1	Asfac BCO-4 1.0 l	1590.0	155.88	570.0	***
20.	T1	Asfac BCO-4 1.5 l	1740.0	170.59	720.0	***
21.	T2	M	1410.0	138.24	390.0	**
22.	T2	Aminosol 1.0 l	2030.0	199.02	1010.0	***
23.	T2	Aminosol 2.0 l	2110.0	206.86	1090.0	***
24.	T2	Aminosol 3.0 l	2140.0	209.80	1120.0	***
25.	T2	TerraSorb Complex 1.0 l	1760.0	172.55	740.0	***
26.	T2	TerraSorb Complex 1.5 l	1800.0	176.47	780.0	***
27.	T2	TerraSorb Complex 2.0 l	1950.0	191.18	930.0	***
28.	T2	Asfac BCO-4 0.5 l	2270.0	222.55	1250.0	***

29.	T2	Asfac BCO-4 1.0 l	2310.0	226.47	1290.0	***
30.	T2	Asfac BCO-4 1.5 l	2440.0	239.22	1420.0	***

DL 5% = 258.2kg·ha^{-1}; DL 1% = 336.3kg·ha^{-1}; DL 0.1% = 423.7kg·ha^{-1}

CONCLUSIONS

1. The influence of the cuttings revealed seed yield results supported at a very significant statistical level in the case of applying two cuttings (2022 kg·ha^{-1}), while for T1 (1561 kg·ha^{-1}), they were distinctly significant after comparison with the uncut control variant.

2. At the level of the year 2020, the application of the Asfac BCO-4 biostimulant, at the maximum dose of 1.5 l·ha^{-1}, determined the highest seed yield in the experiment, the yield increase obtained by the Secuieni - Jubileu variety, compared to the non-fertilized variant, being of 790.0 kg·ha^{-1}, result supported at a very significant statistical level.

3. The results show that the combination of the two factors has led to significant increases in the monoecious hemp seed yield, which may be the basis for recommendations for their widespread use by farmers on a large scale, simultaneously or independently, depending on the financial possibilities or the conditions of the crop year.

***Acknowledgments**:This paper was supported by a grant of the Romanian Minister of Research and Innovation CCDI - UEFISCDI, project number 9/PCCDI/2018 within PNCDI III.*

REFERENCES

1. **Jităreanu G., 1999** – *Tehnica experimentală*. Editura "Ion Ionescu de la Brad", Iaşi.
2. **Leonte Alexandra, Robu T., Druțu Cătălina, 2016** – *Researches regarding the influence of "Secuieni method" on seed yields at monoecious hemp (Cannabis sativa L.) cultivated in the pedoclimatic conditions of Central Moldavia*. Scientific papers – vol. 59 (1) 2016, Agronomy series, pg. 131 - 134.
3. **Popa Diana, Găucă C., Trotuş Elena, Buburuz Alexandra, Leonte Alexandra, 2015** – *Assessment of agronomic performances of some cultivars and hybrids of monoecious hemp (Cannabis sativa L.), cultivated by the early cutting of the growh peak („Secuieni method")*. AN. I.N.C.D.A. Fundulea, vol. LXXXIII, 2015, pg. 139 - 148.
4. **Popa Lorena-Diana, Isticioaia Simona-Florina, Vlăduț N. V., Teliban G. C., Matei Gh., Nedelcu Ancuța, 2019** – *Effect of biostimulators application on the biometric and agroproductive characteristics of a monoecious hemp cultivar by SCDA Secuieni.*
5. **Siriţanu V., Siriţanu Carmen, 2007** – *Cercetări privind comportarea unor soiuri şi linii de cânepă monoică în cultura pentru sămânță*. 45 de ani de activitate ştiinţifică, volum omagial, ed. Ion Ionescu de la Brad, Iaşi.
6. **Trotuş Elena, Isticioaia Simona Florina, Mîrzan Oana, Popa Lorena-Diana, Naie Margareta, Lupu Cornelia, Leonte Alexandra, Pintilie Paula Lucelia, Buburuz Alexandra, Pleşcan Iuliana Daniela, 2020**–*Tehnologii de cultivare a unor plante de câmp pentru zona Centrală a Moldovei*.Editura «Ion Ionescu de la Brad» Iaşi,ISBN 978-973-147-367-3.
7. *********13th - 16th International Conference of the European Industrial Hemp Association*, June 2016 – 2019, Kőln, Germany.