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RESEARCH ON THE INFLUENCE OF BIOSTIMULANTS ON PRODUCTIVITY IN THE MILKWEED (*SYLIBUM MARIANUM* L.)

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Abstract

The purpose of the paper is to study to what extent the production and productivity elements of the armory culture is influenced by biostimulators in the pedo-climatic conditions of the experimental field located in the town of Măciuca, Vâlcea county. The work is based on a trifactorial experience, where factor A is the genotype, with 5 gradations: from Prahova, from Secuieni, from Iasi, Dacia Plant and from Brașov; factor B is the applied biostimulator, with 4 grades: untreated, Cropmax, BioHumusSol and Bioenne; factor C is the sowing density, with 3 gradations: 15 pl/m^2, 10 pl/m^2, 25 pl/m^2. The three-factor interaction genotype x biostimulator x decime influenced calathidium diameter, production and MH. The Prahova population showed differences of 25 pl/m^2, when treated with BioHumusSol and Bioenne. The Sequoia cultivar was more productive at plots of 10 pl/m^2 and 25 pl/m^2 both untreated and treated with BioHumusSol and Bioenne. Desimea and the biostimulator influenced the Iași cultivar to a very small extent. Dacia Plant was the only one that reacted very significantly to the treatment with Cropmax, at the rate of 25 pl/m^2. The Brașov population recorded increases in production when treated with Bioenne, in both plots. These interactions technological requests for the cultivation of armors in experienced pedoclimatic conditions.

Key words**:** *armory, genotype, calathidium, seeds, biostimulator*

INTRODUCTION

Silybum marianum is one of the most important medicinal plants, which are grown on the globe. The seed contains important substances used in the pharmaceutical industry, commonly known as silymarin, consisting of an isomeric mixture of 6 phenolic components: silidianine, silicristine, silibin a, silibin b, isosilibin a and isosilibin b. Silymarin is used for countless medical purposes namely: antidiabetic, hepatoprotective,hypocholesterolemic, antihypertensive, anti-inflammatory, anticancer and antioxidant. It can also be antispasmodic, neuroprotective, antiviral, cardiorpotector, and antihemorrhagic [6, 12]. Worldwide, studies on armorarium have been numerous and with differentiated topics (technological aspects, morphological aspects, aspects related to phytochemical components, etc.). In our country there is little research on this species.

In a study the effect of nitrogen fertilization on biomass production and structure in two milk thistle populations was examined [19]. Higher production of achenes and biomass were obtained in a Polish population, relative to the cultivar Silma. The production of achenes increased proportionally with the dose of nitrogen. The population responded better than the cultivar to increasing nitrogen doses.

The highest percentage of achenes in the total biomass was obtained by applying 2 g of N to the experimental vessel. In order to meet the growing demand for armour, the production and productivity of the armoury should be optimised by the use of appropriate technologies. A field experiment was conducted, for two years, by Arampatzis [5] to assess the effects of plant density, and a

growth regulator in plants, on armorarium crop growth, seed production, and silymarin accumulation, under Mediterranean semiarid conditions.The results showed that plant density had a significant impact on plant growth and seed production. Rahimi and Kamali [13] conducted studies on the influence of sowing date and fertilization system on seed production and essential oil content in milk thistle, in Iran, for 2 years. Hendawy [9] investigated the response of armorarium plants to irrigation intervals combined with fertilization. The study was undertaken to investigate the influence of various types of organic and bio fertilizers, on different irrigation norms, on the growth, production, and chemical constituents of *Silybum marianum* plants. Studies on the effect of foliar or soil fertilization and treatment with the growth regulator Thidiazuron (TDZ) on the vegetative and reproductive growth, several physiological parameters, production, and silimarin content in Silybum marianum were conducted by Stanceva [16]. Angelopoulou [4] conducted a field experiment in western Greece to determine the effects of organic fertilization on the root growth of medicinal plants oregano (*Origanum vulgare* L.) and milk thistle (*Silybum marianum* L. Gaertn.). Katar [10] presented a study aimed at determining the effect of seeding density on achene and silimarin production on yield, number of branches/plant, seed weight/plant, and 1,000 grain of armorarium. The effect of sowing date (23rd September, 12th October, and 1st November) and plant density (4, 6, and 8 plants/m2) on characteristics including: phyllochron, stem diameter, number of capitula/plant, main capitulum weight, average weight of secondary capitula, seed number were studied by Tahernia [18]. Numerous researchers [7],[11], [1], [2], [13], have shown that delaying sowing decreases achene yield but increases silimarin content. Silimarin content is also affected by row spacing. A row spacing of 25 cm increases achene yield but reduces oil and silimarin content compared to plants at 50 cm row spacing [3], [20].

In this context, the purpose of the paper is to study to what extent the production and productivity elements of the armory culture is influenced by biostimulators in the pedo-climatic conditions of the experimental field located in the town of Măciuca, Vâlcea county.

MATERIALS AND METHODS

The experiment is three-factorial, where factor A is the genotype, with 5 levels: from Prahova, from Secuieni, from Iași, Dacia Plant, from Brașov; factor B is the biostimulant, with 4 levels: untreated, Cropmax, BioHumusSol, Bio enne; and factor C is the seeding density with 3 levels: 15 plants/m2, 10 plants/m2, 25 plants/m2. The experiment was conducted between the years 2020 and 2021, in the locality of Măciuca, Vâlcea county, on chernozem soil.

The cultivar "de Prahova" is the only one registered in the Official Catalog of Crop Plant Varieties in Romania, 2022 edition. It was re-registered in 2020, being maintained by the National Research and Development Institute for Soil Science, Agrochemistry and Environmental Protection (INCDA Fundulea) [17]. The seed from the "de Secuieni" population is available in the SCDA Secuieni's offer, both for organic and conventional agriculture [14].

For the other three genotypes, the name is primarily linked to their origin, without having too much information about their source. The one from Brașov seems to originate from Hungary.

The foliar fertilizers used were: Cropmax, Biohumusol, and Bio enne.

Cropmax is a concentrated foliar fertilizer, rich in macro and microelements, growth stimulators, vitamins, polysaccharides, enzymes, etc., with favorable effects on directing plant metabolism. Its application leads to the rapid development of the root system and leaf mass growth, allowing plants to reach their biological production potential.

Certified organic fertilizer, being approved for use in organic farming (certificate issued by BCS-ÖKO), brings a series of benefits to plants, as follows: significant increases in

production, with boosts of 15-25%; improvements in crop quality; enhances the effectiveness of mineral fertilizers and pesticides used; contributes to better and faster root system development, consequently increasing plant resistance to drought and stress considerably; improves shoot growth and plant branching; significantly enhances plant resistance to diseases and pests; improves plant recovery after damage caused by adverse weather phenomena (hail, frost, drought); product compatible with pesticides and NPK soluble fertilizers.

Biohumussol liquid is a 100% organic fertilizer, an active humic fertilizer, purely ecological, which stimulates plant growth and health. It contains salts of humic acids, humic acids, fulvic acids, amino acids, micro and macro elements, live bacteria, and other easily absorbable substances.

It can be applied to both the foliar and root system, through any spraying or irrigation method, increasing the numerical and dimensional growth of leaves and roots [15].

Bio enne contains in its composition organic nitrogen (N) - 12%, water-soluble sulphur (SO^3) - 23%, and organic carbon (C) - 35%.

The data processing was carried out using the statistical analysis program specific to the three-factor experiments, based on the methodology presented by N. A. Săulescu, N.N. Săulescu (PSUB 3).

For presenting the distribution of values from a series of data, in the case of studying the genetic variability of the traits determined throughout the experiment, the boxplot was used [8].

The pedoclimatic conditions during the experimental period were moderately favorable in both experimental years.

RESULTS AND DISCUSSIONS

Results regarding the influence of genotype, biostimulant, and density on: head diameter, achene yield, 1,000-achene weight, and hectoliter weight are presented. The three-factor interaction population x biostimulant x density significantly influenced yield (Table 1). Thus, the Prahova population showed increased yields at a density of 25 plants/m², with statistical significance when treated with the biostimulants BioHumusSol and Bio enne.

The Secuieni population was more productive at densities of 10 plants/m² and 25 plants/m², both untreated and treated with BioHumusSol and Bioenne.

Density and biostimulant had a very minor influence on the Iași population.

The Dacia Plant population was the only one that reacted very significantly to treatment with Cropmax when seeded at a density of 25 plants/m².

Statistically significant increases in production were also observed with the other two biostimulants: BioHumusSol and Bio enne, but at different densities. The Brașov population recorded production increases when treated with Bio enne at both densities tested compared to the recommended density.

Table 1. Influence of population x biostimulator x density interaction on yield

Factor A - Population	Factor B – treatment with biostimulant	Factorul C – density	Prro duction Kg/ha	Difference from mt.	Meaning
a_1-FROM PRAHOVA	b_1 - UNFERTILIZAED	c_1- 15 pl/mp	522	0	
		c_2- 10 pl/mp	599	77	
		c_3- 25 pl/mp	460	-62	
	b_2 - CROPMAX	c_1- 15 pl/mp	657	0	
		c_2. 10 pl/mp	622	-35	
		c_3- 25 pl/mp	685	28	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	694	0	
		c2- 10 pl/mp	762	68	
		c3- 25 pl/mp	818	124	*
	b_4– BIOENNE	c1- 15 pl/mp	871	0	
		c2- 10 pl/mp	925	54	
		c3- 25 pl/mp	1141	270	***
a_2-FROM SECUIENI	b_1 - UNFERTILIZED	c1- 15 pl/mp	532	0	
		c2- 10 pl/mp	890	358	***
		c3- 25 pl/mp	780	248	***
	b_2 - CROPMAX	c1- 15 pl/mp	720	0	
		c2- 10 pl/mp	730	10	

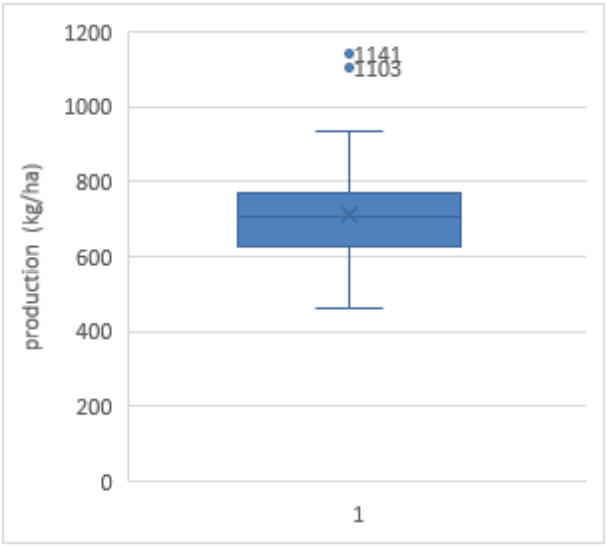
		c3- 25 pl/mp	697	-23	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	737	0	
		c2- 10 pl/mp	763	26	
		c3- 25 pl/mp	889	152	**
	b_4 – BIOENNE	c1- 15 pl/mp	625	0	
		c2- 10 pl/mp	933	308	***
		c3- 25 pl/mp	778	153	**
a_3-FROM IASI	b_1 - UNFERTILIZED	c1- 15 pl/mp	612	0	
		c2- 10 pl/mp	745	133	*
		c3- 25 pl/mp	532	-80	
	b_2 - CROPMAX	c1- 15 pl/mp	552	0	
		c2- 10 pl/mp	587	35	
		c3- 25 pl/mp	628	76	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	693	0	
		c2- 10 pl/mp	723	30	
		c3- 25 pl/mp	719	26	
	b_4– BIOENNE	c1- 15 pl/mp	745	0	
		c2- 10 pl/mp	840	95	
		c3- 25 pl/mp	586	-159	oo
a_4-DACIA PLANT	b1 - UNFERTILIZED	c1- 15 pl/mp	610	0	
		c2- 10 pl/mp	631	21	
		c3- 25 pl/mp	497	-113	o
	b2 – CROPMAX	c1- 15 pl/mp	581	0	
		c2- 10 pl/mp	628	47	
		c3- 25 pl/mp	771	190	***
	b3 - BIOHUMUSSOL	c1- 15 pl/mp	665	0	
		c2- 10 pl/mp	719	54	
		c3- 25 pl/mp	811	146	**
	b4 – BIOENNE	c1- 15 pl/mp	812	0	
		c2- 10 pl/mp	1,103	291	***
		c3- 25 pl/mp	846	34	
a_5-FROM BRASOV	b1 - UNFERTILIZED	c1- 15 pl/mp	681	0	
		c2- 10 pl/mp	715	34	
		c3- 25 pl/mp	686	5	
	b2 - CROPMAX	c1- 15 pl/mp	743	0	
		c2- 10 pl/mp	688	-55	
		c3- 25 pl/mp	625	-118	o
	b3 - BIOHUMUSSOL	c1- 15 pl/mp	640	0	
		c2- 10 pl/mp	737	97	
		c3- 25 pl/mp	619	-21	
	b4 – BIOENNE	c1- 15 pl/mp	572	0	
		c2- 10 pl/mp	886	314	***
		c3- 25 pl/mp	718	146	**
		DL 5%	104 kg/ha		
		DL 1%	138 kg/ha		
		DL 0.1%	179 kg/ha		

Source: original data.

Variability analysis through the boxplot method allowed the identification of two outliers (variants significantly deviating from the cluster of determinations made), namely: the Prahova population treated with Bio enne and seeded at 25 pl/mp (interaction a1b4c3) as well as the Dacia Plant population treated with Bioenne and seeded at 10 pl/mp (interaction a4b4c2). These two interactions represent technological recommendations for cultivating milk thistle under the pedoclimatic conditions in which it was experimented (Figure 1).

The results obtained from the calculation using QUARTILE.INC function represents:

Min	459.55	The minimum value of the series of 60 data points
Q1	624.4417	The maximun value of 25% data points
Med	696.6533	The maximun value of 50% data points
Q3	772.835	The maximun value of 75% data points
Max	890	The maximum value of data set does not include outliers
mean	713	The average of the data set
range	430.45	The difference between mim and max value
IQR	148.3933	interquartil = Q3-Q1
	222.59	interquartil x 1,5
	401.8517	The value at which the lower outliers appear
	995.425	The value at which the upper outliers appear



a_1	b_4	c_3	1,141
a_4	b_4	c_2	1,103

Fig. 1. Yied variability presented by boxplot method
Source: Authors' data.

Regarding the biostimulant used, treatment with BioHumusSol resulted in a significant increase in production compared to the unfertilized variant (Figure 2). The boundary differences had small values due to the fairly uniform dimensions of the variants studied both among themselves and between the repetitions of the same variants.

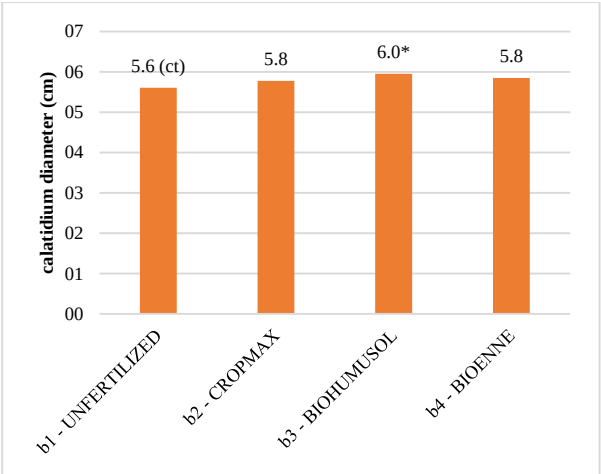


Fig. 2. The influence of the biostimulator on the capitulum diameter at milk thistle
Source: Authors' data.

The three-way interaction population x biostimulant x density significantly influenced the diameter of the capitulum (Table 2). Thus, the Prahova population showed decreases with statistical assurance at a density of 25 pl/mp when treated with BioHumusSol.

Diametrically opposed differences were recorded at a density of 10 pl/mp. It is possible that errors in ensuring the correct density may have occurred here, or it may be that the biostimulant Bio enne provided a significant increase at the same density.

Table 2. Influence of population x biostimulator x density interaction on capitulum diameter

Factor A - population	Factor B – treatment with biostimulator	Factorul C – density	Calthidium diameter (cm)	Difference from mt.	Meaning
a_1- FROM PRAHOVA	b_1 - UNFERTILIZED	c1- 15 pl/mp	6.5	-0.5	
		c2- 10 pl/mp	6.1	-0.9	o
		c3- 25 pl/mp	6.6	-0.4	
	b_2 - CROPMAX	c1- 15 pl/mp	6.0	0.0	
		c2- 10 pl/mp	6.3	0.3	
		c3- 25 pl/mp	6.2	0.2	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	6.9	0.0	
		c2- 10 pl/mp	6.4	-0.5	
		c3- 25 pl/mp	5.6	-1.3	oo
	b_4– BIOENNE	c1- 15 pl/mp	5.9	0.0	
		c2- 10 pl/mp	6.8	0.9	*
		c3- 25 pl/mp	5.8	-0.1	
a_2- FROM SECUIENI	b_1 - UNFERTILIZED	c1- 15 pl/mp	6.2	0.0	
		c2- 10 pl/mp	5.9	-0.3	
		c3- 25 pl/mp	6.5	0.3	
	b_2 - CROPMAX	c1- 15 pl/mp	5.8	0.0	
		c2- 10 pl/mp	6.4	0.6	
		c3- 25 pl/mp	6.9	1.1	**
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	6.1	0.0	
		c2- 10 pl/mp	6.2	0.1	
		c3- 25 pl/mp	6.7	0.6	
	b_4 – BIOENNE	c1- 15 pl/mp	6.4	0.0	
		c2- 10 pl/mp	6.6	0.2	
		c3- 25 pl/mp	6.6	0.2	
a3- FROM IASI	b_1 - UNFERTILIZED	c1- 15 pl/mp	5.6	0.0	
		c2- 10 pl/mp	5.0	-0.6	

		c3- 25 pl/mp	5.2	-0.4	
	b_2 - CROPMAX	c1- 15 pl/mp	6.4	0.0	
		c2- 10 pl/mp	6.1	-0.3	
		c3- 25 pl/mp	6.0	-0.4	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	6.1	0.0	
		c2- 10 pl/mp	5.1	-1.0	o
		c3- 25 pl/mp	4.9	-1.2	oo
	b_4– BIOENNE	c1- 15 pl/mp	5.3	0.0	
		c2- 10 pl/mp	5.1	-0.2	
		c3- 25 pl/mp	5.1	-0.2	
a_4-DACIA PLANT	b_1 - UNFERTILIZED	c1- 15 pl/mp	4.7	0.0	
		c2- 10 pl/mp	5.6	0.9	*
		c3- 25 pl/mp	4.8	0.1	
	b_2 - CROPMAX	c1- 15 pl/mp	5.6	0.0	
		c2- 10 pl/mp	5.0	-0.6	
		c3- 25 pl/mp	4.9	-0.7	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	5.6	0.0	
		c2- 10 pl/mp	6.1	0.5	
		c3- 25 pl/mp	5.5	-0.1	
	b_4 – BIOENNE	c1- 15 pl/mp	5.3	0.0	
		c2- 10 pl/mp	5.9	0.6	
		c3- 25 pl/mp	5.8	0.5	
a_5- FROM BRASOV	b_1 - UNFERTILIZED	c1- 15 pl/mp	4.0	0.0	
		c2- 10 pl/mp	5.7	1.7	***
		c3- 25 pl/mp	5.7	1.7	***
	b_2 - CROPMAX	c1- 15 pl/mp	4.4	0.0	
		c2- 10 pl/mp	6.0	1.6	***
		c3- 25 pl/mp	4.6	0.2	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	6.2	0.0	
		c2- 10 pl/mp	6.9	0.7	
		c3- 25 pl/mp	5.1	-1.1	o
	b_4– BIOENNE	c1- 15 pl/mp	5.0	0.0	
		c2- 10 pl/mp	5.3	0.3	
		c3- 25 pl/mp	6.8	1.8	***
		DL 5%	0.9 cm		
		DL 1%	1.1 cm		
		DL 0,1%	1.5 cm		

Source: Authors' data.

The population from Secuieni presented a larger calathidium at the density of 25 pl/mp in the variant treated with Cropmax.

The density and biostimulant had a very minor influence on the population from Iași. Here, only BioHumusSol intervened by decreasing the calathidium at the densities of 10 pl/mp and 25 pl/mp. Additionally, the density and biostimulant had a very minor influence on the population from Dacia Plant. The population from Brașov recorded very significant increases in diameter when treated with Bioenne or untreated at the density of 25 pl/mp compared to the recommended density, as well as very significant increases in the calathidium when treated with Cropmax or untreated at the density of 10 pl/mp.

The three-way interaction of population x biostimulant x density had a minor influence on the weight of 1,000 achenes (seeds) (Table 3). The density of 10 pl/mp, indicating sparser plants, was the one that stimulated statistically significant increases in the treatment with Bio enne for the Dacia Plant population and for the unfertilized variant of the Secuieni population.

Table 3.Influence of population x biostimulator x density interaction on weight of 1,000 seeds

Factor A - population	Factor B – treatment with biostimulator	Factorul C – density	The weight of 1000 de achenes (g)	The difference from mt.	Meaning
a_1. FROM PRAHOVA	b_1 - UNEFERTILIZED	c1- 15 pl/mp	24.3	0.0	
		c2- 10 pl/mp	24.9	0.6	
		c3- 25 pl/mp	27.9	3.6	
	b_2 - CROPMAX	c1- 15 pl/mp	26.4	0.0	
		c2- 10 pl/mp	27.6	1.2	
		c3- 25 pl/mp	26.9	0.5	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	30.5	0.0	
		c2- 10 pl/mp	27.3	-3.2	
		c3- 25 pl/mp	25.5	-5.0	o
	b_4 – BIOENNE	c1- 15 pl/mp	27.0	0.0	
		c2- 10 pl/mp	29.3	2.3	
		c3- 25 pl/mp	30.5	3.5	

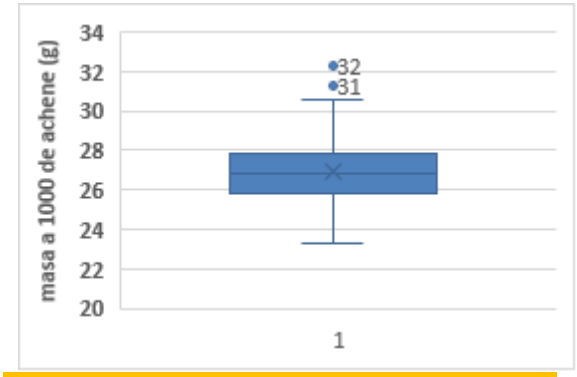
a_2- FROM SECUIENI	b_1 - UNEFERTILIZED	c1- 15 pl/mp	25.9	0.0	
		c2- 10 pl/mp	32.3	6.4	**
		c3- 25 pl/mp	27.5	1.6	
	b_2 - CROPMAX	c1- 15 pl/mp	27.9	0.0	
		c2- 10 pl/mp	26.0	-1.9	
		c3- 25 pl/mp	27.2	-0.7	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	27.2	0.0	
		c2- 10 pl/mp	26.1	-1.1	
		c3- 25 pl/mp	28.5	1.3	
	b_4 – BIOENNE	c1- 15 pl/mp	27.9	0.0	
		c2- 10 pl/mp	27.7	-0.2	
		c3- 25 pl/mp	26.4	-1.5	
a_3-FROM IASI	b1 - UNEFERTILIZED	c1- 15 pl/mp	26.5	0.0	
		c2- 10 pl/mp	27.1	0.6	
		c3- 25 pl/mp	25.6	-0.9	
	b_2 - CROPMAX	c1- 15 pl/mp	25.3	0.0	
		c2- 10 pl/mp	24.1	-1.2	
		c3- 25 pl/mp	23.7	-1.6	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	28.9	0.0	
		c2- 10 pl/mp	28.0	-0.9	
		c3- 25 pl/mp	26.1	-2.8	
	b_4– BIOENNE	c1- 15 pl/mp	28.3	0.0	
		c2- 10 pl/mp	28.5	0.2	
		c3- 25 pl/mp	26.9	-1.4	
a_4-DACIA PLANT	b_1 - UNFERTILIZED	c1- 15 pl/mp	27.1	0.0	
		c2- 10 pl/mp	25.6	-1.5	
		c3- 25 pl/mp	23.3	-3.8	
	b_2 - CROPMAX	c1- 15 pl/mp	25.6	0.0	
		c2- 10 pl/mp	23.3	-2.3	
		c3- 25 pl/mp	26.7	1.1	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	28.3	0.0	
		c2- 10 pl/mp	27.5	-0.8	
		c3- 25 pl/mp	25.6	-2.7	
	b_4– BIOENNE	c1- 15 pl/mp	26.8	0.0	
		c2- 10 pl/mp	31.3	4.5	*
		c3- 25 pl/mp	26.4	-0.4	
a_5- FROM BRASOV	b_1 - UNFERTILIZED	c1- 15 pl/mp	28.0	0.0	
		c2- 10 pl/mp	25.1	-2.9	
		c3- 25 pl/mp	25.3	-2.7	
	b_2 – CROPMAX	c1- 15 pl/mp	26.7	0.0	
		c2- 10 pl/mp	26.4	-0.3	
		c3- 25 pl/mp	26.7	0.0	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	25.1	0.0	
		c2- 10 pl/mp	26.5	1.4	
		c3- 25 pl/mp	26.7	1.6	
	b_4 – BIOENNE	c1- 15 pl/mp	26.8	0.0	
		c2- 10 pl/mp	30.5	3.7	
		c3- 25 pl/mp	27.8	1.0	
		DL 5%	4.2 g		
		DL 1%	5.5 g		
		DL 0.1%	7.2 g		

Source: Authors' data.

The analysis of variability through the boxplot method allowed the identification of two outliers, namely: the Dacia Plant population treated with Bioenne and seeded at 10 pl/mp (interaction a4b4c2) and the untreated Secuieni population seeded at 10 pl/mp (interaction a2b1c2). These results, especially the latter interaction, indicate that the Secuieni population, when sparsely seeded, develops larger seeds, with the biostimulator playing no stimulating role (Figure 3).

The results obtained from the calculation using the QUARTILE.INC function represent:

Min	23.33333	The minimum value of the series of 60 plants
Q1	25.96667	The maximum value of 25% data
Med	26.86667	The maximum value of 50% data
Q3	27.86667	The maximum value of 75% data
Max	32.26667	The maximum value of the data set that does not include outliers
Mean	27.0	
Range	8.933333	The difference between max and min
IQR	1.9	interquartil = Q3-Q1
	2.85	interquartil x 1,5
	23.11667	The value at which the lower outliers appears
	30.71667	The value at which the upper outliers appears



a_4	b_4	c_2	31.3
a_2	b_1	c_2	32.3

Fig. 3. Weight of 1,000 seeds variability presented by boxplot method
Source: Authors' data.

The interaction between biostimulators and population shows that, similar to the test weight, there are no statistically significant differences between the population of Prahova and the other populations tested under any of the biostimulator-treated conditions, regardless of the type of biostimulator used (Table 4). However, differences exist when not fertilized between populations, compared to the Prahova population, in the sense that the populations of Secuieni, Iasi, and Brasov showed statistically significant increases in hectoliter weight. The trifactorial interaction of population x biostimulator x density significantly influenced the hectoliter weight (Table 4). Thus, the Prahova population showed statistically significant increases in hectoliter weight at densities of 10 pl/mp and 25 pl/mp when untreated, as well as with treatment with Cropmax.
The population of Secuieni had a higher hectoliter weight with statistical assurance at densities of 10 pl/mp and 25 pl/mp treated with Cropmax.
The density and biostimulator had a small influence on the hectoliter weight of the Iasi population. The same was observed for the Dacia Plant population.
The Brasov population recorded an increase in hectoliter weight when treated with Bio enne at a density of 25 pl/mp compared to the recommended density.

Table 4. Influence of population x biostimulator x density interaction on test weight

Factor A - populație	Factorul B – treatment with biostimulator	Factor C – density	Mass Helect olitr	Differ ence	Semif icația
a_1- FROM PRAHOVA	b_1 - UNEFERTILIZED	c1- 15 pl/mp	65.2	0.0	
		c2- 10 pl/mp	74.2	9.0	**
		c3- 25 pl/mp	79.0	13.8	**
	b_2 - CROPMAX	c1- 15 pl/mp	67.9	0.0	
		c2- 10 pl/mp	81.9	14.0	***
		c3- 25 pl/mp	80.4	12.5	***
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	80.4	0.0	
		c2- 10 pl/mp	76.5	-3.9	
		c3- 25 pl/mp	75.4	-5.0	
	b4 – BIOENNE	c1- 15 pl/mp	81.2	0.0	
		c2- 10 pl/mp	72.8	-8.4	oo
		c3- 25 pl/mp	79.3	-1.9	
a_2.FROM SECUIENI	b_1 - UNEFERTILIZED	c1- 15 pl/mp	75.8	0.0	
		c2- 10 pl/mp	80.0	4.2	
		c3- 25 pl/mp	83.5	7.7	*
	b_2 - CROPMAX	c1- 15 pl/mp	68.8	0.0	
		c2- 10 pl/mp	78.4	9.6	**
		c3- 25 pl/mp	79.7	10.9	***
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	79.6	0.0	
		c2- 10 pl/mp	78.5	-1.1	
		c3- 25 pl/mp	73.2	-6.4	o
	b_4– BIOENNE	c1- 15 pl/mp	77.4	0.0	
		c2- 10 pl/mp	81.0	3.6	
		c3- 25 pl/mp	78.4	1.0	
a_3- FROM IASI	b_1 - UNEFERTILIZED	c1- 15 pl/mp	72.9	0.0	
		c2- 10 pl/mp	79.7	6.8	*
		c3- 25 pl/mp	80.5	7.6	*
	b_2 - CROPMAX	c1- 15 pl/mp	76.5	0.0	
		c2- 10 pl/mp	78.8	2.3	
		c3- 25 pl/mp	77.9	1.4	
	b3 - BIOHUMUSSOL	c1- 15 pl/mp	80.9	0.0	
		c2- 10 pl/mp	77.8	-3.1	
		c3- 25 pl/mp	79.0	-1.9	
	b_4– BIOENNE	c1- 15 pl/mp	82.3	0.0	

		c2- 10 pl/mp	79.7	-2.6	
		c3- 25 pl/mp	72.5	-9.8	oo
a_4-DACIA PLANT	b1 - UNEFERTILIZED	c1- 15 pl/mp	66.2	0.0	
		c2- 10 pl/mp	62.1	-4.1	
		c3- 25 pl/mp	63.5	-2.7	
	b_2 - CROPMAX	c1- 15 pl/mp	81.2	0.0	
		c2- 10 pl/mp	75.2	-6.0	o
		c3- 25 pl/mp	75.9	-5.3	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	82.9	0.0	
		c2- 10 pl/mp	72.3	10.6	ooo
		c3- 25 pl/mp	80.8	-2.1	
	b4 – BIOENNE	c1- 15 pl/mp	81.1	0.0	
		c2- 10 pl/mp	81.2	0.1	
		c3- 25 pl/mp	76.1	-5.0	
a_5-DE BRASOV	b_1 - NEFERTILIZAT	c1- 15 pl/mp	81.1	0.0	
		c2- 10 pl/mp	76.5	-4.6	
		c3- 25 pl/mp	78.6	-2.5	
	b2 - CROPMAX	c1- 15 pl/mp	78.0	0.0	
		c2- 10 pl/mp	77.0	-1.0	
		c3- 25 pl/mp	81.5	3.5	
	b_3 - BIOHUMUSSOL	c1- 15 pl/mp	80.4	0.0	
		c2- 10 pl/mp	82.1	1.7	
		c3- 25 pl/mp	80.7	0.3	
	b_4– BIOENNE	c1- 15 pl/mp	72.6	0.0	
		c2- 10 pl/mp	77.5	4.9	
		c3- 25 pl/mp	81.5	8.9	**
		DL 5%	6.0 kg/hl		
		DL 1%	8.0 kg/hl		
		DL 0,1%	10.4 kg/hl		

Source: Authors' data.

CONCLUSIONS

The three-way interaction between population, biostimulator, and density significantly influenced production. Thus, the Prahova population showed statistically significant production increases at a density of 25 pl/mp when treated with the biostimulators BioHumusSol and Bioenne.

The Secuieni population was more productive at densities of 10 pl/mp and 25 pl/mp, both untreated and treated with BioHumusSol and Bio enne. Density and biostimulator had very little influence on the Iași population. The Dacia Plant population was the only one to react significantly to Cropmax treatment when seeded at a density of 25 pl/mp. Production increases with statistical assurance were also observed with the other two biostimulators: BioHumusSol and Bio enne, but at different densities. The Brașov population showed production increases when treated with Bio enne at both tested densities, compared to the recommended density.

The three-way interaction of population x biostimulator x density had a significant influence on the diameter of the capitulum, although to a lesser extent on the Iași and Dacia Plant populations.

The analysis of the variability of the weight of 1,000 achenes using the boxplot method allowed the identification of two outliers, namely: the Dacia Plant population treated with Bio enne and seeded at 10 pl/mp, and the untreated Secuieni population seeded at 10 pl/mp. The latter interaction shows that the Secuieni population, when seeded sparsely, develops larger seeds, with the biostimulator not playing a stimulating role.

The trifactorial interaction between population, biostimulator, and density influenced the hectoliter weight to a greater or lesser extent. Thus, the populations of Prahova and Secuieni showed statistically significant increases at the densities of 10 pl/mp and 25 pl/mp when treated with Cropmax. Density and biostimulator had a minor influence on the hectoliter weight of the Iași population. The same was observed for the Dacia Plant population. The Brașov population recorded an increase in hectoliter weight when treated with Bio enne at the density of 25 pl/mp compared to the recommended density.

The analysis of variability through the boxplot method identified two outliers (variants that significantly deviate from the cluster of determinations): the Prahova population treated with Bio enne and seeded at 25 pl/mp,

and the Dacia Plant population treated with Bio enne and seeded at 10 pl/mp.

These two variants represent technological recommendations for cultivating milk thistle under the pedoclimatic conditions in which the experiment was conducted.

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