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CONTRIBUTIONS TO THE DEVELOPMENT OF THE CULTIVATION TECHNOLOGY OF CASTOR HYBRIDS (*Ricinus communis* L.)

Ioan PUIU, Teodor ROBU, Carmen Simona GHITAU, Constantin LUNGOCI

University of Life Sciences "Ion Ionescu de la Brad" from Iasi, 3 Mihail Sadoveanu Alley, Iasi, Romania

Corresponding author email: ioan.puiu@uaiasi.ro

Abstract

Castor bean is cultivated in Romania as an ornamental plant and very little for its seeds rich in oil used in the textile and chemical industry or in pharmacy and cosmetics. Castor oil is at the same time a good melliferous and energetic plant. In 1989, 26,300 ha of castor were cultivated in Romania, and currently insignificant areas are cultivated. Interest in this culture has grown a lot in recent years due to the development of castor hybrids with clearly superior productions compared to the old varieties. The research aimed at the development of an economically efficient cultivation technology, in the pedoclimatic conditions of the north of Moldova. A numar of 6 castor hybrids of French origin were tested, cultivated in rows at a distance of 70 cm, using precision seeders from corn in 3 variants of spacing per row: 70 cm, 100 cm and 130 cm. The highest seed productions were for the hybrid LS-CB-18-04 (4,871 kg/ha) and hybrid LS-CB-18-02 (4,774 kg/ha), at a sowing distance of 130 cm per row (10,989 plants/ha).

Key words*: castor bean, hybrid, cultivation technology.*

INTRODUCTION

Castor (*Ricinus communis* L.) is an endemic plant in sub-tropical and tropical regions and belongs to the Euphorbiaceae family (Scarpa et al., 1982). Its spread was possible due to its high resistance to drought, but also salinity, an abiotic factor that intensifies its action from one year to another (Lungoci et al., 2023; Lungoci et al., 2022). Domains such as encapsulation, incorporation into polymer matrixes of film or gel type (Lungoci et al., 2023), nanoparticles (Ojha et al., 2017) and other products, have taken a great extend, and plant extracts and non-drying castor oil finds its place.

The plant has been known since antiquity for its medicinal properties, being mentioned numerous times in Egyptian papyri, especially for the treatment of skin diseases (Severino et al., 2013). Some other uses of castor oil and extracts are shown in Figure 1 (Iqbal et al., 2011; Sandhyakumary et al., 2003; Shokeen et al., 2008; Rakesh et al., 2011; Taur et al., 2011; Upasani et al., 2011).

Castor oil has a growing international market, as evidenced by its more than 700 uses, from medicines and cosmetics to replacing petroleum products in the production of plastics, biodiesel and lubricants (Ramanjaneyulu et al., 2013), for the insecticide effect, antimicrobial (Soni et al., 2017).

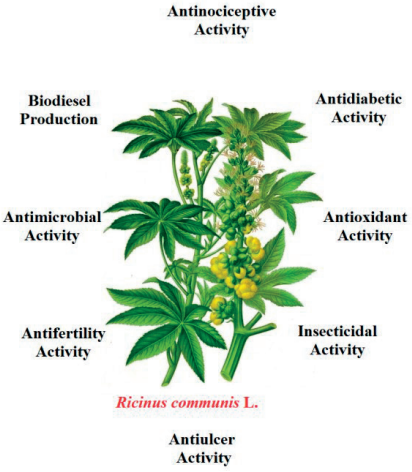

Figure 1. *Ricinus communis* L.

This species was also acclimatized on the European continent, until 1980 the areas were quite extensive. In the area of origin, it is a perennial specie, but in European countries it is known as an annual crop (Patanè et al., 2019). Castor is cultivated in Romania as an ornamental plant and in very small surfaces for

its oil-rich seeds, used in the textile and chemical industry or in pharmacy and cosmetics. Castor is at the same time a good melliferous and energetic plant. From an agronomic point of view, it is a valuable plant, due to the penetrating power of the root, destroying the hardpan (Zoz et al., 2021). In 1989, in Romania, 26,300 hectars were cultivated with castor, and currently insignificant areas are cultivated. The interest for this crop has increased greatly in recent years due to the development of castor hybrids with significantly higher yields than the old varieties (Roman et al., 2012).

MATERIALS AND METHODS

The experimental field was carried out in a commercial farm in Ripiceni, Botosani, according to the following experimental protocol: monofactorial experiment, laid out according to the randomized block method, in three repetitions (155 square meters/repetition).
The tested factor was the distance between the castor plants in a row: A_1-70 cm, A_2 - 100 cm and A_3 - 130 cm.
The applied technology was the traditional one: after harvesting the wheat that was the predecessor plant, weeding was carried out, followed 14 days later by basic fertilization with 400 kg/ha of NPK 16/16/16 type complex fertilizers and plowing at a depth of 33 cm. The shredding and leveling of the land was done with a combine about 20 days after plowing. The soil was prepared in the spring, through a work with the combiner at a sowing depth of 7 cm, carried out on the day of sowing, an operation by which the amount of 100 kg/ha of urea (46% nitrogen active substance) was incorporated into the soil. The sowing was carried out at the end of April, using six hybrids from France that are in the testing and homologation phase: LS-CB-18-01, LS-CB-18-02, LS-CB-18-03, LS-CB-18 -04, LS-CB-18-11, LS-CB-18-12. The seed was treated with Maxim XL 035 FS (fludioxonil 25 g/l + metalaxyl-M (mefenoxam) 10 g/l) to prevent soil infections with *Fusarium* spp.

After sowing, weeding was carried out in the pre-emergence with the product Dual Gold (960 g/l s-metolachlor) in a dose of 1.4 l/ha, and during the growing season three manual weedings were carried out to keep the crop free of weeds. Currently, there is no approved herbicide for the castor crop in Romania. The plants sprouted 12-13 days after sowing and were protected from pests by the preventive application of the pyrethroid insecticide Karate Zeon (lambda-cyhalothrin 50 g/l) in a concentration of 0.1%. At the beginning of flowering, the second treatment was applied against polyphagous pests using the product Mospilan (acetamiprid 200 g/kg) in a concentration of 0.1%: the red spider (*Tetranycus urticea*), the fruit caterpillar (*Helicoverpa armigera*). The culture did not show specific disease symptoms during the entire vegetation period.
Analyzing the climatic conditions of the area, monitored by the nearby weather station, we can observe that, in the case of temperatures, in most months they recorded values much lower than the multi-year average. An exception is the month of January where the average is 0.7 higher than the multi-year average and February, where the difference is 1°C. The results are presented in Figure 2.

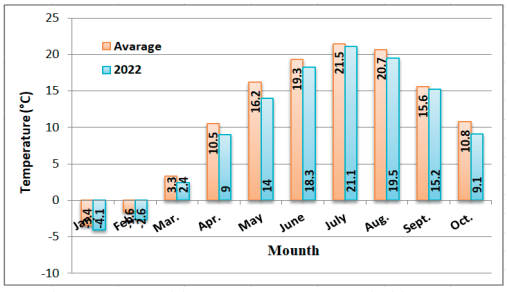

Figure 2. Monthly temperatures recorded in 2022

The rainfall regime recorded values between 25.5 mm in February and 65.5 mm in September. We encounter a positive deviation in September, the difference compared to the multi-year amount being 20 mm. In the other months, the values are close to the multiannual amount. The data are presented in Figure 3.

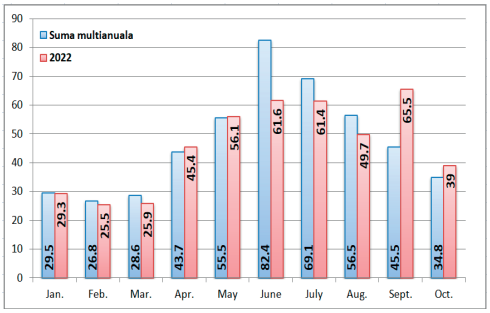

Figure 3. Monthly amount of precipitation in 2022

Soxhlet extraction

A quantity of 150 g shelled and crushed castor seeds was placed in a Soxhlet extractor fitted with a 1000 ml glass flask containing 350 ml of ethanol. The extraction was carried out at the boiling temperature of ethanol (78°C), for 3 hours. After extraction, the solvent was evaporated with the help of a rotoevaporator until a complete removal of the ethanol necessary to determine the weight of the extract was found (Danlami, 2015; Randall, 1978). After the extraction process, the castor seed residues was dried in an oven for 24 hours at 50°C to determine the weight of the dry material.

The hectoliter mass was determined according to the current standard ISO 7971-2:2019, and the TKW according to the SR ISO 520/2002 standard (Zaharia et al., 2017).

RESULTS AND DISCUSSIONS

Table 1. The influence of the hybrid on the production of the 130 cm between rows variant

Hybrid	Yield	Difference (%)	Difference (kg/ha)	Significance
LS-CB-18-04	4165.7	118.93	663.1	***
LS-CB-18-02	4092.3	116.84	589.7	***
Avarage	3502.6	100	0	Mt
LS-CB-18-03	3341	95.39	-161.6	ooo
LS-CB-18-11*	3243.7	92.61	-258.9	ooo
LS-CB-18-01	3153.7	90.04	-348.9	ooo
LS-CB-18-12*	3019	86.19	-483.6	ooo
			DL 5%	42.9 kg/ha
			DL 1%	61.0 kg/ha
			DL 0.1%	88.3 kg/ha

The distance of 130 cm between the rows has a negative influence compared to the other variants analyzed. The hybrids LS-CB-18-04 and LS-CB-18-02, have the highest yields and the differences from the control, which is the average, being 663.1 kg for the first hybrid and 589.7 for the second. These statistically ensured differences are very significant and positive. In the other 4 hybrids, the differences from the average are very significant, but negative.

Table 2. The influence of the hybrid on the production of the 100 cm between rows variant

Hybrid	Yield	Difference (%)	Difference (kg/ha)	Significance
LS-CB-18-04	4592	117.21	674.1	***
LS-CB-18-02	4491.7	114.65	573.8	***
Avarage	3917.9	100	0	Mt
LS-CB-18-03	3771	96.25	-146.9	ooo
LS-CB-18-11*	3636.3	92.81	-281.6	ooo
LS-CB-18-01	3588.7	91.6	-329.2	ooo
LS-CB-18-12*	3427.7	87.49	-490.2	ooo
			DL 5%	37.7 kg/ha
			DL 1%	53.6 kg/ha
			DL 0.1%	77.6 kg/ha

In the case of the distance of 100 cm between the rows, the productions were much higher than in the previous version. The highest productions were also recorded for hybrids LS-CB-18-04 and LS-CB-18-02, varying between 4871 kg/ha for the first and 4774 kg/ha for the second. The differences from the average being very significant and positive. Compared to the previous version, we can see that production has increased for all variants. For the hybrid LS-CB-18-03 the production is very significant, negative, similar being also in the last two hybrids.

Table 3. The influence of the hybrid on the production of the 70 cm between rows variant

Hybrid	Yield	Difference (%)	Difference (kg/ha)	Significance
LS-CB-18-04	4871	115.42	650.8	***
LS-CB-18-02	4774	113.12	553.8	***
Avarage	4220.2	100	0	Mt
LS-CB-18-03	4096	97.06	-124.2	
LS-CB-18-11*	3935	93.24	-285.2	oo
LS-CB-18-01	3903	92.48	-317.2	ooo
LS-CB-18-12*	3742	88.67	-478.2	ooo
			DL 5%	37.7 kg/ha
			DL 1%	53.6 kg/ha
			DL 0.1%	77.6 kg/ha

The variant of sowing at 70 cm between the rows of plants brought the highest yield increase, the hierarchy of the hybrids being the same. The highest production was obtained with the LS-CB-18-04 variant with a value of 4871 kg/ha and a difference compared to the control variant of 650.8 kg/ha, followed by the LS-CB-18-02 variant which obtained a production of 4774 kg/ha, with a positive difference of 553.8 kg compared to the control variant.

For the LS-CB-18-03 variant the production is not statistically assured, while for the LS-CB-18-01 variant it is distinctly significant, negative. In the last two variants, the production is very significant, negative.

Table 4. The influence of the distance between rows on the TKW at Ricinus communis L. hybrids

Hybrid	Yield	Difference (%)	Difference (g)	Significance
LS-CB-18-03	34.3	108.2	2.6	
LS-CB-18-11*	34	107.26	2.3	
LS-CB-18-01	33.4	105.36	1.7	
Avarage	31.7	100	0	Mt.
LS-CB-18-12*	29.9	94.32	-1.8	
LS-CB-18-04	29.5	93.06	-2.2	
LS-CB-18-02	29	91.48	-2.7	
			DL 5%	4.1 g
			DL 1%	5.9 g
			DL 0.1%	8.5 g

The interaction between hybrid and row distance resulted in variability of MMB values. They varied between 29 and 34.3 g. The highest MMB was obtained in the variant LS-CB-18-03 with a value of 34.3, with a value close to the average, and the lowest value was obtained in the variant LS-CB-18-02 and was 29 g. All analyzed variants were not statistically assured.

Table 5. The influence of row spacing on MH at *Ricinus communis* L. hybrids

Hybrid	Yield	Difference (%)	Difference (kg)	Significance
LS-CB-18-04	51.9	102.98	1.5	
LS-CB-18-03	51.4	101.98	1	
LS-CB-18-02	51.1	101.39	0.7	
LS-CB-18-01	50.6	100.4	0.2	
Avarage	50.4	100	0	Mt.
LS-CB-18-12*	49.4	98.02	-1	
LS-CB-18-11*	48.2	95.63	-2.2	
			DL 5%	2.9 kg
			DL 1%	4.2 kg
			DL 0.1%	6.1 kg

Similar to MMB also for MH the variants were not statistically assured. The values varied between 51.9 and 48.2 g. Positive differences were registered by hybrids LS-CB-18-04, LS-CB-18-03, LS-CB-18-02 and hybrid LS-CB-18-01.

Lower than average values wore obtained in the case of LS-CB-18-12* and LS-CB-18-11* hybrids.

The correlation analysis shows us that there is an interaction between TKW and production, the correlation coefficient being r^2 =0.85 and r^2=0.74 in the case of the MH-production interaction.

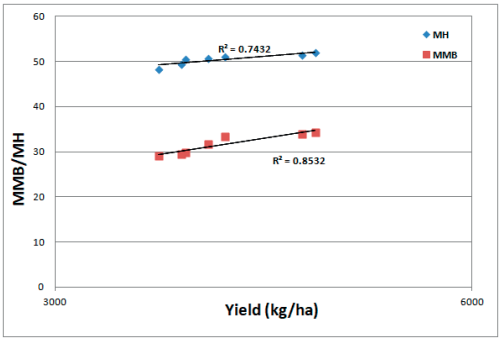

Figure 3. Correlation between MMB and MH for the studied hybrids

The oil content analyzed by the Soxhlet method shows us that there is no great difference between the oil content and the characteristics of the hybrid. The highest percentage is obtained in the LS-CB-18-01 hybrid, which is 45.4%.

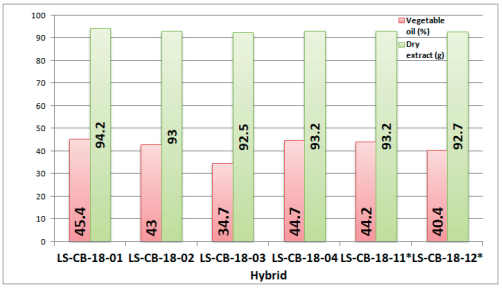

Figure 4. Oil and dry matter content of the 6 hybrids analyzed

CONCLUSIONS

Concluding what has been presented, we can state that at a distance of 70 cm between the rows, the highest production was obtained between it and the main analyzed indicators (MMB, MH) with a weak interaction. Also, there is no positive correlation between oil content and yield.

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