RESEARCH ON THE OPTIMIZATION OF THE INDUSTRIAL HEMP CULTIVATION TECHNOLOGY FOR THE FULL USE OF BIOMASS

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Abstract

The main purpose of the research was to identify the optimal technology for cultivating industrial hemp, so that the obtained biomass can be fully processed at the farm level, without special equipment in this regard. The variety used in the experiment was Zenit, created by the Agricultural Research and Development Station Secuieni, Neamt county. Within the cultivation technology, three technological variants were tested: uncut plants, plants cut once and plants cut twice ("Secuieni" method of hemp cultivation). The optimal technological variant for the full use of hemp biomass was the cultivation technology with a single cut, where the production of grains and biomass ensured the best economic efficiency of the hemp culture.

Key words: hemp yield, biomass, processing, efficiency

Industrial hemp (*Cannabis sativa* L.) is cultivated in the world mainly for the production of seeds or for obtaining natural vegetable fibers and the cultivation technology is very different depending on the purpose of the crop. Researchers have recently highlighted the importance of industrial hemp culture for the medical field or for the environment (Andre C.M. *et. al.*, 2016).

Some of the many uses are shown in (*figure 1*).

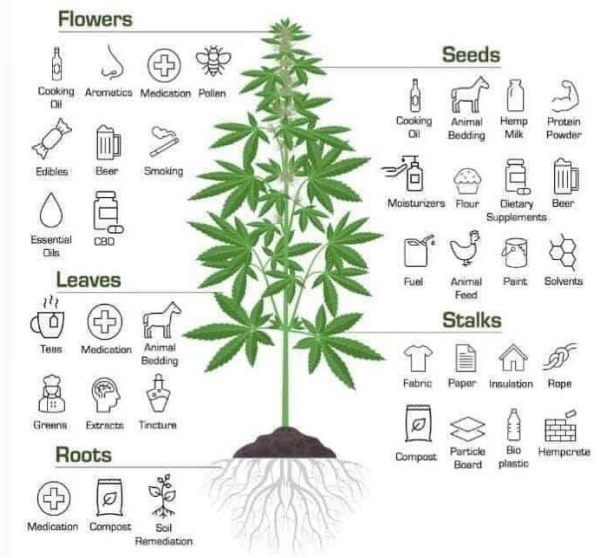

Figure 1 **The most important uses of *Cannabis sativa***

In Romania there is a millennial tradition in the cultivation of hemp, the growers having advanced technological knowledge as well as Romanian monoecious and dioecious varieties, that are very productive and well adapted to the local pedoclimatic conditions, so that the ever-growing market for hemp products can be supplied with Romanian hemp (Druțu C. *et al*, 2016).

Depending on the purpose of production, farmers must use a certain agricultural technique, which in the case of growing hemp for fibers is particularly expensive, especially on the mechanized harvesting side. This aspect is one of the limiting factors in the development of hemp culture for fibers (ElSohly M.A. *et al*, 2017).

That is why, in recent years, hemp growers have developed innovative cultivation technologies for the full use of the biomass of hemp plants, using the agricultural technique available on farms for other important crops (wheat, corn, sunflower, etc.), so that the profitability of the crop be maximized and the specific investments in specialized agricultural techniques for hemp to be minimal (Trotuș E. *et al*, 2020; Găucă C. , 1995, 2012; Tabără V. *et al*, 2006).

The main goal of the research is to optimize the cultivation technology of monoecious industrial hemp, so that growers can produce and fully use hemp biomass at farm level, without investing in special technical equipment for the production and harvesting of hemp (Leonte A. *et al*, 2015). Also, the climatic conditions in

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continuous change, drought, salinity, soil pollution, etc., lead to the search for new culture alternatives (Lungoci C. *et al*, 2022).

MATERIAL AND METHOD

The experimental field was carried out in a commercial farm in the village of Mihalaseni, Botosani county, according to the following experimental protocol: bifactorial experiment, laid out according to the randomized block method, in three repetitions (100 square meters/repetition):

- factor A – cultivation method, with three variants: A1-plants not cuted, A_2-plants cuted once and A3-plants cuted twice;

- factor B – distance between rows: B_1-50 cm and B_2-70 cm.

The applied technology was classic: after harvesting the predecessor plant (maize), weeding and basic fertilization with 400 kg/ha of NPK 15/15/15 complex fertilizers was carried out, followed by plowing at a depth of 30 cm. The shredding and leveling of the land was done with a disc harrow about 30 days after plowing. The germinative soil bed was prepared in the spring, through a work with the combiner at a depth of 4-5 cm, carried out the day before sowing, an operation through which was aplied the quantity of 100 kg/ha of ammonium nitrate (33.5% active substance nitrogen). Sowing was carried out on April 20, using the monoecious hemp variety Zenit, created by the Secuieni Agricultural Research and Development Station from Neamt county. The seed rate used was 7 kg/ha, the sowing depth was 3-4 cm, and the distance between the rows was 50 cm and 70 cm, according to the experimental protocol. After sowing, pre-emergence herbicide was carried out with the product Dual Gold (960 g/l s-metolachlor) in a dose of 1.2 l/ha. The density of the hemp crop after emergence was established at 35 plants/square meter. The culture was herbicided post-emergence with Lontrel 300 (300 g/l clopyralid) to combat some species of dicotyledonous weeds and with Fusilade Forte (150 g/l fluazifop-P-butyl) in a dose of 1.0 l/ha to combat grassy weeds annual and perennial.

During the growing season, the "Secuieni method" of hemp cultivation was used, which involves, among other things, the cutting of the stem as follows: when the plants go into the phase of intense growth and have 5-6 floors with opposite leaves, the first cutting of the growth tip above is applied of the third node with true leaves, 30-35 cm from the ground level. From the insertion of the leaves, 2-6 lateral shoots will develop, after which the second cutting is done above the first cutting, at 15-20 cm. The shoots from the first cutting will form new shoots from the leaf insertion nodes after the second cutting which, depending on the thickness of the plants per row and between rows, can produce up to 8 - 20 shoots/plant. The cutting was done with the windrower for fodder and the hemp culture was foliar fertilized with a mixture of products that contained microelements (boron, sulfur), lignohumates and amino acids. The crop was mechanically weeded to combat weeds and fertilized on the vegetation with a dose of 100 kg/ha of ammonium nitrate (33.5% nitrogen active substance). The harvesting of the industrial hemp crop was carried out with the self-propelled combine for grains properly adjusted, determining two production indicators: the yield of seeds (kg/ha) and the yield of dry stalks (kg/ha).

Figures 2, 3 show the climatic data from the study area. In the case of temperatures, it can be seen that they broadly respect the multi-year average. During the winter, the average temperatures are higher than the annual average. The highest temperature was recorded in July, with an average of 25.2 ^{0}C, and the lowest in January, with -12.2 ^{0}C.

The rainfall regime was deficient in precipitation, as was highlighted in other regions of the Moldovan forest-steppe (Lungoci C. *et al,* 2021). In this case, the first quarter of the year was deficient in precipitation. The quantities stored are below the multiannual average. February being the driest month (25.5 mm). The highest amount of precipitation was recorded in September, which was 65.5 mm.

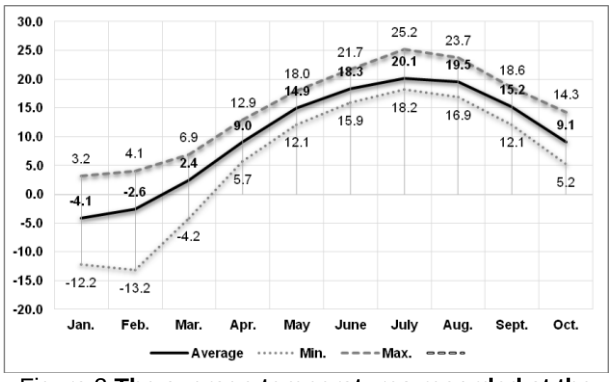

Figure 2 **The average temperatures recorded at the weather station Mihaleșeni, Botoșani**

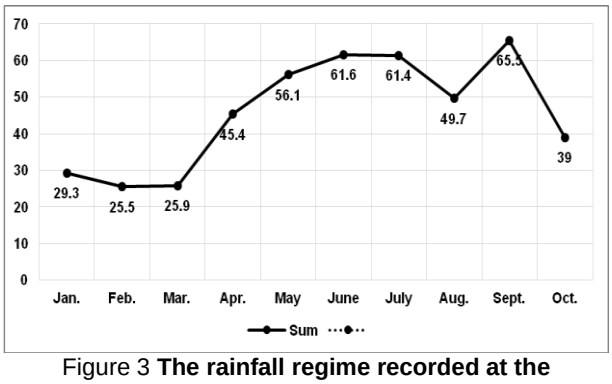

Figure 3 **The rainfall regime recorded at the Mihaleșeni weather station, Botoșani**

RESULTS AND DISCUSSIONS

The full use of hemp biomass leads to net higher incomes compared to the use of separate

production components (seeds or stalks), through the practice of agricultural production technologies adapted to this purpose, with the agricultural technique existing in most farms in Romania. The method of hemp cultivation (plants uncut or cut according to the "Secuieni method") very significantly influences both the production of seeds and the production of stems.

Thus, the uncut plants achieve the lowest seed production regardless of the distance between rows (50 cm or 70 cm), respectively 923.2 kg/ha in the variant sown at 50 cm distance between rows and 902.4 kg/ha at 70 cm between rows. With regard to the production of hemp stems, uncut plants achieve the highest production regardless of the distance between the rows (50 cm or 70 cm), respectively 7,779.2 kg/ha in the variant sown at 50 cm distance between rows and 8,426.0 kg/ha at 70 cm between rows (*table 1*).

The plants cut once according to the "Secuieni method" of cultivating monoecious hemp, achieve a 45.4% higher seed production in the case of the variant sown at 50 cm distance between rows, respectively 1,342.1 kg/ha compared to the uncut version and a 39.0% higher seed production, in the case of the variant sown at 70 cm distance between rows, respectively 1,253.9 kg/ha. In the case of the production of hemp stalks, the plants cut once have a lower production by 23.7% compared to the variant with uncut hemp at a distance between rows of 50 cm, respectively 5,939.3 kg/ha and a lower production with 31.0% at a distance between rows of 70 cm, respectively 5,812.3 kg/ha.

The plants cut twice according to the "Secuieni method" of monoecious hemp cultivation, achieved a 48.0% higher seed production in the case of the variant sown at 50 cm distance between rows, respectively 1,366.7 kg/ha compared to the variant uncut and a 40.6% higher seed production, in the case of the variant sown at 70 cm distance between rows, respectively 1,268.7 kg/ha. With regard to the production of hemp stalks, plants cut twice have a lower production by 40.9% compared to the variant with uncut hemp at a distance between rows of 50 cm, respectively 4,601.4 kg/ha and a lower production with 43.4% at a distance between rows of 70 cm, respectively 4,766.8 kg/ha (*table 2*).

Plants cut according to the "Secuieni method" lead to the production of larger seeds and the production of smaller stems, regardless of the distance between the rows (50 cm or 70 cm). Also, through this method of cultivating hemp, the degree of shading of the soil increases determined by the strong branching of the plants and the increase in the number of shoots, weeds grow much more difficult, the ripening of the seeds is uniform and the most important technological aspect, the hemp is harvested much easier with grain combines, without major problems.

Regarding the economic efficiency of the tested methods, the hemp variant cut once and sown at a distance of 50 cm between rows is the most efficient cultivation method for the full use of the main biomass obtained (seeds and stems), at an average price of 7.5 lei/kg of hemp seeds and 0.5 lei/kg of hemp stalks. In the case of this method, all the technological steps specific to the cultivation of industrial hemp can be carried out with the existing agricultural technique in most farms in Romania, without the need for investments specific to hemp cultivation.

Table 1

Yield and gross margin calculation (distance between rows - 50 cm)

No	Variant	Seed, kg/ha	Price, lei/kg	Income 1, lei	Stem., kg/ha	Price, lei/kg	Income 2, lei	Total income, lei
1	Uncuted plants	923.2	7.5	6.924.0	7.779.2	0.5	3.889.6	10.813.6
2	Plants cuted once	1.342.1	7.5	10.065.8	5.939.3	0.5	2.969.7	13.035.4
3	Plants cuted twice	1.366.7	7.5	10.250.3	4.601.4	0.5	2.300.7	12.550.9

Table 2

Yield and gross margin calculation (distance between rows - 70 cm)

No	Variant	Seed, kg/ha	Price, lei/kg	Income 1, lei	Stem., kg/ha	Price, lei/kg	Income 2, lei	Total income, lei
1	Uncuted	902.4	7.5	6.768.0	8.426.0	0.5	4.213.0	10.981.0
2	Cuted I	1.253.9	7.5	9.404.3	5.812.3	0.5	2.906.1	12.310.4
3	Cuted II	1.268.7	7.5	9.515.3	4.766.8	0.5	2.383.4	11.898.6

CONCLUSIONS

Cannabis sativa L. has a series of properties that differentiate it from the other plants we mentioned: strategic role in crop rotation, i.e. it increases the yield of other crops, the deep root system, leads to the destruction of hardpan and carbon sequestration and increases soil porosity, increased resistance to pathogens and pests, modest need for external inputs: water, pesticides, traditional fertilizations, etc. Therefore, it is a crop with low energy impact very suitable for cultivation especially due to the multitude of uses presented in the introduction.

The climatic conditions of the study year were those of a climatically atypical year. However, hemp, as a moisture-demanding plant, performed well in terms of production under water deficit.

Cutting methods during the vegetation period are important technological links, which save a number of expenses especially with harvesting. Also, cuttings lead to a reduction in the size of the plants, stimulate the formation of inflorescences and thereby directly increase production.

ACKNOWLEGMENTS

Influența produsului biofertilizator Ecofertil P asupra producției agricole", nr. 20045 din 15/11/2022

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