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INFLUENCE OF SOME TECHNOLOGICAL FACTORS AND OF BIOLOGICAL CHARACTERISTICS ON SEED PRODUCTION IN MONOIC HEMP, UNDER CONDITIONS OF THE AGRICULTURAL RESEARCH STATION OF SECUIENI, NEAMȚ COUNTY

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ABSTRACT – The monoic hemp varieties, created at the Agricultural Research Station of Secuieni, Neamț County, are characterized by high fibre content in the stem and high seed production/area unit. Next to the creation of productive varieties, the growing technology has an important role, too. The experiments set up at the Agricultural Research Station of Secuieni, under conditions of year 2007, which was very dry, pointed out that the varieties had a high drought resistance and that the two technological links (fertilization and sowing period) influenced the quantitative, qualitative and economic crop level. The seed yields, obtained under conditions of year 2007, were between 596 and 800 kg/ha. Applying fertilizers has resulted in yield increases between 7 and 34% and improved the seed value. The best time for hemp sowing is when a temperature of 7-8^{0}C is found in soil. The duration of different phenological phases has shown a great variability and was influenced by sowing period, fertilization and climatic conditions of the year.

Key words: fertilization, sowing period, biological characteristics

REZUMAT - Influența unor factori tehnologici şi a unor particularități biologice asupra producției de semințe la cânepa monoică, în condițiile de la S.C.D.A. Secuieni-Neamț. Soiurile de cânepă monoică, create la S.C.D.A. Secuieni, se caracterizează printr-un conținut mai mare de fibră în tulpină şi realizează o producție mai mare de sămânță la unitatea de suprafață. Alături de crearea soiurilor productive, un rol important îl are tehnologia de cultură. Experiențele amplasate la S.C.D.A. Secuieni în condițiile anului 2007, extrem de secetos, au scos în evidență că soiurile au o rezistență mare la secetă şi că cele două verigi tehnologice

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(fertilizarea şi epoca de semănat) influenţează nivelul cantitativ, calitativ şi economic al recoltelor. Producţiile de seminţe obţinute în condiţiile anului 2007 au fost cuprinse între 596 şi 800 kg/ha. Aplicarea îngrăşămintelor a adus sporuri de producţie de 7-34% şi a îmbunătăţit valoarea culturală a seminţelor. Momentul cel mai favorabil pentru semănatul cânepei este atunci când în sol se realizează temperatura de 7-8^{0}C. Durata diferitelor fenofaze a prezentat o mare variabilitate şi a fost influenţată de epoca de semănat, formulele de fertilizare şi de condiţiile climatice ale anului.

Cuvinte cheie: fertilizare, epocă, particularităţi biologice

INTRODUCTION

Hemp is used for the extraction of fibres and oil and as medicinal plant. The hemp stems contain 20-30% fibres with valuable characteristics and seeds have over 30% fat oil, used in colours industry. Leaves representing 18-20% of the biomass are used in pharmaceutics industry and the residues from stem processing, in making chipboards (Şandru et al., 1996; Munteanu et al., 2003).

The areas cultivated with hemp have significantly diminished in the last period, the causes being multiple; the most important cause is represented by growing difficulties. The presence at the same time of the two plant types (male and female) creates difficulties at harvesting, because male plants cease their growing, fade immediately after flowering and pollen release, while female plants continue their vegetation other 30-40 days until fruit ripeness (Şandru et al.,1996; Muntean et al., 2003; Mihăilă et al., 1996; Segărceanu et al., 1982).

Obtaining monoic hemp varieties at the Agricultural Research Station of Secuieni, Neamţ County (Secuieni 1, Irene, Denise, Zenit and Diana), which are characterized by a higher fibre content and, especially, by a very high seed yield (THC content between 0.4 and 01%) determines the increase in the growers' interest for this crop. The elaboration of growing technologies for newly created cultivars, as well as their behaviour under specific conditions, is one of the concerns of the research activity at the Agricultural Research Station of Secuieni.

The goal of this paper was to study the influence of fertilization and sowing period on seed yield in monoic hemp.

MATERIALS AND METHODS

Under the climatic conditions of the year 2007 (a very dry year), at the Agricultural Research Station of Secuieni, Neamţ County, two trials were set up, which investigated the behaviour of Zenit monoic hemp variety, under conditions of two technological links with determining role in obtaining yields (fertilization and sowing period) *(Table 1*).

Table 1 - Weather data registered at the Agricultural Research Station of Secuieni, Neamț County during October 2006- September 2007

Specification		2006			2007									
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	Mean
Temp. °C	First decade	15.0	3.9	1.9	2.5	2.0	5.4	8.0	12.4	20.2	21.7	19.5	15.5	
	Second decade	6.9	7.1	2.7	5.1	1.8	6.5	9.4	18.3	21.7	22.7	21.8	13.6	
	Third decade	9.8	6.1	-0.1	1.5	-2.8	5.9	11.2	21.7	21.0	24.0	21.4	13.4	
	Monthly mean	10.5	5.7	1.4	3.0	0.6	5.9	9.6	17.6	20.9	22.8	20.9	14.2	**11.1**
	Multiannual mean	9.1	3.1	-1.8	-4.0	-2.4	2.4	9.3	15.3	18.6	20.1	19.2	14.7	**8.6**
	Deviation	***1.4***	***2.6***	***3.2***	***7.0***	***3.0***	***3.5***	***0.3***	***2.3***	***2.3***	***2.7***	***1.7***	***-0.5***	***2.5***
Rainfall, mm	First decade	8.8	7.0	0.0	9.0	5.5	4.2	4.6	2.5	0.8	8.2	37.8	36.2	
	Second decade	9.0	0.0	5.5	3.0	2.8	2.0	18.5	1.5	4.8	60.6	14.8	28.2	
	Third decade	5.0	0.0	0.0	0.0	17.0	28.5	9.0	35.0	14.8	8.0	19.8	0.4	
	Monthly sum	22.8	7.0	5.5	12.0	25.3	34.7	32.1	39.0	20.4	76.8	72.4	64.8	**412.8**
	Multiannual mean	33.9	28.6	26.4	21.4	19.1	25.1	46.8	65.7	84.5	86.3	66.2	47.9	**551.9**
	Deviation	***-11.1***	***-21.6***	***-20.9***	***-9.4***	***6.2***	***9.6***	***-14.7***	***-26.7***	***-64.1***	***-9.5***	***6.2***	***16.9***	***- 139.1***
Air temp. °C	Monthly min.		*-4.5*	*-10.5*	*-10.5*	*-23.5*	*-4.5*	*-1.5*	*-0.2*	*10.7*	*9.6*	*9.7*	*1.2*	
	Monthly max.		*19.5*	*15.0*	*16.0*	*18.0*	*22.5*	*23.5*	*33.7*	*38.4*	*38.2*	*37.3*	*26.9*	
Soil temp. °C	Monthly min.		-6.0	-13.5	-14.0	-25.5	-7.5	-2.5	-1.5	11.7	9.4	10.6	1.1	
	Monthly max.		23.0	20.5	19.5	19.5	33.5	41.5	58.9	61.1	60.0	57.2	44	

The trial that has studied the application of fertilizers had 10 variants:

V_1	- N_0P_0
V_2	- N_0P_{50}
V_3	- $N_{50}P_{50}$
V_4	- $N_{16}P_{40}$ + leaf fertilizer (Microfert U) - 5 l/ha
V_5	- $N_{45}P_{60}$ + leaf fertilizer (Microfert U) - 3 l/ha
V_6	- $N_{64}P_{80}$
V_7	- $N_{80}P_{100}$
V_8	- $N_{64}P_{80}$
V_9	- $N_{80}P_{100}$ + leaf fertilizer (Microfert U) – 2.5 l/ha
V_{10}	- N_0P_0+ leaf fertilizer (Microfert U) - 5 l/há

Microfert U – leaf fertilization: N – 90g/l; P_2O_5 - 30 g/l; K_2O-30 g/l; Mg-0.15 g/l; S-12 g/l; B- 0.5 g/l; Co -0.03 g/l; Cu -0.25 g/l; Fe -0.2 g/l; Mn-0.3 g/l; Mo- 0.07 g/l;Zn - 0.5 g/l.

The trial that has established the sowing period had three variants: V1 – the first sowing period on April 2, 2007; V2 – the second sowing period on April 12, 2007 and V3 – the third sowing period on April 20, 2007.

The experiments were of monofactorial type, set up on the method of randomized blocks with four replicates, and were placed at the Agricultural Research Station of Secuieni on a typical cambic Chernozem having the following characteristics: pH = 6.6; humus content = 2.55; C:N ratio = 11.1-1; P_2O_5 = 17 ppm, K_2O = 195 ppm; N_{total} = 0.15%.

Applied growing technology: predecessor crop – soybean, sowing at 70cm between rows and 10cm on the row.

Data were processed according to the variance analysis method.

RESULTS AND DISCUSSION

1. Influence of fertilizers on seed yield in monoic hemp (Zenit Variety). The obtained seed yields had values comprised between596 and 800 kg/ha, according to the used fertilization formula (*Table 2*).

Seed yields were directly correlated to the applied fertilizer rates. The application of only phosphorus fertilizers did not result in increasing seed yield.

The highest yield increases were found at the variants using high nitrogen (N_{80}) and phosphorus (P_{80}) rates, next to leaf fertilizers where yield increases were of 29-34%.

Applying leaf fertilizers at the variants where no chemical fertilizers were used has resulted in getting yield increases of 9%. The application of fertilizers has increased the values of 1000-grain weight until 6% and of Hectolitre weight until 7% (*Table 3*).

Table 2 – Influence of chemical fertilizers on seed hemp yield, Zenit Variety

Variant	Absolute yield (kg/ha)	Relative yield (%)	Difference	Significance
N_0P_0	596	100	Control	_
N_0P5_0	592	99	-4	_
$N_{50}P_{50}$	637	107	41	*
$N_{16}P_{40}$+leaf fertilizer	655	110	59	**
$N_{45}P_{60}$+ leaf fertilizer	735	123	139	***
$N_{64}P_{80}$	656	110	60	**
$N_{80}P_{100}$	755	127	159	***
$N_{64}P_{80}$+ leaf fertilizer	770	129	174	***
$N_{80}P_{100}$+ leaf fertilizer	800	134	204	***
N_0P_0+ leaf fertilizer	650	109	54	**
LSD 5% - 34 kg/ha; LSD 1% - 46 kg/ha; LSD 0.1% - 62kg/ha				

Table 3 – Determinations at harvesting in hemp crops (Zenit Variety)

Variant	Hectolitre weight ($kg/hl_)$	1000-grain weight (g)
N_0P_0	49.5	15.4
N_0P5_0	50.5	15.8
$N_{50}P_{50}$	50.0	16.0
$N_{16}P_{40}$+ leaf fertilizer	50.7	15.8
$N_{45}P_{60}$+ leaf fertilizer	52.0	15.4
$N_{64}P_{80}$	52.0	15.9
$N_{80}P_{100}$	50.2	15.3
$N_{64}P_{80}$+ leaf fertilizer	53.2	16.3
$N_{80}P_{100}$+ leaf fertilizer	50.5	16.0
N_0P_0+ leaf fertilizer	51.2	15.6

The main plant growing and development stages and the bioclimatic indices at applying chemical fertilizers are shown in *Tables 4-8*.

The sowing-rising time was of 10 days and the sum of daily temperatures (Σ) > 0^0C was of 113^0C, of which 97.2^0C >8^0C (*Table 4*). The interval between rising and 4-5 leaf stage lasted 20-21 days (April-May), the sum of useful temperatures > 0^0C having values of 314.4 – 335 ^{0}C and the plant height, of 24-30cm (29% higher at the fertilized variants and directly correlated to the rates of applied fertilizers) (*Table 5*).

Table 4 – Hemp growing and development and the bioclimatic indices, as influenced by fertilization, in the interval sowing–rising (Zenit Variety)

Variant	Date		Interval sowing–rising			
	Sowing	Rising	No. days	Σ of temperatures ^{0}C		Σ of rainfall (mm)
				> 0^0C	> 8^0C	
N_0P_0	17 April	27 April	10	113.0	97.2	14.5
N_0P5_0	17 April	27 April	10	113.0	97.2	14.5
$N_{50}P_{50}$	17 April	27 April	10	113.0	97.2	14.5
$N_{16}P_{40}$+ Leaf fertilizer	17 April	27 April	10	113.0	97.2	14.5
$N_{45}P_{60}$+ Leaf fertilizer	17 April	27 April	10	113.0	97.2	14.5
$N_{64}P_{80}$	17 April	27 April	10	113.0	97.2	14.5
$N_{80}P_{100}$	17 April	27 April	10	113.0	97.2	14.5
$N_{64}P_{80}$+ Leaf fertilizer	17 April	27 April	10	113.0	97.2	14.5
$N_{80}P_{100}$+ Leaf fertilizer	17 April	27 April	10	113.0	97.2	14.5
N_0P_0+ Leaf fertilizer	17 April	27 April	10	113.0	97.2	14.5

Table 5 - Hemp growing and development and the bioclimatic indices, as influenced by fertilization, in the interval rising-5 leaf pairs (Zenit Variety)

Variant	Date of 5 leaf pairs	Interval rising -5 leaf pairs			
		No days	Σ of temperature > 0^0C	Σ of rainfall (mm)	Plant height (cm)
N_0P_0	19 May	21	335.0	13.0	24
N_0P5_0	19 May	21	335.0	13.0	24
$N_{50}P_{50}$	17 May	20	314.4	13.0	26
$N_{16}P_{40}$+ Leaf fertilizer	17 May	20	314.4	13.0	28
$N_{45}P_{60}$+ Leaf fertilizer	17 May	20	314.4	13.0	28
$N_{64}P_{80}$	17 May	20	314.4	13.0	29
$N_{80}P_{100}$	17 May	20	314.4	13.0	31
$N_{64}P_{80}$+ Leaf fertilizer	17 May	20	314.4	13.0	30
$N_{80}P_{100}$+ Leaf fertilizer	17 May	20	314.4	13.0	30
N_0P_0+ Leaf fertilizer	19 May	21	335.0	13.0	26

The interval between 5 leaves and flowering stage was of 32-34 days, Σ of useful temperatures > 0^0C had values of 711.3 ^{0}C-750.5 ^{0}C and plant height, of 150-164 cm (9% higher at the fertilized variants and 13-15 leaf pairs/plant) (*Table 6*).

Table 6 - Hemp growing and development and the bioclimatic indices, as influenced by fertilization, in the interval 5 leaves – flowering (Zenit Variety)

Variant	Interval 5 leaves – flowering					
	Flowering date	Height at flowering (cm)	No. days	Σ of temperature > 0^0C	Σ of rainfall (mm)	No. leaves/ plant
N_0P_0	20 June	150	32	677.0	40.6	13-14
N_0P5_0	20 June	154	32	677.0	40.6	13-14
$N_{50}P_{50}$	20 June	157	33	711.3	40.6	14-15
$N_{16}P_{40}$+ Leaf fertilizer	21 June	160	34	732.2	40.6	14-15
$N_{45}P_{60}$+ Leaf fertilizer	21 June	163	34	732.2	40.6	14-15
$N_{64}P_{80}$	21 June	164	34	732.2	40.6	14-15
$N_{80}P_{100}$	21 June	162	34	732.2	40.6	14-15
$N_{64}P_{80}$+ Leaf fertilizer	21 June	163	34	732.2	40.6	14-15
$N_{80}P_{100}$+ Leaf fertilizer	21 June	164	34	732.2	40.6	14-15
N_0P_0+ Leaf fertilizer	20 June	156	33	677.0	40.6	13-14
Mean		159.3				

The interval between flowering and beginning of ripeness was of 44-45 days, Σ of useful temperatures > 0^0C had values of 991.8 ^{0}C-1010.3^{0}C, Σ of rainfalls, 102.2 mm and plant height, 172-197 cm (14.5% higher at the fertilized variants and the stem diameter of 8.99-9.95 mm) (*Table 7*).

The interval between ripeness and full ripeness was in August of about 28 days (Σ of temperatures > 8^0C: 592.6 – 598.1^{0}C and of rainfalls, 52.8-62.4 mm). Plant height was of 177-203 cm (9% higher at fertilized variants), while the stem diameter was of 9.25 – 10.6 mm (*Table 8*).

Table 7 - Hemp growing and development and the bioclimatic indices, as influenced by fertilization, in the interval beginning flowering-beginning ripeness (Zenit Variety)

Variant	Interval beginning flowering-beginning ripeness					
	Date of interval	No. days	Plant height (cm)	Stem diameter (mm)	Σ of temperature > 0^0C	Σ of rainfall (mm)
N_0P_0	20 June – 3 July	44	172	8.99	991.8	102.2
N_0P5_0	20 June – 3 July	44	185	9.26	991.8	102.2
$N_{50}P_{50}$	20 June – 3 July	44	175	9.18	991.8	102.2
$N_{16}P_{40}$+ Leaf fertilizer	21 June – 5 July	45	167	9.68	1010.6	102.2
$N_{45}P_{60}$+ Leaf fertilizer	21 June – 5 July	45	173	9.72	1010.6	102.2
$N_{64}P_{80}$	21 June – 5 July	45	175	9.76	1010.6	102.2
$N_{80}P_{100}$	21 June – 5 July	45	177	9.87	1010.6	102.2
$N_{64}P_{80}$+ Leaf fertilizer	21 June – 5 July	45	180	9.78	1010.6	102.2
$N_{80}P_{100}$+ Leaf fertilizer	21 June – 5 July	45	197	9.87	1010.6	102.2
N_0P_0+ Leaf fertilizer	20 June – 3 July	44	178	9.95	991.8	102.2
Mean			177.9			

Table 8 - Hemp growing and development and the bioclimatic indices, as influenced by fertilization, in the interval beginning ripeness-full ripeness (Zenit Variety)

Variant	Interval beginning ripeness-full ripeness					
	Date of the interval	No. days	Plant height (cm)	Stem diameter (mm)	Σ of temperature > 0^0C	Σ of rainfall (mm)
N_0P_0	3 Aug. - 30 Aug.	28	186	9.25	598.1	52.8
N_0P5_0	3 Aug. - 30 Aug.	28	193	9.89	598.1	52.8
$N_{50}P_{50}$	3 Aug. - 30 Aug.	28	182	9.32	598.1	52.8
$N_{16}P_{40}$+ Leaf fertilizer	5 Aug. - 1 Sept.	28	177	9.99	592.6	62.4
$N_{45}P_{60}$+ Leaf fertilizer	5 Aug. - 1 Sept.	28	181	9.84	592.6	62.4
$N_{64}P_{80}$	5 Aug. - 1 Sept.	28	183	9.92	592.6	62.4
$N_{80}P_{100}$	5 Aug. - 1 Sept.	28	189	10.2	592.6	62.4
$N_{64}P_{80}$+ Leaf fertilizer	5 Aug. - 1 Sept.	28	191	10.0	592.6	62.4
$N_{80}P_{100}$+ Leaf fertilizer	5 Aug. - 1 Sept.	28	203	10.4	592.6	62.4
N_0P_0+ Leaf fertilizer	3 Aug. - 30 Aug.	28	189	10.6	598.1	52.8
Mean			187.4			

2. Influence of sowing period on plant yield and development in seed monoic hemp, Zenit Variety

The obtained seed yield was influenced by sowing time. Under conditions of year 2007, hemp sowing at 5-6^{0}C has resulted in a yield diminution by 10%, the highest yields being obtained when sowing was done at the soil temperature of 7-8 ^{0}C (*Table 9*).

Table 9 – Influence of sowing time on monoic hemp yield (Zenit Variety)

Time	Variant	Absolute yield (kg/ha)	Relative yield (%)	Difference	Significance
I	Sowing at 5-6^{0}C	600	90	-70	00
II	Sowing at 7-8^{0}C	670	100	Control	-
III	Sowing at 9-10^{0}C	695	104	25	-
	LSD 5% = 38kg/ha	**1% = 57kg/ha**		**0.1% = 92kg/ha**	

The main growing and development stages in hemp crop and the bioclimatic indices are shown in *Table 10*.

Table 10 – Main growth stages and bioclimatic indices, according to sowing time

Phenological observations	Ist time	IInd time	IIIrd time
Date of sowing	2 April	12 April	20 April
Water reserve from soil m^3/ha	2649	2397	2489
Water deficit as regards the field capacity	-438	-684	-592
Date of rising	16 April	28 April	29 April
Plant denseness /m^2	12	13	11
No. of days from sowing to rising	14	10	9
Σ of rainfalls from sowing to rising	86	14.5	70
Σ of temperatures > 0^{0}C from sowing to rising	134.0	177.0	11.2
Σ of temperatures > 8^{0}C from sowing to rising	18.8	41.4	31.2
Date of 5 leaf stage	7 May	12 May	18 May
Plant height (cm)	21	20	19
Number of days from rising to 5 leaf stage	21	20	19
Σ of rainfalls from rising to 5 leaf stage	25.5	13.0	13.0
Σ of temperatures > 0^{0}C from rising to 5 leaf stage	233.5	191.7	289.8
Date of beginning of flowering	11 June	17 June	21 June
No. of days from 5 leaf stage to flowering stage	33	36	34
Plant height (cm)	157	134	127

Phenological observations	Ist time	IInd time	IIIrd time
No. of leaf pairs	14-15	12-13	11-12
Interval from 5 leaf stage to flowering (days)	33	36	34
Date of beginning of ripeness	23 July	3 August	3 August
Plant height (cm)	167	154	146
Plant diameter (mm)	9.7	9.3	9.5
Duration from beginning of flowering to beginning of ripeness	11 June - 23 July	17 June - 1 August	21 June -3 August
Number of days	42	45	43
Σ of temperatures from beginning of flowering to beginning of ripeness (^{0}C)	951.5	1018.7	970.4
Σ of rainfall from beginning of flowering to beginning of ripeness (mm)	89.0	105.8	102.2
Date of full ripeness	21 August	28 August	28 August
Plant height (cm)	178	163	155
Plant diameter (mm)	9.9	9.6	9.8
Duration from beginning of ripeness to full ripeness	23 July – 21 August	3 August- 28 August	31 August- 28 August
Number of days	29	25	25
Σ of temperatures from beginning of ripeness to full ripeness (^{0}C)	645.0	564.3	564.3
Σ of rainfalls from beginning of ripeness to full ripeness (mm)	60.0	65.0	65.0

The interval from sowing to rising was of 10-18 days for the sowing time at 5-6^{0}C and of 8-12 days for times when in soil were found 7-10^{0}C. The sum of temperatures >0^{0}C was of 111.2 - 177^{0}C.

The stage of slow growth from rising to 4-5 leaves lasted 19-21 days, when 233.7^{0}C – 289.8^{0}C were registered and plant height was of 19-21cm. The stage of rapid growth (from 5 leaf stage to beginning of flowering) lasted 33-36 days.

The stage from beginning of flowering to beginning of ripeness lasted 42-45 days (Σ of temperatures > 0^{0}C - 951.5 -1018.7^{0}C and of rainfalls- 89-105.8 mm).

The stage from beginning of ripeness to full ripeness lasted 25-29 days (Σ of temperatures > 0^{0}C - 564.3^{0}C-645 ^{0}C and of rainfalls - 60-60.5, plant height - 155-178 cm and stem diameter – 9.6-9.9mm).

CONCLUSIONS

Among the technological links, the sowing time and fertilizer application have a determining role on the quantitative, qualitative and economic level of the obtained yields. Hemp is known as a plant with high drought resistance.

Applying chemical and leaf fertilizers has resulted in yield increases of 29-34%, under conditions of the year 2007 (an excessively dry one).

The application of only phosphorus fertilizers did not result in yield increases.

The leaf fertilizers, used both at the variants fertilized and unfertilized with chemical fertilizers, has brought yield increases of 7-9%.

The early sowing, when 5-6^{0}C are found in soil, determines the diminution in seed yield by 10%.

The sowing time with the highest obtained seed yields was when 7-8^{0}C were found in soil.

The plant biological characteristics, growth and development stages and bioclimatic indices were significantly influenced by sowing time and used fertilization formula.

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