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STUDY ON MONOIC HEMP LINES, OBTAINED AT THE AGRICULTURAL RESEARCH STATION OF SECUIENI, NEAMȚ COUNTY, CONCERNING THE STEM, FIBRE AND SEED PRODUCTION

V. SIRIȚANU[*] Carmen SIRIȚANU

Agricultural Research Station of Secuieni, Neamț County

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ABSTRACT – During 2003-2006, at the Agricultural Research Station of Secuieni, Neamț County, 20 lines of monoic hemp were tested for stem, fibre and seed production. As control, we have used the monoic varieties Diana (for stems and fibre) and Zenit (for seed). After 4 years of experiences carried out on stem and fibre production, we noticed the following lines: SCM-15 (9.63 t/ha stems and 3.08 t/ha fibre), SCM-19 (10.4 t/ha stems and 3.08 t/ha fibre) and SCM-20 (10.03 t/ha stems and 3.01 t/ha fibre). In 2005, a year favourable to stem and fibre production, the SCM-19 line has obtained the highest yields of 12.3 t/ha stems and 3.69 t/ha fibre. As concerns the seed yield, SCM-3 (74.25 kg/ha), SCM-4 (1073.50 kg/ha) and SCM-7 lines (947.25 kg/ha) proved to be superior to the control. Under the favourable conditions to seed production (year 2004), the SCM-4 line has obtained the highest yield of 1530 kg/ha. The SCM-19 line may represent the basis of a future mixed variety of monoic hemp, exceeding the control varieties used for stems, fibre and seed.

Key words: hemp, fibre, seed

REZUMAT - Studiul unor linii de cânepă monoică, obținute la S.C.D.A. Secuieni, sub aspectul producției de tulpini, fibră şi sămânță. În perioada 2003-2006, la Stațiunea de Cercetare Dezvoltare Agricolă Secuieni- Neamț, au fost testate 20 linii de cânepă monoică, sub aspectul producției de tulpini, fibră şi sămânță. Ca martori, au fost folosite soiurile monoice Diana (pentru tulpini şi fibră) şi Zenit (pentru sămânță). În urma celor 4 ani de experimentare, sub aspectul producției de tulpini şi fibră s-au remarcat liniile SCM-15 (9,63 t/ha tulpini; 3,08 t/ha fibră); SCM-19 (10,4 t/ha tulpini; 3,08 t/ha fibră şi SCM-20 (10,03 t/ha tulpini şi 3,01 t/ha

[*] E-mail: scdasec@yahoo.com

fibră). În anii favorabili pentru producția de tulpini şi fibră (anul 2005), linia SCM-19 a înregistrat producții maxime de 12,3 t/ha tulpini şi 3,69 t/ha fibră. În ceea ce priveşte producția de sămânță, s-au dovedit superioare martorului liniile SCM-3 (74,25 kg/ha), SCM-4 (1073,50 kg/ha) şi SCM-7 (947,25 kg/ha). În condiții favorabile producției de sămânță (anul 2004), linia SCM-4 a atins un maximum de 1530 kg/ha. Linia SCM-19 poate constitui bazele unui viitor soi mixt de cânepă monoică, depăşind soiurile martor folosite sub toate cele trei aspecte: tulpini, fibră, sămânță.

Cuvinte cheie: cânepă, fibră, sămânță

INTRODUCTION

Hemp is one of the most rewarding crops, ensuring the basic requirements for human life: food, clothes, shelter, drugs and energy supply (Ceapoiu N., 1958). Thus, seeds are a food source, being used in human food, animal feeding and in industry. The long fibres, which are extracted from stems, are used for various tissues. The significant characteristics of the hemp fibre (resistance, elasticity, flexibility and hygroscopicity) make this plant become very important in the future, too (Muntean et al, 2003). Chaff and short fibre are used for making insulation plates for constructions or as biocomposites for car bodies. From leaves and inflorescences, they make preparations for the disease prevention and treatments (Şandru et al., 1996). The hemp biomass is used as energy supply, being changed by the pyrolysis process in a similar substance to coal or in car fuel by fermentation, as ethanol or methanol. By using additives in the oil extracted from seeds, one may get a quality biodiesel (Rosenthal, 1997).

The investigations carried out on hemp growing and industrialization were intensified in the last years, as a result of the interest for this crop.

This paper presents the results obtained after testing some monoic hemp lines under the soil and climatic conditions of the Agricultural Research Station of Secuieni, Neamț County.

MATERIALS AND METHODS

A number of 20 lines of monic hemp was tested by placing some experiments in the same locality during 4 years (2003-2006).

The method used in these experiments was that of randomized blocks with tree replicates.

The experiment was carried out on a typical cambic chernozem with nitrogen index=21, P_2O_5 = 3.2 mg/100 g soil, K_2O= 21 mg/100 g soil, pH= 6.4, clay content= 34% and humus content=2.49%.

Fertilization was done by applying 250 kg/ha complex chemical fertilizers of 25:25:0 type and $N_{62}P_{62}K_0$, respectively, at seedbed preparation; for stem and fibre yield, 100 kg/ha NH_4NO_3 and $N_{33,}$ respectively, were added at the vegetation period.

Sowing was done in the first or second decade of April, at the distance of 12.5 cm between rows, with an amount of 400 germinating grains/ m^2 in the hemp crop and 70 cm between rows, a density of 200,000 plants/ha being ensured in the seed hemp crop.

RESULTS AND DISCUSSIONS

In the four testing years, the climatic conditions were various. From the temperature point of view, years 2003 and 2004 exceeded the multiannual mean during the hemp vegetation period (April-August) with values comprised between 0.8 and 1.1 ^{0}C (*Table 1*). Years 2005 and 2006 had mean monthly values close to the multiannual mean.

Years 2003 and 2004 were characterized by rainfall deficit in April, May and June (period of intensive plant growth) and by rainfall excess in July, while 2005 and 2006, by rainfall amounts close to the multiannual mean, in the first part of the vegetation period (April, May and June) and by rainfall excess in July and August (*Table 2*).

The climatic conditions had a different influence on stem, fibre and seed yield in the 4 years of testing (*Table 3*).

2003 and 2004 were unfavourable years as concerns the fibre and stem yield, the stem yields being found between 4.3 t/ha in the SCM 12 line and 9.6 t/ha in the SCM 19 line and between 1.16 and 2.88 t/ha fibre, respectively. 2005 and 2006 were favourable years for the stem and fibre production, being obtained yields comprised between 6.2 t/ha (SCM-12) and 12.3 t/ha (SCM -19) and 1.67 and 3.69 t/ha, respectively.

For the seed yield, the most unfavourable year was 2005, because of the excess rainfall during pollination and fruit formation (July-August). Yields comprised between 319 kg/ha in the SCM-8 line and 853 kg/ha in the SCM-1 line were obtained. In exchange, year 2004 was very favourable to seed production, being obtained yields comprised between 585 kg/ha and 1530 kg/ha.

The mean stem yield, obtained during the 4 years, has varied between 6.35 t/ha in the SCM -13 line and 10.4 t/ha in the SCM-19 line (*Table 4*). The statistical analysis showed that in the 4 years, SCM -19 and SCM-20 lines proved to be very significantly superior to the control (Diana Variety), while the SCM-15 line was distinctively significant. Based on their behaviour in the 4 testing years, we assessed that SCM-19 and SCM-20 lines were a valuable biological material, characterized by high stem yields.

The statistical analysis of the fibre yield shows that, in the testing years, the superior lines to the control (SCM-15, SCM-19 and SCM-20) are the ones that are noticed for their stem yield, which confirms their superiority to the control (*Table 5*).

Table 1 - Temperatures (^{0}C) recorded during 2003-2006

Crop year	Month												Annual mean	Deviation
	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX		
2002-2003	8.6	4.5	-7.3	-3.6	-6.9	0.5	8.4	19.9	21.1	20.8	21.0	14.3	8.4	-0.1
2003-2004	7.7	5.0	-1.0	-5.9	-1.0	-5.5	10.2	17.1	19.6	22.7	19.9	14.8	9.6	1.1
2004-2005	10.0	4.5	0.6	-0.3	-4.3	2.5	9.4	16.2	18.5	20.6	19.5	15.1	9.3	0.8
2005-2006	9.1	2.9	-0.5	-8.6	-4.2	1.1	10.2	14.9	19.1	21.5	20.5	15.6	8.5	0
Multiannual mean 1962-2006	9.1	3.3	-1.8	-4.1	-2.5	2.2	9.2	15.1	18.5	19.8	19.0	14.7	8.5	x

Table 2 - Rainfall (mm) recorded during 2003-2006

Crop year	Month												Annual mean	Deviation
	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX		
2002-2003	69.9	48.2	11.7	26.0	17.0	19.7	22.0	24.0	23.0	139.0	46.6	44.3	491.4	-56.8
2003-2004	66.7	6.2	24.1	27.0	17.5	16.2	39.8	21.0	34.5	182.3	82.5	23.0	540.8	-7.4
2004-2005	19.6	32.7	11.0	15.0	39.9	21.5	57.4	77.5	86.5	110.8	213.0	30.5	715.4	167.2
2005-2006	32.8	41.4	26.6	22.6	11.2	54.4	52.1	78.1	105.3	48.5	137.0	16.6	626.6	78.4
Multiannual mean 1962-2006	32.8	28.6	27.3	21.8	19.5	24.6	48.1	68.7	87.3	80.0	60.8	48.7	548.2	x

Table 3 - Stem, fibre and seed yields, obtained during 2003-2006

Line or variety	Yield														
	Stems (t/ha)					Fibre (t/ha)					Seed (kg/ha)				
	2003	2004	2005	2006	Mean	2003	2004	2005	2006	Mean	2003	2004	2005	2006	Mean
Diana/Zenit	6.9	7.6	10.5	10.4	**8.85**	2.07	2.28	3.15	3.12	**2.66**	875	925	475	873	**787.00**
SCM 1	7.2	8.0	10.7	10.6	**9.13**	2.23	2.48	3.32	2.29	**2.83**	730	950	**853**	745	**719.50**
SCM 2	6.9	7.7	9.8	9.5	**8.48**	2.27	2.54	3.23	3.13	**2.79**	610	811	390	624	**608.75**
SCM 3	7.5	8.7	10.5	10.0	**9.18**	2.03	2.35	2.83	2.70	**2.48**	920	1224	587	1166	**974.25**
SCM 4	6.3	7.1	8.8	7.9	**7.53**	1.64	1.85	2.25	2.05	**1.96**	1150	**1530**	606	1008	**1073.50**
SCM 5	6.8	7.6	9.5	7.1	**7.75**	2.38	2.67	3.32	2.48	**2.71**	440	**585**	406	450	**470.25**
SCM 6	7.8	8.7	10.9	7.9	**8.83**	2.12	2.35	2.94	2.13	**2.39**	890	1184	568	910	**888.00**
SCM 7	7.6	8.4	10.6	10.0	**9.15**	2.05	2.27	2.86	2.70	**2.47**	950	1263	606	970	**947.25**
SCM 8	6.4	7.1	9.0	8.7	**7.80**	2.18	2.41	3.06	2.56	**2.65**	500	665	**319**	530	**503.50**
SCM 9	7.0	7.8	11.1	9.8	**8.93**	2.24	2.50	3.55	3.14	**2.86**	650	864	415	670	**664.75**
SCM 10	7.1	7.9	9.9	8.9	**8.45**	2.27	2.53	3.17	2.85	**2.71**	700	931	447	720	**699.50**
SCM 11	6.7	7.4	9.6	7.3	**7.75**	2.01	2.22	2.88	2.19	**2.33**	836	1086	513	840	**818.75**
SCM 12	**4.3**	7.3	7.7	**6.2**	**6.38**	**1.16**	1.97	2.08	**1.67**	**1.72**	897	1165	560	900	**880.50**
SCM 13	5.1	6.6	7.3	6.4	**6.35**	1.48	1.91	2.12	1.86	**1.84**	857	1113	534	966	**867.50**
SCM 14	5.4	6.5	7.3	6.6	**6.45**	1.57	1.88	2.12	1.91	**1.87**	895	1163	558	883	**874.75**
SCM 15	8.5	8.7	11.2	10.1	**9.63**	2.72	2.78	3.58	3.23	**3.08**	610	792	380	1050	**708.00**
SCM 16	7.4	7.8	10.6	9.5	**8.83**	2.07	2.18	2.97	2.66	**2.47**	851	1105	593	1116	**916.25**
SCM 17	6.6	7.3	9.4	8.5	**7.95**	1.85	2.04	2.63	2.38	**2.23**	816	1060	536	1108	**880.00**
SCM 18	6.4	7.9	9.2	8.3	**7.95**	1.86	2.29	2.67	2.41	**2.31**	860	1117	686	890	**888.25**
SCM 19	8.6	**9.6**	**12.3**	11.1	**10.40**	2.58	**2.88**	**3.69**	3.33	**3.12**	874	1135	545	880	**858.50**
SCM 20	8.5	9.0	11.9	10.7	**10.03**	2.55	2.70	3.57	3.21	**3.01**	715	804	386	995	**750.00**
	LSD 5% = 0.524					**LSD 5% = 0.231**					**LSD 5% = 38.26**				
	LSD 1% = 0.691					**LSD 1% = 0.304**					**LSD 1% = 50.44**				
	LSD 0.1% = 0.887					**LSD 0.1% = 0.391**					**LSD 0.1% = 64.73**				

In the testing years, the mean seed yield was comprised between 470.3 kg/ha in the SCM-5 line and 1073.5 kg/ha in the SCM-4 line (*Table 6*). The analysis of significances shows that out of the 11 lines that proved to be very significantly superior to the control (Zenit Variety), only three lines (SCM-3, SCM-4 and SCM-7) will express in the next years their superior production capacity against the control. The graph representation of mean relative productions shows that only the SCM-19 line was superior to the control, as concerns fibre, stem and seed yields, assessing the prospective value of this line (*Figure 1*).

Table 4 - The stem yield (t/ha) during 2003-2006

Line or variety	Yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	
				To the error	To the interaction between variant x years
Diana	8.85	100	Control		
SCM 1	9.13	103	0.28		
SCM 2	8.48	96	-0.37		
SCM 3	9.18	104	0.33		
SCM 4	7.53	85	-1.32	000	00
SCM 5	7.75	88	-1.10	000	00
SCM 6	8.83	100	-0.02		
SCM 7	9.15	103	0.30		
SCM 8	7.80	88	-1.05	000	00
SCM 9	8.93	101	0.08		
SCM 10	8.45	95	-0.40		
SCM 11	7.75	88	-1.10	000	00
SCM 12	6.38	72	-2.47	000	000
SCM 13	6.35	72	-2.50	000	000
SCM 14	6.45	73	-2.40	000	000
SCM 15	9.63	109	0.78	**	
SCM 16	8.83	100	-0.02		
SCM 17	7.95	90	-0.90	000	0
SCM 18	7.95	90	-0.90	000	0
SCM 19	10.40	118	1.55	***	***
SCM 20	10.03	113	1.18	***	***

To the error:
LSD 5%= 0.52; 1.5
LSD 1%= 0.69; 2.0
LSD 0.1%= 0.89; 2.5

To the interaction:
LSD 5 % =0.79; 2.2
LSD 1 % =1,05; 3.0
LSD 0.1 % =1,36; 3.8

Table 5 - The fibre yield (t/ha) during 2003-2006

Line or variety	Yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	
				To the error	To the interaction between variant x years
Diana	2.66	100	Control		
SCM 1	2.83	107	0.17		
SCM 2	2.79	105	0.13		
SCM 3	2.48	93	-0.18		
SCM 4	1.96	74	-0.70	000	000
SCM 5	2.71	102	0.05		
SCM 6	2.39	90	-0.27	0	0
SCM 7	2.47	93	-0.19		
SCM 8	2.65	100	-0.01		
SCM 9	2.86	108	0.20		
SCM 10	2.71	102	0.05		
SCM 11	2.33	88	-0.33	00	00
SCM 12	1.72	65	-0.94	000	000
SCM 13	1.84	69	-0.82	000	000
SCM 14	1.87	70	-0.79	000	000
SCM 15	3.08	116	0.42	***	**
SCM 16	2.47	93	-0.19		
SCM 17	2.23	84	-0.43	000	000
SCM 18	2.31	87	-0.35	00	00
SCM 19	3.12	118	0.46	***	***
SCM 20	3.01	113	0.35	**	**

To the error:
LSD 5%= 0.23; 2.2
LSD 1 %= 0.30; 2.9
LSD 0.1 %= 0.39; 3.7

To the interaction:
LSD 5 % =0.25 2.2
LSD 1 % =0.33 3.1
LSD 0.1 % =0.42 4.9

Table 6 - The seed yield (t/ha) during 2003-2006

Line or variety	Yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	
				To the error	To the interaction between variant x years
Zenit	787.00	100	Control		
SCM 1	719.50	91	-67.50	000	
SCM 2	608.75	77	-178.25	000	0
SCM 3	974.25	124	187.25	***	**
SCM 4	1073.50	136	286.50	***	***
SCM 5	470.25	60	-316.75	000	000
SCM 6	888.0	113	101.00	***	

Line or variety	Yield (t/ha)	Relative yield (%)	Difference (t/ha)	Significance	
				To the error	To the interaction between variant x years
SCM 7	947.25	120	160.25	***	*
SCM 8	503.50	64	-283.50	000	000
SCM 9	664.75	84	-122.25	000	
SCM 10	699.50	89	-87.50	000	
SCM 11	818.75	104	31.75		
SCM 12	880.50	112	93.50	***	
SCM 13	867.50	110	80.50	***	
SCM 14	874.75	111	87.75	***	
SCM 15	708.00	90	-79.00	000	
SCM 16	916.25	116	129.25	***	
SCM 17	880.00	112	93.00	***	
SCM 18	888.25	113	101.25	***	
SCM 19	858.50	109	71.50	***	
SCM 20	750.00	95	-37.00		

To the error:
LSD 5 %= 38.3; 1.2
LSD 1%= 50.4; 1.6
LSD 0.1%= 64.7; 2.1

To the interaction:
LSD 5 % =138; 4.4
LSD 1 % =184; 5.9
LSD 0.1 % =240; 7.6

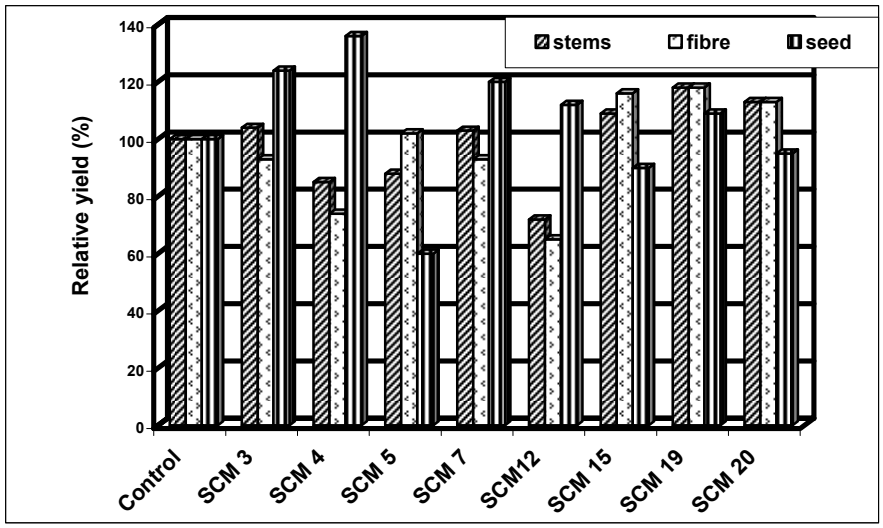

Fig. 1 – Mean relative yield of stems, fibre and seed

CONCLUSIONS

The climatic conditions in the 4 testing years have differently influenced the stem, fibre and seed productions of the investigated lines.

Out of the 20 experimental lines, SCM-19 and SCM -20 lines had a superior stem production potential, with a mean yield of 10.03-10.40 t/ha. In the favourable years, the stem yield has exceeded 12 t/ha.

As concerns the fibre yield, we noticed SCM-15, SCM-19 and SCM -20 lines, with a mean yield comprised between 3.01 and 3.12 t/ha and a maximum one of 3.69 t/ha in the favourable years.

As concerns the seed yield, SCM-3, SCM-4 and SCM-7 lines had a superior production potential, with a mean of 947.2 -1073.5 kg/ha, reaching 1530 kg/ha in the favourable years.

The SCM-19 line may represent the basis of a future mixed variety of monoic hemp, having a superior production potential as concerns the stem, fibre and seed yield.

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