ISSN 1691-5402
ISBN 978-9984-44-027-9
Environment. Technology. Resources
Proceedings of the 7th International Scientific and Practical Conference. Volume 1

BENIKO AND BIALOBREZSKIE – INDUSTRIAL HEMP VARIETIES IN LITHUANIA

BENIKO UN BIALOBREZSKIE – RŪPNIECISKO KAŅEPJU ŠĶIRNES LIETUVĀ

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Abstract. *The biometrical indices of two hemp (Cannabis sativa L.) varieties of Polish origin – Beniko and Bialobrezskie – sown at different rates (40; 55 and 70 kg ha^{-1}) have been investigated at the Upytė Research Station of LIA in 2006. The data from 2006 led to draw conclusion that plants of industrial hemp varieties of Beniko and Bialobrzeskie could be successfully grown in Lithuania. Hemp produced enough high amount of green (up till 42.95 t ha^{-1}) and dry (up till 15.27 t ha^{-1}) biomass. Plants of Beniko were more productive than plants of Bialobrzeskie. The tendencies of higher green and dry biomass were noticed in the plots of lower density. Seed rate had significant influence on crop density. Seed rate (crop density) had significant effect on crop weediness.*

Keywords: *Cannabis sativa* L., *fibre, hemp, seed rate, varieties*.

Introduction

The hemp plant *(Cannabis sativa L.)* is one of the oldest and most versatile plants known to man. Hemp has been cultivated over a period of many centuries in almost every European country. It once represented a significant raw material source for the production of rope, canvas, textiles, paper, and oil products. Until the XVIII century, field- and water-retted mechanically processed hemp fibres, along with flax, nettle, and wool, where the raw materials of the European textile industry. Because of its more coarse and nonhomogeneous fibre bundles, hemp was primary used in the production of outer garments and work clothes. Flax and nettle were used for finer fabrics, and wool for warmer closing [1].

By the end of World War II, hemp was being forgotten once again. The economical cotton imports returned to assert their presence in garment industry. Additionally, marked advances were made with synthetic fibres, which especially took over in the technical textile sector [1].

In Western Europe interest in hemp plant and its abundance of possible uses has increased rapidly at the end of XX and beginning of XXI century. The demand for renewable raw materials is increasing. Many new products processed from strong fibres such as hemp and flax appear all over the world. Many companies produce non-woven products like mats for insulation and automobile composites based mainly on flax but increasingly also on hemp fibres. The advantages are evident, the fibres can reinforce plastics, substitute mineral fibres, be recycled, they are eco-friendly and can be grown ecologically and there is no waste disposal problem. A new break through is now a reality: a new fibre mat made from flax and hemp by means of a new air-forming technique with low production costs is competitive to e.g. mineral wool and glass wool [2]. Hemp fibre could be used for geotextile purposes, seeds – for oil and feeding [3]. The essential oils could be obtained from the panicles of hemp for cosmetics, food products as well as for special products due it repellentic action [4].

In many countries the cultivation of hemp lays under the ban. Because hemp varieties with low THC (Tetrahydrocannabinol) content have been bread, many of them are allowed to grow in the countries of EC. The EC common catalogue of varieties of agricultural plant species in 2008 contains the list of 46 industrial hemp varieties [5].

It is very difficult to decide which variety from the EC list could be the best to grow in Lithuania.

E.P.M. de Meijer reported that from tested 16 hemp accessions, Beniko and Bialobrezskie were the earliest ripening. The most fibrous were Beniko (32.7 %), Uniko-B (28.8-30.8 %), Kompolti (28.0-29.1 %), Bialobrzeskie (29.1-29.5 %) [6].

Some of the industrial hemp varieties included into the EC common catalogue of varieties of agricultural plant species is successfully grown in America. In Canada the following industrial hemp varieties have been evaluated for fibre and grain production in Ontario: Fedora 19, Felina 34, Fedrina 74, Secuieni 1, Irene, Uniko B, Kompolti, Finola (FIN 314) and Anka. Uniko B and Kompolti continued to perform for highest stalk and fibre yields across Ontario [7].

In Poland hemp varieties of Polish origin Beniko and Bialobrezskie were investigated in 1986-1988. Plants of Bialobrzeskie showed higher seed (550 kg ha^{-1}) and stalk (10 000 kg ha^{-1})yield, but the plants of Beniko had higher fibre yield (total fibre yield 2890 kg ha^{-1}, long fibre yield 2670 kg ha^{-1}) [8]. Investigation in 2000-2001 provided with information that from 14 tested hemp varieties (Beniko, Bialobrezskie, Juso 11, Silesia, Novosadka, Ferimon 12, Felina 34, Futura 77, Kompolti, Fedora 17, Fedora 19, Tibolaj, F x T, Hei Bei) in Poland plants of Beniko and Bialobrezskie had the highest total fibre content (28.5 and 26.9 %, respectively) while the highest stalk yield was obtained from plants of Hei Bei (18.9 t ha^{-1}) and Kompolti (18.0 t ha^{-1}) [9].

Hemp production ranges depending on seed rate (crop density). Bocsa and Karus [10] report that optimal sowing density for hemp grown for pulp production is 40-60 kg ha^{-1} while for textile application (only for fibre) – 70-80 kg ha^{-1}. Grabowska and Koziara report that the increase of seed rate caused the decrease of the plant length and diameter. The sowing density of 320-960 seeds per 1 m^2 showed no significant effect on yield in none of tested locations. However, increasing it to 1280 seeds per 1 m^2 caused statistically proven decrease of stalk yield [11].

The hypothesis of our investigations – hemp sowing at different rates will effect on crop density, productivity, and other biometrical indices; different hemp varieties will show different yield potential.

Materials and methods

The aim of the investigation was to evaluate the influence of hemp variety and sowing rate on hemp (*Cannabis sativa* L.) productivity, and to discuss which variety would be more suitable to grow in Lithuania.

The investigation was conducted on a Eutri-Endohypogleyic Cambisol [12]. The content of available P_2O_5 in the soil plough layer was 275 mg kg^{-1}, content of K_2O – 175 mg kg^{-1} (determined in A-L extraction), pH_{KCl} level – 7.3 (potentiometrically), humus content – 2.31 % (by Thyurin method). In the field rotation hemp followed winter wheat.

Bi-factorial trial was carried out at the Upytė Research Station of LIA in 2006: Factor A – variety (A1 – Beniko; A2 – Bialobrzeskie); Factor B – sowing rate (B1 – 40 kg ha^{-1}; B2 – 55 kg ha^{-1}; B3 – 70 kg ha^{-1}). Both of selected varieties are of Polish origin. Varieties were selected following facts, that Poland is the nearest country where hemp breeding is carried out, and the pedoclimatical conditions of Poland could be considered to be most similar to those of Lithuania (in general hemp breeding is carried out in southern countries of EC, therefore those varieties are more adapted to southern pedoclimatical conditions).

Hemp was sown by sowing-machine SLN-1.6 at the middle of May in the plots of 10 m^2, triplicate, harvested in the middle of October by trimmer. The biometrical indices of hemp plants – crop density, weediness, height and stalk diameter in the middle of the stalk at harvesting time, amount of green and dry over ground mass, and fibre content were evaluated. One part of hemp stalk samples (0.5 kg per plot) was water-retted (temperature 37 º C) for 5 days, other part (0.5 kg per plot) was dew-retted on the grassland; then dry straw was scuthched by tool SMT-200. For calculation and statistical evaluation the statistical software developed in the Lithuanian Institute of Agriculture was used [13].

Thermal and irrigation conditions during the growing season could be described by one of the most informative agrometeorological indicators – G. Selianinov's hydrothermal coefficient [14]:

$$HTK = \frac{\Sigma p}{0.1\Sigma t} \qquad (1)$$

where: Σp – total precipitation (mm) sum during the given period, the temperature of which is above 10 °C;

Σt – total sum of active temperatures (°C) of the same period.

If HTK>1.6 – excessive irrigation, HTK=1...1.5 – optimal irrigation, HTK=0.9...0.8 – weak drought, HTK=07...0.6 – moderate drought, HTK=05...0.4 – strong drought, HTK<0.4 – very strong drought.

According to the data presented in Figure 1, it would be fair to say that just after sowing (12th of May) it was enough wet for hemp seed germination. Dry weather was in June and July, but hemp plants didn't suffer from it. The abundant precipitation in August and September allowed hemp plants to thrive, but led to long vegetation period, long flowering period, late seed ripening. Hemp was harvested only in the middle of October.

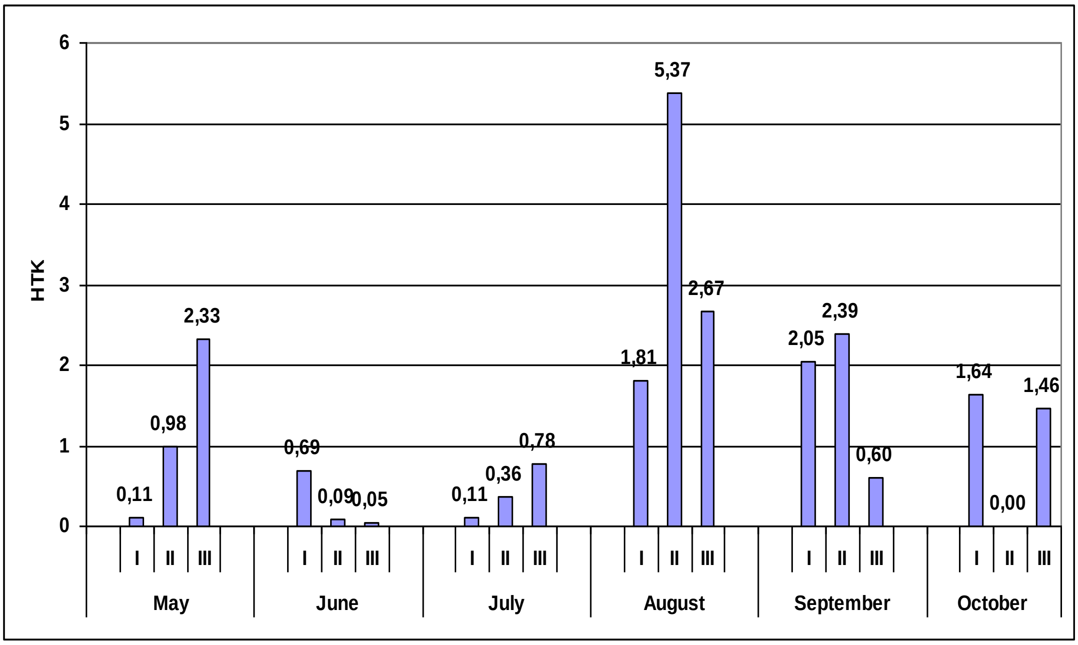

Fig. 1. **Hydrothermal coefficient** (Upytė, 2006)

Results and discussion

The beginning of hemp seed germination was noticed on 21st of May, e.i., on 9th day after sowing. Few days later the crop was fully emerged, the seedlings had first pair of true leaves. Visually any differences between seedlings of different varieties haven't been noticed. On the 29th of May plants had already the second pair of true leaves, and differences between plots sown at different seed rate have been noticed. On 8th of June plats were already 13-16 cm in height; on 23rd of June – 60-80 cm, on 7th of July – above 1 m (some plants reached even 1.5-1.7 m height). One week later hemp plants' height was already about 1.8-2 m. On the 25th of July hemp started flowering. After heavy precipitation some hemp plants at the plot side have lodged. At the beginning of September hemp was still flowering, the seeds were milky, still immature. Some maturated hemp seeds were found on the 5th of October. It was noticed, that some birds are attacking hemp crop and picking hemp seed from growing plants. At hemp harvesting time (16th of October) approximately all seeds in hemp plots have been eaten. Hemp was harvested by trimmer, leaving the stubble of 3-5 cm. Hemp in 2006 was growing about 22 weeks (157 days).

Before harvesting hemp crop density and weediness have been evaluated. Significant differences in crop density were noticed for Beniko and Bialobrzeskie (Table 1), and this could be the result of different weight of 1000 seed (Beniko – 15.56 g; Bialobrzeskie – 14.65 g). As it was expected, seed rate also had significant influence on crop density – the highest crop density (in average 236 units m^{-2}) was obtained sowing 70 kg ha^{-1}, the lowest (in average 100 units m^{-2}) – sowing 40 kg ha^{-1}.

Table 1.

The influence of variety and seed rate on hemp crop density (units m^{-2}) before harvesting

(Upytė, 2006)

Variety (Factor A)	***Seed rate (Factor B)***			***Mean for factor A***
	40 kg ha^{-1}	***55 kg ha^{-1}***	***70 kg ha^{-1}***	
Beniko	94	131	197	141
Bialobrzeskie	106	148	274	176
Mean for factor B	100	140	236	-
LSD_{05} (variety) = 10.3 LSD_{05} (seed rate) = 14.6 LSD_{05} (variety x seed rate) = 23.0				

Seed rate (crop density) had significant effect on crop weediness (Table 2). The amount of weeds in hemp crop at harvesting was quite low – only 1-6 plants m^{-2}. More weeds were found at thin crop. The main part of weeds found at hemp harvesting time consisted of white goosefoots (*Chenopodium album* L.).

Table 2.

The influence of variety and seed rate on hemp crop weediness (units m^{-2}) before harvesting

(Upytė, 2006)

Variety (Factor A)	***Seed rate (Factor B)***			***Mean for factor A***
	40 kg ha^{-1}	***55 kg ha^{-1}***	***70 kg ha^{-1}***	
Beniko	6.0	0	1.3	2.4
Bialobrzeskie	4.7	2.7	1.3	2.9
Mean for factor B	5.3	1.3	1.3	-
LSD_{05} (variety) = 1.38 LSD_{05} (seed rate) = 1.96 LSD_{05} (variety x seed rate) = 3.09				

In 2006 hemp produced enough high amount of green over ground (stalks, leaves and panicles) mass (up till 42.95 t ha^{-1}) (Table 3). Plants of Beniko were more productive than plants of Bialobrzeskie (significant differences). Seed rate didn't show significant influence on the yield of green over ground mass – only tendencies of higher green biomass were noticed in the plots of lower density (differences not significant).

Table 3.

The influence of variety and seed rate on hemp green biomass yield (kg ha^{-1})

(Upytė, 2006)

Variety (Factor A)	***Seed rate (Factor B)***			***Mean for factor A***
	40 kg ha^{-1}	***55 kg ha^{-1}***	***70 kg ha^{-1}***	
Beniko	42 952	39 857	39 810	40 873
Bialobrzeskie	34 286	34 810	33 095	34 064
Mean for factor B	38 619	37 333	36 452	-
LSD_{05} (variety) = 1 511.0 LSD_{05} (seed rate) = 2 136.8 LSD_{05} (variety x seed rate) = 3 378.6				

According to the data of hemp green biomass and amount of crop moisture content at harvesting (it was about 63.6-66.9 %), the yield of dry hemp biomass was calculated. Plants of Beniko showed higher productivity than that of Bialobrzeskie (significant differences) (Table 4). The tendencies of higher dry biomass were noticed in plots of lower density (differences not significant).

Table 4.

The influence of variety and seed rate on hemp dry biomass yield (kg ha^{-1})

(Upytė, 2006)

Variety (Factor A)	*Seed rate (Factor B)*			*Mean for factor A*
	40 kg ha^{-1}	*55 kg ha^{-1}*	*70 kg ha^{-1}*	
Beniko	15 267	14 542	13 888	14 566
Bialobrzeskie	12 070	12 113	10 948	11 710
Mean for factor B	13 668	13 327	12 418	-
LSD_{05} (variety) = 971.6 LSD_{05} (seed rate) = 1 374.1 LSD_{05} (variety x seed rate) = 2 172.6				

The stalks of Beniko plants ware by 7 cm taller than that of Bialobrzeskie (Table 5). We should remind that total plant height would be taller by approximately 5 cm, when taking into account the length of stubble left on the field. Significant differences in plant height were found in the plots of different crop density – plants were taller (even by 20 cm) in thin crop and lower – in thick crop. The same results were described by Grabowska, Koziara [11].

Table 5.

The influence of variety and seed rate on hemp plant height (m) at harvesting

(Upytė, 2006)

Variety (Factor A)	*Seed rate (Factor B)*			*Mean for factor A*
	40 kg ha^{-1}	*55 kg ha^{-1}*	*70 kg ha^{-1}*	
Beniko	2.29	2.18	2.13	2.20
Bialobrzeskie	2.28	2.10	2.02	2.13
Mean for factor B	2.28	2.14	2.08	-
LSD_{05} (variety) = 0.050 LSD_{05} (seed rate) = 0.071 LSD_{05} (variety x seed rate) = 0.112				

Technical hemp stalk length was measured from the foot part of stalk up till first left leaves and panicles. Tendencies of longer technical stalk part in Beniko plants could be observed (Table 6). Also tendencies of longer technical stalk part could be noticed in thin crop (except crop of Beniko).

Table 6.

The influence of variety and seed rate on technical hemp plant height (m) at harvesting

(Upytė, 2006)

Variety (Factor A)	*Seed rate (Factor B)*			*Mean for factor A*
	40 kg ha^{-1}	*55 kg ha^{-1}*	*70 kg ha^{-1}*	
Beniko	1.76	1.81	1.78	1.79
Bialobrzeskie	1.87	1.76	1.68	1.77
Mean for factor B	1.82	1.79	1.73	-
LSD_{05} (variety) = 0.050 LSD_{05} (seed rate) = 0.071 LSD_{05} (variety x seed rate) = 0.112				

The stalk diameter of Beniko plants was higher then that of Bialobrzeskie (Table 7). Significant differences in stalk diameter were found when sowing 40 kg ha^{-1} and when compared to that of sowing rates of 55 kg ha^{-1} and 70 kg ha^{-1}. But we didn't find any significant differences in diameter when sowing 55 kg ha^{-1} and 70 kg ha^{-1}.

Table 7.

The influence of variety and seed rate on hemp stalk diameter (cm) at harvesting

(Upytė, 2006)

Variety (Factor A)	*Seed rate (Factor B)*			*Mean for factor A*
	40 kg ha^{-1}	*55 kg ha^{-1}*	*70 kg ha^{-1}*	
Beniko	0.68	0.63	0.59	0.63
Bialobrzeskie	0.66	0.56	0.54	0.59
Mean for factor B	0.67	0.59	0.57	-
LSD_{05} (variety) = 0.031 LSD_{05} (seed rate) = 0.044 LSD_{05} (variety x seed rate) = 0.070				

The fibre content in hemp stalks was found to be different after stalk dew-retting and water-retting (Tables 8 and 9). Any significant differences in fibre content weren't found in 2006. We can see tendencies that Bialobrzeskie plants had slightly higher content of dew-retted fibre; higher dew-retted fibre content was obtained in thin crop (Table 8).

Table 8.

The influence of variety and seed rate on hemp fibre content (%) in stalks after dew-retting

(Upytė, 2006)

Variety (Factor A)	***Seed rate (Factor B)***			***Mean for factor A***
	40 kg ha^{-1}	***55 kg ha^{-1}***	***70 kg ha^{-1}***	
Beniko	12.3	12.0	13.3	12.6
Bialobrzeskie	12.7	11.7	15.0	13.1
Mean for factor B	12.5	11.8	14.2	-
LSD_{05} (variety) = 1.033 LSD_{05} (seed rate) = 1.460 LSD_{05} (variety x seed rate) = 2.309				

Beniko plants had slightly higher content of water-retted fibre; established water-retted fibre content was very similar in all plots of different crop density (Table 9).

Table 9.

The influence of variety and seed rate on hemp fibre content (%) in stalks after water-retting

(Upytė, 2006)

Variety (Factor A)	***Seed rate (Factor B)***			***Mean for factor A***
	40 kg ha^{-1}	***55 kg ha^{-1}***	***70 kg ha^{-1}***	
Beniko	20.3	19.7	19.7	19.9
Bialobrzeskie	18.0	18.3	19.0	18.4
Mean for factor B	19.2	19.0	19.3	-
LSD_{05} (variety) = 1.246 LSD_{05} (seed rate) = 1.762 LSD_{05} (variety x seed rate) = 2.787				

Conclusions

1. The trial carried out in 2006 led to draw conclusion that plants of industrial hemp varieties of Polish origin – Beniko and Bialobrzeskie – could be successfully grown in Lithuania.
2. In 2006 hemp produced enough high amount of green (up till 42.95 t ha^{-1}) and dry (up till 15.27 t ha^{-1}) over ground mass. Plants of Beniko were more productive than plants of Bialobrzeskie. The tendencies of higher green and dry biomass were noticed in the plots of lower density.
3. Neither of two investigated factors showed significant influence on fibre content in 2006.
4. Seed rate had significant influence on crop density.
5. Seed rate (crop density) had significant effect on crop weediness.
6. The stalks of Beniko plants ware by 7 cm taller than that of Bialobrzeskie. Significant differences in plant height were found in the plots of different crop density – plants were taller (even by 20 cm) in thin crop and lower – in thick crop.
7. The diameter of hemp stalks was lesser when sowing 55 kg ha^{-1} and 70 kg ha^{-1} then that when sowing 40 kg ha^{-1}. But we didn't find any significant differences in diameter when sowing 55 kg ha^{-1} and 70 kg ha^{-1}.

Acknowledgment

The authors thank the Lithuanian Ministry of Agriculture for the financial support.

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