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Short communication

INFLUENCE OF CROP DENSITY AND PINCHING ON HEMP PLANT ARCHITECTURE AND YIELD

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OPEN ACCESS

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SUMMARY

One-year experiments conducted with one hemp variety were established to determinate the cultivation practices (growth density and pinching) which could be used to optimize the technological process of hemp varieties production for different purposes. The results showed that reduced crop density and pinching result in development of shorter plants. In denser non-pinched crops, the stem is over 180 cm high, while the plants start branching in the upper 1/4-1/5 part. In the non-pinched treatment with a larger area available for individual plants, as well as in the pinched treatments, more productive branches of less thickness develop in the lower parts. The non-pinched treatments generally produce higher stem and fiber yields, which increase when crop density is reduced. The obtained results can serve as a basis for determining certain treatments during the evaluation of production technology for different varieties of hemp intended for specific purposes.

Key words:
crop density, hemp, pinching, plant architecture, fiber yield

INTRODUCTION

Hemp as a raw material is used in various industries. In order to obtain maximum yields of appropriate quality, growing hemp requires application of various cultivation practices. The efficiency of the applied mechanization is affected by the architecture of the plant, therefore it is necessary to develop an optimal production technology for each variety. In addition to crop density, the production technology includes the possibility of obtaining more productive branches by pinching (cutting) plants at the beginning of intensive growth. Crop density is related to the seedling rate, seed quality and purposes of production and is generally defined as 30 kg ha^{-1} (100-150 plants m^{-2}) for seed production or twice as much for fiber production (Bocsa & Karus, 1997), although Burczyk et al. (2006) state that for the production of non-textile fiber, sowing 30 kg of seeds per hectare is sufficient. The issue of applying optimal technology becomes even more important if the possibility of multiple uses is taken into account (Burczyk et al., 2009), according to which double purpose hemp crop is economically better for farmers. Similar research with several varieties (Bennett et al., 2006) indicates that, depending on the purpose of cultivation, there is no inter-varietal interaction between the sowing rate and yield, so the assumption is that varietal technology for specific conditions should be viewed in terms of monoecious and dioecious varieties in general and the purpose of their cultivation.

Based on one-year experiments on the example of one hemp variety, the main objective of these short communications is to evaluate more complex research related to development of varietal technology of hemp assortments for different purposes, including both dioecious and monoecious varieties.

MATERIAL AND METHODS

Trials with different crop densities of dioecious hemp variety Marina were conducted during 2022 at the Department for Vegetable and Alternative Plant Species of the Institute of Field and Vegetable Crops Novi Sad in Bački Petrovac (N 50°21'; E 39°56'). The hemp was grown as a rainfed crop without irrigation, as is traditional practice in the region, and by applying the production technology which is the typical production system for commercial production of hemp in Middle and Southern Europe. Hemp was seeded with a small grain planter on 21 April 2022. After sprouting of the plants, manual thinning was performed, which resulted in three varieties with different sowing spacing: 12.5 cm, 25 cm and 50 cm row space. After thinning, the following three different crop densities were obtained: 300, 150 and 20 plants per square meter. When the plants were approximately 60 cm high, manual cutting (pinching) was performed at a height of 40 cm on half of the elementary plot. The experimental design was completely randomized with three replicates, with the size of the experimental plots being 15 m^2. Plants occupying the area of 5 square meters were manually removed from each plot on 6 September. The bundles were allowed to dry in a sheltered area to air-dry weight for two weeks. After measuring the weight of each sample, the stem – yield components were measured on 10 selected (both male and female) plants. The stalk fiber content was determined by Bredeman (1942) method, and the stalk and the fiber yield was calculated for each treatment.

RESULTS AND DISCUSSION

The plant height in the experiment ranged from 199 cm to 305 cm. At each crop density, plants were higher in the non-pinched treatments compared to the pinched treatments. The increase in space available to plants results in the increase in their height in all treatments. Male plants in the population are, although statistically insignificantly, several centimeters higher than female plants in all treatments. The greatest average height (300 cm) was recorded in the non-pinched treatment with the fewest plants per unit area, and the shortest average height (199 cm) was found in the densest pinched crops. The pinched treatment with the lowest density (20 plants per square meter) did not differ in terms of the plant height (258 cm) compared to the non-pinched treatments with 300 and 150 plants per square meter (254 and 271 cm, respectively) (Fig. 1). The shorter height of the plants in the dense crop is explained (Van der Werf et al. 1996) by the reduction of growth rate in the last stages of plant development.

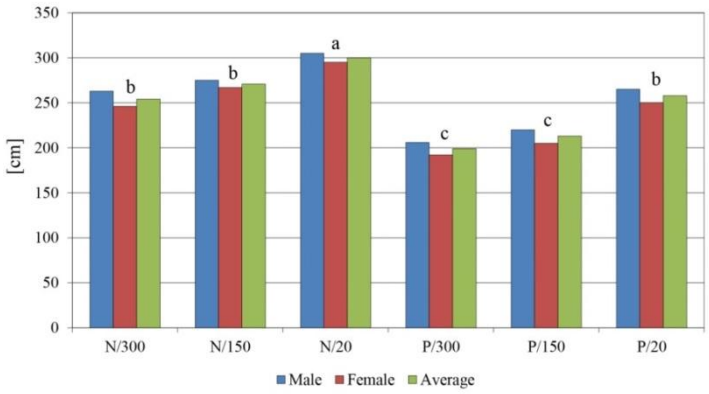

Figure 1. Plant height in different density treatments of hemp crop
(Within each bar: means followed by the same letter are not significantly different at α = 5%)

Stalk and inflorescence proportion in different density treatments of the hemp crop is given in Figure 2. The stalk length of the two non-pinched treatments with the highest crop density (N/300 and N/150) is significantly higher (196 and 187 cm, respectively) compared to all pinched and non-pinched low density treatments. In all pinched treatments, the stalk is cut at the same height of 40 cm, and below this point the plants start branching, forming 2-4 productive branches. At the same height, about 40 cm, branching of low density non-pinched plants (N/20) begins with formation of the longest inflorescence (263 cm) with 4-6 primary branches. The pinched treatment with the fewest plants per unit area (P/20) also formed inflorescence significantly longer (218 cm) than the other pinched and

N/300 and N/150 non-pinched treatments. The length of the inflorescence is followed by the length of the first branch, which is 15-20 cm in the densest treatment and 50-55 cm in N/20 and P/20 treatments (data not shown). A significant influence of hemp crop density on several phenological traits, yield and weed suppression is reported by Hall et al. (2014).

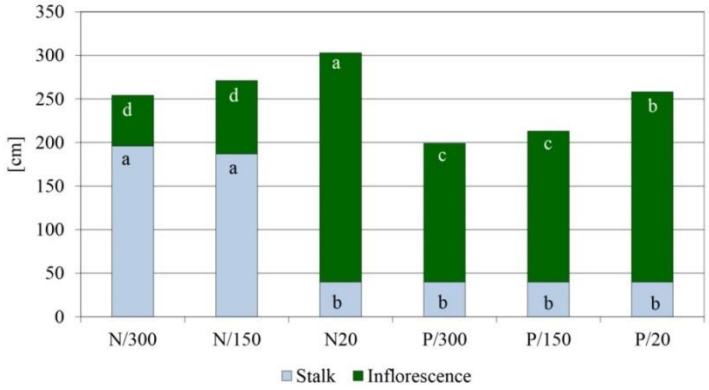

Figure 2. Stalk and inflorescence proportion in different density treatments of hemp crop
(Within each bar: means followed by the same letter are not significantly different at α = 5%)

The yield of the stem in the experiment varied between 7.5 and 14.0 tons per hectare (Tab. 1). The highest yield was achieved in N/20 treatment while two other non-pinched treatments and P/20 had similar yield of 9.0 and 9.5 t ha^{-1}, respectively. It is shown that pinching results in significantly lower stem yields in both male and female plants.

Table 1. Parameters of yield and tree thickness in different density treatments of hemp crop.

Crop density	Stem yield (t ha^{-1})			Fiber yield (t ha^{-1})			Stalk thickness (mm)		
	Male	Female	Total	Male	Female	Total	Male	Female	Average
N/300	6.25	12.45	9.50^{b}	2.0	4.0	3.1^{b}	8.1	8.8	8.5^{b}
N/150	5.85	12.60	9.00^{b}	1.9	4.1	2.9^{b}	9.1	10.0	9.6^{b}
N/20	8.35	19.20	14.00^{a}	2.9	6.6	4.8^{a}	18.0	17.7	17.9^{a}
P/300	4.90	9.80	7.50^{c}	1.6	2.8	2.3^{c}	6.5	6.8	6.7^{c}
P/150	4.30	10.20	7.50^{c}	1.3	3.3	2.3^{c}	6.3	7.3	7.0^{c}
P/20	6.65	11.45	9.00^{b}	2.2	3.6	2.9^{b}	11.0	10.7	10.9^{b}

Legend: Within each column: means followed by the same letter are not significantly different at α = 5%

Thickness of the stem is a trait that is related to the efficiency of the applied machinery and greater thickness can cause harvest difficulties (Bocsa and Karus, 1997). Depending on the treatment, the stem thickness varies in the range of 6.3 to 18.0 cm (Tab. 1). In all non-pinched treatments the stems were on average thicker compared to the corresponding pinched ones, and in all treatments the thickness increased as the number of plants per unit area decreased. No differences were noted between male and female plants regarding this trait.

While Amaducci et al. (2008) reported shorter and thinner stems with higher fiber content under dense seeding conditions, our experiments showed no significant difference between the treatments in the fiber content (data not shown), and the differences in the fiber yields are due to the differences in the stem yields.

CONCLUSION

Preliminary research, which included one variety of hemp grown in non-pinched and pinched treatments of different density, showed that regulating crop density and cutting plants at the beginning of intensive growth can influence the architecture of the plant as well as the yields of stems and fibers. In addition to the analyzed features, it is also necessary to look at the optimal technological parameters for obtaining the highest seed yields. In order to develop optimal technology for both dioecious and monoecious varieties and for successful production of seeds and stalks or fiber, the defined methodology should be applied over several years in order to take into account the G x E x M (genotype x environment x management) interaction.

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Conflict of interest: The authors declare that they have no conflict of interest.

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