FIBER HEMP RESPONSE TO FOLIAR APPLICATION OF GROWTH REGULATORS

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Abstract
The aim of this paper was to test the effect of three plant growth regulators (PGR) on fiber content of hemp cultivar Helena. Applied PGRs, Cycocel®, Regalis® and Moddus® had impact on fiber content in hemp cultivar Helena in medium concentrations: 1-2, 1.25-2.5 and 0.4-0.5 kg/ha, respectively. Further analysis of fiber quality, after application of various PGRs concentrations, should explain which PGR should be used in hemp fiber production**.**

Introduction
Plant growth regulators (PGR) are synthetic compounds used to regulate/retard the shoot length of plants. This is achieved by reducing cell elongation and by lowering the rate of cell division [1]. Most plant growth retardants inhibit the formation of active gibberellins and can be used to reduce shoot elongation [2]. Cycocel® (chlormequat chloride) is a synthetic growth retardant that is extensively used for dwarfing of plants. Studies have indicated that Cycocel® is effective in stimulating the production of secondary metabolites [3]. Regalis® (prohexadione-Ca or 3-oxido-4-propionyl-5-oxo-cyclohexenecarboxylate), primarily used for the control of shoot growth in pome and other fruit trees, is a multifunctional plant bio-regulator that mimic of 2-oxoglutarate, inhibiting dioxygenases, which catalyse distinct steps in the biosynthesis of the growth hormone gibberellin [1]. Moddus® (trinexapac-ethyl) is effective anti-gibberellin PGR marketed primarily for the control of lodging.
Plants cells sense the environment and make appropriate adjustments to gene expression, metabolism and physiology using oxidative stress or oxidative signaling, which could be regarded as interactions between reactive oxygen species (ROS) and the antioxidative system, which set signal intensity, to relay the oxidative message and to determine its physiological outcome [4].
Hemp cultivar Helena is primarily grown for grain production, however it is rich in fiber and can reach up to 4 m height. To achieve complete use of the plant, it is important to understand in which way it is possible to enhance yield of its usable parts.
The purpose of this work was to determine response of hemp cultivar Helena to foliar application of different concentrations of mentioned PGRs with a view to test their impact on plant membrane integrity and the fiber yield.

Experimental
Plants were grown in the experimental field of the Institute of Field and Vegetable Crops (Novi Sad, Serbia). Four concentrations of growth regulators, previously tested on other plant

species, were applied: Cycocel® (C1: 0.5, C2: 1, C3: 2, C4: 3 kg/ha), Regalis® (R1: 1, R2: 1.25, R3: 2.5, R4: 3 kg/ha) and Moddus® (M1: 0.2, M2: 0.4, M3: 0.5, M4: 0.8 kg/ha). Plants were treated at the begining of a period of intensive vegetative growth, after which samples for biochemical analysis were collected. Quantification of investigated biochemical parameters was performed using Perkin Elmer Lambda 25 UV/Visible spectrophotometer. One g of fresh leaves was ground with cooled mortar and pestle and then homogenized with 5 ml 20% trichloroacetic acid for lipid peroxidation determination (LP) or total amount of TBARS (TBA-reactive substances) and expressed as nmol malondialdehyde (MDA) equivalents/g fresh weight (fw). Malondialdehyde (MDA) is a secondary end-product of the oxidation of polyunsaturated fatty acids, and reacts with thiobarbituric acid (TBA) to yield a pinkish-red chromogen with maximal absorbance at 532 nm [5]. Correction for non-specific turbidity at 600 nm was measured due to interference of other compounds including sugars, anthocyanins and other phenolics. Fiber yield [6], as well as plant heights and width were recorded. All statistical analysis were performed by STATISTICA for Windows version 13 (Dell Software).

Results and discussion

There is no registered product that is used for hemp growth regulation, the reason of which three commonly applied PGRs are used in this study. As it is showed in the Figure 1, control represented 100% of lipid peroxidation intensity, and plants reacted differently to various PGRs concentrations. Lipid peroxidation products such as MDA (malondialdehyde) are considered useful and reliable indicator of membrane damage and oxidative signalling, due to the susceptibility of membranes to reactive oxygen species (ROS). Only higher conentrations of Cycocel® had imapct on hemp leaves, while Regalis® and Moddus® induced oxidative stress in lower concentrations (Figure 1).

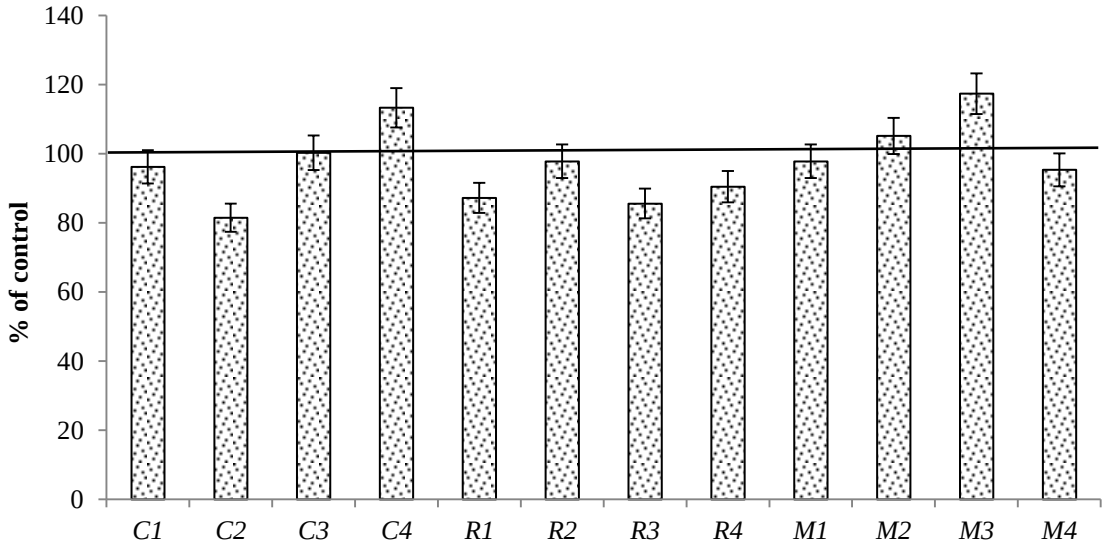

Figure 1. Lipid peroxidation intensity in leaves of hemp ‚Helena' treated with growing concentrations of growth regulators (C-cycocel, R-regalis and M-modus, concentrations in Experimental section). Results expressed as percent of control, control represents 100%.

Shoot height (2.5-3 m) and width (approx. 2 cm) were unaffected by the treatment and however were the differences among teratments, there was no correlation between shoot

lenght and width parameters and fiber content. Higher fiber content was recorded for the second and third concentration of all tested PGRs.

Table 1. Fiber content of 'Helena' plants treated with growing concentrations of growth regulators (concentrations in Experimental section).

	C - Cycocel®					R - Regalis®					M - Moddus®				
%	control	C 1	C 2	C 3	C 4	control	R 1	R 2	R 3	R 4	control	M 1	M 2	M 3	M 4
fiber content	34	33	35	35	33	32	33	35	35	33	33	31	32	33	32

Conclusion

Applied PGRs had impact on fiber content in hemp cultivar Helena. Further analysis of fiber quality after application of various PGRs concentration should explain which PGR should be used in hemp fiber production.

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