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EFFECTS OF DIFFERENT MORPHOREGULATORS ON GROWTH AND DEVELOPMENT OF *CANNABIS SATIVA* L.

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Abstract: The aim of this study was to investigate the effects of concentration of different growth regulators (auxins and cytokinins) on morphological characteristics of hemp variety Bialobrzeskie. The plants were sprayed with 1-naphthaleneacetic acid (*NAA*) and 6-benzylaminopurine (*BAP*) and the resulting influence on the total height and lateral branching was observed. Expected results were obtained for variants treated with BAP, whereas the variants treated with auxin showed an increase in lateral branching.

Key Words: cytokinin, auxin, axillary branches, height, hemp

INTRODUCTION

Phytohormones are endogenous molecules occurring naturally in plants at very low concentrations. They do not have any nutritional function, but act as signalling compounds that regulate plant development and physiology (Sauer et al. 2013). Auxin and cytokinins are hormones influencing a wide range of plant development processes. Cytokinins favour the development of axillary buds whereas auxin supresses the development.

Via regulation of meristem activity, with opposite role in root and shoot morphogenesis (Werner et al. 2001), cytokinins determine plant shape, which allows plant to adjust to site conditions in order to take advantage of the environment. Both auxin and cytokinin have been known for a long time to act either synergistically or antagonistically to control several significant developmental processes, such as the formation and maintenance of meristem (Su et al. 2011). Shoot branching is a major determinant of plant architecture and is highly regulated by endogenous and environmental cues. Both classes of hormones, auxin and cytokinin, have long been known to have an important involvement in controlling shoot branching (Umehara et al. 2008)

Cannabis (*Cannabis sativa* L.) has been grown worldwide for thousands of years for its valuable properties, like fiber and oil content, and for medicinal purposes and as an intoxicant (Small and Cronquist, 1976, Kojoma et al. 2005). Cannabis, or hemp, can provide high biomass quantities in a short time (Weiblen et al. 2015). The stem of this fiber crop supplies both cellulosic and woody fibres: the core is indeed lignified, while the cortex harbours long cellulose-rich fibres, known as bast fibers (Guerriero et al. 2013). The current climatic and economic scenario pushes towards the use of sustainable resources and hemp can be a source of fibres, oil, and hemp biomass. Exogenous phytohormones can be used to influence the shoot branching and can cause greater vegetative biomass, fruit and seed production. The effect of phytohormones on the shoot architecture of *Cannabis sativa* L has never been studied before. The aim of the study was to document the changes in morphological characteristics of Bialobrzeskie, a hemp variety cultivated for fibres.

MATERIAL AND METHODS

The experiment on effects of plant hormones on the morphological characteristics of hemp variety Bialobrzeskie was carried out in the greenhouse of Mendel University in Brno. The seedlings were transferred to the greenhouse after one week after sowing. After acclimatization for three weeks the first measurements of the plants were carried out. The plants were measured for their total height and length

of axillary branches in individual nodes. In total there were seventy plants divided in seven different groups so there were 10 plants placed in each group. Three groups were treated with 1-naphthaleneacetic acid (1-*NAA*) in the concentrations of 5, 10 and 20 mg/l. The other three groups were treated with 6-benzylaminopurine (*BAP*) in the concentrations of 10, 25 and 50 mg/l. The phytohormone solutions were prepared from stock solutions of 100 mg/ml in dimethyl sulfoxide and 200 mg/ml in dimethyl sulfoxide for 1-NAA and BAP respectively. 1.25 ml of Tween was added as a surfactant and the volume of the mixture was adjusted to 250 ml using distilled water.

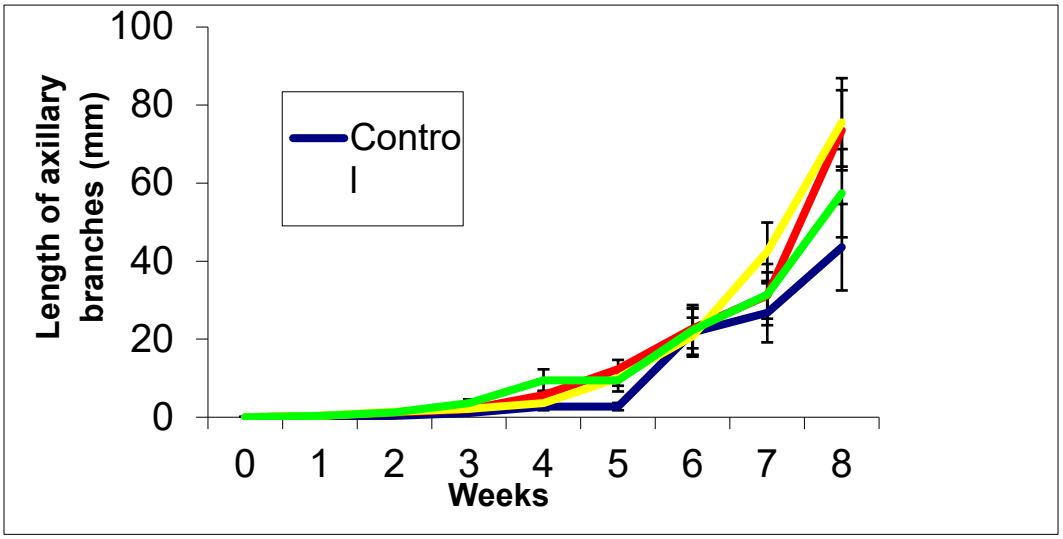
Both 1-NAA and BAP were applied by spraying on the leaves of the plants. The control group were treated with none of the growth hormones. The plants were sprayed with hormones every fortnight and the measurements were done every week on a fixed day. The measurements were noted for every plant in each group for 8 weeks. The mean values, standard deviation and standard error of total plant height and the length of axillary branches for all the variants were calculated.

RESULTS AND DISCUSSION

When comparing the growth of lateral branches in control group vs. NAA treated variants, we can see that the results are contradictory to what was expected (Figure 1). Auxins should inhibit the growth of lateral branches and elongate the stem, but significant increase in axillary branches length in some auxin treated variants in some intervals of measurement was observed. Plants treated with 1-NAA (auxin) variant should have shown an increase in stem length when compared with the control group, but this holds true only for one variant treated with 10 mg/ml of auxin (Figure 2). In many plant species the inhibition of shoot branching caused by exogenous auxin treatment (lanolin paste containing auxin) has been proven (Thimann and Skoog 1934, Morris 1977, Cline 1996) but also a few exceptions have been described (Cline 1996). This result could be caused by decreased sensitivity of hemp buds to inhibitory effect of auxin in apical dominance. Significantly increased length of lateral branches might be consequence of well-known stimulatory effect of auxin on stem elongation of already formed shoots which was described in some species (Yang et al. 1993, Haga and Lino 1997).

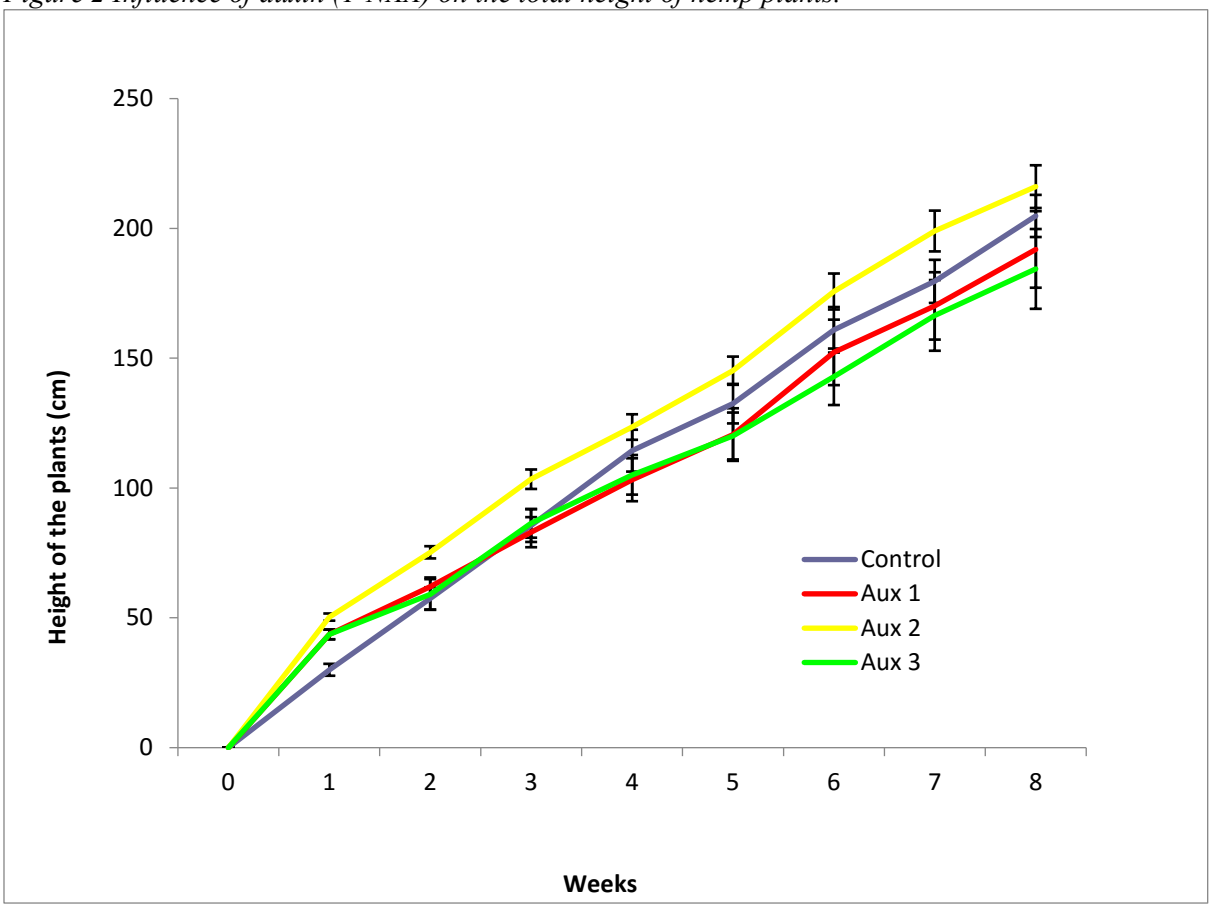
For the 6-BAP (cytokinin) treated group, the results were more in accordance with previous studies (Figure 3). Concentration dependant significant increase in axillary branches length in cytokinin treated variants was observed as known from literature (Sachs and Thimann 1967, Pillay and Railton 1983, Li and Bangerth 2003). The differences were the most significant in the highest dosing. Surprisingly, we can see some disproportion relation to concentration of BAP. Lowest dose promoted the growth of branches more than middle dose. However, the trend was normal before, and the reversal occurred during the sixth week of measurement. BAP did not affect the total height of the plants as they grew similarly with the control group (Figure 4). Exogenous application of cytokinin was not effective in modifying any evaluated plant growth variables also in soybean (Leite et al. 2003).

Figure 1 Influence of auxin (1-NAA) on the length of axillary branches.



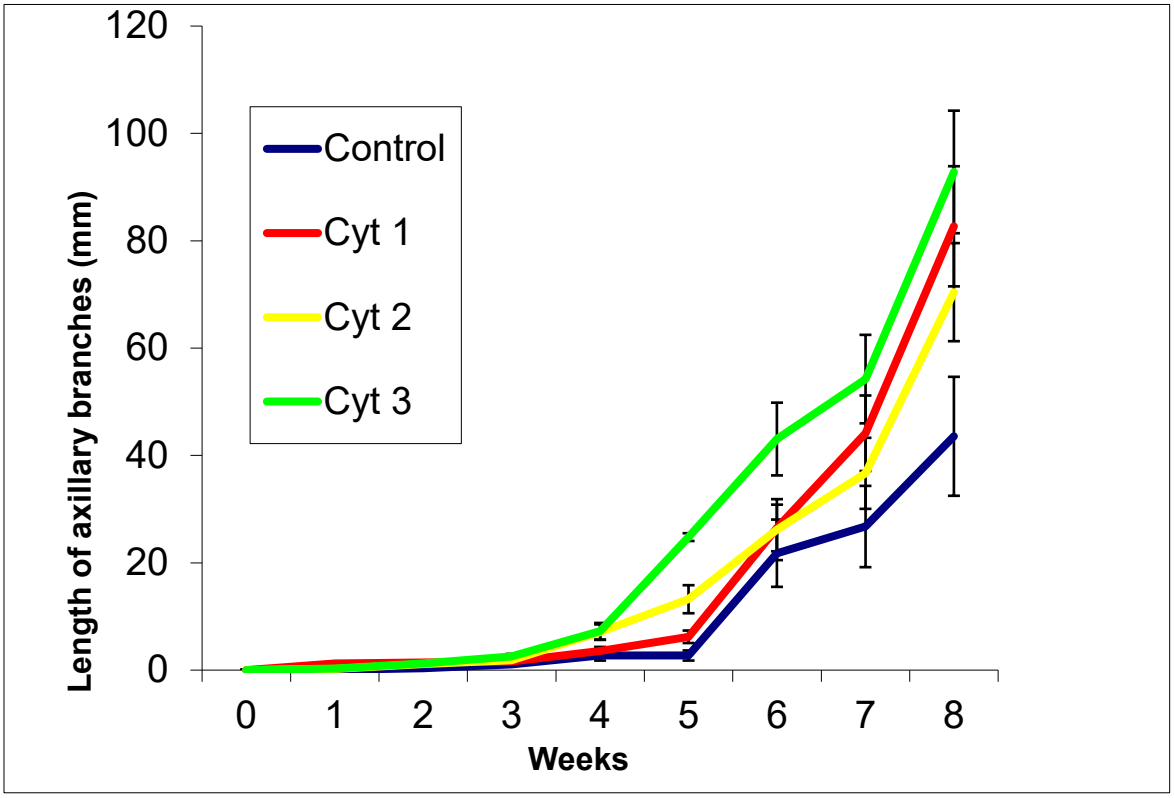
Legend: Aux 1 = 5 mg/ml, Aux 2 = 10 mg/ml, Aux 3 = 20 mg/ml of 1-NAA

Figure 2 Influence of auxin (1-NAA) on the total height of hemp plants.



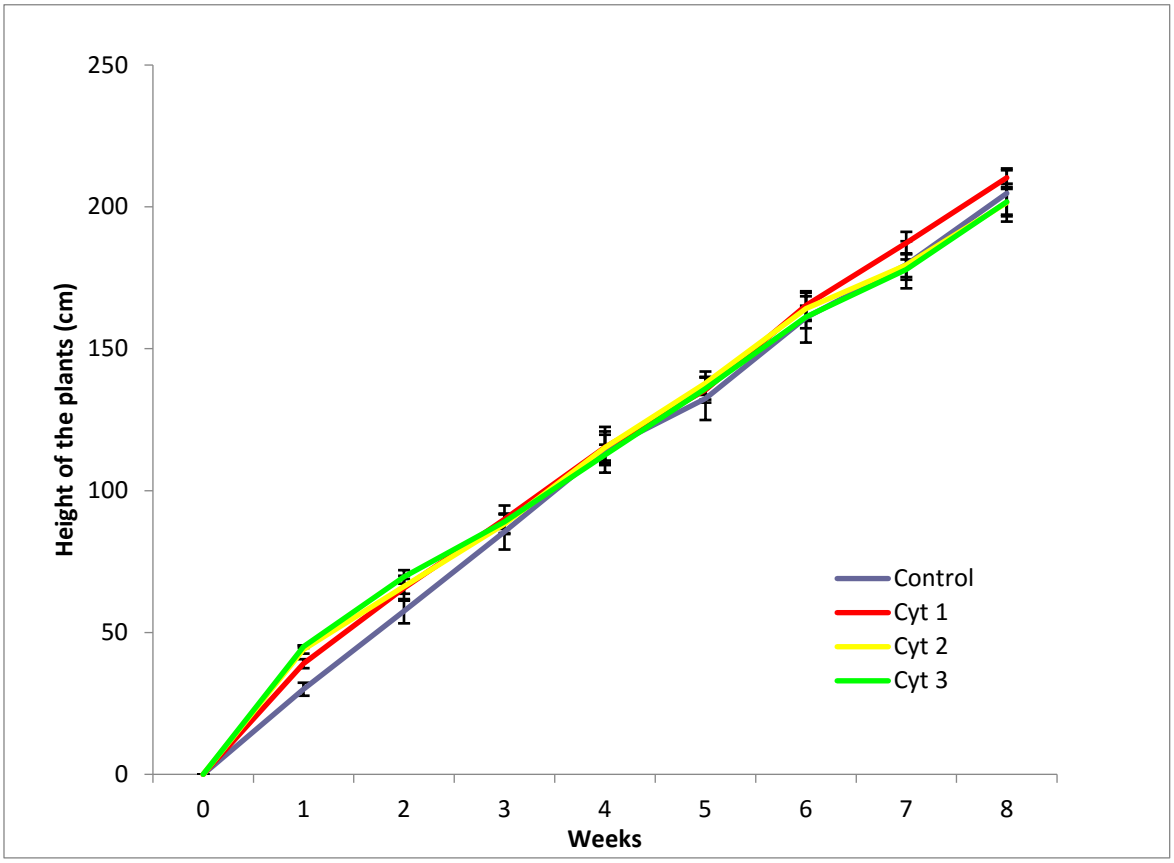
Legend: Aux 1 = 5 mg/ml, Aux 2 = 10 mg/ml, Aux 3 = 20 mg/ml of 1-NAA

Figure 3 Influence of cytokinin (BAP) on the length of axillary branches.



Legend: Cyt 1 = 10 mg/ml, Cyt 2 = 25 mg/ml, Cyt 3 = 50 mg/ml of BAP

Figure 4 Influence of cytokinin (BAP) on the total height of hemp plants.



Legend: Cyt 1= 10 mg/ml, Cyt 2 = 25 mg/ml, Cyt 3= 50 mg/ml of BAP

CONCLUSION

Hemp seems to have a standard response to cytokinins, even when applied externally via leaves. But this study suggests, that it may be less responsive to auxins, when applied exogenously. Another possible explanation is that individual differences between auxin metabolism in hemp and other species contribute to different behaviour when coping with NAA. In future experiments it will be necessary to verify response of hemp plants to auxin using another form of exogenous auxin application e.g. lanolin paste. The influence of increased shoot branching caused by morphoregulators treatment on crop characteristics will also be estimated.

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