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ALLELOPATHIC EFFECT OF *XANTHIUM STRUMARIUM* L. AND *ABUTHILON THEOPHRASTI* MED. EXTRACTS ON GERMINATION OF MAIZE AND SOYBEAN SEED

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Abstract

During 2012 allelopathic effects of *Xanthium strumarium* L. and *Abutilon theophrasti* Med. extracts to germination and initial development of maize (*Zea mays* L.), and soybean (*Glycine max* L.) were studied in laboratory conditions. In addition to the Water extracts out of dry mass of the tested weed species, extracts made by use of hexane, ethyl acetate and methanol in different concentrations were also used. The applied concentrations were 10, 20, 30 and 40 g/l of dry matter made out of weed species in the 3-4 leaf stage of development. Inhibiting effect of water extract from dry matter of *Xanthium strumarium* (L.) and methanol extract from which methanol part was evaporated to maize seed epicotyls and hypocotyls length was established. In comparison to the control, the maximum concentration of 40 g / l of the extract made from Water solution of *Abutilon theophrasti* Med. showed inhibitory effect on soybean seed epicotyls and hypocotyls length. The study was conducted in a randomized block design with 4 replications during which 25 seeds of maize and soybean were laid into Petri dishes. The applied extracts made out of dry matter of the both of the studied weed species *Xanthium strumarium* (L.) and *Abutilon theophrasti* Med. reduced maize seed germination for 14.8-26.83% and soybean seed germination for 18.5-35.82%, in comparison to the control in which it was 95% and 92%, respectively. After germination in a climate chamber, epicotyls' and hypocotyls' length of maize and soybean seeds was measured three, six and ten days following spraying by extracts.

Key words: allelopathy, extraction, maize, soybean, seed.

Introduction

Weeds effect harmfully to crops by releasing phytotoxines from seeds, by decomposition of remainings, leaching and exudates (Narwal, 2004). Plants release harmful chemicals into the environment, reducing growth and establishment of other plants near them: the process known as allelopathy. Allelopathy is natural ecological phenomenon of relationship between organisms which can be applied for control of weeds, pests and diseases in field crops (Ashrafi *et al*., 2007). Chemical substances with allelopathic properties have also other ecollogical roles, such as defend of plants and regulation of soil biotype that has impact on soil degradation and fertility. These ecosystems, proportionally to the roles of allelopathic chemicals may be increased, reduced or their common functions may be altered (Inderjit *et al*., 2011). High allelopathic potential of *Abutilon theophrasti* Med. is shown due to inhibition of germination and growth of competitive plants, by which it reaches superior position. Although allelopathic interactions of *Abutilon theophrasti* Med. with other crops have been known for several decades, weak attention is paid to the biochemical interactions of this weed species, Gressel and Holm (1964), that indicates negative allelophatic effect of *Abutilon theophrasti* Med. to soybean, maize and tomato crops (Quasem and Foy C.L., 2001). Shajie and Saffari (2007) established that extract made of leaves and petioles of *Xanthium* *strumarium* L. significantly reduced germination and growth of maize (*Zea mays* L.), oil rape (*Brassica napus* L.), sesame (*Sesamum indicum* L.), lentil (*Lens culinaris* Medic.) and chickpea (*Cicer arietinum* L.) seedlings. Some researchers studied the effects of Water solutions made from different parts of plants, as well as their impact on other plant species (Kazinczi *et al.*, 2004; Paul and Sultana, 2004; Uremis *et al.*, 2005; Javaid *et al.*, 2006; Xingsiang *et al.*, 2009 and Qian *et al.*, 2010; Konstantinovic *et al.*, 2013). Different allelopathic activity of different parts of the same weed species also differes in its capabilities of harmful effects to germination and beggining growth of cultivated plants (Aziz *et al*., 2008; Konstantinovic *et al* 2012). Plant can show inibiting, but also stimulating effect to germination and growth of the nearby plants. In addition to examples of biochemical competition between weed and crop plants, there are examples of allelopathic interference between cultivated plants. This is the best illustrated by long time applied rotation system *Zea mays* (maize), *Glycine max* (soybean). It is observed that the rotation of these crops provides up to 20% higher yields (Rizvi and Rizvi, 1992).

Allelochemicals can have effect to the change of weed florae composition, crop growth and yield, and potentially can be used as a weed control measure (Singh *et al*., 2001). Allelochemicals escape from plants in different ways; four major methods by which allelochemicals releases from mother plants could be summarized as: 1) leaching- in this way inhibitor components could be produced by dead or alive parts of plants; 2) volatilization- by which terpenes components are released from the leaves of some plant species; 3) decomposition- in this method allelochemicals are released from plant residue; and 4) exudation-in this way high quantities of organic compounds release from roots of several crop and non-crop species which acts as an inhibitor for the growth of other plants (Gill *et al.*, 1993). Allelopathy may be an important mechanism in the plant invasion process. The lack of co-evolved tolerance and resistance of resident vegetation to new allelochemicals produced by invading weed species could have negative effect to dominant species of natural plant communities (Hierro, 2003).

Material and methods

In 2012, at locality KaC near Novi Sad plant parts of *Abutilon theophrasti* Med. and *Xanthium strumarium* L. (stem and leaf) were collected. Water extract was prepared in the following manner: in 0.5 l of water, 150 g of chopped green mass of leaves and stems of *Abutilon theophrasti* Med. and *Xanthium strumarium* L were immersed. Plant material was left in water for 96 hours at room temperature, after which it was removed, and the extract was filtered by vacuum filter. Filter paper in Petri dishes (150 mm x 25 mm) with germinated seed of the assayed soybean and maize crops was saturated by 8 ml of the extract. Control was moistened by distilled water. The assay was performed according to the method of Šcepanovic *et al*., 2007. In addition to the applied aqeous extracts, extracts made by use of methanol, hexane and ethyl acetate, from which by evaporation methanol, hexane and ethyl acetate were thrown, were allso applied. All four extracts made of the above ground partos of *Abutilon theophrasti* Med. and *Xanthium strumarium* L. were made in concentrations of 10, 20, 30 and 40 g/l. By extracts treated soybean and maize seed were germinated in climatic chamber set to the following parameters: 24 ºC for 14 h with illumination (400 lmol) and 22ºC for 10h without illumination (Chon *et al*., 2003). Seed surface was sterillized according to Elemaru and Filhou (2005).

The assayes were set up according to the randomized block design with 4 replications. Each Petri dish contained 25 soybean and maize seeds, i.e. 100 seeds per treatment. All measurements were conducted third, sixth and tenth day after moistening of the studied crops seed. The existence of allelopathic activity of these two studied weed species to the soybean and maize crops were established by measurement of the crops seed epicotyls (mm) and hypocotyls (mm) length and germination (%) (Šcepanovic *et al*., 2007).

Results and discussion

Experimental data confirm results of other authors (Turk and Tawaha, 2002. and Ashrafi *et al*., 2007), in which allelopathic effects were reflected in inhibition of germination, that was even more pronounced for the growth of seedlings. Germination of the studied maize seed was 95% and soybean seed 92%. (Statistica 10) The significant difference of average values of hypocotyls length was tested by statistical data analysis after treatment with extracts made of the above ground parts of *Abutilon theophrasti* Med. and *Xanthium strumarium* L. In the study, allelopathic effect of weed species *Abutilon theophrasti* Med. and *Xanthium strumarium* L. to the beggining growth stages and development of soybean and maize hypocotyls was confirmed, while epicotyls growth was not statistically significantly different from control values for soybean. Water extracts of the above ground (leaves and stem) parts of *Abutilon theophrasti* Med. in concentrations of 20, 30 and 40 g/l showed inhibiting effects to the length of soybean hypocotyls in values (3.88mm; 4.01mm; 4.3mm), lower in comparison to the control value of 20.98mm. All concentrations of methanol extract, hexane and ethyl acetate showed statistically significant difference in comparison to the control. The highest difference in comparison to the control showed hexane extracts made of *Abutilon theophrasti* Med. in concentration of 40 g/l , with measured hypocotyls length of 13.46mm, and control value of 20.98mm (Graph. 1).

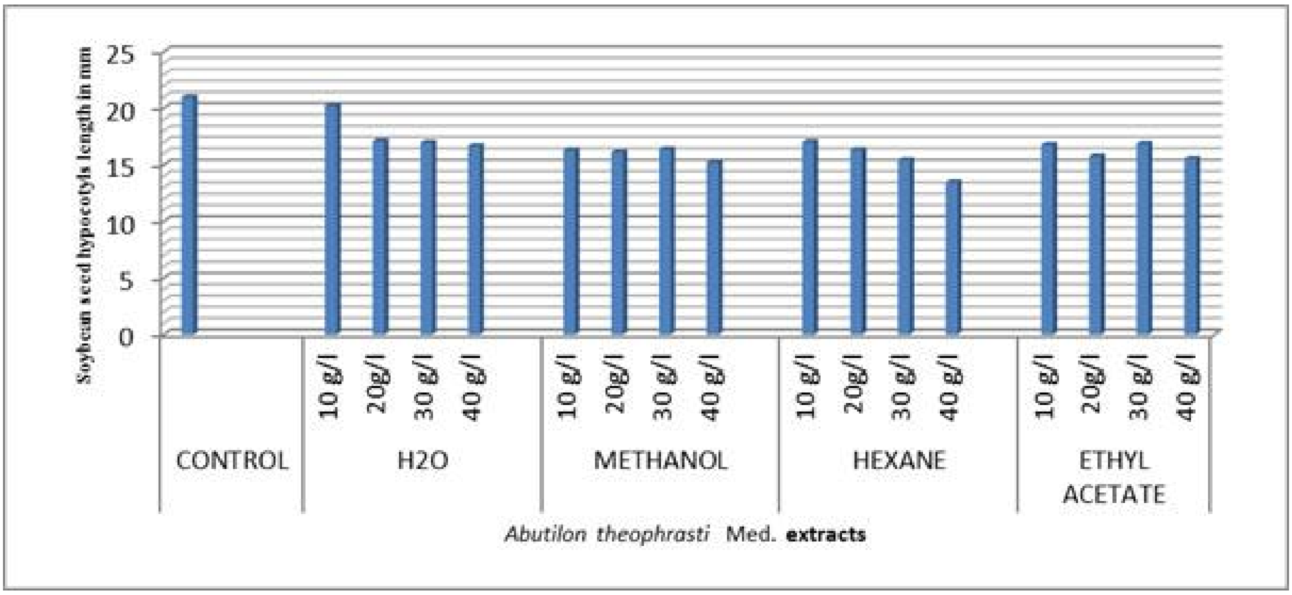

Figure 1 Measured values of soybean seed hypocotyls after treatment with *Abutilon theophrasti* Med.extracts.

All concentrations of extractions of hexane and ethyl acetate made of *Xanthium strumarium* L. had inhibiting effect ot the growht of maize hypocotyls. Hexane extraction of 40 g/l reduced hypocotyls growth for 22.57% in comparison to the control value, while ethyl acetate extract in concentraion of 40g/l reduced maize seed hypocotyls for 24% in relation to the control. Water extracts of *Xanthium strumarium* L. had statistically significant effect to the hypocotyls growth in higher concentrations of 30 and 40 g/l, reducing hypocotyls for 14.8% and 16.29%, respectively. Methanol extraction of *Xanthium strumarium* L. did not show statstically significant effect in concentration of 10g/l, but in remaining three concentrations it inhibited maize seed hypocotyls length. Methanol extraction of *Xanthium strumarium* L. in concentration 40g/l showed the best effect, reducing maize seed hypocotyls growth for 26.83% in comparison to the control (Graph 2).

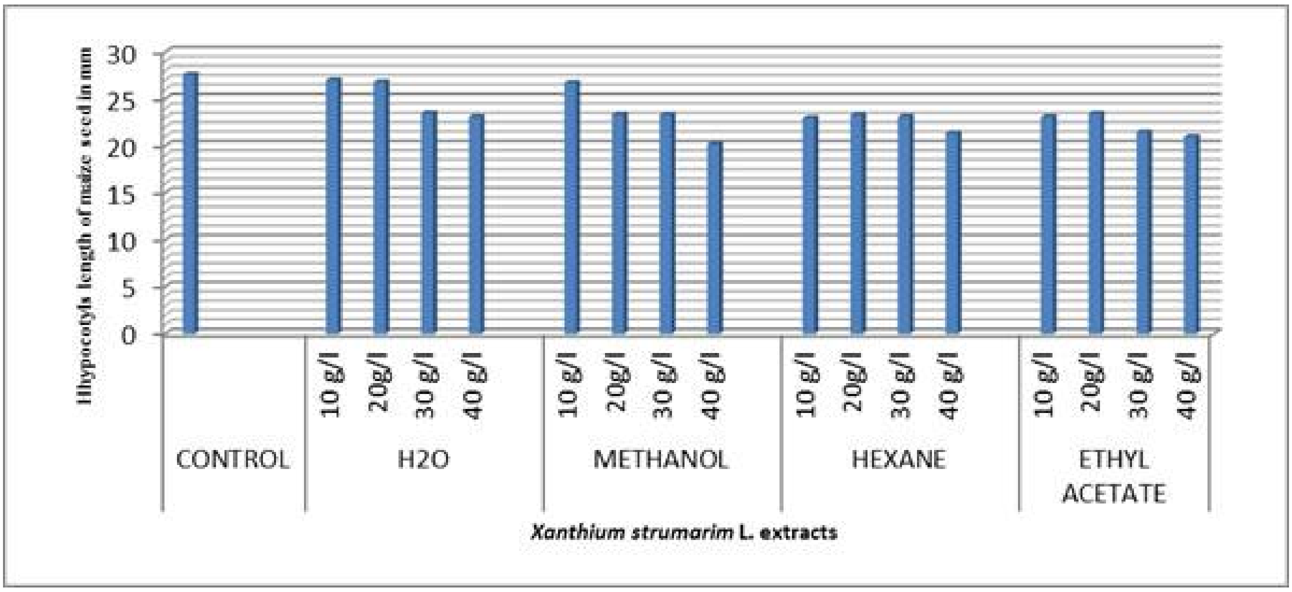

Figure 2 Mesured values of maize seed hypocotils, after treatment with *Xanthium strumarium* L. extracts.

The increase of maize seed hypocotyls statistically differed in comparison to the control value only in extracts with hexane and methanol in the highest concentrations of 40g/l. Epicotyls length of maize seed treated by hexane extract made of *Xanthium strumarium* L. was 6.17mm and control value was 8.43mm. Epicotyls length of maize seed treated by methanol extract made of *Xanthium strumarium* L. was 5.83mm, and control value was 8.43mm. All other studied extract concentrations did not show statistically significant effect to the epicotyls growth. According to the study of Benyas *et al*., 2010, only higher concentrations of *Xanthium strumarium* L. water extracts had also effect to the studied lentil crop. According to the studies of Kalinova *et al*., 2012, water extracts of *Sorghum halepense* (L.) Pers. root had an effect to the germination of soybean, peas and vetch for 28.8% to 86.3%.

Conclusions

Based upon conducted studies, data were obtained on the effect of effect of *Abutilon theophrasti* Med. and *Xanthium strumarium* L. extracts on hypocotyls and epicotyls length of soybean and maize seed. Effect of *Abutilon theophrasti* Med. extract in tested concentrations of 10, 20, 30 and 40 g/l to the growth of soybean seed hypocotyls was between 18.5% in water extract, up to 35.82% in hexane extract, which was lower in comparison to the control. Effect of *Xanthium strumarium* L. extract in tested concentrations of 10, 20, 30 and 40 g/l to the growth of maize seed hypocotyls was between 14.8% in water extract, up to 26.83% in methanol extract, which was lower in comparison to the control. The tested concentrations did not show significant deviations in epicotyls length except for the two *Xanthium strumarium* L. extracts in the highest concentration of 40g/l.

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