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Full Length Research Paper

Study of weed seedbank in soybean crop

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In the period 2007 to 2010, at localities Backi Maglic and Krivaja studies of weed seedbank were performed under soybean crop. Results showed that weed seed separated at Backi Maglic in all years dominated in the top soil layer, while the lowest quantities were separated from the deepest layer, and that number of weeds declined annually. At Krivaja, the lowest weed seed stocks were found in the top layer, and the highest in the deepest layer. At this locality, number of weed seeds kept rising from season to season, which was the consequence of application of different cultural practices.

Key words: Soybean, weed seedbank, *Amaranthus retroflexus* L., *Chenopodium album* L., *Datura stramonium* L.

INTRODUCTION

In field crop production of Serbia, the key role has Northern Province of Vojvodina with its great potential in sector of agricultural production due to convenient climatic conditions, high quality soil and available water resources. In recent years, in comparison to the eighties and nineties, in addition to corn, wheat and sunflower production the growth of soybean production, as well as rising trend in average yield of this oil crop (Miladinovic et al., 2009) has become evident. In the period 2001 to 2007, soybean was grown on the area of about 130 000 ha (Anonymus, 2010). Taking into consideration more intensive production of this culture, that is important source of protein and vegetable oil (Tallman et al., 2009), due attention must be paid to improvement of soybean protection from pests, especially weeds that can significantly reduce yield of this crop (Abusteit, 1993).

Weeds are one of the most significant limiting factors in agricultural production. Their competition for living space and nutrients (Bhatt and Singh, 2007) their influence to the crop yield reduction (Sen, 2000: Vasileiadis, 2007), and presence of weed seed reduces the market value of agricultural products (Renton et al., 2006). Herbicide use represents one of the most successful measures for reduction of weed population in agricultural production. However, more actual system of integral production promotes reduction in herbicide use. For efficient and economical use of herbicides, it is necessary to have knowledge on biological and ecological characteristics of weeds, in order to be able to predict their occurrence in the field.

Problem of weediness of crops rises due to huge stocks of weed seeds in the soil – weed seedbank. This term refers only to the weed seeds in the soil that is able to germinate under convenient conditions (Roberts, 1981). Weed seedbank represents constant source of weeds, which enables their continuous occurrence in the field (Boutsalis and Powles, 1998. It is variable in space and time, and largely depends on application of cultural practices, crop rotation (Vanasse and Leroux, 2000) and herbicide choice (Ovaisi et al., 2006; Dorado et.al., 1999). Monitoring of changes in weed seedbank for extended period enables us to have an insight into efficiency of the applied measures of weed control and to predict weed occurrence in the following period (Cavers, 1995; Ambrosio et al., 2004; Buhler, 1997).

Weed seedbank in the soil is only a part of complex and dynamic system consisting of soil, plants, animals and microorganisms. It is exposed to various influences and changes, and results of its studies provide immediate, but not general insight into the situation in the field (Menalled, 2008).

Weed seedbank is usually in relation with the top soil layer, up to depth of 30 cm, but seeds of some perennial weeds may be found even in deeper layers (Forcela, 2003). Weed seeds are not evenly distributed in the field,

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but in certain parts of the field they occur in lower or higher number. Uneven concentration of seeds is usually a result of weak dissemination and spread of newly formed seeds near mother plant, or it is the consequence of human influence to weeds that mature at the same time as the crop and weed seeds are being scattered in direction of rows (Forcela, 2003).

MATERIALS AND METHODS

In the period 2007 to 2010, studies of weed seedbank under soybean crop were performed at the localities of Backi Maglic and Krivaja. At both of the localities, soil is of chernozem type with 4% of humus. At the locality of Krivaja autumn deep soil tillage and cultivation and spring pre-sowing preparation were regularly performed at a depth of 25 to 30 cm. On the other hand at the locality of Backi Maglic, relatively shallow soil tillage at a depth of 20 cm was followed only by pre-sowing preparation. Every year soil samples were taken from the same experimental plots by earth drill of 4 cm in diameter from depths of 0 to 10, 10 to 20 and 20 to 30 cm (Smutný and Křen, 2002). Seed extraction was done by sieving of the samples through copper sieves that were 5 mm in diameter. This was followed by their rinsing by water and sieving of the samples through sieves of 0.5 mm in diameter. Seeds were than dried at the room temperature and separated manually. Determination of the separated seeds was performed visually by microscope and determinators of seeds of weed plants (Skender et al., 1998; Kronaveter and Bože, 1994; Schermann, 1966 to 1967). The obtained data were statistically processed in the program Statistica 7.

RESULTS AND DISCUSSION

In 2007, at the locality of Backi Maglic, in the studied arable soil layer a significant quantity of weed seed was found. Seeds of 10 weed species were determined, and dominant were annual broadleaf weeds such as *Datura stramonium* L., *Chenopodium album* L., *Stachys annua* L., *Solanum nigrum* L., *Euphorbia helioscopia* L., *Amaranthus retroflexus* L., *Polygonum aviculare* L., *Polygonum lapathifolium* L. and *Bilderdykia convolvulus* (L.) Dum. as well as quarantine weed species *Cuscuta epithymum* L. The highest average number of all weed seed was determined in the soil layer of 0 to 10 cm (11619 seeds/m^2), and the lowest in the layer of 20 to 30 cm (8846 seeds/m^2). In the top soil layer seed of weed species *A. retroflexus* dominated with 1750 seeds/m^2, and in the layer of 10 to 20 cm the most abundant was seed of *C. album* with 1783 seeds/m^2. This can be explained by the fact that *A. retroflexus* has tiny seed that is easily disseminated and accumulated in top soil layers (Bekker et al., 1998), and seed of *C. album* belongs to the group of persistent seeds that can maintain germination capability in the soil through many years (Funes et al., 1999). At depth of 20 to 30 cm seeds of *S. annua* proved dominant with 1652 seeds/m^2. In 2008, results of the studied samples from the same plots somewhat differed. Of 12 determined weed species dominant were *A. retroflexus*, *C. album*, *D. stramonium*, *S. annua*, *S. nigrum, E. helioscopia*, *P. aviculare* and *P. lapathifolium*. In the soil layer of 0-10 cm the most abundant was seed of *A. retroflexus* (4290 seeds/m^2), and in layers of 10 to 20 cm and 20 to 30 cm seed of *S. annua* with 3090 and 2489 seeds/m^2, respectively. The highest average number of all weed seed was found in the soil layer of 0 to 10 cm (13876 seeds/m^2), and the lowest in the layer of 20 to 30 cm (11406 seeds/m^2). In 2009, on the same plots, seeds of 11 weed species were found. The highest number of weed seeds was determined in the layers of 0 to 10 and 10 to 20 cm, that is, 11262 and 11130 seeds/m^2, respectively. Seed of *C. album* dominated at depths of 10 to 20 and 20 to 30 cm, which is in correlation with the results obtained by Boguzas et al. (2004), while seed of *A. retroflexus* proved the most abundant in the layer of 0 to 10 cm with 3202 seeds/m^2. In 2010 studies showed dominance of weed seed in the layer of 0 to 10 cm (4865 seeds/m^2). Seed of *A. retroflexus* was the most abundant in the layers of 0 to 10 and 20 to 30 cm, as well as seed of *S. nigrum* in the soil layer of 10 to 20 cm. In 2008, total number of separated weed seeds in the locality of Backi Maglic was the highest (38233 seeds/m^2), somewhat lower in 2009 (30477 seeds/m^2) and in 2007 (29901 seeds/m^2), and the lowest in 2010 with 11007 seeds/m^2. Separated seed of weeds in all years dominated in the top soil layer, while the lowest quantities were separated from the deepest one. This is the consequence of inadequate use of cultural practices, shallow autumn cultivation (20 cm) and lack of cultivation before spring pre-sowing preparation (Yenish, 1992). The obtained results from the studies performed in the period 2007 to 2010 suggest that number of weed seeds in experimental plot at this locality had tendency to decline which was the effect of regular application of herbicides (a.i. lactofen, clethodim, lactofen + bentazone-Na + thifensulfuron-methyl, lactofen + bentazone). Analysis of variance revealed no statistically significant differences in the number of weed seeds per m^2 in different soil depths ($p = 0.604$, $F9 = 0.506$). Variability of the total number of seeds in all four years at three soil depths was approximately uniform (Figure 1).

In 2007, at the locality Krivaja soil samples were taken under soybean crop and presence of six weed species was determined. Dominant were seeds of dicotyledonous weed species such as *A. retroflexus, C. album, Sinapis arvensis, P. aviculare* and *P. lapathifolium*, and the only seed of monocotyledonous weed species *E. crus-galli* (L.) R.et Sch. The greatest amount of seed was found in the deepest layer of 20 to 30 cm (2996 seeds/m^2), and the lowest in shallow and top layers (849 seeds/m^2). Of the total of extracted seeds dominated seed of *A. retroflexus* in the layer of 10 to 20 cm with 598 seeds/m^2, and *Echinochloa crus-galli* in the layer of 20 to 30 cm with 1007 seeds/m^2. In 2008, from the same plots seeds of eight weed species were separated. Distribution of seeds was the same as in the previous year, it was only slightly more abundant. From the layer of 0 to 10 cm (919 seeds/m^2) was separated from the layer of 10 to 20 cm

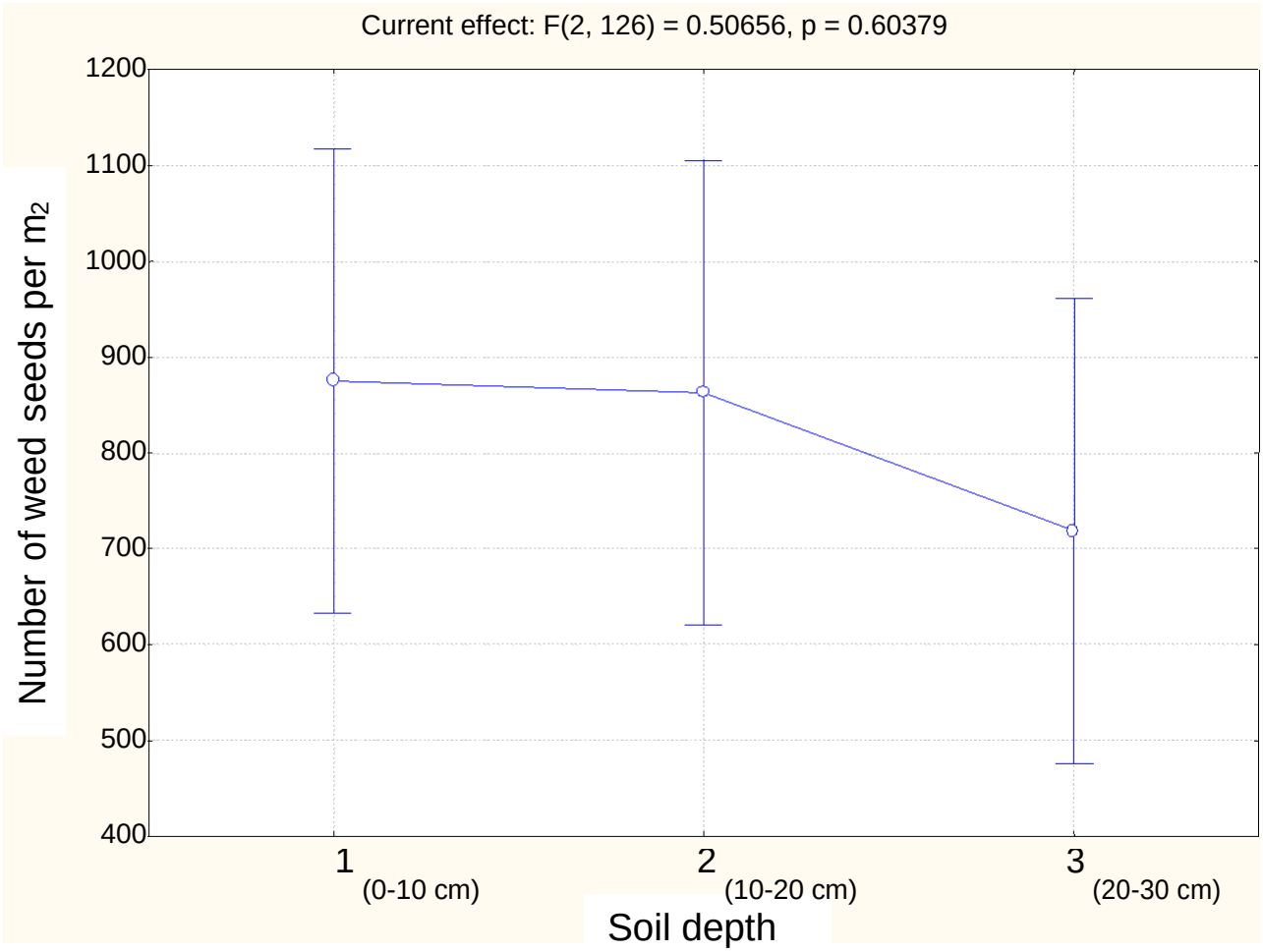

Figure 1. Variability of number of weed seeds in three studied soil depths at the locality of Backi Maglic.

(3575 seeds/m^2), and from the layer of 20 to 30 cm (5518 seeds/m^2). During 2009, from the studied samples seed of 7 weed species was extracted, and the most abundant was seed of *A. retroflexus* in layers of 10 to 20 and 20 to 30 cm, that is, 1998 and 4598 seeds/m^2, respectively and *C. album* with 768 seeds/m^2 in the layer of 0 to 10 cm. The highest number of weed seeds was extracted from the deepest soil layer (7179/m^2), and from the shallowest the lowest (2392/m^2). In 2010 at locality Krivaja, seeds of 15 weed species were separated. In all studied layers, seeds of *A. retroflexus* proved dominant. As *A. retroflexus* is extremely competitive to the soybean crop, this is important for planning of chemical protection (Cowan et al., 1998; Nurse, 2003). In 2010 the total number of separated weed seeds was the highest (23632 seeds/m^2), significantly lower in 2009 and 2008 with 13837 and 10012 seeds/m^2, respectively, and the lowest in 2007 with only 5516 seeds/m^2.

The lowest weed seed stocks, in all studied years were in the shallowest soil layer, while the highest number of weed seeds was found in the layer of 20 to 30 cm. Such weed seed distribution is characteristic for soils on which deep tillage that buries seed deeper is performed regularly. The obtained results are in accordance with the results of Menalled (2008), Swanton (2001) and Ashrafi (2006). The obtained data of studies in the period 2007 to 2010 reveal that number of seed is progressively increasing, possibly due to the reduced herbicide use (Menalled, 2001). Analysis of variance revealed no statistically significant differences in the number of seeds per m^2 in different soil depths ($p = 0.134$, $F = 2.045$). Variability of the total number of weed seeds in all three years, at three soil depths was approximately uniform (Figure 2).

All of the separated seeds belong to the weed species that are typical companions of row crops such as soybean, but also maize and sunflower (Konstantinović, 1999. In each seedbank, despite often great diversity dominate only seed of a few weed species, which enables their continuous germination and occurrence in the field. These weed species are difficult to control because they have huge stock of seeds in the soil that maintains viability. In this case, in the majority of samples dominated seeds of *A. retroflexus*. Based upon the

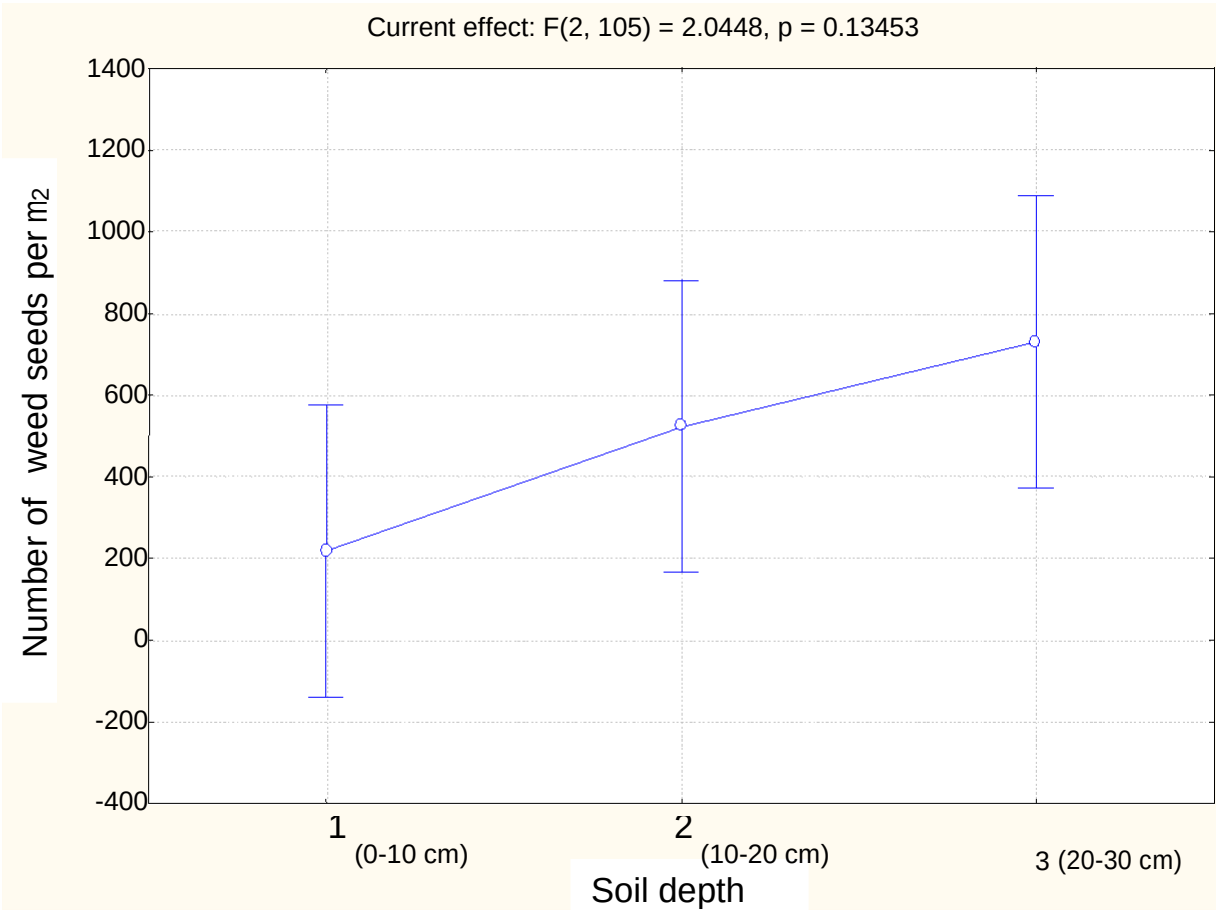

Figure 2. Variability of number of weed seeds in three studied soil depths at the locality of Krivaja.

obtained results it is possible to predict which weed species will dominate in the following growing season in the field, so it is possible also to make more efficient plan of cultivation and chemical crop protection from these weeds (Konstantinović et al., 2010).

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