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COMPOSITION AND GERMINATION CAPABILITY OF WEED SEED BANK IN THE SOIL UNDER MAIZE

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SUMMARY: Monitoring of quantitative and qualitative properties of weed species seeds in the arable soil layer is one of the most efficient methods for prediction of weed occurrence in the field. It provides better herbicide choice, as well as their timely application. In 2011 and 2012 in two localities with similarly applied agricultural practice in maize crop, weed seed bank was studied in the arable soil layer up to 30 cm of depth. In the first locality, seeds of 12 weed species were separated. Of these species, the most numerous were seeds of Polygonum lapathifolium and Sinapis arvenis at all studied depths, and the greatest quantity was found at the depth of 20-30 cm. The greatest number of all remaining evidenced weed species was also found at this depth. In the other locality seeds of even 15 weed species was separated, but only seeds of Amaranthus retroflexus occurred in greater quantity at all studied layers. In average, for all species, the greatest number of seeds was found in the deepest layer, but statistically significant differences were not recorded in number of seeds per soil depth. After determination of the separated weed seeds followed their germination in climatic chamber. The highest germination percentage of 70-80% was recorded for weed species Sinapis arvensis at locality Žabalj. At locality Zmajevo, the highest germinatin was established for weed species Amaranthus retroflexus and Chenopodium album.

Key words: *weed soil seed bank, maize, germination, hypocotyls, epicotyls.*

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INTRODUCTION

Well-designed and efficient crop protection from diseases, pests and weeds is significant for intensive plant protection. Weed occurrence represents constant problem in agricultural production and their control is the basic condition for gaining of optimal yields and high quality products (Vasileiadis et al., 2007). One of preconditions for efficient weed control is prediction of their occurrence in the field. This can be achieved by soil analysis, especially of the arable layer up to the depth of 30 cm, on wich the greatest and for the production the most important mass of weed seeds is found. Beside soil type, presence of weeds in the field is the second factor that has impact to spatial change of agricultural areas, and this makes determination of weed seed bank very important (Walter et al., 2002). Prediction of weed occurrence in the field enables more accurate herbicide choice, as well as their timely applications. This undoubtedly brings positive consequences to yield and crop quality. In studies of the weed seed bank in the soil, it must be borne in mind that it is only part of the complex and dynamic system that consists of land (Otto et al., 2007), plants, animals and microorganisms (Chee-Sanford et al., 2006). It is exposed to different influences and changes, therefore, results of these studies provide only temporary, but not final insight into condition on the terrain. Weed seed bank is usually linked with the top, arable soil layer, up to the depth of 30 cm, although seeds of some perennial weeds can be found at even deeper layers. Weed seeds are not evenly distributed in the field, but are usually concentrated in patches (Wiles and Schwiezer, 1999). This concentration of weeds is usually result of weak dispersal and spread of new seeds from mother plant, or due to the influence of humans to weeds that mature at the same time as crop, causing spreading during harvest and picking in direction of crop rows. For these reasons, field sampling should be performed from the whole plot, by width and depth. Germination capability of weed plants is certainly is of great importance, especially for survival of annual plants (Haj Seyed Hadi and Gonzalez-Andujar, 2009). Viability studies of weed seeds are of high importance for they enable prediction of their occurrence in the field. Because of these reasons, the study of the weed seed bank included determination of seed viability, i.e. germination capability in controlled conditions.

MATERIAL AND METHOD

During 2011-2012 composition of the weed seed bank was studied in various depths of the arable soil layer in maize crops in localities of Žabalj (45°21'N, 20°12'E) and Zmajevo (45°28'N, 19°41'E). Both sites are in moderate climate and soil type is chernozem. At locality Žabalj, sowing of maize was performed in the third decade of April. Sowing was followed by herbicide treatment by ***dimethenamid-P***, and in 4th and 5th leaf phase, the additional treatment was performed by herbicide tembotrione. In Zmajevo, maize was sown in the second decade of April, and the first treatment was in the phase 3-4 leaves of maize by herbicide dicamba, after which followed the second treatment in the phase 5-6 leaves of maize by herbicide combination rimsulfuron + dicamba. Taking of the soil samples was performed by the end of vegetation period, in four replications diagonally from each plot, especially from depths of 0-10 cm, 10-20 cm and 20-30 cm (Smutný and Křen, 2002). Samples of 1.5 kg soil were rinsed by water through copper sieves of 0.25 mm in diameter. After drying of the obtained

samples followed separation of weed seeds and their determination by microscope and determinators (Kronaveter and Boža, 1994). Determination and data processing by the method of Conn (1987) and Sharratt (1998) were followed by two weeks lasted seed germination of weed species in Petri dishes, their keeping in controlled conditions of climatic chamber convenient for seed germination. Subsequently, the evaluation of the germination capabilities and measurement of hypocotyls and epicotyls lengths of shootings were performed. The aim of the paper was study weed seed bank composition and germination capability in arable soil layer under maize crop.

RESULTS AND DISCUSSION

In this locality of Žabalj, seeds of 12 following weed species were found: *Abutilon theophrasti* Med., *Amaranthus retroflexus* L., *Bilderdykia convolvulus* (L.) Dum., *Chenopodium album* L., *Convolvulus arvensis* L., *Panicum crus-galli* (L.) R. et Sch., *Hibiscus trionum* L., *Polygonum lapathifolium* L., *Polygonum aviculare* L., *Ranunculus repens* L., *Sinapis arvensis* L. and *Stachys annua* L. The highest number of seeds belonged to the species *Polygonum lapathifolium* and *Sinapis arvensis* , and they were present at all depths, but the most abundant were at depth of 20-30 cm. LSD test indicated statistically highly significant differences in numbers of seeds of these two species in relation to all other determined weed species, in all depths. The highest number of seeds for all determined weed species was found in the layer of 20-30 cm, somewhat lower number was determined in the layer of 10-20 cm; statistically significantly lower number was established in the layer of 0-10 cm. From soil samples taken from locality Zmajevo, under maize crop, seeds of 15 weed species were segregated. Despite great variety of seeds, from soil samples taken from locality Zmajevo, only seed of *Amaranthus retroflexus* occurred in higher quantity of 834-626 seeds per m^2, at all studied layers. LSD test showed statistically very significant differences in number of seeds of this species in relation to all other determined weed species. *Amaranthus retroflexus* seed was evenly distributed in all examined layers, and the highest number of seeds of all other species occurred in the layer of 20-30 cm . Seed of *Amaranthus retroflexus* may remain persistent in the soil during several years period (Burnside et al. 1996). In average, for all species, the highest number of seeds was in the deepest layer, but statistically significant differences were not found in number of weed seeds concerning soil depth. After determination of segregated weed seeds they were germinated in controlled conditions of climatic chamber for two weeks. The obtained results are given in Figure 1.

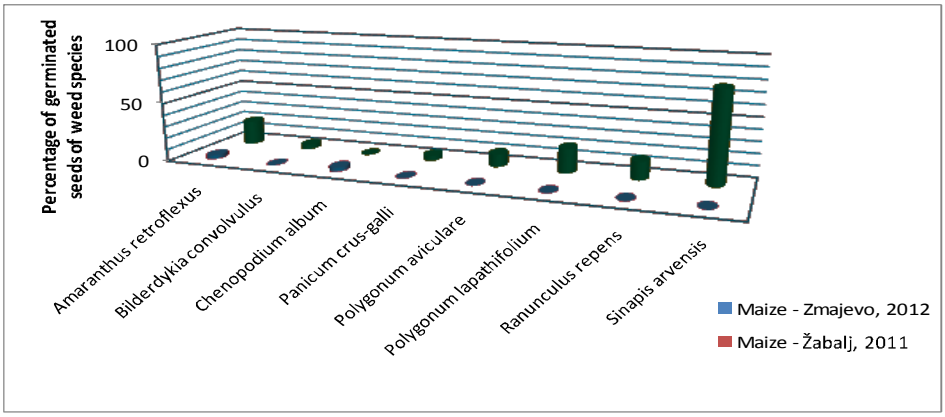

Figure 1. Weed seeds percentage of germination in all studied localities

Seed from soil samples taken in locality Zmajevo, showed very low germination percentage. Only seeds of *Amaranthus retroflexus* and *Chenopodium album* germinated, mostly those from the deepest arable soil depth (Figure 1.). Hypocotyls and epicotyls lengths of germinated seeds were measured. Results are given in Figures 2. and 3.

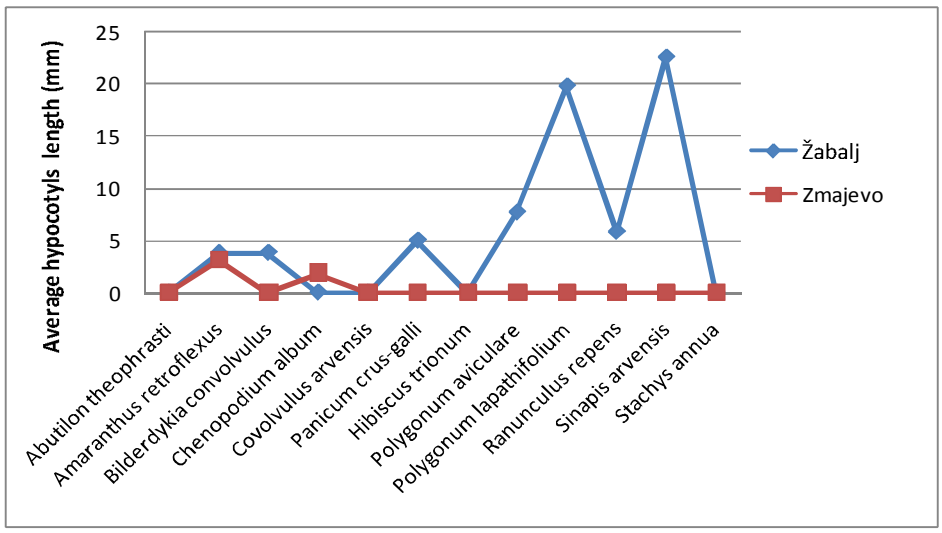

Figure 2 - The average hypocotyls length of weed species seeds in maize crop at localities Žabalj and Zmajevo

The highest average length of seedlings hypocotyls had seeds of weed species *Sinapis arvensis* L. (22.63 mm) and *Polygonum lapathifolium* L. (19.86 mm). In locality Zmajevo, the highest average hypocotyls length had seedlings of weed species *Amaranthus retroflexus* L. (3.13 mm).

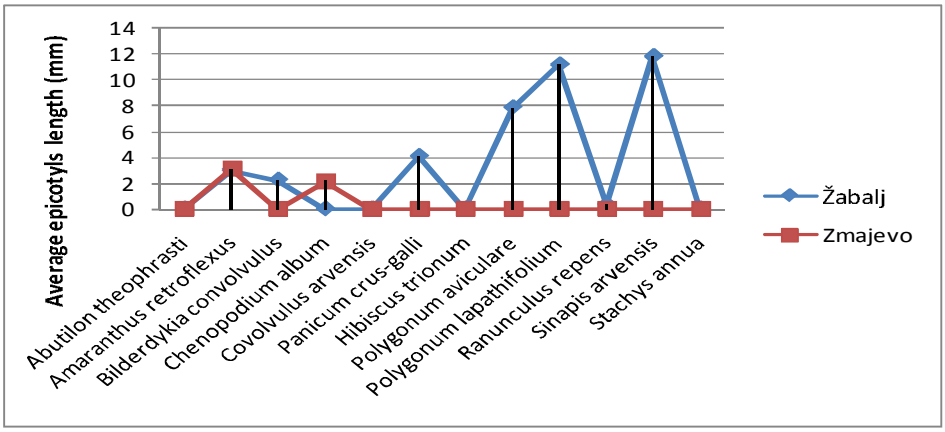

Figure 3. The average epicotyls length in maize crops in localities Žabalj and Zmajevo

Obtained results of epicotyls length measurements of seeds from locality Žabalj (Figure 3.) indicate that the highest average length had seedlings of weed species *Polygonum lapathifolium* L. (11.17 mm) and *Sinapis arvensis* L. (11.79 mm), The average measured epicotyls length of germinated seeds at locality Zmajevo for *Amaranthus retroflexus* L. was (3.13 mm) and for *Chenopodium album* L. (2.17 mm). During 2011-2012 in localities Žabalj and Zmajevo, composition and germination capability of weed seed bank in various depth of the arable layer under maize crop were studied. In locality Žabalj, seeds of 12 species were segregated, and the majority belonged to the species *Polygonum lapathifolium* and *Sinapis arvensis*. Great number of seeds of these species was found in all depths, and mostly was buried in depth of 20-30 cm. LSD test showed statistically very important differences in number of seeds of these two species in regard to all other determined weed species, at all depths. Greater quantities of seeds of weed species *Polygonum lapathifolium* under maize crop represent problem in neighboring countries such as Romania (Bogdan et al., 2007). The highest number of seeds, of all determined weed species was found in the soil layer of 20-30 cm (136 seeds/m^2). Somewhat lower number was found in the layer of 10-20 cm, and statistically significantly lower in the layer of 0-10 cm. Such disposal of weed seeds is characteristic for soils that are regularly ploughed, causing deeper burial of weed seeds. Significant lower number of seeds in shallow layer of 0-10 cm indicates that weed species were controlled by herbicides and surface cultivation. The obtained results were in accordance with results of Swanton (2001), Menalled (2008) and Konstantinović et al. (2008). In locality Zmajevo, seeds of 15 weed species were segregated, of which only seed of the species *Amaranthus retroflexus* occurred in higher quantity in all studied layers. LSD test indicated statistically highly significant differences in number of seeds of this species, in relation to remaining weed species. Seed of the species *Amaranthus retroflexus* was buried in all soil depths, from 0-30 cm, while seeds of remaining species were predominantly detected in the layer of 10-30 cm. In average, the greatest quantity of weeds of all weed species was found in the deepest layer, but statistically significant differences were not recorded in the number of weed seeds in soil depth as a whole. Similar disposal of weed seeds in the soil that was regularly cultivated deeper by plough is in accordance with results of the studies of other authors (Boguzas et al., 2004; Ashrafi, 2006; Menalled, 2008). Dominance of

Amaranthus retroflexus seeds under maize crop was also established in studies of Wiles and Schweizer (2002). Germination tests revealed that seeds taken from soil samples in locality Žabalj, seed of weed species *Sinapis arvensis* had the highest germination rate of 70-80% regardless to the soil depth in which it was found. The highest germination capability had also seeds of *Amaranthus retroflexus*, especially those found at soil depth of 20-30 cm (70%). Significant germination rate showed also seed of weed species *Polygonum aviculare* in the top soil layer (up to 50%), whose fresh seed otherwise also showes higher germination capability. This refers also to the species *Polygonum lapathifolium* whose seed, from all studied soil levels shooted, although in somewhat lower percentage of 15-37%. The greatest quantity of germinated seeds belonged to the weed species *Sinapis arvensis* and *Polygonum aviculare*. Seeds of *Amaranthus retroflexus* had also significantly higher germination percentage. The highest average length of seedlings hypocotyls and epicotyls had seeds of weed species *Sinapis arvensis* L. and *Polygonum lapathifolium* L. from locality Žabalj. In locality Zmajevo, the highest average hypocotyls and epicotyls length had seedlings of weed species *Amaranthus retroflexus* L.

CONCLUSION

Results of germinated seeds from locality Žabalj indicated that the highest germination percentage of 70-80% had seeds of weed species *Sinapis arvensis* regardless on the soil depth in which it was found, which is explained by fact that seed of this weed species may remain dormant for longer time period deep in the soil, without loosing germination capability. Higher germination capability had also seeds of *Amaranthus retroflexus* that was found buried in depth of 20-30 cm. Significant percentage of germination of up to 50% had also seeds of weed species *Polygonum aviculare* in top soil, and *Polygonum lapathifolium* seeds that germinated from all studied soil layers in 15-37%. The highest quantity of germinated weed belonged to weed species *Sinapis arvensis* and *Polygonum aviculare*, that belong to the species of short vegetative cycles, and germinate almost through all vegetation period, which explains the obtained results. Significantly higher germination percentage had also seeds of *Amaranthus retroflexus*. This can be explained by the fact that it is widely distributed weed that grows in differing environmental conditions, due to humble life needs. Seed from soil samples taken from locality Zmajevo had very low germination capability. Shooted only seeds of *Amaranthus retroflexus* and *Chenopodium album*, predominantly those from the deepest arable layer of 20-30 cm. This is explained by the fact that seed was germinated shortly after sampling, and it is possible that majority of seeds had not passed the phase of dormancy. Measurement of the average epicotyls and hypocotyls lengths of segregated seeds it was established that seeds with the highest germination energy also had the highest average epicotyls and hypocotyls lengths, and these were seeds of weed species *Sinapis arvensis* and *Polygonum lapathifolium*.

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SASTAV I SPOSOBNOST KLIJANJA BANKE SEMENA KOROVAU ZEMLJIŠTU U USEVU KUKURUZA

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Izvod

Utvrđivanje kvantitativnih i kvalitativnih osobina semena korovskih vrsta u obradivom sloju zemljišta je jedan od najefikasnijih metoda za predviđanje pojave korova na obradivim površinama. On osigurava bolji izbor herbicida, kao i njihovu pravovremenu primenu. U 2011 i 2012 na dva ispitivana lokaliteta sa sličnom obradom zemljišta u usevu kukuruza, ispitana je banka semena korova u obradivom sloju zemljišta do 30 cm dubine. Na prvom lokalitetu, determinisano je seme 12 korovskih vrsta. Od ovih vrsta, najbrojnija su bila semena *Polygonum lapathifolium* i *Sinapis arvenis* na svim ispitivanim dubinama, a najveća količina semena je pronađen na dubini od 20-30 cm. Najveći broj preostalih determinisanih korovskih vrsta je također pronađena na ovoj dubini. Na ostalim lokalitetima broj semena 15 korovskih vrsta je bila različita, ali samo seme *Amaranthus retroflexus* je zastupljena u većoj količini u svim ispitivanim slojevima. U proseku, za sve vrste najveći broj semena je pronađen u najdubljem sloju, statistički značajne razlike nisu zabilježena u broju semena po dubinama zemljišta. Nakon utvrđivanja izdvojenih korovskih semena praćena je njihova klijavost u klima komori. Procentualno najveća klijavost (70-80%) je zabeležena kod korovske vrste *Sinapis arvensis* na lokalitetu Žabalj. Na lokalitetu Zmajevu najveća klijavost je utvrđena za korovske vrste *Amaranthus retroflexus* i *Chenopodium album*.

Ključne reči: zemljišna banka semena korova, kukuruz, klijavost, hipokotil, epikotil.

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