UNDERSTANDING PESTS AND THEIR CONTROL AGENTS AS THE BASIS FOR INTEGRATED PLANT PROTECTION

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Influence of different fertilization system on weed seed-bank

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ABSTRACT

The aim of the research was to evaluate the different fertilization systems during the biennial review of the soil weed seed-bank. Sampling of soil by the "Square grill" method was carried out on the plots of the 50-year old crop rotation (corn, winter wheat, soybean) at the Institute of Field and Vegetable Crops in Novi Sad (N 45° 19', E 19° 50'). Plots were used for testing where only mineral fertilizer in amount of 50 kg ha^{-1} P and K and mineral N in amount 120 kg ha^{-1} was used each year (P1), mineral fertilizer in same quantities and manure in the amount of 40 t ha^{-1} every third year (P2) and a plot (P3) where fertilizer was not used for 50 years. It was sampled in the autumn of 2014, spring and autumn of 2015, so that it got real insight into the composition and size of the weed seed-bank in the plough layer (0-30 cm). A method of physical extraction of seeds was used whereby 500 ml of the soil sample was washed with a jet of water through a sieve of a different diameter and separate seeds were determined using the determination keys. After the harvest of maize in autumn 2014 it was determined that the number of weed seeds was the highest on plot P2 (22,275 seeds m^{-2}), on plot P1 there was 12,075 seeds m^{-2}, while on the plot where no fertilizers were applied (P3) there was 11,700 seeds m^{-2}. A similar relationship was in the spring of 2015. These methods served to conculde how fertilization affects the number of weed species. On the plots P1 and P2 dominated *Amaranthus retroflexus*, *Chenopodium* album, *Ch. hybridum*, *Veronica hederifolia*. In the non-fertilized variant the species mentioned did not present a problem, and significant number of seeds were found for species *Ambrosia artemisiifolia*, *Ajuga chamaephytis*, *Stachys annua*, *Sorghum halepense*, which certainly influences the selection of herbicides for the following period. In the autumn of 2015, after the harvest of wheat, the situation in P1 and P2 was 14,625 seeds m^{-2} and 23,700 seeds m^{-2}. In non-fertilized treatment (P3) the number increased to 17,250 seeds m^{-2} and seed of those species which the method of assessment from the land samples of the previous year indicated that it would be a problem. Based on the results, it is concluded that the different fertilization systems affect the number and composition of the soil weed seed-bank.

Key words: crop rotation, fertilization, weed seed-bank, physical extraction

INTRODUCTION

Weeds represent a serious problem on most arable land and their control is of great importance for achieving optimal high quality yields. Weed populations can be determined each year on the basis of a persistent of soil weed-seed bank because it is the main source of weed on arable land (Grundy & Jones, 2002). The weed-seed bank is the so-called "resting place" of the seed and is an important component of the weed life cycle. The term

weed seed-bank refers primarily to soil, but there is an aerial seed bank made up of seeds that, after ripening, remain for a certain period of time on the mother plant (Gulden & Shirtliffe, 2009).

Permanent stocking of weed seed in the soil is a result of their adaptive capacity with respect to the cultivated plant because they have higher seed production. The amount of seed produced by a weed species depends on the genetic traits, the degree of genetic variability, the appearance of lower taxonomic units, but also the external and other conditions in which the species develops (Lutman, 2002). The production of vegetative organs (rhizomes, bulbs, roots, root shoots, tubers, tuber bulbs) and buds that have the potential to regenerate and yield new individuals should also not be neglected (Grundy & Jones, 2002). Also, the numerous biological characteristics of the seed as well as the processes that take place in it provide a permanent weed seed-bank in the soil and thus a permanent weediness of agricultural land (Lopez-Granados & Lutman, 1998). Research shows that there are many factors that indirectly affect the size of the weed seed-bank, but that only a few of them affect the seed input into the soil, its persistence and seed germination. Also, herbicides and crop rotation are thought to reduce the influx of seeds into the seed-bank, and the tillage, mulching and application of fertilizers directly affect the size of weed seed-bank (Gulden & Shirtliffe, 2009). Crop rotation affects the number of represented weed species, and in a two year crop rotation the number of species is up to twice as high as in monoculture (Saulić et al., 2017). The choice of fertilizer affects the chemical composition of the soil, increases humus, P_2O_5 and K_2O (Berzsenyi et al., 2000). The impact of fertilization as another significant factor affecting weed seed-bank but research on this topic is still minimal relative to the overall weed survey (Benoit et al., 1992). The addition of mineral fertilizer significantly increases the number of weeds in the soil (Major et al., 2005), while Pyšek and Lepš (1991) consider that poor soil abound in weed species. The research described in this paper evaluated the impact of different fertilization systems on weed seed-bank.

MATERIAL NAD METHODS

Long-term studies were performed on the experimental plots ''Plodoredi'' at the Institute of field and vegetable crops Novi Sad in Republic of Serbia (N 45 19', E 19 50'). Three treatments were chosen for the cultivation of wheat, corn and soybeans in 3-year crop rotation. The fertilized plots were established in 1969/70 and the non-fertilized plots in 1946/47. In the plot 1 (P1) mineral fertlizers have been used each year in amount of 50 kg ha^{-1} P and K and mineral N in amount of 120 kg ha^{-1}. In the plot 2 (P2) mineral fertilizers in the same quantities and manure in the amount of 40 t ha^{-1} have been applied every third year, and in the plot 3 (P3) fertilizers have never been used. Soil sampling was carried out in autumn 2014 (after corn harvest), in spring 2015 in wheat and in the autumn of the same year after wheat harvest. During sampling, each plot, excluding the edge of the plot, was divided into 4 subplots (10 × 10 m) from which 10 soil samples were taken by a random probe (5 cm diameter) at two depths: 0-15 and 15-30 cm. Soil samples from each layer were mixed, dried at room temperature and packed in plastic bags. Using the methods of physical extraction of seed, the sampled soil was washed with a jet of water through a sieve system of different diameters (2 mm, 800 μm, 500 μm, 200 μm). Weed seeds were separated from admixtures under the binocular '' Bio-optica '' (45 × magnification), and the determination was performed using the weed seed collection of the Weed Science Laboratory of the Faculty of Agriculture in Belgrade and the dermin reference manuals (Dobrohotov, 1961; Skender et al., 1998).

RESULTS AND DISCUSSION

The results of the survey after three sampling seasons, by methods of physical extraction and the determination of weed seed, indicated that fertilization system affects the composition and number of seeds in the soil. In Table 1, the number of seeds per layer is shown. In the treatment P1, where only mineral fertilizer is applied every year in autumn and spring, after the first sampling (autumn 2 014), 27 weed species were detected, i.e. 12,075 seeds m^{-2}. The species that are characteristic of all three crops, which have been replaced on this plot for many years, were dominant: *Amaranthus retroflexus, Bilderdykia convolvulus, Convolvulus arvensis, Datura stramonium, Heliotropeum europeum, Lamium amplexicaule, Polygonum lapathifolium, Solanum nigrum, Sorghum halepense, Veronica hederifolia, Consolida regalis,* and *Papaver rhoeas.* In the second treatment (P2) in the same crop rotation system (corn, wheat, soybean), but under the application of mineral fertilizer in combination with manure (P2), fewer weeds were identified (21). However, the number of seeds in seed bank was almost double (22,275 seeds m^{-2}). Species of *A. retroflexus, Ch. album, Ch. hybridum* make up the largest abundance of weed seed reserves in this plot and dictate the pitch of the plot weediness. In the unfertilized treatment

(P3), 19 species were detected, with seed abundance being 11,700 seeds m^{-2}. In this plot, the species *Stachys annua, Ajuga chamaepitys, Ambrosia artemisiifolia,* and *Sorghum halepense* make the largest contribution in abundance. In the spring of 2015, all three plots were under winter wheat during sampling. On the P1 plot 26 species and 14,700 seeds m^{-2} were detected, while on the P2 treatment 21 weeds and 25,050 seeds m^{-2} were detected. In the unfertilized treatment, the situation has changed rapidly. The number of species remained similar (20) but 18,900 seeds m^{-2} were established. In autumn 2015, after the third sampling in P1, 27 species and 12,828 seeds m^{-2} were identified. There was a similar decrease in the P2 treatment, the number of species was 22 and the number of seeds was 23,700 m^{-2}. Much less germination was observed on treatment P3, where the same number of species but more seeds of 17,520 seeds m^{-2} remained in the weed seed-bank.

There are various forms and types of fertilizers available today that vary in origin, formulation, method and timing. In addition to the fact that nutrient intake contributes to the better growth and development of crops and, consequently, to a higher yield, the application of fertilizers as an important agro-technical measure significantly affects the level of weeds in the crop. Nitrogen fertilization leads to an increase in the number of nitrophilic weed species (*Datura stramonium, Solanum nigrum, Stellaria media, Gallium aparine, Galeopsis tetrahit*) (Simić et al., 2016). In our research in a plot where only a mineral fertilizer has been applied for years, a marked abundance of seeds of *D. stramonium* and *S. nigrum* species was observed. Also, the highest number of detected species was in this fertilizer treatment, as confirmed by Major et al., (2005) who found that mineral fertilizers effect on the number of weed species per unit area. On the other hand, on the plot where in addition to mineral fertilizer, manure was introduced, there was a pronounced number of seeds of some species *Ch. album*, *Ch. hybridum*, and *A. retroflexus*. It is estimated that the number of seeds of these species in the weed seed reserve will grow in the future. Using seedling emergence method on the same variant of fertilization it was noticed that the number of seedling was similar, but they differed in the floristic manner (Saulić et al., 2017). Major et al., (2005) state that the use of organic fertilizers (compost, poultry manure) has increased the number of species widely represented. Some results show that the application of 45 t ha^{-1} manure in soil can increase the number of weed seeds up to 3.4 million seed ha^{-1} (Roberts, 1970), while in our case up to 250 million seed ha^{-1} seeds were estimated. One reason for the high abundance of species seeds, *Ch. album*, *Ch. hybridum*, and *A. retroflexus*, is characterized by a seed coat, and by passing through the intestinal tract of ruminants remain intact, and in that process germination increases (Jones & Neto, 1987). Also seed of these species persist in soil for up to several decades, viable (Hossain & Begum, 2015). Studies conducted by Jiang et al., (2014) show the opposite results, that the application of organic fertilizer reduces the number of weeds by up to 80% compared to the plots where the mineral fertilizer was applied. In the plott P3, where fertilizer was not applied, a trend of increasing number of seeds of different weed species was observed. The primary reason may be that in poor soils there is limited crop growth because worse conditions do not benefit them, so more heat, water, light, and space are available to weeds (Jiang et al., 2014). In this plot, weed species that dominated the previous two fertilization systems were not a problem, but there was domination by *Stachys annua, Euphorbia cyparisias, Ajuga chamaepitys, Ambrosia artemisiifolia,* and *Sorghum halepense,* which certainly requires additional care when choosing measures and herbicides for protection weeds.

Table 1. Estimated number of weed seed in plaugh depth (0-15 cm and 15-30 cm)

Estimated number of weed seeds m^{-2}									
Fertilization system									
Season	Autumn 2014			Spring 2015			Autumn 2015		
Depth (cm)	P1	P2	P3	P1	P2	P3	P1	P2	P3
0-15	6,450	11,550	6,300	7,500	13,125	10,950	6,225	12,000	9,600
15-30	5,625	10,725	5,400	7,200	11,925	7,950	6,000	11,700	7,650
Sum	**12,075**	**22,275**	**11,700**	**14,700**	**25,050**	**18,900**	**12,250**	**23,700**	**17,250**

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