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Weed infestation of maize grown in sustainable farming systems

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The main aim of the study was to evaluate the occurrence and development of weed species in maize grown in sustainable farming systems. The work deals with the impact of climate variables (temperature and precipitation) on the actual weed infestation of maize in the period of 2012–2014; the dynamics of occurrence of individual weed species in ecological and integrated farming systems; the effect of fertilizers and year of growing on incidence of weed species in maize. The specific conclusions and recommendations for the implementation of integrated and ecological farming system in practice were drawn from the results. The dynamics of occurrence of individual weed species of maize was different in ecological and integrated farming systems. The most important weed species for maize crop were: *Amaranthus retroflexus*, *Chenopodium album*, *Persicaria lapathifolia*, *Echinochloa crus galli* and *Cirsium arvense*. There was significant difference between fertilizers and no fertilizers variants in integrated farming system during spring. Manure did not affect actual weed infestation in ecological farming system. Effectiveness of herbicides in integrated farming system and effectiveness of inter-row weeding in ecological farming system were analyzed in this study. In applying prevention, direct and indirect measures of weed regulation are environmentally friendly and fully integrated viable in the cultivation of maize.

Keywords: weed infestation, maize, organic farming system

1 Introduction

Weed control is vital to its success because weeds can reduce yield up to 86 %. A broad spectrum of grasses and broadleaved weeds infests maize fields: *Amaranthus retroflexus*, *Chenopodium album*, *Abutilon theophrasti*, *Convolvulus arvensis*, *Sorghum halepense*, *Echinochloa crus-galli*, *Digitaria sanguinalis* and *Setaria* spp. are among the most troublesome weeds in maize. Herbicides use is an essential component of successful maize production. Today, high-yielding agriculture heavily depends on herbicides, as they constitute a vital and integral component of weed management practices. However, there are very few herbicide options available for weed control in maize. But, none of these options currently keep the weed community at an acceptable level and cannot provide satisfactory control of weeds. In addition, these herbicides are used at high rates. Floramsulfuron and rimsulfuron are among the newly released dual purpose sulfonylurea herbicides (Zaremohazabieh, Ghadiri, 2011). The analysis of the crop protection literature demonstrates that only a small fraction is systems-oriented as compared to the bulk of publications with a technology-oriented approach. The analysis of agricultural innovations systems literature shows that, although crop protection is addressed, the potential of this systems approach remains largely unexplored for crop protection innovation. A large share of the publications included in this review focus on cropping or farming 'systems' while 'innovation' often equals the development, transfer, adoption and diffusion of crop protection technologies at farm level. There is relatively little attention for the institutional and political dimensions of crop protection and the interactions between farms, regional and national levels in crop protection systems. The traditional division of roles and responsibilities of researchers as innovators,

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extension personnel as disseminators, and farmers as end-users, is challenged only to a limited extent. The majority of publications discuss ways to optimize existing features of crop protection systems, without exploring more structural transformations that may be required to enhance the resilience of crop protection systems (Schut et al., 2014).

2 Material and Methods

The aim of the study was to evaluate the occurrence and development of weed species in maize grown in sustainable farming systems in the period of 2012–2014. The work was focused on assessment of the impact of climate variables (temperature and precipitation) on the actual weed infestation in two terms (during spring, before the harvest); the dynamics of occurrence of each weed species in integrated and ecological farming systems; the impact of fertilizers and year of growing; effectiveness and proposal for regulatory measures against weeds. The research was realized in two different variants – fertilizers and no fertilizers. There was used manure in ecological farming system and manure and fertilizers in integrated system.

3 Results

The results were statistically analysed and then the specific conclusions and recommendations for the implementation of integrated and ecological farming systems in practice were obtained. The frequency of weeds in maize in the spring was affected by the average temperature in each growing season. Our observations approved statistically significant effect of precipitation on the incidence of weeds in the spring in the integrated farming system. In compare with spring, there was significant lower number of weed species before the harvest. Statistically significant decrease of weeds in maize in integrated and ecological farming systems was detected in the period 2012–2014. The maximum frequency of weeds in both systems was 123 plants per m² and minimum level was about 4 plants per m².

The dynamics of occurrence of individual weed species of maize can be regarded as different in integrated and ecological farming systems. Total of 14 weed species occurred in both farming systems in the period of 2012–2014. There were analyzed all occurring species: *Amaranthus retroflexus*, *Atriplex* spp., *Avena fatua*, *Cardaria draba*, *Cirsium arvense*, *Convolvulus arvensis*, *Datura stramonium*, *Echinochloa crus galli*, *Chenopodium album*, *Chenopodium hybridum*, *Persicaria maculosa*, *Polygonum aviculare*, *Portulaca oleracea* and *Sonchus arvensis*. The most important weed species for maize crop were: *Amaranthus retroflexus*, *Chenopodium album*, *Persicaria lapathifolia*, *Echinochloa crus galli* and *Cirsium arvense*. The similar weed spectrum was observed by Głowacka (2011). Average number of weeds in integrated system was 49 ±15 plants per m². In ecological farming system weed infestation was 50 ±20 plants per m².

There was significant difference between fertilizers and no fertilizers variants in integrated farming system during spring. Significantly higher number of weeds was in fertilizers variants during spring. There was no significant difference between fertilizers and no fertilizers variants in integrated farming system before the harvest. Manure did not affect actual weed infestation in ecological farming system. There was significant lower number of weeds in integrated farming system in 2012 than in 2013 and 2014 growing seasons. In contrast, there was no influence of year of growing in ecological farming system.

There were used herbicides in integrated farming system. Effectiveness of herbicides was at level of 95 %. There was used inter-row weeding in ecological farming system with 85 % efficiency. According to Stefanović et al. (2011), the application of herbicides within maize growing practices had become an important measure with the aim of obtaining planned yields. This application in the period after sowing but before the emergence of the crop or in the course of the growing season significantly reduced the number of weed species, hence, in such a way, favourable conditions for maize development were provided. A great

assortment of herbicides is present on the market and these herbicides can be used in different periods.

4 Conclusions

The occurrence and development of weed species in maize grown in sustainable farming systems (integrated and ecological) in the period of 2012–2014 in two different variants (fertilizers and no fertilizers) were analyzed in this study. Our observations approved statistically significant effect of precipitation on the incidence of weeds in the spring in the integrated farming system. In compare with spring, there was significant lower number of weed species before the harvest. Statistically significant decrease of weeds in maize in integrated and ecological farming systems was detected in the period 2012–2014. The dynamics of occurrence of individual weed species of maize were different in integrated and ecological farming systems. The most important weed species for maize crop were: *Amaranthus retroflexus*, *Chenopodium album*, *Persicaria lapathifolia*, *Echinochloa crus galli* and *Cirsium arvense*. There was significant difference between fertilizers and no fertilizers variants in integrated farming system during spring. Before the harvest the infestation of maize in ecological farming system was higher than in the integrated farming systems. That is the reason for the correct selection of herbicides in integrated farming system in view of the spectrum of weed species in the plot, their quantity and development stage, as well as the development stage of the growing crop. A mechanical method of weed control in the ecological farming systems did not contribute to spreading perennial weed species. In applying prevention, direct and indirect measures of weed regulation are environmentally friendly and fully integrated viable in the cultivation of maize.

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