WEED INFESTATION MAIZE IN SUSTAINABLE AGRICULTURAL SYSTEMS

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Abstract. *The aim of the present papers was to evaluate the occurrence and development of weed species of current weed infestation maize crops in sustainable land management systems. The work has provided some partial objectives. To assess the impact of climate variables (temperature and precipitation) for the current weed infestation for the period 2005 – 2012. To assess the dynamics of individual weed species in ecological and integrated farming systems. To evaluate the influence of factors such as system management, manure and fertilizer grade on incidence of weeds in maize crop for 2005 – 2012. Evaluate the impact of the current crop of against weeds the main product of corn for the years 2005 – 2012. The objectives set were subjected to detailed statistical analysis and evaluation on which were drawn specific conclusions and recommendations for the implementation of integrated environmental and land management system in practice. The dynamics of individual weed species in crops of corn can be regarded as different in integrated and ecological farming systems. It stands for both land management system seedling in the total of 21 weed species of plants for the period from 2005 – 2012. We analyzed all occurring species: Amaranthus retroflexus L., Anagallis arvensis L., Atriplex spp. L., Avena fatua L., Cardaria draba Desv., Cirsium arvense (L.) Scop., Convolvulus arvensis L., Datura stramonium L., Echinochloa crus galli (L.) P. Beauv., Galium aparine L., Chenopodium album L., Chenopodium hybridum L. Lamium spp. L., Persicaria lapathifolia (Raf.)S.F.Gray, Persicaria maculosa (Raf.) S.F.Gray, Polygonum aviculare L., Portulaca oleracea L., Sonchus arvensis L., Stellaria media (L.) Vill., Thlaspi arvense L., Tripleurospermum perforatum (L.) Schultz – Bip. Actual weed infestation proportionally is affecting the yield of corn only for ecological land management system. The integrated system management, although herbicide used to maintain crop harvest almost to no weeds, but not indirectly increase in yield because the yield is more of a statistically significant effect that had a rainfall for the growing season. Based on the analyzes it is possible to say that the rainfall for the period 2005 – 2012, had a statistically significant effect on actual weed infestation of corn crops in the spring, it also had no statistically significant effect on weed infestation before harvest. In applying preventive, direct and indirect measures of regulation weed infestation is environmentally friendly and integrated fully viable in the cultivation of corn as a separate system for sustainable land management.*

Key words: *weeds, actual weed infestation, maize, sustainable agricultural systems*.

INTRODUCTION

The quality parameters for maize intended for use in anaerobic digesters are different than those crops intended for use in forage. For energy maize, high yield is the main driver and hence the agronomy around the crop has come more into focus. Where crop mass and preserving yield is important the best approach to weed control is pre-emergence of the crop. Post-emergence applications of herbicides can be harsh on maize and ultimately limit yield potential. This is demonstrated in the chart below (CHEUNG, 2013.) 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* L.,

Abutilon theophrasti Medik., *Convolvulus arvensis* L., *Sorghum halepense* (L.) Pers., *Echinochloa crus-galli* (L.) Beauv., *Digitaria sanguinalis* (L.) Scop. 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. Also 2,4-D plus MCPA have been applied POST for about a decade for controlling broadleaf weeds 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. The use of these herbicides offers the opportunity for a new mode of action for weed management in maize (ZAREMOHAZABIEH, GHADIRI, 2011).

The experiment was set up in a random split-plot design with four replications, with two methods for controlling weed infestation: I. mechanical – weeding of inter-rows twice; II. chemical, the herbicide Afalon 450 SC (a.i. linuron, 900g.ha^{-1}). Next, potassium, calcium and magnesium contents were determined in maize and in the dominant weed species. Based on the dry weight yield of maize and the biomass of particular weed species, nutrient uptake per hectare area was calculated. The chemical method of weed control reduced both the number and dry weight of weeds more than the mechanical method. The dominant species in the maize crop were *Echinochloa crus-galli* (L.) P. Beauv., *Chenopodium album* L., *Galinsoga parviflora* Cav., and *Cirsium arvense* L. All the weed species examined were more competitive than maize in accumulating potassium, calcium and magnesium. *Galinsoga parviflora* Cav. was the most competitive species with maize for potassium, *Cirsium arvense* L. for calcium, and *Chenopodium album* L. and *Polygonum lapathifolia* L. subsp. *lapathifolia* for magnesium. Weeds are serious competitors in taking up nutrients relative to crop plants; their share in the total uptake of microelements' from the soil by the maize crop and weeds together was considerable and it averaged as follows: for K – 35%, Ca – 27.3%, Mg – 27.4% (GŁOWACKA, 2011). Active substance Mesotrione has recently been registered for weed control in maize in Canada; however, there is still little information on the doses required to provide 90% control for the complete spectrum of broadleaved weeds that the product controls. Our objective was to determine mesotrione doses that would provide at least 90% control of four economically important weeds, without impacting final maize yield by more than 5% in comparison to a weed – free control. Sixteen field trials were conducted at six Ontario locations in 1999–2001 to evaluate the effectiveness of mesotrione at doses ranging from 9 to 280 g a.i. per ha. The doses required to reduce weed biomass by at least 90% varied with location and year, and for common lambs quarters and velvetleaf differed by application timing. For lamb's quarters, the estimated doses required ranged from 10 to 1984 g a.i. per ha, for preemergence applications and 15 – 38 g a.i. per ha, for post emergence applications. Doses of 45 and 19 – 243 g a.i. per ha were required to effectively reduce the biomass of redroot pigweed. Velvetleaf was effectively controlled preemergence with 288 g a.i. per ha and post emergence with 31 g a.i. per ha of mesotrione. Final maize yield was only reduced by more than 5% of a weed-free control when a dose of less than 35 g a.i. per ha of mesotrione was applied. These results show that biologically effective weed control with reduced doses of mesotrione is possible depending on the spectrum of broadleaved weed species present in the field (NURSE et al., 2010).

A systematic literature review is conducted to study the relation between crop protection and systems approaches to innovation. 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, 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).

MATERIAL AND METHODS

The aim of the study was to evaluate the occurrence and development of weed species current weed crops of corn in sustainable land management systems. The work had provided several partial goals. To assess the impact of climate variables (temperature and rainfall) to the current weed infestation in the period 2005 – 2012. Assess the dynamics of occurrences of each weed species in integrated and organic farming systems. To assess the impact of factors such as system management, manure and fertilizer year for the presence of weeds in crops of maize for 2005 – 2012. To assess the effectiveness and propose regulatory measures undertaken against weeds. To evaluate the impact of the current crop of weed on the main product of maize for 2005 – 2012.

RESULTS AND DISCUSSIONS

The objectives set were subjected to detailed statistical analysis and evaluation on the basis of which were drawn up specific conclusions and recommendations for the implementation of an integrated and ecological system of land management in practice. The dynamics of occurrence of individual species of weeds in crops of corn can be regarded as different in integrated and organic farming systems on land. In stands for both systems land management emerged was a total of 21 weed species in the reporting period 2005 – 2012. We analyzed all occurring species: *Amaranthus retroflexus* L., *Anagallis arvensis* L., *Atriplex* spp. L., *Avena fatua* L., *Cardaria draba* DESV., *Cirsium arvense* (L.) Scop., *Convolvulus arvensis* L., *Datura stramonium* L., *Echinochloa crus-galli* (L.) P. Beauv., *Galium aparine* L., *Chenopodium album* L., *Chenopodium hybridum* L., *Lamium* spp. L., *Persicaria lapathifolia* (Raf.) S. F. Gray, *Persicaria maculosa* (Raf.) S. F. Gray, *Polygonum aviculare* L., *Portulaca oleracea* L., *Sonchus arvensis* L., *Stellaria media* (L.) Vill., *Thlaspi arvense* L. *Tripleurospermum perforatum* (L.) Schultz – Bip.

The results of weeds population in the stands maize is very specifically. The species from maize is typical: *Amaranthus retroflexus, Chenopodium album, Persicaria lapathifolia, Echinochloa crus galli* and *Cirsium arvense*. The dynamics of *Amaranthus* spp. is next results. Species *Amaranthus retroflexus* L. – redroot pigweed is one of the most important weed species in crops of maize for the period from 2005 – 2012th. Based on the statistical evaluation of the results, we can put forward the following results. In the years 2005 – 2012 we in organic farming systems on soil had statistically significant decrease weed crops of corn in the spring

pigweed. Weed infestation of an integrated management system was during the period in the spring about the same (Figure 1).

Average number of weeds in the integrated system was 69.73 ± 43.48 units of weeds per m^2. While in organic farming systems on soil weed infestation was higher and 71.79 ± 43.04 units of weeds per m^2. The maximum frequency of weeds in both systems land management stood at 164 units per m^2 of weeds and weed minimum level was about 3.75 units per m^2 of weeds greater in ecosystems as in the integrated land management (Table 1).

Table 1

Descriptive statistics abundance of weeds in crops of corn in the spring (pieces.m^{-2})

System management	Mean	Median	Minimum	Maximum	Variance	Standard deviation	Standard error
Integrated system	69,73	71,75	3,00	164,00	1890,53	43,48	11,62
Ecological system	71,79	59,69	6,75	164,07	1852,44	43,04	11,50

Weed infestation of maize crops pigweed in the years 2005 – 2012 in the spring ratings actual weed highly statistically significantly higher in the integrated system as a loss from the ecological system. Before the harvest of maize, the situation with weed pigweed opposite, since the integrated system exaggerate the effect of regulatory intervention, was recorded in the ecological system highly statistically significantly higher weed infestation species studied (Table 2).

Table 2

Correlations of weeds in the integrated management of average temperature and rainfall of vegetation period (p = 0.05) during 2005 – 2012

	Average temperature GS*	Average precipitations GS*	Integrated system
Average temperature GS	1,00	-0,36	0,06
Average precipitations GS		1,00	0,69 P
Integrated system			1,00

* - Growing periods: IV. – IX.; P - conclusive.

The frequency of weeds in crops of corn in the spring, among other factors affecting the climatic conditions in the unit and especially the average temperature in the growing season (IV. – IX. month). Our observations suggest a statistically significant effect of rainfall on the incidence of weeds in the spring of the integrated system management. The temperature had significant effect on the incidence of weeds in spring plantations of maize (Table 2).

Table 3

Effect of management on weed infestation of maize crops pigweed – Amaranthus retroflexus L. (p = 0.01; Tukey HSD test)

Systems	Frequency of weeds in spring	Frequency of weed in harvest
Integrated	10,24 B	0,00 A
Ecological	7,53 A	6,88 B

A/B – signifficant difference at alpha = 99%

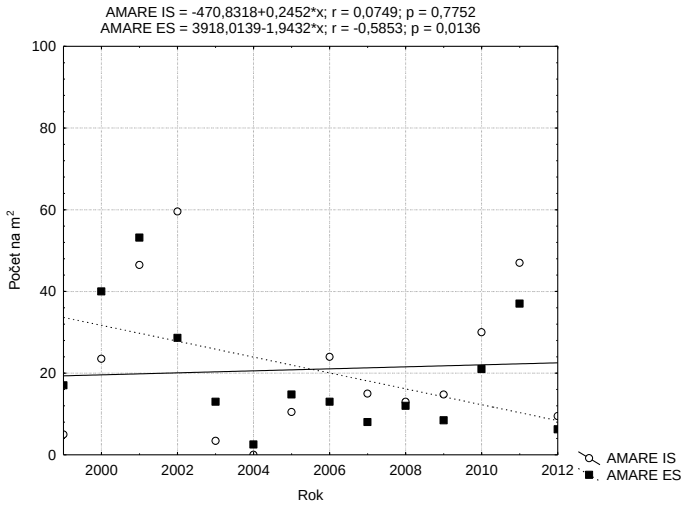

Figure 1: Temporal dynamics of the current crop of corn weed species Amaranthus retroflexus L. in integrated and organic farming systems on soil in spring

In the reporting period 2005 – 2012 was detected statistically significant decrease weed crops of corn in integrated and organic farming systems on land in crops of maize.

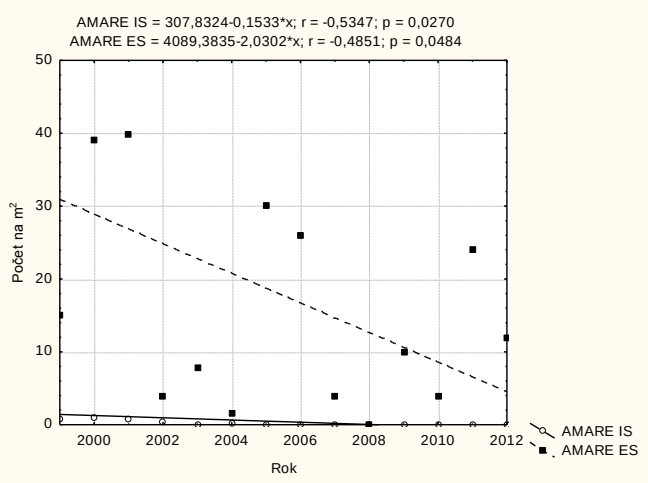

Figure 2: Temporal dynamics of the current crop of corn weed species *Amaranthus retroflexus* L. in integrated and organic farming systems on soil before harvest

Table 4

Effect of fertilization on the level of weed infestation of maize crops pigweed - Amaranthus retroflexus L. (p = 0.05; Tukey HSD test)

Fertilization options	Frequency of weeds in spring	Frequency of weed in harvest
Fertilized	10,39 b	3,72 a
No fertilization	7,37 a	3,16 a

On the statistical analysis based, we found statistically significant effect of fertilization on weed infestation of maize crops pigweed spring. Before harvesting of maize is insignificantly difference in weed vegetation pigweed (Table 3,4). On weed infestation of maize crops pigweed have a statistically significant influence and conditions year. High frequency pigweed in crops of maize was recorded in 2011 and in the two periods. Statistically high significantly lowest representation pigweed in years 2007, 2008, 2009 and 2012 (Table 5).

Table 5

Impact of the current year on weed infestation of maize crops pigweed – Amaranthus retroflexus L. (p = 0.01; Tukey HSD test)

Years	Frequency of weeds in spring	Frequency of weed in harvest
2005	6.31 A	7.5 B
2006	9.25 AB	6.5 B
2007	5.75 A	1.0 A
2008	6.25 A	0.0 A
2009	5.79 A	2.5 A
2010	12.75 B	1.0 A
2011	21.0 C	6.0 BC
2012	3.94 A	3.0 AB

Table 6

Interaction between management systems and year of occurrence pigweed - Amaranthus retroflexus L. crop of corn (p = 0.01; Tukey HSD test)

System	Years	Frequency of weeds in spring	Frequency of weed in harvest
Integrated farming systems	2005	5.25 AB	0 A
	2006	12.0 ABC	0 A
	2007	7.5 AB	0 A
	2008	6.5 AB	0 A
	2009	7.38 AB	0 A
	2010	15.0 BCD	0 A
	2011	23.5 D	0 A
	2012	4.75 AB	0 A
Ecological farming systems	2005	7.38 AB	15.0 C
	2006	6.5 AB	13.0 C
	2007	4.0 A	2.0 AB
	2008	6.0 AB	0 A
	2009	4.21 A	5.0 AB
	2010	10.5 ABC	2.0 AB
	2011	18.5 CD	12.0 C
	2012	3.13 A	6.0 B

Based on the results in Table 6, it can be concluded that the application of herbicides in integrated farming systems had significant effect on the incidence of pigweed, which managed to eliminate harmful. The results confirm the high significantly; the weed infestation of maize crops pigweed was highest spring in integrated and organic management in 2011. In organic farming systems on land was statistically significant weed infestation highest pigweed before harvest in 2005, 2006 and 2011. By contrast, statistically high significantly lowest weed infestation weed infestation can be seen in years 2008, 2007, 2009 and 2010.

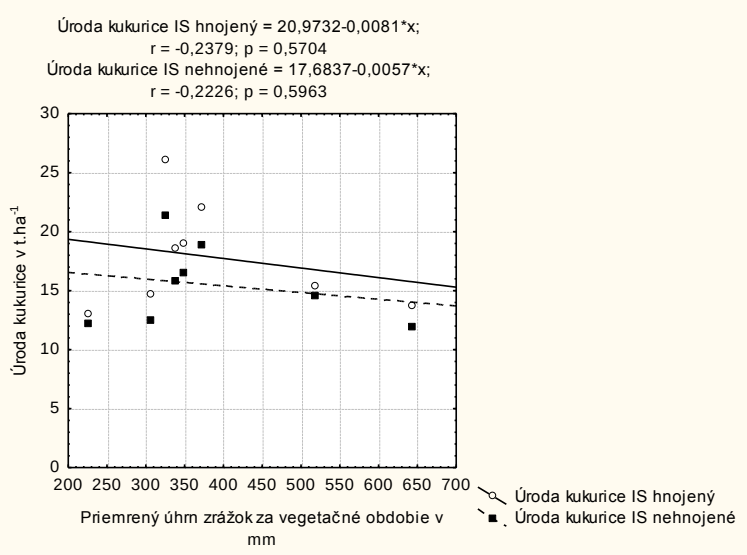

Figure 3: Impact of rainfall during the growing season for crops of corn in the integrated system of management for the years 2005-2012

Based on the correlation analysis of the results achieved as shown in Figure 3, we can say that with increasing rainfall in the growing season there is a significant reduction in the yield of maize in the two systems of fertilization integrated land management. This means that fertilization does not affect the maize crop, but a slight decrease occurs due to increasing precipitation totals. What is the optimal amount of rainfall shows a total in the range of 300 to 400 mm.

Used method of assessing the current weed science in different ways on replaced by an evaluation using camera systems. According to the authors CHRISTENSEN et al., (2009), the last 10 years there has been a shift in technological capability shooting stands with weeds, but so far no one has developed a commercial product that would not be robust and able to quickly evaluate the natural entry to the extent that captured any changes in the morphological characteristics of mutual shadowing the plant species. In addition, intensive work on the algorithm for image evaluation mechanism to eliminate the Driving present weeds in row crop Wide-grown crops.

We use chemical weed control in crops of maize was successful, able to keep the crop weed almost to the end of the growing season, which is an integrated system of management

possible. Results according to WEIDE et al., (2011) are showing the need of reducing the use of herbicides mainly due to the fact that herbicides can cause problems with regard to the quality of surface and groundwater. European and national regulations applying reduce this impact, so as not to jeopardize the efficiency and cost- effectiveness was not increased in the implementation of pollution in general. Recently, the increase in area of reduced tillage, which we did not have, because in sustainable land management systems cannot be applied (substitutability importance of plowing in the regulation of weed). Based on their research shows that reduced tillage can be carried out on the land, which is not weed infestation of perennial weeds without increasing financial herbicide.

The application of herbicides within maize growing practices has 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 reduces the number of weed species, hence, in such a way, favorable conditions for maize development are provided. In order to broaden the spectrum of herbicides activity, combinations of herbicides for the suppression of grass and board – leaf weeds are applied. A great assortment of herbicides is present on the market, and these herbicides can be used in different periods (STEFANOVIĆ, SIMIĆ, ŠINZAR, 2011).

CONCLUSIONS

Actual weed infestation in the integrated management of the spring was statistically significantly higher than in the ecological system at the same time. Before harvest was weed infestation of maize crops in organic farming systems is higher than in the integrated system of management, which had an impact on the choice of effective combinations of herbicides on plant weed control in an integrated system. That is why it is important to choose the correct selection of herbicides in view of the spectrum of weeds in the plot, their quantity and development phase, as well as the development phase of the growing crop. Actual weed infestation in proportion impacted the harvest of corn only in organic farming systems on land. The integrated management system used herbicides while maintain crop to harvest almost no weeds, but indirectly there is an increase in yield, because the harvest had statistically significant greater influence rainfall in the growing season. The optimal amount of rainfall for the area Dolná Malanta based on our results can be seen from 300 to 400 mm. Any smaller or larger aggregates were seen negatively. Based on the analyzes can be said that rainfall in the period 2005 – 2012, had a statistically significant effect on the actual weed infestation of maize crops in the spring and had no statistically significant effect on weed infestation before harvest. For the reporting period 2005 – 2012, there was a reduction in the diversity of weed species, especially in the integrated land management. A mechanical method of weed control in organic farming systems has not contributed to spreading perennial weed species. When applying preventive, indirect and direct measures of weed control is environmentally friendly and fully integrated system viable in the cultivation of maize as a separate system of sustainable land management.

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