THE INVESTIGATION OF CROP WEEDINESS IN THE CROP ROTATION OF ORGANIC FARMING SYSTEM
NEZĀĻU IZPLATĪBAS PĒTĪJUMI ORGANISKĀS LAUKSAIMNIECĪBAS SISTĒMAS AUGSEKĀ

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Kopsavilkums

Laikā no 2004.- 2006.gadam LLU MPS „Vecauce" veikti pētījumi ar mērķi skaidrot bioloģiskās lauksaimniecības sistēmas augsekas lauku sējumu nezāļainības dinamiku. Lai realizētu mērķi, izvirzīti uzdevumi: - noskaidrot dominējošās nezāļu sugas; - pārstāvētās nezāļu bioloģiskās grupas; - nezāļu blīvumu un tā izmaiņas bioloģiskās augsekas lauku kultūraugu sējumos.
Pētījumi veikti sertificētā bioloģiskā laukā sešlauku augsekā. Augsne – velēnu gleja smilšmāls, pH_{KCl} – 6.9; organiskās vielas saturs – 26 g kg^{-1}; P – 37 mg kg^{-1}; K- 69 mg kg^{-1}.

Augsekas shēma: 1. tritikāle / ziemas rudzi zaļmēslojumam pavasarī; 2. baltās sinepes vai eļļas rutki (zaļmēslojumam) / ziemas rudzi (zaļmēslojumam rudenī); 3. kartupeļi; 4. auzas; 5. vīķauzas (zaļmasai) ar āboliņa un timotiņa pasēju; 6. āboliņš, timotiņš (zaļmēslojumam).

Sējumu nezāļainības novērtēšanai veikta nezāļu uzskaite divas reizes kultūraugu veģetācijas periodā. Pirmo reizi agrā kultūraugu attīstības stadijā (labību sējumos to cerošanas laikā) izmantojot uzskaites rāmīti 0.25 m^2, nosakot nezāļu skaitu gab. m^{-2}, sugu sastāvu un bioloģisko grupu īpatsvaru. Otro reizi pirms kultūraugu novākšanas, pēc skaita un masas metodes, vienlaikus to skaita, gab. m^{-2}, sugu botāniskā sastāva analīzei, nosakot arī nezāļu zaļo masu, g m^{-2}. Izmantots 0.1 m^2 liels rāmītis.

Izmēģinājumu laukā izmantota tradicionāla augsnes apstrāde, atbilstoši kultūraugu prasībām.

Triju gadu pētījumu periodā augsekas laukos konstatētas 59 nezāļu sugas, to sortiments atbilst augsnes un audzēto kultūraugu īpatnībām. Salīdzinot pēc nezāļu mūža ilguma, izmēģinājumu laukos pārsvarā bija īsmūža nezāles, no kurām dominēja baltās balandas (*Chenopodium album* L.), no daudzgadīgajām nezālēm augsekā dominēja ložņu vārpata (*Eyltrigia repens* L. Nevski*)*, lielā skaitā bija sastopamas parastās zvērenes (*Barbarea vulgaris*), īpaši daudzgadīgo zālaugu sējumā. Pētījumi parādīja, ka parastās zvērenes izplatību augsekā bioloģiskās saimniekošanas sistēmā var ierobežot ar augsnes mehānisko apstrādi un mainot kultūraugus ar dažādu audzēšanas tehnoloģiju. 3 gadu pētījumi dod iespēju salīdzināt sējumu nezāļainības izmaiņas sešlauku augsekas rotācijas 3 gadu periodam un salīdzināt pa atsevišķiem augsekas posmiem. Kā liecina statistikas dati, aprēķinātā robežstarpība 95% līmenī parāda, ka augsekas posms āboliņš, timotiņš – tritikāle / ziemas rudzi – eļļas rutki/ ziemas rudzi ir bijis sliktāks par citiem augsekas posmiem, jo tajā konstatēts vislielākais nezāļu skaits pirms kultūraugu novākšanas. Turpretim augsekas posms ziemas rudzi/ eļļas rutki/ ziemas rudzi – kartupeļi – auzas, kā rāda 3 gadu vidējie dati, ir bijis vismazāk piesārņots ar nezālēm. Šeit liela nozīme tam, ka zaļmēslojumam audzēto kultūraugu tehnoloģija nedod iespēju nezāļu sēklām nogatavoties, līdz ar to augsne mazāk piesārņojas ar nezāļu sēklām un pēcaugu nezāļainība mazāka.

Nezāļu skaits augsekas laukos ir atkarīgs no kultūraugu secības augsekas posmos un no kultūraugu audzēšanas tehnoloģijas.

Abstract

Field experiments were conducted during the period of 2004 – 2006 at the Research and Study Farm „Vecauce". The aim of the investigation was to establish the weediness' dynamics of crops in a six-field crop rotation of an organic farming system. The field was certified as being organic. Crop rotation: 1. triticale/ rye (for green manure in spring), 2. oil radish (for green manure)/ rye (for green manure in autumn), 3. potatoes, 4. oats, 5. vetch-oats mix (for green forage) with an undersown mixture of red clover and timothy, 6. red clover and timothy. Conventional soil tillage was done according to the requirements of the crops. The weeds were counted two times during the vegetation period of crops: at the early development stages of crops (for instance, at the

tillering of cereals) and before the crop harvesting. The composition of weed flora comprised from 59 species in the crops' stands. The annual dicotyledonus were dominating groups of the weed flora. The most abundant weeds were lambsquarters (*Chenopodium album* L.), quackgrass (*Elytrigia repens* (L.) Nevski), common yellow rocket (*Barbarea vulgaris* R. Br.p.p.). The significantly smaller amount of weeds among crop rotation links was observed in the link rye/ oil radish/ rye – potatoes – oats. Much worse suppression of weeds was obtained in the crop rotation link red clover and timothy – triticale/ rye – oil radish/ rye. The number of weeds in the fields of crop rotation in the organic farming system is dependent on the cultivated crops, the succession of crops in the crop rotation links and crop cultivation technologies.

Key words
Organic farming system, weediness of crops, crop rotation

Introduction

Products from industrial agriculture are not environmentally friendly and every year consumers are asking for more and more products of organic agriculture. Motivation for production of organic crops and consumption of organic foods include economic, food safety and environmental concerns. Organic crop production requires a high level of management to successfully culture a healthy and productive balance in the field environment, minimizing the number of weeds to the benefit of the crops seeded (Delate, 2002, Bond and Grundy, 2001). Weed infestation may even increase when organic farming is continued. In organic agriculture weeds are often one of the biggest problems (Albrecht, 2005). By careful management, these problems can be overcome. Effective crop rotation is absolutely critical for weed management. A well-designed crop rotation will ensure a vigorous crop and reduced competition from weeds. In designing crop rotation for weed control the overall key to success is diversity. (Lampkin, 1994)

Weed population density and biomass production may be markedly reduced using crop rotation strategy (Liebman and Davis, 2000). Weed control strategies can be grouped into four types – improving soil conditions, rotating crops, growing smother crops and using mechanical control. A biologically-active soil with good soil structure will improve the vigour of the crops, it help the crops shade out the weeds. To improve soil conditions, recycle organic matter like green manures. The rotation can include specific crops to control problem weeds in particular fields. Growing a variety crops on the same field will also keep weeds off balance, because certain weeds grow best with certain crops. Clover and forage crops discourage some weeds by shading and lessen the reproductive success of others because they are cut before the seeds ripen. Same plants like rye produce natural chemical toxins which inhibit the growth of other plant species. The phenomenon is known as allelopathy and can be used to assist in weed control. For example, rye used as an autumn cover crop can be effective in suppressing quackgrass. Inhibitory effect on weeds diminishes when rye is disked into the soil rather than left on the surface. Oats release toxins lither as root exudate or from decaying plant materials. Autumn-planted cover crops will greatly reduce weeds in the growing season. Cover crops can be incorporated in the soil in the spring (Liebman and Davis, 2000). Cool-season canopy crops are alternated with warm-season row crops which can provide more cultivation opportunities (Baumann and Slembrouck, 1994). Potatoes were traditionally regarded as a cleaning crop. They are grown in ridges on wide rows and in odder to facilitate weed control through tillage. Vetch-oat mix is a smother crop that grows rapidly and forms a dense canopy and slows the establishment of needs. Smother crops improve weed control by shading them out. Most mechanical weed control methods should be used early in the season, when weeds are just sprouting. Weed harrowing before and after crop emergence is used widely in arable crops. (Hance and Holly, 1990., Lampkin, 1990, Kurstjens and Perdock, 2000, Baumann, Kroff and Bastiaans, 2000)

Cultural control of weeds will not totally eliminate them but it should reduce their vigour and abundance to a level that is either tolerable or that can br managed by more conventional means (Bond, Grundy, 2001).

The aim of the investigation was to establish the weediness' dynamics in crops in six-field crop rotation in organic farming.

Material and Methods

Field experiments were conducted during the period of 2004-2006 at the Research and Study Farm "Vecauce", to determine the dynamics of weed species and number of weeds in fields of crop rotation. The field is certified as being organic. Soil properties: sod gley-soil, loam; organic matter content - 26 g kg^{-1}, pH_{KCl} -6.9; P – 37 mg kg^{-1}; K – 69 mg kg^{-1}.

Crop rotation: 1. triticale/ rye (for green manure in spring); 2. oil radish (for green manure)/ rye (for green manure in autumn); 3. potatoes; 4. oats; 5. vetch-oats mix (for green forage) with an undersown mixture of red clover and timothy; 6. red clover and timothy.

The conventional soil tillage was done according to the requirements of the crops. Weed harrowing after the emergence of oats and at the tillering of triticale. The field of potatoes was harrowed and ridged.

Weed population density and phytomass production were determined. Weed assessments were done two times during the vegetation period of crops: first time – during the early development stages of crops (for instance, at the tillering of cereals) and the second time - before harvesting. The first assaying was done using a 0.25 m^2 big circle, second – using 0.1 m^2 big frame in 20 places per each field of crop rotation identifying weed species and biological groups. In the second assay the fresh weight of weeds was measured. Data analysis was done by ANOVA.

Results and discussion

The composition of the weed flora was comprised of 59 species in the crops' fields. The annual dicotyledonus were the dominati groups of the weed flora. The most abundant weeds were lambsquarters, sheperd's purse *(Capsella bursa-pastoris* (L.) Medic.), frenchweed (*Thlaspi arvense* L.), quackgrass and common yellow rocket.

In the crop rotation every crop does something different and each of them provides some advantage. The green mass of the catch crops included in the crop rotation, such as red clover and timothy mix, rye, oil radish, is rich in nitrogen and is a good substrate for the propagation of soil microflora. The increased soil biological activity influenced the humus amount that improves the soil structure and fertility (Maiksteniene, Arlauskiene, 2005). It will improve the vigour of crops and gets a good start and forms a dense canopy. It can usually compete successfully with weeds during the growing season. The triticale as a canopy crop, vetch-oat mix as a smother crop, the potato as a cleaning crop were included in crop rotation experiments and were found to boost weed control.

Results from the first weed accounting during the early stages of crop development showed no significant differences (probability level 95%) in the weed number among crop rotation links (Table 1). In the potato fields weeds werfe not observed during in the three years of the crop rotation period.

Table 1 The influence of crop sequence in crop rotation on weed dynamics at the early stages of crops, 2004-2006, plants m^{-2}

Number of fields	Years	Crops	Number of annual weeds	Number of perennial weeds	Total number of weeds
1.	2004.	triticale/ rye	4.8	3.8	8.6
	2005.	oil radish/rye	11.2/105	49.6/0	60.8/105
	2006.	potatoes	0	0	0
	Average		**21.0**	**9.5**	**30.5**
2.	2004.	rye/w.mustard	3.4	4.4	7.8
	2005.	potatoes	0	0	0
	2006.	oats	9.0	1.6	10.6
	Average		**4.1**	**2.0**	**6.1**
3.	2004.	potatoes	0	0	0
	2005.	oats	28.0	1.4	29.4
	2006.	vetch-oats mix.	32.8	10.2	43.0
	Average		**20.3**	**3.9**	**24.2**
4.	2004.	oats	4.6	6.0	10.6
	2005.	vetch-oats mix.	18.4	5.4	23.8
	2006.	r. clover, timothy	1.4	5.2	6.6
	Average		**8.1**	**5.5**	**13.6**
5.	2004.	vetch-oats mix.	7.4	10.4	17.8
	2005.	r. clover, timothy	1.2	16.8	18.0
	2006.	triticale/ rye	9.0	1.2	10.2
	Average		**5.9**	**9.5**	**15.4**
6.	2004.	r. clover, timothy	0	17.4	17.4
	2005.	triticale/ rye	9.2	8.1	17.3
	2006.	oil radish/rye	13.6/12.0	5.8/6.6	19.4/18.6
	Average		**7.3**	**10.6**	**18.0**
		$LSD_{0.05}$	27.5	13.3	37.8

Data of second weed accounting (Table 2) show that the total number of weeds in the crop rotation before crop's harvesting in 2004, 2005 and 2006 was 55.8, 99.6 and 43.8 plants m^{-2}, respectively, in this composition the annual weeds were – 21.2, 57.6, 27.8 and perennial weeds - 34.6, 42.0, 16.0 plants m^{-2}. Results showed that weed density was higher in the second year of crop rotation, less – in the third year. They can also be influenced by meteorological conditions. The year 2006 was extremely hot and dry. A high number of annual weeds was observed in 2005 in the stand of triticale where the dominant weed specie was lambsquarter (83 % of the total number of annual weeds), and in the stand of catch crops – rye and oil radish (80 %). In 2006 in the stand of catch crops after triticale lambsquarters there was 48 % of the total number of annual weeds, but it was not dangerous for the next crops, because the crops grown for green manure are incorporated in the soil before the seeds of weeds ripen. In 2005 the high number of quackgrass was observed in the stand of triticale – 88 % of the total number of perennial weeds, but in the stand of next catch crops (2006) the number of this weed was decreased to 67 %, if compared to quackgrass' number m^{-2} in the previous triticale. The highest amount of common yellow rocket was found in 2004 in the red clover and timothy stand (38 plants m^{-2}), that was 53 % of the total number of perennial weeds. In the next year in catch crops the number of this weed was reduced remarkably in rye, but in the second catch crop - oil radish quackgrass was not established. Thereby we can be agree with other researchers, that crop rotation reduces weed density and maintains species diversity, thus preventing the domination by a few problem weeds (Doucet *et all*., 1999). The problem weeds in the investigated crop rotation organic farming system are quackgrass and common yellow rocket.

The significantly smaller amounts of weeds among crop rotation links was observed in link rye/ oil radish/ rye – potatoes – oats. Much less successful suppression of weeds was obtained in the crop rotation link red clover and timothy – triticale/ rye – oil radish/ rye (Table 2).

Table 2 The influence of crop sequence in crop rotation on weed dynamics before harvesting of crops, 2004-2006, plants m^{-2}

Number of fields	Years	Crops	Number of annual weeds	Number of perennial weeds	Total number of weeds
1.	2004.	triticale/ rye	33.5	45.5	79.0
	2005.	oil radish/rye	13.8/ 115.0	16.8/ 0.5	30.6/ 115.0
	2006.	potatoes	16.0	7.0	23.0
	Average		**38.0**	**20.4**	**58.4**
2.	2004.	rye/w.mustard	33.5	17.0	50.5
	2005.	potatoes	8.0	1.0	9.0
	2006.	oats	2.0	1.0	3.0
	Average		**14.5**	**6.3**	**20.8**
3.	2004.	potatoes	20.2	20.8	50.0
	2005.	oats	31.5	4.5	36.0
	2006.	vetch-oats mix.	29.5	13.0	42.5
	Average		**27.1**	**12.8**	**39.9**
4.	2004.	oats	10.0	31.0	41.0
	2005.	vetch-oats mix.	75.2	9.6	84.8
	2006.	r. clover, timothy	12.0	15.0	27.0
	Average		**32.4**	**18.5**	**50.9**
5.	2004.	vetch-oats mix.	19.5	22.4	41.9
	2005.	r. clover, timothy	14.5	44.0	58.5
	2006.	triticale/ rye	25.5	19.0	44.5
	Average		**19.8**	**28.5**	**48.3**
6.	2004.	r. clover, timothy	11.0	71.0	82.0
	2005.	triticale/ rye	152.0	184.0	336.0
	2006.	oil radish/rye	86.5/76.5	65.5/16.5	152.0/93.0
	Average		**81.5**	**98.7**	**180.2**
	$LSD_{0,05}$		57.8	60.6	103.3

Organic farming does not only increase the number of weed species, it also leads to a considerable rise in weed phytomass (Albrecht, 2005). Therefore the weed's phytomass was investigated. The phytomass of weeds is given as fresh weight that was investigated before the crop's harvesting. The results are represented in the Table 3.

Table 3. The influence of crop sequence in crop rotation on weed fresh weight before the harvesting of crops, 2004-2006, g m^{-2}

Number of field	Years	Crops	The fresh weight of weeds
1.	2004.	triticale/ rye	247.2
	2005.	oil radish/rye	51.4
	2006.	potatoes	41.0
	Average		**113.2**
2.	2004.	rye/white mustard	-
	2005.	potatoes	37.4
	2006.	oats	3.0
	Average		**20.2**
3.	2004.	potatoes	72.4
	2005.	oats	32.5
	2006.	vetch-oats mix.	45.7
	Average		**50.2**
4.	2004.	oats	18.9
	2005	vetch-oats mix.	62.6
	2006.	red clover, timothy	21.8
	Average		**34.4**
5.	2004.	vetch-oats mix.	52.9
	2005.	red clover, timothy	49.0
	2006.	triticale/ rye	45.6
	Average		**49.2**
6.	2004.	red clover, timothy	-
	2005.	triticale/ rye	47.8
	2006.	oil radish/rye	51.3
	Average		**49.6**
		$LSD_{0.05}$	97.5

In 2004 in the rye/ white mustard stand, and in the red clover and timothy stand the biomass of weeds was not determined. There were not sygnificant differnces among the crop rotation links.

Conclusions

The number of weeds in the fields of crop rotation in organic farming systems is dependent on cultivated crops, the succession of crops in the crop rotation links and crop cultivation technologies.

We agree with opinion of researchers who indicated that weed infestation is the major crop protection problem in organic farming systems, and the development of weed management strategies requires detailed information on weed population dynamics. Therefore, long term research is necessary to analyse this problem accurately.

The investigations will be continued at least up to the end of a rotation period.

References

1. Albrecht H. (2005) Development of arable weed seedbanks during the 6 years after the change from conventional to organic farming. Weed Research, 45, 339-350.
2. Baumann D. & Slembrouck I. (1994) Mechanical and integrated weed control systems in row crops. Acta Horticulturae 372, Engineering for Reducing Pesticide Consumption and operator Hazards, 245-252.
3. Baumann D., Kroff M. & Bastiaans L. (2000) Intercropping leeks to suppress weeds. Weed Research, 40 (4), 359-374.
4. Bond W. & Grundy A. (2001) Non-chemical weed management in organic farming system. Weed Research 41 (5), 383-405.
5. Delate K. (2002) Using an agroecological approach to farming systems research. HortTechnology, 12 (3), 345-354.
6. Doucet C., Weaver S., Hamill A. and Zhang J.(1999) Separating the effects of crop rotation from weed management on weed density and diversity. Weed Science, 47 (6), 729-735.

7. Kurstjens D. & Perdock U. (2000) The selective soil covering mechanism of weed harrows on sandy soil, Soil & Tillage Research, 55, 193-206.
8. Lampkin N. (1994) Organic Farming. Farming Press Books. Ipswich, U.K., 161.
9. Liebman M. & Davis A. (2000) Integration of soil, crop and weed management in low-external-input farming systems. Weed Research, 40, 27-47.
10. Maiksteniene S. and Arlauskiene A. (2005) The influence of different crop management practices on soil fertility and crop rotation productivity. Agronomijas vēstis, 8, 216-220.
11. Weed Control Handbook: Principles (1990) Edit. by Hance R. & Holly K. Blackwell Scientific Publications. British Crop Protection Council. Oxford, 329-365.

DYNAMICS OF SOIL ORDER AND PENETRATION RESISTANCE IN SOIL WITH AND WITHOUT SPRING BARLEY
AUGSNES SAKĀRTAS UN PENETROMETRISKĀS PRETESTĪBAS IZMAIŅU DINAMIKA AUGSNĒ AR UN BEZ VASARAS MIEŽIEM

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Abstract
Changes in the dynamics of soil bulk density as well as soil penetration resistance with and without spring barley has been investigated in the 30 stationary observation points in the Research and Study farm "Vecauce" of the Latvia University of Agriculture in 2005-2006. the distance between points was 5 m. Observations were made at the stage of 2 till 3 leaves of spring barley, at the end of tillering, at the stem elongation stage (2 till 3 node stage), as well as before harvesting. Soil penetration resistance and moisture was determined till 50 cm deep. Yield and its structure elements were determined with sample sheafs from 0.1 m^2. It was established that in areas sown with spring barley soil moisture losses from topsoil and also from subsoil besauce of the plants' transpiration promoting soil penetration resistance increase substantially in the conditions of 2005 and 2006. Essential differences in soil penetration resistance in plant root action zones were established when compared with observation points without plants in the development stage of spring barley after tillering. It means that plants with their own root action restrict the placement depth of roots.

Key words
Spring barley, soil moisture, soil penetration resistance, yield formation

Ievads
Latvijā jau iepriekšējos gados ir veikti pētījumi par augsnes apstrādes pasākumu optimizēšanas iespējām, lietojot augsnes pretestības mērījumus ar GPS noteiktos stacionāros punktos ziemas kviešu sējumos (Lapins, Vilde, Berzins, *et. al.* 2006), kā arī izmēģinājumos vasaras miežos (Lapins, Berzins, *et. al.* 2005). Konstatētas būtiskas augsnes penetrometriskās pretestības rādītāju atšķirības sezonās. Viens no augsnes penetrometriskās pretestības izmaņu cēloņiem bija nokrišņu daudzums un augsnes mitrums. Pētījumu mērķis bija pārbaudīt hipotēzi par auga sakņu sistēmas iedarbību uz augsnes penetrometrisko pretestību un skaidrot sakarības starp augsnes mitrumu, pretestību un sakārtas blīvumu.

Materiāli un metodes
Lauka izmēģinājumi veikti LLU MPS „Vecauce" 2005. – 2006. g., vasaras miežus audzējot atkārtotā sējumā. Meteoroloģiskie apstākļi abos gados bija atšķirīgi: 2005.g. raksturojās ar pazeminātām gaisa temperatūrām, bet 2006.g. – ar izteikti zemu nokrišņu daudzumu un līdz ar to arī mitruma deficītu augsnē (1. un 2. att.).