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THE DIVERSITY OF WEEDS IN ORGANIC LINSEED AND FLAX CROP

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Abstract. *The flax is grown in the world for many years. The area of linseed in the world is much more than that of fibre flax. The seeds of ecologically grown linseed have high value as the row material for food, medicine, fodder, oil production. The cold pressed oil and seeds of ecologically grown linseed are especially popular in EU, Canada and USA. The quality of the finished linen product is often dependent upon growing conditions and harvesting techniques. The organic textile trend is starting to develop worldwide, while in Lithuania it is still almost non-existent. Therefore, the chance for Lithuanian farmers appears to export the ecological seed and fiber, not only use them in local market.*

Lithuanian farmers are in luck for the advices how to grow flax in ecological way. Therefore, in 2007-2009 some investigations were carried out at the Upytė Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry (Panevėžys district, Lithuania). The results of our investigation showed that it is possible to grow and harvest fibre flax and linseed in organic farms without any pesticides. The incidence of weeds is one of the biggest problems in organic growing of flax and linseed.

Keywords: *Linum usitatissimum L., flax, linseed, organic farming, conventional farming, weeds.*

Introduction

The flax is grown in the world for many years. The area of linseed in the world is much more than that of fibre flax. The seeds of ecologically grown linseed have high value as the row material for food, medicine, fodder, oil production. The cold pressed oil and seeds of ecologically grown linseed are especially popular in EU, Canada and USA. The quality of the finished linen product is often dependent upon growing conditions and harvesting techniques. The facts of the International Federation of Organic Agriculture Movements (IFOAM) suggest that certified organic flax seed for oil is grown in about a half of the USA and certified organic fiber flax is grown in Europe and China [1].

In all agricultural crops the competition between crops and weeds is going on. The incidence of weeds is one of the biggest problems in flax and linseed growing. Their growing intension, compared with the weeds, is small, so weeds can dwarf the germinating flax. The losses of fibre flax yield can reach from 12 % to 36 % depending of weed incidence [2].

Many authors suggest that herbicides are one of the reliable means to solve weed problem in flax crop [2, 3, 4, 5, 6, 7]. Some herbicides had phytotoxic effect on flax plants and may to reduce scutched fiber yield [8], plant height [9]. The results of experiments on the sensitivity of *Linum usitatissimum* to the herbicides showed stronger phytotoxic effect on flax grown on poor and light soils [8, 10].

Organic farming attempt to control crop weeds, without herbicides in agroecosystem. The agroecosystem includes the farm's crops, weeds insect and other pests, and their natural enemies; soils and their tremendous diversity of micro- and macroorganisms; ground and surface waters etc. Understanding these interactions and how they can impact on the crop and its pests can point the way to nontoxic and non-disruptive practices that limit pest species' ability to proliferate and become a problem that requires a pesticide treatment [11]. Harrowing is a traditional form of mechanical weed control for dealing with annual weeds,

but is ineffective against perennial and established deep-rooted weeds. In spring of the weed harrow control weeds by uprooting and/or covering small weed plants with soil. Post-emergence harrowing may also cause crop injury, but selectivity depends on many factors including the soil covering mechanism [12]. J. Duval suggest, that for small-seeded crops (like flax), mechanical weed control is risky and seldom needed due to the good competitive ability of these crops when the seeding rate is high enough. For flax J. Duval recommend underseeding with clover instead pre-emergence and post-emergence harrowing [13].
Common weeds in flax crop in Lithuania are *Chenopodium album* L, *Polygonum convolvulus* L, *Galeopsis tetrahit* L., *Matricaria inodora* L., *Agropyron repens* L., *Cirsium arvense* Scop. and *Sonchus arvensis* L. [14]. *Chenopodium album* L. was one of numerous weeds in the Upyte Experimental Station's flax crop, moreover on the less number the *Lamium purpureum* L., *Matricaria inodora*, L., *Melandryum album* Garckie and *Polygonum* sp. were found in the flax crop. The weed incidence in trial plots was from 77 to 276 plants per sq. meter, and annual dicotyledonous weeds predominated [2].
Flax is less competitive with weeds and should be grown on relatively weed-free fields [15]. Tishkov N.M. and Dryakhlov A.A. suggest that competitiveness of oil flax (linseed) to weeds is depending on crop's contamination and species composition [16].
The diversity of weeds in organic linseed and flax crop was investigated in Jurbarkas and Panevėžys districts by the scientists of the Upytė Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry in 2007-2009.

Materials and methods

Weed diversity investigations in the fiber flax crop were carried out in Jurbarkas and Panevėžys districts in 2007. Investigations in Jurbarkas district was carried out on the Venslauskienė V. farm (situated in the Mantviliai village). The data were collected from 3 hectares of fibre flax in organic farm and from 5 hectares from flax grown by conventional technology. Investigations in Panevėžys district were carried out on the A. Vaičiūnas organic farm (situated in the Puškoniai village). Weed diversity in conventional technology flax fields were carried out on the Joint Stock Company Upytės eksperimentinis ūkis fields (situated in the Upytė village). Fiber flax variety 'Hermes' was cultivated in all tested fields.
Weed diversity investigations in the linseed crop were carried out on the Upytės eksperimentinis ūkis fields (situated in the Upyte village, Panevėžys distr.) in 2008-2009. Data were collected from 1.5 hectares of organic farming and from 1.5 hectares of conventional technology fields of linseed cultivar 'Biltstar'.
Soil tillage, the protection against pests and weeds was performed in accordance with a linseed-growing advice for flax grown by conventional technology [17].
Number of weeds was determined when flax reached "fir tree" stage by counting weeds on 0.25 square meter plots in 10 random locations. Weeds were categorized by particular species. Later on the average amount of weed in 1 square meter was calculated. Weed data representing in this article conventional technology were collected before herbicide application.

Results and discussion

The flax preceding crop in Jurbarkas was black fallow, so weed species composition in flax was not various. The *Sonchus arvensis* L. dominated (59% of the total amount of weeds), and less quantity of *Poa annua* L. (10%), *Convolvulus arvensis* L. (9%) and *Fallopia convolvulus* L. (sin. *Polygonum convolvulus* L.) (7%) was found. On the edge of the flax field there were several flashpoints, where the *Artemisia vulgaris* L. grew tighter. Weed density in some places reached 130 to 150 units in square meter. It should be noted that just a few plants of *Agropyron repens* L. has been found in organically growing flax field. Less number of

Galeopsis tetrahit L., *Equisetum arvense* L. and *Cirsium arvense* L. was found in small isolated flashpoints. In flax crop grown by the conventional technology weed number was very low, only 5-7 units in square meter. The *Poa annua* L. dominated in conventional technology flax fields and several plants of *Polygonum persicaria* L., (sin. *Persicaria maculosa* L.) and *Viola arvensis* L. were found. Perennial weeds were not found in these crops.

Many authors suggest, that weed problem in organic crop may be solved by crop rotation [18, 19, 20]. Weed problem in fiber flax crop rotation in Jurbarkas distr. was tackled by applying the black fallow like a flax preceding crop. Black fallow was harrowed twice in the spring before flax sowing. Due to favourable weather conditions – warm weather and adequate moisture content before flax sowing, weeds germinated and were destroyed in a satisfactory manner. After flax sowing, favorable weather conditions, good flax seed quality and emergency benefited to good flax sprout and its ability to compete with the rest shoots of annual weeds.

Different weather conditions were in Panevėžys district in 2007. In the spring before flax sowing soil was cool and a lack of moisture was noted, therefore before harrowing weeds not sprouted. Flax was sown, and germinated process lasted for a long time and weeds emerged previously. Further followed prolonged rainy period, weeds have raised together with flax, and even faster than they, and crop harrowing was impossible. At flax green maturity stage the crop was abundant and widespread with various species of annual and perennial weeds. A plenty of perennial weed species: *Sonchus arvensis* L., *Cirsium arvense* L., *Centaurea cyanus* L., *Artemisia vulgaris* L., *Matricaria inodora* L. and *Agropyron repens* L. were identified the flax crop. The most widespread annual weeds were *Chenopodium album* L., *Viola arvensis* Murray *Poa annua* L., and biennial (overwintering) *Myosotis arvensis* (L.) Hill, *Papaver rhoeas* L., and *Tragopogon pratensis* L. The abundance of weeds in the flax crop was conditioned by preceding crop – organically grown peas.

The preceding crop of fiber flax grown by conventional technology in Upytės eksperimentinis ūkis field was winter wheat. In this field weed number was low, only 3-8 units in square meter. Perennial weeds were not found in the crop. Only few species were identified in conventional technology grown flax: a *Viola arvensis* L., *Fumaria officinalis* L., *Galium aparine* L.

For linseed growing the years 2008 and 2009 were moderate favourable. Linseed preceding crop in 2008 was winter wheat for both growing technologies and for conventional technology in 2009. For linseed grown by organic technology preceding crop in 2009 was old grassland (perennial grasses).

The incidence of weeds was different in both years and depended upon meteorological conditions: there were 13-33 units of weeds in square meter in 2008 and in 2009 we found from 119 to 534 units of weeds in square meter.

Overall the number of weed species (growing linseed by both technologies) was 17 species in 2008. In 2009, in organic farming system, the total number of weed species was 30, and in conventional farming system – 24 (Table 1).

K. Heller states that earlier some weed species as *Lolium remotum* Schrank, *Spergula arvensis* L. subsp. maxima (Weiche) O. Schwarz, *Camelina alyssum* (Mill.) Thell. and *Cuscuta epilinum* Weihe Ex Boenn. were found only in flax crop. The results of research on segetal weed communities in fibre flax crop in Poland show that now weed communities in fibre flax crop consist of several species typical for cereals and root crops: *Chenopodium album* L., *Polygonum convolvulus* L., *Viola arvensis* Murr., *Stellaria media* Vill., *Lamium amplexicaule* L., *Thlaspi arvense* L., *Elymus repens* (L.) Gould, and *Polygonum nodosum* Pers. and weed species typical for flax are not found [21].

Table 1.

The detected weed species in linseed crop (%). Upytė, 2008-2009.

Weed species	Detection in crop %			
	Organic farming		Conventional farming	
	2008	2009	2008	2009
Anagallis arvensis	0	1	0	0
Artemisia vulgaris	0	1	0	0
Barbarea vulgaris	0	1	0	7
Chenopodium album	20	15	16	19
Chenopodium polyspermum	11	1	16	0
Centaurea cyanus	0	7	0	0
Cerastium arvense	0	1	0	2
Cirsium arvense	0	1	0	0
Convolvulus arvensis	5	2	4	0
Descurainia sophia	0	1	0	2
Erysimum cheiranthoides	0	2	0	1
Erodium cicutarium	2	1	4	4
Euphorbia helioscopia	0	0	0	1
Fumaria officinalis	1	0	1	1
Galeopsis tetrahit	0	0	1	1
Galium aparine	3	1	0	2
Mentha arvensis	2	1	0	0
Myosotis arvensis	1	1	1	7
Papaver rhoeas	1	1	2	1
Persicaria maculosa	4	4	6	4
Polygonum aviculare	5	4	2	5
Raphanus raphanistrum	12	15	5	11
Rumex acetosella	2	3	0	1
Silene pratense	6	6	5	7
Spergula arvensis	0	2	0	0
Solanum nigrum	0	0	0	1
Sonchus arvensis	0	2	0	0
Stelaria media	17	1	13	1
Tripleurospermum perforatum	0	3	0	0
Tussilago farfara	0	1	0	0
Veronica arvensis	0	3	1	6
Viola arvensis	6	5	3	4
Apera spica-venti	0	0	15	1
Elytrigia repens	2	5	5	4
Poa annua	0	8	0	7
Total:	100	100	100	100

Summarizing our research results of weed diversity in linseed, we can conclude that annual weeds, typical for cereals and root crops – *Chenopodium album* L., *Chenopodium polyspermum* L., *Raphanus raphanistrum* L., *Stellaria media* L. (2008) and *Chenopodium album* L., *Raphanus raphanistrum* L., *Poa annua* L. (2009) prevailed in linseed crop in both:

in organic and in conventional farming systems. Perennial weeds had recessive position in linseed crop.

The results of investigation showed that in linseed crop grown on the organic farming weed number ranged from 215 to 534 units in square meter. In linseed crop grown in conventional farming weed number was 119-312 units in square meter.

Conclusions

1. The diversity of weed species in fiber flax fields was not various. The *Sonchus arvensis* L. dominated in the organic flax field. Weed density in some places reached 130 to 150 units in square meter. In flax crop grown by a conventional technology weed number was very low, only 5-7 units in square meter, *Poa annua* was dominating weed specie. Perennial weeds were not found in flax grown in conventional cropping system. Weed problem in fiber flax crop rotation in Jurbarkas distr. was solved applying the black fallow like a flax preceding crop.
2. Unfavourable weather conditions for flax emergency and preceding crop – organically grown peas – determined abundance of weeds in the flax crop grown in organic farming in Panevėžys distr. Only few species of weeds were identified in flax crop, grown by conventional technology, probably due to preceding crop – winter wheat.
3. Research results of weed diversity in linseed crop allowed concluding that annual weeds prevailed in both: in organic and in conventional farming systems.
4. The preceding crop and weather conditions (not depending on growing technology) can determine diversity and the composition of the weed species in fiber flax and linseed crop.

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Summary

The incidence of weeds is one of the biggest problems in organic growing of flax and linseed. Presented in the article research results showed the possibilities of flax and linseed growing in organic farm and weed diversity in these crop.

Weed diversity investigations in the fiber flax crop were carried out in Jurbarkas and Panevėžys districts in 2007. Fiber flax variety 'Hermes' was cultivated in all tested fields. Weed problem in fiber flax crop rotation in Jurbarkas distr. was tackled by applying the black fallow like a flax preceding crop. Black fallow was harrowed twice in the spring before flax sowing so weed species composition in flax was not various. The *Sonchus arvensis* L. dominated, and less quantity of *Poa annua* L. *Convolvulus arvensis* L. and *Fallopia convolvulus* L. was found. In flax crop grown by the conventional technology weed number was very low, only 5-7 units in square meter. Perennial weeds were not found in these crops.

In Panevėžys district before flax sowing in the spring soil was cool and a lack of moisture was noted, therefore before harrowing weeds not sprouted. Further followed prolonged rainy period, weeds have raised faster than flax, and crop harrowing was impossible. The abundance of weeds in the flax crop was conditioned by weather conditions and by preceding crop – organically grown peas. The most widespread weeds were *Sonchus arvensis* L., *Cirsium arvense* L., *Centaurea cyanus* L., *Artemisia vulgaris* L., *Matricaria inodora* L., *Agropyron repens* L., *Chenopodium album* L., *Viola arvensis* Murray *Poa annua* L., *Myosotis arvensis* (L.) Hill, *Papaver rhoeas* L., and *Tragopogon pratensis* L.

Weed diversity investigations in the linseed crop were carried out on the Upytės eksperimentinis ūkis fields. Linseed variety 'Biltstar' was cultivated. The incidence of weeds was different in both years and depended upon meteorological conditions: there were 13-33 units of weeds in square meter in 2008 and in 2009 we found from 119 to 534 units of weeds

in square meter. The annual weeds *Chenopodium album* L., *Chenopodium polyspermum* L., *Raphanus raphanistrum* L., *Stellaria media* L. (2008) and *Chenopodium album* L., *Raphanus raphanistrum* L., *Poa annua* L. (2009) prevailed in linseed crop in both: in organic and in conventional farming systems. Perennial weeds had recessive position in linseed crop.

Results of our investigations showed that the preceding crop and weather conditions not depending on growing technology can determine diversity and the composition of the weed species in fiber flax and linseed crop.

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