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The effect of spring barley (*Hordeum vulgare* L.) sowing rate on the dynamics of crop weediness at different development stages

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Abstract

The experiment was carried out during the period 2004–2006 at the Lithuanian University of Agriculture's Experimental Station. Spring barley 'Aura' was sown at 0, 120, 200 and 280 kg ha^{-1} seed rates (0, 2.7, 4.5, and 6.2 million seeds ha^{-1}). Dynamics of weediness was established having assessed weed density and species composition in a spring barley crop at the beginning and end of tillering, at booting, heading, milk and hard maturity stages. The number of weed species varied between 20 and 27. The prevalent weeds in the spring barley crop were annuals *Chenopodium album* L., *Stellaria media* (L.) Vill. and *Erysimum cheiranthoides* L., while perennials *Sonchus arvensis* L., *Cirsium arvense* (L.) Scop. and *Equisetum arvense* L. were in the minority. At the beginning of the growing season, from the beginning to the end of spring barley tillering, the number of weeds increased from 150–169 m^{-2}, 245–332 m^{-2}, 14–19 m^{-2} to 169–171 m^{-2}, 310–371 m^{-2} and 60–73 m^{-2} in 2004, 2005 and 2006, respectively. At later growth stages, weed density consistently declined to 66–75 m^{-2} in 2004, 166–204 m^{-2} in 2005 and 44–62 m^{-2} in 2006, except for the lowest seed rate crop in 2006, where weed density increased to 88 m^{-2} in spring barley at hard maturity stage. With increasing seed rate (up to 280 kg ha^{-1}) and crop density, weed density consistently decreased to 28.2% and 49.8%, compared with the lower seed rates 120 kg ha^{-1} and 200 kg ha^{-1}. Spring barley seed rate did not have any significant influence on the spread of perennial weeds. In the crop-free soil, formation of weediness was in conformity with spring barley crop weed density dynamics, only was characterized by a higher number of weeds (to 458 weeds m^{-2}) which naturally filled in the vacant ecological niches in a field. At the end of spring barley growing season, in the crop-free plots, the number of perennial weeds was up to 10-fold higher compared with any of the crop densities tested.

Key words: *Hordeum vulgare*, seed rate, weed species, weediness dynamics, weed density, growth stages, competition.

Introduction

In the science of agronomy, considerably high attention is paid to the solution of weediness problems in crops. Many research works and studies are carried out looking for the weed spreading ways, reasons and crop competition. Cultural plant competition is one of the most important means increasing crop productivity (Lazauskas, 1990; Pilipavičius, 2007; Romaneckienė, 2007). Agriculture has an important task to secure high quality of the agricultural products decreasing costs of production and maintaining nature balance (Nazarko et al., 2005). Crops naturally cover consistent patterns of plant communities. In crops, competition occurs both within a species and between different species (Lazauskas, Pilipavičius, 2004). One of the most important forms of plant competition is for vegetative factors (Antanaitis, Švedas, 2000). When conditions for cultural plant development and growth are unfavourable, competition between the crop plants and weeds begins and crop yield decreases (Lazauskas, 1990). Biological and ecological regularities of weed development form the main principals of their control (Pilipavičius, 2007). Competitive ability of cultural plants and weeds depends on plant sowing time, seed rate and seed biomass (Mohler, 2001). In denser crops weeds are more smothered (Pilipavičius et al., 2011). The economic threshold of weed harmfulness in such crops is higher and yield losses are lower because of lower weediness (O'Donovan et al., 1999; Stougaard, Xue, 2005). Selection of proper seed rate of cultural plants is an important factor strengthening domination of the crop and reducing crop weediness. The thinner the crop is, the more weeds spread in it and they are larger (Mohler, Galford, 1997; Pilipavičius et al., 2011). Annual weeds, such as *Tripleurospermum perforatum* and *Galium aparine,* develop better in sparser crop, while perennial ones develop worse (Arlauskienė, Maikštėninenė, 2004). With increasing crop density, the amount of perennial weeds increases, while that of annual weeds decreases by 17% (Maikštėnienė et al., 2006). Increasing spring barley density, barley sprouting energy and weed smothering ability are better used.

The study deals with weed density dynamics in a spring barley crop and crop-free soil. The aim of the experiment was to establish spring barley seed rate influence on weed density dynamics.

Materials and methods

Experimental site and soil type. A field experiment was conducted during the period 2004–2006 at the Lithuanian University of Agriculture's Experimental Station (54°52′ N, 23°49′ E). The soil of the experimental site is *Calc(ar)i-Endohypogleyic Luvisol* (*LVg-n-w-cc*) drained clay loam on sandy light loam. The soil agrochemical characteristics are presented in Table 1. Agrochemical soil properties were established at the LUA's Experimental Station using the IR ray spectrometer PSCO/ISI IBM-PC 4250. Soil samples for agrochemical analyses were taken from 0–20 cm soil layer at the end of June from 10 sites of all treatments and their replications, making composite samples. Index of soil total nitrogen in our experiment was not established, hence other researchers reported total nitrogen amount of 1.3–1.47 g kg^{-1} in soil of LUA's Experimental Station (Marcinkevičienė, Butkevičienė, 2009).

Table 1. Soil agrochemical properties of 0–20 cm arable layer
LUA Experimental Station, 2004–2006

Index	Spring barley seed rate kg ha^{-1}				Statistical indexes	
	0	120	200	280	SE	*P*
2004						
pH	7.04	7.05	7.07	7.04	0.008	0.399
Humus %	2.48	2.46	2.49	2.45	0.125	0.381
Phosphorus (P_2O_5) mg kg^{-1}	283.25	283.25	294.95	287.6	3.792	0.706
Potassium (K_2O) mg kg^{-1}	153.65	144.28	145.64	156.41	2.477	0.237
2005						
pH	7.06	7.03	7.02	7.12	0.015	0.05
Humus %	2.49	2.48	2.50	2.50	0.006	0.566
Phosphorus (P_2O_5) mg kg^{-1}	271.75	266.93	262.21	281.46	5.032	0.593
Potassium (K_2O) mg kg^{-1}	184.32	175.20	171.59	155.52	4.697	0.194
2006						
pH	7.06**	7.13	7.13	7.12	0.009	0.008
Humus %	2.23	2.26	2.27	2.25	0.011	0.762
Phosphorus (P_2O_5) mg kg^{-1}	140.81	123.96	155.91	131.59	6.278	0.301
Potassium (K_2O) mg kg^{-1}	196.91	197.31	185.99	194.52	7.529	0.957

Note. Control treatment – 200 kg ha^{-1} seed rate; * – 95% probability level, ** – 99% probability level, SE – standard error.

Experimental design. Spring barley was sown at four sowing densities 0, 120, 200 and 280 kg ha^{-1} (0, 2.7, 4.5 and 6.2 million seeds per ha^{-1} respectively). The control treatment was chosen 200 kg ha^{-1} of seeds as a conventionally used seed rate in agriculture. The weed abundance dynamics was established according to growth and development stages (decimal code according to Meier (1997): beginning of tillering 25^1, 22^2, 20^3; end of tillering 29^1, 29^2, 29^3; booting 39^1, 37^2, 39^3; heading 51^1, 51^2, 52^3; milk maturity 73^1, 71^2, 75^3; hard maturity 92^1, 97^2, 92^3 (*Note:* ^{1} – 2004; ^{2} – 2005; ^{3} – 2006). Experiments consisted of 4 replicates of a randomized design. The initial (brutto) plots were 150 m^2 (6 x 25 m) and the netto plots were 138 m^2.

General conditions of spring barley growing. In 2004, the fore-crop was maize, in 2005 spring barley and in 2006 sugar-beet. Complex phosphorus, potassium and nitrogen fertilizers $N_{60}P_{60}K_{60}$ "Azofoska" (N:P:K 16:16:16) were applied on spring barley in spring after sowing before emergence. Two-row barley 'Aura' was sown within the first ten days of May following the scheme of sowing 0, 120, 200 and 280 kg seed ha^{-1} (0, 2.7, 4.5 and 6.2 million seeds ha^{-1} respectively). After spring barley, the soil was disc harrowed at 10–12 cm depth and after four weeks it was ploughed with a mould-board plough at a depth of 23–25 cm. After maize and sugar-beet, the soil was ploughed at 23–25 cm depth by a mould-board plough in the autumn. In spring, after all three fore-crops the soil was harrowed at 3–5 cm depth, and before sowing it was loosened and harrowed at 3–5 cm depth. Emerged spring barley crop was not harrowed. Herbicides and other pesticides were not applied.

Meteorological conditions. During all three experimental years meteorological conditions often varied. However, average data of meteorological conditions were similar to average long-term meteorological data. The weather conditions during spring barley vegetation are presented in Table 2. The air temperature in May 2004 was lower by 1.6ºC and amount of rainfall was less by 4.6 mm compared with the long-term average. The air temperature in June was lower by 1.3ºC, in July by 0.4ºC and in August by 1.2ºC compared with long-term average. The amount of rainfall was lower compared with long-term average in June and July by 0.1 and 6.1 mm respectively, when in August it topped the long-term average by 32.3 mm. May and June of 2005 and 2006 were warmer and wetter than in 2004 and cooler and considerably wetter (except dry June in 2006) than long-term average. July of 2005 and 2006 was not just warmer than in 2004, but even topped long-term average by 2ºC and 3.9ºC, accordingly. August of 2005 and 2006 was a bit cooler compared with 2004, likely, because rainfall in August increased 1.4 (2005) and 1.7 (2006) times more than in 2004 (Table 2).

Table 2. Average air temperatures and rainfall during spring barley growing season
Kaunas (Noreikiškės) Weather Station, 2004–2006

Index	Month			
	May	June	July	August
	2004			
Air temperature ºC	11.0	14.2	16.6	17.9
Rainfall mm	38.3	62.9	78.5	98.0
	2005			
Air temperature ºC	12.1	15.0	19.0	16.7
Rainfall mm	76.9	78.1	45.4	136.2
	2006			
Air temperature ºC	12.5	16.5	20.9	17.8
Rainfall mm	74.5	18.0	70.7	165.6
Long term average 1974–2006				
Air temperature ºC	12.6	15.5	17.0	16.7
Rainfall mm	42.9	63.0	84.6	65.7

Weediness dynamics was established by a quantitative method. In each experimental plot, two continuous plots (50 x 50 cm, 0.25 m^2) were set up to establish weediness – number of weed species and their density. The data were recalculated into weed number per square meter. Weeds were counted according to the experimental design in the crop and crop-free plots at the beginning and end of tillering, at booting, heading, milk and hard maturity stages of spring barley. Nomenclature of Latin plant names was based on "Vascular Plants of Lithuania" (Gudžinskas, 1999).

Soil weed seed bank was established in soil samples taken at the end of June from an arable soil layer of 0–20 cm. The samples were taken from 10 places to make composite soil samples of every trial plot. Weed seeds were washed through 0.25 mm sieve and separated by saturated solution of high specific mass of NaCl (Rabotnov, 1958; Warwick, 1984).

Statistical data assessment. The research data were statistically evaluated by ANOVA method – one way analysis of variance, applying the *Sigma-Stat* software package. Standard error SE and reliability criterion of differences among treatments *P* were calculated (SPSS Science, 1997).

Results and discussion

Spring barley weediness dynamics experiment showed heterogenic distribution of weed species during 2004, 2005 and 2006. The number of weed species changed from 20 to 27. At the beginning of spring barley tillering, the number of weed species in the crop of different seed rate varied from 13 to 17 during 2004 and 2005. There were 8 weed species in 2006. The number of weed species in the crop tended to increase to 17–18 in 2004 and to 16–19 in 2005 at the hard maturity stage of spring barley. In 2006, the highest number of weed species was established at spring barley heading stage and reached 13–14 weed species, while they decreased to 10–12 at the hard maturity stage. Crop-free plots had favourable conditions for weed density development, hence, number of weed species in those plots remained similar to crop. The main change in the number of weed species was influenced by appearance and disappearance of weeds such as *Echinocloa crus-galli* (L.) P.Beauv., *Polygonum aviculare* L., *Poa annua* L., *Tussilago farfara* L. and other weeds that were low in number (Tables 3 and 4). Annual weeds prevailed in the crop of spring barley: *Chenopodium album* L., *Stellaria media* (L.) Vill., *Erysimum cheiranthoides* L., *Galium aparine* L., *Capsella bursa-pastoris* (L.) Medik. Perennial weeds were in the minority in the crop. *Sonchus arvensis* L., *Cirsium arvense* (L.)

Scop. and *Equisetum arvense* L. were more numerous of the perennial weeds. Investigating dynamics of *Chenopodium album* L., the highest density was established at the earliest growth stages of spring barley (2004–2006). At later growth stages of spring barley, *Chenopodium album* L. density continuously decreased irrespective of seed rate in 2004 and 2005. That is probably because of biological cycle of annual weed growth. During 2005–2006, *Chenopodium album* L. density increased at heading stage of spring barley and in 2006 the number of *Chenopodium album* L. increased even at the hard maturity stage of spring barley. Such shift in 2006 could be influenced by insufficient rainfall at the tillering and heading stages of spring barley inhibiting sprouting of *Chenopodium album* L. viable seeds that emerged at the end of crop vegetation. This regularity remained in unsown plots as well, where in natural growth conditions without spring barley competition, *Chenopodium album* L. density significantly increased in 2004 and tended to increase in 2005. It showed weed ability to emerge during the whole vegetation period due to favourable meteorological conditions and free ecological niches. The number of *Stellaria media* (L.) Vill. took the second place after *Chenopodium album* L. in crop and crop-free plots. However, as ephemeral weed *Stellaria media* (L.) Vill. has continuous regeneration through vegetation, morphologically belongs to stubble weeds (lower than ¼ crop high) that are well adapted to crop smothering ability and therefore it sustained with no significant change in density during vegetation in the crop of different seed rate. Perennial weeds such as *Sonchus arvensis* L. were present mainly in all crop and crop-free plots through spring barley vegetation period, however, at very low density (Tables 3 and 4).

Weediness dynamics evaluated in spring barley crop at the beginning and end of tillering, at booting, heading, milk and hard maturity stages (Tables 3 and 4) showed, that significant competition between weeds and spring barley was not established till barley booting growth stage. Similar data were obtained when at each weed count, seedlings were thinned-out analysing emergence of different weed species in other model continuous plots (Romaneckienė et al., 2009). At spring barley heading stage, significant inter-species competition started, weed density in crop consistently decreased with increasing spring barley sowing density.

Table 3. Weediness dynamics (weed density weeds m^{-2}) at the beginning of tillering, end of tillering and booting growth stages of spring barley in different seed rate crops

LUA Experimental Station, 2004–2006

Weeds	Growth stages of spring barley												Statistical indexes	
	beginning of tillering				end of tillering				booting					
	spring barley seed rate kg ha^{-1}													
	120	200	280	0	120	200	280	0	120	200	280	0	SE	*P*
	2004													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Amaranthus retroflexus L.	2.2	0.2	0.8	0.0	0.5	0.0	2.0	0.0	13**	7.8	9.7	1.2*	0.57	0.001
Capsella bursa-pastoris (L.) Medik.	3.0	3.2	2.8	2.5	8.3	9.2	6.3	3.5*	7.8	6.8	4.5	6.4	0.80	0.001
Chenopodium album L.	54.2	63.2	65.5	57.4	52.0	58.3	53.8	96.4**	46.2	44.7	45.7	80.2 **	1.57	0.001
Erysimum cheiranthoides L.	18.2*	10.8	11.7	9.1	2.7	5.0	3.7	13.3*	2.8	2.2	3.3	12.6**	1.17	0.001
Fallopia convolvulus (L.) A. Löve	3.7	0.7	1.8	1.9	5.5	3.0	2.7	2.1	4.5	2.7	2.7	3.6	0.57	0.001
Galeopsis tetrahit L.	0.0	0.0	0.0	0.0	0.0	0.0	0.5**	0.0	0.0	0.0	0.0	0.0	0.05	0.25
Galinsoga parviflora Cav.	0.0	0.0	0.0	0.0	0.0*	0.3	0.0	0.1	0.0	0.0	0.0	0.0	0.04	0.37
Galium aparine L.	10.2	15.8	14.2	21.6	27.5	19.3	21.0	28.7*	21.2*	8.7	10.2	25.6**	1.51	0.001
Juncus bufonius L.	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.34
Lamium purpureum L.	0.8	0.3	0.8	0.1*	0.0	0.2	0.2	1.0*	0.0	1.3	0.2*	0.0	0.13	0.002
Polygonum aviculare L.	0.0	0.2	0.0	0.0	0.1**	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.05	0.678
Polygonum lapathifolium L.	1.8	1.3	1.7	1.0	3.5	1.2	3.2	4.2*	1.5	2.0	0.8	2.8	0.18	0.009
Stellaria media (L.) Vill.	49.5	56.3	61.7	47.6	49.8	57.2	59.7	59.1	46.5	43.3	49.8	42.5	3.14	0.958
Thlaspi arvense L.	0.0	0.0	0.0	0.0	1.2	0.0	0.3	8.4**	0.0	0.0	0.0	1.5	0.14	0.001
Tripleurospermum perforatum (Merat) Lainz.	1.0	1.0	0.0	0.0	0.8	1.3	0.5	0.2	0.8	2.2	2.3	0.5	0.31	0.552
Viola arvensis L.	0.0	0.3	0.0	0.0	2.2	1.3	0.5	0.1*	0.0	0.0	0.0	0.0	0.16	0.003
Other annual	0.2	0.0	1.8	0.0	3.7	0.9	2.0	0.4	0.0	0.0	0.0	0.1	–	–
Total annual	144.8	153.3	162.8	141.2	158.0	157.4	156.4	217.7**	144.3	121.7	129.2	177.0**	2.69	0.001

Table 3 continued

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Cirsium arvense (L.) Scop.	2.5	3.3	1.7	0.0	4.8	5.2	4.2	0.1**	2.3	1.2	2.8	0.1	0.55	0.722
Equisetum arvense L.	0.2	0.0	0.2	0.0	0.5	2.2	0.2	0.2	0.0	0.4	0.0	0.2	0.10	0.730
Elytrigia repens (L.) Nevski.	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.01	0.697
Plantago major L.	0.0	0.0	0.0	0.0	0.7*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.39	0.948
Sonchus arvensis L.	2.2	4.0	3.2	4.0	3.7	3.8	9.0*	6.9	2.5	2.2	6.7*	5.2	0.72	0.643
Tussilago farfara L.	0.8	0.0	1.0	0.0	1.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.24	0.941
Total perennial	5.7	7.3	6.1	4.0	10.7	11.2	14.9	7.2	4.8	3.8	9.5	5.5	0.44	0.140
Total weeds	150.5	160.6	168.9	145.2	168.7	168.6	171.3	224.9	149.1	125.5	138.7	182.5	5.10	0.001
2005														
Capsella bursa-pastoris (L.) Medik.	16.8	23.7	15.7	8.9*	8.0	1.7	0.3	0.6	36.5*	25.8	27.2	34.3	0.93	0.007
Chenopodium album L.	73.2	99.0	63.5*	65.3	104.0	110.0	87.2	92.3	85.0	72.2	77.3	101.0	2.14	0.240
Erysimum cheiranthoides L.	55.0	54.2	34.0	31.1	46.8	37.9	37.0	71.1	9.5	8.8	7.8	13.3	1.26	0.002
Euphorbia helioscopia L.	4.6**	1.8	3.0	2.2	1.2	0.5	0.2	0.6	0.7	0.3	0.0	2.7	0.17	0.001
Fallopia convolvulus (L.) A. Löve	2.1	1.3	1.8	2.7	2.5	2.5	4.3	4.6	2.7	4.8	3.2	7.3	0.22	0.023
Galium aparine L.	41.1*	29.8	33.0	48.9**	39.3	43.2	31.0*	33.4	24.0	25.8	19.7	49.0**	0.84	0.001
Polygonum lapathifolium L.	1.2	0.5	1.8	1.3	2.2	2.2	2.0	14.6**	3.3	1.3	2.0	6.3*	0.27	0.001
Sinapis arvensis L.	5.9	7.7	5.5	1.8**	4.0**	7.8	3.3**	2.0**	3.8	5.2	2.2*	2.0	0.21	0.001
Stellaria media (L.) Vill.	99.1	106.0	74.3	145.8	115.2	145.8	121.0	200.9	72.3	69.3	62.5	81.3	3.26	0.007
Tripleurospermum perforatum (Mérat) Laínz.	0.8	1.5	2.3	0.1	2.8	4.3	1.5*	0.6*	2.5	2.2	1.8	0.3	0.19	0.001
Veronica persicaria L.	8.8**	4.3	4.2	6.2	9.2**	4.3	4.2	7.1	5.8	3.0	1.7	1.0	0.26	0.001
Other annual	0.3	0.0	0.9	0.4	2.4	1.2	2.6	1.5	0.9	0.7	3.4	3.0	–	–
Total annual	308.9	329.8	240.0**	314.7	337.6	361.4	294.6*	429.3*	247.0	219.4	208.8	301.2*	5.21	0.001
Cirsium arvense (L.) Scop.	1.3	0.8	2.0	3.1	1.3	1.0	5.0*	2.3	1.5	2.5	7.0*	3.7	0.25	0.001
Equisetum arvense L.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.6	6.3**	0.39	0.698
Plantago major L.	0.0	0.0	0.2	0.0	2.7	5.8	6.3	1.1	0.5	0.0	0.7	0.0	0.16	0.001
Sonchus arvensis L.	1.9	1.7	3.0	10.7*	3.0	3.0	4.0	25.7**	2.5	1.8	5.2	19.3**	0.54	0.001
Tussilago farfara L.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.07	0.041
Total perennial	3.2	2.5	5.2	13.8	7.0	9.8	15.3	29.1**	4.7	4.3	13.2	29.0**	–	–
Total weeds	312.1	332.3	245.2*	328.5	344.6	371.2	309.9	458.4*	251.7	228	222.0	330.2*	0.78	0.001
2006														
Capsella bursa-pastoris (L.) Medik.	0.2	0.7	0.0	0.0	2.3	1.5	3.0	1.0	5.2	3.8	3.3	1.7	0.21	0.012
Chenopodium album L.	6.2	3.5	5.7	4.3	18.0	13.5	13.0	21.0*	18.5	14.0	14.3	15.3	0.508	0.001
Euphorbia helioscopia L.	0.0	0.0	0.0	0.0	0.5	0.5	0.2	1.3	0.7	0.8	0.5	1.7	0.07	0.001
Fallopia convolvulus (L.) A. Löve	1.2	0.5	0.5	2.0	3.5	2.2	1.7	7.0*	5.7	3.2	2.3	8.0*	0.25	0.001
Galium aparine L.	9.0	8.0	6.0	4.7	8.0	5.5	11.8	3.7	4.8	4.3	5.7	4.0	0.34	0.088
Lamium purpureum L.	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	1.7	0.7	0.5	0.3	0.261	0.001
Sinapis arvensis L.	0.2	0.0	0.2	0.3	1.7**	5.0	1.5**	7.7*	1.8	3.7	2.2	4.7	0.18	0.001
Stellaria media (L.) Vill.	1.3	3.5	1.3	1.3	7.3	9.5	7.7	6.0	10.0	7.7	7.2	6.7	0.23	0.062
Veronica persicaria L.	0.7	0.3	0.5	0.3	29.0*	19.5	21.7	14.3	28.8	22.0	23.2	18.3	0.81	0.001
Viola arvensis L.	0.2	0.2	0.0	0.0	0.6	0.5	0.5	0.3	1.7	1.3	1.2	1.0	0.085	0.575
Other annual	0.0	0.0	0.0	0.8	1.9	0.2	0.4	3.7	1.2	0.7	0.2	4.0	–	–
Total annual	19.0	16.7	14.2	13.7	72.8*	57.9	62.2	66.0	80.1*	62.2	60.6	65.7	1.47	0.001
Equisetum arvense L.	0.0	0.0	0.2	2.7	0.2	1.8	0.5	9.0**	0.0	2.0	0.0	17.0**	0.308	0.001
Sonchus arvensis L.	0.0	0.5	0.1*	0.0	0.0	0.2	0.0	0.7	0.3	0.3	0.0	0.7	0.036	0.002
Total perennial	0.0	0.5	0.3*	2.7	0.2	2.0	0.5	9.7	0.3	2.3	0.0	17.7	0.31	0.001
Total weeds	19.0	17.2	14.5	16.4	73.0	59.9	62.7	75.7	80.4*	64.5	60.6	83.4*	1.51	0.001

Notes. Control treatment – 200 kg ha^{-1} seed rate. * – 95% probability level, ** – 99% probability level. SE – standard error. Other annuals 2004: *Chaenorhinum minus* L., *Echinochloa crus-galli* (L.) P.Beauv., *Euphorbia helioscopia* L., *Poa annua* L., *Veronica persicaria* L.; 2005: *Chaenorhinum minus* L., *Echinochloa crus-galli* (L.) P.Beauv., *Galeopsis tetrahit* L., *Poa annua* L.; 2006: *Chaenorhinum minus* L., *Erysimum cheiranthoides* L., *Myosotis arvensis* (L.) Hill., *Polygonum lapathifolium* L.

Table 4. Weediness dynamics (weed density weeds m^{-2}) at heading, milk and hard maturity stages of spring barley in different seed rate crops

LUA Experimental Station, 2004–2006

Weeds	Growth stages of spring barley												Statistical indexes	
	heading				milk				hard					
	spring barley seed rate kg ha^{-1}													
	120	200	280	0	120	200	280	0	120	200	280	0	SE	*P*
	2004													
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Amaranthus retroflexus L.	4.0	9.3	7.3	1.2**	6.5	5.2	5.6	0.5	0.0	0.0	0.0	0.0	0.57	0.001
Capsella bursa-pastoris (L.) Medik.	5.2	3.7	1.5	6.2	6.0	4.3	3.0	13.2**	1.5	0.5	1.0	19.5**	0.80	0.001
Chenopodium album L.	42.2	34.2	31.8	79.8**	44.2	30.5	33.7	87.0**	17.8	14.8	15.7	103.4**	1.57	0.001
Erysimum cheiranthoides L.	6.2	4.2	4.3	12.6*	4.8	5.3	4.7	10.8*	4.0	3.5	2.8	19.7	1.17	0.001
Fallopia convolvulus (L.) A. Löve	5.3	3.2	2.8	3.6	4.2	4.5	3.8	11.0**	5.0	3.2	3.3	10.4**	0.57	0.001
Galeopsis tetrahit L.	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	0.2	0.0	0.05	0.25
Galinsoga parviflora Cav.	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.3	0.0	0.0	0.04	0.37
Galium aparine L.	10.7	6.5	9.0	25.7**	9.8	8.0	7.8	41.6	4.3	5.2	3.0	29.9	1.51	0.001
Juncus bufonius L.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.34
Lamium purpureum L.	0.5	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.2	0.2	0.0	0.0	0.13	0.002
Polygonum aviculare L.	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.05	0.678
Polygonum lapathifolium L.	2.7	1.2	1.3	2.9	4.2	1.8	0.5	3.2	4.0*	1.0	0.7	6.6**	0.18	0.009
Stellaria media (L.) Vill.	38.3	44.3	44.8	41.9	35.0	47.8	44.3	45.6	29.0	41.0	33.2	43.1	3.14	0.958
Thlaspi arvense L.	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.14	0.001
Tripleurospermum perforatum (Merat) Lainz.	1.2	0.8	0.0	0.5	1.3*	3.2	1.5	1.2*	0.5	0.5	0.0	1.1	0.31	0.552
Viola arvensis L.	0.3	0.3	0.0	0.0	0.3	1.0	0.2	1.6	0.0	0.0	0.0	0.2	0.16	0.003
Other annual	0.0	0.0	0.0	0.1	5.0	2.0	0.2	3.3	1.1	0.5	0.5	2.0	–	–
Total annual	116.6	107.7	102.8	176.0**	121.3	114.7	105.6	220.2**	67.4	70.9	60.4	235.9**	2.69	0.001
Cirsium arvense (L.) Scop.	3.0	1.0	2.7	0.1	3.0	1.5	3.0	1.1	4.0	0.8	2.3	1.1	0.55	0.722
Equisetum arvense L.	0.0	0.7	0.0	0.0	0.5	0.0	0.0	0.4	0.5	0.3	0.2	0.3	0.10	0.730
Elytrigia repens (L.) Nevski.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.01	0.697
Plantago major L.	0.5	0.0	0.0	0.0	0.7	0.2	0.0	0.4	0.5	0.2	0.0	0.4	0.39	0.948
Sonchus arvensis L.	2.3	1.7	5.0	5.3	2.8	3.0	4.2	6.3	1.5	2.0	2.7	7.3*	0.72	0.643
Tussilago farfara L.	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.4	0.8	0.0	0.5	0.0	0.24	0.941
Total perennial	5.8	3.4	7.7	5.4	8.0	4.7	7.2	8.6	7.5	3.3	5.9	9.1	0.44	0.140
Total weeds	122.4	111.1	110.5	181.4	129.3	119.4	112.8	228.8	74.9	74.2	66.3	245.0	5.10	0.001
	2005													
Capsella bursa-pastoris (L.) Medik.	35.8*	25.8	24.7	34.3	40.8**	19.0	21.8	37.2**	24.5*	12.7	12	35	0.93	0.007
Chenopodium album L.	72.2	67.3	73.3	101.0*	86.8	86.7	63.7	75.3	69.5	74.9	43.8	83.3	2.14	0.240
Erysimum cheiranthoides L.	8.8	8.0	7.7	11.7	6.8	9.7	6.2	11.6	4.0	7.7	2.8	11.6	1.26	0.002
Euphorbia helioscopia L.	6.5**	2.7	1.3	1.0	2.5	2.0	1.3	0.7	0.5	0.3	0.3	1.5	0.17	0.001
Fallopia convolvulus (L.) A. Löve	3.2	4.0	5.2	7.3	4.7	5.2	4.3	5.0	4.3	5.5	6.5	5.5	0.22	0.023
Galium aparine L.	23.0	25.8	21.0	49.3**	20.0	16.3	12.5	25.7	7.7	9.7	7.8	13.5	0.84	0.001
Polygonum lapathifolium L.	1.7	2.7	2.0	6.3	3.3	3.7	4.5	5.7	2.5	2.7	4.2	8.7**	0.27	0.001
Sinapis arvensis L.	3.3	4.3	1.8*	2.0	0.8	1.7	0.2	2.3	2.0	2.3	1.0	0.0	0.21	0.001
Stellaria media (L.) Vill.	66.2	57.2	59.2	81.3	42.8	44.2	37.0	41.0	58.0	63.3	56.8	28.0	3.26	0.007
Tripleurospermum perforatum (Mérat) Laínz.	2.7	2.2	2.0	0.3	3.8	5.3	2.8*	0.4**	4.0	4.5	3.5	0.4*	0.19	0.001

Table 4 continued

1	2	3	45	56	6	7	8	9	10	11	12	13	14	15
Veronica persicaria L.	0.5	0.0	0.3	0.0	0.7	0.0	0.3	0.0	3.0	1.2	1.3	0.4	0.26	0.001
Other annual	1.3	1.5	2.7*	6.4	5.3	3.0	7.5	11.3	5.3	5.2	12.0	6.0	–	–
Total annual	225.2	201.5	201.2	300.9**	218.3	196.8	161.9	216.2	185.3	190.0	152.0	193.9	5.21	0.001
Cirsium arvense (L.) Scop.	2.3	2.2	6.5*	3.7	2.5	1.8	6.7**	4.7	2.3	2.3	5.0	4.0	0.25	0.001
Equisetum arvense L.	0.0	0.0	0.3	0.0	0.2	0.0	0.3	0.3	0.3	0.0	0.2	8.4**	0.39	0.698
Plantago major L.	0.5	0.0	0.3	6.3	0.8	0.7	0.3	7.3	12.2	3.3	5.8	0.0	0.16	0.001
Sonchus arvensis L.	3.0	2.2	4.8	19.3**	3.5	3.3	5.2	22.3**	4.2	3.0	2.3	18.9**	0.54	0.001
Tussilago farfara L.	0.5	0.0	0.7	0.0	1.8*	0.7	1.8*	0.0	0.0	0.0	0.5	0.4	0.07	0.041
Total perennial	6.3	4.4	12.6	29.3**	8.8	6.5	14.3	34.6	19.0*	8.6	13.8	31.7**	–	–
Total weeds	231.5	205.9	213.8	330.2	227.1	203.3	176.2	250.8	204.3	198.6	165.8	225.6	0.78	0.001
						2006								
Capsella bursa-pastoris (L.) Medik.	2.2	1.3	0.7	1.7	4.8	6.0	3.0*	2.0*	5.0	4.0	2.5	2.3	0.21	0.012
Chenopodium album L.	19.3*	13.2	10.7	20.0	22.0*	15.7	15.2	20.0	24*	16.8	13.3	20.7	0.508	0.001
Euphorbia helioscopia L.	0.8	0.7	0.5	1.7	0.7	0.8	0.5	1.7	0.7	0.7	0.0	1.3	0.07	0.001
Fallopia convolvulus (L.) A. Löve	5.7	2.7	1.5	7.0*	5.5	3.5	2.2	7.0	6.5	3.8	2.2	5.3	0.25	0.001
Galium aparine L.	7.8	5.8	6.6	4.3	4.8	4.7	4.2	4.3	2.2	2.5	3.2	2.0	0.34	0.088
Lamium purpureum L.	6.0*	3.2	1.2	1.3	8.8	6.2	4.8	1.3*	10.5	8.0	3.3**	0.0	0.261	0.001
Sinapis arvensis L.	0.5	0.5	0.5	7.0**	0.5	0.5	1.5	7**	0.3	0.7	0.2	8.3**	0.18	0.001
Stellaria media (L.) Vill.	5.7	5.5	5.7	6.3	8.2	6.2	3.7	6.3	8.5	6.7	5.0	8.7	0.23	0.062
Veronica persicaria L.	10.7	7.7	6.7	7.3	18.7	19.2	17.8	7.3*	30.0*	17.0	14.2	5.3*	0.81	0.001
Viola arvensis L.	0.2	0.3	0.2	1.0	0.7	0.7	0.8	1.0	0.3	0.2	0.2	1.7	0.085	0.575
Other annual	1.3	1.0	0.5	2.3	0.9	1.0	0.7	2.0	0.6	0.5	0.2	1.3	–	–
Total annual	60.2*	41.9	34.8	59.9	75.6	64.5	54.4	59.9	88.3**	60.9	44.3*	56.9	1.47	0.001
Equisetum arvense L.	0.0	2.8	0.3	10.7**	0.0	2.8	0.3	10.7**	0.0	0.8	0.0	8.3	0.308	0.001
Sonchus arvensis L.	0.3	0.0	0.2	0.6*	0.2	0.0	0.2	0.7*	0.0	0.0	0.0	0.3	0.036	0.002
Total perennial	0.3	2.8	0.5	11.3*	0.2	2.8	0.5	11.4*	0.0	0.8	0.0	8.6	0.31	0.001
Total weeds	60.5*	44.7	35.3	71.2*	75.8	67.3	54.9	71.3	88.3**	61.7	44.3*	65.5	1.51	0.001

Note. Explanation under Table 3.

The highest weed density was established in the sparsest crops (seed rate 120 kg ha^{-1}) during all three experimental years. In dense crops, significantly less amount of PAR – photosynthetically active radiation reached soil surface and weeds growing at the lowest crop layers (Romaneckienė et al., 2008 b). Many weeds and their seedlings naturally died because of too intensive shading. In the same experimental field, it was established, that the highest number of weeds died (83–287 weeds m^{-2}) in the densest crop of spring barley (280 kg ha^{-1}, 6.2 million seeds ha^{-1}). The least weed kill (21–134 weeds m^{-2}) occurred at tillering and booting stages of barley, and at heading and milk maturity stages weed seedling death amounted to 118–316 weeds m^{-2}. The weed seedling death constituted 43–71% weeds evaluating spring barley crops of all three seed rates – densities (Romaneckienė et al., 2008 a).

The highest number of weed species (27) was established during spring barley vegetation in 2004. At the end of spring barley tillering, in all plots of crop a very similar number of weeds was found: annual 156–158 weeds m^{-2} and perennial 11–14 weeds m^{-2}. From spring barley booting to hard maturity stage, weed density decreased while seed rate increased, except perennial weeds for which crop density-seed rate had no significant effect (Tables 3 and 4). As a result, denser crop was not able to smother perennial weeds. During three years of field experiment the highest weed incidence in spring barley crop was in 2005. Although weed density was higher, the number of weed species (20) was lower than in 2004 and by a few species (16) higher than in 2006 (Tables 3 and 4). The increase in field crop weediness was influenced by spring barley monoculture. It was confirmed evaluating soil seed bank as well. In 2004, sowing 120 and 200 kg ha^{-1} of spring barley seeds the crop soil contained 16 thousand m^{-2} weed seeds in 0–20 cm arable soil layer. In 2005, on the same plot, growing spring barley continuously soil weed seed bank increased by 5–8 thousand to 21–24 thousand m^{-2} weed seeds in 0–20 cm arable soil layer. Soil weed seed bank increase constituted 32% (crop of 120 kg ha^{-1}) and 20% (crop of 200 kg ha^{-1}). In unsown plot, without weed control, soil seed bank increased even more drastically, weed seed number increase constituted 44% compared experimental year 2005 with 2004 (Table 5). The change of experimental field in 2006 naturally changed soil seed bank that was bigger by 6–20% comparing with the seed bank of crop soil in 2005. Conversely, the number of weeds in spring barley crop in 2006 was lower than in 2005 (Tables 3 and 4). However, extremely dry period in 2006 during June (Table 2) with 18 mm rainfall, i.e. 5 times less than in 2005 and nearly 4 times less than in 2004 and long term average – probably was the main unfavourable factor inhibiting weed emergence. Decrease of weed seed number in crop-free soil in 2006 compared with 2005 and 2004 principally depended on the experimental field and seed distribution heterogenity in the soil. During all three experimental years, seeds of *Chenopodium album* L. and *Stellaria media* (L.) Vill. prevailed in the soil seed bank. Seeds of *Chenopodium album* L. accounted for 74.0–87.8% in 2004, 55.8–82.3% in 2005 and 61.4–71.2% in 2006 of the soil seed bank depending on crop seed rate (Table 5). According to other field trial experiments, *Chenopodium album* L. seeds dominated in the soil seed bank – 38–71% up to 85% in the fields of LUA Experimental Station (Pilipavičius, 2004).

Table 5. Weed seed number (thousand seeds m^{-2}) in 0–20 cm arable soil layer in spring barley different seed rate crops

LUA Experimental Station, 2004–2006

Weeds	Weed seed number in soil, thousand seeds m^{-2} of different seed rate crop kg ha^{-1}				Statistical indexes	
	0	120	200	280	SE	*P*
2004						
Chenopodium album L.	20.02	12.10	13.95	20.62	1.622	0.148
Stellaria media (L.) Vill.	2.15	0.00	1.40	2.14	0.449	0.304
Other	0.72	4.25	1.44	0.72	–	–
Total	22.88	16.35	16.78	23.47	1.901	0.419
2005						
Chenopodium album L.	22.88	19.79	15.40	17.69	1.802	0.590
Stellaria media (L.) Vill.	7.63	3.56	4.14	3.26	1.089	0.575
Other	10.48	0.69	1.36	0.72	–	–
Total	40.99	24.04	20.89	22.38	2.960	0.070
2006						
Chenopodium album L.	13.39	15.78	16.23	19.09	2.035	0.853
Stellaria media (L.) Vill.	2.92	4.25	6.29	2.76	0.808	0.407
Other	2.92	5.68	3.52	4.96	–	–
Total	19.23	25.69	26.03	26.80	2.381	0.753

Note. Control treatment – 200 kg ha^{-1}.

Similar dependence of crop density and fore-crop influence on crop weediness in cereals was established by Skuodienė and Daugėlienė (2003) and by Skuodienė (2005). Competition of inter-species started at spring barley heading stage. In all three experimental years, with increasing seed rate, weed density regularly decreased till spring barley hard maturity stage. The change in weediness in the lowest 120 kg ha^{-1} and the highest 280 kg ha^{-1} seed rate crops, showed significant weed density decrease by 7.0–12.8% in 2004 (except tillering growth stage when weed density increased by 1.5–12.2% in crops of higher seed rate), by 7.6–22.4% in 2005 and by 14.1–49.8% in 2006. Weed number decrease constituted to 28.2% in crop of 280 kg ha^{-1} seed rate compared with spring barley crop of 200 kg ha^{-1} (Tables 3 and 4). In 2006, at the end of spring barley tillering the lowest number of annual weeds (73 weeds m^{-2}) was in the crop of 120 kg ha^{-1} seed rate. In the sparsest crop of 120 kg ha^{-1} seed rate, higher weed density by 16% was established compared with the crop of the highest seed rate 280 kg ha^{-1} and lower density by 3.6% compared with crop-free soil. In the crop of 120 kg ha^{-1} seed rate, perennial weeds constituted 0.2 weeds m^{-2}. Whereas in crop-free plots, perennial weeds constituted 9.7 weeds m^{-2}. At booting stage of spring barley, weed number increased in all plots independent of barley seed rate and in crop-free plots the number of perennial weeds increased by 80.4% compared to tillering stage of spring barley. At heading, milk and hard maturity stages of spring barley, in the crops of higher seed rate weed number significantly decreased (Tables 3 and 4).

Crop weediness (weed number) dynamics directly depended on spring barley seed rate – crop density and in separate years on fore-crop. In other cereal crops similar weediness dynamics was established (Kropf, van Laar, 1993, Stancevičius, Trečiokas, 1995). Reduction of spring barley seed rates under Lithuanian field weediness conditions is inexpedient especially in lower-input farming systems. In the sparsest, less competitive crops, weeds spread more intensively, ripen more seeds, increase soil seed bank and potential weediness of subsequent crop (Pilipavičius, 2007).

Conclusions

1. Spring barley seed rate had significant influence on crop weediness – weed density.

1.1. Weed density at all spring barley development stages proportionally decreased with increase of seed rate of spring barley. With increasing spring barley seed rate up to 280 kg ha^{-1}, weed density consistently decreased to 49.8%, compared with the lowest seed rate 120 kg ha^{-1}. Comparing spring barely crops of 200 and 280 kg ha^{-1} seed rate, the highest decrease in weed number to 28.2% was established, except perennial weeds for which crop density had no significant effect.

1.2. Higher spring barley seed rate (280 kg ha^{-1}, 6.2 million seeds ha^{-1}) should be recommended for low-input or organic agriculture as ecologically acceptable method of weed control.

2. Significant competition between weeds and spring barley was not established from crop emergence till the end of tillering stage. The highest weed density of 169–171 weeds m^{-2} in 2004, of 310–371 weeds m^{-2} 2005 and of 61–83 weeds m^{-2} in 2006 was established at spring barley booting stage. Essential inter-species competition started from spring barley booting stage and continued till hard maturity stage, while weed density in crop decreased on average by 92% in 2004, 24% in 2005 and 11% in 2006 irrespective of the spring barley seed rate.

3. Weediness formation in unsown, crop-free soil corresponded with spring barley crop weediness dynamics. It was characterized by a higher number of weeds (to 458 weeds m^{-2}) which naturally filled in the ecological niches free from other plants (spring barley). At the end of spring barley vegetation period, in the crop-free plots, the number of perennial weeds was up to 10-fold higher compared with any of the crop densities tested.

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References

Antanaitis Š., Švedas A. Miežių derliaus ir kokybės ryšys su dirvožemio savybėmis ir tręšimu [Barley yield and quality in relation to soil properties and fertilisation (summary)] // Žemdirbystė=Agriculture. – 2000, vol. 72, p. 19–33 (in Lithuanian)

Arlauskienė A., Maikštėnienė S. Priešsėlių ir organinių trąšų poveikis vienamečių piktžolių plitimui skirtingose agrosistemose [The effects of preceding crops and organic fertilizers on the occurrence of short-lived weeds in different agrosystems (summary)] // Žemdirbystė=Agriculture. – 2004, vol. 88, No. 4, p. 102–116 (in Lithuanian)

Gudžinskas Z. Lietuvos induočiai augalai [Vascular plants of Lithuania (summary)]. – Vilnius, 1999. – 211 p. (in Lithuanian)

Kropf M. J., van Laar H. H. Modelling crop-weeds interactions. – Sweden, 1993, p. 12–115

Lazauskas P. Agrotechnika prieš piktžoles [Agronomical practices against weeds (summary)]. – Vilnius, 1990. – 216 p. (in Lithuanian)

Lazauskas P., Pilipavičius V. Weed control in organic agriculture by two layer plough // Journal of Plant Diseases and Protection. – 2004, Sonderheft XIX, S. 573–580

Maikštėnienė S., Velykis A., Arlauskienė A., Satkus A. Javų stelbiamosios gebos įtaka sunkiuose priemoliuose plintančioms piktžolėms [Investigations of weed-suppressing ability of cereals on clay loam soils (summary)] // Vagos. – 2006, vol. 72, No. 25, p. 25–32 (in Lithuanian)

Marcinkevičienė A., Butkevičienė L. M. Piktžolių ekologinių grupių pokyčiai žieminių rugių pasėlyje taikant įvairias sėjomainas [The changes of weed ecological groups in the winter rye crop grown in different crop rotations (summary)] // Žemdirbystė=Agriculture. – 2009, vol. 96, No. 1, p. 53–69 (in Lithuanian)

Meier U. Growth stages of Mono- and dicotyledonous plants. BBCH Monograph. – Berlin, 1997. – 622 p.

Mohler C. L. Enhancing the competitive ability of crops / Ecological management of agricultural weeds. – Cambridge, UK, 2001, p. 269–322

Mohler C. L., Galford A. E. Weed seedling emergence and survival: separating the effects of seed position and soil modification by tillage // Weed Research. – 1997, vol. 37, No. 3, p. 147–155

Nazarko O. M., van Acer R. C., Entz M. H. Strategies and tactics for herbicide use reduction in field crops in Canada: a review // Canadian Journal of Plant Science. – 2005, vol. 85, p. 457–479

O'Donovan J. T., Newman J. C., Harker K. N. et al. Effect of barley plant density on wild oat interference, shoot biomass and seed field under zero tillage // Canadian Journal of Plant Science. – 1999, vol. 79, p. 655–662

Pilipavičius V. Changes in soil weed seed bank according to spring barley maturity stages // Agronomy Research. – 2004, vol. 2, No. 2, p. 217–226

Pilipavičius V. Piktžolių plitimo dėsningumai ir adaptyvumas abiotiniams veiksniams: habilitacijos procedūrai teikiamų mokslo darbų apžvalga [Weed spreading regularity and adaptivity to abiotical factors: summary of the review of scientific works presented for dr. habil. procedure]. – Akademija, Kauno r., 2007. – 30 p. (in Lithuanian)

Pilipavičius V., Romaneckienė R., Romaneckas K. Crop stand density enhances competitive ability of spring barley (*Hordeum vulgare* L.) // Acta Agriculturae Scandinavica. Section B: Soil and Plant Science. – 2011. <DOI number: 10.1080/09064710.2010.539574> (in press)

Rabotnov T. A. Methods of botanical investigations // Journal of Botany. – 1958, vol. XLIII (43), No. 11, p. 1572–1581 (in Russian)

Romaneckienė R. Piktžolių ir vasarinių miežių konkurencija ir adaptacija skirtingomis aplinkos sąlygomis: daktaro disertacija [Weed-spring barley competition and adaptivity to different environmental conditions: doctoral dissertation (summary)]. – Akademija, Kauno r., 2007. – 119 p. (in Lithuanian)

Romaneckienė R., Pilipavičius V., Romaneckas K., Aliukonienė I. Piktžolių dygimo dinamika nesėtoje dirvoje ir skirtingo tankumo vasarinių miežių pasėlyje [Germination dynamics of species in non-sowed soil and in different density spring barley crop (summary)] // Vagos. – 2009, vol. 82, No. 35, p. 48–58 (in Lithuanian)

Romaneckienė R., Pilipavičius V., Romaneckas K. Piktžolių dygimas ir sunykimas skirtingo konkurencingumo vasarinių miežių pasėlyje [Weed emergence and death in the crop of spring barley of different copetitive ability (summary)] // Žemės ūkio mokslai. – 2008 (a), vol. 15, No. 1, p. 17–24 (in Lithuanian)

Romaneckienė R., Pilipavičius V., Šlapakauskas V., Romaneckas K. Vasarinių miežių pasėlį ir piktžoles pasiekianti FAR ir UVB spinduliuotė [PAR and UV-B radiation affecting spring barley crop and weeds (summary)] // Vagos. – 2008 (b), vol. 79, No. 32, p. 94–102

Skuodienė R. Trumpalaikių šienaujamų žolynų įtaka po jų auginamų žieminių kviečių piktžolėtumui [The impact of temporary grasslands for cutting on the incidence of weeds in winter wheat crops grown after the temporary grasslands (summary)] // Žemdirbystė=Agriculture. – 2005, vol. 89, No. 1, p. 125–138 (in Lithuanian)

Skuodienė R., Daugėlienė N. Piktžolių paplitimas svidrinių žolynų ir po jų auginamų žieminių kviečių agrofitocenozėse [The spread of weeds in the agrophytocenoses of *Festulolium* and winter wheat (summary)] // Žemdirbystė=Agriculture. – 2003, vol. 81, No. 1, p. 256–266 (in Lithuanian)

SPSS Science SigmaStat® Statistical Software, Version 2.0. User's Manual. – USA, 1997

Stancevičius A., Trečiokas K. Piktžolės specializuotose sėjomainose // Piktžolėtumo problemos dabartinėmis ūkininkavimo sąlygomis Baltijos regione. – Akademija, Kauno r., 1995, p. 250–261 (in Lithuanian)

Stougaard R. N. Xue Q. Quality versus quantity: spring wheat seed size and seedling rate effects on *Avena fatua* interference, economic returns and economic thresholds // Weed Research. – 2005, vol. 45, No. 5, p. 351–360

Warwick A.M. Buried seeds in arable soils in Scotland // Weed Research. – 1984, vol. 24, No. 4, p. 261–268

ISSN 1392-3196
Žemdirbystė=Agriculture, vol. 98, No. 2 (2011), p. 111–120
UDK 633.16"321":[631.531.01:631.816.1]:632.51

Vasarinio miežio (*Hordeum vulgare* L.) sėklos normos įtaka pasėlio piktžolėtumo dinamikai įvairiais vystymosi tarpsniais

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Santrauka

Tyrimai atlikti 2004–2006 m. Lietuvos žemės ūkio universiteto Bandymų stotyje. Pasėlis suformuotas pasėjus 0, 120, 200 ir 280 kg ha^{-1} (atitinkamai 0, 2,7, 4,5 ir 6,2 mln. ha^{-1}) veislės 'Aura' vasarinių miežių sėklų. Pasėlio piktžolėtumo dinamika nustatyta įvertinus piktžolių kiekį ir rūšinę sudėtį vasariniams miežiams esant krūmijimosi pradžios, pabaigos, bamblėjimo, plaukėjimo, pieninės ir kietosios brandos tarpsnių. Piktžolių rūšių skaičius kito nuo 20 iki 27. Vasarinių miežių pasėlyje vyravo trumpaamžės piktžolės *Chenopodium album* L., *Stellaria media* (L.) Vill. ir *Erysimum cheiranthoides* L., o daugiametės piktžolės *Sonchus arvensis* L., *Cirsium arvense* (L.) Scop. ir *Equisetum arvense* L. užėmė recesyvinę padėtį. 2004, 2005 ir 2006 m. vegetacijos pradžioje, nuo vasarinių miežių krūmijimosi tarpsnio, piktžolių skaičius didėjo atitinkamai nuo 150–169, 245–332 ir 14–19 vnt. m^{-2} iki 169–171, 310–371 ir 60–73 vnt. m^{-2} krūmijimosi tarpsnio pabaigoje. Vėlesniais vystymosi tarpsniais vasarinių miežių pasėlyje piktžolių skaičius dėsningai mažėjo iki 66–75 vnt. m^{-2} 2004 m., 166–204 vnt. m^{-2} 2005 m. ir 44–62 vnt. m^{-2} 2006 m., išskyrus 2006 m. mažiausios sėklos normos pasėlį, kuriame piktžolių skaičius padidėjo iki 88 vnt. m^{-2} vasariniams miežiams esant kietosios brandos. Didinant sėklos normą (iki 280 kg ha^{-1}) ir kartu pasėlio tankumą, piktžolių skaičius, palyginti su sėklos mažesnių normų 120 kg ha^{-1} ir 200 kg ha^{-1} pasėliais, dėsningai mažėjo, atitinkamai iki 28,2 ir 49,8 %. Daugiamečių piktžolių paplitimui vasarinių miežių sėklos normos neturėjo esminės įtakos. Vasariniais miežiais neapsėtoje dirvoje piktžolėtumo formavimasis atitiko pasėlio piktžolių kiekio kitimo dinamiką, tik pasižymėjo didesniu skaičiumi (iki 458 vnt. m^{-2}) piktžolių, kurios natūraliai užpildė kitų augalų neužimtas lauko ekologines nišas. Vasarinių miežių vegetacijos pabaigoje miežiais neapsėtoje dirvoje daugiamečių piktžolių buvo iki 10 kartų daugiau nei bet kurio tankumo pasėlyje.

Reikšminiai žodžiai: *Hordeum vulgare*, sėklos norma, piktžolių rūšinė sudėtis, piktžolėtumo dinamika, piktžolių skaičius, brandos tarpsniai, konkurencija.