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ENHANCEMENT OF COMPETITIVE ABILITY OF CEREALS TOWARDS WEEDS BY MEANS OF CROP ROTATIONS

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Abstract

A series of experiments was carried out during the period 1997–2004 to study the effects of crop rotations with a different proportion of winter and spring crops, various legume preceding crops and cover crops and their biomass use for green manure on weed infestation in cereals on a clay loam *Endocalcari-Endohypogleyic Cambisol* (*CMg-p-w-can*) under North Lithuania's conditions. Crop rotations with prevailing winter crops predetermined the reduction in perennial weeds in cereals. The occurrence of weeds in cereals was determined by the weed incidence in the preceding crops tested: red clover (*Trifolium pratense* L.), lucerne (*Medicago sativa* L.) and vetch-oats (*Vicia sativa* L., *Avena sativa* L.) mixture and by competitive ability of cereals. The biomass of clover and vetch-oat mixture incorporated as green manure tended to increase weed incidence in cereals. Undersowing of cover crops (*Trifolium pratense* L., *Lolium multiflorum* Lam., *Dactylis glomerata* L.) tended to reduce the weed emergence in cereals, compared to the crops without undersowing. Undersown red clover performed best at suppressing weeds during the cereal post-harvest period. Its positive effect persisted in the following year after incorporation of red clover biomass for green manure. The effect of post-harvest sown cover crops (*Raphanus sativus* L., *Sinapis alba* L.) on weed incidence in cereals was lower compared to undersown crops.

Key words: crop rotations, preceding and cover crops, green manure, cereals, weeds.

Introduction

Progress in cultural methods of weed control, as sustainable practices has accepted approach of involving the whole cropping system for weed management. Weed infestation is an important factor that determines not only crop yield but also conditions of environmental protection. The productivity of crops is largely influenced by the species of weeds, their development intensity and conditions of spreading. When choosing the structure of crops, it is always necessary to evaluate the competition of plants in agrocenoses. As a result, using competitive ability of crops it is possible to increase the productivity, reduce weed control costs and harm done to the environment.

Weeds are most severely suppressed by dense, wide-leafed perennial legumes or their mixtures with grasses /Ross et al., 2001/. Weed incidence is inhibited by the crops undersown in cereals, especially if they are left to grow in the post-harvest period as cover crops /Fisk et al., 2001/. Experimental evidence suggests that according to weed suppression capacity cruciferous cover crops are equivalent to stubble breaking or herbicidal control of stubble weeds /Kahnt, Eusterschulte, 2000/. However, some authors report that the effects of cover crops on weed control are insufficient and not all weed species are suppressed /Liebman et al., 2001; Hatcher, Melander, 2003/.

On North Lithuania's clay loam soils the most common crops are cereals, especially winter ones, because their yields are higher and more stable than those of spring ones /Velykis, Satkus, 2005/. However, with increasing the area of cereals in crop rotations, the incidence of weeds is increasing /Seibutis, Deveikytė, 2006/. In Lithuania the damage of weeds in the crops is evaluated in scores (from 1 to 10). Weed control becomes necessary, when harmfulness of weeds prevailing in crops is evaluated 4–10 scores on the scale /Špokienė, Povilionienė, 2003/. Winter crops choke better the more damaging rootstock and offset perennial weeds. Wintering annual weeds spread intensively in winter cereals /Milberg et al., 2000; Špokienė, Povilionienė, 2003/. Bond and Grundy especially stress the significance of crop rotations for weed management in organic farming systems /Bond, Grundy, 2001/. Therefore, crop rotation is an important constituent of weed control system as a preventive measure /Maikštėnienė, Arlauskienė, 2006; Szelezniak et al., 2008/.

The study was designed to estimate the effects of crop rotations with different proportions of winter and spring crops, various legume preceding crops, cover crops and their biomass, incorporated for green manure on weed infestation in cereals in clay loams.

Materials and methods

Soil and site. Research was carried out at the Joniškėlis Experimental Station of the Lithuanian Institute of Agriculture situated on an *Endocalcari-Endohypogleyic Cambisol* (*CMg-p-w-can*) of the northern part of Central Lithuania's lowland (56°21′ N, 24°10′ E) during the period 1997–2004. Topsoil characteristics were as follows: 27% clay, 50% silt, 23% sand, 2.2% humus and pH – 6.6. During the last 40 years, the annual means of temperature and total of precipitation were 6.1 °C and 547.4 mm.

Experimental designs. Estimating the influence of crop rotations with different proportions of winter and spring crops on weed infestation in cereal experiments were performed according to the design: 1. Without winter crops: 1) Vetch (*Vicia sativa* L.) and oat (*Avena sativa* L.), 2) Spring wheat (*Triticum aestivum* L.), 3) Spring triticale (x *Triticosecale* Wittm.), 4) Spring barley (*Hordeum vulgare* L.). 2. 25% winter crops: 1) Red clover (*Trifolium pratense* L.) and timothy (*Phleum pratense* L.), 2) Spring wheat, 3) Spring triticale, 4) Spring barley), 3. 50% winter crops: 1) Red clover and timothy, 2) Winter wheat (*Triticum aestivum* Host.), 3) Spring triticale, 4) Spring barley. 4. 75% winter crops: 1) Red clover and timothy, 2) Winter wheat, 3) Winter triticale (x *Triticosecale* Wittm.), 4) Spring barley. 5. 100% winter crops: 1) Red clover and timothy, 2) Winter wheat, 3) Winter triticale, 4) Winter barley (*Hordeum vulgare* L.) (Table 3). All crops were grown every year in four replicates.

Research on the impact of legume crops – red clover, lucerne, vetch and oats mixture as preceding crops and their biomass incorporated in the soil as green manure on the weed infestation in cereal agrocenoses, was conducted following the experimental design. Factor A – preceding crops for winter wheat: red clover, lucerne (*Medicago* *sativa* L.), vetch and oat mixture, factor B – organic manure: 1. 1st crop without manures, 2. 1st crop – green manure (Tables 2 and 3). Green manure was applied correspondingly to the crop: lucerne and clover aftermath (3.1 and 3.9 t ha^{-1} dry matter, respectively) at the beginning of plant flowering, and biomass of vetch and oat mixture (3.5 t ha^{-1} dry matter) upon completion of pod formation. Green material of plants was chopped, disked in and all the plots were stubble broken by a mouldboard stubble breaker, and after two weeks the soil was ploughed at a depth of 25 cm. Cereal sequence was as follows: winter wheat (1st crop) – winter wheat or spring barley (2nd crop). Cereals (2nd crop) were fertilised with mineral fertilisers according to soil $N_{min.}$

The effects of cover crops as well as of their biomass incorporated as green manure on the weed infestation in cereals was investigated following the experimental design – factor A: (cereal blocks): 1) Winter wheat, 2) Spring barley. Treatments of factor B (cover crops whose biomass was incorporated as green manure): 1) Without cover crop, 2) Oil radish (*Raphanus sativus* L.), 3) White mustard (*Sinapis alba* L.), 4) Red clover, 5) Cocksfoot (*Dactylis glomerata* L.), 6) Italian ryegrass (*Lolium multiflorum* Lam.) (Table 4). Red clover and Italian ryegrass were undersown in a winter wheat crop upon resumption of vegetative growth, and in spring barley – shortly after sowing. Cover crops as post-harvest crops: white mustard and oil radish were direct drilled by a stubble drill after cereal harvesting (on the same day). N_{30} was applied after cereal harvesting for optimal growth and development of oil radish, white mustard, cocksfoot and Italian ryegrass. The next year spring barley was grown on both cereal blocks after incorporation of cover crops biomass as green manure by ploughing in the autumn.

Experimental methods and assessments. In all experiments the herbicides with selective mode of action were applied against dicotyledonous weeds in cereals. Weed incidence in cereals was assessed twice during the growing period: number of weeds and species during tillering stage before application of herbicides (BBCH 27–29), during milk stage (BBCH 75–77) of cereals, while the biomass of dry material – only during the milk stage. Number of weeds and mass of dry material in cover crop was determined before cover crop biomass incorporation. Measurements were done in 0.25 m^2 fixed plots, four places per plot. The data of the number and mass of weeds for statistical analysis were transformed according to the formula: $\sqrt{x+1}$. The experimental data were processed by *Anova* and *Stat-Eng*.

Results and discussion

The effect of crop rotations with different proportion of winter and spring crops on the weed infestation in cereals. When increasing amount of winter crops in the structure of rotation, the total average number of weeds during the crop tillering stage was increasing. When growing only winter crops, there were significantly (26.9%) more weeds in the cereals, than in only spring crop rotation (Table 1). The spread of annual weeds, which made up to 82.0–96.1%, was even more distinct because of increasing of winter crop proportion. With 50% and more winter crops in the rotation, the amount of annual weeds significantly increased, compared with the rotation with a lower percent of winter crops. When growing more winter crops in the rotation, the amount of perennial weeds decreased.

During milk stage of the cereals the number of perennial weeds increased from 2.6 to 5.2 times, compared with tillering stage (3.9–18.0% of total number). When winter crops prevailed in the structure of the rotation, the average number of perennial weeds was much lower. During milk stage of the cereals, there were 13.7–39.4 perennial weeds per m^2, which made up 24.2–52.1% of the total weed amount. The lowest mass of weed dry material in the cereals was in the crop rotation with 75% of winter crops.

Table 1. The effect of winter crop proportion in rotations on weed infestation in cereals
1 lentelė. *Žieminių augalų dalies sėjomainoje įtaka javų piktžolėtumui*
Joniškėlis, 1999–2002

Proportion of winter crop in rotation % *Žieminių augalų dalis sėjomainoje %*	Cereal growth stage / *Javų augimo tarpsnis*			
	BBCH 27–29			BBCH 75–77
	weeds m^{-2} / *piktžolės vnt. m^{-2}*			mass of weed DM♦ g m^{-2} *piktžolių SM♦ masė g m^{-2}*
	total *bendras*	annual *trumpaamžės*	perennial *daugiametės*	
0	74.1	60.7	13.4	38.0
25	64.4	56.8	7.6*	27.9
50	80.1	72.8*	7.3*	28.5
75	84.9	79.4*	5.5*	22.8
100	93.8*	90.2*	3.6*	33.3

♦DM – dry matter / ♦*SM – sausosios medžiagos;* * – at $P < 0.05$ / * – *P < 0,05.*

In the final year of the crop rotation (2002), during the tillering stage of spring cereals: in wheat, triticale and barley crops annual weeds prevailed (*Thlaspi arvense* L. − 17.5%, *Fumaria officinalis* L. − 16.3%, *Galium aparine* L. − 14.6%, *Chenopodium album* L. − 12.3%) and perennial weeds made up on average 14.7% of the total amount (102 weeds m^{-2}). In winter cereals (wheat, triticale and barley) annual weeds were more prevalent (*Stellaria media* (L.) Vill − 36.0%, *Veronica arvensis* L. − 10.9%, *Viola arvensis* Murray − 8.3%, *G. aparine* − 7.7% and less prevalent (6.9%) were perennial weeds: *Cirsium arvense* (L.) Scop., *Sonchus arvensis* L., *Elytrigia repens* (L.) Nevski.

In spring cereals the prevailing weeds, when harmfulness was 4–10 scores /Špokienė, Povilionienė, 2003/ during the final rotation year made up 86.5% and in winter cereals 57.7%. When evaluating the effect of winter crops it could be concluded, that increasing proportion of them in the crop rotation structure to 75%, as those ones that have stronger suppressing ability, allowed to diminish the damage done by weeds to crops, especially because of lower spread of perennial and other harmful weeds.

The effects of legume preceding crops and their biomass incorporated as green manure on the occurrence of weeds in cereals. When winter wheat was grown after legume preceding crops, the number and species composition of weeds that emerged in spring during wheat tillering stage (BBCH 27–29) depended on the species of the preceding crop. The lowest number of weeds in wheat crop was identified after red clover, the difference, compared with lucerne and vetch and oats mixture as preceding crops, was by 25.7 and 16.6% lower (Table 2).

However, researchers found that the value of preceding crops for cereals depends on the duration of cultivation, management methods, fertilisation and harvesting dates /Bond, Grundy, 2001; Melander et al., 2005/. After all legume preceding crops, 10–12 weed species dominated in wheat crop. When winter wheat was grown after clover, the dominant weed species were *Lamium purpureum* L. (23.6 weeds m^{-2}) and *Tripleurospermum perforatum* (Merat) M. Lainz (9.9 weeds m^{-2}). However, after lucerne the soil accumulated more nitrogen and labile humic acids[4], which resulted in the occurrence of nitrophilous weeds in wheat crop: *S. media* (12.5 weeds m^{-2}), *G. aparine* (7.2 weeds m^{-2}), *Veronica arvensis* (7.3 weeds m^{-2}). Perennial weeds were more prevalent in winter wheat after lucerne. Under the effect of green manure the increase in weed number was insignificant (averaged data 9.6%).

Table 2. The effect of legume preceding crops and green manure on the weed infestation in winter wheat

2 lentelė. *Ankštinių priešsėlių ir žaliosios trąšos įtaka piktžolių plitimui žieminiuose kviečiuose*

Joniškėlis, 1997, 1998 and 2000

Preceding crops (A) *Priešsėlis (A)*	Green manure (B) *Žalioji trąša (B)*	Winter wheat growth stage *Žieminių kviečių augimo tarpsnis*		
		BBCH 27–29	BBCH 75–77	
		weed / *piktžolės*		
		number m^{-2} / *vnt.* m^{-2}		mass of DM♦ g m^{-2} *SM♦ masė g* m^{-2}
Red clover *Raudonieji dobilai*	Without manure / *Be trąšų*	56.1	22.0	7.8
	Clover aftermath / *Dobilų atolas*	70.1	24.1	8.5
	Average after clover *Vidutiniškai po dobilų*	63.1	23.1	8.1
Lucerne *Mėlynžiedės liucernos*	Without manure / *Be trąšų*	84.9**	30.2	12.5
	Lucerne aftermath *Liucernų atolas*	84.9**	26.5	13.7
	Average after Lucerne *Vidutiniškai po liucernų*	84.9**	28.4*	13.4*
Vetch and oat mixture *Vikių ir avižų mišinys*	Without manure / *Be trąšų*	72.5	19.9	5.9
	Green mass of mixture *Mišinio žalia masė*	78.9	27.2	11.3
	Average after mixture *Vidutiniškai po mišinio*	75.7	23.6	8.6
Average (B) *B veiksnio vidurkis*	Without manure / *Be trąšų*	71.2	24.0	8.7
	Green manure / *Žalioji trąša*	78.0	25.9	11.2

Note / *Pastaba*. ♦DM – dry matter / ♦*SM – sausosios medžiagos.*
* – at $P < 0.05$, ** – at $P < 0.01$ / * – *P <0,05*, ** – *P < 0,01.*

During wheat milk stage (BBCH 75–77), the differences between preceding crops equalised, due to applied herbicides although the largest number of weeds remained in lucerne preceding crop. The following weed species prevailed: *T. perfo-*

ratum, *S. media*, *Viola arvensis* and *Fallopia convolvulus* (L.) A. Löve. Under the effect of incorporation of legume preceding crop biomass as green manure, the greatest increase (36.7%) in weed incidence occurred after vetch and oats mixture. This was determined by weed seed (*S. media*, *F. convolvulus*, *T. perforatum*, *Veronica arvensis*) that got into the soil with the mixture's biomass incorporated as green manure. Experimental evidence obtained in other countries suggests that, harvesting of legumes before weed flowering reduces the chances for the weeds to spread seed /Magda et al., 2004/.

The highest mass of weed dry material was recorded in the treatments where best plant nutrition conditions were created: after preceding crop of lucerne and clover, and after incorporation of aboveground biomass of all crops as green manure. Under the effect of green manure the most marked increase in mass per weed occurred after incorporation of biomass of annual crop – vetch and oats mixture. The highest biomass per weed (*S. media*, *G. aparine*, *F. convolvulus*, *T. perforatum*) was determined when winter wheat had been grown after clover. However, in the wheat crop grown after lucerne, a lower biomass per weed (compared with clover preceding crop) was determined by the higher wheat suppressive ability (productive density 382 and 325 plants m^{-2}, yield 5.36 and 4.31 t ha^{-1} respectively).

When winter wheat is continuously grown, poorer phytosanitary growth conditions are created, which results in the appearance of ecological niches and extra environmental resources availability which are effectively exploited by weeds. During wheat milk stage, the number of weeds remained similar to that in the first year (Table 3).

During this stage the weed incidence was by 46.7 and 24.4% higher after vetch and oat mixture and lucerne preceding crops respectively compared with clover preceding crop. If the weed incidence in winter wheat after clover and lucerne did not distinguish by one prevalent weed species, the following weed species *S. media*, *F. convolvulus* and especially *C. album* dominated after vetch and oat mixture. Under the effect of lucerne and clover there was established a trend of the reduction in the number of annual wintering weeds.

The yield of continuously grown winter wheat was by on average 31.5% lower compared with that of wheat grown in the first year, whereas the mass of weed dry material in continuously grown wheat was twice as large as in the wheat grown in the first year. In continuously grown wheat weeds better exploited the positive potential of the preceding crop of lucerne than in the first year. Here the mass of weed dry material was the highest, especially that of *G. aparine*, *S. media*, *L. purpureum*, *T. perforatum*. The effect of vetch and oats mixture's green manure manifested itself on the productivity of cereals in the second year of effect; however winter wheat was not competitive and had a low suppressive ability.

Table 3. The effect of preceding crops and green manure on weed infestation in continuous winter wheat or changing species of cereal

3 lentelė. *Priešsėlio augalų ir žaliosios trąšos įtaka piktžolių plitimui atsėliavus žieminius kviečius ar pakeitus javų rūšį*

Joniškėlis, 1998, 1999 and 2001

Preceding crops (A) *Priešsėlis (A)*	Green manure (B) *Žalioji trąša (B)*	Winter wheat *Žieminiai kviečiai*			Spring barley *Vasariniai miežiai*		
		cereals growth stage / *javų augimo tarpsnis*					
		BBCH 27–29	BBCH 75–77		BBCH 27–29	BBCH 75–77	
		weed / *piktžolės*					
		number m^{-2} *vnt.* m^{-2}	number m^{-2} *vnt.* m^{-2}	mass of DM♦ g m^{-2} *SM♦ masė g* m^{-2}	number m^{-2} *vnt.* m^{-2}	number m^{-2} *vnt.* m^{-2}	mass of DM♦ g m^{-2} *SM♦ masė g* m^{-2}
Red clover *Raudonieji dobilai*	Without manure *Be trąšų*	65.2	20.4	10.7	46.1	10.7	7.0
	Clover aftermath *Dobilų atolas*	69.7	18.9	13.9	47.3	10.4	3.3
	Average after clover / *Vidutiniškai po dobilų*	67.5	19.7	12.3	46.7	10.6	5.2
Lucerne *Mėlynžiedės liucernos*	Without manure *Be trąšų*	99.5*	26.2*	23.1	53.2	11.8	4.2
	Lucerne aftermath *Liucernų atolas*	109.2*	22.7	20.8	47.8	12.0	2.6
	Average after Lucerne / *Vidutiniškai po liucernų*	104.4*	24.5*	22.0	50.5	11.9	3.4
Vetch and oat mixture *Vikių ir avižų mišinys*	Without manure *Be trąšų*	74.2	27.8*	15.3	53.8	17.1	3.1
	Green mass of mixture / *Mišinio žalioji masė*	78.3	29.9*	25.9	52.7	16.7	3.6
	Average after mixture / *Vidutiniškai po mišinio*	76.3	28.9*	20.6	53.3	16.9	3.4
Average (B) *B veiksnio vidurkis*	Without manure *Be trąšų*	79.6	24.8	16.4	51.0	13.2	4.8
	Green manure *Žalioji trąša*	85.7	23.8	20.2	49.3	13.0	3.2

Note / *Pastaba.* Explanations under Table 2 / *Paaiškinimai po 2 lentele.*

When winter wheat was replaced by spring barley with a shorter growing period, part of the annual wintering weeds specific to winter cereals did not have the chance to emerge and the weed incidence was by 39.3% (BBCH 25–27) and 46.3% (BBCH 75–77) lower compared with continuously grown wheat. Changes occurred in weed species composition: apart from the dominant *L. purpureum*, *S. media*, ecological niches were occupied by the weeds specific to spring cereals: *C. album*, *T. arvense* and others. The lowest number of weeds was found in barley (BBCH 75–77) after clover, whereas vetch and oats mixture determined by 59.4 and 42.0% higher weed incidence compared with clover and lucerne preceding crops. The mass of weed dry material depended not so much on the number of weeds as on the environmental resources and weed growth stage. A significantly higher mass of weed dry material was recorded after clover preceding crop. Green manure tended to reduce weed mass (except for vetch and oats mixture).

The effects of cover crops and incorporation of their biomass into the soil as green manure on weed occurrence in cereals. Cover crops grown in rotation have the potential to aid weed control in all production systems /Barberi, Lo Cascio, 2001; Barberi, 2002; Derksen et al., 2002; Hatcher, Melander, 2003/. By occupying ecological niche, all undersown cover crops tended to reduce weed emergence at cereals crop tillering growth stage (by on average 13.9%). The lowest number of weeds was in the agrocenozis with undersown Italian ryegrass, the difference, compared with the plots without cover crops, amounted to 23.3%. Winter wheat (there were 10–50 weeds per m^2) better suppressed weeds than spring barley (30–78 weeds m^{-2}). Undersowing offer scope for suppressing weeds in a rotation /Hartwig, Ammon, 2002/, but not always increased crop yield /Jorgensen, Moller, 2000/.

When undersown and post harvest sown cover crops were grown, the number of weeds varied annually and depended on the amount of precipitation and distribution during the autumn period, cover crop emergence time, density and competitive ability. In the years favourable for cover crop emergence and growth the structure of agrocenoses was composed of: cover crops – 97.8%, weeds – 2.2%. With an increase in aboveground mass of cover crops the total number of weeds and that of annual ones tended to decline ($r = -0.65$, $r = -0.64$; $P \leq 0.05$, respectively). The greatest reduction in weed incidence occurred after undersown cover crops: after wide-leafed legume red clover more than 52.5%, after narrow-leafed grasses – cocksfoot and Italian ryegrass 42.3 and 26.4%, respectively compared with the plot without cover crops. Diversity of species composition was low: of the annual weeds *Veronica arvensis* (2.6–26.8 weeds m^{-2}) and *F. convolvulus* (1.9–8.4 weeds m^{-2}), of perennial weeds – *Taraxacum officinale* F. H. Wigg. were most prevalent. The more abundant emergence of some weed species in cover crops grown as post harvest sown crops might have been promoted by soil loosening by drill coulters.

After incorporation of the cover crops biomass, the most prevalent weeds in barley (BBCH 25–27) were *G. aparine* (15.4–29.2 weeds m^{-2}) and *F. convolvulus* (3.7–13.5 weeds m^{-2}). In continuously grown barley 23.5% more weeds emerged, compared with barley grown after winter wheat (Table 4). Here the number of weeds specific to spring crops (*C. album* and *F. convolvulus*) was several times higher, and a greater positive effect of cover crops was revealed.

However, when spring barley was grown after winter wheat, weed species composition changed and the regularities were not as distinct. In both blocks of cereals (winter wheat and spring wheat) after incorporation of cover crops biomass the least number of weeds emerged after red clover (on average 12.2%, compared with the plot without cover crops). Literature sources point out allelophatic effect of *Brassicaceae* and *Fabaceae* family plants /Haramoto, Gallandt, 2005; Liebman, Sundberg, 2006/, however, the effect of oil radish and white mustard on weed emergence was not consistent. Cover crops reduced emergence of *F. convolvulus* and *Veronica arvensis* in the autumn, but in the years of effect tended to increase their emergence (by 19.1 and 14.7%, respectively). Linear relationships were established between the soil total nitrogen, organic carbon content and weed emergence in barley crop in spring ($r = 0.68$, $P \leq 0.05$; $r = 0.70$, $P \leq 0.01$, respectively).

Table 4. The effect of cover crops and cereal sequence on the incidence of weeds in spring barley

4 lentelė. *Tarpinių pasėlių ir javų sekos įtaka piktžolių plitimui vasariniuose miežiuose*

Joniškėlis, 2002–2004

Cover crop (B) *Tarpiniai pasėliai (B)*	Cereal blocks (A) / *Javų fonas (A)*					
	winter wheat / *žieminiai kviečiai*			spring barley / *vasariniai miežiai*		
	spring barley growth stage / *vasarinių miežių augimo tarpsnis*					
	BBCH 27–29	BBCH 75–77		BBCH 27–29	BBCH 75–77	
	weed / *piktžolės*					
	number m^{-2} *vnt. m^{-2}*	number m^{-2} *vnt. m^{-2}*	mass of DM♦ g m^{-2} *SM♦ masė g m^{-2}*	number m^{-2} *vnt. m^{-2}*	number m^{-2} *vnt. m^{-2}*	mass of DM♦ g m^{-2} *SM♦ masė g m^{-2}*
Without cover crop *Be tarpinių pasėlių*	73.4	50.0	4.0	95.4**	70.4**	10.2**
Oil radish *Aliejiniai ridikai*	65.8	41.8	3.8	98.4**	61.9	6.2
White mustard *Baltosios garstyčios*	76.6	49.5	3.9	77.6	54.7	6.2
Red clover *Raudonieji dobilai*	66.9	34.4	2.3	81.3	41.7	3.1
Cocksfoot *Paprastosios šunažolės*	75.4	44.6	4.7	98.5**	57.4	5.4
Italian ryegrass *Gausiažiedės svidrės*	73.1	57.2	8.3**	80.9	55.4	8.9**
Average (A) *Vidutiniškai A veiksnio*	71.8	46.2	4.5	88.7**	56.9	6.7

Note / *Pastaba*. Explanations under Table 2 / *Paaiškinimai po 2 lentele.*

The effect of the measures used on weed incidence revealed itself at the end of barley growing season (BBCH 75–77). There were significant negative correlations between the number of weeds and cover crops biomass and nitrogen content introduced with it ($r = -0.62$, $r = -0.67$; $P \leq 0.05$, respectively). The number of weeds was determined by *Veronica arvensis* (5.4–21.0 weeds m^{-2}) and *G. aparine* (6.4–10.9 weeds m^{-2}). In the years of cover crops effect, the number of weeds in spring barley declined (except for the effect of Italian ryegrass undersown in winter wheat). Much lower weed incidence in spring barley was recorded after red clover (undersown in winter wheat – 31.2%, in barley – 40.8%). Under its effect the incidence of *G. aparine* (26.7%), *Veronica arvensis* (57.9%) and *E. repens* (45.7%) declined. After the other cover crops the weed incidence declined more markedly when cover crops are grown in spring barley (12.1–22.3%).

Nitrogen incorporated with cover crops biomass tended to increase barley grain yield ($r = 0.56$, $P \leq 0.05$), which amounted to 5.02–5.54 t ha^{-1}, and its competitive ability against weeds. The greatest reduction in mass of weed dry material occurred after red clover: undersown in winter wheat – 42.5%, in barley – 69.6%. Cereals suppressed *G. aparine*, *L. purpureum*, *Veronica arvensis*, *S. media*, however, the mass of weed dry material of *C. album* and *F. convolvulus* increased.

Conclusions

1. When increasing the proportion of winter crops in the structure of crop rotation, annual weeds spread more abundantly than perennial ones in cereals. Crop rotations with prevailing winter crops as a means for decreasing weed incidence became most effective when they choked out the more harmful and especially the perennial weeds.

2. The effects of legume preceding crops – red clover, lucerne and vetch and oats mixture on the occurrence of weeds in cereals were determined by their weed incidence and cereal crops suppressive ability that formed under its effect. Biomass of clover and vetch and oat mixture incorporated as green manure tended to increase weed incidence. When winter wheat was replaced by spring barley, the weed incidence was lower compared with continuously grown wheat.

3. Undersown cover crops tended to reduce weed emergence in cereals. Of all the cover crops, red clover performed best at suppressing weeds during the post harvest period. Its positive influence persisted during the years of effect after incorporation of cover crops biomass. The effect of post–harvest sown cover crops on weed incidence in cereals was lower compared to undersown crops. Nitrogen–rich biomass of cover crops tended to increase cereal yield and suppressive ability against weeds.

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JAVŲ STELBIAMOSIOS GEBOS PIKTŽOLĖMS DIDINIMAS SĖJOMAINOSE

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S a n t r a u k a

Lietuvos žemdirbystės instituto Joniškėlio bandymų stotyje 1997–2004 m. daryti lauko bandymai, siekiant nustatyti sėjomainų su nevienoda žieminių ir vasarinių augalų dalimi, įvairių ankštinių priešsėlių, tarpinių pasėlių ir jų panaudojimo žaliajai trąšai įtaką piktžolių išplitimui javuose sunkaus priemolio giliau karbonatingame giliau glėjiškame rudžemyje (RDg8-k2), *Endocalcari-Endohypogleyic Cambisol* (*CMg-p-w-can*), Šiaurės Lietuvos sąlygomis. Sėjomainos, jose vyraujant žieminiams augalams, lėmė daugiamečių piktžolių kiekio sumažėjimą javuose. Ankštinių priešsėlių – raudonųjų dobilų (*Trifolium pratense* L.), mėlynžiedžių liucernų (*Medicago sativa* L.) ir vikių bei avižų (*Vicia sativa* L., *Avena sativa* L.) mišinio – piktžolėtumas ir po jų auginimo susiformavusi nevienoda javų pasėlių stelbiamoji geba lėmė piktžolių išplitimą juose. Javų piktžolėtumą turėjo tendenciją mažinti raudonųjų dobilų ir vikių bei avižų mišinio biomasė, įterpta kaip žalioji trąša. Įsėliniai tarpiniai pasėliai (*Trifolium pratense* L., *Lolium multiflorum* Lamk., *Dactylis glomerata* L.) turėjo tendenciją mažinti javų piktžolėtumą, palyginti su pasėliais be įsėlio. Javų popjūtiniu laikotarpiu piktžoles geriausiai stelbė įsėliniai raudonieji dobilai – teigiama įtaka išliko ir kitais metais po jų biomasės įterpimo žaliajai trąšai. Posėlinių tarpinių pasėlių (*Raphanus sativus* L., *Sinapis alba* L.) įtaka javų piktžolėtumui buvo silpnesnė, palyginti su įsėliniais augalais.

Reikšminiai žodžiai: sėjomainos, priešsėlis, tarpiniai pasėliai, žalioji trąša, javai, piktžolės.