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RESPONSE OF WEED FLORA IN BARLEY, WHEAT AND RAPE CROPS UNDER REDUCED SPRING - TIME TILLAGE

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Abstract

Weed flora in a crop rotation of spring barley, spring rape and spring wheat was studied under reduced spring-time tillage. The field experiment was carried out on a light loamy *Endocalcari - Endohypogleic Combisol* at Dotnuva site in the centre of Lithuania over the period 2003-2005. It was designed to investigate the effects of different spring-time tillage (ploughing to 15-17 cm depth, shallow stubble cultivation + sowing, direct drilling) on residual weed populations.

The dominant weeds were *Chenopodium album* L., *Lamium purpureum* L., *Stellaria media* (L.) Vill., *Veronica arvensis* L., *Elytrigia repens* (L.) Nevski, *Cirsium arvense* (L.) Scop., *Sonchus arvensis* L. and *Trifolium pratense* L. Annual broadleaf weeds were a clearly dominating group in all tillage systems, except for direct drilling.

In 2003 weed species densities varied between tillage systems. In 2004 and 2005 weed density was very similar in all tillage treatments except for direct drilling treatment. Ploughing increased the population of annual weeds compared to reduced tillage systems. Density and air-dry weight of perennial weeds in spring wheat and spring rape were significantly higher under direct drilling than after ploughing.

Key words: reduced spring-time tillage, barley, rape, wheat, weeds.

Introduction

Weeds in agricultural fields interfere with crop growth by competing for resources such as nutrients, water and light, and have merely been the targets of elimination in conventional agricultural practices /Clements et al., 1994/. However, exclusion of weed species from the agro – ecosystem may be unnecessary or even inappropriate in consideration of the agricultural system sustainability /Miyazawa et al., 2004/.

Weed communities present within agricultural fields are the end results of the interaction of agronomic, environmental, and ecological selection pressures. The management of these factors and the potential for the introduction of new species are the determinants of community composition /Derksen et al., 1996/. Ideal weed control in sustainable agriculture will be that which can increase species diversity, yet maintain weed biomass below a critical threshold against crop growth and yield /Miyazawa et al., 2004/.

Different primary tillage practices have therefore often led to diversification on weed flora. The effects on weed flora vary widely due to differences in local conditions and weed management /Vanhala, Pietola, 2003/. In some cases, pre-plant tillage is not necessary for weed control and weeds can be effectively controlled by the use of appropriate herbicides. Therefore, an understanding of tillage effects on weed flora is not conclusive /Gill, Arshad, 1995; Kobayashi et al., 2003/. Weed species and aerial mass are lowest under conventional tillage /Menalled et al., 2001/. Reduced tillage seems to favour occurrence of perennial weeds /Gill, Arshad, 1995; Locke et al., 2002; Tørresen et al., 2003; Kobayashi et al., 2004; Velykis, Satkus, 2006/. The perennial species, sowthistle (*Sonchus* L.) and quackgrass (*Elymus repens* L.) have been associated with conventional and reduced tillage systems and have increased in zero-tillage /Derksen et al., 2002/. The infestation of couch grass (*Elymus repens* L.) in reduced tillage is often so severe that chemical control with glyphosate is needed /Vanhala, Pietola, 2003/. Other authors suggest that in successful conservation tillage systems, the amount and cost of herbicides used is similar to that for herbicides used in conventional tillage systems /Moyer et al., 1994/. The results also indicate the complexity of weed communities in their response to different tillage – rotation combinations /Ghosheh, Al-Hajaj, 2004/.

The objective of this study was to compare the effects of different spring tillage systems (ploughing to 15-17 cm depth, shallow stubble cultivation + sowing, direct drilling) on residual weed populations.

Materials and methods

The field experiments were conducted from 2003 to 2005 at the Lithuanian Institute of Agriculture in Dotnuva. The soil was a light loamy *Endocalcari – Endo-hypogleic Combisol* with the content of humus 2.02-2.75 %, available phosphorus 99-142 and potassium 187-341 mg kg^{-1} of soil, pH 7.0-7.6. Spring barley was planted in 2003, spring rape in 2004, spring wheat in 2005 between April 24 and May 4. Spring barley stands were sprayed at BBCH 28-30 with Duplosan Super 1.2 l ha^{-1} (mekoprop-P + MCPA + dichlorprop-P 130+160+310 g a.i. l^{-1}), spring rape – at BBCH 11-14 with Butisan 400 2.5 l ha^{-1} (metazachlor 400 g a.i. l^{-1}), spring wheat – at BBCH 25-28 with Arrat 150 g l^{-1} + Dash 0.5 l ha^{-1} (tritosulphuron + dicamba 250+500 g a.i. l^{-1}). A randomized plot design with four replicates was used. Treatments consisted of five spring tillage systems:

1. Shallow spring-time ploughing (15-17 cm depth) with a mouldboard reversible plough in combination with a compactor. Shallow cultivation for seed bed preparation. Sowing with a shank seed drill. Rolling after sowing with a heavy ring roller (PS).

2. Shallow spring-time ploughing (15-17 cm depth) with a mouldboard reversible plough in combination with a compactor. Shallow cultivation for seed bed preparation. Sowing with a disc seed drill in combination with a heavy spiked roller (PD).

3. Shallow spring-time cultivation (5-7 cm depth) with a stubble cultivator consisting of sweep and disc coulters and spiked roller. Shallow cultivation for seed bed preparation. Sowing with a shank seed drill. Rolling after sowing with a heavy ring roller (CS).

4. Shallow spring-time cultivation (5-7 cm depth) with a stubble cultivator consisting of sweep and disc coulters and spiked roller. Shallow cultivation for seed bed preparation. Sowing with a disc seed drill in combination with a heavy spiked roller (CD).

5. Direct drilling with a seed drill with disc coulters in combination with a heavy spiked roller (DD).

Weed count data (no. m^{-2}) were collected in all trials during each year after crop emergence, prior to herbicide application and before harvest. Weed biomass dry weights were recorded before harvest. Four counts of 0.25 m^2 each using metal quadrants were taken from each plot, resulting in a total sample area of 1 m^2.

The results thus obtained were statistically analyzed using ANOVA software. Weed weight data were transformed to $Y = \sqrt{(X+1)}$.

In 2003, the rainfall during barley vegetation was lower than long-term average, while the air temperature was higher (Table 1). Normal amount of rainfall and low temperature were favourable for weed growth and infestation. In this year weed population was the most one as compared with the other years. In the year 2004 lower rainfall was recorded in April, May and June as compared with the long-term average. High rainfall deficits over spring months of the year analyzed did reduce the weed infestation in the stand of spring wheat. The year 2005 showed rainfall deficit in April, May, June and July. High temperature and low rainfall, as compared with the long-term average were registered over spring rape vegetation and were unfavourable for weed germination.

Table 1. Weather conditions during crop growing season
1 lentelė. *Klimato sąlygos augalų augimo laikotarpiu*
Dotnuva Weather Station / *Dotnuvos meteorologinė stotis*

Month *Mėnuo*	Precipitation / *Krituliai* (mm)				Temperature / *Oro temperatūra* (°C)			
	2003	2004	2005	Mean *Vidurkis* 1924-2005	2003	2004	2005	Mean *Vidurkis* 1924-2005
April / *Balandis*	38	11	24	38	5.4	7.6	7.6	5.7
May / *Gegužė*	36	28	46	52	13.6	11.2	12.4	12.2
June / *Birželis*	55	44	50	62	15.5	14.2	15.3	15.6
July / *Liepa*	55	82	46	73	20.6	16.9	19.3	17.6
August / *Rugpjūtis*	66	94	76	74	17.3	18.1	16.8	16.6
Total / *Suma* (mm)	252	259	242	299				
Average / *Vidurkis* (°C)					14.5	13.6	14.3	13.5

Results and discussion

The weed flora in all tillage systems was dominated by annual broadleaf (6-14 species) compared with the perennial (2-4 species) weeds. Quackgrass (*Elytrigia repens* (L.) Nevski) was the only perennial grassy weed. Four broadleaf (*Chenopodium album* L., *Lamium purpureum* L., *Stellaria media* (L.) Vill., *Veronica arvensis* L.), three perennial (*Cirsium arvense* (L.) Scop., *Sonchus arvensis* L. and *Trifolium pratense* L.) and one grass (*E. repens*) species dominated in weed flora.

In 2003 weed species densities varied between tillage systems. Density of *C. album*, *L. purpureum*, *S. media*, *V. arvensis* and *Viola arvensis* Murray was high in ploughed plots. Wrzesińska et al. (2003) argues that under ploughing the abundance of *C. album*, *S. media*, and *Tripleurospermum perforatum (Merat) M. Lainz* increased. Before barley harvesting *E. repens* increased as compared with spring counts of weeds.

In 2004 when growing spring oil-seed rape the differences in densities of weeds were small. *L. purpureum*, *S. media*, *V. arvensis* and *Euphorbia helioscopia* L. were less abundant in shallow stubble cultivated plots but *Myosotis arvensis* (L.) Hill. – in ploughed plots.

In 2005 weed density in spring wheat was very similar in all tillage treatments except for direct drilling treatment. Direct drilling system affected the increase in *E. repens* number.

Tillage treatments had no significant effect on weed infestation before herbicide application, except for annual weeds density in the direct drilling soils (Fig. 1). Similar data were recorded in all experimental years. A decrease in annual weeds number was

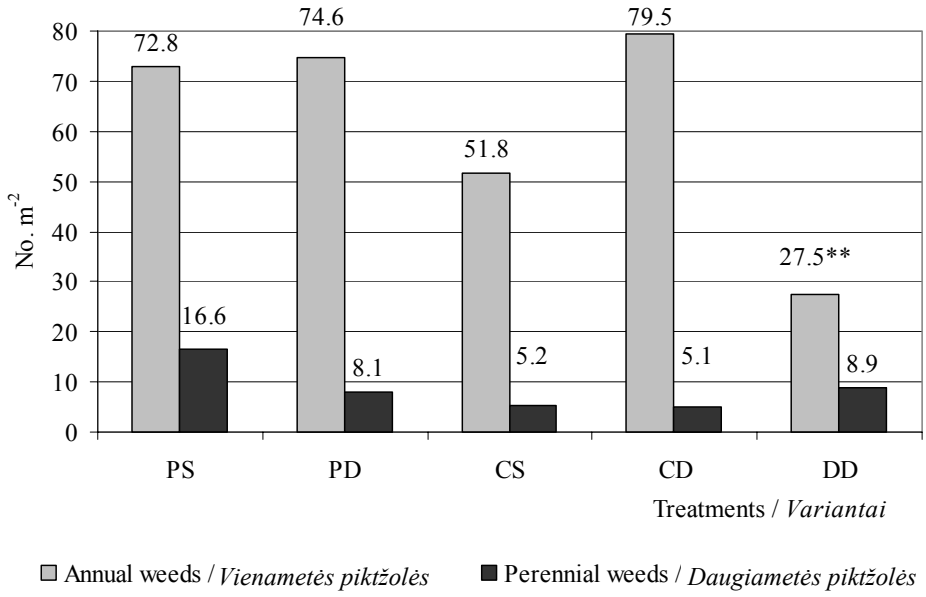

Figure 1. Weed density in different tillage systems before herbicide application,
** – significant at P < 0.1; PS – shallow ploughing, shank seed drill; PD – shallow ploughing, disc seed drill; CS – shallow cultivation, shank seed drill; CD – shallow cultivation, disc seed drill; DD – direct drilling

1 paveikslas. *Piktžolių skaičius prieš herbicidų purškimą, taikant skirtingas žemės dirbimo sistemas, ** – patikima, esant tikimybės lygiui P < 0,1; PS – arimas, inkarinė sėjamoji; PD – arimas, diskinė sėjamoji; CS – skutimas, inkarinė sėjamoji; CD – skutimas, diskinė sėjamoji; DD – tiesioginė sėja*

observed under no tillage, because in this system the soil remained undisturbed, and conditions were not suitable for seed germination. Similar data can be found in literature /Bilalis et al., 2001/. Perennial weeds were more abundant in the ploughed soil than in reduced tillage treatments. As proved by the studies of Knežević et al. (2003), the density of perennial weeds was significantly affected by tillage.

The largest differences in weed infestation between tillage practices were in the weed groups of annuals and perennials (Fig. 2). For example, the population of perennial weeds accounted for 12.5 and 33.8 times less plants per square meter after ploughing and shallow stubble cultivation, respectively, compared with direct drilling tillage, because their roots could not be destroyed by soil tillage. Perennial weed increase in direct drilled plots was also recorded during the two years of the experiment. Similar relationship was found by Stevenson et al., (1998), Bilalis et al., (2001) and Derksen et al., (2002). Annual broadleaf weeds were associated with ploughing treatment.

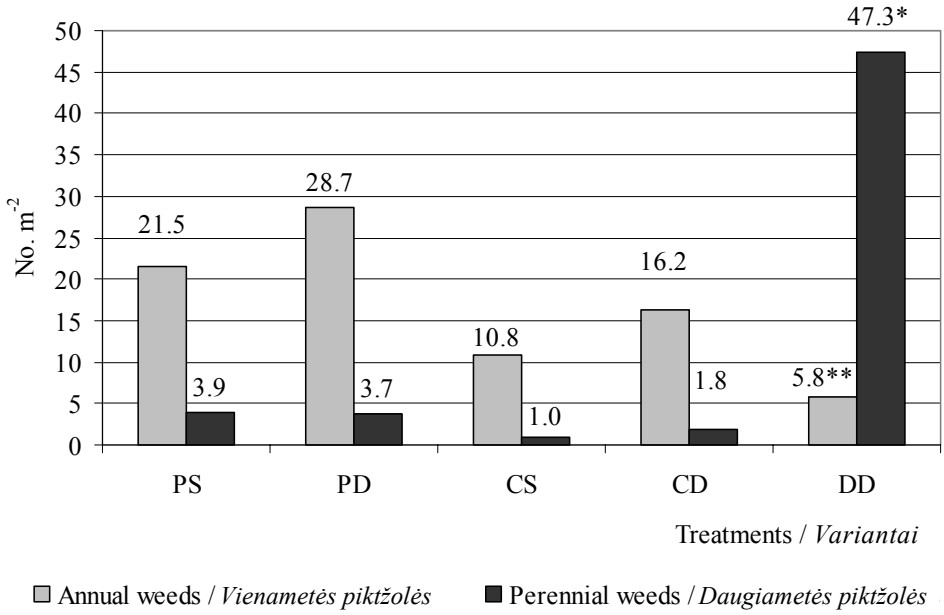

Figure 2. Weed density in different tillage systems before harvest, * – significant at P< 0.5; ** – significant at P < 0.1; PS – shallow ploughing, shank seed drill; PD – shallow ploughing, disc seed drill; CS – shallow cultivation, shank seed drill; CD – shallow cultivation, disc seed drill; DD – direct drilling

2 paveikslas. *Piktžolių skaičius prieš derliaus nuėmimą, taikant skirtingas žemės dirbimo sistemas, * – patikima, esant tikimybės lygiui P < 0,5; ** – patikima, esant tikimybės lygiui P < 0,1; PS – arimas, inkarinė sėjamoji; PD – arimas, diskinė sėjamoji; CS – skutimas, inkarinė sėjamoji; CD – skutimas, diskinė sėjamoji; DD – tiesioginė sėja*

In respect of the year, the weed air-dry weight of total weed population was lowest across all tillage treatments by 78 and 35 % in 2004 and 2005, respectively, compared to the first year of trial (Fig. 3). The highest weed weight was recorded under direct drilling in 2005. In 2003-2005, there was variation in the weed weight between treatments. Significant differences existed only in the direct drilling system.

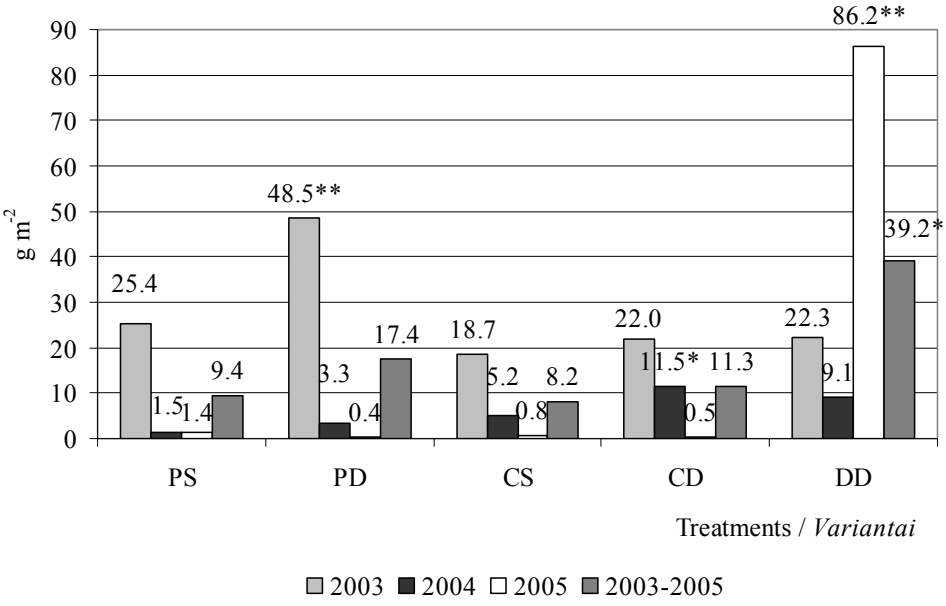

Figure 3. Weed air-dry weight in different tillage systems before harvest, * – significant at P < 0.5; ** – significant at P < 0.1; PS – shallow ploughing, shank seed drill; PD – shallow ploughing, disc seed drill; CS – shallow cultivation, shank seed drill; CD – shallow cultivation, disc seed drill; DD – direct drilling

3 paveikslas. *Piktžolių orasausė masė prieš derliaus nuėmimą, taikant skirtingas žemės dirbimo sistemas, * – patikima, esant tikimybės lygiui P < 0,5; ** – patikima, esant tikimybės lygiui P < 0,1; PS – arimas, inkarinė sėjamoji; PD – arimas, diskinė sėjamoji; CS – skutimas, inkarinė sėjamoji; CD – skutimas, diskinė sėjamoji; DD – tiesioginė sėja*

Conclusions

1. Ploughing increased the population of annual weeds compared to reduced tillage systems.

2. Density and air-dry weight of perennial weeds in spring wheat and spring rape were significantly higher under direct drilling than under ploughing.

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REFERENCES

1. Bilalis D., Efhimiadis P., Sidiras N. Effect of three Tillage Systems on Weed Flora in a 3-year Rotation with four Crops // Journal of Agronomy and Crop Science. - 2001, vol. 186, iss. 2, p.135-141

2. Clements D. R., Weise S. F., Swanton C. J. Integrated weed management and weed species diversity // Phytoprotection. - 1994, vol.75, p. 1-18

3. Derksen D. A., Blackshaw R. E., Boyetchko S. M. Sustainability, conservation tillage and weeds in Canada // Canadian Journal of Plant Science. - 1996, vol. 76, p. 651-659

4. Derksen D. A., Anderson R. L., Blackshaw R. E. et al. Weed Dynamics and Management Strategies for Cropping Systems in the Northern Great Plains // Agronomy Journal. - 2002, vol. 94, p. 174-185

5. Ghosheh H. Z., Al-Hajaj N. A. Impact of Soil Tillage and Crop Rotation on Barley (*Hordeum vulgare*) and Weeds in a Semi-arid Environment // Crop Science. - 2004, vol. 190, p. 374-380

6. Gill K. S., Arshad M. A. Weed flora in the early growth period of spring crops under conventional, reduced, and zero tillage systems on a clay soil in northern Alberta, Canada // Soil Tillage Research. - 1995, vol. 33, p. 65-79

7. Knežević M., Đurkić M., Knežević I. et al. Effects of pre- and post-emergence weed control on weed population and maize yield in different tillage systems // Plant Soil Environment. - 2004, vol. 49, iss. 5, p. 223-229

8. Kobayashi H., Miura S., Oyanagi A. Effects of winter barley as a cover crop on the weed vegetation in a no-tillage soybean // Weed Biology and Management. - 2004, vol. 4, p. 195-205

9. Kobayashi H., Nakamura Y., Watanabe Y. Analysis of weed vegetation of no-tillage upland fields based on the multiplied dominance ratio // Weed Biology and Management. - 2003, vol. 3, p. 77-92

10. Locke M., Reddy K. N., Zablotowicz R. M. Weed management in conservation crop production systems // Weed Biology and Management. - 2002, vol. 2, p. 123-132

11. Menalled F. D., Gross K. L., Hammond M. Weed aboveground and seedbank community responses to agricultural management systems // Ecological Applications. – 2001, vol. 11, p. 1586-1601

12. Miyazawa K., Tsuji H., Yamagata M. et al. Response of weed flora to combinations of reduced tillage, biocide application and fertilization practices in a 3-year crop rotation // Weed Biology and Management. - 2004, vol. 4, p. 24-34

13. Moyer J. R., Roman E. S., Lindwall C. W. et. al. Weed management in conservation tillage systems for wheat production in North and South America // Crop Protection. - 1994, vol. 13, iss. 4, p. 243-259

14. Stevenson F. C., Légère A., Simard R. R. et al. Manure, Tillage, and Crop Rotation: Effects on Residual Weed Interference in Spring Barley Cropping Systems // Agronomy Journal. - 1998, vol.90, p.496-504

15. Tørresen K. S., Skuterud R., Tandsæther H. J. et al. Long-term experiments with reduced tillage in spring cereals. I. Effects on weed flora, weed seedbank and grain yield // Crop protection. - 2003, vol. 22, iss. 1, p. 185-200

16. Vanhala P., Pietola L. Effect of conservation tillage and peat application on weed infestation on a clay soil // Agricultural and Food Science in Finland. - 2003, vol. 12, p. 133-145

17. Velykis A., Satkus A. Influence of crop rotations and reduced tillage on weed population dynamics under Lithuania's heavy soil conditions // Agronomy Research. - 2006, vol. 4, p. 441-445

18. Wrzesińka E., Dzienia S., Wereszczaka J. Wpływy systemów upravy roli na ilość i rozmieszczenie nasion chwastów glebie // Acta Science Poland, Agricultura. - 2003, vol. 2, iss. 1, p. 169-175

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VASARINIŲ MIEŽIŲ, VASARINIŲ KVIEČIŲ IR VASARINIŲ RAPSŲ PIKTŽOLĖTUMO KITIMAS SUPAPRASTINUS PAVASARINĮ ŽEMĖS DIRBIMĄ

I. Deveikytė, V. Feiza, D. Feizienė

Santrauka

2003-2005 metais Lietuvos žemdirbystės institute Dotnuvoje giliau karbonatingame sekliai glėjiškame lengvame priemolyje trilaukėje sėjomainoje (vasariniai miežiai - vasariniai rapsai - vasariniai kviečiai) tirta skirtingo pavasarinio žemės dirbimo: arimo 15-17 cm gyliu, skutimo 5-7 cm gyliu ir tiesioginės sėjos įtaka pasėlio piktžolių populiacijai.

Augalų pasėliuose vyravo baltosios balandos, raudonžiedės notrelės, daržinės žliūgės, dirvinės veronikos, paprastieji varpučiai, dirvinės usnys, dirvinės pienės ir raudonieji dobilai. Visų žemės dirbimo sistemų laukeliuose gerokai dominavo vienametės dviskiltės piktžolės, išskyrus tiesioginės sėjos variantą.

2003 metais piktžolių skaičius varijavo tarp žemės dirbimo sistemų. 2004 ir 2005 metais gauti labai panašūs piktžolėtumo duomenys visuose žemės dirbimo variantuose, išskyrus tiesioginės sėjos sistemą. Ariant didėjo vienamečių piktžolių skaičius, palyginus su supaprastintu žemės dirbimu. Daugiamečių piktžolių skaičius ir orasausė masė iš esmės didesnė nustatyta vasarinių kviečių ir vasarinių rapsų pasėliuose tiesioginės sėjos variante, palyginus su arimu.

Reikšminiai žodžiai: supaprastintas pavasarinis žemės dirbimas, piktžolės, vasariniai miežiai, vasariniai rapsai, vasariniai kviečiai.

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