Agronomy Research **8** (Special Issue II), 493–498, 2010

Control possibilities of *Apera spica-venti* (L.) P.Beauv. in winter wheat with autumn and spring applications of herbicides in Latvia

I. Vanaga, Z. Mintale and O. Smirnova

Latvian Plant Protection Research Centre, Lielvardes iela 36/38, Riga LV-1006

Abstract. This paper presents results on weed control and yield responses in winter wheat grown after winter oilseed rape and after winter wheat, using data from field trials with a range of herbicides registered for use in Latvia that were applied either in the autumn or in the spring. *Apera spica-venti* was the dominant weed in these trials, accounting for 70–80% of the total weed biomass. Spring application of herbicides did not provide good control of *Apera spica-venti* up to harvest time: the infestation at application time was more than 140 plants per m^2. Autumn application of appropriate herbicides gave satisfactory control of *Apera spica-venti* up to harvest time in the following year. All herbicide treatments significantly increased crop yield but the autumn applications gave significantly greater increases than nearly all spring applications.

Key words: *Apera spica-venti*, winter wheat, yield, herbicide application in autumn and in spring

INTRODUCTION

Economic pressures have led many arable farmers in Latvia and other countries of northern Europe to adopt crop rotations based on the sequence of winter oilseed rape followed by winter wheat or successive crops of winter wheat. From 2000–2008 the areas of winter wheat and oilseed rape in Latvia increased annually: winter wheat, from 117.4 to 170.4 thousand ha; oilseed rape from 6.9 to 82.6 thousand ha. On the larger farms the main crop rotation is now based on winter wheat and winter oilseed rape.

These rotations have brought about changes in the weed flora such that *Apera spica-venti* is now an important target for control and serious yield losses have occurred in winter wheat crops where the *Apera spica-venti* has not been controlled effectively. For example, Bartels (2004) found a grain yield loss of 3 t ha^{-1} in untreated plots which were infested with 200 *Apera spica-venti* plants m^{-2} compared to treatments providing successful grass weed control. Increased infestations in winter cereals have also been reported by Danish researchers: Andreasen & Stryhn (2008) and Melander et al. (2008). In a ranking of the 15 most important weed species found in winter cereal crop systems in 26 European countries, *Apera spica-venti* was ranked fifth among all weeds and first among grasses (Schroeder et al., 1993). Weed population in treatments without herbicide application reveal the efficiency of weed management in previous years. Weed populations were more influenced by the preceding crop and by the timing of herbicide application than by the tillage system

(Streit et al., 2003). To improve the efficiency of weed control and to reduce reliance on herbicides in cropping systems with reduced tillage intensity, Streit and his co-workers stated that further research was needed to determine the beneficial effects and the optimization of crop rotation and appropriate weed control.

In recent years the average air temperatures in Latvia, during both the autumn and the spring-summer growing periods, have generally been higher than the long-term averages. These warmer temperatures have provided improved conditions for the germination and development of weeds in autumn-sown crops.

Cereals are most sensitive to competition from weeds in their early stages of growth and, especially in autumn sown crops, grass weeds can be extremely competitive in the early stages, particularly in cereals established with reduced cultivations (Tottman et al., 1982). Autumn application of herbicides will control weeds that could survive during winter to affect winter wheat growth and will provide better conditions for competition by the crop when vegetative growth begins in spring (Pilipavičius et al., 2010). Competition from autumn germinated broad-leaved weeds is generally less severe than that from grass weeds (Tottman et al., 1982). The most favourable application timing for grass weed control is between the 3-leaf stage and the beginning of stem elongation (Hacker et al., 1999). The importance of herbicides that can control grass weeds and dicotyledonous weeds by autumn application is described by Brink & Zöllkau (2004).

To control the yield-reducing weeds, wheat growers in Latvia have used a variety of herbicides applied either in autumn or in spring. During the past five years the range of new herbicides intended for autumn application has increased. This could improve the possibilities to control the weeds in the autumn and so avoid the greater influence on grain yield.

MATERIALS AND METHODS

Field experiments were established in the Jelgava municipality in 2006–07 and 2007–08 in winter wheat. The evaluations of herbicide efficacy in the cereals followed EPPO Guideline PP 93 (2). Field trials were arranged in randomized blocks with 4 replicates. Plot size: 30 m² (3 m x 10 m).

In 2007 the sod-calcareous clay soil in the field had pH_{KCl} 7.2, an organic content of 2.3%; winter wheat cultivar 'Zentos' was sown on 05.09.06. The previous crop was winter oilseed rape. In 2008 the sod-calcareous loamy sand soil in the field had pH_{KCl} 6.1, an organic content of 1.8%; winter wheat cultivar 'Tarso' was sown on 09.09.07. The previous crop was winter wheat. In both fields minimal soil tillage was employed and a fertiliser top-dressing of 120–170 kg ha^{-1} was applied.

The herbicides used in the trials were: Alister Grande OD 217.5 (iodosulfuron-methyl-sodium 4.5 g L^{-1} + mesosulfuron-methyl 6 g L^{-1} + diflufenican, 180 g L^{-1}, Bayer CropScience); Hussar Activ OD 417 (iodosulfuron-methyl-sodium 10 g L^{-1} + 2,4-D 377 g L^{-1} as 2-ethyl-hehyl ester, Bayer CropScience); Monitor (sulfosulfuron 750 g L^{-1}, Monsanto); Arrat (tritosulfuron 25% + dicamba 50%, BASF). The surfactant Kemiwett Plus (alcohol ethoxylate) was added to the tank mix of Monitor and Arrat.

Herbicide treatments were applied using a knapsack sprayer "Gloria" with flat-fan nozzles XR TEEJET 8003VS, delivering a spray volume of 300 L ha^{-1} at a pressure of

300 kPa. Other plant protection measures were applied to the whole trial as necessary.

For the assessment for *Apera spica-venti*, the flowering panicles numbers were recorded at three random places within each plot with the aid of a 0.25 m² frame: when the growth stage of the crop was 86–87 BBCH on 25 July 2007 and 81–83 BBCH on 15 July 2008 (Tables 1, 2).

The total yield of grain from each plot was harvested by trial combine "Sampo 500", respectively on 8 August 2007 and 30 July 2008, recalculated to t ha^{-1} and given at 100% purity and 15% moisture content (Tables 1, 2).

To determine the relationship between the yields of winter wheat and the numbers of *Apera spica-venti,* the flowering panicles, the data from the untreated plots and the plots treated with herbicides were subject to analyses of variance and regression analysis. For statistical analysis the data were subjected to single factor analysis of variance using GenStat for Windows version 12. The treatment means were separated at the 95% probability level (LSD) using Student's *t*-test. Significant differences are stated next to the relevant figures in the tables: treatments marked with the same letter are not significantly different.

Weather conditions in 2006–2007 and 2007–2008. In autumn 2006 the herbicide treatments were applied on 26 September. During the third 10-day period of September the weather was unusually warm: the air temperature was more than 3 Cº above the long-term norm and without precipitation. The weather continued to be warmer than average throughout October and there was sufficient precipitation to provide very good conditions for weed growth after the autumn herbicide application (Figs 1, 2).

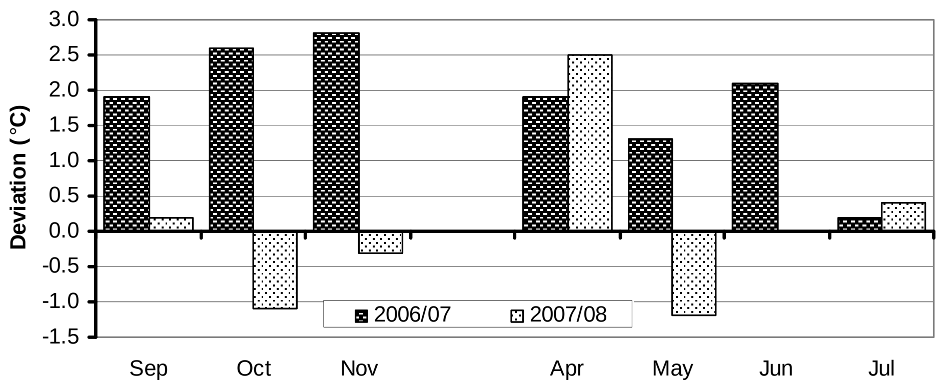

Figure 1. Deviations of monthly mean temperatures from long-term monthly means during growing seasons 2006–07 and 2007–08; data from Jelgava HMS.

In spring 2007 the weather around application time in the third 10-day period of April was unusually warm: the air temperature was more than 4 ºC above the norm, but precipitation was only 36% of the norm for that period. Two rainy days occurred before herbicide application (on 21 and 23 April) and that provided moist soil conditions. During the remainder of the vegetative period, up to the end of July, the weather was warmer than the long term-averages with sufficient precipitation in almost all months for good growth (Figs 1, 2).

The autumn 2007 herbicide treatments were applied on 28 September. The weather during the first and second 10-day periods of September was cooler than the long-term averages and some very rainy days occurred during the second 10-day period. Overall the daily mean temperature for the month was slightly above the long-term average and the precipitation was only 56.5 % of long-term average (Figs 1, 2). Around application time in spring 2008, during the second 10-day period of April, the mean daily temperature was higher than the long-term average and there was sufficient precipitation for plant growth. Overall, the weather during the vegetative period was drier than average which affected crop and weed emergence and development unfavourably.

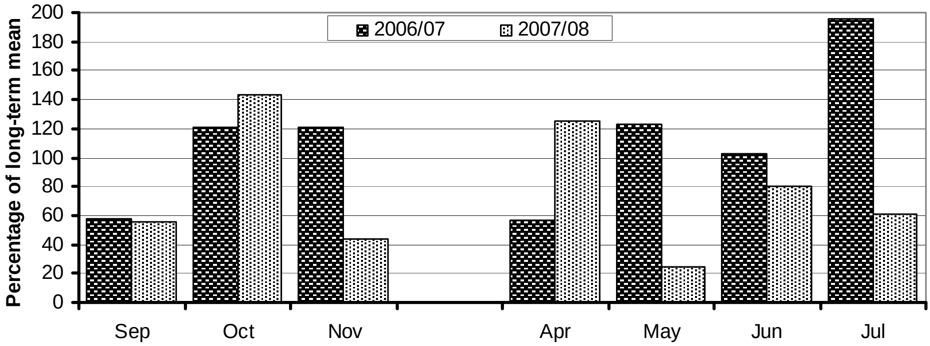

Figure 2. Total monthly precipitation as percentage of long-term monthly mean during growing seasons 2006–2007 and 2007–2008; data from Jelgava HMS.

RESULTS AND DISCUSSION

In autumn 2006 the emergence of the wheat plants was even and the plants were well developed, at 14–15 BBCH stage, when the autumn herbicide treatment was applied. The infestation of *Apera spica-venti* within the trial was 32 plants m^{-2}, up to 2 leaf stage (3–4 cm). In spring 2007 the winter wheat was at the end of the tillering stage (28–29 BBCH) when the spring herbicide treatments were applied and the density of *Apera spica-venti* in the untreated plots was 142 plants m^{-2}, mostly at 8 cm in height and well developed.

In autumn 2007 the winter wheat was at the 13–14 BBCH stage when the autumn herbicide treatment was applied. The growth stage of *Apera spica-venti* was up to 2 leaf stage and the infestation was very high: more than 430 plants m^{-2}. The spring herbicide treatments were applied on 16 April 2008 when the *Apera spica-venti* plants were at the tillering stage (12 cm in height) and the infestation was still very high: more than 424 plants m^{-2}.

In both of these winter wheat experiments dicot weed species were also recorded; the main species were: *Viola arvensis*, *Thlaspi arvense* and *Centaurea cyanus* as well as volunteer oilseed rape (*Brassica napus*). The biomass of the dicot weeds was only 20–30% of the total weed biomass. Most of the weed biomass was accounted for by *Apera spica-venti* and the high infestation of this grass species suppressed the growth of the dicot weeds.

The efficacy of the herbicide treatments in controlling *Apera spica-venti* was evaluated by counts of flowering panicles close to harvest time. All the herbicide treatments gave significant reductions in *A. spica-venti* panicle numbers compared with untreated (Tables 1, 2). Control of *Apera spica-venti* was satisfactory (95–96%) only in the plots where the herbicides had been applied in the autumn. The performance of the herbicides on *A. spica-venti* in reducing the numbers of flowering panicles was the same in both years.

Table 1. Numbers of *Apera spica-venti* and winter wheat yields, 2006–2007.

Treatments, dose per ha	Numbers of *Apera spica-venti* flowered panicles		Grain yield of winter wheat	
	number m^{-2}	decrease, %	kg ha^{-1}	± kg ha^{-1}
1. Untreated	190.0 a	-	1858 a	-
2. Alister Grande, 0.8 L*	8.3 c	96	5596 c	3738
3. Hussar Activ, 0.8 L **	79.3 b	58	3259 b	1401
4. Hussar Activ, 1.0 L **	68.0 b	64	2587 ab	729
5. Monitor,0.018 kg + Arrat, 0.2 kg**	46.7 bc	75	3324 b	1466
LSD 5%	58.06	-	1031.4	-

* in autumn 2006 ** in spring 2007

The average yield in the control plots was very low especially in 2007 (only 1858 kg ha^{-1}), because of the very high infestation of *Apera spica-venti*. Despite the moderate weed control in the herbicide treatments applied in spring, all treatments increased grain yield statistically significantly (Tables 1, 2). The increases given in the treatments where the herbicide had been applied in autumn were significantly higher than all but one of the increases where the herbicides had been applied in spring. The application with herbicides in spring could reduce the infestation of *Apera spica-venti*, but the crop stands were not as dense as in treatments where the herbicide application was made in the autumn. In weather conditions that were favourable for weed germination and development during the vegetative period, new weeds emerged and competed with the winter wheat and gave rise to problems with green weed material at harvest.

Table 2. Numbers of *Apera spica-venti* and winter wheat yields, 2007–2008.

Treatments, dose per ha	Numbers of *Apera spica-venti* flowered panicles		Grain yield of winter wheat	
	number m^{-2}	decrease, %	kg ha^{-1}	± kg ha^{-1}
1. Untreated	204.0 a	-	2606 a	-
2. Alister Grande, 0.8 L*	10.3 c	95	4732 c	2126
3. Hussar Activ, 0.8 L **	88.3 b	57	3576 b	971
4. Hussar Activ, 1.0 L **	84.0 b	59	3858 bc	1252
5. Monitor,0.018 kg + Arrat, 0.2 kg**	62.0 bc	70	3403 ab	797
LSD 5%	57.90	-	961.2	-

* in autumn 2007; ** in spring 2008

In both experiments there was a strong, significant, negative linear relationship between winter wheat yield and the numbers of *Apera spica-venti* flowered panicles (respectively r_{yx} = -0.73, P < 0.001; r_{yx} = -0.64, P < 0.01). The determination coefficients showed that 54% of the variations in the grain yield in 2007 and 41% in 2008 could be explained by the infestation of *Apera spica-venti* in the trial plots.

CONCLUSIONS

1. The application of herbicides in spring could not provide good control of *Apera spica-venti* up to harvest time when the infestation of this weed species at the application time was very high (more than 140 plants per m^2).

2. Application of appropriate herbicides in autumn for *Apera spica-venti* control provided satisfactory control up to harvest time in the following year.

3. The winter wheat crop in plots where herbicides were applied in the autumn was more even, denser and better developed than in plots where herbicides were applied in the spring. In the spring-treated plots the crops became thin and in open places, weed plants that were not controlled by the herbicides could regrow and develop well during the growing season up to harvest time.

4. For the best yield results herbicides should be applied in the autumn, especially when the weather is favourable for prolonged development of weeds and the infestations of competitive weed species like *Apera spica-venti* are very high.

ACKNOWLEDGEMENTS: The field experiments were supported by Bayer CropScience, Monsanto and BASF A/S. Especial thanks to farms "Vilcini" and "Delagri" Ltd. for allowing the use of their fields for these successful trials.

REFERENCES

Andreasen, C. & Stryhn, H. 2008 Increasing weed flora in Danish arable fields and its importance for biodiversity. *Weed Research*, **48**, (1), 1–9.

Bartels M. (2004) Ungräser sollten Sie im Herbst beseitigen. *Top Agrar* **9**, 50–55.

Brink, A. & Zollkau, A. 2004 Optimisation of grass weed control with Atlantis®WG in winter cereals. *Journal of Plant Diseases and Protection*. Supplement XIX, 637–646.

Hacker, E., Bieringer, H., Willms, Ort O., Koecher, H. & Kehne, H. 1999 Iodosulfuron plus mfenpyr-diethyl – a new foliar herbicide for weed control in cereals. *Proceedings of an international conference "The 1999 Brighton Conference – Weeds", Brighton, UK, November 15–18, 1999*. Vol. 3, pp. 737–746.

Melander, B., Holst, N., Jensen, P.K., Hansen, E.M. & Olesen, J.E. 2008 *Apera spica-venti* population dynamics and impact on crop yield as affected by tillage, crop rotation, location and herbicide programmes. *Weed Research*, **48**, (1), 48–57.

Pilipavičius V., Aliukonienė, I. & Romaneckas, K. 2010 Chemical weed control in winter wheat (Triticum aestivum L.) crop of early stages of development: I. Crop weediness. *Journal of Food, Agriculture & Environment*. 8(1); 206–209.

Schroeder, D., Mueller–Schaerer, H. & Stinson, C.S.A. 1993 A European weed survey in 10 major crop systems to identify targets for biological control. *Weed Research* **33**, (6) 519–525.

Streit, B., Rieger, S.B., Stamp, P. & Richner, W. 2003 Weed populations in winter wheat as affected by crop sequence, intensity of tillage and time of herbicide application in a cool and humid climate. *Weed Research*, 43, (1) 20–32.

Tottman, D.R., Ingram, G.H., Lock, A.A., Makepeace, R.J., Orson J., Smith J. & Wilson B.J. 1982 Weed control in Cereals. In: *Weed control handbook: Principles*. Roberts, H.A. (Ed): 7th ed. Blackwell Scientific Publications, Boston Melbourne, pp 268–291.