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Weed emergence and survival in spring barley

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Abstract. Weed emergence and survival in spring barley was investigated in field trials at the Lithuanian Institute of Agriculture in 2003–2005 and 2008.

The soil of the experimental site - *Endocalcary-Endohypogleyic Cambisol*, loam. Conventional soil tillage moldboard ploughing in the autumn and pre-sowing soil tillage in spring - was used. Spring barley var '*Luokė*' during 2003–2005 and '*Aura* DS' in 2008 was sown in the second half of April, at a rate of 4.0 million seed ha^{-1}. Weed emergence was observed in nine unsprayed plots of barley, in 4 places per plot (total 36 places), sites of 50 x 50 cm in size were marked, where all weeds present were counted weekly from sowing until the end of heading.

There were found 11–20 weed species in the spring barley stands. In an extremely dry spring the weed species number was lowest. 36% of all the weeds that emerged in the spring barley growing period emerged during the first assesment performed at the second decade of May.

Weed survival depends on the general weed number in the field and crop development. When weediness was quite low, later emerged weeds were not able to compete with barley and earlier-emerged weeds.

Key words: spring barley, weed emergence

INTRODUCTION

Weed infestation is one of the main factors limiting crop yield. Public concern about the effects of herbicide use on the environment and human health has increased the interest in reducing the use of herbicides in agriculture and in developing alternative methods for weed control. Another problem is the frequent appearance of herbicide-resistant weeds because of the repetitive use of similar active ingredients (Hole & Powles, 1997; Chauvel et al., 2001). Efficient and timely weed control is one of the major tasks of competitive contemporary agriculture (Liebman&Staver, 2001; Sarrantonio & Gallandt, 2003). One way to control weeds in cereals is to improve the ability of the crop itself to suppress weeds (Jordan 1993; Lemerle et al., 2001; Mohler, 2001). A better understanding of the emergence behaviour of weeds in relation to cultural and meteorological conditions presents opportunities to target the timing of cultivation and maximize the efficacy of weed control strategies (Grundy et al., 2003).

The integration of knowledge of weed emergence and survival in agricultural crops could be used to improve the control strategies in organic or integrated growing systems. Being able to predict weed emergence could help adjust the timing of seedbed preparations (Leblanc & Cloutier, 2002). Conventional systems could also benefit from this knowledge when using post – emergence applications of herbicide (Myers et al., 2002), which are extremely dependent on precise timing to maximize their effect and avoid the need for subsequent applications.

A combination of weed seed production, seed movement, seedling emergence and weed competition models could provide a powerful tool for making and testing decisions on weed management that would allow more effective strategies for control to be developed (Grundy & Turner, 2002). There have been some research developments to understand the emergence patterns for a number of weed species (Grundy, 2003).

Environmental factors – temperature, moisture, soil fertility - are also important for plant growth and development. The fate of weed seeds in an agricultural environment is determined by several factors, including the availability of germination cues such as light, water and fluctuating temperatures (Chancellor, 1985; Baskin & Baskin, 1987). Although the periodicity of weed seedling emergence is governed by the underlying annual temperature cycle, soil moisture availability is the over-riding factor determining the timing and duration of the flush of seedlings (Roberts, 1984). Germination rate is clearly related to temperature and water potential (Grundy, 1997) and was observed to decrease with seed depth (Colbach et al., 2006).

In earlier investigations in Lithuania, it was established that most weed emergence occurred in spring - most intensively in May and June, while later, weed emergence tended to slow down (Stancevičius & Špokienė, 1972).

The aim of the present research was to quantify germination longevity and periodicity of annual dicotyledonous weed seeds in spring barley stands.

MATERIALS AND METHODS

Field experiments to evaluate the efficacy of different intensities of weed control were conducted during the period 2003–2005 and 2008 at the crop rotation of Lithuanian Institute of Agriculture's Experimental Department in spring barley stands. The preceding crop for spring barley in 2003 and 2005 was winter wheat, in 2004 and 2008, spring wheat. The spring barley varieties grown were 'Luokė' during the period of 2003 - 2005 and '*Aura* DS' during 2008. Conventional soil tillage was used - moldboard ploughing in the autumn and pre-sowing soil tillage in spring. The soil of the experimental site was *Endocalcary-Endohypogleyic Cambisol*, loam. In all experimental years, spring barley was sown in the second half of April, at a rate of 4.0 million seed ha^{-1}. Prior to sowing, the soil was fertilized with N90 P_2O_5 90 K_2O 90. Ammonium nitrate, granulated superphosphate and potassium chloride were applied. Plots in the replications were arranged randomly, plot size 34.5 m^{-2}.Weed emergence - growth was observed in unsprayed plots: in 4 places of nine plots, sites of 50x50 cm in size were marked out, where all weeds present were counted weekly from sowing to the end of heading of spring barley.

Meteorological conditions were recorded at the Dotnuva Weather Station located at a distance of two kilometers from the field throughout the growing period of the spring barley. As a criterion for determining the area of humidity Seljanin's hydrothermic coefficient *HTK* was used (Bukantis & Rimkus, 1997). It is given by the following relation:

$$HTK = \frac{H}{0.1 * \sum t}$$

where *H* monthly total of precipitation in mm,

Σ*t* monthly sum of mean daily temperatures in °C of those months in which the mean monthly temperature reaches at least 10°C.

All data were analyzed using ANOVA from the package SELEKCIJA (Tarakanovas, Raudonius, 2003). To achieve homogeneity of variance, the data were log(X+1) transformed.

RESULTS AND DISCUSSION

Weed germination began in the second decade of May. At the first observation, 6–17 weed species were found in the spring barley plots. The number of weed species at the begining of spring barley vegetation differed between years: the highest abundance was obtained in 2003, when 20 weed species were detected and the lowest in years 2008–11. Most differences in hydrothermic coeficient were found between 2005 and 2008 in May. The hydrothermal coeficient of May 2008 was 2–3 times lower than usual, because the amount of rainfall differed 40% from the perennial mean (Fig.1).

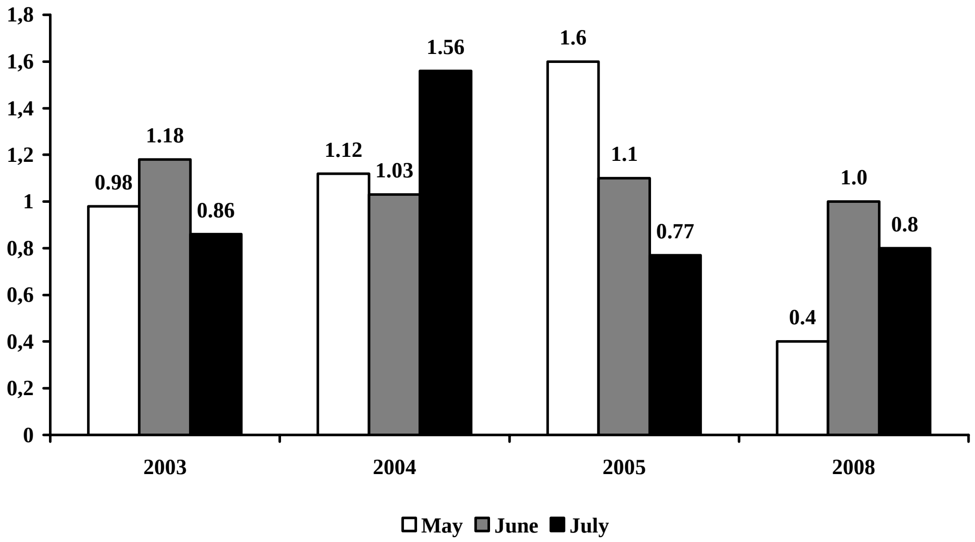

Fig. 1. The hydrothermal coefficient of the growing period of spring barley.

Weather conditions, especially the amount of rainfall during the growing season affected weed incidence and conditions for crop – weed competition (Romaneckiene, 2007).

Previous investigations showed, that in spring cereals in Lithuania *Ch.album*, *L.purpureum, St.media* and other weeds were prevalent (Auskalnis et al., 2007).

During all experimental years, the most frequent annual weed species were: *Chenopodium album* L.*, Lamium purpureum* L.*, Viola arvensis* Murray, *Stellaria media* (L.) Vill. These species accounted for 6–60% (*Ch.album*), 2–40% (*V.arvensis*) 4–14% (*L.purpureum*) of the total weed number (Fig. 2). The highest part of other annual dicotyledonous weeds occurred in the wet spring of 2005, when the hydrothermal coeficient in May was 1.6. More weed species were found: *Tripleurospermum perforatum*, *Veronica spp*. *Galium aparine*. The higher amount of rainfall and greater soil moisture probably promoted weed germination (Mohler& Galford, 1997). In the driest spring of 2008 a big part of the total weed number comprised *Viola arvensis*. The amount of this weed aggregated on average 40% of the total number.

The beginning of weed emergence depended on meteorological conditions and occurred two – three weeks after the sowing of barley, in the second decade of May. According to average data of four years, 36% of all the weeds that emerged during the growing period were found during the first assesment performed at the second decade of May. Previous studies show that the period of massed weed emergence occurs in May – about 42–57% of all weeds emerged in May (Pilipavicius, 2006).

In the third decade of May, 10% of the total weed number emerged. Later, in the 1st and 2nd decade of June, 4–5% weeds of the total weed number emerged.

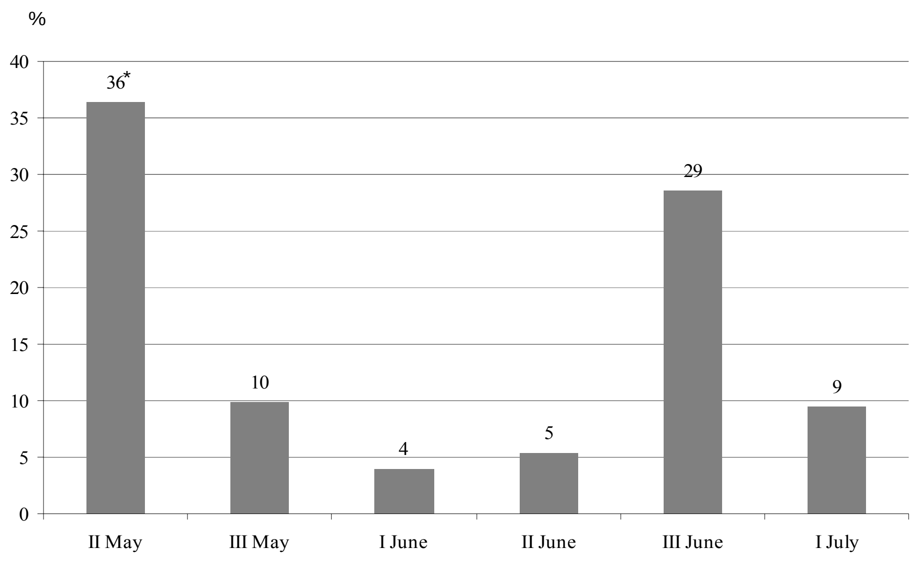

Fig. 2. The share (%) of emerged total number of weeds on different period of growing. Average of 2003–2005, 2008.

Different weed species emerged at different times. At the begining of June, there was a significant ($P > 0.05$) increase in the number of *Lamium purpureum*. According to average data of four years, in the first decade of June, about 83% from the total number of *L.purpureum* germinated. A significant increase in the number of *Chenopodium album* and *Viola arvensis* occurred in the second decade of June. In other studies it was noticed that *Chenopodium album* germinated late and could be effectively suppressed by cereals, especially at higher densities in the uniform pattern (Colquhoun et al., 2001). In our investigations *Ch. album* germinated throughout the growing period of spring barley. The highest total number of weeds was found in the third decade of June. Later, in the first decade of July, the total weed number decreased and number of different weed species decreased significantly. This confirms the results of Pilipavicius (2006), who found that most weeds (about 2/3 of all emerged weeds) would die before the end of cereal vegetation. By contrast, in our investigations about 1/3 of all emerged weeds died before the end of the spring barley growing period. Weeds predominating until cereal harvesting were from earlier emergence. It could be explained for the different weed number in both investigations. Later emerged weeds in our case were not able to compete with barley and other earlier-emerged weeds.

In summary, weed emergence and survival depend not only on meteorological conditions, in particular on amount of rainfall, but also on the general number of weeds in the field: at low densities, early emerged weeds were able to survive, while later emerged weeds were not able to compete with barley and earlier - emerged weeds.

CONCLUSIONS

There were found 11–20 weed species in spring barley stands. In the extremely dry spring of 2008 the number of weed species was lowest.

36% of all weeds that emerged during the growing period emerged during the first assesment performed at the second decade of May.

Weed survival depends on the general weed number in the field and crop development In quite a low level of weediness later emerged weeds were not able to compete with barley and earlier-emerged weeds.

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