VLIV PLEVELŮ NA JARNÍ JEČMEN V EKOLOGICKÉM A KONVENČNÍM ZPŮSOBU PĚSTOVÁNÍ

Spring Barley and Weed interaction in Organic and Conventional Farming Systems

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Summary: The field experiments in spring barley 'Aura' crop were carried out in 2003 - 2004 at the Research station of the Lithuanian University of Agriculture. The aim of the trial was to establish change of spring barley crop weediness during vegetation in organic and conventional farming systems. The biggest weediness of spring barley crop was established in the beginning of vegetation when conditions for weed emergence were favourable. The number and biomass of weeds gradually decreased when crop developed except early milk-late dough and dough stages of maturity in 2004 when because of unfavourable meteorological conditions spring barley was lodged and could not smother weeds effectively. Weed biodiversity has tendency to increase in organic farming system from 21 to 25 species and to decrease in conventional farming system from 19 to 17 weed species in 2003 and 2004 accordingly. Positive linear relationship was established between the number of weeds and their air-dry biomass in the crop r_{2003}=0.604*** (P<0.0001) and r_{2004}=0.481*** (P=0.0003). Negative dependence was established between spring barley and weed air-dry biomass $r_{2003=}$ -0.420** (P=0.0013). 1 t ha^{-1} weed air-dry biomass decreased yield of spring barley air-dry biomass by 3.4 t ha^{-1} in 2003.

Key words: *Weeds, Spring Barley, Organic and Conventional Farming Systems*

Souhrn: Polní pokusy s odrůdou jarního ječmene Aura byly vedeny v roce 2003-2004 na výzkumné stanici Litevské zemědělské univerzity. Cílem pokusu bylo zachytit změny u plečkovaného ječmene během vegetace v ekologickém a konvenčním způsobu pěstování. Nejintenzivnější plečkování bylo provedeno na počátku vegetace, když byly podmínky pro růst plevelů nejpříhodnější. Počet a biomasa plevelů se postupně snižovala v průběhu vývoje ječmene s výjimkou počáteční mléčné zralosti a voskové zralosti v roce 2004, kdy z důvodů nepříznivých meteorologických podmínek ječmen nebyl schopen účinně potlačit plevele. V roce 2004 se v porovnání s rokem 2003 zvýšila biodiverzita plevelů z 21 na 25 druhů v ekologickém systému a poklesla z 19 na 17 druhů v konvenčním systému. Pozitivní lineární vztah byl zjištěn mezi počtem plevelů a jejich suchou biomasou r_{2003}=0,604*** (P<0.0001) a r_{2004}=0,481*** (P=0,0003). Negativní závislost byla zjištěna mezi jarním ječmenem a sušinou biomasy plevelů $r_{2003=}$ -0,420** (P=0,0013). 1 t.ha^{-1} sušiny biomasy plevelů poklesl výnos sušiny biomasy jarního ječmene o 3,4 t.ha^{-1} v roce 2003.

Klíčová slova: *Plevele, jarní ječmen, ekologický a konvenční způsob pěstování*

Introduction

In plant communities so called agrophytocenoses between cultural and wild plants - weeds precede continual competition. One of the most important conditions of crop competition design is formation of optimal density and quality crop which depend not only from applied agrotechnics, plant varieties, soil properties, but as well from farming system. Mostly of alternative farming systems seeks to control crop weediness without herbicides (Raganold et al., 1990). Alternative forms of farming systems past such conventional problem of agriculture as environmental pollution by fertilizers and pesticides, loosing of biodiversity, irrational use of energetically non-replenishing resources and etc. (Parr et al., 1990, Raganold et al., 1990). Radical form of organic (ecological) farming system jointly includes both philosophy and farming way (Hodges, 1982; Merill, 1983). Organic farming system is not only food processing technology but thinking and live stile as well. Controlling weeds in organic farming system is most important to be able to manipulate with agricultural plant and weed interaction (Rasmussen et al., 1995).

Research object – agrophytocenoses of spring barely.

The aim of the researches was to establish changes of spring barely crop weediness during vegetation in organic and conventional farming system.

Material and methods

Evaluating change dynamics of spring barely crop agrophytocenoses in organic and conventional farming systems during 2003-2004; a field trial was carried out at the Research station of Lithuanian University of Agriculture.

Investigating spring barley 'Aura' crop field trials were designed according to two factors trial schema:

Factor A, farming systems:

1) organic; 2) conventional.

Factor B, harvesting time according to spring barley stages of (Zadoks et al., 1974):

1) stem elongation, 31; 2) heading, 57; 3) early milk, 69-71; 4) medium milk, 73-75; 5) late milk-early dough, 77-83; 6) dough, 87; 7) hard (control treatment), 92.

Trials soil was *Calcari-Epihypogleyic Luvisols – LVg-p-w-cc* (Idg 8-k). Soil arable layer 0-25 cm was neutral (pH_{KCl} 6.96-7.05), averagely rich in humus (2,38-2,44 %), rich in phosphorus (235,63-240,09 mg kg^{-1}), averagely rich and rich in potassium (141,12-159,43 mg kg^{-1}). Soil agrochemical properties were analysed with infrared rays system PSCCO/ISI IBM – PC 4250.

Preceding crop for spring barley 2003 was fertilized with manure maize (2001) and black fallow (2002) and preceding crop for spring barley 2004 was spring barley. Spring barley grown accordingly to conventional growing technology were fertilized by azophoska (NPK 1:1:1 each 16 %) 160 kg ha^{-1} active substance, in spring before crop emerging. Spring barley grown accordingly to organic growing technology crop was not fertilized. Spring barley were sown at first ten days of May, sowing 200 kg ha^{-1} two rows spring barely Aura's seeds. Herbicides in trial field were not used.

Weediness of crop were established taking weed samples at seven spring barley crop stages of maturity (accordingly to trial schema) by frame 50 x 50 cm and were calculated and air-dried.

Meteorological conditions. Comparing long term meteorological data of Noreikiškes meteorological station (at the Research station of Lithuanian university of agriculture) were established that May of 2003 was by 1oC warmer and by 1.3 mm dryer. Air temperature (~13°C) and rainfall (~45 mm) were optimal for germinating of spring barley. June characterize with dryer weather according to long term data rainfall decreased by 12 mm when air temperature were about 15.4oC. During this period active growth roots and over-ground plant parts and lake of humidity could negatively affect crop yield. July was warmer (+20.1°C), however, contrary than June, characterize by very rich rainfall (118.2 mm). Therefore crops laid in trial both farming systems. Nevertheless, spring barley crop was at the late milk-early dough stage of maturity and bigger damages were avoided. August were favourable for spring barley vegetation because comparing with long term meteorological conditions weather was dryer – 15.6 mm rainfall less and by 1.6°C warmer. Vegetation of 2004 averagely was by 1-5°C chilly than in 2003 and rainfall was less by 8.4 and 13.8 mm in first and second ten days period in May, 13.6, 2.0 and 9.4 mm more at the last ten days period of May and first and second ten days period in June; in June third ten days period and July was dryer accordingly by 7.2; 8.0; 18.3 and 7.1 mm; and August first and second ten days period even by 25.3 mm more wet period formed unfavourable conditions for spring barley maturing at the end of crop vegetation.

Results

In spring barley crop 2003 *Chenopodium album*, *Echinochloa crus-galli* and *Sinapis arvensis* prevailed from annual weeds in organic as well as in conventional farming system. Perennial weeds took recessive position in the crop, and mostly *Sonchus arvensis* occurred. Spring barley crop weediness was essentially bigger in organic farming system. Spring barley crop weediness in organic farming system in different stages of maturity reached from 215 to 534 weeds m^{-2} and 8.9-73.7 $g.m^{-2}$ air – dry biomass. Spring barley crop weediness in conventional farming system was 119-312 weeds m^{-2} and 20.0-71.9 $g.m^{-2}$ air – dry biomass (Graph 1 and 2).

General number of weed species in organic farming system reached 30, and in conventional farming system – 24. Weed biodiversity has tendency to increase in organic farming system: 21 species were established in 2003 and 25 weed species in 2004. The number of weed species increased by 16 %. The number of weed species in spring barley crop in conventional farming system in contrast to organic agriculture has tendency to decrease: 19 weed species were established in 2003, and 17 species, i.e.12 % in 2004. Annual weeds made 98-100 % in organic and 94-100 % in conventional farming system, and accordingly 2-6 % of perennial ones from general number of weeds. Annual weed biomass made 94-100 % in organic and 97-100 % in conventional farming system, and accordingly 6-3 % of perennial ones. Perennial weeds in organic farming system in contrast to conventional system better developed, were stronger and grew bigger biomass. However, annual weeds dominated in both farming systems in all analysed stages of spring barley maturity. Weed biomass accumulated systematically as plants grew and developed.

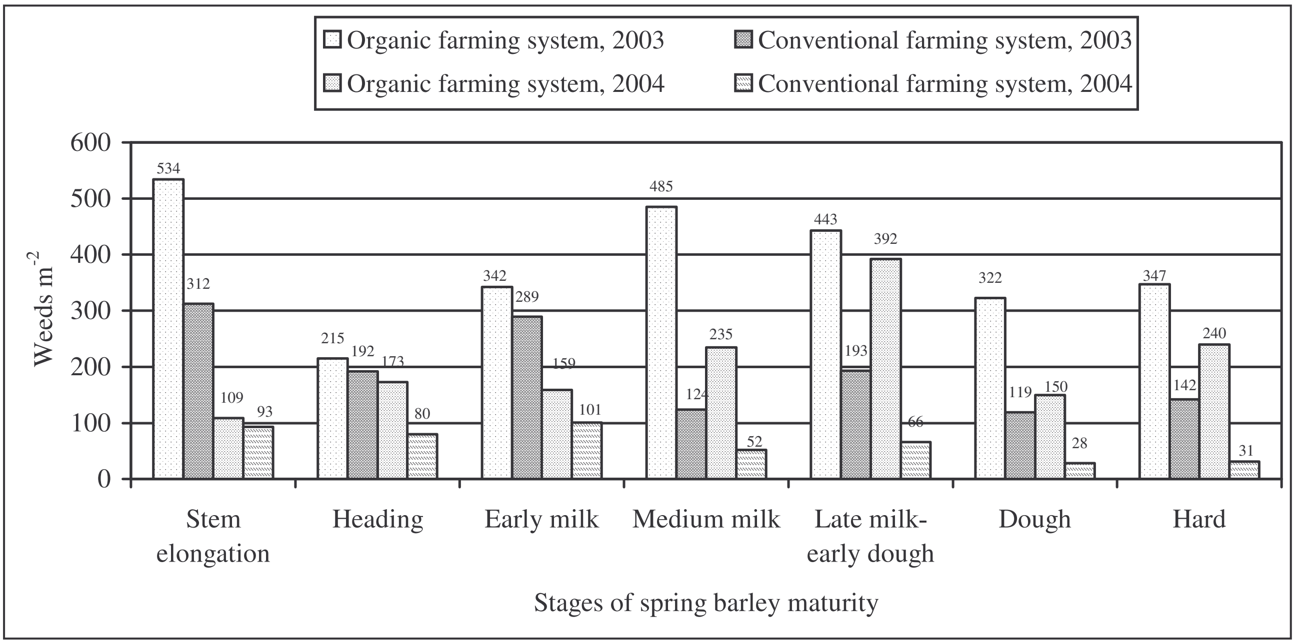
The biggest weediness of spring barely crop, evaluating the number of weeds, was established in the beginning of vegetation, in stem elongation stage: 109-534 weeds m^2 in organic farming system and 93-312 weeds m^2 in conventional farming system (Graph 1).

As spring barley matured, the number of weeds systematically decreased because of species competition – firstly weeds seedlings were lost. Weeds in milk spring barley maturity began to lose biomass – 0.15-0.52 $t.ha^{-1}$ in organic farming system and 0.26-0.69 $t.ha^{-1}$ in conventional farming system (Graph 2). It was conditioned by seed maturity and translocation of nutrition matters in weeds. Annual weeds after seed maturity stop photosynthesis begin to throw leaves and at last naturally fell and their biomass decreases. Perennial weeds, maturing seeds, in contrast, do photosynthesis and can successfully accumulate biomass. However, it did not have essential influence for general weed biomass of the crop, because perennial weeds made on the average only 2-6 % in the crop. In spring barley crop 2004 dynamics of weediness decrease changed and start to increase from the middle of milk stage because of unfavourable meteorological conditions when laid crop decreased smothering power of spring barley and because of enough amount of humidity in the soil intensified weed germination.

The number of weeds increased accordingly from 109 in stem elongation stage to 235-392 weeds m^2, however, the amount of accumulated air–dry biomass remained similar – 0.74 $t.ha^{-1}$ and 0.72 $t.ha^{-1}$ in organic farming system, and it increased to 1.12 $t.ha^{-1}$ in conventional farming system (even though the number of weeds systemically decreased) (Graph 1 and 2). In the end of vegetation it decreased because of natural loss of dominated annual weeds after seed maturity. The number of weeds in conventional farming system increased to 101 (2004) only in early milk stage of spring barley maturity and began essentially to decrease as crop developed (Graph 1).

Graph 1: Weed density [weeds m^{-2}] at different stages of spring barley maturity, 2003-2004

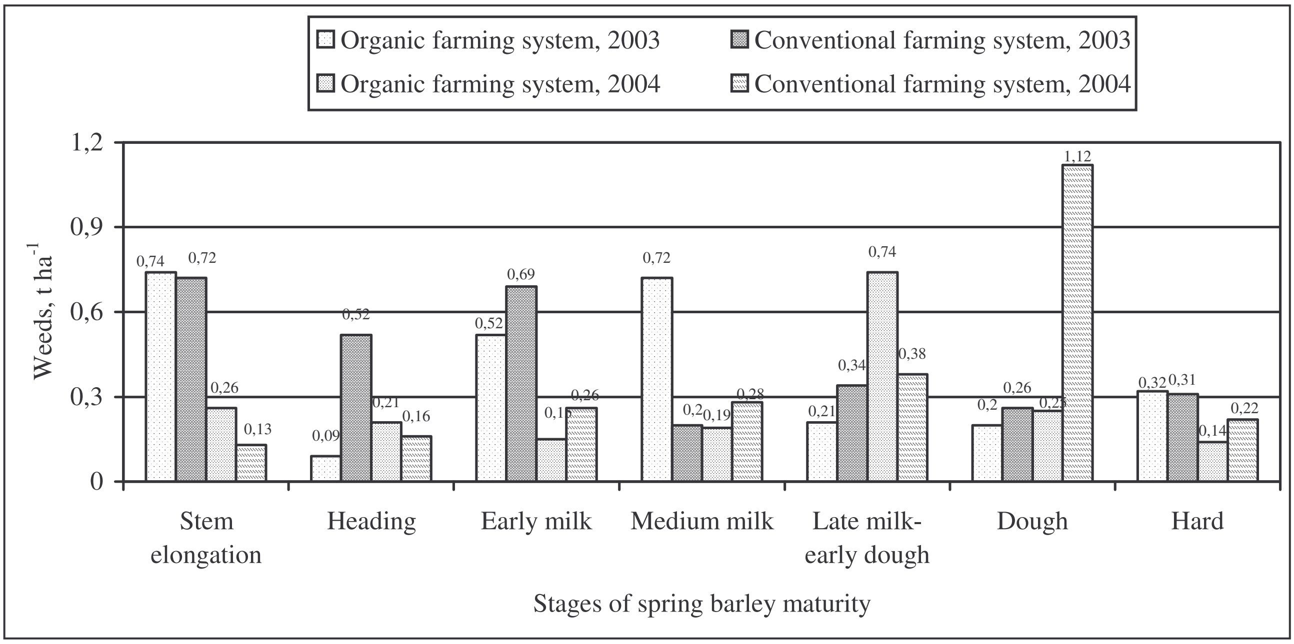
Hustota plevelů (plevele . m^{-2}) v různé fázi zralosti jarního ječmene, 2003-2004



Note. $LSD_{05\,(2003)}$ = 261.2; $LSD_{05\,(2004)}$ = 46.73

Graph 2: Air-dry biomass of weeds [t ha^{-1}] at different stages of spring barley maturity, 2003-2004

Sušina biomasy plevelů (t.ha^{-1}) v různé fázi zralosti jarního ječmene, 2003-2004



Note. $LSD_{05\,(2003)}$ = 0.58; $LSD_{05\,(2004)}$ = 0.33

Weediness variations of spring barley crop were established in different stages of maturity and essentially depended on heterogeneous of crop treatments, because the samples to establish weediness in the crop of every stage of maturity were taken from different treatments of the trial (according to the scheme of the trial). Such population variety of annual and perennial weeds is noticed by other investigators (Geisselbrecht-Taferner et all., 1997; Colbach et al., 2000; Rew et al., 2001).

Analysing dependence between the number of weeds and their air – dry biomass, statistically reliable linear correlation of average strength r_{2003}=0,604*** and weak one r_{2004}=0,481*** was established. Regressive analysis showed that because of one weed plant influence in spring barley crop , air – dry weed biomass changed 0,12 g.m^{-2} in 2003 ($y = 6.14 + 0.12\ x$, $P<0.0001$) and 0,11 g.m^{-2} – 2004 ($y = 9.86 + 0.11\ x$, $P = 0.0003$); the number of weeds changed accordingly 2,98 weeds m^2 in 2003 upon the influence of air – dry weed biomass (i.e. as weed biomass changed by 1 gramme) $y = 165.92 + 2.98\ x$, $P<0.0001$) and 2,11 weeds m^{-2} in 2004 ($y = 88.67 + 2.11\ x$, $P<0.0003$). Weed air –dry biomass grown in 1 t ha^{-1} spring barley crop decreased to 3.4 t^{-1} harvest of over-ground part of spring barley air–dry biomass in 2003 ($y = 10.91 - 3.44\ x$, $P<0.0013$). Reliable dependence between spring barley and weed air – dry biomass r_{2003}=-0,420** was established. During the second year of the trial dependence between spring barley and weed air–dry biomass was not established, coefficient of correlation r_{2004}=0,195 given 85 per cent level of probability ($y = 8.58 + 3.35\ x$, $P=0.154$). The got result was determined by the crop structure when it was established almost 3 times fewer number of weeds and 2 times fewer their air-dry biomass in comparison to investigated spring barley crop in 2003. Moreover, in 2004 unfavourable metrological conditions in July lodged spring barley crop in early milk stage of maturity so decreasing smothering power of spring barley and in the fields of different weediness equalize conditions of crop growth and development.

Conclusion

The biggest weediness of spring barley was established in the beginning of vegetation. As crop develops, the number of weeds and biomass dynamically decreases. In conventional farming system less crop weediness showed in all growth and development stages of spring barley, except late milk–early dough and dough maturity stages, when spring barley was lodged and could not smother weeds effectively because of unfavourable meteorological conditions.

Positive linear dependence was established between the number of weeds and their air–dry biomass in the crop r_{2003}=0,604*** and r_{2004}=0,481***. Increasing weediness in agrophytocenoses regularly decreased harvest of spring barley biomass, reliable dependence between spring barley and weed air–dry biomass was established r_{2003} = - 0,420**.

Diversity of weed species has tendency to increase in organic farming system: 21 species were established in 2003 and 25 species in 2004. In conventional farming system contrary to organic, has tendency to decrease: 19 weed species were established in 2003 and their biodiversity decreased to 17 species.

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