Weed suppression by increasing spring rape crop density

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Abstract. Field experiments were conducted in 2003 and 2004 at the Experimental Station of the Lithuanian University of Agriculture to study the influence of different spring rape (*Brassica napus* L.) densities (50.1–100, 100.1–150, 150.1–200, 200.1–250, 250.1–300, 300.1–350, 350.1–400, 400.1–450 plants m^{-2}) on weed abundance. Increase of crop density and herewith increase of canopy should intensify the competition ability of spring rape plants and suppress weeds better. The results show that light intensity on the soil surface decreases when the assimilation area of spring rape leaves and total crop biomass increases. Weed density decreases when spring rape crop is densier. A significant negative relationship exists between weed biomass and spring rape leaf area index (LAI) (r = -0.62, P < 0.05), as well as between weed biomass and spring rape biomass (r = -0.67, P < 0.01). A significant positive correlation appears between weed abundance and light intensity on soil surface (r = 0.68, P < 0.01).

Key words: *Brassica napus*, weed suppression, crop density, leaf area index, lighting

INTRODUCTION

The most important components of arable land communities are agricultural plants and weeds (Mahn, 1992). Weeds are usually defined as competitors to agricultural plants for moisture, nutrients, light and space (Eisele & Köpke, 1990; Lazauskas, 1990; Börner, 1995; Dau et al., 2004).

The seed rate or density of agricultural plants is a very important factor, which raises domination of agricultural plants and suppresses weeds in the crop stand (Lazauskas 1990; Auler 1998). The essence of weed suppression is that all plants (agricultural plants and weeds) become smaller when crop stand density increases (Lazauskas, 1990). However, an increasing seed rate only raises the number of agricultural plants while the number of weeds do not increase and often even decreases.

Agricultural plants have different capability to suppress weeds. It depends on the biological features of plant, especially on plant growth and development at earlier stages (Börner, 1995). Results of the investigation show that spring rape suppresses weeds worse than spring barley and winter wheat do, because it takes long time for spring rape plants to reach rosette stage (Schpaar, 1999; Velicka & Treciokas, 2002). Increase of crop density and herewith increase of canopy should intensify the competition ability of spring rape plants and suppress weeds better.

The aim of our investigation was to determine the dependency of weed abundance on spring rape plant density increase.

MATERIALS AND METHODS

The field experiments were carried out in the Experimental Station of the Lithuanian University of Agriculture (54°53'N, 23°50'E) in the period of 2003–2004. Soil of the experimental site was carbonated shallow gleyic luvisol (*Calc(ar)i–Epihypogleyic Luvisols*) and it's texture – medium clay loam on heavy clay loam.

Different crop density (Table 1) was formed by seed–drill of exact sowing with respect to rape 'Sponsor' seed germination rate and 1000 seed weight. Size of sampling plot was 41.4 m^2, number of replications – 4. Conducting the experiments randomized block design was used.

Soil tillage: in autumn conventional ploughing at the depth of 23–25 cm, in spring – twice cultivation and harrowing. The applied fertilizers were 90 kg N per ha, 26 kg P per ha and 100 kg K per ha. Forecrop – spring barley. Rape was sprayed 2 times against pests with alfa – cipermetrin (0.01 l ha^{-1}).

Leaf area index was determined at the flowering stage of rape with scanner HP SCANJET 3500C and computer system ROOTEDGE (1998).

Crop lighting was measured at the flowering stage with luximeter Ю 116 (range of measurement 0 – 100000 lx). Lighting was measured at soil surface, at ¼, ½, ¾ crop canopy layers and rape apices. Coefficient of rape apices lighting: τ_r = 100 %. Lighting of a certain crop layer: $\tau_l = E_l \times E_r^{-1} \times 100$ %, (E_l – lighting in a certain crop layer, E_r – lighting of rape apices).

Dry matter (DM) yield of spring rape plants was determined at the flowering stage. Two sampling areas (size 1 m^2) were used to determine these parameters.

Weed abundance (plants m^{-2}) and weed air dry biomass (g m^{-2}) were assessed before crop harvesting on two sampling areas in each plot. Used frame size was 1 m^2.

The experimental data was statistically estimated by using Fisher protected LSD test, correlation and regression analyses (SYSTAT 10). The weediness investigation data that did not meet the normal distribution were transformed by using the function $y = arctgx+1$ before statistical evaluation.

RESULTS AND DISCUSSION

Plant leaf area index (LAI) is often used to describe weed suppressing in the crops of different densities. Some researchers indicate that spring rape plants develop their strong competitive ability only at later growth stages and optimal LAI in the crop stand is reached at the flowering stage (Velicka, 2002; Diepenbrock & Grosse, 1995). Results of the investigation show close relationship between leaf area index (LAI) of the spring rape and plant density ($y = 2.61 + 0.01x$, $r = 0.99$, $P < 0.01$ and $y = 1.65 + 0.02x - 5 \times 10^{-4}x^2$, $r = 0.86$, $P < 0.05$ in 2003 and 2004 respectively). The least LAI was determined in the thinnest rape crop. At a crop density increase until 200 plants m^{-2} the tendency of leaves assimilation area increase was determined. In 2003 the LAI significantly increased from 54.6 to 81.5 % at rape crop density from 200.1 to 450 plants m^{-2} as compared with thinnest crop, in 2004 the LAI reached maximum at the rape crop density of 200.1–250 plants m^{-2} and afterwards it decreased.

The higher LAI is formed the lower light flush penetrates through crop stand and weeds are suppressed at higher extent (Schenke & Köpke, 1994). Results of our investigation show that lighting of canopy levels was in close relationship with the crop density. At the increasing rape density the solar light flush reaching the soil surface and ¼ canopy height decreased (accordingly $y = 6.49 - 0.01x$, $r = -0.76$, $P < 0.01$ and $y = 20.22 - 0.03x$, $r = -0.63$, $P < 0.01$). Lighting of soil surface was significantly higher by 1.3–6.7 times in the thinnest rape crop where the LAI also was the lowest one as compared with that in densier sown crops. Light flush reaching ¼ and ½ canopy height levels decreased at the increasing rape plant density. Similar regularities were determined also at the ¾ canopy height level, but lighting at this level was much higher as compared with that in lower levels where the main amount of leaves was concentrated.

A trend of increasing spring rape DM yield at the increasing crop density up to 150 plants m^{-2} was established. In 2003 at the crop density of 150.1–450 plants m^{-2} the rape yield was significantly higher by 40.8–113.5 % than that at the lowest plant density. In 2004 the maximum yield was produced by the crop of 250.1–300 plants m^{-2} density and it decreased at higher plant densities.

The results of the correlation and regression analyses show significant positive dependency of rape plants productivity on crop density and LAI (accordingly $y = 3.81 + 0.01x$, $r = 0.70$, $P < 0.01$ and $y = 3.69 + 0.47x$, $r = 0.53$, $P < 0.05$).

In both years of investigation 34 weed species belonging to 17 families were found in spring rape plots. Common lambsquater (*Chenopodium album* L.) was the most abundant one.

At crop harvest stage in 2003 the significant decrease of weed plant number was in the densiest rape stand (350.1–450 plants m^{-2}) (Fig. 1). In 2004 different rape density had no significant influence on weed number.

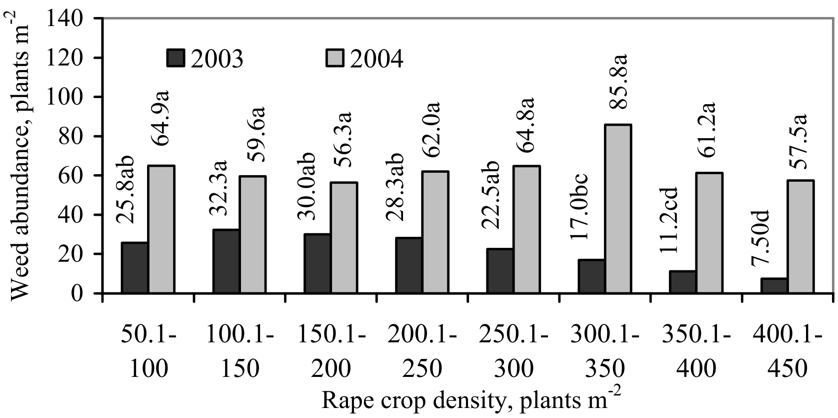

Fig. 1. Weed abundance in different crop densities before harvest. Means not sharing a common letter are significantly different ($P < 0.05$).

Based on the obtained data in both experimental years it is evident that the highest air dry biomass of weed plants was in the thinnest spring rape crop (Fig. 2). At the increasing crop density the air dry biomass of weeds decreases. In 2003 significant decrease of weed biomass was established at the crop density of 350.1–450 plants m^{-2}, or in 2004 – at the density of 400.1–450 plants m^{-2} as compared with that in the thinnest rape crop. The prevailing weed species in the rape crop stand was *Chenopodium album* and changes in the total weed abundance were determined by this species.

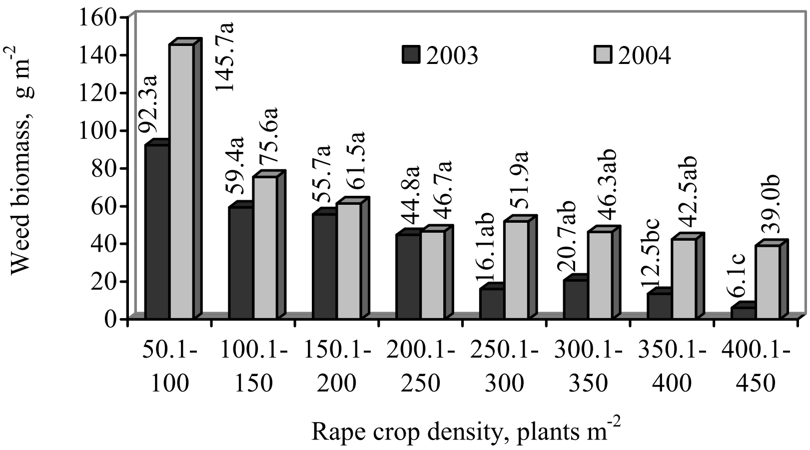

Fig. 2. Air dry weed biomass at different crop densities before harvest. Means not sharing a common letter are significantly different ($P < 0.05$).

Weed suppressing in spring rape crop of different density depends on the LAI, biomass of the rape plants and the light flush reaching the soil surface at the crop flowering stage. Significant negative dependency of weed air dry biomass on the LAI ($y = 113.81 - 16.71x$, $r = -0.62$, $P < 0.05$) and rape plants biomass ($y = 164.72 - 20.91x$, $r = -0.67$, $P < 0.01$) was established. Zacharenko (2000) also presents similar results. Significant positive relationship existed between weed biomass and the light flush reaching the soil surface ($y = 14.69 + 11.31x$, $r = 0.68$, $P < 0.01$).

CONCLUSIONS

Light intensity on soil surface decreases when assimilation area of spring rape leaves and total crop biomass increases.

Weed air dry biomass depends on the spring rape leaf area index ($r = -0.62$, $P < 0.05$), rape plants biomass ($r = -0.67$, $P < 0.01$) and light intensity on soil surface ($r = 0.68$, $P < 0.01$) at the crop flowering stage.

Spring rape density for more effective weed suppressing should be not less than 300 plants m^{-2}.

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