Short Communication

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Non-chemical weed control systems in organically grown spring oilseed rape

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This study aims to determine the impact of different non-chemical weed control systems on organically grown spring oilseed rape (*Brassica napus* L.) crop weediness and yield of seeds. Non-chemical weed control systems: 1) thermal (water steam), 2) mechanical (inter-row loosening), and 3) smothering (self-regulation). Thermal (1.5–1.8 times) and mechanical (2.5–6.8 times) weed control systems significantly reduced the number of weed seedlings in spring oilseed rape crop, compared with the weed smothering system. The most effective system of weed control in rape crop was mechanical (efficiency 30.9–75.5 %). Efficiency of thermal weed control system, compared with mechanical, was lower, 28.4–40.0 %. Before rape harvesting in plots where mechanical weed control was applied, compared with plots where weed smothering was used, the number of weeds was significantly 3.2–4.4 times lower, and dry matter mass of weeds was 2.2–3.1 times lower. The yield of rape seeds increased with increasing efficiency of thermal and mechanical weed control. In 2014, the yield of rape seeds depended on number of weed seedlings and dry matter mass of weeds before rape harvesting.

Keywords: spring oilseed rape, weed control systems, weed, yield, organic farming

1 Introduction

In the organic farming weed control is based on weeds and crop interaction, crop rotations, soil conditions, different management and weed control methods (Lundkvist et al., 2008). Oilseed rape has a lower weed smothering capacity than barley and winter wheat due to the long period of their rosette development (Velička, 2002). Therefore it is very important to establish effective weed control systems. Inter-row mechanical weed control is practiced in organic farms and can significantly reduce crop weediness (Praczyk, 2005). Thermal weed control using water steam is a newly developed method for controlling weeds (Kerpauskas et al., 2010; Sirvydas, Kerpauskas, 2012). Virbickaitė et al. (2006) found that the efficiency of thermal weed control using steam for annual weeds was 22.5 % higher than mechanical weed control; however, the effectiveness of mechanical weed control on perennial weeds was 32.0 % higher than using the thermal method. Kerpauskas et al. (2006) determined that thermal weed control using steam lowered weed dry matter mass by 44.0 %. There have been multiple investigations on oilseed rape cultivated in an organic system, but there is lack of such studies for Lithuanian climatic conditions, especially with non-chemical weed control systems. The aim of this study was to investigate non-chemical weed control systems on organically grown spring oilseed rape (*Brassica napus* L. ssp. *oleifera annua* Metzg) crop weediness and yield of seeds.

2 Material and Methods

Field experiments were performed in 2013 and 2014 at the Experimental Station of Aleksandras Stulginskis University (54°53' N, 23°50' E). The soil was *Calc(ar)i-Endohypogleyic Luvisol* (Drainic) according to the WRB 2014. Non-chemical weed control

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systems used: 1) thermal (water steam); 2) mechanical (inter-row loosening); and 3) smothering (self-regulation). The spring oilseed rape variety 'Fenja' (8 kg ha^{-1}) was cultivated in a certified organic field. Thermal and mechanical weed control were applied in oilseed rape crops cultivated at a wide row spacing of 48 cm. For thermal weed control, a mobile thermal water steam device was used (thermal capacity 90 kW, performance 120 kg h^{-1}, with steam-fired liquefied gas). The steam temperature was 99 °C, and the heat exposure duration was 2 s. For mechanical weed control, inter-rows were loosened twice with a soil loosener (KOR-4.2-01, Ukraine) at the 3-leaf stage of rape. In the smothering treatment, rape was cultivated at an inter-row spacing of 12 cm. Four replications were performed in this experiment. Prior to the crop was bare fallow (mouldboard plough). The efficiency of the different weed control methods (E) with respect to the change in weed seedling number was calculated according to the following formula: E = (S1-S2)/S1*100 %, where S1 is the weed seedling number in 1 m^2 before the weed control method was applied, and S2 is the weed seedling number in 1 m^2 after the application of weed control. The first analysis of weed seedlings abundance was conducted prior to the application of weed control methods in 3 to 4 leaf stage of the rape. The number of weed seedlings was estimated in each replication in four randomly selected 0.10 m^2 sized plots. The second analysis was performed in marked weed accounting plots seven days after the application of weed control systems. The number and dry matter mass of weeds was assessed before rape harvesting in four randomly selected 0.25 m^2 sized plots. Data were statistically evaluated for quantitative characteristics using a one-way ANOVA and correlation-regression methods.

3 Results

In both experimental years in organically grown spring oilseed rape crop the most abundant weeds were *Chenopodium album* L., *Lamium purpureum* L. and *Stellaria media* (L.) Vill. Prior weed control treatments, in 2013 and 2014, the number of weed seedlings in the rape crop with 12 cm inter-rows (smothering treatment) and in the crop with 48 cm inter-rows (thermal and mechanical treatments) was similar. After weed control treatments application, the highest number of weed seedlings was in smothering plots. Thermal (1.5–1.8 times) and mechanical (2.5–6.8 times) weed control systems significantly reduced the number of weed seedlings, compared with the weed smothering system. In 2013, the efficiency of both mechanical and thermal weed control systems was similar (Fig. 1). In 2014, the mechanical weed control system was 1.9 times more efficient than the thermal system. Mechanical weed control in the rape crop lowered the number of the most abundant *Chenopodium album L.* by 21.9.5–78.9 %, thermal weed control – by 23.6–49.6 %. The efficiency of weed control in weed smothering plots was negative. In both experimental years before spring oilseed rape harvesting the lowest number and the least dry matter mass of weeds was determined in plots where mechanical weed control was applied. Compared with plots where weed smothering was used the number of weeds was significantly 3.2–4.4 times lower, and dry matter mass of weeds was 2.2–3.1 times lower. In the first experimental year, thermal weed control significantly lowered the number of weeds by 2.0–2.6 times and dry matter mass of weeds by 2.3 times, compared with weed smothering. In the second year dry matter mass of weeds did not differ significantly between thermal and smothering weed control. The yield of rape seeds increased with increasing efficiency of thermal and mechanical weed control systems (Fig. 2). In the weed smothering plots the yield of rape seed was stable in both years. In 2014, correlation and regression data analysis showed significant relationships between yield of spring oilseed rape seeds and number of weed seedlings prior the use of weed control systems (r = -0.99, y = 2.87 – 0.008x, $P < 0.05$), and dry matter mass of weeds before rape harvesting (r = -0.99, y = 2.19 – 0.003x, $P < 0.05$).

4 Conclusions

The most effective system of weed control in organically grown spring oilseed rape was mechanical (efficiency 30.9–75.5 %). Efficiency of thermal weed control system, compared with mechanical, was lower, 28.4–40.0 %. The yield of rape seeds increased with increasing efficiency of thermal and mechanical weed control. In 2014, the yield of rape seeds depended on number of weed seedlings and dry matter mass of weeds before rape harvesting. In 2013, the crop weediness was not limitig factor for the yield of spring oilseed rape seeds.

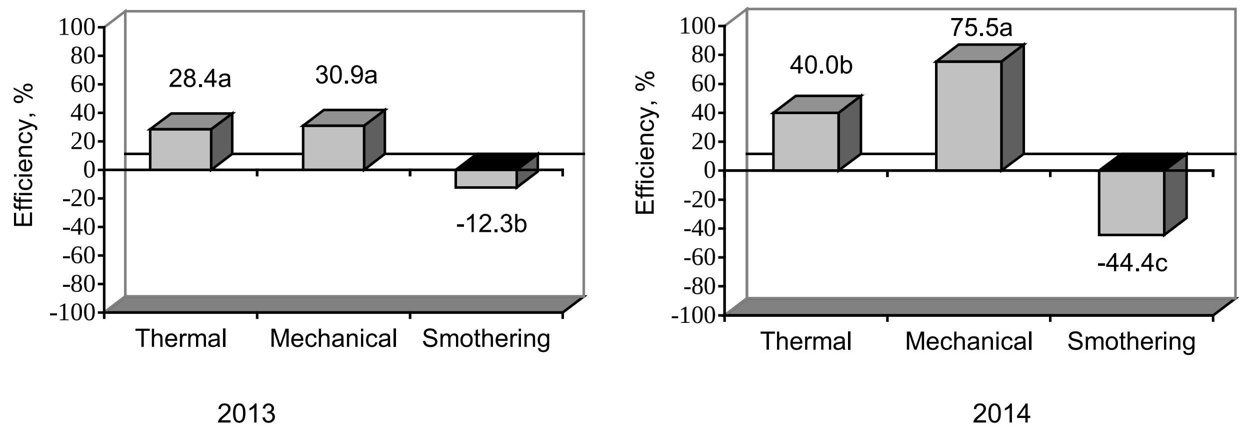

Figure 1 The efficiency of different weed control systems on weed seedlings in the organically grown spring oilseed rape crop, 2013–2014. *Note: means not sharing a common letter (a, b, c) are significantly different (*$P < 0.05$*)*

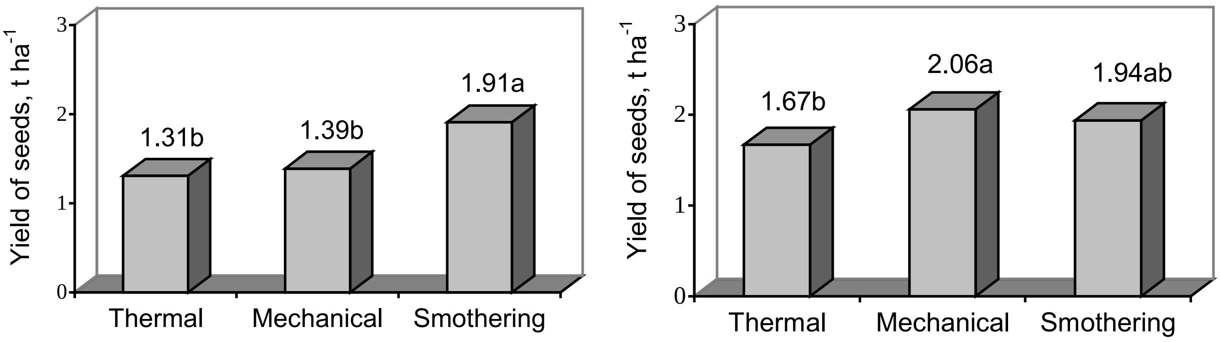

Figure 2 The yield of organically grown spring oilseed rape seeds, using different weed control systems, 2013–2014. Note: means not sharing a common letter (a, b) are significantly different ($P < 0.05$)

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