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Competitive interaction between red beet and weeds, as affected by different weeding time

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Abstract. The competitive interactions between two red beet cultivars ('Pablo F_1', prostrate, and 'Kamuoliai', ect.) and weeds, affected at different weeding times, were studied for three years at the Lithuanian Institute of Horticulture. In all years, a long period of weeding gave lower crop biomass reduction of both cultivars. When weeding was delayed from 2 to 12 weeks after red beet germination the crop biomass of both cultivars was reduced by much more than half. From weed density studies, crop competition during long period of weeding reduced the number of germinating weed species and lowered seed germination of *Chenopodium album* L., *Galinsoga parviflora* Cav., *Cappsella bursa-pastoris* (L.) Medik., *Stellaria media* (L.) Vill. The two cultivars of red beet showed the same response to competition.

Key words: competitive interaction, red beet, weed

INTRODUCTION

During cultivation the conditions of cultured plant and weed competition change. The most dangerous are weeds which germinate earlier than the cultural plants, or at the same time as them (Martin et al., 2001; Froud-Williams, 2002). The strongest weed competition is observed during the first quarter or one third of plant cultivation. Later on the harm from germinated weed is much reduced. Overgrown by the crop they use nutrients, light and water poorly, and thus are often less vigorous (Moody, 1978; Bakalola & Froud-Williams, 1993; Weaver et al., 1994). Weeds are injurious to accumulative plant crops for a longer period, because the potential to overgrow these crops is smaller. Even the weeds which germinate later on, if they are not destroyed, quickly thrive and produce a large seed mass. Red beets tolerate short-term weed mixture for four weeks after the germination of 50% of red beet (Hewson & Roberts, 1973). The strength and duration of the competition when weeds are most harmful depends not only on the species of agricultural plants but also on the botanical composition of the weeds (Frantik, 1994). Plants have an uneven potential to overgrow and various weed types harm the same plants differently. Weeds, which germinated together with agricultural plants, only slightly influence the yield if they are destroyed before the competition starts (Froud-Williams, 2002). According to data by Kołota & Osińska (1998), the critical period of red beet and weed competition lasts for 6 weeks after sowing.

MATERIALS AND METHODS

Field trials were carried out at the Lithuanian Institute of Horticulture in 2000–2002. The trial field was a marginally rolling plane with microrelief. The soil was a shallow calcareous shallow glacious brown soil RDg-kl (Epicalcari-Epihypogleyic Cambisols, CMg-p-w-cap), its granulometric composition waas light clay loam and medium clay loam. The arable layer was weakly alkaline (pH 7.3–7.6), little and medium humus-rich (1.82–3.36%), phosphorus-rich (288–297 mg kg^{-1}), potassium-rich (158–200 mg kg^{-1}), with total nitrogen of 0.11–0.18%. In all research years the beet precursor was a vetch-oat medley. Investigations were carried out with the red beet cultivars 'Kamuoliai 2' and 'Pablo F_1'. The area of the initial experimental plot was 1.0 m x 2.0 m = 2.0 m^2, the area of the record plot was 1.0 x 1.0 = 1.0 m^2. six replications were carried out. Scheme of the experiment: in 1^{st} –6^{th} variants there were weeds in beets 2, 4, 6, 8, 10, 12 weeks from germination; in 7^{th} –12^{th} variants there were no weeds in beets 2, 4, 6, 8, 10, 12 weeks from germination. Before weeding of every plot: weed species, density, and fresh weight were determined; biomass of red beet was determined on every plot.

RESULTS AND DISCUSSION

The experiment of competitive interaction between two red beet cultivars ('Pablo F_1', prostrate; and 'Kamuoliai 2' erect) and weeds affected by different weeding time was carried out in relatively normal weather conditions. Mean temperature during the growing season was similar for the three site-years. However, precipitation was lower in 2002. The weed community was composed of 14 species in the 'Pablo F_1' crop and 12 in 'Kamuoliai 2' in all three years. Overall weed levels, after a long period of weeding, ranged from 17 m^{-2} in 2000 and 2001, up to 14 plants m^{-2} in 2002 in the 'Kamuoliai 2' crop. Overall weed levels ranged from 27 m^{-2} in 2000 and 2001, and 23 plants m^{-2} in 2002 in the 'Pablo F_1' crop. Overall weed levels, after weeding delayed from 2 to 12 weeks after red beet germination, ranged from 139.7–292.8 m^{-2} in 2000 and 2001, and 19–47.6 plants m^{-2} in 2002 in the 'Kamuoliai 2' crop. Overall weed levels after weeding delay ranged from 195.2–318.5 m^{-2} in 2000 and 2001, up to 36.6–72.5 plants m^{-2} in 2002 in the 'Pablo F_1' crop. The lowest density of weeds was recorded in 2002. Total weed level in growing seasons decreased with increasing duration of the weed-free period.

In all three years, *Chenopodium album* L., *Atriplex patula* L., *Galinsoga parvifora* Cav., *Tripleuspermum inodorum* (L.) Sch. Bip., *Thlaspi arvense* L., *Capsella bursa pastoris* (L). Medik., *Galium aparine* L., *Erysimum cheiranthoides* L., *Stellaria media* (L.) Vill., *Lamium purpureum* L., *Amaranthus retroflexus* L., *Veronica arvensis* L. Murray, *Viola arvensis* L., *Senecio vulgaris* L., *Taraxacum officinale* L., *Sonchus arvensis* L., *Cirsium arvense* (L.) Scop., *Poa annua* L., *Echinochloa crus-galli* (L.) Pal. Beauv., *Elytrigia repens* (L.) Nevski composed the weed community. A long period of weeding decreased the number of weed species. After weeding from 2 to 12 weeks only four major species of weeds remained: *C. album* L., *G. parvifora* Cav., *C.bursa pastoris* (L). Medik. and *S. media* (L.) Vill. in both red beet cultivar crops. Seed germination of *C. album* L. decreased to 89.4–98.7%, *G. parvifora* Cav. – to 60.7–87.8%, *C. bursa pastoris* (L). Medik. – to 90.9–95.7% and *S. media* (L.) Vill. – to 85.3–93% in 'Pablo F_1' crop in all three years (Table 1).

Table 1. The species of prevailing weeds in red beet 'Pablo F_1' crop, unit. m^{-2}. Babtai, 2000–2002.

Variants	*Chenopodium album* L.	*Galinsoga parviflora* Cav.	*Capsella bursa-pastoris* (L.) Medik.	*Stellaria media* (L.) Vill.
1. Weedy red beet 2 weeks after germination	32.2	35.1	23.1	17.7
2. Weedy red beet 4 weeks after germination	24.7	43.1	28.0	10.7
3. Weedy red beet 6 weeks after germination	48.7	23.9	20.8	6.1
4. Weedy red beet 8 weeks after germination	41.4	37.1	12.1	9.2
5. Weedy red beet 10 weeks after germination	64.7	43.8	5.6	4.3
6. Weedy red beet 12 weeks after germination	36.1	46.8	9.3	3.9
7. Not weedy red beet 2 weeks after germination	2.5	13.8	2.1	2.5
8. Not weedy red beet 4 weeks after germination	2.2	9.1	2.1	1.5
9. Not weedy red beet 6 weeks after germination	3.4	5.9	1.3	1.2
10. Not weedy red beet 8 weeks after germination	1.4	7.5	1.4	2.8
11. Not weedy red beet 10 weeks after germination	0.8	5.3	0.4	1.3
12. Not weedy red beet 12 weeks after germination	0	0	0	0

Seed germination of *C. album* L. after weeding from 2 to 12 weeks decreased to 82.6–98.5%, *G. parvifora* Cav. – to 75.5–86.4%, *C. bursa pastoris* (L). Medik. – to 86–93,7% and *S. media* (L.) Vill. – to 87.5–96.3% in 'Kamuoliai 2' crop in all 3 years (Table 2).

Table 2. The species of prevailing weeds in red beet 'Kamuoliai 2' crop, unit. m^{-2}. Babtai, 2000–2002.

Variants	*Chenopodium album* L.	*Galinsoga parviflora* Cav.	*Capsella bursa-pastoris* (L.) Medik.	*Stellaria media* (L.) Vill.
1. Weedy red beet 2 weeks after germination	25.9	10.4	17.2	18.9
2. Weedy red beet 4 weeks after germination	17.5	18.4	16.0	35.2
3. Weedy red beet 6 weeks after germination	21.1	14.6	13.0	15.4
4. Weedy red beet 8 weeks after germination	32.0	22.7	15.4	8.2
5. Weedy red beet 10 weeks after germination	33.6	20.5	12.8	6.4
6. Weedy red beet 12 weeks after germination	31.9	11.9	11.8	1.0
7. Not weedy red beet 2 weeks after germination	4.5	4.5	2.4	1.0
8. Not weedy red beet 4 weeks after germination	2.4	4.4	1.8	0.7
9. Not weedy red beet 6 weeks after germination	2.2	4.2	2.0	3.7
10. Not weedy red beet 8 weeks after germination	2.8	2.8	0.8	0.8
11. Not weedy red beet 10 weeks after germination	0.5	4.3	1.2	1.3
12. Not weedy red beet 12 weeks after germination	0	0	0	0

During all years, a long period of weeding gave lower crop biomass reduction of both cultivars. When weeding was delayed from 2 to 12 weeks after red beet germination the crop biomass of both cultivars was reduced by much more than half. Crop biomass of both cultivars of red beet grown with weeds were reduced with prolonged delays in weed removal in all treatments in all three years. Conversely, the biomass of both red beet cultivars increased when increasing the duration of the weed-free period in all treatments during all three years. Crop biomass of red beet cultivar 'Kamuoliai 2' decreased from 20.6 to 2.9 kg m^{-2} in 2000, from 11.2 to 1.2 kg m^{-2} in

2001 and from 8.5 to 4.2 kg m^{-2} in 2002 after weeding was delayed from 2 to 12 weeks. Crop biomass of red beet cultivar 'Pablo F_1' decreased from 18.3 to 2.9 kg m^{-2} in 2000, from 12.1 to 4.0 kg m^{-2} in 2001 and from 4.7 to 1.3 kg m^{-2} in 2002 after weeding was delayed from 2 to 12 weeks. A long period of weeding gave a crop biomass increase of 'Kamuoliai 2' from 17.3 to 23.1 kg m^{-2} in 2000, from 9.9 to 12.2 kg m^{-2} in 2001 and from 8.3 to 9.9 kg m^{-2} in 2002 and 'Pablo F_1' – from 17.1 to 18.4 kg m^{-2} in 2000, from 11.5 to 14.2 kg m^{-2} in 2001 and from 7.1 to 9.4 kg m^{-2} in 2002. According to the average data over the three years, when weeds grew in the crop from 2 up to 12 weeks, red beet 'Kamuoliai 2' biomass decreased from 13.8 to 3.0 kg m^{-2} and 'Pablo F_1' biomass from 12.6 to 2.3 kg m^{-2}. Preserving a non-weeded crop from 2 to 12 weeks, red beet 'Kamuoliai 2' biomass increased from 10.9 to 15.1 kg m^{-2} and 'Pablo F_1' biomass – from 12.9 to 13.2 kg m^{-2} (Table 3). The two cultivars of red beet, despite differences in the positions of leaves, showed the same response to competition. According to investigations carried out in Italy with sugar beet cultivars of two different morphotypes ('Rizor' with more upright leaves and 'Ritmo' with more horizontal leaves), different competitive properties were also not observed (Paolini et al., 1999). Lotz et al (1991) state that sugar beet cultivars with horizontal leaves may overgrow more, and decrease the number of weed shoots (including goose-foot) and at the same time decrease the yield losses .

Table 3. Red beet biomass, kg m^{-2}. Babtai, 2000–2002.

Variants	Red beet cultivar 'Pablo F_1' biomass, kg m^{-2}	Red beet cultivar 'Kamuoliai 2' biomass, kg m^{-2}
1. Weedy red beet 2 weeks after germination	12.6	13.8
2. Weedy red beet 4 weeks after germination	9.2	10.2
3. Weedy red beet 6 weeks after germination	5.8	7.1
4. Weedy red beet 8 weeks after germination	4.1	4.8
5. Weedy red beet 10 weeks after germination	2.5	3.4
6. Weedy red beet 12 weeks after germination	2.3	3.0
7. Not weedy red beet 2 weeks after germination	12.9	10.9
8. Not weedy red beet 4 weeks after germination	12.8	13.0
9. Not weedy red beet 6 weeks after germination	13.5	13.7
10. Not weedy red beet 8 weeks after germination	13.3	14.8
11. Not weedy red beet 10 weeks after germination	13.4	14.4
12. Not weedy red beet 12 weeks after germination	13.2	15.1
P>0.05	2.86	4.75

CONCLUSIONS

Total weed level in growing seasons decreased with increasing duration of the weed-free period. A long period of weeding reduced the number of germinating weed species from 14 in the 'Pablo F_1' crop and 12 in the 'Kamuoliai 2' crop to four major species of weeds: *Cenopodium album* L., *Galinsoga parvifora* Cav., *Capsella bursa pastoris* (L). Medik. and *Stellaria. media* (L.) Vill. in both of the red beet cultivars crops.

The two cultivars of red beet, despite differences in the positions of the leaves, showed the same response to competition. In all years, a long period of weeding gave lower crop biomass reduction of both cultivars. When weeding was delayed from 2 to 12 weeks after red beet germination crop biomass 'Kamuoliai 2' decreased from 13.8 to 3.0 kg m^{-2}, and 'Pablo F_1' biomass – from 12.6 to 2.3 kg m^{-2}.

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