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Determination of weed competition critical period in red beet

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Abstract. The field experiment was conducted at the Lithuanian Institute of Horticulture from 2000-2002 to determine the critical period of weed competition in red beet (*Beta vulgaris* L.) hybrid 'Pablo' crop. Weeding was delayed until 2, 4, 6, 8, 10, 12 weeks after red beet germination (WAG) and was carried out during the first 2, 4, 6, 8, 10, 12 WAG. Weed competition during the first 10 to 12 WAG reduced the marketable yield of red beet by 100%. Competition in the first 8 WAG reduced yield by 92.2%. Competition in the first 2 WAG had no adverse effect on yield; there was only an 8.3% reduction of red beet yield. A period of weeding for 4 WAG provided a yield similar to that achieved with 6 weeks of weeding. It is concluded that the first 4 WAG are the most critical for weed competition in red beet crop at a 5% yield loss level. Weeds emerging later do not appear to be detrimental to red beet growth and marketable yield.

Key words: competition, critical period, red beet, weed, yield

INTRODUCTION

Weeds compete with crops for environmental resources available in limited supply - nutrients, water and light. Competition has been defined as 'the tendency of neighbouring plants to utilize the same quantum of light, ions of mineral nutrient, molecules of water, or volume of space'. As a consequence, weeds may significantly reduce yield and impair crop quality, resulting in financial loss to the grower/farmer. Thus it has been estimated that on a global basis weeds are considered to be responsible for c. 10% reduction of crop yield (Froud-Williams, 2002). Economic and environmental issues are pressing farmers to reduce costs and pesticide use in Europe and other parts of the world. In the case of weed control, this requires a better knowledge of the effects of weed competition on crop productivity and the development of tools that can aid farmers' decisions about weed control (Kropff & Spitters, 1992). The critical period is useful in defining the crop growth stages most vulnerable to weed competition. In practice, the critical period is defined as a number of weeks after crop emergence during which a crop must be weed-free in order to prevent yield losses greater than 5% (Hall et al., 1992; Van Acker et al., 1993; Knezevic et al., 1994). The critical period of weed control has been determined for several vegetable crops (Roberts, 1976; Friesen, 1979; Liu et al., 1984; Weaver & Tan, 1987; Frank et al., 1992; Baziramakenga & Leroux, 1994; Kołota & Osińska, 1998; Shuaib, 2001). This study aimed to determine the critical period for weed competition in red beet under the growing conditions of Lithuania.

MATERIALS AND METHODS

Field trials were carried out at the Lithuanian Institute of Horticulture, Babtai, in 2000–2002. The trial field was a marginally rolling plain with microrelief. The soil was shallowly calcareous/shallowly glacious brown soil RDg-kl (Epicalcari-Epihypogleyic Cambisols, CMg-p-w-cap); its granulometric composition – 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}), total nitrogen - 0.11–0.18%. In all research years, beet precursor was vetch-oat medley. Investigations were carried out with red beet hybrid 'Pablo'. Area of initial experimental plot – 1.0 x 2.0 m = 2.0 m^{-2}, area of record plot – 1.0 x 1.0 = 1.0 m^{-2}. Scheme of the experiment: in 1-6th variants there were weeds in beets 2, 4, 6, 8, 10, 12 weeks from germination; in 7-12th variants there were no weeds in beets 2, 4, 6, 8, 10, 12 weeks from germination. Weed fresh weight was determined before weeding of every plot; the marketable yield of red beet was determined on every plot.

RESULTS AND DISCUSSION

The impact of weed fresh weight on red beet biomass, which accumulated during a common period of growth, is described by regression equations. During the different years of the investigation not dependenton the different meteorological conditions, very strong negative impact of weed fresh weight on red beet biomass was obtained (r = -0.979, -0.921, -0.941, -0.964 respectively) (Fig. 1.). Lindquist et. al. (1999) also pointed out that the relative time of weed and crop emergence and densities of both crop and weed may explain the variation in the crop-weed interference relationship among years and locations.

Weed competition, which lasted more than for 2 weeks after red beet germination (WAG), was most harmful to red beet hybrid 'Pablo'. Weed competition during the first 10 to 12 WAG reduced the red beet marketable yield by 100%. Competition in the first 8 WAG reduced yield by 92.2%. Weeds, which grew in the crop after red beet germination for 2 weeks, didn't decrease their productivity significantly, if they were destroyed after that .Competition in the first 2 WAG had no adverse effect on yield; there was only an 8.3% reduction of red beet yield. It has been reported also that in other crops, weed interference can be tolerated up to a certain period before it causes irrevocable yield loss (Dawson, 1986). When the crop was weedy for 4, 6, 8, 10, 12 WAG, beet productivity was the smallest in comparison with that when the crop weeding was done during the first 2, 4, 6, 8, 10, 12 WAG and delayed until 2 WAG. A period of weeding for 2, 4, 6, 8, 10, 12 WAG provided a yield similar to that achieved when the crop weeding was delayed until 2 WAG. The biggest red beet hybrid 'Pablo' productivity was in the crop which was not weedy during 12 WAG (Table 1).. According to the average data of the thee-year investigations, the critical competition period lasts 4 weeks. For such a period, the beet crop should be preserved without weeds after germination so that yield losses will not exceed 5%. Weeds emerging later do not appear to be detrimental to red beet growth and marketable yield. Similar critical periods for weed competition with red beet were also reported by Kołota & Osińska (1998), who defined the critical weed competition period for red beet as 6 weeks after sowing.

Table 1. Effect of weedy period on marketable yield of red beet, t ha^{-1}. Babtai, 2000–2002.

Treatments	2000–2002 average
Weeds were in beets 2 weeks from red beet germination	54.3
weeds were in beets 4 weeks from red beet germination	31.3
weeds were in beets 6 weeks from red beet germination	18.5
weeds were in beets 8 weeks from red beet germination	4.6
weeds were in beets 10 weeks from red beet germination	0
weeds were in beets 12 weeks from red beet germination	0
weeds weren't in beets 2 weeks from red beet germination	53.4
weeds weren't in beets 4 weeks from red beet germination	56.2
weeds weren't in beets 6 weeks from red beet germination	57.1
weeds weren't in beets 8 weeks from red beet germination	57.7
weeds weren't in beets 10 weeks from red beet germination	58.8
weeds weren't in beets 12 weeks from red beet germination	59.2
LSD_{05}	12.31

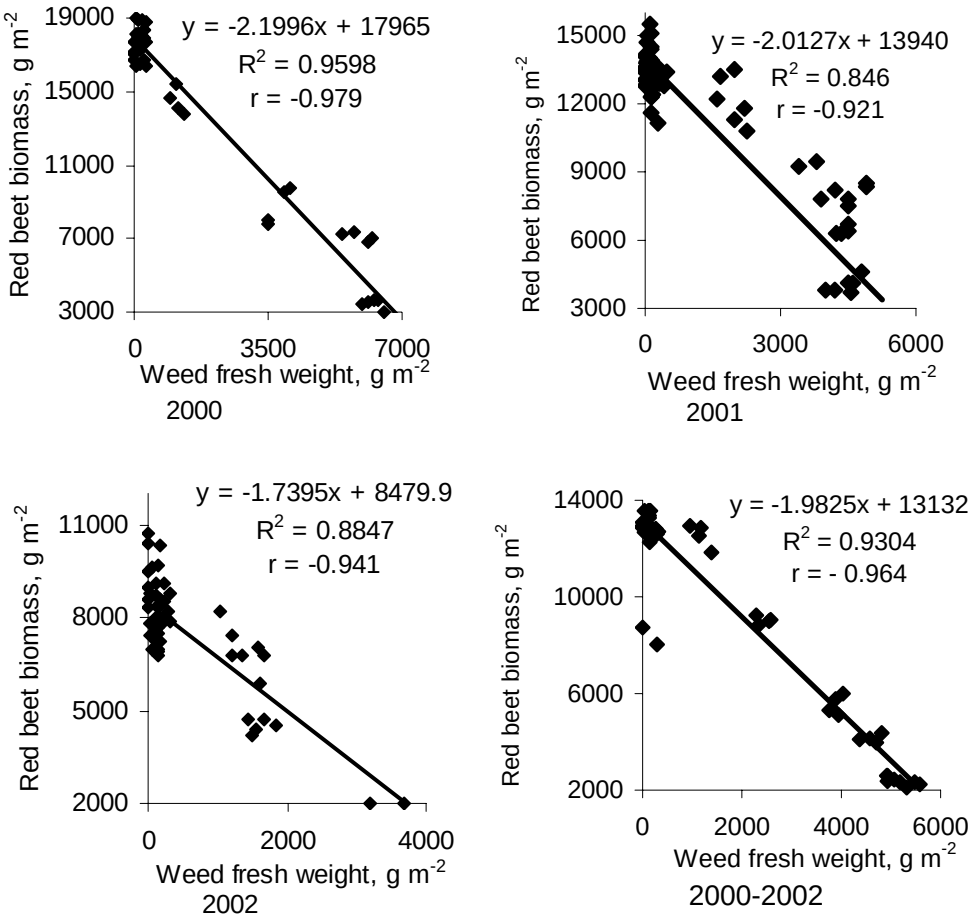

Fig. 1. Impact of weed fresh weight on red beet biomass. Babtai, 2000–2002.

CONCLUSIONS

Very strong negative impact of weed fresh weight on red beet biomass was obtained on every investigation year (r = -0.979, -0.921, -0.941, -0.964 respectively).

The critical competition period in the crop of red beet hybrid 'Pablo' lasted for 4 weeks. Red beet crop should be preserved without weeds for that period after germination so that yield losses will not exceed 5%.

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