Broadleaf weeds and sugar beet response to phenmedipham, desmedipham, ethofumesate and triflusulfuron-methyl

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Abstract. The sugar beet plant is a poor competitor against weeds. Uncontrolled weeds that emerge with the crop typically cause from 50 to 100% yield loss. Field studies were conducted from 2002-2004 to investigate the effects of different rates (1/1, ¾, ½) of herbicides on broadleaf weed control and yield of sugar beet. Phenmedipham + desmedipham + ethofumesate, triflusulfuron, metamitron, chloridazon, chloridazon + quimerac and oil-seed rape oil (1.0 l ha^{-1}) were applied three times at 10 to 15 days intervals starting at the cotyledon growth stage of weeds at 91+71+112, 15, 700, 650, 540+90 g a.i. ha^{-1} dosage (full rate). All rates of herbicides phenmedipham + desmedipham + ethofumesate had a low efficacy. The addition of triflusulfuron to this herbicide reduced the amount of *Tripleurospermum perforatum*, *Thlaspi arvense, Viola arvensis* and *Polygonum aviculare,* but didn't affect *Chenopodium album, Lamium purpureum*. Weed control by applying phenmedipham, desmedipham, ethofumesate and triflusulfuron had increased from 5.5 to 58% by the addition of metamitron, chloridazon and chloridazon+quimerac. The dry-weight of weeds varied significantly depending on the herbicide rates used. Using ½ of full (1/1) rates of the herbicide phenmedipham + desmedipham + ethofumesate had a low efficacy. All herbicide treatments produced higher sugar beet root and sugar yields than did phenmedipham + desmedipham + ethofumesate. Non-sugars were not affected by the herbicide treatments.

Key words: weeds, herbicides, rates, sugar beet, yield

INTRODUCTION

Whenever a crop is seeded, weeds will also appear. Weeds compete with crops for moisture, light and nutrients and uncontrolled weeds can stunt crop growth (Zoschke & Quadranti, 2002). If only a few weeds are present, yield losses may be small, but heavy weed infestations can cause complete crop failure. The level of yield loss depends not only on the infestation, but also the composition of weed flora (Zoschke & Quadranti, 2002). The total potential losses from weeds would be between 26 and 100% of the potential sugar beet yield (Schweizer & Dexter, 1987; May, 2001). Broadleaf weeds often grow to a height two to three times that of sugar beet by mid-summer. Annual broad-leaved weeds are usually more competitive than annual grasses (Schweizer & May, 1993). Weeds may also interfere with harvest operations, making the process less efficient (Zoschke & Quadranti, 2002). Therefore, the control of weeds is an essential component of productive agriculture. Herbicides are the primary tools to manage weeds. Typically, four to five applications of herbicide treatments are used each season (May, 2001). The range of weed species controlled by each herbicide is also limited, so mixtures of herbicides are applied (Lajos & Lajos, 2000). Researchers state a few reasons for the potential successful use of reduced herbicide doses: 1) registered doses are set to ensure adequate control over a wide spectrum of weed species, weed densities, growth stages, and environmental conditions; 2) maximum weed control is not always necessary for optimal crop yields; 3) combining reduced doses of herbicides with other management practices, such as tillage or competitive crops, can markedly increase the odds of successful weed control (Blackshaw et al., 2006). The doses of herbicides could be reduced by application at the early growth stage of the weeds, when the first seed leaves start to appear (Schweizer & May, 1993; Lajos & Lajos, 2000). When reducing herbicide dose by 50%, its effectiveness varies from 75–100%. Herbicide fficacy also depends on the herbicide mixture used. Results have shown that it is possible to reduce herbicide doses in sugar beet (Lajos & Lajos, 2000) on some weed species. The most popular post-emergence herbicides are phenmedipham, desmedipham, ethofumesate, metamitron, triflusulfuron-methyl and chloridazon (Schweizer & May, 1993; Wilson, 1999; May, 2001).

This study was conducted to determine the effect of post-emergence herbicides and the effect of rates of these herbicides on broadleaf weeds and sugar beet.

MATERIALS AND METHODS

Field experiments were conducted at Dotnuva locality in the central part of Lithuania on a light loamy *Endocalcari - Endohypogleic Combisol* from 2002-2004. The field experiment included 5 treatments (A factor) and three rates of herbicides: 1/1, ¾ and ½ of the registered rate (B factor) (Table 1). A randomized plot design with four replicates was used. The herbicides were applied three times. The first application was conducted at the cotyledon stage of weed growth. Subsequent applications were applied when the next weed flush had emerged, or 7–14 days after the first flush. Weed number and dry-weight were sampled four weeks after treatments. The number of weeds and botanical composition was determined at 0.25 m^2 (0.20 m x 1.25 m) in 4 settled places of each treatment.

Table 1. Treatments and rates.

Treatments	Rate g l^{-1}		
	1/1	3/4	½
Phenmedipham+desmedipham+ ethofumesate+oil*	91+71+112	68+53+84	46+36+56
Phenmedipham+desmedipham+ ethofumesate+triflusulfuron +oil*	91+71+112+15	68+53+84+11.2	46+36+56+7.5
Phenmedipham+desmedipham+ ethofumesate+triflusulfuron +metamitron+oil*	91+71+112+15+ 700	68+53+84+11.2 +525	46+36+56+7.5 +350
Phenmedipham+desmedipham+ ethofumesate+triflusulfuron+ chloridazon+oil*	91+71+112+15+ 650	68+53+84+11.2 +488	46+36+56+7.5 +325
Phenmedipham+desmedipham+ ethofumesate+triflusulfuron+ chloridazon+quimerac+oil*	91+71+112+15+ 540+90	68+53+84+11.2 +405+68	46+36+56+7.5 +270+45

*: oil-seed rape oil dose 1.0 l ha^{-1}

The results thus obtained were statistically analyzed using STATISTIKA software. Weed weight data were transformed to $Y=\sqrt{(X+1)}$. The data of investigations were statistically treated as a two-factorial experiment.

RESULTS AND DISCUSSION

The weed spectrum differed among the years. In 2002, *Lamium purpureum* L., *Veronica arvensis* L. and *Viola arvensis* Murray. dominated the weed flora composition; in 2003, *Tripleurospermum perforatum* (Merat) M.Lainz, *Chenopodium album* L. and *Polygonum aviculare* L. were the most prevalent weed species, and in 2004, *C. album* and *Trifolium repens* L. were the most frequently found. The results showed that the addition of triflusulfuron, metamitron, chloridazon and chloridazon + quimerac increased effectiveness of phenmedipham + desmedipham + ethofumesate by 65.5–96.4% (Table 2). Similar results were reported elsewhere (Fisher et al., 1995; Lajos & Lajos, 2000). Air-dry weight of weeds was very similar between the treatments investigated. However, the dry-weight of weeds varied significantly according to the herbicide rates used. The ½ dose of full (1/1) rates of the herbicide phenmedipham + desmedipham + ethofumesate had low efficacy.

Table 2. The influence of herbicide mixtures and rates on dry-weight of weeds, g m^{-2}.

Herbicides mixtures	Herbicides rates (B factor) 1/1	¾	½	Average A factor
Phenmedipham+desmedipham+ethofumesate +oil	151.9	123.6	209.2**	161.6
Phenmedipham+desmedipham+ethofumesate +triflusulfuron +oil	10.4**	25.6**	72.1	36.0**
Phenmedipham+desmedipham+ethofumesate +triflusulfuron +metamitron +oil	5.5**	29.6**	30.7**	21.9**
Phenmedipham+desmedipham+ethofumesate +triflusulfuron+ chloridazon+oil	5.8**	15.3**	68.2*	29.8**
Phenmedipham+desmedipham+ethofumesate+ triflusulfuron+ chloridazon+quimerac+oil	9.4**	36.4**	44.5**	30.1**
Average B factor	36.6	46.1	84.9**	55.9

*, ** - differences significant at the 5%, 1% level, respectively

Results indicated that all herbicide treatments produced relatively higher sugar beet root yield than did phenmedipham + desmedipham + ethofumesate (Table 3). The herbicide phenmedipham + desmedipham + ethofumesate combination with triflusulfuron and chloridazon + quimerac resulted in more significant yield reduction than phenmedipham + desmedipham + ethofumesate combination with triflusulfuron alone. Only the half rate of herbicides significantly reduced root yield (7.2%) as compared with the full rate. In the trials published by Wilson et al. (2005), increasing the herbicide rates by 50% over the full rate, reduced the sugar beet yield by 9.1%.

The white sugar yield varied similarly to the root yield, because of the herbicides, and theses(?) rates investigated did not affect the amount of sugar, sodium, potassium and α-amino nitrogen. According to literature (Farzin & Hossein, 2004), sucrose content and other sugar beet quality characteristics were not affected by the herbicide treatments.

Table 3. The influence of herbicide mixtures and herbicides rates on root yield of sugar beet, t ha^{-1}.

Herbicides mixtures	Herbicides rates (B factor) 1/1	¾	½	Average A factor
Phenmedipham+desmedipham+ethofumesate +oil	49.3	49.7	45.9	48.3
Phenmedipham+desmedipham+ethofumesate +triflusulfuron +oil	60.3	55.1	53.8	56.4
Phenmedipham+desmedipham+ethofumesate +triflusulfuron +metamitron +oil	56.1	58.5	55.3	56.6
Phenmedipham+desmedipham+ethofumesate +triflusulfuron+ chloridazon+oil	60.6	61.0	57.7	59.8
Phenmedipham+desmedipham+ethofumesate+ triflusulfuron+ chloridazon+quimerac+oil	59.4	56.7	52.5	56.2
Average B factor	57.1	56.2	53.0	55.4
LSD_{05} A factor			2.18	
LSD_{05} B factor			1.38	

CONCLUSIONS

All herbicide treatments produced higher sugar beet root and sugar yields than did phenmedipham + desmedipham + ethofumesate. Reducing the rate of phenmedipham + desmedipham + ethofumesate and triflusulfuron, chloridazon, metamitron, chloridazon + quimerac by 25% the dry-weight of weeds increased significantly while root yield did not decrease significantly. Herbicides and theses rates did not affect contents of sugar and non-sugars.

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