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Effect of sulfonylurea herbicides on weeds and maize

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Abstract. Three field experiments, designed to test the new sulfonylurea group herbicides, were conducted in maize crops during 2002–2003 at the Lithuanian Institute of Agriculture in Central Lithuania.

The weed species differed between fields. The most frequent weed species in maize stands were *Elytrigia repens*, and *Chenopodium album.* The efficacy of tested herbicides against *Chenopodium album*, *Echinocloa crus – galli* differed in relation to active ingredients. Rimsulfuron-methyl and nicosulfuron-methyl were effective against *Echinochloa crus – galli;* primisulfuron-methyl did not have any effect on this weed species. Nicosulfuron – methyl and primisulfuron-methyl were effective against *Chenopodium album*, however, rimisulfuron methyl did not control that weed as effectively.

The green matter yield of maize in treated plots was 1–18.4 t ha^{-1} higher than in the untreated.

Key words: maize, weeds, sulfonylurea, herbicide post- emergence application

INTRODUCTION

Weeds cause problems in all crops in Lithuania, but those with the greatest economic importance are *Elytrigia repens*, *Tripleurospermum inodorum*, *Stellaria media,* and *Chenopodium album* (Kavoliunaite, 2001).

Under Lithuanian conditions maize is extremely sensitive to weed infestation. As few as 3–6 annual dicotyledonous weeds per square meter significantly reduced maize green matter yield. (Adzgauskiene, 1996). Approximately 40 weed species occur in maize crops in Lithuania (Auškalnienė &Auškalnis, 2006); the he most frequent were *Elytrigia repens* and *Chenopodium album,* whichwere found in 80–100% of maize fields. The analysis of weed weight showed that perennial weeds accounted for 20-80% of the total weed weight; *Elytrigia repens* accounted for 60–100% annually. Low application rates, broad spectrum weed control and favourable toxicological properties of sulfonylurea have contributed to the success of this group of herbicides (James & Rahman, 1994). Primisulfuron is a sulfonylurea herbicide which controls troublesome perennial grass such as couch (*Elytrigia repens),* at the same rates required for annual grass weeds and many broadleaf weeds in maize (Maurer et al., 1987; Bhowmik et al., 1990). Tests at the Lithuanian Institute of Agriculture using Primisulfuron-methyl indicated that a split application of 15 plus 15 g ha^{-1} provided 99% control of *Elytrigia repens* and 94% control of *Chenopodium album* (Auškalnienė & Auškalnis, 2005).

The aim of the present study was to compare the efficacy of the three herbicides of sulfonylurea group,primisulfuron–methyl, rimsulfuron–methyl and nicosulfuron– methyl, on weed weight and maize biomass.

MATERIALS AND METHODS

Three field trials for the testing of sulfonylurea group herbicides - primisulfuron–methyl (Tell 75WG), rimsulfuron–methyl (Titus 25 DF) and nicosulfuron-methyl (Milagro 40 SC) - were conducted in 2002 - 2003 in Central Lithuania. The soil of the experimental site is endocalcary – endohypogleyic cambisol, sandy light loam with a P_2O_5 value of 142 mg kg^{-1}, K_2O – 195 mg kg^{-1}. The growing conditions were favourable for maize, especially in 2002, when the spring was early and warm, and the summer was hot and dry; the amount of rainfall in May was 3 times as low as the long-term mean and the temperature during the maize growing season was noticeably higher than the long-term mean.

In 2003 the mean air temperature in May was close to the long-term mean, and rainfall was 69% of the long-term mean. Maize cultivation practices were common for all trials. Maize was sown in the last week of April, fertilized with $N_{150}P_{35}K_{166}$ pre-sowing. The seed rate was 90 thousand viable seeds per ha, inter-row spacing 75 cm. Herbicides of the sulfonylurea group were spray – applied post-emergence of maize, at growth stage 13–14 BBCH. Herbicide was sprayed with a compressed nitrogen gas sprayer using a 2.5 m wide boom, at a pressure of 250 kPa, nozzle, 4110-12, spraying speed 1m s^{-1} and a volume rate of 200 L ha^{-1}. Weed assessments were conducted on individual weed species in 4 x 0.25 m^2 per plot 6 weeks after herbicide application. In all treatments with primisulfuron–methyl and rimsulfuron-methyl, the surfactant Kemiwett 0.2 l ha^{-1} was added. Maize was harvested in the last week of September.

Weed number m^2 and weed biomass and efficacy of herbicides were assessed 6 weeks after application. The experimental data were compared using an analysis of variance (ANOVA) and, where the F-ratio was significant, the least significant difference (LSD) was calculated for $P < 0.05$. For statistical analysis weed weight data were transformed according to the equation (log+2).

RESULTS AND DISCUSSION

A total of 13 weed species were found in the experimental fields. *Chenopodium album* and *Elytrigia repens* were found in all trials, whereas *Echinochloa crus galli* was identified in only one trial. Weed density varied from 32 and 350 weeds per m^{-2}. Total weight of the weeds varied from 946 to 2422 g m^{-2}. *Elytrigia repens* accounted for 1-53% of the total weed weight. In trial 1 annual dicotyledonous weeds – especially *Chenopodium album* and volunteer rape (*Brassica napus*) - were the most prevalent. In trial 2 the dominant weed was *Elytrigia repens,* which accounted for 53% of the total weed weight. *Chenopodium album* prevailed in trial 3 where it accounted for 87% of the total weed weight. *Echinochloa crus galli* was found in 30 g m^{-2}. The use of these herbicides effectively decreased weed weight. In treated plots the decrease in total weed weight in all treatments was significant (Table 1).

Table 1. Total weed weight g m^{-2} 6 weeks after herbicide application. Dotnuva, 2002– 2003.

Treatments	Weight of weeds g m^{-2}		
	Trial 1	Trial 2	Trial 3
Untreated	1520	727.7	2422.5
Primisulfuron 30 g ha^{-1}	63.3**	168.9**	676.2**
Nicosulfuron 50 g ha^{-1}	86.7**	105.7**	461.2**
Nicosulfuron 60 g ha^{-1}	62.5**	102.6**	21.2**
Rimsulfuron 12.5g ha^{-1}	234.8**	274.5**	1641.5

*.** significant at $P = 0.05$ and $P = 0.01$, ns not significant

The greatest decrease in weed weight was recorded in the plots treated with nicosulfuron. Especially in trial 3, nicosulfuron 60 g ha^{-1} was most effective, compared to the other active ingredients. In this trial the total weed weight was the highest - 2422.5 g m^{-2}, compared to 1520 in trial 1 and 727.7 in trial 2. Differences in the reduction in *Chenopodium album* weight due to the herbicide application were recorded. The weight of *Chenopodium album* in different trials decreased by 23–94% – from 2098.8 to 391.1 g m^{-2} and from 535.5 to 29.8 g m^{-2}, respectively (Table 2).

Table 2. The comparison of *Chenopodium album* weight g m^{-2} 6 weeks after herbicide application. Dotnuva, 2002–2003.

Treatment	Weight of *Chenopodium album* g m^{-2}		
	Trial 1	Trial 2	Trial 3
Untreated	535.5	30.5	2098.8
Primisulfuron 30 g ha^{-1}	29.8**	22.6ns	530.9**
Nicosulfuron 50 g ha^{-1}	45.5**	15.5ns	391.1**
Nicosulfuron 60 g ha^{-1}	38.4**	13.1ns	392.5**
Rimsulfuron 12.5g ha^{-1}	103.5**	0	1602.2ns

*.** significant at $P = 0.05$ and $P = 0.01$, ns not significant

Weight of *Chenopodium album* in untreated plots in trial 2 was low – 30.5 g m^{-1} and did not significantly decrease. The weight of *Elytrigia repens* in trials 2 and 3 was similar – about 300 g m^{-1}, and in trial 1 it was 10 times lower (Table 3).

Table 3. The comparison of *Elytrigia repens* weight g m^{-2} 6 weeks after herbicide application. Dotnuva, 2002–2003.

Treatment			
	Trial 1	Trial 2	Trial 3
Untreated	34	381.9	326.5
Primisulfuron 30 g ha^{-1}	0	27.1**	1.2**
Nicosulfuron 50 g ha^{-1}	0	4.5**	4.2**
Nicosulfuron 60 g ha^{-1}	0	3.6**	10.2**
Rimsulfuron 12.5g ha^{-1}	0	121.8**	0**

*.** significant at $P = 0.05$ and $P = 0.01$, ns not significant

All of the tested herbicides were effective against *Elytrigia repens*. The weight of this weed decreased in treated plots by 80–100%. The efficacy against *Echinochloa crus galli* differed between herbicides. Nicosulfuron and rimsulfuron were effective against this weed but primisulfuron did not have influence. In all treated plots maize green matter yield was significantly higher compared to the untreated (Table 4).

Table 4. Increase in maize green material yield t ha^{-1}. Dotnuva, 2002–2003.

Treatment	t ha^{-1}		
	Trial 1	Trial 2	Trial 3
Untreated	0	0	0
Primisulfuron 30 g ha^{-1}	+5.36	+0.73	+13.6
Nicosulfuron 50 g ha^{-1}	+7.42	+1.88	+18.4
Nicosulfuron 60 g ha^{-1}	+9.34	+2.31	+17.1
Rimsulfuron 12.5g ha^{-1}	+4.34	+1.08	+7.4
LSD $_{05}$	**4.29**	**0.70**	**3.19**

The greatest differences in maize green matter yield between treated and untreated plots were recorded in the trials applied with nicosulfuron. The maize green matter yield differences between rates of nicosulfuron were not significant.

CONCLUSIONS

The most effective herbicide against *Elytrigia repens, Chenopodium album*, and other weeds was nicosulfuron methyl. Significant differences between the rates of 50 and 60 g ha^{-1} of nicosulfuron were not obtained.

The differences in the efficacy of active ingredients were recorded for *Chenopodium album* and especially for *Echinochloa crus – galli*. Rimsulfuron--methyl and nicosulfuron - methyl were effective against *Echinochloa crus – galli,* and primisulfuron–methyl did not have any effect on this weed species. Nicosulfuron – methyl and primisulfuron-methyl were effective against *Chenopodium album*, however, rimisulfuron-methyl did not controll that weed as effectively.

The maize green matter yield in the treated plots was 1–18.4 t ha^{-1} greater than in the untreated. A greater increase in maize green matter yield was recorded in the plots treated with nicosulfuron–methyl.

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