Effects of pre- and post-emergence weed control on weed population and maize yield in different tillage systems

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ABSTRACT

The effect of chemical weed control with reduced herbicide rates (pre-em., pre-em. + post-em., post-em.) on weed population density and maize yield was compared in three tillage systems (mouldboard, chisel, disk harrowing) for lessive pseudogleyic soil in north-eastern Croatia (1997–1999). These main weeds were present in all tillage variants: *Echinochloa crus-galli* (L.) PB., *Chenopodium album* L., *Ambrosia artemisiifolia* L., *Polygonum lapathifolium* L., *Equisetum arvense* L. and *Calystegia sepium* (L.) R.Br. The density of all weeds was significantly affected by tillage and it ranged from 204 plants on untreated plots with mouldboard to 372 and 421 plants per m^2 with chisel ploughing and disk harrowing, respectively. In comparison with standard tank-mixture of atrazine herbicide (metolachlor 50% & atrazine 20%) at the recommended rate, atrazine-free herbicide combinations (metolachlor + 50% prosulfuron & 30% primisulfuron-methyl; sulcotrione + bromoxynil; thifensulfuron-methyl + nicosulfuron) showed a similar total efficacy of weed control (95–96%). Band spraying with standard treatment at a half-recommended rate combined with mechanical weed control brought a satisfactory total weed reduction (83–87%). The weed control methods had no effects on maize yields that were significantly affected by year and tillage. Compared to the highest yield with mouldboard ploughing (10.2 t/ha), average percent yield depressions with chisel ploughing and disk harrowing were 10 and 22%, respectively.

Keywords: atrazine; metolachlor; sulfonylureas; sulcotrione; bromoxynil; tillage; weed density; weed control; maize yield

Maize is the most commonly grown crop in Croatia with grain production of over two million t per year (Anonymous 2000). In most maize fields in Croatia the weeds are controlled by a traditional weed control programme that includes pre-emergence triazine herbicides. Other herbicides are preferred when there is a risk of damage to the following crop by triazine residues or for the correction after pre-emergence application.

In order to achieve the optimal performance, pre-emergence herbicides require adequate precipitation after their application. Another problem of triazine herbicides is that biotypes of more than 50 weed species all over the world have been proved to be triazine resistant (Ritter et al. 1985, Walter 1998). The number of weeds conferring triazine resistance is especially high in Europe (Rubin 1996). According to some estimations concerning Croatian conditions, weeds resistant to triazine occur in more than 30% of maize fields with a tendency of further spreading (Flegar and Ostojić 1993). An increased concern in the environmental side-effects of herbicides and development of herbicide resistance in weeds led to researches on numerous post-emergence herbicides in addition to soil-applied triazine herbicides that are highly effective, safe and rapidly biodegraded (Palm et al. 1989, Berzsenyi et al. 1995, Mekki and Leroux 1995). There has been an increasing interest in the development of integrated weed management systems (IWM) based on the use of precision weed control in space and time (Swanton and Murphy 1996).

The effect of post-emergence weed control is compatible with IWM and it does not depend on precipitation and is also favourable from environmental and economic aspects. It can also prevent the selection of herbicide resistant weed populations (Altiery and Liebman 1988). The application of less intensive tillage practices in cropping systems brings some changes in weed populations and weed control efficiency (Buhler 1995). There has been a demand for information on the effect of reduced tillage on the efficiency of weed control and some weed populations under environmental conditions.

The aim of this comparative study was to determine the effects of different herbicide combinations at low-rate applications (pre-em., pre-em. + post-em., post-em.) under three tillage practices on weed population density and maize yield.

MATERIAL AND METHODS

Field experiments were conducted at Paušinci locality in north-eastern Croatia on lessive pseudogleyic soil from 1997 to 1999. In all three years maize (cv. OSSK 382-FAO group 410) was planted after winter wheat between May l and 13 in 70cm rows at 69 000 plants/ha. Fertilisation was based on 200 kg N, 100 kg P_2O_5 and 150 kg K_2O per ha. Weather conditions during the maize growing season (April, September) are presented in Table 1.

An experimental split-plot design was used with tillage (T) as the main factor and weed control (W) as the subfactor. Weed control plots (3.5 × 9 m) were replicated four times within each tillage plot. Tillage treatments were as

Table 1. Weather conditions during the maize growing season (1997–1999)

Month	Precipitation (mm)			Temperatures (°C)		
	1997	1998	1999	1997	1998	1999
April	62	65	125	8.9	12.7	12.7
May	59	116	52	17.0	16.1	16.1
June	120	39	228	20.4	21.8	19.8
July	116	73	95	21.1	22.1	21.7
August	81	105	78	21.1	22.1	21.2
September	38	109	79	16.6	16.3	19.4
Total (mm)	476	507	657			
Average (°C)				17.5	18.5	18.5

follows: 1. CT – conventional tillage (ploughing with mouldboard plough to 30–35cm depth, with traditional seedbed preparation and sowing); 2. CP – loosening with chisel plough to 15–20cm depth; 3. DH – disk harrowing to 8–10cm depth. Two inter-row treatments were performed in June. Weed control also included six treatments: 1. W0 = untreated control plots; 2. W1 = 30% metolachlor & 20% atrazine (Primextra 500) at a recommended rate (1.8 & 1.2 l a.i./ha) applied pre-em., broadcast; 3. W2 = 30% metolachlor & 20% atrazine at a half-recommended rate (0.9 & 0.6 l a.i./ha), pre-em., band spraying; 4. W3 = metolachlor (Dual Gold 960 EC), pre-em. (1.15 l a.i./ha) + 50% prosulfuron & 30% primisulfuron-methyl (Ring 80 WG), post-em. (16 g a.i./ha); 5. W4 = thifensulfuron-methyl + nicosulfuron (Harmony 75 DF + Motivell), post-em. (10 g + 0.5 l a.i./ha); 6. W5 = sulcotrione + bromoxynil (Mikado + Pardner), post-em. (0.3 + 0.17 l a.i./ha). Sulfonylurea herbicides in treatments W3 and W4 were applied with the addition of 0.15% of Trend 90 surfactant. Pre-emergence herbicides were applied shortly after sowing and post-emergence herbicides mainly at the 4–6 leaf stage of maize. Spraying was performed by the knapsack sprayer Solo (Lurmark AN 1.0 nozzle type, 3.0 bar pressure) in 250 l/ha of the water volume. Phytotoxic effects of herbicides on maize plants were evaluated using a 1–9 scale.

Weed plants were sampled in eight weeks after maize emergence, from July 5 to 15 in all years. Weed number for each species was estimated on each sub-plot in four quadrants, each measuring 50 cm × 50 cm (16 replications totally). The effects of herbicide treatments are shown according to weed density in these groups of weeds: annual grasses, annual broad-leaved weeds and perennial weeds in relation to the untreated control plots. Life forms of species were determined according to Landolt (1977) and their nomenclatures were taken over from Ehrendorfer (1973). Maize was mechanically harvested between October 10 and 15 in all three years. The yield data were recorded and adjusted to 14% moisture content.

The data on weed density and crop yield in all tillage and weed control treatments as well as their interactions were subjected to analysis of variance and tested by *F*-test (Fisher's protected *LSD* test), using Microsoft Excel and Statgraf program. The means were separated by Duncan's Multiple Range Test using the probability level of $P = 0.05$. Linear regression analyses were performed to evaluate univariate correlations between total weed density and crop yield (Snedecor and Cochran 1987).

Table 2. Effects of pre- and post-emergence herbicide application on weed density and maize yield in different tillage systems (1997–1999)

	Annual grass weeds	Annual broad-leaved weeds	Perennial weeds	Total weeds	Grain yield
	plants/m^2		plants/m^2		t/ha
T	F = 77.157**	F = 0.054	F = 25.902**	F = 81.202**	F = 575.251**
CT	40.56 c	1.56 a	0.45 c	42.57 c	10.22 a
CP	79.52 b	1.54 a	1.63 b	82.69 b	9.20 b
DH	91.83 a	1.58 a	1.87 a	95.28 a	8.01 c
LSD	8.476	0.249	0.193	8.467	0.126
W	F = 790.022**	F = 301.083**	F = 103.714**	F = 841.211**	F = 222.921**
W0	323.32 a	5.89 a	2.92 a	332.13 a	6.60 c
W1	7.28 c	0.44 c	1.71 b	9.43 c	9.53 b
W2	51.09 b	1.62 b	1.64 b	54.35 b	9.48 b
W3	13.28 c	0.57 c	0.62 c	14.47 c	9.68 ab
W4	15.10 c	0.51 c	0.54 c	16.15 c	9.70 ab
W5	13.76 c	0.33 c	0.47 c	14.56 c	9.86 a
LSD	12.323	0.347	0.262	12.209	0.233
Y	F = 78.350**	F = 32.416**	F = 27.375**	F = 78.288**	F = 938.012**
1997	41.92 c	1.76 a	0.97 c	44.65 c	10.66 a
1998	98.44 a	1.83 a	1.28 b	101.55 a	9.19 b
1999	71.54 b	1.09 b	1.69 a	74.32 b	7.58 c
LSD	8.826	0.200	0.192	8.912	0.139

	Annual grass weeds	Annual broad-leaved weeds	Perennial weeds	Total weeds	Grain yield
	plants/m^2		plants/m^2		t/ha
T × W	*F* = 30.189**	*F* = 0.280	*F* = 14.020**	*F* = 31.597**	*F* = 3.155**
CT W0	197.25 c	5.75 a	0.92 d	203.92 c	8.13 e
CT W1	2.67 e	0.54 c	0.50 def	3.71 e	10.46 a
CT W2	23.71 e	1.67 b	0.52 def	25.90 e	10.43 a
CT W3	5.46 e	0.67 c	0.33 ef	6.46 e	10.83 a
CT W4	7.25 e	0.40 c	0.25 f	7.90 e	10.60 a
CT W5	5.02 e	0.33 c	0.19 f	5.54 e	10.87 a
CP W0	361.96 b	5.92 a	3.83 a	371.71 b	6.52 f
CP W1	9.46 e	0.33 c	2.15 bc	11.94 e	9.57 b
CP W2	60.31 d	1.69 b	2.00 c	64.00 d	9.72 b
CP W3	15.30 e	0.52 c	0.60 def	16.42 e	9.72 b
CP W4	15.59 e	0.56 c	0.58 def	16.73 e	9.86 b
CP W5	14.58 e	0.21 c	0.58 def	15.38 e	9.78 b
DH W0	410.75 a	6.00 a	4.00 a	420.75 a	5.13 g
DH W1	9.73 e	0.44 c	2.48 b	12.65 e	8.57 cd
DH W2	69.25 d	1.50 b	2.40 b	73.15 d	8.30 d
DH W3	18.56 e	0.52 c	0.92 d	20.54 e	8.49 cd
DH W4	22.46 e	0.56 c	0.79 de	23.81 e	8.63 cd
DH W5	19.68 e	0.44 c	0.65 def	20.77 e	8.92 c
LSD	21.344	0.601	0.453	21.147	0.449
T × Y	*F* = 44.607**	*F* = 16.335**	*F* = 25.902**	*F* = 44.131**	*F* = 25.635**
CT 97	47.65 e	1.59 bc	0.56 e	49.80 d	11.50 a
CT 98	27.62 f	2.44 a	0.64 de	30.70 e	10.30 c
CT 99	46.40 e	0.65 d	0.16 f	47.21 d	8.80 f
CP 97	45.18 e	2.30 a	1.37 b	48.85 d	10.54 b
CP 98	117.26 b	1.24 bc	1.52 b	120.02 b	9.22 e
CP 99	76.15 d	1.07 cd	1.99 b	79.21 c	7.98 g
DH 97	32.99 e	1.39 bc	0.99 c	35.37 de	9.96 d
DH 98	150.44 a	1.81 b	1.69 b	153.94 a	8.06 g
DH 99	92.05 c	1.54 bc	2.94 a	96.53 c	5.97 h
LSD	14.681	0.431	0.334	14.666	0.230
W × Y	*F* = 46.461**	*F* = 13.134**	*F* = 5.766**	*F* = 47.241**	*F* = 1.862
W0 97	195.66 c	7.25 a	2.17 c	205.08 c	8.38 d
W0 98	464.09 a	6.75 a	2.83 b	473.67 a	6.47 f
W0 99	310.21 b	3.67 b	3.75 a	317.63 b	4.94 g
W1 97	5.23 g	0.06 g	1.17 cd	6.46 g	11.12 a
W1 98	7.13 g	0.94 de	1.27 c	9.33 g	9.84 c
W1 99	9.50 g	0.31 fg	2.69 b	12.50 g	7.78 e
W2 97	34.98 ef	1.85 c	1.25 c	38.08 ef	11.03 b
W2 98	63.37 d	1.50 c	1.73 c	66.60 d	9.58 c
W2 99	54.92 de	1.50 cd	1.94 c	58.35 de	7.83 e
W3 97	2.88 g	0.60 efg	0.48 ef	3.96 g	11.05 ab
W3 98	17.24 f	0.83 ef	0.85 de	18.92 fg	9.80 c
W3 99	19.75 f	0.27 fg	0.52 ef	20.54 fg	8.32 d
W4 97	5.81 g	0.46 efg	0.42 ef	6.69 g	11.50 a
W4 98	21.29 f	0.56 efg	0.48 ef	22.33 fg	9.63 c
W4 99	18.17 f	0.52 efg	0.73 de	19.42 fg	8.30 d
W5 97	7.09 g	0.33 efg	0.35 f	7.77 g	11.50 a
W5 98	17.54 f	0.40 efg	0.52 ef	18.46 fg	9.73 c
W5 99	16.67 fg	0.25 fg	0.54 ef	17.46 fg	8.34 d
LSD	21.344	0.601	0.453	21.147	0.449

The factors: tillage = T (CT = conventional, mouldboard plough 30–35cm depth; CP = chisel plough 15–20cm depth; DH = disk harrowing 8–10cm depth); weed control = W (W0 = untreated plots; l. W1 = metolachlor & atrazine, pre-em., broadcast application; W2 = metolachlor & atrazine, pre-em., band application; W3 = metolachlor, pre-em. + 50 prosulfuron & 30% primisulfuron methyl, post-em.; W4 = thifensulfuron-methyl + nicosulfuron, post-em.; W5 = sulcotrione + bromoxynil, post-em.); year = Y; interactions of tillage and weed control = T × W; tillage and year = T × Y; weed control and year = W × Y; the means followed by the same letter within a column are not significantly different at the 5% level according to Duncan's Multiple Range Test

RESULTS AND DISCUSSION

During the experiment, 9 weed species occurred in conventional tillage (CT) and 18 in chisel plough (CP) and disk harrowing (DH) tillage. The weed species number did not differ very much between the years. However, the density of weed populations varied significantly according to the year and tillage. The reduction of soil tillage had a great influence on weed infestation. In comparison with CT tillage, reduced tillage treatments CP and DH increased weed density on average by 94 and 124%, respectively. In respect of the year, the density of total weed population was higher across all tillage treatments by 127 and 66% in 1998 and 1999, respectively, compared to the first year (Table 2).

The largest differences in weed infestations between tillage practices were in the weed groups of annual grasses and perennials. For example, the population of annual grass *Echinochloa crus-galli* (L.) PB. accounted for 96 and 126% more shoots per square meter after CP and DH, respectively, compared with CT tillage. *E. crus-galli* was the most abundant weed species in all tillage practices and made up 95–96% of the total weed density. In the critical period for maize regarding the competition of this weed grass, the lowest shoot density of 197 per m^2 was found in CT and the highest of 411 shoots per m^2 in DH tillage. Berzsenyi et al. (1993) reported that this critical period begins 6–8 weeks after maize emergence. Volunteer winter wheat populations were more abundant in DH than in CP tillage whereas the residual crop was completely eliminated by CT tillage. The highest number of species was in the group of annual broad-leaved weeds with the main species *Ambrosia artemisiifolia* L., *Chenopodium album* L. and *Polygonum lapathifolium* L. (Table 3). Average density of annual broad-leaved weeds was 1.5 plants per m^2 without any differences between the tillage practices (Table 2). This finding concerning the annual broad-leaved weeds is contradictory to some studies (Cussans 1976, Froud-Williams et al. 1981, Buhler 1995) but concurs with some other reports (Wrucke and Arnold 1985). The perennial weed species *Calystegia sepium* (L.) R.Br., *Convolvulus arvensis* L., *Cirsium arvense* (L.) Scop., *Rumex crispus* L., *Lythrum salicaria* L. and *Symphytum officinale* L. as dicotyledonous species, and *Equisetum arvense* L. as a cryptogamous species, made up only 1–2% of the total weed populations, but with a significantly higher abundance by 3% in CP and DH than in CT tillage.

During the experiment the standard pre-emergence herbicide tank mixture of metolachlor & atrazine applied at the recommended rate (W1) provided a consistent control of *E. crus-galli* (96–98%) and annual broad-leaved weeds (90–94%) and an inadequate control of perennial weeds (38–55%). When the same herbicide tank mixture was applied at the half-recommended rate in bands (W2), it ensured good weed control in crop rows that were weed-free at the 4–6 leaf stage of the crop. Eight weeks after maize emergence and after two inter-row treatments in June, the space between the rows on CT plots was considerably infested with shoots of *E. crus-galli* (5–15 cm height) and with many plants of *Ambrosia artemisiifolia*, *Chenopodium album*, *Polygonum lapathifolium* and *Matricaria inodora* L. at 2–6 leaf stages. At the same time CP and DH plots were infested with perennial weeds of *Calystegia sepium*, *Equisetum arvense*, *Rumex crispus* and *Convolvulus arvensis*. The results showed that at least two inter-row treatments in June are needed for a satisfactory weed control by the standard atrazine herbicide in band application. Our previous study showed that by one-pass inter-row cultivation the weeds were not always sensitive, especially in the years with high weed infestation (Đurkić et al. 1997). In our study this combined chemical and mechanical method of weed control resulted in a satisfactory total weed reduction by 83–87%. It was also the case of DH tillage where a very high weed infestation of 421 plants per m^2 was registered. The efficacy of pre-emergence

Table 3. Weed species composition and plant density per m^2 on untreated plots at different tillage systems eight weeks after maize emergence (1997–1999)

	Tillage treatments		
	CT	CP	DH
Annual grass weeds			
Echinochloa crus-galli (L.) PB.	197.30	361.96	410.75
Panicum dichotomiflorum Michx.	–	0.10	0.10
Annual broad-leaved weeds			
Chenopodium album L.	1.98	3.00	2.25
Ambrosia artemisiifolia L.	2.30	1.50	2.03
Polygonum lapathifolium L.	0.64	0.15	0.40
Polygonum persicaria L.	0.10	0.12	–
Raphanus raphanistrum L.	0.50	–	0.10
Polygonum aviculare L.	0.20		
Chenopodium polyspermum L.	–	0.25	0.50
Erigeron annuus (L.) Pers.	–	0.50	0.30
Stellaria media (L.) Vill.	–	0.10	0.10
Oxalis fontana Bunge	–	0.10	–
Anagallis arvensis L.	–	0.10	–
Spergula arvensis L.	–	0.10	–
Veronica arvensis L.			
Matricaria inodora L.	–	–	0.20
Perennial weeds			
Equisetum arvense L.	0.40	1.85	1.27
Calystegia sepium (L.) R.Br.	0.50	0.80	1.00
Convolvulus arvensis L.	–	0.53	0.50
Rumex crispus L.	–	0.10	0.40
Symphytum officinale L.	–	0.40	0.30
Lythrum salicaria L.	–	0.05	0.10
Cirsium arvense (L.) Scop.	–	–	0.45
Total weed density	203.92	371.71	420.75

CT = conventional tillage with mouldboard plough,
CP = loosening with chisel plough, DH = disk harrowing

herbicide weed control was affected by adequate precipitation after the spraying in all three years (Table 1).

The combination of pre-emergence metolachlor and post-emergence sulfonylureas of 50% prosulfuron & 30% primisulfuron-methyl, both of them at reduced rates (W3), showed a very good efficacy in total weed control (95–97%). Regardless of the weed infestation levels, metolachlor had a high activity against *E. crus-galli* (95–97% control) as well as the previously mentioned sulfonylureas against annual broad-leaved weeds (96% control). An exception was the year 1998, when due to delayed emergence of *A. artemisiifolia* plants in CT the efficacy of annual broad-leaved weed control was 88%. The previous study showed that Ring has a high activity against most annual broad-leaved weeds when applied at an earlier leaf stage of dicotyledonous weeds, independent of the crop stage (Knežević and Đurkić 1998).

The thifensulfuron-methyl + nicosulfuron herbicide combination (W4) also resulted in an efficacious reduction of *E. crus-galli* shoots, even at a high weed level of 411 shoots per m^2 on DH plots (95% control). Weed control efficacy was the best when spraying was performed at the two-leaf stage of *E. crus-galli* because this weed grass displays an especially high competitive ability. Rola (1983) also suggested that post-emergence weeding in maize fields infested with *E. crus-galli* in Poland is to be carried out as soon as possible before the weed plants reach the 2–4 leaf stage. This herbicide combination also shows good efficacy in the control of dominant annual broad-leaved weeds (91–93%) as well as satisfactory efficiency in perennial weed control, including the reduced tillage practices (80–85% control).

The treatment with sulcotrione + bromoxynil in the tank mixture ensured a very high reduction of *E. crus-galli* shoots (95–97%) in all tillage practices, as well as of annual broad-leaved weed plants (92–96%). This treatment manifested acceptable efficacy regarding the reduction of *Ch. album* and *Ch. polyspermum* L. as well as of *P. lapathifolium* populations, at the 2–4 leaf-stage. The experiments of Kappes et al. (1996) also indicated that the efficacy of the sulcotrione herbicide could be improved at lower rates or if it were included in a tank mixture with some other herbicides such as pyridate, rimsulfuron or bromoxynil. Similarly, Adamczewski and Ratajczyk (1995) reported that sulcotrione showed the lower efficacy in the control of *E. crus-galli* when applied alone than in the combination with nicosulfuron. There was no phytotoxic effect of the herbicides on maize plants in this study.

Yields were significantly influenced by the year and soil tillage (Table 2). The yields in 1997 were high from 11.5 to 10.5 and 10.0 t/ha in CT, CP and DH tillage, respectively. However, in the second and third year, unfavourable weather conditions with a prolonged dry period in July 1998 and a long moist period in June 1999 (Table 1) reduced the yields across all tillage practices by 14 and 29%, respectively, compared to 1997. A drastic yield depression occurred in 1999 in all tillage treatments, and the highest one by 40% was after DH tillage, where a significant tillage × year (T × Y) interaction was determined. Namely, the highest water deficit was observed in the seedbed layer, but heavy rains also partly damaged the plants that emerged afterwards. In comparison with maize plants in CT tillage, maize plants on DH plots were smaller and less uniform, and the crop density was lower by 250 plants/ha or by 15% than in CT tillage. In the same year CT tillage gave a plant density lower by 51% (33 550 plants/ha) in relation to the anticipated values. Compared to the highest yield in CT (10.2 t/ha) average percent yield depressions in CP and DH were 10 and 22%, respectively, across all years and all weed control treatments.

With respect to herbicide methods of weed control, the post-emergence sulcotrione + bromoxynil tank mixture (W5) gave the highest yield (9.9 t/ha) but with no statistically significant differences between the yields after herbicide treatments W3 and W4. The analysis of variance showed that there were no statistically significant differences in yields between the standard herbicide treatment at the recommended rate of broadcast application (W1) and the same treatment at the half-recommended rate in band spraying (W2). Regardless of the herbicide treatments, the effects of chemical weed control on grain yields were consistent within each tillage, with the exception of DH tillage, where there was a tillage × weed control (T × W) interaction in the weed control treatment with band spraying (W2). It resulted in a significant yield depression by 620 kg/ha or 7% compared to the highest yield with the sulcotrione + bromoxynil treatment (8.9 t/ha). Maize showed a high reaction in relation to the untreated control plots in form of a significant yield increase across all herbicide treatments by 31, 49 and 67% in CT, CP and DH tillage, respectively. The analysis of regression between the density of total weed populations and yields gave the statistically highly significant negative correlation ($r^2 = -0.635^{**}$, $n = 216$).

Independent of the tillage intensity, all atrazine-free herbicide treatments (pre-em. + post-em., post-em.) provided a high level of *E. crus-galli* control (95–96%) and annual broad-leaved weeds (90–94%) but an inconsistent control of perennial weeds (41–84%), which did not differentiate them from the pre-emergence weed control with standard atrazine herbicide tank mixture at the recommended rate. The band spraying with atrazine at the half-recommended rate combined with two inter-row treatments in June ensured the satisfactory total weed control (83–87%) and yields similar to those of the standard herbicide treatment at the double rate. Different methods of chemical weed control used in this study point to a possibility of herbicide applications at environmentally acceptable rates that are lower than recommended ones and of less intensive tillage practices without any significant impacts on maize yields. The densities of annual weed grasses and perennial weeds as well as maize yields were significantly affected by the tillage and year factors. Compared to mouldboard ploughing, a significant average yield depression by 10 and 22% occurred after chisel ploughing and disk harrowing, respectively.

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Received on October 7, 2002

ABSTRAKT

Vliv pre- a postemergentního hubení plevelů na hustotu porostu plevelů a na výnos kukuřice při různých systémech zpracování půdy

Vliv chemického hubení plevelů s použitím snížených dávek herbicidů (preem., preem. + postem., postem.) na hustotu porostu plevelů a na výnos kukuřice jsme srovnávali při třech systémech zpracování půdy (radlicovým pluhem, dlátovým pluhem, diskovými bránami) na ilimerizované oglejené půdě v severovýchodním Chorvatsku (1997–1999). Na všech variantách zpracování půdy se vyskytovaly zejména tyto plevele: *Echinochloa crus-galli* (L.) PB., *Chenopodium album* L., *Ambrosia artemisiifolia* L., *Polygonum lapathifolium* L., *Equisetum arvense* L. a *Calystegia sepium* (L.) R.Br. Způsob zpracování půdy významně ovlivnil hustotu porostu všech plevelů, která se na kontrolních plochách pohybovala od 204 rostlin při použití radlicového pluhu do 372, resp. 421 rostlin na m^2 při použití dlátového pluhu, resp. diskových bran. Ve srovnání se standardní směsí herbicidu atrazinu (metolachlor 50 % a atrazin 20 %), použitou v doporučené dávce, kombinace herbicidů bez atrazinu (metolachlor + 50% prosulfuron a 30% primisulfuron-methyl; sulcotrion + bromoxynil; thifensulfuronmethyl + nicosulfuron) vykazovala obdobnou celkovou účinnost hubení plevelů (95–96 %). Pásový postřik ve formě standardního ošetření poloviční doporučenou dávkou, spojený s mechanickým hubením plevelů, přinesl uspokojivé snížení výskytu všech plevelů (83–87 %). Postupy hubení plevelů neovlivnily výnosy kukuřice, avšak výrazně na ně působil ročník a způsoby zpracování půdy. Ve srovnání s nejvyšším výnosem při použití radlicového pluhu (10,2 t/ha) pokles průměrného výnosu při použití dlátového pluhu, resp. diskových bran činil 10 a 22 %.

Klíčová slova: atrazin; metolachlor; sulfonylmočoviny; sulcotrion; bromoxynil; zpracování půdy; hustota porostu plevelů; hubení plevelů; výnos kukuřice

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