Cercetări Agronomice în Moldova,
Anul XXXX , Vol. 1 (129) / 2007

RESEARCH CONCERNING WEED CONTROL IN MAIZE CROP

Ileana BOGDAN*, P. GUŞ, T. RUSU, A. POP, Anişoara VÂJU, Paula MORAR
University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca

Received October 12, 2006

ABSTRACT *- The paper presents the results obtained under soil-climatic conditions of Cluj-Napoca, Romania, during 2003-2005. The main goal of experiments was to establish an optimal network for weed control in maize crops. High weed encroachment of maize crops in Cluj area has increased, due to weed seed stock in the arable layer and weather conditions, which allowed weeds to grow alternatively, and to the development of problem species during the maize vegetation period, when no tillage was performed. A good efficiency in controlling the entire weed spectrum from maize crops and with high persistence was the combination of an acetochlore-based herbicide. The variant RELAY 90EC 2.2 l/ha, applied at the stage of pre-emergence, florosulam based-herbicide and acid 2.4D: MUSTANG 0.6 l/ha, applied at the stage of post-emergence, had a control degree of 72%, for the entire vegetative period. The average control degree was achieved by variants controlled before emergence with DUAL GOLD 960 EC 1.5l/ha. In vegetation, the complex herbicides OLTISAN M. 1l/ha or RING 80 WG 25 g/ha were used, the average control degree being of 73%, respectively, 75%.*

Key Words: weed control, maize, Cluj County

REZUMAT - Cercetări privind combaterea buruienilor din cultura de porumb. *Lucrarea prezintă rezultatele obţinute în perioada 2003-2005, în condiţiile pedoclimatice de la Cluj-Napoca, România. Scopul experienţelor a fost stabilirea reţetelor optime din punct de vedere tehnologic şi ecologic la culturile de porumb din această zonă pentru combaterea buruienilor. Gradul de îmburuienare ridicat al culturilor de porumb din zona Cluj se datorează rezervei masive de seminţe de buruieni din stratul arabil şi condiţiilor climatice favorabile răsăririi şi dezvoltării eşalonate a buruienilor, pe de-o parte, şi dezvoltării speciilor problemă de buruieni pe parcursul perioadei de vegetaţie a porumbului, când nu se mai pot aplica praşile, pe de altă parte. S-au remarcat, în privinţa gradului de combatere mediu realizat, variantele erbicidate preemergent cu DUAL GOLD 960 EC 1,5l/ha, iar pe vegetatie, cu erbicidele complexe OLTISAN M. 1l/ha sau RING 80 WG 25 g/ha, care au înregistrat o eficacitate mai bună decât restul variantelor, gradul de combatere mediu raportat la întreaga perioadă de vegetaţie a porumbului fiind de 73, respectiv, 75%. S-a mai remarcat combinaţia*

* E-mail: ileana2105@yahoo.com

(RELAY 90EC 2,2l/ha) - preemergent+MUSTANG 0.6 l/ha - postemergent: 72% grad de combatere.

Cuvinte cheie: combaterea buruienilor, porumb, jud. Cluj

INTRODUCTION

Each area for maize growing is characterized by the presence of certain weed species, the specific weed encroachment being influenced by climatic and soil conditions, and technologies used both in fore crops and maize crop; each area needs specific weed control strategies (Berca, 2004).

The maize crops from the central region of Transylvania suffer from great weed infestation (with diverse flower composition and high frequency/area) that made us find the optimal strategies from management and economic point of view, to reduce weed encroachment degree under the damaging limit. This could lead to a level of crop yield involving specific natural factors (soil fertility and climatic conditions), applied technological factors (fertilization, tillage system, etc.), and biological potential of maize hybrids (Beraud et al., 1991; Swanton et al., 1991)

The protection of maize crops from Central Transylvania against weeds must have in view a few factors, which are typical to the area, such as high weed seed stock from soil, diverse rainfall regimes (very wet periods, followed by very dry ones), favouring weed encroachment of maize crops, gradual emergence of dominant weed species and their biological characteristics. In this area, the abundant rainfall from July, August and September enhanced late infestations of maize with annual weed species (*Echinochloa crus-galli, Setaria* spp., *Polygonum lapathyfolium*) and perennial species (*Cirsium arvense, Convolvulus arvensis*). At maize harvesting, the degree of weed encroachment is very high and weed seed stock from soil is increasing (Bogdan, 2004).

MATERIALS AND METHODS

The investigation on establishing the optimal networks for weed control in maize was conducted during 2003-2005, at the Didactic Centre of Cluj – Napoca, on the experimental field of Land Management Department. Some stationary experiences were carried out on test plots for weed control strategies (chemical and combined ones).

The plot is situated in the Someşul Mic Valley, near the Gârbou Valley, an affluent of the first river. From geological point of view, soil is of quaternary age, and is made of silts, with loamy-clayey and clayey texture. The plot belongs to the hydrographical basin of Someşul Mic.

Soil is of fluvisol type (FAO/UNESCO, 1988). Its profile is Amp-Am-A/C-C_{Ca}. The clay content at 0-40 cm depth varies between neutral and weakly alkaline, with pH=7.25. In the next horizon (20-40 cm), the presence of carbonates leads to an increase in pH up to 7.35. The base saturation degree of 96% frames this kind of soil in the eubasic category. As for the humus content, one can assess that soil has a mean supply, namely 3.21 % at the first 20 cm, and 2.96 % at the 20-40 cm depth. From the agrochemical point of view, soil has phosphorus content of 124-148 ppm, potassium 148-172 ppm, total nitrogen 0.143-0.158 %, SB 26.22-27.0 me/100 g soil, SH 1.07-1.1 me/100 g soil, and V 96%. The terrain is flat, and the ground water is at 2-3 m depth.

The climate is boreal temperate continental (climatologic chart- Cluj Station). According to the Koppen classification system of climates, the hilly area of Cluj belongs to Dfbk; the temperature in the warmest month is 18-22^{0}C, winters are cold, and more than 4 months per year have an average temperature over 4^{0}C. As for precipitation, the highest quantities fall in summer (200-300 mm), and the lowest amounts, in winter (70-120 mm). The torrential trait of summer rainfall is very significant.

Four year-crop rotation was practiced, which contained potato –soy bean – winter wheat - maize.

The biological material used was *Clarica* maize hybrid (FAO 310), in 2003, and *PR 39D 81,* during 2004-2005. The mineral contribution was achieved in two parts, the total dose of N_{120}, P_{60}, K_{60} being supplied.

The experimental method was Latin rectangle, with five replicates, and the plot area of 50 m ^{2} with 12 experimental variants.

The evaluation of the tested herbicides' efficiency was done according to the EWRS methodology, by grades from 1 to 9, according to the control degree expressed as percentage. The degree of weed encroachment was determined by the number method – during the maize vegetation and gravimetriccally – before growing.

The results were interpreted by the variance analysis, being established the LSD values of 5%, 1% and 0.1%.

RESULTS AND DISCUSSION

The weed spectrum presented at the second control, at the beginning of maize vegetation, was composed mainly of annual grasses with 48-55.7% participation for the weed encroachment degree, followed, in the frequency and risk order for maize plants, by the perennial dicotyledonous and annual dicotyledonous. The number of identified species ranged between 17 and 21, of which, problem weeds belonged to seven species: *Echinochloa crus-galli* - medium frequency of 82 plants/m^2; *Setaria glauca*: 42 plants/m^2, *Chenopodium album*: 28 plants/m^2; *Amaranthus retroflexus*: 19 plants/m^2; *Cirsium arvense*: 7.5 plants/m^2; *Convolvulus arvensis*: 4.2 plants/m^2 and *Sonchus arvensis*: 2.8 plants/m^2. The weed biomass from the second control variant, determined before maize cropping, had values in the 7896 and 11234 kg/ha interval, having a composition of 68-73.4% annual monocotyledonous species, 15.5-18.8% annual dicotyledonous species and 10.1-12.4% perennial dicotyledonous species.

The large weed biomass accumulation noted in the control variant and in the herbicide-treated variants has shown the high potential of soil for weed encroachment with large vegetative mass species, as well as climatic conditions of this area, favourable to weed encroachment. In Central Transylvania, the rainfall regime in July (with a mean value of 118.3 mm, during 2003-2005) was very favourable to late weed encroachment and rapid vegetative development of weeds. Our previous studies showed that every 10 mm of summer rainfall led to a weed biomass accumulation in maize crop between 19.3 – 220.3 kg/ha (Bogdan et al., 2004).

The measurements done before maize harvest showed that the weed biomass from variant 2 - without tillage and herbicide application - had a value of 9753 kg/ha, on the average of three years (*Table 1*).

Table 1

Efficacy of weed control methods, tested before maize harvest

(Cluj-Napoca, 2003-2005)

No.	Details on the control networks: active ingredients	Rate g /ha a. i.	Weed weight at harvest				
			Kg/ha	%	Differences		Signif.
					Kg/ha	%Ctrl	
V1	Three hand hoeing variant: control 1	-	703	7	-9050	93	000
V2	No-hoeing: control 2	-	9753	100	Ctrl	0	Ctrl
V3	Three mechanical hoeing variant	-	6521	67	-3233	33	-
V4	*Acetochlor* 76.2% +*dichlorit* 12.6% + *atrazine* 50%	1444 240 1000	4112	42	-5641	58	00
V5	*Pendimethalin* 30% + *atrazine* 20%	1500+1000	4074	42	-5680	58	00
V6	*Acetochlor* 36%+*atrazine* 20%+antidote	2160+1200	3803	39	-5951	61	00
V7	*Isoxaflutol* 5%+*atrazine* 50%	100+1000	3111	32	-6644	68	000
V8	*Alachlor* 33.6%+*atrazine* 14.4%	2016+864	4286	44	-5467	56	00
V9	*Dimethenamid* 90% + *bentazon* 32%+*dicamba* 9%	1440 800 225	3322	34	-6431	66	000
V10	*Alpha metolachlor-S*96% + *acid 2.4D -ester ethilhexilic* 32.5% + *dicamba* 10%	1440 325 100	2612	27	-7141	73	000
V11	*Acetochlor* 90% + *florosulam* 0.625% +*acid 2.4D* 30%	1980 3.75 180	2710	28	-7044	72	000
V12	*Alpha metolachlor-S*96% + *primisulphuron-methyl* 30%+ *prosulphuron* 50% + surfactant	1440 7.5 12.5 200	2427	25	-7327	75	000
					LSD 5% = 3319 kg LSD 1% = 4521 kg LSD 0.1%= 6076 kg		

Compared to this value, the differences obtained at experimental variants, after weed control, were between 5467 (V_8) and 7327 (V_{12}). A very significant diminution in total weed biomass and, implicitly, the positive estimate of control efficacy was achieved in the control (three hand hoeing variants) and in the chemical variants 7, 9, 10, 11 and 12. These variants have used only complex pre-emergent herbicides (V_7= MERLIN MIX) and pre- and post-emergent control (V_9, V_{10}, V_{11} and V_{12}).

The variants 10 and 12, with complex pre-emergent herbicides, using the herbicide DUAL GOLD 960 EC 1.5l/ha, were noticed as concerns the level of average control. The same observation was done on the complex herbicides used on vegetation: OLTISAN M. 1l/ha (V_{10}) or RING 80 WG 25 g/ha (V_{12}), which registered a better efficacy than the rest of the variants. The average degree of control in these variants, compared to the entire maize vegetation period was of 73 and 75%, respectively.

A good efficacy in controlling the entire spectrum of weeds with higher persistence in the maize crop had the combination of the *acetochlore*-based herbicide; RELAY 90EC 2.2l/ha, applied at pre-emergence, *florosulam*-based herbicide and *acid 2..4D:* MUSTANG 0.6 l/ha applied at post-emergence. The average control degree in this variant was of 72%.

We took into account that reporting the efficacy of controlling the entire spectrum of weeds present in maize crop had in view the weed species from crops at the end of vegetation, and their mass value. The low values of the control level from the chemically treated variant, compared to the manual hoeing variant, were explained by the relatively short post- emergent herbicide period, related to entire maize vegetation period and to the presence of species with late emergence and higher capacity of vegetative growing under good conditions (Berszenyi et al., 1995; Hall et al., 1992). We also noticed that the exclusively mechanical method, used for controlling weeds from maize crop, did not ensure a proper hygiene of weeds; the average level of weed control registered in this variant was of only 33%.

From economically point of view, the control methods were different, depending on the used herbicides (simple, complex, and associated) and on the crop plus or lack, registered in each variant (*Table 2*).

Compensation of expenditures by yield enhancement, obtained with each control method was different, according to used herbicide (the way of administrating).

The average production from maize crop, obtained at Cluj-Napoca, varied between 2827 kg/ha (V_2 - no hoeing, no herbicide) and 6470 kg/ha (V_1- control variant 1 – three hand hoeing variants)

The control variants, where yields close to the control variant with hand hoeing were obtained were V_9, V_{11}, V_5, V_{10} and V_{12}. The yield differences from these variants were not significant, so they could be recommended to private maize farmers, as the weed control at these variants was good.

Table 2

Grain maize yield
Cluj-Napoca (2003-2005)

No.	Details about the treatment versions: active ingredients	Rate g /ha a. i.	Maize yield			
			Kg/ha	%	Differences Kg/ha	Signif
V1	Three hand hoeing variants: Control 1	-	6470	100	Ctrl	Ctrl
V2	No-hoeing: Control 2	-	2827	44	-3643	000
V3	Three hand hoeing variants	-	4153	64	-2316	000
V4	*Acetochlor* 76.2%+*dichlorit* 12.6% + *atrazine* 50%	1444+240 1000	5229	81	-1240	0
V5	*Pendimethalin* 30% + *atrazine* 20%	1500+1000	5718	88	-751	-
V6	*Acetochlor* 36%+*atrazine* 20%+antidote	2160+1200	4995	77	-1475	00
V7	*Isoxaflutol* 5%+*atrazine* 50%	100+1000	5239	81	-1230	0
V8	*Alachlor* 33.6%+*atrazine* 14.4%	2016+864	5130	79	-1339	00
V9	*Dimethenamid* 90% +*bentazon*32%+*dicamba*9%	1440 800+225	6000	93	-469	-
V10	*Alpha metolachlor-S* 96% + *acid2.4D -ester ethilhexilic* 32.5% + *dicamba*10%	1440 325+100	5705	88	-765	-
V11	*Acetochlor* 90% + *florosulam* 0.625%+*acid 2.4D* 30%	1980 3.75+180	5749	89	-721	-
V12	*Alpha metolachlor-S* 96% + *primisulphuron-methyl* 30%+ *prosulphuron* 50% + surfactant	1440 7.5 12.5 200	591	86	-879	-
					LSD 5% = 978 kg/ha LSD 1% = 1333 kg/ha LSD 0.1% =1791 kg/ha	

CONCLUSIONS

According to the research results obtained in the weed control variants from maize crops at Cluj-Napoca, the following combinations are recommended as optimal variants for controlling the entire weed spectrum specific to the area:

- RELAY 90 EC 2.2 l/ha – at pre-emergence (*acetochlore* 90%) + MUSTANG 0.6 l/ha – at post-emergence (*florosulam* 0.625%+*2.4D acid* 30%);
- FRONTIER 900 EC 1.6 l/ha – at pre-emergence (*dimethenamide* 90%) + CAMBIO 2.5 l/ha – at post-emergence (*bentazone* 32%+*dicamba* 9%);

- DUAL GOLD 960 EC 1.5 l/ha – at pre-emergence (*alpha metolachlor-S* 96%) + OLTISAN M. 1.0 l/ha – at post-emergence (*2.4D acid - ethilhexilic ester* 32.5% + *dicamba*10%);
- DUAL GOLD 960 EC 1.5 l/ha – at pre-emergence (*alpha metolachlor-S* 96%) + RING 80 WG 25 g/ha (*primisulphurone-methyl* 30%+ *prosulphurone* 50%) + Extravon 200 ml/ha;
- Complex herbicide TAZASTOMP 5.0 l/ha – at pre-emergence (*pendimethaline* 30% + *atrazine* 20%).

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