Bulletin UASVM, Agriculture, 67 (1)/2010
Print ISSN 1843-5246; Electronic ISSN 1843-5386

Researches on the Effectiveness of Two Chemical Weed Control Strategies in Maize

Ileana BOGDAN[1)], George ROIBAN[2)], Teodor RUSU[1)], Adrian POP[1)], Nicoleta IGNAT[1)]

[1)] University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca, ileana2105@yahoo.com
[2)] SC Agroexpert SA Cluj-Napoca, e-mail: roiban_george@yahoo.com

Abstract. Corn, as the main cultivated plant in the Transylvanian agriculture exploitations, remains a preoccupation of scientists to permanently improve the culture technologies or adapt the technology to the modifications occurred in the corn crop habitat, in the specific machinery system or in the economic interests of this crop. The paper presents the results of some stationary experiments developed in a 4 years period: 2004-2007, Noşlac Commune, Alba County which were tested several post-emergence chemical weed control strategies in corn crop. By the research carried out we envisage to clarify certain aspects concerning the specificity of corn crop weeding in Alba County (Commune of Noşlac), the efficacy of two post-emergence weed control strategies for corn crop, and the selectivity of chemical recipes for this crop.

Key words: maize, weed control, post emergence, strategies.

INTRODUCTION

The obligations imposed by the European legislation in the field of environment protection, certified by the modern techniques of plant protections, justify the chemical weed control strategies testing, due to the following aspects:

- ⇨ corn crop is still one of the main agriculture crops at national, European and world wide level;
- ⇨ crop sensitivity to weeding enforces the weed control by effective and rapid methods;
- ⇨ elimination of numerous herbicidal active substances with pre-emergent application from the approved for use list;
- ⇨ ecological impact with low risk in the case of post-emergent chemical control;
- ⇨ possibility of combining the post-emergent methods for weed control with indirect preventive or agro-technical methods in order to obtain an integrated system for weed control in corn crop, economically and ecologically efficient.

Specific literature is quite poor in data regarding post-emergence weed control strategies testing in corn, specific for the crop conditions from different agricultural area from Romania. So, the research topics approached bodes well for improving the economic and ecological efficacy of post-emergence weed control strategies.

MATERIALS AND METHODS

The researches on testing two strategies for post-emergence weed control in corn crop developed in a 4 years period: 2004-2007, in a private property field of Noşlac Commune, Alba County, within the framework of two-factorial stationary experiments, settled after the

randomized blocks method, with 14 variants in four repetitions. The experimental plot area was 30 sq meters. An *aluviosol calcaric molic coluvic* is the soil type, with a good fertility, humus content of 3.84% in the first 60 cm, being assured a humus reserve of 161-200 t/ha. Content of nutritive elements is different in the soil profile, corresponding to an average supply of total nitrogen, very good supply of potassium and weak supply in phosphorous. There are 86 bonitation points for corn of the field where the experimental plot was organized.

The experimental factors and their graduations were:

A. Weed control method: 14 graduations (Tab. 1) grouped in 2 control strategies and 2 control variants:

- ⇨ a_1 = classical weed control, 3 manual hoeing – control variant no 1.
- ⇨ a_2 = no weeding – control variant no 2.
- ⇨ $a_3 – a_6$ = chemical weed control, 2 post-emergence treatments with fractioned dosage: an early first one (2-3 corn leaves); the second one at 5-6 corn leaves stage.
- ⇨ $a_7 – a_{14}$ = 2 years chemical weed control, treatment with total herbicides in triticale stubble field + single treatment with associated herbicides at 5-6 corn leaves stage.

B. Experimental years: 4 graduations: b_1 = 2004, b_2 = 2005, b_3 = 2006, b_4 = 2007

Tab.1

Experimental variants

No. of variant	Weed control variant	Dosage g a.i./ha	Herbicides used
V1	*3 manual hoeing: Control variant 1*	-	-
V2	*No weeding : Control variant 2*	-	-
Strategy 1: ***chemical control variants: two post-emergent treatments with fractionated doses: first one early (2-3 leafs stage of corn); the second at 5-6 leafs stage of corn***			
V3	*foramsulfuron 22,5 g/l + isoxadifen etil (safener) 22,5 g/l + bromoxynil octanoate 400 g/l*	22,5 + 33,8 22,5 + 33,8 +240+240	EQUIP OD: 1 + 1,5 l/ha + BROMOTRIL 40 EC 0,6 + 0,6 l/ha
V4	*foramsulfuron 22,5 g/l + isoxadifen etil (safener) 22,5 g/l + florasulam 6,25 g/l + 2,4 D(EHE) 300g/l*	22,5 + 33,8 22,5 + 33,8 2(3,15 +150)	EQUIP OD: 1 + 1,5 l/ha + MUSTANG 0,5 + 0,5l/ha
V5	*foramsulfuron 22,5 g/l + isoxadifen etil (safener) 22,5 g/l + mesotrione 480g/l*	22,5+33,8 22,5+33,8 96 + 96	EQUIP OD: 1 + 1,5 l/ha + CALLISTO 0,2 + 0,2 l/ha
V6	*rimsulphurone* 25% *+ bromoxynil octanoate 400 g/l*	8 + 8 240+240	TITUS 25DF:20+20g/ha (Trend) + BROMOTRIL 40 EC 0,6 + 0,6 l/ha
V7	*rimsulphurone* 25% *+ florasulam 6,25 g/l 10,5+ 2,4 D(EHE) 300g/l*	8 + 8 3,15+3,15 150 +150	TITUS 25DF: 20 + 20g/ha (Trend) + MUSTANG 0,5 + 0,5 l/ha
V8	*rimsulphurone* 25% *+ mesotrione 480g/l*	8 + 8 96 + 96	TITUS 25DF: 20 + 20g/ha (Trend) + CALLISTO 0,2 + 0,2 l/ha
Strategy 2***: Chemical control variants in 2 years: treatment with total action herbicides in pre-emergent stubble field + treatment with associated herbicides at 5-6 leafs stage of corn***			
V9	*Glifosat acid 36%*	1440	LEONE 36 SL: 4 l/ha

	foramsulfuron 22,5 g/l + *isoxadifen etil (safener) 22,5 g/l* *+ bromoxinil* 28% *+ 2.4D (ester)-28%*	45 + 45 224+224	EQUIP OD: 2 l/ha + BUCTRIL UNIV.: 0.8 l/ha
V10	*glifosat acid 36%* *rimsulphurone* 25% *+ bromoxinil* 28% *+ 2.4D (ester)-28%*	1440 7.5 + 224+224	LEONE 36 SL: 4 l/ha TITUS 25DF: 30g/ha(+Trend) + BUCTRIL UNIV: 0.8 l/ha
V11	*glifosat acid 36%* *foramsulfuron 22,5 g/l* *+ isoxadifen etil (safener) 22,5 g/l* *+ mesotrione 480g/l*	1440 45 + 45+ 96	LEONE 36 SL: 4 l/ha EQUIP OD: 2 l/ha + CALLISTO 0.2 l/ha
V12	*glifosat acid 36%* *rimsulphurone* 25% *+ mesotrione 480g/l*	1440 7.5 + 96	LEONE 36 SL: 4 l/ha TITUS 25DF: 30g/ha (+Trend) + CALLISTO 0.2 l/ha
V13	*glifosat acid 36%* *rimsulphurone* 3.26% *+ dicamba 60.87%*	1440 0.98 + 18.26	LEONE 36 SL: 4 l/ha TITUS PLUS: 300 g/ha
V14	*glifosat acid 36%* *rimsulphurone* 50% *+trifensulphurone-methyl* 2.5%	1440 12.5+0.6	LEONE 36 SL: 4 l/ha BASSIS: 25g/ha (+Trend 0,1%)

There have been done: *determinations of corn specific weeding characteristics in the studied area* (floral compositions, annual and average weeding degree - number and weight; *determination of tested weed control variants efficacy, namely 2 different post-emergence control strategies*: weed control degree assured in the first 50-60 days of corn vegetation - corresponding to the 30 days after first herbicide application determination, weed control degree, assured after 65-70 days of corn vegetation period, for every tested variant - corresponding to the 45 days after first herbicide application determination; *determination of level of obtained grain productions*: annual and 4 experimental years average determination, comparative analyses of tested weed control variants and of tested weed control strategies**.**

The corn cultivation technology in the experimental field comprises: *3 years crop rotation* (autumn triticale – corn – potato + sugar beet + vegetables); *differentiated working system function of applied weed control variants; 3 type of fertilisation:* organic (fermented manure 30 to/ha), mineral (2 fractions: first - NPK with ratio formula 15:15:0: - at germination bed preparation is assured a $N_{40}P_{40}$ dosage; the second at 6-8 leaves stage with ammonium nitrate, being assured a total dosage of $N_{70}P_{40}K_0$) and foliar (2 fractions of Murtonik 20:20:20 Me: first – at the same time with the post-emergence herbicide application at 5-6 leaves stage, 2 l/ha dosage; the second - at ear corn formation, the same dosage).

The thermal and precipitation regime during the corn vegetation period was different in the experimental 4 years, thus the spring and development conditions of weed and the spring and development conditions of corn crop were also different.

Statistical processing of data was made using “two way ANOVA” method and the results interpretation was made by LSD (p5%, 1% & 0.1%), for the comparison between tested variants and control variant and Duncan test (for multiples comparisons).

RESULTS AND DISCUSSIONS

The total number of species determined in control variant no. 2, in the four experimental years was 23 (2 annual monocotyledonous, 1 perennial monocotyledonous, 14 annual dicotyledonous and 6 perennial dicotyledonous), and the annual floristic composition of corn weed comprises between 18 and 20 species, depending on the year.

The average weeding degree during the research period is very high, around 101.7plants/m^2. The coverage degree of soil with weed at the beginning of corn vegetative period, calculated as a 4 years average, is appreciated at 26% - a high value, considering the period in discussion (15-20 days after the spring of corn crop).

In every one of the 4 experimental years, the competition between weed species was high during the whole period of corn vegetation, the soil potential for weeding being relatively high, and the climatic conditions being favourable for vegetative development of weed species and even for late infestations in weed control variants. The strong competition of the weed species was observed especially during 2005, and the weakest competition, established by the general weeding degree and soil coverage was linked to year 2007. Statistically, the average weeding in the control plots is significantly different in the 4 studied years (Tab. 2). It can be stated that, besides the dryer climate in 2007, favourable to a reduced weeding at the beginning of the vegetation period of corn crop, the effect of tested 4 year crop rotation could also be observed.

Tab. 2

Evolution of weed growth degree during research period
Noşlac, 2004-2007

No.	Year	Number of plants/m^2	% compared to Control	Differences compared to Control (pl./m^2)	Significance
1.	2004	89.00	100	0	Ctr.
2.	2005	164.30	184.60	75.30	***
3.	2006	97.00	109.00	8.00	**
4.	2007	66.40	74.60	-22.60	ooo
LSD 5% = 4.16 plants/m^2 LSD1% = 6.31 plants/m^2 LSD 0.1% = 10.13 plants/m^2					

The representative weed species was the annual monocotyledonous, representing for all 4 years an average of 48.5% from the total weed species present in corn crop. The annual dicotyledonous species follow, with an average presence of 43.6% and the perennial dicotyledonous, with an average weeding participation of 13.5%. There were established 15 problem weed species for corn crops from Noşlac area, Alba County: *Echinochloa crus-galli, Chenopodium album, Amaranthus retroflexus, Setaria glauca, Cirsium arvense, Galinsoga parviflora, Convolvulus arvensis, Sonchus arvensis, Polygonum lapathyfolium, Polygonum persicaria, Hibiscus trionum, Agropyron repens, Xanthium strumarium, Atriplex patula* and *Chenopodium polyspermum.*

The difference of average weedy degree from stubble field treated variants with *glyphosate* against control variant no. 2 (no weeding) weedy degree is very significantly statistical (Tab. 3). The lowest weedy degree was achieved in 2007 (27 plants/m^2 only) when the crop rotation effect begins to be felt.

Tab. 3

Average weedy degree in pre-crop stubble treated variants compared with the second control variant, (no weeding) Noşlac, 2004-2007

No.	Specification	V_2 – (Ctr. 2) Control II no weeding	Average weedy degree from stubble field treated variants				
			2004	2005	2006	2007	Average
1.	Number. of plants/m^2	104.2	48	64	38	27	44.25
2.	Differences compared to Ctr.2 (%)	0	53.9	38.6	63.5	74.1	57.5

3.	Differences compared to Ctr.2 (pl./m^2) and significance	0	56.2 ^{ooo}	40.2 ^{oo}	66.2 ^{ooo}	77.2 ^{ooo}	60.0 ^{ooo}
plants/m^2		LSD 5%=26.57		LSD 1%=37.29		LSD 0.1%=52.65	

By comparing the two tested weed control strategies with the classical weed control technology, applied in the control variant no 1 (Tab. 4), in mate matter of efficacy in weed control in the first 50-60 days of corn vegetation (which are very important for the corn growth), it can be concluded that: the 2 years chemical control strategy (stubble field treatment with glyphosate and a post-emergence treatment with associated or complex herbicides) statistically presents insignificant differences compared to the manual hoeing variant, and assured an average control percentage of 98.03; The first control strategy have control average values that overcome 92%, but statistically are significantly different compared to witness variant and the second tested technology.

Tab. 4

Average weed control degree accomplished in tested variants from the four tested technologies after 50-60 days of corn vegetation Noşlac, 2004-2007

No	Weed control strategy	Control I - 3 manual hoeing	Specific variants for weed control technology						
			1	2	3	4	5	6	Media
1.	Chemical: 2 post-emergent treatments with associated herbicides in fractionated doses	99.9	V_3 91.4	V_4 92.8	V_5 90.5	V_6 92.1	V_7 93.7	V_8 91.9	92.07^{ooo}
2.	Chemical in 2 years: glyphosate-based herbicides applied pre-crop stubble and one post-emergent treatment with associated or complex herbicides		V_9 98.5	V_{10} 98.8	V_{11} 97.6	V_{12} 98	V_{13} 97.8	V_{14} 97.5	98.03^{-}
LSD (p 5%) =1.99%		LSD (p 1%) =2.71%			LSD (p 0.1%) =3.67%				

Compared and analysed between them, the control degree diagrams for every of the three periods of determination, specific to the two weed control strategies in corn crop (Fig. 1 and 2) show differences between the strategies, namely the fields limited by the control degrees on every determination period and the whole vegetation period of corn.

The diagram (Fig. 1) specific to the first chemical strategy of weed control (comprised by two post-emergence treatments, from which one is a precocious one) reveals a good and very good efficacy of treatments for both moments of determination, corresponding to first 65-75 days of vegetation period.

Before harvesting can be observed a good efficacy too (owed to cumulating effects of the 2 treatments). For the second strategy (Fig. 2), one can observe high values of control degree, registered in the first determination, correlated to decrease of general weeding compared to control variant, due to herbicide treatment in previous crop stubble field. During the vegetation period of corn crop is observed a relatively constant decrease of control degree, measured on 6 variants. But, two of them overcome the control variant at the moment no 3 of determination.

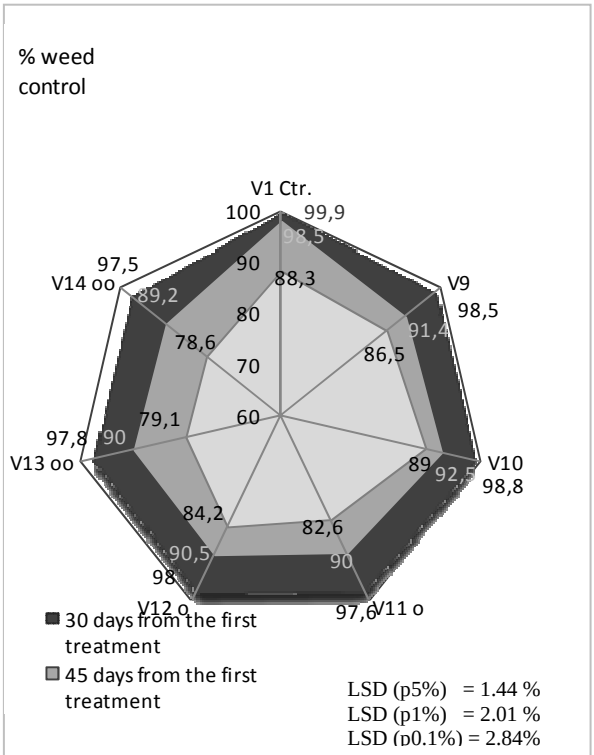

Fig.1. Weed control degree accomplished by the first strategy variants in the three moments of determination (Chemical weed control: two post-emergent treatments with associated herbicides in fractionated doses)

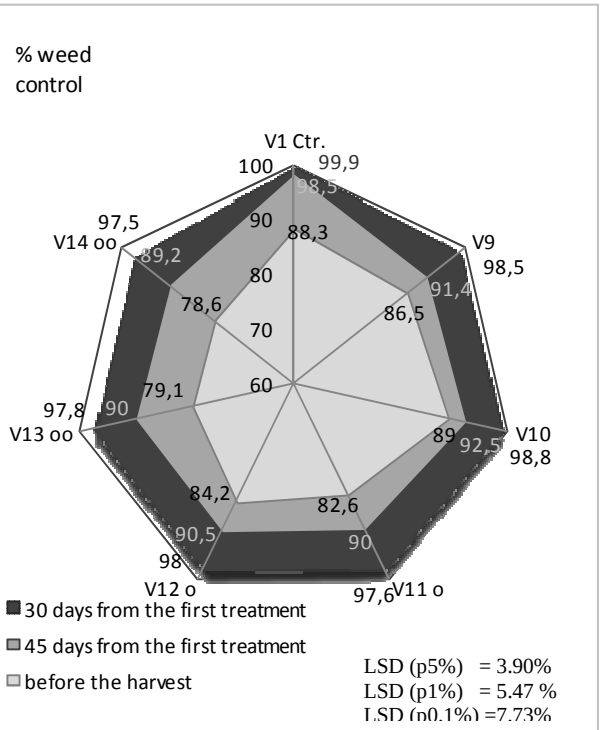

Fig.2. Weed control degree accomplished by the second strategy variants in the three moments of determinations (Chemical weed control in two years: glyphosate-based herbicides applied pre-crop stubble and one post-emergent treatment with associated or complex herbicides)

The average crop yields registered in witness variants are 6884 kg/ha in control variant I – classical weed control with 3 manual hoeing and only 932 kg/ha in control variant for weeding (V_2 – no weeding). Three of the variant for weed control tested obtained a corn grains production close to control variant 1, the differences are statistically insignificant (Tab. 5).

These variants are: 1) V_{104}: LEONE 36 SL 4l/ha applied in stubble field +TITUS 25DF 30 g/ha + Trend 0.1% + BUCTRIL UNIVERSAL 0.8 l/ha applied in post-emergence; 2) V_9: LEONE 36 SL 4l/ha applied in stubble field + EQUIP OD 2l/ha + Extravon 0.15l/ha + BUCTRIL UNIVERSAL 0.8 l/ha applied in post-emergence; 3) V_{12}: LEONE 36 SL 4l/ha applied in stubble field +TITUS 25DF 30 g/ha + Trend 0.1% + CALLISTO 0.2 l/ha. For all these variants, the average control percentage, calculated for the entire vegetation period of corn crop, surpasses 90%.

Between the control degree obtained in tested variants and the corn grains production is established a very significant positive correlation: $r = 0.859^{***}$ (Fig. 3), and the linear regression equation allows the calculation of production depending on achieved control degree. Thus, for an average weed control of 75% only, in Noşlac conditions, the production that can be obtained is calculated with the formula $y = 125.59 x – 4884.1$ and it is only 4535.15 kg/ha.

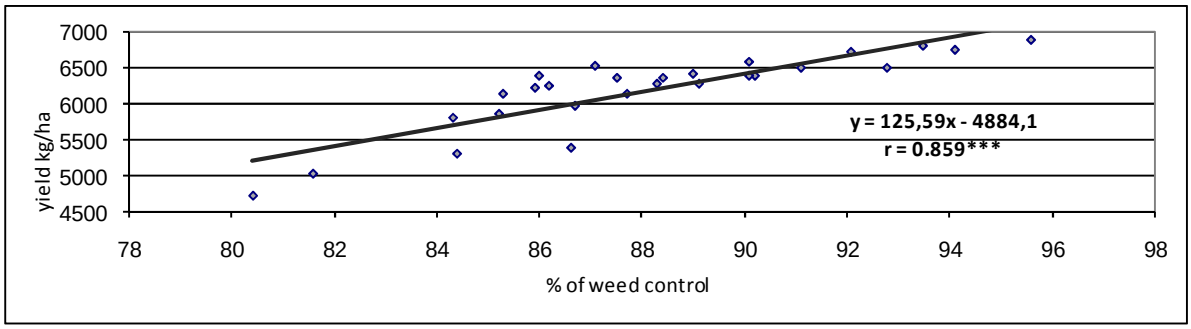

Fig. 3. The relationship between weed control degree (%) accomplished in tested variants and the corn crop yield (kg/ha)

Tab. 5

Weed control efficacy and corn crops yield accomplished in all of tested variants, compared to first control variant with 3 manual hoeing

No.	No. of variant	Weed control variant	Average control %	Significance	Yield kg/ha	Significance
1	V_1	Control 1-3 manual hoeing	95.6	**Ctr.**	**6884**	**Ctr.**
2	V_2	Control 2 – no weeding	0	**ooo**	**932**	**ooo**
3	V_3	EQUIP OD: 1 + 1,5 l/ha + BROMOTRIL 40 EC 0,6 + 0,6 l/ha	86.7	**ooo**	**5980**	**ooo**
4	V_4	EQUIP OD: 1 + 1,5 l/ha + MUSTANG: 0,5 + 0,5 l/ha	89.1	**oo**	**6275**	**oo**
5	V_5	EQUIP OD: 1 + 1,5 l/ha + CALLISTO 0,2 + 0,2 l/ha	86.2	**ooo**	**6260**	**oo**
6	V_6	TITUS 25DF:20+20g/ha (Trend) +BROMOTRIL 40 EC 0,6 + 0,6 l/ha	88.3	**oo**	**6290**	**oo**
7	V_7	TITUS 25DF: 20 + 20g/ha (Trend) + MUSTANG 0,5 + 0,5 l/ha	90.2	**o**	**6385**	**oo**
8	V_8	TITUS 25DF: 30g/ha (+Trend) + CALLISTO 0.2 + 0.2 l/ha	87.7	**oo**	**6130**	**ooo**
9	V_9	1) LEONE 36 SL: 4 l/ha 2)EQUIP OD:2 l/ha +BUCTRIL U.0.8 l	92.1	-	**6730**	-
10	V_{10}	1)LEONE 36 SL: 4 l/ha 2) TITUS 25DF: 30g/ha (+Trend) +BUCTRIL UNIV: 0.8 l/ha	93.5	-	**6800**	-
11	V_{11}	1)LEONE 36 SL: 4 l/ha 2)EQUIP OD: 2 l/ha +CALLISTO 0.2 l	91.1	**o**	**6500**	**o**
12	V_{12}	1)LEONE 36 SL: 4 l/ha 2) TITUS 25DF: 30g/ha (+Trend) + CALLISTO 0.2 l/ha	90.1	**o**	**6580**	-
13	V_{13}	1)LEONE 36 SL: 4 l/ha 2)TITUS PLUS: 300 g/ha	89.0	**oo**	**6420**	**o**
14	V_{14}	1)LEONE 36 SL: 4 l/ha 2)BASSIS: 25g/ha (+Trend 0,1%)	88.4	**oo**	**6362**	**oo**
			LSD (p 5%) = 4.2 % LSD (p 1%) = 6.2 % LSD (p 0.1%) =8.8 %		LSD (p5%) = 356kg/ha LSD (p 1%)= 476kg/ha LSD(p0.1%)=626kg/ha	

CONCLUSIONS

⇨ Taking into account that in the experimental field the annual monocotyledonous weed species are in majority, is very important the rigorous control of those species in the first part of corn crop vegetation. It can be obtained with glyphosate-based herbicides applied pre-crop stubble and one post-emergent treatment with associated herbicides or with two post-emergence treatments with associated herbicides, from which one is a precocious one.

⇨ The late infestations are well controlled by fractioned herbicide treatments, both of them during the corn vegetation or by completing the glyphosate effect with associated post-emergence herbicides.

⇨ Between the control degree obtained in tested variants and the corn grains production is established a very significant positive correlation: $r = 0.859^{***}$ and the linear regression equation allows the calculation of production depending on achieved control degree.

⇨ The positive impact of some variants or weed control strategies on weeding characteristics, corn crop development and grains production is a very good motif to recommend these variants to corn crop farmers from Alba County and elsewhere.

REFERENCES

1. Bogdan, Ileana, P. Guş, T. Rusu, B. Ardelean, G. Roiban and Ioana Moldovan. (2004). Strategies for chemical control of weeds from corn crop for Cluj area. Bulletin of UASVM-CN. 60/2004. ISSN 1454-2382. Agriculture Series. AcademicPres®Publishing house. Cluj-Napoca. p. 69-74.

2. Roiban, G. C. (2010). Contributions to the improvement of post-emergent weed control system in corn crop. PhD Thesis. UASVM Cluj-Napoca.