EFFICIENCY OF POSTEMERGENCE IMIDAZOLINONE HERBICIDES FOR CONTROL OF RESISTANT WEEDS (*XANTHIUM* AND *CIRSIUM)* IN A SUNFLOWER CROP WITH "IR" AND "IT" HYBRIDS

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Abstract

In Romania, sunflower is cropped on about 1 million ha of chernozem soils from the southern, southeastern and western parts of Romania. The soils are strongly infested (80-90%) with annual and perennial, mono- and dicot species, with a predominance of *Xanthium strumarium* and *Cirsium arvense*, which could compromise the crop. As it is well known, these species cannot be chemically controlled, because postemergent systemic selective herbicides for sunflower have not been developed yet. Worldwide, the recent discoveries allowed the first "IMI" resistant (IR and IT type) genetically unmodified sunflower hybrids to be obtained. In 2001, in Romania (at four stations) specific experiments regarding the efficiency and selectivity of imidazolinone mixed herbicides Eurolightning (imazamox+imazapyr), Bolero (imazamox), and Escort (pendimetaline + imazamox), were performed in a sunflower crop with "IR'' and "IT'' hybrids. The Eurolightning herbicide (1.2 L/ha) achieved a superior efficiency (85-95% control) in mono- and dicot weeds (optimum stage of vegetation), including *Xanthium* and *Cirsium,* while the Escort (3.5 L/ha) and Bolero (1.2 L/ha) herbicides obtained a lesser effect of 75-85% control on annual mono- and dicot weeds, including *Xanthium.* The species *Hibiscus, Chenopodium, Polygonum, Convolvulus*, and *Cirsium* were resistant. The selectivity of imidazolinone herbicides applied in due time (sunflower at the 4-6 leaf stage) and optimum rate was satisfactory with "temporary'' light phytotoxic symptoms (yellowing of leaves) observed with intensity that decreased 20 to 25 days after treatment.

Introduction

Due to both low growth in the first vegetative stages (6 weeks) and plant population, the sunflower crop has strong competition from a diverse range of both annual (*Xanthium, Chenopodium, Amaranthus, Solanum, Sinapis, Raphanus, Abutilon, Setaria, Echinochloa, Digitaria*) and perennial weeds (*Cirsium, Convolvulus, Sonchus*). Chemical control represents the only efficient method of preventing weed competition in the first growing stages of sunflower plants (Francesco and Zora, 1992a, b; Millet and Couloume, 1992).

Until the present, the technology for control of annual weeds has been based on the application of two treatments: the first at sowing, with a volatile herbicide (trifluralin, ppi 8 cm) or non-volatile one (metolachloride, acetochloride, propisochloride, dimethenamid, ppi 3-

4 cm or preemergent) applied alone or in mixtures with the following herbicides: prometrine, linurex, fluorochloridone, bifenox, oxydiargil, azafenamid, oxyfluorfen, followed by the second treatment, postemergently applied (sunflower at the 4-6 leaf stage) with one of these herbicides: bifenox, imazethabenz or oxydiargil, for the control of susceptible annual dicots (Pintilie et al., 1986; Sarpe, 1987; Garcia-Torres et al., 1992).

In the last few years, following the appearance of mixed systemic herbicides of the imidazolinone type, as well as of genetically unmodified "IR" and "IT" type sunflower hybrids, at ARDI Fundulea during 2001-2002 (four stations), special experiments were performed to study resistant sunflower hybrid selectivity ("IR" and "IT" type) as well as the efficiency achieved in the application of imidazolinone herbicides for annual and perennial weed control (*Xanthium* and *Cirsium* inclusively).

This paper presents the results obtained regarding the selectivity and efficiency of imidazolinone herbicides applied to the resistant sunflower crop at four stations (Fundulea, Caracal, Lovrin, Oradea).

Materials and Methods

The experiments were performed during 2001-2002 at the Fundulea, Oradea (2001-2002), Lovrin, and Caracal (2002) stations, under different pedoclimatic conditions. In all stations, the experiments were performed in randomized blocks, with a plot area of 25 m sq. in four repetitions. In each plot, four rows of "IR"type of sunflower from the Mycogen and Limagrain firms were sown with 70 cm distance between rows. In the experiments (Table 1), simple and mixed imidazolinone herbicides such as Bolero, 1.2 L/ha; Escort, 3.5 L/ha and Eurolightning, 1.2 L/ha were applied early postemergence (sunflower at the four leaf stage and weeds at the 2-3 leaf stage) and postemergence (sunflower at the 4-6 leaf stage and weeds at the 3-6 leaf stage). A quantity of 200-400 L solution/treatment was used.

Table 1. Experimental variants.

No.	Treatments	Rate a. i. g /ha	Time of application	Experimental year	Content in a.i.g. /L	Company
1	Untreated	--	--	2001 ; 2002	--	--
2	Bolero 40 SL*	48	Early post.[b)]	2001	40 g/l imazamox + Safener	BASF
3	Escort*	875 + 43,8	Early post.	2001	250 g/l pendimetalin + 12,5 g/l imazamox +Safener	"
4	Eurolightning*	39,6 + 18	Early post.	2001	15 g/l imazapyr + 33 g/l imazamox	"
5	Bolero 40 SL*	48	Postem.[c)]	2001 ; 2002	40 g/l imazamox + Safener	BASF
6	Escort*	875 + 43,8	Postem.	2001 ; 2002	250 g/l pendimetalin + 12,5 g/l imazamox +Safener	"
7	Eurolightning*	39,6 + 18	Postem.	2001 ; 2002	15 g/l imazapyr + 33 g/l imazamox	"
8	Frontier 900 + Modown (std)	1080 – 1440 + 480	Preem.[a)] Postem.	2001	900 g/l dimethenamid 480 g/l bifenox	BASF BAYER

* + Adjuvant. a) immediately after sowing; b) In vegetation: sunflower less than less 4 leaves; C) In vegetation: sunflower 4-6 leaves.

Experimental data (soil type, sowing time, observations, rainfall during 20 days after treatment and total rainfall) regarding the achievement of experiments at those four stations are presented in Table 2.

Table 2. Experimental data.

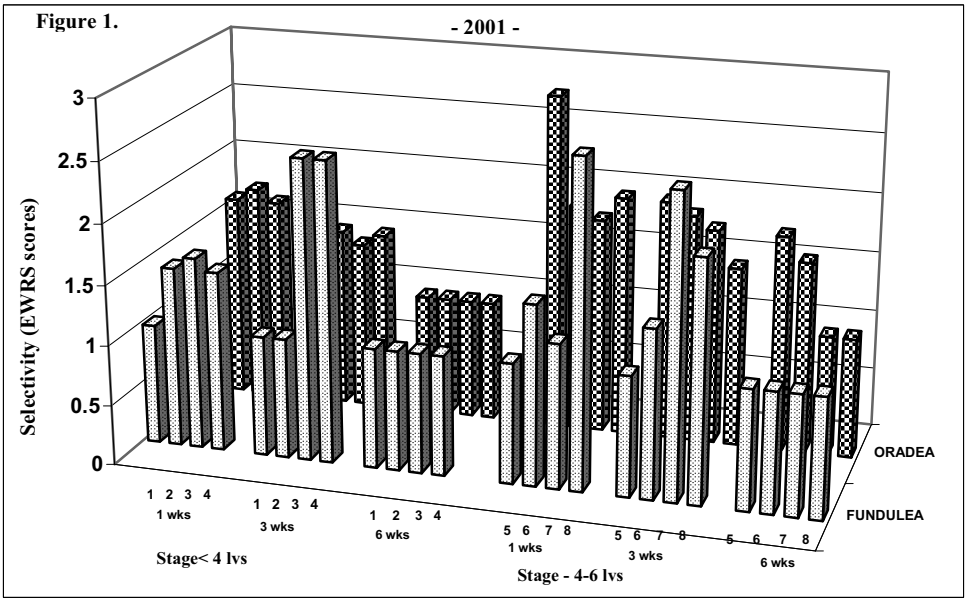
Specification			Fundulea		Lovrin		Caracal		Oradea	
			2001	*2002*	*2001*	*2002*	*2001*	*2002*	*2001*	*2002*
Soil type			Cambic chernozem		Gleyed chernozem		Argilluvial chernozem		Brown luvic	
Humus			3,5%		3,5%		2,8%		2,3%	
Cropped hybrids			"IR" and "IT" hybrids (Mycogen and Limagrain).							
Sowing date			27.04	4.04	--	23.04	--	26.04	2.05	30.04
Treatment time		early	16.04	--	--	--	--	--	26.06	--
		postem.	24.05	10.05	--	6.06	--	31.05	6.07	21.05
		postem.								
Application time		sunflower	Early post.: < 4 leaves				Postemergence.: 4-6 leaves			
		weeds			2-3 leaves				3-6 leaves	
Rainfall (mm)	20 DAT	early	59.7	--	--	--	--	--	32.1	--
		postem.	65.0	18.7	--	79.2	--	47.2	46.5	43.6
	Total	postem.	*328.1*	*440.2*	--	*415.2*	--	*342.5+irrig*	*485.7*	*204.0*
		--								
Solution quantity			200 – 400 L/ha							
Observations		*Selectivity*	1 – 3 – 6 DAT *(EWRS scores)*							
		Efficiency	3 – 6 DAT *(%)*							

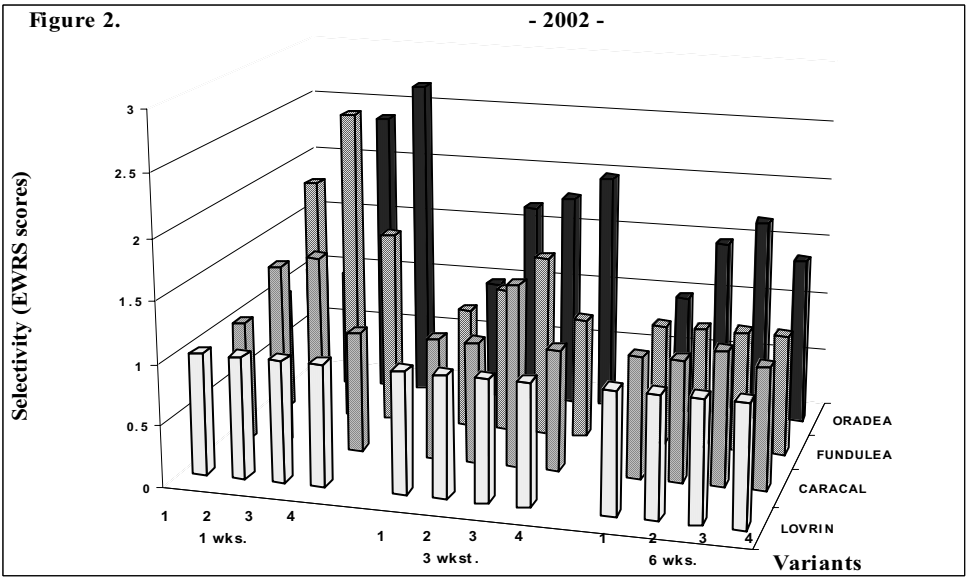
During the vegetative period, after herbicide application, observations were taken at 1, 3, and 6 weeks regarding the sunflower hybrid degree of selectivity vs. the three imidazolinone herbicides applied with EWRS from 1 to 9 (1=plants without phytotoxic symptoms, and 9=up to 85% of plants destroyed) as well as the herbicide efficiency (%) in mono- and dicot control (including *Xanthum, Cirsium*) at 3-6 weeks after treatment,

Results and Discussion

The experiments performed at the four research stations: Fundulea, Oradea, Lovrin and Caracal presented great differentiation regarding the infestation degree (80-90%) and weed spectrum and dominance. Annual monocotyledonous species (*Setaria, Echinochloa, Sorghum* from seed, *Digitaria)* were dominant (65-89%) at Fundulea and Oradea, and dicots (55-60%) at Lovrin and Caracal. The most representative dicots were (by dominance): *Amaranthus, Chenopodium, Xanthium, Cirsium, Solanum, Sinapsis, Raphanus, Convolvulus, Polygonum convolvulus, Polygonum persicaria, Hibiscus, Anthemis, Portulaca,* and *Galium.*

The results obtained (Figures 1 and 2) during the two years of experimentation (2001-2002) were under normal climatic conditions (except Oradea where high temperatures during vegetation were up to 33C). The treatments with imidazolinone herbicides, postemergence applied to sunflower at the 4-6 leaf stage at optimum rates, provoked "temporary" phytotoxic symptoms (yellowing, EWRS=1.5-2.5) in the first ten days, which decreased 20 to 25 days after treatment (EWRS=1).



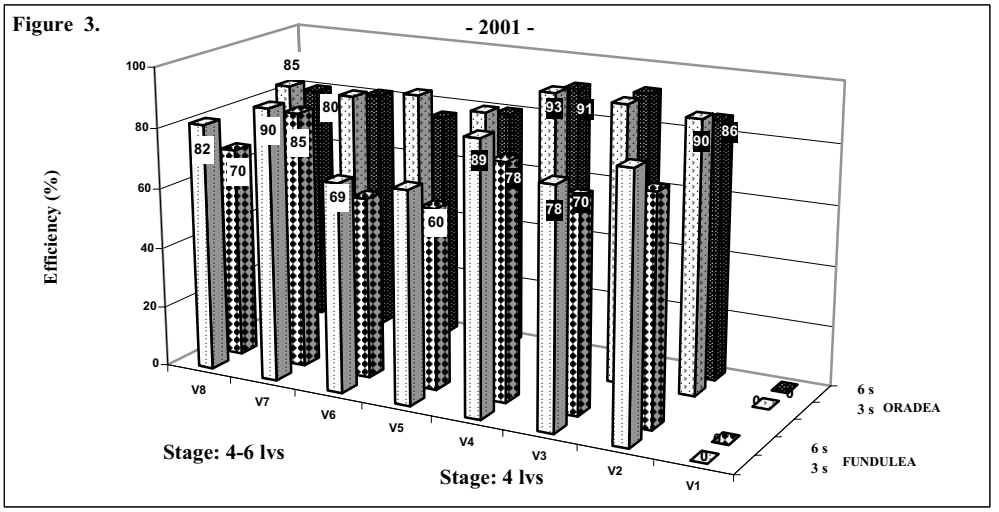


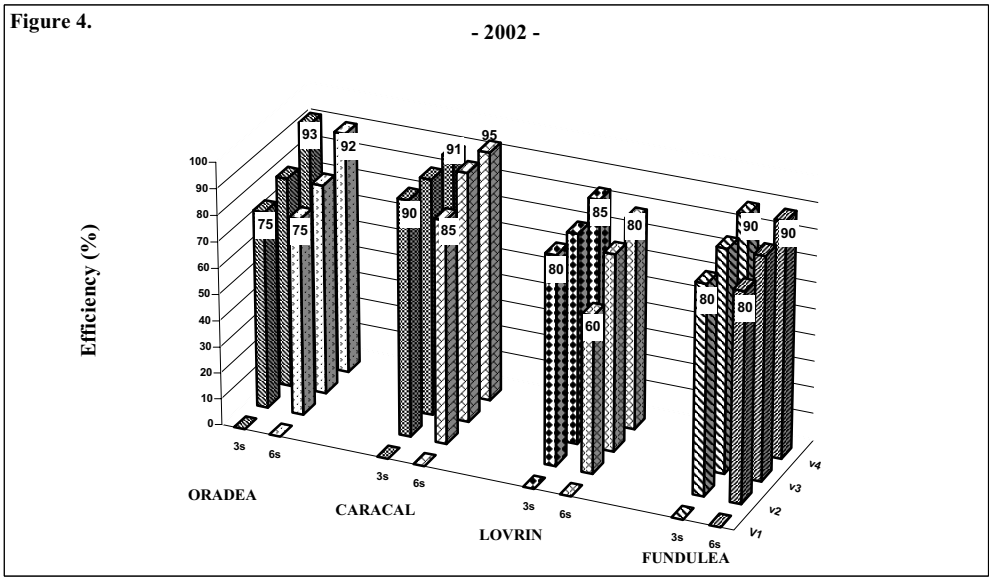
Figures 1 and 2. Selectivity degree of imidazolinone herbicides, postemergence applied for control of resistant weeds, in the "IR" sunflower crop.

In the experiments in Oradea (under the above mentioned conditions) with the Bolero and Escort herbicide application, the phytotoxic symptoms (EWRS note = 1.6-2.7) were more persistent until 30-35 days, after which their intensity decreased.

In mono- and dicot control (Figures 3 and 4), the best results (80-93% efficiency) were registered by the postemergent application (both stages) of Eurolightning herbicide at 1.2

L/ha, in the first 20 days after treatment, with the following species being controlled: *Xanthium, Cirsium, Amaranthus, Solanum, Sinapsis, Raphanus, Anthemis, Galium, Chenopodium* as well as annual monocotyledonous species (2 to 4 leaves) *Setaria, Echinochloa,* and *Sorghum* from seed. Uncontrolled species were *Hibiscus, Digitaria,* and *Convolvulus*.





Figures 3 and 4. Efficiency of imidazolinone herbicides, postemergence applied for the control of resistant weeds in the "IR" sunflower crop.

Bolero herbicide at 1.2 L/ha rate achieved a low effect in the first 20 days, 69-80%- (except the Caracal station, 90% in 2002, under irrigation), because of the dominance of the

grass species, which became resistant to treatment during the tillering stage. The uncontrolled species were *Hibiscus*, *Chenopodium*, *Cirsium*, *Convolvulus*, *Digitaria* and *Echinochloa* (in the tillering stage).

Under conditions of a strong infestation with *Xanthium*, and *Cirsium*, the efficiency of imidazolinonic herbicides (especially Eurolightning 1.2 L/ha plus Adjuvant) was superior, 85-90%, to the standard treatment (Frontier plus Modown, preemergence/postemergence applied, 70-85% efficiency), because of species uncontrolled by Modown application (*Xanthium*, *Cirsium* and annual dicots in advanced stages at treatment).

Conclusions

The imidazolinone herbicides tested (Eurolightning, Escort, and Bolero), early postemergently and postemergently applied, produced "temporary" phytotoxic symptoms (yellowing of leaves) on "IR" and "IT" sunflower hybrids.

Superior results (85-90% efficiency) in mono- and dicot control (including *Xanthium*, *Cirsium)* were registered with the Eurolightning 1.2 L/ha + Adjuvant herbicide, early postemergently and postemergently applied. Uncontrolled species were *Hibiscus*, *Digitaria*, and *Convolvulus.*

The herbicides Bolero 1.2 L/ha + Adjuvant, and Escort 3.5 L/ha + Adjuvant achieved a lower effect of 69-80% (except under irrigation, 90%) in mono- and dicot control (including *Xanthium)* in the first 20 days after application. The species *Hibiscus* and *Chenopodium*, perennial mono- and dicots, and grasses (in an advanced stage at treatment) were uncontrolled.

The selectivity and efficiency of imidazolinone herbicides were determined by the climatic conditions before and after treatment, herbicide type, application time, weed spectrum and dominance.

Under conditions of "resistant" hybrid utilization, the weed control strategy was extremely efficient because of the reduced expenses per ha (herbicide quantity and reduced tillage), flexibility for herbicide application, and maximum effect of weed control, especially of those considered as resistant, *Xanthium* and *Cirsium.*

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