HERBICIDAL SELECTION FOR BROOMRAPE *(OROBANCHE CERNUA)* CONTROL IN SUNFLOWER

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INTRODUCTION

Orobanche cernua Loelf. (*O. cumana* Wallr. broomrape) is an important parasitic weed of confectionary sunflower among others crops. It severely infests important regions of the Mediterranean area, Southern Europe and Middle East (Parker, 1986). Severe infestations of broomrape in confectionary sunflower have been observed in Spain in the province of Cuenca and Fuente Piedra, province of Málaga (Gonzales-Torres et al., 1982) and more recently at El Coronil, province of Sevilla (Castejón et al., 1987). In this last location an area of about 20000 ha previously cropped with confectionary sunflower has declined sharply because of this parasite. We have also recently observed that *O. cernua* have begun to infest oil sunflower cultivars in different areas of Andalusia.

Glyphosate at very low rates controls *O. cernua* in sunflower although, even with these doses it is relatively phytotoxic to the crop and can thus not be recommended for commercial use (Castejón et al., 1987). There is no information available on other herbicidal treatments which efficiently control *O. cernua* in sunflower without crop phytotoxicity.

The purpose of this research has been to determine the efficiency of recently developed herbicides in the control of *O. cernua* in sunflower. The herbicides tested were selected according to the following criteria : a) that they were active in the soil with a medium to high persistence ; or b) that they absorbed through the leaves and were highly translocated via phloema.

MATERIAL AND METHODS

The experiments were carried out in Tomejil (Carmona, Sevilla) and Las Torres (Alcala del Rio, Sevilla). Confectionary sunflower cultivar „Gigante" was sown in both locations in the last week of March 1988. The distance between rows was 1 m and between plants 0,33 cm. At Tomejil infestation of *O. cernua* was artificially induced by spreading 1.3 g of *O. cernua* seeds per test plot made up of two 8 m rows. For easier handling the *O. cernua* seeds were previously mixed with sand. At Tomejil, *O. cernua* seeds were mixed with sunflower seeds before planting. Soil texture was very clayey in Tomejil and sandy-loam in Las Torres.

The herbicides applied and their corresponding doses and methods of applied with a AZO sprayer with SS 8101 nozzles at 3 kg/cm^2 and 175 l/ha. The experimental layout was a split-plot design in randomized complete blocks. Main plots were herbicides, subplots were doses. The blocks were replicated twice. The preplant herbicides were incorporated to the soil with doses. The preemergence ones were applied immediately after sowing and the postemergence ones on May 25 when the sunflower had between 18—20 leaves and most broomrapes were at their „c" and „d" growth stages (Mesa-Garcia and Garcia-Torres, 1985, Castejón et al., 1987). Data on phytotoxicity were visually taken on April 28 for all presowing and preemergence treatments and 15 days after treatment on the postemergence ones. Phytotoxicity scale ranged from O, no injury, to 100, complete death of the crop.

The efficiency of the treatments was determined by counting the number of broomrapes emerged per plant on each test plots on four consecutive dates starting on June 8 and at 8—10 day intervals. The average number of emerged broomrapes per plant and their standard deviation was then calculated for each treatment.

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RESULTS AND DISCUSSION

1. Preplant incorporated and preemergence

Table 1 illustrates the results obtained with the preplant incorporated and preemergence herbicides treatments.

Metolachlor (Dual), only at the highest dosis tested (3.36 kg/ha m.a.) resulted in a medium to high control of the pest during the first three weeks. However, it seems that this dosis slightly reduced the size of the sunflower plants although it did not produce any other toxic symptoms.

Acetachlor (MO—097) at 2.24 and 4.48 kg/ha m.a. produced a high control of the parasitic plants during the first three weeks of emergence and without phytotoxicity.

Chlorsulfuron (Glean) at 1 g/ha resulted in high control of broomrape throughout the attachment period of the parasite without any apparent toxicity. At 0.5 and 0.025 g/ha its control was likewise satisfactory the first three weeks, although not persistent enough to avoid late emergence of broomrapes.

Imazaquin (Scepter) at 10 g/ha considerably reduced broomrape infestation especially during the first three weeks. At higher doses (20, 40 g/ha) it became phytotoxic and reduced the number of emerging plants.

Iamzethapyr (AC—499) also seems to be a promising herbicide for the control of broomrape in sunflower, although the data available were taken only from one replication.

Metazachlor (Basf—4791) in preemergence at 1 and 2 kg/ha produced a regular control of broomrape without any phytoxicity.

Table 1

Effect of preplant incorporated (PPI) and preemergence (PE) herbicide treatments on *O. cernua* control and sunflower injury. Tomejil 1987—1988

Treatments	Dosis (kg/ha m.a.)	Phyto-toxicity	Control (no. of emerged broomrape plants per sunflower plant)			
			1*	2	3	4
Metolachlor (Dual, PPI)	3.36	0	0.9 (0.2)**	1.5 (1.7)	2.9 (7.6)	12.0 (216)
	1.60	0	2.7 (11.6)	3.4 (17.6)	6.3 (56.1)	16.3 (175)
	0.80	0	0.8 (0.3)	1.1 (0.4)	2.3 (1.7)	15.5 (144)
	0.40	0	1.4 (0.5)	2.4 (2.9)	5.8 (22)	14.2 (123)
Acetachlor (Mon—097,PPI)	4.48	0	0.1 (0.0)	0.2 (0.0)	0.7 (2.2)	2.9 (2.2)
	2.24	0	0.2 (0.0)	0.3 (0.1)	1.4 (4.2)	3.4 (23)
	1.12	0	1.1 (1.5)	1.6 (2.0)	3.6 (13)	6.7 (55)
	0.55	0	1.3 (2.7)	1.4 (2.1)	4.6 (3.9)	8.5 (40)
Chlorsulfuron (Glean, PPI)	0.001	0	0.0 (0)	0.0 (0)	0.0 (0)	0.2 (4.7)
	0.0005	0	0.0 (0)	0.0 (0)	0.0 (0)	3.5 (21)
	0.00025	0	0.0 (0)	0.1 (0)	0.3 (0.2)	3.3 (0.2)
	0.00012	0	0.2 (0)	0.6 (0.7)	1.7 (3.8)	8.9 (1.2)
Imazaquin (Scepter, PPI)	0.040	55	0.0 (0)	0.0 (0)	0.5 (0.5)	3.6 (21)
	0.020	45	0.0 (0)	0.0 (0)	0.6 (0)	6.6 (11)
	0.010	0	0.0 (0)	0.1 (0)	1.2 (1.1)	4.8 (0)
	0.005	0	0.5 (0)	0.9 (0.3)	2.8 (3.8)	7.7 (0.3)
Imazethapyr (AC—499, PPI)	0.020	0	0.0 —	0.0 —	0.0 —	0.0 —
	0.010	0	0.0 —	0.0 —	0.1 —	4.5 —
	1.85	0	0.0 —	1.0 —	2.9 —	11.0 —
Metazachlor (Butisan, PE)	2.0	0	0.4 (0.1)	0.7 (0.6)	2.7 (8.8)	4.4 (12)
	1.0	0	0.4 (0)	0.5 (0)	1.7 (0.1)	3.7 (0)
	0.5	0	0.8 (0)	0.8 (0)	2.1 (0)	3.4 (3)
	0.25	0	2.4 (7.6)	2.6 (7.7)	5.1 (21)	8.9 (16)
Check			2.6 (1.5)	4.0 (0.7)	8.7 (14)	15.2 (28)

* First reading took place 6.8.88 and the others at 7—10 days interval.
** In parenthesis : standard deviation.

2. Postemergence

Table 2 shows the results for some postemergence herbicide treatments. Imazethapyr (AC—499) at 0.4 kg/ha and fluozipop-p-methyl at 0.16 kg/ha produced a good control of broomrape without any phytotoxic symptoms. Glyphosine at 0.35 and 0.70 kg/ha despite its control of broomrape seems to be somewhat toxic to sunflower. Treatments with Imazapyr (from 0.0065 to 0.05 kg/ha) and Mon—8000 (at 0.080 and 0.170 kg/ha) were highly toxic to sunflower.

The following herbicides applied postemergence had a low or null effect on broomrape at the range of rates in parenthesis (kg/ha) : Pendimethalin (0.2 to 2.24), Flamprop-methyl (0.08 to 0.65), Gluphosinate (0.04 to 375), Chlorsulfuron (0.0025 to 0.001), Basf—517 (0.012 to 0.01), Bifenox (0.12 to 1.12), Basf—4794 (0.125 to 1.0), Sexothydium (0.125 to 1.0), Basf—56206 (0.125 to 1.0). Haloxifop-etaziethyl (Gallant 0.156 to 1.25), Triclopyr (Garlon 036 to 0.0312) and Lotrel—425 (clopyralid 0.0375 to 0.3) (Data not shown).

The efficiency of the postemergence treatments at Las Torres was similar (data not shown) to that of Tomejil. At Las Torres experiments on preplant or preemergence herbicide treatments were applied and the severity of the infections was low (about 2.5 broomrape plants per sunflower plant).

CONCLUSIONS

Several herbicides treatments, as indicated herein, have shown activity against *O. cernua* in sunflower apparently without phytotoxicity. These results may open a new approach for controlling this parasitic weed in sunflower.

Table 2

Effect of some postemergence herbicidal treatments on *O. cernua* (PE) control and sunflower injury. (Tomejil 1987—1988)

Treatments	Dosis (kg/ha m.a.)	Phyto-toxicity	Control (no. of emerged broomrape plants per sunflower plant)			
			1*	2	3	4
Glyphosine (Polaris)	1.4	70	0.0	0.1	0.5	1.8
			(0)*	(0)	(0.5)	(6)
	0.70	35	0.5	0.9	2.4	3.9
			(0.5)	(1.8)	(12)	(30)
	0.35	20	0.3	0.9	2.1	3.1
			(0.2)	(1.5)	(9.2)	(17)
	0.17	15	1.8	2.2	4.3	6.0
			(6.4)	(10)	(26)	(46)
Imazethapyr (AC—499)	0.400	0	0.0	0.0	0.7	1.9
			(0)	(0)	(1)	(7)
	0.200	0	0.0	0.0	5.2	9.9
			(0)	(0)	(46)	(146)
	0.100	0	0.1	0.9	6.6	14.2
	0.50	0	0.25	1.31	7.84	15.80
Imazapyr (Arsenal)	0.05	80	—	—	—	—
	0.025	65	0.0	0.0	0.6	2.0
			(0)	(0)	(0.2)	(4)
	0.0125	50	0.0	0.0	0.9	1.0
			(0)	(0)	(2)	(1)
	0.0065	50	0.1	0.4	3.9	8.1
			(0)	(0.3)	(0.3)	(12)
Mon—8000 (Polado)	0.170	100	0.0	0.0	0.0	0.0
			(0)	(0)	(0)	(0)
	0.085	100	0.0	0.0	0.0	0.0
			(0)	(0)	(0)	(0)
	0.042	30	0.0	0.0	0.8	3.4
			(0)	(0)	(1)	(16)
	0.021	20	0.1	0.4	1.4	4.3
			(0)	(0.3)	(2)	(23)
Fluozipop	2.24	0	4.4	8.1	17.0	17.5
			(5)	(22)	(72)	(72)
	1.12	0	4.7	7.6	13.0	19.5
			(4.4)	(14)	(19)	(4.5)
	0.56	0	2.7	4.8	9.4	14.5
			(10)	(27)	(58)	(40)
Fluozipop -p-butil	0.28	0	1.4	2.5	5.5	11.0
	0.16	0	0.0	0.0	2.5	4.7
			(0)	(0)	(1.5)	(0.9)
	0.11	0	0.2	0.5	2.6	5.2
			(0)	(0.5)	(4)	(1)
	0.07	0	0.2	0.5	3.0	6.0
			(0.7)	(4)	(20)	(8)
	0.05	0	1.86	2.8	6.5	11.1
			(0.5)	(0)	(3)	(16)
Check			2.6	4.0	8.7	15.2
			(1.5)	(1)	(14)	(28)

* In parenthesis : standard deviation.

Up-to-date genetic resistance was the only feasible way to overcome this problém. Furthermore, the existence of several *O. cernua* strains, the different susceptibility of sunflower cultivars to some of these strains and the time required to introduce genetic resistance in commercial cultivars, strongly support the enterprise of finding a solution through chemical treatments.

However, further studies should be conducted with the herbicides that have shown activity against *O. cernua* in sunflower to gain experience on their possible uses in this crop. Particular attention should be paid to determine the crop response to the herbicidal treatments under weed-free conditions since the potential advantage to control the parasite should not be shaded by crop yield reduction from the herbicide. With some chemicals this may even occur without visible injury.

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CHOIX DES DÉSHERBANTS POUR LA LUTTE CONTRE L'OROBANCHE (*OROBANCHE CERNUA*) DU TOURNESOL

Résumé

Six désherbants ont été testés dans des essais au champ avant le semis ou en préemergence et 18 en postémergence pour contrôler leur efficacité dans la lutte contre l'orobanche (*O. cernua*) et leur toxicité pour la plante cultivée. Chaque herbicide a été testé en 4 doses. Les essais avec les herbicides appliqués après la levée ont été effectués dans deux localités les essais avec les herbicides appliqués avant le semis ou en préemergence dans une seule localité.

Plusieurs traitements aux herbicides ont été efficaces dans la lutte contre l'orobanche du tournesol et ontapparemment été bien tolérés par la plante cultivée. Avant le semis, les herbicides suivants ont été appliqués : acetachlore (4,48 kg/ha), chloresulfurone (1 g/ha), imazaquine (10 g/ha), imazetapyre (0,010 et 0,020 kg/ha) ; avant la levée — métazachlore (1 et 2 kg/ha). Appliqués en postémergence, l'imazetapyre (4 kg/ha) et le fluazipopbutyl (16 kg/ha) ont donné de bons résultats dans la lutte contre l'orobanche, sans effets nuisibles pour la plante cultivée.

Vu la nécessité de trouver une solution pour la lutte chimique contre l'orobanche, les recherches avec les herbicides mentionnés doivent continuer afin d'établir les avantages comparatifs de chacun.

SELECCIÓN DE HERBICIDAS PARA EL CONTROL DE *O. CERNUA* EN GIRASOL

Resúmen

Se han ensayado en experimentos de campo 6 herbicidas en presiembra o preemergencia y 18 en postemergencia para comprobar su eficacia en el control del japo del girasol (*O. cernua*) y toxicidad en el cultivo. Cada herbicida se ha aplicado a cuatro dosis. Los experimentos con herbicidas de postemergencia se han llevado a cabo en dos localidades y los de presiembra/preemergencia en una sola.

Varios tratamientos herbicidas se han mostrado eficaces

contra el jopo del girasol siendo aparentemente bien tolerados por el cultivo. Entre estos cabe mencionar aplicados en presiembra el acetacloro a 4.48 kg/ha, clorsulfuron a 1 g/ha, imazaquin a 10 g/ha e Imazethapyr a 0.010 y 0.020 kg/ha y en preemergencia al metazacloro a 1 y 2 kg/ha. En postemergencia imazethapyr a 0.4 kg/ha y fluozipopbutil a 0.16 kg/ha tambien controlaron aceptablemente el jopo sin dano aparente al cultivo. Dada la conveniencia de encontrar una solucion quimica para el control de *O. cernua* en girasol deberan llevarse a cabo posteriores estudios con estos herbicidas a fin de determinar comparativamente las posible ventajas de uso de cada uno de ellos.