EVALUATION OF SELECTIVE HERBICIDAL MIXTURES FOR THE SUNFLOWER

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Abstract
The results regard a three year trial aimed at evaluating selectivity and efficacy of various herbicidal mixtures and their influence on the productive response of the crop.
The results obtained demonstrated the effectiveness of pre-emergence, chemical weed control for the sunflower. The metobromuron+prometrine mixture proved particularly valid for its high selectivity, its herbicidal efficacy and the good productive response of the crop. Plants treated with metobromuron, on its own or mixed with other active ingredients, also provided promising results.

Introduction

In sunflower cultivation chemical weed control is an essential cultivation technique. Indeed it is the only method capable of eliminating competing weeds at the earliest stages of crop development.
To date the extensive research carried out has enabled identification of a series of highly selective and effective active ingredients, and implementation of rational weed control techniques. Nonetheless, the availability of new active ingredients and different formulations of those known provided the basis for the experiments described herein. The results, which have partly been published (Tei et al., 1991), are reported in this paper.

Materials and Method

The three year trial was carried out between 1986/89 on the "Sparacia" experimental farm (AG).
The principle information on cultivation and experiment techniques, and the soil characteristics, are reported in tab.1.
The herbicides (table 2) were distributed with an F320-type portable pump, utilizing 400 l/ha of solution.
Irrigation was carried out: the first two days before thinning out, the second on bud differentiation, the third on flowering and the fourth on achene formation.
Thinning out was carried out at the first hoeing; the number, height and dry weight of the uprooted seedlings was measured.
Following flowering the heads were protected with gauze bags in order to protect against passerines.
Visual inspection of the crop for phytotoxic symptoms was made 20, 40 and 60 days after emergence for pre-emergence herbicidal treatment, and 14, 21 and 28 days after emergence for post-emergence treatment, according to the EWRS method.
Approximately one month after the foreseen harvesting date the plot floral condition was evaluated by visual inspection according to the phytosociologic method of abundance-dominance

as established by Braun-Blanquet.
The data obtained over the three years were submitted to variance analysis and the differences between the significant means were calculated by Duncan's test.
The data regarding both weed covering (obtained by indexing the total plot covering compared to the unweeded control) and herbicidal efficacy, before statistical calculations, was transformed into angular values; the thus obtained means were inversely transformed into percentage values and are reported in the table.
The thermopluviometric trend over the trial period is illustrated in figure 1.

Results
Weed presence (tab.6), was considerable in the first year (165.1%) and the third year (136.0%), whereas in the second year of the trial it was significantly lower (94.0%). The most common species present in the unweeded controls were: Convolvulus arvensis (72.5%) and Picris echioides (47.5%) in the first year; Cirsium spp. (15.5%), Chenopodium album (15.0%) and Polygonum aviculare (15.0%) in the second; Convolvulus arvensis (37.5%), Chenopodium album (17.5%) and Sinapis arvensis (17.5%) in the third.
Convolvulus arvensis and Polygonum aviculare were to some extent resistant to some of the herbicides tested. The other weeds were almost totally controlled by the pre-emergence treatment herbicides. The post-emergence herbicides were effective on the graminaceae, and imazametabenz also controlled cruciferae, whereas it was not active against Hordeum vulgare.
The most herbicidal efficacy (tab. 5), apart from in the treatment at hoeing, was metobromuron+prometrine in the first year (99.2%), fluorcloridone was second (98.0%) and ethofumesate+metobromuron third (99.5%).
The selectivity of the herbicides (tab. 4) was good on the whole. All chemical treatments resulted in phytotoxicity to some extent which, however, was temporary, progressively diminishing from the first inspection until it completely disappeared by the third. The only exception to this was pre-emergence, oxyfluorfen treated plots and post-emergence, imazametabenz treated plots, which still presented visible signs of phytotoxicity at the last inspection.
With regards to examinations made at thinning out (tab. 3), in the three years of the trial the use of oxyfluorfen, ethofumesate+metobromuron and ethofumesate+linuron brought about a significant reduction in number, height and dry weight of the uprooted seedlings. The effects of linuron+monolinuron were identical with regards to number in the three years, and height and dry weight in the first.
As concerns the stem and head diameter (tab. 7), in all treatments, though with statistically significant differences, there were increases compared to the values obtained with the unweeded control.
Over the three years the highest achene production (tab. 7), was observed with the metobromuron+prometrina treatment (3.8 t/ha three year mean) and in the twice-hoed (3.6 t/ha).

Table 1 - Agronomic and experimental trial information

Year	1986	1987	1988
Location	*Sparacia*	*Sparacia*	Sparacia
Previous crop	durum wheat	durum wheat	durum wheat
Experimental design	randomized block with 5 replications		
Plot area	22,0 m²	25,0 m²	24,0 m²
Fertilization	100 kg/ha P_2O_5 100 kg/ha N		
Variety adopted	Gloriasol	Gloriasol	Gloriasol
Seed quantity	4 times as big as 4 plants/m²		
Sowing date	22 April	27 April	24 April
Thinning out	5 June	20 June	17 June
Pre-emergence treatment date	24 April	30 April	26 April
Post-emergence treatment date	20 May	7 June	3 June
Hoeings	4-6 leaves and 8-10 leaves		
Irrigation	4 interventions		
Watering quantity	500 m^3/ha	500 m^3/ha	500 m^3/ha
Harvesting date	10 Sept.	15 Sept.	13 Sept.
SOIL CHARACTERISTICS			
Clay %	29,0	42,0	46,0
Slime %	21,0	22,0	23,0
Sand %	50,0	36,0	31,0
Organic matter (Lotti) %	1,2	1,4	1,2
pH (in H_2O)	8,2	8,3	8,1
Total nitrogen (Kjeldahl) %	1,1	1,1	1,2
P_2O_5absor. (Olsen) ppm	28,8	37,8	38,2
K_2O trans. (M.Int.) ppm	346,2	368,1	373,6
Total $CaCO_3$ (De Astis) %	8,3	6,8	7,5
Active $CaCO_3$ (Droineau) %	4,1	2,9	3,2

Tab.2 - Treatments compared

Cod.	Treatments	c.f. rates l o Kg/ha	Application time
A	Alachlor 35%+Linuron 10%	4,0+1,0	pre-emerg.
B	Metobromuron 50%	2,5	" "
C	Metobromuron 50%+Prometrine 50%	1,0+2,0	" "
D	Oxadiazon 25%+Metolachlor 60,5%	2,0+1,5	" "
E	Linuron 23,7%+Monolinuron 23,7%	1,0+1,0	" "
F	Pendimethalin 31,7%+Metobromuron 50%	3,5+1,3	" "
G	Pendimethalin 25%+Imazametabenz 10%	4,0	" "
H	Oxyfluorfen 24,3%	1,0	" "
I	Ethofumesate 71,1%+Metobromuron 50%	5,0+1,5	" "
L	Ethofumesate 71,1%+Linuron 50%	5,0+1,0	" "
M	Metabenzthiazuron 70%+*Pendimethalin* 31,7%	2,7+2,0	" "
N	Fluoroloridone 25%	2,5	" "
O	Metobromuron 50%+Metazachlor 50%	1,5+1,5	" "
P	Imazametabenz 20%	1,5	post-emerg.
Q	Fluazifop-buthyl 26%	1,5	" "
R	Twice-hoed	---	4-6; 8-10 leaves
S	One-hoed	---	4-6 leaves
T	Unweeded control	---	-------

Table 3 - At thinning out observations

Treat.	Plants (n/m²) 1986	1987	1988	Plant height (cm) 1986	1987	1988	Plant Dry weight (g) 1986	1987	1988
A	9,1 de	10,3 ac	9,2 ab	19,0 gh	14,8 de	14,6 ef	3,0 ce	2,3 ad	1,8 fh
B	9,0 e	11,2 a	9,3 ab	24,1 ab	16,1 bd	15,8 be	3,7 a	2,6 ab	2,2 bc
C	10,2 bc	10,6 ab	9,8 a	23,8 ac	16,7 ac	16,8 ab	3,6 ab	2,8 ab	2,3 ac
D	7,9 fg	8,7 fh	8,7 bc	19,5 fg	13,8 ef	12,7 hi	2,9 ce	1,9 cd	1,7 gh
E	7,9 fg	8,5 gi	8,0 cd	16,9 k	16,3 ac	15,2 cf	2,4 f	2,6 ab	2,5 ab
F	9,7 cd	10,1 bd	9,5 ab	21,8 e	17,6 ab	17,3 a	3,1 cd	2,8 ab	2,6 a
G	10,0 c	9,2 dg	9,3 ab	22,0 e	16,8 ac	16,6 ab	3,0 ce	2,5 ac	2,6 a
H	8,2 fg	7,3 jl	7,5 d	18,2 ij	13,2 f	12,9 gh	2,7 ef	1,8 d	1,8 eh
I	8,3 f	6,7 kl	6,6 e	18,6 hi	14,1 ef	13,4 gh	2,9 ce	2,3 ad	1,7 gh
L	7,6 g	6,5 l	7,7 d	17,9 j	12,8 f	11,7 i	2,8 de	1,8 d	1,6 h
M	7,5 g	9,1 eg	8,8 bc	19,1 gh	17,6 ab	16,2 ad	2,9 ce	2,9 a	2,3 bc
N	9,7 cd	7,6 ik	7,5 d	22,9 d	14,2 ef	14,1 fg	3,3 bc	2,2 ad	1,9 dg
O	7,9 fg	9,7 be	8,8 bc	18,2 ij	15,9 cd	16,2 ac	2,8 de	2,5 ac	2,1 cf
P	10,7 ab	7,8 hj	7,2 de	23,4 cd	16,1 bd	14,9 df	3,5 ab	2,4 ad	1,9 dh
Q	10,9 a	9,6 cf	8,6 bc	20,0 f	17,8 a	16,9 ab	3,0 ce	2,7 ab	2,4 ac
R	10,8 ab	9,5 cf	8,8 bc	24,2 ab	16,6 ac	15,9 bd	3,5 ab	2,6 ab	2,1 ce
S	10,7 ab	10,0 be	9,2 ab	23,5 bd	16,9 ac	15,1 cf	3,6 ab	2,1 bd	2,2 bd
T	10,3 ac	9,6 cf	8,8 bc	24,2 a	17,0 ac	16,0 ad	3,5 ab	2,4 ad	1,8 fh

Table 4 - Visible fitotoxicity in the crop (EWRS)

Treat.	20/14 gg 86	87	88	40/21 gg 86	87	88	60/28 gg 86	87	88
A	3	3	3	3	2	2	2	1	1
B	3	3	3	2	2	2	2	1	1
C	3	3	3	2	3	2	1	2	1
D	3	2	2	3	2	2	2	1	2
E	4	3	3	3	2	1	2	1	1
F	3	3	3	2	2	2	1	1	1
G	3	4	3	2	3	2	1	1	1
H	4	4	4	3	3	3	2	2	2
I	3	3	3	3	3	2	1	2	1
L	4	3	3	3	2	2	2	1	1
M	3	3	3	3	2	1	2	1	1
N	3	1	2	3	1	1	1	1	1
O	3	2	2	3	1	1	1	1	1
P	2	4	4	2	3	2	1	2	2
Q	3	2	2	2	1	1	1	1	1
R	1	1	1	1	1	1	1	1	1
S	1	1	1	1	1	1	1	1	1
T	1	1	1	1	1	1	1	1	1

Table 5 - Herbicidal efficacy (EWRS)

Treat.	Weed covering (%) 1986	1987	1988	Herbicidal efficacy (%) 1986	1987	1988
A	4,9 k	8,8 e	24,3 c	95,1 f	91,2 g	75,7 h
B	3,6 m	6,8 gh	3,9 h	96,4 d	93,2 eg	96,1 c
C	0,8 o	7,8 f	3,9 h	99,2 b	92,2 fg	96,1 c
D	4,7 kl	4,6 k	7,9 g	95,3 ef	95,4 cd	92,1 d
E	8,7 h	9,9 d	13,2 e	91,3 i	90,1 h	86,8 f
F	2,5 n	5,2 jk	4,0 h	97,5 c	94,8 ce	96,0 c
G	8,0 i	5,7 ij	22,5 d	92,0 h	94,3 df	77,5 g
H	48,4 d	10,4 d	13,1 e	51,6 m	89,6 fg	86,9 f
I	7,6 i	6,2 hi	0,5 i	92,4 h	93,8 df	99,5 b
L	28,1 g	5,7 ij	4,2 h	71,9 j	94,3 df	95,8 c
M	45,9 e	7,3 fg	11,2 f	54,1 l	92,7 eg	88,8 e
N	39,4 f	2,0 m	11,5 f	60,6 k	98,0 b	88,5 e
O	4,4 l	3,6 l	13,3 e	95,6 e	96,4 c	86,7 f
P	73,3 c	16,5 c	24,2 c	26,7 n	83,5 i	75,8 h
Q	81,6 b	65,1 b	57,7 b	18,4 o	34,9 j	42,3 i
R	0,7 o	0,0 n	0,1 j	99,3 a	100,0 a	99,9 a
S	6,0 j	0,0 n	3,8 h	94,0 g	100,0 a	96,2 c
T	100,0 a	100,0 a	100,0 a	0,0 p	0,0 k	0,0 j

Means within the same column not having in common one letter or one of the letter between the extremes of the pair are significantly different for P=0,05.

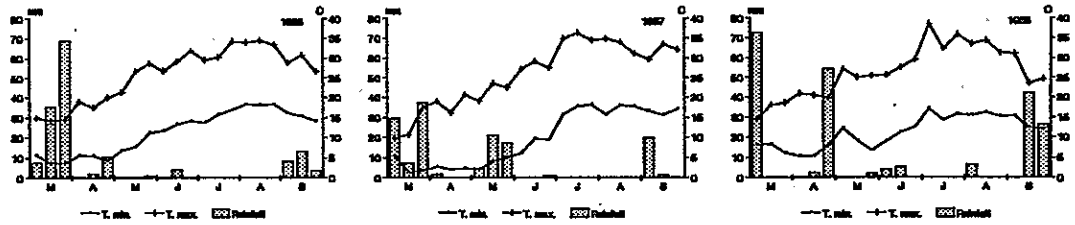
Table 6 - Floristical analysis (Braun-Blanquet method)

TREATMENTS	1986																		1987												1988											
	Picris echioides	Convolvulus arvensis L.	Lactuca virosa L.	Chenopodium album L.	Solanum nigrum L.	Portulaca oleracea L.	Anethum graveolens L.	Brassica nigra Koch	Polygonum aviculare L.	Amaranthus retroflexus L.	Daucus carota L.	Hordeum vulgare L.	Avena ludoviciana Durieu	Lolium spp.	Others	Total covering %	Chenopodium vulvaria L.	Polygonum aviculare L.	Anethum graveolens L.	Sinapis arvensis L.	Chenopodium album L.	Brassica nigra Koch	Cirsium spp.	Amaranthus retroflexus L.	Avena ludoviciana Durieu	Others	Total covering %	Convolvulus arvensis L.	Chenopodium album L.	Chenopodium vulvaria L.	Sinapis arvensis L.	Brassica nigra Koch	Amaranthus retroflexus L.	Anethum graveolens L.	Polygonum aviculare L.	Trifolium spp.	Avena spp.	Others	Total covering %
A	1,1	3,0	+	+	1,1	+	-	-	+	-	-	+	1,1	1,1	0,2	8,1	2,5	2,5	2,5	-	-	+	+	+	+	0,2	8,1	17,5	2,5	+	+	+	5,0	2,5	5,0	+	+	+	33,1
B	1,1	2,1	-	-	+	-	-	-	+	+	-	2,1	+	+	+	5,9	+	5,0	-	-	-	+	-	-	+	0,2	5,3	2,5	+	-	-	+	+	-	2,5	-	+	-	5,4
C	+	+	-	-	-	-	-	-	-	-	-	1,1	-	-	-	1,3	-	2,5	2,5	-	+	+	-	-	+	0,2	5,5	-	-	-	-	+	2,5	+	2,5	-	-	+	5,3
D	1,1	5,0	+	-	+	-	-	-	-	+	-	1,1	+	-	0,2	7,8	-	2,5	-	-	-	+	-	-	+	0,2	2,9	+	-	+	+	2,5	+	2,5	5,0	+	-	0,2	10,7
E	3,0	7,5	-	+	2,1	+	-	-	1,1	+	-	+	-	-	0,2	14,3	2,5	5,0	+	-	+	+	+	-	-	7,9	7,5	2,5	+	2,5	+	-	-	5,0	+	+	+	18,0
F	1,1	1,1	-	-	-	-	-	-	-	-	-	2,1	+	+	0,2	4,7	+	+	-	-	+	2,5	-	-	-	0,2	2,9	2,5	+	+	+	+	-	-	2,5	-	-	+	5,5
G	2,1	7,5	+	-	+	-	-	-	-	+	+	3,0	+	-	+	15,0	+	2,5	+	-	-	+	-	-	-	0,3	3,1	17,5	+	+	-	+	5,0	2,5	5,0	-	+	0,3	30,7
H	5,0	72,5	-	-	-	-	1,1	-	-	-	+	-	-	-	1,2	79,9	5,0	2,5	+	-	-	+	+	-	-	0,2	0,8	12,5	-	-	-	2,5	+	-	2,5	-	+	+	17,8
I	2,1	7,5	-	+	-	-	+	+	+	-	-	2,1	-	+	0,3	12,5	2,5	2,5	-	-	-	+	-	-	-	+	5,2	+	-	-	+	+	-	-	+	-	+	0,2	0,7
L	5,0	37,5	-	-	-	-	1,1	-	1,1	-	+	+	1,1	+	0,3	46,4	2,5	+	+	-	-	+	+	-	-	0,2	3,1	2,5	2,5	-	+	+	-	+	+	+	-	0,3	5,8
M	7,5	62,5	+	-	-	-	+	-	-	-	+	2,1	2,1	-	1,3	75,8	+	2,5	-	-	-	2,5	-	-	+	+	5,3	5,0	+	+	2,5	2,5	2,5	+	2,5	+	-	-	15,4
N	17,5	37,5	1,1	-	-	1,1	2,1	-	-	-	1,1	1,1	1,1	2,1	0,3	65,0	+	+	-	-	-	-	+	-	+	+	0,5	12,5	2,5	+	+	+	-	+	+	-	+	+	15,7
O	2,1	3,0	-	-	1,1	+	+	-	-	-	-	+	-	-	+	6,6	-	2,5	-	-	-	-	-	-	+	0,2	2,7	12,5	-	-	+	+	-	+	+	-	+	+	18,0
P	37,5	52,5	3,0	5,0	3,0	4,0	4,0	+	3,0	2,1	1,1	2,1	-	2,1	1,5	121,0	2,5	3,5	+	-	-	+	7,5	-	-	0,3	14,0	12,5	5,0	+	-	-	7,5	2,5	2,5	2,5	-	0,3	32,9
Q	37,5	62,5	5,0	5,0	3,0	5,0	4,0	3,0	2,1	2,1	1,1	-	-	-	4,5	134,8	8,5	12,5	5,0	10,0	2,5	5,0	10,5	5,0	-	2,7	61,7	17,5	7,5	2,5	12,5	7,5	12,5	5,0	12,5	3,4	-	+	81,0
R	+	1,1	-	-	-	-	-	-	-	-	-	-	-	-	-	1,2	-	-	-	-	-	-	-	-	-	-	0,0	+	-	-	-	-	-	-	+	-	-	-	0,2
S	1,1	7,5	-	-	-	+	-	-	1,1	-	-	-	-	-	+	9,9	-	-	-	-	-	-	-	-	-	-	0,0	2,5	+	-	+	-	-	-	2,5	-	-	-	5,2
T	47,5	72,5	5,0	5,0	3,0	5,0	5,0	4,0	2,1	2,1	1,1	2,1	2,1	3,0	5,6	165,1	12,5	15,0	5,0	15,0	5,0	10,5	15,5	5,0	2,5	8,0	94,0	37,5	17,5	5,0	17,5	12,5	12,5	5,0	12,5	5,0	5,0	6,0	136,0

Table 7 - At harvesting observations

Treat.	Stem diameter at 1 m of height (cm)			head diameter (cm)			Dry weight production of the aerial part (t/ha)			1000 achene weight at 10% of humidity (g)			Yield at 10% of humidity (t/ha)		
	1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988	1986	1987	1988
A	1,52 gh	1,60 ce	1,42 cf	14,9 gh	15,3 be	14,6 bd	9,23 cd	9,18 de	8,71 ce	79,0 bc	78,8 bd	77,3 ad	3,50 eg	3,45 bc	3,14 ce
B	1,64 d	1,56 df	1,54 bc	16,3 bd	15,8 bd	15,0 bc	9,52 b	9,47 bc	8,99 b	79,6 b	79,2 ac	78,6 a	3,60 cd	3,55 b	3,26 bc
C	1,67 cd	1,41 gi	1,36 eg	14,8 hi	14,7 dg	14,1 cd	10,16 a	10,09 a	9,53 a	80,9 a	77,6 ef	75,9 bd	3,90 a	3,86 a	3,55 a
D	1,45 ij	1,36 hi	1,51 bc	15,1 gh	13,8 gh	13,5 de	9,31 c	9,26 de	8,74 cd	77,9 d	78,3 ce	76,5 ad	3,52 dg	3,47 bc	3,16 ce
E	1,40 j	1,51 eg	1,60 b	16,8 bc	15,9 bc	15,0 bc	9,56 b	9,51 b	8,96 b	77,9 d	79,3 ac	77,9 ac	3,55 cf	3,50 bc	3,21 ce
F	1,48 hi	1,72 ab	1,44 ce	15,9 df	17,1 a	16,4 a	9,57 b	9,52 b	9,04 b	79,7 b	78,8 bd	77,5 ad	3,59 ce	3,54 b	3,24 bd
G	1,65 d	1,52 eg	1,53 bc	17,9 a	14,8 cg	14,2 cd	9,30 c	9,25 de	8,61 df	79,2 b	79,4 ab	78,0 ab	3,47 fh	3,42 bc	3,10 ce
H	1,62 de	1,40 gi	1,38 dg	15,2 gh	13,8 fh	13,4 de	9,13 d	9,08 ef	8,52 ef	79,7 b	77,1 f	75,6 d	3,40 h	3,35 c	3,03 de
I	1,56 fg	1,56 df	1,37 dg	15,0 gh	14,9 cf	14,2 cd	8,95 e	8,91 f	8,46 f	77,6 d	79,3 ac	78,0 ab	3,19 i	3,14 d	2,82 f
L	1,46 hi	1,62 a	1,75 a	14,3 i	15,2 ab	15,7 ab	8,80 f	8,72 g	8,19 g	77,4 d	77,9 df	75,7 cd	3,06 j	3,01 d	2,69 f
M	1,57 eg	1,63 be	1,62 b	15,3 fh	15,4 be	14,5 bd	9,14 d	9,09 ef	8,56 df	78,9 bc	79,4 ab	78,1 ab	3,39 h	3,34 c	3,01 e
N	1,45 hi	1,70 bc	1,58 b	15,5 eg	15,8 bd	14,8 bc	9,35 c	9,30 cd	8,85 bc	79,7 b	79,2 ac	77,9 ac	3,51 eg	3,46 bc	3,13 ce
O	1,88 a	1,62 be	1,62 b	16,5 bd	14,6 eg	14,5 bd	9,25 cd	9,20 de	8,68 ce	78,3 cd	79,3 ac	77,6 ad	3,45 gh	3,40 bc	3,06 ce
P	1,61 df	1,47 fh	1,36 eg	16,2 bd	15,2 be	14,6 bd	8,71 f	8,66 g	8,18 g	79,2 b	79,0 bc	77,5 ad	3,14 ij	3,09 g	2,75 f
Q	1,45 hi	1,42 gi	1,31 eg	15,2 gh	14,9 cf	14,7 bc	8,98 e	8,93 f	8,41 f	79,5 b	80,1 a	78,4 a	3,22 i	3,17 d	2,81 f
R	1,79 b	1,65 bd	1,49 bd	16,6 b	15,6 be	15,0 bc	10,07 a	10,02 a	9,43 a	80,6 a	78,8 bd	77,3 ad	3,78 b	3,73 a	3,43 ab
S	1,72 c	1,41 gi	1,31 eg	16,1 ce	13,8 fh	14,4 cd	9,56 b	9,51 b	8,99 b	79,2 b	78,6 bd	77,2 ad	3,61 c	3,56 b	3,27 bc
T	1,31 k	1,34 i	1,28 g	13,1 j	13,2 h	12,5 e	6,83 g	6,78 h	6,51 h	63,3 e	63,6 g	62,5 e	2,00 k	1,96 e	1,78 g

Fig.1 - Thermopluviometric trend over the trial period



Satisfactory values were obtained for the once-hoed, pendimethalin+metobromuron and metobromuron treatments, which were all statistically identical. Over the three years the lowest yields, which were nonetheless statistically higher than the unweeded controls, were obtained utilizing ethofumesate and fluazifop-buthyl, both applied at post-emergence. The same trend was observed for dry weight production of the aerial part of the plant.

Conclusion

An analysis of the results of the three year trial would seem to confirm validity of chemical weed control of the sunflower in pre-emergence, whereas applications in post-emergence were only effective on gramineae.

Herbicidal efficacy of the products applied in pre-emergence was excellent or good, with the exception of certain herbicides which gave poor results on *Polygonum aviculare and Convolvulus* arvensis.

The results obtained by metobromuron+prometrine and pendimethalin+metobromuron were highly interesting, both applied in pre-emergence. These provided excellent or good weed control, excellent crop selectivity and highest seed production which was statistically equalled only by the twice-hoed plots.

In any case the yield increases compared to the unweeded control ranged between +1.86 and +1.34 t/ha for pre-emergence treated crops, and the mean value for post-emergence treated crops was about +1.1 t/ha.

References

Baldoni G.(1986). Risultati di una sperimentazione quadriennale sul diserbo del girasole. Atti Giornate Fitopatologiche, 149-160.

Covarelli G., Gigliotti G., tei F. (1982). Il diserbo del girasole. *L'Informatore Agrario* 12, 20137-20141.

Covarelli G.(1986). Il diserbo del girasole: una produzione indispensabile per ottenere alte produzioni. L'Informatore Agrario, 3, 79-87.

Laureti D., et al. (1983). Prodotti ed epoche di impiego di erbicidi nel girasole. L'Informatore Agrario, 10, 25952-25955.

Salera E., Baldini M. (1988). Le infestanti ed il loro controllo nella coltura del girasole. L'Informatore Agrario, 13, 125-131.

Sarno R., D'Alessandro F., Vinciguerra P. (1985). Primi risultati di una prova sul controllo chimico delle erbe infestanti la coltura del girasole in Sicilia. L'Informatore Agrario, 31,51-57.

Tei F., Covarelli G., Onofri A., Baldoni G., D'Alessandro F., Salera E. (1991). *Flora infestante e diserbo chimico selettivo* del girasole. L'Informatore Agrario, suppl. al n.8, 77-85.