

# CHEMICAL WEED-KILLERS IN SUNFLOWER: RESULTS OF COMPARATIVE TESTS

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## INTRODUCTION

One of the central problems in sunflower cultivation is weed control. Efficient chemical weed-killing helps to avoid falls in production, since this oleaginous plant is highly susceptible to weed competition, particularly in the early stages of development.

The quantity, type and degree of weed competition depend directly on the general environmental conditions and cultivation factors; with late sowing (end of April, beginning of May, weed competition is more accentuated and adversely affects sunflower development from the earliest vegetative stages (Vannozzi et al., 1983). Bad infestation during the first four weeks of growth may mean as much as 2/3 loss in yield (Nalewaja, 1968). Moreover, weed competition may continue through the whole period that goes from maximum growing stage to the completion of anthesis when, with only 25% weed coverage of the soil, sunflower yield both in achenes and in terms of oil produced, is considerably affected (Pechaur, 1973; Regnault et al., 1975).

It is therefore evident that chemical weed-killers play an important role in sunflower cultivation and that it is necessary to improve techniques constantly to keep step with innovations in cultivation methods and to make the most of new herbicides (Baldoni, 1982; Bonciarelli and Covarelli, 1969;

Chiapparini et al., 1976; Covarelli et al., 1981; Parrini, 1980; Rapparini, 1980; Regnault et al., 1979; Tano, 1976).

## MATERIALS AND METHODS

Trials were carried out in 1982 and 1983 at the E.T.S.A.F. Experimental Station of Grosseto (Italy) on a clay-silty soil, on the plain at the locality called Barbaruta (Table 1).

Table 2 presents the cultivation methods.

Table 1

Soil physical and chemical characteristics

Analyses	Results	
	1982	1983
Sand (%)	15.0	14.3
Silt (%)	43.1	41.8
Clay (%)	41.9	43.9
pH (of water)	7.20	7.67
Total lime	12.68	13.22
Total nitrogen (%)	1.58	1.69
Assimilable Phosphorus (ppm) (Olsen's method)	4.79	5.64
Exchangeable Potassium (ppm) (inter. method)	392.6	410.5
Organic matter (%) (Lotti's method)	1.84	1.93

Table 2

Cultivation methods

	1982	1983
Previous crop	barley	wheat
Fertilization	P <sub>2</sub> O <sub>5</sub> 100 kg/ha (at ploughing); N 100 kg/ha (at sowing).	P <sub>2</sub> O <sub>5</sub> 100 kg/ha (at ploughing); N 100 kg/ha (at sowing).
Hybrid used	Romsun HS 52	Gloriasol
Date of sowing	30 April	2 May
Plant density	4 plants/m <sup>2</sup> (70 cm × 35 cm)	4 plants/m <sup>2</sup> (70 cm × 35 cm)
Size of blocks	29.4 m <sup>2</sup> (4.2 m × 7 m)	29.4 m <sup>2</sup> (4.2 m × 7 m)

Trials were carried out in the first year in randomized blocks with four replications which were compared to the absolute control. Of the nine trials, six were treated with the active principles in pre-emergence and three in the period following emergence of the crop (Table 3).

This method was repeated during the second year of trials, but with five replications, one absolute control and one hoed control. Fourteen treatments were performed with active principles in pre-emergence and two in post-emergence (Table 4).

Table 3  
Phytotoxicity of active principles used as revealed by some characteristics in plant development and yield (1982 trials)

Active principles, time of application and dose (g/ha)	Phytotoxicity 20 days after emergence or post-emergence treatment	(EWRC scale 1-9) 40 days after emergence or post-emergence treatment	Plant height (cm)*	Head diameter (cm)*	Achene yield (10% moisture) (q/ha)
Metobromuron + Prometryn Pre-em. 500+1,000	3	2	117.0	16.0	16.9 ad
Linuron + Trifluralin " 472+ 940	2	2	117.7	16.3	17.1 ac
Linuron + Ethalfluralin " 600+1,200	2	2	118.4	15.5	16.6 bd
Linuron + Ethalfluralin " 840+1,260	3	2	119.3	15.9	17.6 a
Linuron + Oryzalin " 625+1,125	3	2	117.2	15.8	17.3 ab
Fluorochloridone " 600	2	1	116.7	15.4	16.4 ce
Propyzamide Post-em. 750	2	1	118.0	15.2	16.1 df
Trifluralin " 800	3	2	116.5	15.2	15.7 ef
Pendimetalin " 1,200	3	2	117.6	15.3	16.2 de
Absolute control	—	—	116.6	15.0	15.3 f
Average data	—	—	117.5	15.6	16.5

Figures not followed by the same letter, including partials, differ from each other when  $P = 0.05$  (Duncan's test).  
\* Figures do not differ when  $P = 0.05$ .

Table 4  
Phytotoxicity of active principles used as revealed by some characteristics in plant development and yield (1983 trials)

Active principles, time of application and dose (g/ha)	Phytotoxicity 20 days after emergence or post-emergence treatment	(EWRC scale 1-9) 40 days after emergence or post-emergence treatment	Plant height (cm)*	Head diameter (cm)*	Achene yield (10% moisture) (q/ha)
Metobromuron Pre-em. 1,250	3	2	149.7	21.5 ae	30.6 be
Metobromuron+Prometryn " 500+1,000	3	2	152.4	21.2 be	30.3 cf
Metobromuron+Metazaclor " 750+1,000	3	2	150.7	22.5 a	32.8 ab
Metobromuron+Metolaclor " 750+ 675	3	2	151.3	21.8 ac	31.4 ad
Metazaclor " 1,000	3	1	150.1	22.1 ab	32.2 ac
Fluorochloridone " 625	2	1	147.8	21.6 ad	31.5 ad
Linuron " 750	2	1	151.5	20.3 ef	29.8 df
Linuron+Alachlor " 750+1,728	3	1	152.4	22.3 ab	33.4 a
Linuron+Trifluralin " 472+ 940	1	1	151.8	20.6 cf	30.2 cf
Linuron+Ethalfluralin " 600+1,200	2	1	150.3	21.7 ac	31.7 ad
Linuron+Pendimetalin " 540+ 960	2	1	152.6	22.0 ab	32.1 ac
Neburon+Pendimetalin " 2,000+ 800	3	2	148.9	21.4 ae	30.9 be
Pendimetalin Post-em. 1,204	3	2	150.6	22.3 ab	32.4 ac
Propyzamide " 1,204	4	3	147.3	22.0 ab	30.3 cf
Hoed control	—	—	148.5	20.4 df	29.1 ef
Absolute control	—	—	149.2	19.8 f	28.2 f
Average data	—	—	150.3	21.5	31.1

Figures not followed by the same letter, including partials, differ from each other when  $P = 0.05$  (Duncan's test).  
\* Figures do not differ when  $P = 0.05$ .

The weed-killer was diluted according to a ratio of 700 litres water/ha and spread using a special pump for plot treatment.

The following observations were made :

**a) on the crop**

— inspection for phytotoxic effects at 20 and 40 days from emergence when treatment was effected in pre-emergence, at 20 and 40 days from treatment when this was effected in post-emergence (E.W.R.C. scale) ;

- plant height ;
- diameter of head ;
- achene production.

**b) on the weeds**

— floristic and quantitative inspection during the period of physiological maturity, following the phyto-sociological method of Braun and Blanquet.

Variations in temperature and rainfall are reported for the period in question in Figures 1 and 2 ; they reveal the following :

— during the period of cultivation in 1982 rainfall was only 75.8 mm which adversely affected sunflower yield as well as weed development, which was also restricted by the high temperature registered ;

— rainfall in 1983 was, on the other hand, higher than average (238.0 mm during the cultivation cycle), but was poorly distributed since the maximum was registered in August. From the time of pre-emergence treatment, there was a long period of drought which hampered the effect of the active principles, but heavy rainfall immediately after post-emergence treatment enhanced their effect.

**RESULTS AND DISCUSSION**

**Phytotoxic effects on crop and control of infesting plants**

An examination of Tables 3 and 4, which report data relevant to phytotoxicity levels of each weed-killer as revealed during the two years of trials, shows that under our experimental conditions, in the presence of the clay-silty soil, only Propyzamide (in doses of 1,500 g/ha with post-emergence treatment) has proved to be phytotoxic (4th level on the E.W.R.C. scale, or 10% plants damaged). None of the other active principles showed a marked degree of phytotoxicity, since temporary damage did not exceed 5% of the plants (grade 3 on the E.W.R.C. scale).

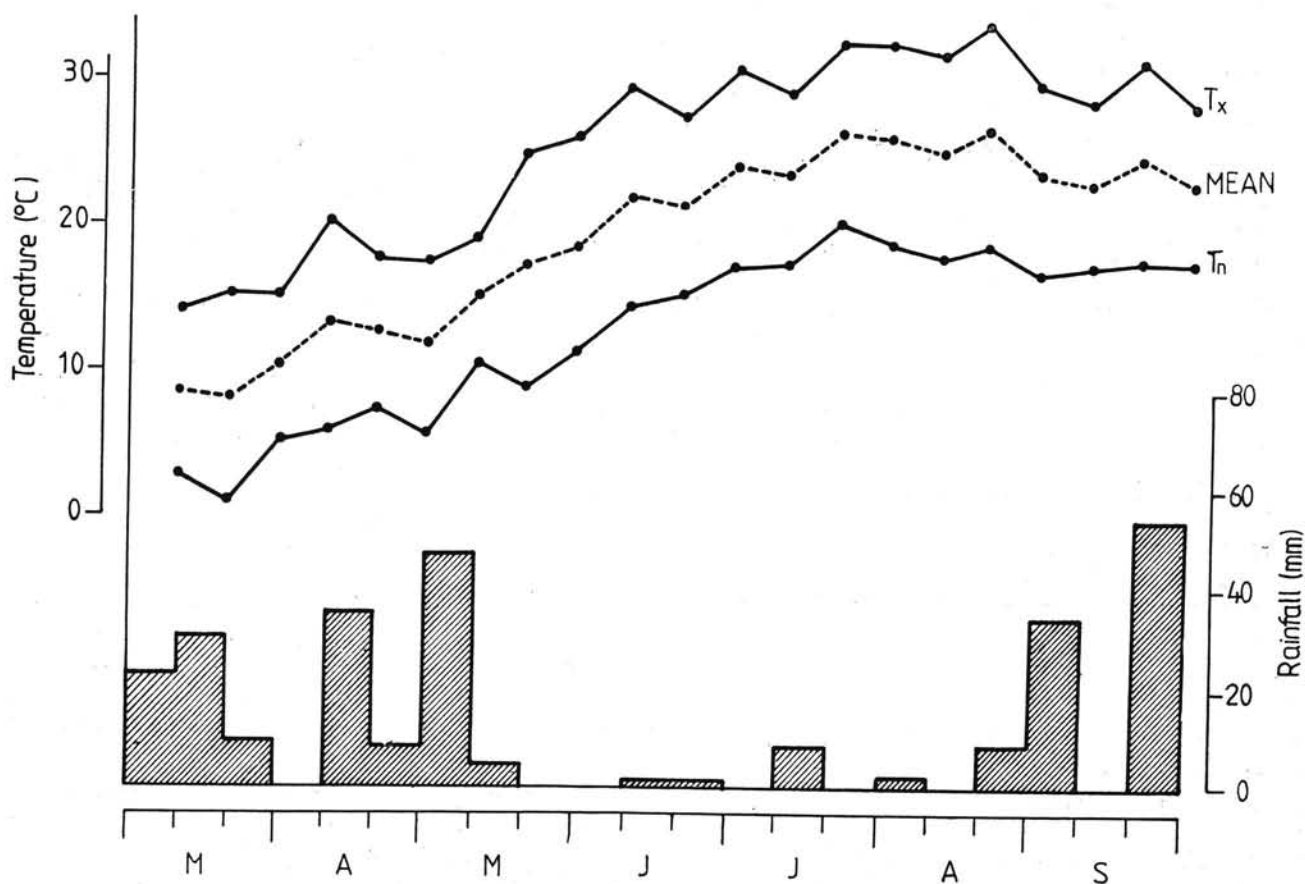


Fig. 1 — Rainfall and temperature (ten-day averages) in 1982

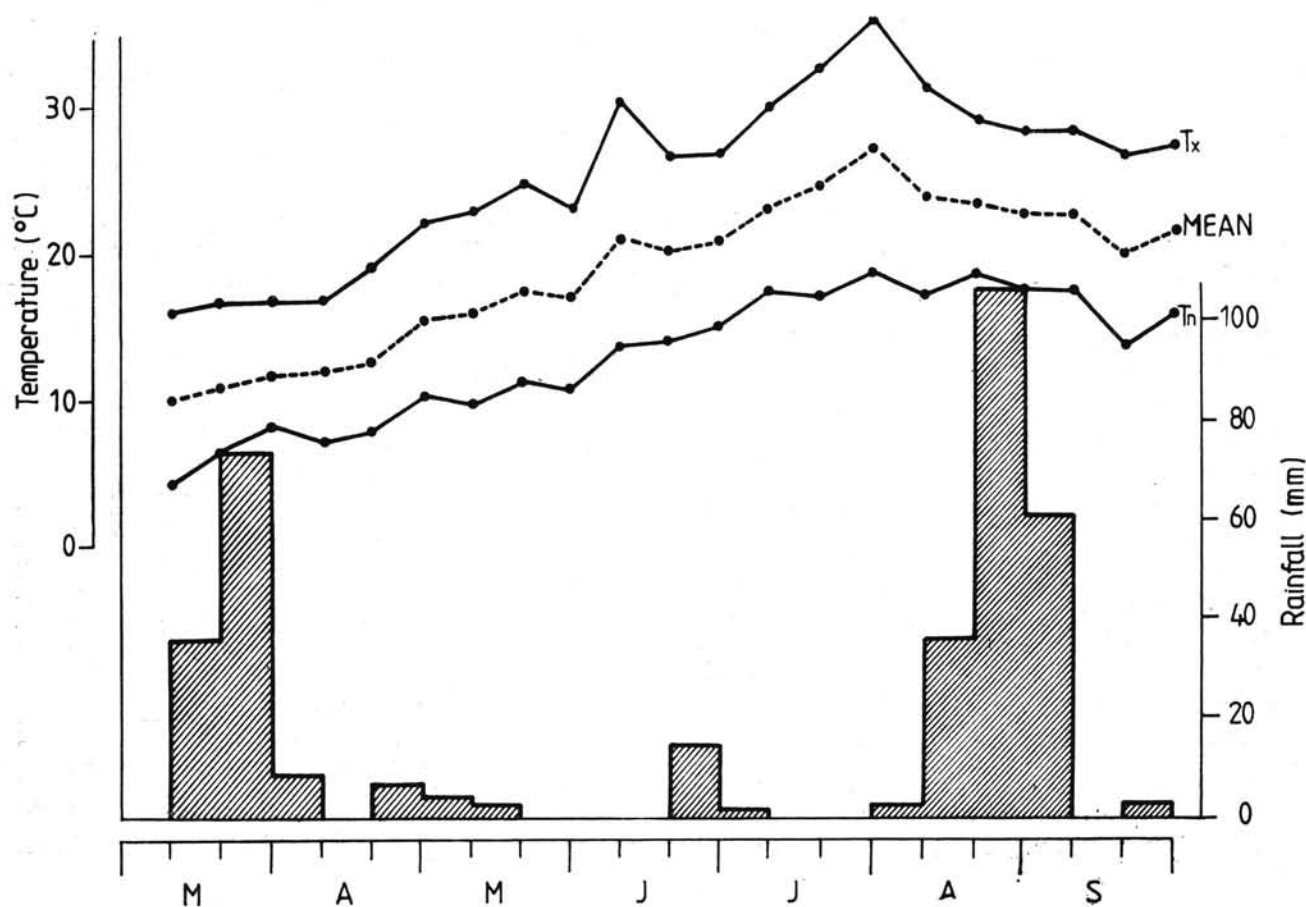


Fig. 2 — Rainfall and temperature (ten-day averages) in 1983

Of the weeds present in the two years of trials in the "untreated" control, annual dicotyledons, in decreasing order were the following: *Amaranthus retroflexus*, *Solanum nigrum*, *Sinapis arvensis*, *Chenopodium album*, *Polygonum* spp. and *Convolvulus arvensis*. Among the graminaceous plants were: *Echinochola crus-galli*, *Lolium* spp., *Digitaria sanguinalis*, *Setaria viridis* and *Phalaris* spp.

The following observations regarding the herbicidal activity expressed by the various active principles tested (alone or in blends) can be made from an examination of Tables 5 and 6, which report results.

In the pre-emergence treatment carried out in 1982, blends of Linuron + Ethalfluralin (840+1,260 g/ha), Linuron + Oryzalin (625+1,125 g/ha); Linuron + Trifluralin (472+940 g/ha) and Metobromuron + Prometryn (500+1,000 g/ha) all proved to be globally efficient weed-killers. During the 1983 trials, when infestation was more pronounced and there was a long period of drought after treatment, neither Linuron alone (750 g/ha) or blended with Trifluralin (472+940 g/ha) nor Metobromuron alone (1,250 g/ha) or blended with Prometryn (500+1,000 g/ha) gave the same satisfactory results as in the previous year. More-

over also the blend of Linuron + Ethalfluralin (600+1,200 g/ha) failed to produce the same results as before. During both trials Fluorchloridone (625 g/ha) failed to control weeds efficiently. The blend of Linuron + Oryzalin (625+1,125 g/ha) was not included in the 1983 experiments because although not directly demonstrating phytotoxic effects in the particular environment of these trials, it had done so in others elsewhere (Pisa and Tarquinia).

Some active principles were tested only during the second year; of these, a blend of Linuron + Alachlor (750+1,728 g/ha) and Metazachlor (1,000 g/ha) alone, or blended with Metobromuron (1,000+750 g/ha) showed good results. Linuron + Pendimetalin (540+960 g/ha) and Metobromuron + Metolachlor (750+675 g/ha) were also effective, whereas Neburon + Pendimetalin (2,000+800 g/ha) were rather less so.

Control by hoeing was also barely effective, since heavy rainfall encouraged the growth of new infesting plants after hoeing, which had a marked effect on the production of achenes.

Post-emergence application gave the following results: during the first year the three active principles employed Propyzamide (750 g/ha), Trifluralin (800 g/ha) and Pendimetalin (1,200 g/ha), did not give sufficient control over

Table 5

Percentage coefficient of weed coverage in relation to treatment (1982 trials)

Weeds	Active principle, time and dose applied (q/ha)	Treatments									
		Metobromuron + Prometryn pre-em. 500+1,000	Linuron + Tri-fluralin pre-em. 472+940	Linuron + Ethal-fluralin pre-em. 600 + 1,230	Linuron + Ethal-fluralin pre-em. 840 + 1,260	Linuron + Oryza-lin pre-em. 625 + 1,125	Flurochloridone pre-em. 600	Propyzamide post-em. 750	Trifluralin post-em. 800	Pendimctalin post-em. 1,200	Absolute control
<i>Sinapis arvensis</i>		8	11	14	7	7	14	14	17	17	39
<i>Amaranthus retroflexus</i>		4	2	4	2	2	4	8	8	8	14
<i>Chenopodium album</i>		4	2	4	2	4	5	5	8	5	11
<i>Sonchus</i> spp.		4	4	5	4	5	5	11	11	8	11
<i>Lolium</i> spp.		4	4	7	4	5	5	4	8	8	11
<i>Phalaris</i> spp.		5	2	4	2	5	4	4	5	6	8
<i>Solanum nigrum</i>		5	5	5	5	5	5	4	5	5	7
<i>Polygonum aviculare</i>		2	1	2	1	1	2	4	4	4	5
<i>Galium aparine</i>		2	2	2	1	1	2	2	2	2	4
<i>Polygonum convolvulus</i>		2	2	2	1	1	2	2	2	2	2
<i>Convolvulus arvensis</i>		2	1	2	1	2	2	2	2	2	2
<i>Rumex</i> spp.		2	1	2	1	1	1	2	1	2	2
<i>Anagallis arvensis</i>		—	+	1	—	—	+	1	2	1	2
Others		1	1	4	1	2	2	5	5	5	5
Total		47 DF ef	43 EF ef	60 BE ce	35 F f	42 EF ef	56 CF de	70 ED bd	83 B b	78 BC bc	126 A a

Figures not marked by the same letter, including partials, differ when  $P = 0.01$  (capital letters) and  $P = 0.05$  (small letters), Duncan's test.

+ = Traces.

— = Absent.

Table 6

Percentage coefficient of weed coverage in relation to treatment (1983 trials)

Weeds	Active principle, time and dose applied (q/ha)	Treatments															
		Metobromuron pre-em. 1,250	Metobromuron + Prometryn pre-em. 500+1,000	Metobromuron + Metazachlor pre-em. 750+1,000	Metobromuron + Metolachlor pre-em. 750+675	Metazachlor pre-em. 1,000	Flurochloridone pre-em. 625	Linuron pre-em. 750	Linuron + Alachlor pre-em. 750+1,728	Linuron + Trifluralin pre-em. 472+940	Linuron + Ethal-fluralin pre-em. 600+1,200	Linuron + Pendimctalin pre-em. 540+960	Neburon + Pendimctalin pre-em. 2,000+800	Pendimctalin post-em. 1,204	Propyzamide post-em. 1,500	Hoed control	Absolute control
<i>Amaranthus retroflexus</i>		8	17	7	14	14	14	17	5	22	14	14	14	5	4	17	44
<i>Solanum nigrum</i>		22	22	11	19	14	19	22	11	27	22	17	22	14	5	27	44
<i>Echinochola crus-galli</i>		17	11	8	11	8	14	17	11	14	11	17	8	8	8	17	32
<i>Chenopodium album</i>		5	5	2	7	4	4	8	1	4	5	8	8	5	8	8	17
<i>Digitaria sanguinalis</i>		8	8	5	11	5	14	11	2	14	8	8	8	5	5	14	17
<i>Setaria viridis</i>		5	5	4	2	2	4	4	4	4	4	4	7	7	2	5	14
<i>Lolium temulentum</i>		5	5	1	+	2	2	4	2	2	+	1	+	1	2	5	11
<i>Convolvulus arvensis</i>		4	4	+	2	+	2	7	1	1	2	4	1	2	1	5	8
<i>Polygonum persicaria</i>		5	4	+	1	1	1	4	1	1	2	2	+	1	1	5	5
Others		5	5	5	5	4	2	5	4	1	2	1	1	2	2	11	14
Total		85 CE cd	87 CE cd	44 FG g	75 CG cf	56 EG eg	79 CF cf	100 BC c	44 FG g	93 BD cd	73 DG df	72 DG df	80 CF ce	52 EG fg	40 G g	127 B b	208 A a

Figures not marked by the same letter, including partials, differ when  $P = 0.01$  (capital letters) and  $P = 0.05$  (small letters), Duncan's test.

+ = Traces.

weeds; this may be due to the long drought after application, which did not permit the products to work efficiently. In the following year, when conditions were more propitious, Propyzamide (1,500 g/ha) gave the best results of all the products experimented as far as global effects are concerned, but was unfortunately slightly phytotoxic towards sunflower. The other weed-killer used in post-emergence also showed satisfactory results (Pendimetalin, 1,204 g/ha) which leads us to suppose that it may be possible to treat sunflower in the post-emergence period.

#### Production of achenes

In all the trials, treatment in general gave rise to significantly higher yields in achenes when compared to the absolute control (Tables 3 and 4).

In 1982 the best results were obtained from blends of Linuron+Ethalfuralin (840+1,260 g/ha) and Metobromuron+Prometryn (500+1,000 g/ha), the least satisfactory were obtained when the active principles were applied in post-emergence.

In the second year of trials no striking difference in yield was revealed between the pre and post-emergence treatments. There is no statistically significant difference between the yield from the best pre-emergence treatment (Linuron+Alachlor: 750+1,728 g/ha) and the best post-emergence treatment (Pendimetalin: 1,204 g/ha). The lowest yields were obtained from the pre-emergence treatment with Linuron (750 g/ha).

#### Plant height

No effects on plant height could be attributed to treatments (see Tables 3 and 4), although in some treatments slight but temporary inhibitory dwarfing effect was noted; this did not last more than a few days.

#### Head diameter

Because of the unusual weather conditions and the variability in plot data, no statistically significant differences in head size among treatments were registered in 1982 (Table 3). During the following year however, all the treated plots showed better results than the absolute control (Table 4), although no statistically significant differences were found among the various treatments.

### CONCLUSIONS

The results obtained during these trials allow us to draw the following conclusions concerning the possibilities of applying the active principles tested:

— the best results, in terms of global weed control, were obtained from blends of Linuron

+Ethalfuralin, Linuron+Alachlor and Metobromuron + Metazaclor, applied in pre-emergence;

— in 1983 Pendimetalin and Propyzamide gave good weed control when applied in post-emergence. Pendimetalin showed a very low level of phytotoxicity but Propyzamide proved to be rather toxic when used on sunflower and had an adverse effect on yield;

— the highest achene yield was given by the pre-emergence treatment with Linuron+Alachlor and the post-emergence treatment with Pendimetalin in 1983, and by the pre-emergence treatment with Linuron+Ethalfuralin in 1982.

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#### SUBSTANCES CHIMIQUES POUR LA LUTTE CONTRE LES MAUVAISES HERBES CHEZ LE TOURNESOL: LES RÉSULTATS DES ESSAIS COMPARATIFS

##### Résumé

Certaines des plus efficaces substances chimiques pour la lutte contre les mauvaises herbes des cultures de tournesol ont été essayées pendant 1982 et 1983 dans les régions de Pise et Grosseto, où cette culture est importante pour l'agriculture locale.

Quant à la capacité de lutte, les meilleures performances lors des traitements de pré-levée ont été obtenues avec les mélanges Linuron + Ethalfuralin, Linuron + Alachlor et Métobromuron + Métazaclor. Dans les traitements de post-levée, Pén-dimétalin a particulièrement montré en 1983 une bonne capacité de lutte contre les adventices, sans engendrer de la phytotoxicité. Concernant le rendement en graines du tournesol, les meilleurs résultats ont été obtenus avec Linuron + Alachlor, Linuron + Ethalfuralin et Pén-dimétalin.

SUSTANCIAS QUÍMICAS PARA EL COMBATE DE  
LAS MALAS HIERBAS DE GIRASOL: RESULTADOS  
DE LOS TESTOS COMPARATIVOS

*Resumen*

Unas de las más eficientes sustancias químicas para combatir las malas hierbas de los cultivos de girasol fueron experimentados entre los años 1982 y 1983 en las regiones Pisa y Grosseto, donde este cultivo presenta importancia para la agricultura local.

En cuanto a la capacidad de combate, las mejores performances en los tratamientos aplicados antes del brote se obtuvieron con las mezclas Linuron + Ethalfluralin, Linuron + Alachlor y Metobromuron + Metazaclor. En los tratamientos aplicados después del brote, Pendimetalin mostró, sobre todo en 1983, una gran capacidad de combate de las malas hierbas, sin que el cultivo quede afectado por fitotoxicidad. En cuanto a la producción de semillas del girasol, los mejores resultados se obtuvieron con los produjos Linuron + Alachlor, Linuron + Ethalfluralin y Pendimetalin.