THE INFLUENCE OF HOEING AND EARTHING-UP IN CONJUNCTION WITH CHEMICAL WEED-KILLERS ON SUNFLOWER YIELD

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INTRODUCTION

Doubt has recently been thrown upon the necessity of hoeing and earthing-up in agronomical practice as an adjuvant to the use of chemical weed-killers in sunflower cultivation (Covarelli and Tei, 1984 ; Pouzet and Regnault, 1982 ; Regnault et al., 1980). This is in consequence of the ever-increasing availability of weed-killers able to control almost all the weeds which infest this crop (Baldoni, 1982 ; Covarelli et al., 1981 ; Covarelli et al., 1982 ; Laureti et al., 1983).

In order to obtain useful information on the various aspects of weed control, both chemical and agronomic ones (Armstrong et al., 1976 ; Bonciarelli, 1971 ; Cantele and Zanin, 1983 ; Catizone, 1979 ; Toniolo, 1982), and evaluate the effective influence of hoeing and earthing-up on sunflower yield, two comparative trials were run in an area in Central Italy which is typical for sunflower cultivation.

MATERIALS AND METHODS

The trials were carried out in 1982 and 1983 at the Centro Sperimentale of the Instituto di Agronomia Generale e Coltivazioni Erbacee, locality Torretta (San Piero, Pisa), on a silt soil plain (Table 1).

The fertilizers used were 100 kg/ha P_2O_5 at ploughing and 100 kg/ha N at sowing .

The hybrid Romsun 52 was employed in 1982 and Gloriasol in 1983 : in both cases plant density was 4 plants/m^2.

The experimental lay-out was the Latin square in which the following combinations were compared :

A) chemical weed-killer only ;

B) chemical weed-killer + hoeing once ;

C) chemical weed-killer + hoeing twice ;

D) chemical weed-killer + hoeing once + earthing-up once ;

Table 1

Physical and chemical characteristics of soil in trials

Analyses	Results	
	1982	1983
Sand (%)	42.8	44.3
Silt (%)	38.8	38.4
Clay (%)	18.4	17.3
pH (of water)	7.64	7.82
Total lime	9.23	7.96
Total nitrogen (‰)	1.15	1.22
Assimilable Phosphorus (ppm) (Olsen's method)	6.7	7.2
Exchangeable Potassium (ppm) (inter. method)	127.8	144.8
Organic matter (%) (Lotti's method)	1.56	1.74

E) chemical weed-killer + hoeing twice + earthing-up once ;

F) untreated control.

Weed-killer was applied at pre-emergence using a Metobromuron + Prometryn mixture (500 + 1,000 g/ha) which has shown to be one of the most effective solutions at all times for the locality where the trials were run.

Hoeing and earthing-up were carried out at the dates reported in Table 2.

Table 2

Times of planting, weed-killer application, hoeing and earthing-up treatments

Agronomical practices	1982	1983
Planting	19 May	28 April
Weed-killer application		
Metobromuron + Prometryn (500 + 1 000 g/ha)	21 May	29 April
1st hoeing	14 June	24 May
2nd hoeing and/or earthing-up	28 June	8 June

The first hoeing was carried out when plant development was at the 4 true-leaf stage and the second at the 10 true-leaf stage, with earting-up if the trials required it. Samples of soil

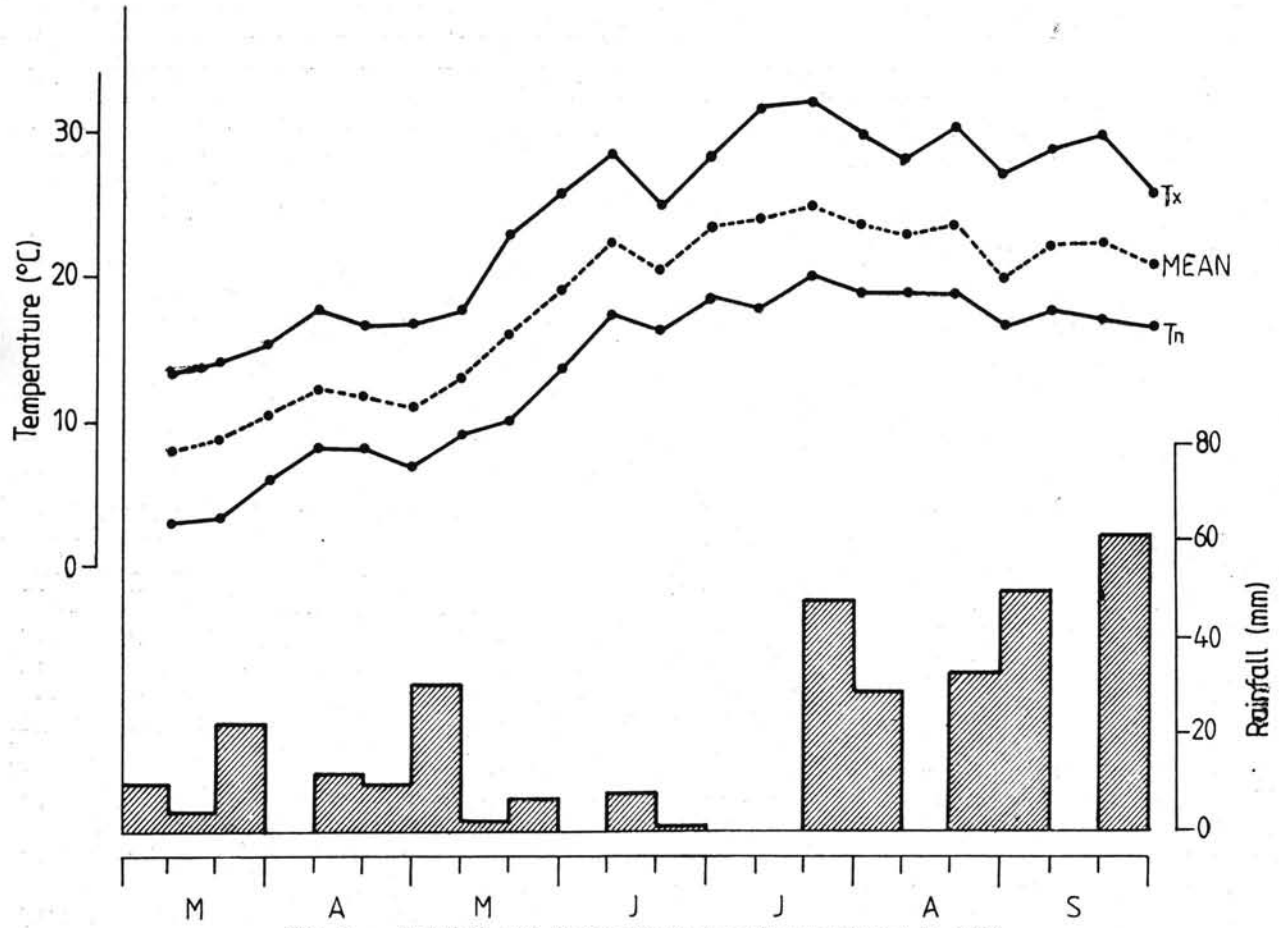

Fig. 1 — Rainfall and temperature (ten-day averages) in 1982

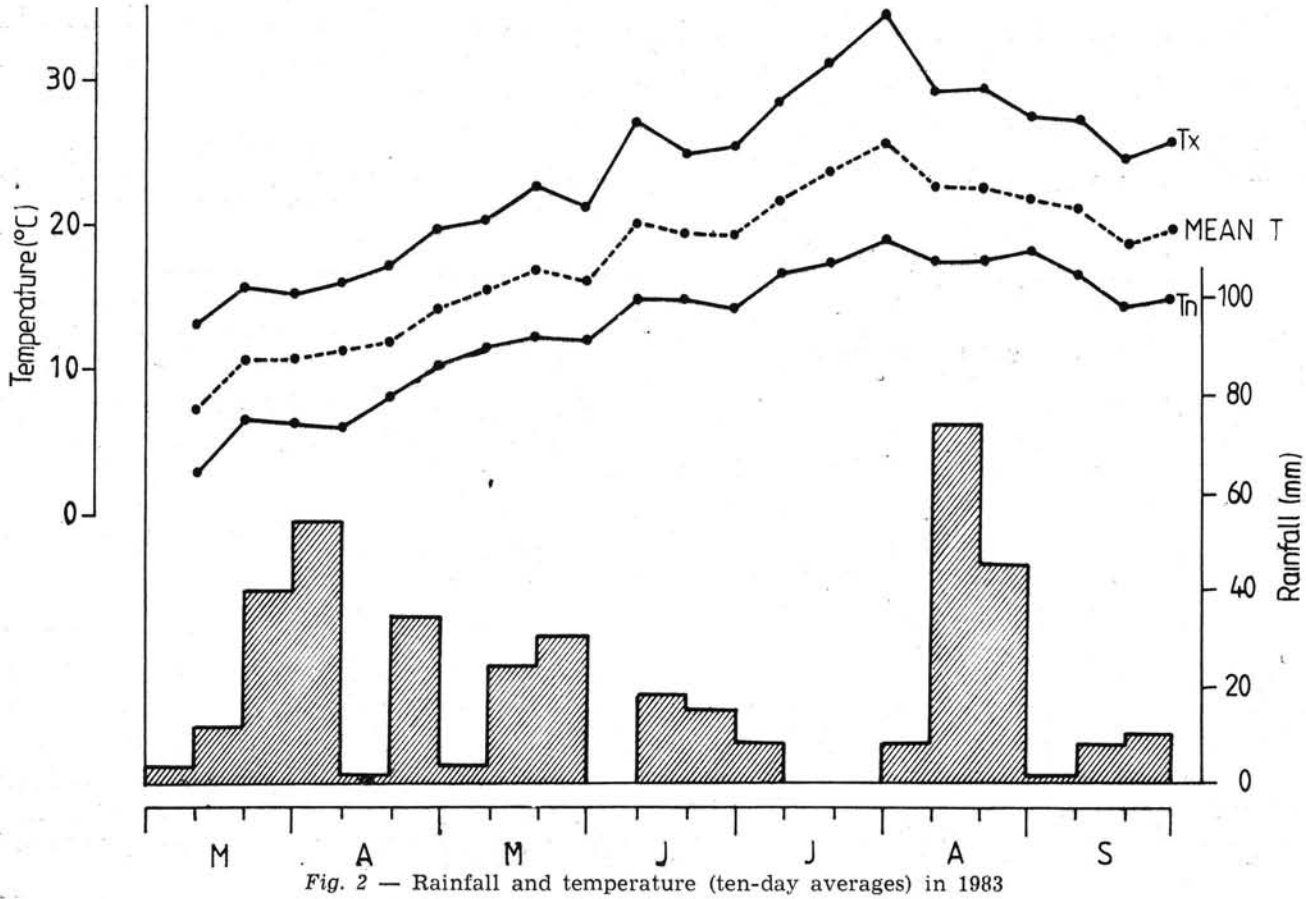

Fig. 2 — Rainfall and temperature (ten-day averages) in 1983

were taken to a depth of 30 cm about one month from the time of the final hoeing or earthing-up, in order to determine the effect of these procedures on soil water content.

The Braun-Blanquet quantity-dominance method was used at physiological maturity to estimate at sight the weeds present in the plots.

The following biometric and yield measurements were made during both years : plant height, head diameter, dry weight of the epigene parts at harvest, seed moisture at harvest, weight of 100 l, weight of 1,000 seeds and achene production.

METEOROLOGICAL OBSERVATIONS

Rainfall over the entire period of cultivation in 1982 (Fig. 1) was 170.4 mm. Hardly any rain fell for about 70 days (from the first ten days in May to the last in July) during the flowering stage and the beginning of achene maturity. Temperature was generally above the seasonal average.

Rainfall during the 1983 trials was above the usual level (Fig. 2), being 266.4 mm, but most of it fell after August 10th (124.9 mm). The delay of this rainfall determined the development of few weeds even after hoeing and earthing-up had been completed.

Temperatures in both years were rather high, in particular during July and the first ten days of August.

RESULTS AND DISCUSSION

Weed control

The most prevalent weeds during the 1982 trials were *Amaranthus retroflexus, Chenopodium album, Equisetum arvense, Sinapis arvensis* and *Echinocloa crus-galli* (Table 3). The weather, with its low rainfall and high average mean temperatures affected the development of weeds, which was rather low.

Control by chemical weed-killer was generally good over all weeds present, although less satisfactory than when combined with one or other methods.

The main weeds present in 1983 were *Polygonum convolvulus, Polygonum persicaria, Chenopodium album, Echinocloa crus-galli, Cynodon dactylon* and *Sinapis arvensis* (Table 4).

The blend of herbicides used had a satisfactory effect on weed control in spite of the unusual weather, but it was not so efficient against *Cynodon dactylon, Polygonum convolvulus* and *Polygonum persicaria.*

The plot which was hoed twice (C) and those which were also earthed-up (D and E) gave the best results.

Yields

No statistically significant differences were observed in the characteristics of the yield between the plots which had only chemical weed-killing and the others which had been hoed and earthed-up (Table 5). Only the dry weight of the epigene portion at harvest in plot B (Chemical weed-killer and hoeing once) was found to be statistically higher than that of plot A (chemical weed-killer only). The control plot produced plants with a statistically lower head diameter, dry weight and yield of achenes than any of the other plots.

The following year, when the weed population was greater and of a type more difficult to control with the blend of weed-killer used, plot C (chemical weed-killer + hoeing twice), plot D (chemical weed-killer + hoeing once and earthing-up) and plot E (chemical weed-killer + hoeing twice+earthing-up) gave

Table 3

Percentage coefficient of weed coverage in relation to the applied treatment (1982 trial)

Treatments / Weeds	Trial A	Trial B	Trial C	Trial D	Trial E	Trial F
Amaranthus retroflexus	3.4	2.5	1.7	1.7	1	14.6
Chenopodium album	3.8	3.4	2.5	2.5	1.7	12.5
Equisetum arvense	7.1	4.2	1.7	3.4	1	12.5
Sinapis arvensis	4.6	3.4	1.7	2.5	1.7	12.5
Echinocloa crus-galli	5.4	3.4	1.7	3.4	1	11.2
Phalaris caerulescens	3.4	3.4	1	1.7	1	7.1
Polygonum persicaria	3.4	2.5	1	1.7	1	7.1
Convolvulus arvensis	1.7	1	+	1	+	5.4
Polygonum convolvulus	2.5	2.5	1.7	2.5	1	5.4
Lolium perene	1.7	1	+	1	+	5.0
Rumex crispus	1	1	+	1	+	3.4
Anagallis arvensis	1	+	—	—	—	1.7
TOTAL	38.8 b	28.0 bd	13.0 de	22.3 ce	9.0 e	98.5 a

Values not indexed by the same letter, including partials, differ by P=0.05 (Duncan test).
+ = Traces

Table 4

Percentage coefficient of weed coverage in relation to the applied treatment (1983 trial)

Treatments Weeds	Trial A	Trial B	Trial C	Trial D	Trial E	Trial F
Polygonum convolvulus	11.2	9.6	7.1	11.2	4.2	35.0
Polygonum persicaria	9.2	7.1	4.2	8.3	3.3	24.2
Chenopodium album	4.2	3.3	2.5	2.5	1.7	15.4
Echinocloa crus-galli	4.6	5.4	2.5	2.5	1.7	15.4
Cynodon dactylon	11.2	4.6	2.5	3.4	2.5	13.3
Sinapis arvensis	4.2	3.7	3.3	2.5	2.5	11.2
Amaranthus retroflexus	2.5	2.5	1.7	2.5	1.7	9.2
Solanum nigrum	4.6	1.7	1.7	1.7	1.7	7.5
Equisetum arvense	2.9	1	1.7	1.7	1	5.4
Borrago officinalis	1	1	+	1	+	3.3
Fumaria officinalis	1.7	+	+	1	+	2.5
Veronica spp.	1	+	+	+	+	1.7
TOTAL	58.0 b	41.2 bc	29.6 cd	38.8 cd	22.8 d	144.2 a

Values not indexed by the same letter differ by P=0.05 (Duncan test).
+ = Traces

Table 5

Biological characteristics and yield (1982 trial)

Treatments and means Characters	Trial A	Trial B	Trial C	Trial D	Trial E	Trial F	Means
Plant height (cm)	144.3 a	141.6 a	140.1 a	142.0 a	143.4 a	146.8 a	143.0
Head diameter (cm)	20.5 a	21.2 a	21.1 a	20.2 ab	20.6 a	19.4 b	20.5
Plant dry weight at harvest (epigene part) (g)	189.3 b	198.2 a	195.3 ab	196.3 ab	192.4 ab	175.0 c	191.1
Achene moisture at harvest (%)	8.4 a	8.7 a	8.3 a	8.7 a	8.5 a	8.7 a	8.5
Weight of 100 litres (kg/hl)	38.7 a	37.8 a	38.2 a	38.3 a	38.3 a	38.2 a	38.2
Weight of 1,000 achenes (g)	54.8 a	55.5 a	55.7 a	55.9 a	54.7 a	54.4 a	55.2
Achene production at 0% humidity (q/ha)	26.4 a	27.6 a	27.8 a	26.1 a	26.6 a	23.0 b	26.2

Values not indexed by the same letter differ by P=0,05 (Duncan test).

Table 6

Biological characteristics and yield (1983 trial)

Treatments and means Characters	Trial A	Trial B	Trial C	Trial D	Trial E	Trial F	Means
Plant height (cm)	143.1 a	141.7 a	135.1 a	137.4 a	141.4 a	145.1 a	140.6
Head diameter (cm)	22.0 a	21.8 a	22.5 a	22.1 a	22.3 a	20.8 a	21.9
Plant dry weight at harvest (epigence part) (g)	207.0 ab	203.0 ab	212.3 ab	210.0 ab	216.0 a	198.0 b	207.7
Achene moisture at harvest (%)	8.6 a	8.8 a	8.7 a	8.6 a	8.9 a	8.5 a	8.7
Weight of 100 litres (kg/hl)	63.2 a	63.3 a	63.5 a	62.9 a	63.7 a	61.5 a	63.0
Weight of 1,000 achenes (g)	43.0 a	42.7 a	43.3 a	42.5 a	43.2 a	41.3 a	42.7
Achene production at 0% humidity (q/ha)	31.3 c	31.8 bc	33.1 a	32.1 abc	32.6 ab	27.2 d	31.3

Values not indexed by the same letter differ by P=0.05 (Duncan test).

the best yields (Table 6). The plot with one hoeing and chemical weed-killer showed no significant differences in yield.

No influence on either the yield characteristics (weight of 1.000 achenes and 100 l weight of chemical) or the morphological characteristics (plant height, head diameter and dry weight of the epigene part at harvest) was seen that could be attributed to the effect of hoeing and earthing-up added to chemical weed-killers. No particular effect on water balance was found from hoeing : there was no appreciable difference since the soil moisture percentage in the plots which were hoed showed no significant variation in 1982 (mean content 16.5%) or 1983 (mean content 18.7%). It must not however be overlooked that a water-bearing layer in the area of the trials is present even during the summer.

CONCLUSIONS

The results obtained lead us to following conclusions :

— weed control by the blend of Metobromuron (500 g/ha) and Prometryn (1,000 g/ha) was unsatisfactory against *Polygonum convolvulus, Polygonum persicaria* and *Cynodon dactylon* in the second year of trials ;

— hoeing, whether accompanied by earthing-up or not, gave a certain increase in yield, but only after the unusual weather of 1983. Yield was 33.1 q/ha in plots with two hoeings and chemical weed-killer and .31.3 q/ha in plots with only chemical weed-killer ;

— no variations were found in soil moisture content among the plots ;

— the usefulness of hoeing and earthing-up depended on the efficiency of the chemical weed-killer. When their effect was satisfactory yield was not very different from that obtained by adding hoeing and/or earthing-up.

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INFLUENCE DU BINAGE ET DU RECOUVREMENT DE TERRE ASSOCIÉS AUX HERBICIDES SUR LE RENDEMENT DE TOURNESOL

Résumé

Des expériences ont été effectuées en 1982 et 1983 à la ferme expérimentale de l'Institut d'Agronomie de l'Université de Pise, afin de tester l'influence du binage et du recouvrement de terre, en tant que travaux supplémentaires dans la lutte chimique contre les mauvaises herbes du tournesol.

Les résultats ont montré que le mélange au Metobromuron + Prometrin a généralement donné de bons résultats, cependant sans être différents d'une façon significative des résultats obtenus lors du traitement combiné avec le recouvrement de terre. Quant à l'humidité du sol, ces travaux n'ont pas mené à la croissance de celle-ci. De cette façon, quand les herbicides ont manifesté une bonne efficacité horizontale, les travaux d'entretien, associés à la lutte chimique contre les adventices, n'ont pas contribué à une importante augmentation du rendement.

INFLUENCIA DE LA BINA Y DEL CUBRIMIENTO CON TIERRA EN ASOCIACIÓN CON LAS HERBICIDAS SOBRE LA PRODUCCÍON DE GIRASOL

Resúmen

Los experimentos fueron ejecutados en los años 1982—1983 en la finca experimental del Instituto de Agronomía de la Universidad de Pisa, para testar la influencia de la bina y del cubrimiento con tierra como trabajos complementarios en combatir las malas hierbas del girasol por vía química.

Los resultados mostraron que la mezcla Metobromuron + Prometrín ha dado generalmente buenos resultados, sin embargo sin que difiriesen sustancialmente de los resultados obtenidos al combinar el tratamiento con el cubrimiento con tierra. En lo que se refiere a la humidez del suelo, los respectivos trabajos agrónimicos no conducieron al aumento de ésta. De este modo cuando las herbicidas tuvieron una buena eficacia horizontal, los trabajos de mantenimiento combinados con el combate químico de la malas hierbas no contribuyeron al aumento significativo de la producción.