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SUNFLOWER YIELD CHARACTERISTICS AS AFFECTED BY WEED CONTROL, PLANT DENSITY, NITROGEN LEVEL AND SOWING TIME

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SUMMARY

Two trials were conducted during the years 1985 - 86 at the experimental farm of the Agronomy Institute of Pisa University, with the aim of singling out the combined effects of three treatments: A) two herbicide mixtures for weed control (active compounds: Trifluralin + Fluorochloridride for the first one, and Linuron + Alachlor for the second one); B) two sowing densities (5 and 8 plants/sqare meter) and C) three levels of nitrogen fertilization (0, 100 and 200 kg/ha N). This experiment was conducted in a sunflower crop grown in dry soil and typical coastal lands of Toscany. Moreover the trial was realized in three different sowing times for each year: early, normal and late, with a delay of 15 days among them.

A good weed control was obtained with both mixtures employed, while no influence was revealed for the various levels of density and sowing times on weeds, whose proliferation was emphasized with the greatest nitrogen level.

It seems that achene yield may have been increased by chemicals; in fact, with an increment of 1 q/ha of weedy dry matter, there was a decrement of about 0.14 q/ha in achene yield.

The greatest density (8 p/sq.m) and the highest nitrogen level (200 kg/ha) determined the highest achene production, whereas the best sowing time in our environment was between the end of March and the beginning of April.

INTRODUCTION

Like genetic improvement, mechanization, and the use of fertilizers and other products, the use of weed killers is a fundamental practice in modern agriculture. However, although the advent of weed killers has enabled the problem of weed control to be resolved, it has created a whole range of new ones concerning agronomics, the environment, economics and society, making it necessary to evaluate their use more critically than in the past.

The use of chemical herbicides on combinations of weeds can have undesirable effects such as encouraging other flora in substitution, or the development of resistant biotypes and the spread of perennial weeds or weeds from ruins into agricultural territory. Other qestions raised by the use of weed killers are the selectivity of these products towards the crops and phytotoxic effects of residues. The sensitivity of these products to climatic variations and soil (with particular regard to organic matter content, power of absorbtion and water permeability) should also be taken into consideration.

More research has to be done on the relationship between weed killers and the environment if we are to have a better knowledge of certain basic aspects - such as persistence of residues, their interaction with other chemical substances in the soil, the

formation of dangerous metabolites and their effects on soil microflora balance, fauna and flora.

Most of those engaged in research (Massantini et al.,1977; Catisone, 1979; Toniolo, 1982) agree on the point that the control of weeds cannot reasonably be carried out through chemical means alone and that on the contrary the possibility of a combination of means should be given greater consideration. This combination should be based on the use of weed killers but would involve agronomical methods as well as biological control trough allelopathic mechanisms and phytopathogenic microorganism.

In a plan for integrating vastly different control methods particular interest should be devoted to the qestion of competition between crop and weeds in order to have an idea of the degree of infestation which is economically acceptable and the time at which most damage is caused by competition (Catisone, 1979). For control to be effective two important aspects must be taken as starting points. These are linked to the duration of weeds in crops and are: the duration of competition tolerated without damage to yield (DCT) and the period during which weeds must not be present (PAW - period of absence of weeds) necessary to avoid damage to final yield (Covarelli et al., 1983).

The former of these, duration of competition tolerated (DCT), is of particular importance in sunflower since there is no safe weed killer for this crop after emergence, making it necessary at times to hoe the ground, something which cannot always be done in good time.

Investigations carried out in other parts of the world indicate that competition is worst during the first 4-5 weeks after emergence (Nalewaja et al., 1972; Johnson, 1971). Trials carried out in Italy over the three-year period from 1981 to 1983 (Covarelli and Tei, 1983) showed that yield reduction caused by late weed control by hoeing 10, 20, 30 and 40 days after crop emergence was 3, 7 and 24 % for the periods of 20, 30 and 40 days, respectively.

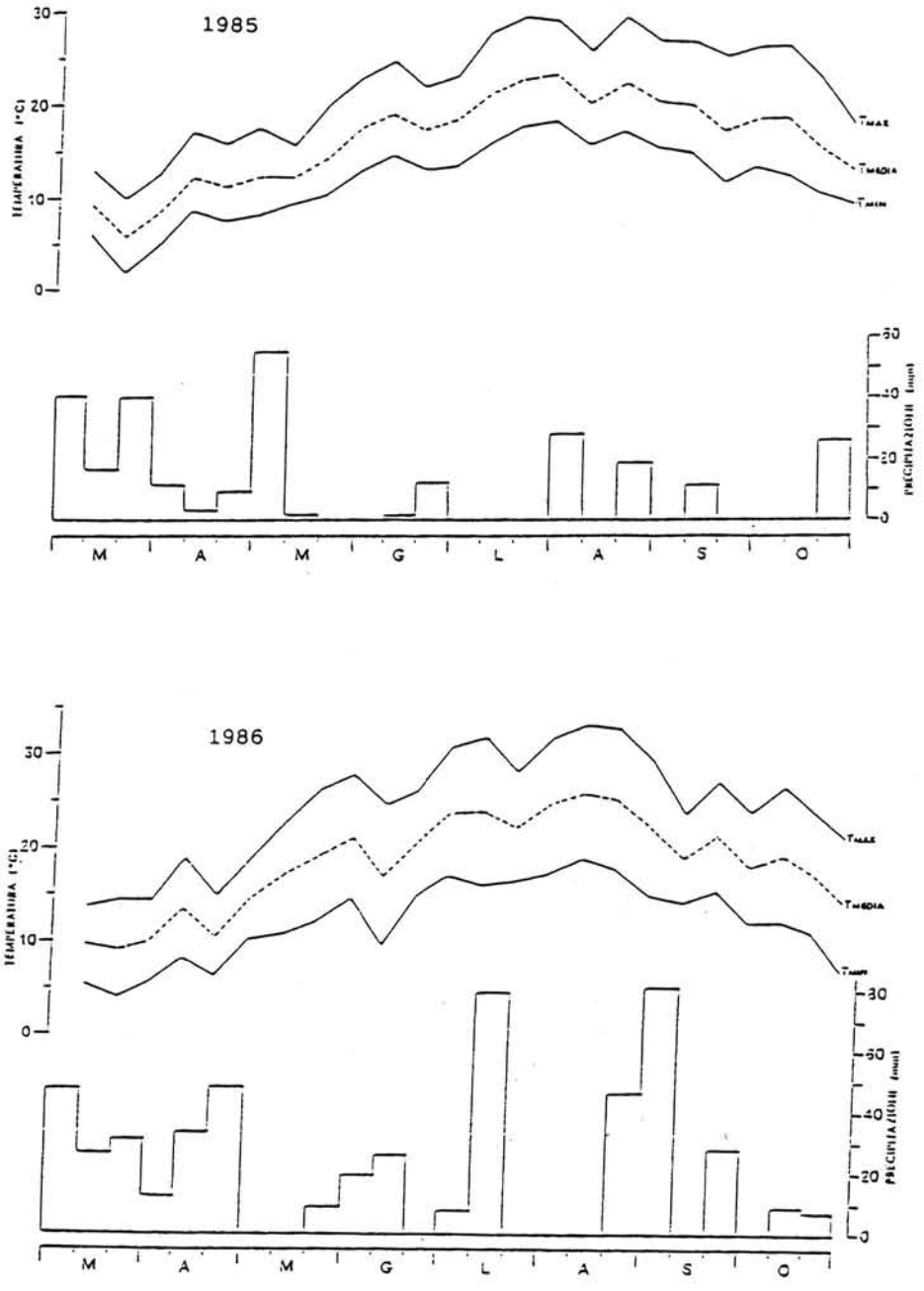
Cultivation techniques have a marked influence on competition. Sowing time and methods, working of soil and use of fertilizers all affect the relationship between weeds and crop.

For this reason trials were carried out during two years, 1985 and 1986, with the object of determining the most favourable sowing time, plant density and N-fertilizer dosage for use in combination with chemical weed killer in order to obtain the lowest possible degree of infestation and , as a consequence, best yield.

By finding the best combination of means for weed control it will become possible to reduce the dosage of chemicals required for this and with undeniable advantages for the ecosystem.

SEASONAL PATTERNS

Total rainfall over the period of the growth cycle during the 1985 experiments was 196 mm for the 1st sowing time , 145 for the 2nd and 141 for the third (Graph 1). It can be said that the crop had a lower overall rainfall supply available in 1985 than is the average for the area. It must not be forgotten however that in the first ten days in May the total rainfall reached an unusual 55 mm which enhanced the growth of both the crop



Graph 1. Ten-day average temperatures and rainfalls recorded during March-September 1985 and 1986.

and the weeds, although the former was also able to draw water from the high-level ground water (high phreatic nappe).

The temperatures followed the average pattern for the area.

The rainfall in 1986 supplied the crop with 364.3, 222.1 and 298.3 mm of water for the 1st, 2nd and 3rd sowing, respectively. Contrary to 1985, the rainfall was almost zero in May whereas between 10 and 20 July a good 87.5 mm rain fell with obvious beneficial effects on yield.

Temperature averages for ten-day periods were similar to those measured over recent years.

MATERIALS AND METHODS

Trials were carried over a two-year period (1985-86) at the Pisa University, Institute of Agronomics Experimental Station at Toretta, near Pisa, Italy. Table 1 reports the chemical and physical characteristics of the soil.

Table 1 - Soil physical and chemical characteristics

Analysis	Result	
	1985	1986
Sand (%)	44.8	41.3
Silt (%)	38.5	39.1
Clay (%)	16.7	19.6
pH (of water)	7.8	7.8
Total lime (%)	7.8	9.1
Total nitrogen (%)	1.08	1.26
Assimilable phosphorus (ppm) (Olsen's method)	7.1	7.3
Exchangeable potassium (ppm) (inter. method)	102.3	146.5
Organic matter (%) (Lotti's method)	1.43	1.56

Plots were laid out with four replications for three different sunflower seeding periods each year. One of these periods was normal for sunflowers in this area and of the other two, one was 20 days earlier and the other was 20 days later. The effectiveness of two weed killer mixtures which in previous trials (Covareli & Tei, 1985; Vanozzi & Salera, 1985; Laureti, 1985, Tei, 1986; Vanozzi & Salera, 1986) had proved to be among the best for central Italy (Trifluralin + Fluorchloridone 1000 + 5000 g/ha and Linuron + Alachlor 500 + 1,728 g/ha) were compared with the control. This was the main tratment (A); futhermore, the effect of plant density (5 or 8 plants/m^2) (treatment B) and the use of nitrogen fertilizer (treatment C) on the degree of weed infestation were also evalued for each plot.

In all cases the crop followed after *durum* wheat and the hybrid Gloriasol was used. The sowings took place on 21 March, 8 April and 26 April in 1985 and on 28 March, 17 April and 7 May in 1986.

Weed killer was applied by a special pump for plots. Methods, techniques and dates of sowing for these experiments are summarized in Table 2.

Table 2 - Cultivation methods

Year and sowing time	1985			1986		
Legend	I	II	III	I	II	III
Previous crop	hard wheat			hard wheat		
Tilling	winter ploughing and harrowing			winter ploughing and harrowing		
Fertilization	100 kg/ha of P_2O_5 (at the ploughing) 0; 100; 200 kg/ha of N (at the sowing)			100 kg/ha of P_2O_5 (at the ploughing) 0; 100; 200 kg/ha of N (at the sowing)		
Sunflower CV.	Gloriasol			Gloriasol		
Sowing time	21–3	8–4	26–4	28–3	17–4	7–5
Density	5 and 8 p/m^2			5 and 8 p/m^2		
Plot size:						
mainplot	144 m^2			144 m^2		
subplot	72 m^2			72 m^2		
sub-subplot	24 m^2			24 m^2		
Weed killer application data	22–3	8–4	26–4	29–3	17–4	9–5
Experimental design adopted	split plot axbxc with 4 blocks			split plot axbxc with 4 blocks		

I - Early sowing time
II - Normal sowing time
III - Late sowing time

The following data were collected:

a) on the crop:
- periodical inspection to verify the phytotoxic effects (Scale EWRS) of the weed killer on sunflower;
- plant height at harvest-time (cm): measured from the base of the steam to the attachment of the disk;
- head diameter at harvest-time (cm);
- seed yield per hectare (q at 0% moisture);
- dry weight of the seed (g);
- oil content in the seed (% dry matter);
- oil yield (g/ha, derived value)

b) on the weeds:
- floristic and quantitative inspection during the period of flowering, following the phyto-sociological method of Braun - Blauquet.

RESULTS AND DISCUSSION

Effectiveness of herbicides

As was expected, the time of sowing affected the type and degree of weed infestation in sunflowers. In central Italy in fact, the most common combination of weeds found in sunflowers (as well as in beets) in late winter - early spring is *Linarieto-Stachyetum annuae* belonging to *Poligono-Chenopodion* alliance, *Chenopodietalia* order and *Stellarietea*

Table 3 - Percentage coefficient of weed coverage in relation to treatment.

Year	1985			1986			1985			1986			1985			1986		
Sowing time	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Weed coverage Active ingredient	Total						Dicotyledons						Monocotyledons					
Control	198 a	169 a	143 a	176 a	189 a	82 a	151 a	139 a	100 a	129 a	123 a	70 a	47 a	30 a	43 a	47 a	66 a	12 a
Trifluralin+ Fluorchloridone	12b	7b	11b	25b	26b	4b	10c	6b	8b	20b	16b	3b	2b	1b	3b	5c	10b	0b
Linuron + Alachlor	22b	3c	4c	28b	15b	2b	20b	3c	3b	20b	9b	2b	1b	1b	1c	8b	6c	0b
Weed control capacity (%)																		
Trifluralin+ Fluorchloridone	94	96	92	86	86	95	93	96	92	84	87	96	96	97	93	89	85	100
Linuron + Alachlor	89	98	97	84	92	98	87	97	97	84	93	97	98	97	98	83	91	100

Figures not marked by the same letter differ with P = 0.05. Duncan's test.
I - Early sowing time
II - Normal sowing time
III - Late sowing time

mediae class. With the earlier sowing dates the following dicotyledons were found: *Polygonum aviculare, Sinapis arvensis, Polygonum persicaria, Chenopodium album, Stachys annua, Papaver rhoeas, Veronica persicaria, Matricaria chamomilla* and *Anagallis arvensis*, together with the grasses *Avena fatua, Lolium spp.* and *Alopercurus myosuroides.*

With sowings in late April-early May weeds are similar to those found in maize and soybean. These belong to *Panico-Setarion* alliance and in the late sowings we found the dicotyledons *Amaranthus spp., Solanum nigrum* and *Portulacea oleracea* with the grasses *Setaria viridis* and *Echinochloa chrus-galii.*

With regard to the relationship between weed density and sowing time over this two-year period, as can be seen from Table 3, it is the earliest time which presents the highest total percentage of weed coverage due to increased rainfall in March and April.

The two herbicide mixtures used, neither of which was phytotoxic (value 1 on the EWRS scale), proved to have almost the same weed control capacity (Tab. 3), allowing 90% control and more almost all of the time.

Plant density did not seem to affect weed population.

A statistically significant increase in weeds was found in most cases with nitrogen fertilizers (200 kg N/ha), as can be seen in Figure 1.

Treatment A: Weed Control

The two weed killer treatments (Trifluralin + Fluorchloridone and Linuron + Alachlor) gave almost identical results in the parameters considered with statistically significant values in comparison with the untrated control (see Figure 2).

The flower head diameter was statistically smaller in the controls for all seeding times in 1985 and in the early sowing in 1986. Unit seed weight was affected in the first and the second sowing in both 1985 and 1986, showing values lower in the untreated

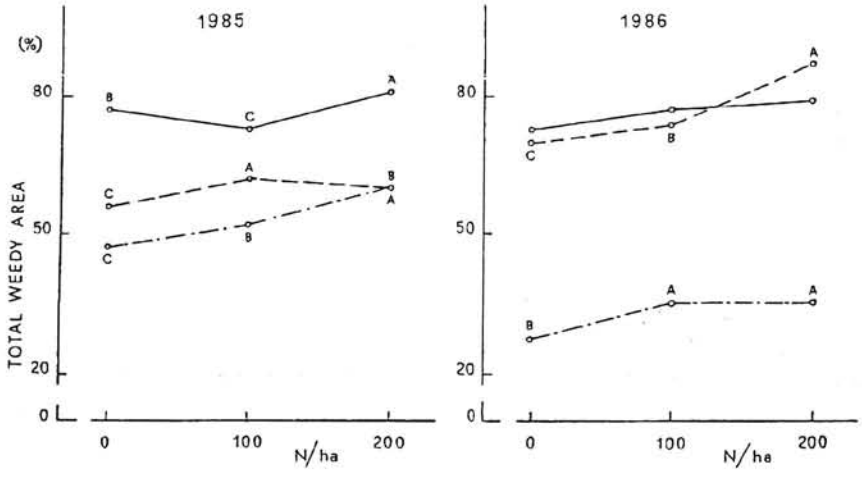


Fig. 1 Effect of nitroge dosage on total weedy area.

control, with a difference by a minimum 2.3 g and a maximum 6.8 g when compared whith the treated plots. Oil production (%) was only affected to a statistically significant extent by the early sowings in both years, with lower values in the untreated plots, which gave 46.8 % in 1985 and 45.4 % in 1986. Achene yield too was statistically higher in both years for the treated plots, with the exception of the 3rd 1986 sowing, when differences were minimal.

Particulary in 1985 yield differences between the control and the treated plots were lowest for the 3rd sowing time, with 3.8 ql/ha, and highest for the 1st, with 6.9 ql/ha. In 1986, the differences for the 1st and 2nd sowing were 5.3 and 2.5 ql/ha, respectively.

Highest oil yields were produced by the treated plots with 12, 11.5 and 8.1 ql/ha for the 1st, 2nd and 3rd 1985 sowings, respectively, and with 15 and 15.5 ql/ha for the 1st and 2nd sowing in 1986, respectively. These values were statistically higher than those for the untreated plot.

Treatment B: Plant Density

In all cases in 1986 and in the 2nd 1985 sowing time, plant density affected flower head diameter considerably. Highest values were found in plots with the lower density (5 plants/m^2) (see Figure 3).

Unit seed weight was also higher for the lower density with statistically significant differences in the 1st and 2nd 1985 sowing time and for the 2nd and 3rd 1986 sowing time, with maximum differences of 1.5 g. Achene yield was also affected by plant density, particularly in the first two sowing times in both years when 8 plants/m^2 gave statistically higher results than 5 plants/m^2, with differences between 1 and 2.3 ql/ha.

Treatment C: Nitrogen Dosage

In all cases greater flower head diameters were obtained by increasing nitrogen dosage. The diameter was statistically largest in 1986 with the highest N dosage (200

kg/ha) and similar results were obtained in 1985, although the control showed statistically larger diameters than the treated plots for the 2nd sowing, with 100 kg/ha N (see Figure 4).

Unit seed weight showed an increasing trend with higher N dosages showing maximum values with the highest dosage.

By contrast, the oil percentage fell with increasing N but was significantly lower only in 1986 with the differences between the control and the highest N dosage of 1.8 and 3.1 % in the 3rd and 2nd sowing times, respectively.

Achene yield increased in both years and at all sowing times, with higher N dosages. The highest N dosages at all times gave statistically higher yields, whereas between the control and 100 kg N/ha these differences were seen only in 1986 for the 2nd and 3rd sowing times.

Interaction

Analysis of significant interactions is reported in Figure 5. Interaction between plant density and fertilizer was low in the 3rd 1986 sowing time regarding weight / 1000 seeds and gave highest value at the highest N dosage, with identical interactions at 5 and 8 plants/m^2.

For the 2nd sowing time in 1986, the oil percentage was affected by the interaction weed killer treatment/N fertilizer with highest percent-

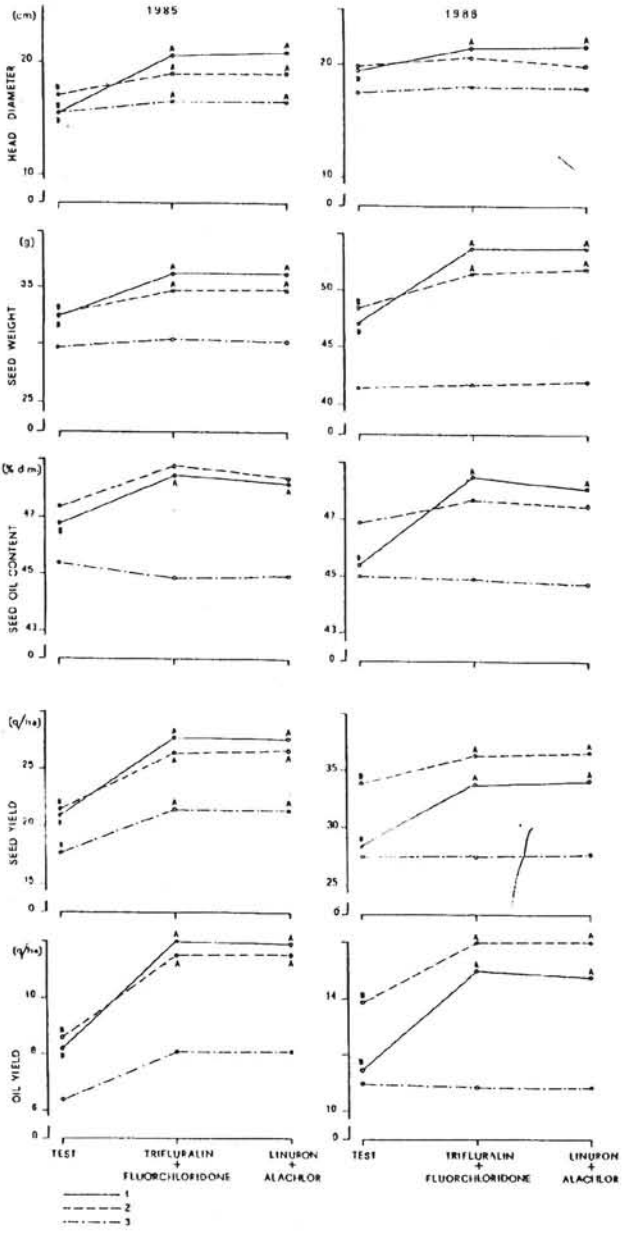


Fig. 2 Effect of weed control on yield characteristics. 1 - Early sowing time; 2 - Normal sowing time; 3 - Late sowing time

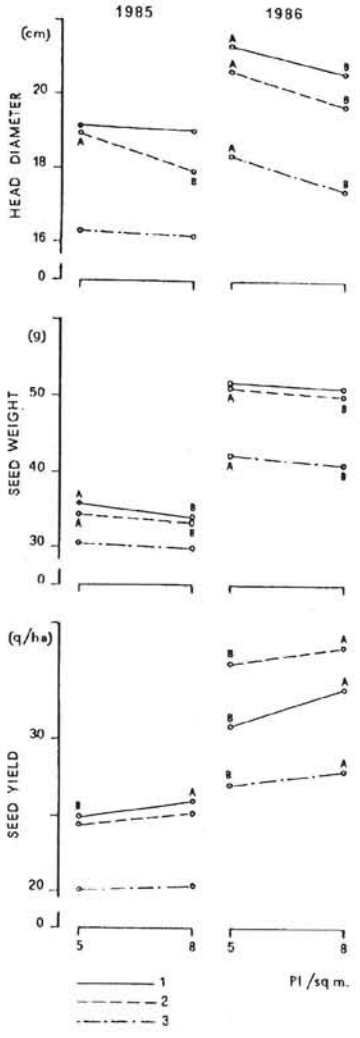


Fig. 3 Effect of density on yield characteristics. 1 - Early sowing time; 2 - Normal sowing time; 3 - Late sowing time

ages in the plots treated with weed killer against N-untreated controls. By contrast, with untreated plots against N-untreated controls this percentage fell considerably.

Sowing Time and Yield

Average achene yields were submitted to variance analysis giving statistically higher values for 1st and 2nd sowing times. Regression analysis with statistic significance for $P <= 0.05$, showed the effect of sowing time on achene yield (see Figure 6). This character in fact showed a falling linear pattern with lowest values for the latest sowing time.

Finally, Figure 7 shows a close connection (r=-0,97) between seed yield and weed density, as statistic analysis yields a straight line with negative regression coefficient. This indicates that these two characters are inversely proportional.

CONCLUSIONS

The results of these experiments indicate that damage from weeds in sunflowers affects all the characters considered, with the exception of plant height which was not affected by any of the treatments used in this research, while no significant differences were registered between the weed killer mixtures used (Trifluralin + Fluorochloridone and Linuron + Alachlor).

A comparison of the treated plots with the untreated controls shows that the latter gave smaller flower heads, lower unit seed weight and lower oil content. As a consequence, and in agreement with Covarelli and Tei (1984), the untreated control plots gave at all times lower yields of achenes and oil than the plots treated with weed killer, with the only exception of the 3rd 1986 sowing time.

A comparison of the two plant densities (5 and 8 plants/m^2) reveals that the flower head diameter character and weight per 1000 seeds have lower values at the higher plant density, as already observed by Pacucci et al., 1975; Laureti, 1981; Vannozzi et al., 1985. However, the higher number of plants per unit area more than compensates

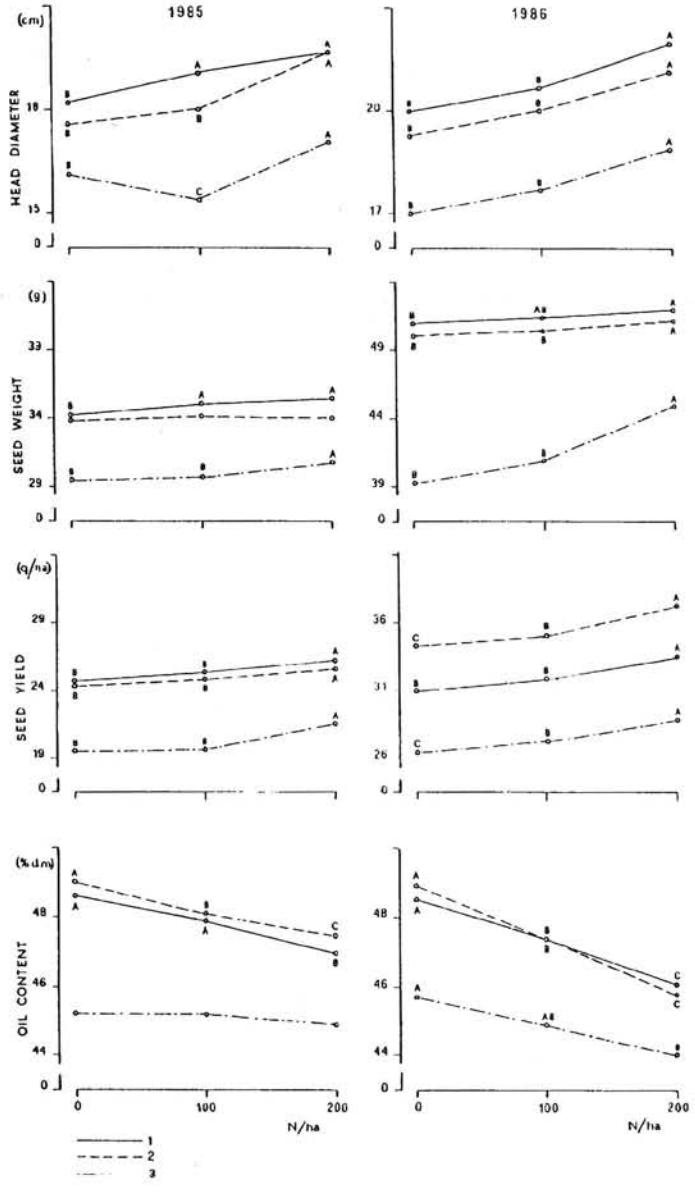


Fig. 4 Effect of nitroge dosage on yield characteristics. 1 - Early sowing time; 2 - Normal sowing time ; 3 - Late sowing time

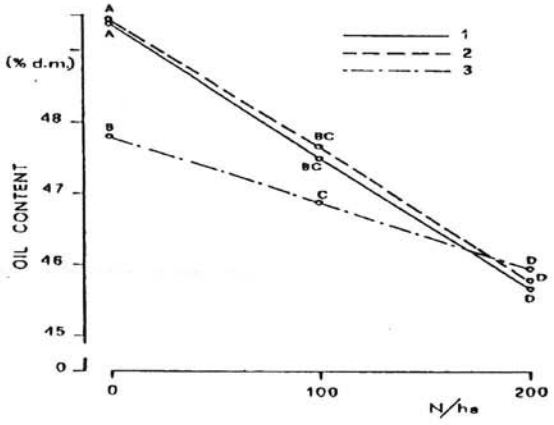


Fig. 5a. Effect of "nitrogen dosage x weed control" on oil content in the second planting date in 1986.
1 – Trifluralin + Fluorchloridone
2 – Linuron – Alachlor
3 – Control

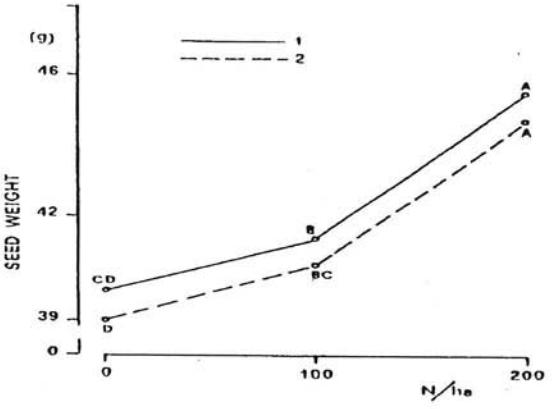


Fig. 5 b Effect of "nitroge dosage x density" on seed weight in the third planting date in 1986.
1 - 5 p/m^2
2 - 8 p/m^2

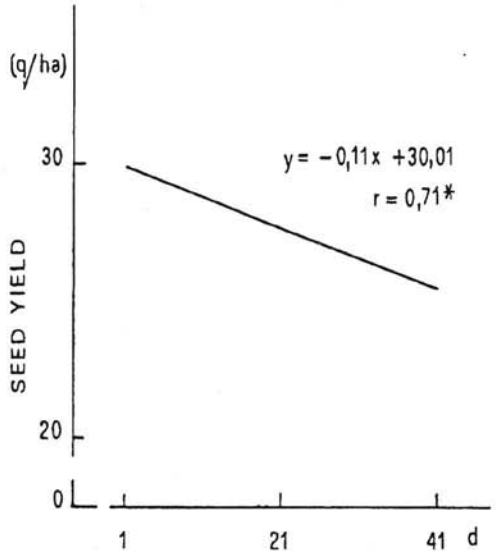


Fig. 6 Regression of planting date on seed yield (average of two years). Correlation coefficient significant per P<=0,05.

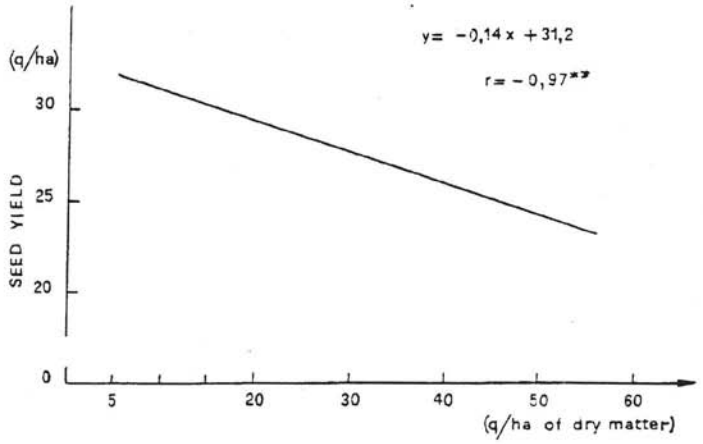


Fig. 7 Regression of weed dry matter on seed yield (average of two years). Correlation coefficient significant per P<=0,01.

these lower results since it gives a higher achene yield which in our case was particulary significant in the second year of the trial. Increased N dosage gives larger flower heads and increases in weight / 1000 seeds as found by Zubriski and Zimmerman (1974). High N dosage results in lower oil yield percentage in the seed (see Robinson, 1973) and a sharp increase in achene yield (Vannozzi, 1986), so that oil yield per ha is significantly affected.

During these experiments, sowing times were shown to have a significant effect on achene production, indicating the period from mid-March until early April as the most suitable in the area where the research was carried out.

The two non-phytotoxic weed killer mixtures had an analogous good control effect over the period in consideration. Plant density had no noticeable effect on weed density. By contrast, weeds profit like the crop from N fertilization.

A close connection was revealed between achene yield and treatment with weed killer to the extent that in our research the seed yield average in the control plots is lower by 18% then in the treated plots with highest weedy area present at flowering. Particulary we have established that for each quintal of weeds'dry matter per hectare the achene yield decreases by 0,14 q/ha.

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EFFETS DU CONTROL DES ADVENTICES, DE LA DENSITE DE PLANTES, DU NIVEAU DE FERTILISATION AZOTEE ET DE LA DATE DE SEMIS SUR LES PRINCIPALES CARACTERISTIQUES DU RENDEMENTS CHEZ LE TOURNESOL

Vannozzi, G. P., Salera, E. & Baldani, M.

Deux essais ont été conduits au cours des années 1985-1986 à la ferme expérimentale de l'Université de Pisa, ayant pour but la détermination des effets combinés de trois traitments:

- A. une association de deux herbicides (matières actives: Trifluralin + Fluorochloridrine pour la premiére association et Linuron + Alachlore pour la seconde),
- B. deux densités de semis (5 ou 8 plantes au métre carré),
- C. trois niveaux de fertilisation azotée (0, 100 et 200 kg d'azote/ha).

Cette expérimentation a été conduite en sec sur des sols "cotiers", typiques de la Toscane. De plus, ces essais ont été semés a trois dates diffèrentes: date précoce, normale et tardive, avec un délais de quinze jours entre chacune des dates.

Un bon controle des adventices a été obtenu avec les deux associations testées, cependant aucune influence imputable à la densité et à la date de semis n'a été observée sur le niveau de population des adventices. Par contre la prolifération des adventices a ete favorisée par les hauts niveaux de fertilisation azotée.

Il semble que le rendement en grain ait été augmenté par les traitements chimiques; en fait, une augmentation de 1 q/ha de matière séche produite par les adventices a provoqué une diminution de 0,14 q/ha du rendement en grain.

La plus forte densité de plantes (8 plantes par métre carré) et le plus fort niveau de fertilisation azotée (200 kg/ha) ont détermine le plus haut rendement. De même, la meilleure date de semis dans nos conditions environnementales se situe entre la fin mars et le début avril.

EFECTO DEL CONTROL DE MALAS HIERBAS, DENSIDAD DE PLANTAS, NIVEL DE NITROGENO Y FECHA DE SIEMBRA EN ALGUNAS CARACTERISTICAS PRODUCTIVAS DEL GIRASOL

Vannozzi, G. P., Salera, E. & Baldani, M.

Durante los años 1985-86 se llevaron a cabo dos experimentos en la estación experimental del Instituto Agronómico de la Universidad de Pisa, con el objectivo de evaluar los efectos combinados de tres tratamientos: a) Una mezola de dos herbicidas (materia activa: Trifluralin + Fluorocloridrato); B) dos densidades de plantas (5 y 8 plantas por m^2) y C): tres niveles de fertilización nitrogenada (0, 100 y 200 Kg/Ha de N). Los ensayos se llevaron a cabo en secano en un suelo típico de la costa de Toscana. Asi mismo este experimento se hizo en tres épocas de siembra: temprana, normal y tardia, con un intervalo de 15 dias entre ellas.

Se obutvo un buen control de malas hierbas con el tratamiento dado, mientras que no se observó ninguna influencia de las diferentes densidados o épocas de siembra en las malas hierbas, que se hicieron mas patentes con el incremento de la fertilización nitrogenada.

El tratamiento herbicida pareció aumentar el rendimiento en una proporción de 0.14 Q/Ha por cada Q/Ha de materia seca de mala hierba eliminada.

La mayor densidad de plantas (8 p/m^2) y el nivel mas alto de Nitrógeno (200 Kg/Ha)determinó la producción mas alta de aquenios, concluyéndose que la mejor época de siembra en este medio ambiente coincide entre finales de Marzo y principios de Abril.