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EFFECTS OF FEWER WATER APPLICATIONS ON SUNFLOWER (*Helianthus annuus* L.) IN THE SOUTH OF ITALY

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SUMMARY

The research has been carried out at Foggia (Apulian Tavoliere) in the years 1981 and 1982. Its aim was to evaluate the variations brought on by different level of irrigation on the quantitative and qualitative characteristics of the production in sunflower.
Four irrigation treatments based on an increasing number (from 1 to 4) of waterings, an unirrigated control and a treatment kept at high level of available water in the soil (70 % of field water capacity) for the entire cropping cycle have been compared. In the first four treatments the water supplies are to be applied corresponding to the biological stages of the plant.
The achene's yield are in average varied from 1.22 t/ha in not irrigated control, to 3.75 t/ha in treatment that foresaw the greater number of waterings. However, all the yields were much more influenced by the different climate conditions, particularly dryness and heat, of the two years of experiment.

INTRODUCTION

Among the spring-summer cycle crops, the sunflower has become widely grown in recent years even in areas with a hot-dry climate, where it seems to present a valid alternative to the various grain cereals and to sugarbeet.
In order to define one of the most important parameters of adaptability of sunflower in these areas a study has been made on the effects of the progressive limitation of irrigation related to particular stages of its growing cycle.

MATERIALS AND METHODS

The research was carried out in 1981 and 1982, using the sunflower variety "Luciole", sown in the first ten days of April at seeding rate of 5 plants/m^2. The field of experiment is located in a tipical environment (the Apulian "Tavoliere") of Southern Italy, which has a very low rainfall, a high evaporation, and temperatures which in summer season often rise above 40 °C.
The soil is a fine textured of alluvial origin. It has good water retention, with humidity values of 21 and 40 % (at Richard's apparatus) respectively at the conventional tension limits of - 0.03 and - 1.50 MPa.
The most usual cropping techniques used in the area were adopted, except for the irrigation which was different for the six treatments described below, distributed in the experimental field according to a random blocks scheme with three replications:
A) not-irrigated control; B) only 1 watering at the flower budding stage; C) two waterings at flower budding and seed setting stages; D) three waterings at the stages of flower budding, seed setting, and dough maturation; E) four waterings at the stages of 5th-6th leaf, flower budding, seed setting, and dough maturation; F) sub-optimal irrigation realized maintaining a constant level of available water at 70 % of the field's capacity from the plant emergence to the dough maturation stage.

Checking of the soil humidity was carried out at weekly rate, and the irrigation treatments B, C, D, E, brought the soil back to the field water capacity for a layer of 0 - 40 cm.
To having an uniform emergence of the plants, in both of the trial years two waterings were applied at all of the treatments immediately after sowing, with a total volume of 850 m^3/ha.
The two years of experiment were characterized by very scanty rainfall; in fact, during the cropping cycle of sunflower only 73.6 mm of rain were recorded in 1981 and 25.7 mm in 1982, vs. 160 mm of the average for the 1953-80 period (see figure below).

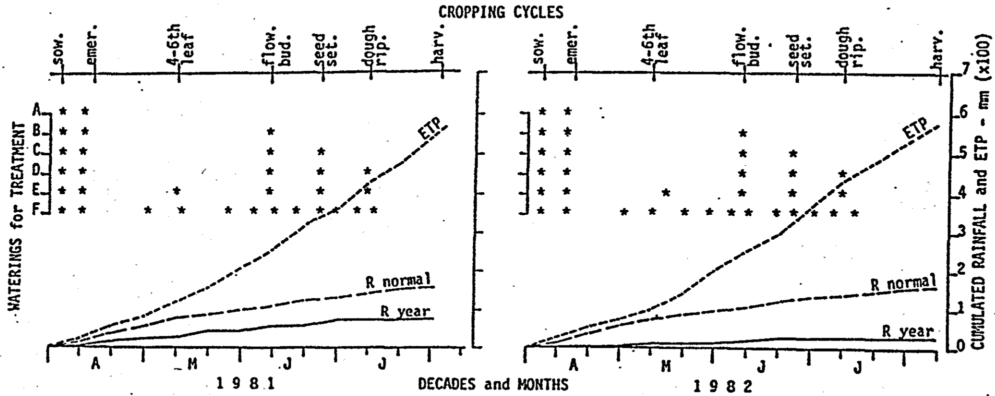

Figure - Time and number of waterings for each treatment during the cropping cycle; cumulated rainfall (R) in the two years and in the period 1953-80, and cumulated evapotranspiration (ETP).

The water deficits of the two years of trial, in comparison with the corresponding potential evapotranspiration (ETP), were respectively -490 and -551 mm. Furthermore, the rainfall was not entirely useful to the plants since only twice in the two years did the rainfall exceed 10 mm daily.
At the same time, temperatures were more or less corresponding to the normel in 1981, but above the normal in 1982, with tops exceeding 40 °C in the end of June.

RESULTS
The seasonal water input and the water efficiency for kg of achene's dry matter are listed in table 1. Water input includes the useful rainfall, i.e. namely all the rains > 10 mm. Treatment A received only the first two waterings applied on all the plots to assuring a uniform emergence. Only tretments E and F received a seasonal water volume close to, or slightly above (1982), the potential evapotranspiration, based on the values of the Class A pan evaporation (Doorenbos and Pruitt, 1977).
In both the years treatment E with six water supplies received more water than F, which was kept with 12-13 waterings at a constant level of 70 % of available water in the soil. Nevertheless, only in 1982 the dry matter yield in the plots E exceed that in F, according to the different irrigation treatments; in other plots, however, the dry matter increased progressively as the volume of water increased. On the contrary, the water efficiency almost always lessened.

Table 1 - Water input (usefull rainfall + irrigation) and number of waterings for treatment; dry matter (D.M.) yield of achenes and corresponding water efficiency.

YIELDS and WATER DATA		1981				1982			
		Water input	Water supply	D.M. yield	Water effic.	Water input	Water supply	D.M. yield	Water effic.
		$m^3\ ha^{-1}$	n.	$kg\ ha^{-1}$	$kg\ m^{-3}$	$m^3\ ha^{-1}$	n.	$kg\ ha^{-1}$	$kg\ m^{-3}$
TREATMENTS	A	1270	2	1239	0.98	850	2	956	1.12
	B	2945	3	2377	0.81	2275	3	1571	0.69
	C	3670	4	2677	0.73	3796	4	2748	0.72
	D	4810	5	2808	0.58	5320	5	3234	0.61
	E	5650	6	3402	0.60	6021	6	3586	0.60
	F	5576	12	3465	0.62	5896	13	3187	0.54

Table 2 shows once again that the increase in achene's yield (at 10 % of humidity) in both years followed the increase of irrigation according to the treatments. On average, the greatest yield differences between two consecutive treatments were recorded between the "A" (1.2 t/ha), irrigated only at sowing stage, and the "B" (2.2 t/ha), irrigated also at flower budding stage, with an increase of 80 %. In these two treatments, furthermore, a greater productive difference occurred also between the two years, due to the smaller water volume applied in 1982.
The oil production varied more or less in corrispondence with the achene's yield, also because the oil percent did not seem to be much influenced by the different irrigation. Treatment E gave better results in both the trial years, with 1.55 and 1.44 t/ha of oil, respectively in the first and second year.

Table 2 - Effects of irrigation treatments on the yield of achenes in sunflower.

TREATMENTS (*)			A	B	C	D	E	F	AVERAGES
YIELDS ($t.ha^{-1}$)	ACHENES	1981	1.38	2.64	2.97	3.12	3.78	3.85	2.96 a
		1982	1.06	1.75	3.05	3.59	3.98	3.54	2.83 a
		Averages	1.22e	2.19d	3.01c	3.36b	3.88a	3.70a	2.89
	SEED OIL	1981	0.51	1.02	1.56	1.27	1.55	1.45	1.16 a
		1982	0.38	0.54	1.05	1.27	1.44	1.17	0.97 b
		Averages	0.44e	0.78d	1.10c	1.27b	1.49a	1.31b	1.07

(*) Means followed by the same letters are not significantly different at the 0.05 level of probability (Duncan's Multiple Range Test).

Also the two biometric characteristics taken into consideration (table 3) showed increases analogous with the yields. The mean diameter of the heads went from 11.5 cm in the plots A to 18.4 cm in the F, an increase of 60 %. The highest of the plants increased from 96 to 151 cm respectively, an increase of 57 %.
It should be noted that the tendencies of these two characteristics moved in opposition each other in the two trial years: the diameter was greater in 1981; the height, on the contrary, was greater in 1982. It would seem, therefore, that the increase in height of the plants came about to detriment of the dimension of the heads, and consequently also of the achene's yield.

Table 3 - Effects of irrigation treatments on two biometric characteristics of sunflower.

TREATMENTS (*)		A	B	C	D	E	F	AVERAGES
HEAD DIAMETER cm	1981	12.3	16.9	17.8	17.3	18.4	20.0	17.1 a
	1982	10.7	12.8	15.5	16.6	17.7	16.8	15.0 b
	Averages	11.5e	14.8d	16.2c	17.0b	18.0a	18.4a	16.0
PLANT HEIGHT cm	1981	99	98	99	97	112	150	109 b
	1982	93	114	117	108	122	152	118 a
	Averages	96d	106c	109c	103c	117b	151a	114

(*) Means followed by the same letters are not significantly different at the 0.05 level of probability (Duncan's Multiple Range Test).

It was also observed that the heights of the plants in the treatment F were much greater than those in E, unlike the results for the other characteristics. This could evidently be attributed to the greater availability of water in the plots F during the cropping cycle.

DISCUSSION

Among the various agronomical practices, the irrigation is the most significant in conditioning the growth and yields of spring-sown crops, especially in regions characterized by scanty summer rainfall.

The sunflower also seems to confirm this assumption. The biometrical and productive differences recorded between the various irrigation treatments of experiment were caused not only by the volume of water received, but also by the number and timing of the water applications. The differences recorded between treatments E and F are of particular significance. These two treatments received almost equal total volume of irrigation, but in the former the water was applied in only six applications (2 at sowing, 2 during growth, and 2 during the riproductive stages); in the latter, a good level of water supply was maintained throughout all cropping cycle with 12-13 water applications.

As a result of the, presumably, better conditions of treatment F, however, the only improved characteristic was the height of the plants, while the oil yield seems to have suffered, and the other characteristics, although varying between the two years, did not on the whole benefit.

The reasonable levels of production given by treatments B and C (2.2 and 3.0 t/ha of achenes), which were irrigated respectively only once, at the time of flower budding, and twice at flower budding and seed setting stages (apart from the two waterings common to all the treatments at sowing time), confirm the good adaptability of sunflower to limited irrigation (Tarantino, 1979; Venezian, 1982).

It should be remembered, however, that the two years had very drought climatic conditions. The negative effects of rainfall deficit (-86 mm in 1981 and -134 mm in 1982) were felt more by the treatments with a low number of water supplies. Long intervals between the waterings also caused large soil crackings, and as a result of this a part of the water used to bring the soil back to the field water capacity for a layer of 0 - 40 cm was in fact lost through deep percolation. This would confirm the hardness of sunflower in drought conditions (Bonciarelli, 1972; Venturi, 1982), also because in both the years many of the waterings were carried out when the humidity in the soil was 16 - 18 % below the theoretical

wilting point of these soils (21 %).
On the whole, therefore, the sunflower has shown very good characteristics of adaptability to the hot-dry environment and to limited irrigation. It resulted, in fact, that a high volume of water, even if assures increase of yield, drastically reduces the water efficiency (from 1.12 to 0.54 g/l of achenes dry matter). These values are very similar to those obtained by other Authors (Puech et al., 1976; Blanchet et al., 1978; Losavio et al., 1980; Costantini, 1985), but below those found for other spring sown crops (maize and sorghum) in the same environment of research (Rizzo et al., 1980; Rizzo and Di Bari, 1985).

CONCLUSIONS

The results obtained in the two years of research have shown that in the trial environment:
- the sunflower has overcome long periods of drought, managing to survive conditions of soil humidity below the wilting point;
- economically viable yields were obtained with a reduced number of waterings and seasonal minimum volumes of 2000 m^3/ha, applied only at sowing and during the flower budding;
- four waterings (besides those at sowing) and seasonal volumes of about 5600 and 5900 m^3/ha, in the first and second year respectively, gave the highest yields of achenes and oil (3.9 and 1.5 t/ha respectively), but also the lowest values of water efficiency;
- applying the same water volumes, the treatments with the higher number of water supplies (12-13) gave more luxuriant plants but yields similar to (achenes) or lower than (oil) those obtained by the treatment with only 6 water applications, and therefore with lower managing costs;
- values of water efficiency were worst than those for other crops studied in the same environment, and decreased with the increase of irrigation, confirming that the sunflower uses poorly higher irrigations.

RESUME

Effects de réduits régimes hydriques sur le Tournesol (Helianthus annuus L.) dans le Sud de l'Italie.

Au cours de deux ans (1981 et 1982), dans la zone du "Tavoliere" des Pouilles, on a développé une recherche pour évaluer les réponses productives à l'irrigation circonscrite à différents phases phenologiques du tournesol (cv. Luciole).
En essai de plein champ, la culture a été soumis à réduit régime hydrique, avec un nombre variable d'arrossages (de 2 à 6), en comparaison avec une thèse non irriguée et un'autre prévoyant un niveau constant d'eau dans le sol pour tout le cycle du tournesol (60-70 % de la capacité au champ).
La production de graines - conditionnée par le climat sec et chaud sourtout dans le 1982 - est augmentée de 1,22 t/ha pour le temoin pas irrigué, jusqu'à 3,75 t/ha pour les thèses plus arrossées.

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