

## PERFORMANCE OF HIGH AND LOW OLEIC ACID HYBRIDS OF SUNFLOWER UNDER DIFFERENT ENVIRONMENTAL CONDITIONS. Note I

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### SUMMARY

The trial was carried out in two years (1992 and 1993) at two different locations in the centre of Italy (Pisa and Grosseto) and the main aim was to evaluate the influence of four different environmental conditions (Pisa, 1992; Grosseto, 1992; Pisa, 1993 and Grosseto, 1993) and the effects of two different water availabilities (without and with irrigation) on six sunflower hybrids: Ares, Cisa, Granada and Oleica, with high oleic acid content, and Gloriasol and Select, conventional hybrids (high linoleic), used as controls. The experimental scheme adopted was a split-block experimental design with five replications. The following characteristics were observed: duration of main phenological periods, plant height, leaf area index at flowering, aboveground biomass and seed yield per plant, harvest index, growing degree-days, water use and water use efficiency.

The water use efficiency for seed yield per plant was highest at Pisa, 1993 under rainfed conditions (1.02 g/l) and at Grosseto, 1993 under both water treatments (1.00 g/l). The irrigation treatments led to an increase of the harvest index in all environments except for the wettest environment (Pisa, 1992). In the four environments examined, the growing degree-days ranged from 789 to 1108°C and from 1612 to 2036°C for the sowing-flowering and sowing-maturity periods, respectively. Seed yield per plant in all high oleic hybrids, with the exception of Ares, were not significantly different from those of Select and Gloriasol in all environments, with the exception of Pisa 1993, which was characterized by a limited water availability during flowering-maturity period, where all high oleic hybrids showed a significant decrease of seed yield per plant.

**Key words:** Sunflower, environmental conditions, water use efficiency, high oleic.

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## INTRODUCTION

Interest in high oleic sunflower hybrids is likely to increase with European farmers, particularly those in Central and Northern Italy, as it is considered to be a non-food crop in set-aside areas but is a source of edible oil, with an excellent quality similar to that of olive oil, rich in monosaturated fatty acids (Fuller *et al.*, 1967; Doty, 1978; Fernandez-Martinez *et al.*, 1993). Standard cultivated sunflower produces a seed oil with levels of oleic acid ranging from 150 to 550 g kg<sup>-1</sup>, depending on environment, especially temperature, during seed development (Miller *et al.*, 1987; Fernandez-Martinez, 1993). In particular elevated temperature caused a marked reduction in the percentage of linoleic acid, due to the effect of temperature on the activity of the desaturase enzymes which are responsible for the conversion of oleic to linoleic acid (Harris *et al.*, 1978).

The first high oleic open pollinated variety "Pervenets" was obtained by Soldatov (1976) and it has become a world-wide source for this trait in modern sunflower hybrids and in breeding programs.

The first high oleic hybrids obtained and marketed by seed companies at the end of 1980's were not really suitable for Italian environments, with a lower yield potential (in terms of seed and oil) than the conventional hybrids, late flowering and maturity and very tall plants (Baldini *et al.*, 1992, Del Pino *et al.*, 1996). Furthermore, much research was focused on genetic control of the high oleic varieties, and developing high-yielding genotypes with high oleic acid contents has become relatively easy to perform, thanks to the low number of genes involved, their dominant nature and the embryo control of the character (Fernandez-Martinez *et al.*, 1989). The success also depends on the possible association of the mutant alleles of oleic (Ol) with some characters related to agronomic performance, particularly leaf area index, total water use, water use efficiency, harvest index, biomass per plant and duration of phenological periods, which are all considered to be very important characters related to the achene yield (Merrien *et al.*, 1981; Rawson and Turner, 1982; Blanchet *et al.*, 1988; Connor and Sadras, 1992; Villalobos *et al.*, 1994). As already reported for other crops (e.g., safflower) the Ol gene responsible for high levels of oleic acid is associated with gene(s) for early flowering (Knowles, 1968); in soybean, stearic acid content is associated with yield and earliness (Lundeen *et al.*, 1987) and in rapeseed, zero erucic lines have lower yields and lower oil contents than their isogenic high erucic lines (Morice, 1974). Data obtained by Fernandez-Martinez *et al.* (1993) for sunflowers indicated that the high oleic acid content was associated with similar or better agronomic performance and although these results were only obtained in one environment and with a restricted genetic background, they contrast with previous information that associated high oleic hybrids with poorer yield potential.

The purpose of this study was to compare the agronomic performance of high oleic sunflower hybrids with respect to conventional hybrids under different envi-

ronmental conditions in Italy, in order to evaluate the suitability of high oleic hybrids and the influence of high oleic content on the main agronomic characters.

## MATERIAL AND METHODS

The research was carried out at the Experimental Center of the University of Pisa, (latitude 43° and 41' North, longitude 10° and 23' East), and at the experimental farm of the Tuscan Agricultural and Forestry Development Board, near Grosseto (latitude 42° and 48' North, longitude 11° and 04' East).

The experimental scheme adopted was a split-block design in five replications. The effects of four different environments (Pisa 1992, Grosseto 1992, Pisa 1993 and Grosseto 1993) and two water managements (with and without irrigation) on the main characters of four high oleic sunflower hybrids (Ares, Cisa, Granada and Oleica) and two conventional hybrids (Gloriasol and Select) were evaluated. The latter hybrids were used as controls due to their high yield potential and stability in the above environments (Vannozzi *et al.*, 1990; Monotti *et al.*, 1995).

Plots were plowed after cereal harvest to a depth of 50 cm. The basal dressing consisted of 100 kg/ha of P<sub>2</sub>O<sub>5</sub> and 80 kg/ha of K<sub>2</sub>O. In addition, 120 kg/ha of N was distributed during seed bed preparation.

Sowing took place on April 15 at Pisa and April 14 at Grosseto in 1992, and on April 21 in both environments in 1993. In 1993, the sowing was repeated on May 27 at Pisa due to adverse climatic conditions during the first sowing. All the experiments were thinned at 2-4 true leaves to the population of 5 plants/m<sup>2</sup>. Each plot consisted of eight rows of plants, 9 m in length and interrow spacing was 50 cm. The irrigated treatments consisted of two irrigations of 50 mm each, the first at the flowering time of the hybrid Select and the second 15 days later.

The irrigated treatments received two irrigations of 50 mm each, the first at the flowering time (F2 phase, as reported by Merrien, 1986) of the earliest hybrid (Select) and the second 15 days later. An appropriate weeds control was done (Salera, 1991).

All observations were carried out on the four central rows of each plot, eliminating the last four plants at each end. Data for the following characteristics were obtained in each environment and from each replication:

- sowing-flowering period (SF): flowering time corresponded to F2 phase (Merrien, 1986) (days);
- flowering-physiological maturity period (FM): physiological-maturity corresponded to M2 phase (Merrien, 1986) (days);
- sowing-physiological maturity period (SM): considered as (SF) + (FM) (days);
- seed yield per plant (SY). Mean grain yield of five consecutive plants for each of the two central rows (g/plant);

- biomass per plant (BY). Above-ground biological dry matter of five consecutive plants for each of the two central rows. After harvesting, the plants were dried at 80°C to constant weight before weighing (g/plant);
- harvest index (HI) obtained as the SY and BY ratio;
- leaf area index (LAI) was computed following the method suggested by Rawson and Turner (1982).
- Growing degree-days (GDD) (°C) was calculated as follows:

$$\text{GDD} = \frac{T_{\max} - T_{\min}}{2} - T_{\text{base}}$$

with 6°C as base temperature in accordance with Merrien (1986);

- the total amount of water used (WU) by the crop during the phenological periods was determined by the water balance method: WU=soil water at sowing + rainfall + irrigation(s) - soil water remaining at flowering or at physiological maturity.

Soil moisture content was monitored at sowing time, at flowering and at the end of the experiment, by gravimetric analysis of the top 1.5 m of soil (by step of 0.3 m). Groundwater levels during the study period were more than 2 m below the soil surface. Drainage and runoff were negligible.

Water use efficiency (WUE) (g/l) was calculated as SY and WU ratio for seed yield and as BY and WU ratio for biomass yield.

For analysis of variance, locations and years were combined and termed environments. All data acquired were submitted to analysis of variance following an ANOVA model in accordance with the experimental design adopted.

## RESULTS AND DISCUSSION

### Growing degree-days

Among environments, the highest GDD requirement for the global crop cycle (SM) was recorded at Pisa in 1993 (Table 1), due to the excessively late sowing time in this environment (May 27). GDD differences among hybrids were due mainly to their differences in lengthening of the biological cycle and to significant interaction with environments. The growing degree-days (GDD) required for the crop to develop the main phenological stages showed significant differences among environments, cultural practices and hybrids, both as regards mean values and interactions (Table 2). A significant increase in GDD required for the SM and FM periods were found in the irrigated treatment as compared with the rainfed crop at Grosseto in 1992 (Table 4). In both cases the increase in GDD (+123°C) was due to a lengthening of the FM period.

### Water use and water use efficiency

Water use (WU) was influenced in all phenological periods analysed by the environments, crop management practices and their interaction (Table 2). Crop WU during the SF, FM and throughout the SM was significantly higher at Pisa 1992 compared to the other environments (Table 1). The similarities between WU values obtained under the two irrigation treatments and, substantially, among environments (with the exception of Pisa 1992) during the SF period, was due to the heavy rainfall during the first stage of the cycle.

Table 1: Mean effects of environments, water managements and hybrids on accumulated growing degree days and water use for the main phenological periods in sunflower hybrids

Treatment	GDD			WU		
	SF	FM	SM	SF	FM	SM
Environments						
Pisa 1992	949 b	973 a	1922 b	230 a	185 a	414 a
Grosseto 1992	829 c	935 b	1765 c	181 b	157 b	338 b
Pisa 1993	1108 a	928 b	2036 a	174 bc	98 d	271 d
Grosseto 1993	789 d	823 c	1612 d	169 c	133 c	302 c
Water management						
Rainfed crop	919	898 b	1817 b	182 b	120 b	300 b
Irrigated crop	919	932 a	1850 a	195 a	171 a	362 a
Hybrids						
Ares	882 d	915 b	1797 d	186	140	326
Cisa	942 b	894 c	1836 bc	186	146	332
Gloriasol	884 d	922 b	1806 cd	185	141	326
Granada	965 a	943 a	1907 a	188	148	336
Oleica	932 b	925 b	1857 b	188	145	333
Select	908 c	891 c	1799 d	185	143	328

Means followed by the same letters do not differ significantly at the 5% probability level according to Duncan's multiple range test.

SF = sowing-flowering period in days; FM = flowering-physiological maturity period in days; SM = sowing-physiological maturity period in days; GDD = growing degree-days in °C; WU = water used by the crop in mm.

The highest WU was likewise found in the irrigation treatment, especially during the FM period, at Grosseto 1992 and 1993 (Table 4); this led to an increase of GY and BY with respect to the rainfed condition in this environment, while on the contrary, the water use efficiency (WUE) resulted unaffected (Table 5). On the contrary at Pisa 1992 and 1993, the irrigation treatments did not lead to an increase of SY and contemporary caused a lower WUE than the rainfed condition (Table 5). This result could be explained by the copious rainfalls during the whole crop cycle in 1992 and by utilization, during the FM phase, of the water reserve accumulated during the vegetative phase in 1993, thanks to the elevated water retention capability of the soil of this area. For this reason in Pisa environment, where water availa-

Table 2: Summary of statistical significance for treatments and interaction effects on phenological, biometrical and productive characters and on accumulated growing degree-days and water use for the main phenological periods in sunflower hybrids

Source of variation	GDD										WU			
	SF	FM	SM	PH	SY	BY	HI	LAI	SF	FM	SM	SF	FM	SM
Environments (E)	**	**	**	**	**	**	**	**	**	**	**	**	**	**
Water management (W)	NS	NS	NS	**	**	**	*	*	NS	*	*	**	**	**
Hybrids (H)	**	**	**	**	**	**	**	**	**	**	**	NS	NS	NS
E x W	NS	NS	NS	NS	**	**	*	*	NS	*	*	**	**	**
E x H	**	**	**	**	**	**	**	**	**	**	**	NS	NS	NS
W x H	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	*	NS	NS	NS
E x W x H	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

\*, \*\* P < 0.01 and 0.05 respectively. NS = not significant, SF = sowing-flowering period in days; FM = flowering-physiological maturity period in days; SM = sowing-physiological maturity period in days; PH = plant height in cm; SY = seed yield per plant in g; BY = above-ground biomass per plant in g; HI = harvest index; LAI = leaf area index; GDD = growing degree-days in °C; WU = water used by the crop in mm

Table 3: Mean values of environments, water management and hybrids on phenological, biometrical and productive characters in sunflower hybrids

Treatment	SF	FM	SM	PH	SY	BY	HI	LAI
Environments								
Pisa 1992	80 a	55 a	136 a	203 a	72.1 a	251.8 a	0.29 d	5.69 a
Grosseto 1992	75 b	53 b	129 b	170 b	54.1 c	149.2 c	0.36 a	4.46 c
Pisa 1993	70 c	50 c	120 c	165 b	50.1 d	153.5 c	0.32 c	4.32 c
Grosseto 1993	69 c	50 c	118 c	132 c	60.2 b	172.2 b	0.34 b	4.75 b
Water management								
Rainfed crop	73	51	125	164 a	56.6 b	176.5 b	0.32 b	4.69 b
Irrigated crop	73	53	126	170 b	61.7 a	186.8 a	0.34 a	4.91 a
Hybrids								
Ares	71 d	52 ab	123 c	137 e	53.2 d	158.0 d	0.34 a	4.39 d
Cisa	75 b	51 b	126 b	177 b	61.2 b	182.8 c	0.34 a	5.38 a
Gloriasol	71 d	53 a	124 c	170 c	60.8 b	187.2 ab	0.33 b	4.68 c
Granada	77 a	52 ab	130 a	163 d	58.6 c	189.1 a	0.31 c	5.12 b
Oleica	74 bc	53 a	127 b	184 a	57.6 c	185.1 bc	0.31 c	4.64 c
Select	73 c	51 b	123 c	173 c	63.5 a	187.7 a	0.34 a	4.62 c

Means followed by the same letters do not differ significantly at the 5% probability level according to Duncan's multiple range test. SF = sowing-flowering period in days; FM = flowering-physiological maturity period in days; SM = sowing-physiological maturity period in days; PH = plant height in cm; SY = seed yield per plant in g; BY = above-ground biomass per plant in g; HI = harvest index; LAI = leaf area index

bility is never too low, the irrigations, especially during the FM period, do not appear useful. In this environment, genotypes with a good vegetative apparatus, deep root and with a medium-late cycle seem most suitable (Merrien *et al.*, 1981). In fact, as obtained in the experiment, the water used, during both SF and FM period, resulted positively related to LAI development (0.66\*\* and 0.60\*\* respectively, data not shown) and to SY (0.58\*\* and 0.73\*\*, respectively, data not shown).

On the contrary at Grosseto, considered an environment more arid with often limited water availability, a moderate vegetative development could be preferable, leading to an improved plant efficiency with a better water use efficiency; character, this latter, positively related to HI (0.49\*\*, data not shown).

### Analyzed characters

Analysis of variance (Table 2) indicated significant differences in the main analysed characters caused by the environments, the hybrids and the irrigation treatments adopted.

The highest values of all phenological periods (Table 3) were found at Pisa 1992, due to the high water availability in this environment. In 1993 at Grosseto and Pisa the duration of all phenological phases resulted significantly reduced with than respect to the previous year (Table 3).

The high oleic hybrids, with the exception of Ares, were later than the conventional hybrids Gloriasol and Select. In particular, a significant longer SF period was shown by Granada in all environments and by Cisa and Oleica at Pisa and Grosseto 1993, as reported in the "environment x hybrids" interaction (Figure 1).

All hybrids strongly reduced the FM period, at Pisa and Grosseto 1993 with respect to the other environments, with the exception of Gloriasol (Figure 2).

The environmental conditions recorded at Pisa 1992 positively influenced SY and BY (72.1 and 251.8 g, respectively), irrespective of irrigation treatments, as reported in the "environment x water management" interaction (Table 5). SY was lowest at Grosseto 1992 under rainfed conditions (49.6 g) and at Pisa 1993 under both rainfed and irrigated conditions (48.9 g and 51.3 g, respectively) (Table 5).

SY values in all high oleic hybrids, with the exclusion of Ares, were not significantly different from those of Select and Gloriasol in all environments, with the exception of Pisa 1993, where all high oleic hybrids showed a significant decrease of SY with respect to the other environments (Figure 3).

The mean HI was highest at Grosseto 1992 (36.4 %) and lowest at Pisa 1992 (28.7%) (Table 3), where unlimited water availability, due to abundant water availability during the first growth of the crop, increased the crop development and resulted in very high plants with a large LAI at flowering (Table 3) and an elevated BY (more than 65.3% of the values recorded at Grosseto 1992).

The irrigation treatments did not let to a significant increase of HI in all environments with the exception of Grosseto 1992 (Table 5).

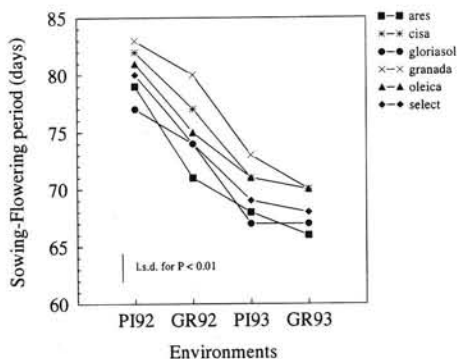


Figure 1: Effect of environment x hybrid interaction on sowing - flowering period.

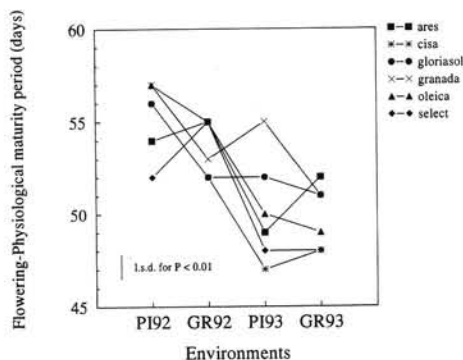


Figure 2: Effect of environment x hybrid interaction on flowering - physiological maturity period.

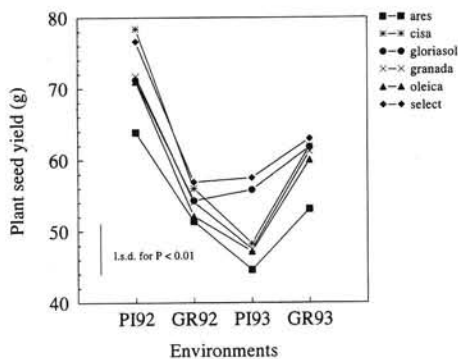


Figure 3: Effect of environment x hybrid interaction on plant seed yield

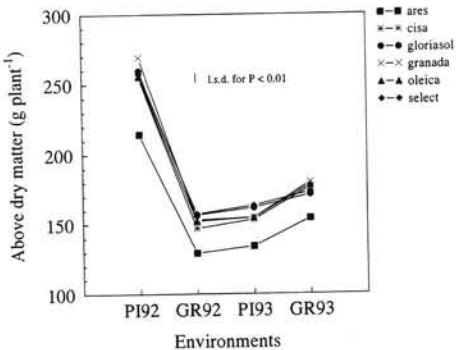


Figure 4: Effect of environment x hybrid interaction on plant dry matter

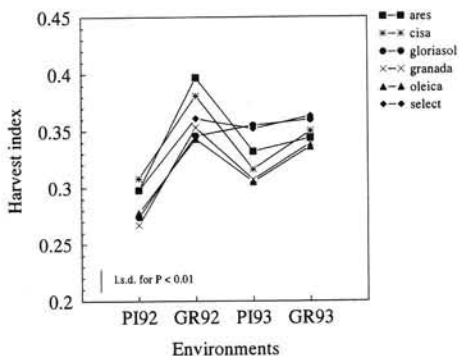


Figure 5: Effect of environment x hybrid interaction on harvest index

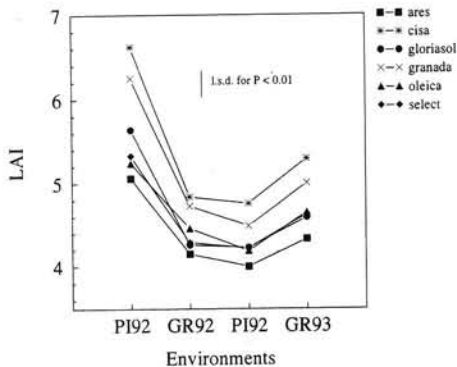


Figure 6: Effect of environment x hybrid interaction on LAI at flowering

Table 4: Effects of "environment x water management" interaction on accumulated growing degree-days and water use for the main phenological periods in sunflower hybrids

Environment	GDD				WU				SM	
	FM	I	R	SM	SF	R	I	FM		
Pisa 1992	973 a	973 a	1922 b	1922 b	203 b	257 a	182 b	188 ab	384 b	444 a
Grosseto 1992	874 c	997 a	1703 d	1826 c	181 c	180 c	121 d	193 a	302 e	373 c
Pisa 1993	928 b	928 b	2036 a	2036 a	173 cd	174 cd	68 f	127 d	241 g	301 e
Grosseto 1993	817 d	829 d	1606 d	1618 d	169 d	168 d	103 e	163 c	272 f	331 d

Means followed by the same letter do not differ significantly at the 5% probability level, according to Duncan's multiple range test.  
 R = rainfed crop; I = irrigated crop.  
 SF = sowing-flowering period in days; FM = flowering-physiological maturity period in days; SM = sowing-physiological maturity period in days; GDD = growing degree-days in °C; WU = water used by the crop in mm.

Table 5: Effect of "environment x water management" interaction on same yield characters and water use efficiency in sunflower hybrids

Environment	SY		BY		HI		LAI		SY		BY	
	R	I	R	I	R	I	R	I	R	I	R	I
Pisa 1992	73.5 a	70.6 a	251.4 a	252.1 a	0.29 d	0.28 d	5.6 b	5.8 a	0.96 ac	0.80 d	3.27 a	2.84 bc
Grosseto 1992	49.6 e	58.7 c	145.8 e	152.5 d	0.34 bc	0.39 a	4.2 e	4.7 c	0.82 cd	0.79 d	2.41 de	2.04 e
Pisa 1993	48.9 e	51.3 de	150.5 d	156.5 c	0.32 c	0.33 c	4.2 e	4.4 d	1.02 a	0.85 bd	3.12 ab	2.60 c
Grosseto 1993	54.0 d	66.3 b	158.2 c	186.2 b	0.34 bc	0.35 b	4.7 c	4.8 c	0.99 ab	1.00 ab	2.91 ac	2.81 bd

Means followed by the same letter do not differ significantly at the 5% probability level, according to Duncan's multiple range test.  
 R = rainfed crop; I = irrigated crop.  
 SY = seed yield per plant in g; BY = above-ground biomass per plant in g; HI = harvest index; LAI = leaf area index; WUE = water use efficiency in g/l.

The hybrids, Select (34.4%) and Ares and Cisa (both high oleic) had the highest HI mean values (34.6 and 33.9% respectively), and in contrast Granada and Oleica (31.6 %) had the lowest (Table 4).

The high oleic hybrids showed a significant lower HI than the conventional hybrids at Pisa 1993 (Figure 5), where, due to the delayed sowing time, the grain-filling period (FM) was very shortened (Table 4). Under these environment conditions, the conventional hybrids showed more efficient plants than the high oleic hybrids, regarding the redistribution of the assimilates, previously accumulated, to the growing seeds.

The LAI recorded at Pisa 1992 was higher than the other environments (Table 3) without significant differences between the two water treatments (5.6 and 5.8 under rainfed and irrigated conditions respectively) (Table 5).

Cisa and Granada had the higher LAI values than the other genotypes in all environments and particularly at Pisa 1992 (6.62 and 6.25 respectively) and Grosseto 1993 (5.29 and 5 respectively) (Figure 6).

## CONCLUSIONS

High oleic and conventional hybrids studied had similar WUE, as already reported for other genotypes under different pedo-climatic conditions (Majid and Schneiter, 1988; Zaffaroni and Schneiter, 1989) confirming the limited genetic variability in the cultivated sunflower for the above character. In contrast, the same character was significantly influenced by the different environmental conditions. In the four environments examined, the growing degree-days ranged from 789 to 1108°C and from 1612 to 2036°C for the SF and SM periods, respectively. These values were strongly influenced by sowing time, in particular at Pisa 1993, where the growing degree-days were the highest in the trial for all phenological periods, due to a delayed sowing time as already observed in previous trials (Baldini *et al.*, 1990).

The high oleic sunflowers examined, with the exception of Ares which, due to its reduced height needs a more appropriate crop management technique (higher density in particular), exhibited a late flowering time, tall plants and large LAI at flowering in environments with unlimited water availability during the whole crop cycle. In these environments, the high oleic hybrids showed a similar seed yield potential to the conventional hybrids. At Pisa 1993 the high oleic hybrids showed their exuberant development due to the adequate water supply during the period between sowing and first anthesis, but when high air temperature during the FM period occurred (Table 3), the high transpiration rate required could not be satisfied. This caused a severe reduction of the FM period (grain-filling period) (Figure 2) and an early ageing of the medium-high leaves, which many authors report as the most active in the assimilate translocation (Merrien, 1986; Merrien, 1992; Masoni *et al.*, 1992) causing a lower assimilates redistribution efficiency in high oleic plants and consequently a reduced seed yield. In conclusion, the high oleic hybrids are comparable, in terms of seed yield per plant, with the conventional hybrids in favourable

environments in the center of Italy. However, in the environments characterized by water stress during the post-flowering period, (very usual in many Italian sunflower growing areas), genotypes more tolerant to limited water availability and with a shorter sowing-flowering period, would be more suitable (Monotti *et al.*, 1992). Breeding efforts in the future should be focused on the development of high oleic hybrids with higher variability in the duration of the crop cycle and more tolerant to water stress in order to exploit different Italian environments for sunflower cultivation.

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## COMPORTAMIENTO DE HÍBRIDOS DE GIRASOL CON ÁCIDO OLÉICO ALTO Y BAJO EN DISTINTAS CONDICIONES AMBIENTALES. NOTA I

### RESUMEN

Se llevó a cabo este ensayo a lo largo de dos años (1992. y 1993.) y en dos ubicaciones distintas en el centro de Italia (Pisa y Grosseto) y el objetivo principal fue el de evaluar la influencia de cuatro condiciones ambientales distintas (Pisa, 1992.; Grosseto, 1992.; Pisa, 1993.; Grosseto, 1993.) y los efectos de dos disponibilidades de agua diferentes (con o sin riego) en seis híbridos de girasol: Ares, Cisa, Granada y Oleica, con un alto contenido oléico, y Gloriasol y Select, híbridos convencionales (linoléico alto), utilizados como controles. Se adoptó un esquema consistiendo en un diseño experimental de bloques divididos con cinco repeticiones. Se evaluaron en las siguientes características: la duración de los principales períodos fenológicos, la altura de la planta, índice de la superficie de la hoja durante la floración, biomasa aérea y producción de semillas por planta, índice de cosecha de las plantas, integral térmica utilización del agua y la eficacia en el uso del agua.

La eficiencia del uso de agua para la producción de semillas por planta ocurrió en Pisa, 1993., en condiciones de riego por precipitaciones ( $1,02 \text{ g l}^{-1}$ ) y en Grosseto, 1993., con ambos tratamientos de agua ( $1,00 \text{ g l}^{-1}$ ). Los tratamientos de riego produjeron un aumento del índice de cosecha de las plantas en todos los ambientes salvo en el más húmedo (Pisa, 1992.). En los cuatro ambientes investigados la integral térmica osciló desde  $789$  a  $1108^{\circ}\text{C}$  y de  $1612$  a  $2036^{\circ}\text{C}$  para los períodos sembrado-floración y siembra-madurez, respectivamente. La producción de semillas por planta en todos los híbridos con un alto contenido oléico, con la exclusión de Ares, no fue significativamente diferente de la de Select y Gloriasol en todos los ambientes, con la excepción de Pisa 1993., caracterizado por una disponibilidad limitada de agua durante el período floración-madurez, donde todos los híbridos con un alto contenido oléico mostraron una disminución significativa de la producción de semillas por planta.

**PERFORMANCE D'HYBRIDES DE TOURNESOL À FORTE  
OU À FAIBLE TENEUR EN ACIDE OLÉIQUE, SOUS  
DIFFÉRENTES CONDITIONS DE MILIEU. NOTE I**

## RÉSUMÉ

L'expérimentation a été réalisée sur deux années (1992. et 1993.) en deux lieux au centre de l'Italie (Pise et Grosseto), l'objectif principal étant d'évaluer l'influence de 4 conditions de milieu (Pise, 1992.; Grosseto, 1992.; Pise, 1993. et Grosseto, 1993.) ainsi que les effets de deux régimes de disponibilité en eau (avec et sans irrigation) sur six hybrides de tournesol: Ares, Cisa, Granada et Oleica à teneur élevée en acide oléique et sur Gloriasol et Select, hybrides classiques (riches en acide linoléique), utilisés comme témoins. Le dispositif expérimental utilisé consiste en un split-plot à 5 répétitions. Les caractéristiques suivantes ont été observées: durée des principales phases phénologiques, taille de la plante, indice de surface foliaire, biomasse aérienne, production de grains par plante, indice de récolte, degrés-jour, consommation d'eau et efficacité de l'utilisation de l'eau.

L'efficacité de l'utilisation de l'eau pour le rendement en grains par plante était plus élevée à Pise, en conditions pluviales ( $1.02 \text{ g l}^{-1}$ ) et à Grosseto, 1993, sous les deux régimes hydriques ( $1.00 \text{ g l}^{-1}$ ). Les traitements irrigués conduisent à un accroissement de l'indice de récolte dans tous les milieux à l'exception du milieu le plus humide (Pise, 1992.). Parmi les 4 milieux étudiés, le nombre de degrés-jour en phase de végétation était compris entre 789 et  $1108^{\circ}\text{C}$  et entre 1612 et  $2036^{\circ}\text{C}$  respectivement pour les phase de semis-floraison et de semis-maturité. Le rendement en grains par plante chez tous les hybrides oléiques, à l'exception d'Ares, n'était pas différent de celui de Select et Gloriasol quel que soit le milieu, à l'exception de Pise, 1993. caractérisé par une disponibilité hydrique limitée durant la phase de floraison-maturité, où les hybrides oléiques ont montré une baisse significative du rendement en grains par plante.

