Effects of winter sowing on sunflower yield, oil and plant characteristics in Southern Italy

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Abstract

Winter sowing of sunflower is considered a mean to escape summer drought and/or to reduce irrigation requirement in water-limited environments. In a trial carried out in 1991/92 at Foggia (Southern Italy), the influences of climatic behaviour on yield of sunflower in relation with sowing time and hybrids were analysed.

Eleven sowing times (from 28 October to 3 April, with twenty-day intervals) and five cultivars were arranged in a split-plot field design with 3 blocks. Two supplemental irrigations, each of 50 mm of water, were applied, while 250-400 mm are normally used with spring sowing. The climate is a mesomediterranean accentuated with hot and dry summer and temperate winter; the soil is a cromic vertisol, silty-clay (Typic Chromoxerert).

Number of days, growing degree days, heat units, photothermal units and mean temperature of phenological phases were calculated. Sowing-Emergence (E) and E-V6 (6th leaf) phases length resulted the most variable. Diameter head, seed weight, seed nitrogen content were positively correlated with average temperature of R4-R9 period, negatively oil content.

The main results regard sowing dates (SD) showed that 2-3 days with frost and cold wind during E-V2 period, killed the little plants in the earlier time of sowing (28 October and 12 November). The SD3, SD4 and SD5 (8 December to 9 January) gave very much yield (3.8 t ha^{-1} of achenes) as for as the SD10 and SD11; the intermediate times, instead, yielded less (2.5 t ha^{-1}). Among the cultivars, Euroflor and Pulsar yielded more. Seed oil content (%) resulted highest in the earlier sowing times probably for the low temperature in seed ripening, while seed nitrogen content gave opposite results.

Winter sowing resulted a good mean to reduce water requirement in sunflower and to increase achenes and oil yield, but cold resistant genotypes yet need.

Key words: *Helianthus annuus* L., winter seeding, phenological phases, yield.

Introduction

Sunflower (*Helianthus annuus* L.) is a macroterm specie, grown in warm environments during spring-summer seasons (Monotti, 1980). It has a base temperature of 5-7 °C, an optimal temperature of 15 °C for germination, 18-20 °C for flowering (Benvenuti *et al.*, 1978) and 18-22 °C for seed formation and repening (Vranceanu, 1974). It shows frost damages below 0 °C.

Seed germination, however, at 8-10 °C yet occurs (Bonciarelli, 1972) and in Southern Italy environments planting date of sunflower normally is from the second decade of March to the half of July (in this case is grown as catch crop after a winter crop).

Early planting (February) or, where the climate allow it, a winter sowing (November-December) can be carried out only with high cold-resistant hybrids.

temperatures followed seasonal values except in August (+ 4 °C) and April (+ 2 °C). About rainfall 357 mm of total water were recorded from November to August respect to 450 of "long term" average: more rainy were April and June, while more drought were February and August (Fig. 1).

Results

The results of the first (28 October) and the second (12 November) planting date are not reported because of the frost (low temperatures and northern cold wind) at the end of December which killed a great part of young plants at V2-V4 stage (2nd-4th leaf). Moreover, the sixth sowing date (24 January) for a delay in the net covering was completely eaten by birds.

The achenes yield of 8 remaining sowing dates (SD) were analysed: sowing date and hybrids effects come out highly significant in all the variables examined and, therefore, only main effects are reported in table 1.

The SD3, SD4 and SD5 showed a good productivity (3.75 t ha^{-1} in average) at same level of SD10 and SD11 (3.9 t ha^{-1}), sowing dates normally used in the trial environment, while significantly less productive resulted the SD7, SD8 and SD9 (2.48 t ha^{-1} in average).

Examining the production components, a great influence of number of calatides per square meter on yield (r = 0.92 ***) come out, and, inversely on the 1000 seed weight (r = - 0.9 ***).

The head diameter was influenced by plant population (r = - 0.89 ***) while sterile zone in SD11 gave the worst result probably for the severe water stress during flowering and seed repening periods (July). Except for some minor variations, seed oil concentration generally declined with planting delay because of a lower temperature during seed repening (mean temperature (TM) of R6-PM phase vs. oil content, r = - 0.72 ***).

The seed fibre content resulted higher in the last two sowing dates: this parameter resulted significantly correlated to TM (r = 0.5 **) and P (r = - 0.55 **) in the reproductive phase.

Euroflor and Pulsar yielded more than the others with the greater number of plants, while Femme showed the lowest oil content.

The influence of planting time on length of sunflower growth stages is shown in figure 2. Planting time had a major effect on the length of S-E and E-R2 stages, and relatively minor effect on the other periods, as in other researches (Unger, 1986). In particular, the S-E period ranged from 15 (SD11 and SD3) to 41 (SD7 and SD8) days and among hybrids Euroflor and Pulsar reduced this period of 5-6 days, in average. The phase E-R2, characterized by leaves formation, ranged from 122 (SD3) to 46 (SD9 and SD11) days.

Considering the length in terms of GDD, the variability among sowing dates is lower (Robinson, 1971) and, in average, 150 GDD occur to reach emergence, 750 for the E-R2 period and 2000 GDD for physiological maturity.

The importance of quickness of emergence and the first growth phases on percentage of plant survival come out by the significant correlations among number of days of E-R2 phase and plant population (r=0.68 ***) in relation to a greater risk of pest damages.

The early sowing permits the sunflower plants to use, thanks to their deep roots, soil water reserve, accumulated by winter rains and therefore to better resist the summer dryness. In this trial we have obtained a reduction of water requirement, using 100 mm of water only, respect to 250-400 mm, normally used.

On the other hand, the risk of frost is high in winter sowing and it can completely kill the crop. An analysis of probability (using daily data from 1951 to 1990) to have in a decade same days with minimum temperature below 0 °C has been carried out. The figure 3 shows, in fact, that in the trial environment the frost risk is particularly high in January and in the first decade of February.

Conclusions

The shortness of the experiment do not permit to take out any definitive conclusion. In general we have reported the possibility to increase yield and oil content of sunflower using winter seeding, or at least, to reduce irrigation water requirement.

In planting date choice, the environmental frost occurrence togheter with hybrid cold resistance must to be evaluated. Moreover genetic improvements to obtain more resistant hybrids to low temperatures are hoped.

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Tab. 1 - Main quantitative and qualitative characteristics of sunflower achenes, separatly for the main effects.

	Grain yield ($t\ ha^{-1}$ at 10% moisture)	n. of calatides m^{-2}	1000 seed weight (g)	Head diameter (cm)	Sterile zone diameter (cm)	Seed fibre content (%)	Seed oil content (%)
Sowing dates							
SD3 - 28 November	3.55 AB	3.35 A	68.53 B	20.81 C	1.46 CDE	2.07 B	56.65AB
SD4 - 20 December	3.95 A	3.87 A	63.29 B	19.69 C	0.92 E	2.36 B	58.34 A
SD5 - 9 January	3.74 AB	3.24 A	68.69 B	22.88 ABC	1.14 DE	2.07 B	56.22 ABC
SD7 - 8 Febrary	2.58 BC	1.52 B	91.82 A	26.38 AB	2.19 BCD	2.69 B	54.96 BC
SD8 - 23 "	2.63 BC	1.53 B	91.16 A	26.11 AB	2.20 BCD	2.60 B	53.51 DC
SD9 - 10 March	2.24 C	1.27 B	91.61 A	26.8 A	2.41 BC	3.03 B	51.15 D
SD10 - 24 "	4.18 A	3.52 A	64.19 B	21.78 BC	3.23 B	5.89 A	52.07 D
SD11 - 8 April	3.63 AB	3.13 A	61.29 B	22.89 ABC	4.18 A	5.44 A	51.75 D
Hybrids							
PULSAR	3.85 A	3.27 A	72.63 B	22.64 B	2.05 B	3.81 AB	54.47 A
VIP	3.20 B	2.56 B	75.61 B	24.33 A	2.84 A	2.63 B	55.00 A
FLORIDA 2000	2.61 C	1.91 C	81.27 A	24.57 A	2.74 A	3.07 AB	54.76 A
EUROFLOR	3.97 A	3.27 A	73.24 B	22.87 B	2.40 AB	2.92 AB	54.90 A
FEMME	3.00 B	2.42 B	72.45 B	22.82 B	1.15 C	4.13 A	52.26 B

Means followed by different letters are significantly different at $P>0.05$ level of probability (Student-Newman-Keuls test).

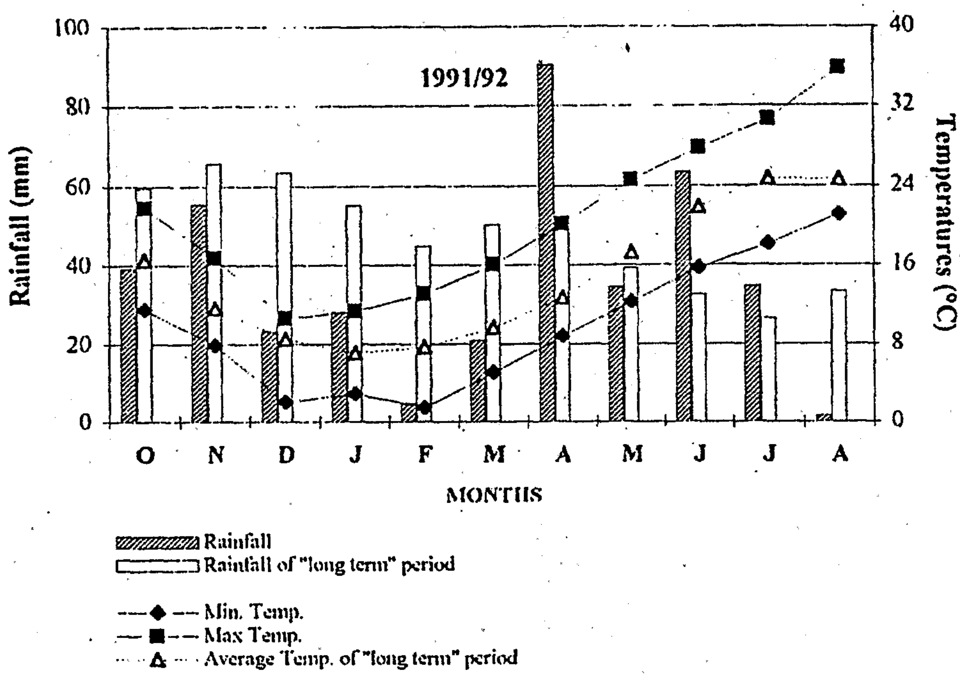

Fig. 1 - Climatic behaviour at Foggia in 1991/92.

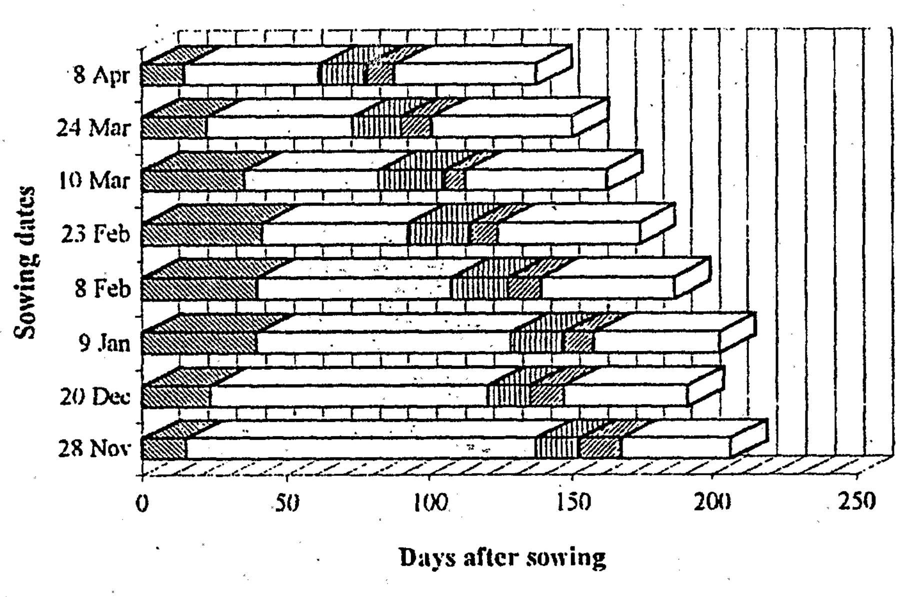

Fig. 2 - Days after sowing of main phenological phases in sunflower planting dates. S= Sowing; E= Emergence; R2= Visible flower bud; R5= Beginning of flowering; R6= End of flowering; PM= Physiological maturity.

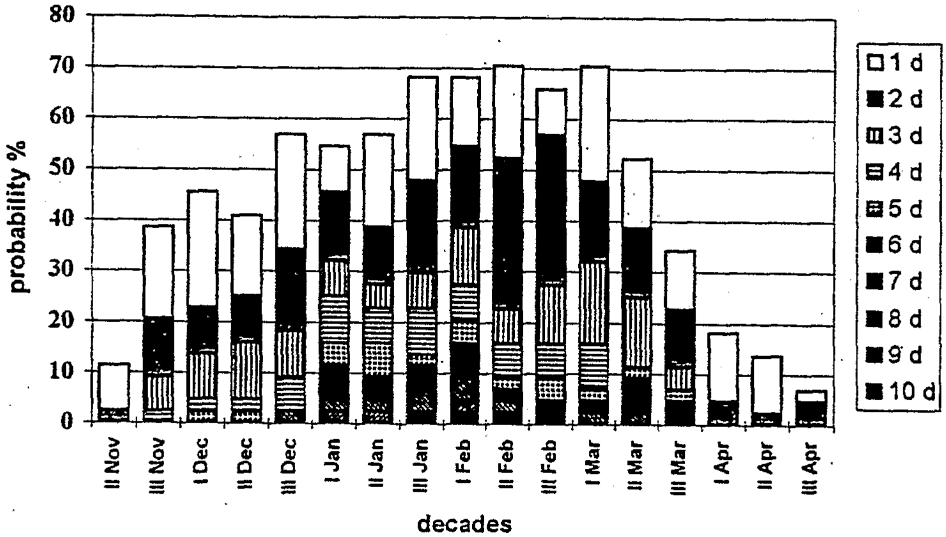

Fig. 3 - Cumulated probability that a number of days with minimum temperature below 0 °C occours in a decade at Foggia.