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GROWTH ANALYSIS OF SUNFLOWER (Helianthus annuus L.) IN TWO-YEAR ROTATIONS (*)

RINALDI M., VONELLA A.V., SANTAMARIA P., VENTRELLA D., RIZZO V.
Istituto Sperimentale Agronomico, C. Ulpiani 5, 70125 Bari, Italy

SUMMARY

This research is part of a long-term comparative study of two-year rotations carried out in Foggia (Southern Italy) within a joint project on "Cropping Systems" supported by the Italian Ministry of Agriculture.

The growth analysis was performed for two years on sunflower in rotation with durum wheat, followed or not by soybean as catch crop. Both rotations were submitted to two agrotechnical input levels.

The dry matter accumulation, leaf area index, crop growth rate, net assimilation rate and relative growth rate were assessed.

The analysis of the above parameters showed significant differences of "Rotation" effect, and no significant differences of "Input level" and "Rot. x Input" effects. Sunflower in rotation with catch soybean gave the best results in terms of seed yield.

INTRODUCTION

Sunflower cropping has greatly developed over the last years in Central-Southern Italy, where it gave experimental results of great interest (Giordano et al. 1991). However, under the generally dry conditions of Southern Italy, the limited water supply can cause a sudden drop of seed yield in sunflower, because of the reduced photosynthetizing surface, the low photosynthetic rate and the subsequent reduced dry matter accumulation (Losavio et al., 1985).

The growth analysis studies the yield physiological bases in order to detect the mechanisms of the environment and agronomic factors which determine restrantis to yield processes (Gregory, 1926; Danuso et al., 1985).

This note reports the trend of primary parameters (LAI and DM) and of derived growth indices (CGR, NAR, RGR) of sunflower in 2 two-year rotations: sunflower-durum wheat, with and without catch soybean.

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MATERIALS AND METHODS

The research was carried on in Foggia (Apulian Tavoliere) in 1989 and 1990 on irrigated sunflower in 2 two-year rotations with wheat - with and without the catch crop (soybean) - submitted to two input levels. Both rotations were part of a larger experimental study on "cropping systems" (Lanza, 1988) within a joint project of the Ministry of Agriculture and Forestry, which is still in progress.

In both years, the sunflower hybrid "Romsun HS 90" was sown at early April with a population density of 6 plants per m^2 and by rows 50 cm apart. Further information on the trial and the cropping technique were reported by Rinaldi et al. (1992).

Every week, from 8th leaf to the wax-ripe stage, two plants were taken from each plot unit and the number of leaves, stem height, head diameter, leaf area (by the LICOOR 3000 area meter) and the above-ground dry matter (after oven drying at 80 °C) were measured. Based on those values, growth indices were calculated by the "classical" method (Abbate e Tuttobene, 1982).

At commercial ripening, heads were harvested from a test area where no sampling had been carried.

CLIMATE

Figure 1 shows the decadal values of maximum and minimum temperature, rainfall and evaporation rate from class A pan.

1989 was characterized by a dry period (40 mm effective rainfall from March till May), followed by frequent rainfall events (73 mm) in June. Compared to the "standard" of the 40 past years, the mean temperature was higher in April (+1.2 °C) and lower in June (-1.4 °C). On the other hand, the evaporation from class A pan was within the standard limits.

In 1990 rainfall was far lower than the "standard"; except the mid-April rainfall event (about 40 mm), "effective rainfall" (> 10 mm) amounted to 56 mm only. Similarly, evaporation was very high (about 12 mm d^{-1} in July).

Temperatures followed the mean values.

RESULTS

In both years, the dry matter (DM) and the leaf area index (LAI) of sunflower were higher in the S-W+Sb rotation rather than in the S-W rotation (Figs 2a and 2b).

The difference in DM accumulation between the two rotations, in 1990, increased through the plant growing season and was maximum (351 g m^{-2}) at late flowering (79 days from emergence) (Fig.

2b). The above DM trend is similar to the one observed for the head diameter which had the highest value at milk ripeness (21.4 and 20.4 cm in 1989 and 17.6 and 15.3 cm in 1990, respectively for S-W+Sb and S-W) when the plant had already formed the maximum DM.

The LAI showed, in both years, the highest value at head opening stage days from emergence) when the maximum difference between the two tested ri tions was observed. The sunflower LAI was, on the average, 6 in the S-W+Sb tation and 4.6 in the S-W rotation. During the reproductive stage sunflow reduced the green leaf area expansion notably the second year when, due t low rainfall events, the LAI was on the average 2.1 at wax-ripe stage (86 from emergence).

The above LAI behaviour is somewhat related to the one observed for the total number of leaves and for the number of photosynthetizing leaves during the reproductive stage (Fig. 2c).

The daily dry matter growth rate (CGR), although quite high, showed an increasing trend till the milk ripeness of seeds, followed by a decrease (Fig. 3a).

The maximum mean CGR of the two years was 36.2 g m^{-2} d^{-1}, 79 days from emergence; however, significant differences were observed although maximum values were similar. Lower CGR values were found in 1989 compared to 1990 during the early growth stages (till 52 days from emergence) and at flowering (66 to 73 days from emergence) as a result of the stunted crop establishment (caused by the dry spring) and the mean temperature reduction in June, below the optimal level for sunflower growth (Pirani, 1981).

On the other hand, in 1990, the trend was more regular, except the sharp drop recorded at the last sampling, as a consequence of the high evaporative demand of the atmosphere (330 mm evaporation rate in July) and of the sudden LAI reduction.

A sharper CGR differentiation was observed the second year between the two rotations under comparison, with higher values in the one with the second soybean crop.

The relative growth rate (RGR), which is not reported in the figure, showed a general decreasing evolution from the first to the last interval, with mean values ranging between 0.21 and 0.01 g g^{-1} d^{-1} in 1989 and 0.15 and 0 g g^{-1} d^{-1} in 1990.

Also the net assimilation rate (NAR) showed in general a decreasing trend (Fig. 3b). The figure shows clearly the sharp drop of 1989 values in the initial growth stage whereas in 1990 this occurred in the late season because of the above reasons. Moreover, in 1989 a higher photosynthetic efficiency was observed for sunflower in the S-W rotation than in the other one.

In terms of yield, the seed yield (at 10% moisture) was in both years significantly higher in the S-W+Sb rotation than in the S-W (3.8 against 3.37 t ha^{-1} in 1989 and 3.0 against 2.52 t ha^{-1} in 1990) (Rinaldi, l.c.).

CONCLUSIONS

The introduction of catch soybean in the two-year rotation S-W resulted in a higher photosynthetic leaf area and dry matter of sunflower compared to the same crop in a simple rotation. This laid the bases for a higher yield potential of sunflower which was also reflected by a higher head diameter and seed yield per unit area.

The favourable effect of catch soybean on the following sunflower is due, maybe, to the improved soil physical properties which also determined a higher soil moisture.

None of the derived indices (CGR, NAR and RGR) provided better results than sunflower growing primary parameters (LAI and DM). The CGR, however, showed a marked sensitivity of sunflower to environmental factor variations.

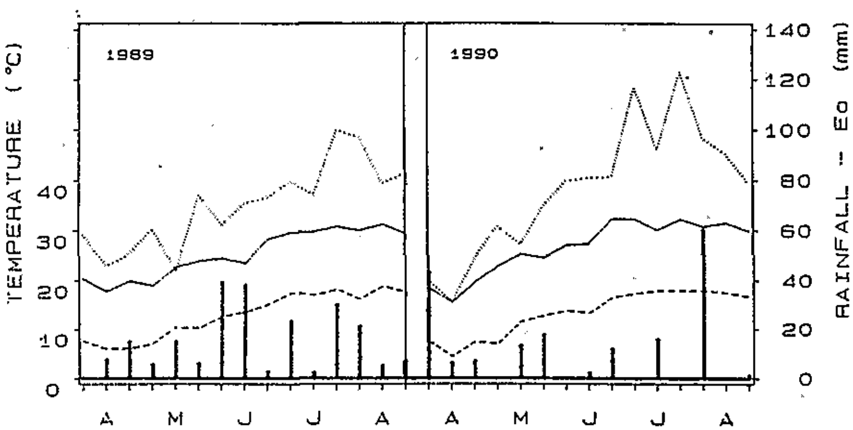

Figure 1 - Mean decadal values of maximum (————) and minimum (--------) temperature, cumulative evaporation from class A pan (·········) and rainfall (|).

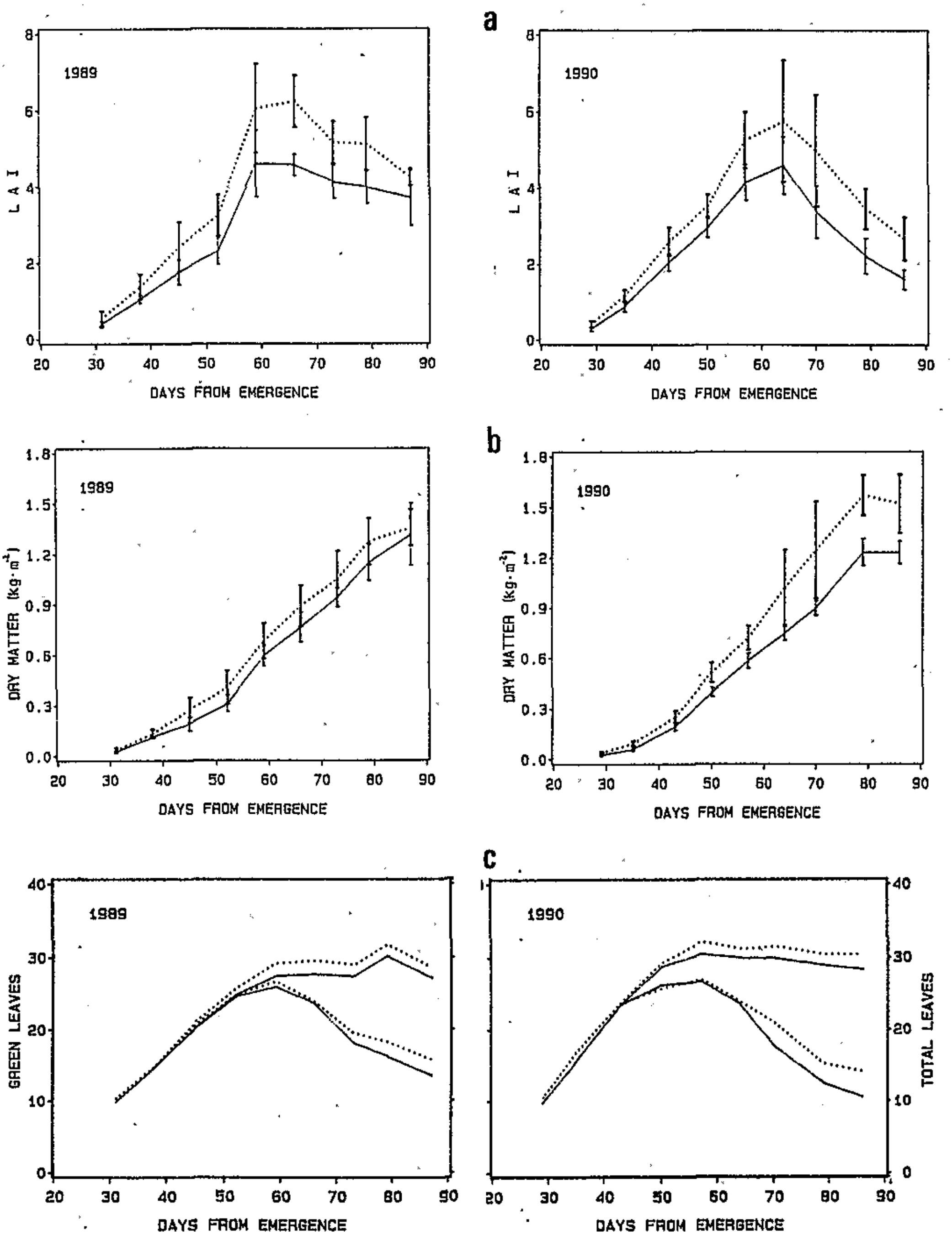

Figure 2 - Sunflower leaf area index (a), dry matter (b) and green and total leaves (c) in sunflower - wheat (———) and sunflower - wheat + soybean (-------) rotations. The vertical lines represent standard error (±2).

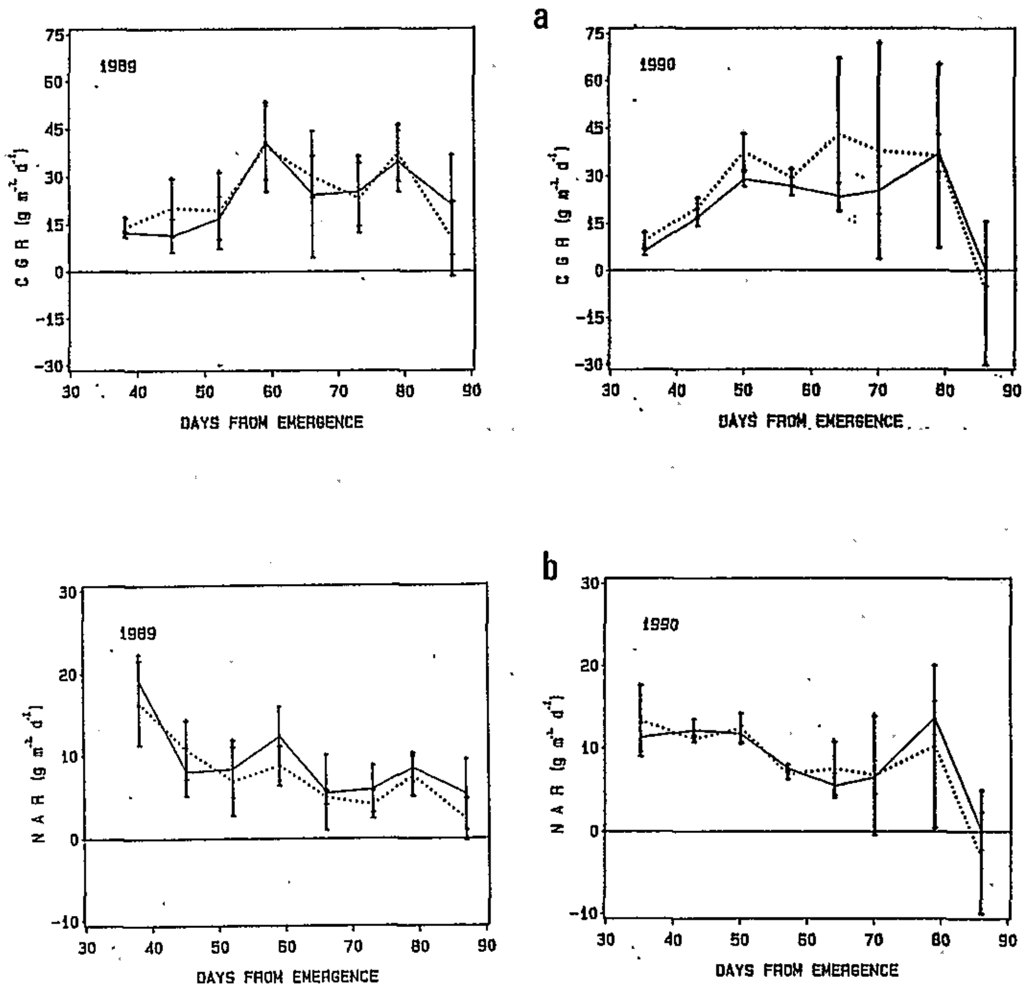

Figure 3 - Sunflower crop growth rate (a) and net assimilation rate (b) in sunflower - wheat (————) and sunflower - wheat + soybean (--------) rotations. The vertical lines represent standard error (±2).

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