Co_2 balance of sunflower subjected to moisture stress during grain filling

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The CO_2 balance of a crop represents the net of assimilatory gains and respiratory losses. This study contrasts the CO_2 balance of a well-watered sunflower crop with one subjected to moisture stress during grain filling.

Methods

Six plots, sown at the Institute for Irrigation and Salinity Research in November, 1985, were irrigated at weekly intervals beginning 45 days after sowing (DAS 45). Irrigation was maintained until maturity in three plots (treatment I) and discontinued at DAS 80 in the others (treatment D). Net CO_2 exchange over 24 hours (P_N) and night respiration were measured in two plots of each treatment using the assimilation chambers described by Connor et al (1). Chambers were deployed for five days each week beginning at DAS 48. Gross daily CO_2 assimilation (PG) was estimated on the basis that rates of respiration measured at night were maintained during daylight.

Indirect estimates of head respiration were made on several occasions by comparing the rates of exchange of intact and decapitated crops in blacked-out chambers.

Results and discussion

Leaf area index (LAI) increased from 1.2 at DAS 48 to a maximum of 2.5 at anthesis on DAS 72. It then decreased to approximately 0.5 at DAS 112 in treatment I. These changes were associated with an increase in P_N from approximately 35 g CO_2 m^{-2} day^{-1} to 55 g CO_2 m^{-2} day^{-1} at anthesis and a subsequent decrease leading to negative rates of exchange after DAS 108.

The major effects of withdrawing irrigation were an enhanced, rapid decrease in LAI between DAS 87 and DAS 94, and an associated marked decrease in PN. The mean difference in LAI of treatments I and D between DAS 91 and 105 was 0.6 and the difference in P_N was 18 g CO2 $_m{}^{-2}$ day^{-1} (s.e. = 5.4 g CO_2 m-2 day-1). P_n treatment D was negative during this period.

Despite these changes, there were only small effects of treatment on respiration, which increased from 8 g CO2 $_m{}^{-2}$ day^{-1} to a maximum of 14 g CO2 m^{-2} day^{-1} as late as DAS 91. The mean difference between treatments between DAS 91 and 105 was only 1.4 g CO_2 m^{-2} day^{-1} (s.e. = 0.6 g CO_2 m^{-2} day^{-1}). Thus, greater respiratory loads were imposed on rapidly declining rates of assimilation, particularly in treatment D.

On a cumulative basis, net gains after anthesis were 0.74 and 0.44 kg CO_2 m^{-2} day^{-1} in treatments I and D, respectively. By comparison, the net gain was 1.42 kg CO_2 m^{-2} between DAS 45 and anthesis. Whereas respiration accounted for 10% of PG before anthesis, this increased to 67% and 58% in treatments D and I, respectively, during grain filling. However, total losses were greater in treatment I.

Indirect estimates of head respiration showed that the seed and capitulum accounted for at least two-thirds of the total respiratory load after DAS 86. Collectively, the data show that respiration of the head, in particular, comprises a major component of the CO_2 balance of sunflower if a large potential sink has been established at anthesis.

1. Connor,D.J., Palta, J.A., and Jones, T.R. 1985. Field Crops Res. 12:281.