TEMPERATURE EFFECTS AT FLOWERING ON PHOTOSYNTHESIS AND YIELD OF WINTER OILSEED RAPE

A.M. TRIBOI-BLONDEL, A. LARDON

Station d'Agronomie-INRA, 12 Avenue du Brézet
63039 Clermont-Ferrand (France)

ABSTRACT

A cold treatment (5°C instead of 18°C) at flowering affects essentially the duration of flowering : each flower needs 3 degree-days to be opened. The net photosynthetic rate and the daily Carbon assimilation of the canopies slightly decrease (by 10%) with cold treatment, but the total assimilate production during flowering is higher at low temperature because of a larger duration of flowering. However, yield seems to be determined at anthesis and is not affected by temperature.

INTRODUCTION

Various stresses during flowering may interfere with plant productivity. Our objective was to quantify the effects of the climate, and more particularly in this study, of a low temperature during flowering, on dynamics of flower development, photosynthesis and plant productivity.

MATERIAL AND METHODS

The plants (winter rapeseed, cultivar Samouraï) were grown from sowing to anthesis, in $2m^2$ containers, into natural conditions. During flowering, the containers were introduced in closed tunnels (1), with controlled day/night temperature conditions 21/14°C (T1=control) or 6/1°C (T2=cold). The net photosynthetic rate and the dark respiration (μg C-CO_2 $m^{-2}s^{-1}$) were determined under natural light, by measuring the quantity of CO_2 injected (day) or ejected (night) to keep the CO_2 concentration at a set-point level. We estimated the net photosynthetic rate (μg C-CO_2 m^{-2} s^{-1}) at a given irradiance to compare the 2 treatments and the dynamics of daily and cumulative Carbon balance of the 2 canopies.

The number of newly opened flowers was examined 3 times weekly from the main raceme of 20 plants selected at random, on each temperature treatment. At maturity, plants were harvested. Number of pods, seeds per pod, individual seed dry weight, and yield per plant were determined.

RESULTS AND DISCUSSION

Flower development

From the data of Figures 1 & 2, it is clear that the total flowering duration was 21 days (T1) or 53 days (T2) with about the same total flower numbers for the 2 contrasted temperatures. Each flower needs 3 degree-days to be opened : about 6 (T1) or 2 (T2) new flowers opened each day.

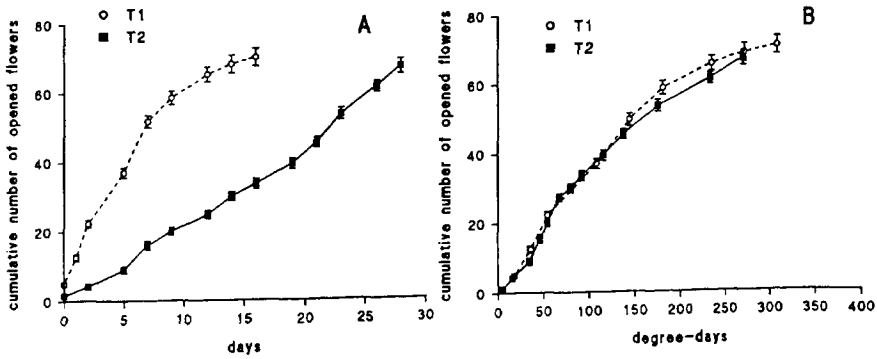

Fig 1 - Flowering kinetics of the main raceme for the control (T1) and the cold treatment (T2). A : Cumulative Number of opened flowers per day. B : per degree-days. Each point is the mean value for 20 plants. 95 Percent Confidence intervals for means are shown.

Photosynthesis of the canopies

The Net Photosynthetic Rate (NPR) at a given irradiance (100, 300 or 500 W m^{-2}) was almost constant during flowering and we did not observe the previously described decline in NPR (2). The mean values of NPR T2/T1 were respectively 1.16, 0.91 and 0.93 at 100, 300 and 500 W m^{-2}.

In cold conditions (T2), the daily Carbon Assimilation (Fig 2), was about 90% of the control (T1) and the Cumulative Carbon balance at the end of flowering is higher for T2 : more than 400 gC (CO_2) m^{-2} instead of 190.

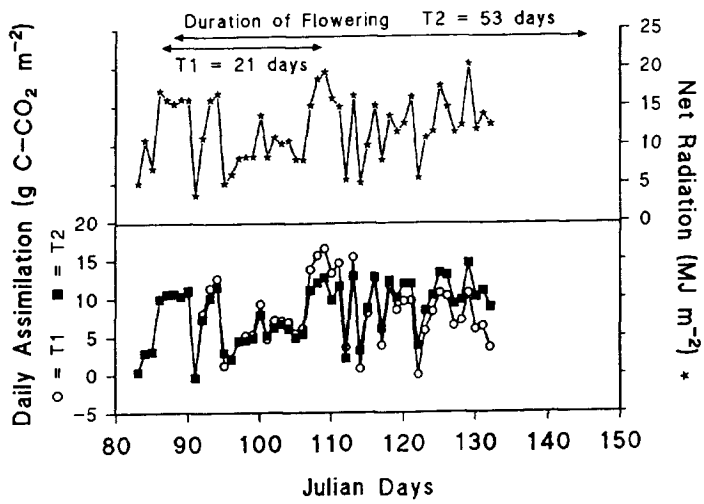

Fig 2 - Dynamics of daily Carbon Assimilation and Net Radiation for the 2 temperature conditions during flowering.

Yield components and yield

Therefore, a larger duration of flowering combined with a larger assimilate production at low temperature could lead to a better yield.

Table 1. Yield Components and Yield

Treatments Day/Night temperature	T1 21/14°C	T2 6/1°C
No. of Pods per Plant	89	76
No. of Seeds per Pod	13.5	15.5
Mean Seed, Dry Weight (mg)	3.64*	3.26*
Yield (g/Plant)	7.04	6.33

(*) Means differ significantly at the 0.05 probability level

In fact, the seed yield potential in winter rapeseed seems to be determined at anthesis. The total pod number and the seed number per pod were not very different, but yield decreased slightly with cold conditions because the dry weight per grain was smaller.

CONCLUSION

A cold treatment (5°C instead of 18°C) at flowering affects essentially the duration of flowering (expressed in calendar days), but not pod, grain numbers and yield. The net photosynthetic rate and the daily Carbon assimilation slightly decrease (by 10%) with cold treatment but the total assimilate production is higher.

ACKNOWLEDGEMENTS

This work was supported by a grant from CETIOM.

REFERENCES

(1) Martignac M., Falcimagne R., Triboi E., Triboi A.M. and Bancal P. (1991). Experimental devices for measuring gas exchanges in crops at Agronomy Station of Clermont-Ferrand. *International Symposium, "Physiology and Determination of Crop Yield"*, Gainesville (Florida, USA), 10-14 June 1991.

(2) Robelin M. and Triboi A.M. (1983). Assimilation nette d'une culture de colza d'hiver au cours du cycle de végétation sous l'influence de l'environnement climatique, de la densité du peuplement et de la fertilisation azotée. *6th International Rapeseed Congress*, Paris (France), 17-19 May 1983, 98-103.