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END OF DAY RED AND FAR-RED LIGHT EFFECTS ON MORPHOGENESIS AND ASSIMILATES PARTITIONING IN WHITE CLOVER

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INTRODUCTION

The control of white clover contribution to the forage yield of a white clover/grass mixture still remains an important problem at the field level. The grass/legume mixture balance depends mostly on the morphogenesis of white clover in dense canopy through the competition for the light. The importance of the light quality modifications on the morphogenetic adaptation of plants is now well established. The extent to which the phytochrome control of morphogenesis and carbon partitioning which could explain the evolution of white clover in dense canopy was investigated.

MATERIALS AND METHODS

Three experiments were conducted in controlled environment with constant day/night temperature of $20 \pm 0.5^\circ\text{C}$, relative humidity of $70 \pm 10\%$ and PAR of 350 or 450 $\mu\text{mole/m}^2/\text{s}$ at plant level during 9 hours. Cuttings of cv Huia were supplied with nutrient solution. Far-red (FR) and Red (R) light were applied on whole plants during one or half an hour after switching off the white light (End of Day treatments). Experiments were conducted for 11, 18 and 23 days respectively. Two types of experiments were conducted: comparison between FR, FR followed by R and dark control (C) or comparison between FR and C. Morphological data (petioles and stolon length, ramification number ...) were taken at different dates during each experiment. Assimilates partitioning was investigated in two experiments by ^{14}C labelling on whole FR or C plants. Comparison of ^{14}C photosynthates partitioning were based upon the relative specific activity (RSA) calculated as the ratio between the specific activity of a particular organ and the specific activity of the whole plant.

MORPHOLOGICAL TRAITS

Far-red stimulated strongly petioles and leaflets expansion and inhibited branching. Branching rate of the main stolon was less decreased than branching rate of the stolons of first order. The FR treatment particularly increased elongation of the main stolon (no change in nodes number but longer internodes). Therefore FR plants had similar stolon length, resulting from longer stolon per axe but fewer axes per plant. All these effects were reversed by red light but they do not persist with time. No effect of FR treatment was observed on well developed plants.

DRY MATTER ALLOCATION

Total DM per plant was not significantly affected by light treatment but the allocation between organs was changed. The most important feature was the increase of the relative allocation of DM to petioles of FR treated plants corresponding to smaller allocation to stolons and roots, especially for the ramifications. The smaller DM allocated to stolons was due to the decrease of the number of stolons by far red light. The greater accumulation of DM in petioles resulted from longer petioles. About one third of the total dry matter was allocated to leaflets and this part is not significantly changed by light. The FR plants had fewer but larger leaflets. The total leaf area of FR plants was higher.

¹⁴C PARTITIONING

The results of the ¹⁴C-assimilates partitioning experiments are in good agreement with dry matter allocation. The effect of FR is very important for petioles in which more ¹⁴C-photosynthates were partitioned. The relative specific activity of stolons and roots was lower for FR plants than for control plants. These effects appeared 2-3 days after the beginning of the FR treatment but they were transitory. After 10-15 days of FR treatment the sink strength (RSA) of all organs were the same for both treatments, indicating a modification of the FR-plant strategy for carbon allocation.

CONCLUSIONS

These results show that phytochrome controls both "space exploration" through the modulation of the internodes extension and the rate of branching, and the "exploiting strategy" by production and positioning of photosynthesizing leaf area (i.e. vertical colonization). This phytochrome dependence acts on Source-sink relationships. This work is the first step in the analysis of the light quality effects on the functioning of a crop. The aim of following studies will be to determine the sites of photoperception and to establish quantitative relationships between light quality on these sites ("Morphogenetically Active Radiation") and responses of the plant. The light quality inside the canopy could be estimated from a radiative exchange model.

| | MAIN AXIS | | WHOLE PLANT | |
|------------------------------------|-----------|-----------|-------------|-----------|
| | C | FR | C | FR |
| Length of stolons (mm) | 195 | 246 (*) | 1081 | 1064 (NS) |
| Total number of leaves | 14 | 14.8 (NS) | 142 | 99 (*) |
| Branching rate | 0.73 | 0.66 | 0.26 | 0.21 |
| Total leaf area (cm ²) | 50 | 71 (*) | 206 | 284 (*) |
| Total length of petiole (mm) | 1234 | 1760 (*) | 6607 | 8967 (*) |
| Leaflet dry matter (%) | 19.8 | 21.2 | 33.7 | 34.0 |
| Stolon dry matter (%) | 15.4 | 15.1 | 22.3 | 18.8 |
| Petioles dry matter (%) | 13 | 18.0 | 20.8 | 28.0 |
| Roots dry matter (%) | 51.7 | 46.6 | 23.1 | 19.0 |

Table 1: Main morphological traits and Dry Matter allocation at the end of the experimentation 3

FIGURE 1 : PLANT ASPECT AFTER 10 DAYS OF EOD FAR-RED IRRADIATION (RS) OR NOT (T), Experimentation 2

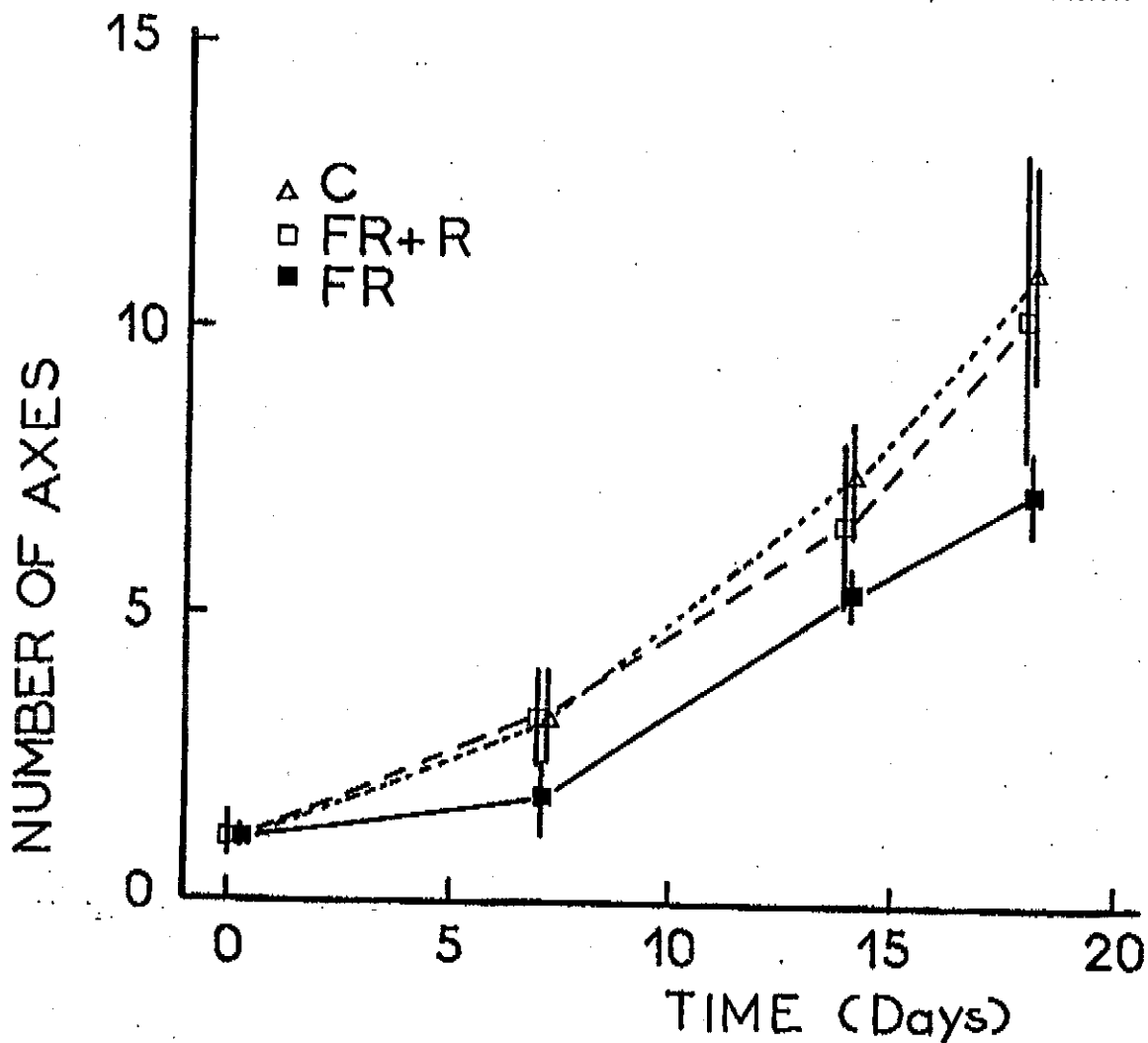


FIGURE 2 : TIME-COURSE OF THE MEAN NUMBER OF BRANCHES PER PLANT Experimentation 1

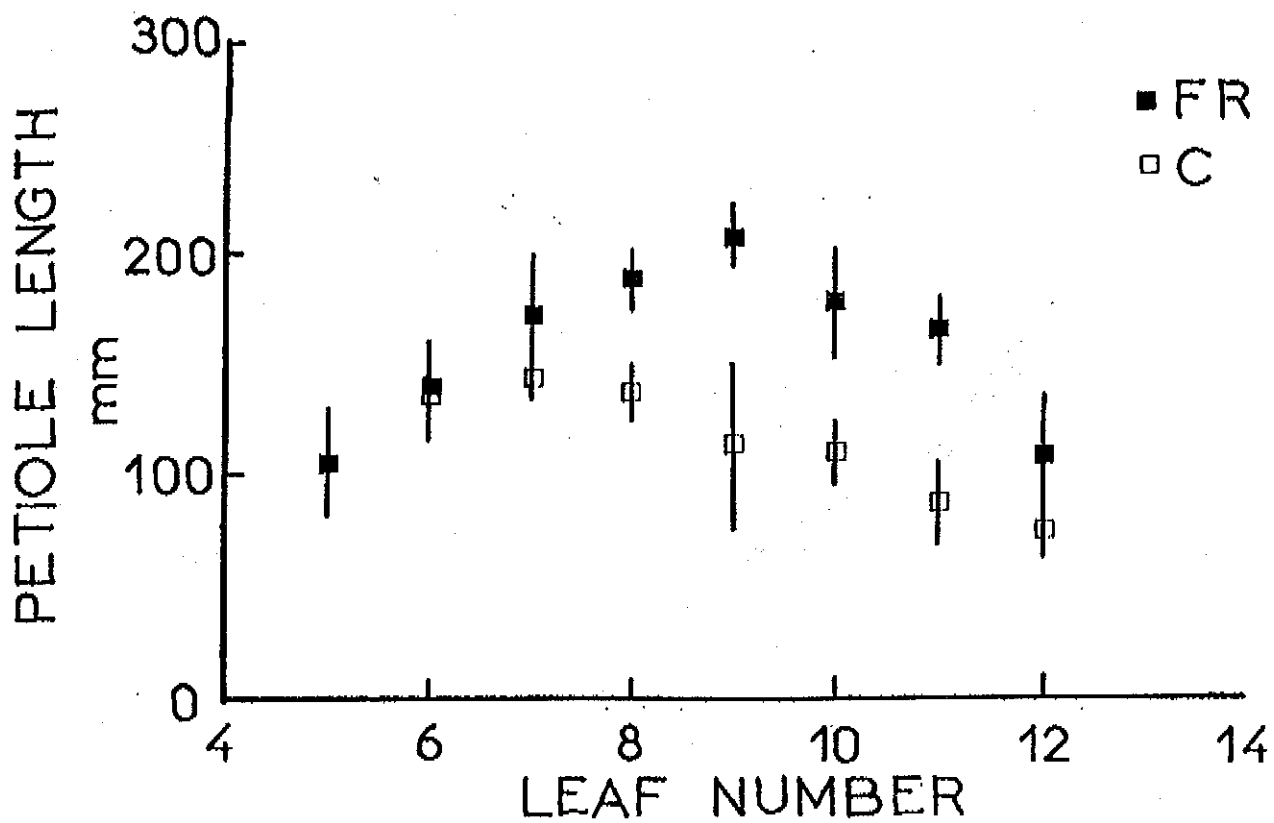


FIGURE 3: MEAN PETIOLE LENGTH OF THE MAIN STOLON LEAVES (Expe. 2)

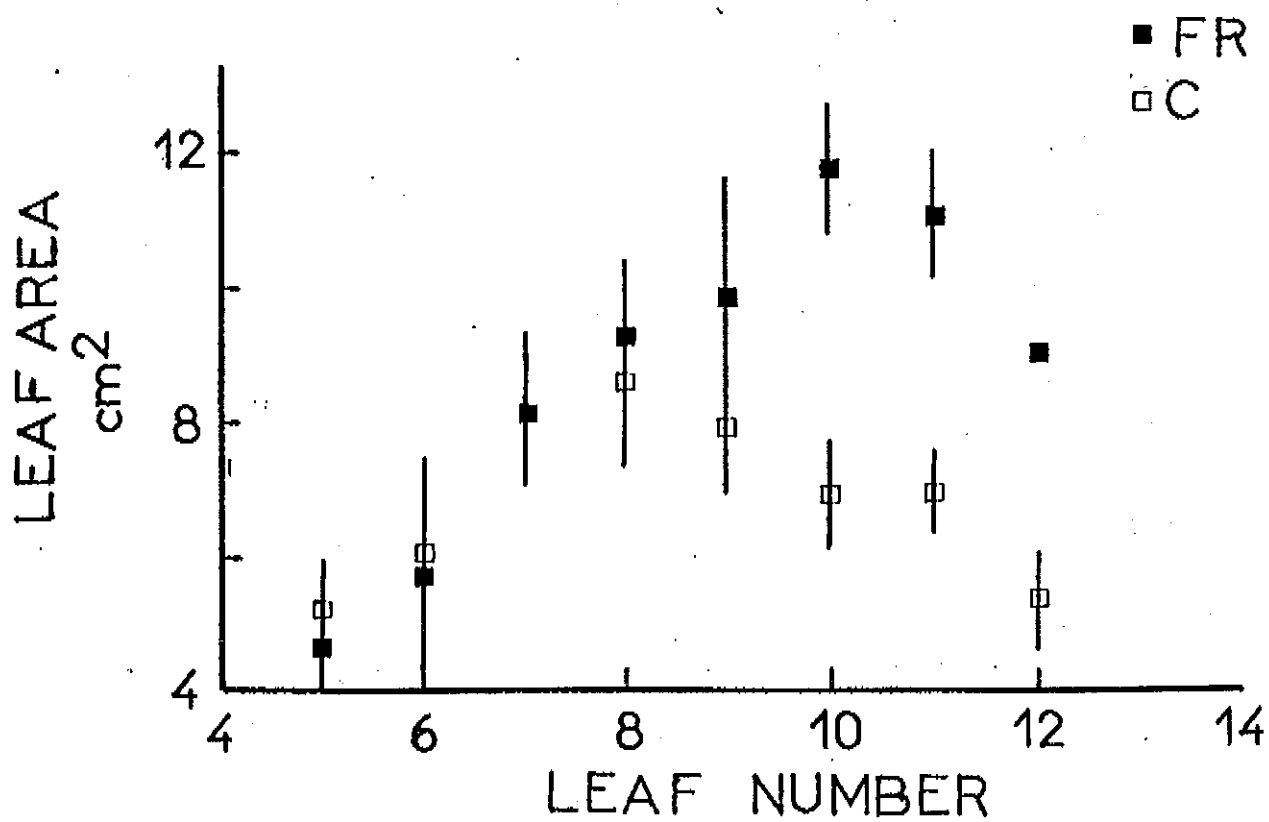


FIGURE 4: MEAN LEAFLET AREA OF THE MAIN STOLON LEAVES (Expe. 2)

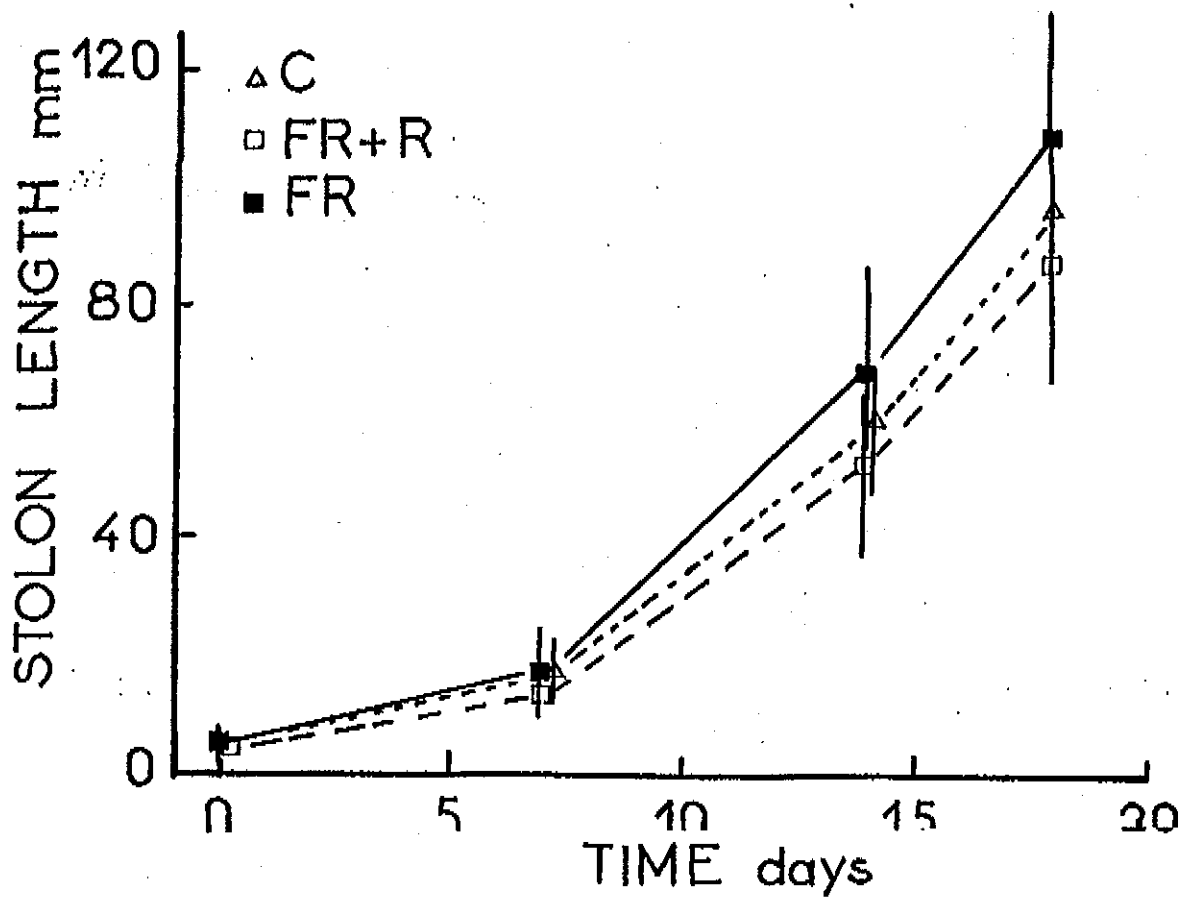


FIGURE 5: TIME-COURSE OF THE MAIN STOLON LENGTH (Expe. 1)

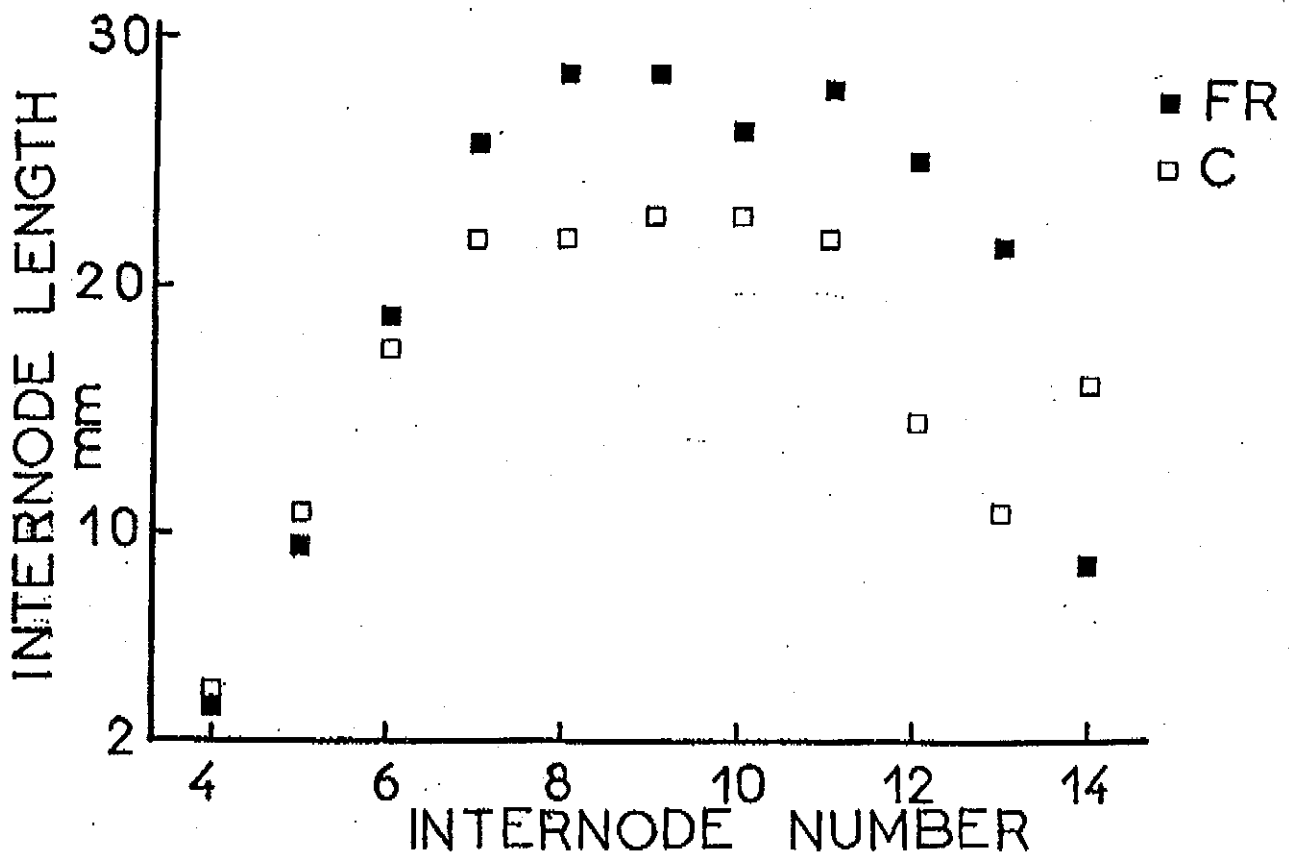


FIGURE 6: INTERNODES MEAN LENGTH OF THE MAIN STOLON (Expe. 3)

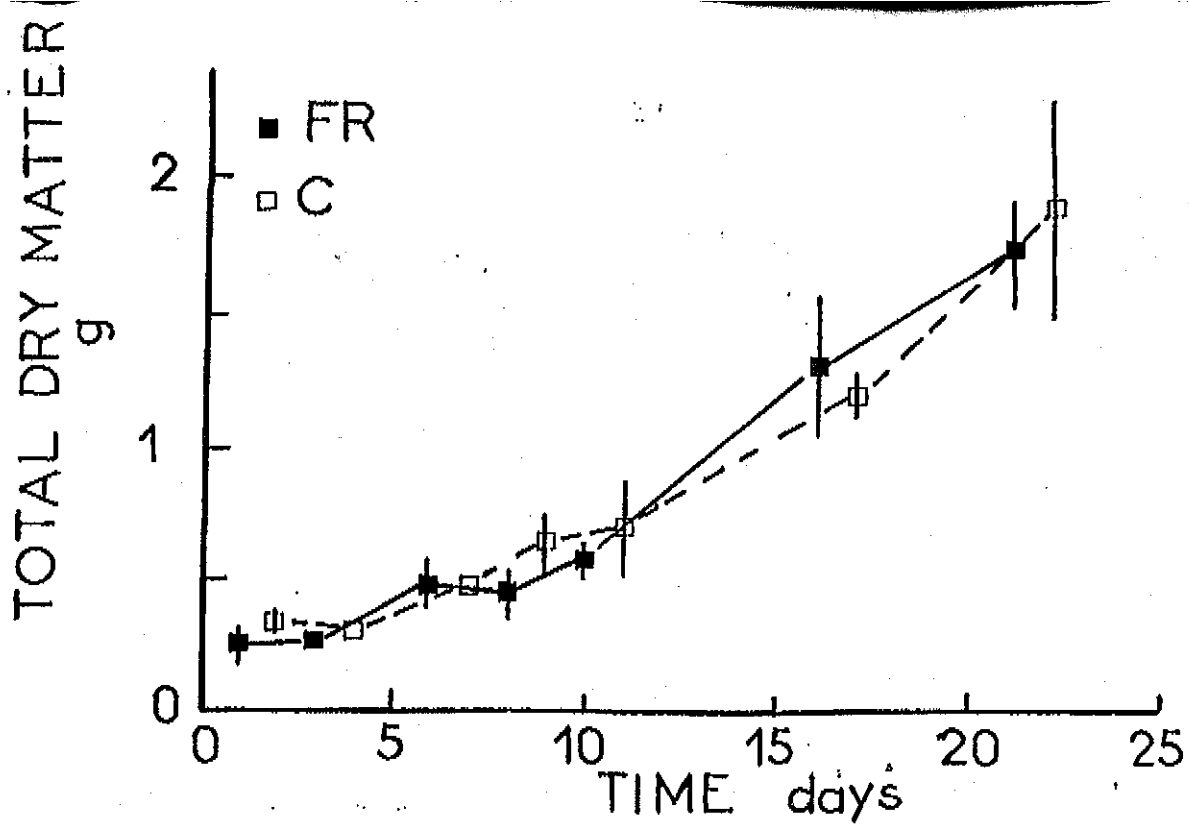


FIGURE 7: TIME-COURSE OF THE MEAN TOTAL DRY MATTER PER PLANT (Expe. 3)

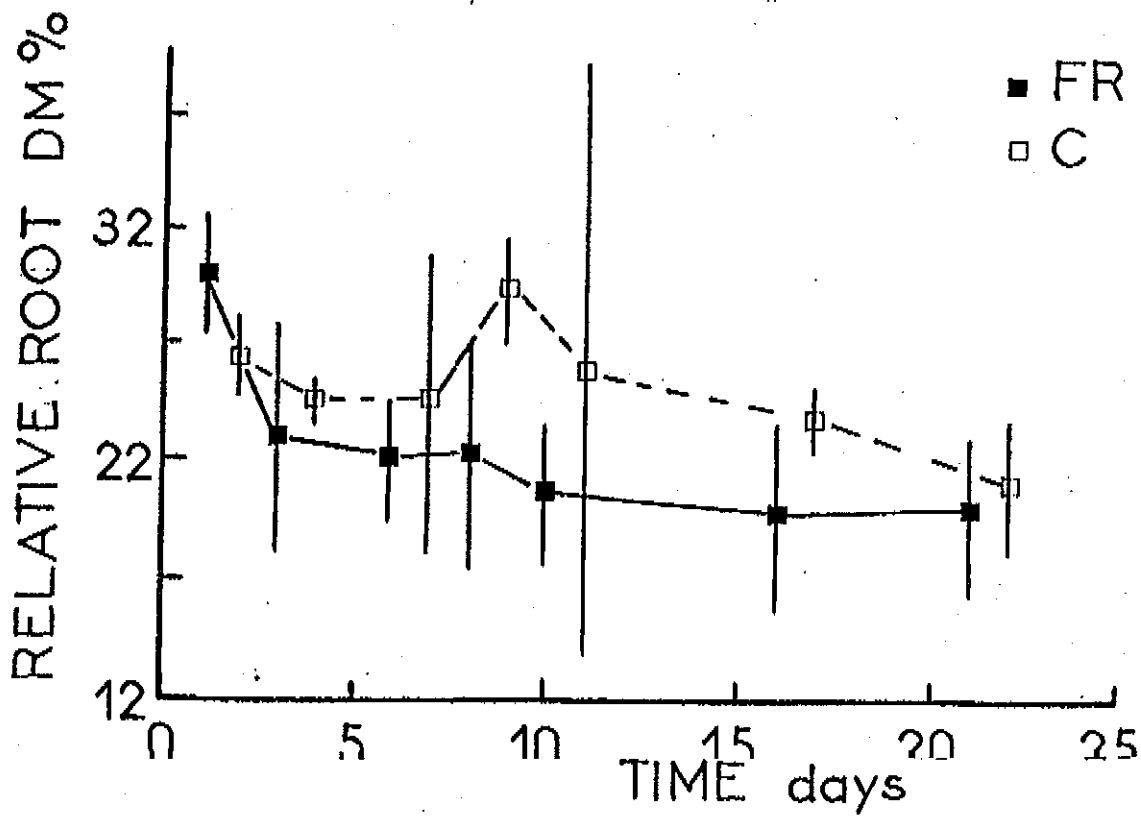


FIGURE 8 : TIME-COURSE OF THE RELATIVE ROOT DRY MATTER ALLOCATION % OF THE TOTAL DM (Expe. 3)

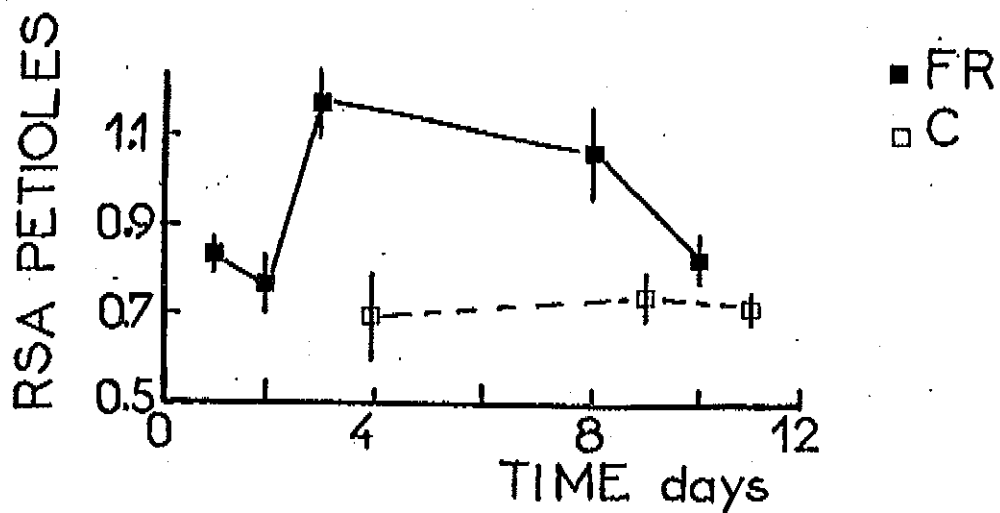


FIGURE 9 : TIME-COURSE OF ASSIMILATES PARTITIONING TO THE PETIOLES (Expe. 2)

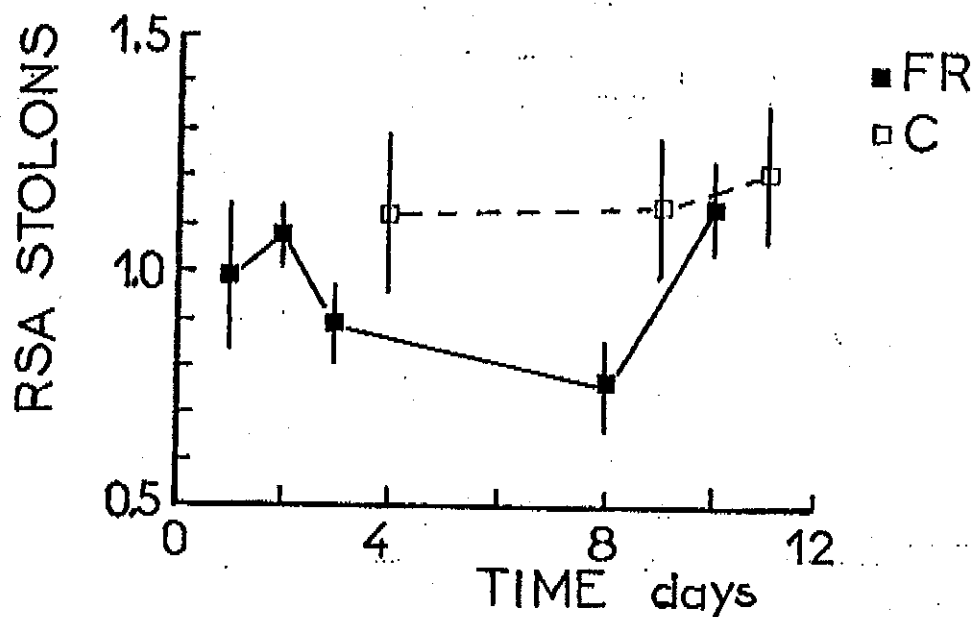


FIGURE 10 : TIME-COURSE OF ASSIMILATES PARTITIONING TO THE STOLONS (Expe. 2)

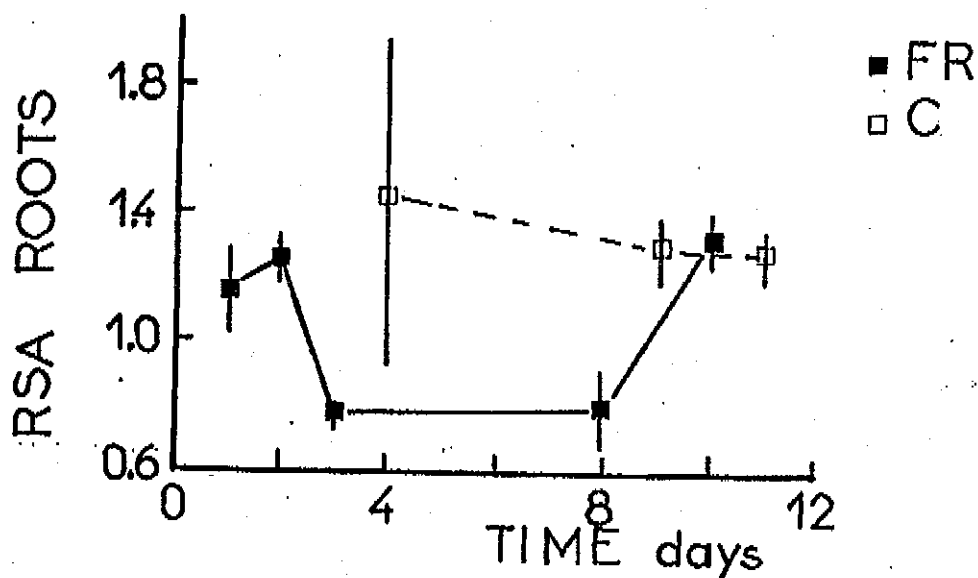


FIGURE 11 : TIME-COURSE OF ASSIMILATES PARTITIONING TO THE ROOTS (Expe. 2)