Productivity of Brassica juncea and B. carinata in relation to rapeseed, B. napus. II. Plant development and water relations.

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INTRODUCTION

In view of the differences in growth and productivity of the species Brassica juncea, B. napus and B. carinata detailed studies of early growth and development were carried out. The plants were grown in pots in a controlled environment and were monitored during the first 2 months of growth for leaf appearance, leaf area development, leaf blade anatomy, dry weight distribution and plant water relations. The information from these studies will be used in a model of plant and canopy development which will be used to explain the differences in productivity of the three Brassica species.

MATERIALS AND METHODS

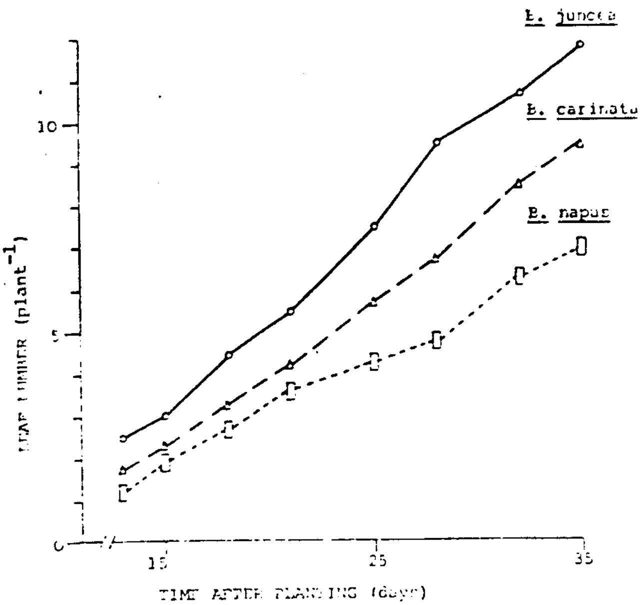
Seed were planted in 8 l pots in a mixture of soil, sand and peat. They were maintained in a growth chamber for 11 hours a day at around 700 $\mu Em^{-2}S^{-1}$ of PAR and 20/15°C day and night temperatures, respectively. Six to 10 pots per species with 2 plant per pot during the first 3 weeks then 1 plant per pot, were used.

As leaves reached 5 cm long they were tagged and blade length and width measurements were made every 2 to 3 days afterwards. Blade length and width were later correlated with electronic planimeter readings to allow us to calculate the continuous development of leaf area for all leaves. Dry weight was obtained at various intervals during the studies by drying at 70° for 48 hrs. Anatomical studies of leaf blades made use of standard paraffin techniques. The water relations of the three species were evaluated by determining the relation between relative water content (RWC) and water potential (ψ) for leaves of the three species Fereres et al. (1979). Also the relation between stomatal conductance and (ψ) during a drying cycle was determined under controlled conditions.

RESULTS AND DISCUSSION

The number of leaves produced by each of the 3 species is shown in Fig. 1. Clear differences were established 10 days after planting and were maintained throughout the course of the experiments. Brassica juncea produced the highest number of leaves, B. carinata was intermediate, and B. napus was lowest in leaf

Figure 1.- The number of leaves produced during the first 5 weeks of growth for 3 Brassica species grown in the growth chamber.

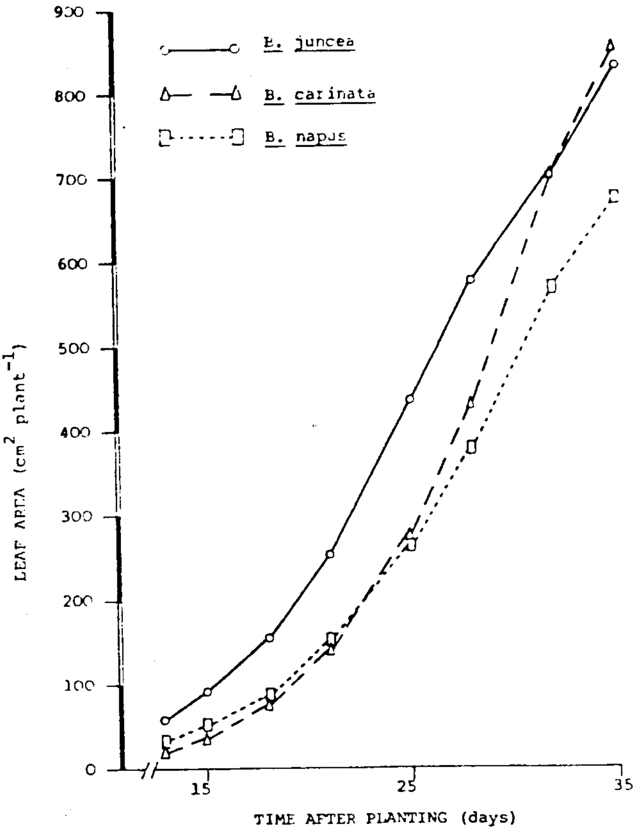


production.

Figures 2 and 3 present leaf area development for the whole plants and for leaf 4 a representative leaf, respectively. As with leaf number (Fig. 1), total plant leaf area (Fig. 2) was high for B. juncea and low for B. napus, B. carinata, however, started out with low leaf area similar to that of B. napus but then experienced a rapid increase in leaf area growth, catching up and surpassing that of B. juncea 30 days after planting. The initial high plant leaf area of B. juncea (Fig. 2) is due to high leaf number (Fig. 1) even thought individual leaf size was smallest for that species (Fig. 3). Large leaf size in B. napus (Fig. 3) was not enough to compensate for low leaf numbers (Fig. 1). B. carinata produced large individual leaves (Fig. 3) which, combined with intermediate leaf appearance rate (Fig. 1) allowed for the eventual achievement of the highest leaf area (Fig. 2).

Dry weight distribution among blades, petioles, stem and root at 3 and 6 weeks after planting is shown in Fig. 4.

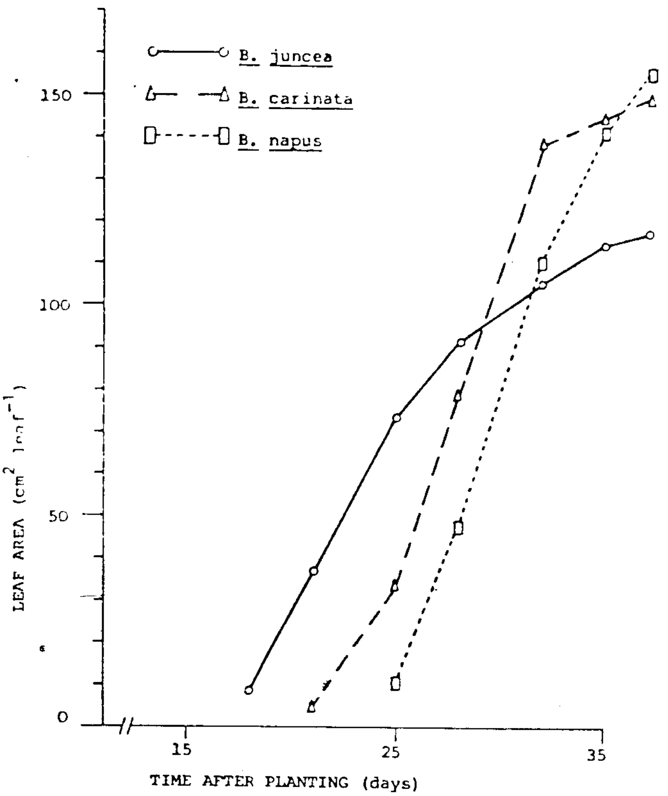
Figure 2.- Plant leaf area during the first 5 weeks of growth for 3 *Brassica* species grown in the growth chamber



Dry weight for all organs was highest in *B. juncea*, intermediate in *B. carinata*, and lowest in *B. napus* at both ages. Early plant growth is definitely dependent on the early achievement of leaf area, and both of these features may be important for later productivity.

Thickness of mature leaf blades was greatest for *B. napus*, equal or intermediate for *B. carinata* and lowest for *B. juncea*, following the same relationships as individual leaf area (Fig. 3). Thinner leaves might help in the early achievement of leaf area and ground cover because less assimilates are needed for leaf growth. Later in development plant assimilate status is higher so this feature would have a less significant role.

Figure 3.- Leaf area development of leaf number 4 for 3 *Brassica* species grown in the growth chamber.



The results from the water relations studies are summarized in Figure 5 and Table 1. Figure 5 shows that the RWC-Ψ relationships are nearly identical for the three species, thus under controlled conditions there is no indication of greater drought tolerance at the leaf level of any of the three species. The relations between leaf conductance and Ψ under the same conditions are presented in Table 1. Only a slight difference was encountered with *B. napus* maintaining higher stomatal conductance at a lower Ψ than the other two species. This would explain the visual wilting symptoms which were observed in *B. napus* but not in the other two species. From the results summarized above it can be concluded that there are not basic differences in the water relations of the three species at the individual plant level under controlled conditions. We are presently

Figure 4.- Distribution of dry weight between blades, petroles, stem and root in 3 species of Brassica for growth chamber plants 3 and 6 weeks after germination.

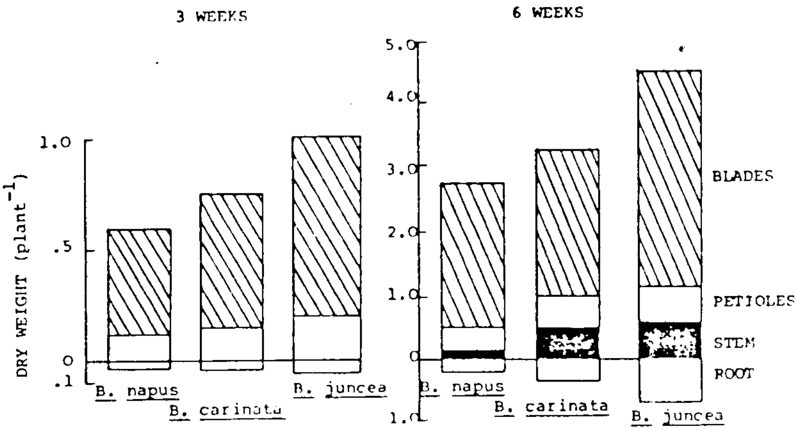


Table 1.- Relationships between stomatal conductance (gl) and leaf water potential (ψ) for three Brassica species.

gl (cm/s) = a + b ($-\psi$) (bars)

Species	a	b	R^2
B. napus	0.91	-0.05	0.64
B. juncea	0.85	-0.06	0.83
B. carinata	0.86	-0.05	0.51

evaluating the crop water relations in the field when root development plays a major role in water stress avoidance during a drought.

REFERENCES

- Fereres E., Cruz-Romero G., Hoffman G.J. and S.L. Rawlins. (1979). Recovery of orange trees following severe water stress. J. Appl. Ecol. 16, 833-842.

Figure 5.- Relationships between RWC and ψ for three species of *Brassica* under controlled conditions.