DROUGHT STRESSED MUSTARD YIELDS MORE THAN CANOLA DUE TO GREATER LEAF TURGOR

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Abstract

In three experiments the growth, yield, and plant water relations of canola (*Brassica napus*) and mustard (*B. juncea*) were compared over a range of water deficits. Mustard had greater dry weights (9 to 120%) and seed yields (up to 100%). Mustard leaves had greater leaf turgor pressures. In terms of growth, mustard's advantage was due to longer leaf area durations (1.5 times) and greater crop growth rates (up to 2 times). These differences in growth were positively correlated to leaf turgor. It is concluded that mustard's greater adaptation to drought conditions is chiefly due to its greater ability to maintain leaf turgor.

Key words: Brassicas, leaf turgor, water deficit, plant water relations, osmoregulation.

Canola (*Brassica napus*) is relatively poorly adapted to drought conditions and is normally grown on the wetter margins of the wheat belt. Mustard (*B. juncea*) in contrast has a reputation for drought tolerance. However, few comparisons of the two crops have been made and little is understood about why mustard is better adapted to drought. Evidence is presented in this paper showing that mustard is better adapted to drought and that this is chiefly due to a greater ability to maintain leaf turgor.

Materials and Methods

Field experiments were conducted at Tamworth (151&degree;E, 31&degree;S). Complete experimental details are provided in Wright et al (3). The genotypes selected were all of dissimilar pedigree but similar maturity type. Experiment A was carried out on a dark brown cracking clay. Three genotypes of each species were sown on 8 June, 1990 at two sites. The first site received 289 mm of water as rainfall over the growing season (classified as low deficit in this paper) and the second site 485 mm of water (classified as very low deficit), 289 as rainfall and 196 mm applied in six approximately equal applications by trickle irrigation during pod filling. Plot size was 1.5 m x 15 m. There were three replicates of the treatments in a randomised complete block design. Canola genotypes were 79NO13-364, Maluka and Taparoo while the mustard genotypes were CPI61680, JE8 and WA5.

Experiment B was conducted on a reddish brown hard setting clay. Treatments included four genotypes of each Brassica species sown on 4 September, 1990 in a fully hydrated soil profile. All subsequent rainfall was excluded by a mobile shelter (extreme deficit). Plot size was 1 m x 2 m and each genotype was replicated four times using a randomised complete block design. Canola genotypes were 79NO13-364, 82N128N9x36, Maluka and Taparoo, and mustard genotypes were CPI61680, JE8, WA5 and ZE Sporospelka.

Experiment C was conducted at the at the same location as Experiment B. Treatments consisted of four genotypes of each species sown between 28 and 30 May, 1991 on a fully hydrated soil profile at two adjacent sites. Each site thereafter was subjected to a different water regime. The first site had all rain excluded by a mobile shelter (high deficit), the second received rainfall of 153 mm and an additional 246 mm of water applied through a drip irrigation system giving a total of 399 mm (moderate deficit). Plot size was 1 x 2 m and each genotype was replicated four times at each site using a randomised complete block design. Genotypes were the same as in Experiment B.

Analysis of variance with orthogonal contrasts was used to compare the species.

Results

Mustard had greater dry matter production in all experiments and its advantage in dry matter production tended to increase as the water deficit increased (Table 1). This resulted in mustard having greater seed yields under high deficits (Table 2) and greater oil yields (data not presented).

Mustard had a great leaf area duration in experiment C (Table 3). Leaf area duration could not be calculated from experiments A and B as the number of sampling dates was insufficient. However, mustard did have greater peak leaf area indices in these experiments. Mustard's advantage in leaf area duration or in peak leaf area tended to increase as the water deficit became stronger (Table 3)

In experiment C crop growth rates could be calculated. Mustard had greater crop growth rates early in the season (between 50 and 64 days after sowing) at both moderate and high deficits, and later in the season (78 to 92 and 134 to 148 DAS) for high deficit site (Fig. 1).

Mustard was found to have greater leaf turgor pres sure on 17 out of the 44 occasions it was measured across all sites, while canola was never found to have greater leaf turgor than mustard (data not shown). Averaged across all measurements mustard's advantage in turgor pressure was 0.1 MPa, however, on individual occasions mustard had up to 0.36 Mpa greater leaf turgor. The leaf area duration of both species (Fig. 2) and crop growth rates (Fig. 3) were positively related to leaf turgor pressure.

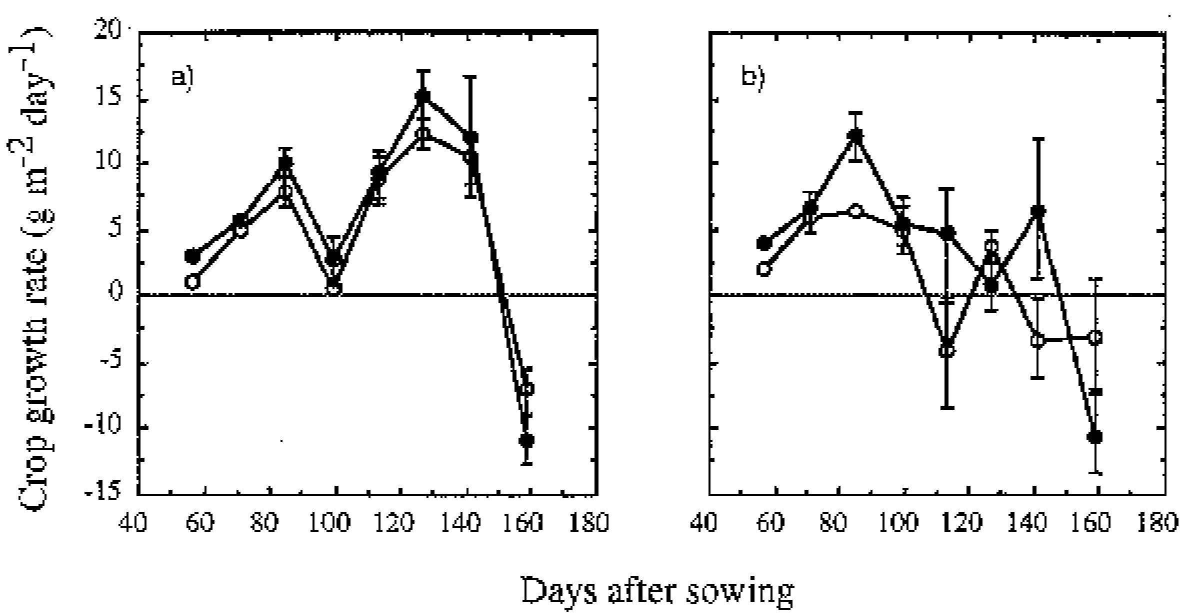

Figure 1

Discussion

The results provide clear evidence of mustard's greater adaptation to water deficit compared to canola. Seed yields in mustard were more than double those of canola under high deficits and interestingly were similar under low deficits. Oil yields follow a similar pattern (1). In an analysis of the yield structure of the two species under drought it was shown that the most important factor in mustard's yield advantage was its greater capacity to produce dry matter (1). Mustard's advantage in dry matter production is accompanied by an advantage in leaf area duration. The results also clearly show a sustained advantage for mustard in expanded-leaf turgor and significant correlations between leaf turgor and leaf area duration

(Fig. 2) and leaf turgor and crop growth rate. In an analysis of the plant water relations of the two species leaf turgor was found to be the most important factor (2). Mustard's advantage in leaf turgor chiefly arises from its greater capacity to osmoregulate (3).

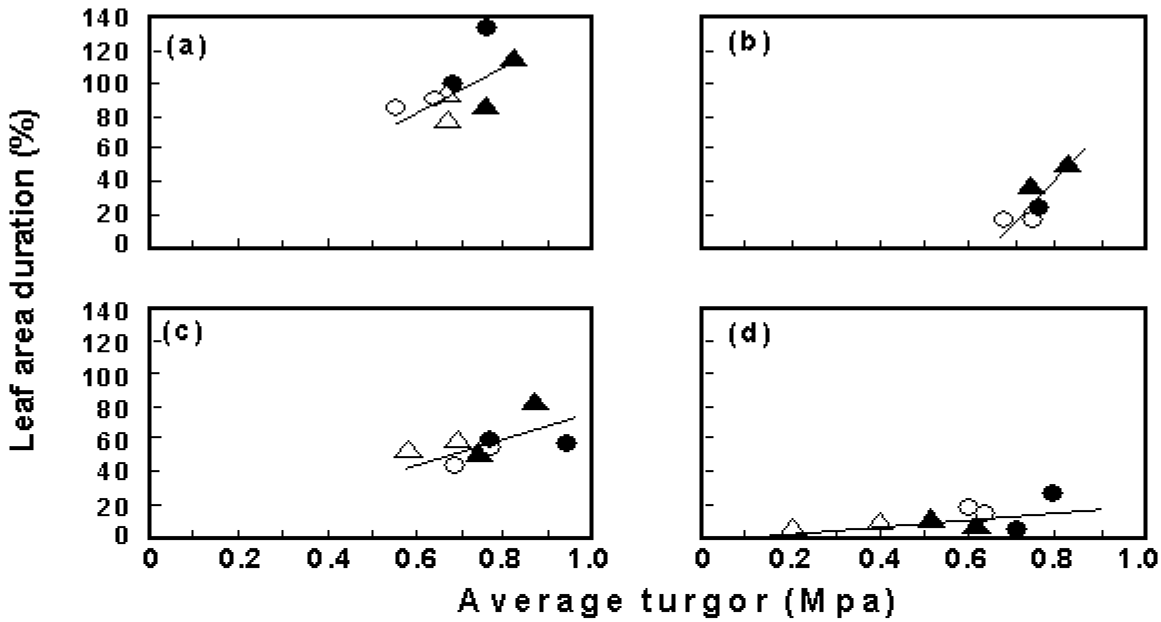

Figure 2

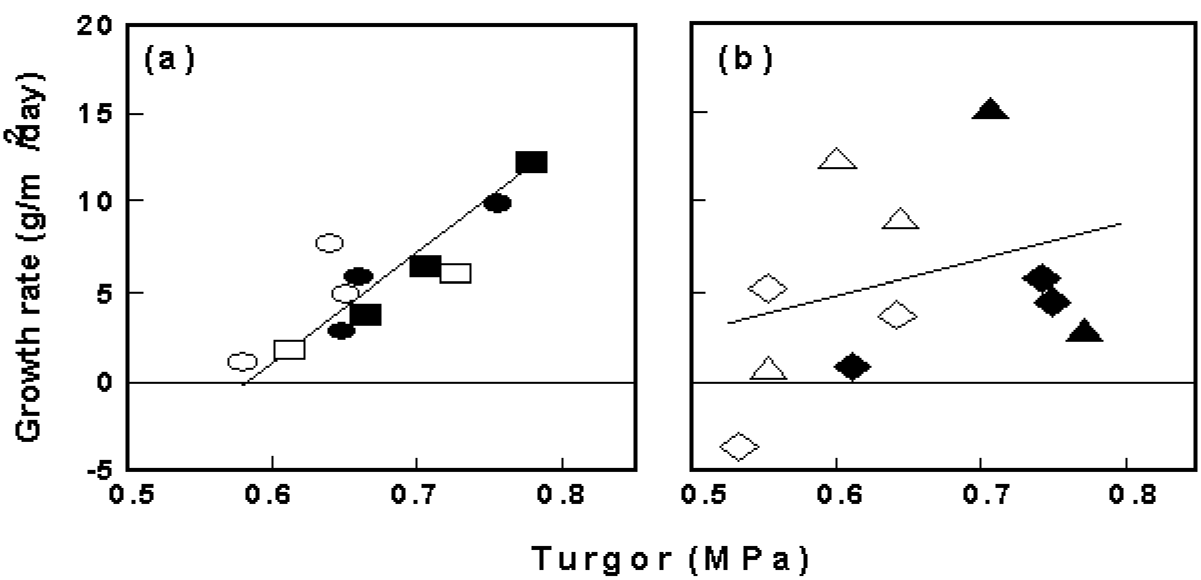

Figure 3

Conclusion

Mustard is better adapted to drought than canola because it can maintain higher leaf turgor which allows it to sustain higher crop growth rates and longer leaf area durations.

References

1. Wright, P.R., Morgan J.M., Jessop R.S. and Cass A. 1995. *Field Crop Res* **42,** 1-13.

2. Wright, P.R., Morgan J.M. and Jessop R.S. 1996. *Field Crop Res* **49,** 51-64.

3. Wright, P.R., Morgan J.M. and Jessop R.S. 1997. *Ann. Bot*. **80,** 313-319.