Effects of water stress on water relations and yield of Indian mustard (*Brassica juncea* L.) and canola (*Brassica napus* L.)

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Abstract

The morphological and physiological basis of drought tolerance of Indian mustard and canola was investigated in a field experiment at Merredin in 2001. Two mustard and one canola genotype were tested for their response to water stress after 50% flowering by employing three water stress treatments. The leaf water potential (ψ) and osmotic potential at full turgor (π_{sat}) of all genotypes were significantly lower under severe water stress conditions. At the end of the season when soil moisture stress developed rapidly, ψ and π_{sat} of mustard fell significantly faster than that of canola. However, seed yield did not differ significantly between genotypes under severe water stress treatment.

Key Words

Indian mustard, canola, water potential, osmotic potential, seed yield

Introduction

In the Mediterranean type environments of South Western Australia, rainfall and thus soil moisture are the most important factors affecting crop production. Seed yields are primarily limited by the relatively short duration of the growing season and the severity of soil moisture deficits experienced during the latter phases of reproductive development. Genotypes, which flower at a time that would ensure avoidance of severe drought stress at the end of the season, are therefore better adapted to these environments. Genotypes having greater tolerance to water stress in addition to earliness generally would have an advantage for improving adaptation and seed yields in these environments. Indian mustard has a reputation to be more drought tolerant than canola and is considered as an alternative crop to canola in the low rainfall cropping areas of South Western Australia. In this study the morphological and physiological basis of drought tolerance of mustard and canola was investigated.

Methods

A field experiment was conducted in a low rainfall cropping region of Western Australia at Merredin (31?29'S, 118?18' E) in 2001. The mustard cultivar, Muscon (Early, short, condiment type) and a breeding line, 887.1.6.1 (Early, short, near canola quality type) and an early canola cultivar Monty were tested for their response to water stress after 50% flowering. The three stress treatments were: severe stress (rainfall excluded after flowering in a rainout shelter), mild stress (rainfed) and stress free (irrigated to replace pan evaporation). Each block was a randomized complete block design with four replicates. The water relations, dry matter production and seed yield data were recorded.

Results

Water relations

The leaf water potential (ψ) and osmotic potential at full turgor (π_{sat}) of all genotypes were significantly lower under severe water stress conditions. ψ and π_{sat} of canola was lower than those of mustard at flowering. However, at the end of season when soil moisture stress developed rapidly, ψ and π_{sat} of mustard fell significantly faster than that of canola (Figure 1). 887.1.6.1 and Monty showed clearer Osmotic adjustment that was judged by differences in π_{sat} between the stressed and stress free treatments, when compared to Muscon.

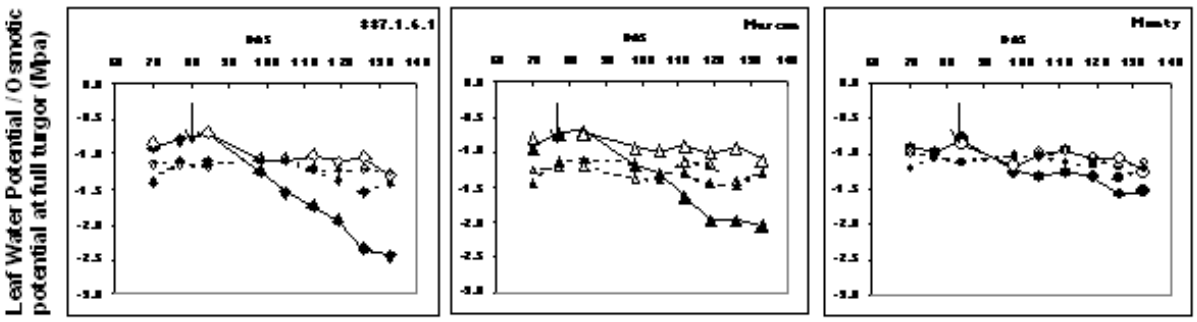

Figure 1. Leaf Water Potential (smooth line) and Osmotic Potential at full turgor (dashed line) of two mustard and one canola genotype subjected to severe water stress after flowering (solid symbols) and stress free (open symbols) at Merredin, WA in 2001. Arrows indicate flowering date.

Seed yield

The final above ground dry matter and seed yield of all genotypes was highest in the stress free treatment and lowest in the severe stress treatment (Table 1). Final above ground dry matter of mustard was significantly higher than canola in all stress treatments. Seed yield did not differ significantly between genotypes in the severe stress treatment, but in the mild stress and stress free treatments that of Muscon were significantly lower than 887.1.6.1 and Monty.

Table 1. Seed yield and final above ground dry matter of two mustard and one canola genotype subjected to three water stress treatments after flowering at Merredin, WA in 2001.

Genotype	Seed yield (t/ha)				Final above ground dry matter (t/ha)			
	severe stress	mild stress	stress free	mean	severe stress	mild stress	stress free	mean
887.1.6.1	1.23	1.55	1.90	1.56	7.57	9.09	10.89	9.18
Muscon	1.00	1.20	1.54	1.24	6.77	7.86	9.87	8.17
Monty	1.05	1.59	1.90	1.51	5.47	6.98	8.44	6.96
Mean	1.09	1.45	1.78	1.44	6.60	7.98	9.73	8.10
LSD (P =		stress = 0.22				stress = 1.07		

0.05)	genotype = 0.20 stress x genotype = 0.35	genotype = 0.97 stress x genotype = 1.68

Conclusions

This study reveals that water stress after flowering adversely affects dry matter and seed yield of mustard and canola. Contrary to expectation mustard did not show any yield advantage over canola under severe water stress treatment. However, the best adapted mustard line 887.16.1 showed greater osmotic adjustment and dry matter production under severe water stress conditions in this study.