Performance of *Brassica* genotypes in contrasting environments

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Abstract

Short growing season with terminal drought is a challenge for canola production in low rainfall areas of Australia. This research evaluates variation in range of canola genotypes to identify plant types having characters that offer better production in low rainfall areas of Australia. In field experiments conducted at two contrasting environments in Western Australia (WA), we measured variation in plant canopy structure, phenological development and biomass production and resource allocation in a range of *Brassica* (*B. napus* and *B. juncea*) genotypes. Differences in some physiological yield determinants (interception of photosynthetically active radiation (PAR), leaf gas exchange and instantaneous water use efficiency (WUE) were also measured and correlated with seed yield and yield components. Using back-crossing we incorporated selected traits (apetally, dwarfness and long pods) into two commercial canola cultivars (used as recurrent parents) that performed well in a low rainfall environment. Selected new progeny lines can be used as model for breeding canola cultivars with higher productivity for low rainfall areas of Australia.

Keywordds

Extinction coefficient, harvest index, Indian mustard, net photosynthesis.

Introduction

Variation in yield of *Brassica* genotypes could be related to canopy structure at flowering (1). Low plant populations are found to significantly affect floral canopy structure for improved seed yield of oilseed rape (2), however, the importance of pre-anthesis growth in determining the yield of *Brassica* species (3) and its reduction under drought should not be overlooked. The aims of this study were, (i) to find variation in canopy structure of *Brassica* genotypes in two contrasting environments and (ii) to identify the traits that contribute to the development of canola canopy with high water use efficiency and improved seed yield for the low rainfall areas of Australia.

Methods

Experiments were conducted at the Dryland Research Institute, Merredin, WA (31 31.00S and 118 10.00E) and at the Avondale Research Station, Beverley, WA (32 08.842S and 117 10.452E) during 1997–2000. Seeds were direct drilled at a depth of 2-3 cm using a cone seeder with finger harrows, at a rate of 6 kg/ha. Eight-row-plots, 15 m long, were sown with a distance of 20 cm between the rows. Superphosphate (D. super), at the rate of 74 kg/ha was drilled with the seeds and 40 kg/ha urea was topdressed at the same time. Six weeks after sowing a further 40 kg/ha urea was topdressed. Sprayseed (2L/ha), IBS Sprayseed (2L/ha) and Talstar (100 ml/ha) were applied as pre-emergence herbicides. Weeds, diseases and insects were controlled effectively using appropriate post-emergent herbicides, fungicides and insecticides. Crops were grown to maturity and harvested using a combined harvester for direct heading.

We crossed and back-crossed five canola lines having either apetalous flowers, dwarf habit or long pods (*special traits*) with two commercial canola cutivars Monty and Narendra that performed well in a low rainfall environment. The performance of back-cross progeny (BC_2F_3) was evaluated at Merredin and Beverley, in 2000, using standard agronomic management practices as described above.

Results

There was considerable variation among *Brassic*a genotypes for the variables studied in the two environments (Table 1). In particular, the number of leaves on the main stem and the number of first-order branches varied substantially over environments and lines. Among the genotypes, Monty produced 0.77 t/ha and Narendra 0.83 t/ha at Merredin. However, the floral canopy of these cultivars with petalous flowers absorbed 35-40% of incoming PAR whereas that of Trap-16, a semi-apetalous line, absorbed only 29%. A dwarf canola cultivar, DB-53, showed a similar pattern to the apetalous cultivar.

Table 1: Genotypic variation in architectural and physiological traits of *Brassica* genotypes grown in a medium (Beverley) and low (Merredin) rainfall environment. BA=Before anthesis.

Characteristics	**Beverley**		**Merredin**	
	Minimum	Maximum	Minimum	Maximum
Rainfall, May to October, during 1997-2000 (mm)	201.8	319.8	129.4	286
Mainstem height (cm)	64	118	64	122
No of leaves on mainstem (MS)	4.06	5.83	6.89	11.94
No of first-order branches	3.83	5.17	4.78	7.11
Extinction coefficient (*k*) BA*	0.25	0.59	0.19	0.45
Total dry weight (gm/plant)	3.3	6	2.7	4.5
Seed yield (t/ha)	1.19	1.64	0.27	0.87
Harvest index	0.56	1.06	0.32	0.67
Net photosynthesis (μmol/m^2/s) BA*	11.7	17	12.8	23.8
Water use efficiency (mmol/mol) BA*	3.04	4.45	1.86	3.39

At Merredin the back-cross progeny carrying all three special traits (apetally, dwarfness and long pod) gave higher seed yield than the recurrent parents. In Beverley such an increase in seed yield was observed in progeny lines carrying traits for apetally and long pod, and this was associated with an increase in net photosynthesis (Table 2).

Table 2: Yield and net photosynthesis of groups of back-cross progeny lines, with different donor parents, and their recurrent parents, grown in two contrasting environments in 2000. LP=Long pod.

Donor parent	Seed yield (g/plant)			Net photosynthesis (mmol/m^2/s)		
	Beverley	Merredin	Mean	Beverley	Merredin	Mean
Apetalous x LP	9.4	1.7	4	23	17	20
DB 52	6.6	1.8	3.5	25	19	22
DB 53	6.4	1.8	3.4	23	19	21
Chinese LP	6.7	1.8	3.5	21	17	19
TRAP 16	6.1	1.8	3.3	22	18	20
Recurrent parents	6.7	1.7	3.3	22	18	20

Conclusion

We conclude that canopy structure and morpho-physiological characteristics of *Brassica* genotypes influences their yield and harvest index in relation to other agro-ecological factors. These traits thus provide useful plant types for future canola breeding in low rainfall areas of Australia.

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