Growth attributes for higher wheat yields in the high rainfall zone of south-western Victoria

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ABSTRACT

Growth attributes of six wheat varieties with different maturities were related to grain yield. Results indicated that leaf to stem ratios in the early stage of crop development, maximum leaf area and harvest index were important factors governing final grain yields. High relative leaf mass and leaf area appeared to be associated with lower grain yields. Leaf area indices (LAI) of the poorer performing wheats were considerably higher (>9.0) than levels recommended in similar environments in Europe (maximum 6.6). Results from 1999 trials suggest that agronomic factors may be important and should be considered when selecting wheat varieties for the high rainfall zone.

KEY WORDS

Leaf area, dry matter, wheat, harvest index.

INTRODUCTION

The introduction of wheat varieties more suited to the high rainfall environment and the adoption of raised bed technologies has seen a rapid increase in the area sown to crops in south-western Victoria. To date, much of the research aimed at increasing grain yields has been concentrated in the lower rainfall areas (<550 mm). Results and recommendations from these areas may not be appropriate for the high rainfall zone due to the different growth and development patterns of crops in this environment (2). Wheat varieties and management practices therefore may need to be “tailored” to this environment in order to maximise grain yields. It may also be appropriate to adopt some recommendations (for example, the application of N fertiliser and growth regulators) from the Northern Hemisphere where considerable research has been conducted and crop growth may be similar to that in south-western Victoria. In this study we assessed some key growth attributes (i.e. leaf:stem ratio, leaf area index, harvest index and dry matter) to evaluate the performance of wheat varieties in south-western Victoria.

MATERIALS AND METHODS

Four wheat varieties with different maturities were sown in autumn (May, 1999) at Hamilton (soil type: sandy clay loam; pH 4.8 in $CaCl_2$; average annual rainfall (aar) 700 mm). These included two spring type; Silver Star (145 days to flowering) and Kellalac (165 days to flowering), and two winter types; Declic (156 days to flowering) and Lawson (170 days to flowering). Total dry matter (DM) and the DM of plant components (stem, leaf) were determined every 21 days throughout the growing season. Leaf area was determined using a LI-COR LI-3100 area meter. In a spring-sown trial, four spring wheat varieties were sown in October at Penshurst (soil type: clay loam; pH 4.45 in $CaCl_2$; aar 700 mm). Varieties included Silver Star, Kellalac, Frame (early maturity) and Goldmark (mid-season maturity). Leaf area, total DM and the DM of plant components (stem, leaf) were determined 42 days after sowing. Grain yields from both trials were determined using a plot harvester. Trials were sown in a randomised block design with four replicates at Hamilton and three at Penshurst. Analysis of variance was performed to analyse data.

RESULTS AND DISCUSSION

Crop maturity (early, mid or late) appeared to bear little relation to final grain yield. Silver Star and Kellalac both tended to have higher total DM and lower leaf to stem ratios (by weight) during early growth (growth stage 30-31) (5) compared to the other varieties. Spring sown Frame and Goldmark and autumn sown Lawson and Declic had lower grain yields and tended to have higher leaf:stem ratios during early growth

(Tables 1 and 2). Harvest indices were generally low (31.8-45.8%) (Table 1) relative to most regions of the world (50%) (4). This suggests that considerable yield gains could be achieved if strategies were put in place to reach the estimated threshold of 60% (1).

For the May-sown wheat, Lawson had the highest maximum leaf area index (LAI) (LAI of 9.6) followed by Declic (LAI of 9.1) and Kellalac (LAI of 7.9), with Silver Star having the lowest LAI (LAI of 5.3) (Figure 1). For all but Silver Star, these measurements were considerably higher than those recommended as optimum to maximise crop output (optimum LAI 5-6 with a maximum of 6.6) in England (3).

Table 1. Mean grain yields, harvest index (HI), leaf: stem ratio (L:S ratio) and dry matters (DM) of four wheat varieties with different maturities sown in May at Hamilton. DM and L:S ratio were determined at growth stage 30-32 (*GS) (5). Grain yields and HI were determined at final harvest.

Variety	Grain Yield (kg/ha)	Harvest Index	L:S ratio (*GS 30-32)	DM (kg/ha) (*GS)
Silver Star	7000	45.8	0.67	5400
Kellalac	4900	35.3	1.27	4400
Declic	4000	33.4	2.26	3400
Lawson	4400	31.8	2.02	3800
l.s.d. (*P*=0.05)	670	12.4	0.286	700
P value	<0.001	<0.001	<0.001	<0.001

Table 2. Mean grain yield, leaf:stem ratio (L:S ratio) and dry matter (DM) of four wheat varieties with different maturities sown in October at Penshurst. DM and L:S ratio were determined 42 days after sowing at growth stage 30-32 (*GS) (5). Grain yields were determined at final harvest.

Variety	Grain Yield (kg/ha)	L:S ratio (*GS 30-32)	DM (kg/ha) (*GS)
Frame	2120	1.67	1800
Goldmark	2200	2.56	1600
Kellalac	2280	1.58	1800
Silver Star	2730	1.38	1900
l.s.d. (*P*=0.05)	330	0.381	310

P value	<0.05	<0.001	ns

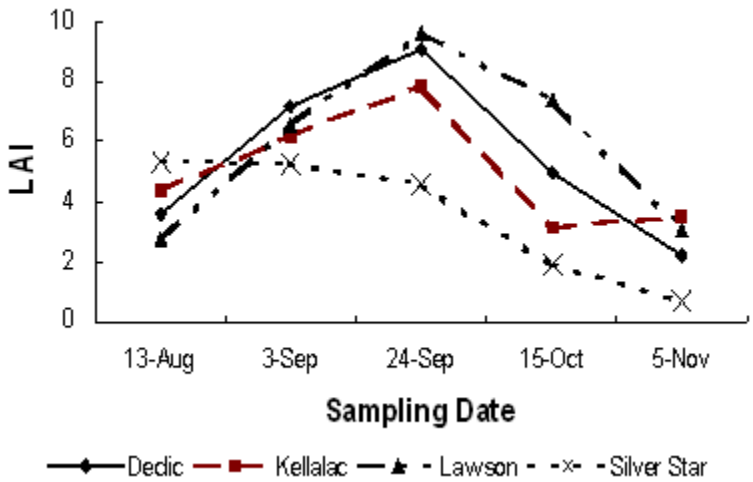

Figure 1. Leaf area index (LAI) of four wheat varieties with different maturities sown in May.

Results from 1999 trials suggest that a lower leaf:stem ratio during early growth, a lower leaf area and a higher harvest index may be important for increasing the grain yields of wheat in the high rainfall zone. There is potential to increase yields significantly in this region if ideal traits for the environment are identified.

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