

Performance of modern wheat cultivars as affected by leaf area, disease and weather conditions

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Abstract

The research undertaken has sought to improve the amount and quality of variety-specific information available to cereal growers on the South Coast of Western Australia. The South Coast environment is considerably different from the more traditional grain growing areas of the Western Region. Investigations were carried out to evaluate the performance of modern wheat cultivars for both yield and quality. Experiments were monitored for crop emergence, growth, green leaf area and diseases during the growing season.

A strong interaction existed between leaf area index, foliar diseases and yield of premium paying modern cultivars such as Camm, Carnamah, Cascades and Westonia on the Esperance Sandplain (high rainfall) and Mallee soils (low rainfall). Foliar diseases reduced the green area index and ultimately affected the yield of all varieties. This effect was particularly more devastating on the Esperance Sandplain than Mallee soils. The maximum green area index (GAI) of Camm was greatest at both sites. This was probably the result of Camm's later maturity and superior disease resistance. Carnamah out-yielded Cascades on the Mallee site but not on the Sandplain site mainly due to higher GAI and less leaf diseases at Salmon Gums. In a high disease season, Carnamah was the second best after Camm and could be considered a better alternative to Cascades on Mallee soils. There was no difference in yield and quality of Carnamah and Cascades on Sandplain soils. Both yielded 1.75 t/ha despite different disease levels (56 and 73%) respectively). Westonia yielded the most at Mallee soils but yielded the lowest on Sandplain soils. Westonia was found susceptible to stem rust during 1999 and could be a risky option in the Sandplain areas.

Key words: *wheat, cultivars, varieties, agronomy, Foliar diseases, green area index, yield, grain quality*

There are two distinct agricultural zones on the South Coast (5) – the Esperance Sandplain in the South (874, 000 hectares) and the Mallee to the North (874, 000 hectares). The Esperance Sandplain has large areas of grey sand over gravel or clay (duplex), ranging in depth from shallow to deep sands. These soils are prone to wind erosion and waterlogging. The Esperance mallee has mostly heavier loams (calcareous) or shallow sandy duplex soils that range from slightly acidic to highly alkaline. The average rainfall on the Sandplain is between 500mm and 700mm. Agricultural land use on the Sandplain is predominantly grazing and pastures (70%) and cropping (30%). In the Mallee the rainfall varies between 350mm and 500mm and strongly favours cropping.

Perry and Hillman (4) have indicated that the growing season on the south Coast is comparatively longer, with a greater component of summer rainfall and mild winter temperatures, giving rise to greater problems of grain sprouting and staining, and diseases such as the rusts and septorias. During 1999, experiments were conducted to study the effect of weather and climatic conditions on yield and quality of a range of premium paying modern wheat varieties on the Esperance Sandplain and Mallee soils.

Materials and methods

Experiments were sown on three occasions from mid May to mid June in 1999, on six sites both on the Sandplain and Mallee soils. There were 10 premium paying varieties (including Brookton, BT Schomburgk, Camm, Carnamah, Cunderdin, Cascades, Karlgarin, Perenjori, Stiletto and Westonia) and 6 Noodles and Soft grades (such as Ajana, Arrino, Calingiri, Krichauff, Tincurrin and WAWHT2179). These experiments were conducted in three rainfall zones (3) under different rotations including canola, lupins, peas and pastures (Table 1, 2, 3).

Wheat was sown at 75 kg/ha in high and medium rainfall sites and at 50kg/ha in low rainfall sites. Experiments were monitored for growth assessment, disease ranking, yield and quality (1). No foliar sprays were applied during the growing season.

The modern wheat cultivars Camm, Carnamah, Cascades and Westonia were further investigated for green area index (2) on the Esperance Sandplain soils (Esperance Downs, Gibson, high rainfall, >450 mm) and the Esperance Mallee soils (Salmon Gums, low rainfall, <350 mm). Crop growth, dry matter production and leaf area including green leaf, dead leaf and stem were measured at 25, 50, 75, 100 and 125 days after sowing (DAS). Foliar diseases such as leaf rust, stem rust and septorias were assessed at Zadok stages 71-75 after anthesis at high and low rainfall sites, and Zadok stages 51-59 at ear emergence at medium rainfall sites. Grains were analysed and assessed for quality including protein, moisture content, screening, hectoliter weight, thousand grain weight, sprouting, staining and falling numbers.

Results and discussion

In 1999, wet weather and mild temperature during harvesting in the months of November and December affected the quality of grains in the Esperance region (1). Results on yield and quality performance are presented for high rainfall sites at Gibson and Gairdner in Table 1, for medium rainfall sites at Scaddan/Cascade in Table 2 and for low rainfall sites at Salmon Gums and Mt Madden in Table 3. Plant population averaged about 150 plants/m² at high and medium rainfall sites and 100 plant/m² at low rainfall sites. There were small differences between the varieties but they were not sufficient to affect the results.

Table 1. Disease, yields and grain quality in high rainfall (>450mm, H5E) on grey deep sandy duplex.

Variety	Kim Norris, Gibson Crop rotation: after canola				Kevin Gleeson, Gairdner Crop rotation: after lupin			
	Leaf area Diseased (F, F-1 & F-2)*, %	Yield (t/ha)* *	Grain protein %	Falling Nos.	Leaf area Diseased (F, F-1 & F-2)*, %	Yield (t/ha)	Grain Protein %	Falling Nos.
AH/APW/ASW								
Brookton	48	1.78	8.7	212	66	1.57	9.1	89
Bt. Schomburgk	78	1.25	9.8	312	76	1.30	10.7	120
Camm	35	2.56	9.5	369	57	1.44	11.1	314
Carnamah	56	1.75	9.6	292	80	1.46	10.6	129
Cascades	73	1.76	9.7	325	65	1.40	10.3	146
Cunderdin	65	1.81	9.4	244	75	1.4	10.2	92
Karlgarin	80	2.19	9.0	341	68	1.46	9.5	78
Perenjori	63	2.00	10.3	373	81	1.41	11.3	214
Stiletto	62	1.47	9.1	342	73	1.37	10.7	328
Westonia	42	1.60	9.8	271	76	1.42	10.4	109
ASW only/Noodles/Soft grade								
Ajana	76	1.71	9.6	297	72	1.55	10.3	134
Arrino	83	1.67	9.6	210	86	1.31	11.0	90
Calingiri	40	2.11	9.5	286	69	1.63	10.5	269
Krichauff	49	2.02	9.3	234	75	1.46	10.2	78
Tincurrin	56	2.23	8.0	272	80	1.37	8.3	215
WAWHT2179	79	1.66	9.0	233	83	1.42	9.1	101
SED	-	0.31	0.1		-	.08	0.2	

*F= flag leaf, F-1 is second leaf, etc.

**The site was affected by Rhizoctonia - patches were cut out and yield adjusted to represent areas not affected.

Table 2. Disease, yields and grain quality in medium rainfall (<450mm, M5E) on grey shallow sandy duplex.

Variety	Mic Curnow, Scaddan/Cascade Crop rotation: after peas				Mic Curnow, Scaddan/Cascade Crop rotation: after lupin			
	Leaf area Diseased (F- 1, F-2 & F- 3)*, %	Yield (t/ha)	Grain protein %	Falling Nos.	Leaf area Diseased (F- 1, F-2 & F- 3)*, %	Yield (t/ha)	Grain protein %	Falling Nos.
AH/APW/ASW								
Brookton	8	3.91	9.1	125	4	2.83	8.7	178
Bt. Schomburgk	19	3.31	10.1	266	20	2.99	9.6	240
Camm	8	3.83	10.0	365	2	3.01	9.5	333
Carnamah	2	3.92	10.3	231	8	2.84	10.1	204
Cascades	29	3.47	9.4	230	26	2.84	8.6	271
Cunderdin	1	4.11	10.0	127	6	2.90	9.3	182
Karlgarin	57	3.30	9.6	305	29	2.85	8.9	276
Perenjori	4	3.56	10.5	192	8	2.78	10.7	312
Stiletto	8	3.50	9.8	339	24	2.61	8.9	330
Westonia	1	4.03	8.8	192	2	2.94	9.4	212
ASW only/Noodles/Soft grade								
Ajana	40	3.45	9.8	231	24	2.45	9.8	249
Arrino	17	3.19	9.5	355	7	2.78	9.9	199
Calingiri	1	3.59	10.1	296	3	2.97	9.9	274
Krichauff	1	3.85	9.8	137	19	3.01	9.1	301
Tincurrin	30	3.22	8.5	116	15	2.81	7.6	148
WAWHT2179	28	3.36	9.6	80	23	2.78	9.3	117
SED	-	0.07	0.3	-		0.22	0.13	

* F= flag leaf, F-1 is second leaf, etc.

Table 3. Disease, yields and grain quality in low rainfall (<325mm, L5) on alkaline grey shallow sandy duplex.

Variety	Rory Graham, Salmon Gums Crop rotation: after pasture				Steve Tillbrook, Mt Madden Crop rotation: after peas			
	Leaf area Diseased (F, F-1 & F-2)*, %	Yield (t/ha)	Grain protein %	Falling Nos.	Leaf area Diseased (F, F-1 & F-2)*, %	Yield (t/ha)	Grain protein %	Falling Nos.
AH/APW/ASW								
Brookton	40	2.73	9.7	394	74	2.34	11.3	63
Bt. Schomburgk	62	2.28	10.9	454	86	2.07	12.7	105
Camm	35	2.62	11.1	451	53	2.59	12.4	316
Carnamah	41	2.70	10.7	455	83	2.70	12.3	82
Cascades	45	2.28	10.6	424	73	2.11	12.2	196
Cunderdin	42	2.66	10.6	438	87	2.67	12.1	65
Karlgarin	73	2.50	9.7	420	82	2.49	11.1	281
Perenjori	41	2.45	10.8	398	73	2.48	12.4	168
Stiletto	56	2.44	10.4	408	66	2.32	11.6	422
Westonia	48	2.83	10.3	423	71	3.01	12.1	122
ASW only/Noodles/Soft grade								
Ajana	68	2.44	10.3	437	76	2.70	11.9	175
Arrino	75	2.16	10.0	407	91	2.34	12.1	77
Calingiri	11.4	2.32	10	316	67	2.89	12.1	249
Krichauff	20	2.84	10.2	460	55	2.92	11.9	65
Tincurrin	67	2.04	8.9	304	83	2.25	10.2	86
WAWHT2179	83	2.25	9.4	299	90	2.22	10.6	68
SED	-	0.20	0.14			0.07	0.36	

* F= flag leaf, F-1 is second leaf, etc.

Green leaf area

The maximum green area index (GAI) of Camm was greatest at both sites and it was reached later in the season (Figure 1), 90 DAS at Gibson and 100 DAS at Salmon Gums compared to 80 DAS for other varieties on both sites (Table 4). The combination of later maturity and superior disease resistance in Camm probably lead to this result.

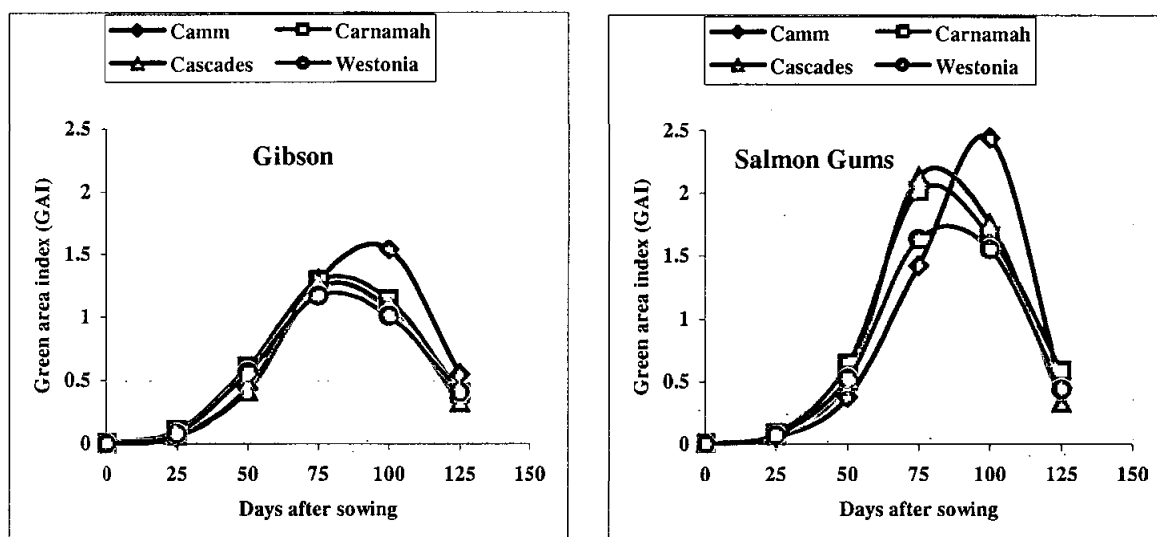


Figure 1. Leaf area development of four wheat varieties at Gibson and salmon Gums in 1999.

Table 4. Maximum GAI and days to Maximum GAI for different varieties

Location	Varieties			
	Camm	Carnamah	Cascades	Westonia
Gibson				
Max. GAI	1.6	1.3	1.25	1.2
Days to Max. GAI	90	80	80	80
Salmon Gums				
Max. GAI	2.4	2.1	2.2	1.7
Days to Max. GAI	100	80	80	85

After anthesis, the foliar diseases such as rusts and septorias were prominent and greatly reduced the GAI particularly of the top three leaves. The average area of the top three leaves that was diseased was compared with the grain yield and the maximum green area index of the growing seasons (Figure 2).

Foliar diseases generally reduced the green area index and resulted in lower yield. This effect was particularly more devastating on the Esperance Sandplain (high rainfall) than Mallee soils (low rainfall). Main diseases present at both sites were septorias in combination with leaf rust. Stem rust was a problem only late in the season. Camm had the highest GAI, and was least affected by foliar diseases (35%) in both environments.

Carnamah outyielded Cascades on the Mallee site but not on the Sandplain site mainly due to the higher GAI and less leaf diseases at Salmon Gums. In a high disease season, Carnamah was the second best after Camm and could be considered a better alternative to Cascades on Mallee soils. There was no difference in yield and quality of Carnamah and Cascades on Sandplain soils. Both yielded 1.75 t/ha despite different disease levels (56 and 73%) respectively). Westonia yielded most at Salmon Gums but was the lowest yielder at Gibson. Westonia was found susceptible to stem rust during 1999 and could be a risky option, particularly in high rainfall areas.

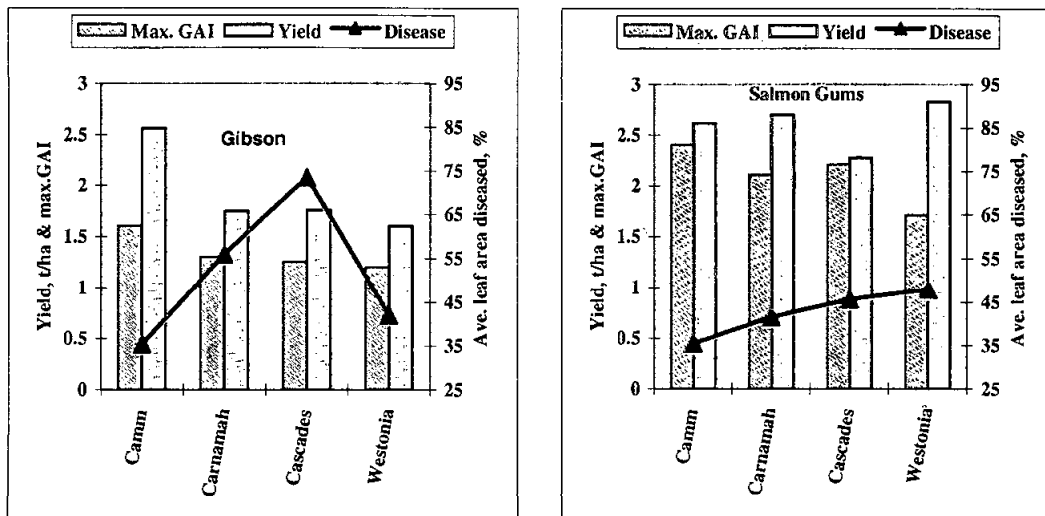


Figure 2. Maximum green area index, area diseased and grain yield at Gibson and Salmon Gums.

Conclusions

Camm, the triple rust resistant variety, has performed extremely well on all six sites both for yield and quality (including protein, sprouting, staining and falling numbers). Perenjori, Stiletto, Karlgarin, Carnamah and Cascades performed reasonably well in spite of heavy leaf diseases at anthesis. Quality issues such as grain sprouting and staining have greatly downgraded some of the high yielding varieties on all sites except Salmon Gums. Brookton, Cunderdin and Westonia yielded well but have been downgraded because of sprouting (low falling number) and fungal staining.

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