Agronomic management for production of Prime Hard quality wheat in South Australia.

H.A. Reimers[1], M.Miyan[1], M.Bennie[2], G.Hollamby[1], R.Holloway[2], G.McDonald[3], A.Rathjen[3] and R.Saunders[4]

[1]Adelaide University, Roseworthy Campus, SA.
[2] Minnipa Agricultural Centre, Minnipa, SA.
[3]Adelaide University, Waite Campus, Urrbrae, SA.
[4] SARDI, Loxton Research Centre, Loxton, SA.

Abstract

Management trials have been conducted to determine the agronomic management practices required to produce Prime Hard quality wheat in South Australia. The trials were at three sites (Minnipa, Roseworthy and Wunkar) over a five year trial period (1995-1999) and commenced with the pre-treatments in 1995. The results indicate the management systems required for the production of high quality, high protein wheat in South Australia differ depending upon the environment in which the wheat is produced. At the low rainfall sites (<350mm) moisture is the major limiting factor and so fallowing, chemical (at Minnipa) or mechanical (at Wunkar), has resulted in the best yields of grain of suitable protein level and adequate grain size. At the higher rainfall (440mm) Roseworthy site, incorporation of legumes into the rotation is required if the desired protein levels are to be reached. Based upon this study recommended management guidelines have been developed.

Key words

Wheat, protein, rotation, N rates, prime quality.

Introduction

The production of Prime Hard wheat is currently restricted to N.S.W and Queensland growers. Following an extensive research program conducted by NSW. Agriculture the area in which such wheat is received has recently been extended into southern N.S.W (1). Growers in Vic. and S.A. currently do not have access to a Prime Hard segregation and the research reported in this paper was conducted to determine the agronomic requirements to produce such high quality wheat in South Australia. Particular emphasis has been placed on research in the low rainfall areas of the Upper Eyre Peninsula and Northern Murray Mallee where the cropping options open to growers are restricted by the low and unreliable rainfall.

Methods

At each of 3 sites a split-split plot factorial field trial was conducted in which a comparison was made between 4 potential Prime Hard quality varieties, at 6 rates of nitrogen, following 3 pre-treatments. The pre-treatments, which were sown in the year before each wheat trial, were selected to reflect common district practices and recommended rotational management and so differed at the 3 sites. At Minnipa (upper Eyre Peninsula), a crop of field peas was grown for grain production in the year before whilst at Wunkar (northern Murray Mallee) annual medic was used. At Roseworthy (Lower North) field peas were turned in as a green manure crop. All 3 sites had a chemical fallow pre-treatment and Minnipa and Roseworthy had oats as a pre-treatment whilst Wunkar included a mechanical fallow. The 4 varieties were Janz, Molineux, Kukri and Sunstar and each was sown at a density of 200 germinable seeds/m^2. The 6 nitrogen treatments (0, 15 kg N, 30 kg N, 45 kg N, 15 kg N at sowing + 15 kg N at tillering (Zadok 23) and 15 kg N at sowing + 15 kg N at anthesis (Zadok 65)) were changed in 1998 to include a 7.5 kg at sowing in place of the split anthesis treatment which had shown no response in the first two years. All N (NH_4NO_3) treatments were banded below the seed whilst triple super + 5% Zn was applied with the seed at the rate of 100 kg/ha across all treatments.

Data for soil moisture and nitrate nitrogen at seeding, emergence counts, dry matter production at tillering and anthesis, grain yield, grain quality and flour and dough quality were collected for each of the four years in which wheat was grown. The underlined data is not given in this paper. Grain yield and protein data are given in Tables 1-3 whilst selected data from other measurements taken are referred to in the text. Analysis of variance was carried out using Genstat for Windows version 4.1.

Results and Discussion

The two low rainfall sites, (Tables 1and 2), were similar in that the highest yields at adequate protein levels followed fallow pre-treatments. The subsoil moisture collected at time of seeding was higher under the fallow pre-treatments compared with the crop and pasture pre-treatments (data not shown). There was no significant yield response to nitrogen treatments above 15 kg N. Thus only low rates of nitrogen could be recommended in order to maintain adequate protein levels and yet avoid haying off with excessive protein levels and inadequate grain size. Split applications of nitrogen were ineffective in these dry environments and so application at seeding is recommended.

Table 1. Mean yield t/ha and protein (%) of management trials at Minnipa 1996-1999.

Pre-treat	**peas***	**oats**	**chem. Fallow**				**l.s.d. 0.05**
1996	0.88(14.0)	0.91(14.3)	1.02(15.2)				0.11 (#)
1997	1.46(13.4)	1.18(12.8)	1.76(12.7)				0.39 (#)
1998	1.70(15.2)	1.65(14.7)	1.79(14.7)				n.s. (n.s.)
1999	0.95(15.8)	0.49(15.9)	1.31(15.0)				0.08 (0.33)
Variety	**Molineux**	**Sunstar^**	**Janz**	**Kukri**			
1996	0.78(14.9)	0.83(14.7)	1.06(14.5)	1.07(14.7)			0.05 (#)
1997	1.52(13.4)	1.40(12.9)	1.53(12.4)	1.40(13.0)			0.07 (#)
1998	1.44(15.2)	1.65(15.2)	1.95(14.5)	1.81(14.8)			0.06 (0.20)
1999	0.93(15.7)	0.78(15.5)	0.99(15.0)	0.97(16.0)			0.05 (0.18)
N treat	**zero**	**7.5kg***	**15kg**	**15/15T**	**30kg**	**45kg**	
1996	0.90(13.9)		0.96(14.3)	0.92(15.0)	0.95(14.7)	0.96(14.8)	0.31 (#)
1997	1.44(12.5)		1.48(12.8)	1.46(13.2)	1.47(13.1)	1.46(13.1)	n.s. (#)
1998	1.72(14.6)	1.71(14.9)	1.71(15.0)	1.71(15.0)	1.73(14.9)	1.71(15.0)	n.s (0.22)
1999	0.91(15.5)	0.93(15.6)	0.92(15.5)	0.92(15.6)	0.91(15.5)	0.91(15.7)	n.s. (n.s.)

Interactions for yield	**l.s.d.0.05**	**Interactions for protein %**	**l.s.d.0.05**
1996 n.s.			#
1997 pre-treatment X variety			#
1998 pre-treatment X variety		pre-treatment X variety	0.67
1999 pre-treatment X variety			n.s.

* Note: In 1996 vetch was used as a pre-treatment and Suneca was used as a Prime Hard quality variety.
# Note: Protein levels obtained from an unreplicated bulked sample in 1996 and 1997. Replicated samples in 1998 and 1999, NIR technique was used.

The recognised Prime Hard variety Janz was consistent in producing the highest yields, however protein levels and grain size were lower than those achieved by the other varieties. The newly released Kukri yielded well and produced higher levels of protein with larger grains when compared to Janz. Sunstar was lower in yield than Janz or Kukri grown at Minnipa but was similar in performance to Kukri at Wunkar.

Molineux yielded poorly in comparison to the other varieties, except in 1997 at Minnipa when there were rains at the end of October.

Prime Hard quality standards were maintained when wheat was grown in these environments. In addition, Kukri was found to have qualities that ideally suited it for use as a source of flour for high protein Asian noodles that are currently produced from selected Prime Hard varieties grown in N.S.W and Qld. The major agronomic problems, which occurred in these low rainfall environments, were low yields and small grain size. Low and variable yields in these low rainfall areas are characteristic of wheat growing in general and not simply due to Prime Hard types. For example, the average wheat yields in the management trials at Minnipa agricultural centre in 1996 and 1997 were 0.94 t/ha and 1.46 t/ha respectively even though the April to October rainfall was over 40 mm higher in 1996. The low yields in 1996 were mainly attributed to late seeding resulting from a late seasonal break and a dry October. The 1997 season had good spring rains.

At the higher rainfall Roseworthy site, (Table 3), the green manure pre-treatment resulted in high yields at adequate protein levels. The oats pre-treatment consistently produced the lowest yields and lowest protein levels. No significant yield response was obtained with application of nitrogen following green manure, however increased yields and protein levels were obtained following application of nitrogen to the oats pre-treatment plots in 2 of the 3 years reported.

Janz was the highest yielding variety in this environment, but consistently produced lower protein levels than the other varieties that were larger grained. Overall, at the Roseworthy site, it was difficult to achieve the minimum protein levels (13%) required of Prime Hard even though yields were high.

Table 2. Mean yield t/ha and protein (%) of management trials at Wunkar 1996-1999.

Pre-treat	**medic**	**mech. Fall**	**chem. Fallow**				
	l.s.d.0.05						
1996	0.72(14.8)	0.87(15.2)	0.82(14.7)			0.04	(#)
1997	1.26(14.2)	1.30(14.1)	1.22(14.3)			n.s.	(#)
1998	1.79(13.3)	1.94(13.4)	1.84(13.3)			n.s.	(n.s.)
1999	1.22(14.0)	2.11(13.4)	1.59(13.8)			0.42	(n.s.)
Variety	**Molineux**	**Sunstar**	**Janz**	**Kukri**			
1996	0.46(15.0)	0.82(14.8)	1.06(14.7)	0.88(15.0)		0.05	(#)
1997	1.02(15.4)	1.36(13.6)	1.33(13.7)	1.32(14.1)		0.06	(#)
1998	1.79(13.7)	1.95(13.4)	1.88(12.9)	1.83(13.5)		0.09	(0.23)
1999	1.48(13.7)	1.63(14.1)	1.79(13.1)	1.65(13.9)		0.17	(0.35)
N treatment	**zero**	**7.5kg**	**15kg**	**15/15T**	**30kg**	**45kg**	
1996	0.78(14.5)		0.81(14.8)	0.83(15.0)	0.81(15.0)	0.80(15.2)	n.s. (#)
1997	1.19(13.7)		1.27(14.1)	1.26(14.8)	1.28(14.8)	1.28(14.5)	0.05 (#)
1998	1.78(13.0)	1.89(13.2)	1.89(13.3)	1.89(13.5)	1.85(13.7)	1.87(13.5)	n.s. (0.22)
1999	1.62(13.2)	1.60(13.5)	1.64(13.5)	1.68(13.9)	1.67(14.0)	1.62(14.2)	0.06 (0.27)

Interactions for yield	**l.s.d.0.05**	**Interactions for protein %**
	l.s.d.0.05	
1996	pre-treatment X variety	#
1997	n.s.	#
1998	n.s.	n.s.
1999	n.s.	n.s.

Note: Protein levels obtained from an unreplicated bulked sample in 1996 and 1997. Replicated samples in 1998 and 1999, NIR technique was used.

Table 3. Mean yield t/ha and protein (%) of management trials at Roseworthy 1997-1999.

Pre-treat	green manure	oats	chem. fallow				l.s.d. 0.05
1997	2.36(11.5)	2.14(8.5)	1.88(8.7)				n.s. (#)
1998	4.01(12.7)	3.52(10.0)	3.81(12.6)				0.13 (0.17)
1999	3.91(14.0)	3.17(11.6)	4.31(12.9)				0.43 (0.34)
Variety	**Molineux**	**Sunstar**	**Janz**	**Kukri**			
1997	1.87(10.1)	2.20(9.2)	2.35(9.0)	2.09(9.6)			0.11 (#)
1998	3.21(12.0)	3.69(11.9)	4.35(11.4)	3.85(11.9)			0.26 (0.20)
1999	3.62(12.6)	3.76(13.1)	4.06(12.3)	3.74(13.3)			0.29 (0.35)
N treat	**zero**	**7.5kg**	**15kg**	**15/15T**	**30kg**	**45kg**	
1997	1.95(8.7)		2.17(9.2)	2.13(9.7)	2.21(9.7)	2.16(10.5)	0.11 (#)
1998	3.45(11.5)	3.85(11.7)	3.84(11.6)	3.86(12.0)	3.82(11.9)	3.8411.9)	0.11 (0.26)
1999	3.81(12.7)	3.72(12.7)	3.84(12.8)	3.85(13.0)	3.72(13.0)	3.84(12.8)	n.s (0.19)

Interactions for yield	l.s.d.0.05	Interactions for protein %	l.s.d.0.05
1997 pre-treatment X treatment	0.43		#
1998 pre-treatment X treatment	0.21	pre-treatment X variety	0.33
1999 n.s.		pre-treatment X treatment	0.43

Note: Protein levels obtained from an unreplicated bulked sample in 1997. Replicated samples in 1998 and 1999, NIR technique was used.

Conclusions

The recommended management for the production of prime quality, high protein wheat in South Australia differs depending upon the production and edaphic environment.

The following management practices will increase the probability of achieving better yields of larger grains within the desired 13-16%. protein range.

For the upper Eyre Peninsula and northern Murray Mallee moisture conservation in the subsoil is critical so sow after a fallow (chemical or mechanical/chemical) commenced in the previous late winter/early spring. Use high quality varieties Janz or Kukri seeded at the rate of 200 viable seeds/m^2 in early to mid-May with no more than 15 kg/ha N.

For the Lower North it is difficult to achieve the minimum protein level of 13% unless the crop is grown after a green manure crop of legume. If a green manure crop is used do not apply N fertiliser at a rate above 15 kg/ha of N. When grown after a cereal, higher rates of N will increase both protein and yield but 13% protein is unlikely to be achieved unless haying off occurs. Use high quality varieties Janz or Kukri seeded at the rate of 200-250 viable seeds/m^2 in the third week of May.

Growers in the Lower North should consider the possibility of growing durum rather than prime quality high protein wheat. Direct comparisons, using the same treatments, conducted over a two year period have indicated the achievement of higher protein levels with increased returns from durum.

All other practices that contribute to the production of high quality grain should be maintained along with these recommendations. Particular attention should be taken to application of trace elements such as Zn. Also, as many producers are currently using Diammonium phosphate as their P source care must be taken not to exceed the recommended N rate and so increase the probability of increased screenings and excessive levels of protein**.**

Adherence to these recommendations should increase the probability of achieving the quality standards required for Prime Hard wheat. Where high screenings percentages have been a problem with Janz the larger seeded early variety Kukri may assist. The AWB would prefer delivery of more than one variety to this segregation if a further southern Prime Hard class is to be created in the future. As the yield of these Prime Hard quality varieties is approximately 10% below that of the current highest yielding Australian Hard variety (Yitpi) received in South Australia, growers will need to be paid a premium for the high quality grain they produce.

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