4. NUTRITION TRIALS

4.1 MANIPULATING WHEAT GRAIN PROTEIN THROUGH NITROGEN APPLICATION

Can the lessons learnt in growing Prime Hard wheat in southern NSW be extended to the high rainfall grain regions of Southern Victoria?

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Introduction:
Prime hard (PH) and Australian hard (AH) grade wheat has been successfully grown in higher rainfall areas of southern NSW over the last three seasons. Given this success, it is thought that the high rainfall cropping areas of Victoria & SA (>500 mm p.a.) have potential given suitable management & varieties. Potential benefits for growers pursuing high protein wheat in this area include: (i) traditionally Victorian wheat yields have been limited through nitrogen deficiency as evidenced by the low protein wheat delivered to silos - once grain is below a threshold protein (thought to be 10%), yield will be reduced. (ii) Historically, higher protein grades of wheat have attracted a price premium translating to better returns. (iii) With a strong pasture history, residual soil nitrogen levels tend to be high - this is of benefit to growers who incur large start up costs with the transition to cropping - it is thought that the initial years of cropping will not require high rates of nitrogenous fertilizers despite high yield potential.

Table 1: Wheat Quality Analysis of Selected Samples From 1999 Program:

Site	Skipton	**Skipton**	**Skipton**	Gnarwarre	Gnarwarre	Gnarwarre	Skipton	Benchmark Or Typical
Variety	Janz	**Chara**	**Chara**	Janz	Janz	Kellalac	Janz	
Wheat Results..........								
Test Weight (kg/hl)	81.5	**79.5**	**80.0**	82.0	81.5	77.0	80.5	>74
Protein % (11% mb)	12.9	**13.7**	**13.8**	11.7	12.1	13.9	13.8	>13.0
Hardness (PSI)	16	**15**	**16**	13	14	16	18	14 – 24
Screenings % (2.00 mm)	1.6	**0.9**	**1.2**	1.6	1.7	2.2	1.2	<5
1000 Kernal Weight (g)	40.8	**38.6**	**36.8**	36.0	38.0	32.0	37.7	>25
Flour Results...........								
Extraction %	74.6	**74.2**	**75.7**	76.7	75.3	74.2	74.0	76
Protein % (14.0% mb)	11.8	**12.7**	**12.7**	10.7	10.9	12.5	12.8	>12
Colour Grade	-1.8	**-1.3**	**-1.4**	-2.4	-2.3	-1.8	-1.2	<10
Water Absorption %	67.4	**65.2**	**65.6**	63.0	64.7	61.2	68.2	>60 is excellent
Extensibility (cm) 45 min	19.1	**24.8**	**23.4**	17.1	20.6	22.5	19.7	25
Height (BU) 45 min	395	**500**	**570**	315	305	210	375	500
Alveograph L (mm)	74	**97**	**112**	82	73	111	81	>95 high extensibility
Alveograph W ($Jx10^{-4}$)	380	**490**	**505**	240	280	195	350	>350 high dough strength

A series of trials in the 1999 season indicated that wheat of equivalent or higher quality than current PH standard was grown at Streatham (see table 1). The variety that produced these results was Chara, while Janz produced more variable results. The one sample of Kellalac tested also produced variable results.

In 2000, 5 sites were established – Dookie (north Vic), Gnarwarre (SFS), Woorndoo (SFS Streatham), Naracoorte (south east SA) & Clare (mid-north SA). Trials compared tactical nitrogen management options for improving nitrogen use and high quality wheat varieties including Janz, Chara & Mira.

Materials and Methods

Management Schedule:

	Gnarwarre	Woorndoo
Previous Crop	Canola 1999	Lupins 1999 Wheat 1998
Soil sample date	03/04/00	05/04/00
Pre-plant herbicide & date	Pre-sow (16/06/00) Roundup 2.0 l/ha + LI700 100 ml/100l	Pre-sow (15/05/00) Roundup 2.0 l/ha + Stomp 1.25 l/ha + LI700 400 ml/100l Post-sow/pre-em (15/05/00) Logran 35 g/ha + Dual gold 300 ml/ha
Sowing date	16/06/00	15/05/00
Basal Fert/Rate	Granulock 12 150 kg/ha	Granulock 12 150 kg/ha
Emerge count & date		07/06/00 163/m^2
Post-em Herbicide & date	Monza g/ha + 250 mL/ha Lontrel + Le-mat 100 mL/ha 10/07/00 Topik 200mL/ha + spray oil 11/08/00	Ally 5g/ha + Le-mat 150 ml/ha + LI700 100 ml/100l 07/06/00 (1-leaf)
Foliar Fertilizers		Librel Zn 1 kg/ha + Wetter 100 ml/100l 02/08/00
Shoot counts	05/09/00	02/08/00
Topdress: Z31 Z41 Z65	 13/09/00 27/10/00	 13/09/00 17/10/00
DM cuts	27/10/00	17/10/00
Harvest	20/12/00	02/01/01

Each site was designed to assess rate x split x timing of nitrogen application. At Gnarwarre, the boot stage top dress was moved forward to first node stage due to severe nitrogen deficiency. The design was randomised block with three replicates. At both sites the benchmark variety was Janz. Chara was compared to Janz at Gnarwarre while at Woorndoo, Mira was the comparison variety.

Soil Measurements:
Each replicate was shallow (0 - 10 cm) & deep (10 - 60 cm) sampled prior to sowing. 12 shallow cores & 3 deep cores were taken from each replicate. Samples were analysed for texture, pH (water & $CaCl_2$), OC%, ammonium & nitrate nitrogen, Olsen P, exchangeable cations (Ca, Mg, K, Na & Al), EC_{se}, Cu, Zn, Mn, Fe & B.

Plant Measurements:
Emergence counts were taken approximately 3 - 4 weeks after sowing. Tiller counts were taken at DC30 on selected plots (0, 40, 80, 120 & 160 kgN/ha) across both varieties.

Application of Nitrogen Treatments:
Planting N treatments were applied as urea on 444 mm row spacings using a disk opener. Top dress N treatments were applied as ammonium nitrate (Nitram®) spread by hand.

Dry Matter Cuts:
Dry matter cuts were taken from selected plots at DC65 to determine dry matter accumulation & nutrient uptake.

Yield, Protein & Quality Data:
Yield was measured at each site by harvesting the inner six of the eight rows sown in each plot. Grain protein was determined using the near infrared spectrometry (NIR) for total nitrogen determination. Grain quality attributes are to be assessed on selected samples based on grain protein.

Results & Discussion

Soil Data

Sites were identified and soil sampled in May 2000. Gnarwarre in particular had very low (48 kg/ha) profile nitrogen while Woorndoo was more variable across the site 50 – 120 kgN/ha. Early in the trial at Woorndoo, it became evident that all was not well – what initially appeared to be a micronutrient disorder was later diagnosed as Take-all which severely limited the progress and responsiveness of the trial.

The occurrence of this disease and the apparent lack of responsiveness to nitrogen at this site highlights the extreme importance of the need for good rotations and excellent grass weed control in this area. If there is any risk of root disease, forget about growing anything other than feed wheat.

	Gnarwarre	Woorndoo
Texture	Light Clay	Silty Clay Loam
pH (water)	5.9	5.5
pH ($CaCl_2$)	5.1	5.2
OC %	1.7	3.0
Mineralised Nitrogen (kgN/ha)	80	80
Inorganic (kgN/ha 0–60 cm)	48	90
P Olsen	10	9.5
K	1.1	0.75
Al %		0.8
Na %	3	5.8
EC_{se}	0.9	1.8
Cu	1.0	0.7
Zn	0.2	0.9
Median GSR (Apr – Nov)	379	384
GSR	436	512

Dry Matter & Nutrient Uptake at DC65

The table below confirms the effects of root disease on the crop at Woorndoo – no significant differences in dry matter at flowering or in nitrogen uptake despite an excellent season. Gnarwarre on the other hand provides some useful information. In what may be described as a highly nitrogen deficient situation, the application of 80 kgN/ha provided extremely efficient uptake.

At 80 kgN/ha, the striking difference is between the two methods used to apply nitrogen – mid-row banding (MRB) and broadcast & incorporated by sowing (IBS). For 80 N, IBS provides near significant improvement in uptake while at 160 N IBS does give a significant effect. This suggests that mid row banding has indeed had an effect on the supply of nitrogen to the crop by delaying the evolution of plant available nitrate nitrogen. When yield data is considered, a different trend emerges........

Gnarwarre		Treatment	Woorndoo	
Dry Matter (kg/ha)	N uptake (kg/ha)		Dry Matter (kg/ha)	N uptake (kg/ha)
6879	59.9	Control	8653	122
11601	144.1	80 MRB	9753	187
12217	190.8	80 IBS	9123	149
9548	154.4	160 MRB	9695	166
10047	225.9	160 IBS	9064	170
1419	47.6	LSD	2528	84.1
<0.001	<0.001	P	0.833	0.501

Yield Data

Gnarwarre			Woorndoo		
N Treatment	Variety		N Treatment	Variety	
	Janz	Chara		Janz	Mira
CONTROL	2674	3457	CONTROL	5237	5592
40 MRB	3722		40 MRB	5495	
40 DC31	4012		40 DC41	5389	
40 DC65	2847		40 DC65	5192	
80 MRB	4670	4756	80 MRB	5305	5671
80 IBS	4371		80 IBS	5536	
80 DC31	5402		80 DC41	5743	
80 DC65	4084		80 DC65	5194	
40 MRB:40 DC31	4399		40 MRB:40 DC41	5637	
40 MRB:40 DC65	4164		40 MRB:40 DC65	5669	
120 MRB	4776		120 MRB	5698	
160 MRB	4951	5035	160 MRB	5419	5930
160 IBS	4577		160 IBS	5781	
80 MRB:80 DC31	4929	5466	80 MRB:80 DC41	5716	5932
80 MRB:80 DC65	5349		80 MRB:80 DC65	5472	
80 MRB:40 DC31:40 DC65	4850		80 MRB:40 DC41:40 DC65	5567	
	LSD (5%)	**P**		**LSD (5%)**	**P**
Treatment (all vars)	797	<0.001	Treatment (all vars)	382	0.004
Variety	834	<0.001	Variety		
Treatment x Variety	N.S.		Treatment x Variety	N.S	

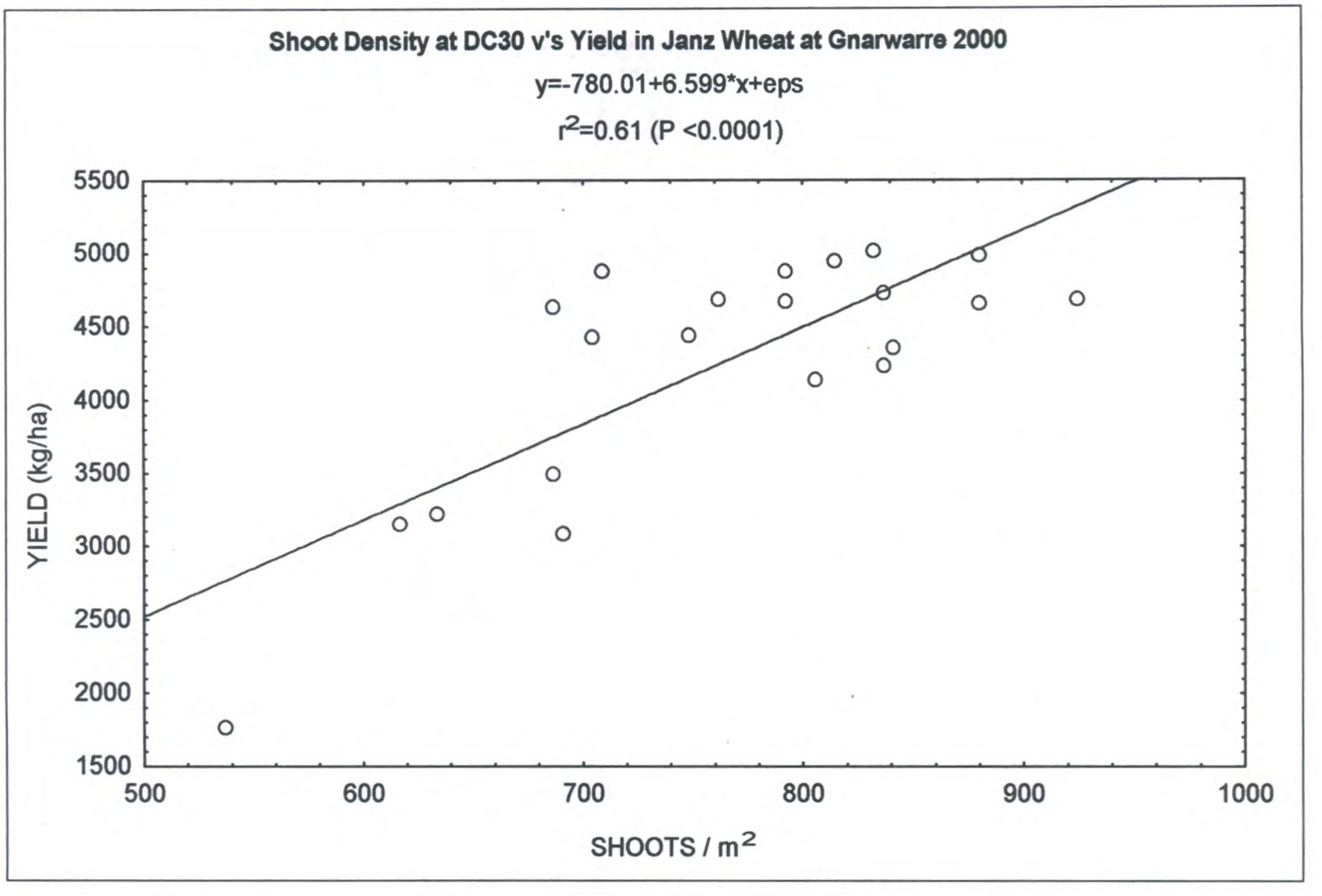
Due to root disease at Woorndoo, not too much should be read into yield data due to the varying severity of Take-all patches through out the plots. It is interesting to note however, that it is generally split applications of nitrogen that gave the best yield results relative to the total amount of nitrogen applied. This perhaps suggests improved nitrogen supply to the damaged root system by splitting N applications. Gnarwarre was extremely nitrogen responsive with almost a linear response to applied fertilizer nitrogen. This is in stark contrast to the site at Gnarwarre in 1999, which had extremely high profile inorganic nitrogen levels. This type of variability, coupled with a farm survey of profile nitrogen levels in the region during 2000 has highlighted the variability and the fact that deep soil testing is a critical tool in managing cereal and oilseed crops in this area.

In terms of variety, Chara was clearly superior yielding to Janz. When the data for dry matter accumulation is considered, the trend at flowering for the IBS treatments to give higher dry matter and N-uptake, have been reversed for grain yield. This suggests that while IBS is a quick way of moving nitrogen into the plant and encouraging earlier dry matter accumulation, it may indeed lead to wasteful water consumption early in the crop resulting in lower yields where water is limiting (during grain fill in most years).

When nitrogen treatments are compared within rate, it is interesting to note that for both 40 & 80 kgN/ha, a single top dress at the fully tillered stage gave full yield recovery and best yield for that rate of nitrogen. This suggests either that tiller production was adequate with no applied nitrogen or that the crop continued tillering after the fully tillered stage. When tiller density is considered in 0N treatments at fully tillered stage, average density was around 615 / m^2. At flowering, density had fallen to 510 / m^2 suggesting that the top dressed nitrogen was not responsible for increasing yield potential, rather maintaining it.

Other take home messages are that very late applied nitrogen at flowering can have some affect on yield although it is more likely to contribute to protein. This appears to be more so where the early potential of the crop has boosted by the application of nitrogen at planting.

Shoot Density & the Effect on Yield



Tiller density counts at Woorndoo showed only small responses to increased nitrogen status, again exhibiting the effects of root disease. At Gnarwarre, a strong increase in density was observed in response to added nitrogen. The graph above indicates the sort of relationship expected between shoot counts at the fully tillered stage and end crop yield where crop water is not excessively limited during spring. While the slope of this line is expected to remain constant, in years with a better start, it is expected that the line may move to the left to reflect larger grain heads in the crop.

At other experimental sites this year, where bigger heads were observed, it was noted that grain yield either reached a plateau, or in some cases started to decline past a certain shoot density. This is important information, suggesting that excessive early nitrogen nutrition may lead to haying off and/or excessive early development of leaf disease which will penalise yield and quality.

Conclusion:
A full report will be written when protein & quality analyses are complete.