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WI 3107 - A New Hulless Barley developed for southern Australia

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Summary

WI 3107 is a new hulless barley developed by the South Australian Barley Improvement Program with a national, co-ordinated approach to the development of a hulless barley industry. WI 3107 was bred from a simple cross between Galleon, a well adapted, CCN resistant, South Australian feed variety, and CIMMYT 42002, a hulless 2-row barley line with bright, white and plump grain selected from CIMMYT, Mexico.

WI 3107 was developed as a hulless replacement for Namoi averaging 4% higher yields. In 1998, WI 3107's average across South Australia was 2% above Namoi, in 1999 was 10% above Namoi and in 2000 was 16% above Namoi with best performances in Mid North, Yorke Peninsula and Lower Eyre Peninsula districts. WI 3107 produces larger grain and has better feed and malt quality than Namoi.

WI 3107 has a similar plant type to Galleon and is shorter and early maturing compared to Namoi. WI 3107 has a higher yield potential than Namoi in all agro-ecological zones of South Australia. It is less susceptible than Namoi to leaf rust, powdery mildew and spot form of net blotch. It is sensitive to both manganese and zinc deficiencies.

Breeding, Selection and Performance in Adelaide University Trials

WI 3107 progressed through early generation selection trials and was promoted to Adelaide University Stage 3 trials in 1995. Table I provides a summary of grain yields (expressed as a % of Schooner) from replicated trials grown over five seasons for WI 3107 compared to Namoi and three other major barley varieties. The South Australian Barley Improvement Program, at the University of Adelaide, conducted these trials. WI 3107 produced grain yields that ranged between 2 and 22 percentage points higher than Namoi in four out of five growing seasons.

Table I: Grain yield of barley varieties (as % of Schooner) in Adelaide University breeding trials (1996 - 2000)

Genotype	1996 6 Sites	1997 6 Sites	1998 5 Sites	1999 6 sites	2000 6 sites
WI 3107	87	101	87	87	95
Namoi	85	86	71	89	81
Barque	-	-	87	112	107
Schooner	100	100	100	100	100

Yield and Adaptation

Subsequently, it was promoted to SARDI Stage 3 trials in 1997. WI 3107 has now completed three years of SARDI Stage 4 trial evaluation in South Australia and will be included in this trial series in 2001. Figure 1 and Table II provide a summary of the South Australian yield of WI 3107 in SARDI Stage 4 trials over 1998, 1999 and 2000. It has also been included in collaborative trials in Victoria, New South Wales, Queensland and Western Australia since 1997. Results from 2000 collaborative trials indicated WI 3107 yielded up to 30% above Namoi with the best performances at Condobolin, New South Wales and Wagga Wagga, New South Wales. At Raywood, Victoria WI 3107 yielded 3% above Namoi and at Hermitage, Queensland WI 3107 yielded 13% lower than Namoi.

Figure 1: Grain yield of WI 3107 in South Australia compared to Namoi in SARDI Stage 4 Trials (expressed as mean of 21 sites from 1998 and 1999 and 20 sites from 2000). Yield expressed as a percentage of Schooner.

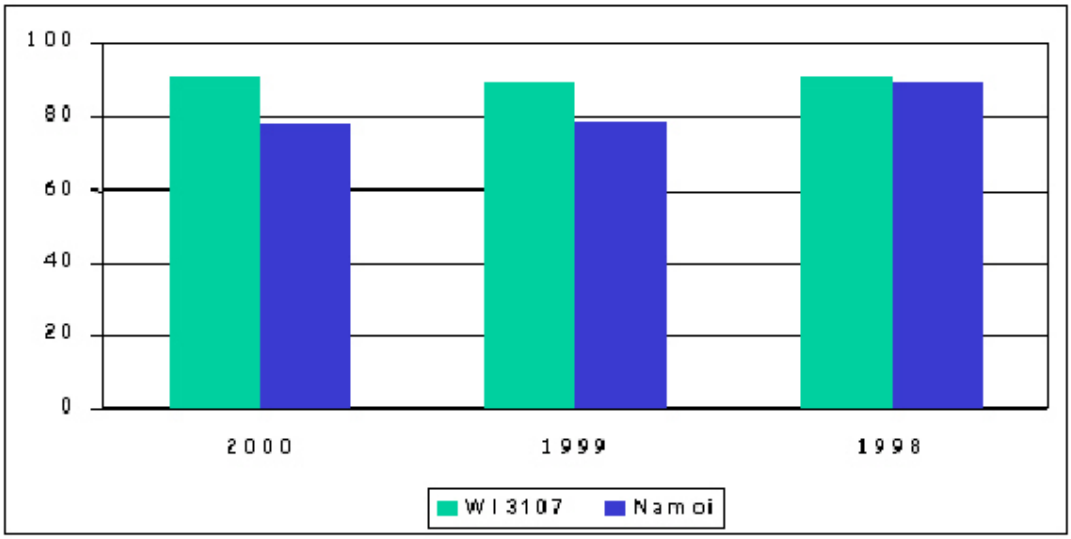

Table II: Grain yield of barley varieties (as % of Schooner) in different agro-ecological zones of South Australia (Stage 4 Trials, 1998 and 1999)

Genotype	**Yorke Peninsula**	**Mid North**	**Murray Mallee**	**South East**	**Lower Eyre Peninsula**	**Central, East & West E.P.**
WI 3107	94	94	90	95	93	91
Namoi	91	92	86	92	89	85
Barque	108	108	112	107	108	113

Table III provides a summary of grain yields (expressed as a % of Schooner) from single replicated trials grown at Hermitage, Queensland, Condobolin and Wagga Wagga, NSW and Raywood, Victoria in 2000 for WI 3107 compared to Namoi, Barque and Schooner.

Table III: Grain yield of barley varieties (as % of Schooner) in Collaborative Trials grown in 2000

Genotype	**Hermitage**	**Condobolin**	**Wagga Wagga**	**Raywood**
WI 3107	90	85	79	80
Namoi	75	79	92	81
Barque	-	97	90	108
Schooner	100	100	100	100

Table IV provides a summary of grain yields for WI 3107 (expressed as % of Namoi) from single replicated trials grown at Hermitage, Queensland and Condobolin and Wagga Wagga, NSW in 1998 and 1999. In 1998 WI 3107 averaged up to 45% higher than Namoi at Wagga Wagga. In 1999, WI 3107 averaged 3% higher than Namoi at Wagga Wagga and 18% higher than Namoi at Condobolin.

Table IV: Grain yield of WI 3107 (as % of Namoi) in Collaborative Trials grown in 1998 and 1999.

Year	**Genotype**	**Site Name**		
		Hermitage	**Condobolin**	**Wagga Wagga**
1998	WI 3107	-	136	145
1999	WI 3107	104	118	103

Disease Resistance

Table V provides a summary of the disease ratings of WI 3107 and other major barley varieties. These ratings are based on observations made in field trials and field and laboratory disease screening nurseries by the Field Crops Pathology Unit (SARDI) and University of Adelaide.

Table V: Disease ratings for WI 3107 and other major barley varieties.

Genotype	**Leaf Scald**	**Powdery Mildew**	**Leaf Rust**	**Spot form of net blotch**	**P. neglectus**		**CCN**
					resistance	**tolerance**	
WI 3107	MS	MR/MS	MR/S	MS	MR	I	R
Namoi	MR	S	S	MS	MR	I	S
Barque	S	MR/MS	S	MR	MS	MT	R
Schooner	MS/S	S	S	MS/S	MR/MS	MI	S

Disease rating codes: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, VS = very susceptible, MT = moderately tolerant, MI = moderately intolerant, I = intolerant

Physical Grain Quality

Table VI provides a summary of grain plumpness and 1000 grain weights of WI 3107 compared to other major barley varieties from SARDI Stage 4 trials from 1998 and 1999 seasons. For the 1998 season, the range of grain plumpness for WI 3107 was between 5% at Minnipa and 84% at Lameroo. In addition, 12 sites had grain plumpness greater than 60% for WI 3107. The lower grain plumpness percentages for both seasons may be explained by the drier conditions experienced during flowering and grain filling periods.

Table VI: 1998, 1999 and 2000 SARDI Stage 4 trial results for grain plumpness (>2.5mm) and 1000 grain weight (gm/1000 seeds). These results are expressed as a mean of 21 sites around South Australia.

Genotype	**1998**		**1999**		**2000**	
	grain size (>2.5mm)	1000 gr wt (gm/1000 seeds)	grain size (>2.5mm)	1000 gr wt (gm/1000 seeds)	grain size (>2.5mm)	1000 gr wt (gm/1000 seeds)
WI 3107	55	36.12	50	35.37	64	37.97
Namoi	47	37.24	32	36.41	46	37.79
Barque	76	41.81	82	41.39	76	41.83
Schooner	75	38.87	82	38.59	79	39.98

Recommended End Use and Grain Quality

Progress with Animal Feed Quality

The primary use of hulless barley in Canada is in pig diets. One of the major objectives of the South Australian program is to develop hulless barleys that have potential in Australia's pig industry. In South Australia, we have evaluated eight hulless barley genotypes in three animal feeding assays - *in vitro* digestible dry matter, *in vitro* pig digestible energy (DE) and *in vivo* apparent metabolisable energy (AME) in chickens. In all three assays, the hulless genotypes are clearly superior to the covered control Schooner (Table VII). Barr and Kniepp (1995) estimated that a unit of AME was worth approximately $20 per tonne at 1995 feed prices. On this basis, hulless barley is valued at between $10 (SB85216) and $24 (Namoi) per tonne more than Schooner. This data is encouraging but more research into *in vivo* pig digestible energy and amino acid digestibility is required before hulless barley cultivars could be launched confidently into the Australian pig industry. WI 3107 was not included in this preliminary study and will be analysed after 2000 harvest. Preliminary and further feed evaluation trials have and will be conducted by SARDI Pig and Poultry Institute and Pastoral and Veterinary Institute, Agriculture, Victoria.

Table VII: Least squares means and standard errors for eight hulless barley genotypes compared to Schooner grown in 1995 and 1996 in South Australia tested in three feed quality assays, Digestible dry matter (DDM); *in vivo* poultry Apparent Metabolisable energy (AME) and *in vitro* pig Digestible Energy (DE).

Genotype	DDM (%)	SE	AME (MJ/kg)	SE	DE (MJ/kg)	SE
Schooner	85.4	0.23	13.76	0.28	11.89	0.33
Galleon	84.9	0.23	14.10	0.28	11.90	0.33
Namoi	89.4	0.25	15.16	0.36	13.02	0.43
Richard (Canada)	89.5	0.37	14.91	0.36	11.92	0.43
SB85216 (Canada)	90.1	0.37	14.24	0.49	13.15	0.43
CIMMYT 42002	90.1	0.37	14.99	0.49	13.33	0.43

Progress with Malt Quality Evaluation

Initial results of WI 3107 show a wide range of variation in key malting traits. In general, both WI 3107 and Namoi consistently produced malt extracts 6 - 7% higher than Schooner and DP had a range of 8 - 64% higher than Schooner (Table VIII). Wort beta glucan level for WI 3107 is higher than the covered controls and should be targeted towards the pig/animal feed industries. However, WI 3107 produced a friability that was higher than Namoi, Galleon and Barque. This result is a good one because it indicates embryo damage is being minimised during harvesting, allowing for grain modification to be being maximised during the malting process.

Table VIII: Summary of malt quality traits (expressed as mean of Adelaide University Stage 3 trials grown at Brinkworth and Weetulta, SA during 1998) of WI 3107 compared to other major barley varieties. Analyses and results provided by Dr. Sue Logue and Barley Quality Evaluation Laboratory, Plant Science, Adelaide University.

Genotype	DP	Malt Protein (%)	Soluble Protein (%)	Kolbach Index	HWE EBC	Viscosity (cP)	WBG (mg/L)	Friability (%)
WI 3107	391	13.0	3.92	30.97	83.35	2.21	823	71.7
Namoi	595	15.6	3.94	25.22	80.11	2.30	836	45.9
Barque	322	11.9	3.10	26.00	76.12	1.92	1175	64.1

Schooner	362	12.1	4.00	33.22	77.83	1.74	520	80.2

Progress with Human Food Evaluation

An alternative prospect for a successful hulless barley industry may come in the supplying of barley to the human food markets in Asian countries, particularly Japan. Presently, over 40,000 tonnes of Australian barley is exported to Japan each year for staple foods and shochu. The quality parameters of barley for specialty brewing processes in Japan are becoming more exacting and the need for Australian barley breeders to recognise these traits is important to maintain and expand Australia's strong export position. Barley for Japanese specialty foods may attract a price equivalent to or greater than malting barley, even for non-premium malting varieties. From a nutritional and processing point of view, barley has enormous potential. In order to utilise barley for food it is necessary to understand primarily, its processing and health characteristics. Japanese food products from barley include shochu, a fermented and distilled spirit; miso, a soup paste; pearled barley for food; barley mixed with rice (new waxy Canadian barley varieties including hulless types are being produced for this purpose); and barley tea.

Hulless barley appears to be desirable for these markets since covered barley is pearled to approximately 65% of its original weight to remove all of the husk on the `crease' for shochu and can be greater for rice extender.

Preliminary investigations into the suitability of WI 3107 for human food involves measuring the following parameters:

- Assessing for ratio of whole/broken kernels in pearled samples
- Kernel colour assessment - pre and post pearl
- Grain quality (hardness and weight) assessment using `Single Kernel Characterisation Systems' - Perten Instruments
- Grain protein
- Beta glucan content
- Novel starch types (amylose and amylopectin)/starch content

Figure 2 provides a summary of preliminary results of pearl quality research of WI 3107 and Namoi compared to covered barley varieties, including Schooner. These results are very promising because both Namoi and WI 3107 performs equal to Schooner in numerous quality parameters. Quality parameters for other food products and hulless barley suitability needs to addressed immediately as it is overall poorly researched. It is important from both an economic and health perspective to understand these quality requirements better.

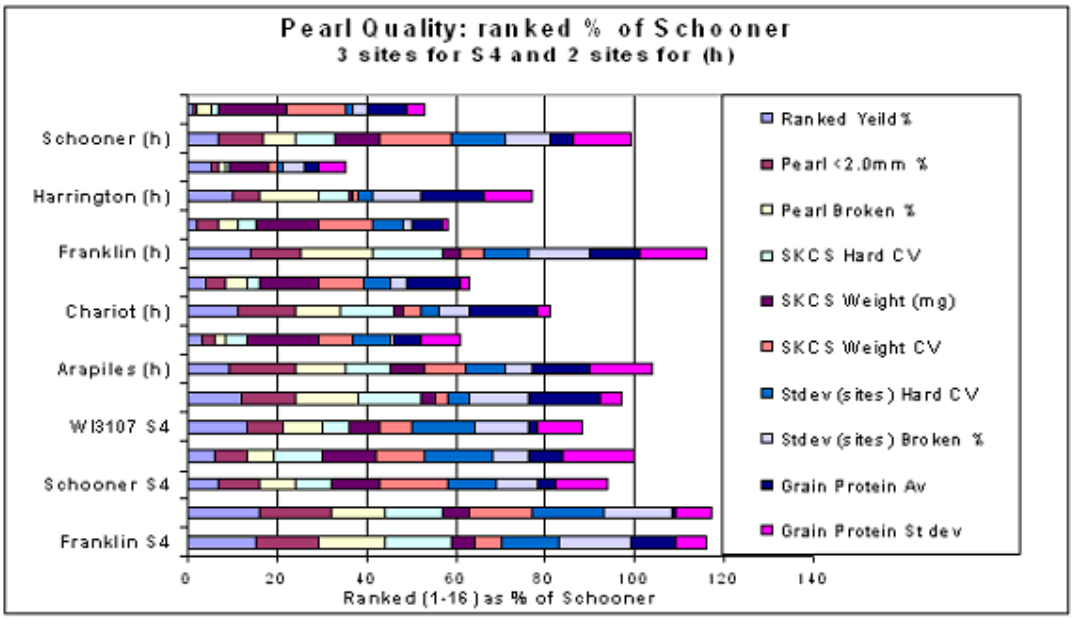

Figure 2: Summary of preliminary results of pearl quality research of WI 3107 and Namoi compared to covered barley varieties. High scores on the x-axis indicate best overall quality. Analyses and results provided by Jennifer Washington, GRDC project UA453 - `Alternative End Uses of Barley', Plant Science, Adelaide University

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