Which malt barley cultivar for Western Australia after Hamelin and Baudin?

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Abstract:

Small plot trial work suggests that Vlamingh (if released by the Western Malting Barley Council) will offer growers a significant agronomic improvement relative to growing Stirling, Hamelin, Schooner, Baudin and Gairdner in almost all regions of Western Australia. Vlamingh has the yield potential of Gairdner, Baudin and many of the best-feed cultivars, combined with the grain plumpness of Hamelin. Vlamingh lifts the receival probability of later flowering cultivars to a level similar to that of Stirling at a significant yield advantage (ie. 10%). In lower rainfall areas Vlamingh will need to be sown early to realise this advantage, as it flowers some 7 days later than Stirling.

When grain yield and grain quality are used to calculate net return, results from the 2002 to 2004 seasons suggest that Vlamingh delivers $40/ha more to growers than Stirling and Gairdner, $30/ha more than Hamelin and Schooner and $25/ha more than Baudin.

If there were no market restrictions to the areas in which Vlamingh could be grown, it is predicted that Vlamingh would replace the majority of land currently planted to Stirling, Hamelin, Schooner, Baudin and Gairdner. Its later flowering habit is the only factor restricting it being widely sown in lower rainfall areas. Moreover, the net return analysis suggests that Vlamingh may be a better cultivar to grow on alkaline duplex soils, where Schooner is currently grown, despite Vlamingh showing boron toxic spots.

Of the elite malting cultivars being commercially evaluated in eastern Australia, the most promising line for sowing under Western Australian growing conditions appears to be Buloke. Small plot trial results suggest that Vlamingh will have a higher probability of meeting export malting barley receival standards because it produces grain which is plumper than Buloke, WI3586-1747, Flagship and Cowabbie. Whilst Buloke and Cowabbie are the plumpest of the eastern export-type cultivars, their grain plumpness is comparable to Baudin, with Flagship between Baudin and Gairdner and WI3586-1747 equivalent to Gairdner. The plumpness of Vlamingh is slightly better than Schooner and similar to Hamelin. None of the eastern state cultivars offer a disease resistance package that is superior to Vlamingh, but Buloke and Flagship do have single disease advantages over Vlamingh. Only Buloke has a higher yield potential than Vlamingh, particularly at sites with a low yield potential (ie. < 2 t/ha). Flagship and Baudin have many similarities: similar malting quality, similar grain yield and similar grain plumpness. Baudin, however, is not susceptible to pre-harvest sprouting and can therefore be grown in a wider range on environments. In medium rainfall environments, the grain plumpness of Flagship is not competitive with Vlamingh and Buloke.

Key Words:

Malting barley, Vlamingh, Buloke, WI3586-1747, Flagship, Cowabbie

Introduction:

The release of Hamelin and Baudin as new malting barley cultivars for sowing in Western Australia has been shown to be of economic benefit to both growers and the industry (2). This is through a combination of improved returns per hectare and cultivars with a malting quality that more closely matches the requirements of brewing markets in China and Japan (1, 2). However both cultivars have a number of agronomic weaknesses. Hamelin has only a small yield advantage over Stirling, poor disease resistance, potential issues with straw strength and lodging resistance and susceptibility to pre-harvest sprouting. For Baudin, grain plumpness and disease resistance are two areas where breeding improvements are required.

All of the major barley breeding programs in Australia, with the exception of Queensland, have elite malting barley cultivars nearing the completion of commercial malting and brewing trials. In 2006, growers in Western Australia could be growing one or more of them for seed with a view to producing marketable quantities in 2007. The purpose of this study was to determine whether any of these elite malting cultivars

had an agronomic advantage over Hamelin and Baudin that would warrant their release in Western Australia. The potential for their having a 'niche role' in replacing Schooner on the south coast was also evaluated.

This paper discusses the performance of five elite malting barley cultivars when grown in Western Australia. The lines under consideration (and their pedigrees) were –

a) Vlamingh (WABAR0570/TR118),
b) Buloke (Franklin/VB9104//VB9104),
c) WI3586-1747 (Gairdner/Keel//Gairdner),
d) Flagship (Chieftan/Barque//Manley/VB9104), and
e) Cowabbie (AB6/Franklin//Franklin/3/Rubin/Skiff).

Methods:

Fields trials with Vlamingh

Vlamingh has been evaluated in over thirty small plot trials over the last three seasons (2002 to 2004). The majority of these trials have been soil type × date of seeding comparisons where Vlamingh has been compared to Stirling, Hamelin, Schooner, Baudin and Gairdner at two soil types per location at two dates of seeding usually three weeks apart. In all there were 119 direct comparisons between Vlamingh and the other five cultivars. Many of these comparisons were those used to analyse the economic benefit of Hamelin and Baudin in Western Australia in the paper of Paynter (2). Only 5% of the trials used in this dataset were from the dry season of 2002, with the remaining comparisons spread evenly over the other two seasons.

Nearly 90% of the small plot trials were conducted in rainfall regions where the average annual rainfall was above 325mm. The percentage of observations in each Agzone was: Agzone 1 (8%), Agzone 2 (33%), Agzone 3 (14%), Agzone 4 (9%), Agzone 5 (20%) and Agzone 6 (16%). Just over 30% of the trials have been located in high rainfall regions, 60% in medium rainfall regions and 10% in low rainfall regions. The trials have been distributed equally on non-alkaline sandy and loamy duplex soils, alkaline sandy and loamy duplex soils, and gravelly soils with 30% of trials on each soil type. The remaining 10% of trials were located on gradational earths and deep sands.

Field trials with Buloke, WI3586-1747, Flagship and Cowabbie

Buloke, WI3586-1747, Flagship and Cowabbie were sown at all the same sites as Vlamingh in the 2004 series of small plot trials. In 2003, the cultivars were only sown at a limited number of sites in crop cultivar evaluation type trials with a single time of sowing at a single date of seeding. Overall there were 55 direct comparisons for each cultivar.

Agronomic traits, grain yield and physical grain quality determination

Plots were scored 8 weeks after sowing for early growth habit, during grain filling for presence of physiological spots and boron toxicity symptoms, at maturity for plant height (cm) to the base of the ear and just before harvest for their resistance to lodging. Relative maturity (duration to awn emergence relative to Stirling) for a late May sowing was estimated from flowering date trials. Disease resistance ratings were provided by Sanjiv Gupta and Jason Bradley from the Department of Agriculture.

Grain yield was collected from 20 m long plots of between 6 to 8 rows wide (25 cm to 18cm row spacing) using an experimental harvester. The harvested samples were cleaned and de-awned through a Pfeuffer Sample Cleaner Model SLN3 with a 1.5mm cleaning screen. Screenings were calculated as % of grain passing through a 2.5mm slotted sieve and were determined by placing approximately 100g of barley on a Pfeuffer Sortimat with a three stack setup (2.8, 2.5 and 2.2mm slotted sieves) for 2 minutes. Grain protein (%, db) and grain brightness (Minolta L) were estimated on a Foss Systems NIRS6500 using calibrations developed at the Department of Agriculture, South Perth (Allen Tarr and Stefan Harasymow). The NIRS6500 was also used to estimate malt extract (%, db) and grain hardness (SKCS units).

Net return from growing Vlamingh

Vlamingh was subjected to the same economic analysis as described by Paynter (2). For the analysis it was assumed that if Vlamingh was released it would receive a cultivar premium of $5/t and be subject to end point royalty payments of $3/t if delivered as malting and $1/t if delivered as feed as per the cultivars Hamelin and Baudin.

Results and Discussion:

Economic analysis of the performance of Vlamingh

Economic analysis over the last three seasons suggests that Vlamingh has the potential to deliver more $/ha to growers than Stirling, Gairdner, Baudin, Schooner and Hamelin (Table 1). Even if Stirling was delivered for shochu and received the $20/t shochu premium, Vlamingh ($38.25/ha) still had a higher average return over the three years. Stirling only met shochu receival standards in 8% of the trials.

During the three years of study, returns from growing Vlamingh ranged from -$17/ha to +$65/ha relative to Stirling, with an average return of +$43/ha (Table 1). The average relative returns from Vlamingh were double those of Baudin, three times those of Hamelin and Schooner and markedly higher than Gairdner.

The returns from Vlamingh were equal to or above Stirling in over 74% of trials. In 40% of trials, returns were more than $60/ha higher than Stirling. In only 12% of situations were the returns from Vlamingh more than $25/ha lower than those achieved by Stirling.

Table 1. Relative performance of Baudin, Gairdner, Hamelin, Vlamingh and Schooner when grown under the same management conditions as Stirling in statewide trials over 3 seasons between 2002 to 2004 (119 comparisons).

Cultivar	Baudin	Gairdner	Hamelin	Vlamingh	Schooner	Stirling
%samples received malt						
May sown	49%	37%	60%	63%	60%	66%
June sown	35%	25%	50%	48%	51%	56%
Average 2002 to 2004	**40%**	**29%**	**53%**	**52%**	**54%**	**59%**
Return by year ($/ha)						
2002	$0.80	-$12.95	$5.91	-$17.12	$5.28	-
2003	$23.43	$2.41	$19.63	$65.44	$24.46	-
2004	$15.41	-$5.88	$0.47	$25.01	-$0.21	-
Average 2002 to 2004	**$18.65**	**-$2.13**	**$10.25**	**$42.93**	**$12.30**	**-**
Return by sowing ($/ha)						
May sown	$39.13	$23.29	$23.77	$75.84	$26.79	-
June sown	$10.12	-$12.72	$4.61	$29.22	$6.26	-
Return by Agzone ($/ha)						
Agzone 1	$25.71	$20.27	$33.23	$92.36	$42.31	-
Agzone 2	$9.72	-$23.52	$6.30	$55.17	$5.07	-
Agzone 3	$50.16	$13.86	-$6.99	$2.47	$16.18	-
Agzone 4	-$16.63	-$25.35	$6.51	$19.72	$12.58	-
Agzone 5	$24.59	$14.03	$15.41	$30.88	$7.83	-
Agzone 6	$21.85	$16.08	$21.02	$58.45	$15.74	-
Return by soil-type ($/ha)						
Non- alkaline duplex	$36.34	$14.41	$17.97	$57.97	$25.59	-
Alkaline duplex soils	$1.85	-$9.64	$0.35	$27.45	$1.56	-
Gravelly soils	$16.05	-$13.75	$9.03	$37.45	$13.47	-
Gradational & sands	$12.65	-$4.81	$13.68	$50.55	-$3.88	-
Premium over feed ($/t)						
2002	-$0.83	$0.00	-$1.00	-$1.00	$0.00	$0.00
2003	$18.07	$12.39	$22.34	$23.85	$23.80	$23.69
2004	$12.38	$10.47	$18.49	$17.15	$16.66	$20.05
Average 2002 to 2004	**$14.53**	**$10.89**	**$19.42**	**$19.56**	**$19.36**	**$20.84**
Grain yield (t/ha, %Stirling)						
May sown	3.37 (115%)	3.32 (113%)	3.13 (106%)	3.46 (118%)	3.15 (107%)	2.94 (100%)
June sown	2.67 (107%)	2.58 (104%)	2.55 (102%)	2.71 (109%)	2.54 (102%)	2.49 (100%)
Average 2002 to 2004	**2.88 (110%)**	**2.80 (107%)**	**2.72 (104%)**	**2.93 (112%)**	**2.72 (104%)**	**2.62 (100%)**

The probability of Vlamingh being delivered as malting was just less than Stirling, similar to Hamelin and Schooner and greater than for Baudin and Gairdner (when May and June sowing date data was combined) (Table 1). Despite having a narrower grain shape than Stirling and therefore subject to higher screenings discounts, the average premium from growing Vlamingh was similar to Hamelin and Schooner and just over $1/t less than Stirling. The median screenings of Vlamingh over the 119 comparisons was 13.1% compared

to Stirling 8.5%, Hamelin 10.8% and Baudin 22.1%. The discounts due to higher screenings were offset by slightly lower grain protein and brighter grain colour in some situations.

The proportion of research trials in which Vlamingh met all receival standards ranged from around 75% in Agzones 1 and 2, 55% in Agzones 3 and 4, 30% in Agzone 5 and 15% in Agzone 6. Poor grain colour and high grain screenings were the main reasons for the lower proportion of malt receivals in Agzone 6. High grain screenings and high grain protein were the main problems in Agzones 4 and 5.

The area where Vlamingh is best suited for growing is presented in Figure 1, and is based on maturity, grain plumpness, pre-harvest sprouting risks and market demand. With grain plumpness equivalent to Hamelin and a later flowering habit, Vlamingh will be less adapted to low rainfall regions where many growers are already opting to grow feed barley cultivars like Mundah. Strategic use of Vlamingh in lower rainfall zones, ie. sowing early, is necessary for growers to exploit the yield and economic potential of the cultivar. Agronomic work is required to define the management practises required to increase the probability of growers in lower rainfall regions meeting export malting barley receival standards.

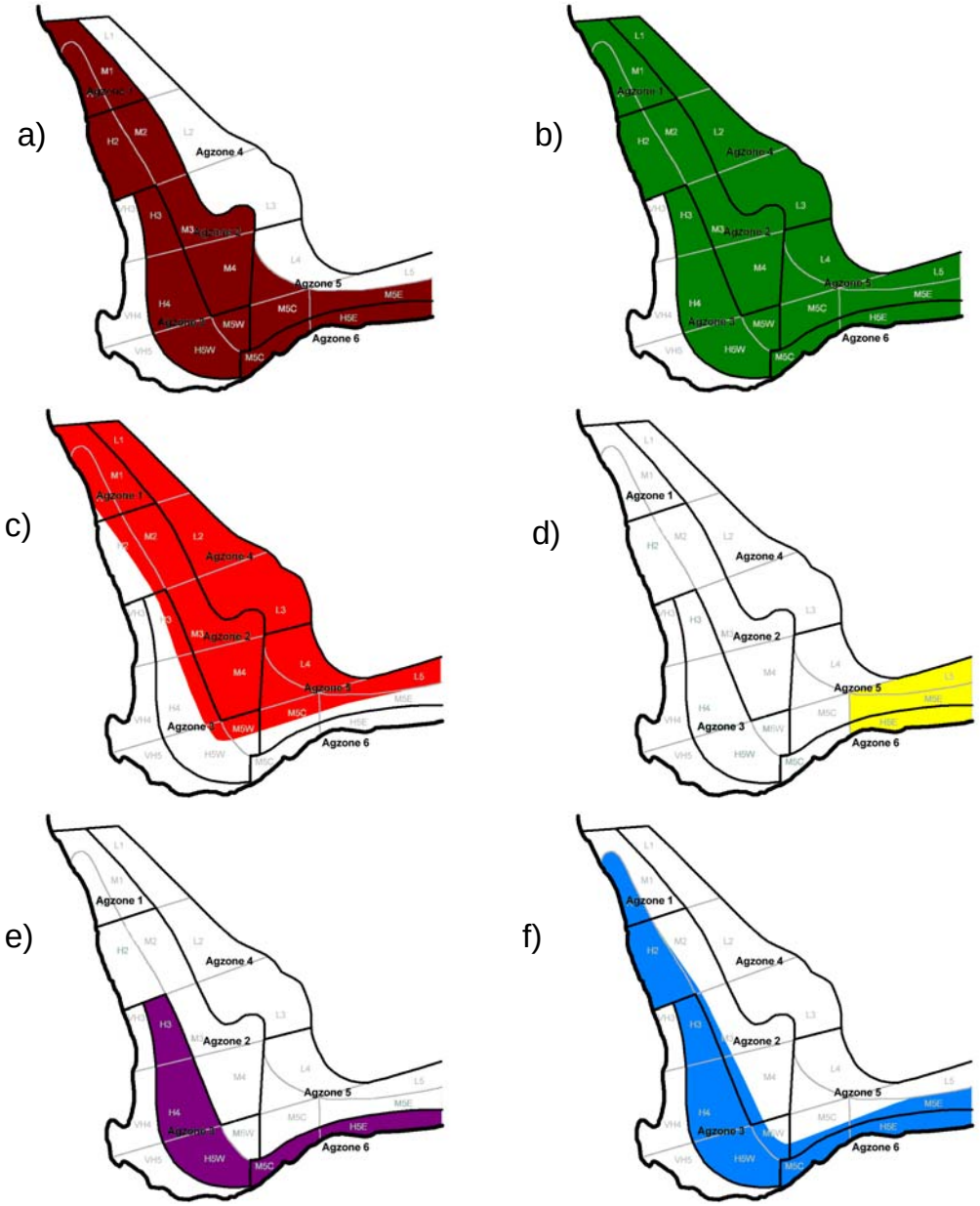

Figure 1. Adaptation maps. Areas best suited to each cultivar based on maturity, grain plumpness, pre-harvest sprouting risk and market demand for a) Vlamingh, b) Stirling, c) Hamelin, d) Schooner, e) Gairdner and f) Baudin.

Agronomic performance of Buloke and Flagship

When sown in late May, the flowering date of early spring maturity barley lines Buloke and Flagship was 9 to 10 days later than Stirling and Hamelin, slightly later than Vlamingh and equivalent to Schooner and Baudin (Tables 2 and 4). Plant height of Buloke was similar to Stirling. Plant height of Flagship was slightly shorter than Buloke and similar to Vlamingh. Vlamingh was more resistant to lodging than Buloke and Flagship, though not as resistant as Baudin. Head loss and lodging risks were higher for Flagship than for Buloke, but Buloke was susceptible to mid-stem lodging.

Neither Buloke nor Flagship have a disease resistance profile that is greatly superior to Vlamingh, but their disease resistance is generally better than Stirling, Hamelin and Baudin (Table 2). Buloke has very good resistance to scald and powdery mildew, whilst Flagship has very good resistance to barley leaf rust but is susceptible to powdery mildew. Vlamingh is also susceptible to powdery mildew but displays some tolerance to the other diseases.

Neither Buloke nor Vlamingh are prone to physiological leaf spotting. Physiological leaf spotting is evident on Flagship in some situations, although not to the degree displayed by Hamelin, Baudin or Gairdner (Tables 2 and 4). Buloke, like Schooner, shows minimal boron toxic leaf symptoms when grown in situations with alkaline sub-soils in the Esperance region and in the central wheatbelt. Flagship was rated as medium for symptoms of boron toxicity, whereas Stirling, Hamelin and Vlamingh are very prone.

Buloke and Flagship were higher yielding than Stirling, Hamelin and Schooner for observations over a range of grain yields when grown in Western Australia (Table 3). Flagship had a similar grain yield to Baudin and Vlamingh, whereas Buloke had a higher grain yield, particularly at lower yielding sites (Table 2, 3 and 4). The average yield advantage of Buloke was 115% of Stirling compared to Flagship, Baudin and Vlamingh which were around 109% to 110% of Stirling. The yield advantage of Vlamingh was reduced at low yielding sites (ie. < 1.2 t/ha).

Grain shape analysis suggests that in situations where screenings levels in Baudin were below 30%, screening levels in Buloke were similar to Baudin but higher than Stirling, Hamelin, Schooner and Vlamingh (Tables 2 and 3). Flagship was not a plump as Baudin, but was plumper than Gairdner.

Table 2. Observations on the physical and disease resistance attributes of alternatives to Stirling and Schooner from Western and Eastern Australia (control cultivar is Stirling) from 2003 and 2004.

	Hamelin	Vlamingh	Buloke	Flagship	Schooner
a) Physical attributes					
Early growth habit	Erect	Erect	Erect	Erect	Erect
Plant height (cm)	~ Stirling	- 5 cm	~ Stirling	- 5cm	~ Stirling
Straw strength rating	Fair-Good	Good	Fair	Fair	Fair-Good
Maturity (days)	- 1 day	+ 7 days	+ 9 days	+ 9 days	+ 10 days
Grain yield (%Stirling)	101%	109%	115%	109%	101%
Av grain weight (mg, db)	- 1 mg	- 1 mg	+ 4 mg	+ 2 mg	+ 1 mg
Screenings (% < 2.5mm)	+ 2%	+ 2%	+ 6%	+ 10%	+ 4%
Grain protein (%)	~ Stirling	~ Stirling	- 0.5 %	~ Stirling	~ Stirling
Protein yield (kg/ha)	~ Stirling	+ 25 units	+ 25 units	+ 20 units	~ Stirling
Grain colour (L)	+ 0.5 L	+ 0.5 L	~ Stirling	~ Stirling	~ Stirling
NIR Malt extract (%)	+ 0.5%	~ Stirling	+ 2.5%	+ 0.5%	~ Stirling
Pre-harvest sprouting risk	High	Low	Moderate	High	Low
NIR Hardness (units)	~ Stirling	- 5 units	~ Schooner	~ Schooner	- 8 units
b) Disease resistance					
Scald	S	**MR**	**I**	MS-**I**	MS
Net type net blotch	S	**I**	**I**	**I**	**I**
Spot type net blotch	MS	S	MS	MS	**I**
Powdery mildew	S	S	**MR**	MS	S
Barley leaf rust	S	MS	MS	**MR**	MS
BYDV	VS	**I**	MS	**I**	MS
CCN resistant	No	No	No	Yes	No
Physiological spotting	High	Low	Low	Very low	Very low
Boron spot rating	High	High	Low	Medium	Low

The grain brightness of Buloke and Flagship was inferior to Hamelin, Baudin and Vlamingh, but similar to Stirling and Schooner. Brightness is an issue for all barley grown on the south coast and growers are seeking cultivars which are less prone to caramelling just before harvest. Whilst Vlamingh is no major improvement in grain brightness over Buloke and Flagship, it may still equate to a higher return per hectare or higher probability of malting, as found in the economic analysis completed earlier in this report.

Table 3. Relative performance of barley cultivars over a) a range of grain yields (kg/ha, %Stirling) achieved by Stirling and b) a range of screenings achieved by Baudin (%<2.5mm) in small plot trials conducted in 2003 and 2004.

Stirling yield (kg/ha)	Stirling	Hamelin	Gairdner	Baudin	Vlamingh	Schooner	Buloke	WI3586-1747	Flagship	Cowabbie
a) grain yield (%Stirling)										
1000	100%	103%	85%	110%	105%	99%	122%	102%	112%	98%
2000	100%	101%	101%	110%	109%	101%	116%	106%	109%	107%
3000	100%	101%	106%	109%	110%	101%	114%	107%	108%	110%
4000	100%	100%	109%	109%	111%	102%	112%	108%	108%	112%
r^2		0.98	0.90	0.93	0.91	0.94	0.91	0.87	0.94	0.90

Baudin range (%)	Stirling	Hamelin	Gairdner	Baudin	Vlamingh	Schooner	Buloke	WI3586-1747	Flagship	Cowabbie
b) average screenings for a range of screenings achieved by Baudin (%< 2.5mm)										
0-10%	3.2	4.7	9.9	4.3	3.9	4.4	6.7	9.9	8.4	4.4
10-20%	9.4	10.4	29.9	17.2	10.3	13.7	19.5	35.6	19.6	16.5
20-30%	16.1	19.2	42.3	25.2	18.2	24.4	23.1	45.9	36.0	26.9
30-60%	21.9	22.3	54.9	45.7	26.6	27.7	39.1	57.6	42.3	38.5
>60%	59.5	58.0	73.5	78.0	55.9	66.6	70.1	81.8	79.9	70.9

Western Australia supplies Stirling to Japan for use in the shochu industry. With growers switching to Hamelin, Baudin and feed cultivars, the area sown to Stirling is decreasing and as such will be less available for supply to Japan. One of the characteristics making Stirling suitable for shochu production is it produces hard grains, whereas Schooner produces relatively soft grains. Grain hardness aids the pearling process when grain is being prepared for distillation in making shochu. Vlamingh, Buloke and Flagship are all softer than Stirling, Hamelin and Baudin (Table 2). Vlamingh, however, is slightly harder than Schooner, with Buloke and Flagship having a similar hardness to Schooner.

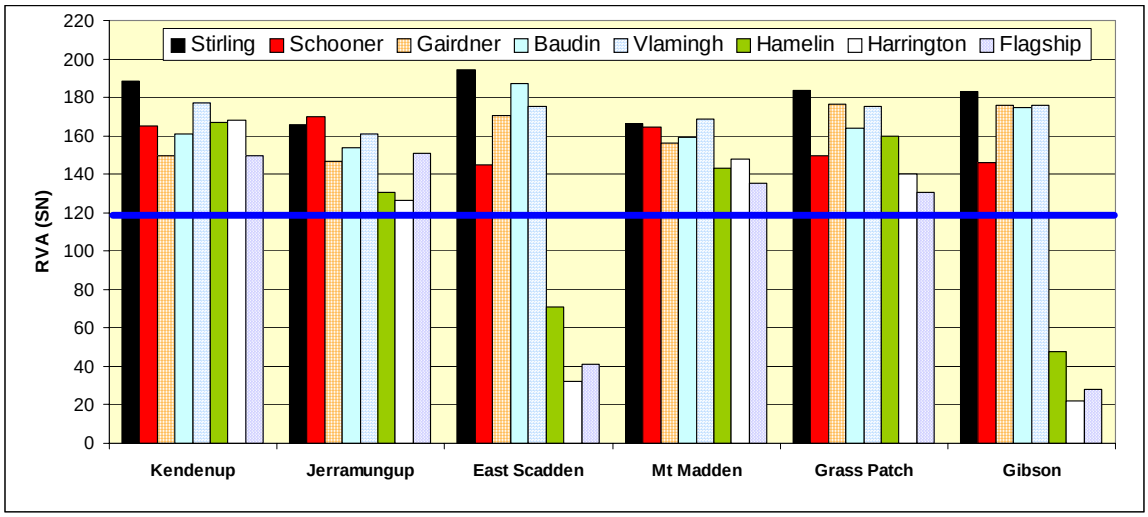

Figure 2. Rapid visco analysis of grain samples from agronomy trials on the south coast in 2003. An RVA value below a stirring number of 120 indicates sprouting activity present in grain.

In addition to producing softer grains, Flagship is susceptible to pre-harvest sprouting as evidenced by grain samples harvested from rain affected trials on the south coast in 2003 (Figure 2). RVA values fell below a stirring number of 120 at sites where cultivars with a know susceptibility to pre-harvest sprouting (Hamelin and Harrington) were also below 120. As a consequence the area in which Flagship could be safely grown in Western Australia is significantly reduced. Like Hamelin, Flagship would not be considered suitable for sowing in coastal areas (ie. Agzone 6 and parts of Agzone 1) where rain at harvest is common. Vlamingh is

not considered susceptible to pre-harvest sprouting. Buloke was not sown in the trials presented in Figure 2, but trials conducted subsequently suggest that Buloke may be susceptible to pre-harvest sprouting with the risk being rated as moderate or similar to Gairdner, rather than high like Flagship or Hamelin (Table 2).

In summary, the data collected in 2003 and 2004 suggests that Vlamingh offers the greatest agronomic advantage of the early spring cultivars being evaluated by the malting and brewing industry for Western Australian conditions. Vlamingh is the most likely to offer Western Australian growers an advantage over the existing malting barley cultivars Hamelin, Baudin and Schooner. Vlamingh has good straw strength, good yield potential, an improved disease resistance package relative to Hamelin and Baudin, has grain plumpness similar to Hamelin and a low risk of pre-harvest sprouting. In Western Australian conditions Buloke is more promising than Flagship because it has the highest grain yield potential, tolerates boron toxic soils well and has grain plumpness that is similar to Baudin. As Flagship is susceptible to pre-harvest sprouting it would be unsuitable for high rainfall, coastal areas around Esperance and even Geraldton, restricting it to medium rainfall zones. With grain plumpness less than Baudin and no yield advantage, the small plot data suggests that Flagship is of no real advantage to growers. Two key advantages it does have - resistance to cereal cyst nematode and barley leaf rust - are of much less importance in medium rainfall zones than resistance to powdery mildew, for which Buloke has better tolerance.

Table 4. Observations on the physical and disease resistance attributes of alternatives to Gairdner from Western and Eastern Australia (control cultivar is Stirling) from 2003 and 2004.

	Baudin	Vlamingh	WI3586-1747	Cowabbie	Gairdner
a) Physical attributes					
Early growth habit	Prostrate	Erect	Prostrate	Prostrate	Prostrate
Plant height (cm)	- 20 cm	- 5 cm	- 10 cm	- 10 cm	- 10 cm
Straw strength rating	Very good	Good	Fair-good	Good	Fair-good
Maturity (days)	+ 10 days	+ 7 days	+ 14 days	+ 14 days	+ 14 days
Grain yield (%Stirling)	110%	109%	107%	108%	103%
Av grain weight (mg, db)	- 2 mg	- 1 mg	~ Stirling	~ Stirling	+ 2 mg
Screenings (% < 2.5mm)	+ 5%	+ 2%	+ 17%	+ 5%	+ 15%
Grain protein (%)	- 0.5 %	~ Stirling	~ Stirling	~ Stirling	~ Stirling
Protein yield (kg/ha)	+ 15 units	+ 25 units	+ 15 units	+ 20 units	+ 10 units
Grain colour (L)	+ 1 L	+ 0.5 L	+ 1.5 L	~ Stirling	+ 1 L
NIR Malt extract (%)	+ 1%	~ Stirling	+ 1 %	~ Stirling	+ 1%
Pre-harvest sprouting risk	Low	Low	-	-	Moderate
NIR Hardness (units)	~ Stirling	- 5 units	~ Schooner	~ Stirling	~ Schooner
b) Disease resistance					
Scald	**I**	**MR**	**I**	**I**	**I**
Net type net blotch	S	**I**	**I**	S	**I**
Spot type net blotch	S	MS	MS	S	S
Powdery mildew	S	S	S	S	MS
Barley leaf rust	S	MS	VS	S	S
BYDV	**MR**	**I**	**MR**	**MR**	**R**
CCN resistance	No	No	Yes	-	No
Physiological spotting	Low-Medium	Low	Low	Low	Medium
Boron spot rating	Medium	High	Medium	Low	Medium

Agronomic performance of WI3586-1747 and Cowabbie

The late spring maturity cultivars WI3586-1747 and Cowabbie have a similar flowering window to Gairdner with May sowing (Table 4). However, due to higher levels of daylength sensitivity WI3576-1747 and Cowabbie flower earlier than Gairdner with later planting (ie. late June) (3). Plant height of Cowabbie and WI3586-1747 is similar to Gairdner, or approximately 10cm shorter than Stirling and Schooner. Cowabbie appears to have better lodging resistance than both Gairdner and WI3586-1747. Lodging resistance in Cowabbie is similar to Vlamingh but not as good as Baudin.

One of the key differences between Gairdner and the Gairdner backcross, WI3586-1747, is that WI3586-1747 possesses a more open canopy. However, the Keel parentage of WI3586-1747 has only slightly enhanced its tolerance to spot type net blotch when grown in Western Australia (Table 4). This is a shame since this was one of the key reasons that the cross with Keel was made. The inclusion of cereal cyst nematode resistance is of value to the agronomy of WI3586-1747 in South Australia, but it is currently of

less value in Western Australia. Observations in the presence of powdery mildew and barley leaf rust suggest that WI3586-1747 may be more susceptible to these two diseases than Gairdner. Cowabbie offers no improvement in disease resistance at all over either Baudin or Gairdner.

WI3586-1747 may have some yield advantage over Gairdner at sites with a yield potential below 2 t/ha (Tables 3 and 4). Cowabbie appears to have an advantage over Gairdner at all yield levels. Neither WI3586-1747 nor Cowabbie are higher yielding than Vlamingh, Buloke, Flagship or Baudin.

WI3586-1747 has a grain plumpness similar to Gairdner and its grain shape was narrower than Baudin when grown in the current trials (Table 4). Cowabbie grain shape was plumper than Gairdner and similar to Baudin. WI3586-1747 grains were brighter than all other cultivars sown, being nearly 0.5 Minolta L units brighter on average than Gairdner. Cowabbie grains were similar in colour to Stirling and Schooner. Grains of WI3586-1747 are relatively soft like Gairdner, whereas Cowabbie grains have a similar hardness to Stirling. We have no observations on the risk of pre-harvest sprouting in WI3586-1747 and Cowabbie to say whether or not they are an improvement over Gairdner.

The area being sown to Gairdner in WA is beginning to decline as growers adopt Baudin. In many cases the prime driver of this decline is the higher probability of Baudin meeting export receival standards for grain plumpness (2). As WI3586-1747 offers no improvement in grain plumpness or real improvement in leaf disease resistance over either Baudin or Gairdner, it is unlikely that if the cultivar was released that it would be widely grown in Western Australia. Whilst Cowabbie has some agronomic advantages over Gairdner, it has no advantages over Baudin for disease resistance, grain yield, grain plumpness or grain colour. As a consequence it is also unlikely to tempt growers when they could adopt a cultivar like Vlamingh or Buloke.

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