Oat

By Georgie Troup, Helene Metzinger and Blakely Paynter, DPIRD

Introduction

This guide is designed to help you determine which milling oat or export hay variety to grow in your region. The guide provides variety characteristics, disease ratings and agronomic information for oat varieties that offer the best opportunity to meet market requirements.

This guide should be read in conjunction with industry information provided in the Grains Industry Association of Western Australia (GIWA) 'Oat variety and grade update' (available at www.giwa.org.au/oat-council).

GIWA collaborates with Western Australian bulk handlers to review grain standards as needed to ensure that WA grain standards match customer requirements and to maximise returns to the WA grain value chain.

There are several oat grain varieties available for delivery into the CBH system. CBH delivery grades are Oat1, Oat2 and OWAN, which is an exclusive segregation for Wandering oats. Each variety has its own strengths and weaknesses and their characteristics will determine their suitability for your area. Because no single oat variety is likely to provide optimum agronomic traits, disease resistance, yield and quality in any one year, most successful oat growers choose to grow more than one variety. The strengths and weaknesses of each oat variety are detailed in the variety description section of this sowing guide.

WHAT IS NEW?

Kingbale is a new oat hay variety released in 2020, for commercial production in 2021. While it has not been evaluated for commercial hay production, Kingbale is expected to perform similarly to its parent, Wintaroo, which has been accepted as a suitable export hay variety.

Kingbale is derived from Wintaroo, through a process of mutagenesis, and has a single gene trait tolerance to imidazolinone (IMI). Kingbale is a mid-maturity oaten hay variety with tolerance to imidazolinone residues present in the soil. Kingbale is suitable where there are IMI residue concerns from previous crops. A Sentry® registration for pre-emergent use only has been submitted to the Australian Pesticides and Veterinary Medicines Authority (APVMA), with March 2021 the earliest potential registration for its use in oaten hay production.

Seed of Kingbale is available through Intergrain and PBR and EPR are yet to be determined.

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

AgriFutures Australia

OAT VARIETY CHOICE IN 2021 – WHAT SHOULD I GROW?

Figure 1 outlines the change in oat variety popularity from 2018 to 2019 and highlights the subtle shift in the popularity of Williams and Carrolup and the increase in popularity of the short-season variety Durack.

Varieties have been suggested for the high, medium and low rainfall areas based on their performance in the NVT and agronomy trials. Deciding whether to grow milling oats depends on three main factors:

1. Profitability of Oat1 and Oat2 grain production.
2. Likelihood that grain will meet Oat1 or Oat2 receival specifications.
3. Location of receival segregations for Oat1 and Oat2 varieties.

Grain

If targeting the Oat1 market and septoria risk is low-moderate, then Bannister is suggested. In high rainfall areas, with low risk of drought stress during grain filling, Bilby and Williams are suggested.

If targeting the OWAN or Oat2 market, then Wandering is suggested.

Hay

High-yielding, high-quality hay varieties Brusher and Forester are suggested for the far southwest (in high yielding areas only) while Mulgara and Wintaroo are suggested for medium to high yielding areas. For high disease-risk areas the new variety Koorabup and Williams are suggested. For growers wanting a dual-purpose variety (milling oat and export hay eligible) Carrolup, Williams and Yallara are suggested.

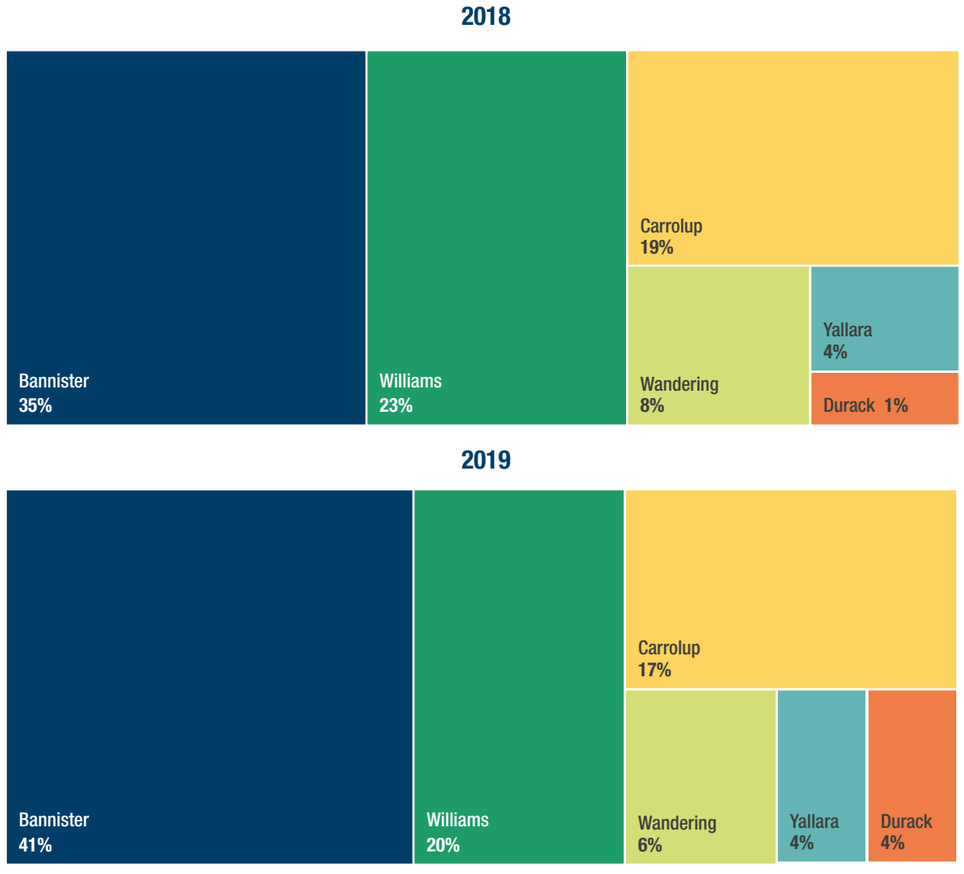

FIGURE 1. Popularity (percentage of oat area) of the top six oat varieties delivered in WA in 2018 and 2019. The top six varieties occupied about 90% of the area planted to oats in both years.

Source: grower estimates as provided to CBH for 2018 and 2019

Eligibility of oat varieties for delivery

TABLE 1. Suitability of oat varieties for grain (Oat1, Oat2, OWAN) and hay

Variety	Oat1	Oat2	OWAN	Hay
Bannister	✓	✓		✓
Bilby	✓	✓		
Brusher				✓
Carrolup	✓	✓		✓
Coomallo	✓	✓		
Durack		✓		✓
Forester				✓
Hotham	✓	✓		
*Kingbale				✓
Kojonup	✓	✓		✓
Koorabup				✓
Kowari	✓	✓		
Mitika	✓	✓		
Mortlock	✓	✓		
Mulgara				✓
Pallinup	✓	✓		
Tammar				✓
Tungoo				✓
Wandering		✓	✓	
Williams	✓	✓		✓
Winjardie				✓
Wintaroo				✓
Vasse				✓
Yallara	✓	✓		✓

*Released in 2020

OTHER CONSIDERATIONS FOR OAT GROWERS

Nitrogen management

When making decisions regarding the amount of nitrogen to apply to oat crops during the growing season the following points should be considered:

- Target market for crop – grain or hay?
- Nitrogen application strategies differ for grain vs hay.
- Seasonal rainfall to date – if the season is dry the positive impact of applied nitrogen on yield will be less.
- High nitrogen increases risk of screenings, low hectolitre weights and reduced hay quality. Williams and Carrolup are more sensitive to increasing nitrogen than Bannister.

Target plant density

Growers have traditionally sown oats at a set seeding rate, however this approach can mean target plant density is not reached which, in turn, can compromise yield and/or quality.

Suggested target plant density:

Crop purpose	Lower rainfall zone (e.g. Agzone 4)	Higher rainfall zone (e.g. Agzone 3)
Grain	160 plants/m²	240 plants/m²
Export hay	240 plants/m²	320 plants/m²

Differences in seed size, germination percentage and sowing conditions can result in variable plant densities at establishment and it is recommended that growers determine the 1000-grain weight of their seed to determine target seed rate (kg/ha):

$$\text{Seed rate (kg/ha)} = \frac{[\ \text{Target plant density (plants/m}^2) \times \text{Average grain weight (mg)}\ ]}{\text{Expected establishment (\%)}}$$

For example, if the desired plant population is 240 plants/m², the average grain weight is 40mg and expected establishment is 80% the calculation is: (240 x 40) / 80 = 120kg/ha

Impact of delayed harvest on grain shedding

In 2019, a trial was established in a high rainfall environment (Gibson) to compare the influence of a three, six or nine-week week delay in harvest date on grain yield and quality. Seven milling oat varieties and five breeding lines were evaluated, including Bannister, Bilby, Carrolup, Kowari, Wandering, Williams, Yallara, 09143-21, 09143-35, 09036-3, 11018-17 and 11022-82. The four harvest date treatments were (H1): at the first sign of physical maturity – when the peduncle had lost greenness, (H2): three weeks after physical maturity, (H3): six weeks after physical maturity, and (H4) nine weeks after physical maturity.

Delaying harvest by three weeks reduced grain yield by 13%. Grain yield loss increased to 23% when harvest was delayed by six weeks and to 38% when harvest was delayed by nine weeks. All varieties suffered similar grain yield loss when harvest was delayed. Grain quality was unaffected by delays in harvest date and consistently met Oat1 requirements (for hectolitre weight and screenings). While grain loss can be minimised by selecting varieties of differing maturities, the limited difference in physiological maturity between oat varieties makes this difficult. Yield remains the highest priority when selecting an oat variety, however a delayed harvest will reduce oat yields in general so harvesting on time is important.

Management of grain staining

Bannister is one of the top three oat varieties grown in WA for grain due to its yield advantage over Carrolup and its higher grain quality than Williams. However, Bannister is susceptible to septoria and, in higher rainfall areas where septoria is more prevalent, there is a greater risk of grain being downgraded at harvest due to grain staining.

In scenarios of high disease pressure such as growing a susceptible variety, oat-on-oat rotation and regions of high rainfall, our research suggests that if disease pressure becomes evident at stem elongation a two-spray regime at stem elongation and flag emergence should be implemented to achieve the greatest benefit.

Where disease pressure is lower, or when disease enters the canopy later in the season, a single application at flag leaf emergence was the best strategy.

Rainfall between grain-fill and harvest can also result in grain staining in Bannister but applying late fungicides has proved unreliable.

GRAIN YIELD

The National Variety Trials (NVT) compare current and new crop varieties in trials run across Australia. Each year, the NVT program coordinates about 31 oat variety trials with thirteen of these located in Western Australia. Grain yield comparisons (based on trials from 2015 to 2019 or 2015 to 2018 for Agzone 6) for current milling oat varieties are presented in Tables 2 to 7.

To find the latest NVT data (both long-term and seasonal) visit www.nvtonline.com.au or download the NVT yield app.

Grain yield data are presented in five WA Agzones, which group together environmental regions that give similar crop performance.

TABLE 2. Grain yield of oat varieties in AGZONE 2 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.33	4.11	3.15	3.46	2.67	
Variety	(No. trials)	(6)	(6)	(7)	(6)	(7)	(32)
Deliverable as Oat1							
Bannister	(32)	113	120	117	116	111	115
Bilby	(32)	109	107	111	111	110	110
Carrolup	(32)	91	93	97	98	93	94
Kojonup	(32)	99	103	101	99	95	99
Kowari	(32)	103	98	105	104	105	103
Mitika	(32)	98	94	101	100	100	99
Williams	(32)	112	111	111	112	110	111
Yallara	(32)	94	92	90	93	95	93
Deliverable as Oat2							
Durack	(32)	96	85	94	95	99	94
Wandering	(32)	111	121	111	113	111	113

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

TABLE 3. Grain yield of oat varieties in AGZONE 3 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.03	4.11	4.07	3.02	2.93	
Variety	(No. trials)	(3)	(4)	(4)	(4)	(3)	(18)
Deliverable as Oat1							
Bannister	(18)	111	113	115	113	110	113
Bilby	(18)	106	103	103	103	96	102
Carrolup	(18)	90	100	102	98	93	97
Kojonup	(18)	102	102	107	103	111	105
Kowari	(18)	99	97	96	97	90	96
Mitika	(18)	96	94	95	94	90	94
Williams	(18)	114	111	114	111	110	112
Yallara	(18)	96	100	98	98	98	98
Deliverable as Oat2							
Durack	(18)	96	91	91	91	87	91
Wandering	(18)	108	115	109	113	108	111

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

TABLE 4. Grain yield of oat varieties in AGZONE 4 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		2.19	3.72	3.43	2.06	1.11	
Variety	(No. trials)	(1)	(1)	(1)	(1)	(1)	(5)
Deliverable as Oat1							
Bannister	(5)	112	115	121	116	112	115
Bilby	(5)	113	107	110	116	112	112
Carrolup	(5)	95	96	87	99	105	96
Kojonup	(5)	98	97	104	88	83	94
Kowari	(5)	109	100	101	110	105	105
Mitika	(5)	106	96	98	102	96	100
Williams	(5)	104	110	104	115	118	110
Yallara	(5)	88	98	84	98	110	96
Deliverable as Oat2							
Durack	(5)	97	92	80	103	107	96
Wandering	(5)	106	119	122	119	123	118

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

TABLE 5. Grain yield of oat varieties in AGZONE 5 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.17	2.79	2.84	3.05	1.77	
Variety	(No. trials)	(2)	(1)	(2)	(1)	(2)	(8)
Deliverable as Oat1							
Bannister	(8)	111	128	128	116	102	116
Bilby	(8)	107	109	115	110	108	110
Carrolup	(8)	90	96	95	98	94	94
Kojonup	(8)	95	111	107	97	87	98
Kowari	(8)	100	97	104	102	106	102
Mitika	(8)	96	92	100	97	100	98
Williams	(8)	107	126	116	116	108	113
Yallara	(8)	97	91	83	98	104	95
Deliverable as Oat2							
Durack	(8)	93	85	83	97	109	94
Wandering	(8)	118	118	119	116	109	116

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

TABLE 6. Grain yield of oat varieties in AGZONE 6 expressed as a percentage of site mean yield for each trial year (2015-2018) and the weighted average over the four-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2015-2019
Site mean yield (t/ha)		3.73	1.82	3.56	4.82	
Variety	(No. trials)	(1)	(1)	(1)	(1)	(4)
Deliverable as Oat1						
Bannister	(4)	130	156	120	128	134
Bilby	(4)	127	121	109	107	116
Carrolup	(4)	85	93	100	104	96
Kojonup	(4)	106	136	115	111	117
Kowari	(4)	118	99	103	95	104
Mitika	(4)	114	91	102	91	100
Williams	(4)	105	170	113	124	128
Yallara	(4)	63	75	84	95	79
Deliverable as Oat2						
Durack	(4)	83	82	88	83	84
Wandering	(4)	112	103	101	120	109

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

TABLE 7. Grain yield of oat varieties in AGZONE 2 to 6 expressed as a percentage of site mean yield for each trial year (2015-2019) and the weighted average over the five-year period (where there are four or more observations)

Year		2015	2016	2017	2018	2019	2015-2019
Site mean yield (t/ha)		3.18	3.80	3.40	3.29	2.47	
Variety	(No. trials)	(13)	(13)	(15)	(13)	(13)	(67)
Deliverable as Oat1							
Bannister	(67)	114	119	118	117	110	116
Bilby	(67)	110	106	109	108	106	108
Carrolup	(67)	90	96	98	99	93	95
Kojonup	(67)	99	104	105	101	98	102
Kowari	(67)	103	98	102	101	101	101
Mitika	(67)	99	94	99	97	97	97
Williams	(67)	110	114	112	113	110	112
Yallara	(67)	92	94	91	95	97	94
Deliverable as Oat2							
Durack	(67)	94	87	91	93	97	92
Wandering	(67)	111	118	111	114	111	113

Source: based on MET analysis from NVT Online, **nvtonline.com.au**

GRAIN YIELD – COMPARISONS

The highest yielding oat varieties in WA are Bannister and Williams (Figures 2 to 3, Tables 2, 3, 5 to 7). Newly released variety Bilby appears to be close to Williams in yield in the 3t/ha growing environment. Bannister appears to have the highest yield at sites with a potential above 2.5t/ha.

Bilby has an advantage below 2t/ha. Carrolup, Durack, Kojonup, Kowari, Mitika and Yallara are other milling oat options, none of which are yield competitive with Bannister.

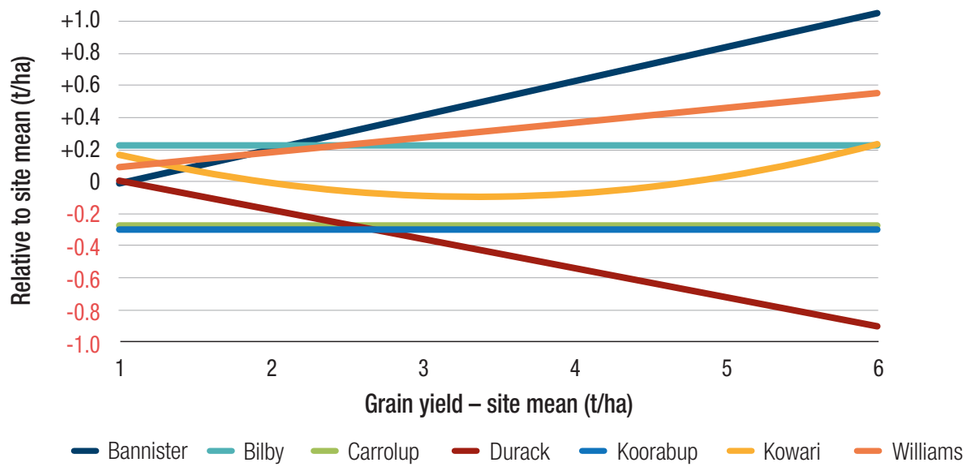

FIGURE 2. Fitted grain yield of Bannister, Bilby, Carrolup, Durack, Koorabup, Kowari and Williams at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

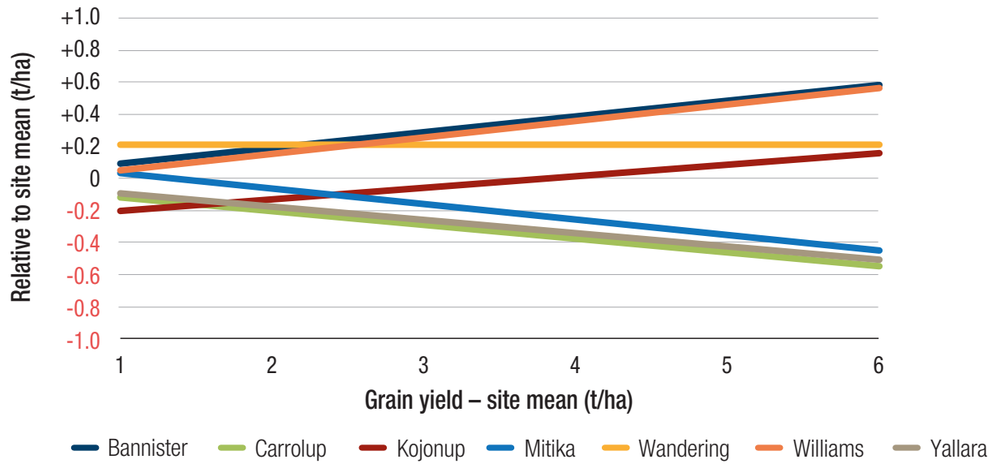

FIGURE 3. Fitted grain yield of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site mean yields.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data.

GRAIN QUALITY

When comparing milling oat varieties, grain quality is an essential trait to consider – including the hectolitre weight and percentage of screenings compared to known benchmark varieties. Physical grain quality (hectolitre weight and screenings through a 2.0mm slotted sieve) of milling oat varieties have been plotted relative to the site mean in Figures 4 to 7. Deviation from the site mean was then assessed for quadratic and linear trends. If neither the quadratic nor the linear trend was significant, the grain quality response of a variety was deemed to run parallel to the site mean quality at the average deviation for that variety. The data used for this analysis have been extracted from the NVT document 'State-wide tables of yield and grain quality' available at **nvtonline.com.au**.

Figures 4 to 5 compare the hectolitre weight of varieties suitable for delivery into the Oat1 or Oat2 segregations in WA. Figures 6 to 7 present grain plumpness comparisons (percentage through a 2.0mm sieve).

Grain quality – hectolitre weight comparisons

Of the nine varieties segregated for milling in WA, Carrolup continues to be the benchmark variety for hectolitre weight. Durack and Yallara displayed a similar hectolitre weight to Carrolup over the years they were evaluated together (eight years for Carrolup vs Yallara and four years for Carrolup vs Durack) (Figure 4 and Figure 5). The hectolitre weights of Bilby, Kowari, Mitika, Wandering and Williams were ~2kg/hL lower than Carrolup ($p<0.05$).

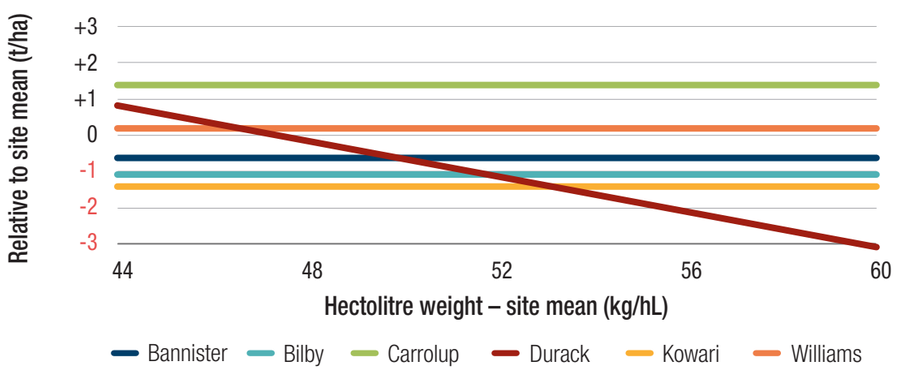

FIGURE 4. Fitted hectolitre weight of Bannister, Bilby, Carrolup, Durack, Kowari and Williams at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

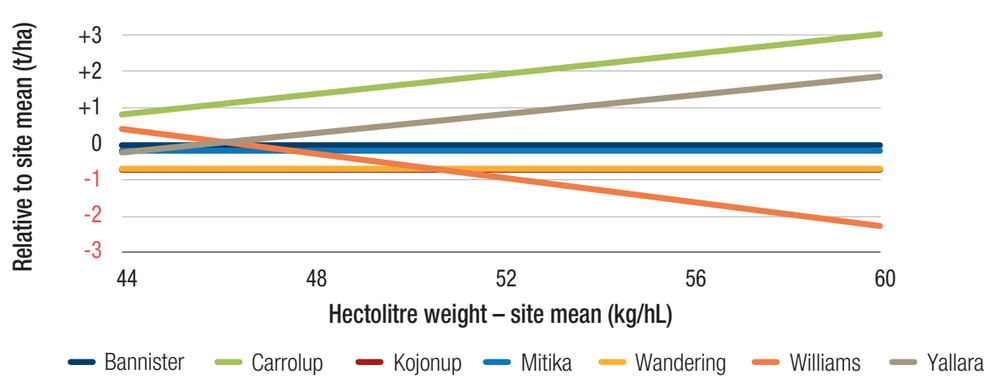

FIGURE 5. Fitted hectolitre weight of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2018-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data.

Grain quality – grain plumpness comparisons

The benchmark oat variety for grain plumpness is Mitika (Figure 7), which has lower screenings than the other varieties segregated for milling in WA. Yallara appears to behave similarly to Mitika, while Carrolup behaves similarly to Williams, with screenings percentage increasing as the site mean increased. At very low screenings, most varieties have similar values. Around the Oat1 limit of 10% screenings, genetic differences are notable, and this will likely influence variety selection in different environments. Of the newer varieties, Bilby has similar grain plumpness to Bannister, while Kowari and Durack are plumper than Bannister.

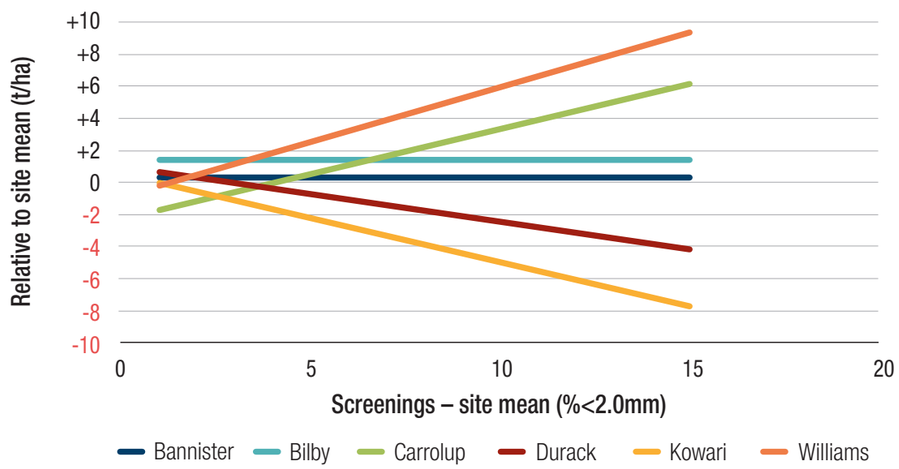

FIGURE 6. Fitted grain plumpness of Bannister, Bilby, Carrolup, Durack, Kowari and Williams at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2016-2019), **nvtonline.com.au**. Each variety sown in all 47 trial-years of data.

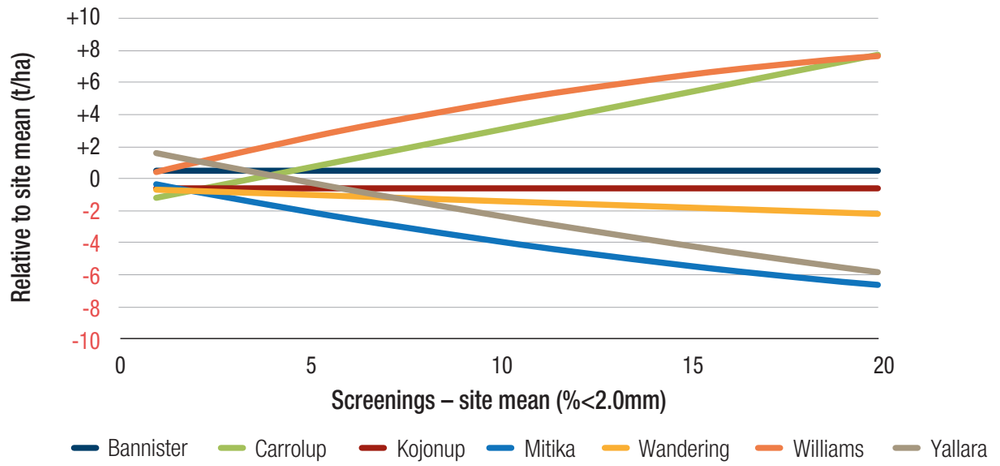

FIGURE 7. Fitted grain plumpness of Bannister, Carrolup, Kojonup, Mitika, Wandering, Williams and Yallara at different site means.

Source: based on NVT state-wide tables of yields and grain quality (2012-2019), **nvtonline.com.au**. Each variety sown in all 101 trial-years of data..

DISEASE RESISTANCE RATING

Rust and BYDV reactions may vary in different regions and with different seasonal conditions depending on the prevalent pathotype/serotype. Crop monitoring is essential.

TABLE 8. Disease and virus resistance ratings of oat varieties in 2020

Variety	Septoria	Rust		BYDV
		Leaf rust	Stem rust	
Bannister	MSS	R	MS	MRMS
Bilby	S	MR	S	MRMS
Brusher*	SVS	R-MS	MR-S	MRMS
Carrolup	S	VS	SVS	MSS
Durack	SVS	MRMS*p*	S	MSS
Forester*	MSS	R-MS	R-MS	MS
Kojonup	SVS	SVS	MSS	MS
Koorabup	MRMS	MRMS	MSS	MSS
Kowari	SVS	R	S	MS
Mitika	SVS	MR	MSS	S
Mulgara*	MR-S	MR	MRMS	MSS
Wandering	MSS	VS	SVS	MS
Williams	MRMS	MR	MS	MRMS
Winjardie*	SVS	SVS	MR-S	MSS
Wintaroo*	MSS	SVS	MR	MS
Yallara	S	MRMS*p*	MSS	MS

Source: DPIRD and National Oat Breeding Program (*)

VS = very susceptible, S = susceptible, MS = moderately susceptible,
MR = moderately resistant, R = resistant, - = range in disease resistance, *p* = provisional rating

HAY YIELD AND QUALITY

The National Oat Breeding Program (NOBP) compares current and new hay varieties in trials across Australia. The South Australian Research and Development Institute (SARDI) leads the National Oat Breeding program, working closely with DPIRD to develop high quality export hay varieties, along with improved milling oats. The NOBP is supported by the Australian Government and growers through the Grains Research and Development Corporation (GRDC) and AgriFutures Australia, along with investment from DPIRD, South Australian Grain Industry Trust (SAGIT), and commercial partners AEXCO and Barenbrug.

Each year, the NOBP program coordinates about eight oat hay variety trials, with two of these located in Western Australia. Hay yield comparisons (based on trials from 2014 to 2019) for current oat hay varieties are presented in Table 9. Quality performance is also included in Table 9, with the parameters of digestibility, water soluble carbohydrates, acid detergent fibre, neutral detergent fibre and the neutral detergent fibre digestibility after 30 hours presented.

The suggested quality specifications that growers need to achieve to meet export hay requirements are given in Table 10.

Hay yield and quality performance is also included in the variety snapshots, as a comparison with the benchmark variety Carrolup.

TABLE 9. Average hay yield (t/ha) and quality for sixteen oat varieties in WA (2014-2019, with NDFDom30 2017-2019)

Variety	Hay yield (t/ha)	Digestibility (% dm)	WSC[1] (% dm)	ADF[2] (% dm)	NDF[3] (% dm)	NDFDom30[4] (% dm)
Early-mid varieties						
Bannister	6.6	69.6	32.6	27.1	47.6	59.2
Brusher	7.2	68.4	32.8	28	48.2	57
Carrolup	6.3	66.9	31.7	28.8	49	55.4
Durack	6.2	66.7	30.2	28.6	49.4	53
Koorabup	6.5	67.1	29.1	29	50.8	56
Mulgara	6.7	68.1	31.7	28.1	48.7	58.5
Swan	7.2	66.5	30.7	29.1	50.4	52.7
Wandering	6.8	69	32.9	27.3	48	58.4
Williams	6.3	67.3	30.7	28.5	49.6	56.1
Winjardie	7	66.9	31.3	28.7	49.8	55.7
Wintaroo	7.1	67.4	30.6	29	50	56.6
Yallara	6.8	67.9	32	28.2	48.4	54.6
Mid-late to very late varieties						
Forester	6.4	70.3	34.2	28.1	46.3	-
Kangaroo	6.8	66.3	29.9	29.3	51	-
Tammar	6.2	68	30.6	28.8	49.7	-
Tungoo	6.7	68.2	31.9	28.4	48.7	-
No. sites	*13*	*9*	*11*	*10*	*11*	*5*

Source: National Oat Breeding Program. Analysis by Chris Lisle, BBAGI, University of Woollongong.

WSC[1]= Water soluble carbohydrates, ADF[2] = Acid detergent fibre, NDF[3] = Neutral detergent fibre, NDFDom30[4] = Neutral detergent fibre digestibility after 30 hours.

TABLE 10. Quality standards to meet export hay requirements in WA

Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Crude protein (% CP)	>4	<4	<4	<4
Estimated metabolisable energy (est. ME MJ/kg DM)	>9.5	<9.5	<9.5	<9.5
In vitro digestibility (% DMD)	>60	>58	>56	>53
Water soluble carbohydrates (% WSC)	>22	>18	>14	>14
Acid detergent fibre (% ADF)	<30-32	>32-35	>35-37	>37-40
Stem thickness (mm)	<6	<8	<9	>9-12

Variety snapshots

Variety snapshots are presented for:

- seven dual-purpose varieties (Bannister, Carrolup, Durack, Kojonup, Wandering, Williams and Yallara) that can be delivered as either milling grain (Oat1 or Oat2) or hay into the export or domestic market when they meet receival requirements.
- three milling oat varieties (Bilby, Kowari and Mitika) that are not suitable for hay production, and
- eight hay varieties (Brusher, Forester, Kingbale, Koorabup, Mulgara, Swan, Winjardie and Wintaroo) that can only be delivered as hay varieties and which are not suitable for milling.

The comment section in each snapshot describes essential characteristics of a variety including their yield relative to another variety, key weaknesses and strengths (including where appropriate disease resistance) and relevant market information.

Grain yield data extracted from the Long Term MET Yield Reporter (available at NVT online, nvtonline.com.au) are presented as a percentage of the site mean yield. Hay yield data are presented relative to a control variety (Carrolup) from data provided by the National Oat Breeding Program trials 2015-19.

Disease resistance ratings are sourced from Table 8 within this guide.

The phenology data presented in the snapshots are the median predicted date to Z71 (date predicted for 50% of 'normal' seasons) based on performance when sown at four sowing dates from late-April to early-July in hill plot trials located at Northam and Katanning in 2015-19.

Agronomic traits are tabulated based on published data, data collected by DPIRD, data generated from the DPIRD-GRDC co-funded projects DAW00227 and the National Oat Breeding Program.

Variety information including pedigree, the seed licensee, seed trading restrictions and the EPR payable sourced from breeding companies, Variety Central (varietycentral.com.au/) and IP Australia Plant Breeders Rights database (pericles.ipaustralia.gov.au/pbr_db/search.cfm).

ACKNOWLEDGEMENTS

The information contained in this bulletin is based on work conducted by many research scientists and technical officers from the Department of Primary Industries and Regional Development (DPIRD), plant breeders from the National Oat Breeding Program and Consultants.

The authors would like to thank the following groups of people:

- Plant pathology staff and RSUs involved under the NVT Services Agreement: Manisha Shankar, Geoff Thomas, Pip Payne, Ryan Varischetti, Carnarvan RSU and Manjimup RSU.
- Biometrics: Andrew Van Burgel.
- Oat agronomy: Kimberly Arnold and Michelle Sampson.
- Research support units: Esperance, Katanning, Merredin, Northam and Wongan Hills.

Thank you to National Variety Trials, trial co-operators and the National Oat Breeding Program for their cooperation in providing data and Co-operative Bulk Handling for providing data on sowing area by variety information.

This publication presents data and information developed from research supported by the Department of Primary Industries and Regional Development, Western Australia, AgriFutures Australia and the Grains Research and Development Corporation (GRDC).

BANNISTER(D)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Bannister is a medium spring, tall milling variety with a high grain yield (~15% higher than Carrolup). It is 15cm shorter than Carrolup and heads about 4 days later than Carrolup, Yallara and Williams. Its suitability for the lower rainfall regions is supported by robust hectolitre weight and moderate screening percentages. Bannister is susceptible to grain staining (both septoria and alternaria have been isolated). Growers should avoid sowing Bannister in high risk, grain staining scenarios, oat-on-oat rotations, and where the occurrence of pre-harvest rain is a high risk. Bannister is not recommended as an export hay variety.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	113	120	117	116	111
Agzone 3	111	113	115	113	110
Agzone 4	112	115	121	116	112
Agzone 5	111	128	128	116	102
Agzone 6	130	156	120	128	-
Statewide	114	119	118	117	110
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	R				
Stem rust	MS				
BYDV	MRMS				
Agronomic traits					
Plant height	Tall				
Coleoptile length (mm)	110.3				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	Dumont/Echidna Mortlock//75Q:198 Swan Fulmark/Newton				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Seednet				
EPR ($/t, excl. GST)	$2.30				

CARROLUP

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Carrolup is a medium spring, mid-tall, dual purpose (milling grain and hay) variety. It has a similar height and maturity to Yallara. Carrolup has lower yields than the new milling varieties Bannister and Williams. With a consistently high hectolitre weight, screenings tend to be high, similar to Williams. Carrolup is suitable for export hay.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	91	93	97	98	93
Agzone 3	90	100	102	98	93
Agzone 4	95	96	87	99	105
Agzone 5	90	96	95	98	94
Agzone 6	85	93	100	104	-
Statewide	90	96	98	99	93
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	VS				
Stem rust	SVS				
BYDV	MSS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	104.7				
Growth habit	Medium spring				
Stem diameter	Medium				
Variety information					
Pedigree	Mortlock/5/Kent/Ballidu/Curt/3/Cortez/ 4/TAMO-312/2.2*West				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	No EPR				

DURACK(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Durack is an early spring, mid-tall, milling variety that was accredited as OAT2 only. It is similar in height and yield to Carrolup and Yallara, but with improved hectolitre weight. Screenings are low due to its plump grain shape compared to Carrolup and Williams. Durack is the earliest maturing oat variety of any current milling or hay variety. Whilst earlier flowering helps to produce large grains it may also increase the risk of frost during flowering, so growers are encouraged to sow between May and mid-June when sown in frost prone areas. While Durack is suitable for export hay, its hay yields are generally lower yielding than Carrolup and Williams.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	96	85	94	95	99
Agzone 3	96	91	91	91	87
Agzone 4	97	92	80	103	107
Agzone 5	93	85	83	97	109
Agzone 6	83	82	88	83	-
Statewide	94	87	91	93	97
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MRMS*p*				
Stem rust	S				
BYDV	MSS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	112.2				
Growth habit	Early spring				
Stem diameter	Medium				
Variety information					
Pedigree	01Q211/94Q601-45-28				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.30				

p = provisional assessment

KOJONUP(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Kojonup is a medium spring, medium height, dual purpose (milling grain and hay) variety. Grain yield is less competitive than Bannister and Williams, and similar to Wandering. It has good grain quality, large seed size, high hectolitre weight and low screenings. Kojonup is not suitable for lower rainfall regions (e.g. less than 200mm growing season rainfall). While Kojonup is suitable for export hay, its hay yields are generally lower than Carrolup.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	99	103	101	99	95
Agzone 3	102	102	107	103	111
Agzone 4	98	97	104	88	83
Agzone 5	95	111	107	97	87
Agzone 6	106	136	115	111	-
Statewide	99	104	105	101	98
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	SVS				
Stem rust	MSS				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	-				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	83Q:384/Coomallo				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	$2.25				

WANDERING(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Wandering is a medium spring, medium height feed variety that is received as Oat2 and OWAN only. Wandering has comparable yields to Bannister and Williams. Wandering is suitable for export hay, its hay yields are generally higher than Carrolup and Williams.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	111	121	111	113	111
Agzone 3	108	115	109	113	108
Agzone 4	106	119	122	119	123
Agzone 5	118	118	119	116	109
Agzone 6	112	103	101	120	-
Statewide	111	118	111	114	111
Disease resistance	**Rating**				
Septoria	MSS				
Leaf rust	VS				
Stem rust	SVS				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	106.6				
Growth habit	Medium spring				
Stem diameter	Medium				
Variety information					
Pedigree	SA Seln 41/75Q36-144-31				
Breeder / Seed licensee	Dept. of Agriculture, WA				
Access to seed	Free to trade				
EPR ($/t, excl. GST)	No EPR				

WILLIAMS(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Williams is an early spring, mid-tall dual purpose (milling grain and hay) variety. Williams has the best overall foliar disease resistance of milling and dual purpose varieties. Williams has a similar grain yield to Bannister and Wandering. Williams has lower hectolitre weight and higher screenings than Bannister, Mitika and Yallara, especially in lower rainfall regions. Williams may lodge in high yielding environments. Williams is suitable for export hay and its hay yields are around 0.5-1.0t/ha lower than specialist hay varieties like Brusher, Mulgara and Winjardie at a comparable hay quality. The main issue with Williams hay is stem thickness, so a target density of 320 plants/m2 is required when grown for export hay.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	112	111	111	112	110
Agzone 3	114	111	114	111	110
Agzone 4	104	110	104	115	118
Agzone 5	107	126	116	116	108
Agzone 6	105	170	113	124	-
Statewide	110	114	112	113	110
Disease resistance	**Rating**				
Septoria	MRMS				
Leaf rust	MR				
Stem rust	MS				
BYDV	MRMS				
Agronomic traits					
Plant height	Mid-tall				
Coleoptile length (mm)	109.8				
Growth habit	Early spring				
Stem diameter	Moderately thick				
Variety information					
Pedigree	Pennlo/Murray//Carrolup/3/ TAM386/Carrolup				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.30				

YALLARA(Þ)

DELIVERABLE AS A DUAL PURPOSE VARIETY

Comments

Yallara is a medium spring, mid-tall dual purpose (milling grain and hay) variety. Yallara grain has a similar grain quality to Carrolup but the variety is not susceptible to stem and leaf rust. It has good hectolitre weight, low screenings and high groat percent. Yallara is suitable for export hay, slightly higher hay yield than Williams and a comparable hay quality to the specialist hay variety Brusher. Yallara is replacing Winjardie as a hay variety in the northern half of Agzone 2.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	94	92	90	93	95
Agzone 3	96	100	98	98	98
Agzone 4	88	98	84	98	110
Agzone 5	97	91	83	98	104
Agzone 6	63	75	84	95	-
Statewide	92	94	91	95	97
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MRMS*p*				
Stem rust	MSS				
BYDV	MS				
Agronomic traits					
Plant height	Erect mid tall				
Coleoptile length (mm)	121.4				
Growth habit	Medium spring				
Stem diameter	Moderately fine				
Variety information					
Pedigree	Euro*2/ND931075				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Seednet				
EPR ($/t, excl. GST)	$2.00				

p = provisional assessment

BILBY(Þ)

MILLING VARIETY

Comments

Bilby is a cross between two breeding lines, 98011-6 and 98240-19. Bilby is a dwarf, early-mid season variety. Its grain yield and quality is between that of Kojonup and the higher yielding varieties Bannister and Williams (based on data from NVT 2016-19, and DPIRD oat agronomy 2017-19). Without a yield advantage over Bannister or Wandering, it is not expected that Bilby will displace these dominating varieties in the WA oat growing environment. The National Oat Breeding Program has developed this variety, along with Kowari, to have high ß-glucan, an important nutritional quality trait, which is valued by oat markets worldwide.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	109	107	111	111	110
Agzone 3	106	103	103	103	96
Agzone 4	113	107	110	116	112
Agzone 5	107	109	115	110	108
Agzone 6	127	121	109	107	-
Statewide	110	106	109	108	106
Disease resistance	**Rating**				
Septoria	S				
Leaf rust	MR				
Stem rust	S				
BYDV	MRMS				
Agronomic traits					
Plant height	Dwarf				
Coleoptile length (mm)	-				
Growth habit	Early - Mid spring				
Stem diameter	-				
Variety information					
Pedigree	98011-6/98240-19				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.50				

KOWARI(Þ)

MILLING VARIETY

Comments

Kowari is a newly released, medium spring, medium height milling variety. Kowari has improved green leaf retention relative to Mitika. Kowari has similar yields and slightly lower hectolitre weight than Mitika, but it has higher 1000 grain weight compared to Mitika. It combines high ß-glucan with low screenings.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	103	98	105	104	105
Agzone 3	99	97	96	97	90
Agzone 4	109	100	101	110	105
Agzone 5	100	97	104	102	106
Agzone 6	118	99	103	95	-
Statewide	103	98	102	101	101
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	R				
Stem rust	S				
BYDV	MS				
Agronomic traits					
Plant height	Medium				
Coleoptile length (mm)	-				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	Mitika/WAOAT2099				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.50				

MITIKA(Þ)

MILLING VARIETY

Comments

Mitika is a medium spring, short height milling variety. Yield of Mitika is an improvement on Carrolup, but less competitive with Bannister and Williams. Mitika has high hectolitre weight, low screenings and high groat percent. Mitika like Kowari has higher levels of ß-glucan than current milling and dual purpose varieties. Mitika has improved feed quality due to low husk lignin and high grain digestibility. Mitika is not recommended as an export hay variety.

Grain yield (% Site mean)	2015	2016	2017	2018	2019
Agzone 2	98	94	101	100	100
Agzone 3	96	94	95	94	90
Agzone 4	106	96	98	102	96
Agzone 5	96	92	100	97	100
Agzone 6	114	91	102	91	-
Statewide	99	94	99	97	97
Disease resistance	**Rating**				
Septoria	SVS				
Leaf rust	MR				
Stem rust	MSS				
BYDV	S				
Agronomic traits					
Plant height	Short				
Coleoptile length (mm)	133.2				
Growth habit	Medium spring				
Stem diameter	-				
Variety information					
Pedigree	0X87;072-13/0X87;080-1// 0X88;045-12				
Breeder / Seed licensee	National Oat Breeding Program				
Access to seed	Barenbrug				
EPR ($/t, excl. GST)	$2.00				

BRUSHER(Þ)

HAY VARIETY

Comments

Brusher is a tall, medium spring hay variety. In phenology trials (2015-17) located at Northam, Brusher reached watery ripe (Z71) 4 days later than Carrolup when sown in late May.

Hay yield and quality	Brusher	Carrolup
Hay Yield (t/ha)	7.2	6.3
Digestibility (% dm)	68.4	66.9
WSC (% dm)	32.8	31.7
ADF (% dm)	28.0	28.8
NDF (% dm)	48.2	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	SVS	
Leaf rust	RM-S	
Stem rust	MR-S	
BYDV	MRMS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	114.2	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	Dumont/Wallaroo//Bandicoot	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	

FORESTER(Þ)

HAY VARIETY

Comments

Forester is a tall, very late spring hay variety adapted to high rainfall areas. In phenology trials (2015-17) located at Northam, Forester reached watery ripe (Z71) 25 days later than Carrolup when sown in late May, indicating it does not have a fit in this region of export hay production (similar to Tammar and Tungoo which are not listed in this guide).

Hay yield and quality	Forester	Carrolup
Hay Yield (t/ha)	6.4	6.3
Digestibility (% dm)	70.3	66.9
WSC (% dm)	34.2	31.7
ADF (% dm)	28.1	28.8
NDF (% dm)	46.3	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	MSS	
Leaf rust	R-MS	
Stem rust	R-MS	
BYDV	MS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	99.1	
Growth habit	Very late spring	
Stem diameter	Moderately thick	
Variety information		
Pedigree	OT285/OX92;056-4	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	

KINGBALE(Þ)

HAY VARIETY

Comments

Kingbale is an imidazolinone tolerant variety. Kingbale has a single gene trait tolerance to imidazolinone (pre-sowing and plant-back residue tolerance only), and is very similar to its parent – Wintaroo.

Hay yield and quality	Kingbale	Carrolup
Hay Yield (t/ha)	No data currently available	6.3
Digestibility (% dm)		66.9
WSC (% dm)		31.7
ADF (% dm)		28.8
NDF (% dm)		49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	No current rating available	
Leaf rust		
Stem rust		
BYDV		
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	-	
Variety information		
Pedigree	Wintaroo	
Breeder / Seed licensee	GIA/Intergrain	
Access to seed	Intergrain in 2021- pending registration	
EPR ($/t, excl. GST)	TBC	

KOORABUP(Þ)

HAY VARIETY

Comments

Koorabup is a tall, medium spring hay variety. In phenology trials , Koorabup had similar maturity to Wintaroo and Vasse, about 4-5 days later than Carroulp when sown in mid-May and early-June. Koorabup produces slightly higher hay yield than Carrolup (Muresk, May sown, 2019 National Hay Agronomy trial), with similar hay quality. Koorabup has similar septoria resistance to Williams (MRMS).

Hay yield and quality	Koorabup	Carrolup
Hay Yield (t/ha)	6.5	6.3
Digestibility (% dm)	67.1	66.9
WSC (% dm)	29.1	31.7
ADF (% dm)	29.0	28.8
NDF (% dm)	50.8	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	MRMS	
Leaf rust	MRMS	
Stem rust	MSS	
BYDV	MSS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	95.8	
Growth habit	Medium spring	
Stem diameter	Moderately fine	
Variety information		
Pedigree	WAOAT2282/WAOAT223	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	

MULGARA(b)

HAY VARIETY

Comments

Mulgara is a tall, medium spring hay variety. In phenology trials (2015-17) located at Northam, Mulgara reached watery ripe (Z71) 3 days later than Carrolup when sown in late May. Mulgara is resistant to stem nematode (not listed in table below).

Hay yield and quality	Mulgara	Carrolup
Hay Yield (t/ha)	6.7	6.3
Digestibility (% dm)	68.1	66.9
WSC (% dm)	31.7	31.7
ADF (% dm)	28.1	28.8
NDF (% dm)	48.7	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	MR-S	
Leaf rust	MR	
Stem rust	MRMS	
BYDV	MSS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	121.7	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	0X89;030-26/93-112	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	

SWAN

HAY VARIETY

Comments

Swan was is a tall, medium spring variety which was released in 1967. In trials conducted in 2004 and 2005, Swan outyielded Carrolup by 900kg/ha. Due to its tendency to produce thick stems, and its lodging susceptibility it is only suited to lower rainfall environments where these quality constraints are limited by rainfall.

Hay yield and quality	Swan	Carrolup
Hay Yield (t/ha)	7.2	6.3
Digestibility (% dm)	66.5	66.9
WSC (% dm)	30.7	31.7
ADF (% dm)	29.1	28.8
NDF (% dm)	50.4	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	No current rating available	
Leaf rust		
Stem rust		
BYDV		
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	-	
Variety information		
Pedigree	Kent/Ballidu	
Breeder / Seed licensee	Dept. of Agriculture, WA	
Access to seed	Free to trade	
EPR ($/t, excl. GST)	No EPR	

WINJARDIE

HAY VARIETY

Comments

Winjardie is a tall, medium spring variety which was released in 1985. Its low disease resistance makes it unsuitable for disease prone locations, however Winjardie can produce quality export hay when grown in the northern half of Agzone 2 where disease pressure is reduced.

Hay yield and quality	Winjardie	Carrolup
Hay Yield (t/ha)	7.0	6.3
Digestibility (% dm)	66.9	66.9
WSC (% dm)	31.3	31.7
ADF (% dm)	28.7	28.8
NDF (% dm)	49.8	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	SVS	
Leaf rust	SVS	
Stem rust	MR-S	
BYDV	MSS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	Fulmark/Newton//Swan /3/Kent/ Ballidu//Curt	
Breeder / Seed licensee	Dept. of Agriculture, WA	
Access to seed	Free to trade	
EPR ($/t, excl. GST)	No EPR	

WINTAROO(b)

HAY VARIETY

Comments

Wintaroo is a tall, medium spring variety. It resists brown leaf tipping by hot winds and maintains good colour longer than most varieties. In phenology trials (2015-17) located at Northam, Wintaroo reached watery ripe (Z71) 8 days later than Carrolup when sown in late May.

Hay yield and quality	Wintaroo	Carrolup
Hay Yield (t/ha)	7.1	6.3
Digestibility (% dm)	67.4	66.9
WSC (% dm)	30.6	31.7
ADF (% dm)	29.0	28.8
NDF (% dm)	50.0	49.0
Hay yield and quality 2014-19, courtesy National Oat Breeding Program		
Disease resistance	**Rating**	
Septoria	MSS	
Leaf rust	SVS	
Stem rust	MR	
BYDV	MS	
Agronomic traits		
Plant height	Tall	
Coleoptile length (mm)	-	
Growth habit	Medium spring	
Stem diameter	Medium	
Variety information		
Pedigree	MIOLRP-86-3/Echidna//Wallaroo	
Breeder / Seed licensee	National Oat Breeding Program	
Access to seed	AEXCO Seed distributor	
EPR ($/t, excl. GST)	$2.00	