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2019 Oat variety sowing guide for Western Australia

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

WESTERN AUSTRALIA

AgriFutures Export Fodder

National Variety Trials
A GRDC INITIATIVE

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Company and industry abbreviations:

- CBH – Co-operative Bulk Handling
- CBB – Centre for Bioinformatics and Biometrics
- DPIRD – Department of Primary Industries and Regional Development (formerly DAFWA)
- GIWA – Grain Industry Association of Western Australia
- GRDC – Grains Research and Development Corporation
- NVT – National Variety Trials
- SAGI – Statistics for the Australian Grains Industry

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Edited by
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Department of Primary Industries and Regional Development

Contents

AgriFutures Export Fodder
National Variety Trials A GRDC INITIATIVE
GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Introduction

Georgie Troup (DPIRD)

This bulletin is designed to help you determine which milling oat or export hay variety to grow in your region. It provides variety characteristics, disease ratings, and agronomic information for oat varieties that offer growers the best opportunity to meet market requirements. Each variety available for sowing has their own strengths and weaknesses, and their characteristics will determine their suitability for your area and your business. No one oat variety is likely to provide optimum agronomic traits, disease resistance, yield and quality in any one year, therefore 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.

This bulletin should be read in conjunction with industry information provided by the Grain Industry Association of Western Australia (GIWA) available at giwa.org.au/oat-council. GIWA collaborates with Western Australian bulk handlers to review oat grain receival standards on an as-needs basis to ensure that the WA grain receival standards are fit-for-purpose. A review of standards conducted in 2018 resulted in two changes to the Oat2 receival standards that will be introduced at the 2019/20 harvest (Table 1).

Not all varieties of oats are suitable for delivery as hay and as grain. Table 2 outlines the suitability of varieties for cutting and baling for export hay and those varieties suitable for the delivery as grain into Oat1 or Oat2 milling segregations. It is worth noting that the milling variety Durack is not suitable for delivery into Oat1 segregations. OWAN is an exclusive segregation for the variety Wandering. Wandering can also be delivered into Oat2 segregations.

A crop which is grown to produce high quality milling grain is unlikely to also meet high quality export hay requirements as the plant density and nutrition (rate and strategy) applied during the growing season will adversely affect the outcome of the alternate end product. It is important that growers determine their end product prior to sowing to increase profitability.

Table 1 Changes to oat receival standards for 2019/20 harvest (More information on the standards review is available at giwa.org.au/standards)

Standard	2018/19 harvest	2019/20 harvest
Oat2 Screenings	N/A	15%
Oat2 Groat count	144 per 2 black plastic measure	72 per 2 black plastic measure

Table 2 Oat variety suitability for grain (Oat1, Oat2 and OWAN) and export hay

Variety	Oat1	Oat2	OWAN	Export hay
Bannister(b)	II	II		II
Brusher(b)				II
Carrolup	II	II		II
Coomallo(b)	II	II		
Durack(b)		II		II
Forester(b)				II
Hotham(b)	II	II		
Kojonup(b)	II	II		II
Kowari(b)	II	II		
Mitika(b)	II	II		
Mortlock(b)	II	II		
Mulgara(b)				II
Pallinup(b)	II	II		
Tammar(b)				II
Tungoo(b)				II
Wandering(b)		II	II	
Williams(b)	II	II		II
Winjardie				II
Wintaroo(b)				II
Vasse(b)				II
Yallara(b)	II	II		II

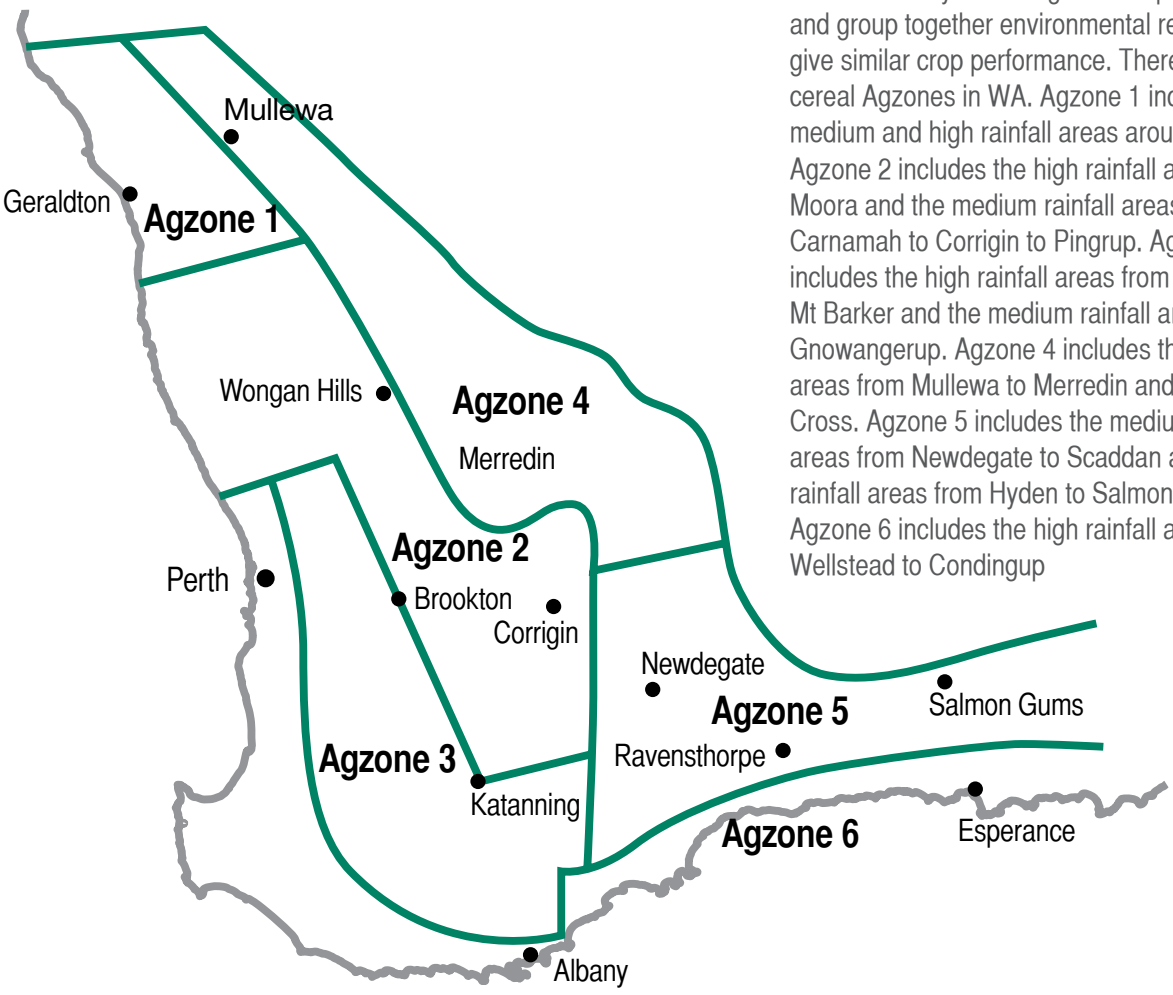


Figure 1 Agzone map of the south west corner of WA. Agzones have been developed through statistical analysis of long term crop variety trials and group together environmental regions that give similar crop performance. There are six cereal Agzones in WA. Agzone 1 includes the medium and high rainfall areas around Geraldton. Agzone 2 includes the high rainfall areas around Moora and the medium rainfall areas from Carnamah to Corrigin to Pingrup. Agzone 3 includes the high rainfall areas from Bolgart to Mt Barker and the medium rainfall areas around Gnowangerup. Agzone 4 includes the low rainfall areas from Mullewa to Merredin and Southern Cross. Agzone 5 includes the medium rainfall areas from Newdegate to Scaddan and the low rainfall areas from Hyden to Salmon Gums. Agzone 6 includes the high rainfall areas from Wellstead to Condingup

What's new?

Kowari (tested as 03198-18) is a new milling oat variety suitable for growing in WA, having been approved for a milling end use in early 2018. Kowari is a cross between Mitika and a WA breeding line and has an end-use quality improvement over Mitika. Kowari is similar in maturity, grain yield and physical grain quality (including low hull lignin) to Mitika, but with a little extra height (dwarf gene present). Seed is available through Heritage Seeds. EPR of $2.50/tonne (excl. GST) applies.

What should I grow?

Based on their performance in DPIRD-GRDC funded agronomy trials (DAW00227) and GRDC funded NVT trials, the following varieties are suggested for a grain end use and for a hay end use.

Grain

- High rainfall – Kojonup, Wandering and Williams.
- Medium rainfall – Bannister, Kojonup and Wandering in the southern half of Agzone 2 and Bannister, Kowari, Mitika and Wandering in the northern half of Agzone 2.
- Low rainfall – Bannister, Wandering, and Durack (for a late sowing opportunity).

Growers in all rainfall zones are encouraged to grow more than one milling variety to mitigate season, grain quality and disease risks.

Hay

- High rainfall – Brusher, Mulgara, Wintaroo, and Forester (in southern areas only).
- Medium rainfall – Brusher, Mulgara, Yallara, Carrolup, Williams and Wintaroo.
- Low rainfall – Yallara, Carrolup, Williams

Best management agronomy

Georgie Troup, Blakely Paynter, Geoff Thomas (DPRID), Trent Butcher (ConsultAg)

The oat agronomy team at DPIRD, with co-investment from the GRDC, has been assessing best management practices for oat production in WA since 2014 in partnership with the farm business consulting firm ConsultAg. The aim of the research being to assist oat growers to select the right variety for the right environment with appropriate management to meet market demand, with a focus on the milling oat market. In recent years the team has focused on the following areas of nitrogen management strategies and determining the target plant density.

Nitrogen management

How does nitrogen influence grain and hay yield and grain and hay quality? What is the best nitrogen management strategy? In the first three years the project focus was to support emerging milling oat production in lower rainfall regions where market demand was driving growers' interest in oats as a break crop. In the past three seasons the focus has shifted to traditional oat growing areas of the Kwinana West port zone.

Field trials have indicated that nitrogen can have a significant role in a grower's ability to meet milling oat quality requirements when growing high yielding oat varieties. Results from field trials in lower rainfall regions indicated that when more than 40kg/ha of nitrogen was applied, grain yield decreased in 2015 (when there was an abrupt finish to the growing season in spring). At eight out of eleven trials conducted from 2014-16, increasing applied nitrogen (from 10kg N/ha to 60kg N/ha) decreased hectolitre weight. At all sites, increasing applied nitrogen increased screenings percent.

Growers should use this information to assist them in their milling oat production system by understanding the background nitrogen of the paddock prior to crop establishment, and if growing a narrow grain variety (e.g. Williams) apply nitrogen conservatively. Research indicates that Bannister and Williams are more sensitive to applied nitrogen than Carrolup, so growers adopting these varieties need to consider their background nitrogen, and apply nitrogen based on a) start-up nitrogen requirements, and b) in-season crop requirements to suit the current conditions and short term outlook.

The nitrogen strategy for grain and hay production systems differ. Hay production is focussed on maximising tillering and biomass early in the season with in-season nitrogen focussed on green leaf retention and crop health. As a result hay growers apply 2/3 of their applied nitrogen as a split between seeding and pre-tillering, with the remainder applied in response to crop requirements mid-season. Late nitrogen applications will result in a reduction in hay quality, and are not suggested. In contrast, grain growers apply 1/3 of their nitrogen at seeding, enabling them to respond to seasonal conditions and crop requirements for the remainder of the nitrogen application.

In conclusion when growers are making decisions on 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
- Strategy for nitrogen application differs for grain and hay.
- Seasonal rainfall to date. If the season is dry, then the positive impact of applied nitrogen on yield is less.
- Late nitrogen application on hay will decrease hay quality.
- Increasing nitrogen can increase screenings, and decrease hectolitre weight.

Plant density

Establishment of an optimum plant population is essential to achieve the maximum possible yield. The desired number of plants per square metre is mainly dependent on yield potential but also can improve crop competitiveness against herbicide resistance ryegrass.

- The recommended plant density for oat grain production in the higher rainfall regions is 240 plants per square metre (m^2), while in the lower rainfall region it is 160 plants/m^2.
- The recommended plant density for oat hay production is between 240-320 plants/m^2, with higher density helping to compete better with weeds and to reduce stem thickness, which is desirable in quality export hay.

Reasons to increase plant density include:

- Hay production – to help plants compete against weeds and to produce finer stems as required for the export market (target 320 plants/m^2).

- Dwarf varieties – plump-grained varieties can be sown at higher density.
- Seedling emergence and establishment are likely to be reduced.
- Plant tillering is expected to be low because of variety or soil fertility effects.
- A high risk of waterlogging (mid-season) – to compensate for a lack of tillering.
- Moderate to high grass weed densities are likely – increase competitiveness.

Avoid higher plant densities where:

- Plump grain is required for milling quality.
- Lodging could be a problem - slightly lower densities can encourage thicker stem growth.
- Crops are growing on stored soil moisture and may risk depleting most of the moisture before the crop matures.

Traditionally, growers have sown oats with a set seeding rate, however this approach can mean growers may not achieve their target plant density, reducing their ability to achieve optimum yield and/or quality. The actual seed rate in kg/ha will vary from year-year due to changes in the seed size, seed viability and establishment conditions. It is recommended that growers determine the 1000 grain weight of their seed, select the target plant density in plants/m^2 for their region, variety and target end-use and us that information to calculate their seeding rate in kg/ha. To determine the seed rate in kg/ha use the following formula:

Management of grain staining

Grain staining can occur when fungal spores are present with sufficient moisture, infecting grains. Grains appear discoloured to charred-like. Oat receival standards term this ‘septoria stained’ (see photo), with a limit of 15 grains per 2 black plastic measures (720 grains) for all grades. Varieties that are susceptible to septoria are at greatest risk of infection (e.g. Bannister), due to the increased likelihood of fungal spores on the plant. Additionally, infection of the grain is more likely in high rainfall areas, or where there is an oat-on-oat rotation where septoria is more prevalent during the growing season, and/or when pre-harvest rain occurs.

Managing grain staining is an area of research that is currently underway. Preliminary findings indicates that fungicide timing has a significant impact on the number of stained grains. If disease pressure becomes evident at stem elongation then growers should implement a two-spray strategy with applications at stem elongation and flag leaf emergence to provide the best opportunity to reduce the number of stained grains. Where disease pressure is lower, or when disease enters the canopy later in the season then a single application at flag leaf emergence will provide the most protection than other spray strategies, protecting the flag leaf and potentially providing a yield benefit. Pre-harvest rainfall (between grain filling and harvest) has also resulted in grain staining in Bannister crops, and in this scenario applying late fungicides to reduce grain staining has shown to be unreliable.

$$\text{seed rate (kg/ha)} = \frac{\text{1000 grain weight (g) x target density (plants/m}^2\text{)}}{\text{germination \% x establishment \% x 100}}$$

For example, if the desired target density is 240 plants/m^2 with a germination of 94%, a grain weight of 40 g per 1000 grains with an expected establishment of 80%, then the seed rate in kg/ha required to establish 240 plants/m^2 is:

$$\text{seed rate in kg/ha} = 84 \text{ kg/ha} = \frac{\text{42g x 150 plants/m}^2}{\text{94\% x 80\% x 100}}$$

Variety and yield comparisons

Georgie Troup (DPIRD)

The decision whether to grow milling oats depends on three main factors:

(1) the profitability of Oat1 and Oat2 grain production.

(2) the likelihood that grain will meet Oat1 or Oat2 receival specifications.

(3) the location of receival segregations for Oat1 and Oat2 varieties.

In the 2017/18 season, four oat varieties, Bannister, Wandering, Williams and Carrolup (in decreasing popularity) occupied just over 80% of the area sown to oats (based on grower estimates as provided to CBH for 2018).

Grain yield and quality comparisons

Variety trials are conducted across Australia by the GRDC NVT program and by the National Oat Breeding Program. The NVT program was established in 2005 to provide a nationally independent means of assessing varietal performance to enable growers to select the best variety for their environment. The results of these trials are available as individual site reports or as multi-environment (MET) long term summaries. The MET analysis generates a table of performance values for each variety in comparison to the mean of the NVT site at which it was included. Growers and consultants can select the state, region, site or group of sites of their choice to assist in selecting the best variety for their environment.

Both the individual and multi-year analyses are available at nvtonline.com.au. Growers and consultants can also download a version of the MET summaries on their portable devices for both Apple (via the iTunes app store) and Android (via Google play) devices.

For this sowing guide, additional analysis is presented to that available on the NVT website. Table 3 re-works the NVT long term MET analysis and presents the data against a reference variety,

Table 3 Grain yield of oat varieties in Agzones 1 to 6 expressed as a per cent of Bannister(Þ). Data presented for each year (2013-2017) and as an overall MET analysis (source: NVT Online nvtonline.com.au)
Table 3a Grain yield in Agzone 2 expressed as a per cent of Bannister(Þ).
(source: based on MET analysis from NVT Online nvtonline.com.au)

Agzone 2	Single year (% Bannister(Þ))					Multi year (% Bannister(Þ))	
Variety	2013	2014	2015	2016	2017	2013-2017	*no. obs*
Valid trials	6	5	7	6	7	31	
Milling and dual purpose varieties							
Carrolup	84	84	83	79	83	**82**	*31*
Durack(Þ)	81	88	90	71	84	**83**	*31*
Kojonup(Þ)	94	93	90	87	91	**91**	*31*
Kowari(Þ)	86	93	96	83	92	**90**	*31*
Mitika(Þ)	83	91	90	81	89	**87**	*31*
Wandering(Þ)	96	103	101	101	96	**99**	*31*
Williams(Þ)	102	100	101	95	98	**99**	*31*
Yallara(Þ)	84	88	87	77	82	**83**	*31*
Bannister(Þ) yield (t/ha)	5.39	3.63	3.44	5.18	3.69	4.27	

Table 3b Grain yield in Agzone 3 expressed as a per cent of Bannister(Þ).
(source: based on MET analysis from NVT Online nvtonline.com.au)

Agzone 3	Single year (% Bannister(Þ))					Multi year (% Bannister(Þ))	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**3**	**3**	**3**	**4**	**4**	**17**	
Milling and dual purpose varieties							
Carrolup	75	71	81	86	83	**80**	*17*
Durack(Þ)	81	73	84	84	80	**81**	*17*
Kojonup(Þ)	91	92	88	92	95	**92**	*17*
Kowari(Þ)	81	78	83	92	85	**84**	*17*
Mitika(Þ)	84	78	78	92	84	**84**	*17*
Wandering(Þ)	91	90	95	101	97	**95**	*17*
Williams(Þ)	79	84	92	105	97	**93**	*17*
Yallara(Þ)	79	71	87	88	83	**82**	*17*
Bannister(Þ) yield (t/ha)	**5.64**	**4.20**	**3.67**	**4.61**	**4.67**	**4.56**	

Table 3c Grain yield in Agzone 4 expressed as a per cent of Bannister(Þ).
(source: based on MET analysis from NVT Online nvtonline.com.au)

Agzone 4	Single year (% Bannister(Þ))					Multi year (% Bannister(Þ))	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**0**	**0**	**1**	**1**	**1**	**3**	
Milling and dual purpose varieties							
Carrolup	–	–	88	75	58	**74**	*3*
Durack(Þ)	–	–	86	79	67	**77**	*3*
Kojonup(Þ)	–	–	91	84	86	**87**	*3*
Kowari(Þ)	–	–	100	83	80	**87**	*3*
Mitika(Þ)	–	–	97	82	83	**87**	*3*
Wandering(Þ)	–	–	102	93	101	**99**	*3*
Williams(Þ)	–	–	94	90	85	**90**	*3*
Yallara(Þ)	–	–	88	75	76	**80**	*3*
Bannister (Þ)yield (t/ha)	**–**	**–**	**2.45**	**4.54**	**4.53**	**3.84**	

Table 3d Grain yield in Agzone 5 expressed as a per cent of Bannister(Þ).
(source: based on MET analysis from NVT Online nvtonline.com.au)

Agzone 5	Single year (% Bannister(Þ))					Multi year (% Bannister(Þ))	
Variety	**2013**	**2014**	**2015**	**2016**	**2017**	**2013-2017**	*no. obs*
Valid trials	**0**	**0**	**2**	**1**	**2**	**5**	
Milling and dual purpose varieties							
Carrolup	–	–	83	71	65	**73**	*5*
Durack(Þ)	–	–	85	77	67	**76**	*5*
Kojonup(Þ)	–	–	88	87	87	**87**	*5*
Kowari(Þ)	–	–	90	79	82	**83**	*5*
Mitika(Þ)	–	–	86	72	77	**78**	*5*
Wandering(Þ)	–	–	98	101	94	**98**	*5*
Williams(Þ)	–	–	103	93	89	**95**	*5*
Yallara(Þ)	–	–	82	82	75	**80**	*5*
Bannister(Þ) yield (t/ha)	**–**	**–**	**3.71**	**3.85**	**4.00**	**3.85**	

Table 3e Grain yield in Agzone 6 expressed as a per cent of Bannister(Þ).
(source: based on MET analysis from NVT Online nvtonline.com.au)

Agzone 6	Single year (% Bannister(Þ))					Multi year (% Bannister(Þ))	
Variety	2013	2014	2015	2016	2017	2013-2017	*no. obs*
Valid trials	1	1	1	1	1	5	
Milling and dual purpose varieties							
Carrolup	83	84	57	62	73	**72**	*5*
Durack(Þ)	92	86	65	62	76	**76**	*5*
Kojonup(Þ)	101	95	90	70	88	**89**	*5*
Kowari(Þ)	85	99	86	73	83	**85**	*5*
Mitika(Þ)	100	95	88	58	88	**85**	*5*
Wandering(Þ)	97	97	87	111	98	**98**	*5*
Williams(Þ)	101	95	86	88	99	**94**	*5*
Yallara(Þ)	88	83	64	71	82	**77**	*5*
Bannister(Þ) yield (t/ha)	**5.16**	**4.50**	**5.07**	**3.09**	**4.27**	**4.42**	

Bannister, rather than against the site mean yield. It also presents the data based on Agzones (Figure 1). Agzones were developed by DPIRD through statistical analysis to group together environmental regions that give similar crop performance in WA. Data is presented for each year from 2013 to 2017 and as an overall MET for the period 2013-2017.

Grain quality characteristics of a variety are important to consider when selecting an oat variety.

Currently in Western Australia delivery of oat grain into the segregations of Oat1 and Oat2 is limited mainly by two key grain quality specifications; hectolitre weight and screenings (Table 4). Hectolitre weight, screenings and 1000 grain weight of the twelve oat varieties suggested for WA have been provided by the National Oat Breeding Program (Table 5).

Table 4 2018/2019 Oat recieval standards

Standard	Oat1	Oat2
Hectolitre Weight (kg/hL)	51	49
Screenings (%)	10	No limit

Hay yield and quality comparisons

Hay yield and quality comparisons are provided by the National Oat Breeding Program, led by Pamela Zwer at the South Australian Research and Development Institute. Trials conducted in Western Australia, are delivered by the DPIRD staff based at Northam. The focus of the National Oat Breeding Program is to improve productivity and quality in new oat varieties developed for hay and grain end users. Average hay yield comparisons for varieties eligible for export hay, and one new breeding line - expected to be released within the next 2 years are listed in Table 6.

Table 5 Grain quality data from twelve oat varieties and two breeding lines from trials in Agzone 2 and 3, WA, 2008-2017.
(source: National Oat Breeding Program)

	AgZone 2			Agzone 3		
Variety	Hectolitre Weight (kg/hl)	1000 Grain Weight (g)	Screenings (%)	Hectolitre Weight (kg/hl)	1000 Grain Weight (g)	Screenings (%)
Bannister(Þ)	49.5	34.9	9.6	48.5	38.3	7.4
Carrolup	50.0	33.3	14.1	49.5	35.0	9.9
Durack(Þ)	50.5	32.8	12.2	50.5	34.4	8.6
Kojonup(Þ)	48.4	34.0	10.0	47.2	36.1	7.3
Kowari(Þ)	48.5	35.7	7.9	48.2	38.2	5.7
Mitika(Þ)	49.3	36.3	7.9	49.1	38.6	5.2
05096-32	51.2	33.6	7.9	50.3	35.4	5.8
06204-16	48.7	36.0	11.1	48.3	38.4	8.5
Wandering(Þ)	48.5	35.1	10.4	46.5	37.4	7.8
Williams(Þ)	48.2	32.9	13.0	47.3	36.0	10.1
Yallara(Þ)	49.4	33.5	7.5	49.1	35.1	6.1
No. trials	*17*	*6*	*17*	*16*	*11*	*16*

Table 6 Average hay yield (t/ha) for twelve oat varieties and one breeder line from trials in Western Australia during the period 2005 to 2017. (source: Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB)

Variety	Hay yield (t/ha)
Bannister(Ⓑ	8.4
Brusher(Ⓑ	8.7
Carrolup	7.9
Durack(Ⓑ	7.0
Forester(Ⓑ	8.3
Mulgara(Ⓑ	8.5
Swan	8.9
Wandering(Ⓑ	8.2
Williams(Ⓑ	7.9
Winjardie	8.5
Wintaroo(Ⓑ	9.3
Yallara(Ⓑ	8.1
05096-32	8.0
No. sites	*32*

The quality of hay is determined by the variety grown, agronomy applied to the crop, the crop growth stage at which the hay is cut and the conditions during the period between cutting and baling. Table 7 describes the suggested quality specifications growers need to achieve to meet export hay requirements.

Hay varieties differ in their quality. All of those varieties listed below in Table 8 are deliverable as export hay varieties when grown in the right environment, with the right agronomy, and the right seasonal conditions. Growers are encouraged to discuss with their intended hay buyer which variety they intend to sow, to ensure that it meets current market demands.

Table 7 Quality standards to meet export hay requirements in Western Australia

Parameter	Grade 1	Grade 2	Grade 3	Grade 4
Crude protein (% CP)	4-10	<4	<4	<4
Water soluble carbohydrates (% WSC)	>22	>18	>14	>14
Estimated metabolisable energy (est. ME MU/kg DM)	>9.5	<9.5	<9.5	<9.5
Acid detergent fibre (% ADF)	<30	>32	>36	>37-40
Neutral detergent fibre (% NDF)	<55	<55-59	<64	>64
In vitro digestibility (% DMD)	>60	>58	>56	>53
Stem thickness (mm)	<6	<8	<9	>9-12

Table 8 Average hay quality for twelve oat varieties and one breeder line in Western Australia during the period 2013 to 2017. (source: Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB)

Variety	Digestibility (%dm)	[1]WSC (%dm)	[2]ADF (%dm)	[3]NDF (%dm)	Crude Protein (%dm)	Stem Diameter[4]
Bannister(Ⓑ	67.9	31.4	28.5	49.3	7.3	M
Brusher(Ⓑ	66.6	31.5	29.8	49.6	7.1	M
Carrolup	65.1	30.3	30.0	49.7	7.1	M
Durack(Ⓑ	65.3	27.8	30.0	51.0	7.7	M
Forester(Ⓑ	69.2	33.2	29.1	47.3	7.6	MT
Mulgara(Ⓑ	66.7	30.9	29.5	49.4	7.0	M
Swan	65.3	29.3	30.5	51.2	7.1	–
Wandering(Ⓑ	65.7	31.9	28.3	48.6	7.5	M
Williams(Ⓑ	65.6	29.1	29.7	50.9	8.0	MT
Winjardie	66.1	30.3	30.0	50.7	6.9	M
Wintaroo(Ⓑ	65.4	29.8	30.6	50.7	6.6	M
Yallara(Ⓑ	66.7	31.5	29.4	48.8	7.0	MF
05096-32	65.7	28.0	30.3	51.5	7.3	MF
No. sites	*6*	*9*	*7*	*8*	*8*	*na*

[1]WSC=water soluble carbohydrates
[2]ADF=acid detergent fibre
[3]NDF=neutral detergent fibre
[4]Stem Diameter: F = fine MF = moderately fine MT = moderately thick

Disease and insect surveillance

Geoff Thomas, DPIRD

Disease, virus and nematode resistance data is presented in Table 9. Leaf disease ratings in this guide are recorded from infection on adult plants for rusts, barley yellow dwarf virus, and septoria. Ratings for bacterial blight are recorded at tillering. Adult plant ratings are applicable at later plant growth stages (after flag leaf emergence), but in some varieties and for some diseases the adult ratings may be applicable as early as late tillering to stem elongation.

The ratings of varieties may vary over time. Seasonal changes occur with time mainly due to differences in disease pressure, spread of the disease in the region, changes in climatic conditions, stubble retention and development of new pathotypes/races. There have been some minor changes in the resistance score for a number of the varieties listed since the last sowing guide, usually up or down one resistance score, but there have been no major changes in resistance score as the result of a new pathotype. A list of registered foliar fungicides is presented in Table 10.

Septoria

Septoria avenae blotch is the most common oat disease in Western Australia. It occurs throughout the cereal growing areas and is most severe in the high rainfall areas. The fungus infects leaves, leaf sheathes and stems and may also infect heads. Disease symptoms begin as small dark spots on leaves and develop into larger, light-brown oval-shaped blotches with dark brown centres. Lesions can coalesce, resulting in complete necrosis of the leaf. Severe infection may spread to the leaf sheaths and stems resulting in lodging. In some varieties, the fungus sometimes causes a dark discolouration of the grain when unseasonably late rain occurs.

Infected stubble is the main source of carryover infection from one season to another; crops sown onto or adjacent to oat stubble are at greatest risk development of earlier and more severe outbreaks.

Septoria can cause significant yield and grain quality losses. Choice of more resistant varieties in high disease risk environments and in-crop application of registered fungicides in susceptible varieties can reduce disease impact.

Oat leaf rust

Oat leaf rust (also known as crown rust) appears on leaves as small, circular to oval pustules, containing masses of orange to yellow powdery spores. Under heavy infection pustules can also occur on stems and heads. As the crop matures, pustules darken and produce black spores embedded in leaf tissue. The spores are windborne and can spread over large distances in the air. Wet summer / autumn conditions supporting volunteer oats and wild oats favour the survival of leaf rust over summer and increase risk for subsequent crops. In-season the disease is favoured by mild and damp weather, typical of late winter and spring in Western Australia. Leaf rust can build up very quickly on susceptible varieties under suitable conditions causing significant yield and quality losses. Resistant varieties are available, and it is important to avoid (or closely monitor) susceptible varieties in high disease pressure environments.

Growers and consultants observing oat varieties rated as MRMS, MR or R to leaf or stem rust carrying significantly greater levels of disease than expected should collect infected material for pathotype identification. Samples should be collected before spraying the crop to ensure sample viability and sent in paper envelopes directly to the ACRCP Annual Cereal Rust Survey, Plant Breeding Institute, Reply Paid 88076

Narellan NSW 2567. For more information contact Dr Will Cuddy, via email at will.cuddy@dpi.nsw.gov.au or phone (02) 9351 8871.

Oat stem rust

Oat stem rust appears as elongated pustules containing mases of reddish-brown powdery spores, mainly on stems but also on leaves and head in heavy infections. The spores are windborne and can spread over large distances in the air. Stem rust is most severe under warm temperatures and moist conditions and infection levels are usually highest when spring conditions are suitably wet. Wet summer / autumn conditions supporting volunteer oats and wild oats favour the survival of stem rust over summer and increase risk for subsequent crops.

Under suitable conditions, stem rust epidemics can develop very rapidly and can cause extreme yield and quality losses. Resistant varieties are available, and it is important to avoid susceptible varieties in high disease pressure environments.

Red leather leaf

This disease has not been confirmed in WA, suspect samples should be sent to DPIRD Diagnostic Laboratory Services (DDLS) marked Grain Guard. For more information about plant disease testing, sample submission forms and sampling techniques, contact: DDLS Specimen Reception on (08) 9368 3351 or email DDLS@dpird.wa.gov.au

Russian Wheat Aphid

Currently, Russian Wheat Aphid (Diuraphis noxia) (RWA) has not been detected in Western Australia, it was first detected in Australia in May 2016 in South Australia. Any suspected detection of RWA should be reported using the MyPestGuide Reporter App, a photographic reporting App which lets users take up to four photos, map their pest observations and communicate directly with DPIRD. MyPestGuide Reporter is available for Android and Apple devices.

Disease resistance ratings

Disease and virus resistance data is presented in Table 9. Rust and Barley yellow dwarf virus reactions may vary in different regions and with different seasonal conditions depending on the prevalent pathotype/serotype. Monitoring your oat crop is therefore essential.

Table 9 Leaf disease resistance profiles when grown in WA - 2018. (source: National Oat Breeding Program)

Disease[1]	Septoria	Leaf rust	Stem rust	Barley yellow dwarf virus	Bacterial blight	CCN resistance	CCN tolerance
Growth Stage[2]	Adult	Adult	Adult	Adult	Seedling	Adult	Adult
Milling and dual purpose varieties							
Bannister(b)	S	R	R-MS	MR-MS	MR-S	R	MI
Carrolup	S-VS	S-VS	MS-S	MS-S	MR-S	S	I
Durack(b)	S-VS	R-S	MS	MS-S	MR-S	R	MI-MT
Kojonup(b)	S-VS	S-VS	MS-S	MS	MS-S	VS	I
Kowari (b)	S-VS	R	MR-MS	MS	MR	VS	I
Mitika(b)	S-VS	MR	MR-MS	S	MR	VS	I
Wandering(b)	S-VS	VS	MS-VS	MS	MR-S	VS	I
Williams(b)	MR-MS	R-MR	MR	MR-MS	R	S	I
Yallara(b)	S	R-MS	MR-MS	MS	MR-MS	R	I
Hay varieties							
Brusher(b)	S-VS	R-MS	MR-S	MR-MS	MR-MS	R	MI
Forester(b)	MS-S	R-MS	R-MS	MS	MS-S	MS	MI
Mulgara(b)	MR-S	MR	MR-MS	MS-S	MR	R	MT
Winjardie	S-VS	S-VS	MR-S	MS-S	S	S	I
Wintaroo(b)	MS-S	S-VS	MR	MS	MR	R	MT
05096-32(b)	MR-MS	R-MR	R-MS	MS	MR	S	no data

[1]Resistance rating: VS = very susceptible, S = susceptible, MS = moderately susceptible, MR-MS = intermediate, MR = moderately resistant, R = resistant, I = intolerant, MI = moderately intolerant, MT = moderately tolerant, – = no data available.

[2]Growth stage: the adult resistance score reflects resistance after flag leaf emergence, the seedling resistance score reflects resistance at early tillering. If sowing varieties with a VS or S rating ensure appropriate cultural (i.e. rotation) and/or chemical (i.e. fungicide) disease management strategies are used to minimise the risk when planting those varieties.

Table 10 Foliar fungicides registered for use on oats in WA — 2018-19

Rates of registered products in mL/ha or g/ha. Chemical labels should be read and rates should be checked before using fungicides. Mention of trade names does not imply endorsement of any company's products. For more information contact ciara.beard@dpird.wa.gov.au

Active ingredient	Stem rust	Leaf rust	Septoria	Example product trade names ® = registered trademark	Withholding period (harvesting or grazing, in weeks)
Epoxiconazole 62.5g/L and Pyraclostrobin 85g/L	No registration	No registration	500	Opera®	Harvest- 0 if not applied after Z59, Grazing- 3
Propiconazole 250g/L	500	250–500	250–500	Aurora® 250EC, Bumper®, Cracker® 250, Detour® 250EC, Procon® 250EC, Propicol® 250EC , Propicure®, Tilt® 250EC, Prestige®, Pace® 250EC, Restore® 250EC, Propiconazole 250, Petulant®, Proten®250EC, Picaro®250EC, Propeller®	Harvest- 4, Grazing-1
Propiconazole 435g/L	285	145-285	145-285	Propimax®, Fitness® Fungicide	Harvest- 4, Grazing-1
Propiconazole 500g/L	250	125-250	125-250	Throttle® 500, Prop® 500, Propiconazole 500EC	Harvest- 4, Grazing-1
Propiconazole 550g/L	230	115-230	115-230	Cracker Jack® 550EC, Propiconazole 550EC, Propicon® 550, Pacer® 550EC, Prestige® 550	Harvest- 4, Grazing-1
Propiconazole 625g/L	200	100-200	100-200	Bumper® 625EC	Harvest- 4, Grazing-1
Propiconazole 750g/L	170	85-170	85-170	Cracker Jack 750EC	Harvest- 4, Grazing-1
Propiconazole 250g/L and Tebuconazole 250g/L	250	125-250	125-250	Cogito®	Harvest-5, Grazing-2
Prothioconazole 210g/L and Tebuconazole 210g/L	300	300	150-300	Prosaro® 420SC	Harvest-5, Grazing-2
Tebuconazole 430g/L	1: 145-290 or 2: 145:	145-290[1, 2]	No registration	1: Folicur®, Laguna®, Orius®, Rebuke®, Zolo® Stingray®, Tebazal, Tebucol®, Tebucon®, Whirlwind®, Tebuconazole 430SC, Hornet®, Tebcon®, Toledo® 430EC,Cure®, Teboo®, Tebby®, Tebuconazole, Isis® 430SC (Isis not registered for stem rust), Launch®, Tripod® 2: Tusk®	Harvest-5, Grazing-2
Tebuconazole 750g/kg	83-166	83-166	No registration	Tebuconazole 750WDG, Buzz Ultra 750 WG, Ultrateb® 750 WG	Harvest-5, Grazing-2
Tebuconazole 800g/kg	78-156	78-156	No registration	Tebuconazole 800WG, Laguna® Xtreme 800WG, Turbulence® 800WG	Harvest-5, Grazing-2
Sulphur 700g/Kg and Tebuconazole 45g/kg	1370-2750	1370-2750	No registration	Unicorn® 745WG	Harvest-5, Grazing-2
Azoxystrobin 80g/L and Epoxiconazole 31.25g/L	500-1000	No registration	500-1000	Tazer® Xpert	Harvest-0 if not applied after Z59, Grazing-3

Note: Isis® 430SC is only registered for leaf rust (unlike other tebuconazole 430g/L products, it is not registered for stem rust).

Herbicide tolerance

Harmohinder Dhammu and Georgie Troup (DPIRD)

Herbicide timing abbreviations:

- IBS = incorporated by seeding
- Z12 = Zadoks growth score 12, 2 leaves emerged on the mainstem.
- Z13 = Zadoks growth score 13, 3 leaves emerged on the mainstem.
- Z14 = Zadoks growth score 14, 4 leaves emerged on the mainstem.
- Z15 = Zadoks growth score 15, 5 leaves emerged on the mainstem.
- Z16 = Zadoks growth score 16, 6 leaves emerged on the mainstem.
- Z31 = Zadoks growth score 31, 1st node detectable on the mainstream.

Eleven herbicide tolerance trials conducted between 2006 and 2017 at Katanning on loamy sand to sandy loam soils in WA, indicate that some oat varieties are more susceptible to damage from certain herbicides than others. The variation in tolerance may be due to differences in any combination of morphological and physiological characters and/or internal ear development stages among the varieties. The level of tolerance amongst varieties varies with the rate of herbicide, the environmental conditions when the herbicide is applied, and the stage of the crop growth. The sensitivity of important oat varieties to herbicides registered for use on oats can be found in the factsheets at the end of this sowing guide. The full list of varieties tested in herbicide tolerance trials can be found at nvtonline.com.au/herbicide-tolerance.

Seasonal variability makes it essential to test herbicide and variety interactions over several seasons and locations. The risk of crop damage from a herbicide should be balanced against the potential yield loss from both the weed competition and the number of weed seeds returning to the soil seed bank. Small yield reductions due to herbicide damage in sensitive varieties may not be easily detected at the paddock level, but over larger areas can be of great economic importance.

Several oat varieties have shown some sensitivity (yield loss) to Glean® (chlorsulfuron) and Amicide® Advance 700 (2,4-D amine) (consistently in at least two trials) when applied at label rates.

Similarly, some oat varieties demonstrated yield loss (at in least two trials) when the following herbicides were applied at label rate in at least two trials;

Glean® (chlorsulfuron) (20g/ha) at Z12-Z13

- Carrolup (10 – 23%)
- Durack (9 – 15%)
- Williams (8 – 20%)

Amicide® Advance 700 (*2,4-D dual salt amine*) (1.15 L/ha) at Z31

- Durack (23 – 35%)
- Williams (9 – 10%)

Broadside® *(bromoxynil + MCPA + dicamba)* (1 L/ha) at Z13-Z14

- Williams (8 – 9%)

Flight® (*picolinafen + bromoxynil + MCPA ester*) (720 mL/ha) at Z13-Z14

- Williams (11 – 12%)

Precept® *(pyrasulfotole + MCPA ester)* (2 L/ha) at Z13-Z14

- Bannister (6 – 12%)

Several of the herbicides tested have caused a yield loss in two or more varieties during the trial years. Growers should be cautious when using those products with new varieties. Sensitivity at label rates has been noted in at least in two varieties for these products:

- Amicide® 625 (2,4-D amine) at Z15-Z16
- Amicide® Advance 700 (*2, 4-D dual salt amine*) at Z31
- Conclude® (florasulam + MCPA) at Z13-Z14
- Diuron + Dual® 720 (diuron + metolachlor) applied IBS
- Flight® (picolinafen + bromoxynil + MCPA) at Z13-Z14
- Glean® (chlorsulfuron) at Z12-Z13
- Igran® + MCPA (terbutryn + MCPA) at Z13-Z14
- Tigerx® (diflufenican + MCPA) at Z13-Z14

A narrow crop safety margin was also noted in Bannister and Carrolup when Amicide® Advance 700 *(2, 4-D dual salt amine)* was applied at above the label rate, but no significant negative effect was registered at the label rate. A narrow crop safety margin implies that when spraying under less than optimal conditions, herbicide damage and yield loss may occur even at the label rate.

Herbicide tolerance is also influenced by external factors such as environmental conditions, herbicide rate applied vs crop growth stage at application and general health of the crop (nutrition, moisture stress, presence of disease, soil type etc.).

Chlorsulfuron is the only registered post-emergent herbicide option available for ryegrass control/suppression in oats. Carrolup, Durack and Williams have shown sensitivity to chlorsulfuron, suggesting that oat growers need to manage ryegrass populations effectively in the season preceding growing oats, or plan to use registered pre-emergent herbicides. Due to widespread resistance of ryegrass to Group B herbicides in WA growers are reminded to rotate between different mode-of-action groups to reduce weed numbers, stop replenishment of the seed bank and minimise the risk of developing herbicide resistant weeds.

Trifluralin tolerance

The Department of Primary Industries and Regional Development conducted 6 trials from 2006 to 2017 to evaluate the potential for trifluralin to be used as a pre-emergent option in both grain and hay oats to control/suppress certain annual grass weeds and broadleaf weeds. The research aimed to understand the level of tolerance commonly grown oat varieties have to trifluralin, when applied alone or, in mixture with other pre-emergent herbicides.

Results indicated that trifluralin up to 960g a.i./ha was tolerated well by all the oat varieties sown with knife point and press wheel seeding system at 4 to 9km/hr. However, when sowing at 9km/hr, and in combination with the following;

1) Higher rates of trifluralin (higher than permit rate) = reduced crop establishment and hay yield, and
2) A higher than the permit/label rate of trifluralin + terbuthylazine = reduced grain yield compared to seeding at a slower speed (4.5km/hr.), indicating a narrow crop safety margin. This effect could be attributed to the throwing of treated soil into the adjacent furrow at the higher speed.

Trifluralin selectivity in oats is largely due to placement of the seed away from treated soil and factors like soil type, soil moisture, point types, row spacing, crop residue, seeding speed etc determine the soil throw into the adjacent rows.

Growers should remain within the permitted rates of trifluralin and its tank mix herbicides when using on oat crops. For safe use of trifluralin alone and in mixture with other herbicides on oats, seeding should be done using a knife point and press wheel seeding system at a reduced speed or minimum speed to reduce the risk of any negative impact on crop establishment, hay and grain yield.

The Grain Industry Association of WA Oat Council secured a permit (minor use permit PER 84040) through the APVMA (Australian Pesticides and Veterinary Medicines Authority) allowing the use of trifluralin up to 960g a.i./ha in oats. The permit is valid up to 31 March 2022 and the full permit can be found at http://permits.apvma.gov.au/PER84040.PDF

Factsheets

Bannister(b)

Milling variety

Comments

Bannister is a medium spring, tall milling variety with a high grain yield (~15% higher than Carrolup). It is 15 cm 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.

Yield (% Carrolup)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	119	120	121	127	121
Agzone 3	133	140	124	116	121
Agzone 4	–	–	113	134	172
Agzone 5	–	–	121	141	153
Agzone 6	120	118	177	162	136

Disease resistance	
Septoria	S
Leaf rust	R
Stem rust	R-MS
Bacterial blight	MR-S
BYD	MR-MS
CCN resistance	R
CCN tolerance	MI

Agronomic traits	
Target plant density	200-240 plants/m^2 (grain)
Dwarf gene present	Yes

Herbicide tolerance

Sensitive to a label rate applications of Diuron + MCPA (diuron + MCPA) sprayed at Z13-Z16; Flight® EC (picolinafen + bromoxynil + MCPA) sprayed at Z13-Z14; and Precept® (pyrasulfotole + MCPA) + Hasten™ sprayed at Z13-Z14. Bannister may be sensitive to label rate applications of Tigrex® (diflufenican + MCPA) sprayed at Z13-Z14; and 2,4-D Amine 625 sprayed at Z15-16 and later.

Variety information	
Pedigree	Dumont/Echidna Mortlock //75Q:198 Swan Fulmark/ Newton
Breeder	National Oat Breeding Program
Access to seed	Seednet
EPR ($/t, excl. GST)	$2.30

Kowari(b)

Milling variety

Comments

Kowari is a newly released, medium spring, medium height milling variety. Kowari has improved green leaf retention relative to Mitika.

Yield (% Bannisterr)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	86	93	96	83	92
Agzone 3	81	78	83	92	85
Agzone 4	–	–	100	83	80
Agzone 5	–	–	90	79	82
Agzone 6	85	99	86	73	83

Disease resistance	
Septoria	S-VS
Leaf rust	R
Stem rust	MR-MS
Bacterial blight	MR
BYD	MS
CCN resistance	VS
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	Yes

Herbicide tolerance

Limited data indicates that Kowari may be sensitive to label rate applications of 2,4-D Amine 700 (1.15 L/ha) sprayed at Z15-16. It may also have low crop safety margin for Glean® (chlorsulfuron) at 20g/ha sprayed at Z12-Z13.

Variety information	
Pedigree	Mitika/WAOAT2099
Breeder	National Oat Breeding Program
Access to seed	Heritage Seeds
EPR ($/t, excl. GST)	$2.50

Mitika(b)

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 β-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

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	83	91	90	81	89
Agzone 3	84	78	78	92	84
Agzone 4	–	–	97	82	83
Agzone 5	–	–	86	72	77
Agzone 6	100	95	88	58	88

Disease resistance	
Septoria	S-VS
Leaf rust	MR
Stem rust	MR-MS
Bacterial blight	MR
BYD	S
CCN resistance	VS
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	Yes

Herbicide tolerance

May be sensitive to a label rate application of Paragon® (picolinafen + MCPA) sprayed at Z15-16 and later.

Variety information	
Pedigree	OX87;072-13/OX87;080-1// OX88;045-12
Breeder	National Oat Breeding Program
Access to seed	Heritage Seeds
EPR ($/t, excl. GST)	$2.00

Carrolup

Dual purpose variety

Comments

Carrolup is a medium spring, mid-tall, dual purpose (milling grain and hay) variety. Carrolup has lower yields than the new milling varieties Bannister and Williams. Has a similar height and maturity to Yallara. Carrolup is suitable for export hay.

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	84	84	83	79	83
Agzone 3	75	71	81	86	83
Agzone 4	–	–	88	75	58
Agzone 5	–	–	83	71	65
Agzone 6	83	84	57	62	73

Disease resistance	
Septoria	S-VS
Leaf rust	S-VS
Stem rust	MS-S
Bacterial blight	MR-S
BYD	MS-S
CCN resistance	S
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	No

Herbicide tolerance

Sensitive to label rate applications of Diuron 500 + Dual® 720 (diuron + metolachlor) when incorporated by seeding; Brominil® M + Eclipse® (bromoxynil + MCPA + metosulam); Glean® (chlorsulfuron) sprayed at Z12-Z13; Conclude® (florasulam + MCPA) + Uptake™ sprayed at Z13-Z14; Flight® EC (picolinafen + bromoxynil + MCPA) sprayed at Z13-Z14; 2,4-D Amine 625 sprayed at Z15-16 and later; and Tordon® 75D (2,4-D + picloram) sprayed at Z22.

Variety information	
Pedigree	Mortlock/5/Kent/Ballidu/Curt/3/ Cortez/4/TAMO-312/2.2*West
Breeder	Dept. of Agriculture, WA
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR

Durack(Þ)

Dual purpose variety

Comments

Durack is an early spring, mid-tall, milling variety that was accredited as OAT2 only. 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 it's hay yields are generally lower yielding than Carrolup and Williams.

Yield (% Bannister))	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	81	88	90	71	84
Agzone 3	81	73	84	84	80
Agzone 4	–	–	86	79	67
Agzone 5	–	–	85	77	67
Agzone 6	92	86	65	62	76

Disease resistance	
Septoria	S-VS
Leaf rust	R-S
Stem rust	MS
Bacterial blight	MR-S
BYD	MS-S
CCN resistance	R
CCN tolerance	MI-MT

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	No

Herbicide tolerance

Sensitive to a label rate application of Glean® (chlorsulfuron) applied at Z12-Z13. Durack may be sensitive to label rate applications of Diuron + Dual® (diruon + metolachlor) applied IBS; Broadside® (bromoxynil + MCPA + dicamba); Conclude® (florasulam + MCPA) + Uptake™ sprayed at Z13-Z14; Precept® (pyrasulfotole + MCPA) applied at Z13-Z14; 2,4-D Amine 700 applied at Z15-Z16.

Variety information	
Pedigree	01Q211/94Q601-45-28
Breeder	National Oat Breeding Program
Access to seed	Heritage Seeds
EPR ($/t, excl. GST)	$2.30

Kojonup(Þ)

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, it's hay yields are generally lower than Carrolup.

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	94	93	90	87	91
Agzone 3	91	92	88	92	95
Agzone 4	–	–	91	84	86
Agzone 5	–	–	88	87	87
Agzone 6	101	95	90	70	88

Disease resistance	
Septoria	S-VS
Leaf rust	S-VS
Stem rust	MS-S
Bacterial blight	MS-S
BYD	MS
CCN resistance	VS
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	Yes

Herbicide tolerance

May be sensitive to label rate applications of Glean® (chlorsulfuron) sprayed at Z12-Z13; and 2,4-D Amine 625 sprayed at Z15-16 and later.

Variety information	
Pedigree	83Q:384/Coomallo
Breeder	Dept. of Agriculture, WA
Access to seed	Free to trade
EPR ($/t, excl. GST)	$2.25

Wandering(Þ)

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. While Wandering is suitable for export hay, it's hay yields are generally higher than Carrolup and Williams.

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	96	103	101	101	96
Agzone 3	91	90	95	101	97
Agzone 4	–	–	102	93	101
Agzone 5	–	–	98	101	94
Agzone 6	97	97	87	111	98

Disease resistance	
Septoria	S-VS
Leaf rust	VS
Stem rust	MS-VS
Bacterial blight	MR-S
BYD	MS
CCN resistance	VS
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	Yes

Herbicide tolerance

May be sensitive to label rate applications of Diuron + MCPA (amine); Affinity® + MCPA (carfentrazone-ethyl + MCPA) sprayed at Z13-Z15; MCPA Amine 500 (MCPA) sprayed at Z15-Z16 and later; and Kamba® 500 (dicamba) sprayed at Z15-Z16 and later.

Variety information	
Pedigree	SA Seln 41/75Q36-144-31
Breeder	Dept. of Agriculture, WA
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR

Williams(Þ)

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 Williams. Williams has lower hectolitre weight and higher screenings than Bannister, Mitika and Yallara, especially in lower rainfall regions. and years. 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.

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	102	100	101	95	98
Agzone 3	79	84	92	105	97
Agzone 4	–	–	94	90	85
Agzone 5	–	–	103	93	89
Agzone 6	101	95	86	88	99

Disease resistance	
Septoria	MR-MS
Leaf rust	R-MR
Stem rust	MR
Bacterial blight	R
BYD	MR-MS
CCN resistance	S
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	No

Herbicide tolerance

Sensitive to label rate applications of Barrel®/Broadside® (bromoxynil + MCPA + dicamba); and Flight® EC (picolinafen + bromoxynil + MCPA) sprayed at Z13-Z15.

Williams may be sensitive to label rate applications of Diuron 500 + Dual® 720 (diuron + metolachlor) sprayed IBS; Glean® (chlorsulfuron) sprayed at Z12-Z13; Conclude® (florasulam + MCPA) + Uptake™ sprayed at Z13-Z14; Diuron + MCPA (amine) sprayed at Z13-Z15; Igran® + MCPA (terbutryn + MCPA amine) sprayed at Z13-Z15; Precept® + Hasten™ (pyrasulfotole + MCPA) sprayed at Z13-Z15; and 2,4-D Amine sprayed at Z15-Z16 and later.

Variety information	
Pedigree	Pennlo/Murray//Carrolup/3/TAM386/Carrolup
Breeder	National Oat Breeding Program
Access to seed	Heritage Seeds
EPR ($/t, excl. GST)	$2.30

Yallara(ᵇ)

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 not the variety is 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.

Yield (% Bannister)	2013	2014	2015	2016	2017
Agzone 1	–	no data for Agzone 1			–
Agzone 2	84	88	87	77	82
Agzone 3	79	71	87	88	83
Agzone 4	–	–	88	75	76
Agzone 5	–	–	82	82	75
Agzone 6	88	83	64	71	82

Disease resistance	
Septoria	S
Leaf rust	R-MS
Stem rust	MR-MS
Bacterial blight	MR-MS
BYD	MS
CCN resistance	R
CCN tolerance	I

Agronomic traits	
Target plant density	160-240 plants/m^2 (grain)
Dwarf gene present	No

Herbicide tolerance

May be sensitive to label rate applications of Glean® (chlorsulfuron) sprayed at Z12-Z13; Diuron + MCPA (amine) sprayed at Z13-Z15; and 2,4-D Amine 700 sprayed at Z15-Z16.

Variety information	
Pedigree	Euro*2/ND931075
Breeder	National Oat Breeding Program
Access to seed	Seednet
EPR ($/t, excl. GST)	$2.00

Brusher(ᵇ)

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)	8.7	7.9
Digestibility (% dm)	66.6	65.1
WSC (% dm)	31.5	30.3
ADF (% dm)	29.8	30.0
NDF (% dm)	49.6	49.7
Crude protein (% dm)	7.1	7.1
Stem thickness	Medium	Medium

Hay yield and quality 2013-17; courtesy National Oat Breeding Program

Disease resistance	
Septoria	S-VS
Leaf rust	R-MS
Stem rust	MR-S
Bacterial blight	MR-MS
BYD	MR-MS
CCN resistance	R
CCN tolerance	MI

Variety information	
Pedigree	Dumont/Wallaroo//Bandicoot
Breeder	National Oat Breeding Program
Access to seed	AEXCO seed distributor
EPR ($/t, excl. GST)	$2.00

Forester(b)

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)	8.3	7.9
Digestibility (% dm)	69.2	65.1
WSC (% dm)	33.2	30.3
ADF (% dm)	29.1	30.0
NDF (% dm)	47.3	49.7
Crude protein (% dm)	7.6	7.1
Stem thickness	Medium-thick	Medium

Hay yield and quality 2013-17; courtesy National Oat Breeding Program

Disease resistance	
Septoria	MS-S
Leaf rust	R-MS
Stem rust	R-MS
Bacterial blight	MS-S
BYD	MS
CCN resistance	MS
CCN tolerance	MI

Variety information	
Pedigree	OT285/OX92;056-4
Breeder	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 reistsant to stem nematode (not listed in table below).

Hay yield and quality	Mulgara	Carrolup
Hay yield (t/ha)	8.5	7.9
Digestibility (% dm)	66.7	65.1
WSC (% dm)	30.9	30.3
ADF (% dm)	29.5	30.0
NDF (% dm)	49.4	49.7
Crude protein (% dm)	7.0	7.1
Stem thickness	Medium	Medium

Hay yield and quality 2013-17; courtesy National Oat Breeding Program

Disease resistance	
Septoria	MR-S
Leaf rust	MR
Stem rust	MR-MS
Bacterial blight	MR
BYD	MS-S
CCN resistance	R
CCN tolerance	MT

Variety information	
Pedigree	OX89;030-26/93-112
Breeder	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)	8.9	7.9
Digestibility (% dm)	65.3	65.1
WSC (% dm)	29.3	30.3
ADF (% dm)	30.5	30.0
NDF (% dm)	51.2	49.7
Crude protein (% dm)	7.1	7.1
Stem thickness	–	Medium

Hay yield and quality 2013-17; courtesy National Oat Breeding Program

Disease resistance	
Septoria	No current rating available
Leaf rust	
Stem rust	
Bacterial blight	
BYD	
CCN resistance	
CCN tolerance	

Variety information	
Pedigree	Kent/Ballidu
Breeder	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)	8.5	7.9
Digestibility (% dm)	66.1	65.1
WSC (% dm)	30.3	30.3
ADF (% dm)	30.0	30.0
NDF (% dm)	50.7	49.7
Crude protein (% dm)	6.9	7.1
Stem thickness	Medium	Medium

Hay yield and quality 2013-17; courtesy National Oat Breeding Program

Disease resistance	
Septoria	S-VS
Leaf rust	S-VS
Stem rust	MR-S
Bacterial blight	S
BYD	MS-S
CCN resistance	S
CCN tolerance	I

Variety information	
Pedigree	Fulmark/Newton//Swan /3/Kent/ Ballidu//Curt
Breeder	Dept. of Agriculture, WA
Access to seed	Free to trade
EPR ($/t, excl. GST)	No EPR

Wintaroo(b)

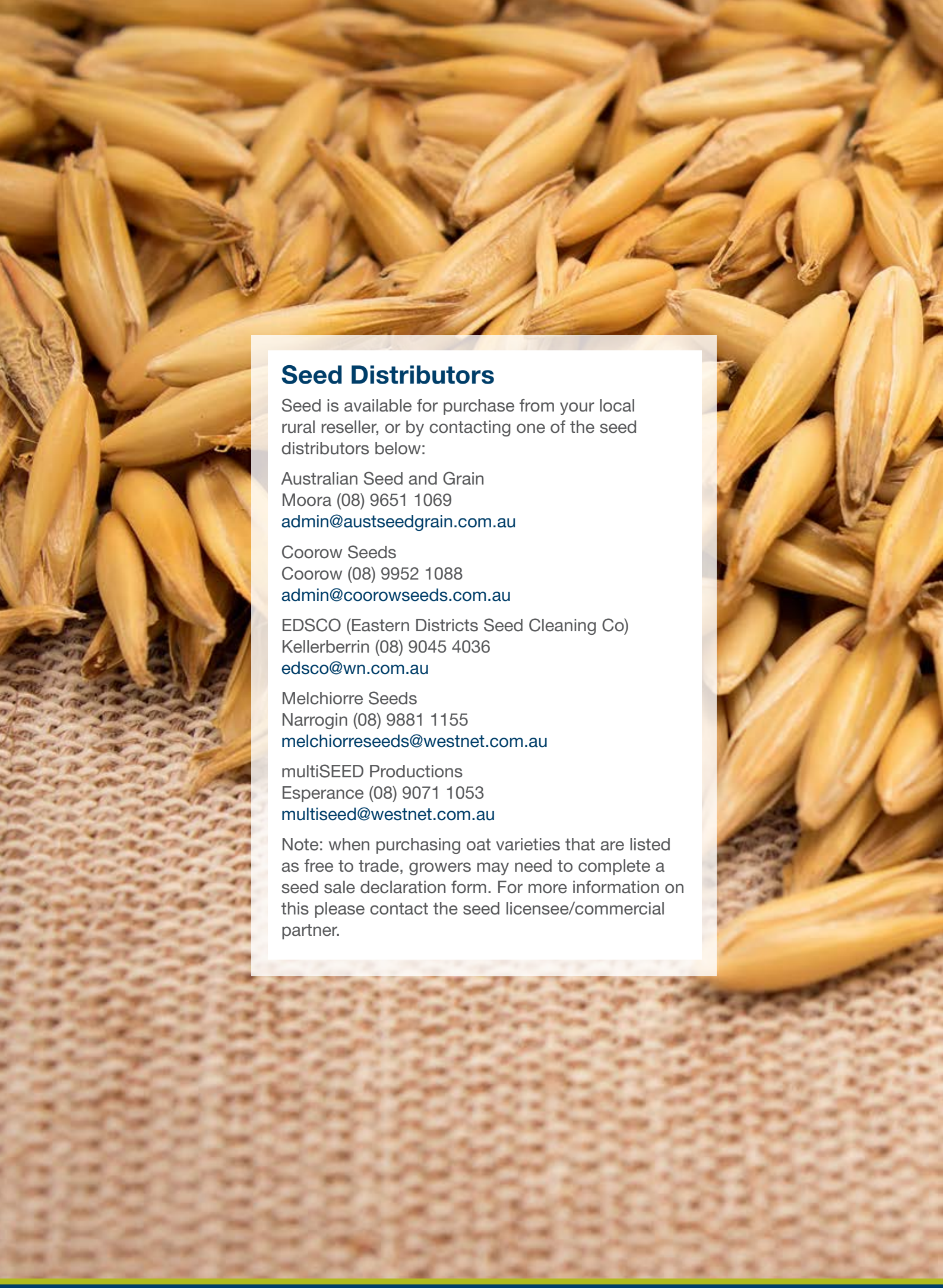
Hay variety

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)	9.3	7.9
Digestibility (% dm)	65.4	65.1
WSC (% dm)	29.8	30.3
ADF (% dm)	30.6	30.0
NDF (% dm)	50.7	49.7
Crude protein (% dm)	6.6	7.1
Stem thickness	Medium	Medium
Hay yield and quality 2013-17; courtesy National Oat Breeding Program		

Disease resistance	
Septoria	MS-S
Leaf rust	S-VS
Stem rust	MR
Bacterial blight	MR
BYD	MS
CCN resistance	R
CCN tolerance	MT

Variety information	
Pedigree	MIOLRP-86-3/Echidna//Wallaroo
Breeder	National Oat Breeding Program
Access to seed	AEXCO seed distributor
EPR ($/t, excl. GST)	$2.00



Seed Distributors

Seed is available for purchase from your local rural reseller, or by contacting one of the seed distributors below:

Australian Seed and Grain
Moora (08) 9651 1069
admin@austseedgrain.com.au

Coorow Seeds
Coorow (08) 9952 1088
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Kellerberrin (08) 9045 4036
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multiSEED Productions
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multiseed@westnet.com.au

Note: when purchasing oat varieties that are listed as free to trade, growers may need to complete a seed sale declaration form. For more information on this please contact the seed licensee/commercial partner.

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