Oat Breeding Newsletter

October 2018

Attending AFIA Fodder Conference in Adelaide at the Convention Centre, August 2018

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SARDI New Variety Agronomy Group
SARDI Molecular Genetics Group
SARDI Field Crops Pathology
Centre for Bioinformatics and Biometrics (CBB) at the National Institute for Applied Statistics Research Australia (NIASRA)
NVT Program
DPIRD NVT and Agronomy Group
Australian Cereal Rust Control Program (ACRCP)

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Grain Industry Western Australia – Oat Committee (GIWA)
Australian Fodder Industry Association (AFIA)

NEWSLETTER HIGHLIGHTS

- Read about the entries and trial locations for our most advanced material in grain and hay trials in sections 1 and 2
- Read about our visiting scientist from Iran on page 8, our farewell for Maha and new oat thresher on page 9
- Project updates for the oat pre breeding project are on page 10 – read about the progress being made in molecular markers for CCN and new work on stem nematode,
- Abiotic stress management in oats is on page 11 – read all of the critical outcomes from the six year project
- Saline-sodicity tolerance in oats is on page 13 – read about the latest results from this important screening work
- Read about what the WA program been up to on page 18 including the new field research facility
- Information about the WA oat agronomy project is on page 20 including information about the exciting new National Hay Agronomy project
- Information about new varieties including the two new breeder's lines (06204-16 - new milling potential dwarf variety and 05096-32 - a new hay variety) we are launching next year in section 4 starting on page 22
- Find information about the newest forage oat varieties released by private seed companies and DAF Qld on page 24
- Section 5 on page 26 contains summaries about newly released grain lines including the latest results for various yield, quality and disease resistance ratings
- Section 6 on page 38 contains summaries about newly released grain lines including the latest results for various yield, quality and disease resistance ratings

Drought stressed Pinery trial site in September, 2018

OAT 2020
International Oat Conference

GIWA
Grain Industry Association of Western Australia

International Oat Conference

Perth, Western Australia
11th – 15th October 2020

The Grain Industry Association of Western Australia (GIWA) Oat Council and the International Oat Committee invite you to attend the 11th International Oat Conference in Perth, Western Australia from 11th to 15th October 2020.

Held every four years around the world, the conference theme for Oat 2020 is 'Health and Nutrition'.

Western Australia is vast and diverse — from desert to forest, endless beach to endless bush. It is a unique destination filled with unexpected experiences. From the dynamic capital city of Perth to the spectacular regions, in Western Australia you will enjoy an authentic Australian experience.

To Register Your Interest please visit:

www.internationaloat.org

www.internationaloat.org www.giwa.org.au

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The DPIRD stand at the Dowerin Field Day, August 2018 (photo courtesy Cody Hull)

Editors' note:
Just a reminder, this newsletter should not be quoted without consent from the authors.

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1. Entries for 2018 Grain Trials

1.1 NVT and Stage 4 Grain Trials

New in 2018

- All NVT oat trials now comprise 16 entries

National Variety Testing (NVT) trials comprising 16 entries were sown at a total of 27 locations throughout SA, Victoria, NSW and WA in 2018 (Table 1). Trial locations and plans can be found on the NVT website www.nvtonline.com.au

The Stage 4 grain trial increased from 40 entries in 2017 to 48 entries in 2018. Stage 4 grain trials were sown at four locations in SA, one location in NSW and five locations in WA (Table 2). The Stage 4 grain entries were sown in nurseries at Manjimup to evaluate leaf rust, barley yellow dwarf virus (BYDV) and septoria resistance and at Canarvon in a stem rust nursery. Stage 4 grain entries were also evaluated for CCN resistance at the Waite Campus in SA and for stem and leaf rust by the Australian Cereal Rust Control Program, the University of Sydney, at Cobbitty in NSW.

Information about the grain yield and quality of named lines is included in section 6 of this newsletter.

Leaf rust build up for nurseries in WA (photo courtesy Cody Hull)

Table 1: NVT trial locations in 2018.

South Australia	Victoria	New South Wales	Western Australia
NVT 16 Bordertown Crystal Brook Frances Paskeville Waikerie	**NVT 16** Diggora Dookie Eastville Hamilton Streatham	**NVT 16** Condobolin Cowra Gerogery Oaklands Quandialla Wagga Wagga Wellington	**NVT 16** Corrigin Cunderdin Dandaragan Esperance R.S. Holt Rock Merredin Pingrup Rylington Park Wagin York

Table 2: Stage 4 grain trial and nursery locations in 2018.

South Australia	New South Wales	Western Australia
Yield trials Riverton Pinery Turretfield Padthaway **Seed increase** Wasleys **Nurseries** Waite (CCN resistance)	**Yield trials** Leeton irrigated trial **Nurseries** Rust evaluation at ACRCP Cobbitty	**Yield trials** Cunderdin Brookton Muresk Rylington Park Wongan Hills **Nurseries** Manjimup (BYDV, rust & septoria) Canarvon (rust)
	Victoria	
	-	

Carnarvon stem rust nursery showing the value of stem rust resistance!

2. Entries for 2018 Hay Trials

2.1 Hay trials

New in 2018

- Stage 4 hay trial sown at Dunn Rock instead of Lake Grace in WA for observation
- Hay trial at Wongan Hills sown as a Stage 4 trial

The Stage 5 (S5) hay trial for 2018 reduced to 30 entries and was sown at Cunderdin and Muresk in WA, Horsham and Finley in NSW. Stage 4 (S4) hay trials include the 30 entries from the S5 trial and an additional 14 entries to make a total of 44 entries. Four late hay entries were again added to the Elmore trial for comparison. Hay and grain yield and quality assessment will be conducted at three locations in SA, two locations in Victoria, one location in NSW and two locations in WA (Table 3). The Stage 4 late hay trial for 2018 has 20 entries and was sown at three locations in SA and one location in WA. Late hay trials located at Riverton and Turretfield in SA will be cut for hay yield and quality assessments. All trials will be assessed for grain yield and grain quality. The Stage 4 entries from both the hay and late hay trials were also sown in nurseries to evaluate stem and leaf rust, BYDV and septoria resistance in WA, CCN resistance at the Waite Campus in SA and stem and leaf rust by the Australian Cereal Rust Control Program. Information about the hay yield and hay quality as well as grain yield of released lines is included in section 6 of this newsletter.

Table 3: Stage 5 and Stage 4 hay and late hay trial and nursery locations in 2018

<table>
<tr><th>South Australia</th><th>Victoria</th><th>Western Australia</th></tr>
<tr><td rowspan="3">Stage 4 trials
Pinery (hay & late hay)
Turretfield (hay & late hay)
Riverton (hay & late hay)
Seed increase
Wasleys
Nurseries
Waite Campus (CCN resistance)</td><td>Stage 5
Horsham (Longrenong)
Stage 4
Elmore (44 entries including Forester, Kangaroo, Tammar & Tungoo. S5 entries only cut for hay. All entries harvested for grain)</td><td rowspan="2">Stage 5
Cunderdin
Muresk (obs only)
Stage 4
Brookton
Wongan Hills
Dunn Rock (obs & grain harvest)
Merredin (obs & grain harvest)
Rylington Park (late hay-observation and grain harvest only)
Nurseries
Manjimup (septoria, BYDV, stem and leaf rust)</td></tr>
<tr><td>New South Wales</td></tr>
<tr><td>Stage 5
Finley
Nurseries
Rust evaluation at ACRCP Cobbitty</td><td></td></tr>
</table>

3. Breeding Program Developments

3.1 Dr Sohbat Bahraminejad

Dr Sohbat Bahraminejad from the Iranian province of Kermanshah visited our program for 9 months in 2017/18. He is the Associate Professor at the Razi University where he is an oat and wheat breeder. Sohbat was a valuable asset to our program while he was here and learnt a lot about how our program runs. We wish him and his family all the best for the future.

3.2 Farewell Dr Mahalakshmi Mahadevan

It is with sadness that we farewelled Maha after 6 years of working in the program. Maha has moved on to working with the University of Adelaide's frost project and we wish her all the best in her new role. She has been an instrumental part of the successful drought tolerance project with oats and we thank her for all of her hard work and dedication while working on this project. She will be missed by our program.

3.3 Oat Program uses new oat thresher

In December 2017 the oat program took delivery of a new thresher. The Haldrup thresher is a much improved and safer thresher.

3.4 Project

updates

3.4.1 Oat Pre-Breeding Project

SARDI's John Harris is developing molecular markers to select for two CCN resistance genes found in NOBP material. Presently two populations, Kangaroo x Eurabbie and Mortlock x Potoroo, are being used to develop breeder markers for CCN resistance. Two distinct genetic locations are responsible for CCN resistance in Kangaroo, found on chromosomes 15A and 4C, and headway has been made in developing markers to follow the genes in the breeding program. However, the same genetic location on chromosome 15A is also responsible for CCN resistance in Potoroo yet gives the opposite response in our diagnostic tests. This phenomenon is being investigated further. The genetic location on 4C for the second Kangaroo CCN resistance gene has been greatly reduced. This has improved the likelihood that available markers are reliable for implementation within the breeding program. A broad screen was performed on stage 1 and stage 4 material that was also part of the routine annual CCN screening to verify reliability.

In addition, funding was obtained from the Yitpi Foundation and AEXCO to commence initial screening of NOBP material and a diverse international set for resistance to stem nematode (*Ditylenchus dispaci*). Increased demand for both oat hay and grain is characterized by a shift in grain oat production into non-traditional areas such as SA's mid-north where hay varieties are typically grown and stem nematode is found. This expansion is signified by the purchase of Blue Lake Milling Pty Ltd by CBH and increased production capability in their new mill. The National Oat Breeding Program (NOBP) historically screened hay and grain varieties for stem nematode reaction but this activity ceased in 2008. This year's attempts to reinstate stem nematode screening have involved collection of stem nematode to establish inoculum. Special thanks go to the Abbotts of Farrell Flat and Schusters of Freeling for allowing John to collect material from their fields which has led to the isolation of stem nematode.

Picture showing intolerant (left) and tolerant (right) oat varieties to Stem nematode

3.4.2 Abiotic stress management (Project funded by GRDC); Enhancing grain yield and quality of oat under water deficits (Project funded by SAGIT) – update thanks to Dr Mahalakshmi Mahadevan

Studies on oat adaptation to water-limited environments are scarce, because most efforts are localised in comparatively favourable environments. Long-term profitability of farming business requires simultaneously managing the risk of yield losses in dry seasons, and capturing the benefits of favourable seasons. This can involve trade-offs in crop traits seeking both adaptation to drought and high yield potential. The aim of the project was to evaluate grain, hay, and grazing oat varieties for adaptation to dry conditions and their potential under favourable conditions. Grain and hay yield and quality and several secondary traits potentially related to improved drought performance were evaluated in this material. The project was conducted from 2012 to 2017 resulting in 16 environments as a combination of locations and seasons. Modelling was used to quantify the actual patterns of water supply and demand. Phenotypic plasticity for yield, yield components and quality traits of grain and hay, were quantified to capture genotype by environment interactions and elucidate putative trade-offs between adaptations to water deficit and yield under favourable conditions. The overall outcome of the project were as follows:

1. The critical period of yield determination under Australian conditions spanned from GS31 to 300^{o}Cd after anthesis (~ 35 days before anthesis to ~14 days after anthesis) with difference of responses of varieties to shade stress
2. Grain number per panicle influenced final yield rather than the number of panicles per unit area
3. The main environmental drivers of yield were water supply:demand from 500^{o}Cd before and 500^{o}Cd after anthesis and minimum temperature in the same period.
4. Selection for higher plasticity would improve both yield potential in favourable years and drought adaptation
5. Yield correlated positively with leaf greenness (SPAD) particularly during grain filling stage and negatively with WSC at anthesis
6. Yield response of oats to interspecific competition was a plastic trait i.e. the same genotype produced different phenotype depending on environmental conditions. Yield reponse to competition is related to variety dependent responses to competition for biomass, harvest index, number of panicles and number of grains per panicle.
7. Oats emerged as an interesting model to investigate the mechanisms of phenotypic plasticity for interspecific competitive ability
8. Selection for low concentration of water soluble carbohydrates at anthesis could increase oat grain yield partially by improving all senescence traits (Max NDVI, Minimum NDVI, rate of senescence, thermal time to 50% senescence and leaf area duration)
9. High negative associations of WSC exist in the shoot at anthesis with yield, yield components and N content

10. Higher carbohydrates favours higher hectolitre weight and groat percent and lowers grain set and screenings for grain. Lower grain set and more carbohydrate reserves could favour high hectolitre weight, low screenings and high groat percentage, at the expense of yield. High concentrations of water soluble carbohydrates for hay could lead to higher digestibility and lower fibre at the expense of yield

The publications out of this project are as follows

A: Scientific Papers

Sadras, V.O, Mahadevan M and Pamela K. Zwer. 2018. Stay-green associates with low water soluble carbohydrates at flowering in oat. Field crops Research **(Paper accepted for publication)**

Sadras, V.O, Mahadevan M, Michelle M. Williams, Sue D. Hoppo and Pamela K. Zwer. 2018. Phenotypic plasticity of grain and hay quality in varieties and advanced lines from the Australian oat breeding program. European Journal of Agronomy **(Paper accepted for publication).**

Sadras, V.O, Mahadevan M and Pamela K. Zwer. 2018. Intraspecific competition in oat varieties selected for grain yield and milling. Crop and pasture science. Published online on 26June 2018. https://doi.org/10.1071/CP18098

Sadras, V.O, Mahadevan M and Pamela K. Zwer. 2017. Oat phenotypes for drought adaptation and yield potential. Field crops research 212, 135-144.

Mahadevan M, Calderini D.F, Zwer P.K and Sadras V.O. 2016. The critical period for yield determination in oat (Avena sativa L.). Field crops research 199, 109-116.

B: Conference papers

Sadras VO, Mahadevan M, Zwer PK. 2018. Stay-green associates with low water soluble carbohydrates at flowering in oat. 5th International Plant Phenotyping Symposium. 2-5 October 2018, Adelaide, Australia

Mahadevan, M, Pamela K. Zwer and Victor O. Sadras. 2017. Phenotypic plasticity of yield components in oat (*Avena sativa* L.). Session: Crop physiology and breeding, In: Doing More with Less In: Proceedings of the 18th Australian Society of Agronomy Conference, 24 - 28 September 2017, Ballarat, VIC (http://www.agronomyaustraliaproceedings.org/).

Zwer P.K, Mahadevan M, Calderini D.F, and Sadras V.O. 2016. Stress sensitive stages in oats. Plenary session 4: Physiology, pest disease resistance. At: The 10th International Oat conference. 11 -15 July 2016, St. Petersburg, Russia. P.34.

Mahadevan M., Victor O. Sadras and Pamela K. Zwer. 2015. Phenotypic plasticity of grain yield in oat and its association with agronomic and phenological traits. Session: Crop Phenology. In "Building Productive, Diverse and Sustainable Landscapes". Edited by T. Acuña, C. Moeller, D. Parsons and M. Harrison. In: Proceedings of the 17th Australian Agronomy Conference, 21 – 24 September 2015, Hobart, TAS. (http://www.agronomyaustraliaproceedings.org/)

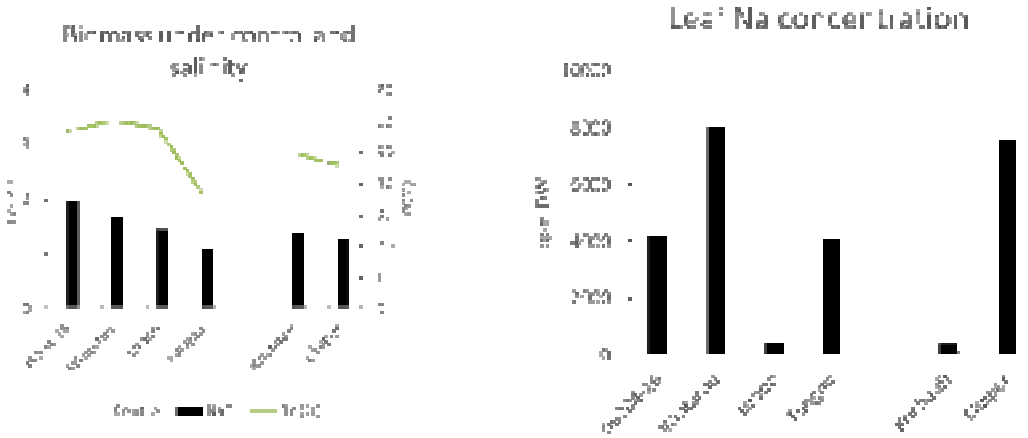
3.4.3 Saline - sodicity tolerance in oats (update thanks to Dr Graham Lyons, Univ Adel)

Project led by Graham Lyons in conjunction with the SARDI Oat Breeding Group, John Harris, Yusuf Genc with funding from SAGIT. Photos and results presented are from a talk that Graham did at a recent Waite seminar featuring oat research.

Aims of the project:
Screening under controlled environment
Screening overseas oats in birdcage
Field trials

They have been trialling plants in controlled environments in the glasshouse and growth room.

Biomass and leaf [Na] at heading



RY = relative yield (%)

NaCl tolerance

NaCl intolerance

Waite birdcage graduates

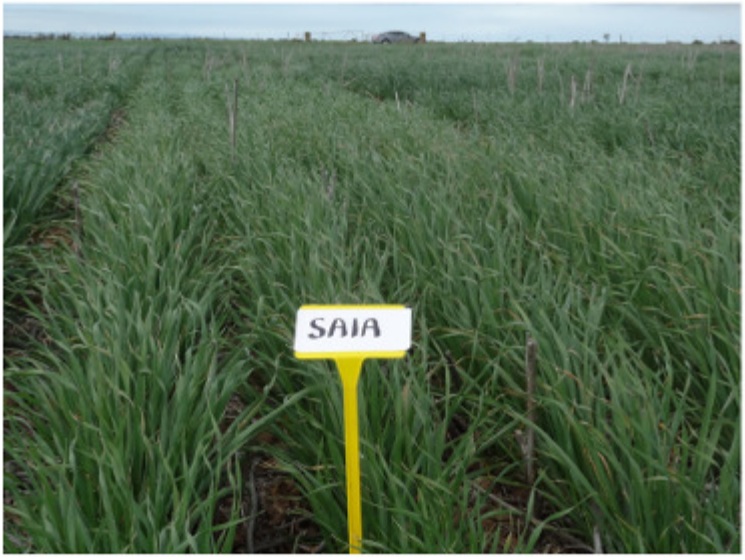
Of 30 overseas oat varieties trialled in 2017, these produced sufficient grain to be included in the 2018 field trials:

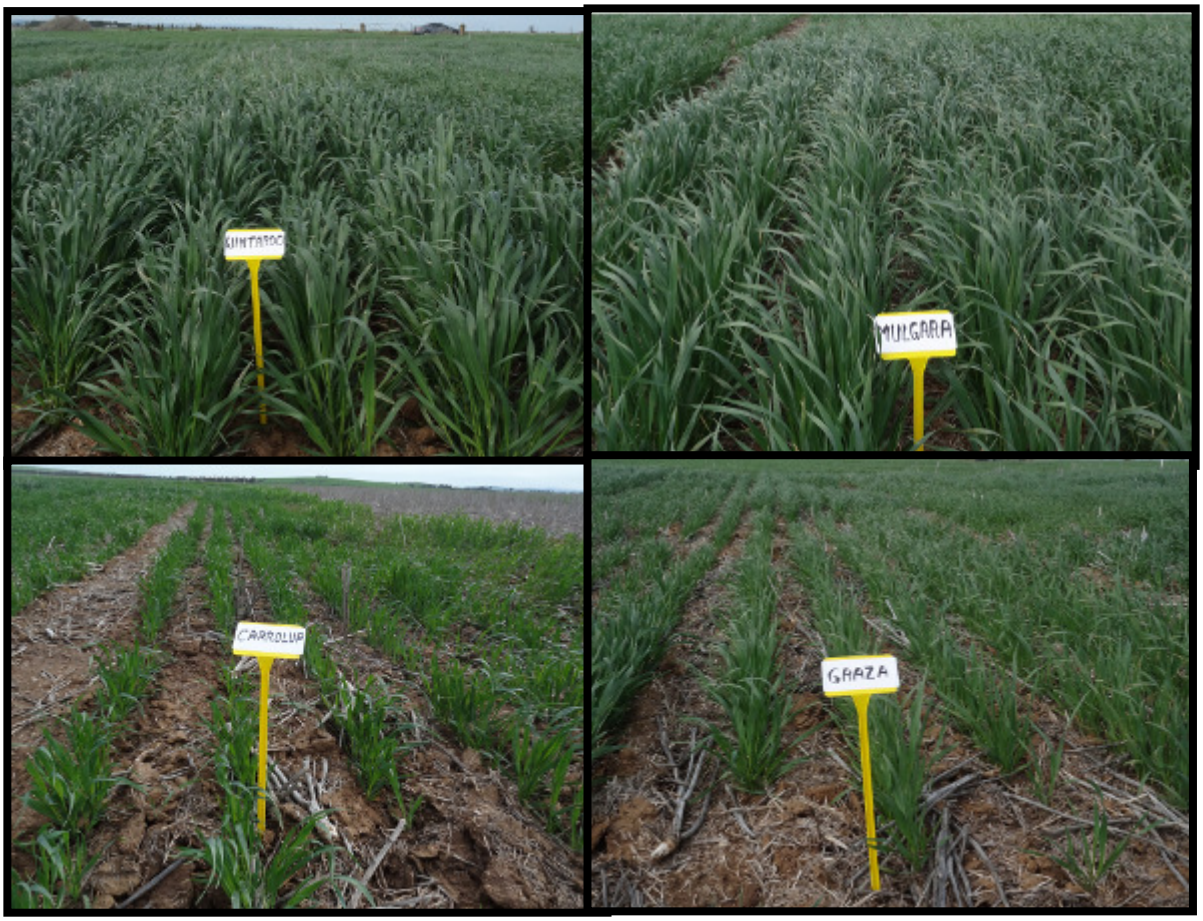
Noble 2, Troy, Florida 501, Hazel (USA)
Pro-Fi (Canada)
Urano (Chile)
Matilda (Sweden)
Drummond (Scotland)

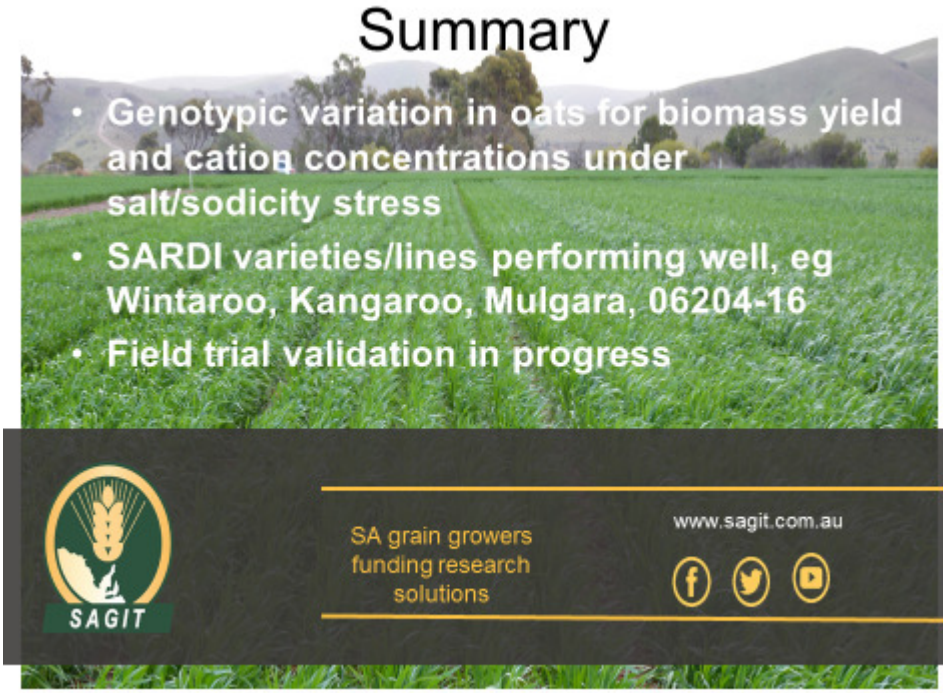
Field trials

- Two seasons
- Redhill: saline-sodic: at 60cm, Na adsorption ratio 27; exchangeable Na % 80; ECe 8.7; pH 8.2
- Turretfield: good soil control
- Randomized block, 3 replications
- 32 varieties/lines: 8 overseas, 17 Australian commercial milling and hay/feed grain, 7 Australian pasture/forage
- Will measure biomass at late tillering and heading; leaf minerals at heading; grain yield

SAGIT Redhill trial 2018

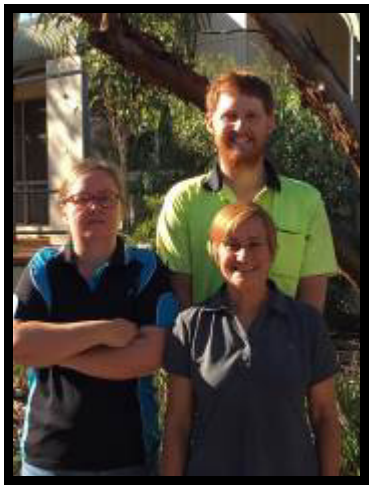



WINTAROO
MULGARA
CARROLUP
GRAZA


Summary
• Genotypic variation in oats for biomass yield and cation concentrations under salt/sodicity stress
• SARDI varieties/lines performing well, eg Wintaroo, Kangaroo, Mulgara, 06204-16
• Field trial validation in progress
SAGIT
SA grain growers funding research solutions
www.sagit.com.au

Oats: wide height range

3.4.4 WA program developments – thanks to Pip Payne, DPIRD



WA team Deb Donovan, Cody Hull & Pip Payne

This year the WA program moved into the much larger field research facility built at the Department of Primary Industries & Regional Development (DPIRD), Northam location. While construction took place over the last two years processing and storage of samples was done in Wongan Hills (over 100km away) which resulted in a lot of time travelling between the two sites. We were able to move everything back to Northam for this year's seeding preparation. We are thankful to Australian Exporters Company (AEXCO) who provided funding for an additional oven that the WA oat-breeding program has exclusive use for our hay cut samples. This will speed up our processing and analysis time considerably. Due to the expanded facility, we also moved our oat leaf rust bulk up from South Perth to the Northam glasshouses. A new -80^{0}C freezer means we can store the rust over many years and it will remain viable to inoculate our disease trials at Manjimup. The purchase of an additional Sortimat & seed counter will also enable us to process the data from our harvest samples faster which will give Dr Pamela Zwer more time to select which lines are to progress in the breeding program.

New oven provided by AEXCO for hay sample drying

The season in WA has generally been good with all our trial sites going in on time. This year we have sites at Wongan Hills (S4 hay and grain trials), Merredin (S4 hay for grain), Cunderdin (S1 to S4 trials), Northam (S4 grain & hay), Brookton (S1 to S4 trials), Boyup Brook (S2 to S4 trials) and Dunn Rock (S4 hay for grain). With well over 9,000 plots in the ground we had a busy year looking after the trial sites and collecting data. We are currently in the middle of hay cuts with over 300 plots to cut, assess & analyse. Soon Dr Pamela Zwer and Peter McCormack will be arriving to assess all the trial sites and do disease ratings on our Septoria, Leaf Rust and Barley Yellow Dwarf Virus (BYDV) trials at Manjimup. The DPIRD cereal pathology group have already completed Stem Rust assessments on the disease nursery in Carnarvon.

In addition to our trial work the team had a display at the Dowerin Field Day in August, presented our Boyup Brook trials at the Rylington Park Field Day and our Wongan Hills trials at the Liebe Group field walk in September.

Cunderdin S1 plots 6-9-18

3.4.5 Oat agronomy project update – thanks to Georgina Troup, DPIRD

Oat agronomy research in Western Australia is investigating the responses of new varieties and breeding lines (that are due to be released in the near future), to crop management. In 2018, we had trials from Yerecoin (north) to Lake Grace (south east) focussing on;

1. Responses to nutrition and plant density
2. Early sowing cereal options
3. Hay phenology – response to changes in sowing date
4. Nitrogen rate and timing influence grain and hay (yield and quality)

We had a moderately late season break following a strong wind event on the 25th May 2018. With little-to-no moisture prior to this rain event across the grain growing region, there was a considerable amount dry sown. At one trial site, which was dry sown, we had the unfortunate experience of having some of our pre-emergent herbicide blow into the furrow leading to uneven distribution of plants – so one trial was abandoned very early on. Luckily for us, we had rainfall throughout June, July and August, albeit a rather dry September, followed by welcome rains again in October (unless you had hay on the ground!).

This year we have included 6 longer season (including winter types) varieties of each species (wheat, barley and oats) into our first time of sowing (mid-April, irrigated to emerge) in the Early Sowing Cereal Options trial at Muresk. While there were no winter type oats to include, we did include two breeding lines; 05096-32 and 09143-35 which have shown longer maturity type than the current suite of varieties on offer for our oat growing region (see photo taken 12/10/18).

Our hay phenology research for 2018 is nearly complete with the longer season types like Forester being the last to reach watery ripe. This research will be published in time for the GRDC Research Updates in Perth, February 2019.

Last but not least is the exciting new National Hay Agronomy Project, which kicked off in August 2018, with field trials planned for 2019. This project is an investment by Agrifutures, the Department of Primary Industries and Regional Development WA, South Australian Research and Development Institute, Department of Primary industries NSW, and Agriculture Victoria. We will be working to fill the following knowledge gaps to support export fodder producers;

1. Hay variety responses to nutrition and plant density
2. Effect of time of sowing on hay quality
3. Impact of diseases on hay quality and yield (including rust, septoria, and red leather leaf)
4. Optimum timing of disease management intervention and the impact on return ($/ha)

Please contact your local #nationalhayagronomy team member to find out what's happening in your region;

- ✓ South Australia – Courtney Peirce Courtney.peirce@sa.gov.au
- ✓ Victoria – Mark McLean (pathologist) Mark.S.McLean@ecodev.vic.gov.au

- ✓ New South Wales – Peter Matthews Peter.Matthews@dpi.nsw.gov.au
- ✓ Western Australia – Geoff Thomas (pathologist) Geoff.J.Thomas@agric.wa.gov.au or myself Georgie.troup@agric.wa.gov.au

Follow us on Twitter by searching for #nationalhayagronomy and see what we've been up to.

Muresk early sown cereal options trial

4. New varieties & advanced breeder's lines

Key to diseases – SRR = stem rust resistance, LRR = leaf (crown) rust resistance, BYDV = barley yellow dwarf virus, RLL = red leather leaf, CCN = cereal cyst nematode and SN = stem nematode. Key to disease ratings - R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible, T=tolerant, MT= moderately tolerant, MI=moderately intolerant, I=intolerant.

Kowari (previously 03198-18) – new milling grain variety

Kowari, released at the Royal Adelaide Show in 2017, is a new milling oat variety commercialised by Heritage. It has dwarf stature measuring 65 to 70 cm and is slightly taller than Mitika. It has a maturity similar to Mitika, 8 to 10 days earlier than Bannister and 3 to 10 days earlier than Williams. Kowari is 4 to 8 days later to head than Durack.

Kowari is a cross between Mitika and WAOAT2099 and was tested as the breeder's line 03198-18. It has similar grain yield to Mitika and Kojonup, but lower than Bannister and Williams.

The grain quality is excellent. Kowari has slightly lower hectolitre weight than Mitika, but it has higher 1000 grain weight compared to Mitika. It combines high β-glucan with low screenings. Kowari has high protein and slightly higher groat percent compared to Mitika. The trait of interest for this variety is improved β-glucan content. The β-glucan content was measured using the Megazyme method. Kowari averaged 5.2% B-glucan (dm basis) compared to 4.7% for Mitika and Kojonup.

To download the Heritage Seeds brochure based on National Oat Breeding Program results for this variety go to –
https://www.heritageseeds.com.au/field-crops-2/winter-crop-varieties/kowari.htm

06204-16 – potential new grain variety

06204-16 is a dwarf, early-mid season potential milling oat. It has excellent grain yield similar to Williams and Bannister in SA, but with improved grain quality compared to the two varieties. 06204-16 has low screenings and high groat percent compared to Williams and Bannister. It has slightly lower hectolitre weight and slightly higher groat percent compared to Mitika and Bannister. 06204-16 has high β-glucan with bright grain. 06204-16 is moderately susceptible to susceptible to stem rust, resistant to leaf rust, moderately susceptible to susceptible to barley yellow dwarf, moderately susceptible to bacterial blight, moderately susceptible to susceptible to septoria, and susceptible to CCN.

Heritage is the commercial partner. A commercial seed increase was sown in 2017 with a second one sown in 2018. The launch will be in spring 2019 with seed available for the 2020 growing season.

05096-32 – potential new hay variety

05096-32 is a mid-tall potential hay variety with early mid to mid-season maturity. It is similar in height, 2 to 4 days later in maturity and has similar grain yield and stem diameter compared to Yallara. Hay yield is slightly higher than Carrolup, but lower than Yallara and Brusher. It has improved disease and grain quality compared to other current hay varieties and combines improved septoria resistance with good rust and bacterial blight resistances. It is moderately susceptible to cereal cyst nematode (CCN), resistant to susceptible to stem rust in SA/Vic and resistant in WA, moderately susceptible to susceptible to leaf rust in SA/Vic and resistant to moderately resistant in WA, moderately susceptible to susceptible to barley yellow dwarf, moderately resistant to bacterial blight, moderately resistant to moderately susceptible to septoria in WA. It has excellent hay colour and hay quality is similar to Wintaroo across all traits except water soluble carbohydrates which averages slightly lower in Victoria and WA. Grain quality is similar to Yallara but with a lower groat percent. It has low oil and bright grain.

This line is a cross between two WA advanced breeding lines. Commercial seed increases were sown in 2017 with a second one sown in 2018. The expected release for this variety is spring 2019 with seed available for the 2020 growing season.

Harvest 2017 at Turretfield Research Centre

New forage oat varieties

There has been numerous forage oats released by private companies as well as DAF Qld recently, most of which are direct introductions from the North Dakota State University. These lines are generally very late maturing and not suitable for the majority of South Australia and Western Australia but may have some role in high rainfall areas (minimum 500mm rainfall) of Queensland and NSW as a forage oat ONLY. Beware that some have only limited data about the variety.

A forage oat guide published by DAF Qld is available at the following link and summarises the characteristics of some of these varieties - https://www.daf.qld.gov.au/business-priorities/plants/field-crops-and-pastures/broadacre-field-crops/oats/forage-oat-variety-guide Information is also available in the NSW DPI Winter Crop Sowing Guide - https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/807269/WCVSG-2018-accessible-v2.pdf

Photo source: Heritage Seeds

A list of the most recently released forage oat varieties (from 2016 onwards) is below –

Variety	PBR	Source	Year Released	More information
Austin	Yes	AusWest Seeds	2018	No information available
Bond	Yes	AusWest Seeds	2016	https://www.auswestseeds.com.au/Products/Bond
Boss	Yes	Elders	2016	https://eldersrural.com.au/farm-supplies/plant-genetics/boss-oats/
Brigalow	Yes	Selected Seeds	2017	https://static1.squarespace.com/static/5ac6bfaecc8fed35cb14f4e3/t/5ae94a7d03ce640346cd3ad5/1525238407520/SS+Fact+Sheet_Brigalow+Oat.pdf
Cooee	No	PGG Wrightsons	2018?	https://www.pggwrightsonseeds.com.au/Seeds/Forage-Cereal/Oats/Cooee
Comet	Yes	Pacific Seeds	2014	https://www.pacificseeds.com.au/images/Products/Oats/Comettechnote10032016.pdf
Flinders	Yes	PGG Wrightsons	2018	No information available
Graza53	Yes	Elders	2016	https://eldersrural.com.au/products/graza-53-forage-oats/
K78R7	Yes	Kaneco Seeds Co.	2017	No information available
Lavish	Yes	Not available	2017	No information available
Massive	TM	Upper Murray Seeds	NA	https://www.uppermurrayseeds.com.au/massive_oats.html
Savannah	Yes	PGG Wrightsons	2016	https://www.pggwrightsonseeds.com.au/Seeds/Forage-Cereal/Oats/Savannah
SF Colossus	No	Seed Force	NA	https://www.seedforce.com.au/product/sf-colossus/
SF Empire		Seed Force & Aust Premium Seeds	2017	https://www.seedforce.com.au/product/sf-empire/
SF Tuscana	No	Seed Force	NA	https://www.seedforce.com.au/product/sf-tucana/
Odyssey	Yes	Pacific Seeds	2018	No information available
Victory	TM	Upper Murray Seeds	NA	https://www.uppermurrayseeds.com.au/victory_oats.html
Warlock	Yes	Heritage Seeds	2018	https://www.heritageseeds.com.au/forage-pasture-3/forage-crops/warlock.htm
Wizard	Yes	DAF Qld/Heritage Seeds	2017	https://www.heritageseeds.com.au/forage-pasture-3/forage-crops/wizard.htm

5. Long term grain trial results

Results for individual NVT trials are not presented in this newsletter. However, they are incorporated into the long term performance of varieties and advanced breeding lines which are presented in this newsletter in Tables 4 to 8**.** Grain yield and grain quality information for individual sites is available at the NVT web site: www.nvtonline.com.au.

Table 4 shows the relative yield performance of new varieties compared to existing varieties for four different states and Tables 5 to 8 show the relative yield performance of new varieties compared to existing varieties for regions within states. An updated analysis for grain quality was available for this newsletter. Tables 9 and 10 show the relative grain quality across all states and Tables 11 to 16 show the relative grain quality parameters by state. Tables 17 to 19 show the relative disease resistance characteristics for these varieties in different regions. Care needs to be taken to look at not only grain yield but grain quality and disease resistance characteristics to determine if a variety is suitable for your region. **Please note:** Stem and leaf rust reactions reported for all oat varieties will vary by region due to genetic variation in the pathogen population. A pathotype that overcomes most resistance genes for stem rust is now present in southern Australia. Hence it is important to monitor oat crops for early detection of rust, so fungicide applications can be applied to control the disease.

Brochures are available for new varieties from the website, the SA and WA components of the NOBP and our commercial partners; AEXCO who commercialises the hay varieties and Seednet and Heritage who commercialise the milling varieties from the SARDI node of the National Oat Breeding Program. (Seednet for Bannister and Heritage Seeds for Williams and Durack.)

5.1 Grain Variety Summary

Kowari (03198-18)

Kowari, released at the Royal Adelaide Show in 2017, is a new milling oat variety commercialised by Heritage. It has dwarf stature measuring 65 to 70 cm and is slightly taller than Mitika. It has a maturity similar to Mitika, 8 to 10 days earlier than Bannister and 3 to 10 days earlier than Williams. Kowari is 4 to 8 days later to head than Durack.

Kowari is a cross between Mitika and WAOAT2099 and was tested as the breeder's line 03198-18. It has similar grain yield to Mitika and Kojonup, but lower than Bannister and Williams.

The grain quality is excellent. Kowari has slightly lower hectolitre weight than Mitika, but it has higher 1000 grain weight compared to Mitika. It combines high β-glucan with low screenings. Kowari has high protein and slightly higher groat percent compared to Mitika. The trait of interest for this variety is improved β-glucan content. The β-glucan content was measured using the Megazyme method. Kowari averaged 5.2% (dm basis) compared to 4.7% for Mitika and Kojonup.

https://www.heritageseeds.com.au/field-crops-2/winter-crop-varieties/kowari.htm

Durack

Durack is a moderately tall variety similar in height to Carrolup and Yallara measuring between 80 and 90 cm. Check out this new variety as it is a minimum of one week earlier than any other variety released from the program. Durack has good lodging and shattering resistance and good early vigour. Grain yield is similar to the tall varieties Carrolup and Yallara across all states and an improvement compared to tall varieties bred for hay. Grain quality for this line is excellent. Hay yield averaged over low, medium, and high rainfall sites is lower than other longer season varieties. Care will need to be taken to cut this very early maturing variety at the correct growth stage. Monitoring the crop will be the key to achieving the highest hay quality.

The 2017 Durack crop will be reassessed for B-glucan content in WA. A decision will be made regarding potential assignment to WA milling class 1.

Heritage Seeds brochure based on National Oat Breeding Program results available at –
https://www.heritageseeds.com.au/field-crops-2/winter-crop-varieties/durack.htm

Bannister$^{\Phi}$

Bannister is a tall dwarf milling variety with high grain yield released for Western Australia in 2012. Bannister is suited to eastern Australia as well as Western Australia. It is adapted to low, medium, and high rainfall zones of southern Australia. It is 13 cm taller than Mitika and heads about 3 to 4 days later than Mitika. Seednet is the commercial partner.

Bannister is resistant to leaf rust and moderately resistant to bacterial blight. It is resistant and intolerant to CCN.

Bannister has slightly lower hectolitre weight and slightly higher screenings compared to Mitika. It is similar to Mitika for groat percent.

Bannister Fact Sheet based on National Oat Breeding Program results available from Seednet -
http://www.seednet.com.au/documents/Bannister_Factsheet_June_2014.pdf

Williams$^{\Phi}$

Williams is a tall milling variety commercialised by Heritage. Williams formerly known as the breeding line, WA2332, is an early to midseason variety similar to Yallara, but three to seven days later than Mitika. Williams is 15 cm taller than Mitika, 5 cm taller than Bannister, and 15 cm shorter than Yallara.

Although classified as MS for septoria, Williams has the highest level of septoria resistance compared to all other current oat varieties. It is resistant to leaf rust and depending on the stem rust pathotype present can range from moderately resistant to susceptible. Williams is

resistant to bacterial blight and moderately resistant to moderately susceptible for BYDV. It is susceptible and intolerant to CCN.

Williams has grain yield similar to Bannister except in the lower rainfall regions where it yielded less. Williams yielded similar to Mitika except in the Mid North where it yielded significantly more grain.

Grain quality is lower than Mitika. Williams has higher screenings than Mitika, Yallara, and Bannister, especially in the low rainfall regions.

Williams had similar hay yield compared to other hay varieties at Pinery and Turretfield, but lower hay yield at Riverton. Hay quality is also similar to hay varieties, except for slightly higher crude protein. Care must be taken to achieve high plant populations to reduce stem thickness.

Heritage Seeds brochure based on National Oat Breeding Program results available at – https://www.heritageseeds.com.au/field-crops-2/winter-crop-varieties/williams.htm

Wombat$^{\Phi}$

Wombat is a dwarf milling variety that was commercialised by Seednet. It is similar in height to Possum and slightly taller than Mitika. It is a midseason variety flowering about six days later than Mitika.

Wombat is the first dwarf milling variety with CCN resistance and tolerance. It is also moderately tolerant to stem nematode.

Wombat has high hectolitre weight and low screenings compared to the feed variety Potoroo, which was the first dwarf variety with CCN resistance and tolerance. It also has high groat percent, slightly higher than Mitika.

Wombat Fact Sheet based on National Oat Breeding Program results available from Seednet - http://www.seednet.com.au/documents/Wombat_Factsheet_Jan_2014.pdf

Yallara$^{\Phi}$

Yallara is a medium tall early to midseason variety similar to Euro for flowering and maturity. Yallara, released in 2009, is a milling line with slightly better grain quality than Euro but not as susceptible to stem rust. It has bright, plump grain suitable for the milling industry and specialised feed end-uses. Seednet is the commercial partner.

Yallara is a Euro look alike with improved leaf rust resistance. It is resistant but intolerant to CCN. It is moderately susceptible to BYDV, bacterial blight, and septoria. Yallara is susceptible and intolerant to stem nematode and susceptible to red leather leaf.

Yallara has excellent grain quality. It has high hectolitre weight, low screenings, and high groat percent. The grain is plump and bright and could suit niche markets like the horse racing industry in addition to human consumption. Yallara was evaluated for hay production and hay yield is similar to popular hay varieties with excellent hay quality.

Yallara Fact Sheet based on National Oat Breeding Program results available from Seednet - http://www.seednet.com.au/documents/Yallara_Factsheet_Aug_2013.pdf

Mitika$^{\Phi}$

Mitika is a dwarf milling oat commercialised in 2005 by Heritage Seeds. It is earlier maturing than Possum and Echidna and this trait favours Mitika in a dry finish.

Mitika is moderately resistant to leaf rust. It has improved resistance to bacterial blight and is superior to Echidna for septoria resistance. Mitika is similar to Echidna for BYDV and red leather leaf resistance. It is very susceptible and intolerant to cereal cyst nematode (CCN) and moderately intolerant of stem nematode (SN) and is not recommended in areas where either of these nematodes are a problem.

Mitika has high hectolitre weight, low screenings, and high groat percent compared to Echidna. It also has higher levels of β-glucan than current varieties. Mitika also has improved feed quality with low husk lignin and high grain digestibility.
Heritage Seeds brochure based on National Oat Breeding Program results available at – https://www.heritageseeds.com.au/fieldcrops/varieties/oats/productname.htm

Trial plots at Turretfield showing the dry finish to the season at this site in 2017.

Table 4. Average grain yield (t/ha) in four states and the average for all states for twelve oat varieties and two breeder's lines (2013 to 2017). Data courtesy National Oat Breeding Program, NVT Programs in SA, Vic and NSW and CVT Program in WA. Analysis by Jess Meza, Centre for Bioinformatics and Biometrics (CBB)

Variety	State				All Zones
	NSW	SA	VIC	WA	
Bannister	3.9	3.9	4.6	4.2	4.1
Carrolup (tall)	3.2	3.0	3.8	3.5	3.4
Durack (tall)	3.4	3.2	3.6	3.4	3.4
Echidna	3.6	3.7	4.2	3.9	3.8
Kojonup	3.5	3.6	4.1	3.9	3.8
Kowari	3.7	3.7	4.0	3.7	3.8
Mitika	3.6	3.6	3.9	3.6	3.7
Possum	3.6	3.6	4.1	3.8	3.7
05096-32 (tall)	3.2	3.0	3.6	3.5	3.3
06204-16	3.8	3.9	4.3	4.0	4.0
Wandering	4.0	3.7	4.4	4.1	4.0
Williams (tall)	3.7	3.7	4.4	4.2	4.0
Wombat	3.6	3.6	4.2	4.0	3.8
Yallara (tall)	3.3	3.0	3.7	3.5	3.4
No. trials	*35*	*45*	*27*	*56*	*163*

Table 5. Average grain yield (t/ha) by site in South Australia for twelve oat varieties and two breeder's lines (2013 to 2017). Data courtesy National Oat Breeding Program, NVT Programs in SA, Vic and NSW and CVT Program in WA. Analysis by Jess Meza, Centre for Bioinformatics and Biometrics (CBB)

	South Australia					
Variety	Lower EP	Upper EP	Yorke Peninsula	Mid North	South East	Murray Mallee
Bannister	2.9	2.2	4.4	4.4	4.2	1.7
Carrolup (tall)	1.4	1.9	2.9	3.4	3.5	1.0
Durack (tall)	2.6	1.5	3.3	3.6	3.6	1.4
Echidna	2.2	2.1	4.2	4.1	3.9	1.5
Kojonup	3.2	2.3	4.0	4.0	3.8	1.4
Kowari	3.4	1.8	4.2	4.1	4.0	1.6
Mitika	3.2	1.8	4.1	4.0	3.8	1.5
Possum	3.0	1.9	3.9	4.0	3.9	1.3
05096-32 (tall)	1.2	1.5	2.9	3.3	3.4	1.5
06204-16	3.7	2.0	4.5	4.3	4.1	1.7
Wandering	1.2	1.5	3.9	4.0	4.1	2.0
Williams (tall)	3.0	2.1	4.0	4.2	4.0	1.7
Wombat	2.7	2.3	4.0	4.1	3.9	1.3
Yallara (tall)	1.3	1.5	2.9	3.4	3.5	1.3
No. trials	*1*	*1*	*5*	*18*	*15*	*5*

Table 6. Average grain yield (t/ha) by site in Victoria for twelve oat varieties and two breeder's lines (2013 to 2017). Data courtesy National Oat Breeding Program, NVT Programs in SA, Vic and NSW and CVT Program in WA. Analysis by Jess Meza, Centre for Bioinformatics and Biometrics (CBB)

Variety	Victoria		
	North Central	North East	South West
Bannister	4.5	4.5	4.7
Carrolup (tall)	3.7	4.0	3.8
Durack (tall)	3.4	3.7	3.7
Echidna	4.0	4.2	4.3
Kojonup	3.9	4.2	4.3
Kowari	3.9	4.0	4.3
Mitika	3.7	3.9	4.1
Possum	3.9	4.1	4.2
05096-32 (tall)	3.4	3.8	3.6
06204-16	4.1	4.2	4.5
Wandering	4.4	4.4	4.4
Williams (tall)	4.3	4.5	4.5
Wombat	4.1	4.3	4.4
Yallara (tall)	3.6	3.8	3.7
No. trials	*10*	*9*	*8*

Table 7. Average grain yield (t/ha) by site of New South Wales for twelve oat varieties and two breeder's lines (2013 to 2017). Data courtesy National Oat Breeding Program, NVT Programs in SA, Vic and NSW and CVT Program in WA. Analysis by Jess Meza, Centre for Bioinformatics and Biometrics (CBB)

Variety	New South Wales		
	North East	South East	South West
Bannister	3.0	4.0	4.0
Carrolup (tall)	2.9	3.2	3.2
Durack (tall)	3.0	3.4	3.4
Echidna	2.9	3.8	3.7
Kojonup	2.8	3.5	3.6
Kowari	3.0	3.9	3.8
Mitika	3.0	3.7	3.7
Possum	3.0	3.7	3.7
05096-32 (tall)	2.9	3.3	3.3
06204-16	3.0	4.0	4.0
Wandering	3.2	4.2	4.0
Williams (tall)	3.0	3.8	3.8
Wombat	2.9	3.7	3.7
Yallara (tall)	3.0	3.4	3.3
No. trials	*5*	*17*	*13*

Table 8. Average grain yield (t/ha) by site for Western Australia for twelve oat varieties and two breeder's lines (2013 to 2017). Data courtesy National Oat Breeding Program, NVT Programs in SA, Vic and NSW and CVT Program in WA. Analysis by Jess Meza, Centre for Bioinformatics and Biometrics (CBB)

Variety		Western Australia			
	Agzone 2	Agzone 3	Agzone 4	Agzone 5	Agzone 6
Bannister	4.3	4.5	3.8	3.6	4.4
Carrolup (tall)	3.5	4.0	3.0	2.9	3.4
Durack (tall)	3.5	3.8	2.7	2.8	3.4
Echidna	3.9	4.1	3.9	3.1	4.0
Kojonup	3.9	4.3	3.3	3.2	4.2
Kowari	3.8	3.9	3.3	3.1	4.0
Mitika	3.7	3.8	3.3	2.9	3.9
Possum	3.8	4.0	3.2	3.2	4.0
05096-32 (tall)	3.5	4.0	3.0	2.7	3.1
06204-16	4.0	4.1	3.5	3.3	4.3
Wandering	4.2	4.3	3.8	3.5	3.8
Williams (tall)	4.3	4.7	3.4	3.5	4.3
Wombat	4.0	4.2	3.5	3.3	4.2
Yallara (tall)	3.5	3.9	2.9	2.8	3.2
No. trials	*27*	*15*	*3*	*6*	*5*

Table 9. Average physical and chemical grain quality (measured using NIR) characteristics for twelve oat varieties and two breeder's lines (combined SA, WA and NSW data), 2008 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB

Variety	Hectolitre weight kg/hl	1000 grain weight g	Screenings %<2 mm*	NIR Protein %	NIR Oil %	NIR Groat %	Minolta L
Bannister	48.9	34.2	8.8	10.6	7.7	71.1	59.4
Carrolup (tall)	50.3	34.0	10.8	11.9	6.3	72.6	60.0
Durack (tall)	51.1	33.8	9.8	11.9	6.9	72.1	60.1
Echidna	47.1	32.1	12.8	10.9	6.6	70.6	60.6
Kojonup	48.6	36.2	6.7	12.3	7.1	73.6	57.6
Kowari	47.8	34.4	8.0	11.9	6.4	74.1	60.5
Mitika	49.5	36.5	6.1	12.0	7.1	72.9	57.7
Possum	47.7	34.9	6.2	11.5	6.4	71.8	58.8
05096-32 (tall)	50.6	34.2	6.4	10.3	4.7	71.0	61.1
06204-16	48.7	36.6	9.1	11.8	6.3	73.6	62.0
Wandering	47.5	34.3	9.1	11.4	6.8	70.9	61.1
Williams (tall)	47.6	32.6	12.1	10.8	7.3	69.6	60.7
Wombat	48.0	33.3	11.3	11.3	6.8	73.3	60.3
Yallara (tall)	49.9	34.4	6.5	10.7	5.4	74.7	62.2
No. trials	*78*	*60*	*78*	*76*	*76*	*76*	*77*

Table 10. Average hectolitre weight (kg/hl) in three states and the average for all states for twelve oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All Zones
Bannister	49.7	48.5	50.3	49.0	48.9
Carrolup (tall)	52.3	50.4	51.4	49.7	50.3
Durack (tall)	53.5	51.1	51.7	50.5	51.1
Echidna	47.2	46.6	49.2	47.3	47.1
Kojonup	48.5	47.4	49.5	47.9	47.8
Kowari	50.4	48.4	49.4	48.3	48.6
Mitika	51.5	49.3	50.3	49.2	49.5
Possum	49.4	47.8	48.8	47.1	47.7
05096-32 (tall)	51.6	50.0	52.6	50.8	50.6
06204-16	50.4	48.5	49.8	48.5	48.7
Wandering	47.5	47.3	49.8	47.6	47.5
Williams (tall)	48.5	47.0	49.4	47.8	47.6
Wombat	49.3	48.0	49.5	47.6	48.0
Yallara (tall)	51.9	50.0	50.7	49.3	49.9
No. trials	*8*	*34*	*2*	*34*	*78*

Table 11. Average 1000 grain weight (g) in three states and the average for all states for twelve oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All zones
Bannister	33.7	32.6	37.3	37.1	34.2
Carrolup (tall)	34.4	33.5	35.8	34.4	34.0
Durack (tall)	34.3	33.6	35.2	33.8	33.8
Echidna	31.8	31.4	34.1	33.2	32.1
Kojonup	34.7	33.8	36.4	35.4	34.4
Kowari	36.2	35.5	37.3	37.3	36.2
Mitika	37.0	35.7	38.4	37.8	36.5
Possum	34.8	34.0	36.6	36.3	34.9
05096-32 (tall)	34.6	33.6	36.0	34.7	34.2
06204-16	36.8	36.0	37.5	37.6	36.6
Wandering	35.0	32.7	38.7	36.6	34.3
Williams (tall)	32.0	31.4	35.2	34.9	32.6
Wombat	33.6	33.0	34.7	33.5	33.3
Yallara (tall)	34.9	34.0	36.0	34.6	34.4
No. trials	*8*	*33*	*2*	*17*	*60*

Table 12. Average screenings percent (% < 2mm) in three states and an average for all states for twelve oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All Zones
Bannister	6.3	8.9	3.8	9.6	8.8
Carrolup (tall)	8.0	9.1	5.4	13.4	10.8
Durack (tall)	7.4	8.6	5.5	11.8	9.8
Echidna	9.4	12.1	5.5	14.6	12.8
Kojonup	5.4	7.2	3.8	9.7	8.0
Kowari	4.5	6.2	3.7	7.8	6.7
Mitika	3.4	5.6	3.1	7.6	6.1
Possum	4.1	5.9	3.4	7.2	6.2
05096-32 (tall)	3.6	6.0	2.6	7.6	6.4
06204-16	6.8	8.0	4.5	10.9	9.1
Wandering	5.5	9.2	3.0	10.1	9.1
Williams (tall)	9.5	12.4	4.9	12.9	12.1
Wombat	9.5	9.9	5.7	13.4	11.3
Yallara (tall)	5.1	5.8	3.8	7.6	6.5
No. trials	*8*	*34*	*2*	*34*	*78*

Table 13. Average NIR protein (% dm) in four states and the average for all states for twelve oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All Zones
Bannister	10.8	11.1	10.8	10.2	10.6
Carrolup (tall)	12.4	12.3	12.2	11.3	11.9
Durack (tall)	12.4	12.3	12.4	11.2	11.9
Echidna	11.2	11.3	11.2	10.4	10.9
Kojonup	12.5	12.3	12.3	11.3	11.9
Kowari	13.0	12.8	12.8	11.7	12.3
Mitika	12.6	12.5	12.5	11.4	12.0
Possum	12.0	11.9	11.9	11.0	11.5
05096-32 (tall)	10.5	10.7	10.4	9.9	10.3
06204-16	12.3	12.2	12.2	11.2	11.8
Wandering	11.8	11.8	11.7	10.9	11.4
Williams (tall)	11.1	11.2	11.0	10.3	10.8
Wombat	11.7	11.7	11.5	10.8	11.3
Yallara (tall)	10.9	11.1	10.9	10.2	10.7
No. trials	*8*	*32*	*2*	*34*	*76*

Table 14. Average NIR oil (% dm) in four states and the average for all states for twelve oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All Zones
Bannister	7.9	7.8	8.1	7.5	7.7
Carrolup (tall)	6.2	6.4	6.7	6.2	6.3
Durack (tall)	6.9	7.0	7.3	6.7	6.9
Echidna	6.6	6.7	7.0	6.5	6.6
Kojonup	6.3	6.5	6.8	6.2	6.4
Kowari	7.1	7.2	7.5	6.9	7.1
Mitika	7.1	7.2	7.5	6.9	7.1
Possum	6.3	6.5	6.8	6.2	6.4
05096-32 (tall)	4.4	4.8	5.3	4.7	4.7
06204-16	6.2	6.4	6.7	6.2	6.3
Wandering	6.8	7.0	7.2	6.7	6.8
Williams (tall)	7.4	7.5	7.7	7.1	7.3
Wombat	6.8	6.9	7.2	6.6	6.8
Yallara (tall)	5.2	5.5	5.9	5.4	5.4
No. trials	*8*	*32*	*2*	*34*	*76*

Table 15. Average NIR groat percent in four states and the average for all states for thirteen oat varieties and two breeder's lines (2008 to 2017). Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	State				
	NSW	SA	VIC	WA	All Zones
Bannister	71.6	71.0	72.6	70.9	71.1
Carrolup (tall)	73.3	72.8	73.7	72.1	72.6
Durack (tall)	73.6	72.4	72.5	71.3	72.1
Echidna	71.4	70.3	71.5	70.6	70.6
Kojonup	75.0	74.2	74.9	73.8	74.1
Kowari	74.9	73.9	74.4	73.0	73.6
Mitika	74.2	73.1	73.7	72.3	72.9
Possum	73.5	72.5	72.5	70.6	71.8
05096-32 (tall)	71.8	71.3	72.3	70.4	71.0
06204-16	75.0	73.7	73.9	73.2	73.6
Wandering	71.1	70.4	72.0	71.1	70.9
Williams (tall)	70.6	69.2	70.3	69.8	69.6
Wombat	74.3	73.6	74.3	72.8	73.3
Yallara (tall)	76.1	75.5	75.9	73.6	74.7
No. trials	*8*	*32*	*2*	*34*	*76*

Table 16. NIR measured Minolta L (2008-2017) and hull lignin characteristics for twelve oat varieties and two breeder's lines. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB

Variety		State				Hull lignin
	NSW	SA	VIC	WA	All zones	
Bannister	58.5	60.3	60.7	58.6	59.4	High
Carrolup (tall)	59.1	60.9	61.5	59.1	60.0	High
Durack (tall)	59.3	61.1	61.6	59.3	60.1	High
Echidna	59.8	61.6	62.3	59.7	60.6	High
Kojonup	59.6	61.5	62.2	59.6	60.5	High
Kowari	56.7	58.5	58.3	57.0	57.6	Low
Mitika	56.8	58.5	58.4	57.0	57.7	Low
Possum	57.9	59.7	59.9	58.0	58.8	High
05096-32 (tall)	60.3	62.2	63.0	60.2	61.1	High
06204-16	61.2	63.1	64.3	61.0	62.0	High
Wandering	60.3	62.1	63.0	60.1	61.1	High
Williams (tall)	59.8	61.7	62.4	59.8	60.7	High
Wombat	59.5	61.3	62.0	59.5	60.3	High
Yallara (tall)	61.4	63.3	64.5	61.2	62.2	Mod high
No. trials	*8*	*33*	*2*	*34*	*77*	-

Table 17. Stem rust and leaf rust reactions for twelve grain varieties and two breeder's lines in South Australia and Victoria and in New South Wales.

	SA and Victoria		New South Wales	
Variety	Stem rust[1] Field	Leaf rust[1] Field	Stem rust[1] Field	Leaf rust[1] Field
Bannister	MR-S	R	MS-S	MR-S
Carrolup (tall)	S	VS	S	S-VS
Durack (tall)	S	R-S	R-S	MR-MS
Echidna	S	S	S	S
Kojonup	S	VS	S	MS-VS
Kowari	MR-S	R	MR-S	MS-S
Mitika	MR-S	MS	S	MS-S
Possum	MS-S	MS	MR-S	MR
05096-32	R-S	MS-S	-	-
06204-16	S	R	-	-
Wandering	S	VS	S	VS
Williams (tall)	MR-S	R	MR	MR
Wombat	MS-S	MS	MS-S	MS-S
Yallara (tall)	MR-S	R	MR-MS	MS-S

[1] Disease reactions from field trials conducted in SA, Victoria and New South Wales where R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible. Rust reactions may vary in different regions depending on the prevailing pathotypes. None of these varieties are resistant to the Pga virulent pathotype of stem rust which can be found in New South Wales, Victoria and parts of South Australia.

Table 18. Stem rust, leaf rust, BYDV and septoria reactions for twelve grain varieties and two breeder's lines in Western Australia.

	Western Australia			
Variety	**Stem rust[1] Field**	**Leaf rust[1] Field**	**BYDV[2] Field**	**Septoria[1] Field**
Bannister	R-MS	R	MR-MS	S
Carrolup (tall)	MS-S	S-VS	MS-S	S-VS
Durack (tall)	MS	R-S	MS-S	S-VS
Echidna	S	S	MS	S-VS
Kojonup	MS-S	S-VS	MS	S-VS
Kowari	MR-MS	R	MS	S-VS
Mitika	MR-MS	MR	S	S-VS
Possum	MR-S	MR	MS-S	S-VS
05096-32 (tall)	R-MS	R-MR	MS	MR-MS
06204-16	MS-VS	R	MR-MS	S
Wandering	MS-VS	VS	MS	S-VS
Williams (tall)	MR	R-MR	MR-MS	MR-MS
Wombat	MR-MS	S	MS	S
Yallara (tall)	MR-MS	R-MS	MS	S

[1] Disease reactions from field trials conducted in WA where R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible. Rust reactions may vary in different regions depending on the prevailing pathotypes.

Table 19. Septoria, bacterial blight, CCN, stem nematode and red leather leaf (spermospora) disease reactions for twelve grain varieties and two breeder's lines grown in South Australia and Victoria.

Variety	**Septoria[1]**	**Bacterial blight[1]**	**Red leather leaf[1]**	**CCN R[1]**	**CCN T[2]**	**Stem Nematode[2]**
Bannister	-	MR-S	MS	R	MI	MI
Carrolup (tall)	MR	MR-S	S	S	I	VI
Dunnart	MS	MR-S	MS	R	MT	MT
Durack (tall)	MS	MR-S	MS	R	MI-MT	I
Echidna	S	S	MS	S	I	MT
Kojonup	MR	MS-S	MS	VS	I	MI
Kowari	S	MR	S	VS	I	I
Mitika	S	MR	MS-S	VS	I	I
Possum	S	S	MS	VS	I	I
05096-32 (tall)	-	MR	-	S	-	MI
06204-16	-	MS	-	S	-	-
Wandering	S	MR-S	MS	VS	I	I
Williams (tall)	-	R	MS	S	I	I
Wombat	MS	MS	MS	R	MT	MT
Yallara (tall)	MS	MR-MS	MS	R	I	I

[1] Disease reactions where R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible, [2] T=tolerant, MT= moderately tolerant, MI=moderately intolerant, I=intolerant

6. Long term hay trial results

Tables 20 to 27 show the long term hay yield, grain yield and hay quality of varieties in the hay series. Tables 28 and 29 show the disease reactions of current and new hay varieties in SA, Victoria and WA. **Please note:** Stem and leaf rust reactions reported for all oat varieties will vary by region due to genetic variation in the pathogen population. A pathotype that overcomes most resistance genes for stem rust is now present in southern Australia. Hence it is important to monitor oat crops for early detection of rust, so fungicide applications can be applied to control the diseases. Grain quality data is a simple mean for the five year period 2010-2014. Table 30 to 32 show grain quality for hay varieties.

The Breeding Program sincerely thanks AEXCO for funding the analysis of our hay yield and quality data and for their support of our breeding program.

6.1 Hay Variety Summary

Forester$^{\Phi}$

Forester is a very late hay variety adapted to high rainfall and irrigated cropping regions that was released in 2012. It is seven to 10 days later than Glider, three days later than Riel, two days later than Targa, and three weeks later than Wintaroo. Forester has excellent early vigour and is an improvement compared to Glider. It has excellent lodging and shattering resistance.

Forester has an excellent foliar disease resistance spectrum. It is moderately susceptible to CCN. It has good hay colour, but like all late hay varieties may not resist hot dry winds as well as earlier varieties. Forester has excellent hay quality and is an improvement compared to Glider, Tammar, Targa, and Vasse, but similar to Riel.

Seed of Forester is available from AGF Seeds, Smeaton, Victoria.

Tammar$^{\Phi}$

Tammar is a medium tall late variety that was released in 2012 and commercialised by AEXCO. It is four to seven days later than Tungoo to cut. Tammar also has an excellent disease resistance profile. It is moderately resistant to stem and leaf rust, septoria, BYDV, and bacterial blight. Tammar is the first late variety available with resistance to CCN and SN, tolerance to CCN, and moderate tolerance to SN.

Tammar has improved hay quality compared to Kangaroo. It has high crude protein and hay digestibility with lower WSC than Mulgara and Brusher, but higher than Kangaroo.

Mulgara$^{\Phi}$

Mulgara was released in 2009 and commercialised by AEXCO. It is a tall mid season variety with excellent early vigour and good straw strength. Hay yield is lower than Wintaroo, but hay quality is better than Wintaroo. Mulgara also retains good hay colour and resists brown leaf tipping. Grain yield is similar to Wintaroo, but Mulgara has slightly better grain quality with the exception of high

hull lignin. The seed size of Mulgara is larger than other hay varieties and similar to Swan. Care should be taken to sow this variety at the correct seed density taking into account its seed weight.

Mulgara has excellent disease resistance. It is resistant and tolerant to CCN and SN. Compared to Wintaroo, Mulgara has improved leaf rust, bacterial blight, and red leather leaf resistance.

Tungoo[Φ]

Tungoo was released in 2010. It is a medium tall mid to late season variety and seed is available through AEXCO. Tungoo has an excellent disease resistance profile. It combines resistance and moderate tolerance to CCN and SN. It also is resistant to leaf rust and the only variety with red leather leaf resistance. Tungoo is moderately resistant to BYDV, septoria, and bacterial blight and moderately susceptible to stem rust. It has the best combination of disease resistance compared to all other varieties except Tammar.

Hay yield is slightly lower than Kangaroo, but Tungoo's hay quality is an improvement compared to Kangaroo. Tungoo has grain quality similar to Kangaroo, but the grain size is smaller resulting in higher screenings. Tungoo has low hull lignin which improves feed grain quality.

Brusher[Φ]

Brusher is an early-mid season hay variety commercialised by AEXCO. Brusher is a tall line about three to seven days earlier to head than Wintaroo. It has good early vigour, but slightly less than Wintaroo. Brusher has excellent hay yield in low to medium rainfall zones and has consistently had excellent hay quality to match the yield. Brusher is an improvement compared to Wintaroo for hay quality, stem rust, leaf rust, bacterial blight and septoria resistance. It is resistant but moderately intolerant to CCN and stem nematode. Brusher has proved to be a popular variety in the earlier regions of SA, WA, and VIC.

Yallara[Φ] *and Durack*[Φ]

See section 5.1

Pamela addressing the 2018 AFIA conference held at the Adelaide Convention Centre in August, 2018.

Table 20. Average hay yield (t/ha) for twenty one oat varieties and one breeder's line in three states during the period 2005 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	9.6	10.0	8.4	8.4	9.0
Brusher	9.9	10.0	8.6	8.7	9.2
Carrolup	9.8	9.7	8.7	7.9	8.8
Durack	9.4	9.3	7.7	7.0	8.2
Mulgara	9.7	9.9	8.5	8.5	9.1
Swan	9.7	10.3	8.3	8.9	9.4
Wallaroo	9.6	9.9	8.5	8.1	8.9
Wandering	9.6	10.0	8.4	8.2	9.0
Williams	9.7	9.6	8.3	7.9	8.7
Winjardie	9.5	9.9	8.7	8.5	9.1
Wintaroo	10.0	10.5	8.9	9.3	9.7
Yallara	9.6	10.2	8.5	8.1	9.1
05096-32	9.6	9.7	8.2	8.0	8.8
Mid-Late to Very Late Varieties					
Eurabbie	9.2	9.5	8.4	8.2	8.8
Forester	9.7	9.6	8.6	8.3	8.9
Glider	9.5	9.7	8.2	8.0	8.8
Kangaroo	9.4	10.0	8.1	8.6	9.1
Riel	9.6	9.8	8.2	7.9	8.8
Tammar	9.2	10.1	8.5	8.4	9.1
Targa	9.6	9.7	8.3	7.7	8.7
Tungoo	9.3	10.0	8.4	8.5	9.1
Vasse	9.7	10.8	8.8	8.9	9.6
No. sites	*4*	*36*	*21*	*32*	*93*

Table 21. Average grain yield (t/ha) from hay trials for twenty one oat varieties and one breeder's linesin three states during the period 2008 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties				
Bannister	4.0	3.5	3.7	3.7
Brusher	3.1	2.4	2.8	2.6
Carrolup	3.4	2.9	3.1	3.1
Durack	3.7	3.1	3.3	3.1
Mulgara	3.2	2.6	2.9	2.9
Swan	3.0	2.3	2.7	2.5
Wallaroo	3.1	2.5	2.8	2.7
Wandering	3.9	3.4	3.6	3.8
Williams	4.0	3.4	3.6	3.6
Winjardie	3.2	2.7	3.0	3.1
Wintaroo	3.1	2.6	2.9	2.9
Yallara	3.5	2.9	3.2	3.1
05096-32	3.3	2.8	3.1	3.2
Mid-Late to Very Late Varieties				
Eurabbie	3.5	2.9	3.2	3.1
Forester	2.5	1.7	2.1	1.7
Glider	2.8	2.1	2.5	2.2
Kangaroo	2.9	2.3	2.7	2.7
Riel	2.5	1.8	2.2	1.9
Tammar	3.1	2.5	2.9	2.6
Targa	2.7	1.9	2.3	2.0
Tungoo	2.8	2.1	2.6	2.2
Vasse	3.2	2.6	2.9	2.8
No. sites	*4*	*42*	*20*	*40*

Table 22. Average hay quality for seventeen oat varieties and one breeder's line for trials conducted in three states during the period 2013 to 2017 and for *two varieties tested in late hay trials in SA only. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	Digestibility (%dm)	WSC* (%dm)	ADF* (%dm)	NDF* (%dm)	Crude Protein (%dm)
Early – Mid Season Varieties					
Bannister	65.6	26.5	28.9	51.8	7.9
Brusher	64.0	26.1	30.4	52.6	7.4
Carrolup	62.0	25.1	30.9	52.7	7.5
Durack	62.3	23.6	31.0	53.3	7.7
Mulgara	63.8	26.1	30.7	52.6	7.5
Swan	62.9	24.9	30.9	54.0	7.4
Wallaroo	63.2	24.9	30.8	53.5	7.5
Wandering	64.8	25.1	29.6	52.0	7.9
Williams	62.5	23.1	30.7	53.8	8.3
Winjardie	63.8	25.2	30.5	53.6	7.5
Wintaroo	63.1	24.7	31.3	53.9	7.3
Yallara	63.8	27.5	30.1	51.3	7.3
05096-32	62.9	23.8	31.3	54.4	7.7
Mid-Late to Very Late Varieties					
Eurabbie	68.1	28.3	27.7	49.3	7.9
Forester	66.8	29.1	29.3	49.5	7.9
Glider*	63.0	23.3	30.9	53.0	8.2
Kangaroo	62.0	23.5	31.9	55.3	7.7
Riel*	65.2	22.4	28.9	50.0	7.9
Tammar	64.0	24.5	30.8	53.6	8.0
Tungoo	64.5	24.7	30.1	52.6	7.9
No. sites	*35*	*37*	*36*	*37*	*35*

*WSC=water soluble carbohydrates, ADF=acid detergent fibre, NDF=neutral detergent fibre

Table 23. Average hay digestibility (%dm) for nineteen oat varieties and one breeder's line in different states during the period 2013 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	61.6	65.1	66.5	67.9	65.6
Brusher	60.3	63.3	65.0	66.6	64.0
Carrolup	58.2	61.3	62.8	65.1	62.0
Durack	58.3	61.7	63.0	65.3	62.3
Mulgara	60.1	63.1	64.8	66.7	63.8
Swan	58.9	62.4	63.8	65.3	62.9
Wallaroo	59.3	62.5	64.1	65.7	63.2
Wandering	60.8	64.2	65.6	67.3	64.8
Williams	58.5	61.9	63.2	65.6	62.5
Winjardie	59.7	63.5	64.6	66.1	63.8
Wintaroo	59.2	62.6	64.1	65.4	63.1
Yallara	59.9	63.0	64.6	66.7	63.8
05096-32	59.1	62.1	63.8	65.7	62.9
Mid-Late to Very Late Varieties					
Eurabbie	64.7	67.3	69.5	70.3	68.1
Forester	63.5	65.8	68.3	69.2	66.8
Glider		63.0			
Kangaroo	58.0	61.4	62.7	65.0	62.0
Riel		65.2			
Tammar	60.2	63.3	64.9	66.7	64.0
Tungoo	60.9	63.8	65.7	67.0	64.5
No. sites	*4*	*15*	*10*	*6*	*35*

Table 24. Average hay water soluble carbohydrates (% dm) for nineteen oat varieties and one breeder's line in different states during the period 2013 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	23.1	24.1	26.8	31.4	26.5
Brusher	21.5	23.7	26.3	31.5	26.1
Carrolup	21.0	22.2	25.9	30.3	25.1
Durack	19.9	21.9	23.6	27.8	23.6
Mulgara	21.3	23.9	26.5	30.9	26.1
Swan	20.8	22.7	25.3	29.3	24.9
Wallaroo	20.2	22.9	25.0	29.6	24.9
Wandering	21.0	21.7	25.5	31.9	25.1
Williams	19.0	20.3	23.2	29.1	23.1
Winjardie	20.8	22.8	25.4	30.3	25.2
Wintaroo	19.8	22.2	25.3	29.8	24.7
Yallara	22.8	25.7	28.0	31.5	27.5
05096-32	19.8	21.9	24.3	28.0	23.8
Mid-Late to Very Late Varieties					
Eurabbie	24.5	25.8	28.2	33.7	28.3
Forester	26.1	26.6	30.2	33.2	29.1
Glider		23.3			
Kangaroo	18.6	21.1	24.0	28.6	23.5
Riel		22.4			
Tammar	19.9	22.0	25.2	29.5	24.5
Tungoo	21.2	22.6	24.7	29.2	24.7
No. sites	*3*	*15*	*10*	*9*	*37*

Table 25. Average hay ADF (% dm) for nineteen oat varieties and one breeder's line in different states during the period 2013 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	31.0	29.2	28.0	28.5	28.9
Brusher	32.7	30.6	29.5	29.8	30.4
Carrolup	33.4	31.3	30.0	30.0	30.9
Durack	33.0	31.4	30.1	30.0	31.0
Mulgara	33.5	31.2	29.7	29.5	30.7
Swan	33.2	31.0	30.1	30.5	30.9
Wallaroo	33.2	31.0	30.0	30.4	30.8
Wandering	32.3	30.1	28.5	28.3	29.6
Williams	33.1	31.1	29.8	29.7	30.7
Winjardie	32.9	30.8	29.7	30.0	30.5
Wintaroo	34.1	31.4	30.4	30.6	31.3
Yallara	32.1	30.4	29.2	29.4	30.1
05096-32	33.9	31.6	30.4	30.3	31.3
Mid-Late to Very Late Varieties					
Eurabbie	29.9	27.8	26.7	27.4	27.7
Forester	31.5	29.4	28.4	29.1	29.3
Glider		30.9			
Kangaroo	34.5	32.3	31.0	30.8	31.9
Riel		28.9			
Tammar	33.2	31.0	29.9	30.0	30.8
Tungoo	32.7	30.3	29.2	29.5	30.1
No. sites	*4*	*15*	*10*	*7*	*36*

Table 26. Average hay NDF (% dm) for nineteen oat varieties in different states and one breeder's line during the period 2013 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	55.6	52.7	50.8	49.3	51.8
Brusher	56.7	53.8	51.4	49.6	52.6
Carrolup	57.0	54.0	51.5	49.7	52.7
Durack	56.9	54.1	52.6	51.0	53.3
Mulgara	57.0	54.0	51.2	49.4	52.6
Swan	58.0	55.1	53.0	51.2	54.0
Wallaroo	57.6	54.7	52.5	50.7	53.5
Wandering	56.7	53.6	50.5	48.6	52.0
Williams	57.8	54.9	52.7	50.9	53.8
Winjardie	57.7	54.8	52.5	50.7	53.6
Wintaroo	58.3	55.3	52.7	50.7	53.9
Yallara	55.2	52.4	50.3	48.8	51.3
05096-32	58.5	55.6	53.4	51.5	54.4
Mid-Late to Very Late Varieties					
Eurabbie	53.5	50.6	47.9	46.5	49.3
Forester	53.1	50.3	48.5	47.3	49.5
Glider		53.0			
Kangaroo	59.6	56.6	54.1	52.0	55.3
Riel		50.0			
Tammar	57.7	54.8	52.5	50.7	53.6
Tungoo	56.5	53.6	51.5	49.9	52.6
No. sites	*4*	*15*	*10*	*8*	*37*

Table 27. Average hay crude protein (% dm) for nineteen oat varieties and one breeder's line in different states during the period 2013 to 2017. Data courtesy National Oat Breeding Program. Analysis by Jess Meza, CBB.

Variety	New South Wales	South Australia	Victoria	Western Australia	All States
Early – Mid Season Varieties					
Bannister	8.5	8.0	8.0	7.3	7.9
Brusher	7.2	7.6	7.4	7.1	7.4
Carrolup	7.9	7.7	7.5	7.1	7.5
Durack	7.6	7.9	7.5	7.7	7.7
Mulgara	7.6	7.6	7.6	7.0	7.5
Swan	7.4	7.6	7.4	7.1	7.4
Wallaroo	7.4	7.7	7.4	7.3	7.5
Wandering	8.2	8.1	7.9	7.5	7.9
Williams	8.4	8.5	8.1	8.0	8.3
Winjardie	7.9	7.6	7.6	6.9	7.5
Wintaroo	7.8	7.5	7.4	6.6	7.3
Yallara	7.8	7.5	7.2	7.0	7.3
05096-32	7.7	7.8	7.7	7.3	7.7
Mid-Late to Very Late Varieties					
Eurabbie	8.6	8.0	8.1	7.3	7.9
Forester	7.9	8.2	7.8	7.6	7.9
Glider		8.2			
Kangaroo	7.9	7.9	7.7	7.3	7.7
Riel		7.9			
Tammar	8.5	8.2	8.0	7.5	8.0
Tungoo	8.5	7.9	8.0	7.3	7.9
No. sites	*4*	*14*	*9*	*8*	*35*

Table 28. Disease reactions in SA and Victoria and comparative stem diameter for current and new hay variety releases.

DISEASE PROFILE

Variety	Stem rust[1]	Leaf rust[1]	BYDV[1]	Septoria[1]	Bacterial blight[1]	CCN R[1]	CCN T[2]	Stem Nematode R[1]	Stem Nematode T[2]	Red leather leaf[1]	Stem diameter[3]
Bannister	MR-S	R	MS	-	MR-S	R	MI	-	MI	MS	M
Brusher	MS-S	MR-MS	MS	MS	MR-MS	R	MI	MS	I	MS	M
Durack	S	R-S	MS	MS	MR-S	R	MI/MT	-	I	MS	M
Forester	R-S	MR-MS	MR-S	MR	MS-S	MS	MI	S	I	R-MR	MT
Kangaroo	MS-S	MS	MR-S	MR-MS	MR-MS	R	MT	MS	MI	MS	MF
Mulgara	MS-S	MR	MS	MS	MR	R	MT	R	MT	MS	M
Tammar	MR-S	MR	MS	MR	MR	MR	MT	R	MT	R-MS	MF
Tungoo	MS-S	MR	MR-MS	MR	MR	R	MT	R	MT	R	M
Wallaroo	S	S	MS	S	S	R	MT	MS	MI	MS	F
Wandering	MR-S	VS	MR-MS	S-VS	MR-S	VS	I	VS	I	MS	M
Williams	MR-S	R	MR-MS	-	R	S	I	-	I	MS	MT
Wintaroo	S	MS	MS	MR-MS	MR	R	MT	MR	MT	MS	M
Yallara	MR-S	R	MS	MS	MR-MS	R	I	S	I	MS	MF
05096-32	R-S	MS-S	MS-S	-	MR	S	-	-	MI	-	MF

[1] Disease reactions where R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible

[2] T=tolerant, MT= moderately tolerant, MI=moderately intolerant, I=intolerant

[3] F=fine, MF=moderately fine, MT=moderately thick, T=thick, VT=very thick

(Rust and BYDV 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 29. Disease reactions in WA and comparative stem diameter.

DISEASE PROFILE

Variety	Stem rust[1]	Leaf rust[1]	BYDV[1]	Septoria[1]	Bacterial blight[1]	CCN R[1]	CCN T[2]	Red leather leaf[1]	Stem diameter[3]
Brusher	MR-S	R-MS	MR-MS	S-VS	MR-MS	R	MI	MS	M
Carrolup	MS	S	MS	S-VS	MR-S	S	I	S	M
Durack	MR-MS	R-S	MS	S-VS	MR-S	R	MI/MT	MS	M
Forester	R	R-MS	MS	MS-S	MS-S	MS	MI	R-MR	MT
Kangaroo	R-S	MS-S	MR-S	MS-S	MR-MS	R	MT	MS	MF
Mulgara	MR-MS	MR	MS-S	MR-S	MR	R	MT	MS	M
Tammar	R-MR	R-MR	MS-S	MS	MR	MR	MT	R-MS	MF
Tungoo	MR-S	R-MS	MR-MS	MS-S	MR	R	MT	R	M
Wallaroo	MS-S	VS	MS	S-VS	S	R	MT	MS	F
Wandering	MR	VS	MS-S	S-VS	MR-S	VS	I	MS	M
Williams	MR	R-MR	MR-MS	MR-MS	R	S	I	MS	MT
Winjardie	MR-S	S-VS	MS-S	S-VS	S	S	I	MS	M
Wintaroo	MR	S-VS	MS	MS-S	MR	R	MT	MS	M
Yallara	MR-MS	R-MS	MS	S	MR-MS	R	I	MS	MF
05096-32	R-MS	R-MR	MS	MR-MS	MR	S	-	-	MF

[1] Disease reactions where R= resistant, MR=moderately resistant, MS=moderately susceptible, S= susceptible, VS=very susceptible

[2] T=tolerant, MT= moderately tolerant, MI=moderately intolerant, I=intolerant [3] F=fine, MF=moderately fine, MT=moderately thick, T=thick, VT=very thick

Note: Stem rust, leaf rust, BYDV & Septoria reactions are from WA trials, Bacterial blight, CCN & red leather leaf reactions are from SA trials

(Rust and BYDV 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 30. Average physical grain quality characteristics for twenty one hay oat varieties and one breeder's line (combined SA, Victoria, NSW and WA data), 2010 to 2017. Data are unanalysed means from hay trials with two replicates per trial tested courtesy National Oat Breeding Program.

Variety	Hectolitre weight kg/hl	1000 grain weight g	Screenings %<2 mm	*No. obs.*
Early – Mid Season Varieties				
Bannister	50.2	33.5	10.7	*76*
Brusher	46.8	33.2	11.0	*123*
Carrolup	51.8	32.7	12.8	*124*
Durack	53.8	35.7	4.8	*27*
Mulgara	47.8	35.5	9.2	*124*
Swan	48.4	36.7	12.1	*120*
Wallaroo	47.3	34.0	14.6	*122*
Wandering	48.9	32.4	11.4	*119*
Williams	48.3	30.3	16.5	*122*
Winjardie	45.4	31.9	15.3	*122*
Wintaroo	47.5	33.6	14.6	*123*
Yallara	51.3	32.8	8.8	*114*
05096-32	51.5	32.3	6.5	*81*
Mid-Late to Very Late Varieties				
Eurabbie	45.2	29.0	14.7	*160*
Forester	44.1	32.1	8.8	*54*
Glider	41.2	31.2	14.8	*48*
Kangaroo	45.6	32.1	13.8	*66*
Riel	45.6	25.7	29.3	*36*
Tammar	44.8	29.6	20.6	*68*

Targa	44.6	33.3	12.9	*14*
Tungoo	46.3	29.7	16.6	*72*
Vasse	42.5	31.4	16.9	*26*

Table 31. Average chemical grain quality (measured using NIR) characteristics for twenty one hay oat varieties and one breeder's line (combined SA, Victoria, NSW and WA data), 2010 to 2017. Data are unanalysed means from hay trials with two replicates per trial tested courtesy National Oat Breeding Program.

Variety	NIR Protein %	NIR Oil %	NIR Groat %	*No. obs.*
Early – Mid Season Varieties				
Bannister	11.2	8.2	72.1	*76*
Brusher	12.2	6.9	72.2	*123*
Carrolup	12.6	6.5	73.5	*124*
Mulgara	13.0	7.6	74.8	*27*
Swan	13.5	7.0	73.9	*124*
Durack	11.5	6.7	71.2	*120*
Wallaroo	12.0	7.6	71.3	*122*
Wandering	12.0	7.0	71.3	*119*
Williams	11.7	7.5	70.2	*122*
Winjardie	10.8	5.8	71.2	*122*
Wintaroo	12.3	7.4	71.4	*123*
Yallara	11.6	5.8	75.6	*114*
05096-32	11.4	4.9	72.5	*81*
Mid-Late to Very Late Varieties				
Eurabbie	12.0	6.0	69.2	*160*
Forester	12.9	6.1	69.3	*54*
Glider	13.8	5.7	69.0	*48*
Kangaroo	12.1	6.2	71.3	*66*
Riel	12.3	6.0	70.0	*36*

Tammar	13.1	6.7	71.8	*68*
Targa	13.4	6.4	66.3	*14*
Tungoo	13.0	6.7	71.1	*72*
Vasse	12.6	6.1	68.6	*26*

Table 32. NIR measured Minolta L, estimated metabolisable energy and hull lignin (2010-2017) characteristics for twenty one hay oat varieties and one breeder's line (combined SA, Victoria, WA and NSW data). Data are unanalysed means from hay trials with two replicates per trial tested courtesy National Oat Breeding Program.

Variety	**Minolta L**	**Estimated ME MJ/kg dm**	**Hull lignin**	***No. obs.***
Early – Mid Season Varieties				
Bannister	61.4	11.9	10.0 (High)	*76*
Brusher	59.7	12.5	4.7 (Low)	*123*
Carrolup	62.1	11.7	11.0 (High)	*124*
Mulgara	60.0	11.8	10.9 (High)	*27*
Swan	62.7	12.2	4.4 (Low)	*124*
Durack	59.7	12.4	10.6 (High)	*120*
Wallaroo	59.2	12.5	4.8 (Low)	*122*
Wandering	63.4	11.7	10.7 (High)	*119*
Williams	62.9	11.6	11.5 (High)	*122*
Winjardie	60.5	12.4	3.6 (Low)	*122*
Wintaroo	60.2	12.6	4.7 (Low)	*123*
Yallara	64.3	11.7	11.0 (High)	*114*
05096-32	63.2	11.8	9.6 (High)	*81*
Mid-Late to Very Late Varieties				
Eurabbie	59.9	12.2	4.3 (Low)	*160*
Forester	62.8	11.8	8.2 (High)	*54*
Glider	61.3	12.1	5.1 (Low)	*48*
Kangaroo	61.6	11.7	10.5 (High)	*66*
Riel	62.6	12.1	6.9 (Low)	*36*

Tammar	60.1	12.3	5.7 (Low)	*68*
Targa	63.2	12.0	8.7 (High)	*14*
Tungoo	61.3	12.4	5.3 (Low)	*72*
Vasse	61.3	11.8	8.9 (High)	*26*