SECTION A

Introduction

A.1 Crop overview

Barley (*Hordeum vulgare*) is a widely grown and highly adaptable winter cereal crop that is used mainly for stock feed and the production of malt for the brewing industry.

Barley (Figure 1) is an annual plant that has been selected from wild grasses. It is thought to have been an important food crop from as early as 8000 BCE (Before Common Era) in the Mediterranean–Middle East region.

Because of barley's tolerance of salinity, by 1800 BCE it had become the dominant crop in irrigated regions of southern Mesopotamia, and it was not until the early CE period that wheat became more widely grown.

Figure 1: Barley has long been an important food crop. (Photo: Rachel Bowman)

Over the past 5 years, Australian barley farmers produced an average of 7.5 million tonnes (Mt) of grain per year, of which around two-thirds was exported.

Australia is the world's second-largest exporter of barley and supplies almost 30% of the world's barley trade. Saudi Arabia, Japan and China are large importers of Australian barley, and these markets are growing rapidly. [1]

Australia produces high-quality 2-row spring-type barley, with annual production averaging ~7.0 Mt/year. It is a widely grown crop (second only to wheat) and occupies

[1] N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

a large geographic area—almost 4 Mha, dispersed from Western Australia to southern Queensland.

Australia has an enviable reputation for producing a reliable supply of high-quality, contaminant-free barley that is sought after by the malting, brewing, distilling, shōchū (Japanese distilled spirit) and feed industries.

Australia produces around 2.5 Mt of malting barley and 4.5 Mt of feed barley; the average Australian malting selection rate is the highest of the world's exporting nations, with ~30–40% of the national crop selected as malting.

Domestically, malting barley demand is ~1 Mt/year and Australian domestic feed use ~2 Mt/year. Domestic brewers are tightly linked to Australia's barley production, and strong relationships exist between all facets of the industry, from breeder to brewer and all stages in between.

In addition, Australia exports around 1.5 Mt of malting barley and ~2.5 Mt of feed barley. Major exporting states are Western Australia and South Australia, where domestic demand for malting and feed barley is considerably smaller than in the eastern states.

Australia makes up >30% of the world's malting-barley trade and ~20% of the global feed-barley trade. On a production basis (as opposed to actual inter-country trade), Australia makes up ~5% of the world's annual barley production. [2]

Barley is very versatile in its planting time, being slightly more frost-tolerant (1°C) than wheat prior to ear emergence and at flowering, and can be planted earlier in the season. It is also often a better option than wheat for late planting, especially if feed-grain prices are good. Preferred planting times are from late April to mid-May but this will vary for each region depending on frosts and seasonal effects.

Early planting will generally produce higher yields, larger grain size and lower protein levels, making it more likely to achieve malt quality. However, early crops are more likely to have exposure to frost and growers should assess the frost risk for their area prior to sowing. Late plantings will often mature in hot dry weather, which can reduce grain size, yield and malting quality.

The major determinant of barley profitability is yield. [3] To maximise yield, it is important to ensure that the crop has every chance to succeed.[4]

Paddock selection and nitrogen (N) management are often the keys to producing malting quality. [5] Use adequate N fertiliser but do not over-fertilise because this will encourage excessive vegetative growth and could result in lodging, and excess protein levels (above malting requirements) if applied late. Phosphorus, zinc and sulfur levels are also important. A starter fertiliser is recommended.

Growers should record paddock rotations or use soil-testing to ensure adequate nutrition. To grow a barley crop of 4 t/ha at 11.5% protein requires 144 kg N/ha, and adequate phosphorus.

Inspect barley crops regularly for insect infestations and foliar diseases and consult your agronomist about potential control methods. [6]

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2 Barley Australia (2014) Industry information. Barley Australia, http://www.barleyaustralia.com.au/industry-information

3 DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

4 DAF Qld (2013) Barley planting and disease guide. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-disease-guide

5 P Matthews, D McCaffery, L Jenkins (2015) Winter crop variety sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

6 DAF Qld (2013) Barley planting and disease guide. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-disease-guide

Selecting a variety with proven performance in the region is important. If trying a new variety, it is important to compare it with a variety you have grown before. Factors to take into consideration for variety selection include:

- suitability of the variety for the region
- time of planting
- available moisture at planting
- disease risks
- yield potential
- standability and straw strength
- soil N status (i.e. starting N levels not high for malting barley)
- marketing options—malt *v.* feed
- rotation (past crops and future planting intentions)
- availability of seed [7]

Barley growers have access to a number of barley varieties. Identifying the variety that is best suited to a region and will give the greatest return requires consideration of factors including relative yield, disease resistance, the probability of achieving particular quality grades, and the relative End Point Royalty (EPR) charged on varieties.

The decision to grow either a malting or feed variety may depend on one or more factors, including: the difference in payments between malting and feed grades related to yield differences, the probability of producing a malting grade barley, availability of malting storage segregations in storage facilities, and disease resistance and agronomic considerations.

Podcast

GRDC Podcasts: Barley holy grail

Farmers now growing only feed varieties should consider including some malting varieties in their cropping. However, growers should contact grain marketers to discuss market demand prior to sowing a malting variety.

Malting barley is grown, stored and sold on a variety-specific basis and it is important to ascertain whether the variety chosen can be stored and marketed in your area. [8]

A.2 Malting barley and malt

Malt is produced from a cereal grain (usually barley) that has been allowed to germinate for a limited period of time prior to undergoing a mild kilning.

During the malting process, raw barley is steeped, germinated and kilned to change the raw barley seed into a friable, biscuit-like texture, which from the outside looks just like a barley kernel.

It is then easily crushed in the brewery mill in preparation for the sugar conversion that takes place in the brewery mash tun. The malting process converts ~10% of the carbohydrate in the raw grain into fermentable sugars via the process of germination. The malting process prepares the grain for more modification, which will be undertaken in the brewhouse.

For the Australian barley industry, there are two distinct markets to service—a domestic market and an export market—each of which has different requirements and needs for malt and raw barley. This is due to fundamentally different styles and methods of brewing, whereby in Australia brewers use sugar as an adjunct, whereas in Asia, solid adjuncts such as rice are predominantly used in the brewing process.

The malting process causes numerous chemical reactions to occur between amino acids and reducing sugars to develop colour and flavour compounds. Malt extract is a natural

[7] DAF Qld (2013) Barley planting and disease guide. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-disease-guide

[8] Agriculture Victoria. Growing barley. DEDJTR Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-barley

flavouring and colouring that is high in protein and natural sugars and is a major natural energy source. In addition to its use in brewing, it is widely used in baking, confectionery, breakfast cereals, malt beverages, dairy products, condiments and as a caramel substitute.

Australia produces >900,000 t of malt per year, with ~200,000 t consumed domestically (predominantly in the brewing industry) and >700,000 t exported predominantly into the Asian regional marketplace. [9]

A.2.1 Feed barley

Barley is used as stock feed, especially in the intensive pig, poultry, dairy and beef industries. This demand is met by varieties specifically grown as high-yielding feed types as well as grain that does not meet the quality requirements for malting or human food.

A few varieties (e.g. Urambie(Þ) and Yambla) are suitable as a dual-purpose crop (i.e. for grazing by livestock and for grain). Other varieties lose too much yield potential if grazed. When barley crops are grazed, care must be taken with the use of pesticides on the seed or in the crop to observe the withholding periods for grazing or cutting for hay or silage. [10]

A.3 Southern Barley Agronomy project

Several key points emerged from this Grain Research and Development (GRDC)-funded project, which ran from 2008 to 2010.

In South Australia:

- Pre-emergent herbicide damage was more pronounced at shallow sowing depths, due to rain after application.
- Fleet(Þ) (long coleoptiles) is better sown deeper with recommended rates of pre-emergent herbicide.
- Hindmarsh(Þ) (short coleoptile) is better sown shallow (herbicide is less damaging than deep sowing).
- Oxford was the highest yielding variety in 2010.
- When N was managed correctly, there was no difference in the yield of a variety between early and late sowing. Timing was more important than rate for yield and quality.
- The late application of N at growth stage (GS) 30–37 was most profitable in malt varieties Buloke(Þ) and Commander(Þ).
- Crop sensors (NDVI measurements) can assist N management.
- Gairdner(Þ) was the only variety not to suffer a yield penalty with multiple grazing events.
- Fleet(Þ) and Maritime(Þ) produced the most dry matter for early grazing.

In Victoria:

- Mid-May sowing gave the highest yields, but the yield penalty for late (June) sowing was not as severe as in drier years. April sowings suffered from locusts.
- Hindmarsh(Þ) was the highest yielding variety; Commander(Þ) yielded well and achieved the best gross margin because of the higher price for malt.
- Responses to N were similar in all varieties.
- Timing of N application was not important, so split or delayed applications (up to the 4-leaf growth stage) allowed seasonal risk to be managed.
- Leaf scald caused yield losses of 10–20% in susceptible varieties in the Wimmera but only 5–7% in the Mallee. Leaf scald was effectively managed with seed treatments and early fungicide application.

More information

GRDC Ground Cover: Avoid deep sowing for short-coleoptile barley

[9] Barley Australia (2014) Industry information: Malt. Barley Australia, http://www.barleyaustralia.com.au/industry-information/malt

[10] N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf.