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# Effect of delayed harvest on yield and grain quality of sixteen barley varieties in central west NSW – 2016

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## Key findings

- Grain yield and quality was significantly reduced in all varieties when harvest was delayed. Oxford and La Trobe$^{\phi}$ suffered least yield penalty, while Bass$^{\phi}$, and Fathom$^{\phi}$ had the greatest yield losses.
- Yield losses and quality downgrades ranged from $75–300/ha in lost revenue in 2016, despite overall low prices and distinction between malt and F1 grades.

## Introduction

When harvesting cereals, growers will often prioritise wheat over barley due to higher prices. This often leads to barley being harvested outside its optimum time, exposing it to the risk of weather damage. This can result in head loss, shattering or lodging leading to yield reductions, and weather-related quality damage affecting price at receival.

This experiment quantified the effect of delayed harvest on the grain yield and quality of 16 barley varieties.

## Site details

| | |
|---|---|
| Location | Condobolin Agricultural Research and Advisory Station |
| Soil type | Red–brown chromosol |
| Soil nitrogen | 30 kg/ha (0–10 cm), 39 kg/ha (10–60 cm) |
| Experimental design | Latin square design, varieties randomised within three replicates |
| Sowing date | 19 May 2016 |
| Sowing | Sown using a six-row DBS plot seeder at 30 cm row spacings for a target plant density of 120 plants/m$^2$<br>70 kg/ha mono-ammonium phosphate (MAP) was applied at sowing |
| Weed control | Pre-emergent weed control: WipeOut 450® 2 L/ha<br>In crop application: Axial® 100EC 300 mL/ha + Adigor® 500 mL/100 L water |
| Pest control | Targeting aphids: Primor WG® 150 g/ha |
| Growing season rainfall (1 April–30 September) | 467 mm (long-term average is 192 mm) |

## Treatments

### Harvest dates

Table 1. Harvest dates, number of days and rainfall between harvest events.

| Harvest date | Days after harvest 1 | Rainfall (mm) |
|---|---|---|
| 22 Nov | NA | NA |
| 20 Dec | 29 | 47.5 |

### Varieties

Bass$^{\phi}$, Buloke$^{\phi}$ Commander$^{\phi}$, Compass$^{\phi}$, Fathom$^{\phi}$, Flinders$^{\phi}$, GrangeR, Hindmarsh$^{\phi}$, La Trobe$^{\phi}$, Oxford, Rosalind$^{\phi}$, Schooner, Scope CL$^{\phi}$, Spartacus CL$^{\phi}$, Urambie$^{\phi}$, Westminster$^{\phi}$

## Results

### Grain yield

There was a significant difference between both varieties and harvest dates. Grain yields were highest in the first harvest and significantly reduced in all varieties when harvest was delayed, with a mean yield loss of 23% (Table 2). Oxford and Rosalind$^{\phi}$ were the highest yielding varieties when harvest was delayed, with Fathom$^{\phi}$ suffering the greatest yield losses. There was no correlation between phenology type and yield losses.

Table 2. Grain yield of 16 barley varieties harvested on two dates at Condobolin, 2016. Varieties presented in order of grain yield as recorded on first harvest (22 November). Figures in parentheses rank varieties in order of yield reduction between harvest dates; l.s.d. ($P = 0.05$) variety 0.43 t/ha, harvest date 0.47 t/ha, variety × harvest date 1.09 t/ha.

| Variety | Grain yield 22 Nov (t/ha) | Grain yield 20 Dec (t/ha) | Yield reduction (t/ha) |
|---|---|---|---|
| Bass | 5.91 | 3.78 | 2.13 (15) |
| Westminster | 5.51 | 3.83 | 1.68 (13) |
| Commander | 5.36 | 4.28 | 1.08 (5) |
| Rosalind | 5.32 | 4.06 | 1.26 (11) |
| Fathom | 5.28 | 3.38 | 1.90 (16) |
| Spartacus CL | 5.25 | 3.65 | 1.60 (14) |
| Buloke | 5.12 | 3.88 | 1.24 (12) |
| Oxford | 5.10 | 4.60 | 0.50 (2) |
| Scope CL | 4.91 | 3.76 | 1.16 (10) |
| Urambie | 4.82 | 3.82 | 1.00 (6) |
| Compass | 4.79 | 3.70 | 1.09 (8) |
| Flinders | 4.75 | 3.97 | 0.78 (4) |
| Hindmarsh | 4.72 | 3.73 | 0.99 (7) |
| GrangeR | 4.69 | 4.09 | 0.61 (3) |
| La Trobe | 4.64 | 4.36 | 0.28 (1) |
| Schooner | 4.62 | 3.55 | 1.06 (9) |

### Grain quality

All varieties and harvest times differed significantly for all quality traits, with the exception of protein content by harvest time ($P = 0.055$). Interactions were also observed for hectolitre weight, screenings and retention. Malting barley must meet minimum hectolitre weights of 65 kg/hL and maximum moisture levels of 12.5%. Delaying harvest resulted in nine varieties failing hectolitre weight standards, and 11 varieties exceeding moisture standards, although it should be noted that not all varieties in this experiment are accredited malting varieties (Table 3).

### A note on falling numbers

Rainfall on mature cereal crops before harvest can lead to damage in the form of pre-harvest sprouting. Enzyme α-amylase activation breaks down the starchy grain endosperm into sugars intended to fuel growth of the developing seedling, and reduces germination efficiency. Malting quality barley is required to germinate (>98%) consistently under controlled conditions in the malthouse in order to produce adequate quality malt. Falling numbers testing is a method of indirectly measuring the level of α-amylase associated with pre-harvest sprouting via measuring the viscosity of a ground grain sample. Following grinding, samples are mixed into a slurry in a glass tube and placed in a boiling water bath. A standard weight is suspended at the top of the tube, and the time taken for the weight to fall a pre-determined distance is recorded. High viscosity indicates minimal α-amylase activation, while low viscosity and subsequent low falling numbers indicates pre-harvest sprouting activity. Grain samples with falling numbers below 300 seconds are deemed unsuitable for malt and are downgraded to feed at receival.

When harvested at the optimum time, 22 November, all barley varieties, except Scope CL$^{\phi}$, had falling numbers above 300 seconds – above the threshold for malt classification.

After an additional 28 days and 47.5 mm of rain, falling numbers for all varieties fell significantly, with an average reduction from 351.2 seconds to 70.2 seconds (Figure 1). All malting varieties would be downgraded to feed if sold. All varieties dropped to less than 100 seconds, indicating extensive sprouting.

While there was a significant difference between harvest dates and varieties when harvested on 22 November, there was no significant difference between varietal falling numbers from the late harvest, due to high rainfall damaging all varieties.



Table 3. Grain quality of 16 barley varieties harvested on two different dates at Condobolin, 2016.

| Variety | Harvest date | Protein (%) | Moisture (%) | Retention (%>2.5 mm) | Screenings (%<2.2 mm) | Hectolitre weight (kg/hL) |
|---|---|---|---|---|---|---|
| Bass | 22 Nov | 10.7 | 9.5 | 98.0 | 0.4 | 72.4 |
| | 20 Dec | 10.5 | 12.5 | 99.1 | 0.3 | 65.7 |
| Buloke | 22 Nov | 9.4 | 9.1 | 90.5 | 1.1 | 70.2 |
| | 20 Dec | 10.2 | 12.8 | 95.9 | 0.4 | 64.8 |
| Commander | 22 Nov | 8.8 | 9.1 | 93.9 | 1.7 | 70.0 |
| | 20 Dec | 9.6 | 12.6 | 97.4 | 0.8 | 64.5 |
| Compass | 22 Nov | 8.9 | 8.9 | 96.8 | 0.7 | 69.4 |
| | 20 Dec | 8.1 | 12.6 | 98.1 | 0.4 | 62.8 |
| Fathom | 22 Nov | 9.5 | 9.0 | 96.7 | 0.5 | 69.5 |
| | 20 Dec | 9.7 | 12.7 | 98.2 | 0.4 | 62.5 |
| Flinders | 22 Nov | 9.4 | 9.2 | 96.7 | 0.6 | 71.3 |
| | 20 Dec | 9.6 | 12.7 | 98.4 | 0.4 | 65.4 |
| GrangeR | 22 Nov | 8.4 | 9.1 | 95.2 | 1.1 | 70.8 |
| | 20 Dec | 8.9 | 12.8 | 97.7 | 0.4 | 64.1 |
| Hindmarsh | 22 Nov | 10.1 | 9.1 | 89.1 | 2.0 | 71.3 |
| | 20 Dec | 10.0 | 12.7 | 93.2 | 1.3 | 65.0 |
| La Trobe | 22 Nov | 9.1 | 9.2 | 90.9 | 1.6 | 70.8 |
| | 20 Dec | 10.1 | 12.8 | 94.8 | 1.1 | 65.3 |
| Oxford | 22 Nov | 8.0 | 8.9 | 89.7 | 1.2 | 69.3 |
| | 20 Dec | 8.8 | 12.5 | 93.7 | 0.9 | 62.9 |
| Rosalind | 22 Nov | 8.6 | 9.1 | 92.8 | 1.2 | 69.9 |
| | 20 Dec | 9.4 | 13.0 | 96.4 | 0.8 | 63.2 |
| Schooner | 22 Nov | 9.7 | 9.1 | 97.1 | 0.4 | 71.6 |
| | 20 Dec | 10.1 | 12.3 | 98.3 | 0.4 | 65.0 |
| Scope CL | 22 Nov | 9.7 | 9.2 | 92.8 | 0.7 | 70.4 |
| | 20 Dec | 9.9 | 12.7 | 96.4 | 0.5 | 65.5 |
| Spartacus CL | 22 Nov | 9.8 | 9.0 | 90.5 | 1.6 | 71.5 |
| | 20 Dec | 9.7 | 9.4 | 96.5 | 0.8 | 64.9 |
| Urambie | 22 Nov | 9.2 | 9.1 | 79.2 | 3.0 | 70.8 |
| | 20 Dec | 10.1 | 12.4 | 92.4 | 1.3 | 63.8 |
| Westminster | 22 Nov | 9.7 | 9.5 | 96.7 | 0.5 | 71.8 |
| | 20 Dec | 9.5 | 12.8 | 98.7 | 0.2 | 65.0 |
| l.s.d. (variety) | | 0.72 | 1.15 | 0.95 | 1.84 | 0.71 |
| l.s.d. (harvest) | | 0.20 | 0.33 | 1.04 | 0.24 | 0.25 |
| l.s.d. (harvest × variety) | | NA | NA | 1.91 | 0.43 | 0.93 |

**Summary**

Due to relatively low prices and small malt premiums, barley harvests are often postponed in preference for higher value wheat. This can expose the crops to inclement weather, affecting yield and quality. In this experiment, significant yield losses occurred due to delayed harvest. Harvest date one occurred at physiological maturity (22 November), with all varieties achieving their greatest yields. Harvest date two was 20 December, following 31.4 mm of rain on 16 December. Despite four days of warm, dry conditions, grain moisture content remained above receival standards for malting barley, while hectolitre weights dropped below malting grade. All varieties displayed significant reductions in falling numbers, making them unsuitable for malt. Lost revenue ranged from $75–300/ha (Figure 2), based on yield losses and quality downgrades from malt to F1 (for malt classified varieties). Lost revenue is a factor of barley prices and malt premium, which was low in 2016 due to high global stocks of barley. In years of high demand, particularly for malt, these losses would increase proportionally.

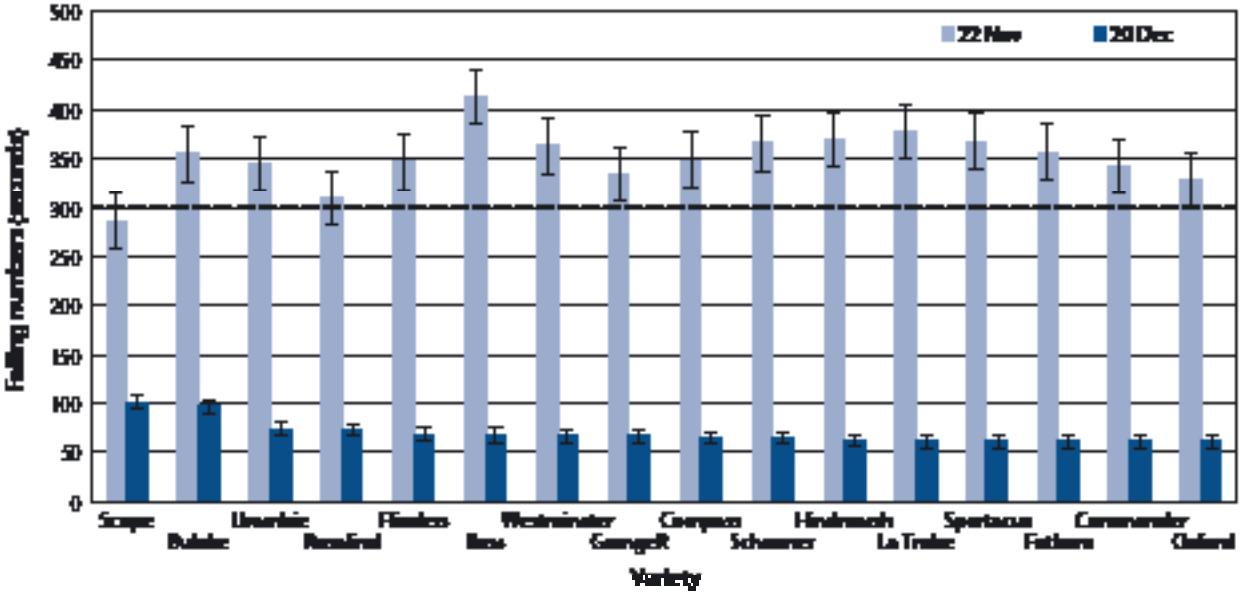


Figure 1. Falling numbers of 16 barley varieties harvested at an optimum time (22 November) and delayed by 28 days (20 December). Horizontal dashed line indicates threshold value of 300 seconds for malt standard; l.s.d. ($P = 0.05$) harvest 41.53 sec; variety 25.37 sec; harvest × variety 37.96 sec. Error bars indicate varietal l.s.d ($P = 0.05$).

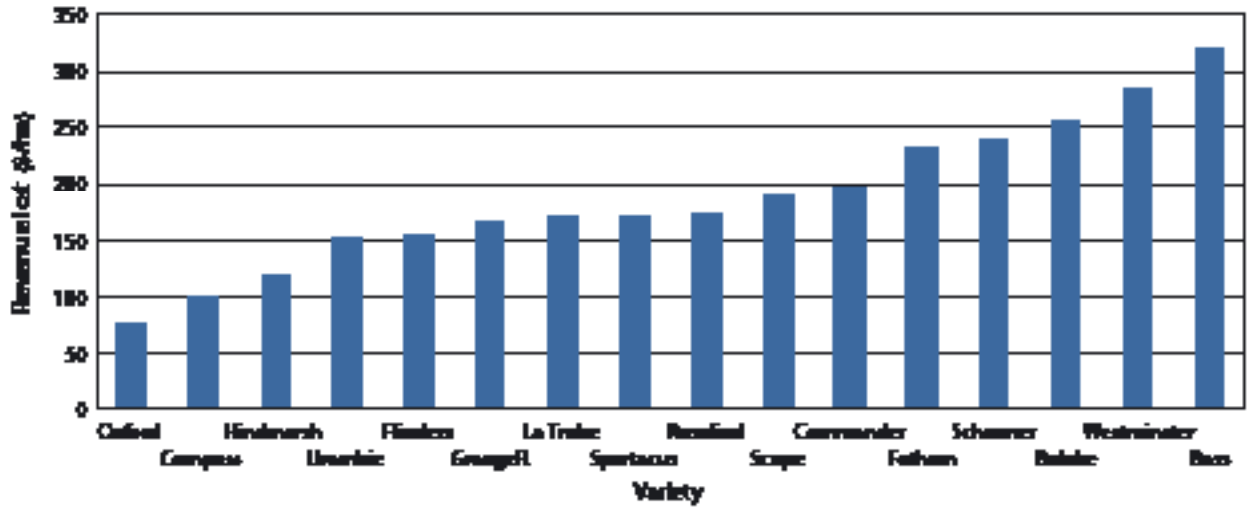


Figure 2. Revenue lost by variety following delayed harvest and weather damage. Revenue losses based on yield difference and downgrading of malt varieties to F1 following weather damage. Prices taken from Graincorp daily contract prices 24 March 2017 at the Condobolin site.

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