Department of Primary Industries
Department of Regional NSW

NSW research results

RESEARCH & DEVELOPMENT – INDEPENDENT RESEARCH FOR INDUSTRY

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Evaluation of dual-purpose oat varieties, Glen Innes 2020

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Summary of results

- Oat varieties Nile, Eurabbie and Dynasty demonstrated the greatest flexibility as 'graze and grain' options for growers. These varieties can achieve grazing at growth stage 30 (GS30) and grain at harvest in this environment.
- For grain production sowing date 3 (SD3) in mid-April produced significantly higher yields than SD1 (5 March) for all varieties in both the grazed and ungrazed treatments.
- Nile and Eurabbie, from the SD3 grazing treatments, produced the highest grain yields of 2.87 t/ha and 2.85 t/ha respectively.
- Yiddah^{(D} and Bimbil had the lowest grain yield from SD1.
- Grain quality was low for all varieties and treatment combinations due to frequent rainfall before harvest.
- Simulated grazing at GS30, the optimal time for first grazing, resulted in a higher grain yield than most of the ungrazed treatments of the corresponding varieties. Early grazing is a useful management option to improve grain production from dual-purpose oat varieties in this environment as it reduces lodging in the crop, particularly in a high growth potential season such as 2020.
- Varieties differed widely in the time taken to reach GS30 and the amount of biomass that they produced at this stage.
- Dynasty, Nile and Bimbil were the fastest varieties (55 days) to reach GS30 for SD1, producing biomasses of 3.06 t/ha dry matter (DM), 2.52 t/ha DM and 2.44 t/ha DM respectively.
- From SD1, Eurabbie produced the greatest amount of early biomass at GS30 of 4.1 t/ha DM, taking 69 days to reach this stage.
- From SD2, Yiddah^{(D} and Nile produced the greatest amount of biomass at GS30, with 4.75 t/ha DM and 4.73 t/ha DM produced respectively in 99 days.
- From SD3 Eurabbie and Nile produced the greatest amount of biomass at GS30 with 4.06 t/ha DM and 3.51 t/ha DM produced respectively, taking 106 days.
- Dynasty had the greatest response to sowing date, scoring the lowest DM production at GS30 in the experiment from the later sowing dates: SD2 (1.52 t/ha DM) and SD3 (1.71 t/ha DM) and respectively, compared with DM production from SD1 of 3.06 t/ha.
- A strong sowing date effect was also observed for Dynasty in relation to grain yield, which ranged from 0.42 t/ha (SD1 non-grazed) to 2.58 t/ha (SD3 grazed).
- Dynasty produced the most biomass at GS65 from the SD3 ungrazed treatment (11.71 t/ha DM), however, it took two weeks longer to reach GS65 than all other varieties. Yiddah^{(D} (10.93 t/ha, SD2), Nile (10.81 t/ha DM, SD3), and Bimbil (10.80 t/ha

DM, SD3) produced comparable DM at GS65, but required less time to achieve it than Dynasty.

- Feed values at GS30 were within the recommended dietary ranges for most sheep and cattle.
- Dynasty and Nile produced the highest forage quality at GS65 with Australian Fodder Industry Association (AFIA) Grades A1-B2 and A2-B2 respectively.

Introduction

Dual-purpose cereal crops (graze and grain recovery) offer flexibility in producing winter forage for livestock and additional income from the grain harvested. The ability to exploit early sowing windows with suitable dual-purpose varieties improves both profitability and options for the perennial pasture and cropping systems of the Northern Tablelands of NSW. Oat crops are particularly important in the region for early sowing, grazing, silage, hay and grain production. In 2020, early season soil moisture conditions were ideal for this experiment, which evaluated six varieties of oat for grazing and grain recovery potential at the NSW DPI research station at Glen Innes.

This experiment is a component of the NSW DPI–GRDC Grains Agronomy and Plant Pathology (GAPP) project BLG116 'Northern high rainfall zone dual purpose winter crop evaluation 2019–22' that is evaluating oat, wheat, barley, triticale, canola and perennial cereal varieties for their potential to produce grain following simulated grazing treatments. The project aims to support the expansion of grain production in the high rainfall zones of north eastern NSW.

Site details

Location	NSW DPI Glen Innes Agricultural Institute, 444 Strathbogie Road, Glen Innes NSW 2370 Latitude 29° 70› 18.2" S, Longitude 151° 70' 02.3" E
Paddock history	2019 perennial grazing pasture
Soil type and nutrition	• NSW DPI Glen Innes research station • Light brown-grey clay loam soil type. • Chemical analysis of the site is presented in Table 1.
Rainfall and temperature	Figure 1 summarises the Bureau of Meteorology rainfall and temperature data for 2020.
Experiment design	• Split plot design with three replicates. • Treatments on main plot: three sowing dates (SD). • Treatments on split plot: six varieties combined with two grazing treatments (grazed and non-grazed).
Fertiliser	• 160 kg/ha of urea (N:47%) was incorporated via shallow cultivation one month before sowing. • 40 kg/ha of Granulock® Z (N:11%, phosphorus:21.8%, sulfur:4%, zinc:1%) and 141 kg/ha of urea (N:47%) applied at sowing.
Target plant population	100 plants/m^2
Weed management	2 L/ha Roundup 450® (glyphosate 450 g/L) and 1.2 L/ha LVE MCPA 570 (MCPA 570 g/L) applied before sowing.

Insect management	120 mL/100 kg Gaucho® 600 seed treatment (imidacloprid 600 g/L)
Disease management	180 mL/100 kg Vibrance® seed treatment (difenoconazole 66.2 g/L, metalaxyl-M 16.5 g/L, sedaxane 13.8 g/L)
Harvest	Harvest ranged from early November to mid December 2020.

Table 1 Soil chemical analysis of the experiment site at Glen Innes, NSW, 2020.

Characteristic	Depth (cm)				
	0–10	10–30	30–60	60–90	90–120
Ammonium nitrogen (mg/kg)	56	12	5	3	3
Nitrate nitrogen (mg/kg)	50	8	2	<1	<1
Phosphorus (mg/kg) [Colwell test]	82	9	4	3	2
Potassium (mg/kg) [Colwell test]	138	32	46	53	72
Sulfur (mg/kg)	25.4	11.4	18.5	12.8	9.6
Organic carbon (%)	2.0	0.75	0.48	0.36	0.3
Conductivity (dS/m)	0.18	0.05	0.04	0.04	0.04
pH_{Ca}	5.1	4.5	5.0	5.3	5.9
pH level (1:5 water)	5.9	5.7	6.2	6.6	7.3
BSES phosphorus (mg/kg)	58.2	4.0	–	–	–

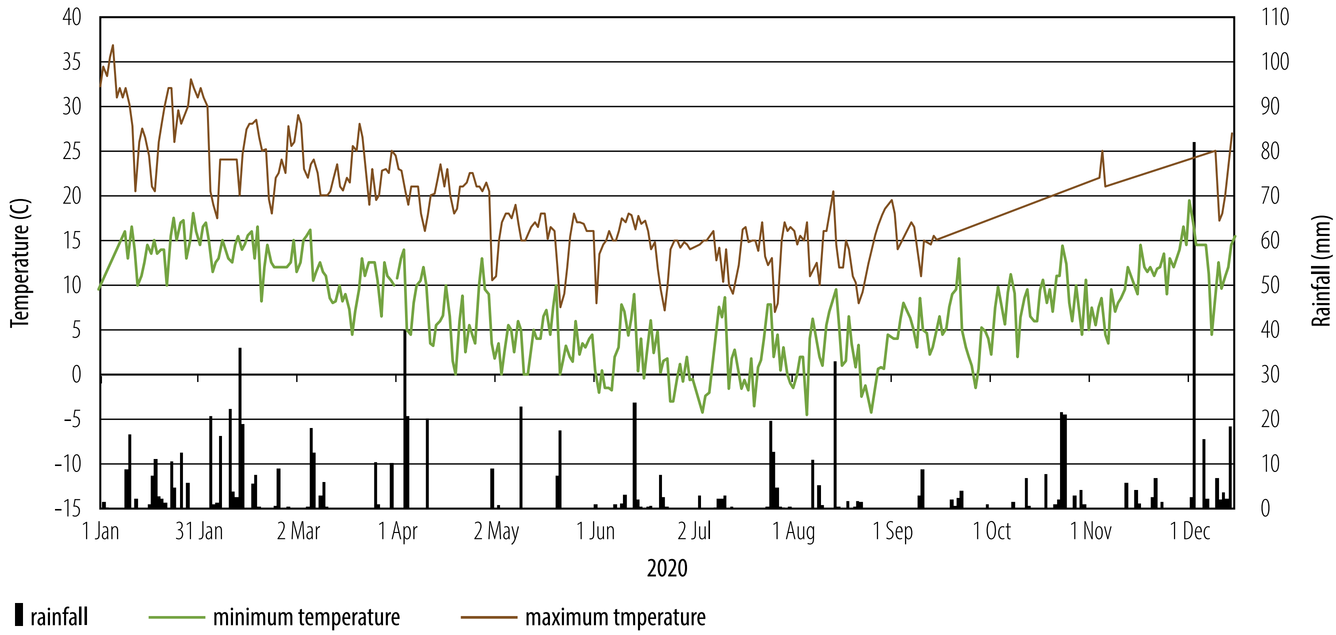


Figure 1 Rainfall and temperature data for NSW DPI Glen Innes Agricultural Research Station, 2020. (Source: Bureau of Meteorology).

Treatments

Varieties (6)

Table 2 Description of dual-purpose oat varieties in the experiment.

Variety	Traits and reason for inclusion
Bimbil	Dual-purpose type suitable for early to mid-season sowing in NSW.
SF Dynasty	A late-maturing forage oat released in Australia in 2020. As a later maturing variety, it produces most feed later into the season. It has good crown rust resistance and has good 'warm start' tolerance for early sowings.
Eurabbie	Late-maturing, semi-dwarf winter habit variety considered to have outstanding grain recovery potential. Grazing management is important as can be very short following a heavy late grazing leading to harvesting difficulties. Susceptible to *Barley yellow dwarf virus* (BYDV).
Mannus⊕	Mid maturing, tall, strong-strawed, dual-purpose feed grain quality variety. Moderately susceptible to BYDV.
Nile	Late-maturing, medium height benchmark dual-purpose variety on the Northern Tablelands of NSW. It has good BYDV tolerance.
Yiddah⊕	Tall, strong-strawed, early maturing variety. Moderate tolerance to BYDV with effective resistance to stem rust, and some resistance to crown rust.

Sowing dates

Three sowing dates: SD1 – 5 March; SD2 – 24 March; and SD3 – 14 April 2020.

Grazing treatments (2)

- Grazed and non-grazed treatments were applied to each variety, in each replicate of the experiment.
- Grazing treatments were simulated by mowing at 3 cm above ground height when plots reached the start of the stem elongation phase, or GS30, (GRDC Cereal growth stages guide, 2005). https://www.daf.qld.gov.au/__data/assets/pdf_file/0009/1373436/12-518-DL-File-C-Documents-RELEASE.pdf for crops intended for grain harvest, GS30 marks the end of grazing to prevent the removal of the developing grain heads and tiller death.
- All cut plant matter was removed from the grazed plots (Figure 2).

Figure 2 Application of a simulated grazing treatment to oat plots at GS30 by NSW DPI Ashley Moss, 13 May 2020.

Results

Establishment

The target population of 100 plants/m^2 was achieved across all sowing dates averaging 96 plants/m^2 established with an even establishment across the plots (Figure 3).

Figure 3 Uniform plant establishment is evident in this photo of SD1 (right) and SD2 (left) of the dual-purpose oat experiment at Glen Innes, 4 April 2020.

Statistical analysis

Variation in the traits was described by fitting a linear mixed-effects model considering the sowing date, variety and grazing treatment plus all interactions as fixed effects. Random effects were assigned to replication, main plot, range, and row of the experiment. An analysis of variance was derived from the model to test the null hypothesis with respect to each fixed term. Model assumptions of normal and homogeneous residuals were checked by graphical methods.

The analysis of variance was used to infer a statistically important effect when the relevant F-ratio statistic exceeded the expected F-ratio under the null hypothesis at 5% critical value. Specific pairwise contrasts were made by comparing the estimated effect with a calculated least significant difference at 5% critical value. The models were also used to estimate the mean and standard error of the trait under all combinations of variety, grazing and sowing date.

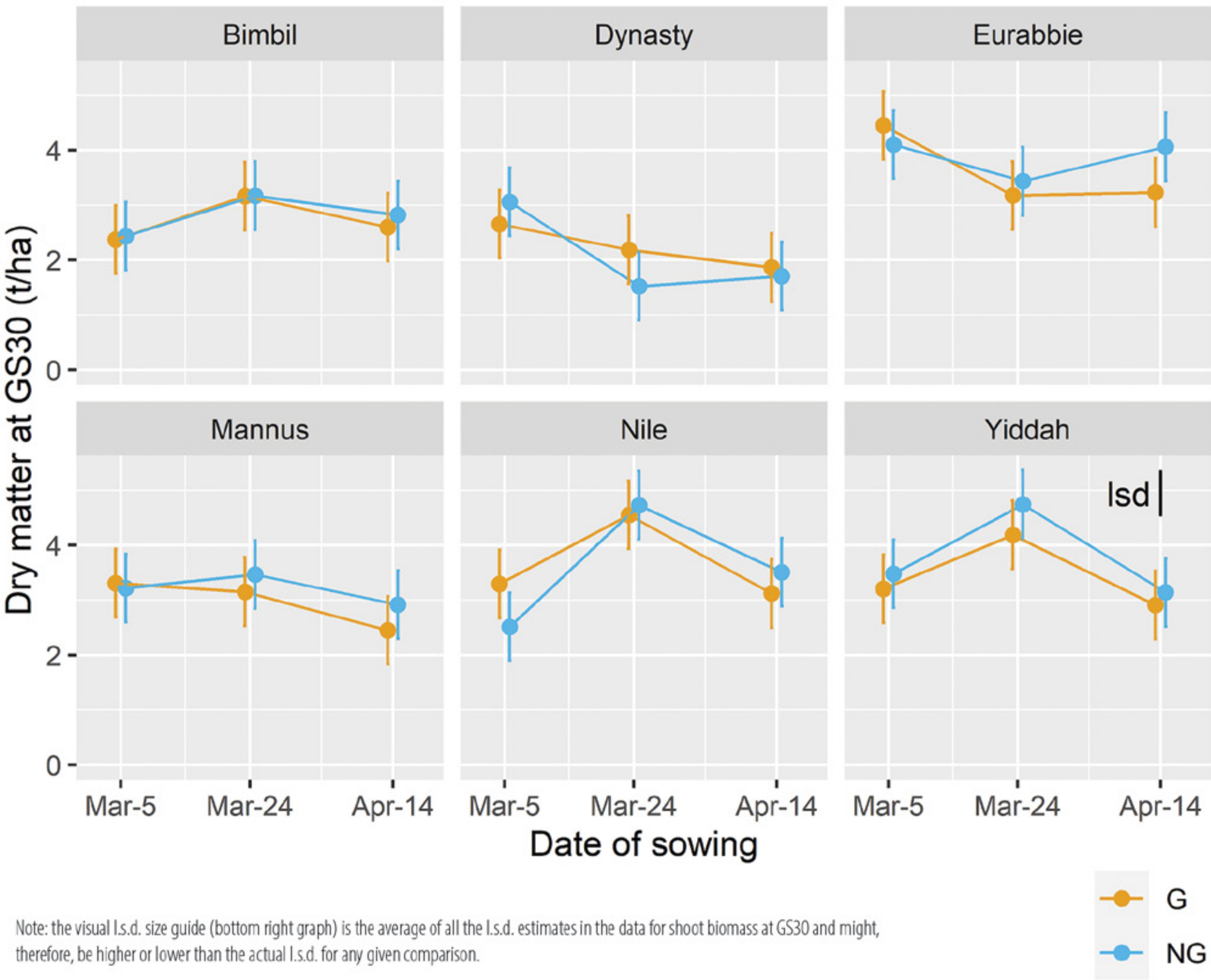
Data summaries are presented graphically in figures 4, 5 and 6. The estimates of grain yield, biomass and maturity are provided in more detail in Table 3.

Grain quality data is presented in Table 4 and feed value analyses in Table 5.

The data analysis was conducted in the R environment (R Core Team, 2021) with particular use of the lme4 package (Bates et al. 2015).

Plant shoot biomass at growth stage 30

Analysed data for plant shoot biomass at GS30 is presented in Figure 4. As the grazing treatments were applied directly after the GS30 biomass data was collected, there was no significant difference between the grazed (G, orange line) and non-grazed (NG, blue line) treatments (Figure 4).



Note: the visual l.s.d. size guide (bottom right graph) is the average of all the l.s.d. estimates in the data for shoot biomass at GS30 and might, therefore, be higher or lower than the actual l.s.d. for any given comparison.

Figure 4 Plant shoot biomass (tonnes dry matter/ha) at GS30 for six oat varieties from three sowing dates, with grazed (G, orange line) and non-grazed (NG, blue line) treatments.

The greatest amount of shoot biomass at GS30 in this experiment was produced from SD2 by Yiddah⁽ᴾ⁾ and Nile (4.75 t/ha DM and 4.73 t/ha DM respectively).

Eurabbie produced the highest biomass from SD1 (4.10 t/ha DM) and SD3 (4.06 t/ha DM). For SD1 the next highest biomass production was Yiddah⁽ᴾ⁾ (3.48 t/ha DM) and Nile from SD3 (3.51 t/ha DM).

Dynasty showed the greatest response to sowing date, scoring the lowest DM production in the experiment for SD2 and SD3 (1.52 t/ha DM and 1.71 t/ha DM respectively) and the highest DM production at GS30 for SD3 at 4.06 t/ha DM.

The days taken to reach GS30 varied widely with variety (Table 3). For SD1 Nile, Dynasty and Bimbil reached GS30 in 55 days while the remaining varieties Eurabbie, Mannus⁽ᴾ⁾ and Yiddah⁽ᴾ⁾, required 69 days to reach this stage.

For SD2, the days to reach GS30 ranged from 64 days (Dynasty) to 99 days (Mannus⁽ᴾ⁾ and Yiddah⁽ᴾ⁾). For SD3, the days to reach GS30 ranged from 78 days (Dynasty) to 106 days (all remaining varieties).

Plant shoot biomass at GS65

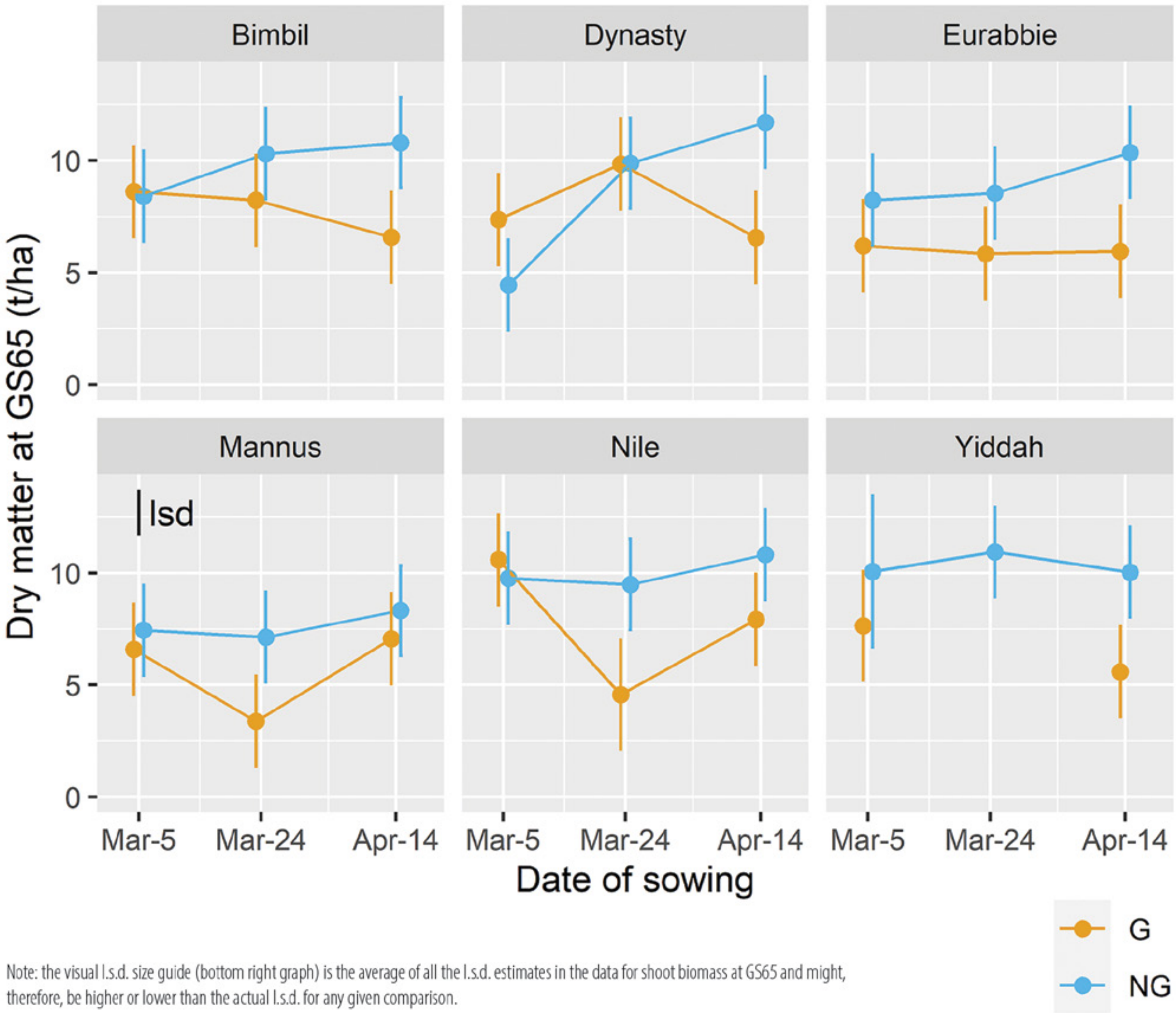
Feed values generally decline from anthesis (GS65) (GRDC. 2018), representing the decision point for growers regarding the options to graze, cut and bale for hay or silage, or take the crop through to grain harvest.

Figure 5 and Table 3 presents a summary of the analysed data for plant shoot biomass at GS65.

Of the non-grazed treatments, the greatest amount of shoot biomass at GS65 was produced from SD2 and SD3 by Dynasty (11.71 t/ha DM; SD3), Yiddah$^{\Phi}$ (10.93 t/ha DM; SD2) and Nile (10.81 t/ha DM, SD3) (Figure 5).

Most treatment combinations that received a simulated grazing treatment at GS30 produced less biomass at GS65 than the corresponding non-grazed treatments. The most notable exception was Nile from SD1 with a biomass of 10.59 t/ha DM, (0.83 t/ha higher than the non-grazed treatment of 9.76 t/ha DM at GS65). None of the other varieties from SD1 showed this capacity to recover from the GS30 grazing treatment.

The time required to reach GS65 decreased as sowing time was delayed, irrespective of grazing treatment (Table 3).



Note: the visual l.s.d. size guide (bottom right graph) is the average of all the l.s.d. estimates in the data for shoot biomass at GS65 and might, therefore, be higher or lower than the actual l.s.d. for any given comparison.

Figure 5 Plant shoot biomass (tonnes dry matter/ha) at anthesis, GS65 for six oat varieties from three sowing dates, with grazed (G, orange line) and non-grazed (NG, blue line) treatments.

Harvest maturity

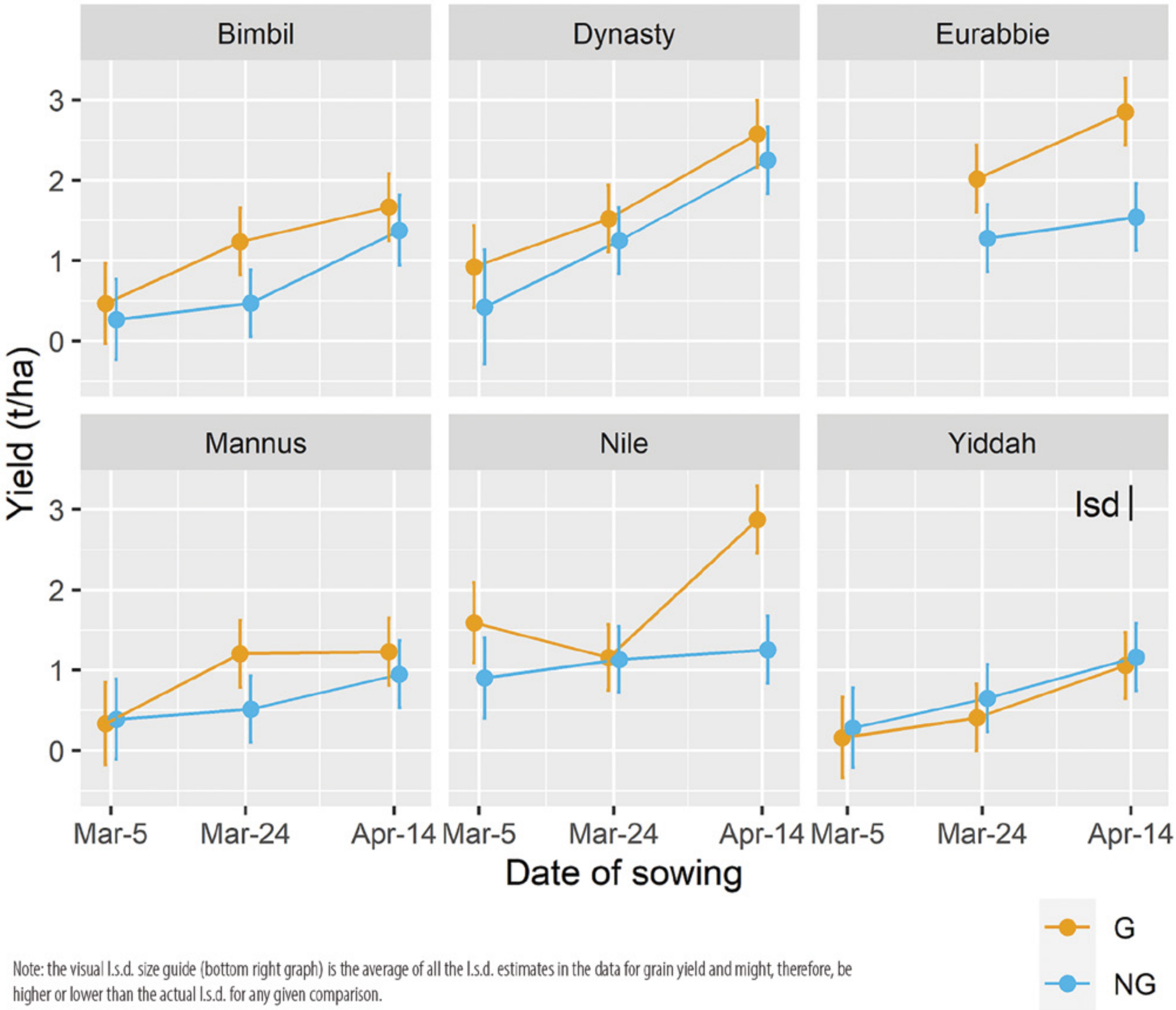
Frequent rainfall at the end of the 2020 season could have delayed maturity (Figure 1).

- For SD1, Eurabbie took 265 days (37 8 weeks) to reach maturity, which was three weeks earlier than the other varieties, which took 286 days (40.8 weeks).

- Eurabbie was also faster to mature from SD2 taking 246 days (35.1 weeks) compared with all other varieties, which took 267 days (38.1 weeks).
- For SD3 all varieties took 246 days (35.1 weeks) to reach harvest maturity.
- Grazing treatments did not affect maturity in comparison with non-grazed treatments.

Grain yield

Figure 6 and Table 3 present a summary of the analysed grain yield data for this experiment.



Note: the visual l.s.d. size guide (bottom right graph) is the average of all the l.s.d. estimates in the data for grain yield and might, therefore, be higher or lower than the actual l.s.d. for any given comparison.

Figure 6 Grain yield (t/ha) for six oat varieties at three sowing dates, with grazed (orange line) and non-grazed (blue line) treatments.

- Grain yield from all treatment combinations was highest from SD3, compared with SD1 and SD2 (Figure 6 and Table 3).
- Nile and Bimbil had the highest yield for grazed treatments from SD3 (2.87 t/ha2.85 t/ha respectively).
- Yiddah^⊕ and Bimbil had the lowest grain yield from SD1 (0.16 t/ha, grazed; 0.27 t/ha, non-grazed respectively).
- No yield data was recovered from Eurabbie from SD1 due to bird damage, however, a sample of grain was possible for quality analysis.

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- For grain production in this experiment, the later sowing date (14 April) was preferable to the earlier (5 March, 24 March) sowing dates.
- Across all treatment combinations, grain yield was higher in the grazed treatment compared with its corresponding non-grazed treatment (Figure 6), suggesting that grazing at GS30 was beneficial for grain production in the varieties used in this experiment. This is likely to be because grazing can reduce crop lodging, particularly in a high biomass, high rainfall season such as 2020.
- For the non-grazed treatments, grain yield ranged from 2.25 t/ha (Eurabbie, SD3) to 0.27 t/ha (Bimbil, SD1).
- A strong sowing date effect on grain yield was observed for Dynasty, which ranged from 0.42 t/ha (SD1, non-grazed) to 2.58 t/ha (SD3, grazed) (Figure 6).

Table 3 shows yield and biomass at GS30 and GS65 and the days to reach GS30 and GS65.

Table 3 Grain yield, biomass and maturity data summary for grazed (G) and non-grazed (NG) treatments of six oat varieties at three sowing dates (5 March, 24 March, 14 April), Glen Innes, 2020.

Variety	SD	Yield (t/ha)[a]		Dry matter at GS30 (t/ha)		Dry matter at GS65 (t/ha)		Days to reach GS30		Days to reach GS65	
Grazing treatment		NG	G	NG	G	NG	G	NG	G	NG	G
Bimbil	1	0.27	0.47	2.44	2.37	8.41	8.61	55	55	229	229
	2	0.47	1.24	3.17	3.17	10.31	8.23	84	84	210	210
	3	1.38	1.66	2.82	2.60	10.80	6.57	106	106	189	189
Dynasty	1	0.42	0.92	3.06	2.66	4.44	7.37	55	55	244	244
	2	1.25	1.52	1.52	2.19	9.89	9.85	64	64	225	225
	3	2.25	2.58	1.71	1.87	11.71	6.57	78	78	204	204
Eurabbie[b]	1	–	–	4.10	4.46	8.24	6.20	69	69	229	229
	2	1.28	2.02	3.44	3.18	8.55	5.84	84	84	210	210
	3	1.54	2.85	4.06	3.23	10.37	5.95	106	106	189	189
Mannus	1	0.39	0.33	3.22	3.31	7.44	6.59	69	69	229	229
	2	0.52	1.21	3.46	3.15	7.14	3.37	99	99	210	210
	3	0.95	1.23	2.92	2.45	8.32	7.06	106	106	189	189
Nile	1	0.90	1.59	2.52	3.29	9.76	10.59	55	55	229	229
	2	1.13	1.16	4.73	4.55	9.48	4.56	99	99	210	210
	3	1.25	2.87	3.51	3.12	10.81	7.93	106	106	189	189
Yiddah[b]	1	0.28	0.16	3.48	3.21	10.07	7.64	69	69	209	209
	2	0.65	0.41	4.75	4.19	10.93	-	99	99	210	210
	3	1.16	1.06	3.14	2.91	10.03	5.59	106	106	189	189
P-value (variety)		<0.001		<0.001		<0.001		–		–	
P-value (graze)		0.001		ns		<0.001		–		–	
P-value (SD)		<0.001		ns		ns		–		–	
P-value (variety:graze)		<0.001		ns		ns		–		–	
P-value (variety:SD)		0.026		<0.001		<0.001		–		–	
P-value (graze:SD)		ns		ns		<0.001		–		–	
P-value (variety:graze:SD)		0.02		ns		ns		–		–	

[a] Yield is expressed at 11% moisture content.

[b] Data not available for Eurabbie from SD1 due to bird damage; and for variety Yiddah(b) in SD2 as it did not recover from a frost after grazing.

Grain quality

All varieties in this experiment were feed/forage classified. Grain quality parameters and classifications from the Grain Trade Australia (GTA) trading standard (GTA, 2020) were used to define quality as per the Feed Oats No.1 receival standards.

Grain quality was reduced due to frequent rainfall before harvest (figures 1 and 7). Grain quality data is summarised in Table 4.

Low test weights of <48 kg/hL (GTA, 2020) were the major quality parameter responsible for downgrading feed oats. Grain test weights decrease following rain due to the kernels swelling. Although grain weight does not change, the test weight is reduced because the kernels are larger, taking up greater volume. Only Eurabbie from SD3 (non-grazed) produced a test weight just above 48 kg/hL (Table 4).

Figure 7 NSW DPI Nguyen Nguyen inspecting oat grain quality and maturity in the dual-purpose oat experiment at Glen Innes, 2020.

In addition to low test weights, high levels of screenings (the % of material by weight below 2.0 mm screen) was another quality parameter responsible for downgrading from Feed Oats No 1, being >20%. Dynasty and Mannus$^{\Phi}$ performed the worst with screenings above 20% from most treatments (Table 4).

Grain protein responses in general were variable, although Yiddah$^{\Phi}$, at comparable grain yields, appeared to achieve a higher grain protein concentration.

Of the varieties evaluated, Eurabbie from SD2 and SD3 with its lower screenings and higher test weight performed better than the recognised benchmark variety Nile for this environment.

Table 4 Grain quality data summary for grazed (G) and non-grazed (NG) treatments of six oat varieties at three sowing dates (5 March, 24 March, 14 April), Glen Innes, 2020.

Variety	SD	Protein content[a] (%)		Test weight (kg/hL)		Seed weight (g/1000 grains)		Screenings	
Grazing treatment		**NG**	**G**	**NG**	**G**	**NG**	**G**	**NG**	**G**
Bimbil	1	13.3	13.3	40.9	41.7	24.3	26.8	11.7	11.1
	2	13.8	13.2	42.6	42.2	24.6	26.2	13.5	12.5
	3	13.0	13.0	43.9	42.4	27.0	28.3	11.2	12.0
Dynasty	1	12.0	12.2	24.9	34.5	14.6	16.9	18.0	26.0
	2	12.6	12.4	33.2	36.2	17.8	19.4	20.3	23.8
	3	13.2	12.3	40.4	40.6	20.2	24.9	20.1	24.1
Eurabbie	1	11.0	11.7	29.8	34.8	18.2	21.1	14.8	13.1
	2	11.9	11.8	40.4	40.7	21.9	25.0	11.3	8.2
	3	12.5	11.7	48.4	45.1	28.9	26.0	6.7	10.3
Mannus	1	12.0	11.7	28.9	24.2	18.0	16.2	20.3	28.1
	2	11.6	11.8	29.5	32.9	18.9	25.0	24.3	15.8
	3	12.0	11.6	29.8	28.9	16.7	17.1	26.2	25.0
Nile	1	11.8	11.6	29.3	33.1	19.0	20.2	22.4	19.3
	2	11.7	11.4	29.3	31.0	21.5	30.0	17.6	13.0
	3	12.6	12.1	35.3	38.4	23.4	25.3	15.3	13.8
Yiddah	1	12.7	12.6	36.4	38.5	25.4	25.1	16.0	16.3
	2	13.4	12.7	40.2	39.8	24.9	34.3	13.2	15.4
	3	14.1	13.2	40.2	38.3	24.2	25.3	12.2	12.3
P-value (variety)		<0.001		<0.001		<0.001		<0.001	
P-value (graze)		0.008		0.04		<0.001		ns	
P-value (SD)		ns		0.012		0.03		ns	
P-value (variety:graze)		ns		ns		ns		<0.001	
P-value (variety:SD)		0.005		<0.001		<0.001		<0.001	
P-value (Graze:SD)		ns		0.04		0.002		0.002	
P-value (variety:graze:SD)		ns		ns		0.04		<0.001	

[a] Grain protein concentration is expressed as % dry matter basis

Feed value analysis

The dry matter cuts from SD1 at GS30 and GS65 were retained for feed value analysis. A bulked sample was prepared for each variety from the three field replicates and analysed by the NSW DPI Feed Testing Laboratories at Wagga Wagga (Table 5).

Table 5 Feed quality analysis of six oat varieties at GS30 and GS65, sown on 5 March, 2020 at Glen Innes, NSW.

Variety	Growth stage	Near infrared (NIR) spectrophotometry analysis									Cereal hay grade (GS65 only)		
		ADF (%)	ASH (%)	CP (%)	DMD (%)	DOMD (%)	ME (MJ/kg DM)	NDF (%)	OM (%)	WSC (%)	AFIA Grade	DM (%)	Moisture (%)
Bimbil	GS30	23	13	27.1	87	81	13.4	43	87	9.0			
	GS65	34	9	11	54	53	7.7	62	91	<4.0	C1–D2	95.1	4.9
Dynasty	GS30	24	11	25.1	84	78	12.9	49	89	7.9			
	GS65	31	7	10	64	61	9.5	57	93	13.8	A1–B2	96.2	3.8
Eurabbie	GS30	23	11	23.3	86	80	13.2	44	89	11.8			
	GS65	31	9	12	60	57	8.6	57	91	8.6	B1–C1	95.8	4.2
Mannus	GS30	25	14	21.0	87	80	13.3	46	86	14.8			
	GS65	36	5	9	54	53	7.7	64	95	9.2	C2–D2	95.0	5.0
Nile	GS30	25	11	26.4	87	81	13.4	47	89	9.3			
	GS65	30	7	9	64	61	9.4	56	93	15.6	A2–B2	96.4	3.6
Yiddah	GS30	23	11	24.9	89	82	13.7	44	89	11.4			
	GS65	31	9	13	59	56	8.5	58	91	8.3	B1–C1	93.9	6.1

ADF – acid detergent fibre
DMD – dry matter digestibility
NDF – neutral detergent fibre
ASH – ash
DOMD – digestibility of the organic matter contained in the dry matter
OM – organic matter
CP – crude protein
ME – metabolisable energy
WSC – water soluble carbohydrates

Important feed quality traits include neutral detergent fibre (NDF), metabolisable energy (ME) and crude protein (CP).

Neutral detergent fibre is a measure of the structural, slowly digested, cell wall components of a plant and includes hemicellulose, cellulose and lignin or indigestible fibre. As the percentage of NDF increases, animal intake tends to decline due to increasing fibre content, which takes longer to digest in the rumen. It is also important that NDF values are not too low (i.e. <30%) to avoid stomach upsets such as acidosis. Conversely, high NDF values (i.e. >60%) can affect digestibility, limiting intake.

Feed quality analysis of samples taken at GS30 ranged in NDF values from 43% to 49% (Table 5), which were within the recommended NDF values of above 30%, and below the upper limit of 60%.

The ME of samples taken at GS30 were very similar, ranging from 12.9 MJ/kg to 13.7 MJ/kg of DM, which is acceptable for the dietary requirements of most sheep and cattle. Forage quality of >11 MJ/kg is considered high quality.

Levels of CP for the early simulated grazing samples ranged from 21% DM to 27.1% DM. It is important to note that CP includes both true protein and non-protein nitrogen (NPN) and does not differentiate between nitrates and proteins in plants, with nitrate concentrations usually higher in younger plants, and declining as plants mature. High nitrate levels can be an issue when grazing young cereal crops. Producers should exercise caution and contact their veterinarian or Local Land Services livestock officer before grazing to discuss any potential animal health and/or management issues.

Feed analysis of the dry matter cuts taken at anthesis (GS65) showed that NDF values increased and DM digestibility (%) decreased as the crop matured. The NDF values ranged from 57% to 64%, which is borderline or over the recommended limit of 60% NDF.

The ME values in the GS65 cuts ranged from 7.7 MJ/kg to 9.5 MJ/kg of DM (Table 5).

The CP concentration % of dry matter at GS65 ranged from 9% to 13%, which is low but within the recommended range.

Cereal hay grades

Australian Fodder Industry Association (AFIA) grades for cereal hay specify the highest grade A1, where A refers to ME >9.5 and 1 = CP >10%. Conversely, the lowest grade D3 specifies an ME of <7.4 and a CP of <7%. Later letters (i.e. D) indicate lower ME and higher numbers (i.e. 3) lower CP.

Dynasty and Nile produced the highest grade of forage quality at GS65, with AFIA Grades A1-B2 and A2-B2 respectively (Table 5). In contrast, Mannus$^{\Phi}$ produced the lowest forage quality at GS65 with a grade of C2-D2.

Conclusions

This experiment completed in the winter of 2020 provides data to help growers and agronomists identify oat varieties with the potential to produce grain along with the option of grazing with grain recovery, in the NSW Northern Tablelands. Nile was included for comparison as it is popular with local graziers.

Grain yield

- Grain yield from all treatment combinations was higher from SD3 (mid April) than in SD1 and SD2 (5 March and 24 March respectively).
- The highest grain yield in the experiment was produced by Nile (2.87 t/ha) and Eurabbie (2.85 t/ha) in the SD3 **grazed** treatments.
- Dynasty produced the highest grain yield in the **ungrazed** treatments from SD3 at.2.5 t/ha. Dynasty (SD3) achieved a yield increase of 15% to 2.58 t/ha when grazed compared with the ungrazed treatment.

The simulated grazing treatment applied at GS30 resulted in a higher grain yield for most of the treatment combinations suggesting that early grazing is a useful management option for recovering grain from dual-purpose oat varieties in this environment. This is likely to be due to the positive effect of early grazing to reduce lodging in the crop, particularly in a season with high growth potential as experienced in 2020.

Biomass at GS30

- In contrast to grain yield, biomass production at GS30 was generally higher for SD1 and SD2.
- Yiddah$^{\Phi}$ and Nile produced the greatest amount of DM for SD2 (4.75 t/ha DM and 4.73 t/ha DM, respectively).
- For SD1, Eurabbie, Yiddah$^{\Phi}$, Mannus$^{\Phi}$ and Dynasty produced more biomass at GS30 (4.10 MJ/kg to 3.06 t/ha DM) than the local benchmark variety Nile (2.52 t/ha DM).
- Feed values at GS30 for all varieties were high and within recommended ranges for sheep and cattle diets.

Biomass at GS65

- Biomass and feed value analysis was conducted at GS65 (anthesis) as it is a critical decision point for most dual-purpose crops to either graze, cut for hay or silage, or to 'lock up' the crop for grain harvest.
- The biomass at GS65 was higher in the non-grazed treatments compared with the grazed treatments in almost all the variety × sowing date combinations. Nile from SD1 was the exception with the highest biomass at GS65 of 10.59 t/ha DM, demonstrating the ability of this variety to recovery from grazing at GS30 in this environment.
- At GS65, Dynasty (SD3) produced the greatest amount of biomass (11.71 t/ha DM).
- Yiddah$^{\Phi}$, Nile, and Bimbil produced comparable dry matter production at GS65 to Dynasty but required less time to achieve it.

- In most treatment combinations, varieties that received a simulated grazing treatment at GS30 produced less biomass at GS65 than their corresponding non-grazed treatment. However, the local benchmark variety Nile showed the greatest capacity to recover from the grazing treatment applied at GS30 to produce higher biomass at GS65 than the corresponding ungrazed treatment.

Feed quality at GS65

Feed value analysis of all varieties at GS65 indicated border line to above the recommended levels for NDF, which can affect digestibility, limiting intake.

Response to sowing date

Varieties showed a wide variety in the time required to reach critical growth stages. For example, from SD3 Nile and Eurabbie required 106 days to reach GS30 while Dynasty took only 78 days. Whilst it was faster to reach GS30 from SD3, Dynasty then took longer to reach GS65 (204 days) compared with Nile and Eurabbie (both 189 days).

The relatively new variety Dynasty, (released in Australia in 2020) showed the greatest response to sowing date. This variety was the fastest to reach GS30 taking 55 days, 64 days and 78 days for SD1, SD2 and SD3 respectively – at least two weeks faster than most other treatment combinations. This data suggests that a later sowing date and grazing at GS30 are critical to reach the genetic potential of this variety in this environment. A strong sowing date effect was also observed for this variety in relation to grain yield, which was very low from SD1 and highest from SD3.

Grain quality

The grain quality in the experiment was low due to frequent rainfall before harvest, with most treatment combinations scoring test weights below the 48 kg/hL standard specification (GTA, 2020).

Screenings were also high in many treatments. The inability to achieve grain receival standards, limited the marketability of the grain produced.

Eurabbie, from a mid-April sowing, was the best performing variety in terms of physical grain quality.

This experiment suggests that the oat varieties that offer the greatest flexibility for growers to achieve both grazing at GS30 and the opportunity to harvest grain in this high rainfall environment, included Nile, Eurabbie and Dynasty. Both Eurabbie and Dynasty produced biomass at GS30 and grain yield comparable with Nile at the late sowing date (14 April). Like Nile, at all sowing dates, Eurabbie and Dynasty produced higher grain yield from the grazed treatments compared with the corresponding ungrazed treatments.

The NSW DPI 2021 *Winter crop variety sowing guide* (Matthews et al. 2021) provides additional multi-season biomass and yield data and disease ratings for oat varieties in the Northern Tablelands and northern slopes regions of NSW. It also includes information on varietal differences in terms of feed values in oat grain.

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