National Hay Agronomy - what variety, when to sow and what N rate to use?

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Location
Kalkee North
Rainfall
2019 (Nov-Oct): 363 mm
2019 (Apr-Oct): 254 mm
Soil type
Clay Loam
Paddock history
2018: Duram wheat
Nutrition
Available nitrogen (0-100cm) 30kg N/ha
Plot size
7 m x 1.8 m x 3 reps x 30 cm row spacing

Key messages

- **Hay yield was optimised by sowing either Mulgara, Wintaroo, Yallara or Brusher at the start of May.**
- **Delaying sowing from 1 May to 6 June reduced hay yield by 1.5 t/ha.**
- **WA hay varieties Williams and Carrolup were lower yielding when sown early, yet yielded similarly to Mulgara, Wintaroo and Brusher when sowing was delayed.**
- **Hay yield was optimised when 120 kg N/ha was applied.**
- **Stem thickness increased as applied N increased to 60 kg N/ha, before plateauing as N increased to 150 kg N/ha**

Why do the trial?

Hay can provide the highest gross margin crop in the program, while reducing business and production risk. Hay reduces risk by diversifying income across additional markets and selling periods and, due to the earlier harvest, hay crops can conserve moisture for subsequent crops. Deciding to cut hay can provide opportunities for frosted, water limited and heat-affected crops that are unlikely to fill grain, while reducing the weed seedbank at the same time.

Oaten hay accounts for almost 75 per cent of fodder exported from Australia each year. The National Hay Agronomy project is a four-year investment by the AgriFutures™ Export Fodder Program, led by Western Australia's Department of Primary Industries and Regional Development, with BCG, Agriculture Victoria, NSW DPI and SARDI. The project aims to improve understanding of how agronomic practices affect export oaten hay production and quality. This will help growers better manage oaten hay crops to meet export market specifications and develop a competitive advantage in our export fodder markets.

The aim of this research is to evaluate hay production and quality of oat varieties at different times of sowing and under different nitrogen (N) nutrition strategies.

How was it done?

A replicated field trial was sown with oats using a complete randomised block trial design. The treatments and sowing dates are listed in Table 1. The targeted plant density was 320 plants/m^2 and the trial had three replicates. The trial was sown using small plot equipment with knife points + splitter boot (70 mm split), press wheels and 30 cm row spacing. The fertiliser used was Granulock® Supreme Z + Flutriafol (200 mL/100 kg) @ 60 kg/ha at sowing, and seed treatments of Vibrance® @ 360 mL/100 kg and Gaucho® @ 240 mL/100 kg. The trial was managed as per best practice for herbicides, insecticides and fungicides.

Assessments included establishment counts, NDVI crop biomass, hay biomass at GS71, plant height, lodging, leaf greenness (SPAD chlorophyll measure) and stem diameter. NIR (including DairyOne calibration) was being analysed at the time of writing.

What happened?

Hay yield was influenced by variety selection, sowing date and rate of applied nitrogen. An interaction between sowing date and variety selection reflected the different maturity types within the trial - the ranking of varieties changed as sowing was delayed. An interaction between variety and nitrogen rate indicated that there were different sensitivities to applied N within the varieties in the trial.

Sowing in early May produced an additional 1.5 t/ha of hay than June sowing in 2019 (Table 2). All varieties yielded higher at TOS 1 except Carrolup.

The highest yielding TOS 1 varieties were Mulgara, Wintaroo, Brusher and Yallara, which averaged more than 8 t/ha (Table 2). The early finish to the 2019 spring meant the early-mid season variety Yallara finished better than expected.

Table 1. Treatments, time of sowing (TOS), oat variety and nitrogen rate (kg N/ha), Kalkee 2019.

Time of sowing	Oat variety	Nitrogen rate (kg N/ha applied as 2/3 at seeding, 1/3 at 6 weeks after germination)
TOS 1: 1 May TOS 2: 6 June	Brusher Carrolup Durack Forester Koorabup Mulgara Williams Wintaroo Yallara	10 (Mulgara, Wintaroo, Yallara only) 30 60 90 120 (Mulgara, Wintaroo, Yallara only) 150 (Mulgara, Wintaroo, Yallara only)

Table 2. Oaten hay yield (t/ha) response to TOS and N rate. Letters indicate significant difference.

Variety	Hay yield (t/ha)				
	Time of sowing		Nitrogen rate (kg N/ha)		
	TOS 1	TOS 2	30N	60N	90N
Brusher	8.1^{abc}	6.3^{hijk}	6.0^{ijkl}	7.9^{bc}	7.8^{bc}
Carrolup	7.1^{efg}	6.5^{ghi}	5.5^{l}	7.7^{bcd}	7.2^{cdefg}
Durack	7.8^{bcd}	5.8^{jk}	5.7^{kl}	6.9^{defgh}	7.7^{bc}
Forester	6.7^{gh}	5.7^{k}	5.7^{l}	6.5^{hijk}	6.5^{ghik}
Koorabup	7.5^{cde}	5.7^{k}	5.8^{jkl}	6.6^{fghi}	7.5^{bcd}
Mulgara	8.6^{a}	6.6^{gh}	6.0^{ijkl}	8.0^{ab}	8.5^{a}
Williams	7.4^{def}	6.4^{hij}	6.0^{ijkl}	7.2^{cdef}	7.4^{bcde}
Wintaroo	8.2^{ab}	6.8^{fgh}	6.7^{efghi}	7.9^{bc}	7.9^{bc}
Yallara	8.2^{abc}	5.9^{ijk}	6.2^{ijkl}	7.3^{bcdef}	7.6^{bcd}
Average	**7.7**	**6.2**	**6.0**	**7.3**	**7.6**
Sig. diff.			*<0.001*		
TOS Variety			*<0.001*		
TOS x Variety			*0.011*		
N			*<0.001*		
TOS x N			*ns*		
Variety x N			*0.05*		
TOS x Variety x N			*ns*		
LSD (P=0.05)			*0.37*		
TOS			*0.45*		
Variety			*0.25*		
TOS x Variety			*0.66*		
N			-		
TOS x N			*0.74*		
Variety x N			-		
TOS x Variety x N					
CV%			*9.2*		

The lowest yielding was late-maturing Forester (6.2 t/ha), which is well adapted for high rainfall and irrigated regions. In other low-medium rainfall regions Forester generally fails to finish for hay by starting to discolour before it reaches the hay cutting, watery ripe stage. This is the general experience right across southern Australia from WA to southern NSW.

A new variety Koorabup (formerly 05096-32) with early-mid to mid-season maturity, was expected to yield better from the shorter finish than it did.

Nitrogen response

Yield increased as N rate increased from 30 to 60 kg N/ha for all varieties, but only Koorabup and Durack responded to the increase to 90 kg N/ha (Table 2). The largest yield responses to increasing N from 30 to 60 kg N/ha were by Brusher, Carrolup and Mulgara, and Koorabup. Mulgara yielded the highest with 90 kg N/ha. Forester's response to increasing N was low, again because its maturity is too late.

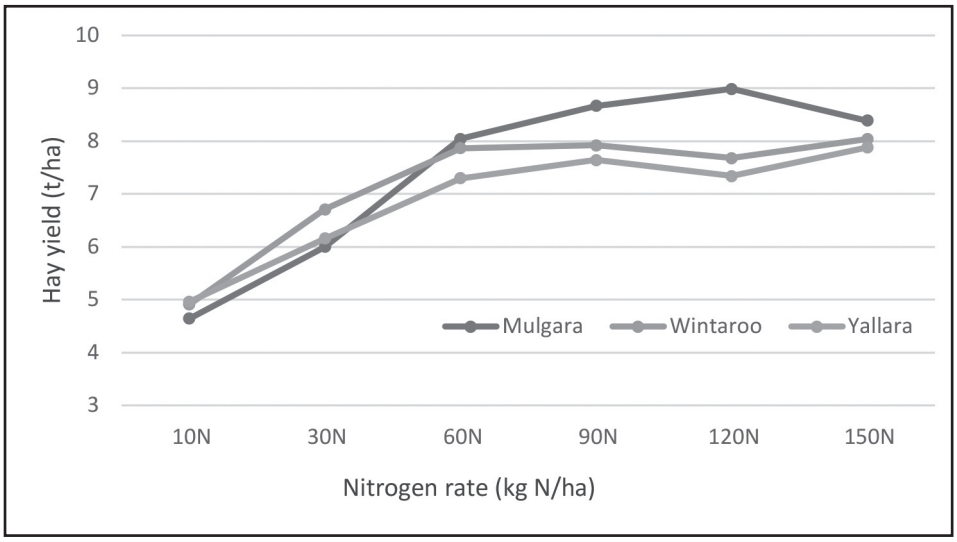

Figure 1. Mean oaten hay yield (t/ha) response to six nitrogen rates, Kalkee 2019 (P=0.024, LSD=0.79 t/ha, CV=9.7%).

Hay yield rose as N rate increased until 60 kg N/ha in Mulgara, Wintaroo and Yallara. Yield then plateaued and no further yield benefit was obtained from higher rates of N (Figure 1).

Hay quality

Plant height: The dry finish stalled plant height in general. Height responded to TOS x Variety x N (P=0.017). An earlier TOS allows plants to have a longer growing season before maturing and hence reach greater heights. May sown plants averaged 81.1 cm compared with early June sown plants at 67.8 cm. The tallest varieties were TOS 1 Mulgara, Durack, Wintaroo and Brusher above 88 cm. As N rate increased from 30 to 60 kg N/ha, plant height increased by 5 cm.

Lodging: There were no issues with lodging for any treatments in 2019.

Leaf greenness (SPAD chlorophyll measure): Greenness of hay is an indicator of plant health at cutting i.e. whether plants have been heat or water stressed, or if hay has been weather damaged, and forms part of the subjective analysis that determines hay price. Leaf greenness was highest for Williams, closely followed by Mulgara, Brusher and Koorabup, while Carrolup had the least colour. Later sown June varieties were greener than May sown (P<0.001), with the largest changes due to sowing time measured in Koorabup and Carrolup (P<0.01). Raising N from 30 to 60 kg N/ha increased greenness (P<0.05) for Brusher, Carrolup, Durack, Forester and Mulgara. There was no further response to 90 kg N/ha.

Stem thickness: Thinner stems (<6 mm) with lower fibre and higher water-soluble carbohydrates make better quality hay. Stem thickness responded to TOS (P<0.001), variety (P<0.001) and N rate (P<0.05). Later sowing reduced stem thickness from 4.73 mm to 3.98 mm. Varieties with the finest stems were Koorabup and Brusher, both under 4 mm. Raising N from 30 to 60 kg N/ha increased stem thickness from 4.22 to 4.41 mm. There was no further response to 90 kg N/ha.

What does this mean?

A combination of an adapted variety and the right agronomy will maximise the production and quality of oaten hay crops. Varieties with early-mid season maturity will perform best in the southern Mallee and Wimmera. Production of a late season variety, such as Forester, won't be optimised because it must be cut before peak biomass is reached in order to achieve hay quality.

Sowing early produces higher yielding hay crops. Better quality can be achieved when adequate N is applied in response to seasonal conditions, rather than large amounts applied early which are at risk of not being used if the season dries off. Despite good winter growing conditions, the dry finish meant 60 kg N/ha maximised yield and quality for all varieties, and the standard N rate of about 90-100 kg was more than adequate in a season like 2019.

This is the first year of a four-year research program. Results are indicative of the 2019 season and should be considered on the basis of growing conditions during this one season. The trial will be repeated in 2020 to evaluate these agronomic practices under a different set of seasonal conditions.

Acknowledgements

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