Nitrogen and Potassium...Important for Oat Hay Yield and Quality

By Stephen Loss

Production of oats for hay and grain is increasing in Western Australia, particularly for the export hay market. Initially, some growers suspected that high rates of fertilizer could have a negative impact on hay quality. However, this study found that adequate nitrogen (N) and potassium (K) fertilization enhanced the yield and quality of oat hay and grain. Nitrogen increased hay and grain yield, and hay protein content. While it appeared that K was less important than N for hay yield, K improved hay quality parameters important for the export market. There was no evidence that high rates of N or K decreased hay quality.

Over 500,000 tonnes (t) of cereals are cut for hay annually in Western Australia from more than 100,000 hectares (ha). Around 150,000 t of oat hay is currently exported, primarily to Japan, with the industry growing rapidly. Exporters have specific quality standards for oat hay to meet market requirements. Limited farmer experience had suggested that high rates of fertilizer might reduce quality. In response, several field experiments were conducted to examine the effect of K and N application on hay yield and quality.

One trial was conducted in 2000 at Yerecoin, and three trials were conducted in 2001 at Yerecoin, Aldersyde, and Williams, which represent the main oat producing regions of Western Australia. All sites were on grey brown, sandy loam soils. Soil fertility characteristics are outlined in **Table 1** for pH, organic carbon (C), nitrate-N (NO_3^--N), ammonium-N (NH_4^+-N), and available P, K, and sulfur (S).

Treatments were a complete factorial of four N rates (0, 30, 60, 90 kg N/ha, except at Yerecoin in 2001 where they were 0, 40, 80, 120 kg N/ha) and three rates of K (0, 30, 60 kg K_2O/ha at Aldersyde and Williams and 0, 48, 96 kg K_2O/ha at Yerecoin). Nitrogen sources were urea in 2000 and liquid urea ammonium nitrate (UAN) in 2001, broadcast on the surface before sowing except for the highest rate, which was split between sowing and four to eight weeks after sowing. Potassium was top-dressed as muriate of potash (KCl) before sowing. At Yerecoin, a soil

Table 1. Soil characteristics (0 to 10 cm depth) at experimental sites, Western Australia.

	Yerecoin	Aldersyde	Williams
Soil pH, calcium chloride	4.5	4.3	5.2
Organic C, %	1.03	0.73	2.75
NO_3^--N, mg/kg	13	8	6
NH_4^+-N, mg/kg	10	5	9
Available P, mg/kg	18	28	58
Available K, mg/kg	24	70	60
Available S, mg/kg	6	7	15

Table 2. Effect of N application on biomass production at spring oat hay harvest, Western Australia.

N rate, kg/ha	Yerecoin (2000)	Williams (2001)	Aldersyde (2001)	Yerecoin deep-ripped area (2001)
0	1.96	5.32	3.44	6.27
30	3.18	6.01	4.60	–
40	–	–	–	7.71
60	3.56	6.41	5.82	–
80	–	–	–	8.97
90	4.21	6.73	5.67	–
120	–	–	–	9.24
LSD (p=.05)	0.64	0.49	0.99	1.83

Table 3. Improvement in crude protein content (%) of oat hay with N application, Western Australia.

N rate, kg/ha	Yerecoin (2000)	Williams (2001)	Aldersyde (2001)	Yerecoin deep-ripped area (2001)
0	7.25	4.68	5.77	6.37
30	7.16	5.01	6.31	–
40	–	–	–	7.44
60	7.71	5.93	6.93	–
80	–	–	–	8.14
90	8.03	5.94	6.97	–
120	–	–	–	9.01
LSD (p=.05)	0.74	0.46	0.58	0.91

compaction layer was noted at about 15 cm depth, and in 2001 half the trial was deep-ripped to 30 to 40 cm three days after sowing. Spring hay production was measured in four quadrats cut from each plot, oven-dried, and analyzed for quality parameters [i.e., protein content, metabolizable energy (ME), digestible dry matter (DDM), neutral detergent fibre (NDF), and acid detergent fibre (ADF)].

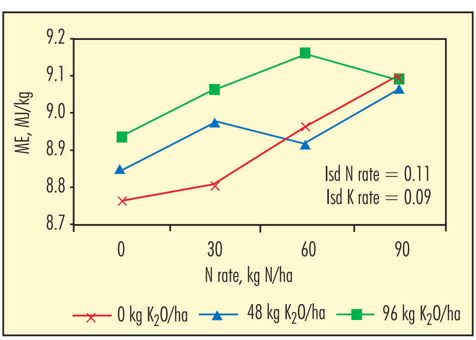
Production and Quality Responses

Application of N increased hay production at all sites (**Table 2**), but there were no significant yield responses to K. Maximum response to N occurred at 40 to 60 kg N/ha at all sites except for Yerecoin in 2000, where increases in biomass did not plateau before 90 kg N/ha. Deep ripping at Yerecoin in 2001 increased average hay production from 6.2 to 8.4 t/ha and there was no response to N or K unless the soil was deep-ripped.

Crude protein content of hay was significantly increased by N application at all sites (**Table 3**). Ripping at Yerecoin and K application had no consistent effect on protein content.

Other hay quality parameters did not respond to N or K application at Yerecoin or Aldersyde in 2001, but at both sites hay quality achieved export standards. On the other hand, the application of fertilizer at Yerecoin in 2000 and Williams in 2001 significantly improved other hay quality parameters. In one case, export standards were met only when K fertilizer had been applied.

Figure 1. Metabolizable energy (MJ/kg) increased with N and K application at Yerecoin, Western Australia, 2000.



At Yerecoin in 2000, the ME of hay was increased by N and K application, from 8.8 mega joules (MJ)/kg at zero N and K to 9.2 MJ/kg at 60 kg N/ha and 96 kg K_2O/ha (**Figure 1**). Digestible dry matter showed similar trends, increasing from 61.5% at zero N and K to 63.5% at 60 kg N/ha and 96 kg K_2O/ha.

While NDF is a measure of the amount of structural carbohydrate in forage (including both digestible and indigestible components) and is negatively correlated with animal voluntary feed

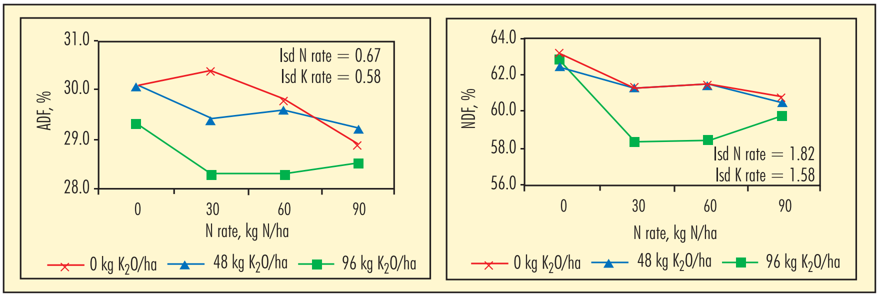


Figure 2. Both ADF (left) and NDF (right) decreased with N and K application at Yerecoin, Western Australia, 2000.

intake, ADF is a measure of indigestible carbohydrates only and is negatively correlated with digestibility. Both NDF and ADF decreased with N and K application (**Figure 2**).

At Williams, quality parameters were not affected by N application, but improved significantly with K application (**Table 4**). Digestible dry matter increased from 60.5% in the control to 62.0% at 60 kg K_2O/ha. Neutral detergent fibre was 58.3% in the control treatment, exceeding the 57% level generally demanded by exporters, but this fell to 56.8% at 30 kg K_2O/ha. Acid detergent fibre fell from 30.7% at zero K to 29.2% at 60 kg K_2O/ha.

Table 4. Improvement in hay quality parameters with K application at Williams, Western Australia, 2001.

K_2O rate, kg/ha	ADF, %	NDF, %	DDM, %	ME, MJ/kg
0	30.7	58.3	60.5	8.65
30	29.7	56.8	61.4	8.80
60	29.2	56.3	62.0	8.86
LSD (p=.05)	1.03	1.53	0.87	0.14

Grain yield was recorded at Yerecoin and Williams in 2001. At Yerecoin, grain yields were significantly greater in the ripped (3.4 t/ha) than the unripped areas (2.9 t/ha). Grain yield also responded to N application reaching a maximum at 80 kg N/ha, but did not respond to the addition of K.

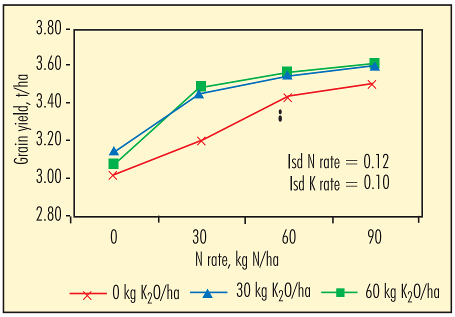


Figure 3. Grain yield was increased with N and K application at Williams, Western Australia, 2001.

At Williams, grain yields increased with N application from 3.0 t/ha to 3.5 t/ha at 90 kg N/ha. The addition of 30 kg K_2O/ha increased grain yields further, especially at low N rates (**Figure 3**).

Conclusions

Application of N fertilizer improved the hay and grain yield of oats. Apart from hay protein content, N affected hay quality parameters at only one site. On the other hand, K application did not affect the yield of hay, but was able to improve hay quality and could also affect grain yield. There was no evidence that high rates of N or K decrease hay quality. Soil hard pans can restrict oat growth and, hence, limit responses to fertilizer application. **BCI**

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