Research Report:

Nitrogen and potassium are important for oaten hay yield and quality

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 fertiliser could have a negative impact on hay quality. The effect of K and N fertilisation on the yield and quality of oaten hay and grain was studied by CSBP futurefarm in 2000 and 2001. It was found that N improved the yield of hay and grain, and improved the protein content of hay. It appeared that K was less important than N for hay yield, but 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 of cereals are cut for hay annually in Western Australia from over 100 000 hectares. Of this, Western Australia currently exports around 150 000 tonnes of oaten hay, primarily to Japan, with the industry growing rapidly. Exporters have specific quality standards for oaten hay to meet export market requirements. Limited farmer experience had suggested that high rates of fertiliser might reduce oaten hay quality. In response, several field experiments were conducted to examine the effect of K and N application on oaten hay yield and quality.

Method

One trial was conducted in 2000 at Yerecoin and three trials 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 and soil fertility characteristics are outlined in Table 1.

Table 1. Soil characteristics (0-10cm) at experimental sites.

	Yerecoin	Aldersyde	Williams
pH_{CaCl}	4.5	4.3	5.2
OC%	1.03	0.73	2.75
P (mg/kg)	18	28	58
NO_3-N (mg/kg)	13	8	6
NH_4-N (mg/kg)	10	5	9
K (mg/kg)	24	70	60
S (mg/kg)	6	7	15

The treatments were a complete factorial of four N rates (0, 30, 60, 90 kg/ha except at Yerecoin in 2001 where they were 0, 40, 80, 120 kg/ha) and three rates of K (0, 25, 50 kg/ha at Aldersyde and Williams and 0, 40, 80 kg/ha at Yerecoin). Nitrogen was applied as urea (2000) or liquid urea ammonium nitrate (2001), and was applied broadcast before sowing except for the highest rate, which was split between sowing and 4-8 weeks after sowing. Potassium was applied as muriate of potash top-dressed before sowing. At Yerecoin, a soil compaction layer was noted at about 15cm depth, and in 2001 half the trial was deep ripped to 30-40cm three days after sowing. Spring hay production was measured in four quadrats cut from each plot, which were oven dried and analysed for quality parameters (protein content, metabolisable energy, digestible dry matter, neutral detergent fibre and acid detergent fibre).

This research was undertaken by CSBP futurefarm with the assistance of Milne Feeds and Canpotex Ltd

CSBP futurefarm.

Hay Production Responses

Application of N increased hay production at all sites (Table 2), but there were no statistically significant yield responses to K application. Maximum response to N application occurred at 40 – 60 kg N/ha at all sites except for Yerecoin in 2000 where increases in biomass at 15 weeks after sowing (WAS) 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 at Yerecoin in 2001 where soil was not ripped.

Table 2. Effect of N application on biomass production at 15 WAS (Yerecoin 2000) or at hay harvest (all other sites).

N rate (kg/ha)	**Yerecoin 2000**	**Williams 2001**	**Aldersyde 2001**	**Yerecoin 2001** (ripped area)
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	*0.64*	*0.49*	*0.99*	*1.83*

Hay Quality Responses

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.

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

N rate (kg/ha)	**Yerecoin 2000**	**Williams 2001**	**Aldersyde 2001**	**Yerecoin 2001** (ripped area)
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	*0.74*	*0.46*	*0.58*	*0.91*

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 fertiliser at Yerecoin in 2000 and Williams in 2001 significantly improved other hay quality parameters. In one case, export standards were only met once K fertiliser had been applied.

At Yerecoin in 2000 metabolisable energy (ME) of hay was increased by N and K application, from 8.8 MJ/kg at nil N and K to 9.2 MJ/kg at 60 kg N/ha and 80 kg K/ha (Figure 1). Digestible dry matter showed similar trends increasing from 61.5% at nil N and K to 63.5% at 60 kg N/ha and 80 kg K/ha.

Neutral detergent fibre (NDF) is a measure of the amount of structural carbohydrate in a forage, including both digestible and indigestible components, and is negatively correlated with animal voluntary feed intake. Acid detergent fibre (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).

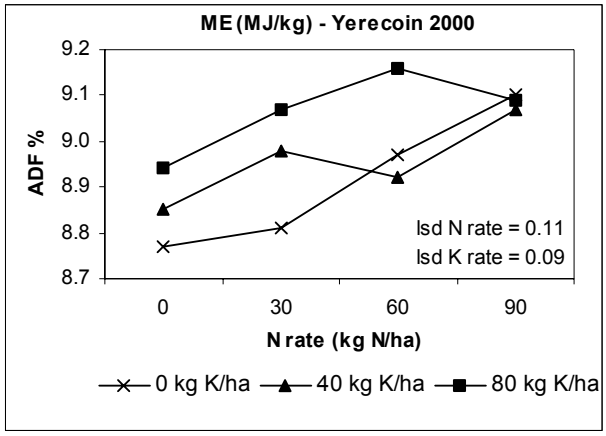
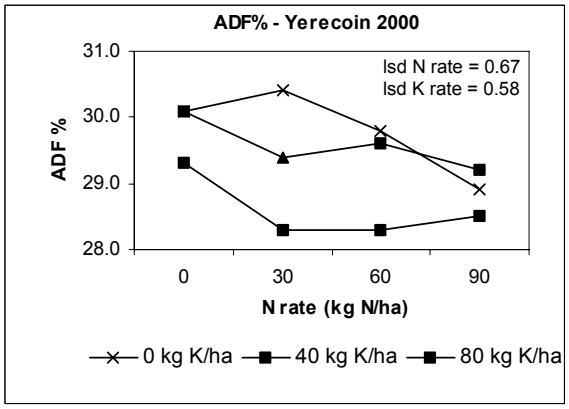


Figure 1. Metabolisable energy (MJ/kg) increased with N and K application at Yerecoin in 2000.



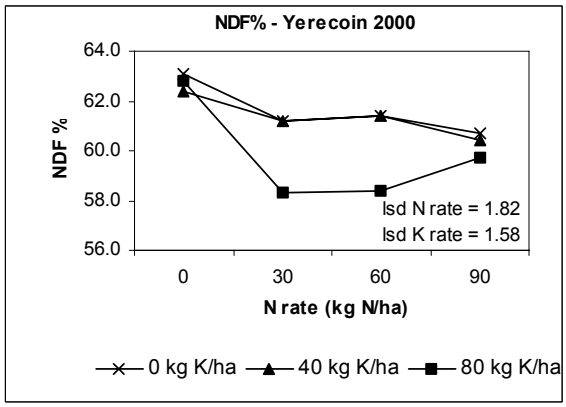


Figure 2. Both acid and neutral detergent fibre were reduced with N and K application at Yerecoin in 2000.

At Williams, quality parameters were not affected by N application, but were improved significantly with K application (Table 4). Digestible dry matter increased from 60.6% in the control to 62.0% at 50 kg K/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 25 kg K/ha. Acid detergent fibre fell from 30.7% in the nil to 29.2% at 50 kg K/ha.

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

K rate (kg/ha)	**ADF %**	**NDF%**	**DDM%**	**ME** (MJ/kg)
0	30.7	58.3	60.5	8.65
25	29.7	56.8	61.4	8.80
50	29.2	56.3	62.0	8.86
lsd	*1.03*	*1.53*	*0.87*	*0.14*

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Grain Yield Responses

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.

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 25 kg K/ha increased grain yields further, especially at low N rates (Figure 4).

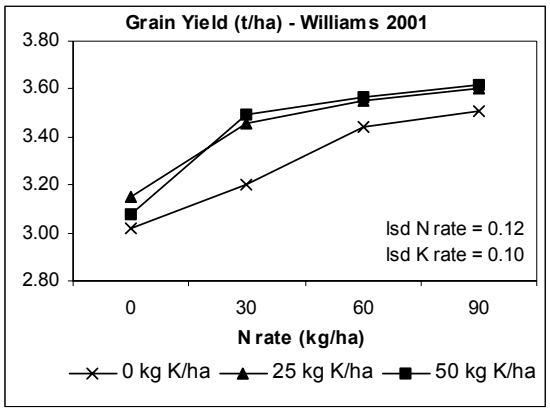

Figure 3. Grain yield was increased with N and K application at Williams in 2001

Conclusions

Application of N fertiliser improved the hay and grain yield of oats. Apart from hay protein content, N only affected hay quality parameters at 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 fertiliser application.

Further information

Further information on this research is available by contacting

Dr Stephen Loss
Field Research Manager
CSBP futurefarm
PO Box 345
Kwinana WA 6965
Ph: (08) 9411 8777
Fax: (08) 9382 9121
stephen_loss@csbp.wesfarmers.com.au

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