DOES ZONAL NITROGEN MANAGEMENT IN MILLING WHEAT PAY?

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Abstract

Is there value in variable rate nitrogen (N) management of a wheat crop with variable soil properties and variable potential yield? Specifically, can the N rate be reduced in zones with lower potential yield with no loss of yield? A nitrogen trial was set up in a paddock of irrigated autumn sown milling wheat cv Sage at Methven as part of a MAF SFF funded crop sensing project. Two N response trials were established in different yield potential zones of the paddock based on soil texture. Lighter and heavier soil zones were selected as identified by an EM survey of the paddock. A desktop comparison of variable rate N based on the optimal N rate for each of the two zones with one rate applied to the paddock was made.

Methods

Two trials were set up in a paddock of 'Sage' wheat at Methven, in Mid-Canterbury, on an irrigated Mayfield silt loam soil type. Lighter and heavier soil zones (low and high yield potential zones) were selected as identified by an EM survey of the paddock (Figure 1). The EM measurements are related to soil texture and hence water holding capacity estimates. Most yield maps will show a relationship or interaction with soil EM because of the link between texture and water holding capacity.

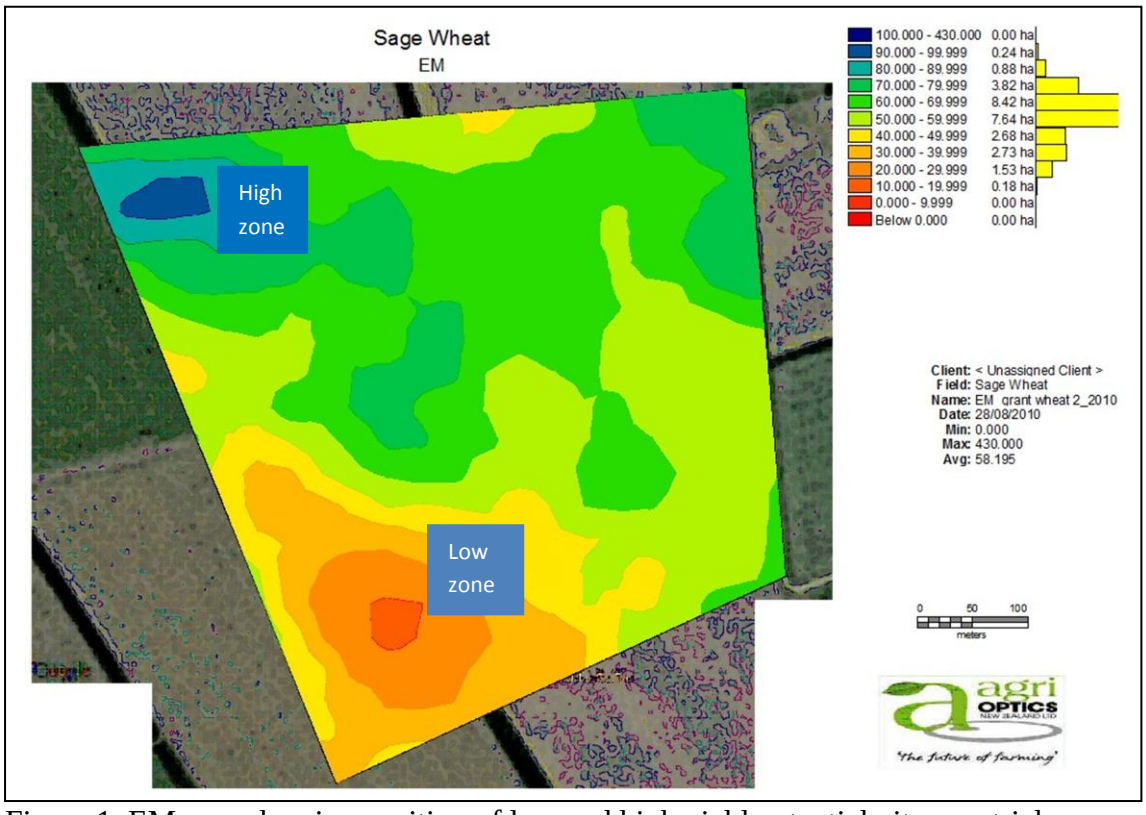

Figure 1. EM map showing position of low and high yield potential nitrogen trials

Both trials were a randomised complete block trial design with 5 treatments and 4 replicates. The amounts of nitrogen applied were determined by soil mineral N test results conducted in early spring, in each of the trial zones. The low zone had 63 kgN/ha, and the high zone 53 kgN/ha, (0-60cm). Nitrogen rate treatments ranged from 123 to 445 kg N/ha including soil mineral N. Nitrogen was applied at 3 timings 16 September, 20 October and 19 November 2010. At all N application dates a rainfall or irrigation event occurred which ensured that the Urea was taken into the soil, minimising any significant losses due to volatilisation.

The grain yields were measured on 17 February 2011 by harvesting a 1.65m wide swath from the centre of each plot with a Sampo plot combine. The % protein, thousand grain weight (TGW), test weight (TW) and % screenings for each treatment were measured.

Results and Discussion

In the low potential yield zone, a maximum yield of 9.2 t/ha was reached with a total soil mineral + applied N of 320 kg N/ha (Figure 2). In the high potential yield zone, a maximum yield of 10.7 t/ha was reached with a total of 260 kg N/ha. Protein increased linearly with increasing N rate (Figure 3).

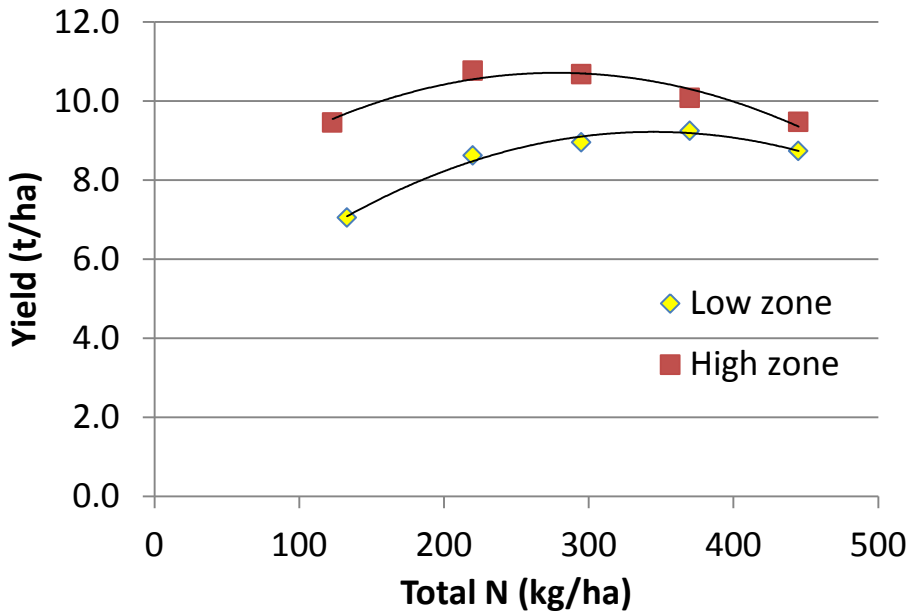

Figure 2. Yield response to nitrogen (soil mineral and applied) on the low and high yield potential zones. LSD = 0.53.

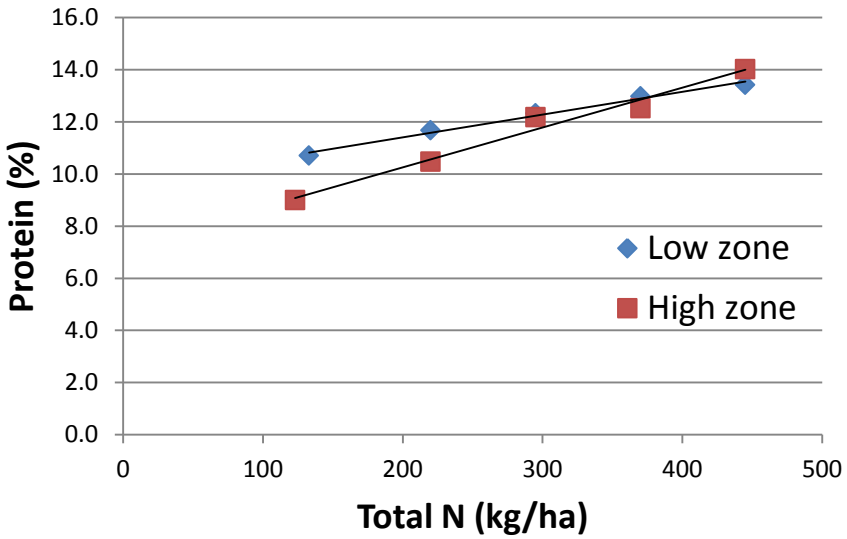

Figure 3. Protein response to nitrogen (soil mineral and applied) on the low and high yield potential zones. LSD = 0.4.

Because the yield and N off-take in the grain on the high zone was higher at a lower N rate compared with the low zone it is probable the heavier soil mineralised more N through the season or this zone retained its fertiliser N from the previous crop better. This may explain why the higher yield was achieved in the high zone with less applied N. Revenue less N cost was optimal at a total N rate of about 20 kg/ha less than the rate for maximum yield for both trials. The total N required per tonne of grain for maximum yield ranged between 24 and 35 kg N/T for the high and low zone respectively. This agrees with previous N trials on milling wheat which averaged a total N requirement of 30 kg N/T at maximum yield. Additional N to that required for maximum yield increased the protein content but wasn't economic.

Table 1. Yield, optimal N rates, protein, returns, for a low and high potential yield zone for Sage milling wheat and estimated yield and return at one N rate for the paddock

	Low potential yield zone	High potential yield zone
Maximum yield (t/ha)	9.2	10.7
Optimal total N for max yield (kg/ha)	320	260
Optimal total N for max revenue - N cost (kg/ha)	300	240
Total kg N/T grain at maximum yield	35	24
Protein (%) at maximum yield	12.4	11.2
Revenue less N cost at maximum yield ($)	3,700	4,400
Yield with total N 300 kg/ha (t/ha)	9.1	10.7
Revenue less N cost with total N 300 kg/ha ($)	3,700	4,300
N off-take in grain at maximum yield (kg/ha)	200	210

Was there an advantage to variable rate N management based on zones with different potential yields? A desktop comparison of variable rate N with one rate applied to the paddock was made. An assumption was made that the potential yield of the paddock was 10 t/ha with a total N requirement of 30 kg/t of grain equivalent to 300 kg N/ha would be optimal. A N rate of 300 kg N/ha was the economic optimum on the low potential yield zone. On the high potential yield zone the profit is reduced by about $100/ha because N is applied surplus to requirements. However, the high potential yield zone makes up only a small part of the paddock and therefore variable rate N application from the results of the desktop study would not be viable in a paddock with this level of soil variability.

Conclusions

- There was minimal economic advantage to variable rate N application in this trial.
- High and low potential yield zones were successfully detected by EM measurement.
- Nitrogen use efficiency ranged between 24 and 35 kg total N/T of grain for the high and low potential yield zones respectively.