Summary of January, 1998 Report to Agricultural Development Fund, Province of Saskatchewan

Project Name: Agronomic and Economic Assessment of Variable Rate Fertilization (95000063 Res/ 18BV)

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Abstract/Summary

The interest in the use of variable rate fertilizer (VRF) application has increased substantially over the past two years. Our ADF-funded research program was designed to measure the inherent fertility variations in typical Saskatchewan landscapes and to determine the different yield response of wheat and canola to fertilizer levels in these landscapes. The research sites are located on adjacent quarter-sections of land near Hepburn, Saskatchewan. Canola showed a consistent response to N and P treatments over the two crop years (1996 and 1997). The canola response in the lower slope units was an approximately 14 bu/ac increase in yield with the addition of 140 lb/ac of N. The response of wheat was similar in upper and mid slope units but differed in the two years in the lower slope units. Overall the topographically based management units used in our study are clearly related to actual productivity differences in the fields; the challenge in the remaining year is to predict the response of the units to different inputs based on readily available spring measurements of fertility and moisture.

Technical Summary

The overall objectives of our ADF-funded project are to 1) examine the agronomic implications of VRF, 2) assess the economic component of VRF, and 3) develop the mapping tools to delineate management units on the farm scale. The project has achieved all of the milestones as specified in the original proposal for the reporting

period. All of the groups listed as co-investigators and sponsors above have maintained their contributions at the level specified in the original proposal.

The field and laboratory work on the above-named project has progressed according to schedule. The treatment structure used in the ADF-sponsored research was fully documented in the interim report of June 1, 1997. Summer spraying and soil sampling operations and fall harvesting were carried out at the two sites successfully. Both sites were sampled in spring prior to seeding to allow us to examine the correlation between pre-seeding soil measurements at final yield. A more extensive set of growing season measurements were made at the wheat site to bring the data base for this site in line with the other sites funded by the AFIF program. As well, the meteorological station was maintained throughout the growing season to provide a suite of climatic variables.

1997 Yield Results

Harvest operations were carried out by the Saskatchewan Wheat Pool under the supervision of G. Hnatowich. At both the wheat and canola sites a very clear difference in overall yield among the three management units (upper, mid, and lower slopes) was observed. For the five N treatments at the wheat site, the yields overall were lower on the upper slope units and the response shows a curvilinear form – the maximum yields were observed at the 1X rate and yields declined for higher N rates (Figure 1). The response to N treatments was relatively flat at the mid slope units, but a strong response to N fertilizer occurred in the lower slope units (Figure 1).

At the wheat site, P treatments and seeding rate treatments were also carried out to bring the treatments in line with the treatment structure of the four sites funded under the AFIF program. The P treatments show a consistent response to P additions to the 1X rate, but no apparent benefit exists to increasing P to the 2X rate (Figure 2). In the case of the upper slope units, the 2X P rate decreased yield. The seeding rate treatments were largely designed to influence plant populations, but a consistent decrease from the 1.5 bu/ac seeding rate to the 2.0 bu/ac seeding rate was observed (Figure 3).

A very strong management unit effect exists at the canola site – the overall means increase from the lower slope through the mid slope to the lower slope units (Figures 4 and 5). The upper slope units again show a curvilinear response – the yields flatten or decline slightly after the 1X N rate (Figure 4). A small but progressive increase occurs in the mid slope units and a major increase occurs through the five N treatments in the lower slope units. The increase in the lower slope units is from approximately 22 bu/ac of canola at the 0X N treatment through to 36 bu/ac at the 2X N rate. Given the economics of N costs and the price of canola this represents a major economic benefit. The response to the P treatments at the canola site suggest that the 0.5X P rate was optimum in the mid and lower slope units in 1997.

The final economic assessment for the wheat site awaits the protein measurements. The protein measurements taken at this site in 1996 show a very clear protein response to the N treatments in 1996 (Figure 6). The increase in protein in the N treatments was greatest in the upper slope units, but a consistent response also occurred in the mid and lower slope units.

The protein results for 1997 became available after the submission of the report to ADF in January, 1997 but have been added to the current summary. The grain protein response to the N treatments were very similar in 1997 (Figure 9) to 1996 (Figure 6). The

most consistent response occurred in the upper management unit. In 1996, protein increased from less than 10 to about 13%; in 1997 the increase was from about 11.5 to slightly above 14%. The same progressive increase with higher fertilizer N inputs occurred in both years. The major difference in the midslope and lower slope units was the low protein levels in the 0N1P treatment in 1997 for the lower position compared to 1996. Otherwise the rather flat response to the 0.5 to 2X treatments in the lower slope unit was consistent between the two years.

Protein contents were also measured for the seeding rate treatments at the wheat site in 1997 (Figure 10). On the upper and midslope units the protein contents dropped slightly at the higher seeding rates. No differences were observed with the higher seeding rates at the lower slope unit.

We believe that we have made significant progress towards our objective of providing sound agronomic support for Saskatchewan producers as they move towards adoption of variable rate fertilization. At this point, however, we caution that the full three years of results will be required before a final recommendation can be made. The reason for this caution can be seen in results for the lower slope management units at the two sites for the 1996 and 1997 crop years (Figures 7 and 8). The response to the N treatments for the canola site are very consistent between the two years – the variability increased within treatments in 1997, but the average response was very similar. For the wheat site, however, the response was quite different – no apparent response to the N treatments in 1996 and a pronounced response in 1997. In both years an extensive suite of soil and moisture measurements was made, and we will be analyzing those properties this winter to attempt to explain the differences in response between the two years.

Work in Progress

Our research program over the next six months is designed to use the soil and climate measurements taken over the growing season at the sites to help to explain these differences further. The next report will include the values for fertilizer use efficiency and water use efficiency at the two sites, as well as a report on the dynamics of N availability over the growing season at the N treatments for the wheat site.

We are also using the site mapping tools developed over the first year of the study as the basis for calculating the economic benefit of VRF using the yield results of the two seasons. The site mapping tools are currently being adopted by the new Land Resource Unit of the Saskatchewan Centre for Soil Research for the routine mapping of quarter-sections of land for precision farming.

Acknowledgements

We are grateful to the sponsoring groups for their continued support of this research program. We are also very grateful to the two farm owners, Mr. Fehr and Mr. Goetz, for their patience in working around our field plots during their farming operations.

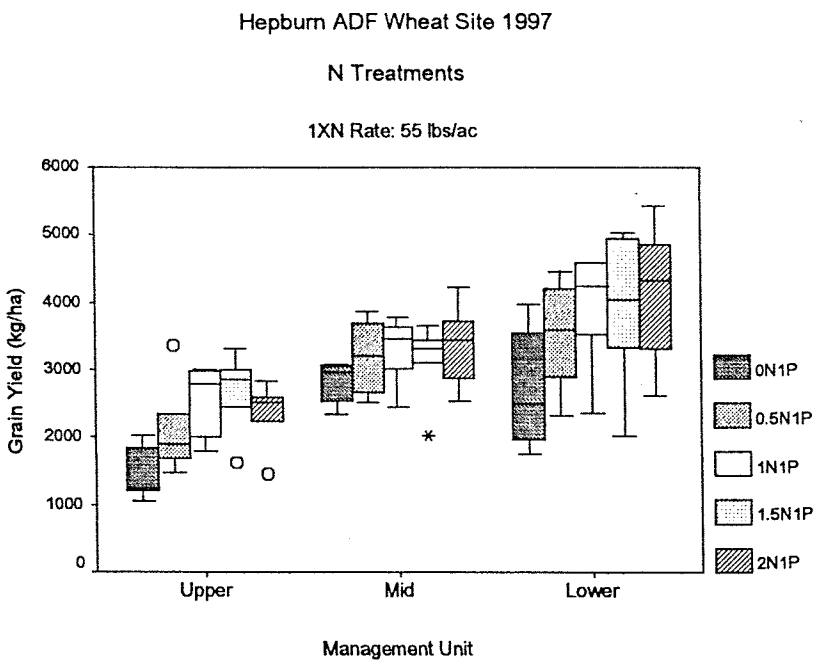

Figure 1: Boxplots for crop yield response to N treatments at the Hepburn ADF Wheat site, 1997. The line in the middle of the box is the median or the 50th percentile; the box and whiskers extend through the full range of values for the six replicates for the treatment.

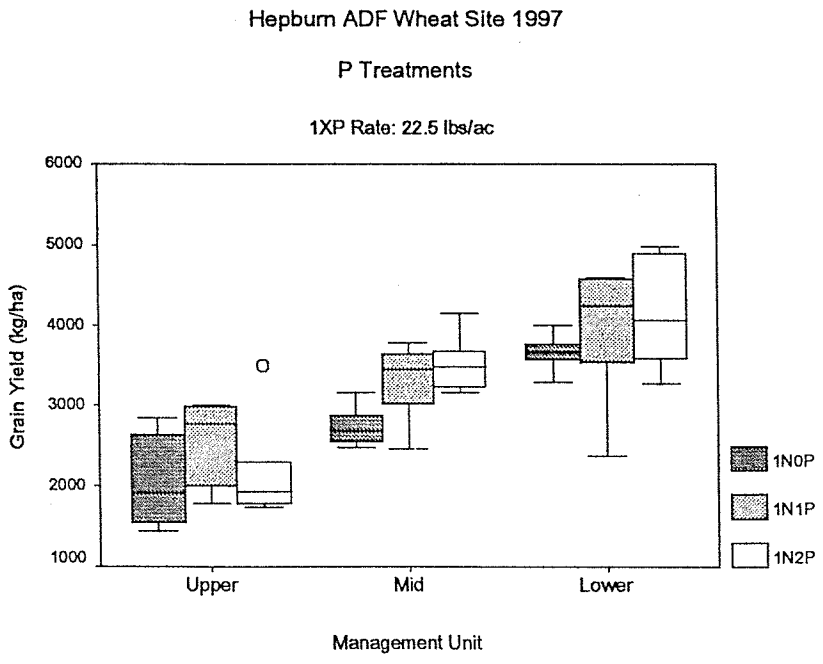

Figure 2: Boxplots for crop yield response to P treatments at the Hepburn ADF Wheat site, 1997.

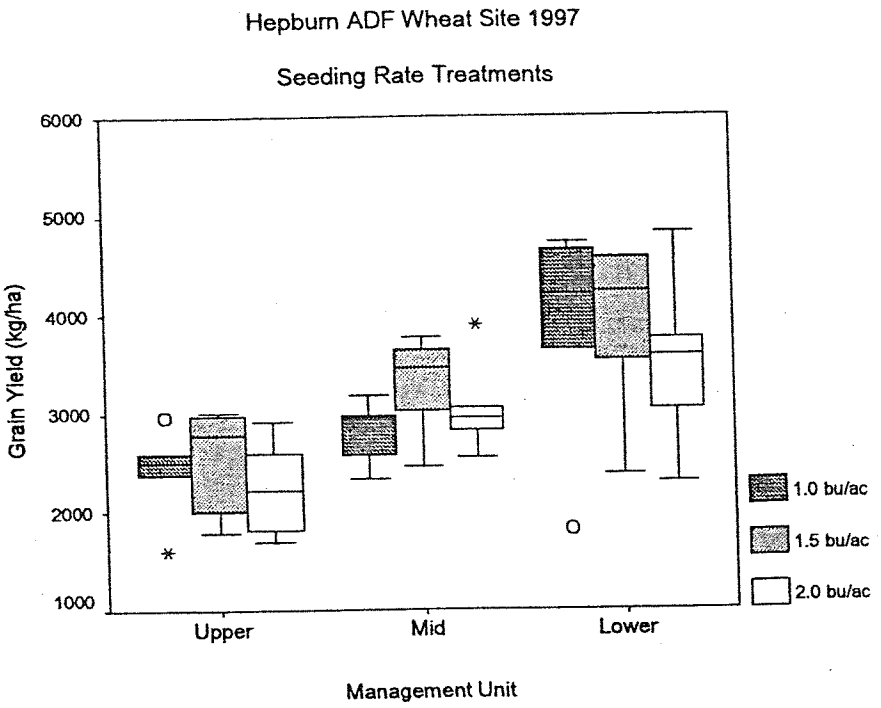

Figure 3: Boxplots for crop yield response to seeding rate treatments at the Hepburn ADF Wheat site, 1997.

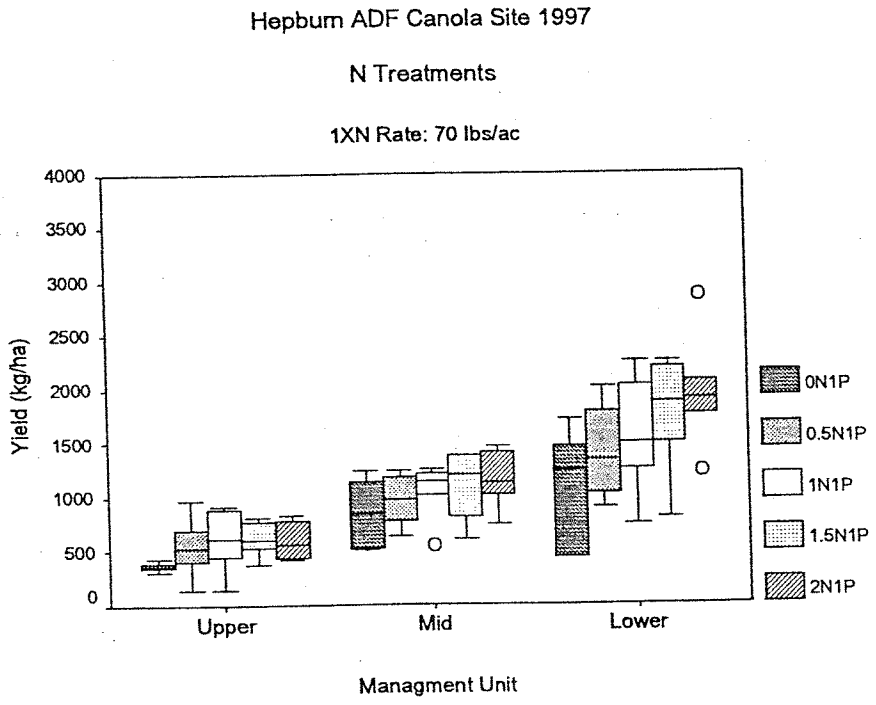

Figure 4: Boxplots for crop yield response to N treatments at the Hepburn ADF Canola site, 1997.

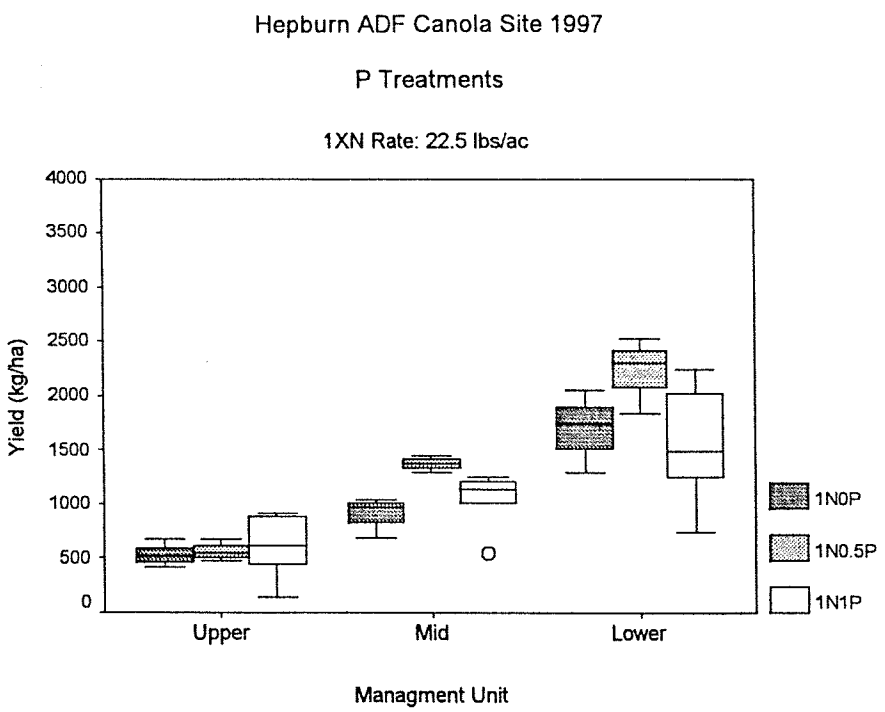

Figure 5: Boxplots for crop yield response to P treatments at the Hepburn ADF Canola site, 1997.

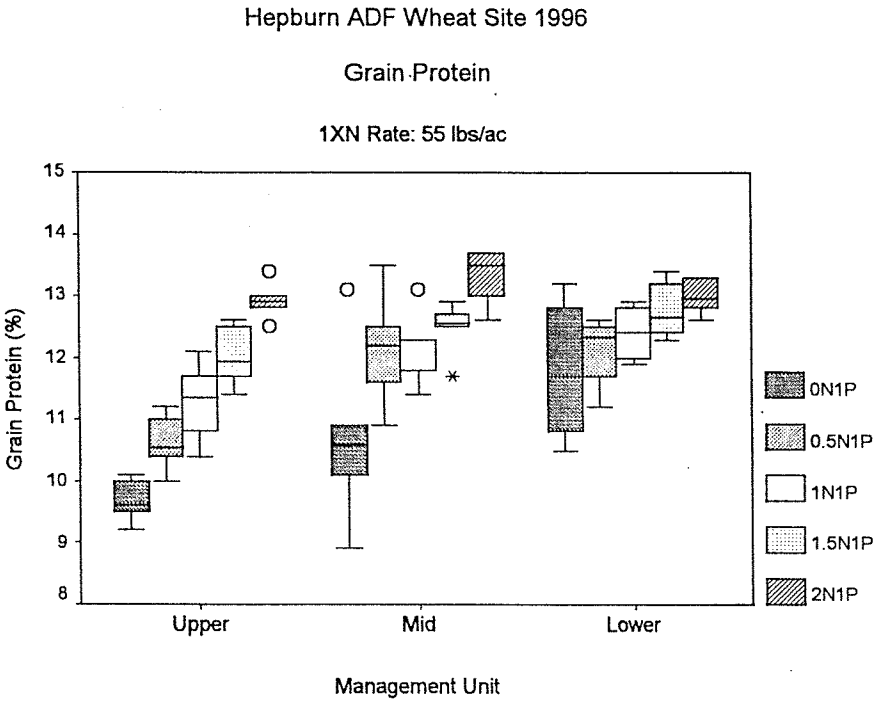

Figure 6: Boxplots for protein response to N treatments at the Hepburn ADF Wheat site, 1996.

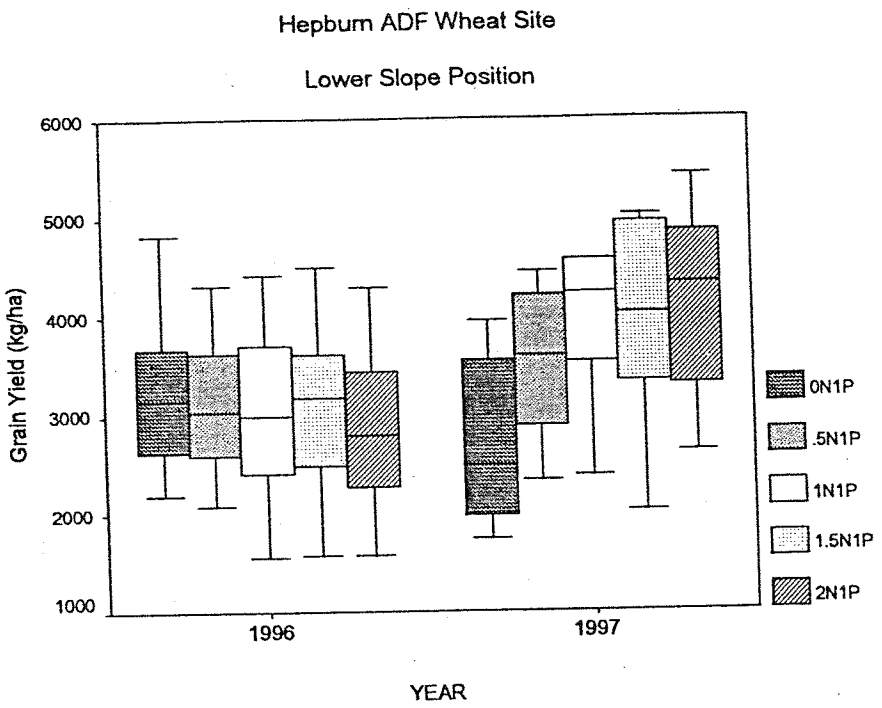

Figure 7: Boxplots for crop yield response to N treatments in the lower management unit at the Hepburn Wheat site in 1996 and 1997.

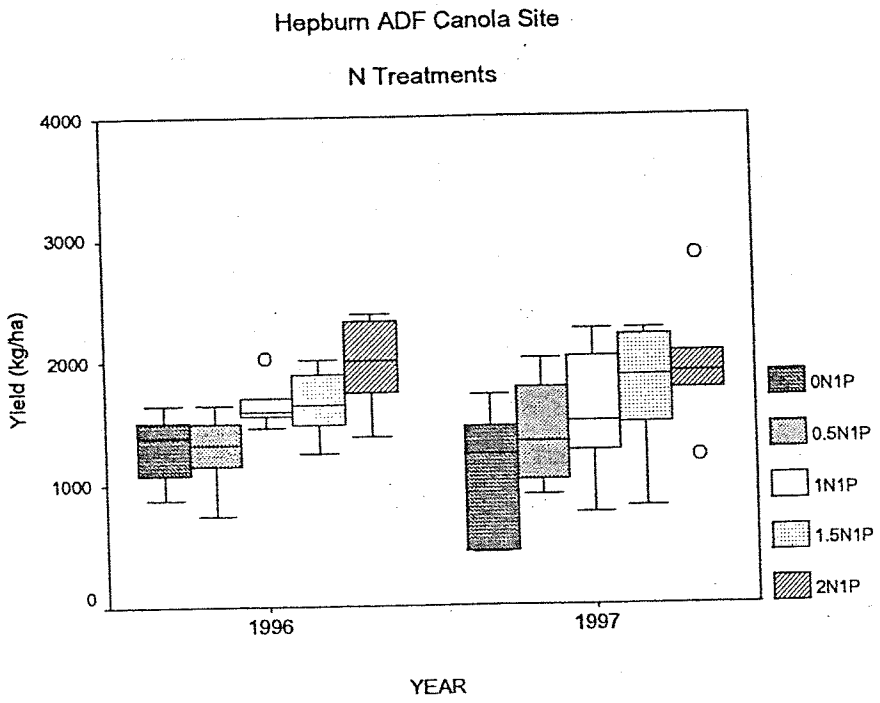

Figure 8: Boxplots for crop yield response to N treatments in the lower management unit at the Hepburn Canola site in 1996 and 1997.

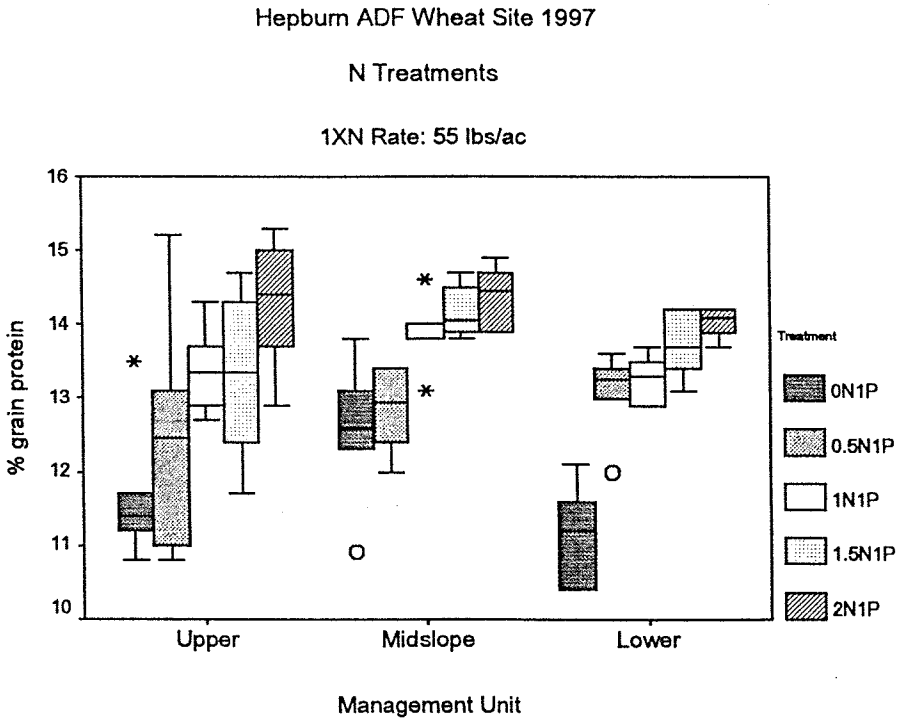

Figure 9: Grain Protein response to N treatments at the Hepburn Wheat site, 1997.

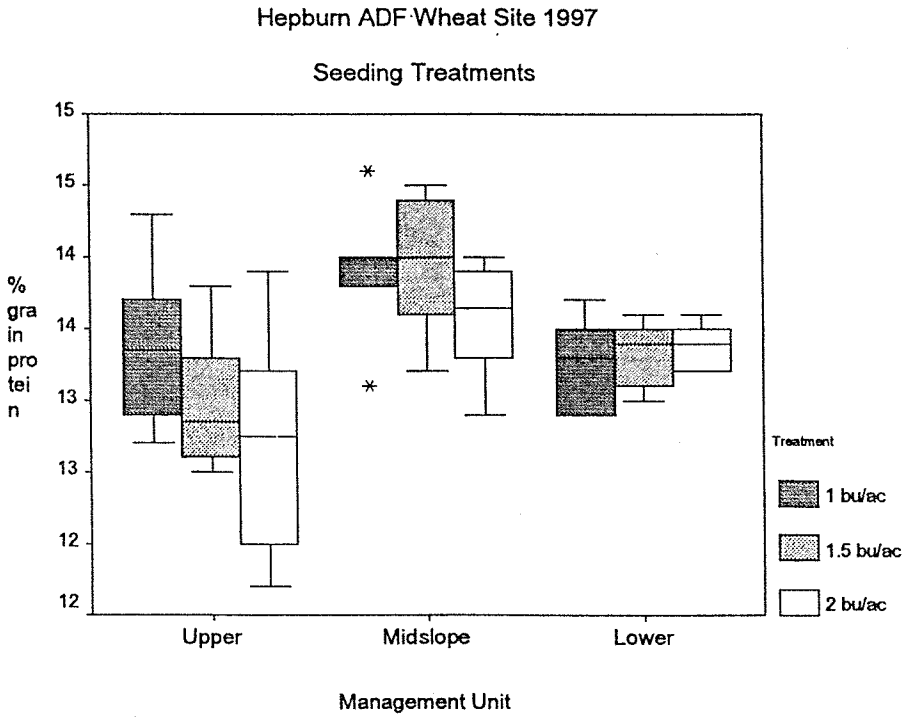

Figure 10: Grain protein response to the seeding rate treatments at the Hepburn Wheat site, 1997.