Effect of landscape position and rates of seed and fertilizer on growth of spring wheat in the Brown and Dark Brown soil zones.

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Introduction

The objectives of this study were to evaluate the interaction of landscape position on crop growth for several fertilization and seeding rates. The study involved one site having spring wheat on wheat stubble (Dark Brown soil zone - Shaunavon, Brett Meinert, cooperator), one site having spring wheat on field pea stubble (Dark Brown soil zone - Biggar, John Bennett, cooperator), and one site having durum wheat on fallow (Brown soil zone - Kyle, Ken Allport, cooperator).

Methods

The treatments were laid out in one drill-width strips along the length of the field (≈800 m) and usually included several landscape positions. At the Kyle site, two experiments were laid out side by side: one measuring the effect of different levels of fertilization and one measuring the effect of different seeding rates on the yield and protein content of the crop (Table 1). At the Shaunavon site, an incomplete factorial involving seeding rates and fertilization rates was established (Table 1). The fertilizer blends used were: Shaunavon, 40-1 O-O; Biggar, 35-15-o; and Kyle, 28-26-O.

Table 1. Fertilizer rates and blends for the experimental sites.

Site	N Rate (ab/ac)	Seed rate (lb/ac)
Shaunavon	0	70
	25	45,70
	50*	45, 70,95 120
	100	70, 120
Biggar	0, 27, 50*, 74, 91	70
Kyle (seed exp.)	20*	40, 60, 70
(fertilizer exp.)	20*, 45.65	50

*soil test recommended

Although the experiments were laid out with two replications of the strips, a yield subsample was taken with a plot combine wherever a strip intersected a different slope position. We treated each of these subsamples as the basic experimental unit and used multiple linear regression to test for treatment effects with indicator variables to discern differences in response between landscape positions (Neter et al., 1990). We used the general liear model procedure in SAS (SAS Inst., 1989). Grain yields and protein contents first converted to a 13.5% moisture basis before analysis.

The yield subsample areas were rated for diseases, insects, and weeds in late July at the Shaunavon and Biggar and in July and August at Kyle.

Results and Discussion

Weeds, diseases, and insects

Insects pests were absent or present at very low levels. There was no obvious effect of seed or fertilizer rates on either leaf diseases or weeds at Shaunavon or Kyle. At Biggar, there was a trend for better weed control and lower incidence of tan spot for the highest two fertilizer rates (74 and 91 lb N/ac) compared with the lowest two rates (0 and 25 lb/ac) (data not shown). There was no clear effect of landscape position on weeds or diseases (data not shown).

Effect of the seeding rate

There was no significant effect of seeding rate on yield or significant interaction of landscape position and seeding rate at Kyle (Figure 1) or Shaunavon (Figure 2). There was no apparent or significant interaction between seeding rate and fertilizer response at Shaunavon (data not shown).

Effect offertilizer rate

The yield response to fertilizer was not as pronounced on the upper slope positions as that on the mid and lower slopes, but it was significant at all landscape positions (see Figures 3-6). There was apparent interaction of fertilizer rate and landscape position at all sites with the response at the knolls being different than that in the lows. This interaction was significant (P=O.O5) at Shaunavon.

Under the generally favourable moisture conditions at Kyle and Shaunavon, the grain protein response was approximately inverse of that for yield (Figures 7 and 8). Increased uptake of N from the first units of added fertilizer resulted in a yield increase such that grain N concentration (or protein) was not increased. Under drought conditions at Biggar, there was insufficient water to produce a large yield response to fertilizer. Thus, additional uptake of N caused an increase in grain N concentration (protein). Because of the experimental design we can not separate the growth response to N and P. However, the yield-protein response to fertilizer was consistent to that expected for N alone (Selles, 1997).

Economics of varying fertilizer based on landscape position

We did a simple economic analysis to determine the effect of applying different rates of the fertilizer blends to upper, mid and lower positions of the field on economic returns. We estimated that the upper and lower slope positions each consisted of 20% of the field area for the fields at Shaunavon and Bigger, with the remaining 60% consisting of mid-slopes. We also assumed that the mean yield and protein for the area sampled within each combination of landscape position and treatment (the experimental unit) was applicable to that entire experimental unit. At the Kyle site, the upper and lower slopes were estimated to each occupy 10% and 80% of the area of the field was estimated to consist of mid-slopes. We used a final farm-gate wheat price of $3.55/bu (basis < 12%protein) with protein premiums of $0.11, 0.21, 0.32, 0.46, 0.59, 0.76, and 0.92 per bushel for each sequential 0.5% protein unit increase. The net return was calculated by subtracting the fertilizer costs of $0.25/lb N and $0.30/lb P (as P_2O_5) from the gross return. We estimated the maximum return possible for variable rate fertilization by assuming no additional cost for variable rate fertilization.

There was not a substantial extra return at any of the sites from varying fertilizer rates with the landscape position compared with uniform application at recommended rates based on N and P at the mid positions (Table 2). Applying more fertilizer to the lower slopes than the other slope positions sometimes resulted in important yield and protein increases. However, the prediction of optimal application rates for either a upper or lower slope position is uncertain as the effects of varying fertilizer by landscape position were not consistent among sites. If a field contained a larger area of upper or lower slopes than existed for these fields, there would be more advantage to varying fertilizer based on slope position. Therefore, variable rate fertilizer technology will have to be low cost to implement to be profitable in the Brown and Dark Brown soil zones.

Conclusions

There was no interaction between seeding rate and landscape position. However, there was an interaction between landscape position and fertilizer; the lower slopes responded more to fertilizer than the upper slope position and the mid-slopes had an intermediate response to fertilizer. The general results regarding yield and protein response to seed and fertilizer rates were similar to that found by McConkey at al. (1998) for a site in the Brown soil zone near Swift Current.

Although the magnitude of yield increases varied among the landscape positions, the general shape of the yield or protein response to fertilizer was similar for all landscape positions. Thus, applying fertilizer at a uniform rate across the field provided similar yield increases at all landscape positions.

The economic returns of the best combination of fertilizer rates for each individual landscape position at all sites (assuming no costs for variable rate technology) was similar to the returns for a uniform application of the soil test recommended rate. Therefore, fertilizer application rates based on soil tests performed on the midslopes may be the best option for many growers at this time.

Acknowledgments

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References

McConkey, B., D. Pennock, F. Walley, M. Solohub, B. Nybo, S. Dormer, G. Hnatowich, A. Johnston, T. Hogg, and B. Liang. 1998. A preliminary look at the potential for variable rate fertilization for rolling land in the Brown soil zone. Soils and Crops 1998. University of Saskatchewan: Saskatoon, SK.

Neter, J., W. Wasserman, and M.H. Kutner. 1990. Applied linear statistical methods: regression, analysis of variance, and experimental designs (3rd ed.). Richard D. Irwin Inc.: Boston, MA.

SAS Institute Inc. 1989. SAS/STAT User's Guide (Version 6, 4th ed, Volume 2). SAS Institute Inc.: Cary, NC.

Selles, F. 1997. Factors affecting grain protein content in wheat. In: Proceedings: Western Canada Agronomy Workshop. Potash and Phosphate Institute of Canada: Saskatoon, SK.

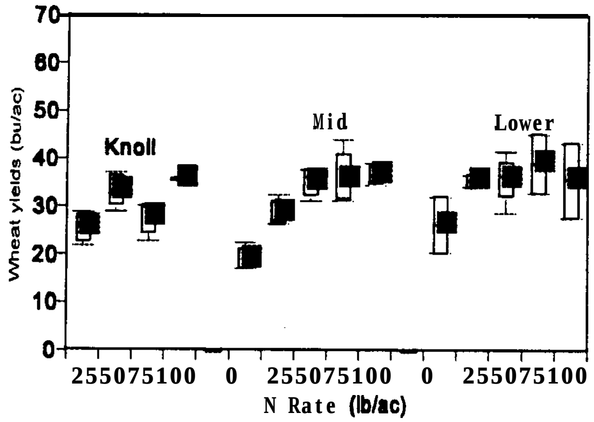

Figure 1. Effect of N rates (lbs/ac) on wheat grain yields (bu/ac) at the Shaunavon site ("box and whisker plot": the line in the box is the median, the dark box is the mean, the outlined box ends are the 25th and the 75th percentiles, and the whiskers are the 10th and 90th percentiles).

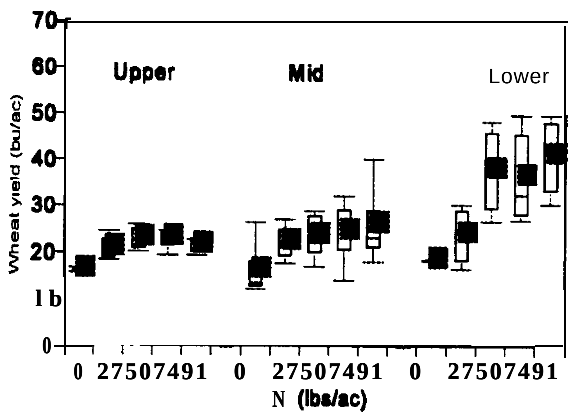

Figure 2. Effect of N rates (lbs/ac) on wheat grain yields (bu/ac) at the Biggar site.

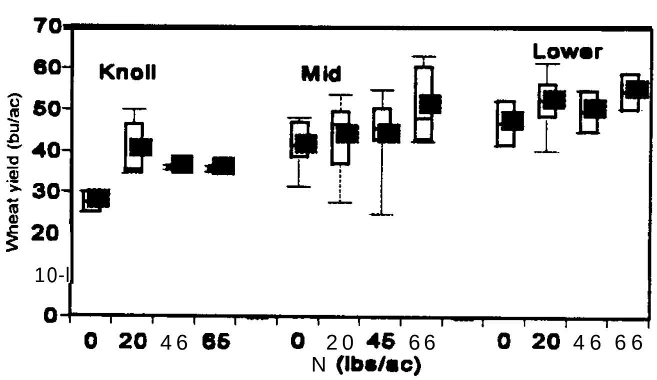

Figure 3. Effect of N rates (lbs/ac) on durum wheat grain yields (bu/ac) at the Kyle site.

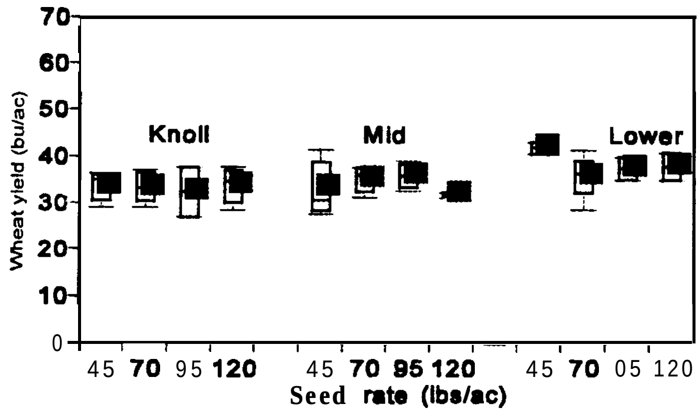

Figure 4. Effect of seeding rates (lbs/ac) on wheat grain yields (bu/ac) at the Shaunavon site.

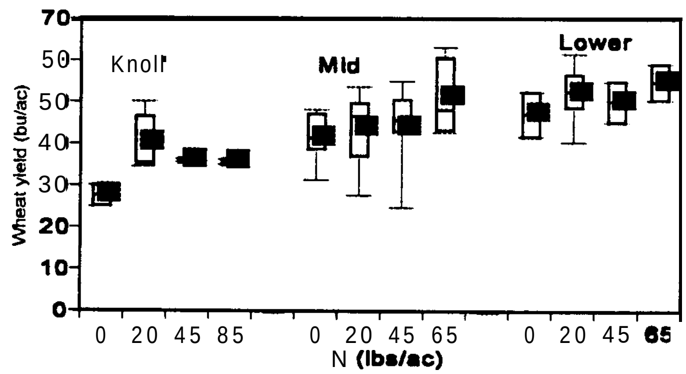

Figure 5. Effect of seeding rates (lbs/ac) on durum wheat grain yields (bu/ac) at the Kyle site.

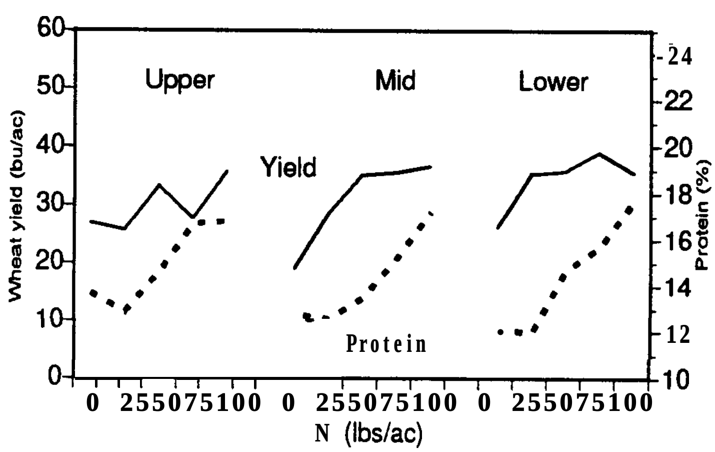

Figure 6. Mean wheat grain yields (bu/ac) and protein content as a function of N rate (Ib/ac) at the Shaunavon site.

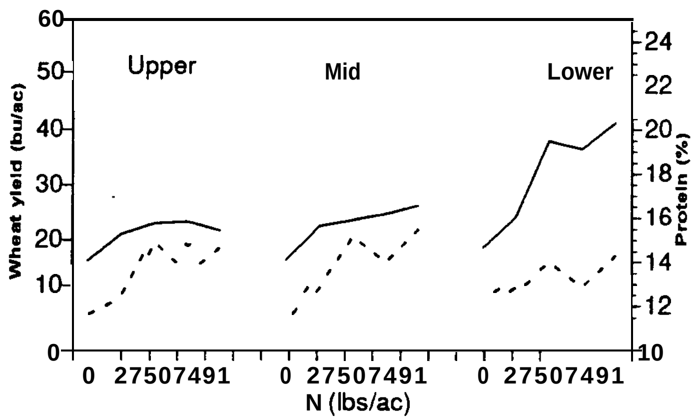

Figure 7. Mean wheat grain yields (bu/ac) and protein content (%) as a function of N rate (lb/ac) at the Biggar site.

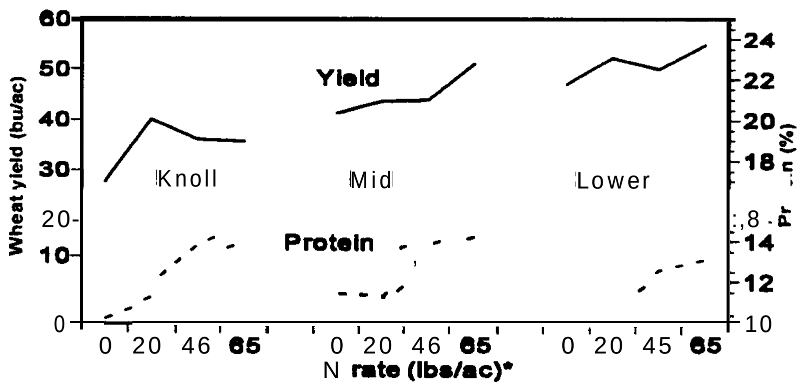

Figure 8. Mean durum wheat grain yields (bu/ac) and protein content (%) as a function of N rate (lb/ac) at the Kyle site.

Table 2. Economic analysis of the addition of variable rates of a single fertilizer blend at each site.

N rate					
Upper (lb/ac)	Mid (lb/ac)	Lower	Yield	Protein	Net return
			Shaunavon		
0	0	0	22.2	12.8	78.81
25	25	25	29.3	12.5	102.11
50	50	50	34.9	14.0	127.58
75	75	75	34.7	15.6	135.90
100	100	100	36.2	17.2	128.15
25	75	50	33.6	14.7	126.53
25	75	75	34.3	14.9	128.88
50	75	100	35.1	15.6	131.41
			Biggar		
0	0	0	16.8	11.3	58.94
25	25	25	22.4	12.7	73.62
50	50	50	26.3	14.9	94.77
75	75	75	26.7	13.7	78.85
100	100	100	28.2	15.1	90.54
0	50	100	25.6	14.3	89.36
50	75	100	27.5	14.2	86.53
100	50	100	26.7	14.9	93.23
			Kyle		
0	0	0	40.5	11.3	216.52
20	20	20	44.2	11.3	219.75
45	45	45	43.7	13.1	215.57
65	65	65	49.9	13.6	249.67
20	65	20	50.0	13.1	245.60
0	65	65	49.0	13.2	245.59
20	65	65	50.3	13.3	245.78