FERTILIZER MANAGEMENT PRACTICES FOR WINTER WHEAT

D.A. Rennie, M. Wood, J. Valby and R.P. Voroney
Saskatchewan Institute of Pedology, University of Saskatchewan
Saskatoon, Sask.

ABSTRACT

Nitrogen management practices for winter wheat including side banding at time of seeding, broadcasting in early December, and in April, were evaluated at nine locations in the province. Under the widely ranging climatic conditions that prevailed over the 1982-83 winter period and the 1982 growing season, side banding the N at time of seeding in the fall was equally as good as broadcasting the N in mid-April. Broadcast applications of urea made in early December resulted in disappointing yield increases. It is concluded from these experiments that where the nitrogen is side banded in the fall, spring wheat soil test guidelines for the humid areas of the province should be applicable to winter wheat grown in any soil zone.

Unequal distribution of crop residues was shown to seriously reduce yields of winter wheat, possibly as a result of the production of phytotoxic compounds.

The successful production of winter wheat depends on moderating the soil temperature sufficiently so that winter kill does not occur. Fowler et al. (1976) reported the results of several years of field testing where one of the simplist and more reliable methods of moderating soil temperatures was to trap an insulating snow cover using upright stubble. Proper fertilization however is equally as important (Fowler, 1983), and at the present time general guidelines are to apply the phosphate requirements by banding an appropriate phosphate carrier with the seed at time of seeding in the early fall and to broadcast the nitrogen requirements as soon as the soil has dried sufficiently the following spring. Nitrogen fertilization in the fall has frequently been shown to decrease winter hardiness and therefore is not generally recommended. However, Rourke (1983) reported that banding the fertilizer N at time of seeding in the fall results in yields equal or greater than when the fertilizer is broadcast in the early spring providing damage done to the standing stubble does not affect the overwinter survival. In general, however, the data reported from Manitoba (Grant, 1983; Rourke, 1983) suggest that early spring broadcast of the fertilizer nitrogen is as good as the banded, and generally better than a late fall broadcast application.

The objective of the project reported in this paper was to examine a variety of placements and timing of nitrogen fertilizer and placement at time of seeding of phosphorus.

MATERIALS AND METHODS

The twelve sets of experimental yield data obtained in this study were collected from nine widely scattered locations in the province. Reference is made to the data included in Table 1 for details on soil type and available N, P, K and S at each location. The plots were layed out during the period August 21 to September 7 in the fall of 1982. Northstar wheat was seeded at 90 kg ha^{-1} (80 lbs ac^{-1}) in 22 cm (9 in.) row widths. Each of the six row plots were arranged in a field strip design with a common control (11-55-0 @ 30 kg P_2O_5 ac^{-1}) adjacent to every treatment. Grain yields were determined by removing paired square meter samples at selected intervals. At most of the locations, six samples were taken from each treatment, however, at two locations the number of samples was increased to as high as 12.

At three sites, unequal crop residue from the previous year's wheat crop resulted in noticeable waves in the plot; in these instances, samples were taken both on the residue and from adjacent areas where little or no residue remained from the previous crop.

The harvest yields were adjusted in accord with the ratio of the mean control to the adjacent control for the particular replicate. The data was then statistically analyzed following a standard randomized block procedure.

RESULTS AND DISCUSSION

The winter of 1982-83 was relatively mild and there was no indication at any of the sites of winter kill. However, at the Carrot River location (Enns), an early spring thaw followed by a lengthy period of cold weather resulted in extensive icing across the plot. Severe damage resulted in an extremely irregular stand and consequently, the majority of the yield data had to be discarded (Table 2).

The response to phosphate in general would appear to have been low and in many cases, non-existant (Table 2; Figure 1). This may explain the marked similarity in yield between treatments where the phosphorus was seed placed as compared to side banded. This observation holds whether nitrogen was applied or was not. In no instances was there any significant change in yield between these two placements.

A strong response to nitrogen fertilization was evident at most locations. The application of 60 lbs of N on the average resulted in a 100% increase in yield where the nitrogen was side banded at time of seeding in the fall. It is of interest to note that while on the average the yields were statistically identical, irrespective of whether the nitrogen was side banded at time of seeding in the fall or applied as a broadcast application in mid-April, the results obtained at individual locations varied widely. Under relatively dry growing conditions such as those which prevailed at Kindersley, Assiniboia and Lucky Lake, the fall side banded urea treatment proved superior. In

Table 1. Background information on the field sites.

Location	Farmer	Soil type	Available nutrients, lb/ac				Ppt. (cm)	
			P (P_2O_5, 0-15 cm)	N (NO_3-N, 0-60 cm)	K 0-15 cm	S 0-60 cm	Snow[1] 82-83	Rain[2] 83
Lucky Lake	Jessiman	Sc HvC	6	22	480	26	2.68	21.5
Waldheim	Johnson	O L	13	22	445	71+	--	--
Lipton	Senft	O L	14	25	360	86+	3.59	28.8
Aberdeen	Wilkinson	Su C	12	18	700	68	--	16.3
Canora	Yaholnitsky	Y L	14	22	230	82+	3.96	28.4
Foam Lake	Markusson	Y L	16	30	235	86+	5.22	36.1
Mossbank	Robb	By Vsl-Sc C	18	22	505	36	3.89	17.1
Kindersley	Walde	Fc CL	6	20	370	71+	8.39	16.3

[1]Snow = soil water recharge, 82-83 winter

[2]Rain = ppt from April to July inclusive

Table 2. The effect of time of application, rate, form and placement on yield of winter wheat.

Treatment		Enns[1] Carrot River	Jessiman Lucky Lake	Johnson	Senft	Wilkinson I[3]	Wilkinson II[3]	Yaholnitsky I[3]	Yaholnitsky II[3]	Markusson	Robb I[3]	Robb II[3]	Walde
			22	22	25								
I. Time of Seeding (SB = Side Band; SP = Seed Placed)													
N	P_2O_5												
0	0	30.2	17.5	35.5	16.5	13.3	17.9	8.2	7.6	15.2	21.7	18.7	21.9
0	30 (SP)	36.9	19.7	31.2	17.5	13.5	15.8	10.9	12.2	17.8	21.1	15.6	18.7
0	30 (SB)	29.1	21.1	31.3	23.1	9.7	12.8	14.6	14.2	23.9	23.4	20.3	16.9
40 (SB)	30 (SP)	—	40.7	—	32.1	21.5	27.9	15.6	19.4	36.8	25.9	29.1	32.7
60 (SB)	30 (SP)	—	43.3	42.2	36.5	39.7	45.6	28.7	36.8	31.9	33.4	39.8	39.1
60 (SB)	30 (SB)	—	48.1	43.4	43.1	44.0	51.2	23.5	33.4	32.9	28.6	36.1	34.1
80 (SB)	30 (SP)	—	51.1	44.1	43.8	47.0	55.5	23.6	35.7	33.7	33.6	33.8	33.1
II. December - Broadcast													
46-0-0 @ 80 lbs N		—	24.0	49.0	35.0	52.1[2]	52.4[2]	27.0	25.3	38.1	20.0	16.6	25.8
34-0-0 @ 80 lbs N		—	41.3	48.8	42.0	52.2[2]	57.1[2]	23.9	32.0	42.2	24.8	25.8	28.0
III. April - Broadcast													
46-0-0 @ 80 lbs N		61.9	47.9	53.4	46.4	47.9	45.2	36.1	41.3	40.4	23.7	25.0	27.4
34-0-0 @ 80 lbs N		—	44.0	50.3	43.9	51.4	47.7	33.3	39.8	33.7	24.3	33.1	35.1
Mean Plot Yield		—	36.3	40.5	33.5	35.7	39.0	22.8	26.2	31.0	25.5	26.8	28.4
"F"		15.8	31.5**	3.7*	13.1*	60.8**	54.3**	12.2*	20.5**	12.2*	2.0	5.3*	11.2**
L.S.D. P = .05		4.5	6.5	12.2	8.7	6.3	6.5	7.5	7.2	6.9	9.2	9.3	6

[1]Early spring flooding damaged a major part of the plot

[2]Late Nov. snowfall made Dec. fertilizer N application impossible. In the spring, these treatments received 120 lbs N/ac.

[3]I = Heavy crop residue, II = Light to no residue

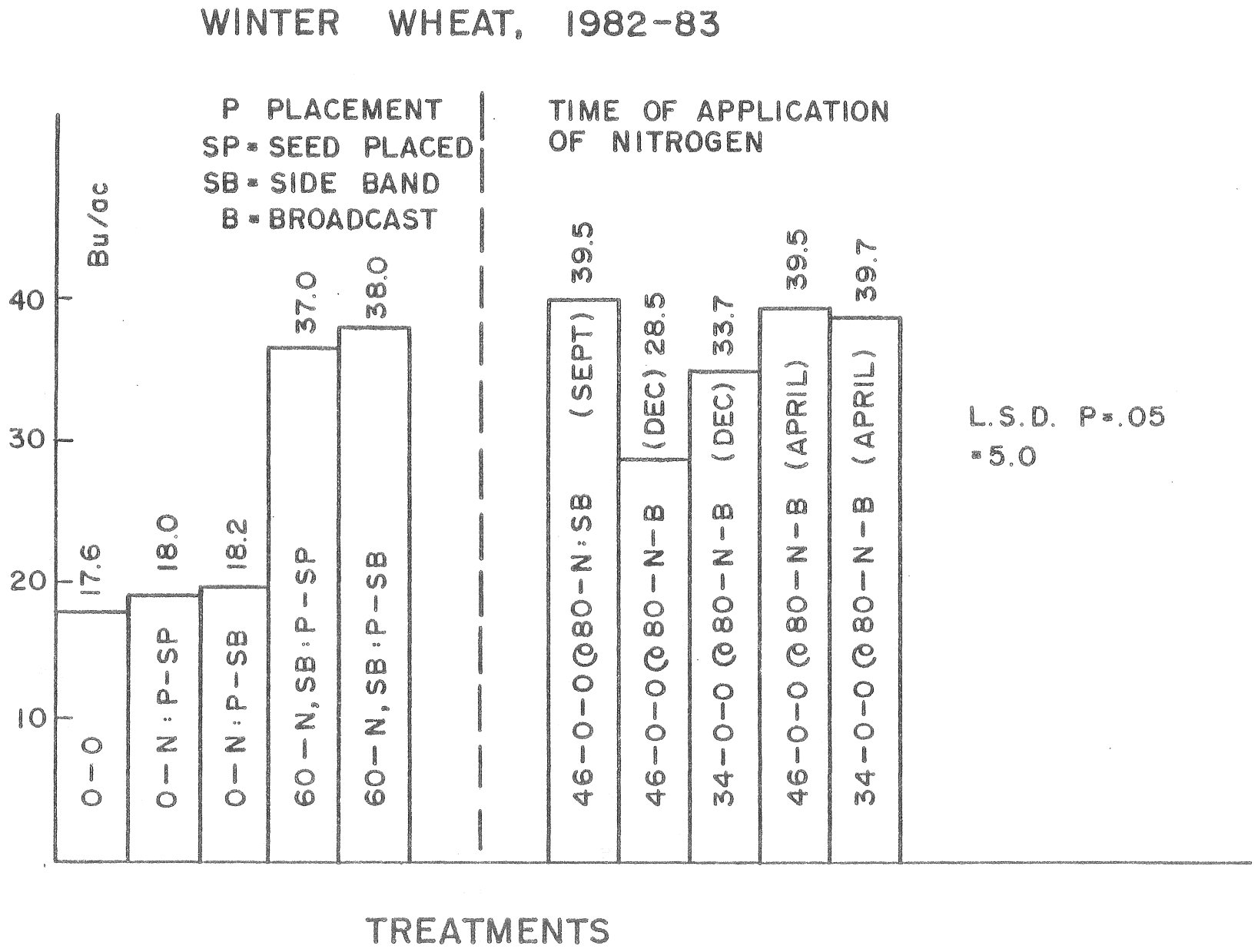

Figure 1. Urea N applied as a side band at time of seeding, or broadcast in mid-April resulted in maximum yield increases

contrast at Canora and Waldheim, the reverse trend was apparent. In general it would appear that under dry spring weather conditions, the broadcast application of urea can be expected to result in a somewhat lower yield than the side banded application applied at time of seeding in the fall.

The early December broadcast application of 46-0-0 resulted in substantially lower yields of winter wheat at many locations (Table 2; Figure 1). The very much improved performance of 34-0-0 as compared to 46-0-0 would suggest that significant quantities of the urea nitrogen were lost by volatilization. This is particularly evident in the data obtained from Lucky Lake and Assiniboia, but is also evident in the data from the Lipton plot. At all three locations there was no snow on the surface of the ground at the time of application.

The unequal distribution of crop residues sharply reduced yields (Table 2; Table 3). These differences in yield, which were significant in two out of three instances were not due to adverse effects of the heavier crop residue on germination. Preliminary research suggest that the production of phytotoxic substances, in particular acetic acid may be largely responsible. However, whether the yield reduction under the heavy residue is due to production of phytotoxic substances or a poorer stand due to mechanical problems encountered during seeding, the loss in yield is significant.

Table 3. Effect of unequal crop residue distribution on yield of winter wheat.

Location		Heavy residue	Light residue
Aberdeen	Av. for plot	35.7	39.0
	80 lb N ac^{-1}	47.0*	55.5*
Canora	Av. for plot	22.8	26.2
	80 lb N ac^{-1}	23.6*	35.7*
Assiniboia	Av. for plot	25.5	26.5
	80 lb N ac^{-1}	33.4	39.8

*Yield significantly different (P = .05)

The average production surface for the 11 sets of data is illustrated in Figure 2. This figure is remarkably similar to that which was obtained during the 1982 crop year with spring wheat (Rennie

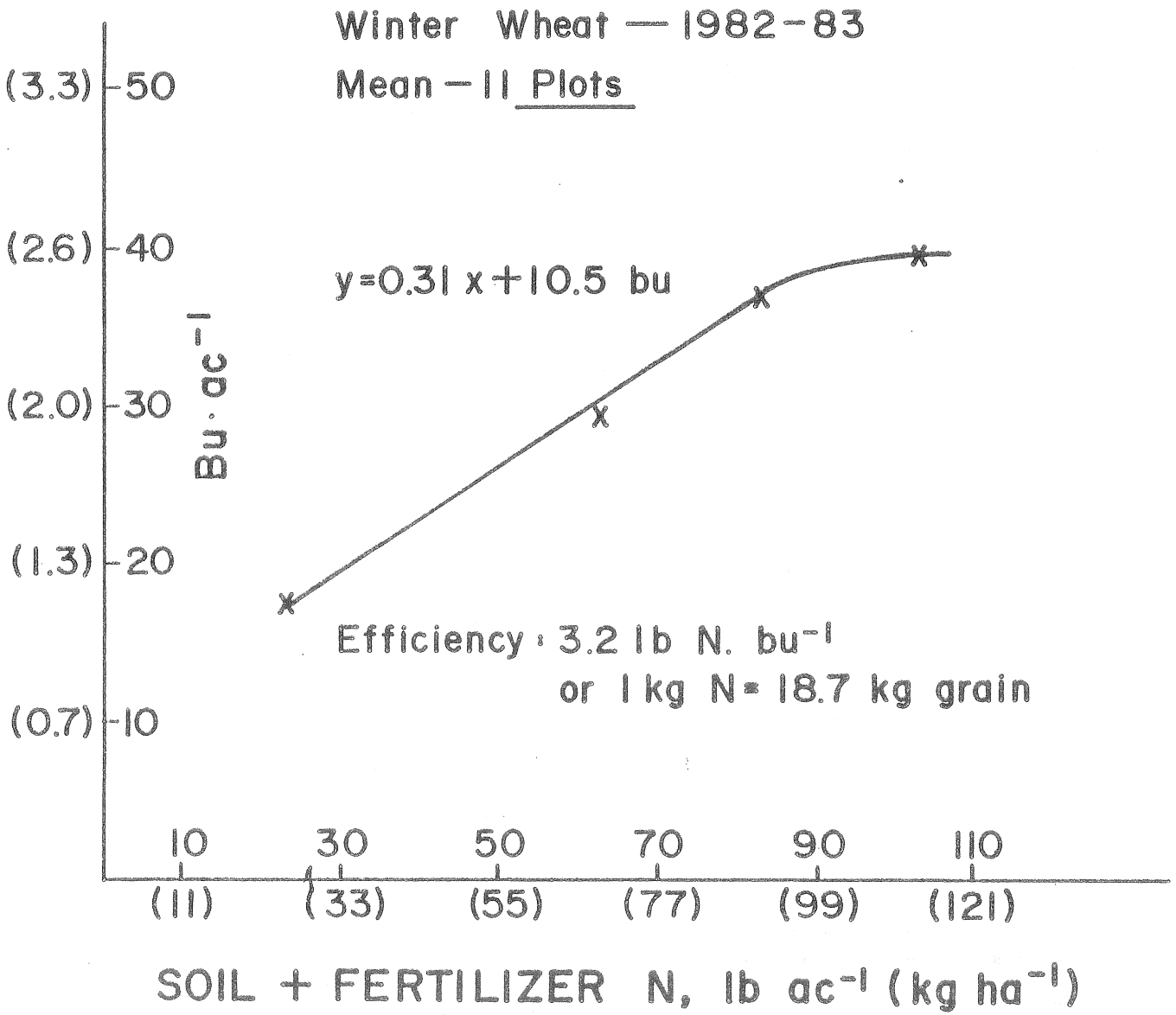

Figure 2. Winter wheat response to urea N follows a similar pattern to that of spring wheat.

et al., 1983). It should be noted that the primarily data used was that where the phosphorus was seed placed and the nitrogen side banded at time of seeding in the fall.

It has been assumed in Figure 2 that the soil nitrate in the 0-60 cm profile and fertilizer nitrogen side banded at time of seeding in the fall were equivalent. This assumption is yet to be tested. Haby et al. (1983) has found that for winter wheat grown in Montana these two sources of nitrogen are not equivalent. Nonetheless, the data do suggest that the present soil test guidelines for spring wheat in the more humid zones of the province should hold for winter wheat grown throughout the province.

CONCLUSIONS

The data reported in this manuscript confirm that the present soil test guidelines (nitrogen) for spring wheat in soil zones other than the Brown and Dark Brown should be fallowed for winter wheat grown in all soil zones. In addition, the following additional guidelines all suggested

1. P should continue to be banded with the seed.

2. Side banding (or deep banding) urea-N is preferable to an early spring broadcast in the drier regions of the province.

3. Broadcast applications of urea in the late fall should not be recommended.

REFERENCES

Fowler, D.B., L.V. Gusta, K.E. Bowren, W.L. Crowle, E.D. Mallough, D.S. McBean and R.N. McIver. 1976. Potential for winter wheat production in Saskatchewan. Can. J. Plant Sci. 56: 45-50.

Fowler, D.B. 1983. The effect of management practices on winter wheat survival and yield of winter wheat produced in regions with harsh winter climates. In New Frontiers in Winter Wheat Production. University of Saskatchewan Press, pp. 238-282.

Grant, C.A. 1983. Nitrogen and phosphorus effects on winter hardiness, yield and protein in zero till winter wheat. Manitoba Soil Science Annual Meetings, Winnipeg.

Haby, V.A., C. Simons, M.S. Stauber, R. Lund, and P.D. Kresge. 1983. Relative efficiency of applied N and soil nitrate for winter wheat production. Agron. J. 75: 49-52.

Rennie, D.A., D.B. Wilkinson, E. de Jong, G.R. Kachanoski and R.P. Voroney. 1983. Innovative Acres 1982 Report, a Farmlab Project. S.I.P. M68 publication. 187 p.

Rourke, D.R.S. 1983. Method and timing of N-A applications for winter wheat. Man. Soil Sci. Annual Meetings, pp. 124-132.