Response of Winter Wheat and Rye to N and P Fertilization

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Introduction

Winter cereals are not produced on large acreages in Saskatchewan. For example, in the fall of 1977 approx. 157,000 ha and 10,000 ha were seeded to rye and wheat respectively.

Traditionally rye production has been confined to lighter, less productive soils where erosion and summer drought are problems. Because risks associated with production on these soils are high there has not been the incentive to add extra costs in the form of fertilizers. For similar reasons there has not been a demand for agronomic research on this crop.

A low level of winter hardiness makes winter wheat production in Saskatchewan a high risk venture. The most successful method of reducing the probability of winterkill is to maintain a snow cover by seeding directly into standing stubble. However, this practice presents its own questions on optimum fertilizer usage.

This study was initiated to obtain data on nitrogen and phosphorus fertilizer responses by winter wheat and rye grown in the parkland area. Special emphasis was given to fertilizer responses of these crops when they are seeded directly into standing stubble the year of spring crop production.

Materials and Methods

All tests were conducted on commercial fields on section 12-36-15 W2 and the NE quarter of section 36-35-15 W2 (Municipality no. 337). This land is located north of the Quill Lakes in the transition area between the Yorkton and Whitewood soil associations. Soil texture ranged from sandy loam to silty clay loam.

Cultivars utilized in these studies were 'Cougar' winter rye, 'Sundance' winter wheat and 'Neepawa' spring wheat. Fertilizers utilized were ammonium nitrate (34-0-0) and mono-ammonium phosphate (11-55-0 or 11-48-0). In all phosphate fertilizer trials correction was made for nitrogen added as ammonium phosphate. All phosphate fertilizer was banded with the seed at the time of seeding. Ammonium nitrate fertilizer was broadcast.

A brief summary of the trials conducted is given in Table 1. Winter wheat and rye were seeded during the last week of August or the first week of September. Spring wheat was seeded the first week of May, which is earlier than average for this area. All plots were seeded with a small plot hoe press drill with 20 cm row spacing. Plot size was 1.2 x 4.9m. Unless otherwise indicated each plot received 35 kg/ha P_2O_5 added with the seed and 100 kg/ha N broadcast during the first week of May. On stubble there was no seedbed preparation for the winter cereals. Spring wheat plot areas were rototilled prior to seeding. A 1.2m wide buffer area was left untreated between plots which received different N treatments.

Date headed, date ripe and mature height were recorded for all plots. At maturity a 1.2 x 4.3m area was harvested and seed yield, hectoliter wt. and 1000 kernel wt. were determined.

Results and Discussion

Response to Phosphorus fertilization

Soil analyses indicated a 30 to 35 kg/ha P_2O_5 requirement for all trials (Table 1). Yield responses to the first 17 kg/ha P_2O_5 added were large, averaging 37% for Sundance winter wheat and 23% for Cougar winter rye (Table 2). An additional 17 kg/ha P_2O_5 gave further 13 and 4% yield increases for Sundance and Cougar respectively. The threshold response level for Sundance was approx. 34 kg/ha. A similar threshold level was not clear for Cougar. In this instance yield responses tapered off gradually after the initial 17 kg/ha P_2O_5.

Added P_2O_5 advanced heading by 4 days for both Sundance and Cougar and advanced maturity by 6 days for Sundance and 2 to 3 days for Cougar (Table 2). In response to added P_2O_5 mature plant height increased for both cultivars and hectoliter and 1000 kernel weights increased for Sundance.

Response to N fertilization

Soil analyses indicated a 80 to 105 kg/ha N requirement in all trials seeded into stubble (Table 1). In these trials yield responses to the first 33 kg/ha N added were large, averaging 61% for Sundance and 67% for Cougar (Table 3). Beyond this level the rate of increase gradually tapered off giving an asymptotic response curve. Yield did not increase significantly for N levels above 101 kg/ha.

For Cougar added N delayed maturity up to 3 days and decreased hectoliter wt. by 1 to 2 kg (Table 3). N fertilization increased height by up to 15 and 3 cm for Sundance and Cougar respectively. Added N also decreased the 1000 kernel weight of both cultivars by up to 3 g.

Influence of date of N application

Timing of N application was important in maximizing yield. Early spring (May 1) applications gave maximum yield responses for both winter wheat and rye (Table 4). However yields of Cougar observed for fall

applications of N were not significantly lower than those for May 1 N application. This was in contrast to the significantly lower yields observed for fall relative to May 1 applications for Sundance winter wheat. Late spring (June 1) application of N gave lowest yield responses for both cultivars. Relative yields for the different dates of fertilizer application considered were: (wheat, rye), Sept. 15 (73, 93), Oct. 15 (89,96), May 1 (100,100) and June 1 (63,63).

Date of nitrogen application also influenced most other characters considered. Once again largest deviations were noted for the late spring applications of N (table 4).

Relative responses of winter wheat, spring wheat and winter rye to N fertilization.

A comparison was made of the responses of Sundance winter wheat, Neepawa spring wheat and Cougar winter rye to N fertilization (Table 5). The direction of responses to added N were similar for Sundance and Neepawa wheats for all characters. However the pattern and magnitude of these changes differed. The yield response curve for Sundance was similar to that previously outlined (Table 3). The rate of yield increase for Cougar was not as uniform as previously outlined, however, the general pattern still held. Both winter cereals responded to much higher levels of added N than Neepawa spring wheat. In fact maximum yields for Neepawa were obtained for an N level considerably lower than that indicated from soil tests (Table 1). One possible explanation for this is that early harvest of the previous year's crop allowed for considerable mineralization of nitrogen by the time large N demands occurred for Neepawa.

Table 1. Trials conducted at Clair 1974-1978.

Year	Previous Crop	Variables considered				Soil test Recommendations (kg/ha)[3]	
		Cultivars	N	Date of N application	P_2O_5	N	P_2O_5
1974-75	Summerfallow	C, S[1]	(X)[2]	(X)	X	15	35
1975-76	Rapeseed	C, S	X	X	X	95	30
1976-77	Rapeseed	C, S, N	X			105	35
	Rapeseed	C, S	X	X		105	35
	Rapeseed	C, S	X		X	105	35
	Summerfallow	C, S			X	11	30
1977-78	Barley	C, S, N	X			80	30
	Barley	C, S	X	X		80	30

1. C - Cougar winter rye, S - Sundance winter wheat, N - Neepawa spring wheat.
2. X - Variable was considered. (X) Response was not observed for different levels of these variables, therefore data was not summarized.
3. From Nutrient Requirement Guidelines for Saskatchewan 1978-79, Sask. Soil Testing Lab. Soil samples were taken for analyses prior to seeding of the winter crops, i.e., in early to mid August.

Table 2. Influence of phosphorus fertilizer on winter wheat and rye. N added - 100 kg/ha on stubble.

Character	Cultivar	P_2O_5 Added (kg/ha) 0	17	34	50
Yield (kg/ha)	Sundance	2089a[1]	2868b	3241c	3283c
	Cougar	2884a	3548b	3690bc	3828c
Date headed (da/mo)	Sundance	1/7b	27/6a	27/6a	26/6a
	Cougar	12/6c	8/6b	8/6a	7/6a
Date ripe (da/mo)	Sundance	11/8b	5/8a	5/8a	4/8a
	Cougar	31/7b	29/7a	28/7a	28/7a
Height (cm)	Sundance	93a	96b	97bc	99c
	Cougar	104a	106ab	106ab	107b
Hectoliter wt. (kg)	Sundance	79a	81b	81b	81b
	Cougar	76a	76a	76a	76a
1000 kernel wt. (g)	Sundance	31a	32ab	33b	35c
	Cougar	24a	24a	24a	23a

1 - Within rows means followed by the same letter are not significantly different at the .05 level as tested by a Duncan's new multiple range test.

Table 3. Influence of nitrogen fertilizer on winter wheat and rye.
P_2O_5 added - 35 kg/ha

		N added (kg/ha)				
Character	Cultivar	0	33	66	101	202
Yield (kg/ha)	Sundance	1540a[1]	2473b	2876c	3425d	3629d
	Cougar	1812a	3018b	3444c	3863d	4178d
Date headed (da/mo)	Sundance	24/6a	23/6a	24/6a	23/6a	24/6a
	Cougar	4/6a	4/6a	5/6a	5/6a	5/6a
Date ripe (da/mo)	Sundance	3/8a	3/8a	3/8a	3/8a	4/8a
	Cougar	27/7a	28/7ab	28/7ab	29/7bc	30/7c
Height (cm)	Sundance	75a	84b	88bc	89bc	90c
	Cougar	94a	97b	96ab	97b	97b
Hectoliter weight (kg)	Sundance	80a	81a	80a	80a	80a
	Cougar	77b	77b	76ab	76ab	75a
1000 kernel wt. (g)	Sundance	35b	34ab	33a	32a	33a
	Cougar	27b	25a	24a	24a	25a

1 - Within rows means followed by the same letter are not significantly different at the .05 level as tested by a Duncan's new multiple range test.

Table 4. Influence of date of nitrogen application on winter wheat and rye. N added - 100 kg/ha.

Character	Cultivar	Date of N application			
		Sept. 10	Oct. 15	May 1	June 1
Yield (kg/ha)	Sundance	2577b	3130c	3529d	2235a
	Cougar	3936b	4086b	4236b	2684a
Date headed (da/mo)	Sundance	26/6b	25/6a	25/6a	25/6a
	Cougar	6/6b	5/6a	5/6a	5/6a
Date ripe (da/mo)	Sundance	4/8a	4/8a	4/8a	4/8a
	Cougar	29/7a	29/7a	30/7a	2/8b
Height (cm)	Sundance	91b	93b	91b	82a
	Cougar	103b	100b	100b	95a
Hectoliter weight (kg)	Sundance	79ab	79ab	80b	78a
	Cougar	76b	76b	76b	74a
1000 kernel wt (g)	Sundance	32b	31ab	32b	30a
	Cougar	25b	24b	25b	22a

1 - Within rows means followed by the same letter are not significantly different at the .05 level as tested by a Duncan's new multiple range test.

Table 5. Comparison of the effect of nitrogen fertilizer application on Sundance winter wheat, Neepawa spring wheat and Cougar winter rye. P_2O_5 added - 35 kg/ha.

		N added (kg/ha)					
Character	Cultivar	0	33	66	101	202	302
Yield (kg/ha)	Sundance	1540a[1]	2611c	3076d	3617fg	3798gh	3441ef
	Neepawa	1889ab	2604c	2596c	2546c	2408c	2473c
	Cougar	1985b	3256de	3640fg	3725fgh	4224i	3978hi
Date headed (da/mo)	Sundance	23/6b	23/6b	24/6b	23/6b	23/6b	24/6b
	Neepawa	29/6c	29/6c	29/6c	29/6c	29/6c	29/6c
	Cougar	5/6a	5/6a	6/6a	6/6a	6/6a	6/6a
Date ripe (da/mo)	Sundance	3/8f	3/8f	2/8f	2/8ef	3/8f	3/8f
	Neepawa	12/8a	12/8a	11/8a	12/8a	12/8a	12/8a
	Cougar	27/7b	28/7bc	30/7cde	29/7bcd	31/7de	1/8e
Height (cm)	Sundance	75a	86bc	90de	86bc	92efg	87bc
	Neepawa	77a	85b	86bc	87bc	88cd	86bc
	Cougar	94gh	95h	93fgh	93fgh	91ef	88cd
Hectoliter wt (kg)	Sundance	81cd	81cd	81cd	80c	81cd	80c
	Neepawa	84fg	85g	84fg	83ef	83ef	82de
	Cougar	77b	77b	76ab	76ab	76ab	75a
1000 kernel wt (g)	Sundance	36g	35fg	34efg	33def	33def	32cde
	Neepawa	33def	33def	32cde	32cde	31cd	30c
	Cougar	28bc	25a	24a	25a	26ab	24a

1 - For each character means followed by the same letter are not significantly different at the .05 level as tested by a Duncan's new multiple range test.