Influence of Seeding Rate and KC1 Application Across the Landscape

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Abstract

The development of variable rate controllers for air seeder carts has provided farmers with the opportunity to consider varying the rate of fertilizer and seed at seeding. While considerable work has been completed, or is currently under way, evaluating variable fertilizer rates, little has been done to determine the effect of varying seeding rates. In addition, application of potassium chloride across the landscape has been found to provide variable grain yield responses for CWRS wheat. Field research trials were established in 1997 at St. Louis (Black soil zone) and Watrous (Dark Brown soil zone) to evaluate the effect of varying CWRS wheat seeding rate and KC1 application across the upper, mid and lower slope positions of a hilly landscape. While increasing seeding rate resulted in an increase in plant establishment, this was not reflected in final grain yield. Yield component analysis determined that the increase in grain filled heads at harvest with increased seeding rate was offset by a reduction in the number of kernels per head. Wheat response to KC1 was highly variable, with an increase in grain yield at St. Louis and a decrease at Watrous. While July growing season conditions were dry at both Watrous and St. Louis, we did not collect sufficient crop establishment and yield component data to explain the results obtained.

Introduction

The development of air carts with variable rate controllers have allowed farmers to develop plans for on-the-go application of inputs at seeding. While varying fertilizer application has been widely tested in research and on-farm trials, varying seeding rates has not received much attention. Work with potassium chloride across the landscape indicates that responses may be found on certain slope positions, providing an opportunity to optimize grain yield and quality (Schoenau et al., 1997). An Agri-Food Innovation Fund (AFIF) sponsored project, lead by Dr. Dan Pennock, is evaluating spring wheat response to variable N and P rates at St. Louis, Watrous, Outlook (irrigation) and Swift Current, Saskatchewan. Wheat seeding rate was evaluated at these projects to determine if benefits could be obtained from varying the seeding rate of CWRS wheat across the landscape. In addition, at Watrous and St. Louis, potassium chloride fertilizer was added to determine crop response at upper, mid and lower slope landscape positions.

Study Description

Spring wheat (cv. AC Barrie) was seeded in seed drill width strips running up and down the slope in a commercial field, with each strip covering the upper, mid and lower landscape

elements (only upper and lower slope at St. Louis). Details on seeding date, seeding rates, N (urea) and P_2O_5 (MAP) rate, monthly precipitation and average air temperature are outlined in Table 1. Data was collected at each location using those field positions identified as being either upper, mid or lower slope by Dr. Dan Pennock. Data collection included:

- crop establishment: determined from 2 row x 1 m at the 3-4 leaf stage.
- harvest head count: determined from 2 rows x 1 m at the early dough stage.
- grain yield: determined from a 10 m section of crop from each landscape element.
- harvest index: determined from grain yield and harvest dry matter yield (square metre sample).
- kernel weight: from weight of 1000 seeds (not collected at Watrous).
- kernels per head: calculated from harvest head count, kernel weight and grain yield.
- Seeding depth: determined from 10 plants collected at the 5-6 leaf stage.
- Haun stage: from 10 plants collected at the 5-6 leaf stage.

Table 1. Seeding date, seeding rate, fertilizer N and P rate, monthly precipitation and average air temperature at St. Louis, Watrous, Outlook and Swift Current, 1997.

Variable	St. Louis	W atrous	Outlook	Swift Current
Seeding Date	May 24	May 15	May 16	May 7&8
Seeding Rates (kg/ha)	69 - 104 - 139	69 - 104 - 139	69 - 104 - 139	69 - 104 - 139
N Rate (kg/ha)	80	67	100	56
P_2O_5 Rate (kg/ha)	25	28	25	34
Harvest Date	September 22	August 27	September 8	Aug. 25&26
Monthly Precipitation (mm)				
May	7.6	33.2	18†	50.3
June	137.2	62.6	67	67.9
July	9.2	5.9	8	26.5
August	28.3	62.7	NAS	52.2
Average Air Temperature (“C)				
May	NA	NA	NA	NA
June	NA	NA	NA	NA
July	19.4	18.5	19	18.4
August	17.5	18.2	19	18.5

† Irrigation water applied = 182.1 mm

‡ NA - data not available.

For the assessment of potassium chloride trials at St. Louis and Watrous a fertilizer blend of 25 kg/ha of P_2O_5 (MAP) and 30 kg/ha of KCl (O-0-60) was seed row applied. Spring wheat (cv. AC Barrie) was seeded at a rate of 104 kg/ha and N applied at 80 kg N/ha at St. Louis and 67 kg N/ha at Watrous. The following data was collected:
- grain yield: determined from a 10 m section of crop from each landscape element.
- harvest index: determined from grain yield and harvest dry matter yield.
- kernel weight: from weight of 1000 seeds (not collected at Watrous).
- Seeding depth: determined from 10 plants collected at the 5-6 leaf stage.
- Haun stage: from 10 plants collected at the 5-6 leaf stage.

Each study used a 6 replicate field layout. Data was analysed using a split plot model, with seeding rate or KCL treatment as the main plot and slope position as the sub plot.

Major Findings

Seeding Rate

Increasing seeding rate resulted in a significant increase in crop emergence at all trial locations (Table 2). However, this increased crop emergence was not reflected in wheat grain yield. At Outlook and Swift Current the increased seeding rate increased the number of grain filled heads at harvest. An increase in head number was compensated by a reduction in the number of kernels per head at each location, preventing any grain yield response. The increased seeding rate resulted in a reduction in harvest index at Swift Current, with a poor ratio of grain to total biomass at the high seeding rate.

Landscape, or slope, position was found to have a much greater effect on crop response (Table 2). The higher moisture at the lower slope position resulted in improved grain yield at St. Louis and Watrous, bushel weight at St. Louis, thousand kernel weight at St. Louis and Swift Current, and heads/m^2 at St. Louis, Watrous and Outlook. However, the opposite response was recorded for harvest index at Watrous and Outlook and plant emergence at Swift Current, where crop response was superior in the upper slope position. At Swift Current a seeding rate x slope interaction was recorded, with crop emergence increasing as you move from the upper to lower slope position with the low seeding rate, while the opposite occurred with the medium and high seeding rates. Significant seeding rate by slope interactions were recorded at St. Louis for harvest heads/m^2 and kernels/head (Table 2). An increase in heads/m2 resulted in a decrease in kernels/head, compensating for each other and resulting in interaction for grain yield.

Wheat seeding depth was unaffected by either seeding rate or slope position at both the St. Louis and Watrous locations (Table 2). However, seedlings in the lower slope at Watrous were found to be further advanced than either the upper or mid slope positions. It would appear that the higher moisture content at this lower slope position improved seedling establishment.

Potassium Chloride

Wheat crop response to potassium chloride was highly variable. While a large positive

grain yield response to KC1 was measured at St. Louis, a large yield reduction was recorded at Watrous (Table 3). At both locations the KC1 was blended with the P and seed row applied, and no damage to stand was observed on crop emergence. The yield reduction at Watrous was largest on the upper slope (798 kg/ha), and declined as you moved down the slope (617 kg/ha). At St. Louis the yield increase was highest in the lower slope position (776 kg/ha), while at the upper slope position the yield increase from KC1 was only 307 kg/ha. Unfortunately, we did not collect sufficient data to allow for a detailed interpretation of these results, and we have no explanation for this variation in wheat response to KCI.

Applied Questions

1. Can variable seeding rates be used to optimize the yield of CWRS?
From the first years results of this study we would have to answer NO. While the crop responded to the increase in seeding rate with increased plant stand, this was not reflected in grain yield. Yield component analysis revealed that the increase in grain filled heads at harvest with increased seeding rates was offset by a reduction in kernels per head.

2. **Were there portions of the field where application of potassium chloride improved C WRS yield?**
Our results from the 1997 growing season indicate large variability to the application of potassium chloride. While grain yields were significantly lower when KCL was applied at Watrous, at St. Louis grain yields were increased by 300 to 800 kg/ha (4.5 - 12 bu/ac) moving from the upper to lower slope positions, respectively. While this response at St. Louis was statistically significant only at the 10% level of probability, KC1 would increase economic returns by $15.75 - $42.00/acre (using $3.50/bu wheat) for a $3.81/acre investment in fertilizer (KC1 @ $180/mt). Further assessment of the potassium chloride treatment will be required to develop an understanding of those situation where it can be expected to provide a positive grain yield response.

References

Schoenau, J.J., V. Jowkin, C. MacLeod, and M. Ruszkowski. 1997. Response of spring wheat to chloride fertilization at Craik, Saskatchewan. Pp. 3 17-32 1. In Soils and Crops ‘97. Extension Division, University of Saskatchewan, Saskatoon, SK.

Table 2. Probability values and treatment and slope means for crop response to seeding rate at St. Louis, Watrous, Outlook and Swift Current in 1997.

	PM2†	GY	BWT	HI	TKWT	HM2	KHead	Depth	Haun
St. Louis									
Tmt	0.0078	NS	NS	NS	NS	NS	NS	NS	NS
Slope	NS	0.0001	0.0001	NS	0.0008	0.0001	NS	NS	NS
T x S	NS	NS	NS	NS	NS	0.0067	0.0395	NS	NS
c v	9	13	1	15	4	10	13	28	8
Seeding Rate Means									
Low	190 c‡	2259	78.1	0.32	33.0	454	15.1	3.4	7.9
Med.	222 b	2377	78.3	0.34	33.0	477	15.4	3.5	7.8
High	240 a	2401	78.4	0.35	33.1	494	14.8	3.8	7.7
Slope Means									
Upper	216	2059 b	77.8 b	0.33	32.0 b	432 b	15.0	3.73	7.9
Lower	219	**2633** a	**78.8** a	0.34	34.0 a	519 a	15.2	3.41	7.7
Watrous									
Tmt	0.0231	NS	N/C§	NS	N/C	NS	N/C	NS	NS
Slope	NS	0.0001		0.0057		0.0425		NS	0.0015
T x S	NS	NS		NS		NS		NS	NS
c v	15	20		15		15		23	8
Seeding Rate Means									
Low	143 c	2248		0.31		309		4.2	7.1
Med.	161 b	2368		0.31		318		4.4	7.0
High	189 a	2345		0.31		336		4.9	6.9
Slope Means									
Upper	169	2103 b		0.34 a		304 b		4.5	6.7 b
Mid	157	2082 b		0.31 ab		314 ab		4.5	6.8 b
Lower	168	2807 a		0.29 b		345 a		4.5	7.4 a

...Continued

Table 2. Continued

	PM2	GY	BWT	HI	TKWT	HM2	KHead	Depth	Haun
Outlook									
Tmt	0.0001	NS	N/C	NS	NS	0.0479	NS	N/C	N/C
Slope	NS	NS		0.0001	NS	0.0310	NS		
T x S	NS	NS		NS	NS	NS	NS		
c v	11	6		9	2	11	15		
Seeding Rate Means									
Low	153 c	4386		0.41	40.0	458 b	24.6		
Med.	237 b	4187		0.39	40.2	479 ab	22.1		
High	307 a	4467		0.42	40.5	516 a	21.5		
Slope Means									
Upper	228	4243		0.43 a	40.3	456 b	24.0		
Mid	233	4404		0.43 a	40.1	490 ab	22.5		
Lower	235	4393		0.36 b	40.3	507 a	21.7		
Swift Current									
Tmt	0.0001	NS	N/C	0.0200	NS	0.0001	0.0001	N/C	N/C
Slope	0.0006	NS		NS	0.0001	NS	NS		
T x S	0.0371	NS		NS	NS	NS	NS		
CV	13	18		17	5	13	20		
Seeding Rate Means									
Low	123 c	1933		0.47 a	31.1	247 b	25.7 a		
Med.	158 b	1908		0.47 a	31.4	264 b	23.3 a		
High	270 a	1996		0.42 b	32.2	331 a	18.8 b		
Slope Means									
Upper	185 a	1795		0.45	29.9 b	287	21.2		
Mid	201 a	2012		0.46	31.9 a	281	23.3		
Lower	165 b	2031		0.46	32.9 a	275	23.4		

† PM2 = plants/m2; BWT = bushel weight; HI = harvest index; TKWT = thousand kernel weight (g); HM2 = harvest heads/m2; KHead = kernels/head; Depth = seeding depth (cm); Haun = haun stage.

‡ Numbers followed by the same letter are not significantly different using LSD,,,.

§ N/C indicates data not collected at this location.

Table 3. Probability values and treatment and slope means for crop response to potassium chloride at St. Louis and Watrous in 1997.

	PM2†	GY	BWT	HI	TKWT	HM2	KHead	Depth	Haun
St. Louis									
Tmt	N/C	6.0605	NS	NS	0.0550	N/C‡	N/C	NS	NS
Slope		0.0005	0.0001	NS	0.0002			0.0309	NS
T x S		NS	NS	NS	NS			NS	NS
CV		10	1	14	3			17	7
Potassium Chloride									
- KCL		2377 b§	78.2	0.34	33.0 b§			3.5	7.8
+ KCL		2697 a	78.5	0.34	34.0 a			3.6	7.6
Slope Means									
Upper		2272 b¶	78.0 b	0.33	32.4 b			3.9 a	7.8
Lower		2802 a	78.8 a	0.34	34.5 a			3.3 b	7.5
Watrous									
Tmt	N/C	0.0020	N/C	NS	N/C	N/C	N/C	NS	NS
Slope		0.0115		NS				NS	NS
T x S		NS		NS				NS	NS
c v		28		23				20	9
Potassium Chloride									
- KCL		2368 a		0.31				4.4	7.0
+ KCL		1685 b		0.36				4.1	6.6
Slope Means									
Upper		1767 b		0.37				4.3	6.5
Mid		1851 b		0.32				4.4	6.8
Lower		2461 a		0.30				4.0	6.9

† PM2 = plants/m2; BWT = bushel weight; HI = harvest index; TKWT = thousand kernel weight (g); HM2 = harvest heads/m2; KHead = kernels/head; Depth = seeding depth (cm); Haun = haun stage.

‡ N/C indicates data not collected at this location.

§ Numbers followed by the same letter are not significantly different using LSD, $_{10}$.

¶ Numbers followed by the same letter are not significantly different using $LSD_{0.05}$.