1986

ANNUAL REPORT

PPI-SUPPORTED PROJECT

Agriculture Canada Research Station
Swift Current, Saskatchewan

1. Title of Project ... "Interaction of Fertilizer N and P and Snow Conservation on Yield of Spring and Winter Wheat in Southwestern Saskatchewan"

2. Project Leader & Cooperators ... C.A. Campbell (Project Leader)
   F. Selles (Cooperator)
   B.G. McConkey (Cooperator)
   R.P. Zentner (Cooperator)

3. Location of Research Demonstration ... Agriculture Canada Research Station, Swift Current, Saskatchewan

4. Objectives of the Study ...

   4.1 To determine advantage in stored soil water that can be expected from leaving strips of tall cereal stubble to trap snow as compared to stubble cut at one uniform, short height (standard practice).

   4.2 To determine the optimum rate, method and time of application of N for spring wheat production under conditions of improved snow management and zero-tillage.

   4.3 To determine the optimum rate of P application for spring wheat production under conditions of improved snow management and zero-tillage.

   4.4 To determine the maximum yield achievable for spring wheat under dryland culture.

   4.5 To determine whether zero-tillage, snow trapping and various fertilizer treatments (cited in 4.3) are economically feasible in southwestern Saskatchewan.

   4.6 To determine effect of zero-tillage on soil quality.

5. Results and Conclusions ...

Objective 4.1 ... The water equivalent of snow received in 1985-86 was second highest in the 5 years of study but thaw-freeze conditions in winter coupled with instantaneous warming in early spring resulted in an ice-coated soil in the first instance and considerable run-off in the second. Thus, over winter, soil moisture capture was only 17% (lowest of the 5 years) and there was no effect of stubble height on moisture conserved. Over the 5 years the average efficiency of intake of winter precipitation was 44% for tall stubble, 32% for short and an average annual advantage of 12 mm of stored water in tall stubble.

Objective 4.2 ... The growing season precipitation for 1986 was 205 mm (ie; 23% above average) and well distributed. This resulted in the highest yields obtained in the 5 year study (avg. 2665 kg/ha or 40 bu/ac). N fertilizer significantly increased yields but the difference due to rate was small because initial soil N & P content were high and also because the N supplying power of this soil has been markedly increased by 5 years of zero-tillage. Yields were about 100 kg/ha higher for tall than short stubble but this difference was not significant. Yields were 77 kg/ha higher for banded than for broadcast applications of N but yields were unaffected by time of N application. Based on the 5 year study highest yields were obtained at an N rate of 75 kg/ha; yields were 8% higher for tall stubble compared to short; and if banded in spring was rated 100 then fall banding, spring broadcast and fall broadcast N would be rated 98, 97 & 94 respectively.

Objective 4.3 ... In 1986 P had no effect on yields and over the 5 year period P rarely affected yields, thus the 30 kg P_2O_5/ha was probably sufficient even with any extra water captured by trap strips.

Objective 4.4 ... The maximum yield obtained in 1986 and also in the 5 year study was 4909 kg/ha (73 bu/ac) for the 100 kg/ha N, 30 kg/ha P_2O_5, deep banded in tall stubble in spring. Next in line 75/60, N/P_2O_5 broadcast in fall on tall stubble with a yield of 3054 kg/ha (46 bu/ac).

Objective 4.5 ... The economic analysis will be done during the coming year.

Objective 4.6 ... In May, 1985, after 4 years of zero-tillage continuous spring wheat cropping on the snow management plots, soil samples were taken from these plots and from the adjacent conventional fallow-wheat area. These samples were analysed to assess changes in soil quality. The results show a significant increase in soil organic matter and an improvement in soil quality of the top 7.5 cm depth as measured by increases in potentially mineralizable N, soil microbial biomass, soil respiration, and neutral phosphatase activity. Analyses still to be done are aggregate stability, nitrifier and denitrifier activity and amino acids and amino sugars. As well, soil samples were again taken in fall, 1986 for repeat of soil characterization after 6 years cropping by zero-tilling.

6. <u>Yield Limiting Factors Observed in 1986.</u>

6.1 Severe grasshopper infestation but damage to crop was limited.

6.2 Foxtail barley was a severe problem (Fig. attached). This has forced us to fallow conventionally prior to returning the land to the producer in 1988.

7. Comments ...

<u>Publications in 1986</u>

Campbell, C.A., Nicholaichuk, W., Zentner, R.P., and Beaton, J.D. 1986. Snow and fertilizer management for continuous zero-till spring wheat. Can. J. Plant Sci. 66: 535-551.

Selles, F., Campbell, C.A., Zentner, R.P. and Dyck, F.B. 1986. Effect of fertilizer on spring wheat production on a zero-tillage snow trap system in the Brown soil zone. p. 161-178 In Soils & Crops Workshop "Research in Agriculture", Univ. of Sask., Saskatoon, Sask., Feb. 20-21, 1986.

Campbell, C.A., Zentner, R.P., Dyck, F.B., and Selles, F. 1986. Soil fertility and snow management. p. 56-71 In Proc., 'Soil Conservation - A Resource Worth Saving'. Swift Current, Sask. Feb. 18.

Campbell, C.A. and Zentner, R.P. 1986. Economics of crop rotations, snow trapping and fertilization use. A paper presented at Sask. Agriculture Soil Fertility Seminar, Regina, Sask., February 25, 1986 (mimeo).

- The coming year 1986-87 will be the final year of this study. Our plans are to complete the laboratory analyses, write the economics and soil quality papers, and summerfallow the test site prior to returning it to the producer from whom it was rented. Since we were not paid for first year of study (land preparation) and since we still have expenses re land rental and technician to meet, it is hoped that you will be able to pay the 1987 stipend in full for this final year.

- We have enjoyed cooperating with you on this project and believe it has been quite worthwhile.

Addendum

Response of Spring Wheat to K on Two Soils

The response of spring wheat to K applied at rates of 0, 50, 100 and 150 $kg.ha^{-1}$ K_2O was determined on Hatton sandy loam and Swinton clay loam. No effect on yield was obtained at either site. Thousand kernel weight and bushel weight were significantly increased on the Swinton clay loam.

Campbell, C.A., Selles, F., McConkey, B.G., and Zentner, R.P. 1986.
Report on Joint Study with PPI

Project 22310-1580-81-51

INTERACTION OF FERTILIZER N AND P AND SNOW CONSERVATION ON SPRING WHEAT IN SOUTHWESTERN SASKATCHEWAN

Annual Report 1986

In this fifth and final year of this study, spring wheat production and moisture conservation were again studied. As well, the quality of soil taken from the test site and the adjacent fallow-wheat area was assessed for changes due to tillage.

1. Description of Treatments for Spring Wheat Test

This experiment was composed of four replicates (Blocks) (Fig. 1) each about 2.5 ha in size and carried out on a Brown Chernozem (Wood Mountain loam). Each replicate was split into two main treatments [short (standard height) stubble vs. tall (alternate height) stubble]. Each stubble treatment block was divided equally and randomly into three year-sub-blocks (viz., yr 1, yr 2, yr 3) to allow us to move the experiment to a different area each year. The test-year sub-blocks (in 1985-86, the fifth year of study, these were the year 2 blocks) were divided into six fertilizer rate sub-sub-blocks to allow four comparisons of N rates and three comparisons of P rates: (viz., 25/60, 50/60, 75/60, 100/60; 100/45; 100/30: ($kg.ha^{-1}$ $N/kg.ha^{-1}$ P_2O_5). Each fertilizer rate treatment was divided into two sub-sub-sub-blocks allowing comparison of banded vs. broadcast urea N. There was a further split comparing fall vs. early spring N application. The year-blocks that were not being used in a particular year (filler blocks) were seeded and 28-28-0 fertilizer applied at 90 $kg.ha^{-1}$ (product) on these at seeding. No S or K was applied as we try to strive for better net returns. In this study we use the zero-till technique.

2. Establishment and Management of Crop

The 1985 crop was harvested on August 19, and the trap strips sculptured. Heads were left on trap strips to increase height since stubble was very short.

The various herbicide and fertilizer treatments, the dates of application, and the seeding and harvest dates are shown in Table 1. Due to intermittent rainfall in fall 1985, again no 2,4-D was applied in fall; thus, Hoegrass II was applied a week after seeding to control wild oats and winter annuals. There was a severe infestation of foxtail barley. These were hand-weeded since this is the last year of the study and we plan to conventional fallow in 1987 before returning the land to the producer.

The number of samplings for soil and plant samples (10 plants per plot) during plant development were reduced to 3 for soil and 2 for plant analysis this year. Soil samples were taken on September 24, 1985 (post harvest), October 15, 1985 (Pre-winter), and on April 3, 1986 (spring), June 23, 1986 (5 leaf stage), July 9, 1986 (early heading) and September 4, 1986 (shortly after harvest). Except for October 15, 1985, only moisture, NO_3-and NH_4-N were determined on the soil; bicarbonate soluble P was determined on the October 15, 1985 samples. Plant samples were only taken at early heading and harvest. Number of tillers and plant weight were determined but plant N and P content was only done at maturity on grain and straw.

Major snowfall events were measured. Soil temperatures were not measured since these are being determined in another nearby site.

3. Weather and Snow Trap

3.1 Weather (1985-86)

Generally, temperatures were lower than the long-term average during the September and November, 1985 while January and March, 1986 were very warm (Table 2). In contrast to 1984 and 1985 precipitation was good in 1985-86. In the fall of 1985 precipitation was above average and although precipitation during January to April was only 55% of long-term average, heavy rains in May more than compensated and the growing season (May-June-July) precipitation was 204.9 mm (i.e., 23% above average). Furthermore, the distribution of GSP was good (Figure 2) thus leading to above-average yields (shown later).

3.2 Snow Trap and Soil Moisture Conservation (1981-86)

The height of both tall and short stubble decreased yearly and in year 5 after 2 successive drought years the heads were left on the tall stubble strips to provide sufficient height differentials (Table 3). Thus, farmers planning to use this trap strip approach could face a problem of not having sufficient stubble height to allow proper use of this technique in some years. Farmers would be wise to phase into this type of study immediately after growing wheat on fallow in a good rainfall year.

In 1985-86, snow depth was as high as in 1981-82 and 1984-85 and much higher than in the other two years of the study (Table 3). The water equivalent of the snow received in 1985-86 was second highest to that received in 1984-85. However, the efficiency of melt water intake which had tended to increase each year being over 60% in tall stubble in the two previous years was lowest of all years in 1985-86 (avg. 17%). This was due to (a) thawing and refreezing of meltwater in the warmer than usual winter

(Table 2) and, (b) rapid run-off in late winter as a result of a sudden Chinook. The meltwater had no chance of entering the soil. Last year we suggested that the improved physical soil characteristics resulting from zero-tilling may be enhancing water infiltration into soil. Last year's results merely show that there are conditions when even good soil permeability is of little help.

In the fall of 1985, the tall and short stubble plots had about the same amount of available water (Table 3 and Figure 3). In spring, both tall and short stubble had the same amount of water (33 mm available water) and most of this water was in the top 60 cm of soil. Over the 5 year period the average advantage of tall stubble over short stubble was 12 mm. The average efficiency of water intake was 44% for tall stubble and 32% for short.

4. Results

4.1 Water in Soil

Soil moisture at spring sampling was not as good as in 1985 but growing season precipitation was so good that soil moisture remained above wilting point (40 bar) until after heading (Figure 3(b) and Figure 2). Under these conditions the small amount of stubble decomposed rapidly so that one could not tell by eye which was the tall stubble plots after mid June. Furthermore, since there was no difference in stored moisture due to stubble height, this lack of difference carried through to harvest (Figure 3[b]).

4.2 Mineral N & P in Soil

After two consecutive dry years (1984 and 1985) of low crop production, there was a buildup of mineral N in the soil and available P was also well above adequate levels (Table 4). NO_3-N levels in the top 60 cm depth in the fall of 1985 was twice as high as fall, 1984. Nitrates and bicarbonate P levels such as those observed in early spring, 1986 would indicate that little response to N or P fertilizer could be expected, and as seen later this was generally the case.

Soil analyses were not taken as often this year because of the timeliness of growing season precipitation. Mineral N was higher than in 1985 at similar stages (Table 5) likely reflecting frequent wet/dry occurrences and the improved fertility of this soil caused by annual fertilizing and zero-tilling practice (see second section of this report).

4.3 Plant Population and Dry Matter

Plant measurements were made only at early heading and harvest this year (Table 6). There was an average 1.7 more tillers per plant in 1986 as compared to 1985. Furthermore, plant dry matter was twice as great as in 1985. The tiller numbers did not die back as occurred due to severe drought in 1985. The effect of treatments on tillers and dry matter per plant was small in most cases. Grain to straw ratio was about 0.65, down compared to 0.73 in the dry 1985. Thus, under conditions of good early rainfall more vegetative dry matter is produced but the efficiency of conversion of this dry matter to grain is lower.

4.4 Grain Yields

Yield data for the 5 years were pooled and analyzed for the test plots (Table 7, 8 & 9). Filler plot yields were erroneously not taken in 1986.

In 1986 yields averaged 2665/kg/ha (40 bu/ac) by far the best yields obtained in the five years (Table 7). Fertilizer rates, method of application and the interaction of stubble height and time of application were significant ($P > 0.05$). The response to fertilizer rate was small (only

160 kg/ha spread between 25/kg/ha and 100 kg/ha rates of N (Table 7) and no effect of P (Table 8). There was a 100 kg/ha difference in average yield favouring tall stubble treatment over short stubble in 1986 (Tables 7 & 8) but this difference was not significant.

Based on the pooled data for 5 years all main effects were significant (Table 7) as were several interactions. The data was summarized in Tables 7 - 9 for consistency and simplicity of comparison. Over the 5 years yields increased with N rate reaching a maximum at 75 kg N/ha (Table 7) but P rates generally had little or no effect on yield (Table 8). Thus the optimum rate of P for this soil was no more than 30 kg/ha P_2O_5 and the extra P was not required. Based on the 5 yr average, there was a 100 - 300 kg/ha yield advantage for tall stubble treatments over short stubble (Table 7).

In 1986 method of application and the interaction of time of application and stubble height were significant, however the data were summarized as shown in Table 9 for convenience of discussion. In 1986 yields were 77 kg/ha higher for banded compared to broadcasting (averaged over all other treatments). There was no effect of time of application. Over the 5 years of study response to timing and method of N application varied with year. But based on 5 year average, the relative responses were rated 100, 98, 97 & 94 for spring banded, fall banded, spring broadcast and fall broadcast N respectively.

5. <u>Analyses That Were Incomplete in 1985</u>

Grain protein increased with N rate and was slightly higher for the May application than for April (Table 10). Neither stubble height nor method of N placement affected protein concentration. In Filler plots, protein concentration was higher for the short stubble treatment than the tall with mean grain protein being 14.4% (Table 11).

6. Effect of Zero-Till and N & P Fertility Treatments on Soil Quality

In the spring of 1985, after 4 years of continuous zero-till spring wheat cropping on the NxPxSnow test site, soil samples were taken from the test area and from the adjacent area on which the farmer had continued to use a fallow-wheat rotation. Biological characterization of the soil taken from these two areas showed that zero tillage has already significantly improved the potential productivity of the top 7.5 cm of soil but not the 7.5 - 15 cm depths (Table 12 and Figure 4). For example the amount of organic matter C & N have been significantly ($P < 0.01$) increased in the 0 - 7.5 cm depth (Table 12). Complementing this change in quantity was the improvement in soil quality shown by an increase in microbial biomass C & N, CO_2 respiration (Table 12) and an increase in the potentially mineralizable N components and thus in the rate of N mineralization due to zero-tillage (Figure 4). There was also a significant ($P < 0.05$) increase in the neutral phosphatase activity but alkaline phosphatase and the urease activities were not affected by tillage. Bulk density was not increased by zerotillage (Table 12).

These results help to explain (a) the size of the stubble crop yields this year and, (b) the dampening of response to N fertilizer even with such excellent growing season precipitation as received in 1986.

7. Plans for 1986 - 87

This study will be concluded in 1987 after the following analyses are completed:

(1) Measurement and analysis of conservation of winter precipitation;

(2) Completion of analysis on 1986's grain (eg) grain protein.

(3) Completion of soil characterization to assess effect of tillage by determining (i) nitrifier and denitrifier activity and amino acid and amino sugars on samples taken in 1985 and (ii) repeating all analysis done on the 1985 soil samples, on samples taken in fall, 1986.

(4) Writing two papers for scientific publication, (a) on economics of snow and fertilizer management for spring wheat based on the 5 year data and, (b) the effect of zero-tillage on change in soil quality.

(5) The experimental site will be conventionally summerfallowed to remove grassy weeds infestation (Figure 5) prior to returning land to the producer.

Because of the above activity, it is requested that this project be funded for this final year of the study.

Table 1. Management activities in 1985-86

Activity	Date	Rate	Comments
Herbicides			
Hoegrass II	20/5/86	3.5 l/ha	There was no fall 2,4-D treatment because of intermittent rainfall.
*Hoegrass II	6/6/86	3.5 l/ha	
Insecticides			
*Decis	6/6/86	150 ml/ha	Grasshoppers
‡Fertilizers			
P	26/9/85	Required rates (see text)	Banded at 10 cm depth
Urea	26/9/85	Required rates (see text)	Banded & broadcast (see Fig. 1). (Fall)
Urea	21/4/86	Required rates (see text)	Banded & broadcast (see Fig. 1).(Spring)
Seeding			
Leader	14/5/86	67 kg/ha	17.8 cm spacing using offset disc drill.
Harvest	26/8/86		Wentersteiger combine.

‡ All treatments and also the filler plots received 90 kg/ha of 28-28-0 with the seed.

* Decis & Hoegrass II mixed and applied together.

Table 2. Monthly temperature and precipitation September 1985 to August 1986

	Mean air temperature (°C)		Precipitation (mm)	
	Long-term average	1985-86	Long-term average	1985-86
September	11.7	7.9	30.5	42.8
October	5.6	4.9	18.7	21.4
November	-3.5	-13.7	13.8	16.0
December	-9.8	-9.5	15.4	21.2
January	-13.7	-3.9	17.2	5.4
February	-11.3	-11.5	14.8	9.1
March	-5.1	4.4	17.9	10.8
April	4.6	4.2	22.2	14.4
May	10.8	11.4	42.6	121.7
June	15.3	17.0	72.0	50.8
July	18.7	17.0	52.0	32.4
August	17.6	17.9	42.1	16.2
Avg.	3.4	3.8	Total 359.3	362.2

+ Growing season precipitation (May - July) = 204.9 mm, i.e., 23% greater than long-term avg. of 166.6 mm.

Table 3. Conservation and Efficiency of Intake of Fall and Winter Precipitation by Cereal Stubble Treatments (1981-86)

Season	Precip. fall to spring (mm)[+]	Stubble Ht (cm)		Mean Snow Depth (cm)		Water in snow (mm)		Available water in soil[‡] (mm 120cm^{-1})				Water Conserved (mm 120 cm^{-1})		Advtg. of Tall Short (mm 120 cm^{-1})	% Efficiency of intake of precip.	
								Fall		Spring						
		Tall[±]	Short	Tall	Short	Tall	Short	Tall	Short	Tall	Short	Tall	Short		Tall	Short
1981-82	132	60	20	39	17	97	43	-10	-10	38	28	47	38	9	35	29
1982-83	93	52	19	20	17	40	34	80	67	111	93	31	26	5	33	28
1983-84	68	45	15	25	12	69	27	14	22	58	42	45	20	25	66	29
1984-85	131	40	14	41	24	122	61	-1	0	82	56	83	56	27	63	43
1985-86	63	39	13	38	24	100	60	30	16	39	33	8	14	-6	13	22
Mean	97	47	16	33	19	85	45	23	19	66	50	43	31	12	44	32
Sx̄ (stub. ht)		1.0		1.0		2		—		5		3		—	3	
Sx̄ (yr)		1.7		1.4		3		4		6		7		7	7	
Sx̄ (ht x yr)		2.2		1.5		4		6		—		—		—	9	
Significant Factors																
Stubble height (Ht)		**		**		**		NS		*		*		—	**	
year (yr)		**		**		**		**		**		**		*	**	
Ht x yr		**		**		**		*		NS		NS		—	*	

[+] Soil samples were taken on 23/9/81 and 13/5/82; 1/10/82 and 3/5/83; 27/9/83 & 25/9/83 & 25/4/84; 18/9/84 & 26/4/85; 15/10/85 and 3/4/86.

[±] This height refers to the tall part of tall stubble treatment which in 1985-86 included heads since stubble was so short; in all other cases tall and short refer to the entire tall or short treatment.

[‡] Available water = water held by soil at potentials above -4MPa: at -4MPa this soil retains 154 mm of water in 120 cm depth

*,** Significant at $P < 0.05$ and at $P < 0.01$, respectively; NS, not significant.

Table 4. Nitrate and Bicarbonate soluble P in plots sampled on October 15, 1985 and April 3, 1986

Depth (cm)	Nitrate -N in soil (kg/ha)		Bicarbonate Sol P (kg/ha)	
	Tall	Short	Tall	Short
Fall 1985				
0-15	10.7	13.8	35.8	31.9
15-30	14.9	17.4	11.5	10.7
30-60	23.2	17.2	12.6	13.3
60-90	11.2	9.0	10.5	10.6
90-120	12.7	12.1	15.0	14.2
Total	72.7	69.5	85.3	80.5
Spring 1986				
0-15	10	15.0	29.3	26.1
15-30	17.5	32.8	8.5	8.4
30-60	30.8	26.1	9.0	8.4
60-90	15.1	13.0	7.3	6.6
90-120	16.1	15.6	9.3	8.7
Total	89.5	102.5	63.5	58.1

Table 5. Mineral N recovered in top 120 cm of soil at three growth stages

Method of Application	Fertilizer applied per ha (kg N / kg P_2O_5) 25/60	50/60	75/60	100/60	100/45	100/30	Av
+ Fert **;M **							
	June 23/86 5-leaf stage						
	+NO_3-N (kg/ha)						
Band	59.9	71.1	92.5	119.5	89.9	109.1	90.4
Broadcast	54.8	73.2	69.8	76.6	74.0	83.0	71.9
Av	57.4	72.2	81.1	98.1	82.0	96.1	81.1
Fert ** : M ** : T *							
	Exch. NH_4-N (kg/ha)						
Band	115.4	121.3	125.7	151.9	130.9	139.6	130.8
Broadcast	117.0	120.4	118.5	130.5	131.0	130.3	124.6
Av	116.2	120.9	122.1	141.2	130.9	135.0	127.7
	July 7 - Early Heading						
	NO_3-N (kg/ha)						
Band							
Broadcast							
Av							
	Exch NH_4-N (kg/ha)						
Band							
Broadcast							
Av							
	Aug 28, 29 - Harvest						
	NO_3-N (kg/ha)						
Band							
Broadcast							
Av							
	Exch NH_4 (kg/ha)						
Band							
Broadcast							
Av							

6. Plant Weight and Number of Stems at early Heading and Harvest.

	Fertilizer applied per ha (kg N / kg P_2O_5)						
Growth Stage, Date & Significance	25/60	50/60	75/60	100/60	100/45	100/30	Av
Early Heading			--Stems/plant--				
(July 7th) Fert.*;SxT**	3.37	3.51	3.66	3.58	3.69	3.71	3.59
			--Dry Wt/plant(g)--				
Fert**;SxM*	2.54	2.81	2.99	2.82	2.76	2.83	2.79
Harvest			--Stems/plant--				
(Aug. 28, 29) SxT*	3.27	3.25	3.23	3.40	3.38	3.38	3.32
SxT*			--Straw Wt/plant (g)--				
	3.39	3.36	3.34	3.52	3.50	3.52	3.44
SxT*			--Grain Wt/plant (g)--				
	2.37	2.19	2.15	2.22	2.30	2.23	2.24
			--Total Dry Wt/plant (g)--				
	5.76	5.55	5.49	5.77	5.80	5.75	5.68
			--Grain/Straw Ratio--				
	0.70	0.65	0.64	0.63	0.66	0.63	0.65

Table 7. Effect of N and Stubble Height on Grain Yield (1982-86).

Year	Stubble Height	kgN/ha/kg P_2O_5/ha					Mean	Significance of F Ratio
		25/120+	50/120+	75/120+	100/120	100/60		
1982	Tall	2008	2226	---	2484	2446	2291	
	Short	1813	2070	---	2662	2627	2293	
	Mean	1911	2148	---	2573	2537	2292	
1983	Tall	1396	1635	1968	1988	1685	1734	
	Short	1358	1627	1651	1900	1608	1629	
	Mean	1377	1631	1809	1944	1647	1682	
1984	Tall	653	585	710	723	781	690	
	Short	489	456	436	476	353	442	
	Mean	571	521	573	600	567	566	
1985	Tall	784	683	546	---	645	665	
	Short	554	514	523	---	462	513	
	Mean	669	599	534	---	553	589	
1986	Tall	2638	2609	2834	---	2790	2718	Fert.*
	Short	2529	2625	2606	---	2689	2612	Meth.*
	Mean	2583	2617	2720	---	2740	2665	Stub*Time*
1982-86	Tall	1496	1548	1514	1732	1669	1620	Year**
	Short	1349	1458	1304	1679	1548	1498	Stub.*
	Mean (Years)	1422(5)	1503(5)	1409(4)	1706(3)	1609(5)	1559	Fert.**
1983-86	Mean (Years)	1300(4)	1343(4)	1409(4)		1377(4)	1357	

+1982 to 1984: P_2O_5 = 120 kg/ha; 1985 & 1986 P_2O_5 = 60 kg/ha.

Table 8. Effect of P and Stubble Height on Grain Yield (1982-86)

Year	Stubble Height	kg/ha P_2O_5 at 100 kg/ha N 120	60	45	30	Mean
1982	Tall	2484	2446	--	2375	2435
	Short	2662	2627	--	2583	2624
	Mean	2573	2537	--	2479	2530
1983	Tall	1988	1685	--	1864	1846
	Short	1900	1608	--	1610	1706
	Mean	1944	1647	--	1737	1776
1984	Tall	723	781	--	625	710
	Short	476	353	--	466	432
	Mean	600	567	--	545	571
1985	Tall	--	645	618	603	622
	Short	--	462	509	464	478
	Mean	--	553	563	534	550
1986	Tall	--	2790	2753	2889	2811
	Short	--	2689	2634	2730	2684
	Mean	--	2740	2693	2809	2747
1982-86	Tall	1732	1669	1686	1671	1685
	Short	1679	1548	1572	1571	1585
	Mean	1706	1609	1629	1621	1635

Table 9. +Effect of Method of N Placement and Time of Application on Yield of Spring Wheat (1981-86)

Year	Method of Application	‡Time of Application: Fall	Spring	Mean
1982	Banded	2373	2502	2438
	Broadcast	2177	2390	2284
	Mean	2275	2446	2361
1983	Banded	1733	1740	1736
	Broadcast	1582	1708	1645
	Mean	1658	1724	1691
1984	Banded	571	560	566
	Broadcast	566	553	560
	Mean	569	557	563
1985	Banded	576	572	574
	Broadcast	585	568	576
	Mean	580	570	575
1986	Banded	2728	2736	2732
	Broadcast	2695	2616	2655
	Mean	2711	2676	2694
‡‡1982-86	Banded	1596	1622	1609
	Broadcast	1521	1567	1544
	Mean	1559	1595	1577

+ These values are averaged across stubble height and rates of fertilizer.

‡ In 1985 these treatments were early April vs. mid-May because early arrival of winter prevented a fall application.

‡‡ Time**;Method**

Table 10. +Effect of Fertilizer rate and time of Application on Grain Protein Conc. (1985)

Time N Applied	Rate of Fertilizer (kg N/ha/kg P_2O_5/ha)						
	25/60	50/60	75/60	100/60	100/45	100/30	Mean
			--% Protein--				
April	13.5	14.1	14.7	15.0	14.6	15.3	14.5
May	13.8	14.5	15.1	14.9	15.0	15.5	14.8
Mean	13.6	14.3	14.9	15.0	14.8	15.4	14.7

+ Significant factors were fertilizer rate and time of N application.

Table 11. Grain Protein in Filler Plots

Stubble Height	Grain Protein (%)
Tall	13.8
Short	15.0
Mean	14.4

$S_{\bar{x}}$ (stub ht) = 0.22

Table 12. Effect of Tillage on Some Soil Biological Properties after 4 years of Zero-tillage.

atment	Depth	Bulk Density	Nitrogen		Carbon		C/N Ratio	CO_2-C Respiration	Micro Biomass (µg g^{-1} soil)		Soil Enzymes Alk. Phos.	Neutral Phos.	Urease
	(cm)	(g/cc)	%	kg/ha	%	kg/ha		(µg g^{-1} soil)	Carbon	Nitrogen	P-nitrophenol	(µg. g^{-1} hr^{-1})	(µg urea. g^{-1} soi
	0-7.5												
nt		1.35	0.123	1.23	1.14	11.66	9.27	81.6	205	ND	480	396	60.8
ort Stubble		1.29	0.160	1.58	1.66	16.32	10.41	131.5	263	ND	907	601	50.6
ll Stubble		1.28	0.155	1.52	1.57	15.34	10.16	134.1	262	ND	603	688	64.4
		--	0.006	0.06	0.06	0.58	0.33	13.0	30	ND	162	46	7.7
	7.5-15												
nt		1.49	0.112	1.30	1.00	11.33	8.87	31.3	ND		409	399	36.7
rt Stubble		1.43	0.123	1.36	1.16	12.61	9.45	44.3	ND		480	448	34.9
l Stubble		1.42	0.125	1.36	1.26	13.66	10.18	43.2	ND		320	519	46.4
		--	0.005	0.05	0.06	0.62	0.45	3.0	ND		94	66	5.8
	15-30												
nt		1.36	0.095	1.99	0.79	16.47	8.34	ND	ND		ND	ND	ND
rt Stubble		1.35	0.095	1.97	0.85	17.45	8.86	ND	ND		ND	ND	ND
l Stubble		1.36	0.095	1.99	0.90	18.58	9.45	ND	ND		ND	ND	
		--	0.004	0.09	0.05	1.07	0.21	ND	ND		ND	ND	ND
	0-30												
nt		--	--	4.52	--	39.47	8.73	ND	ND		ND	ND	ND
rt Stubble		--	--	4.90	--	46.38	9.46	ND	ND		ND	ND	ND
l Stubble		--	--	4.87	--	47.58	9.78	ND	ND		ND	ND	ND
				0.10	--	1.45	0.20	ND	ND		ND	ND	ND

ero tilled continuous cropped to spring wheat for 4 years at time of sampling in Spring, 1985.
= Not done yet.

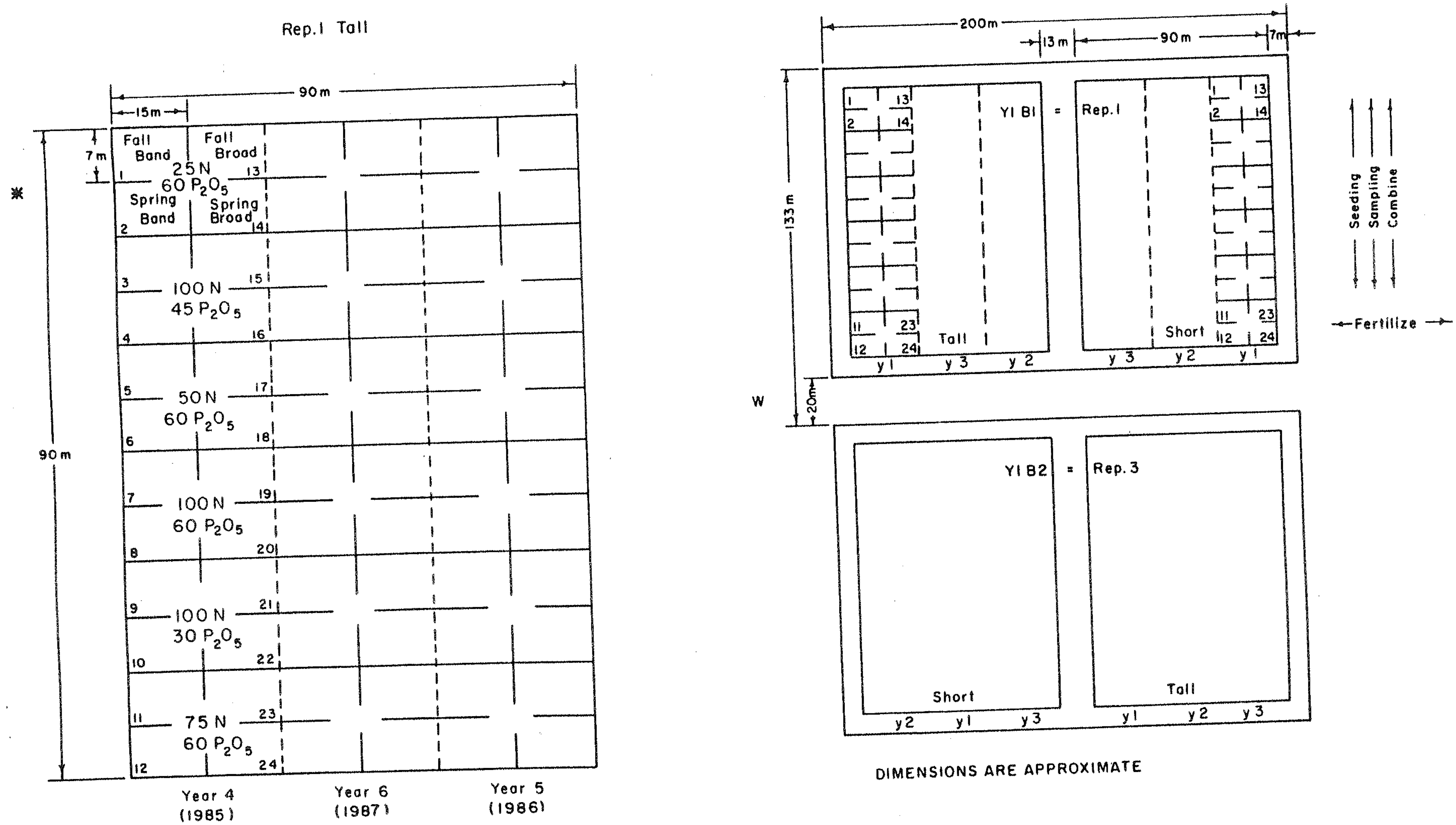

Figure 1. Right - general field plan and direction of operations.
Left - details of plot layout for tall stubble treatment.

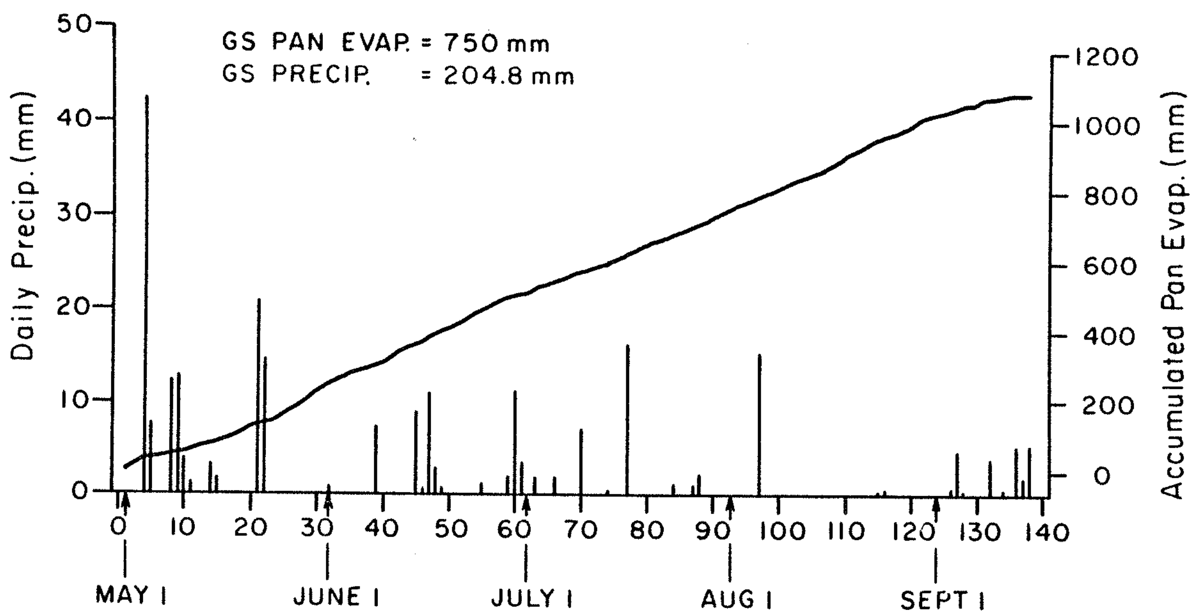

Figure 2. Daily Rainfall and Accumulated Pan Evaporation (1986).

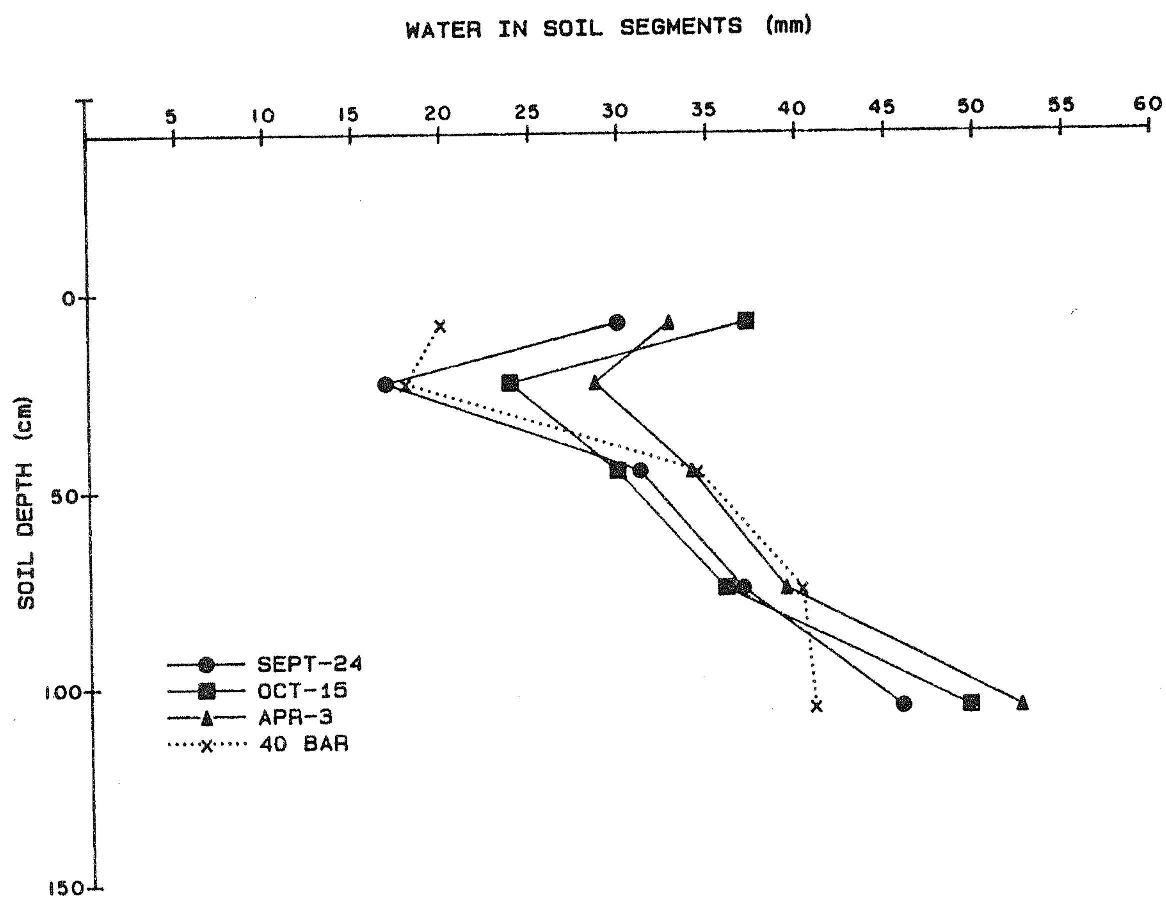

Figure 3(a). Distribution of Moisture in Soil Profile in Fall and Spring. (Data averaged across stubble height which was not significant.)

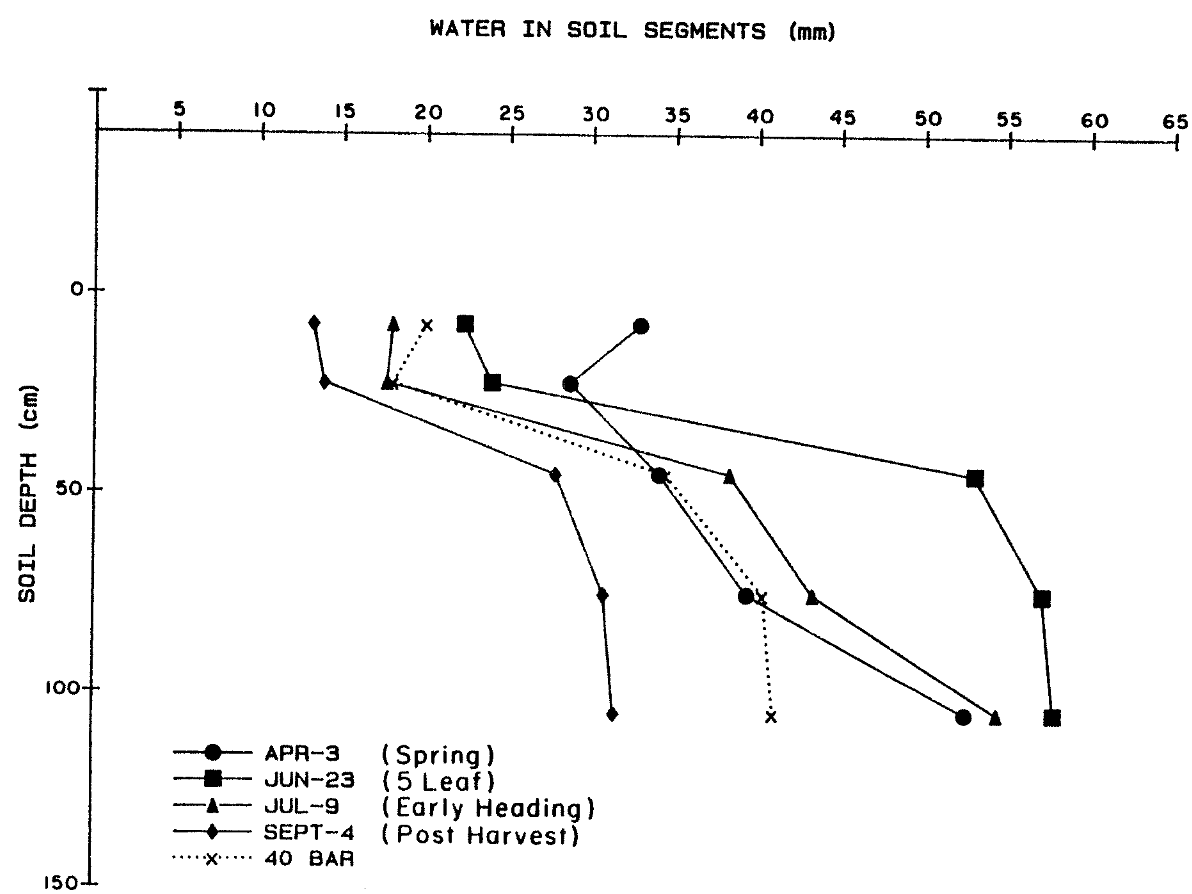

Figure 3(b). Distribution of Soil Moisture in Soil Profile Throughout 1986 Growing Season. (Data averaged across all treatments.)

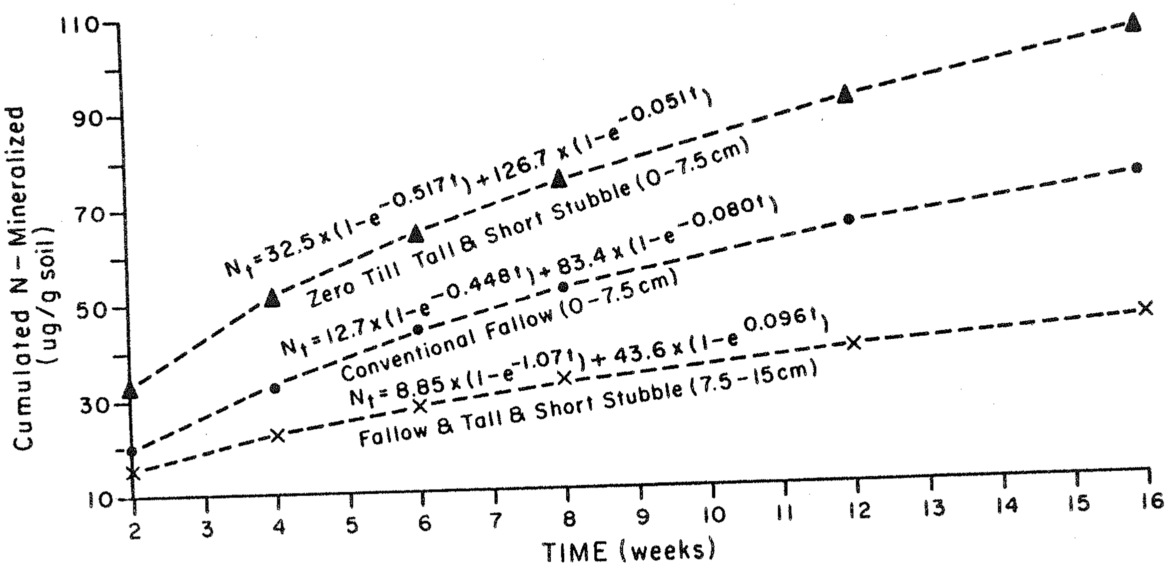

Figure 4. Effect of Tillage on Potentially Mineralizable N and Decomposition Rate Constant in 0 to 7.5 and 7.5 to 15 cm depths after 4 years of zero-tillage.

Figure 5. Top - Wild Barley Infestation in Zero-Till Continuous Spring Wheat (after 6 years Cropping).
Bottom - Bags of Wild Barley Pulled From Test Plots.

Addendum

Response of Hard Red Spring Wheat to Potassium Fertilization

by F. Selles and C.A. Campbell

In the 1985 report to PPI it was indicated that there was no response to K fertilization by HRSW and Tripple M type of wheats. Due to the severe drought experienced during 1985 it was thought that some of the fertilizer effects may have been masked by the water stress.

During 1986 one experiment was conducted on Hatton sandy loam and Swinton clay loam to assess the response of HRSW (cv Leader) to different levels of K fertilization. The soil nutrient content and spring soil moisture of the soil and summarized in Table 1.

The experiment consisted of four treatments (0,50, 100 and 150 kg ha^{-1} K_2O as 0-0-60 side banded) replicated four times in a complete randomized block lay out. In addition to the K treatments, every plot received 35 and 30 kg. ha^{-1} of N and P_2O_5, respectively. Nitrogen was applied as 34-0-0 side banded together with the 0-0-60 and the P_2O_5 was applied as 0-45-0 seed placed. The crop was seeded at a rate of 61 kg ha^{-1} (1 bu. ac^{-1}) with a 25 cm row spacing. Grain yield, thousand kernel weight and bushel weight were measured.

Results

In the sandy loam soil neither grian yield, thousand kernel weight, nor bushel weight were affected by the potassium application. In the clay loam soil grain yield was not affected by K rates, whereas bushel weight and thousand kernel weight were significantly increased when 50 kg ha^{-1} K_2O or more was applied (Table 3).

Table 1. Fall Nutrient Content, Available Spring Soil Water and Growing Season Precipitation.

Soil	Available Nutrients (kg/ha) NO_3-N[1]	PO_4-P[2]	K[2]	SO_4-S[3]	Spring Soil Water mm	Growing Season precipitation (mm)
Hatton SL	49	19	403	205	98.2	182
Swinton CL	66	28	463	nd[+]	51.8	205

1 - 0-60 cm depth
2 - 0-15 cm depth

Table 2. Grain Yield, Thousand Kernel Weight and Bushel Weight in a Hatton SL Soil.

K_2O Rate kg ha^{-1}	Grain Yield kg ha^{-1}	1000 Kernel Wt. g	Bushel Weight lb.
0	1152	25.8	62.2
50	979	26.1	62.8
100	1081	26.3	62.9
150	975	26.7	63.0

Table 3. Grain Yield, Thousand Kernel Weight and Bushel Weight on a Swinton CL Soil.

K_2O Rate kg ha^{-1}	Grain Yield kg ha^{-1}	1000 Kernel Wt. g	Bushel Wt. lb.
0	2236[a]	24.9[a]	60.7[a]
50	2278[a]	26.5[b]	61.5[b]
100	2226[a]	26.4[b]	61.6[b]
150	2211[a]	26.4[b]	61.4[b]

Means followed by the same letter are not significant according to Duncan's multiple test (P=0.05)