SOIL PLANT NUTRIENT RESEARCH REPORT

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HIGHLIGHTS OF THE 1967 FERTILITY RESEARCH PROGRAM

1. Wheat, oats and barley seeded on stubble - Gray Wooded soils - responded strongly to fertilizer nitrogen. An optimum fertilizer-N input of approximately 65 lb of N per acre resulted in a 9.3, 13.2 and 16.4 bushel increase for wheat, barley and oats respectively.
2. Unfertilized check yields for tests laid down on the Chernozemic soils were approximately twice as high as for the Gray Wooded soils. An optimum input of 30 lb of fertilizer-N increased yields of wheat and barley by approximately 9 bu per acre.
3. The V.L.A. cooperative program continues to provide an excellent guideline as to the performance of soil test recommendations. Yield increases based on soil tests resulted in average yield increase of 7.9 bu/acre, in comparison to the 5.6 bu increase where the general fertilizer recommendations were followed.
4. Urea-phosphate carriers such as 27-27-0 and 23-23-0 S can be fully recommended for barley and oats on the basis of the data obtained in 1967 and previous years. The performance of these carriers has been somewhat erratic when used as a source of N and P for wheat, and it is suggested that rates of application of N using these carriers should not exceed 20 lb of N/ac.
5. Under the climatic conditions prevailing in 1967, maximum efficiency of fertilizer nitrogen was obtained with seed placement. Note, however, where the rate of N applied with the seed exceeded 20 lb of N/ac, yield reduction occurred with wheat.

6. Incorporation of straw into the surface soil reduced the availability of the soil N during the 1967 growing season. The value of straw residues was clearly demonstrated in that yields on the straw-amended plots adequately fertilized was higher than on comparable plots receiving no straw.
7. Amendments of Procal to moderately saline soil was again demonstrated to be of little value.
8. A single trial carried out comparing ammonium poly-phosphates with mono-ammonium phosphates using rape as the test crop suggests the former to be a comparable source of phosphorus.
9. Significantly higher yields of wheat were obtained where additional nitrogen, above that carried in the 11-48-0 fertilizer, was applied to wheat seeded on low-N summerfallow fields. The 18-46-0 carrier, although previously shown to be a less effective source of phosphorus, performed better than 11-48-0, primarily as a result of the somewhat higher nitrogen content. The data obtained from these summerfallow tests support the conclusion that summerfallow fields containing less than 45 lb of N per acre 2' require additional nitrogen for satisfactory growth of cereal grains. On the basis of these data, the 18-46-0 carrier is recommended for use on 'low-N' fallow fields.
10. Barley seeded on soils testing very low and low in exchangeable potassium responded well to the application of potash fertilizer. The 0-0-60 carrier broadcast and incorporated into the soil prior to seeding was generally superior to carriers such as 10-30-10 applied with the seed. Wheat did not respond to additional potassium, even though the need for fertilizer-K was suggested by a soil test.

FIELD FERTILIZER INVESTIGATIONS
1967

The 1967 field fertilizer testing program included 50 large scale field plots on stubble land and 27 on summerfallow. The investigations carried out on stubble land were primarily designed to confirm or adjust the present soil and test benchmarks. A limited number of these tests involved comparisons between urea nitrogen and ammonium nitrate nitrogen applied together with 11-48-0. The effect of different nitrogen placements was also investigated in a number of field-scale plots. Straw placement experiments were set out at two locations. Soil test data obtained in the fall of 1966 indicated that approximately 20% of the summerfallow fields in the province possibly required additional nitrogen for optimum yields. Field strip tests were set out to assess the economics of applying additional nitrogen on the low-N fallow soils. In addition, a series of tests involving potash fertilization were set out on soils with low available K.

Most of the data obtained from the individual plots are presented in the Appendix.

I. THE NITROGEN REQUIREMENTS OF CEREALS SEEDED ON STUBBLE LAND

(A) Gray Wooded Soils

Six plots located on Gray Wooded soils in the area east of Kelvington included treatments of 11-48-0, and 11-48-0 plus 20, 30, 60, 80 and 100 lb N/acre broadcast. These plots were seeded with the department's equipment. Sub-plot sites, which were used for soil and yield sampling, were selected and identified on a Sub-Group profile basis. Because of the small size of the fields, it was necessary in some cases to reduce the number of sub-plot sites from the usual 10 to 5 sites.

Visually observed response to nitrogen applications was very dramatic on the 2 wheat and 1 oats plots. The response was less apparent on the barley plots, but the yield data indicate increases ranging as high as 23.0 bu/acre. The average yields, yield increases and soil test values for the different crops are shown in Table 1, and presented graphically in Figure 1. The results indicate that the optimum rate of fertilizer nitrogen varied between 60 and 100 lb N/acre. The soil test nitrogen values were in the low and very low ranges. Check yields were generally quite low, and in some cases the harvest of such crops would probably be unprofitable. However, the demonstrated yield increases from fertilizer applications indicate the necessity of maintaining the fertility of these soils if profitable yields on stubble land are to be obtained.

Table 1. Stubble Fertilizer Tests on Gray Wooded Soils

A. Mean Yield of Check and Yield Increases (bu/ac)

Crop	Check Yield	11-48-0 @ 60	11-48-0 @ 60, plus 33.5-0-0 @ 45	78	165	222	282
Wheat (2)	7.6	3.0	3.2	7.5	13.0	12.5	10.2
Barley (3)	14.1	6.7	3.0	4.9	9.5	8.3	11.1
Oats (1)	29.5	6.9	10.4	4.8	22.7	30.5	25.0

B. Soil Test Values

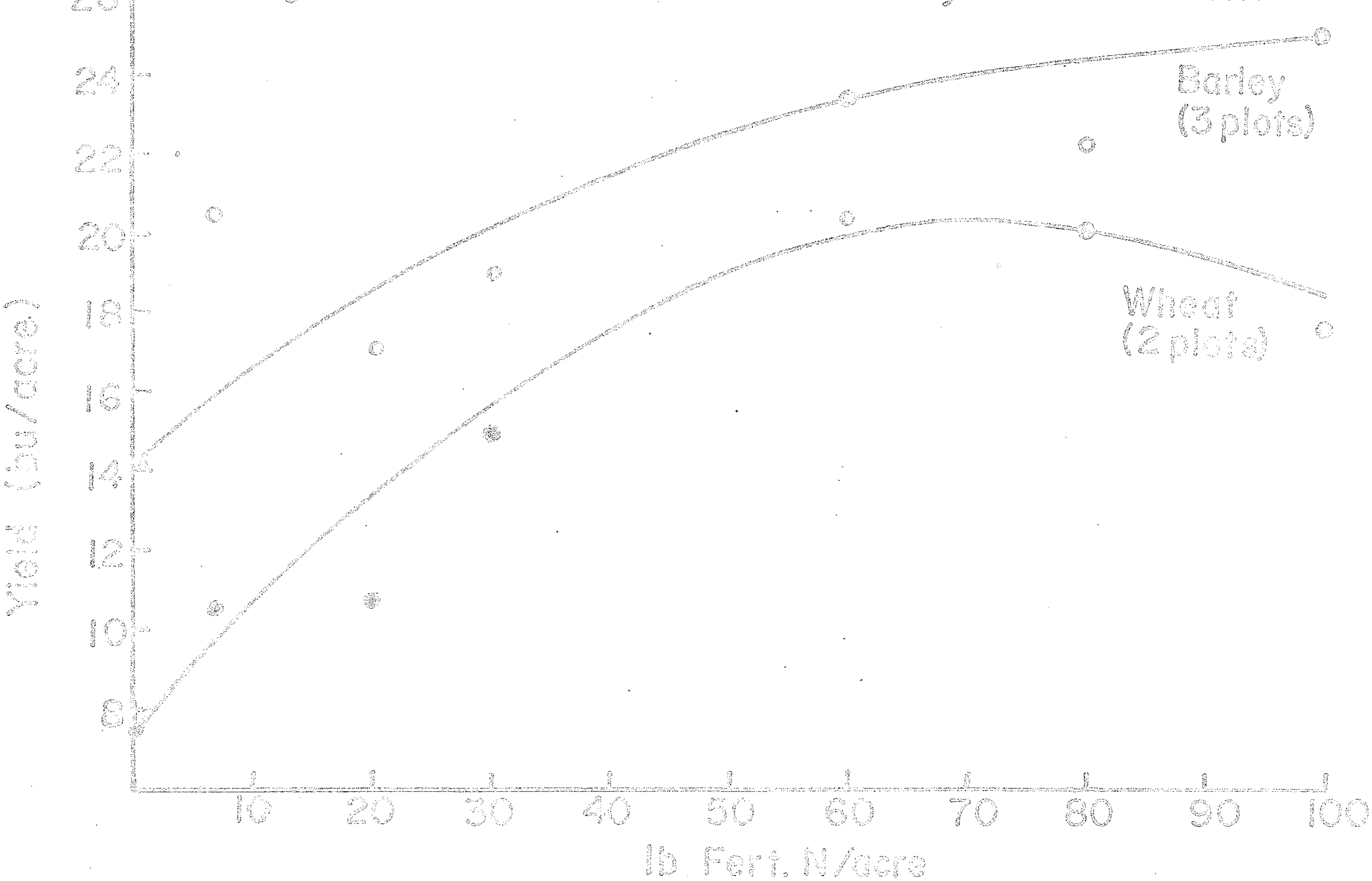
	lb NO_3 N/acre 2'	lb P/acre 6"	1 lb K/acre 6"
Wheat (2)	10	13	320
Barley (3)	25	12	266
Oats (1)	20	30	392

(B) Chernozemic Soils (Stubble Land)

Thirteen field-scale experiments were conducted on the farms of former students of the School of Agriculture. These experiments included 7 wheat plots, 8 barley plots, 1 durum and 1 oats plot. The treatments consisted of 2 rates of P_2O_5 (20 and 30 lb/acre) in combination with 4 rates of nitrogen (20, 30, 40 and 60 lb/acre). The plots were seeded with the farmers' equipment. Ten sub-plot sampling sites were selected on a topographical basis and the depth of moist soil was determined at seeding time. The average yields and soil test values are presented in Table 2 and Figures 2a and 2b.

In general, there were no significant differences in response to the two rates of P_2O_5, although in some individual

Figure I. Fertilizer Tests on Gray-Wooded Soils



cases (R. Bruce, Coolidge) the 30 lb rate gave higher yields. There were several plots with soil test P values in the very low range which did not show significant responses to the additional 10 lb P_2O_5 per acre.

Table 2. School of Agriculture - Co-operative Tests (Stubble)
A. Mean Yield and Yield Increases (bu/acre)

Crop	Check Yield	11-48-0		11-48-0 plus 33.5-0-0 @ 45	78	105	165
Wheat (7)	22.0	@ 40	3.3	6.1	6.7	5.8	8.0
		@ 60	4.7	4.7	5.2	7.4	8.8
Barley (4)	23.2	@ 40	4.9	5.0	6.6	6.3	5.1
		@ 60	3.9	6.8	3.1	5.3	6.0
Durum (1)	16.4	@ 40	0.9	1.5	5.2	5.8	8.8
		@ 60	4.0	12.1	12.5	12.5	10.9
Oats (1)	27.9	@ 40	4.9	5.0	4.7	5.0	4.2
		@ 60	-0.8	7.9	5.9	7.8	10.8

B. Soil Test Value

	lb NO_3-N/acre 2'	lb P/acre 6"	lb K/acre 6"
Wheat (7)	42	16	741
Barley	31	18	910
Durum (1)	57	19	1058
Oats (1)	28	17	1276

For the 7 wheat plots, the average yield continued to increase with increasing fertilizer nitrogen up to the 60 lb/acre rate, whereas with the 4 barley plots, the optimum rate of nitrogen was about 30 lb/acre. The soil test N values ranged from 10-68 lb NO_3-N per acre 2 feet, with most of them (9 plots) falling in the medium to very low ranges.

Figure 2a. School of Agriculture Tests (Wheat - 7 plots)

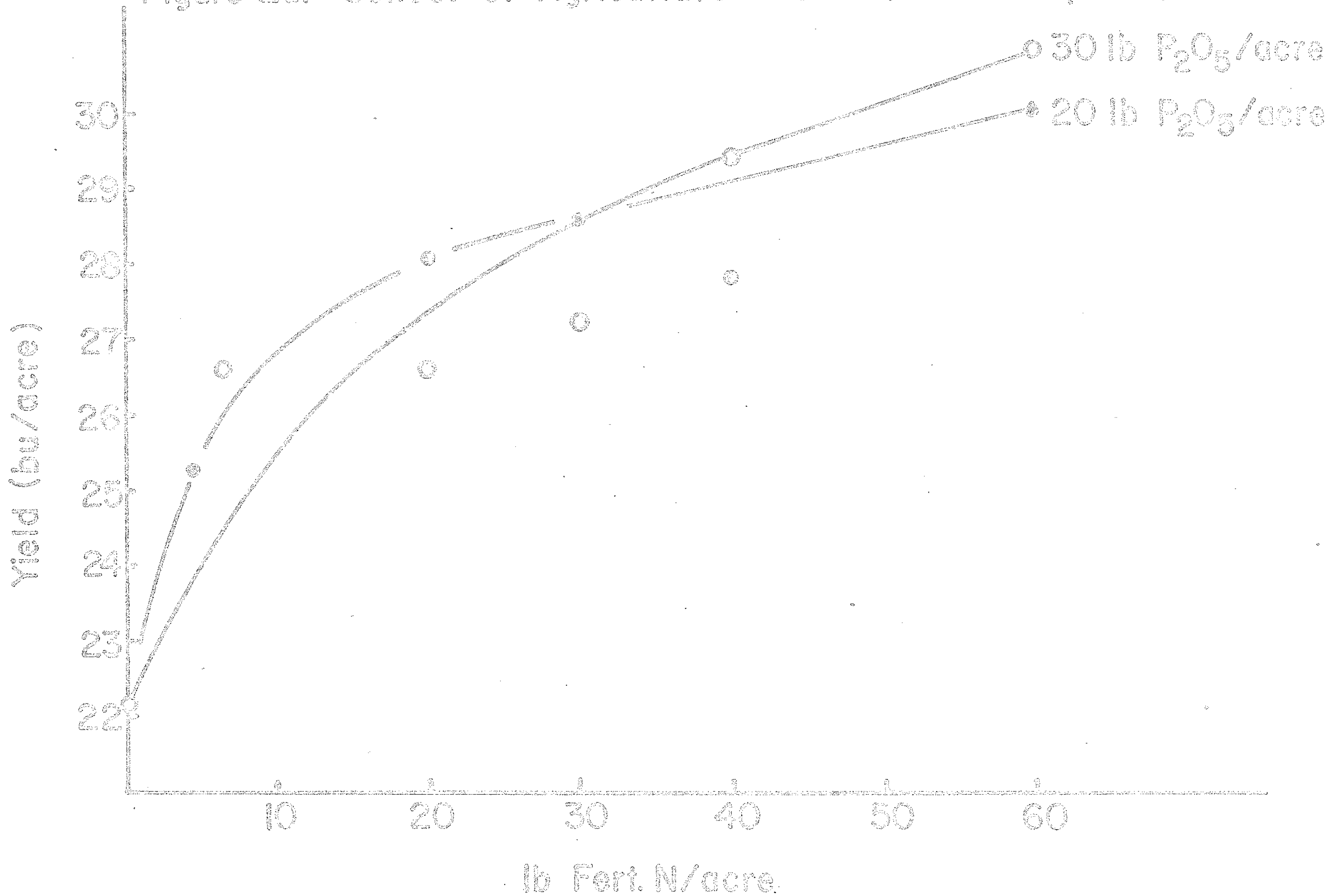
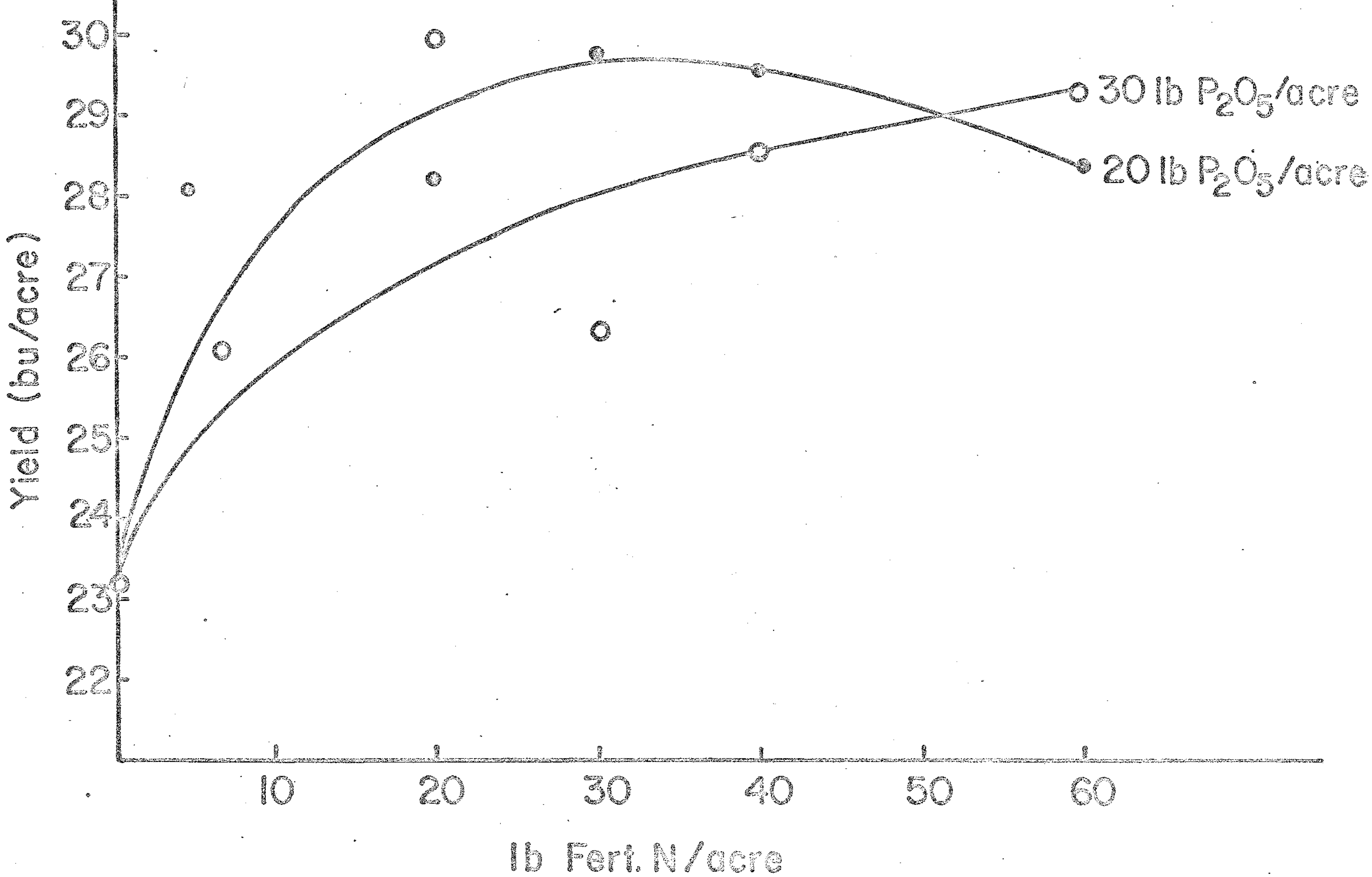


Figure 2b. School of Agriculture Tests (Barley - 4 plots)



(C) VLA Co-operative Tests (Stubble land)

The stubble fertilizer project in cooperation with the district Credit Advisors of the Veterans' Land Administration was continued in the 1967 fertility program. Twenty-four field-scale tests were seeded, one in each VLA district. As in previous years, the veteran farmers' equipment was used in seeding the plots under the supervision of the VLA Credit Advisors. Soil and grain yield samples were taken on a 10 sub-plot basis and the depth of moist soil was recorded at seeding time. Soil samples were also taken on a field basis in the fall of 1966. Yield samples were not obtained from 3 plots, either because the plot was plowed under or because the plot was harvested before yield samples could be taken. The yield data from 2 plots were not used because of the extreme variability in sample size.

The actual rates of fertilization varied somewhat from plot to plot, however, for summarization purposes, the yield results in Table 3 and Figure 3 have been grouped and averaged.

Table 3. V.L.A. Cooperative Tests (Stubble)

A. Mean Yield and Yield Increases (bu/ac)

Crop	Check Yield	11-48-0 @ 40	23-23-0 @ 80	11-48-0 plus 33.5-0-0 @ 100
Wheat (16)	16.9	1.8	4.6	6.8
Barley (2)	17.2	3.9	10.4	11.5
Durum (1)	11.8	1.8	1.8	-

B. Soil Test Values

	lb NO_3-N/acre 2'		lb P/acre 6"		lb K/acre 6"	
	F	S	F	S	F	S
Wheat (16)	18	36	20	21	753	892
Barley (2)	8	18	56	43	740	845
Durum (1)	90	52	33	19	1208	1190

The spring soil test N values (19 plots for which yield data are reported) varied from 12 to 94 lb, NO_3-N/acre 2', with 5 plots in the very low range, 7 in the low range and 3 in the medium range. In general, good responses to N and P fertilization were obtained on these plots.

At 13 locations, a treatment corresponding to the soil test recommendation was applied. A comparison of the yield increases of this treatment and the general recommendation of 23-23-0 @ 87 lb/acre is shown in Table 4. The average yield increases indicate that an additional 2.3 bu/acre were obtained by following the soil test recommendation, rather than the general recommendation. This additional increase resulted from an additional 17 lb N and 4 lb P_2O_5 per acre.

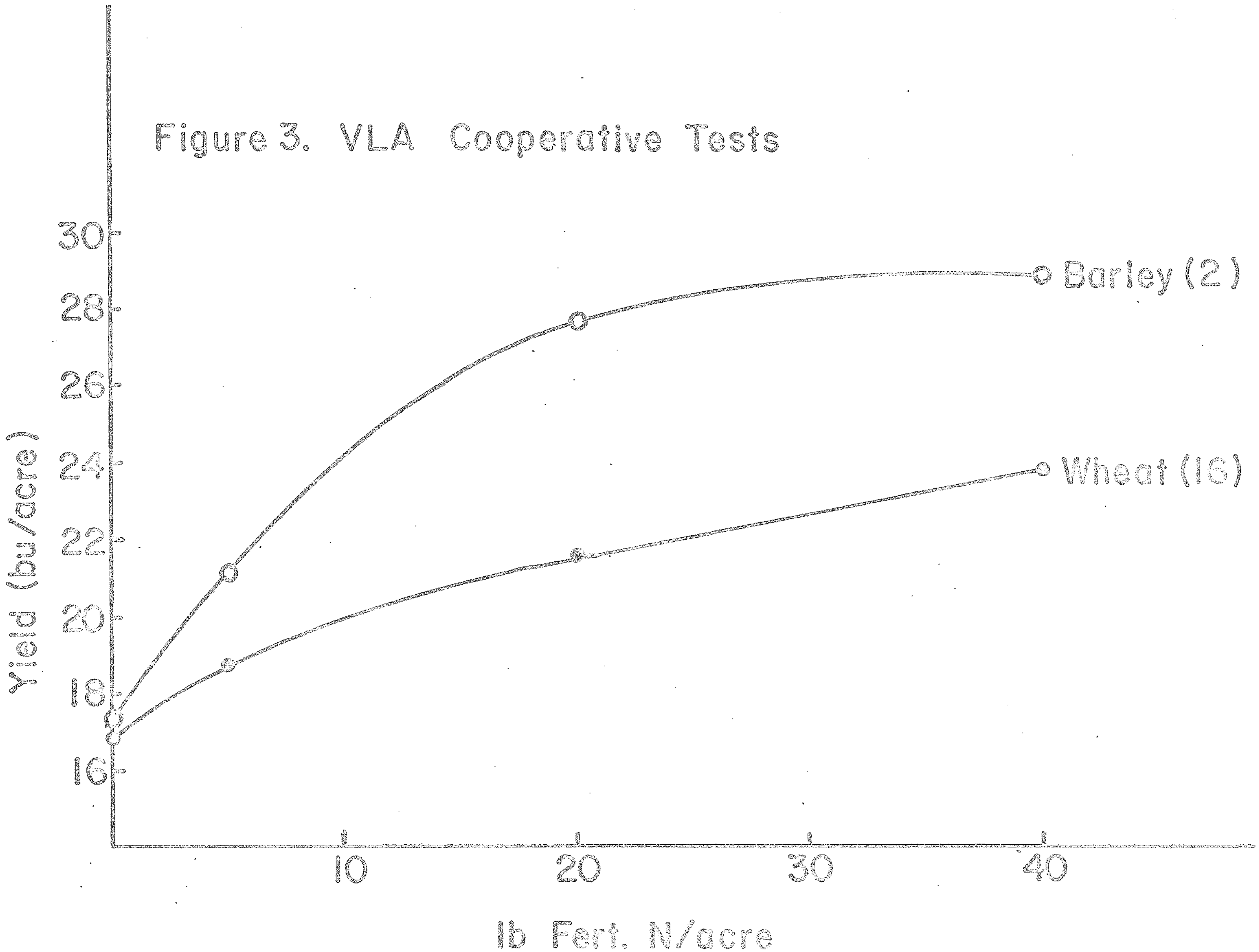


Figure 3. VLA Cooperative Tests
Yield (bu/acre)
30
28
26
24
22
20
18
16
Barley (2)
Wheat (16)
10
20
30
40
lb Fert. N/acre

Table 4. Average Yield Increases from Application of Soil Test Recommendation Rate vs. 20 lb N and 20 P_2O_5/Acre

	Check Yield	Average Recommended N lb/acre	Average Recommended P_2O_5 lb/acre	Yield Increase 20 lb N 20 lb P_2O_5	Yield Increase Soil Test Recommendation
Average of 13 test locations (VLA co-op tests)	17.5	37	24	5.6	7.9

II. UREA-PHOSPHATES

Urea-phosphate fertilizers were tested in 4 field plots; these consisted of 2 barley and 2 wheat plots located on sites near Saskatoon, Rosthern and Hoey. The following fertilizer materials were used: 11-48-0 - MAP plus ammonium nitrate, 23-23-0 MAP plus ammonium sulphate plus urea, and 27-27-0 - MAP plus urea. These plots were seeded with the departmental equipment, each plot consisting of 19 variously treated 8 ft x ½ mile strips. The sub-plot sites were selected at seeding time, and these served as sites for soil sampling, yield sampling and installation of neutron moisture meter access tubes. The sub-plot sites were identified on a Sub-Group profile basis.

The data presented in Table 5 and Figures 4a and 4b indicate different response patterns of wheat and barley to urea-phosphate fertilizers. On the wheat plots, a yield decrease was noted for the 25 lb rate as compared to the 20 lb rate. (In Figs. 4a and 4b, the fertilizer P_2O_5 rates also refer to fertilizer-N rates for the three 1:1 fertilizers.) This effect cannot be observed in the yield data for the barley plots. The 27-27-0 fertilizer seems to be slightly superior for barley and was the least detrimental in lowering the yield at the 25 lb rate on the wheat plots.

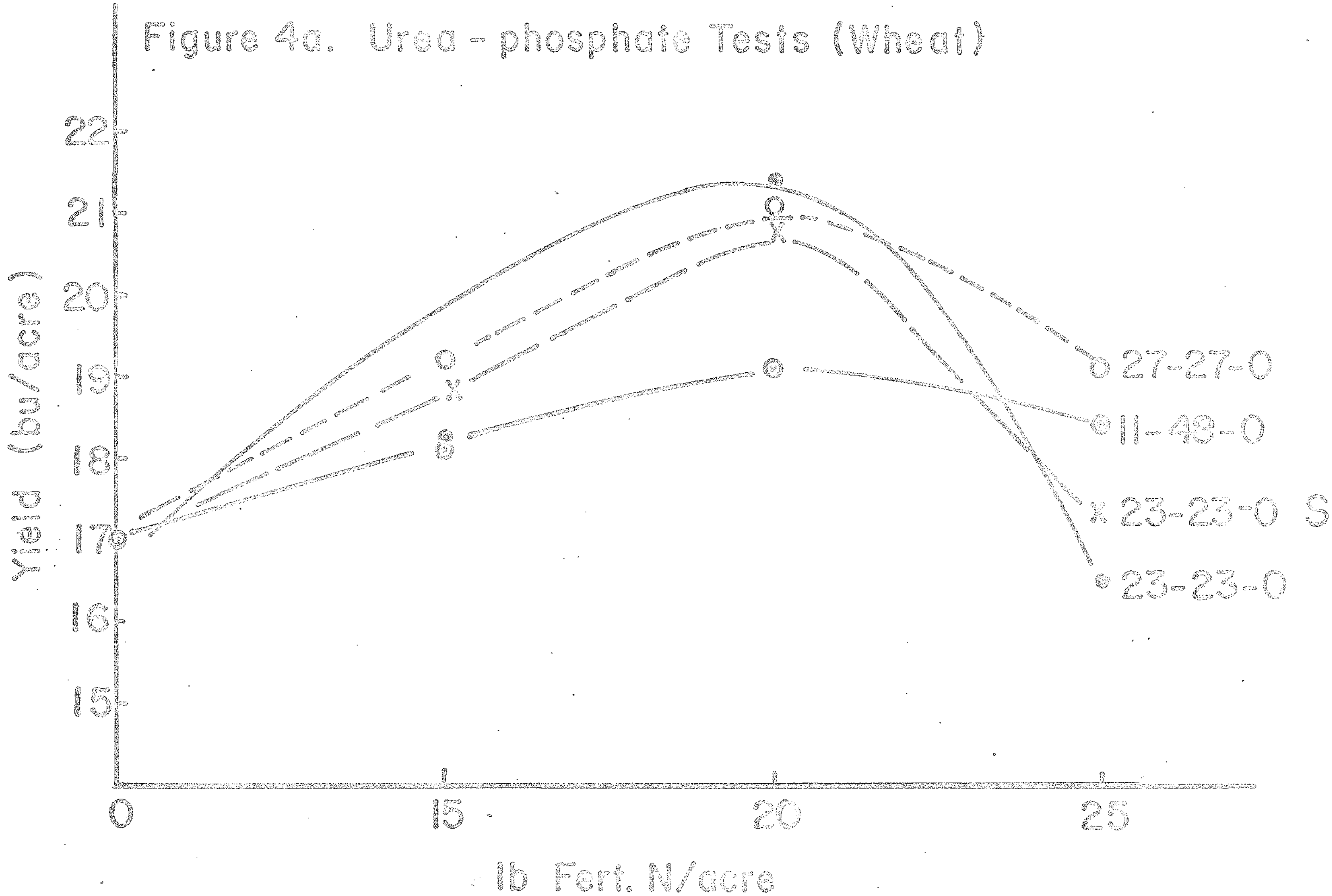


Figure 4a. Urea - phosphate Tests (Wheat)

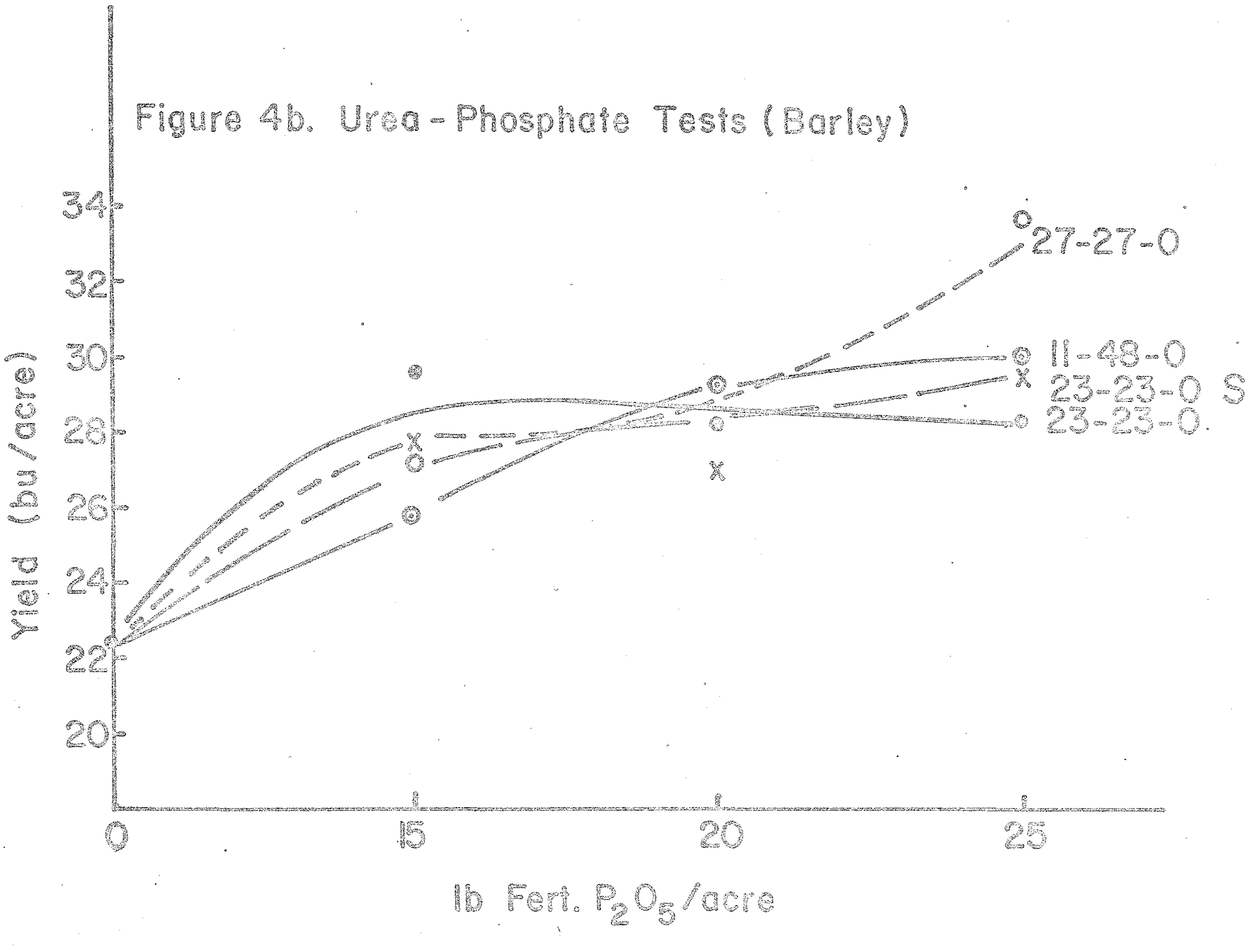


Figure 4b. Urea-Phosphate Tests (Barley)

Table 5. Urea Phosphates (Stubble)

A. Mean Yield and Yield Increases (bu/acre)

Crop	Check Yield	P_2O_5 lb/ac.	11-48-0	23-23-0	23-23-0S	27-27-0
Wheat (2)	17.0	15	1.1	1.2	1.8	2.2
		20	2.1	4.4	3.8	4.1
		25	1.4	-0.5	0.3	2.1
Barley (2)	22.5	15	3.4	7.0	5.2	4.8
		20	6.9	5.8	4.6	5.9
		25	7.6	6.0	7.2	10.8

B. Soil Test Values

	lb NO_3-N/acre 2'	lb P/acre 6"	lb K/acre 6"
Wheat (2)	52	21	950
Barley (2)	47	20	1036

Some caution should be exercised in interpreting the average data. The average for the two wheat plots largely reflects the results obtained on the Roth plot, since essentially no yield differences were observed on the Goodale plot. For the Hoey barley plot, all 1:1 fertilizers gave lower yields than the 11-48-0, whereas on the Popoff plot, the 1:1 fertilizers gave good yield increases over the 11-48-0 applications. These trends are what might be expected from the soil test N values which were very high for the Goodale and Hoey plots, and low and medium for the Popoff and Roth plots respectively.

In order to check for possible germination damage, plant counts were conducted on these plots at the 2-3 leaf stage. The results are shown in Table 6. No significant differences were observed.

Table 6. Germination Counts - Urea-phosphate Tests, 1967[1]
(no. of plants per 3' row)

Fertilizer	Barley[2]	Wheat[2]
23-23-0	25.2	34.3
23-23-0 S	25.0	34.8
27-27-0	25.3	35.5
11-48-0	25.3	34.8
Check	24.6	34.5
L.S.D. (P=.05)	N.S.	N.S.

[1]Triplicate counts per treatment were taken at each of the 10 sampling sites at the 2-3 leaf stage.

[2]Two barley and two wheat trials; the data for each treatment is the mean of the 15, 20 and 25 lb P_2O_5/acre treatment.

III. NITROGEN PLACEMENT

Three field-scale plots (wheat) were set out in which 3 fertilizer placements were studied: with the seed, side-banded about 1 inch from the seed, and broadcast. Both the phosphorus and nitrogen were side-banded in the second application, whereas in the other applications the phosphorus was banded with the seed. The sampling pattern, plot layout, and installation of neutron meter access tubes was the same as outlined for the urea-phosphate tests described above.

The yield data (Table 7 and Figure 5) indicate that the yield decreases when the rate of nitrogen applied with the seed exceeds 20 lb/acre. Figure 5 shows that 20 lb of N/acre with the seed gave the best average yield. In general, the side-band and broadcast treatments did not give significantly higher yields than the placement with the seed.

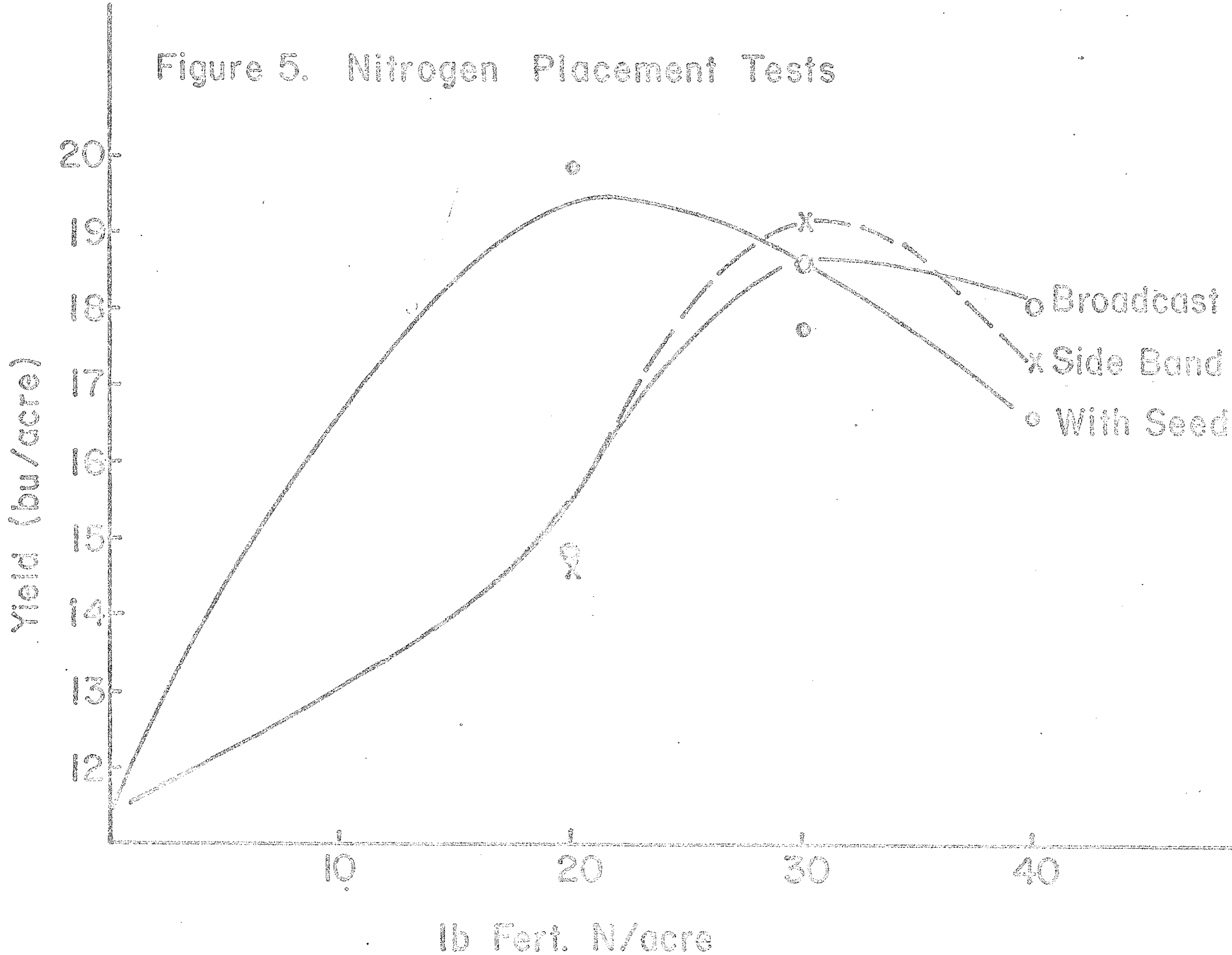


Figure 5. Nitrogen Placement Tests

The soil test N values varied considerably among the plots; very low, low and high N values were observed for the Honey, Shields and Bellamy plots, respectively.

Table 7. N-Placement Tests (Stubble)

A. Mean Yield and Yield Increases (bu/acre), 3 Wheat Plots

Check Yield	Placement	11-48-0 @ 40	23-23-0 @ 87	25-17-0 @ 118	27-14-0 @ 145
11.5	with seed	2.7	8.4	6.3	5.1
	side banded	-	3.2	7.7	5.8

broadcast — 11-48-0 @ 40 with seed plus 33.5-0-0 broadcast @

45	78	105	105 (June)
3.3	7.1	6.5	4.2

B. Soil Test Value

lb NO_3-N/acre 2'	lb P/acre 6"	lb K/acre 6"
29	15	602

IV. STRAW PLACEMENT

Straw incorporation trials were conducted on a Waitville Loam soil in the Kelvington area and a Blaine Lake soil near Rosthern. The data from these experiments has not, as yet, been fully processed. However, the following generalizations concerning the immobilization of nitrogen by straw are suggested. These comments are supported by data obtained by R. Ledingham at Saskatoon, Scott and Swift Current.

1. The addition of chopped wheat straw accentuated the deficiency of nitrogen characteristic of both the Blaine Lake and Waitville soil sites.
2. Under medium and high N levels, the straw amended plots out-yielded plots where all straw had been removed. This has tentatively been attributed to reduction in loss of soil moisture by evaporation afforded by the residue cover.
3. The data obtained from the Gray Wooded plot was confounded by the soil physical condition. The very poor surface structure of this soil made seed bed preparation very difficult, particularly on the no-straw plots.

V. PROCAL TESTS (Fallow)

Procal, a product containing primarily calcium sulphate with various contaminants, was applied at 300 and 500 lb/acre in field-scale tests at two locations on moderately saline soils. The yield data given in Table 8 support the conclusions that Procal applied at the rates of application recommended by the distributors is of no value.

Table 8. Procal Tests - Yield of Wheat (bu/acre)

	Check	Procal	
		300 lb/acre	500 lb/acre
Christoph Guernsey NW12-34-23-W2	14.1	17.3	12.3
Dyck Guernsey NE6-33-23-W2	17.7	16.9	16.8

...MONIUM POLY-PHOSPHATE FERTILIZER TESTS (Fallow)

...d-scale test was conducted in which ammonium ...-0) was compared with mono-ammonium phosphate ...e poly-phosphate fertilizer was not available ...eason, only one plot site was obtained, and ...d being sown to rapeseed. The yield results ... indicate that 15-60-0 resulted in slightly higher ...e produced by 11-48-0 applications.

...9. Poly-phosphate Test - Yield of Rapeseed (lb/ac)
(Schrader, Okla, NW1-35-9-W2)

Check Yield	-	506
11-48-0 @ 20	-	573
40	-	535
60	-	690
80	-	569
15-60-0 @ 16	-	557
33	-	492
50	-	671
66	-	716
23-23-0 @ 87	-	545

VII. NITROGEN REQUIREMENTS OF 'LOW N' FALLOW SOILS

Purpose

To assess the economics of applying nitrogen, at rates recommended for stubble, to summerfallow fields which test lower than normal in nitrate-nitrogen.

Experimental

Summerfallow fields which tested very low, low or medium in nitrate-nitrogen were selected from samples analyzed by the lab in the fall of 1966. On the 16 sites selected composite soil samples were taken at the time of seeding for comparison with fall levels. With-the-seed fertilizer placements were made with the co-operating farmers equipment. Nitrogen was broadcast with a 6 foot Cominco 70 attachment* which was trailer mounted. The following fertilizer treatments were compared:

1) Check
2) 11-48-0 as indicated by the phosphorus test
3) 23-23-0 at 80 lb/acre
4) 11-48-0 + 33.5-0-0 as indicated by soil test data
5) 18-46-0 as indicated by the phosphorus test was used at 5 locations.

Results

Table 1 summarizes the soil test data from the various locations. When comparing the fall and spring tests it should be kept in mind that the fall data is from the field as sampled by the farmer. The spring data

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* Supplied courtesy of Cominco Limited.

TABLE 10 COMPARISON OF FALL AND SPRING SOIL TEST DATA* (lb/acre)

Farmer	Soil Type	Nitrate-Nitrogen Fall	Nitrate-Nitrogen Spring	$NaHCO_3$ - P Fall	$NaHCO_3$ - P Spring	Exchangeable K^+ Fall	Exchangeable K^+ Spring
Evans 1	BrVL	45	42	18	17	656	755
Evans 2	WL	34	45	14	19	904	880
Drew	RHvC	18	54	6	6	1088	1324
Rennick 1	RHvC	23	32	18	9	1272	1088
Grandfield	LcVL	10	18	35	30	200	205
Lazaroff	KSiL	10	44	24	19	304	482
Cadrin 1	HmL	23	50	14	24	352	594
Cadrin 2	HmL	37	51	21	48	496	635
Halstead	AFL	32	51	7	7	760	720
Konschuh	BrVL	40	85	20	15	648	724
Ewert	WL	15	95	13	8	520	562
Wilkinson	ECL	45	45	27	15	984	1326
Mickleborough	RHvC	37	55	12	6	848	990
Tomashewski	KSiCL	29	55	37	22	632	785
Rennick 2	RHvC	41	50	20	6	1240	1142
Mayerle	TiCL	22	31	44	42	448	636
AVERAGE		28.8	50.2	20.6	18.3	710	803

* Note-these data compare the fall field tests to those obtained from the trial area in the spring.

is the average value obtained by the field crew from the area on which the test strips were located. Since the fertilizer rates used were based on the fall field sampling data the rates used in these experiments were not necessarily those that the soil tests from the plot area would have indicated.

TABLE 11 YIELD RESPONSE TO NITROGEN FERTILIZATION FOR WHEAT GROWN ON SUMMERFALLOW FIELDS WITH LOWER THAN NORMAL NO_3^--N TESTS *
(Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase 23-23-0	11-48-0	11-48-0 + 33.5-0-0
Evans 1	BrVL	19.23	+8.31	+ 5.29	+ 6.41
Evans 2	WL	18.17	+8.30	+ 6.27	+ 4.39
Drew	RHvC	23.70	+0.48	- 2.29	+ 4.28
Rennick 1	RHvC	13.00	+8.73	- 0.48	+ 4.93
Grandfield	LcVL	8.75	-2.91	+ 2.78	- 0.20
Lazaroff	KSiL	23.99	+5.36	+ 2.87	+ 6.57
Cadrin 1	HmL	33.39	+15.50	+16.25	+11.54
Cadrin 2	HmL	52.42	+1.67	+ 0.08	+ 6.42
Halstead	AFL	25.60	+7.36	+ 3.56	+ 4.72
Konschuh	BrVL	29.31	+5.54	+ 5.63	+ 5.27
Ewert	WL	20.18	+3.22	+ 0.34	+ 4.07
Wilkinson	ECL	29.72	+4.99	+ 5.78	+12.25
AVERAGE		24.79	+5.55	+ 3.84	+ 5.89

* 23-23-0 applied at 80 lb/acre. Rates of 11-48-0 and 11-48-0 plus 33.5-0-0 applied as recommended by the soil test for stubble seeded crops.

Table II includes data from 12 sites on which wheat was the test crop. The data indicates on the average a 2 bushel/acre increase above 11-48-0 to broadcast applied nitrogen at rates recommended for stubble seeded crops. A similar average increase was obtained in the comparison between 23-23-0 applied at 80 lb/acre and 11-48-0 applied at soil test recommended rates. On 5 of the 12 sites the split application gave the largest increase over the check. On 4 of the 12 sites 23-23-0 at 80 lb/acre gave the largest increase in yield. On the remaining 3 sites 11-48-0 gave the best response. At the Konschuh site the spring soil test value of 85 lb/acre of nitrate-nitrogen would indicate that a nitrogen response would not be expected. On the Grandfield and Cadrin 1 sites the spring nitrate levels were such that one might have expected a response to nitrogen fertilization.

TABLE 12 YIELD RESPONSE TO VARIOUS FERTILIZER APPLICATION FOR WHEAT GROWN ON SUMMERFALLOW FIELDS TESTING LOWER THAN NORMAL IN NO_3^--N *
(Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase			
			23-23-0	11-48-0	11-48-0 + 33.5-0-0	18-46-0
Evans 1	BrVL	19.23	+8.31	+5.29	+6.41	+ 5.82
Drew	RHvC	23.70	+0.48	-2.29	+4.28	+ 3.66
Lazaroff	KSiL	23.99	+5.36	+2.87	+6.57	+10.30
Halstead	AFL	25.60	+7.36	+3.56	+4.72	+ 4.09
Konschuh	BrVL	29.31	+5.54	+5.63	+5.27	+ 5.46
AVERAGE		24.37	+5.41	+3.01	+5.45	+ 5.87

* 23-23-0 applied at 80 lb/acre. Rates of N and/or P_2O_5 for other treatments as recommended by the soil test for stubble seeded crops.

Table 12 includes the trials on which 18-46-0 was applied to wheat grown on summerfallow. The average data for the 5 sites indicates that 18-46-0 at soil test recommended rates of P_2O_5 gave similar responses as 23-23-0 at 80 lb/acre and the split application. On 4 of the 5 sites the response of 18-46-0 was greater than that for 11-48-0. The highest yielding treatment was not consistent. On 2 of the 5 sites 23-23-0 at 80 lb/acre gave the highest yield. The other three treatments each gave the highest yield on 1 site.

TABLE 13 YIELD RESPONSE TO NITROGEN FERTILIZATION FOR BARLEY, OATS and FLAX ON SUMMERFALLOW FIELDS WITH LOWER THAN NORMAL NO_3-N TESTS * (Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase 23-23-0	11-48-0	11-48-0 + 33.5-0-0
BARLEY					
Mickleborough	RHvC	25.56	+5.32	+9.75	+28.81
Tomashewski	KSiCL	34.30	+4.00	+1.53	+ 4.97
OATS					
Rennick 2	RHvC	22.81	+3.69	+12.32	+11.82

* 23-23-0 applied at 80 lb/acre. Rates of 11-48-0 and 11-48-0 + 33.5-0-0 applied as recommended by the soil test for stubble seeded crops.

Farmer	Soil Type / Treatment	Yield
FLAX		
Mayerle	TiCL	
	Check	15.48
	23-23-0 @ 50	+0.34
	33.5-0-0 @ 90	+1.53

Table 13 includes limited data for barley, oats and flax seeded on summerfallow. For barley, the data indicates the possiblity of good responses to nitrogen fertilization on summerfallow fields with lower than normal nitrate-nitrogen soil tests. This was particularly true on the Regina Heavy Clay soil. For oats seeded on summerfallow on a similar soil with a similar nitrate test, there was no response to additional nitrogen fertilization beyond that contained in 11-48-0. For flax, a response of 1.5 bushels/acre to 30 lb of N/acre was obtained on Tisdale Clay Loam soil with a low nitrate-nitrogen test.

Conclusion

Recommendations based on the results of these trials are:

1) On summerfallow fields with nitrate-nitrogen tests in the medium range (31 - 45 lb/acre 24 inches) the use of higher nitrogen ammonium phosphates such as 23-23-0, 18-46-0, 17-34-0 etc., may be beneficial. The phosphate recommendation should be considered when selecting the fertilizer to use.

2) For very low and low nitrate-nitrogen soil tests on summerfallow (0 - 30 lb/acre 24 inches) that nitrogen be recommended as indicated by the present benchmarks. The choice of fertilizer materials being dependent on the soil test data.

3) That research be continued in this area to determine the economics of nitrogen response on summerfallow fields with very low and low nitrate-nitrogen tests.

VIII. POTASH FERTILIZATION ON SOILS WITH 'LOW' AVAILABLE-K

Purpose

To assess the response to potash fertilization on fields with very low and low exchangeable potassium levels.

Experimental

Fields which tested very low and low in exchangeable potassium were selected from samples analyzed by the lab in the fall of 1966. On the sites selected, composite soil samples were taken at the time of seeding for comparison with fall samples. With-the-seed fertilizer placements were made with the co-operating farmer's equipment. Broadcast applications of nitrogen and potash were made with the equipment described previously. The following treatments were compared:

1) Check
2) 11-48-0 as indicated by the phosphorus test
3) 10-30-10 as indicated by the phosphorus test
4) 11-48-0 as indicated by the phosphorus test plus a broadcast application of 0-0-60 at 100 lb/acre.

In addition to these treatments nitrogen was broadcast where indicated by soil test data. The test crops were barley, wheat and rapeseed.

TABLE 14 COMPARISON OF FALL AND SPRING SOIL TEST DATA *
(lb/acre)

Farmer	Soil Type	Nitrate-Nitrogen Fall	Nitrate-Nitrogen Spring	$NaHCO_3$ - P Fall	$NaHCO_3$ - P Spring	Exchangeable K+ Fall	Exchangeable K+ Spring	
Arnold	GbLS	193	88	22	12	56	48	Fallow
Harrison 2	CrVL	143	96	20	11	64	79	Fallow
Rediger	CrVL	75	60	18	9	48	75	Fallow
Youzwa	CrVL	20	52	16	12	48	45	Stubble
Gentner	CrVL	134	123	33	25	56	57	Stubble
Kozun	CrVL	121	124	13	6	56	36	Fallow
Skogsrud	SbFL	7	22	27	27	150	224	Stubble
Harrison 1	CrVL	35	58	18	11	64	49	Stubble
Lang	WfVL	21	35	14	14	152	159	Stubble
Hayes	SbVL	16	32	26	21	128	282	Stubble
Foy	SbVL	34	84	51	30	136	323	Fallow
Collins	SbVL	21	30	6	7	64	70	Stubble
Wylie	LcVL	43	42	35	19	152	155	Fallow
AVERAGE		66.4	65.1	23.0	15.7	90.3	123.2	

* NOTE: these data compare the fall _field_ tests to those obtained from the trial area in the spring.

Results

Table 14 summarizes the soil test data from the various locations. When comparing the fall and spring tests keep in mind that the fall data is from the field as sampled by the farmer. The spring data is the average value obtained by the field crew for the area on which the test strips were located. The rates of fertilizer applied were determined from the fall field test.

TABLE 15

YIELD RESPONSE ON BARLEY TO
PHOSPHATE AND/OR POTASH FERTILIZATION *
(Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase 11-48-0	10-30-10	11-48-0 + 0-0-60	K test lb/acre	
Arnold	GbLS	28.25	- 0.76	+14.44	+10.09	48	Fallow
Harrison 2	CrVL	48.22	+22.72	+24.98	+22.02	79	Fallow
Rediger	CrVL	42.38	+13.00	+ 8.35	+16.01	75	Fallow
Youzwa	CrVL	28.86	+15.30	+ 6.95	+22.03	45	Stubble
Gentner	CrVL	25.34	+ 3.65	+ 5.33	+ 6.58	57	Stubble
Kozun	CrVL	28.80	- 1.81	+11.20	+10.25	36	Fallow
AVERAGE		33.64	+ 8.68	+11.88	+14.50		

* 11-48-0 and 10-30-10 applied at rates of P_2O_5 recommended by soil test. 0-0-60 broadcast at 100 lb/acre

Table 15 compares the results of 6 trials on which barley was the test crop. In all cases the highest yields were obtained where potash was applied. At 3 of 6 sites 10-30-10 was superior to 11-48-0 plus 0-0-60 broadcast. On the other 3 sites the results favor the split application. The average yield increase is the greatest for the split application.

TABLE 16 YIELD RESPONSE ON BARLEY TO NITROGEN, PHOSPHATE AND POTASH FERTILIZATION* (Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase 11-48-0 + 33.5-0-0	Yield Increase 11-48-0 + 33.5-0-0 + 0-0-60	K test lb/acre	
Skogsrud	SbFL	25.63	+ 8.72	+26.07	224	Stubble
Harrison	CrVL	26.23	+ 3.10	+17.87	49	Stubble
Lang	WfVL	23.90	+ 9.72	+15.22	159	Stubble
AVERAGE		25.25	+ 7.18	+19.72		

* 11-48-0 and 33.5-0-0 applied at rates recommended by soil test. 0-0-60 applied at 100 lb/acre.

Table 16 compares 3 sites on which nitrogen as well as phosphate and potash were applied. At all three locations good responses on barley to a broadcast application of 0-0-60 at 100 lb/acre were obtained. The average increase was 12.5 bushels/acre.

TABLE 17 YIELD RESPONSE ON WHEAT TO NITROGEN, PHOSPHATE AND POTASH FERTILIZATION*
(Bushels/acre)

Farmer	Soil Type	Check Yield	Yield Increase 11-48-0 + 33.5-0-0	Yield Increase 11-48-0 + 33.5-0-0 + 0-0-60	K test lb/acre	
Hayes	SbFL	8.89	+ 6.45	+ 4.49	282	Stubble
Foy	SbFL	23.94	+ 7.56	+ 4.56	323	Fallow
Collins	SbFL	15.58	+ 2.52	+ 2.77	70	Stubble
AVERAGE		16.14	+ 5.51	+ 3.94		

* 11-48-0 and 33.5-0-0 applied at rates recommended by soil test. 0-0-60 applied at 100 lb/acre.

Table 17 shows the data obtained for wheat. The application of a broadcast application of 0-0-60 did not increase yields on any of the fields. At Hayes and Foys the potassium soil test data for the trial area is higher than for any of the other fields tested. This fact is undoubtly related to lack of response.

At the Wylie site (data not included in tables) both 10-30-10 and 23-23-0 plus 0-0-60 were superior to 23-23-0. The best treatment was the split application which yielded 10 bushels/acre higher than the 23-23-0 alone.

At the Arnold site wheat and rape were also tested. While the potassium soil test was very low these crops showed only small yield responses to potash fertilization. Visual observation during the growing season indicated that a yield response should have been obtained for all three crops tested. Yield data showed good response to potash only on the barley.

Conclusions

1) The observation that barley responds better to potash fertilization than wheat is verified by these results.

2) Generally, on barley the response to a broadcast application of 0-0-60 at 100 lb/acre was superior to 10-30-10 placed with the seed at a rate determined by the phosphorus test. However, in some cases equally as good or better responses were obtained with 10-30-10.

3) Field experiments should be continued and expanded in the following areas:

a) a study on the residual effect of broadcast application of 0-0-60 at various rates.

b) extension of field trials to include fields with higher potassium soil tests (particularly for barley).

c) extension of work in the potash deficient areas on other crops such as; rapeseed, alfalfa, clover, oats and wheat.

A P P E N D I X

Yield Results (bu/acre) - Department of Soil Science - School of Agriculture
Students Co-operative Field Fertilizer Tests on Stubble Land, 1967

			Yield Increase									
				11-48-0 @ 40 plus 33.5-0-0 @					11-48-0 @ 60 plus 33.5-0-0 @			
rmer	Soil Type	Check Yield	11-48-0 @40	45	78	105	165	11-48-0 @60	45	78	105	165
Bruce xford ts	RHvC 3-19-26-W2	27.9	4.9	5.0	4.7	5.0	4.2	-0.8	7.9	5.9	7.8	10.8
Bruce xford rum	RHvC SE16-18-26-W2	16.4	0.9	1.5	5.2	5.8	8.8	4.0	12.1	12.5	12.5	10.9
olidge shburn eat	WaL 20-49-25-W3	30.2	5.7	8.4	6.3	6.1	7.3	11.8	2.7	6.8	9.7	22.0
.ay .llmore .eat	T-EsCL SW3-10-11-W2	17.2	1.0	1.4	2.6	3.4	1.9	-0.8	-1.8	-1.1	-1.4	-3.0
oh edive rley	W-EsCL SW6-8-19-W2	16.7	9.9	6.1	9.6	6.8	10.6	7.3	8.4	5.3	7.5	9.0
od .llmore rley	W-TCL NW6-11-10-W2	22.0[1] 34.3[2]	2.1 -0.1	5.9 -1.4	5.9 2.8	1.0 4.5	5.1 2.7	5.4 1.7	6.1 6.8	-0.8 4.8	2.7 2.2	6.8 3.8

[1]West field

[2]East field

Yield Results (bu/acre) - Department of Soil Science - School of Agriculture
Student Co-operative Field Fertilizer Tests on Stubble Land, 1967

			Yield Increase									
				11-48-0 @ 40 plus 33.5-0-0 @					11-48-0 @ 60 plus 33.5-0-0			
Farmer	Soil Type	Check Yield	11-48-0 @40	45	78	105	165	11-48-0 @60	45	78	105	165
Hamilton Ruthilda Wheat	WL 21-33-17-W3	9.2	4.0	14.5	4.9	7.3	8.7	2.3	4.0	4.8	7.2	8.7
Hult Waseca Wheat	WaL 20-47-24-W3	21.3	4.0	6.1	15.8	13.5	16.1	4.0	8.7	6.1	12.3	14.9
Latrace Tessier Barley	ESiL-SiCL E11-34-11-W3	19.8	7.7	9.4	8.2	13.2	2.1	1.4	6.1	3.1	8.7	4.4
Longmire Kindersley Wheat	R-ScHvC 32-29-21-W3	26.8	5.7	1.9	7.0	5.8	4.8	-0.9	8.1	8.4	9.7	0.3
Wallace Unity Wheat	WL 30-39-24-W3	30.7	0.6	5.3	6.4	0.7	12.6	12.4	5.7	5.7	11.5	15.2
Wallin Margo Wheat	YL-LL NW20-33-9-W2	18.7	2.0	5.1	4.2	4.1	4.3	3.9	5.2	5.8	3.0	3.7

Yield Results: Department of Soil Science - V.L.A. Co-operative Fertilizer Tests on Stubble Land

			11-48-0		23-23-0		11-48-0 plus 33.5-0-0	
edit Advisor - rmer	Soil Type	Check Yield	Fert. Rate lb/acre	Yield Increase	Fert. Rate lb/acre	Yield Increase	Fert. Rate lb/acre	Yield Increase
ker-Hayward siniboia eat	ScC-HvCL S22-8-30-W2	12.7	42	1.8	80	0.5	40 + 110	0.7
x-Ford mboldt eat	BL SW28-37-23-W2	16.0	43	4.8	83	4.4	43 + 70[1]	4.8
addock-Casavant sdale eat	TiSiC SE24-44-15-W2	14.8	35	2.2	85	8.4	45 + 110	4.0
aftenza-Denis avelbourg rum	FxSiC-CL SE33-11-5-W3	11.8	43	1.8	87	1.8		
ndel-Tosh ngbank eat	OL-CL SW22-14-3-W2	27.1	38	3.2	85	3.8	39 + 120 60 + 85	9.8 7.4
ng-Humphrey wletta eat	TuC SW4-19-29-W2				50	10.4	62+(32+64)[2]	16.1

[1] 46-0-0 @ 70

[2] 33.5-0-0 @ 32 plus 46-0-0 @ 64

Yield Results: Department of Soil Science - V.L.A. Co-operative Field Fertilizer Tests on Stubble Land

			11-48-0		23-23-0		11-48-0 plus 33.5-0-0	
Credit Advisor - Farmer	Soil Type	Check Yield	Fert. Rate lb/acre	Yield Increase	Fert. Rate lb/acre	Yield Increase	Fert. Rate lb/acre	Yield Increase
McDonald-Yakubowich Yorkton Wheat	OL-LL N20-25-5-W2	6.9	34	0.6	97	2.9	48 + 95 84 + 95	2.1 4.2
Mitchell-Stadnick Radville Wheat	ECL SE6-7-18-W2	12.4	40	4.4	85	3.7	35 + 75	1.1
Morrow-Young Nipawin Barley	Wf-Np VL-CL SW19-51-14-W2	15.4	39	4.5	79	11.2	39 + 60 43 +120	10.7 14.7
Murch-Clark Ardath Wheat	WL NE22-20-9-W3	19.1	38	11.2	87	4.1	38 + 110 72 + 82	4.9 0.4
McLeod-Beddome Prince Albert Wheat	HmSiCL-LL 30-46-26-W2	14.7	67	4.7	68	1.7	79 + 220 158 + 192	0.3 1.7
Peace-Porter Kinistino Barley	MSiC SW6-45-21-W2	18.9	44	3.3	63	10.3	44 + 146	12.6
Puckey-Nowosad Meacham Wheat	ESiC SE32-36-27-W2	20.5	36	0.0	68	2.2	36 + 73	3.1

Yield Results: Department of Soil Science - V.L.A. Co-operative Field Fertilizer Tests on Stubble Land

Credit Advisor-Farmer	Soil Type	Check Yield	11-48-0 Fert. Rate lb/acre	11-48-0 Yield Increase	23-23-0 Fert. Rate lb/acre	23-23-0 Yield Increase	11-48-0 plus 33.5-0-0 Fert. Rate lb/acre	11-48-0 plus 33.5-0-0 Yield Increase
Salkeld-Keith Yorkton Wheat	CaSiCL-CL SW33-26-3-W2	25.6	42	-4.9	88	14.5	42 + 120 55 + 120	5.0 7.9
Sherwin-Sharp Shaunavon Wheat	CyL SW20-10-18-W3	12.4	37	3.5	73	3.1	37 + 85*	6.6
Simpson-Zunti Unity Wheat	E-WCL NE33-38-25-W3	18.5	42	2.6	85	7.6	42 + 100 75 + 125	13.5 14.5
Steabner-Peckham Hearts Hill Wheat	EC-CL SE32-36-26-W3	19.8	50	0.4	96	5.4	50 + 127	12.0
Steenson-Frolek North Battleford Wheat	MeFSL SW9-44-17-W3	11.9	45	0.6	90	3.5	45 + 90 45 + 110	5.8 5.5
Zinkhan-Powell Rosetown Wheat	RHvC SE10-31-15-W3	22.0	38	-0.6	87	1.4	38 + 120 38 + 90FB	11.8 0.5

*46-0-0 @ 85

Yield Results: Department of Soil Science - V.L.A. Co-operative Field
Fertilizer Teats on Stubble - Additional Treatments

			16-20-0		27-14-0	
Credit Advisor- Farmer	Soil Type	Check Yield	Fert. Rate lb/acre	Yield Increase	Fert. Rate lb/acre	Yield Increase
Morrow-Young Nipawin Barley	Wf-Np VL-CL SW19-51-14-W2	15.4			54 77	2.2 4.1
Puckey-Nowosad Meacham Wheat	ESiC SE32-36-27-W2	20.5	75	3.3		

Yield of Grain (bu/acre) - Department of Soil Science Field Fertilizer Tests on Stubble Land - Nitrogen Levels

			Yield Increase					
				11-48-0 @ 60 plus 33.5-0-0 @				
rmer	Soil Type	Check Yield	11-48-0 @ 60	45	78	165	222	282
shford la rley	WvL NW24-35-8-W2	9.2	4.4*	--	4.7	9.9	8.2	5.1
ndquist ntlaw eat	WvL SE32-36-9-W2	9.7	3.0	3.2	4.4	7.2	13.7	9.3
rkin la rley	WvL NW33-35-8-W2	12.8	5.8	3.0	3.2	8.8	10.2	25.7
ven lvington ts	WvL SW13-37-10-W2	29.5	6.9	10.4	4.8	22.7	30.5	25.0
inhandl ntlaw eat	WvL NE33-36-9-W2	5.4	--	--	10.6	19.0	11.2	11.2
lson la rley	Y-WhL SE4-35-8-W2	20.3	10.0	3.0	6.8	9.8	6.6	2.5

*11-48-0 @ 40

Yield of Grain (bu/acre) - Department of Soil Science Field Fertilizer Tests
on Stubble Land - Urea-Phosphates

armer	Soil Type	Check Yield	11-48-0 @			23-23-0 @			23-23-0S @			27-27-0 @		
			30	40	50	65	87	110	65	87	110	55	75	95
oodale askatoon heat	ECL NE32-35-3-W3	13.7	-1.9	-0.7	-0.8	0.1	0.5	-1.6	0.1	0.0	-1.8	-0.7	-1.5	-0.3
oey oey arley	HmFL NE14-45A-27-W2	23.2	7.5	9.7	12.4	1.1	3.5	7.0	2.0	6.5	7.2	1.5	4.3	7.3
opoff askatoon arley	ECL NE6-36-3-W3	21.8	-0.7	4.2	2.8	13.0	8.1	5.2	8.4	2.7	7.3	8.2	7.5	14.4
oth osthern heat	BCL NE35-42-4-W2	20.1	4.2	5.0	3.8	2.3	8.4	0.6	3.6	7.5	2.4	5.2	6.6	4.5

23-23-0 Ammonium phosphate + Ammonium nitrate

23-23-0S Ammonium phosphate + Ammonium sulphate + Urea

27-27-0 Ammonium phosphate + Urea

Soil Test Results - 1967 Field Strip Plots.

A. Stubble fertilizer tests on Gray-Wooded Soils.

Farmer	NO_3 - N lb/acre 2 ft.	Plot average and range Available P lb/acre 6 in.	Exchangeable-K lb/acre 6 in.
Bashforth	28 (11-39)	11(3-29)	241(160-310)
Lindquist	15 (7-26)	14 (6-38)	386(210-580)
Parkin	15 (1-34)	15(11-19)	306(220-410)
Raven	20 (12-28)	31(11-64)	392(290-490)
Weinhandl	6 (2-12)	12(3-22)	255(200-320)
Wilson	33 (14-85)	10(4-26)	251(150-460)

B. School of Agriculture Cooperative Tests.

Farmer	NO_3 - N lb/acre 2 ft.	Available P lb/acre 6 in.	Exchangeable-K lb/acre 6 in.
A. Bruce	28 (17-47)	17(6-26)	1276(860-1820)
R. Bruce	57 (20-213)	19(14-27)	1058(680-1380)
Coolidge	42 (19-109)	13(8-21)	614(370-1620)
Clay	68 (26-128)	32(19-98)	1081(810-1710)
Froh	16 (11-23)	10(6-13)	756(530-1110)
Good (1)	38 (15-135)	24(7-51)	1180(630-1930)
Good (2)	59 (20-134)	19(8-32)	939(620-1170)
Hamilton	15 (9-21)	10(3-16)	610(330-930)
Hult	21 (15-29)	12(7-26)	542(360-1170)
Latrace	10 (2-24)	21(8-44)	766(570-1040)
Longmire	57 (24-247)	9(6-12)	1269(870-1630)
Wallace	42 (12-171)	23(16-31)	761(310-1080)
Wallin	47 (21-111)	9(6-11)	310(250-400)

C. V.L.A. Plots

	NO_3-N lb/acre 2 ft.		Available P lb/acre 6 in.		Exchangeable K lb/acre 6 in.	
	Fall	Spring	Fall	Spring	Fall	Spring
Hayward	37	35	28	15	728	880
Ford	15	39	31	28	608	840
Casavant	9	12	26	50	368	770
Wharran	30	88	18	24	544	680
Denis	90	52	33	19	1208	1190
Currie	42	82	40	43	672	930
Tosh	16	35	12	10	512	650
Humphrey	37	46	15	23	688	630
Yakubowich	13	46	9	12	344	300
Beddome	31	94	10	17	688	1340
Stadnick	45	51	36	22	864	1000
Young	7	15	47	40	456	390
Clark	34	56	23	19	672	1020
Porter	10	22	66	46	1024	1300
Nowosád	--	35	--	18	---	1220
Këith	6	20	20	21	544	870
Sharp	19	21	24	18	688	790
Kulovany	35	49	28	35	568	700
Zunti	6	14	14	24	720	1230
Peckham	7	12	18	34	864	1620
Frolek	9	27	13	12	352	490
McLeod	288	115	39	46	728	1340
Lindstrom	68	79	18	12	304	360
Powell	5	29	17	18	1016	1390

D. Urea-phosphate tests.

	NO_3-N lb/acre 2 ft.	Available -P lb/acre 6 in.	Exchangeable K lb/acre 6 in.
Goodale	64(26-100)	26(8-46)	1146(870-1930)
Hoey	74(45-115)	11(7-17)	717(620-800)
Popoff	20(9-39)	29(12-48)	1355(870-2250)
Roth	40(13-89)	16(10-28)	755(570-1000)

E. N-placement tests.

Bellamy	54(24-181)	11(4-17)	579(390-860)
Honey	8(5-13)	11(4-21)	281(130-430)
Shields	24(10-43)	22(7-44)	945(400-1460)

F. Procal tests.

Dyck	34	26	315
Christoph	146	14	570

G. Poly-phosphate test

Schrader	78(13-245)	13(8-21)	347(240-600)

Yield of Grain (bu/acre) - Department of Soil Science Field Fertilizer Tests on Stubble Land - Nitrogen Placement

Farmer	Soil Type	Check Yield	YIELD INCREASE: 11-48-0 @40 banded with seed plus 33.5-0-0 broadcast @ 45	78	105	June 105
Bellamy Birch Hills Wheat	MSiCL NE20-46-24-W2	9.1	5.2	9.5	5.7	6.3
Honey Lintlaw Wheat	WvL SE5-37-9-W2	5.6	4.0	5.9	9.3	3.3
Shields Nokomis	WL NE30-29-21-W2	(1)19.8	0.8	5.9	4.4	3.0
Wheat		(2)19.0	2.0	2.6	3.5	4.6

(1) Square Yard

(2) Combine

Yield of Grain (bu/acre) - Department of Soil Science Field Fertilizer Tests on Stubble Land - Nitrogen Placement

			YIELD INCREASE						
			Banded with seed				Side-banded		
Farmer	Soil Type	Check Yield	11-48-0 @ 40	23-23-0 @ 87	25-17-0 @ 118	27-14-0 @ 145	23-23-0 @ 87	25-17-0 @ 118	27-14-0 @ 145
Bellamy Birch Hills Wheat	MSiCL NE20-46-24-W2	9.1	2.0	5.1	6.0	1.8	0.3	5.6	-0.2
Honey Lintlaw Wheat	WvL SE5-37-9-W2	5.6	4.4	14.1	14.0	12.6	5.7	7.1	14.4
Shields Nokomis Wheat	WL NE30-29-21-W2	(1)19.8 (2)19.0	1.7 2.2	6.0 2.2	3.1 2.8	1.0 3.4	3.6 3.7	6.2 2.8	3.3 4.8

(1) Square Yard

(2) Combine

Moisture use and Evaportranspiration Ratio of Fertilizer Tests on Stubble Land.

	Spring* Inches H_2O/4ft	Growing Season Rainfall (inches)	Fall* Inches H_2O/4ft	Water Used Inches/4ft	Evapo Trans. Ratio
	Barley				
Hoey	9.78	4.22	6.65	7.35	1429
Popoff	14.29	4.42	11.68	7.03	1455
	Wheat				
Bellamy	12.93	3.82	12.32	4.43	1757
Goodale	14.94	4.42	11.01	8.35	2199
Honey	12.66	2.78	9.49	5.95	4018
Roth	12.24	4.85	9.15	7.94	1426
Shields	11.34	2.62	6.98	6.98	1333

*Total soil moisture as measured with neutron moisture meter.

Spring Moisture Conditions and Growing Season Rainfall.

	Soil Texture	Depth of Moist Soil (inches)	Estimated available moisture (in.)	Growing Season Rainfall (in.)	Av. Check yield Bu/acre
Bashforth	L	48	6.4	2.25	9.2
Lindquist	L	48	6.4	3.31	9.7
Parkin	L	48	6.4	----	12.8
Raven	L	48	6.4	2.79	29.5
Weinhandl	L	48	6.4	3.31	5.4
Wilson	L	48	6.4	4.32	20.3

Spring Moisture Conditions and Growing Season Rainfall (Cont'd)

	Soil Texture	Av. Depth of Moist Soil (inches)	Estimated available Moisture (inches)	Growing Season Rainfall (inches)	Av. Check yield Bu/acre
Beddome	SiCl-LL	27	3.6	5.76	14.7
Casavant	Si C	22	4.0	3.69	14.8
Clark	L	31	4.1	2.61	19.1
Denis	SiC-CL	42	7.0	1.92	11.8
Frolek	FSL	34	3.1	8.52	11.9
Ford	L	36	4.8	7.30	16.0
Hayward	C-HvCL	17	3.1	2.18	12.7
Humphrey	C	36	6.1	3.70	16.6
Keith	SiCL-CL	36	5.4	2.87	25.6
Nowosad	SiC	36	6.0	4.30	20.5
Peckham	C-CL	23	3.8	6.55	19.8
Porter	SiC	26	4.3	2.63	18.9
Powell	HvC	32	5.9	2.66	22.0
Sharp	L	35	4.7	1.00	12.4
Stadnick	CL	33	5.0	1.76	12.4
Tosh	L-CL	31	4.4	2.94	27.1
Yakubowich	L-LL	35	4.1	2.16	6.9
Young	VL-CL	24	3.2	4.97	15.4
Zunti	CL	34	5.1	7.51	18.5
A.Bruce	HvC	36	6.6	2.80	27.9
R.Bruce	HvC	36	6.6	2.25	16.1
Clay	L	36	4.8	2.60	17.2
Coolidge	CL	21	3.2	7.28	30.2
Froh	CL	36	5.4	.70	16.7
B. Good	CL	36	5.4	2.20	22.0
A. Good	CL	36	5.4	2.20	34.3
Hamilton	L	20	2.7	2.60	9.2
Hult	L	15	2.0	6.73	21.3
Latrace	SiL-SiCL	30	4.5	3.20	19.8
Longmire	HvC	48	8.8	2.85	26.8
Wallace	L	36	4.8	----	30.7
Wallin	LL	36	4.2	----	18.7

IX. THE NITROGEN SUPPLYING POWER OF PRAIRIE SOILS

E.A. Paul

September, 1967

The title of this technical session, "Breaking production barriers with specific references to nitrogen", is very applicable at this time both from a world food standpoint, and from the standpoint of the vitality and well-being of Agriculture in Western Canada. The Production barrier (if indeed there is one) relating to agricultural production in Western Canada is somewhat of a man-made one because of [1]the somewhat anomylous surplus of food in three wheat producing countries in a basically hungry world, [2]the grading systems of our government organizations together with the desire of the farmer to maintain a fairly large percentage of summerfallow in his cropping practice have accentuated the apparent production barrier. The yield limiting varieties of many of our grains, especially wheat, presently being utilized tend to have a high nitrogen content. They produce a relatively small amount of carbohydrates in the presence of fairly adequate amounts of nitrogen supplied by the soil especially under summerfallow conditions and therefore, could be said to waste nitrogen.

There is a generally well-established correlation between the amount of total nitrogen in a soil and the nitrogen-supplying power. Many soil testing laboratories utilize this fact and measure total organic matter. The data in Table 1 indicate some of these relationships. The Oxbow soil with a nitrogen content of slightly over 5000 lbs in the top 6 inches probably represents a typical prairie soil, if there is any such thing. The

Grey Wooded Maitville with 2380 lbs of total nitrogen in the upper 6 inches represents a soil that is often very nitrogen deficient. We added C^{14} labeled plant material to these soils and incubated them under laboratory conditions for 666 days. Taking into account the variations in soil temperature and moisture that occur under the field conditions, this incubation period represents approximately 10 years in the field. In both soils, even after this extended period of incubation, the added plant tissue (which was green oat hay) had not completely been decomposed. After the rapid initial attack, the decomposition of the residues was quite slow. One must look at residue incorporation into a soil on a long term basis. It is data like these that make me ask a farmer who wants to burn his straw whether he owns the land or is renting it for one year only.

The nitrogen values shown are in parts per million, to obtain pounds per acre, one multiplies by two. The Black and the Grey Wooded soils release identical concentrations of nitrogen from the added plant residues, with approximately 76 pounds being released in the initial 65 days of laboratory incubation and a total of 107 pounds being released from the 10 tons of added green residues during the incubation period. Although the plant material was fairly slow in undergoing decomposition, the addition of this material to the soil enhanced the decomposition of nitrogen rich soil organic matter, such that large amounts of nitrogen were released. The Oxbow soil mineralized 69 ppm of nitrogen during the first 65 days incubation in the absence of plant material but released 130 ppm of nitrogen in the presence of plant material.

We thus have a priming effect of 50 ppm. After long term incubation, this priming effect is overcome such that at 666 days, the amount of nitrogen released from the amended soil is the same as that of the summerfallow without crop residues. The soil having the added plant residues would contain the additional 107 ppm from the plant material.

Table 1

Plant and soil nitrogen released during incubation

	All N values in ppm soil					
	Oxbow			Waitville		
	65 days	222 days	666 days	65 days	222 days	666 days
Plant tissue mineralized (%)	49	58	69	50	59	72
N mineralized from added plant residues	76	90	107	78	92	111
N mineralized from S.O.M. in amended soil	130	338	556	99	155	204
N mineralized from control soil	69	290	527	38	98	161

Total N content of Oxbow 2560 ppm = 5120 lbs/acre

Total N content of Waitville 1190 ppm = 2380 lbs/acre

The Waitville Grey Wooded soil contained approximately one half as much total nitrogen as the Oxbow and released a proportionate amount during the first 65 days. The summerfallow soil on long incubation released only one-third that of the Oxbow giving a total of 161 ppm or 320 lbs per acre in the absence of plant material and 200 ppm in the presence of plant material. These data represent the nitrogen reserves of the soil on a ten-year basis. If no additional plant residues are added to the soil system, the Oxbow soil would supply the majority of nitrogen required by crops during this period, for it released an average of 34 ppm or 68 lbs per acre during the latter incubation period which is equivalent to the fourth to tenth year under field conditions. The Waitville soil, however, would show extreme nitrogen deficiencies.

Table 2 shows the results of another approach we have used to estimate the nitrogen-supplying power of a soil. The Melfort soil is one of our most productive soils. It had 9600 lbs of nitrogen per acre furrow slice with an approximate equal amount beneath this. The use of carbon dating techniques to measure the mean residence time, or average age, of different fractions of the soil organic matter makes it possible to calculate their turnover rate.

Table 2

Estimate of Nitrogen released per annum from the humus of the Melfort soil

	% of Total nitrogen	Nitrogen lbs/acre	Estimated Nitrogen lbs/acre
Humic acids-hydrolysate	15.6	1500	60
Acid Extract	20.1	1930	6
Humin hydrolysate + Fulvic acids III	37.5	3600	7
Non-hydrolysable Humic Acids	14.7	1410	1
Non-hydrolysable Humin	12.1	1160	1
TOTAL	100	9600	75

From this one can estimate the nitrogen that would be released on an annual basis. A small fraction of the soil, the humic acid hydrolysate, making up 15% of the total soil nitrogen, releases the greatest proportion of nitrogen with the other fractions being practically inert from a nitrogen availability viewpoint. Summing up the production from the individual fractions, one sees that 75 lbs of nitrogen were estimated to be released per acre per year if no further crop residues were incorporated into this system. This figure is somewhat lower than the release figure for the Oxbow soil shown in Figure 1. These calculations are based using naturally occurring C^{14} under field, not laboratory conditions, and represent a somewhat longer equilibrium time.

The effect of growing plants and of added fertiliser nitrogen on the nitrogen-supplying power must also be estimated. Tables 3 and 4 show the results from carefully controlled growth chamber experiments in which N^{15}-labeled NH_4NO_3 was utilized as a fertiliser. The use of a tracer nitrogen made it possible to determine the disposition of nitrogen in the soil-plant system and to calculate nitrogen losses. Thatcher wheat was grown at three moisture stresses, field capacity to one atmosphere tension constituted the low moisture stress treatment whereas the plants approached wilting in the high moisture stress treatment.

All the moisture treatments had an identical nitrogen treatment (200 lbs per acre equivalent, of available nitrogen at seeding time). Adequate supplies of nitrogen were available as indicated by the percent grain proteins in Table 3.

Since these are growth chamber experiments, the plant yields can be used for comparison purposes only. Although the high moisture stress in the Oxbow soil decreased the yield of grain by 40%, the percent of the total plant nitrogen in the grain did not vary. In the Melfort soil, which is a heavy clay soil, the moisture stress did not have any significant effect. Forty percent of the total plant nitrogen was in the straw and roots with 60% in the grain. In the Oxbow soil, the low stress-high yield treatment obtained 56% of its nitrogen from the soil organic matter during the growth of the crop. The high moisture stress treatment which resulted in lower yields had received 48% of its nitrogen from the soil organic matter and 52% from the initial mineral nitrogen. Moisture stress which didn't appear to affect plant growth significantly again didn't affect the nitrogen-supplying power of the Melfort soil with 58% of the nitrogen coming from the soil organic matter.

Table 3

Source of nitrogen in the plant

Moistur stress	% grain protein	Plant yield bu/acre	% of total plant N in grain	Total N in plant lb N/acre	% from mineral N	% from soil organic matter	lb N/bu wheat/acre*
			Oxbow				
Low	16.3	100	60	338	44	56	3.36
Medium	16.3	79	54	294	47	53	3.75
High	17.7	59	58	228	52	48	4.13
			Melfort				
Low	16.1	85	57	291	41	59	3.55
Medium	15.7	94	56	327	42	58	3.62
High	16.9	90	64	288	44	56	3.60

*Nitrogen either present in the plant or lost from the system.

The last column of data shows the pounds of nitrogen required to grow a bushel of wheat under these conditions. In the low moisture stress treatment, where there was adequate water for plant use, 3.36 lbs of nitrogen were required per bushel of wheat. Where the grain protein percentage was higher, and where there were excess nitrates in the soil, such that denitrification occurred, 4.13 lbs of nitrogen were required per bushel of wheat. The Melfort again shows consistent results with an average 3.6 lbs per bushel.

The Oxbow soil in the low stress treatment had a 71% plant uptake of the original nitrogen. The high stress low moisture treatment resulted in only 59% uptake (Table 4). Information that can only be obtained with tracers is the percent of fertilizer-N that was incorporated into the soil organic matter. Twenty-eight percent in the high moisture (low stress treatment) of the Oxbow and 36% in the equivalent treatment of the Melfort was immobilized. The high stress treatment resulted in 15% immobilization in both soils.

Table 4

Distribution of available mineral nitrogen *
(Initial level = 200 lb N/acre)

Moisture stress	% plant uptake	% left as NO_3^--N	% in soil organic matter	% unaccounted for
		Oxbow		
low	71	nil	28	1
medium	69	9	21	1
high	59	18	15	8
		Melfort		
low	60	nil	36	4
medium	68	5	20	7
high	63	5	15	17

* Assuming the original NO_3^--N in the soil reacted similarly to the fertilizer nitrogen.

Data that are very important to the fertilizer industry relate to the percent loss of fertilizer-N. There was little loss in the treatment where most of the nitrogen was utilized by the plant. The greatest loss of 17% in the Melfort and 8% in the Oxbow occurred where excess nitrates were found after the conclusion of the experiment, indicating that the loss was from denitrification (the reduction of nitrate nitrogen).

The figures of 3.6 lbs of nitrogen per bushel of wheat is probably the most important piede of information obtained from this work. This would apply to field conditions where there is little loss of nitrogen from denitrification and in which the grain made up approximately 60% of the total plant nitrogen. Young, R.A., J.L. Osbun, A Bauer and E.H. Vasey ,(S.S.A. Proc. 31:407-410, 1967) working with spring wheat in North Dakota calculated that 4.48 lbs of fertilizer nitrogen were required to produce a yield response of 1 bushel per acre. This would indicate a higher percent nitrogen unaccounted for than was obtained in our growth chamber and probably did not take into account immobilized nitrogen.

If we require some 3.6 to 4.5 lbs of nitrogen to produce a bushel of wheat, one must carefully look at the total nitrogen requirements of the crop in relation to the nitrogen-supplying power of the soil and take into account the value of the crop produced. In this connotation, nitrogen-supplying power of the soil would include both nitrogen from rainfall and nitrogen fixed by free-living bacteria during crop growth. The Chernozemic soils are still reasonably well supplied with nitrogen and can be used on a wheat summerfallow rotation for fairly extensive periods without running into serious nitrogen deficiencies. Soils such as the Podzolic Grey Wooded (Table 1), will have to have nitrogen amendments not only for stubble but also for summerfallow crops.

If the average figure of 4 lbs of nitrogen per bushel of wheat is utilized, and in the Grey Wooded soil, only 1 to 2 lbs are available from the soil, 2 to 3 lbs of fertilizer nitrogen will have to be applied for each bushel of grain that is expected. This indicates a phenomenal potential for the fertilizer industry . It also has a number of serious economic considerations. If the price of wheat continues at the present level, a farmer would have to consider carefully whether he can afford to grow wheat in contrast to some other farm practice which doesn't require as much nitrogen per unit of crop harvested.

There are a number of factors controlling what I will call the "nitrogen input requirements" required to grow a bushel of grain. The first, of course, is the cost of buying and applying the nitrogen fertiliser. With increased consumption of nitrogen fertilisers, it may be possible to reduce both the distribution and the manufacturing costs.

There are a number of other factors which can be altered. The wheat and other grain crops that we are presently utilizing are very inefficient in producing lbs of carbohydrates or energy material per lb of nitrogen utilized. The wheat breeders in Western Canada are located on fairly high nitrogen soils which they have usually summerfallowed for two years before they conduct their breeding experiments. This means that they have selected for crops that are used to growing in an excess of nitrate nitrogen. The artificially high protein requirements of our selling agencies further adds to this problem. If we are truly interested in feeding a hungry world, we have to worry about the content of essential amino acids such as lysine rather than that of total protein. At present the nitrogen in wheat is primarily present as glutamine which is of little use to the animal body.

The third factor is that of maximization of the efficiency of applied nitrogen. This can be done by keeping nitrogen losses at a minimum and maintaining the soil's nitrogen-supplying power as high as possible. It is in the interest of both the fertilizer trade and the farmers that as much nitrogen as possible be incorporated by symbiotic fixation such as legumes and by non-symbiotic fixation through the proper handling of crop residues such that fertilizer nitrogen is used to supplement a reasonable supply in the soil.

It is generally estimated that the soils of Western Canada under a grain-cropping system will receive some 10 to 20 lbs of non-symbiotic and rainfall nitrogen per year. Because of the inability to separate this, at present, from the nitrogen-supplying power of the soil, we will include this in the general nitrogen-supplying figures. Reviewing the data I have presented so far, one would see that the Grey Wooded soil can supply from 30 to 40 lbs per acre of nitrogen from the soil humus, whereas soils such as the Deep Black Lacustrine Melfort should be able to supply from 70 to 80 lbs with the Glacial Till-Black soils being somewhat lower. The decomposition of crop residues should proceed similarly in all the soils and will add some nitrogen. A summary of all the soil tests conducted in our laboratory last year indicated that 76 lbs of nitrate nitrogen accumulated in the top 2 feet of summerfallow with 33 lbs being found in stubble field last fall.

Since we are using nitrate nitrogen present in the fall as an indication of the fertilizer requirements for the crops we grow under our prairie conditions, I would like to discuss some of the results we are obtaining in relation to the changes in nitrate nitrogen in the field. The selected data is typical of the averages we are obtaining and, I believe, more information can be often obtained from a specific plot than from a series of averages.

There isn't much difference in nitrogen consumption between the 0 to 24 inch depth as compared to the 0 to 48 inch depth. The Wagner plot on a Black Silt Loam showed a slightly higher consumption from the 0 to 48 inch depth. The Shield plot on a Weyburn Loam showed practically identical utilization (Table 5). Twenty-four lbs and 31 lbs of nitrate nitrogen utilized respectively during the crop year could not have produced a yield of 23 bushels to the acre. If one uses the previously calculated figure of 3.6 lbs of nitrogen required per bushel of grain, it can be estimated that the Wagner field provided 60 pounds of nitrogen during the growth of the crop, whereas the Shield's field produced 53 lbs of nitrogen.

Table 5

Changes in NO_3-N in cropped field (1966)

Location	0-24" depth Spring	Fall NO_3-N	Change	0-48" depth Spring	Fall NO_3-N	Change	Yield bu/acre
Wagner	25	6	19	49	25	24	23.2
Shields	43	14	29	77	46	31	23.2

One of the most interesting experiments we conducted last year was located on a Grey Wooded soil. The check treatment gave a yield of 10.9 bushels per acre from an initial nitrate level of 14 lbs per acre-2 feet in spring. The addition of 40 lbs of 11:48:0 resulted in a 7.8 bushel increase. Increments of nitrogen resulted in a fairly uniform yield increase. The addition of 75 lbs of nitrogen resulted in slightly greater than 40 bushels to the acre. Plotting these gives a yield regression curve showing that slightly less than 3.5 lbs of nitrogen were required per bushel of grain and that approximately 35 lbs of nitrogen probably supplied from the soil during the crop year. A calculation such as this does not indicate variation in the nitrogen-supplying power of the soil with differing amounts of crop growth, nor does it include nitrogen losses or gains from the atmosphere. This information can only be obtained by the utilization of tracers such that one can tag the fertilizer nitrogen and measure the efficiency of uptake.

Comparisons of 21, 1966 fall samplings with the identical samplings in the spring indicated that 12 lbs of nitrate nitrogen were accumulated during this period (Table 6). The spring samplings were taken at seeding time which would be later than if a farmer was utilizing the Soil Testing Lab in the spring.

Table 6
Comparison of Fall 1966 versus Spring 1967 sampling
(V.L.A. cooperative tests, 21 locations)

Sampling date	Fall 1966	Spring 1967
NO_3-N lb/acre 2 ft	25	37

This year we set up a number of experiments in which we followed the transformations of nitrogen in the crop. Most of the results have not yet been compiled, however, Table 7 indicates the data from one field just east of Saskatoon.

Table 7
Changes in NO_3-N in cropped field during 1967 (Stevenson)

Date	NO_3-N lbs/acre 2 ft
May 29	93
June 6	72
June 26	37
July 10	34
July 24	30
August 15	39
September 6	41
September 20	27

From May 29 to time of seeding of the crop until July 24, the wheat removed 63 lbs of nitrate nitrogen. From this time on, the nitrate nitrogen level started to decrease with a fair amount of variability evident in the fall. This field yielded 25 bushels of wheat this year.

Work by Rennie in the early 1950's and more recently by Ferguson indicated that incorporated straw residues did not result in decreased yields of grain from nitrogen deficiency. We conducted two experiments, one on a Blaine Lake Silt Loam and one on the Grey Wooded which showed the very large responses of nitrogen last year. The treatments included the normal residues on the field, straw removal, and as much as an additional 3 tons per acre of straw added. We do not have data from the extensive nitrate nitrogen samplings that were obtained throughout the growing period. However, the microorganisms and the wheat plant under Saskatchewan conditions apparently still have not read the soil nitrogen and the microbiological textbooks of the world. The addition of straw residues, although giving pronounced nitrogen deficiency symptoms throughout the growing period, resulted in yield increases. There was no indication that the addition of straw resulted in an enhanced immobilisation of nitrogen resulting in the nitrogen deficiency.

Three conclusions can be drawn from this work. 1) I will never again try to estimate yield from a nitrogen experiment, for the straw plots looked yellow and poor all year and yet resulted in the greatest yield; 2) The priming effect of added straw as shown in Table 2 must be active under field conditions. The straw treatments had a definite physical effect on the Grey Wooded soils. We also have had a moisture saving effect on the Blaine Lake soils; 3) The conclusion from these experiments, therefore, is that we have to repeat them next year.

The multiple regression equation shown in Table 8 was calculated from the summary of our University of Saskatchewan plots in 1966. We are still experimenting with the use of computers in interpreting field data and must use information such as this carefully. If I can interpret this information correctly, it means that we required 7 lbs of fertilizer nitrogen to obtain 1 bushel of yield increase. These data, however, are for all of our experiments. A number of excess nitrogen treatments were included in the data. When we eliminate the treatments that have had excess nitrogen, a lower figure will be obtained. In 1965 the nitrate nitrogen in the 0-6, 6-12, and 12-24 inch depths all affected the crop yield. In the wet year of 1966, the nitrate nitrogen in the 0-6 inch depth was the only nitrogen factor strongly affecting crop yield, with each 3.5 lbs of nitrogen at this depth being responsible for a bushel of wheat. The overall regression for all of the fields we worked on last year accounted for 28% of the variability in grain yield. On an individual field basis, from 35% to 65% of the variability in yield was accounted for.

Table 8

Multiple regression of factors affecting yield
(U. of S. plots, 1966)

$$y \text{ (yield)} = 19.3 + .144\, x_2(\text{Fertilizer N}) + .482\, x_3(\text{Fertilizer P}) + .284\, x_4(NO_3\text{-N } 0\text{-}6'') - - .051\, x_5(6\text{-}12'') + .042\, x_6(12\text{-}24'')$$

In an independent study, de Jong, utilizing 1964 and 1965 data, calculated that moisture use accounted for 10% of the variability in yield on stubble fields and 35% on summerfallow. This confirmed the conclusions of Rennie and de Jong this spring at the Wheat Symposium when they stated that moisture was not nearly the limiting factor that we have claimed it to be. We have used moisture conditions as an excuse for many years, however, fertility levels, soil physical conditions and management play the dominant role.

A number of people have asked me to what extent fertilizers affected the crops of Saskatchewan during the summer of 1967. Even most of the farmers, themselves, had underestimated the yield by at least 4 to 5 bushels per acre. It is too early to get an accurate estimate of the yield responses we obtained from fertilizers. Observation of our test strips during the summer months and a preliminary look at some of the data we are obtaining indicates that the yield responses on fields testing low in nutrients will approach the long term average. It is estimated that 7.8 M acres of summerfallow and 3.2 of stubble were fertilised. At an estimated yield increase of 4.3 bushels per acre, this would account for 50 million bushels of wheat. Another way of estimating the yield increase would be to utilize the regression equation for the 1966 data (Table 8). Knowing the amount of nitrogen that was added to stubble soils and using the figure of 3.5 lbs N per bushel of wheat plus the 4 lb P_2O_5, and 1 lb N required to produce a bushel of grain from 11-48-0, one gets a figure of 58.7 M bushels. This figure is very close to yield increase that was actually obtained. The impact of the cool spring and other good agronomic factors such as relatively weed-free fields all played an important role.

The fertilizer recommendations for this fall's sampling are shown in Table 9. In adjusting the soil test benchmarks, we had used last year, we took into account the droughty nature of the soils in the Brown soil zone. The Thick-Black and the Grey Wooded soils, theoretically, should have separate recommendations, for the Grey Wooded soils have a much lower nitrogen-supplying power during crop growth than have the Black. Experience has shown us, however, that the Grey soils, because of poor physical structure and possibly because of some climatic limitations for the crops presently being grown do not have the yield potential, in practice, of the Black soil. This results in similar overall nitrogen requirements.

Table 9

1967 fertilizer recommendations

		lbs/acre nitrogen required Wheat, oats barley, rye buckwheat		
Pounds N in soil	Nitrogen rating	Brown soil	Dark Brown thin black	Thick blacks greys
0-20	VL	30	40	50
21-35	L	25	30	40
36-50	M	20	25	30
51-60	H	15	20	20
61-70	VH	0	15	15
71+	VH+	0	0	0

In conclusion, we can state that although much more work is required, the research underway is giving us a fairly good idea of the nitrogen-supplying power of this soil. The soil test recommendations which were initially set up largely on our knowledge of the soil nitrogen-supplying power in relation to soil crop needs, have been little altered by three years of soil correlation work. They assume an average of approximately 50 lbs of nitrogen supplied by the soils during the crop year with this amount ranging from 30 to 35 lbs in the Grey Wooded soils, up to 70 lbs in some of the more fertile chernozemics.

Soil Testing has proven to be a very useful tool not only to the trade and farmers but also for our research purposes. With a balanced research approach using both field and laboratory studies by government and industry personnel, nitrogen deficiencies should not for long be a barrier to increased crop production.