1957 TRACER FERTILIZER RESEARCH REPORT

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This report summarizes the field and green house experiments conducted during the 1957 growing season. No material contained herein may be reproduced without written authority from the Department of Soil Science.

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I. FIELD EXPERIMENTS

The radioactive phosphorus fertilizers used on the field plots were obtained from the Bureau of Plant Industry, Beltsville, Maryland. All active fertilizers used in greenhouse experiments were prepared in the laboratory using P_{32} obtained from the Atomic Energy of Canada Limited, Ottawa, Ontario.

The plots were seeded with a six-furrow, double-disc, V-belt rodrow seeder mounted on a Bolens ride master tractor. A Flexicoil packer was pulled behind the seeder.

Each treatment constituted three rows, the centre row only being taken for yield determinations. In projects where radio-phosphorus was used, the treatments were seeded in rows of 7 in. spacing and 16 ft. long. Since economy in amount of fertilizer used was not important for the non-active projects, the length of row was increased to 25'. All plots were seeded with Thatcher wheat at a rate of 2 bushels per acre. The grain was harvested at maturity, dried at 55-60°C, threshed and weighed. Radio-phosphorus analyses were carried out using the hollow cylinder technique.

Composite soil samples were taken from the 0-6" depth from all plot sites for chemical analyses. The analytical data obtained on the samples are outlined in Table 1.

Table 1 Analytical data on Soil Samples

Name of Co-operator	Legal Location	Soil type		pH	Extractable phosphorus CO_2 ppm	$NaHCO_3$ ppm	Total N %
1 Hutcheon (stubble)	SE 17-31-14-3	Elstow	CL	6.1	9.9	9.2	0.16
2 Hutcheon (stubble)	NE 8-31-14-3	Elstow	CL	7.2	15.8	11.2	0.16
3 Mellum	N 19-29-23-3	Sceptre(P.D.)	HvC	7.1	34.0	27.3	0.19
4 Mellum	N 19-29-23-3	Flaxcombe	SCL	6.7	18.9	16.0	0.25
5 Mellum	N 19-29-23-3	Kindersley	C	6.6	9.3	6.8	0.17
6 Mellum	N 19-29-23-3	Sceptre	HvC	7.4	9.3	4.0	0.17
7 Njaa	NW 19-45-24-2	Whitewood	L	7.3	19.6	6.6	0.22
8 Njaa (stubble)	NW 19-45-24-2	Whitewood	L	7.1	29.7	9.8	0.23
9 Warder (stubble)	SE 11-47A-24-2	Hoey	L	6.5	6.3	4.0	0.48
10 Warder (Stubble)	SE 11-47A-24-2	Hoey	L	7.7	34.7	12.6	0.31
11 Purdy	NE 9-45-15-2	Tisdale	CL	6.3	14.5	13.6	0.27
12 Purdy (stubble)	NE 9-45-15-2	Tisdale	C	6.1	16.4	15.8	0.30

Regional Fertilizer Tests (Saskatchewan Advisory Fertilizer Council)

(a) Effects of varying rates and ratios of N and P on yield of wheat sown on stubble land.

Nitrogen (NH_4NO_3) and phosphorus (CaH_2PO_4) were applied with the seed at rates ranging from 0 to 60 lb. of N and P_2O_5 respectively.

Two 5 x 5 balanced lattice designed experiments were laid down on stubble land, one near Rosetown, the other near Tiger Hills. The locations of the two sites, together with soil type, general seeding and growing conditions were as follows:

(a) Mr. A. D. Hutcheon, SE 17-31-14-3; Elstow clay loam. The soil in the vicinity of the plot was very dry at seeding time. Percentages of soil Moisture for the 0-6, 6-12, 12-18, and 18-24 inch depths were 16.9, 13.7, 8.3 and 7.5 respectively. Assuming an average bulk density of 1.5 and a wilting point moisture content of 10%, there was approximately 0.95 inches of available moisture in the soil at seeding time.

The crop germinated very unevenly. While a response to nitrogen fertilization was evident throughout the growing season, the crop was not harvested due to the abundant green growth of the late germinating seeds at harvest time.

(b) Mr. T. Njaa, NW 19-45-24-2; Whitewood Loam soil. Mean moisture percentages of the 0-18, and 18-24 inch depth were 21.6 and 15.3 respectively. The soil below the 24" depth was dry. Approximately 4.3 inches of available water (W.P. = 7.7%, bulk density = 1.5) were present in the upper two feet of soil at seeding time (May 16).

The crop germinated uniformily. Growing conditions in the area were much drier than normal for the district. Treatments receiving nitrogen with no phosphorus matured 6 to 10 days later than where phosphorus was applied; minimal amounts of phosphorus were sufficient to overcome this delay in maturity even where high rates of nitrogen had been applied. The crop was harvested on August 20.

Results The data obtained on the Whitewood loam stubble plot are given in Table 2.

Table 2 Effect of varying rates of N and P on yield of wheat (bu./ac.) sown on stubble land. (Whitewood loam) Grey-Black soil zone.

Lb. P_2O_5 Per Acre.	Lb. nitrogen per acre. 0	10	20	40	60
0	5.8	7.8	6.3	8.3	8.3
10	7.9	9.7	10.8	10.9	12.0
20	10.4	9.9	9.6	13.2	13.1
40	8.2	10.9	12.5	13.1	13.7
60	7.8	11.9	13.4	13.6	12.4

L.S.D. - 5% = 2.5

1% = 3.3

These data are typical of those obtained from similar experiments reported in the past in that neither phosphorus nor nitrogen applied alone are as effective as when both are applied together. This stubble soil was somewhat deficient in both nitrogen and phosphorus. It is interesting to note that even under the very dry conditions that existed during the growing season a minimal application of 10 lbs. of N and P_2O_5 respectively resulted in a highly significant yield increase.

(b) Nitrogen placement studies on stubble land.

The various rates of N (NH_4NO_3) and P_2O_5 (CaH_2PO_4) are given in conjunction with the yield data, in Table 3. The nitrogen was applied (1) together with the phosphorus, and (2) as a top dressing treatment, the phosphorus only being applied with the seed. The top dressed nitrogen treatments were applied after the plot was seeded, followed by gentle raking to incorporate the nitrogen into the soil.

The plot was laid down on the farm of Mr. A. Warder, Birch Hills, on the SE 11-47A-24-2 (Soil type - Hoey L).

The soil, at time of seeding, contained 4.8 inches of available water to a depth of 18". Below this level, the soil was below the W.P. moisture percentage. Growing conditions throughout the spring and summer were similar to those prevailing in the vicinity of the Njaa plot.

Results:

Table 3 Effect of N placement on yield of wheat (bu./ac.) sown on stubble land. (Hoey loam - Black Soil Zone).

Lb. P_2O_5 Per Acre.	Lb. nitrogen per acre. 0	20	30	40	80
	(a) nitrogen applied with seed				
0	23.2	26.7	24.4	23.0	21.7
20		28.9	30.4	29.7	30.4
40		32.2	31.6	38.1	33.4
	(b) nitrogen top dressed				
0		23.6	24.6	23.9	23.8
20		33	26.5	24.5	31.4
40		32.3	33.3	27.2	29.1

L.S.D. 5% = 4.9
1% = 6.5

There is evidence in the data presented in Table 3 that where no phosphorus was used, nitrogen applied with the seed in excess of 20 lb. per acre resulted in yield reductions. Applications of phosphorus along with the nitrogen appeared to have reduced the effect of the heavier rates of nitrogen. These observations are open to question, however, since yield variations were, in general, non significant.

The top dressed nitrogen treatments did not result in as large a yield increase as where comparable rates of nitrogen were applied with the seed. It would appear that because of the extended spring drought, the surface applied nitrogen did not move into the root zone until late in the growing season. Thus, comparisons between the 'top dressed' and 'with the seed' nitrogen are perhaps not valid.

Radio-Phosphorus Field Tests

(a) The phosphorus fertility level of differing soil members.

Fallow plot sites were selected on the farm of Mr. F. Mellum (N 19-29-23-3), Kindersley, in which the following soil members had previously been identified.

1. Cloddy granular member of the Sceptre soils, containing free lime at the surface. No well defined B horizon was evident. Surface texture - heavy clay.
2. Poorly drained member of the Sceptre soils with lime free, dark greyish brown A_p horizon underlain by a heavy textured massive B horizon mottled with various shades of grey.
3. Solonetzic member of the Kindersley soils. Greyish brown clay textured surface with large irregular plate like clods in the A_p horizon. Heavy, very compact lime free B horizon at 4 inches below the surface, breaking into hard angular fragments. The B horizon graded into the parent material at about 18 inches. Numerous small stones were present in the parent material, but the surface was relatively stone free.
4. Solonetz member of the Flaxcombe soils, similar to the Kindersley member, but with a clay loam surface texture, and containing stones throughout the profile.

A portion of the N 19-29-23-3 had been cropped in 1956, and stubble plot sites on member profiles similar to Numbers 1, 3, and 4 above were selected. Each stubble member site was approximately 150 feet from the comparable fallow site. On each of the stubble sites, and on the Poorly Drained Sceptre Fallow site, randomized block experiments consisting of 11-48-0 applied at 20 and 40 lb. P_2O_5 per acre, 23-23-0 at 20 lb. P_2O_5 and 27-14-0 at 20 lb. P_2O_5 were laid down. Similar treatments were used for the remainder of the fallow sites, with the exclusion of the 27-14-0 treatment. The phosphorus carriers were tagged with P32.

Germination was very erratic on the three stubble sites, and the plots were not harvested.

Results

The yields obtained on the four fallow sites are outlined in Table 4.

Table 4 Yield of wheat (bu. per acre) obtained with phosphorus fertilization on four member profiles

Soil member	Check	11-48-0 20	11-48-0 40	23-23-0 20	27-14-0 20	L.S.D.(P=.05
		Lb. per acre - P_2O_5				
1. Sceptre heavy clay cloddy granular.	30.6	42.2*	50.3*	37.3		7.9
2. Sceptre heavy clay poorly drained.	56.0	66.1	61.2	72.9*	82.2*	10.4
3. Kindersley clay solonetzic.	33.9	39.1	42.6*	41.8*		5.2
4. Flaxcombe sandy clay loam - Solonetzic.	28	33.3	32.7	31.9		N.S.

The phosphate response pattern obtained on the Sceptre, Kindersley and Flaxcombe soils was similar to that recorded in 1956 (See Tracer Fertilizer Report, 1956) notwithstanding the higher than average precipitation in 1956, and the extended periods of little or no rainfall during the 1957 growing season. Applications of phosphate to the Sceptre cloddy granular soil resulted in large yield increase, while only moderate, but significant increases in yield were recorded for the Kindersley soil. Only slight (non significant) yield increases occurred on the Flaxcombe soil.

The 23-23-0 fertilizer did not increase yields beyond those obtained with 11-48-0. Thus there appears to be no need for additional nitrogen on these three soil members for fallow crops.

Wheat grown on the Sceptre poorly drained member did not respond significantly to phosphate fertilization. Nitrogen in the soil, however, was quite deficient as evidenced by the highly satisfactory yield increases obtained where 23-23-0 or 27-14-0 were applied.

Table 5 'A' Values obtained on Four Member Profiles

per acre - P_2O_5

Soil member	11-48-0		23-23-0	27-14-0	L.S.D.
	20	40	20	20	
1. Sceptre heavy clay cloddy granular.	77.3	238.2	187.5	159.2	67.8
2. Sceptre heavy clay poorly drained.	254.8	82.7	66.7	-	16.9
3. Kindersley clay solonetzic.	82.8	92.5	65.2	-	8.4
4. Flaxcombe sandy clay loam - solonetzic	75.8	93.7	62.7	-	24.3

The A value data, given in Table 5, orientate the soils in the following order of increasing phosphate fertility level: Sceptre (cloddy granular), Flaxcombe (solonetz) and Kindersley (solonetz) equal, and Sceptre (P.D.).

(b) Trash placement studies.

A trash placement experiment set out in 1956, suggested that different trash management practices had little effect on levels of available nitrogen and phosphorus in the soil. (See Tracer Fertilizer Report, 1956). This experiment was continued during 1957. Representative soil areas were selected in the Grey Black soil zone (Mr. K. C. Purdy, Tisdale; Tisdale CL - NE 9-45-15-2), the Black soil zone (Mr. Art Warder, Birch Hills; Hoey L - SE 11-47A-24-2) and in the Dark Brown soil zone (Mr. A. D. Hutcheon, Rosetown; Elstow CL - NE 8-31-14-3). Each site was subdivided into three sub-plots, and the following straw treatments were prepared:

(a) Straw worked into the surface soil.

(b) Straw removed, but returned to the surface after seeding.

(c) Straw removed.

The fertilizer treatments, arranged in a randomized block design on each of the sub-plots included tagged mono-ammonium phosphate applied at 30 lb. P_2O_5 per acre, broadcast treatments of 40 and 80 lb. N (NH_4NO_3) applied with and without the 30 lb. of P_2O_5, and a check.

Approximately 2-3 tons per acre of trash from the previous wheat crop was present on the three plot sites.

Soil moisture reserves on the Elstow CL and Hoey L plots were essentially the same as that given for the Regional N and P experiments e.g. less than one inch of available moisture in the Elstow and approximately four inches in the Hoey soil. The Tisdale soil, on the other hand, contained abundant moisture reserves.

Germination on the Elstow sub-plot (B) (straw worked in) was very erratic due to the inability of the double disc seeder to penetrate the heavy trash; the plot was not harvested.

Results

The effect of the various trash management practices on the yield grain are given in Tables 6, 7, and 8 for the Tisdale, Elstow and Hoey soils respectively. The following conclusions are indicated in these data:

1. Incorporating the trash into the surface soil, as compared to surface placement did not result in a decrease in yield on the Hoey and Tisdale soils where a uniform depth of seeding was achieved (a rather marked increase in yield was recorded on the Hoey soil).

2. Removing all trash resulted in general in a decrease in yield as compared to the other trash management practices at all three sites. This effect was obvious during the growing season, and may possibly be due

to a somewhat greater moisture efficiency (less evaporation) where a trash cover was present.

3. While a greater response to nitrogen was obtained at all sites where trash was present as compared to where all trash had been removed, the indigenous deficiency of nitrogen in the soil itself (removal by the previous crop?) appears to be the major factor contributing to a deficiency of N. In effect, the biological fixation of available soil-N did not appreciably contribute to a nitrogen deficiency in the soil under the environmental conditions existing in the vicinity of the plots.

Table 6 Effect of trash management practices on the yield of grain (bu./ac.) with and without fertilizer

Soil type - Tisdale CL
Co-operator - Purdy, Tisdale

Fertilizer treatments lb. per ac.	(a) Straw on surface.	(b) Straw worked in.	(c) Straw removed.
Check	8.2	10.8	8.2
30 lb. P_2O_5	11.8	12.4	12.7
30 lb. P_2O_5 & 40 lb. N	30.1	27.6	25.8
30 lb. P_2O_5 & 80 lb. N	42.6	42.3	32.8
40 lb. N	24.8	21.1	24.1
80 lb. N	31.9	30.8	23.8
L.S.D.(P=.05)	3.8	6.0	3.9

Table 7 Effect of trash management practices on the yield of grain (bu./ac.) with and without fertilizer

Soil type - Elstow CL
Co-operator - Hutcheon, Rosetown.

Fertilizer treatments lb./ac.	(a) straw on surface	(b) straw removed
Check	9.0	8.5
30 lb. P_2O_5	10.1	8.1
30 lb. P_2O_5 & 40 lb. N	11.5	10.7
30 lb. P_2O_5 & 80 lb. N	13.4*	10.5
40 lb. N	10.4	8.8
80 lb. N	11.4	9.5
L.S.D.	2.6	2.5

Table 8 Effect of trash management practices on the yield of grain (bu./ac.) with and without fertilizer

Soil - Hoey SiL
Co-operator - Warder, Birch Hills, Sask.

Fertilizer Treatments lb./ac.	(a) Straw on surface	(b) Straw worked in	(c) Straw removed
Check	19.4	26.8	18.3
30 lb. P_2O_5	20.2	25.9	19.3
30 lb. P_2O_5 & 40 lb. N	*23.7	30.0	19.6
30 lb. P_2O_5 & 80 lb. N	21.7	27.6	*21.7
40 lb. N	21.4	27.3	18.9
80 lb. N	20.9	24.9	19.1
L.S.D.(P=.05)	3.1	4.6	2.7

The 'A' value data, given in Tables 9, 10 and 11 respectively, suggest that the trash management practices have not altered the level of available soil phosphorus appreciably on the Hoey soil, but have decreased the level of available soil phosphorus on the Elstow and Tisdale soils.

Table 9 Effect of trash management practices on 'A' values

(Elstow CL; Hutcheon, Rosetown)

Fertilizer treatments lb./ac.	(a) Straw on surface	(b) Straw worked in	(c) Straw removed
30 lb. P_2O_5	52		64.5
30 lb. P_2O_5 + 40 lb. N	38.7		42.8
30 lb. P_2O_5 + 80 lb. N	37.8		41.0
L.S.D. 5%	12.6		8.8

Table 10 Effect of trash management practices on 'A' values

(Hoey L; Warder, Birch Hills)

Fertilizer treatments lb./ac.	(a)Straw on surface	(b) Straw worked in	(c) Straw removed
30 lb. P_2O_5	161	189	171
30 lb. P_2O_5 + 40 lb. N	155	165	141
30 lb. P_2O_5 + 80 lb. N	119	154	143
L.S.D. - 5%	41.0	40.0	39.4

Table 11 Effect of trash management practices on 'A' values

(Tisdale CL; Purdy, Tisdale)

Fertilizer treatments lb./ac.	(a) Straw on surface	(b) Straw worked in	(c) Straw removed
30 lb. P_2O_5	175	225	175
30 lb. P_2O_5 + 40 lb. N	90	114	151
30 lb. P_2O_5 + 80 lb. N	81	88	121
L.S.D. - 5%	16.8	43.2	53.4

Protein Investigations

(a) Effect of nitrogen sprays on the protein content of wheat.

Previous experiments conducted in 1952, 1953 and 1954 (Rennie, D.A. Can. Jour. Agr. Sci. 36:491-504, 1956) indicated that the protein content of wheat was not affected by nitrogen and phosphorus fertilization. The uniformity of the protein content, on any one soil type was rather surprising in view of the large yield increases that occurred due, in particular, to nitrogen fertilization. Rates of nitrogen and phosphorus ranged from 0-192 lb. N., and 0-96 lb. P_2O_5 per acre.

Three plot sites were selected for the protein experiments. Two of these were fallow sites (Whitewood loam - N.W. 19-45-24-2, Mr. T. Njaa, Hagen; and Tisdale clay loam - N.E. 9-45-12-2, Mr. K. C. Purdy, Tisdale, and one on stubble land (Tisdale clay loam N.E. 9-45-12-2). The initial fertilizer treatments together with subsequent foliage spray applications were as follows:

Treatment No.	Fertilizer treatments applied at seeding time.	Foliage sprays
1	Check	
2	*11-48-0 at 30 lb. P_2O_5	
3	*11-48-0 at 30 lb. P_2O_5	(S_1) 5 lb. N applied at 4 leaf stage
4	*11-48-0 at 30 lb. P_2O_5	(S_2) 5 lb. N. applied at the shot blade stage.
5	*11-48-0 at 30 lb. P_2O_5	(S_3) 5 lb. N. applied at the flowering stage.
6	*11-48-0 at 30 lb. P_2O_5	(S_1) + (S_2)
7	*11-48-0 at 30 lb. P_2O_5	(S_1) + (S_2) + (S_3)
8	*11-48-0 at 30 lb. P_2O_5	(S_2) + (S_3)

*When seeded on stubble land, 27-14-0 at 20 lb. P_2O_5 was used.

A portable Webster Paint sprayer with compressor driven by an air cooled gasoline engine and 25' of hose connected to the spray gun was used to apply a dilute solution of NH_4NO_3.

The sprayer was calibrated to deliver 6.4 ml. per sec. With an average walking time of 11 sec. for a 25 foot row, 70.4 ml. of solution was delivered to each row. The concentration of the NH_4NO_3 solution was adjusted so that an aliquot of 70.4 ml. would contain an equivalent of 5 lb. N. per acre when applied to a 25' row with 7" spacings. Approximately 0.01% of a detergent (Vel) was added to the nitrogen solution to reduce surface tension.

Results

The crude protein percentages are given in Table 12 for the three plot sites. In no instances did the spray applications alter the protein content of the grain. Fertilizer applied with the seed, whether 11-48-0 on the fallow plots or 27-14-0 on the stubble plot, resulted in a significant reduction of one percent or more in the protein content of the grain. This reduction in protein content may be due, in part, to the relatively large yield increases that were obtained from the seed applied fertilizer treatments (See Table 13).

Previous experiments (Tracer Fertilizer Report, 1953) have indicated that the protein content of stubble grain might be expected to be higher than that grown on an adjacent fallow site. The data recorded in Table 12 illustrate that the reverse can also occur. The moisture content of the soil at seeding time, together with optimum summer rainfall were probably responsible for the contrasting results obtained on the Tisdale CL soil.

Table 12 Crude protein percentage (%Nx5.7) expressed on oven dry basis (105°C.)

Treatments	Njaa Fallow plot	Purdy Fallow plot	Purdy Stubble plot
Check	19.0	15.4	14.6
*11-48-0 at 30 lb. P_2O_5	18.1	14.2	12.5
11-48-0 plus S_1	18.2	14.3	12.5
11-48-0 plus S_2	18.4	14.1	12.9
11-48-0 plus S_3	18.5	14.4	13.1
11-48-0 plus S_1 S_2	18.3	14.6	12.7
11-48-0 plus S_1 S_2 S_3	18.5	14.5	13.2
11-48-0 plus S_2 S_3	18.3	14.4	13.1
L.S.D. P = .05	0.48	0.52	0.54

*27-14-0 at 20 lb. P_2O_5 was used on the stubble plot.

Table 13 Yield of grain (bu/ac) obtained on the protein plots.

Treatments	Njaa Fallow	Purdy Fallow	Purdy Stubble
Check	17.3	28.1	7.0
*11-48-0 at 30 lb. P_2O_5	25.1	51.5	25.3
11-48-0 + S_1	25.1	49.0	25.5
11-48-0 + S_2	23.9	52.6	24.9
11-48-0 + S_3	24.3	46.9	26.4
11-48-0 + S_1 S_2	23.4	48.2	26.6
11-48-0 + S_1 S_2 S_3	22.5	49.6	26.5
11-48-0 + S_2 S_2	24.7	50.1	26.5
L.S.D. P = .05	3.7	2.3	4.2

*27-14-0 at 20 lb. P_2O_5 was used on the stubble plot.

(b) Protein content of selected grain samples from the Field Strip Fertilizer Tests.

One hundred and thirty two grain samples from the 1957 Field Strip fertilizer samples were analysed for crude protein (%N X 5.7). These grain samples were taken from both fallow and stubble fertilizer trials.

Results

1. Influence of nitrogen fertilization on the protein content of grain seeded on stubble land.

The protein content of unfertilized and fertilized grain from trials laid down at Kinistino (Tisdale CL), Birch Hills (Melfort SiCL) and Humboldt (Oxbow L) are given in Table 14. In every case, the protein content of the grain was higher where the nitrogen was applied as a broadcast treatment, than applied with the seed; seed placement of nitrogen did not alter the protein content as compared to the check. The yield of the checks and increases from both fertilizer treatments were very similar at all three locations.

Table 14 Percentage protein of fertilized and unfertilized grain sown on stubble land

Location	Fertilizer treatment	Yield bu/ac.	*% Protein
Kinistino (TiCL)	1. 11-48-0 at 40 lb./Ac. + A.N. at 120 lb./Ac. broadcast.	37.9	16.3
	2. Check	27.7	14.6
	3. 27-14-0 at 75 lb./Ac.	37.6	15.4

(cont'd)

Table 14 cont'd.

Location	Fertilizer treatment	Yield bu/ac.	*% Protein
Birch Hills (MSiCL)	1. 11-48-0 at 30 lb./Ac. + A.N. at 90 lb./Ac. broadcast	31.0	16.0
	2. Check	21.6	15.0
	3. 27-14-0 at 110 lb./Ac.	30.3	14.9
Humboldt	1. 11-48-0 at 30 lb./Ac. + A.N. at 90 lb./Ac.	29.7	16.8
	2. Check	20.8	15.3
	3. 27-14-0 at 110 lb./Ac.	27.7	15.4

*Determined on a composite of 10 samples taken from each treatment.

2. Percentage protein of grain samples taken from the unfertilized strips at various locations.

The protein content of grain samples taken from the check strips of 63 fallow fertilizer trials are given in Table 15. Digits preceding the protein percentages in the table indicate trials in the same locality i.e.- the grain from four fertilizer trials in the Kindersley area were taken for protein analysis.

Table 15 Percentage Protein of Wheat Grown on Various Soils in Saskatchewan

Soil	Place	*Protein %	Grain Yield (bu./ac.)
Sceptre HvC	Kindersley	1. 14.9	37.3
		2. 14.6	34.6
		3. 15.3	36.0
		4. 15.8	33.8
Asquith FSL	Asquith	1. 18.1	27.8
		2. 19.0	17.9
Elstow L-CL	Tessier	18.3	33.8
	Wilkie	18.0	29.1
	Adanac	18.3	15.8
Elstow-Weyburn L	Wilkie	1. 16.8	23.9
		2. 16.8	34.8

(cont'd)

Table 15 cont'd.

Soil	Place		*Protein %	Grain Yield (bu./ac.)
Weyburn L	Wilkie		17.6	37.8
Blain Lake L-CL	St. Isidore de Bellevue		16.8	21.3
	Domremy		19.0	21.6
	Speers	1.	15.7	26.9
		2.	14.9	23.4
		3.	15.6	30.7
	Radisson		16.3	37.5
	Fielding		19.0	12.3
	Marsden		18.5	19.4
Melfort-Blaine Lake SiCL	Hagen		17.8	23.3
	Birch Hills		16.5	27.3
Indian Head C	Abernethy	1.	15.0	34.5
		2.	16.5	26.8
		3.	17.8	20.8
		4.	16.7	19.2
Melfort SiCL -SiC	Birch Hills	1.	17.2	25.0
		2.	17.2	33.2
	Melfort	1.	15.7	45.5
		2.	16.1	34.8
		3.	16.6	39.9
Meota FSL	Paynton	1.	16.3	18.3
		2.	16.0	27.5
	Bresaylor	1.	15.5	18.4
		2.	16.8	34.9
Naicam L	Naicam	1.	15.5	27.8
		2.	16.9	24.4
		3.	18.6	30.6
		4.	17.0	27.8
Oxbow L	Muenster	1.	18.1	30.2
		2.	16.9	27.6
		3.	16.1	29.4
	Neudorf	1.	16.3	23.5
		2.	18.3	25.5
		3.	17.3	22.9
		4.	17.4	25.6
	Lemberg		18.0	21.7

(cont'd)

Table 15 cont'd.

Soil	Place		*Protein %	Grain Yield (bu./ac.)
	Cut Knife		16.6	25.3
Waseca L	Lashburn	1.	17.3	38.9
		2.	18.3	23.2
		3.	19.8	25.3
		4.	16.8	36.8
Yorkton L	Wadena	1.	16.8	23.9
		2.	17.3	22.1
	Wynyard		16.8	24.5
	Watson		16.6	21.1
Waitville L	Wynyard	1.	15.0	25.7
		2.	16.3	26.3
		3.	18.1	22.8
	Winthorpe		14.4	29.1
	Sheho	1.	17.3	20.0
		2.	13.0	26.8
		3.	16.1	25.3

*Determined on a composite of 10 grain samples taken from the unfertilized strip.

It is generally assumed that the lower the yield (the drier the soil during the growing season) the higher is the protein content. The results given in Table 15 do not, in general, conform to this assumption; a correlation coefficient of -0.3449 between yield and percentage protein suggests that while protein content is partially dependent on yield, other factors are perhaps of greater importance.

There was a wide variation in protein content of grain grown at different locations on the Blaine Lake, Naicam, Oxbow, Waitville, Waseca, Sceptre and Indian Head soils; the protein content of the grain for the Yorkton, Elstow and Asquith soils was relatively uniform. The average protein content of the grain from the 63 locations was 16.8 percent.

3. Variation in protein content within any one field.

Grain samples were taken for protein determinations from each of the 10 replicates from the unfertilized strips of six trials. The variability of the protein content at any one location is evident from the data presented in Table 16. It is apparent that the range of protein content on any one field may be as great or greater than between widely separated points (See Table 15).

Table 16 Protein Percentages of Wheat Within Fields at Various Locations in Saskatchewan

Place	Soil	Replicate Number	Protein %	Grain Yield (bu./ac.)
Kindersley	Sceptre HvC	1	11.6	48.9
		2	16.0	33.2
		3	15.3	36.7
		4	13.9	39.5
		5	15.3	22.0
		6	13.6	36.8
		7	15.1	31.8
		8	14.5	31.5
		9	14.7	38.0
		10	15.2	22.6
Asquith	Asquith FSL	1	17.3	35.2
		2	16.7	33.1
		3	17.7	31.6
		4	17.2	39.1
		5	16.7	31.9
		6	18.8	25.8
		7	18.6	24.5
		8	18.1	13.8
		9	20.3	21.9
		10	19.1	20.8
	Asquith FSL	1	18.7	17.8
		2	17.9	26.5
		3	18.3	13.9
		4	20.7	7.9
		5	18.4	11.0
		6	17.1	33.4
		7	21.2	10.0
		8	19.6	14.7
		9	20.7	13.8
		10	17.6	31.1
Neudorf	Oxbow L	1	16.5	19.8
		2	16.3	20.0
		3	18.3	28.3
		4	16.3	22.2
		5	16.9	25.1
		6	17.7	35.1
		7	16.5	22.0
		8	20.5	7.9
		9	17.1	19.7
		10	17.1	29.2

(cont'd)

Table 16 cont'd.

Place	Soil	Replicate Number	Protein %	Grain Yield (bu./ac.)
Cut Knife	Oxbow L	1	16.5	23.5
		2	16.3	39.7
		3	16.4	22.2
		4	16.7	22.3
		5	16.9	21.8
		6	16.7	21.4
		7	16.8	20.4
		8	16.5	22.2
		10	17.0	34.3
Neudorf	Oxbow L	1	17.9	30.0
		2	16.3	27.9
		3	16.6	23.9
		4	17.4	26.13
		5	19.6	18.0
		6	17.8	26.2
		7	17.2	26.7
		8	17.3	32.0
		9	17.0	22.5
		10	17.2	22.3

II Greenhouse and Laboratory Investigations

(a) Correlation of 'A' values determined in the greenhouse and chemical soil tests for available soil phosphorus with yield responses from phosphorus fertilizers - 1956-57 cooperative fertilizer test plots.

'A' values were determined in the greenhouse on bulk soil samples taken from 28 field plot sites (12 from the tracer plot sites and 16 from tests laid down by the Scott, Regina, Indian Head, Swift Current and Melfort Experimental Farms). The results obtained from this study, together with carbonated water and $NaHCO_3$ extractable phosphorus values are presented in Table 17. Since the field plot yield data, included in this table, were obtained from both fallow and stubble plot sites, some difficulty was experienced in obtaining true comparisons between the check and the 40 lb. P_2O_5 treatment. In the majority of cases, the yields represent an average of more than one treatment - i.e. where various rates of N and P_2O_5 were applied, the check yield represents the average yield of the nitrogen treatments, and the phosphate the average of the N and 40 lb. P_2O_5 treatments.

Table 17 Greenhouse and Laboratory Tests for Available Soil-Phosphorus. Tracer and Regional Fertilizer Tests.

Co-operator and Soil Type	Extractable Phosphorus (ppm) CO_2	Extractable Phosphorus (ppm) $NaHCO_3$	F.C. $\%H_2O$ (1/3A)	Green House A Value	Field Plot Data Yield, bu/ac. Check	Field Plot Data Yield, bu/ac. 40lb. P_2O_5	% Yield
		(Tracer Plot Soil Samples)					
(1) Hutcheon ECL	9.9	9.2	22.2	81.4	11.4	13.4	85.1
(2) Hutcheon ECL	15.8	11.2	-	-	-	-	-
(3) Mellum ScHvC-Pd	34.0	27.3	47.8	168.6	56.0	-	-
(4) Mellum FcCL	18.9	16.0	26.0	126.8	28.0	-	84.8
(5) Mellum Kd.C	13.7	6.8	37.0	52.6	33.9	40.8	83.1
(6) Mellum ScHvC	9.3	4.0	40.8	41.5	30.6	46.2	66.2
(7) Njaa Wh.L	19.6	6.6	-	-	17.3	25.1	68.9
(8) Njaa Wh.L	29.7	9.8	24.5	86.5	7.7	12.6	61.1
(9) Warder Hoey SiL	6.3	4.0	35.5	73.5	19.1	21.7	88.0
(10) Warder Hoey SiL	34.7	12.6	35.6	109.0	24.0	33.8	71.0
(11) Purdy TiCL	14.5	13.6	-	-	28.1	51.5	54.6
(12) Purdy TiCL	16.4	15.8	30.4	95.1	31.9	42.6	74.9
		(Experimental Farm Soil Samples)					
Scott Scott-L.							
(13) (1) Fertilizer form	12.7	11.5	21.8	52.8	14.1	18.7	75.4
(14) (2) Brome fallow	9.4	7.6	28.6	50.2	11.3	14.9	75.8
(15) (3) Stubble	8.4	7.7	27.1	41.3	7.4	12.2	60.7
(16) (4) Brome sod	6.2	4.6	27.6	26.9	-	-	-
Regina - RHvC							
(17) Rouleau	25.8	13.0	49.7	78.8	12.8	14.5	88.3
(18) Regina	12.9	6.4	49.5	47.3	8.1	9.4	86.2
(19) Ricetown	26.3	13.0	50.2	95.6	21.7	24.6	88.2
(20) Indian Head IHvC	12.3	6.8	39.3	83.5	19.2	18.9	100.0
(21) Swift Current WmCL	22.5	14.0	24.4	64.4	-	-	-

(cont'd)

Table 17 cont'd.

Co-operator and Soil Type	Extractable Phosphorus (ppm) CO_2	$NaHCO_3$	F.C. %H_2O (1/3A)	Green House A Value	Field Plot Data Yield, bu/ac. Check	40lb. P_2O_5	% Yield
Melfort							
(22) Somme TiC	12.0	7.2	37.8	41.3	30.9	41.4	74.6
(23) Snowden GaL	21.0	15.6	28.1	88.5	52.0	55.0	94.5
(24) Parkside BLSiL	11.6	7.2	21.1	55.5	10.6	25.0	42.4
(25) Archerwell Wh.L	14.0	9.4	31.6	67.2	51.8	59.5	87.1
(26) Stubble fert. MCL	17.9	12.4	42.7	91.9	29.8	34.4	86.6
(27) Whitefox Wf.SL	44.4	39.6	14.8	217.0	27.5	27.0	100.0
(28) Fallow fert. MCL	16.8	11.2	41.2	78.8	27.5	33.0	83.3

The correlation coefficients, given in Table 18 were calculated from data obtained from the co-operative test plot samples in 1956 (see Tracer Fertilizer Report, 1956) and 1957. The very low and non significant correlation between the CO_2 extractable - P and percentage yield, and the low, but significant correlation between the $NaHCO_3$ and percentage yield indicate that both quick tests are of doubtful value in predicting response from phosphorus fertilization. On the other hand, greenhouse 'A' values approximate, rather closely, the relative amount of available soil phosphorus in the surface soil.

Table 18 Correlation Coefficients

	CO_2 Extractable Phosphorus	$NaHCO_3$ Ext. Phosphorus	A Values
Percent yield	.2469	.3904*	.8231**
CO_2 extractable phosphorus	-	.7768**	.5389**
$NaHCO_3$ ext. phosphorus	-	-	.5254**

* - significant at the 5% level.

** - significant at the 1% level.

(b) Correlation of 'A' values obtained from field data with yield responses from phosphorus fertilizers - 1951 to 1957 inclusive.

During the 1951 to 1957 growing season, tagged phosphate fertilizers have been used on 70 field plot sites. The % yield and 'A' value data obtained from these plots were subjected to a correlation analysis to obtain a statistical measure of the value of the Field 'A' value as a means of indicating the phosphorus fertility status of the soil. A highly significant 'r' value of 0.5072 was obtained. It is apparent that while 'A' values obtained under field conditions reflect, in part, the availability of the soil phosphorus, other factors (probably moisture, temperature, etc.) influence the magnitude of the 'A' value appreciably.

(c) Comparison between Field 'A' values and Greenhouse 'A' values as a means of measuring the level of available soil phosphorus.

During the past three years, Greenhouse "A" values have been determined on 23 soil samples taken from field plots where tagged $NH_4H_2PO_4$ had been used. A comparison between the two series of "A" values, and percentage yield from phosphate fertilization in the field should afford a measure of the reliability of Field or Greenhouse 'A' values as a means of indicating the relative amount of available phosphorus in the soil. Highly significant correlation coefficients of 0.7202 and 0.8520 were obtained when Field 'A' values and percent yield in the field, and Greenhouse 'A' values and percent yield in the field, respectively, were compared. It is apparent that the Greenhouse 'A' value measures more precisely the level of available soil phosphorus than the Field 'A' value. In addition, it should be noted that the determination of Field 'A' values is considerably more time consuming and expensive.

(d) Effect of environmental conditions in the greenhouse on 'A' values.

The results of a study designed to illustrate the influence of fertilizer placement on 'A' values was reported in the 1956 tracer fertilizer report. Further data on other factors influencing the relative magnitude of 'A' values obtained under greenhouse conditions were obtained in the past year.

(1) Effect of season on greenhouse 'A' values.

Twenty six soil samples taken from the 1956 tracer and co-operative test plot sites were used in this experiment. 'A' values were determined on the soils in the fall of 1956, and again in the spring of 1957. Each soil was removed from the pots (four fertilized with 50 lb. P_2O_5 per acre using tagged $NH_4H_2PO_4$ and four check pots for each soil) following the harvest of the fall experiment and thoroughly mixed prior to re-potting for the spring experiment. The 'A' value data, together with the percentage yield (Check/Fertilized X 100) for the two growth periods are given in Table 19.

The 'A' values obtained from the spring seeding range from 50% to more than 100% higher than those obtained on the same soils in the fall. Since greenhouse techniques - six weeks growth period, watering practices, temperature, etc. were approximately the same for both crops it would appear that the greater light intensity prevailing in the spring had markedly changed the rooting habits of the plant; however, other factors may have in part accounted for the marked increase in 'A' values recorded for the spring crop. A portion of the increase could be attributed to the fertilizer applied in the fall experiment since plant removal accounted for only about 60% of the applied fertilizer (50 lb. P_2O_5 per acre). In addition, the possibility of a release of available soil phosphorus between the fall and spring could not be entirely disregarded, although such a high release did not seem reasonable.

Table 19 Influence of season on 'A' values and percentage yield in the Greenhouse.

Soil type	% yield		A value (lb. P_2O_5/acre)	
	Fall	Spring	Fall	Spring
Melfort SiCL	79	84	47.5	93.9
Melfort	70	90	27.9	74.8
Sceptre C	53	54	20.7	34.5
Elstow CL	92	90	68.0	156.0
Tisdale CL	91	100	79.7	167.1
Melfort SiCL	82	100	52.8	107.1
Kamsack CL	72	83	20.6	51.8
Kamsack (Ev)	75	70	20.6	46.2
Melfort CL	80	88	24.3	80.1
Melfort (Ev)	63	69	15.1	63.9
Kamsack CL	75	70	17.7	48.5
Kamsack (Ev)	76	68	16.2	49.0
Sceptre HvC	80	49	38.6	36.0
Kindersley C	85	97	57.5	106.1
Kindersley C (shallow)	96	90	96.6	171.3
Flaxcombe SCL	92	100	64.8	112.8
Regina HvC	81	80	73.7	101.5
Regina	63	76	37.8	66.6
Regina	88	80	54.6	83.2
Regina	83	93	50.0	64.2
Indian Head C	88	83	27.2	58.8
Indian Head	82	79	19.8	56.5

(cont'd)

Table 19 cont'd.

Soil type	% yield Fall	Spring	A value (lb. P_2O_5/acre) Fall	Spring
Scott L			15.1	51.7
Scott			32.9	77.1
Scott			18.0	56.8
Scott			24.9	77.1

In the fall of 1957, a further greenhouse experiment was designed to determine whether variations in sunlight intensity during October, November, December and January influenced A values. Two soils were used, a Melfort silty clay loam, and an Oxbow loam. Four planting dates were selected at three week intervals beginning October 23. Each crop was grown for a six week period. Tagged $NH_4H_2PO_4$ banded with the seed (Thatcher wheat) was used as a source of phosphorus.

The results obtained from this study are given in Table 20. Variations in plant weight between the various seeding dates were small, and in general, non significant. Dates of seeding however resulted in significant variations in A values. In general, as the date of seeding was delayed, 'A' values increased. This trend was not so pronounced for the Oxbow soil, but significant increases were recorded between each three week interval for the Melfort soil. These data confirm the observations drawn from the initial experiment in that the effect of season on 'A' values may be so marked as to invalidate comparisons between two experiments grown only a few weeks apart.

Table 20 Influence of date of seeding on A values

(a) Oxbow

Date of Seeding	Plant Wt. g/pot	A value	% utilization of applied fertilizer
Oct. 23	2.93	58.9	25.3
Nov. 9	3.71	63.0	29.0
Dec. 4	3.04	69.7	23.6
Dec. 22	3.03	65.3	23.9
L.S.D.	0.6	10.5	3.9

(cont'd)

Table 20 cont'd.

Date of Seeding	Plant Wt. g/pot	A value	% utilization of applied fertilizer
		(b) Melfort SiCL	
Oct. 23	3.14	68.3	23.4
Nov. 9	3.62	72.9	28.4
Dec. 4	3.08	89.0	22.5
Dec. 22	3.88	99.0	22.8
L.S.D.	N.S.	3.6	2.1

On the basis of these experiments, it appears that 'A' value data obtained in the greenhouse at different periods may not be comparable, or at least, must be interpreted in view of the above findings. Undoubtedly, if the incandescent lighting in the greenhouse were replaced with higher intensity flourescent fixtures, these marked variations would not occur. All future 'A' value experiments will be conducted in the growth chamber now under construction.

(2) Influence of watering practices on 'A' values.

Occasionally, errors are made in determining the field capacity moisture content of soils, or watering practices followed are varied, during greenhouse experiments. This experiment was designed to determine whether the availability of water influences the reproducability of 'A' values.

A Melfort SiCL soil was used. The six soil moisture treatments were as follows:

(1) Soil maintained at a measured F.C. of 45% water.

(2) Soil maintained at a (incorrect) F.C. of 30% water.

(3) Soil maintained at a (incorrect) F.C. of 15% water.

(4), (5), and (6) Soil watered up to F.C. (45% moisture) and rewatered only when the moisture content dropped to 4/5, 3/5, and 1/2 F.C. respectively.

It is to be noted that in treatments (2) and (3), the lower 1/3 and 2/3 respectively of the soil in the pot would remain dry throughout the growing period.

The results of this experiment are given in Table 21. A rather marked error in field capacity moisture content would have to be made before significant effects on either plant weight or 'A' values would be obtained. Reducing the F.C. to 2/3 of the correct value did not alter either 'A' values or yields appreciably. However, the 1/3 F.C. treatment resulted in a marked decrease in yield (due to an actual deficiency of water) and a significant drop in 'A' values (due to limited soil volume and therefore, limited amount of total available soil phosphorus for the plant).

As the pots were watered less frequently, a gradual rise in 'A' values, and a decrease in plant weight was recorded.

Table 21 Influence of watering practices on 'A' values.

	Moisture Treatments						
	(1) 45% water F.C.	(2) 30% water (2/3F.C.)	(3) 15% water (1/3F.C.)	(4) 4/5 F.C.	(5) 3/5 F.C.	(6) 1/2 F.C.	L.S.D.
Yield g/pot	2.78	2.55	1.65	2.75	2.22	1.95	-
'A' value lb. P_2O_5/Ac.	58.7	52.9	35.0	64.5	62.0	67.7	9.4
% Fertilizer utilization.	23.1	21.0	18.9	20.9	18.6	16.3	1.1

From the data obtained in this experiment, it can be concluded that watering practices do effect 'A' values; 'A' values determined on different soils are only comparable when the plant is grown under similar soil moisture tensions.

(e) Results of the field strip soil testing program 1956-57.

The co-operative fertilizer and soil testing program, carried out with the co-operation of the Agricultural Representative Service and members of the fertilizer trade was initiated in 1957. The initial objective of this program was to determine whether it was possible to distinguish between responsive and non-responsive soils by means of the carbonated water test.

The fertilizer and soil testing was done utilizing, in most instances, a single strip fertilized with 40 lb. of 11-48-0 per acre and an adjacent unfertilized strip. All tests were on fallow land. Both yield and soil samples were taken from the same locations on the strips. Ten samples were taken from each test strip.

The yield data obtained from the 104 field strip locations has been reported in the "Results of Field Strip Fertilizer test, 1957". The soil test data, which included texture, pH, and CO_2 extractable phosphorus on approximately 1100 samples are not included in this report, but will be compiled at a later date. Certain of the statistical results obtained on the 1957 (and a few samples taken from the 1956) field strip trials are given in Table 22. It is apparent that the CO_2 extractable phosphorus is of doubtful value in predicting the yield response from phosphorus fertilization. The calculated correlation coefficients were considerably higher for the soils containing free lime (Sceptre and Yorkton) than for the lime free soils.

Certain of the test strips were re-sampled in the fall to determine whether the CO_2 extractable phosphorus varied appreciably from the values obtained for the spring sampling; in general, the CO_2 values were 10-20% lower in the fall than in the spring, while the pH of the soil remained relatively constant.

Table 22 Statistical Results on Soil Testing 1956-1957.

Correlation coefficients for comparisons of Extractable Phosphorus (CO_2 method) and % Yield Increases. The population is the mean of 10 individual samples from check strips at each location.

Comparison of	Number of plots	'r'
1. All Field check strips	104	-0.338**
2. Sceptre soils	8	-0.603
3. Waitville soils	8	-0.269
4. Yorkton soils	8	-0.603
5. Elstow soils	10	-0.366
6. Blaine Lake soils	10	-0.264

**Indicates highly significant correlation.

Additional extractants - i.e. $NaHCO_3$ - will be used to measure the available soil phosphorus on certain of the 1957 soil samples, as time permits, during the coming year. In addition, the co-operative field strip soil testing program will be continued during the 1958 growing season.

Summary

1. Minimal applications of 10 lb. of N and 10 lb. of P_2O_5 applied with the seed resulted in a 67% yield increase under the very dry conditions that existed in the Hagen area. While additional N and P resulted in further yield increases, the extra yield obtained was not large.

2. Seed placement vs broadcast applications of nitrogen were difficult to compare since the amount of rainfall was insufficient to move the broadcast nitrogen into the root zone.

3. The soil member study, conducted in the Kindersley area, orientated the four soils into the following order of increasing phosphate fertility, - Sceptre (cloddy granular), Flaxcombe (solonetz) and Kindersley (solonetz) equal, and the Sceptre (poorly drained) member with the highest amount of available soil phosphorus.

4. Trash placement studies conducted at three locations indicate that the nitrogen deficiency in the stubble soils was largely due to previous crop removal, as incorporating the trash did not appreciably increase the response to nitrogen fertilization. Greater average yields were obtained on the plots containing trash than where the trash was removed; this was attributed to a decreased loss of moisture by evaporation. There was an indication at two sites that the incorporated trash decreased the level of available soil phosphorus.

5. Nitrogen sprays, applied at the 4 leaf, shot blade, and flowering stage did not alter the protein content or yield of the grain. The 11-48-0 applied to fallow crops, or the 27-14-0 applied at seeding time to the stubble crop, decreased the protein content, and increased the yields at all sites.

6. Correlation analysis conducted on the soil test data obtained from the 1956, and 1957 co-operative soil site samples, and previous tracer plot sites (1951-57 inclusive) indicate that the greenhouse 'A' value closely reflects yield responses to phosphate fertilization obtained in the field. The CO_2 extractable phosphorus, was inferior to the $NaHCO_3$ test but both appear to be of

doubtful value in predicting response from phosphate fertilization. Field 'A' values did not correlate as highly as greenhouse 'A' values with the % yield values obtained on field plots.

7. Approximately 1100 soil samples taken from the 1956 and 1957 field strip fertilizer tests were analysed for CO_2 extractable phosphorus. This comprehensive testing program indicated that the phosphorus extracted with carbonated water does not correlate appreciably with yield response from phosphorus fertilization.

8. One hundred and thirty two samples taken from various field strip fertilizer sites were analysed for protein. Broadcast nitrogen increased, while seed applied nitrogen did not alter the protein content of grain. The protein content of the grain was found to vary equally as much within any one field strip as between different locations.

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