Fertilizer Placement and Corn Stand
Rosemount Agricultural Experiment Station - 1961

Paul M. Burson

Diammonium phosphate is a common ingredient in mixed fertilizers whether they are manufactured by treating superphosphate with ammonia or by adding a previously manufactured ammonium phosphate. It is known that if any considerable amount comes in contact with corn seed, germination is damaged.

In the trials in 1961 the splitboot and band placement fertilizer attachments for the corn planter were used. The fertilizers studies were 18-46-0 and a mixed fertilizer, 5-20-20, at different rates. As an additional placement treatment the inverted V shaped spreader was removed from the splitboot attachment allowing the fertilizer and seed to fall together (with seed) so the fertilizer was known to be in contact with the seed.

Fertilizer rates	Number of plants per acre		
	Splitboot	With Seed	Band
	Ammonium phosphate (18-46-0)		
100 lbs	11,350	8750	16,700
200 lbs	8,700	5850	17,000
400 lbs	10,350	1450	16,600
	Mixed fertilizer (5-20-20)		
200 lbs	13,000	11,100	16,750
400 lbs	11,100	5350	16,350

The data shows that straight diammonium phosphate (18-46-0) either with the spreader (inverted V) in or out seriously damaged germination regardless of the rate used and that when placed in a band to the side and below the seed had little effect. The normal mortality rate regardless of the planter used and the kind of seed can range from 10 to 15 percent of the number of kernels dropped.

The germination damaged with the mixed fertilizer (5-20-20) was less in the splitboot attachment than it was with straight diammonium phosphate (18-46-0) but was still serious enough to suggest that the 200 pound rate was too heavy when a splitboot attachment is used. For this attachment the rate should probably not exceed 150 pounds per acre. There was no damage when the band placement was used. The above table shows how placement injured germination and reduced the final stand.

Comparative Effects of Deep Tillage Versus Plowing on Soil & Water Losses and Corn Yield over Three Years (1959-61) on Port Byron Silt Loam at Rosemount.

By J. M. MacGregor

In 1953, a seed-bed preparation experiment was initiated on a 9% slope of the Port Byron silt loam at Rosemount to determine the relative effect of deep tillage seed-bed preparation versus conventional plowing, on losses of soil and water and of corn, oat, and hay yields where a four year rotation of corn, oats, followed by two years of alfalfa was practiced.

Six years of experimental results (1953-1958) indicated that the four year rotation in use was adequately maintaining soil tilth, and with no treatment replication there was no significant difference in soil or water loss with the two methods of soil preparation or in the yields of corn, oats, or of alfalfa hay.

Therefore, in 1959, the four year rotation was changed to a continuous corn sequence on each of the eight plots. After harvest each fall, a stalk cutter was used on all plots, after which four were plowed and the remaining four adjacent plots were deeply cultivated (to approximately an eight inch depth) and then reworked to a slightly shallower depth in the spring. Corn was planted to obtain approximately 16,000 plants per acre, using 5-20-20 as starter fertilizer each year at the rate of 200 pounds per acre. A nitrogen sidedressing of 80 pounds of ammonium nitrate nitrogen per acre was broadcast annually in late June or in early July.

Results

The growing season of 1959 was abnormally wet, followed by two comparatively dry summers of 1960 and 1961. This variation in growing season moisture has produced considerable difference in all of the results obtained, as shown in the following table:

Table 1. The effect of seed-bed preparation by plowing or by deep cultivation on soil and water losses and resulting corn yield on a 9% slope of Port Byron silt loam at Rosemount (1959-61) (Averages of four replicates).

	Year		
	1959	1960	1961
Total precipitation (April-Oct. inc.)	32.5"	21.8"	19.3"
Water runoff on plowed plots	6.3"	0.7"	None
Runoff as % of 7 month pptn.	19	3	None
Runoff on cultivated plots	5.6"	0.3"	None
Runoff as % of 7 month pptn.	17	1	None
Tons of soil eroded/A on plowed plots	2.4	None	None
Tons of soil eroded/A on cultivated plots	1.3	None	None
Yield of ear corn per acre on plowed plots	119	88	99
Yield of ear corn per acre on cultivated plots	122	74	81

Discussion

Precipitation - the total amount, the distribution and the relative intensities of each rain, has a great effect on soil erosion and water runoff - and also materially affects subsequent corn yields on the two different methods of seed-bed preparation. The heavier than normal rainfall of 1959 was more effectively controlled and conserved by deep tillage rather than by the plowing, and this method of soil preparation reduced both soil and water losses and also resulted in a 122 bushel yield of ear corn per acre. The plowed plots (all plots of the experiment are worked on the contour) had a greater runoff and soil loss under the heavy rains of that summer, and yielded 118 bushels of corn per acre.

The growing seasons of 1960 and 1961 were drier than normal, and although there were some rains resulting in runoff water in 1959, no measured soil loss occurred in either of these two latter years. The drier soil conditions apparently lowered corn yields substantially in comparison to those produced in 1959, and the deeply cultivated plots were less productive where the seed-bed was prepared by plowing. A yield difference of either 14 or 18 bushels per acre would be of primary concern to a farmer following such conservation practices. In addition, the corn population on the deeply cultivated plots was generally unsatisfactory, although this effect was largely corrected when the corn yields per acre were calculated.

Conclusion

While nothing definite can be concluded from the results from only three years data, it is evident that there was better control of soil moisture under higher rainfall where deep cultivation was used rather than plowing. This better moisture control may have been improved by increasing the water infiltration into the subsoil by working at deeper levels than by normal plowing. Under dry conditions, this may have been detrimental in allowing greater losses of soil moisture to the air under prolonged periods of drier soil conditions. It is possible that cutting the corn stalks in a field chopper rather than with a stalk cutter will allow preparation of a suitable seed-bed by cultivation to a maximum depth of six inches. This may allow a greater retention of subsoil moisture, which is apparently a critical factor in drier growing seasons.

Fertilizer Experiment on Continuous Soybeans
Rosemount, 1961

A. C. Caldwell and J. B. Weber

An experiment was set up in 1957 to study the effects of P, K and barnyard manure on the yields and plant composition of soybeans. Plots were laid out consisting of four replications and fifteen treatments.

In 1958 through 1961 no fertilizer was applied in order to study the residual effects of the 1957 applied fertilizer.

Yield results for 1961 are shown in table 1. Significant increases in yields, above the control, occurred only on the 0-400-400-6T treated plots, lsd at 5%. The increases of about 4 bushels per acre above the control are in agreement with the results of the past several years. Significant decreases in yield resulted on the 0-0-80 and 0-400-0 treated plots and this is also in agreement with results of the past several years. None of the treatments, other than the control, are significantly different from each other, hsd at 5%.

Table 1. Effect of residual fertilizer on yield of continuous soybeans, 1961.

Treatment $N-P_2O_5-K_2O$ lbs/A	Yield bu/A	Diff.
0-0-0	20	-
0-0-20	19	-1
0-0-80	16	-4
0-0-400	23	3
0-20-20	18	-2
0-40-40	21	1
0-60-60	21	1
0-80-80	18	2
0-400-400	23	3
0-400-400 + *6T	24	4
0-20-0	19	-1
0-80-0	18	-2
0-400-0	16	-4
0-20-0 + *6T	19	-1
*6 T	21	1
*6 T refers to 6 tons manure/A.		
standard error =		1.4
lsd ($F_{.95}$)		3.5
hsd ($F_{.95}$)		7.3

Fertilizer Effect on Yield & Longevity of Ranger Alfalfa on Port Byron Silt Loam at Rosemount, 1949-61.

By J. M. MacGregor & R. G. Hanson

In the fall of 1949, an experiment was initiated to study the effect of different systems of fertilization on the longevity, yield, and composition of Ranger alfalfa. The alfalfa seeding was made in June of 1950 with the first of three annual cuttings being made a year later. Initially eight replications were included, but the continued excessively high production level of the eighth replicate led to its being discarded at the end of three years.

Systematic fertilization and crop removal has been carried on as outlined in the following table, with a variable deterioration in alfalfa stand and a gradual invasion of grasses and a few broad leaved weed species which was more evident in the unfertilized or more poorly fertilized plots. After ten years of continuous hay removal, it was decided to renovate and reseed the entire area after the first cutting of 1961 (31 cuttings having been harvested).

The following table shows the 31 treatments arranged in descending order of effectiveness in hay production for the entire period, including the 1951 yield, the first cut of 1961, the total 10 year yield and the relative increases above those plots receiving no fertilizer

Conclusions

1. Fertilization is highly effective for increasing both yields and longevity of alfalfa.

2. Potassium in addition to the phosphorus is essential if alfalfa stands and yields are to be satisfactory over a period of many years.

3. The ranking effectiveness of potassium of treatment 5 indicates that an 0-1-2 or even 0-1-3 fertilizer ratio might be much more desirable for alfalfa fertilization in Minnesota than the more commonly used 0-1-1 ratio.

4. Heavy initial fertilization is relatively inefficient - better to use lower initial rates and use the remainder as annual or biennial top dressings.

5. Annual top dressings were considerably more economically productive than biennial fertilizer treatments.

6. Initial fertilization followed by annual topdressing was more effective than annual topdressings alone.

7. The inclusion of nitrogen in the fertilizer was not profitable.

8. Initial fertilization with several trace elements failed to increase alfalfa yield or longevity (No's. 22 and 26).

9. Over the ten year period, initial fertilization at moderate rates with no later additions was ineffective for increasing alfalfa yields.

10. Spring fertilization produced essentially the same results as similar treatments applied in the previous fall.

Total Yield - Rosemount Alfalfa - 1951-61

Average of Seven Replications

11 year yield rank	Treatment	(Tons/acre at 15% moisture) 1951	1961	Eleven year total Yield	Increase
30	Check	3.10	1.09	30.19	----
1	300# 0-20-20 SBS + 200# AS	3.96	1.51	45.53	15.34
2	300# 0-20-20 FBS + 200# AF	3.89	1.55	44.75	14.56
3	300# 5-20-20 SBS + 200# AS	4.03	1.64	44.50	14.31
4	1000# 0-20-20 SBS + 200# AS	4.42	1.47	44.01	13.82
5	1000# 0-20-0 SBS + 100# of KCl AFC	4.26	1.60	43.72	13.53
6	1000# 0-20-20 SBS + 200# 5-20-20 BS	4.34	1.33	43.42	13.23
7	200# 0-20-20 AS	3.25	1.42	43.20	13.01
8	1000# 0-20-0 SBS + 200# 0-20-20 AS	4.14	1.15	42.56	12.37
9	300# 0-20-20 FBS + 200# BF	3.51	1.44	41.23	11.04
10	200# 0-20-20 AF + 200# BS	3.60	1.48	41.23	11.04
11	1000# 0-20-20 SBS + 200# BS	4.30	1.42	39.05	8.86
12	300# 0-20-20 SBS + 200# BS	3.79	1.20	38.50	8.31
13.	1000# 0-20-0 SBS + 200# 0-20-20 BS	3.95	1.51	37.12	6.93
14	300# 0-20-0 SBS + 200# AS	3.77	1.13	36.57	6.38
15	300# 0-20-20 SBS	3.90	1.37	35.64	5.45
16	1000# 0-20-20 SBS	4.09	1.17	35.22	5.03
17	1000# 0-20-0 SBS + 200# AS	4.04	1.27	34.71	4.52
18	200# 0-20-0 AS	3.64	1.25	34.69	4.50
19	200# 0-20-0 AF	3.84	1.16	34.44	4.25
20	300# 0-20-0 FBS + 200# BF	3.68	1.07	33.86	3.67
21	300# 0-20-0 FBS + 200# AF	3.77	1.17	33.67	3.48
22	300# 0-20-20 + Trace Elements SBS	3.88	1.15	33.33	3.14
23	300# 0-20-0 SBS + 200# BS	3.64	1.09	32.64	2.45
24	300# 5-20-20 SBS + 20# Nitrogen AS	3.75	1.09	32.62	2.43
25	300# 0-20-0 FBS	3.61	0.97	32.02	1.95
26	300# 0-20-20 + 20# Boron SBS	3.84	1.01	31.07	0.98
27	1000# 0-20-0 SBS	4.01	0.97	30.68	0.49
28	300# 0-20-20 FBS	3.78	1.03	30.15	-0.04
29	300# 5-20-20 SBS	3.82	0.95	30.13	-0.06
31	300# 0-20-20 SBS	3.59	0.93	29.42	-0.77

SBS - Spring before seeding
FBS - Fall before seeding
AFC - Annual first cutting
AS - Annual spring
BS - Biennial spring
AF - Annual fall
BF - Biennial fall
Trace Elements - $CuSO_4$ 25#/A; $ZnSO_4$ 25#/A; $MnSO_4$ 25#/A; $FeSO_4$ 25#/A; Borax 20#/A.

With the gradual invasion of grasses and weeds and the depletion of the alfalfa stand, the experimental area is being renovated and was seeded with Vernal alfalfa following the removal of the first cutting in 1961. The same fertilization will be continued.

This experiment was designed by Dr. C. O. Rost. The research work has been carried on under the direction of Dr. J. M. MacGregor by W. W. Nelson, J. R. Brownell, R. G. Burau and R. G. Hanson.

TEN YEARS OF PASTURE EXPERIMENTS
FERTILIZATION AND MANAGEMENT

Paul M. Burson, Soils, & A. L. Harvey, Animal Husbandry

1. Pasture forage and livestock production is the best landuse program for land that is too rolling and steep for production of cultivated crops. This combination program of landuse will maintain soil fertility. It may control erosion and can bring economical returns to the farmer.

2. Lime and fertilizer needs were determined by soil tests.

   a. Lime requirement was 3 tons per acre. It was applied in 1951.

   b. In 1951, soil tests showed phosphate to be low to very low and potash to range from medium to low to very low.

   c. In 1951, all slopes were badly eroded, gullied and no topsoil. This resulted in low organic matter and nitrogen.

   d. The soil fertility was generally low.

3. In 1960, soil tests on fertilized pastures showed pH above 6.0, phosphate and potash tests to be generally high with some areas in the pastures as very high.

4. The fertilizer program, depending on soil tests, included a basic treatment of 60 to 100 lbs. of phosphate (P_2O_5) and the same amount of potash (K_2O) per acre at the time the pastures were originally seeded.

   a. The use of 60 lb. per acre each of phosphate and potash as a basic treatment seems to be adequate.

   b. Annual topdressed applications followed of 40 lbs. per acre each of phosphate and potash applied in early spring.

   c. Annual application of 66 lb. of topdressed nitrogen are made at different times of the pasture season.

5. Clipping yields were made comparing nitrogen fertilization as to time of application and split versus one application.

   a. All the nitrogen applied at one time generally is the most satisfactory.

   b. With all nitrogen applied in the 1st week of June, the yields were about equal to that being applied in the last week of April.

   c. June application has been effective because it stimulated growth after early spring growth, has been partially grazed off and while an adequate moisture supply is still available to make the nitrogen response most effective.

   d. If split applications of nitrogen are used, with one-half applied in July, the effectiveness is dependent upon the amount and distribution of the summer rainfall.

   e. The annual application of 60 to 80 lbs. of actual nitrogen applied per acre appeared adequate. Higher amounts per acre should be used on severely eroded and at the time of initial seeding.

6. Nitrogen fertilizer changed pasture composition.

   a. In 1957-58, 60 lb. of nitrogen increased the percent grass from 3 in May to 24 in July.

   b. For the same period, all the nitrogen applied at one time increased the percent range of grass throughout the season from 40 to 80, while the split applicatinn ranged from 40 to 59.

7. Adequate fertilization is most essential on eroded land if uniform composition of the pasturage is to be maintained.

8. The steers showed grazing preference to the fertilized pastures over the unfertilized pastures.

   a. On the unfertilized pastures the steers grazed the grasses before they grazed the legumes.

   b. On the fertilized pastures, the steers grazed both the grasses and legumes, showing no selective preference.

9. Dropping spots were well grazed off on the fertilized pastures while the same spots in the unfertilized pastures generally were not grazed.

10. Manure has been applied annually in the fall since 1957.

   a. It has not retarded grazing when applied in the fall. Steers may do more uniform grazing on manured pastures.

   b. Manure is slower in the release of nitrogen and provides a residue material that tends to conserve moisture in the dryer periods of the grazing season and at the same time reduce excessive runoff during heavy rains.

11. On land subject to erosion, plowing is not recommended for reestablishing pastures. Renovate the old sod with a heavy field cultivator and a disk to prepare the seed bed.

For additional and more detailed information see stations bulletin 452, "Beef from Grassland", and the other sections of the 1961 Beef Cattle-Grassland Field Day report.

12. An average of seven years' results (1953-1959) shows that fertilizing alfalfa-brome pastures increased:

   (1) Carrying capacity 55 steer days (114-169 days) or 8%;
   (2) Beef produced per acre, 85 lb. (206 to 291) or 41%;
   (3) Value of beef produced per acre less fertilizer cost, $10.04 per acre ($47.64-$57.68) or 21%.

When weather conditions were favorable, as in 1958, 461 lb. of beef were produced per acre on the fertilized pastures, which was 159 lb. more than produced per acre on similar unfertilized pastures. The additional beef produced from the fertilized pastures (valued at $28/cwt.) increased the margin, after deducting costs of fertilizing ($15 per acre), $29.52 per acre.

During the summer of 1960, the application of 60 lb. of nitrogen upon a bromegrass pasture increased: (1) carrying capacity, 46 steer days (86-132) or 53%; (2) beef produced per acre, 76 lb. (134-210 lb.) or 57%; (3) value of beef produced per acre less fertilizer costs, 96¢ per acre

($28.14-$29.10) or 3%.

Fertilizing brome-timothy pastures with manure and nitrogen over a 3-year period (1958-1960) did not prove to be a profitable procedure after fertilizer charge and seed costs were deducted.

PASTURE FERTILITY AND BEEF PRODUCTION

P. M. Burson, Soils; A. R. Schmid, Agronomy
A. L. Harvey and O. E. Kolari, Animal Husbandry

On May 23, 1961, steers were lotted and turned onto pasture. One-half of each of the three pastures was fertilized and the other one-half unfertilized. Each pasture received an annual topdressing of 200 lb. per acre of 0-20-20 and 200 lbs. of 33-0-0, ammonium nitrate (66 lbs. of nitrogen). The 0-20-20 was applied in early spring while the nitrogen was applied at different times during the spring and summer as shown in table 2. Pastures A and C are a mixture of alfalfa, brome and some orchard grass, while pastures B and F are brome and orchard grass. Table 1 shows the production of beef for 1961. The total production of beef per acre ranged from 171 lb. on the unfertilized B and F pastures to 385 lb. on the fertilized renovated A and C pastures. It should be noted that the greatest beef production per acre was from the fertilized renovated pastures which also gave the greatest beef return per acre over seed, tillage and fertilizer costs. The carrying capacity as shown by steer-days per acre ranged from 95 on the unfertilized grass to 170 on the fertilized grass to a top of 180 on the fertilized renovated pastures.

As shown in table 2, the application of nitrogen fertilizer on pastures A, B, C, F, and G was made at two different times in the spring. This was compared with a split application with one-half put on in the spring and one-half during mid-summer. The effect of nitrogen fertilizer on the yield of forage produced per acre was determined. The difference in time of application or the use of split applications had no major effect on the amount of forage produced per acre over single applications all applied in early or late spring. In some areas where rainfall is sufficient and well distributed during the summer months, the split application of nitrogen may boost pasture yields during mid-summer. A split application may be important where the soils are eroded to the extent that no topsoil remains. Where no topsoil remains, higher rates of nitrogen should be used at the spring application along with the mid-summer application. The application of nitrogen fertilizer did boost pasture yields from 1.00 ton per acre on the unfertilized G5 pasture to 3.56 tons on the nitrogen fertilized C1 pasture. The percentage of grass in the pasturage was increased by nitrogen fertilizer. However, no difference in the percentage of grass could be noted as to the time of nitrogen application. Sufficient and well distributed moisture throughout the grazing season is very essential for the most efficient response from nitrogen fertilizer.

Table 1. Beef produced with yearling steers on unfertilized and fertilized pastures grazed in rotation. May 23, 1961 to September 6, 1961. (106 days)

	Unfertilized		Fertilized[a]
	Grass B3, B4, F1 5.65 acres	60#N on Grass B1, B2, F1 5.65 acres	Renovated[b] A2, A3, C1 7.50 acres
No. steers at start	6[c]	10[d]	14
Initial weight, lb.	680	680	679
Average wt. 9/6/61 lb.	850	876	913
Total gain, lb.	966	1754	2890
Total steers days	536	960	1352
Daily gain, lb.	1.80	1.83	2.14
Steer days/acre	95	170	180
Beef produced/acre, lb.	171	310	385
Value beef produced/acre @22.00 cwt.	37.62	68.20	84.70
Fertilizer and lime cost/acre	-----	15.00	8.00
Tillage and seed cost/acre	-----	-----	6.00
Value beef produced/acre less seed, tillage and fertilizer cost	37.62	53.20	70.70

a/ 200#/acre 0-20-20 annual
b/ Renovation - three workings with deep tiller and once with disk. Seeded to alfalfa 5#, alsike 1#, Lincoln brome 6#, and orchard grass 2# per acre.
c/ 2 steers removed 7/18/61
d/ 6 steers removed 8/15/61

Table 2. Clipping yields from fertilized pastures A, B, C, F, and G, comparing nitrogen fertilization as to time of applicatinn and split versus one application. P.M. Burson, Soils; A.R. Schmid, Agronomy; A. L. Harvey, Animal Husbandry[a]

Treatments[b] Lb. N/acre	Total tons and average per acre for each pasture at 15% moisture[c] A3	A4	B1	B2	C1	F	G2	G5	Av.
No fertilizer	1.54	1.54	1.38	1.12	----	1.66	1.29	1.00	1.36
1. 66# April	3.13	3.10	1.44	2.08	3.56	3.24	1.98	2.60	2.14
2. 33# April - 33# July	2.87	3.21	2.00	1.57	3.28	2.97	1.72	2.37	2.50
3. 66# June	2.48	2.84	1.86	1.50	3.12	3.51	1.40	1.98	2.34
4. 33# June - 33# July	2.58	1.23	1.93	2.00	2.74	----	1.41	1.81	1.96

a/ Acknowledgement is due Ed Bonnell and Jobst Siefkin who harvested the samples.

b/ Annual application - 200# per acre 0-20-20, April 22, 1960.

c/ All pastures had 3 clippings except C1 which had 4.

BEEF PRODUCTION FROM FERTILIZED GRASS PASTURES

A. R. Schmid, Agronomy; P. M. Burson, Soils;
A. L. Harvey, and O. E. Kolari, Animal Husbandry

Three types of pasture were compared on "G" for the fourth successive year. A fourth type, the renovated, which was compared in previous years was omitted in 1961 because it was being reseeded to alfalfa-grass. The renovation of this pasture consisted of three cultivations with the Glencoe Deep Tiller in the fall of 1960, followed this spring by fertilizer spreading, deep tilling, discing, harrowing and seeding with a cultipacker seeder. The seed mixture used was alfalfa, 6 pounds per acre; Alsike clover, 1; Lincoln brome, 6; and orchardgrass, 2. This was all seeded without a companion crop in the hopes that with some mowing early in the season, the new seeding might make good enough growth to give some grazing in mid-summer. Unfortunately, yellow foxtail, which is unpalatable, predominated in the mixture and so very little grazing was obtained. The use of an oat companion crop still appears to be the best method of establishing a stand on these pastures.

Beef production was measured from the grass pastures. For the manure treatments applications were made each fall. Commercial fertilizer used on the various treatments was applied in the spring. The rates of fertilization, manure and lime are shown in table 1.

Results - The beef produced per acre was 183 lbs., 270 lbs., and 287 lbs. respectively for the unfertilized, manure and nitrogen treatments. In returns per acre above costs, no spectacular differences were obtained. Steers on the pasture treated with manure returned $0.21 less per acre than the unfertilized, the nitrogen $3.53 more per acre. It should be noted that $9.60 per acre is being charged for the manure applied. Thus subtracting the 21 cent loss leaves $9.39 per acre return for the manure applied. After the weight date, September 6, the steers were placed back on these pastures for a few more weeks of grazing. Gains made during this period will register as return above costs.

Table 1. Beef produced from fertilized brome-timothy pastures on "G" (two-pasture rotational grazing system) May 23, 1961 to September 6, 1961. (106 days)

	Unfertilized	Fertilized	
		Manure a/	Nitrogen b/
	G 4 & 6 3.2 acres	G 1 & 7 3.2 acres	G 2 & 5 3.2 acres
No. steers at start	4 c/	6 c/	6 c/
Initial weight, lb.	679	678	680
Final weight, lb.	833	871	843
Total gain	585	864	919
Total steer days	324	536	536
Daily gain per steer/lb	1.81	1.61	1.71
Steer days per acre	101	168	168
Beef produced per acre	183	270	287
Value of beef produced per acre @$22.00 cwt.	$ 40.26	$ 59.40	$ 63.14
Fertilizer, lime and manure cost per acre a/ b/ d/	$ 0.97	$ 20.32	$ 20.32
Value beef produced per acre less lime, manure and fertilizer costs	$ 39.29	$ 39.08	$ 42.82

a/ Manure, 8 tons/acre annually, value $9.60. Also 300 lbs. 0-20-20 in 1957 and 200 lbs. annually since 1957. Annual 0-20-20 cost $9.75.

b/ Nitrogen, 80 lb. N/acre annually, cost $9.60. Also same amount 0-20-20 as on manure.

c/ Two steers removed 7/18/61.

d/ Lime, all pastures @ 3 tons per acre, cost $0.97 per year over 10 year period.

Table 1. The effect of cobalt bullets given steers on various fertilized pastures. May 23 to September 6, 1961. (106 days).

Treatment[a]	Control		Cobalt[b]	
Pasture	Av. daily gain, lb.	Beef prod. per acre, lb.	Av. daily gain, lb.	Beef prod. per acre, lb.
Fertilized leg & grass (A2, 3, C1)	2.07	371	2.22	400
Fertilized grass (B1, 2, F1)	1.77	301	1.89	320
Unfertilized grass (B3, 4, F2)	1.76	167	1.84	175
Manure on grass (G1, 7)	1.62	271	1.60	269
Nitrogen on grass (G2, 5)	1.65	276	1.78	298
Unfertilized grass (G4, 6)	1.67	169	1.94	197
Weighted averaged	1.82	272	1.94	290
Increase due to cobalt				
Average daily gain, lb.			0.12	
Beef produced per acre, lb.			18 (6.6%)	
Value of beef produced/acre @$22.00/cwt.		$59.84		$63,80
Increase in value due to cobalt				$ 3.96

[a] All steers implanted with 24 mg. stilbestrol 5/23/61.
[b] 20 gram cobalt bullets given 5/23/61.

Table 2. The effect of cobalt bullets on steers grazed on unfertilized and fertilized pastures. May 23 to September 6, 1961 (106 days).

	Control			Cobalt Bullets[a]		
Pasture	Unfert. grass (B3,4,F2)	Fert. grass (B1,2,F1)	Fert.leg.& grass (A2,3,C1)	Unfert. grass (B3,4,F2)	Fert. grass (B1.2.F1)	Fert.leg. & grass (A2,3,C1)
Acres	2.825	2.825	3.75	2.825	2.825	3.75
No. steers at start	3[b]	5[b]	7[c]	3[b]	5[b]	7[c]
Av. initial wt., lb.	692	667	671	668	692	688
Av. final wt., lb.	839	881	879	860	872	948
Total gain/pasture, lb.	472	849	1390	494	905	1500
Total steer days	268	480	676	268	480	676
Av. daily gain, lb.	1.76	1.77	2.07	1.84	1.89	2.22
Steer days/acre	95	170	180	95	170	180
Beef produced/acre lb.	167	301	371	175	320	400
Increase/acre due to cobalt, lb.(%)				8(5%)	19(6%)	29(8%)
Value of beef produced /acre @ $22.00/cwt.	$36.74	$66.22	$81.62	$38.50	$70.40	$88.00

a. 20 gram cobalt bullets given 5/23/61. b. 1 steer removed 7/18/61. c. 3 steers removed 8/15/61.

Table 3. Comparison of yearling steers grazed on unfertilized and fertilized pastures. May 23 to September 6, 1961 (106 days).

Comparison	Fert.grass (B1,2,F1) vs. Unfert.grass (B3,4F2)	Fert.leg.& grass (A2,3,C1) vs. Fert. grass (B1,2,F1)	Fert.leg.& grass (A2,3,C1) vs. Unfert.grass (B3,4,C1)
Increase due to:	Fertilization	Pasture Mixture	Fertilization and pasture mixture
Steer days/acre	75	10	85
Beef produced/acre, lb.	140	75	215
Value of beef produced /acre[a]	$ 30.69	$ 16.50	$ 47.19

[a] Estimated value of beef produced - $22.00/cwt.

THE EFFECTS OF COBALT BULLETS AND PASTURE FERTILIZATION ON BEEF PRODUCTION

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P. M. Burson, Soils; Ar. R. Schmid, Agronomy

Cobalt is one of the essential trace mineral elements required by the rumen microorganisms in the synthesis of vitamin B12. A deficiency of cobalt results in a deficiency of vitamin B12. The cobalt requirement of cattle is very small; 0.1 part per million (p.p.m.) in forages is considered sufficient. Certain areas in the United States, including parts of Minnesota, have been reported deficient in cobalt.

Recently 20 gram cobalt bullets composed of 90% cobalt oxide and 10% binding agent have become available for cattle. Since the bullet is heavy, when it is given with a balling gun it goes to the ramen and remains there, dissolving slowly and furnishing the rumen microorganisms with a continuous supply of cobalt. This method of supplying cobalt is particularly well adapted to studying the need for supplemental cobalt of cattle on pasture.

Fertilizing pastures in the Beef-Cattle Grassland project since 1953 (Mimeo B-29c) has resulted in increased: (1) carrying capacity; (2) beef produced per acre; (3) value of beef produced per acre. In only one year was the application of fertilizer unprofitable.

The objective of this experiment was to determine the effect of cobalt bullets on the performance of steers grazing unfertilized and fertilized pastures.

PROCEDURE

"Medium-to-good" grade yearling steers were lotted as uniformly as possible into three groups, each grazed in a three-pasture rotation (repeat of 1960 trial). Group I consisted of 6 steers (reduced to 4 steers after 56 days) on unfertilized brome-grass pastures (B3, B4, F2) totaling 5.65 acres; Group II consisted of 10 steers (reduced to 8 steers after 56 days) on fertilized brome-grass pastures (B1, B2, F1) totaling 5.65 acres; and Group III consisted of 14 steers (reduced to 8 steers after 84 days) on fertilized alfalfa-brome pastures (A2, A3, C1) totaling 7.5 acres.

In a series of trials on brome-timothy pastures totaling 3.2 acres in each group (partial repeat of 1960, B-36b), Group IV consisted of 4 steers (reduced to 2 steers after 56 days) on unfertilized pastures (G4 and G6); Group V consisted of 6 steers (reduced to 4 after 56 days) on pasture (G1 and G7) fertilized with manure; Group VI consisted of 6 steers (reduced to 4 after 56 days) on pastures (G2 and G5) fertilized with nitrogen.

Steers in these pasture trials were purchased at South St. Paul in May, 1961. All were implanted with 24 mg. stilbestrol when turned on to pasture May 23, 1961. One half were given 20 gram cobalt bullets at the same time.

RESULTS AND DISCUSSION

Giving 20 gram cobalt bullets to yearling steers on pasture increased average daily gain per head 0.12 lb. (1.82 to 1.94 lb.), beef produced per acre 18 lb. (272 to 290 lb.) or 6.6%, and value of beef produced per acre $3.96 ($59.84 to $63.80). See table 1.

The results of fertilizing pastures grazed by steers, one half of which were given cobalt bullets, are summarized in tables 2 and 3.

Fertilizing brome grass pastures increased: (1) the number of steer days per acre 75 (95 to 170) days or 79%; (2) the pounds of beef produced per acre 140 lb. (171 to 311 lb.) or 82%; and (3) value of beef per acre $30.69 ($37.62 to $68.31).

Using a legume and grass mixture increased: (1) the number of steer days per acre 10 (170 to 180) days or 6% (2) the pounds of beef produced per acre 75 (311 to 386) lb. or 24%; and (3) value of beef produced per acre $16.50 ($48.31 to $84.81).

Fertilizing a legume and grass mixture increased: (1) the number of steer days per acre by 85 (95 to 180) days or 89%; the pounds of beef produced per acre 215 (171 to 386) lb. or 126%; and (3) value of beef produced per acre $47.19 ($37.62 to $84.81).

Fertilizer Experiments on Park Kentucky Bluegrass Seed Production in Roseau County

P. M. Burson, J. M. MacGregor, & H. W. Kramer

Park Kentucky Bluegrass seed is produced on both organic and on mineral soils of Roseau County. Fertilizer effect on seed productinn on both of these soils has been studied for two years with variable effect.

A. Fertilization on Organic (peat) Soils

Two experimental fields were selected during the summer of 1959 and the first fertilizer treatments were made that autumn and comparable treatments were applied in the spring of 1960. No later treatments were made with the 1961 yields obtained and the residual yield effect was also observed in 1961. The yields for the two years are shown in the following table.

Table 1. The effect of different fertilizer treatments on the 1960 and on the 1961 yields of Park Kentucky Bluegrass on two peat soils of Roseau County.

Fertilizer Treatment (lbs/A)			Charles Habstritt deep peat-1959 seeding (Roseau)				Stanley Roadfeldt shallow-1957 seeding (Badger)			
N	P_2O_5	K_2O								
None			54	133	54	113	205	113	205	113
			Fert. fall '59		Fert. Spring '60		Fert.fall '59		Fert.spring '60	
			1960	1961	1960	1961	1960	1961	1960	1961
			Pounds of harvested grass seed per acre.							
0 + 80 + 0			167	327	237	371	382	192	300	195
0 + 80 + 80			196	255	242	259	349	229	334	229
30 + 80 + 0			164	247	218	272	327	202	387	179
30 + 80 + 80			197	265	146	370	306	140	372	216
60 + 80 + 80			128	268	255	257	377	177	409	173
90 + 80 + 80			250	248	221	247	331	223	365	144
40 + 20 + 80			186	220	179	220	-	-	-	-
33 + 33 + 33(winter)			173	203	173	203	279	-	279	-

The 33 + 33 + 33 (winter) applied was the form operator application of 12 - 12 - 12 at the rate of 275*/A.

Although the first half of 1961 was very dry, it is apparent that the additinn of phosphorus is the most profitable single element for the production of grass seed on these organic soils. Spring fertilization was apparently slightly more effective, probably due to the greater availability of the spring applied phosphorus. Potassium (potash) had the least or no effect.

Table 3. The Residual Fertilizer Response vs Additinal Nitrogen on Seed Yields of a Five Year Stand of Park Bluegrass on Mineral Soil. Halvorson Bros. Farm - Roseau County

Fertilizer Lbs./Acre N + P_2O_5 + K_2O	1961 - Yield Pounds per Acre		
	Residual Yield/A	Lbs. N applied Spring 1961 (1)	Residual plus N Yield/A
0 + 0 + 0	6	60	15
0 + 80 + 0 F	19	30	40
0 + 80 + 0 S	11	60	28
0 + 80 + 80 F	20	30	30
0 + 80 + 80 S	16	60	26
30 + 80 + 0 F	8	30	11
30 + 80 + 0 S	13	30	10
30 + 80 + 80 F	14	30	15
30 + 80 + 80 S	12	30	14
60 + 80 + 80 F	8	60	9
60 + 80 + 80 S	12	60	19
90 + 80 + 80 F	10	90	9
90 + 80 + 80 S	6	90	10

F - Fertilizer applied in Fall of 1959
S - Fertilizer applied in Spring of 1960
(1) Lbs. of N applied in spring of 1961 on one-half of each plot.

B. Fertilization of Park Kentucky Bluegrass on Mineral Soils

Several bluegrass fields on mineral soils were treated with different fertilizers in different ways or times of application to try and determine more efficient fertilization methods for grass seed production. The results are shown in the following two tables.

Table 2. The effect of fall or of spring fertilization (1959-60) of Park Kentucky Bluegrass on Mineral soil and additional Nitrogen Treatments in 1961 on 1960 and 1961 seed yields.
(Oliver Wold farm - Roseau)

1959-60 fert. treat. (lbs/A) N P_2O_5 K_2O	New Seeding in 1959. 1959-60 fertilization				Plus 1961 N fertilization[1]	
	Fall Fert.		Spring Fert.		Fall Fert.	Spring Fert.
	1960	1961	1960	1961	1961 Yield	
	Pounds harvested grass seed per acre.					
0 + 0 + 0	80	51	80	51	57 (60 N)	51
0 + 80 + 0	117	51	108	48	31 (30 N)	145 (60 N)
0 + 80 + 80	123	44	101	56	102 (30 N)	90 (60 N)
30 + 80 + 0	202	51	235	48	70 (30 N)	115 (30 N)
30 + 80 + 80	183	38	228	54	70 (30 N)	101 (30 N)
60 + 80 + 80	368	43	284	49	70 (60 N)	93 (60 N)
90 + 80 + 80	379	39	371	40	52 (90 N)	48 (90 N)

[1] Bracketed values refer to lbs. of N per acre applied in spring of 1961 on old treatments.

The 1960 seed yield was better with fall fertilization where minerals alone were used, but where nitrogen was included, there was a better effect from spring fertilization, and the addition of nitrogen was markedly effective when applied to these mineral soils - in contrast to its lack of effect when applied to the peat soils.

It was considered that a second nitrogen application in the spring of 1961 might be effective, and ammonium nitrate was broadcast on half of the 1959-60 plot area to supply either 30, 60 or 90 pounds of N per acre. With the drowth of 1961, the additional nitrogen increased seed yields considerably, with the heaviest rate (90 lbs. of N/A) producing the poorest results, and it is evident that additional nitrogen topdressing at high rates of application should be avoided in favor of lower rates.

A second field was a 5-year old stand of Park Bluegrass which is considered by farmers in the area as being "sod-bound". This experiment was also established in the fall of 1959. One series of plots was fertilized in the fall of 1959 and a second series was fertilized in the spring of 1960. In the spring of 1961 one-half of each plot was given an additional topdressing treatment of nitrogen so as to compare the residual response with three rates of nitrogen of 30, 60 and 90 lbs. per acre. The following yields give the residual response and the residual plus the nitrogen response. These yields mean very little because 1961 was a very dry year with a shortage of 5.75 inches of rain from April through August which is the critical period for grass seed production. Where the highest rate of N was used (90#/Acre) the seed yields were reduced.

A summary average of the yields of the three rates of N showed the 30 and 60 lbs. rates each produced 20 lbs. of seed per acre with the 90 lb. rate only 10 lbs. were produced as compared to 6 lbs. per acre on the check. Extreme drought was the greatest limiting factor for 1961.

After studying the effects of the fall of 1959 and spring of 1960 fertilization effect on the 1960 bluegrass seed yields, it was reasoned that possibly lowered rates of mineral fertilization might be more practical. A new experimental area was selected on the Clarence Wold farm near Roseau in the spring of 1961, and the phosphate - potash rates were reduced to 50% of those used in 1959-60. The results are shown in the following table. Since nitrogen had previously shown the greatest effect on mineral soils, it was used on all treatments in this experiment.

Table 4. The effect of spring fertilization (1961) of Park Kentucky bluegrass on Mineral soil on 1961 seed yield.

Fert. Treatment (lbs./A)			1961 Seed Yield lbs./A.
N	P_2O_5	K_2O	
0	+ 0	+ 0	39
40	+ 0	+ 0	83
80	+ 0	+ 0	93
40	+ 40	+ 0	94
80	+ 40	+ 0	110
40	+ 40	+ 40	95
40	+ 0	+ 40	100
40	+ 40	+ 20	104
80	+ 40	+ 40	101
80	+ 0	+ 40	84

It is evident that nitrogen is the most effective element for increasing seed yield, potash had little or no beneficial effect, and phosphate had a slight effect when applied along with the nitrogen. Although nitrogen doubled yields in all cases, the drowth of 1961 caused a serious yield reduction on all treatments.

C. Winter vs Spring Fertilizer Application on Park Bluegrass Seed Production.

A study was conducted in 1961 on time of application of fertilizer in the production of Park bluegrass seed. A number of farmers in Roseau County think that a winter application of fertilizer is the best. Two fields were selected on which 60 + 0 + 0 and 60 + 80 + 80 were applied in February on top of 2 ft. snow cover. This time of application was compared with an early April application of the same rates of nitrogen, phosphate and potash. These fields were located on the Clarence Wold and J. Magnuson farms. Both fields were on mineral soils and were on established Park bluegrass stands that had been in seed production for 3 of the past years. The question of fertilizer less frmm spring runoff has been raised when winter applications are made.

Table 5. Winter vs Spring Fertilizer Application

1961
Roseau County

Fertilizer Treatment (lbs./Acre)	Pounds of Harvested Seed Per Acre			
	February		April	
$N + P_2O_5 + K_2O$	Wold	Magnuson	Wold	Magnuson
0 + 0 + 0	53	39	53	39
60 + 0 + 0	60	43	115	66
60 + 80 + 80	77	97	113	52

The above data shows that 60 lbs. of N applied on the plots on the Wold field in February produced 60 lbs. of seed per acre as compared to 115 lbs. of seed when the fertilizer was applied in April. This is an increase of 55 lbs. of seed in favor of the spring applicatinn. On the same form where 60 + 80 + 80 fertilizer was applied similar results were obtained. The February application produced 77 lbs. of seed per acre as compared to 113 lbs. when the fertilizer was applied in April. This was an increase of 36 lbs. per acre in favor of the April application.

On the Magnuson field 60 lbs. of nitrogen per acre gave an increase of 23 lbs. of seed per acre in favor of the April application. However, with the 60 + 80 + 80 treatment the winter applicatinn produced 97 lbs. of seed per acre as compared to 52 lbs. from the April application.

It is possible that considerable fertilizer could be lost from spring runoff when fertilizer is applied in the winter on a deep snowfall, as were the conditions here in Roseau County in 1961. If the snowfall is light and field conditions are satisfactory for machine operations and there will be no rapid spring runoff, winter may be a satisfactory time to apply the fertilizer.

The Effect of Fertilizer on Yield of Climax Timothy Seed 1960-61

Paul M. Burson, J. M. MacGregor, & H. W. Kramer

Roseau County is fast becoming a grass seed producing area which includes both Park bluegrass and Climax timothy. This northern area of Minnesota is well adapted for the production of these grass seed crops. Grass such as timothy is a basic part of a permanent agriculture for this area. Timothy fits into a forage program. It is an excellent grass crop in mixtures with alfalfa, medium red clover and alsike clover for hay or for pasture. It has a wide range of soil and fertility adaptation and is very palatable for livestock as either hay or pasture. About 5,000 acres of timothy are now being grown in Roseau County for seed production.

In the Fall of 1959 three fields were selected to study the effect of fertilizer on timothy seed production. The two fields selected in Roseau County were on the Clifford Foss and the B. J. Borgen farms while the third was the Andrew Skaar farm in Pennington County. The fertilizer treatments included 80 lbs. of P_2O_5 alone and in combination with 80 lbs. of K_2O with 30, 60, and 90 lbs. of actual nitrogen per acre. On the Borgen and Skaar fields the treatments were applied in the spring of 1960. On the Foss fields the same treatments were applied in the fall of 1959 and on adjacent plots in the spring of 1960. The purpose here was to determine if there was any difference between fall and spring application.

The following table gives the seed yields from the various fertilizer treatment combinations for the years 1960 and 1961. The year 1961 should not be considered as a representative year because of the severe drought from April to September with the rainfall being 5.75 inches below normal during this period. Timothy is not a productive crop during extreme dry periods, and is better adapted to cool moist conditions typical of the usual growing conditions of northern Minnesota. The yield results for 1960 might be considered as quite representative of what could be expected from the fertilization of timothy for seed production.

In 1960 the seed yields ranged from 159 lbs. on the unfertilized soil to almost 900 lbs. with a 90 + 80 + 80 treatment. Spring fertilizer applications gave the greater increase in seed production with an average yield of 531 lbs. in comparison to 431 pounds when fertilized in the fall.

Timothy is not subject to as much lodging as some other grasses or grain crops. Some lodging did occur on the 90 lbs. rate of nitrogen plots, however.

On the basis of the present information 60 lbs. of N appears to be adequate in seed production with little or no danger of lodging. For phosphate and potash needs, the soil test should be the basis for this determination, the same as for any other crop.

Timothy Seed Yields 1960-61

Fertilizer (lbs/acre)	Lbs. per acre - 1961			Lbs. per acre - 1960	
	Skaar[1]	Foss[2]	Borgen[1]	Skaar[1]	Foss[2]
Check	63	56	76	225	159
0 + 80 + 0	141	102	119	235	177
0 + 80 + 80	111	105	104	226	173
30 + 80 + 0	134	70	139	568	494
30 + 80 + 80	121	68	113	634	505
60 + 80 + 80	100	80	144	815	710
90 + 80 + 80	103	62	145	892	823
Ave. Inc. Fall	---	80	---	---	431
Spring	---	82	---	---	531

1 Fertilized Spring, 1960

2 Fertilized Fall, 1959 and Spring, 1960 (Yields include spring and fall treatments) 1961 very dry.

Lake of the Woods County Potato Fertility Demonstration - 1961

Merle Halverson, John Grava and Otto Lee*

Location: John Knutson farm, Graceton, Minnesota

Soil Test Information: Values given represent the range (lowest and highest of six samples taken from the demonstration area.

Texture: loamy sand
Percent organic matter: 2.8 to 4.8 (medium)
pH: 8.1 to 8.3 (alkaline)
Extractable phosphorus, lb/A: 17-21 (medium)
Exchangeable potassium, lb/A: 35-60 (very low)

1960 crop: Oats (fall plowed). No manure.
1959 crop: Flax.

Variety: Irish Cobbler

Crop Details: Between-row spacing: 40 inches
Planting date: June 3
Harvest date: September 25.
Individual plot size: 13 feet 4 inches
(4 rows) x 30 ft. = 0.00918 acres
Area harvested from each plot: 6 feet 8 inches
(center 2 rows) x 25 feet.

Rainfall Data: (Baudette), February-August

	Average, 1931-55 inches	1961 inches
February	0.65	0.38
March	0.84	0.20
April	1.34	0.95
May	2.06	0.53
June	3.69	1.01
July	3.34	3.85
August	3.44	1.49
TOTALS	15.36	8.41

Deficit, February-August 1961 6.95 inches

Demonstration:

(a) Nitrogen (as ammonium nitrate) was broadcast before planting and disced in. 4 rates (0, 40, 80 and 120 lbs of actual nitrogen per acre) were used.

(b) Phosphate (as 0-45-0 concentrated superphosphate) was band placed through the planter attachment. One rate (120 lb. actual P_2O_5) was used throughout to assure a uniform and adequate phosphate supply.

(c) Potash (as 0-0-60, muriate of potash) was broadcast before planting and disced in. 5 rates (0, 60, 80, 120 and 240 lbs. K_2O per acre) were used.

Note 1. Each of the 5 potash rates was used in combination with each of the 4 nitrogen rates, resulting in a total of 20 treatments per series. This series was replicated 3 times, making for a total of 60 plots in the complete demonstration.

Note 2. Two 50 foot lengths of double row receiving no fertilizer were harvested and the resulting yield compared with the average yield from 3 plots treated with 120 lb./acre of phosphate only. Because fewer observations were used in estimating this yield increase, it is not as reliable an estimate of true yield as the nitrogen and potash figures, where 15 and 12 observations, respectively, were used to estimate each yield.

Note 3. The following measurements were made:

a. Yield (cwt/A) of No. 1 (more than 2" in diameter) tubers.
b. Yield (cwt/A) of Size B (less than 2" in diameter) tubers.
c. Specific gravity (hydrometer method).

Results:

TABLE 1
Effect of phosphate using no nitrogen or potash

Rate, lb. P_2O_5/acre	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	53.4	16.4	1.087
120	77.2	11.3	1.086

TABLE 2

Effect of nitrogen on yield of No. 1 and Size B tubers, and on specific gravity. (each figure is an average from 15 separately harvested plots receiving the indicated nitrogen rate).

Nitrogen rate lb. N/A	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	98.0	11.2	1.088
40	109.9	11.6	1.089
80	108.8	12.5	1.089
120	108.9	10.0	1.091

TABLE 3

Effect of potash on yield of No. 1 and Size B potatoes and on specific gravity. (Each figure is an average from 12 separately harvested plots receiving the indicated potash rate.)

Potash rate lb. K_2O/A	Yield of No. 1 tubers, cwt/A	Yield of size B tubers, cwt/A	Specific gravity
0	75.3	13.6	1.089
60	100.3	11.8	1.090
80	113.1	10.8	1.090
120	121.1	10.2	1.090
240	122.1	10.1	1.091

TABLE 4

Cost of - and return to - best nitrogen and potash rates

Nutrient	Rate, lb./A	Cost dollars/A	Yield increase Cwt/A of No. 1 tubers
Nitrogen (N)	40	$6.00	11.9
Potash (K_2O)	120	$6.00	45.8
	Totals	$12.00	57.7

Interactions

No significant interaction effects between nitrogen and potash were observed. This means that the effect of potash on yield was about the same regardless of which nitrogen rate was used. Conversely, it says that the influence of nitrogen on yield was much the same at each of the several potash rates.

Remarks:

In evaluating these date, it is well to keep in mind that they are the product of particular combination of soil, season, moisture condition, and variety. It is quite possible that under a different set of conditions, the effect of nitrogen and potash may have been more or less favorable. However, the serious moisture deficit in Lake of the Woods county this season would suggest, if anything, that even greater increases might be expected on this soil in a season more normal with respect to rainfall amount and distribution.

(a) Yield of No. 1 Potatoes

(1) Phosphate effects:

The one phosphate rate used (120 lb. P_2O_5/A) resulted in an apparent yield increase of 23.8 cwt. (39.6 bu) per acre. (see Table 1). As noted previously, this apparent difference is not as reliable as those due to nitrogen and potash, because fewer plots were used in arriving at the yield estimates.

(2) Nitrogen effects: (see Table 2)

The initial 40 lb./A nitrogen application produced an apparent yield increase of 11.9 cwt. (20 bu) per acre. The second and third 40 lb./A nitrogen increments did not result in further yield increases. Accordingly, we would conclude that 40 lb. N per acre was as effective as any higher rate under these conditions of placement, moisture supply, soil, season and variety.

(3) Potash effects:

The first 60 lbs./A of potash gave a yield increase of 25.0 cwt. (41.7 bu) per acre. Increasing the potash rate from 60 to 80 lbs. K_2O/A resulted in an additional yield increase of 12.8 cwt (21.3 bu) per acre. Changing the potash rate from 80 to 120 lbs. K_2O per acre boosted yields still another 8.0 cwt. (13.3 bu) per acre. Further yield increases failed to occur only when the potash rate exceeded 120 lbs. K_2O per acre.

It is obvious that potassium was present in extremely short supply on this soil. The return to 120 lbs. K_2O per acre was 45.8 cwt. (76.3 bu.) per acre. It is significant that our soil test procedures (see page 1) were able to describe in advance of planting this very low soil potassium condition.

(b) Yield of Size B (less than 2" in diameter) potatoes

There was a strong tendency for potash to decrease the yield per acre of size B tubers. A variance analysis of the data shows this effect to be significant at the 90 per cent confidence level. Nitrogen, however, had no particular favorable or unfavorable effects upon the number of small tubers produced.

(c) Specific Gravity

In previous demonstration work on soils more adequately supplied with potassium, small but consistent reductions in specific gravity of the tubers has occurred with increasing rate of potash application. The effect of nitrogen has been variable depending upon the soil and season.

Tables 2 and 3 show that neither the nitrogen or potash fertilizers had any adverse effect upon tuber specific gravity in this work.

There is some evidence in the literature to show that potash fertilizers will not seriously reduce tuber specific gravity when used on soils poorly supplied with potassium. It is also possible that the extremely dry season had something to do with failure of this effect to show up in the present work. It would be well to see data from a season of more nearly normal moisture supply before drawing firm conclusions about these effects as they might apply on low potassium soils.

(d) Cost - return relationships

In Table 4 the most profitable rates of nitrogen and potash are shown, together with their costs and the yield increases they produced. Growers with a knowledge of harvesting and handling costs and current potatoes prices can apply such information to the figures in the table and arrive at estimates of the net return per acre and and per dollar spent due to use of nitrogen and potash on this soil.

The phosphate effects are not listed in Table 5. This is because the yield increase due to phosphate was measured less precisely than the nitrogen and potash effects. There is, however, good reason to suppose that the phosphate rate used was an economical one. Figuring phosphate at $0.10 per pound, the 120 lbs. per acre rate used would cost $12 per acre. With potatoes worth as little as $1 per hundredweight, our apparent yield increase due to phosphate (23.8 cwt/A could be considerably in error and still enable the grower to more than break even on its cost.

The authors are indebted to the John Knutson family for their generous cooperation in providing the land, labor, and equipment necessary to establish and care for the demonstration area. They are also grateful to Dr. O. C. Turnquist, Extension Horticulturist, who provided the data on specific gravity, and to Dr. R. D. Munson, American Potash Institute, for his capable assistance at harvest time.

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Fertility Studies on Organic Soils at Hollandale, 1961

by R. S. Farnham

The fertility studies on organic soils at Hollandale begun in 1960 were continued in 1961. The object of these studies was to compare the effect of several rates and grades of commercial fertilizers on the yield and quality of Cobbler potatoes.

The plot area in 1961 was about 1/2 mile west of the 1960 site on the same type of organic soil. The pH of this soil varies from 7.0 to 7.3 and extractable P (Bray No. 1) by soil test was very high (170-200+ lbs/acre) and extractable K was very high (500-600+ lbs/acre). The plot area was tiled.

The design was a randomized block split plot including four replicates. Three fertilizer grades 0-20-20, 4-12-36, 0-12-36 were applied broadcast in late May prior to seeding at 0, 300, 600 and 900 pounds/acre rates. The plots were harvested October 20th and total yields of tubers and specific gravity data are shown in Table 1.

The highest yields were obtained using the 900 pound rate of all the grades with yield increases as high as 62.4 hundred weight in case of 900 rate of 0-20-20. Responses to both potash and phosphate are indicated - nitrogen doesn't appear to give any increases.

In 1961 the 0-20-20 grade having a 1 to 1 P to K ratio is just as effective as the 4-12-36 grade containing a 1 to 3 P to K ratio.

It is of interest to note that these high yield responses are obtained despite the very high soil test values for both phosphorus and potassium

Specific gravity does not seem to be effected by either rate or grade of fertilizer. The high rates of potassium did not materially decrease the specific gravity this year as in 1960.

In a comparison of extracting solutions for soil test phosphorus it was found that water extractable phosphorus values are about 1/10 the values when Bray's No. 1 extracting solution (NH_4F and NH_4Ac) was used. Since there seems to be a response to phosphorus as well as potassium it is suggested that the Bray No. 1 soil test for phosphorus is not too accurate. Water extractable phosphorus content correlates better with yield responses to added phosphorus than does the Bray No. 1 test. Further work along these lines is planned for next year.

Soil test correlation studies with yield responses on various organic soils are planned for several different areas of the state.

Table 1. Yield and Specific Gravity of Cobbler Potatoes on an Organic Soil at Hollandale, 1961.

	0-20-20		4-12-36		0-12-36	
Rate lbs/acre	Yield cwt/acre	Sp. Gr.	Yield cwt/acre	Sp. Gr.	Yield cwt/acre	Sp. Gr.
0	312.2	1.062	312.2	1.063	366.6	1.061
300	350.6	1.059	320.1	1.065	332.5	1.059
600	355.7	1.062	336.8	1.066	326.7	1.063
900	374.6	1.064	373.9	1.061	371.7	1.065

Structure Nitrogen Study

G. R. Blake and J. M. MacGregor
O. C. Soine, J. R. Thompson, & L. E. Ahlrichs

A. Crookston. Structure effects are measured only each third year as all rotations are in wheat. In 1961 only fertilizer effects are measured as shown in the table.

	No fertilizer	20+40+20	100+40+20	L.S.D.
	Corn after Wheat			
Bu./A (15.5% moisture)	77.4	89.0	87.1	7.2**
% H_2O in grain	52.9	51.6	51.1	N.S.
Shelling %	71.7	74.2	71.3	N.S.
	Continuous Wheat			
Bu./A	17.3	27.8	31.2	11.1**

B. Morris

Corn Yields, bu./A

Seedbed preparation Handling residues plow fall or spring	0-40-40	40-40-40 fall	40-40-40	80-40-40	240-40-40	Ave.
Minimum - chop - spring	21.1	49.8	45.3	41.6	48.5	41.3
Minimum - Not chop - spring	46.6	47.3	50.6	45.7	42.4	46.5
Minimum - chop - fall	35.0	42.4	49.2	48.7	45.3	45.3
Conv. - chop - fall	32.6	55.3	51.1	42.9	44.9	44.9
Field cultivator - chop - fall and spring	26.1	46.8	41.8	46.2	41.4	41.4
Average	32.3	48.3	47.6	45.0	46.1	----

L.S.D. fertilizer 9.3 (99%); Tillage, Not significant
A residual effect of old experiment (Minn. Ag. Expt. Station Bul. 448, 1958) was shown at 95% level. This is believed to have no meaning because of a bias in the old experiment due to location with respect to slope. It is evident that the application of nitrogen at the rate of 40 pounds per acre was highly effective for increasing corn yields and higher application rates failed to increase corn yields further.

C. Waseca

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G. R. Blake and J. M. MacGregor
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C. Waseca

Subsoil Regeneration Study
Lamberton, 1961

G. R. Blake and W. W. Nelson

Deliberate soil packing in earlier years has been observed to persist indefinitely in horizons not loosened by the plow. An experiment was established in 1960 on Nicollet silty clay loam to study this persistence in a field situation. Variables include

a) Packing 9-24 inches vs no packing
b) Crop: corn vs alfalfa
c) Soil water content during winter: (2 levels).

Packing was done with 4 passes of a tractor-mounted packing wheel weighing 5600 lbs. giving pressures at 9" of the order of 100 to 200 lbs. $inch^{-2}$. Packed zone extended to about 22 inches below the surface.

Packing in 1960 reduced corn yields 7%, corn forage 10%, and oat-alfalfa forage 29%.

Packed layers persisted in 1961, essentially unchanged from 1960, as shown by bulk density profile samples taken at 4 inch intervals to 40 inches deep. However, treatment differences had no significant effect on yields of corn, corn silage, or alfalfa hay. Corn yields averaged 122 bushels.

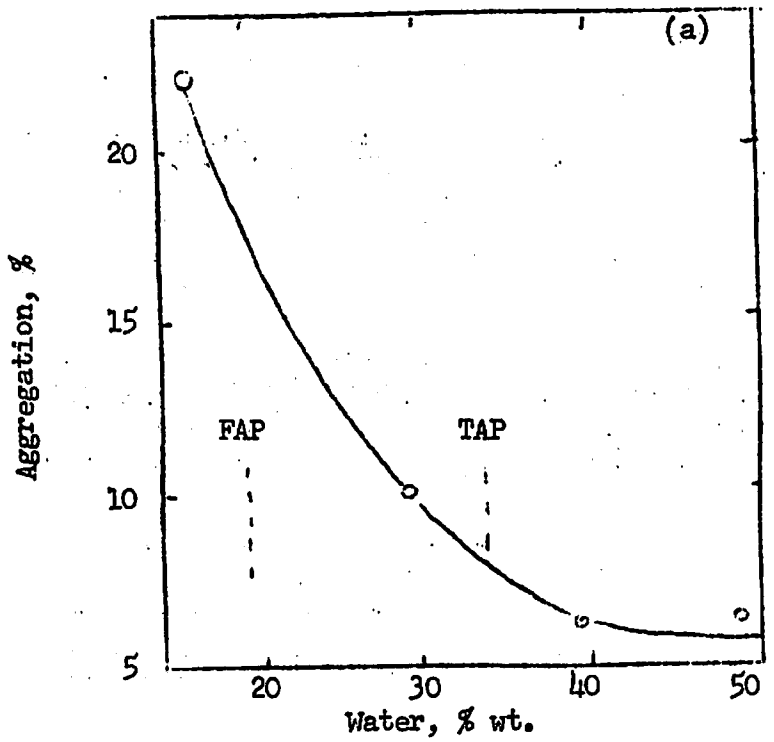
Date Cut	Date Book Reference	Packed		Not Packed	
		Irrigated	Not Irrigated	Irrigated	Not Irrigated
	Alfalfa (lbs./A at 20% moisture)				
June 9	19:19;89-92	2378	2686	3013	3086
July 28	19:94-98	4120	4011	3993	4138
September 6	19:104-113	2385	2258	2513	2461
	Corn fodder (T./A @ 67%; grain Bu./A @ 15.5% moisture)				
Fodder	19:105,110	24.5	21.4	23.9	25.6
Corn	19:106,112	125.8	127.2	115.1	119.0
Corn (% H_2O at harvest)	19:106,118	26.7	24.4	26.9	29.6

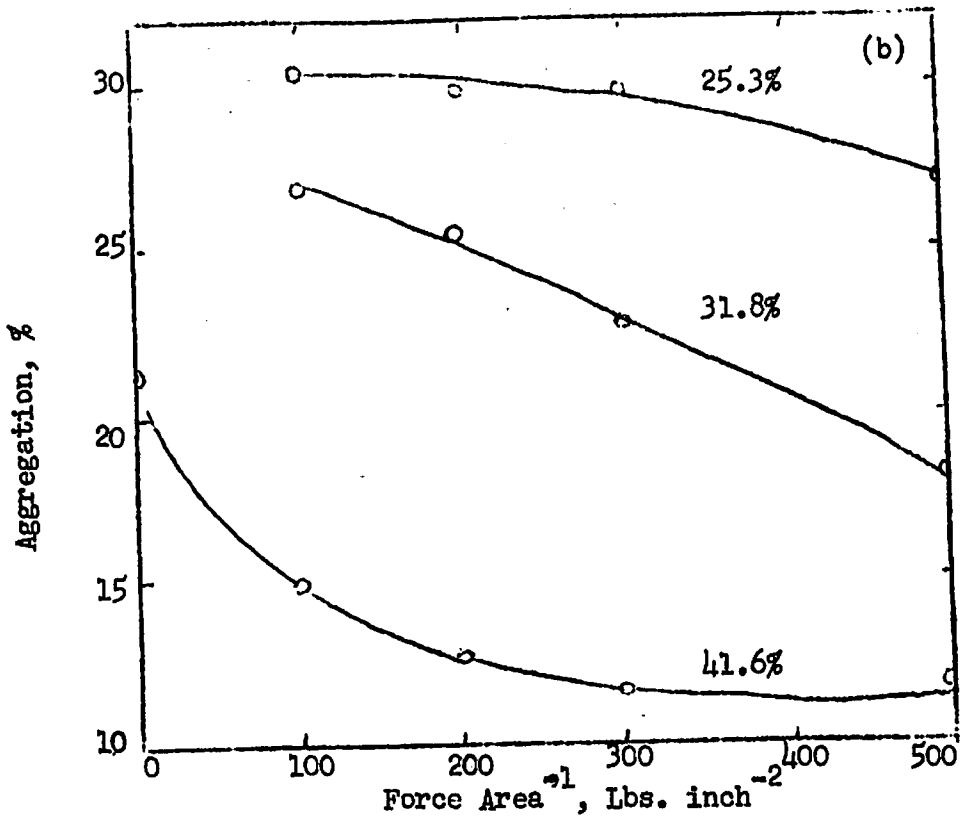
Differences not significant.

Compaction and Soil Structure
St. Paul, 1961

D. Seefeldt and G. R. Blake

Aggregate Stability, Webster Silty Clay
(a) Forced through 2.5 mm holes, air dried, wet sieved with 2 and 0.5 mm sieves.
(b) Forced into $\frac{1}{4}$"x$\frac{1}{4}$" cylinders at moisture content shown, air dried, wet sieved.





Soil Compaction and Nutrient Uptake
St. Paul 1961

E. Bonnie-Baffoe & G. R. Blake

Phosphorus and potassium content of above-ground plant parts were determined in 1957 and 1958 on plants grown on packed and unpacked soils. P and K were usually decreased by packing and N was often increased. However, these changes were by no means consistent with crop, soil type, nor year.

As a follow-up, small plots were established in 1961 at 4 bulk density and 2 moisture levels with corn and sorghum. A new technique was used (Stanford, G. and J. D. DeMent, SSSA Proc. 21:612. 1957) in which plants were germinated in sand cultures low in the element to be tested. After plant emergence, the whole culture was transplanted to the test plot and nutrient absorption measured by partial harvesting at approximately 2-week periods.

In the present experiment 30 X 30 inch plots were surface packed to 4 bulk density levels with a hand tamper. Four pots of each crop were placed on each plot. Corn pots contained 10 plants, sorghum 30 plants, initially. Plants from 2 pots were harvested the 9th, 23rd and 37th day after setting on the field plots.

Analysis for P and K are essentially complete but data are not yet analyzed.

Seedbed Preparation for Potatoes
Grand Forks

G. W. French & G. R. Blake

The two chief purposes of seedbed preparation for corn, on northern soils that do nut crust, are hypothesized on the basis of field tests, to be;

(a) to increase soil temperatures by removing residues, and,
(b) to insure seed-soil contact (germination).

Neither of these conditions was necessary for potatoes in 1961 tests on Bearden silty clay loam where potatoes following wheat with no tillage produced as well as with any of 4 other treatments.

Green Manure Evaluation Study
Crookston 1961

G. R. Blake and O. C. Soine
A. R. Schmid

Green Manure	No Fertilization	0-40-0	Average
Continuous Wheat			
Check	13.6	20.8	17.3
Orchard Grass	14.2	17.3	15.7
Madrid Sweet Clover	16.2	22.4	19.3
Vetch	16.4	28.0	22.2
Vernal Alfalfa	16.4	27.2	21.8
Average	15.3	23.1	
Wheat in Wheat-Fallow Rotation			
Check	39.1	42.9	41.0
Orchard Grass	38.2	45.0	41.6
Madrid Sweet Corn	36.8	43.0	39.9
Vetch	37.3	48.8	48.8
Vernal Alfalfa	44.3	50.9	47.6
Average	39.1	46.1	

L.S.D:	Green Manure	4.3 Bu. (0.05)
	Rotation	5.7 Bu. (0.01)
	Fertilizer	3.3 Bu. (0.01)

Effect of Nitrogen rate and Method of Placement on Yield and Quality of Wheat in the Red River Valley

R. D. Curley, Curtis Klint, Carl Ash, and Marlin Johnson*

Demonstrations were conducted in Norman and Polk counties during 1961 for the primary purpose of showing fertilizer dealers, county agents and farmers (1) comparative effects of various rates of nitrogen application on yield and germination of wheat by broadcast and drill application and (2) correlate stored soil moisture at planting time with yield response from applied nitrogen.

Five sites were selected - 2 in Norman county and 3 in West Polk county. The sites were selected on the basis of soil texture - 3 were silty clay loams and 2 fine sandy loam soils. The approximate location of the plots and the general soil textures are as follows:

Hermandson farm - about 10 miles south of Crookston - silty clay loam
Ness farm - about 2½ miles west of Ada - silty clay loam
Sewill farm - about ½ mile south of Harold - fine sandy loam
Scott farm - 5 miles north and 3 miles east of Ada - fine sandy loam
Vanya Farm - north west corner of W. Polk county - silty clay loam

All plots were planted with a 6 foot grain drill beginning on April 21 at the Ness farm, April 29 at the Scott farm, May 3 at Hermandson and May 4 at the Sewill farm. Each treatment was replicated 3 times in a simple randomized block design using reps as blocks. Treatments consisted of five rates of nitrogen (30, 40, 50, 60 and 80#/acre) applied as (1) broadcast, (2) with the seed, and (3) split drill and broadcast placement methods. TVA ammonium nitrate and granular 54% concentrated superphosphate were used as the nitrogen and phosphorus sources on the broadcast and drill methods of placement plots. In each of these 2 methods, 30# of P_2O_5 were placed with the seed. The split drill and broadcast placement was achieved by applying 10# of N through the drill spout with the seed as diammonium phosphate 16-48-0 grade supplemented with additional broadcast ammonium nitrate after planting to get the desired rate of total nitrogen. Thus with the latter method results are confounded with forms of both N and P. Comparison of this method with the other two should not be made. The fertilizer attachment was calibrated for each treatment prior to planting.

Soil moisture and various chemical determinations were made inthe laboratory by Dr. Ralph Young, North Dakota State University, and by Dr. John Grava, University of Minnesota. Soil samples to a depth of 4 feet were taken from five spots within the over-all site area at each of the 5 locations. The Vanya plots in the northwest corner of West Polk county were not harvested. Extreme drought during June, July and August prevented sufficient plant growth for yield measurements. However, for purposes of providing complete chemical and moisture characterization for future reference the chemical and moisture data are reported for all five locations in series Tables 1 and 2.

Table 3 contains the yield data for all five locations. Tables 4 and 5 contain the yield data and baking quality of the wheat for the Scott and Ness farms, respectively. Tables 6 and 7 contain yield responses only for the Hermandson and Sewill farms, respectively.

Sedimentation tests have not been made on the wheat from the Sewill and Hermandson farms to date. Sedimentation values are a measure of the baking quality of wheat. For detailed information concerning the test contact the Crop Quality Council, Minneapolis or the USDA, ARS. To give the reader some indication of the proposed market value of higher sedimentation scores see table 8. Table 9 shows the relation between % protein and sedimentation values as determined by USDA.

Table 1. - Soil moisture characterization data of the soils at each of five locations in Norman and Polk counties.

Depth (ft.)	Texture	Relative[1] Carbonates Level	Conductivity	Soil moisture characterization: Seeding time	1/3 atmos.	15 atmos.	Avail. water	Maximum water hldg. capacity
				....percent....				acre inches
NESS FARM								
0-1	SiCl	3	70	30.79	41.98	21.14	1.36	3.03
1-2	"	3	114	24.70	31.91	16.07	1.29	2.47
2-3	"	3	163	23.64	30.60	12.62	1.75	2.85
3-4	"	3	190	28.14	35.08	14.18	2.47	3.69
							6.87	12.04
HERMANDSON FARM								
0-1	SiCl	2	58	32.14	41.39	20.92	1.59	3.03
1-2	Clay	3	81	24.63	36.37	17.93	1.05	2.86
2-3	Clay	3	154	20.49	34.27	17.24	0.52	2.70
3-4	Clay	3	172	24.46	31.36	14.56	1.22	3.32
							4.38	11.91
SCOTT FARM*								
0-1	FSL	3	33	22.37	19.42	8.32	1.70	2.15
1-2	"	3	24	19.78	15.19	7.59	1.19	1.90
2-3	"	3	20	15.89	6.98	2.60	0.71	2.19
3-4	"	3	23	19.46	5.49	1.82	0.65	3.12
							4.25	9.36
SEWILL FARM								
0-1[a]	VFSL-SiL	3	41	22.47	25.24	11.27	1.65	2.06
1-2[a]	FSL-C	3	44	21.92	22.77	11.22	1.67	1.81
2-3[a]	SL-C	3	76	18.67	21.56	10.93	1.26	1.70
3-4[b]	SiCl-C	3	147	24.61	30.95	15.81	1.55	2.68
							6.13	8.25
VANYA FARM								
0-1	SiL-Si Cl	2	78	25.07	38.86	18.64	1.31	2.87
1-2	Si Cl	3	85	18.35	33.07	15.36	0.47	2.76
2-3	C	3	103	19.74	34.69	16.16	0.57	2.94
3-4	Si C - C	3	117	25.30	39.24	19.44	1.03	3.50
							3.38	12.07

* Values are average of three soil sample borings

1/ 0 = None present
1 = Low amounts present
2 = Medium amounts present
3 = High amounts present

a/ values are average of 5 soil sample borings

b/ values are average of 4 soil sample borings

Table 2 - Chemical Characteristics of the Soils at Five Locations

Depth (ft)	Texture 1/	#NO_3 -N per acre	# P/acre $NaHCO_3$	# P/acre Bray #1	# P/acre Bray #2	Exchangeable K (#/acre)	O.M. (%)	pH
NESS FARM								
0-1	SiCl	39.6	26	23	54	540	5.0	7.9
		.... 61.6						
1-2	"	22.0	6	4		310	1.8	8.2
2-3	"	20.8	3	3		320	0.9	8.2
3-4	"	20.0	2	3		370	0.7	8.1
HERMANDSON FARM								
0-1	SiCl	95.6	11	14	74	600	5.1	7.9
		.... 155.2						
1-2	Clay	59.6	4	5		510	2.3	8.1
2-3	Clay	48.8	3	3		440	1.3	8.1
3-4	SiCl-C	39.6	3	2		400	0.7	8.1
SCOTT FARM								
0-1	FSL	96.4	14	6	0	120	3.9	8.2
		....133.6						
1-2	"	37.2	3	9		70	1.3	8.6
2-3	"	24.8	2	6		40	0.5	8.7
3-4	"	28.4	1	4		40	0.3	8.8
SEWILL FARM								
0-1	VFSL-SiL	84.4	15	10	25	290	4.1	8.3
		.... 117.2						
1-2	FSL-C	32.8	5	5		260	1.4	8.6
2-3	SiL-C	30.8	4	4		280	0.9	8.4
3-4	SiCl-C	26.0	3	3		450	0.8	8.1
VANYA FARM								
0-1	SiCl	111.2	23	31	162	1180	5.4	7.8
		.... 192.8						
1-2	SiCl	81.6	8	6		570	1.8	8.1
2-3	C	60.0	4	3		480	1.2	8.1
3-4	SiC-C	40.0	3	4		490	0.9	8.0

1/ Soil texture abreviations

Si cl	= silty clay loam	Si L	= silt loam
VFSL	= very fine sandy loam	Si C	= silty clay
FSL	= fine sandy loam	C	= clay

Table 3. Effect of rate and method of nitrogen placement on yield of Selkirk wheat at four locations in the Red River Valley (1961)

lbs N/acre 1/	NESS Method of placement: 2/ #1	#2	#3	HERMANDSON Method of placement: #1	#2	#3	SEWILL Method of placement: #1	#2	#3	SCOTT Method of placement: #1	#2	#3
	yields bu/A			yields bu/A			yields bu/A			yields bu/A		
30	48.5	50.2	50.3	22.7	20.4	23.5	19.0	15.4	22.9	22.7	20.4	26.9
40	3/	60.0	55.3	22.3	23.9	22.7	19.0	19.1	18.0	22.5	25.3	23.1
50	66.0	58.8	60.6	22.9	24.3	24.7	14.4	17.5	22.5	21.2	20.7	24.1
60	64.2	64.9	58.9	24.9	26.8	26.3	20.9	22.9	18.2	20.6	21.5	24.0
80	60.1	59.5	53.7	22.9	22.5	22.7	16.1	20.8	19.2	16.2	18.1	19.7
CHECK 4/	39.9			21.5			14.8			17.1		
SOIL TEXT.	silty clay loam			silty clay loam			fine sandy loam			fine sandy loam		

2/ #1 - all nitrogen applied with the seed at planting time
#2 - all nitrogen broadcast and harrowed in after drill
#3 - 10 lbs of N with the seed plus broadcast N up to desired level

1/ Source of N and P -
Methods of placement #1 and #2 - ammonium nitrate & concentrated superphos (54
Methods of placement #3 -------- 10+30+0 with seed at planting time as 16-48-0 grade diammonium phosphate plus supplemental BC nitrogen as ammonium nitrate immediately after planting.

3/ Treatment missing due to error in planting

4/ Check plots received 0+0+0 treatment; all plots of methods 1 & 2 received 30# P_2O_5 with the seed.

Table 4. Yield response and sedimentation values as affected by method of placement and rate of nitrogen application at Scott farm. (fine sandy loam soil)

Method of nitrogen placement	Nitrogen rate (#/acre) Check	30	40	50	60	80
	.....yield - bu/acre.....					
1	17.1	22.7	22.5	21.2	20.6	16.2
2		20.4	25.3	20.7	21.5	18.1
3		26.9	23.1	24.1	24.0	19.7
Average of 3 methods -		23.6	23.6.	22.0	22.0	18.0
Average of #1 & 2 -		21.6	23.9	21.0	21.0	17.2
	....sedimentation values.....					
All 3 methods combined	48(ck)	62	62	62	63	66