A SUMMARY OF 1979 and 1980 SOIL FERTILITY RESEARCH IN THE DELTA—CLEARWATER AREA OF ALASKA

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INTRODUCTION

During 1979 and 1980, soil fertility research was conducted at two locations in the Delta-Clearwater area. One of the test sites, Lee Fett's Farm, was cleared in the mid-1950s and has been in production for about 25 years. The other test site is situated on a tract of newly cleared land owned by Dennis Green. The new lands site was cleared by the traditional berm-pile method during the winter of 1978-79. This method removes much of the moss layer, and in some cases, part of the topsoil. Land cleared by this procedure is lower in natural fertility, but has the advantage of enabling the farmer to plant a crop the first summer after clearing.

In this publication, progress reports are given for several research projects involving fertilizer use and rates of application.

WEATHER SUMMARY FOR THE 1979 AND 1980 GROWING SEASON

Climatic data for the 1979 and 1980 growing season at Delta Junction are summarized in Table 1. Temperature and precipitation values given in parentheses represent long-term averages and are useful in determining the degree of normality for the two growing seasons. The Delta Junction weather station is located approximately 10 and 15 miles from the two test sites in the area.

THE 1979 GROWING SEASON

Although there was considerable deviation from the norm for individual months, total precipitation for the growing season at Delta Junction was nearly normal. For May through September, Delta Junction received a total of 9.21" compared to 9.04" for the long-term average. Precipitation for the month of May was almost nil but rainfall during the prime-growth months of June and July was above normal. Crops planted where surface soil moisture supplies were sufficient for seed germination and early growth produced exceptional yields. The early season drought caused deeper rooting of seedlings, enabling the plants to draw upon a more extensive supply of soil nutrients when the midseason rainfall was ample.

Growing-season temperatures were above average for May, July, August, and September. Daily maximum temperatures for June, the only cool month, averaged about 2^0 F below normal. The unseasonably warm temperatures experienced in August and September, together with below-normal rainfall, produced highly favorable conditions for ripening and harvesting of crops. These conditions were particularly favorable for late-maturing crop varieties and for late-planted crops which, under normal conditions, would not fully mature and would fail to dry out in the field.

The 1980 Growing Season

Total precipitation for the 1980 growing season, May through September, was below normal at the Delta Junction recording station. Overall, this station had a 1.64" deficit in rainfall which amounted to about 18% of its 9.04" seasonal average. During the 5-month period, only August received above normal rainfall. The most damaging aspect of the rainfall pattern for Delta Junction occurred during the month of July. Precipitation for July was only half of normal. It is during this month that most grains flower, pollinate, and fill. Moisture stress during this critical growth period probably was a major factor contributing to the low grain test weights recorded by many farmers in the 1980 harvest.

Lower-than-normal rainfall during May and June could also have been a factor effecting grain quality. Moisture stress at this time caused uneven seed germination and failure of some spring-applied fertilizer, particularly phosphorus, to dissolve and become available for plant growth. When these nutrients finally became available as a result of rainfall later in the season, some fields of grain had substantial amounts of secondary growth and late tillering. These conditions caused uneven ripening and delayed harvest.

August and September might be described as cool and wet by Delta farmers waiting for an opportunity to harvest their grain. This is true if they were comparing climatic conditions with those which occurred the previous year. Although the total amount of recorded precipitation did not vary greatly from the norm for this period, the number of days (frequency) where at

least a trace of precipitation was recorded was much greater than normal. For Delta Junction, a trace or more of precipitation was recorded on 35 days out of the 61-day August-September period. Also, during this time, there was no period spanning several days that was totally free of precipitation. These conditions slowed the ripening process of grains and made field drying difficult.

Overall, temperatures for the 1980 growing season at Delta Junction did not vary greatly from long-term averages. If anything, they were warmer. Monthly mean temperatures were above average for every month expect September. However, there were some damaging abnormalities which occurred during the latter part of the growing season. For some low-lying areas, the first killing frost (to sensitive plants) occurred on July 31, nearly 3 weeks earlier than normal. This may have had an adverse effect on grain quality in late-planted fields or in fields where seed germination was delayed for lack of moisture. Also, during the first week of September, the area received colder-than-normal temperatures plus an early snowfall. However, after this initial hint at an early winter, temperatures warmed and conditions were near normal.

Table 1. Climatic Data for Delta Junction During the 1979 and 1980 Growing Seasons.

	May		June		July		August		September	
	1980	1979	1980	1979	1980	1979	1980	1979	1980	1979
Temp.(^{0}F)										
daily max.	61.9	62.5 (57.1)*	66.6	65.4 (67.1)	70.9	70.5 (69.1)	63.5	68.9 (64.0)	51.4	57.9 (51.8)
daily min.	43.2	40.0 (36.9)	48.8	47.8 (47.1)	52.2	52.0 (50.1)	46.4	52.1 (45.6)	34.9	38.7 (35.3)
daily mean	52.6	51.3 (47.0)	57.7	56.6 (57.1)	61.6	61.3 (59.6)	55.8	60.5 (54.8)	43.2	48.3 (43.6)
Precip. (in.)	0.08	0.10 (0.86)	1.98	2.97 (2.26)	1.32	3.55 (2.68)	2.44	2.08 (2.00)	0.86	0.51 (1.24)

*Values in parentheses represent a 24-year average.

RESPONSE OF BARLEY TO NITROGEN AND PHOSPHORUS FERTILIZER APPLICATIONS ON NEW LAND

Since barley will probably be the major crop grown on the new lands development project area near Delta Junction, it is of utmost importance to have meaningful fertilizer recommendations for farmers which are based on crop response in the field and soil-test data. Of the major nutrients, nitrogen and phosphorus have been the most limiting for crop production on farms that have been established in the area for a number of years. Most soils in the area have the capacity to produce barley yields of 50 to 60 bushels per acre without application of potassium, particularly on fallowed land. Sulfur application has, in some situations, resulted in slight gains in yield. This has occurred primarily where straw and stubble from the previous year's crop have been incorporated into the soil during the spring, just prior to planting.

In 1979, a soil-fertility study was established on a newly cleared Volkmar silt loam located on the Dennis Green farm. Nitrogen was supplied as urea (46-0-0) at rates of 0, 30, 60, 90, and 120 pounds per acre. Phosphorus was supplied as triple superphosphate (0-46-0) at rates of 0, 30, 60, 90, and 120 pounds $P_2 0_5$ per acre. These rates of nitrogen and phosphorus were applied in all possible combinations in an attempt to bracket crop requirements. To assure that potassium and sulfur were not limiting, all treatments received a uniform application of 120 pounds potassium sulfate (0-0-50+ 17.6 S) per acre. This rate provided 60 pounds $K_2 0$ per acre and 21 pounds sulfur per acre. Otra barley was planted on May 25, 1979, just two months after removal of forest vegetation. During 1980, the study was continued with the same treatments and in the same plot area.

Grain yields for the 1979 and 1980 growing seasons are presented in Table 2. Both nitrogen and phosphorus were severely limiting to barley growth immediately after land clearing (1979 results). The absence of nitrogen and phosphorus application resulted in grain yields of less than two bushels per acre. The application of either nitrogen and phosphorus alone resulted in little or no increase of yield. However, when the two nutrients were applied in combination, grain yields were substantially increased. An application rate of 90 pounds nitrogen per acre in combination with 60 pounds phosphorus ($P_2 0_5$) per acre resulted in an average yield of 61 bushels per acre. Further increases in either nitrogen or phosphorus rates resulted in minimal increases in grain yields.

In the second year of cropping (1980 results), the high yield of the first year was equaled with an application rate of 60 pounds nitrogen per acre in combination with 30 pounds phosphorus ($P_2 0_5$) per acre. In other words, it required 33 per cent less nitrogen and 50 per cent less phosphorus to produce the same yield for the second crop year after land clearing. Also, during the second year, higher rates of nitrogen and phosphorus application beyond 60 pounds nitrogen per acre and 30 pounds phosphorus ($P_2 0_5$) per acre resulted in increased grain yields. The yield peaked at 99 bushels per acre when 120 pounds nitrogen per acre was applied in combination with 90 pounds phosphorus ($P_2 0_5$) per acre. The greater fertilizer efficiency which occurred during the second year is attributed to soil warming and decomposition of forest residues remaining on or near the soil surface.

This study will be repeated on the same site for a third year. Chemical analysis of soil and plant samples collected from the first two years of work has been completed and the data are currently being tabulated.

Table 2. Response of Barley to Nitrogen and Phosphorus Fertilizers on New Land in the Delta-Clearwater Area of Alaska.*

Plant Nutrient Application**				Grain Yield		
N	P_2O_5	K_2O	S	1979	1980	Ave.
lbs/acre				bu/acre		
0	0	60	21	0.8	3.5	2.2
30	0	60	21	1.3	3.5	2.4
60	0	60	21	2.2	4.0	3.1
90	0	60	21	1.9	6.8	4.4
120	0	60	21	1.7	6.9	4.3
0	30	60	21	1.5	12.1	6.8
30	30	60	21	9.7	40.6	25.2
60	30	60	21	27.7	70.0	48.9
90	30	60	21	31.6	74.4	53.0
120	30	60	21	35.3	67.0	51.2
0	60	60	21	2.8	12.3	7.6
30	60	60	21	14.7	47.6	31.2
60	60	60	21	35.8	74.3	55.1
90	60	60	21	61.2	85.9	73.6
120	60	60	21	64.9	75.9	70.4
0	90	60	21	1.6	10.3	6.0
30	90	60	21	16.5	49.6	33.1
60	90	60	21	42.2	79.0	60.6
90	90	60	21	46.7	84.8	65.8
120	90	60	21	58.2	99.1	78.7
0	120	60	21	0.8	7.5	4.2
30	120	60	21	19.0	50.5	34.8
60	120	60	21	26.9	71.1	49.0
90	120	60	21	49.0	89.4	69.2
120	120	60	21	66.1	98.9	82.5

*The test was conducted on a Volkmar silt loam soil located on Dennis Green's farm. The land was cleared in March of 1979.

**Nitrogen was supplied as urea (46-0-0). Phosphorus was supplied as triple super phosphate (0-46-0). All treatments received a uniform application of potassium sulfate (0-0-50+ 17.6 S) which provided 60 pounds K_2O per acrea and 21 pounds sulfur per acre.

VARIETY-FERTILIZER INTERACTIONS OF BARLEY GROWN ON NEWLY CLEARED LAND

Previous work with grain variety testing has shown that individual varieties do not perform the same when grown under different sets of conditions. The yield a variety produces can be influenced by crop rotation, fertilizer rate, soil pH, tillage practices, rainfall distribution and amount, seeding rate, planting date, and many other factors. Each variety has its own peculiar set of growing conditions at which it performs best.

In 1979, a variety-fertilizer study was established on a newly cleared Volkmar silt loam located on the Dennis Green farm. Seven barley varieties (Galt, Otra, Paavo, Hankkija's Eero, Lidal, Weal, and Shabet) were grown on newly cleared land at five levels of fertilization. Application rates for the five fertilizer levels, expressed as pounds per acre (N-P_2O_5-K_2O), are as follows: *none* (0-0-0); *low* (30-15-15); *moderate* (60-30-30); *high* (90-45-45); and *very high* (120-60-60). Fertilizer was supplied from a 20-10-10 mixture composed of ammonium nitrate, ammonium phosphate, and potassium sulfate. The barley varieties were planted on May 23, 1979, just two months after removal of forest vegetation. During 1980, the study was continued with the same treatements and in the same plot area.

Grain yields for the 1979 and 1980 growing seasons are presented in Table 3. For the first year of cropping on new land (1979 results), grain yields obtained at the *none* (0-0-0) and *low* (30-15-15) levels were poor for all varieties. However, the *moderate* (60-30-30) level produced yields that were equal to or greater than the U. S. average of 42 bushels per acre. Yields of three varieties (Otra, Paavo, and Shabet) peaked at the *high* ((90-45-45) fertilizer level. Yields of the remaining four varieties (Galt, Hankkija's Eero, Lidal, and Weal) were greatest at the *very high* (120-60-60) fertilizer level. Paavo was the highest yielding barley variety on new land when yields at all fertilizer levels were averaged.

In the second year of cropping (1980 results), yields of all varieties were noticeably higher at the *low* (30-15-15) level of fertilization. Also, slight gains in yield occurred where no fertilizer was applied. However, at the *moderate* (60-30-30) and *high* (90-45-45) fertilizer levels, average yields for the seven varieties were lower than those obtained the previous year. Average yields obtained at the *very high* (120-60-60) fertilizer level showed little change during the second year.

For the second year of cropping, yields for six out of the seven varieties were greatest at the *very high* (120-60-60) fertilizer level. Paavo was the only variety to have its yield peak at the *high* (90-45-45) level. Otra was the highest-yielding variety when yields at all fertilizer levels were averaged. Paavo came in a close second, producing the highest yields for the low (30-15-15), *moderate* (60-30-30), and *high* (90-45-45) fertilizer levels.

Results for the two years in which this study was conducted strongly suggest that fertilizer recommendations for barley should take into consideration the variety to be grown. The noticeable differences in the performance of individual varieties which occurred between the first and second year of the study indicate that cropping sequence (*barley on new land* versus *barley after barley*) is also a factor to be considered in variety selection.

This study will be repeated, with slight modications, at the same site in 1981. The soil at this site is very acid, ranging from pH 5.2-5.4. For the 1981 growing season, the plot area for each of the fertilizer levels will be split, with half being limed to approximatley pH 6.5 and half remaining unlimed. Fertilizer will be applied at the same levels as in the previous two years. The limed and unlimed portions of each plot will be planted to three barley varieties (Otra, Paavo, and Hankkija's Eero). These are the three varieties which have given the best performance during the two previous years of testing.

Table 3. Variety-Fertilizer Interactions of Barley Grown on New Land in the Delta-Clearwater Area of Alaska.*

Barley Variety	Fertilizer Level** None	Low	Moderate	High	Very High	Variety Ave.
	Grain Yield (bu/acre)					
			1979			
Galt	0.5	10.9	54.1	59.5	69.5	38.9
Otra	0.7	14.5	50.0	72.8	70.1	41.6
Paavo	0.2	13.7	62.2	85.5	81.1	48.5
Hankkija's Eero	0.3	14.5	61.1	60.3	77.3	42.7
Lidal	0.6	9.6	53.9	49.5	65.2	35.8
Weal	0.6	16.8	61.5	62.4	81.5	44.6
Shabet	1.0	15.1	46.2	69.7	58.8	38.1
Fertilizer Average	0.6	13.6	55.6	65.7	71.9	
			1980			
Galt	2.7	26.6	39.0	43.7	64.8	35.4
Otra	2.8	32.4	58.9	70.1	89.8	50.8
Paavo	0.5	41.7	60.7	71.0	70.2	48.8
Hankkija's Eero	0.8	34.8	46.8	56.8	74.6	42.8
Lidal	3.3	28.1	54.9	57.7	76.4	44.1
Weal	7.7	34.7	38.3	42.8	60.4	36.8
Shabet	7.8	22.4	42.1	39.0	55.5	33.4
Fertilizer Average	3.7	31.5	48.7	54.4	70.2	

*The test was conducted on a Volkmar silt loam soil located on Dennis Green's farm. The land was cleared in March of 1979.

**Fertilizer was supplied from a 20-10-10 mixture composed of ammonium nitrate, ammonium phosphate, and potassium sulfate. Nutrient rates for different fertilizer levels are as follows:

Fertilizer Level	Nutrient Rate (lbs/acre) N	P_2O_5	K_2O
None	0	0	0
Low	30	15	15
Moderate	60	30	30
High	90	45	45
Very High	120	60	60

RESPONSE OF BARLEY AND RAPESEED TO SULFUR FERTILIZATION

Rapeseed is a heavy feeder on the plant nutrient, sulfur. Plant concentrations of sulfur in rapeseed are generally higher than for grain crops. Therefore, when barley follows rapeseed in the crop rotation, sulfur may be a limiting factor for yield. Lack of sulfur may also result in lower barley yields when straw residues from the previous crop are incorporated into the soil in the spring just prior to planting. Sulfur, like nitrogen, can be immobilized (tied-up) by decomposing crop residues for a period of several weeks. To date, sulfur response has not been obtained when barley is grown on summer-fallowed land.

In the following studies, sulfur was applied at rates of 0, 10, 20, 30 and 40 pounds per acre. Variations in rate of sulfur application were accomplished by using combinations of potassium sulfate (0-0-50+ 17.6 S) and potassium chloride (0-0-62). All sulfur treatments received uniform applications of nitrogen (100 N), phosphorus (40 $P_2 0_5$), and potassium (114 $K_2 0$). In 1979, these treatments were applied to barley in the following crop rotations: barley after rapeseed, barley after barley, and barley after fallow. During the 1980 growing season, these same sulfur treatments were applied to rapeseed grown on barley stubble land and summer-fallowed land. The studies were all conducted on a Richardson silt-loam soil type located in the Delta-Clearwater area. The land has been cleared and in production for about 25 years.

Results of the barley studies are presented in Table 4. Some grain-yield response from sulfur applications was obtained for barley grown in all three crop rotations. The most noticeable response occurred at the 10-lb. sulfur rate which resulted in yield gains of 7.3 bushles per acre for barley after rapeseed, 6.6 bushels per acre for barley after barley, and 4.0 bushels per acre for barley after fallow. The average gain in yield for all rotations at the 10-lb. sulfur rate was 6.0 bushels per acre. Yield response for higher rates of sulfur fertilization was not clearly defined, although some benefit appeared to be obtained for barley after rapeseed.

Table 4. Response of Barley to Sulfur Fertilization When Grown Under Different Crop Rotations.*

Sulfur** Application Rate	Grain Yield (bu/acre)			
	Crop Rotation			
	Barley after Rapeseed	Barley after Barley	Barley after Fallow	Average for all Rotations
lbs S/acre				
0	58.8	64.5	83.8	69.0
10	66.1	71.1	87.8	75.0
20	63.2	69.1	90.6	74.3
30	66.9	72.4	89.1	76.1
40	72.0	73.2	86.6	77.3

*The test was conducted on a Richardson silt loam soil located on Lee Fett's farm. The land was cleared in the mid-1950s and has been in production for approximately 25 years.

**In addition to sulfur all treatments received uniform applications of nitrogen, phosphorus, and potassium (See text, above, for rates.)

Results for the rapeseed studies are given in Table 5. Like Barley, the most noticeable response from sulfur application occurred in the 10-lb. rate. This accounted for a 16 per cent increase in yield for rapeseed grown on fallow land and a 9 per cent increase in yield for rapeseed grown on barley stubble land. A further increase in yield was obtained at the 20-lb. sulfur rate for rapeseed grown on barley stubble land. However, higher rates of sulfur application, particularly the 40-lb. rate, had a depresssing effect on yield of rapeseed.

Sulfur needs for crops grown in the Delta-Clearwater area can *probably* be adequately supplied by use of potassium sulfate for lands requiring potassium, or by supplying part of the nitrogen as ammonium sulfate for lands not requiring potassium. An application rate of 10 pounds sulfur per acre in the form of sulfate should satisfy the requirements of most crops. A 20-lb. sulfur application may prove to be beneficial where substantial amounts of crop residues are incorporated into the soil during the spring, just prior to planting.

Table 5. Response of Rapeseed to Sulfur Fertilization When Grown Under Different Crop Rotations.*

Sulfur** Application Rate	Grain Yield (bu/acre)		
	Crop Rotation		
	Rapeseed after Barley	Rapeseed after Fallow	Average for all Rotations
lbs. S/acre			
0	25.4	28.5	26.9
10	27.6	33.1	30.4
20	29.4	30.4	29.9
30	27.3	28.4	27.9
40	22.4	30.2	26.3

*The test was conducted on a Richardson silt loam soil located on Lee Fett's farm. The land was cleared in the mid-1950s and has been in production for approximately 25 years.

**In addition to sulfur, all treatments received uniform applications of nitrogen, phosphorus, and potassium (See text, above, for rates.)

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