Report on the 1972 Field Research Program

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This report briefly outlines the 1972 field research program of the Department of Soil Science, University of Saskatchewan, giving an indication of the various research projects conducted during the past year and pointing out a few of the highlights of the research findings to date on some of these projects.

During the 1972 season, various members of the Soil Science Department participated in and conducted experiments in several areas of soil research. The following is a list of the major research project areas in which field investigations were conducted in the past year:

1) Nutrient and water requirements of irrigated crops.*
2) Potassium placement for barley and rapeseed.*
3) Nitrogen-sulphur requirements of rapeseed, barley, wheat and flax.
4) Nitrogen sources and placement for barley, wheat and rapeseed.
5) Deep placement of phosphorus for rapeseed.*
6) Soil, fertilizer and symbiotic nitrogen uptake by horsebeans.
7) Effect of low dose irradiation on the nutrient uptake of vegetable cultivars.
8) Effect of management practices on the subsoil nitrate levels in Saskatchewan soils.
9) Productivity studies on soils in the Swift Current Map Area.*
10) Effect of salt dust from potash refineries on soil productivity.
11) Remote sensing - Use of multiband photography for studying and identifying soil and crop conditions.
12) Studies on the uptake of soil applied mercury by various crops.*

A discussion of the results of some of these projects is contained in ensuing papers presented at these meetings (those marked *). The following is a more detailed discussion of certain of the major soil fertility research projects conducted during the past summer.

1) Nutrient Requirements of Irrigated Crops

In 1971 a three-year research project was initiated in the Outlook area of the Gardiner Dam Development to investigate the nutrient requirements of various crops grown under different irrigation schedules. The test crops included rapeseed, barley, soft wheat and alfalfa. Similar experiments were again conducted in 1972.

For the crops barley, soft wheat and rapeseed, two types of experiments were conducted. One type of experiment, designated as the type "A" experiment, was of the small plot design and was conducted on two soil types; an Asquith very fine sandy loam, and an Elstow loam. In this experiment the crops were all grown under three irrigation schedules as follows:

a) Water 1 treatment - irrigation water was applied as soon as the soil reached a moisture tension of 0.5 atmosphere.
b) Water 2 treatment - irrigation water was applied after sufficient time had elapsed to evaporate 2.0 inches of water following the soil reaching a moisture tension of 0.5 atmosphere.
c) Water 3 treatment - dryland treatment except for an initial application of 0.5 to 1.0 inches of water in the spring to ensure germination.

For each crop grown under each irrigation schedule a number of fertilizer treatments were super-imposed. Phosphorus was applied to all treatments at a rate of 30 lbs P_2O_5/acre for rapeseed and 40 lbs P_2O_5/acre for soft wheat and barley. Nitrogen was broadcast at rates varying from 0 to 300 lbs N/acre. In some of the nitrogen treatments half of the nitrogen was applied at seeding and half later in the growing season. To augment the information from split nitrogen applications, separate treatments were included in which ^{15}N enriched fertilizers were applied. Other treatments included the application of additional phosphorus, potassium, sulphur and one treatment in which a micronutrient spray was applied.

The second major type of experiment conducted for the three forementioned crops, designated as the type C experiments, was of the

strip plot design. Data from three plots of barley and two plots each of soft wheat and rapeseed were obtained. In these experiments, fertilizer treatments were super-imposed on fields seeded and irrigated by co-operating farmers, so for each individual field trial irrigation water was applied under only one scheduling. Phosphorus was applied uniformly to all crops at approximately 40 lbs P_2O_5/acre; nitrogen was applied at rates of 0 to 300 lbs N/acre in single and split applications, and single rates of potassium and sulphur were applied in separate treatments.

A third series of experiments was conducted on irrigated alfalfa. Three experimental sites were chosen, one sight in which leveling operations had removed the surface soil, and two in which the soil was relatively undisturbed. Fertility treatments included rates of phosphorus from 0 to 200 lbs P_2O_5/acre applied initially in 1971 along with annual phosphorus applications of up to 100 lbs P_2O_5/acre superimposed on the initial applications. Additional treatments included single rates of potassium, sulphur and boron.

Some of the highlights of results obtained from these plots over the past two years have indicated that:

a) The level of nitrogen available for plant growth is a major factor influencing the yields of irrigated rapeseed, soft wheat and barley. Strong response to applied nitrogen have been realized in all three crops with generally greater yields and responses being obtained from irrigated over non-irrigated crops and greater response being obtained for fields testing low and medium in nitrate nitrogen than from those testing high. Yields of 80, 70 and 50 bushels per acre should be attainable for barley, soft wheat and rapeseed respectively under adequate irrigation and nitrogen fertilization. From data collected to date there appears to be little difference in crop response to single and split applications of nitrogen fertilizer. It also appears that present phosphorus recommendations are adequate for irrigated rapeseed, while further work is required to determine whether higher rates of

phosphorus would be economical for barley and wheat, since in some cases there have been indications of further responses to additions of phosphorus in amounts greater than that presently being recommended. It also appears that potassium and sulphur are adequately available in these soils for the irrigated production of wheat, barley and rapeseed.

b) Residual fertilizer nitrogen may remain in the soil following crop removal from high nitrogen application rates. There appears to be no fertilizer nitrogen remaining following the application of up to 100 lbs N to either irrigated or dryland crops, however, some nitrogen has been detected remaining in the 300 lb N/acre application rate treatments in both irrigated and non-irrigated crops. This has been detected in the top 6 inches of soil in non-irrigated conditions and in the second foot of soil under irrigated conditions.

c) Very little or no response was attained by applying phosphorus to irrigated alfalfa, except where leveling operations had completely removed the surface soil. Under these conditions excellent responses of alfalfa to applied phosphorus have been realized and data indicates that a single large application of 200 lbs P_2O_5/acre results in a more rapid economical reclamation of such areas than with small annual application. For alfalfa, there has been no response detected to other applied fertilizer nutrients.

2) <u>Potassium placement for barley and rapeseed</u>

During the past five years, a continuing project has been conducted by the Department of Soil Science to investigate potassium deficiencies in Saskatchewan soil. The objectives of the study were:

a) To establish the extent of potassium deficient soils in Saskatchewan.

b) To refine current soil test benchmarks for different crops with respect to potassium.

c) To determine the relative efficiency of various placements of potassium bearing fertilizers.

Work during 1971 and in the past year, the final year of the five-year project, was primarily directed toward the third objective. A summary of much of the five-year project is presented in an ensuing paper along with a discussion of the proposal changes in soil test benchmarks to be considered as a result of these findings. This report deals primarily with last summer's experimentation.

In 1972 small plots were placed on two sites on Carrot River soils where previous work had established that potassium deficiencies existed. Barley and rapeseed were sown as test crops at both locations. A uniform application of 20 lb P_2O_5/acre was applied in all treatments to both crops. Potassium was applied at rates varying from 15 to 240 lbs K_2O/acre in broadcast and sideband application treatments, and at rates varying from 15 to 120 lbs K_2O/acre in seed-placed application treatments. Two additional treatments were included in which a portion of the potassium was placed with the seed and the remainder either broadcast or side banded. Rapeseed was harvested at only one location since a serious infestation of Bertha Army worms destroyed the second plot, while barley was harvested from both sites.

Highlights of this year's work are as follows:

a) On the one plot where rapeseed was harvested, no response to added potassium was realized. On the second plot, which contained similar amounts of available potassium in the soil, visual responses were noted to applied potassium through the growing season, although final harvest was not possible to confirm these observations.

b) Barley responded well to applied potassium at both locations where the non-potassium treatments gave yields of only 10 to 20 bu/acre in contrast to potential yields of 50 to 60 bu/acre obtained from certain potassium treatments. Yields from seed placed potassium treatment were slightly greater than those from side banded treatments; while broadcast application

treatments generally gave lower yields than those from either of the other placement treatments.

General conclusions which have been drawn from results obtained over the past five years of this project are as follows:

a) The extent of potassium deficient soils in Saskatchewan is approximately one million acres. These soils are, for the most part, restricted to sandy soil in the Gray-Black and Gray soil zones. The Carrot River soil association, which has a history of poor drainage and in many instances has peat on the surface, is the soil association in which potassium deficiencies are most common. The extent of soils in which potassium deficiency severely reduces yield is undoubtedly much less than the one million acres in which some yield reduction would be expected.

b) Where potassium deficiencies occur, the yields of barley can be expected to be reduced to a greater degree than yields of other annual crops. Rapeseed is affected to a much lower degree by potassium deficiency than is barley.

c) Seed placement of potassium is much more efficient than broadcast applications. Sideband applications of potassium may provide a means of applying relatively large rates and avoiding germination damage. Results from two successive growing seasons indicate that germination damage due to seed-placement of potassium occurs only at rates far in excess of current recommendations.

3) <u>Nitrogen-sulphur requirements of rapeseed, barley, wheat and flax</u>

A series of strip trial experiments were conducted in the past summer to study the responses of rapeseed, barley, wheat and flax to a nitrogen only and a nitrogen-sulphur fertilizer, namely, 34-0-0 (ammonium nitrate) and 34-0-0-11% S (urea-ammonium sulphate). Similar studies using rapeseed only as a test crop and ammonium nitrate and ammonium sulphate as the nitrogen only and nitrogen-sulphur fertilizers were conducted in the summer of 1971.

This past year a total of ten trials were conducted, six with Zephyr and Span rapeseed, two with wheat, and one each with barley and flax on soils containing a range in NO_3-N and SO_4-S contents. (The soils on which the rapeseed trials were conducted contained between 22 and 90 lbs/acre NO_3-N to 2 feet and between 11 and 28 lbs/acre SO_4-S to 2 feet; the two soils on which wheat trials were placed contained respectively 91 lbs/acre NO_3-N and 33 lbs/acre SO_4-S to two feet, and 27 lbs/acre NO_3-N and 19 lbs/acre SO_4-S to 2 feet. The soil on which the barley plot was placed contained 47 lbs/acre NO_3-N and 17 lbs/acre SO_4-S to 2 feet, while the soil in which the flax plot was placed 42 lbs/acre NO_3-N and 6.5 lbs/acre SO_4-S to 2 feet). Treatments in each experiment included, besides a check, rates of nitrogen application varying from 25 to 200 lb N/acre for both carriers, which in the case of the urea-ammonium sulphate fertilizer supplied sulphur in rates ranging from 8 to 65 lbs S/acre. All phosphate, if any, was applied by the cooperating farmer.

From a general review of the data (which to the time of the meetings had not been examined in detail), the following observations have been made:

a) Rapeseed appeared to respond well to applied fertilizer nitrogen, showing some response even on soils testing high in NO_3-N (up to 60 lb/acre NO_3-N to 2 feet). However, how significant and economical the latter mentioned response was, has yet to be determined. There appeared to be only sporadic responses of rapeseed to applied sulphur as indicated by differences in yields obtained from the two fertilizer sources applied at comparable rates. On some soils testing less than 15 lb SO_4-S to 2 feet, these were indications of yield increases due to sulphur application, while on the other soils of similar SO_4 content no responses were evident. Similar observations of inconsistent responses were apparent from trials on soils with higher SO_4 contents.

b) Data from the one flax plot put out this year showed no

response of flax to applied nitrogen on a soil testing 42 lb/acre NO_3-N to 2 feet. However, significant yield increases in the neighborhood of 2 to 4 bu/acre were obtained from the nitrogen-sulphur fertilizer indicating a good response of flax to sulphur on this soil which contained 6.5 lbs SO_4-S to two feet. Total flax yields were not as good as anticipated since the crop was seriously affected by an early fall frost, which caused the check treatment to yield only 8 bu/acre.

c) Results from the two wheat plots showed little response of wheat to fertilizer nitrogen except at high application rates on the soil testing 27 lbs/acre NO_3-N to 2 feet. There appeared to be no consistent response of wheat to sulphur on either plot.

d) On the one barley plot good responses were obtained to applied nitrogen, however, there were no indications of a sulphur response.

Since oil analyses of the rapeseed has just been completed and protein analyses of all crops is still being conducted, no comments as yet can be made on these results.

4) Nitrogen sources and placement for barley, wheat and rapeseed

In 1970 a program was initiated to study the comparative efficiencies of urea and ammonium nitrate fertilizers for cereal crops. Also incorporated into these studies was a comparison of broadcast and seed drilled nitrogen fertilizer placements. During this past year, the project was resumed at a much larger scale, which involved a study of the relative efficiency of urea and ammonium nitrate applied in three fashions, broadcast, seed drilled and side-banded to three test crops: barley, wheat and rapeseed. The experiment was of the small plot design and was successfully conducted on two soil types - a Carrot River very fine sandy loam and a Blaine Lake clay loam. A non-replicate, multirate experimental design was employed in which nitrogen was applied to each crop in 5 lb N/acre rate increments from 10 to 90 lbs/acre for each method of application and at 100, 120 and

160 lb N/acre rates for broadcast and side-banded applications only. Phosphate was uniformly applied to all treatments at a rate of 40 lbs P_2O_5/acre for barley and wheat, and 20 lbs P_2O_5/acre for rapeseed.

Also included in this project was a nitrogen balance experiment conducted at both sites, in which ^{15}N enriched urea and KNO_3 were used as nitrogen carriers. Aluminum cylinders, 8 inches in diameter and 2 feet deep, were forced into the soil to obtain confined soil volume. Within these cylinders the ^{15}N enriched fertilizer was applied at a rate of 75 lbs N/acre in each of the three application methods to each of the three crops. At maturity the plant samples were harvested and the cylinder containing the soil was removed and brought to the laboratory for analysis in an attempt to determine a total nitrogen balance.

As of the time of these meetings, no comments can be made regarding the results of these experiments since both statistical and laboratory analyses are still being conducted.

5) <u>Effect of Management Practices on Subsoil Nitrate Levels in Saskatchewan Soils</u>

During the past summer a project was undertaken to determine the effect that various cropping sequences and soil management practices have on the levels on NO_3-N in the region of soil immediately below the rooting zone of crops. The project was intended as a preliminary study to provide data which could possibly determine potential problem areas where further detailed investigation may be warranted.

Sites were selected for investigation on locations where information was available to indicate there had been significant differences in past cultural practices such as pastures on haylands, lands cultivated under different cropping and summerfallow sequences, irrigated and non-irrigated land, land under feedlots, etc.

From these sites a number of soil samples were taken to depth, air dried and analyzed for NO_3-N content.

Some of the general conclusions which have been drawn from this study are as follows:

a) Excess summerfallowing operations, or production of inter-tilled crops such as tree nursery crop can result in the accumulation of significant quantities of NO_3-N.

b) In certain areas NO_3-N levels of the subsoil appear to be increased through the practice of a two-year rotation, while in other areas it does not appear to be the case.

c) The utilization of high rates of nitrogen fertilizer, particularly for irrigated and inter-tilled crops, may give rise to an accumulation of NO_3-N in the subsoil.

As indicated, this project was intended to be of a preliminary nature, and further work is suggested to be undertaken to investigate more fully on those areas where there may be a problem with NO_3-N accumulations in the subsoil and groundwater.

This report has just briefly outlined five of the research projects conducted by the Department of Soil Science in 1972. A more detailed report on these as well as the other research projects of the Department will be contained in the 1972 Nutrient Research Report.