RECENT TRENDS IN SOIL TESTING NUTRIENTS

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INTRODUCTION

Rennie (1993) in a recent review provided a historical perspective of the trends of macronutrients in prairie soils. The soil test results presented in that review covered the period from the early to mid-sixties to the late eighties.

Weather conditions in the last decade included two major extremes (drought and wet conditions) that have had a significant impact on the levels of soil "available" nutrients in prairie soils in general and Saskatchewan soils in particular. The 1985 -1995 soil test result database of Enviro-Test Laboratories Saskatoon was utilized to demonstrate recent trends in macronutrient levels of Saskatchewan soils. Although soil testing databases may be considered biased, as there is no statistical design for obtaining a representative sample of fields in an area, the large number of samples involved, which represent 10 to 15% of the province's soils, allow for a very good reflection on the overall trends in the nutrient levels of the province's soils.

SOIL **NITROGEN**

Soil residual nitrogen levels in the last five to six years reached two sharply opposite extremes over the 30 year history of the laboratory (Figure 1). First, a record high, in the aftermath of the 1988-89 drought and, then, a record low in 1993-94 after a 3-4 year period of unusually wet and cool conditions and record crop yields (Figure. 2).

Besides weather conditions during a fallow year, residual nitrogen levels in summerfallow fields also reflect crop growing conditions during the preceding stubble year. Thus, the residual fertilizer nitrogen levels from the 1988 and 1989 drought years are reflected in the nitrogen levels of fallowed fields in 1989 and 1990, respectively (Figures 1 and 2). In contrast, the impact of weather conditions during a crop year is noticed on the residual levels of stubble fields in the fall of the same year (Figure 2).

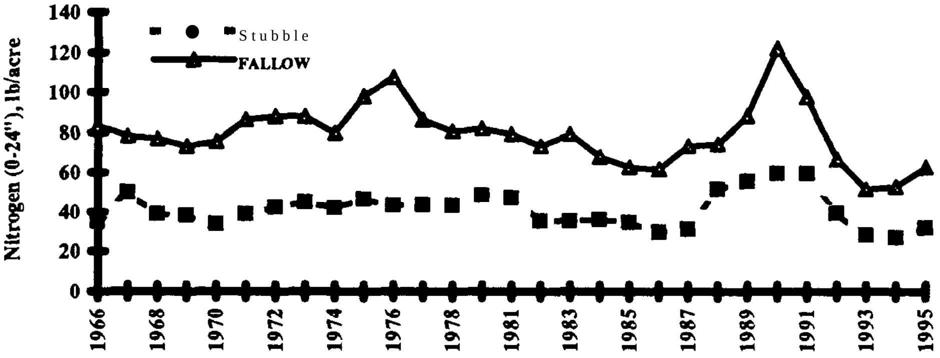

Figure 1. Mean soil residual nitrate-nitrogen levels in the top 24" (60 cm) of Saskatchewan soils based on soil tests carried out Enviro-Test Laboratories.

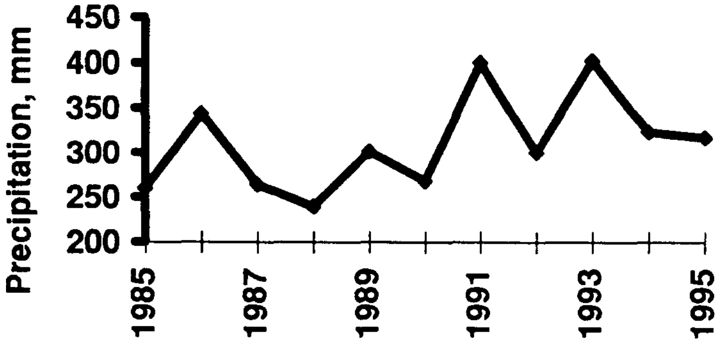

Figure 2. Mean April1 to September 30 precipitation in Saskatchewan.

Karamanos and Kruger (1992) estimated that collectively in the 1990 and 1991 crop years, crops grown in Saskatchewan removed nearly 1.1 million tonnes of nitrogen in grain alone. Karamanos (News Release, November 22, 1993) further estimated that a record of 850,000 tonnes of nitrogen was removed from Saskatchewan soils by the 1993 crop (both grain and straw).

A number of events contributed to the record low residual nitrogen levels in 1993-94. In addition to record nutrient removal by crops, fertilizer nitrogen application rates were lower than the record crop demanded (only approximately 300,000 tonnes of fertilizer were applied in 1993 by Saskatchewan producers). Producers in 1991 and 1992 were, in many cases unknowingly, taking advantage of the high residual levels left from the 1988-89 drought years. Thus, the yields in 1991 and 1992 were excellent with relatively low inputs. In this sense, there was a "psychological" factor that resulted in reduced inputs to meet crop demand. Nature contributed to the record lows by stubbornly persisting on cool conditions for four consecutive years, thus significantly reducing nitrogen mineralization rates in soil. Losses due to volatilization and in some cases (light textured soils) leaching also contributed to the low residual nitrogen levels.

Traditionally, major emphasis has been placed on the nitrogen levels in prairies soils. The preoccupation with this important nutrient, because of the impact it has had on both crop yields and crop quality characteristics, may have caused us to overlook a number of other very important changes that have occurred in our soils over the last decade.

SOIL pH

Contrary to common belief that pH is always the same, a number of factors can cause it to vary from season to season and from year to year. In addition to the effect a sampling pattern can have on pH differences from year to year, nature also plays an important role in the variation of pH from season to season and year to year.

The pH of pure solutions depends on the concentration (activity) of H+ ions. Soil contains a solid phase in addition to the liquid phase. The solid phase may consist of water soluble salts, gypsum and carbonates as well as the composition, quantity and nature of cations adsorbed to the surface of soil colloids. The quantity of gases such as carbon dioxide that are dissolved in the soil water films will also influence soil pH. The increase in concentration (activity) of sulfates and nitrates that occurs during dry years will lower soil pH. An increase in the concentration of neutral salts, such as sodium chloride or gypsum, has the same effect (Puri and Agshar, 1938). As a result, soil pH at a specific location will also change during the year or from one year to another. Generally, soil pH drops during hot and dry seasons and increases during cold and wet seasons (Hester and Shelton, 1933).

An example of these trends is shown by the median soil pH for the province of Saskatchewan over the last eleven years. Figure 3 shows that the dry weather in 1988 and 1989 was accompanied by accumulation of soluble salts, as shown by soil conductivity and nitrate (Figure 2) and sulfate (Figure 9) levels. Soil pH dropped during this period. The high yields of the subsequent years that removed large quantities of nutrients from the soil combined with wet and cool weather in 1992-94 resulted in lower soluble salt concentration in the soil and subsequently increased overall soil pH levels (Figure 4).

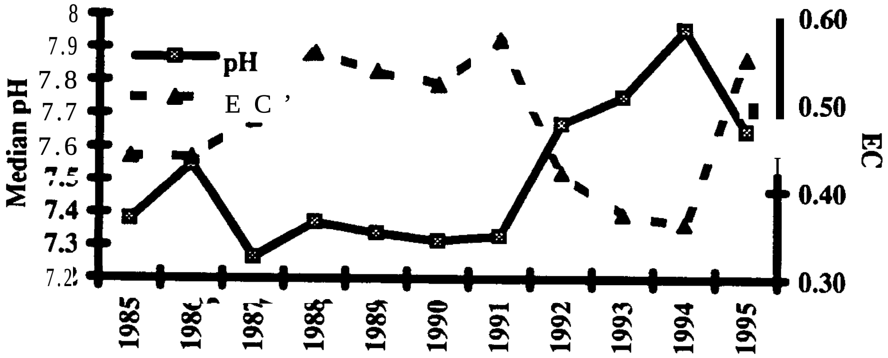

Figure 3. Median soil pH and Electrical Conductivity (EC) for Saskatchewan soils.

Although, there is no direct relationship between pH and electrical conductivity, changes in the latter may reflect changes in the redox potential of soils, which in turn is inversely related to soil pH (Tan, 1982).

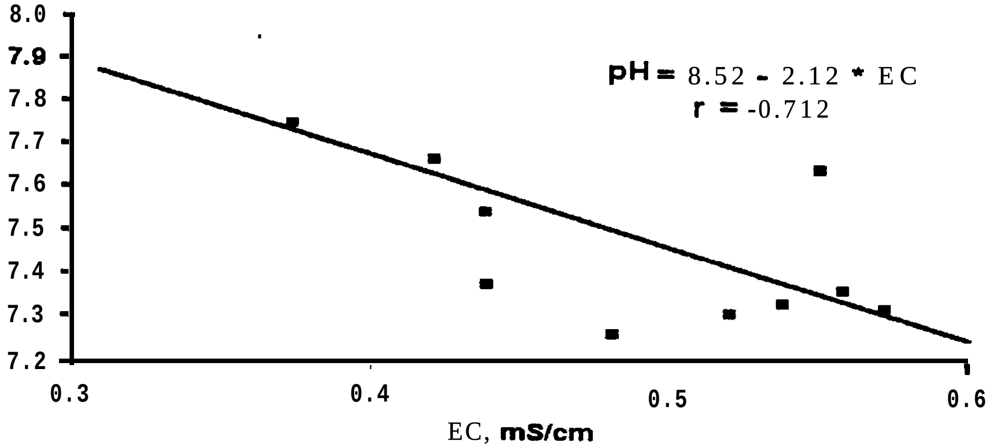

Figure 4. Relationship between mean soil pH and electrical conductivity levels for Saskatchewan soils.

SOIL PHOSPHORUS

These changes over the 1990-94 period of record crops and above average moisture conditions had an impact on another very important soil nutrient, phosphorus. The common belief is that "available" phosphorus levels in our soils remain approximately constant. This has been very well supported with data since the mid sixties and carried on until 1987 (Rennie, 1993). During the dry years of 1988 and 1989 there was a slight increase, which was overlooked as a "noise" in an otherwise predictable "constant" phosphorus trend. However, although "available" P levels were much higher in 1991, there was a constant decline between 1992 and 1994 (Figure 5). The activity of the soil phosphorus is seriously impaired when soil pH is raised much above 7, as complex insoluble calcium phosphates are formed (our soils contain plentiful supplies of exchangeable calcium and in many cases calcium carbonates). This would result in lower phosphorus availability (Figure 6). With the return of more "normal" weather conditions in 1995 a decrease in soil pH was accompanied by an increase in "available" phosphorus.

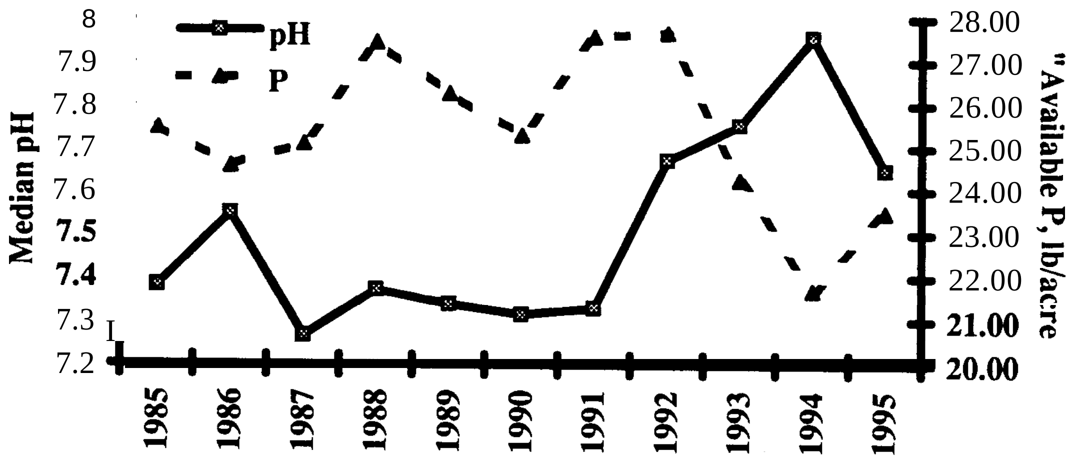

Figure 5. Median soil pH values and "available" Phosphorus in Saskatchewan soils.

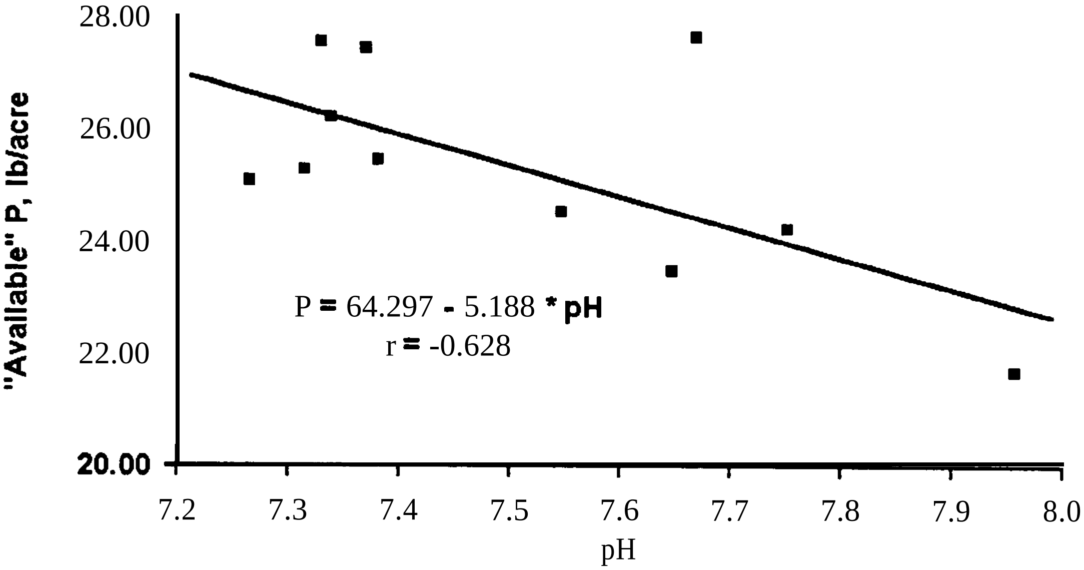

Figure 6. Relationship between soil "available" phosphorus levels and median soil pH in Saskatchewan soils.

These changes were by far more dramatic in the Lloydminster area, which experienced a drought in 1995 (Figures 7 and 8).

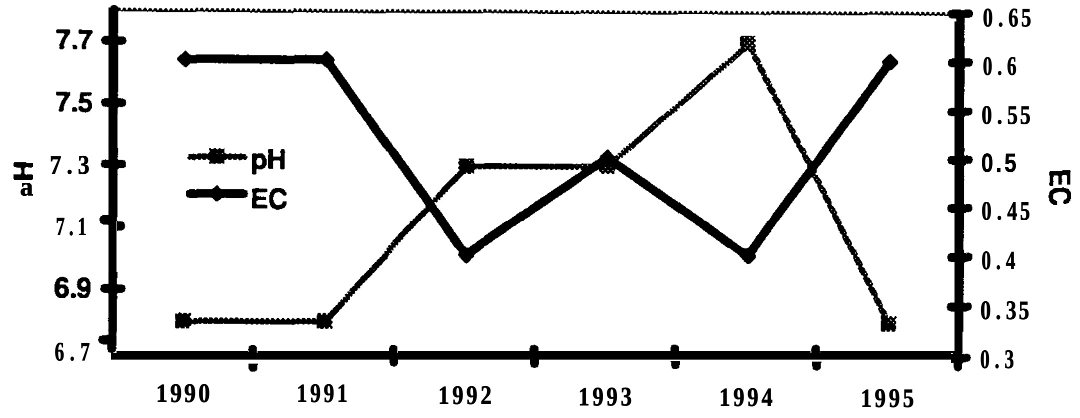

Figure 6. Median soil pH and Electrical Conductivity (EC) of soils in the Lloydminster area.

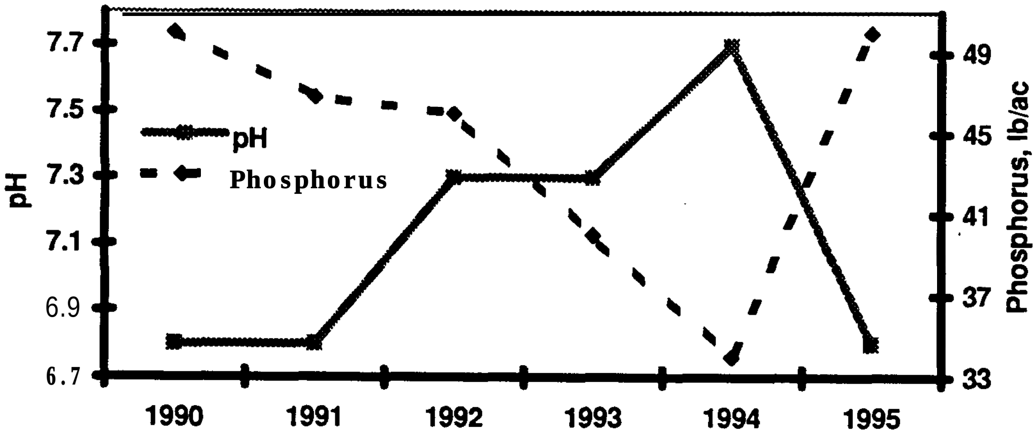

Figure 5. Median soil pH and "available" Phosphorus of soils in the Lloydminster area.

SOIL SULPHUR

Sulphate-sulphur levels in the soil followed a similar pattern to that of nitrate-nitrogen. However, the 1995 sulphate levels remained similar to those of 1993 and 1994 in spite of the corresponding increase in the electrical conductivity (EC) in the O-12" depth (Figure

9). This trend will have to be monitored closely in the future to ascertain whether a pattern of soil sulphur depletion is developing.

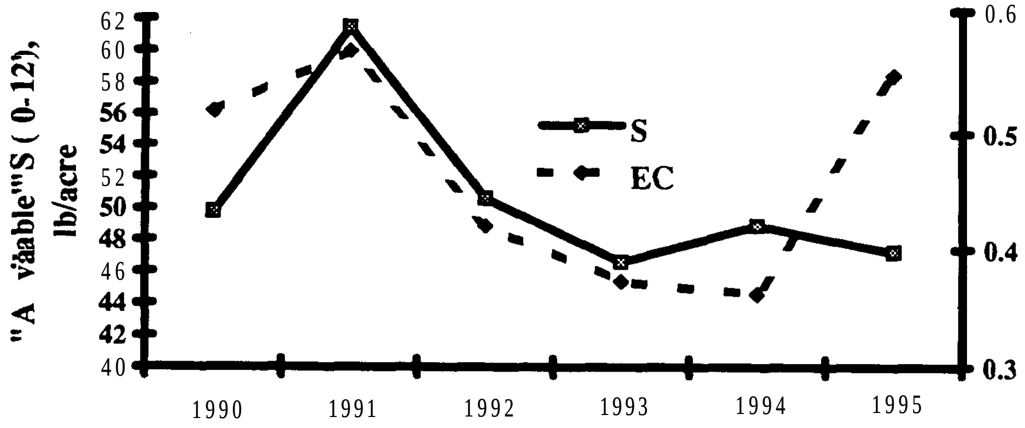

Figure 9. Electrical Conductivity values and “available” Sulphur in Saskatchewan soils.

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