CSRP

Cropping Systems Research Program at the Nova Scotia Agricultural College

Fact sheet #1, June 2004

Scope: To provide information on the Cropping Systems research to the Atlantic Canada growers.

Contact information: Dr. Valtcho Jeliazkov (Zheljazkov), Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, NS B2N 5E3, Ph: (902) 893 7859, Fax: (902) 897 9762, http://www.nsac.ns.ca/pas/instind/csrc/index.htm

PHOSPHOROUS-ENRICHED SOILS

Introduction

Phosphorus (P) is a major plant nutrient affecting crop yields, forage quality, and the environment. Plants require a significant amount of P since this nutrient has important functions in plants. Phosphorus helps plants sprout early, use water more efficiently, resist cold and diseases, and improve quality of produce and N uptake efficiency.

Many soils contain a lot of P but it is unavailable or 'fixed'. Growers and researchers have noticed that P start up fertilizers would provide yields response on most soils. That is why growers have been applying P fertilizers and continue to do so. Atlantic Canada has well developed livestock industry that has been and is generating significant amount of manure. Growers know that more than 60 % of the nutrients (NPK) in animal feed may end up in manure. Growers have traditionally been using manure as crop nutrient source, and in doing so, recycling the nutrients and closing the nutrient loop. In most cases, manure has been applied on the basis of its N content. However, the N:P ratio in manure is usually higher than N:P uptake ratio for corn and small grains. Hence, if manure is applied to meet N requirements of a crop, most probably it may unnecessary raise P content of soil.

An example of this effect is given below (Figures 1&2). One of our long-term field experiments is looking at nutrient availability from dairy liquid manure (DLM) to corn, soybeans, and wheat in a rotation and under no-till system. The liquid manure has been surface applied prior to seeding with no incorporation. While liquid manure was able to meet N requirements of soybeans and corn, it also contributed towards P enrichment of soil.

Figure 1. Effect of liquid dairy manure application at 32 t/ha on soybeans yields and quality.

P is most available at pH 6.5-6.8. At lower pH, P is tided up with iron into insoluble iron phosphates. Hence, keeping your soil pH at around 6.5 by following a proper liming program is important for ensuring good P availability to crops.

Our research indicates that significant amount of agricultural soils in NS have high to excessive P, due to the traditional uses of super phosphates and manure (as outlined above).

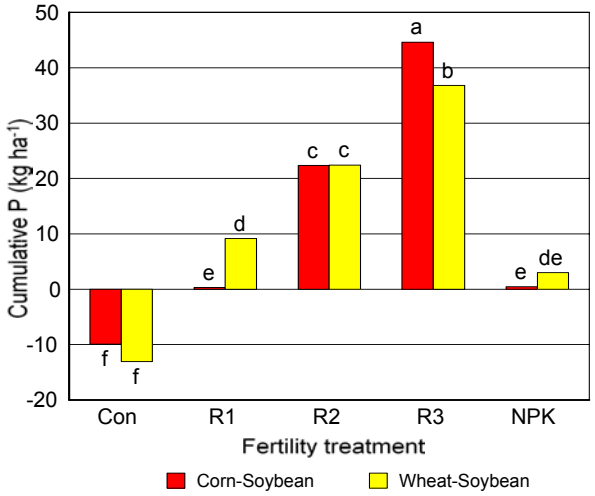

Figure 2. Accumulation of P in cropping systems as a result of liquid manure application. Interaction effect of fertility and rotations of soybean on the cumulative amount of P after two growing seasons in a no-till system. Con – unamended control, R1 – 32 t/ha Liquid Dairy Manure (LDM), R2 – 48 t/ha LDM, R3 – 64.3 t/ha LDM, NPK – Chemical fertilizers applied based on soil tests and to meet crops requirements.

The emphasis on nutrient management planning has been based, in most part, on optimizing nitrogen inputs. On farms where animal manure is the major or only fertilizer source, this system has allowed P to be over applied. Soils in many areas near intensive livestock production facilities are very rich in P. When soil P exceeds the soil's capacity to bind P, runoff, erosion, or leaching becomes an environmental concern with the eutrophication of rivers and lakes. Eutrophication is water pollution caused by excessive plant nutrients whereby excessive growth of algae is promoted by these phosphates. Eutrophication limits the use of surface waters for aesthetics, fisheries, recreation, industry, and drinking, and may kill fish. P-enriched soil has been named a national problem in the US by the USDA and EPA. In many states, nutrient management and manure application are based on P.

Research conducted by the Cropping Systems Research Program (CSRP) to address the P-enriched soils in Atlantic Canada:

The CSRP has several projects on P

I. Evaluation of Phosphorous Availability from Manure

Environmental concerns have led a trend toward P-based manure application. With this approach the P-content of the manure is matched with the crop P requirements to determine manure application rates. Lab analysis can determine the P content of livestock manure very accurately; however, to determine the appropriate manure applications for crop production it is also necessary to know how much of the manure P is actually available for crop uptake. Estimates of manure P availability (as a % of total manure P content) vary quite widely (between 35% and 95%). The wide range of estimates makes practical management decisions difficult. Research has been initiated to determine the fertilizer P equivalence of different livestock manure and compost on soils with different properties. The information derived from this research would assist producers in making management decisions which give the greatest economic benefit from manure use, while helping to mitigate the potential environmental problems. Results from this research will be available soon.

Figure 3. Solid manure application to forages in a dykeland experiment. CSRP, field #306.

II. Assessment of Phosphorous Levels in Nova Scotia Soils from 1985 to 2004

An assessment of the soil phosphorous levels of Nova Scotia over the past 19 years (1985-2004) is currently under way whereby deep soil cores are being collected from 30 selected farms throughout NS. P characterization for these soil samples will be conducted. The data will be applied to GIS using postal code and counties as the location distinction. We are analyzing the archive data on soil P available at the Nova Scotia Department of Agriculture and Fisheries (NSDAF) Quality Evaluation Lab. There are over 150,000 records over the past 19 years from 18 different counties, 6 crop groups, and more than 19,000 postal codes. Preliminary investigation of the data shows that range of phosphorous for crop group 1 (includes forages, grains such as wheat, barley corn) is 44-7855 kg/ha. When the soil P levels for the individual counties of Nova Scotia from 1999 to 2004 (crop group 1) were averaged, the P levels range from 101-642 kg/ha (Table 1). Each crop has a rate classification for P and the ratings for crop group 1 are low (0-141 kg/ha), medium (142-215 kg/ha), high (216-411 kg/ha) or excessive (416-1000 kg/ha).

The 'normal' background level of total P in soils is approximately 800-1700 kg/ha, whereas the range for extractable soil P is between 165-411 kg/ha. Therefore, some farms are applying excessive amounts of P to their soils (according to the individual records from Harlow). The selected farms with either excessive or low P levels will be investigated by survey and deep core soil samples in 2004&2005.

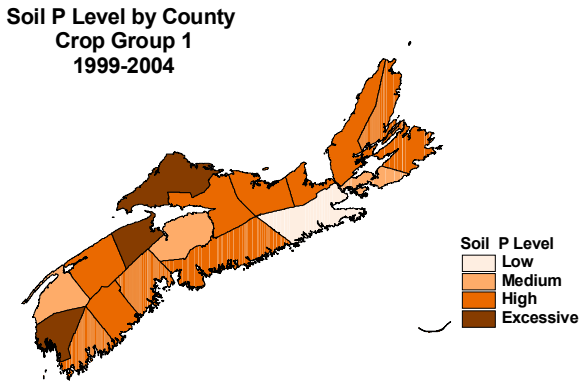

Table 1. Mean soil P levels

County	Mean soil P (kg/ha)	Range (kg/ha)
Annapolis	302.5	62-5301
Antigonish	295.9	120-4847
Cape Breton	344.0	70-7855
Colchester	327.7	70-5009
Cumberland	438.8	100-4375
Digby	241.3	229-5260
Guysborough	143.4	57-652
Halifax	201.2	56-4348
Hants	257.3	66-2201
Inverness	210.4	60-1805
Kings	605.9	51-5331
Lunenburg	352.6	105-4189
Pictou	274.9	88-2169
Queens	207.2	107-2084
Richmond	126.9	66-498
Shelburne	166.0	44-330
Victoria	213.6	194-1403
Yarmouth	442.6	158-6041

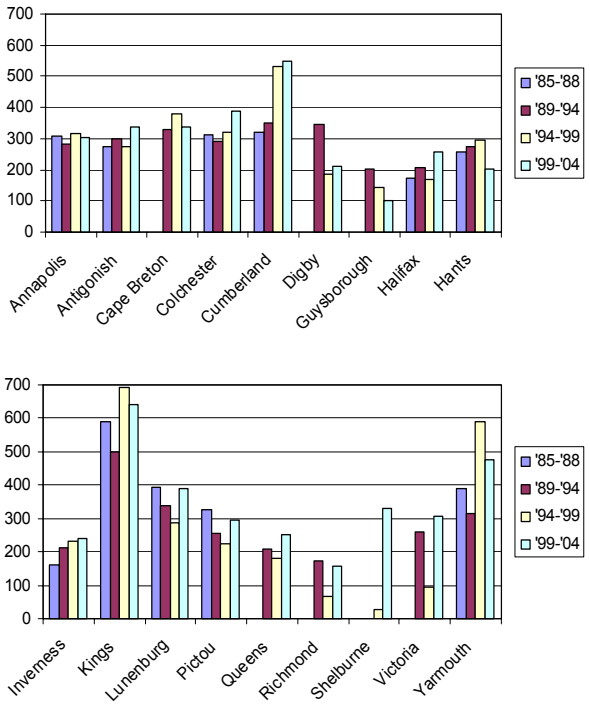

Figure 3. Mean soil P levels (kg/ha) for each county in Nova Scotia over 19 year (4 time periods).

III. Remediation of High Phosphorus Soils in Nova Scotia.

The goal of this project is to develop practically feasible and economically viable approaches for reducing excessive phosphorus (P) and P availability in NS soil. Specific objectives of the field experiments are: (1) To assess various approaches for phytoextraction of excessive P in NS soils. 1.1. Estimation of phytoextraction ability of 8 crop plants in combination with enhancer of P availability. (2) To assess immobilization approaches. 2.1. To evaluate the ability of 16 soil amendments and tillage practices for their capacity to modify P availability and thus surface P runoff. Field, controlled environment, and in-lab incubation experiments are being conducted to meet the above objectives. Expected outcome include: (1) Identify combination of crop plants, soil amendments, and agricultural practices that have a significant potential to reduce or immobilize excessive soil P, (2) Develop a feasible phytoremediation technology for phytoextraction of excess P in NS soils, (3) Develop a feasible immobilization technology for immobilization of excess P in NS soils. Application of such technology may have a significant impact on agricultural industry and on the environment in the region.

Figure 4. Field experiments with liquid manure application to rotations of soybeans, corn, wheat, and red clover. Cropping Systems Research Program, field #400.

Figure 5. Experiments at CSRP on remediation of P-enriched soils in NS.

Figure 6. Experiments at CSRP on availability of P from various manures.

The information derived from the research performed by the Cropping Systems Research Program (CSRP) would assist producers in making management decisions which give the greatest economic benefit from manure use, while helping to reduce the potential environmental problems. Nutrient management practices and manure application should be based on P rather than on N alone.