

# NEWS & VIEWS

A regional newsletter published by the  
Potash & Phosphate Institute (PPI) and the  
Potash & Phosphate Institute of Canada (PPIC)



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May 2000

## Soil Fertility Research for Production Agriculture

THE fertilizer industry is committed to the betterment of crop production. This brief review of research projects in the Eastern Canada and Northeast U.S. region is a reflection of that commitment. These projects are supported by the Foundation for Agronomic Research (FAR), the Potash & Phosphate Institute (PPI) and the Potash & Phosphate Institute of Canada (PPIC), through financial and professional involvement.

### Ontario



#### Soil Fertility Effects on Soybean Isoflavones

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*Project Co-operators: Dr. Chung-Ja Jackson, Dr. Tony J. Vyn, Dr. T.Q. Zhang.*

Isoflavones are considered one of the health-promoting components of soybeans. The U.S. Food and Drug Administration has recently affirmed the role of soybean-based foods in the prevention of heart disease. The objective of this project is to determine the effect of potassium (K) fertility in soils on the isoflavone content and composition of soybeans. Soybeans grown at various levels of fertility in 1998 and 1999 were analyzed for isoflavone compounds as aglycones of the three principal isoflavones: genistein, daidzein, and glycitein.

Two years of research at a site with low soil K indicate a positive effect of K fertilization on both yield and isoflavone concentration in soybeans. In addition, across six sites in 1998, seed concentrations of K and isoflavones were positively correlated. Yield was also positively

correlated with isoflavone levels. These results give soybean producers additional incentive to manage K fertility for soybeans. The work also provides an important message for consumers, indicating that high-yield production practices for soybeans enhance rather than detract from nutritional quality. Further research continues.



#### Effect of Phosphate Fertilization on the Levels of Functional Food Ingredients in Fruits and Vegetables

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In recent years, public interest in the disease-preventive and health-regulatory roles of fruits and vegetables has grown dramatically. The components that support these roles are termed functional food ingredients or phytochemicals. Fertility management for fruit and vegetable production has not been oriented towards maximizing these phytochemicals and secondary metabolites. Preliminary work has shown an association between phosphorus (P) compounds in apples and phytochemicals that prevent development of superficial scald in storage. The purpose of this project is to determine the effect of P nutrition on a range of secondary metabolites and phytochemicals in apples and tomatoes.

We applied P fertilization treatments on two varieties of apples (Red Delicious and McIntosh), and two varieties of tomatoes (Celebrity and H 9478), either as soil-applied superphosphate or as foliar spray (Hydrophos and Seniphos, Phosyn Ltd.). Phosphorus fertilization appears to have increased several quality parameters of apples. These include increased red pigments, farnesene and ester volatiles and a reduction in the incidence of superficial scald. Further analyses of P components, flavonoids, and sugars remain to be completed.

These preliminary results are being confirmed as the project continues. We are also working with modified expression of genes in both apples and tomatoes that influence the translocation of P within the plants. The objective is to evaluate the role of these genes on lycopene levels in tomato and other P compounds in apple.



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### **Surface Broadcast and Incorporated Lime: Impact on Soil pH, Soil pH Distribution, and Soybean Yield Response to Fertilizers**

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In recent years, Ontario soybean production has expanded to exceed the acreage of corn. Yet, compared to corn, far less research has been done on soybean phosphorus (P) and potassium (K) needs. Soybeans are more frequently planted with reduced or no-tillage, and this raises further questions regarding optimum placement of P and K and its interaction with lime. The objective of this project is to determine the rate of reaction and depth of influence of lime in soil under reduced tillage systems, and to assess its effect on soybean yield response to applied nutrients. This study is being carried out with funding from the Ontario Agri-Business Association, the Canadian Fertilizer Institute, and three soil testing laboratories: Agri-Food Laboratories, Guelph; A&L Canada Laboratories East, London; and Stratford Agri-Analysis, Stratford.

Continued monitoring of soil pH changes in 1999 has indicated that much of the pH change induced by lime occurs within the first few weeks after lime application, and that additional lime effects in the following one to two years are small. Without tillage, the effect of lime on soil pH did not extend below the top two inches. Within-season, soil pH fluctuated by up to 0.5 units. At the same site where soybean yields responded to the P and K starter in 1998, the 1999 corn crop yielded 37 percent more with starter, despite severe drought that limited corn yields to 65 bu/A. There were no interactions between lime and starter fertilizer at any of the three sites.



### **Potassium Sources for Soybeans**

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*Project Cooperator: Mr. Tom Welacky*

Little Ontario research has been done on soybean K needs. The relative chloride (Cl) sensitivity of Ontario cultivars has not been tested. The objectives of this project were to determine whether Cl or magnesium (Mg) applied with K fertilizers influence soybean response to K, and to determine whether Ontario soybean varieties differ in response to K and sources of K.

As in 1998, differences among K sources were small and subtle, on the five soybean varieties evaluated. In 1999, sulfate sources tended to promote oil and depress protein, relative to chloride sources. Seed diseases, including *Alternaria*, *Phomopsis*, *Diaporthe*, *Fusarium*, *Cladosporium*, and others, tended to decline with addition of K fertilizers of any source. In the clay loam soil used in 1999, K sources had no effect on seedling emergence. The two years of research have not identified a clear preference for one source of K over another, but suggest that the most direct role of K on the soybean crop was in reducing seed diseases. The project is continuing.



### **Potassium Placement for Conservation-Till Corn Production in Ontario: Residual Effects on Following Soybean Crop**

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Continued conservation tillage produces a stratified distribution of K in the soil profile. For the past three years in Ontario, we compared methods of K placement in combination with tillage strategies in long-term no-till production fields. Generally, we found conservation-till corn to respond more frequently to K in a starter band than corn grown with moldboard plow tillage. Wherever applied K has benefited corn, we have generally observed a soybean response to the residual fertilizer as well. This response has been less consistent in some years than in others, but the residual benefit ranged from a 5 to 17 percent yield boost. This research has stimulated further projects, funded by the Ontario Soybean Growers, to evaluate placement effects of K on soybeans.

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## **Quebec**



### **Using Site-Specific Assessment to Match Nitrogen and Potassium Applications with Corn Requirements**

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The heavy clay soils of Quebec, while level and uniform in appearance, are unique in their distinctive patterns of variability. These patterns were produced by a system of traditional tillage management used in the past to facilitate surface drainage. Preliminary assessments indicated that this variability may be manageable. The purpose of this

new project is to assess the responsiveness of these soils to variable rate application of nitrogen (N) and K, in order to maximize beneficial interactions between the two nutrients.

Within nine producer-managed fields, detailed analysis of the spatial structure of variation in soil fertility has revealed complex correlations. Further analysis is required to determine the manageability of this within-field variation. The project has received matching funding from the Canadian government (NSERC), and is continuing.



### **Development of Plant-Based Phosphorus Diagnosis in Timothy Grass**

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Forage grasses are grown on more than 7 million acres in Eastern Canada. Fertilizing such grasses requires diagnostic tools to assure farmers that applications are economical. Phosphorus concentrations in plant tissue can be diagnostic of fertility status, but the critical concentration varies with advancing growth and development of the plant. This project was conducted to determine critical P levels for each stage of timothy plant growth.

Field and growth chamber experiments included four rates each of N and P in all possible combinations. The field site was established in 1998 and treatments were applied in 1999. Fertilization with N increased yield and N and P uptake of the timothy crop. Fertilization with P increased P uptake but not yield, even though the soil test level predicted a response. The results confirmed the possibility of using P concentration at a given volume of sward growth as an indicator of P requirement. Further work on the same site will aim to confirm critical levels, and will also evaluate the pools of soil P being drawn down by crop removal.

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## **Prince Edward Island**



### **Efficient Phosphorus Management for Potatoes**

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Potatoes are the most important economic crop of Prince Edward Island. Phosphorus fertility is critical for both yield and quality of the crop, but a recent Round Table on the Environment questioned the sustainability and environmental impact of potato production. For these reasons, it is important to document P rate recommendations and investigate methods of improving P uptake efficiency. Additionally, retailers have recently made monoammonium phosphate (MAP) available as a P fertilizer source in addition to the traditional diammonium phosphate (DAP). This project's objectives are twofold: (1) to assess the effect of P sources (DAP versus MAP), at different levels of soil pH, on P and calcium (Ca) uptake and yield of potato, and (2) to evaluate placement of P on the seed piece or topdressed before hilling.

In the past two growing seasons, top-dressed P applications increased petiole P levels more than other P placement methods, but only temporarily. Seed-placed applications did not consistently increase petiole P levels. The Shepody variety maintained higher levels of petiole P than the Russet Burbank variety. Even though the soil test P levels were high to very high, total tuber yield responded to applied P, more in 1998 than in 1999, and more for Russet Burbank than for Shepody. Lime application did not increase yields significantly, and differences among MAP and DAP sources of P were not significant. The project is continuing in the 2000 growing season.

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## **Connecticut**



### **Potassium Fertilization of Kentucky Bluegrass to Increase Summer-Stress Tolerance**

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The objective of this project was to examine various combinations of N and K rates on Kentucky bluegrass to assess whether superoptimal levels of K uptake would contribute to stress tolerance. The project was initiated in spring 1999 on newly sodded Kentucky bluegrass turf plots. Treatments included four rates each of N and K in factorial design. Measurements of leaf temperature under stress conditions indicated no differences in leaf temperature, and thus no differences in transpiration, caused by any of the treatments. The high soil test level for K (115 ppm), and a non-optimal application timing, were likely responsible for a lack of response to K in 1999. The project is continuing.

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## Maine



### Nutrient Management Strategies for Increased Forage Production

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Across eastern Canada and the northeastern U.S., more than 5 million acres of land produces mixed hay. The lost opportunities arising from under-fertilizing this crop could be in the neighborhood of \$300 million. The objective of this project is to investigate the influence of N, P and K fertilization on forage yield, persistence and quality. In particular, this study will compare manure and commercial sources of nutrients.

In past years, hay yields have responded to both sources of nutrients. Results from 1999 continue trends identified in previous years. Applications of manure to supply the recommended amount of N produced a hay yield of 3.6 tons/A, in comparison to 3.9 tons/A with equivalent rates of N, P and K as commercial fertilizer. Using manure results in slightly lower yields in about one-half of harvests, mostly due to unpredictable losses of N with surface application. When N alone is applied, the botanical composition appears to shift toward a single low-productivity species (bluegrass) while the manured and NPK treatments maintain a desirable mixture of several grass species and clover.

These results should encourage forage producers to use both sources of nutrients to increase yields from the current average of 1.95 tons/A. Continued study in 2000 will measure more precisely the shift in species composition.

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## New Jersey



### Nutrient Removal in Corn Grain as Influenced by Phosphorus Fertilizer Practices

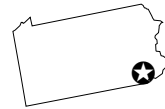
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An important aspect of nutrient management planning is an accurate estimate of nutrient removal by crops. Today's crops may remove different amounts of nutrients than those in the past because of new hybrids, yield levels and nutrient management practices. The objective of this project is to measure P and K removal by corn grain over a range of growing conditions in the Northeast.

Across 13 sites in 5 states (DE, MA, MD, NJ, and PA) of the northeast U.S., grain corn removal of  $P_2O_5$  averaged 0.42 lb/bu with a CV of 24 percent. Removal of  $K_2O$  averaged 0.27 lb/bu with a CV of 17 percent. Corn yield was significantly and positively correlated to concentration of P, copper (Cu) and zinc (Zn) in the grain. Higher yielding corn also tended to contain more K and Mg per bushel. Further analysis will be done on 1999 corn samples to confirm these findings.

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## Pennsylvania



### Optimum Corn Management Practices for Drought Prone Soils in Southern Pennsylvania

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Drought risk is a major issue for corn producers in southern Pennsylvania. Growers often choose lower plant populations as one method of reducing the impact of drought on corn yield. The overall objective of these two studies is to evaluate hybrids, plant populations, and starter fertilizers under drought prone growing conditions. This study forms one component of the Mid-Atlantic Regional Interdisciplinary Cropping Systems Project.

Six commercial hybrids were grown at populations ranging from 20,000 to 32,000 plants per acre at two sites in southeastern Pennsylvania. Both sites were strongly influenced by drought in 1999, with average yields of 96 and 65 bu/A. In contrast to the previous year, yields generally declined as plant populations increased. It appears that when drought reduces yield potential below 100 bu/A, optimum plant population decreases from 30 to 20 thousand plants per acre. The six hybrids were also planted with and without a starter fertilizer (10-20-20 applied at 140 lb/A). All six hybrids responded to the starter with increased height and dry matter at V6, but there were no significant responses at harvest in terms of grain yield, moisture or lodging. The three hybrids that responded to starter in the previous year also had slight yield responses in 1999.

In a third study, seven different starter fertilizer treatments were compared, varying in amount and source of N and amount of P and K. These were evaluated in field-length plots in two counties. The Lebanon county site had no significant responses to starter treatments owing to drought (average yield was 105 bu/A). The Centre county site had yield reductions from several starters containing P and sulfur (S) but not from starters containing N only (50-0-0) or N-P-K (10-30-10).

A combination of high soil test levels, a warm spring, ample growing degree days, and limited yields due to drought reduced responses to the starter fertilizers. These studies are continuing.