SPUDLINES

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CONFERENCE ISSUE

THE UNIVERSITY OF MAINE Cooperative Extension

Dear Potato Grower,

This first fall issue of SPUDLINES after the harvest of the 2001 crop. In this issue, we are enclosing the program for the Seventeenth Annual Maine Potato Conference and Trade Exhibit. The conference will be at the Caribou Inn and Convention Center on January 23 and 24, 2002. The trade show again promises to be interesting and informative. License recertification credits will be available for those holding a valid license from the Maine Board of Pesticides Control as will CCA credits for those so certified (call 760-9ipm for details). Be sure to attend and support the exhibitors at the booths.

The Maine Potato Board is holding their annual meeting the evening of January 25, 2002. We hope to see everyone there. Don't miss it.

This publication is in part supported by a grant from the Educational Committee of the Maine Potato Board. The potato growers, processors and brokers of Maine pay assessments. Portions of these assessments were approved for the educational purpose of keeping Maine potato growers and related Maine industry people informed.

Sincerely,

Steven B. Johnson, Ph.D.
Crops Specialist

January 8	**Potato Storage Refrigeration Workshop** Caribou Inn and Convention Center, Caribou
January 8-10	**Augusta Trade Show** Civic Center, Augusta
January 23-24	**Annual Extension Potato Conference** Caribou Inn and Convention Center, Caribou
January 25	**Maine Potato Board Annual Meeting** Presque Isle Inn and Convention Center, Presque Isle
February 1	**CCA Exam** Cooperative Extension, Presque Isle

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Upcoming Programming of Interest

INTERPRETING SOIL ANALYSES

Steven B. Johnson, Ph.D.
Crops Specialist

There are a number of components that make up a soil analysis, as there are a number of components that make up a soil. This is an effort to increase the understanding of some of the components of soils and soil analyses.

Soil pH: The "potential (of) hydrogen" or pH test measures the relative acidity of the soil. The pH is only a measurement of hydrogen and tells us that the soil is acid or alkaline but does not tell us the reason why the soil is acid or alkaline. A low pH does not necessarily mean a shortage of calcium. The pH is purely a measure of the number of hydrogen ions in the soil. Hydrogen ions are positively charged and are attracted to colloidal particles of clay or organic matter. In a balanced soil, the colloidal particles have the correct proportion of various minerals attracted to them. This allows the soil to interact correctly with its environment, giving and taking different nutrients to plant roots and microbes. When hydrogen levels become too high, the soil can no longer interact well with the living organisms around it. Trace elements such as copper, zinc and phosphorus become "locked up" and although present, are not available to plants as nutrients.

The pH of a soil is influenced by three crucial elements: calcium, magnesium and potassium. The balance of these within any soil will determine the hydrogen level (or pH) and the relative health of the soil. Only a healthy soil, well balanced with these elements, can support a good level of microbial activity, hold air and water in its structure and allow trace elements to become available for plant use.

Some clay particles are so small that they stay suspended in water. These clay particles are negatively charged and repel each other, which is why they are held in suspension. This is called a suspended colloid. Portions of the organic matter in soils are also suspended colloids. The colloidal constituent of soils is of great importance to pH and the availability of nutrients for plant growth. All the electrical energy of the colloid portion of the soil tells us how much potential there is in that soil to react with other nutrients.

Cation Exchange Capacity (CEC): The negative charge of soil colloids attracts positively charged cations such as calcium, magnesium and sodium. The surfaces of clay and organic matter that hold cations are the action exchange sites. The soil's ability to react is measured as its cation exchange capacity (CEC) in milliequivalents (Meq). CEC is usually related to soil texture. For example, clay soils will have a higher CEC because they have more "surface area" than coarse, sandy soils. The more sites a soil has, the higher its cation exchange capacity (CEC), and the greater its ability to hold nutrients. In order to maintain equilibrium, the negative charges in the soil must be balanced by positive charges. This means that exchange sites are always full, safely storing plant nutrients. In a nutshell, the higher the CEC and organic matter, the more lime it will take to move the pH.

Base Saturation Balancing -- Major Elements of Cation Exchange: Conventional soil analysis centers around phosphorus, potassium, magnesium and pH, but does not focus on the *balance* of the soil. In order to have chemical equilibrium it is essential that major elements are balanced on the soil colloid exchange sites. This allows the soil to function far more efficiently than if they are out of balance. The first priority is to achieve a balance between calcium and magnesium. This will benefit nutrient availability, soil structure and ease of cultivation.

Base saturation analysis centers around the ratio of exchangeable bases making up the CEC, and is expressed on a percent basis. There are several theories on what these ratios should be. Some deal with the ratio of Ca:Mg being from 5 to 10 based on the CEC; others involve the Ca being a 7-fold multiple of the Mg and the Mg being a 2-fold multiple of the K. I prefer the following approach which identifies ranges for the Ca:Mg:K.

Calcium	**60% to 80%**
Magnesium	**10% to 25%**
Potassium	**5% to 7%**

Calcium (Ca^{2+}): Calcium activates a number of plant growth-regulating enzyme systems, helps convert nitrate-nitrogen into forms needed for protein formation, is used in cell wall formation and normal cell division and contributes to improved disease resistance. Along with magnesium and potassium, calcium helps to neutralize organic acids, which form during cell metabolism in plants. In soil, calcium replaces hydrogen (H) ions from the surface of soil particles when lime is added to reduce soil acidity. Calcium is essential to microorganisms as they turn crop residues into organic matter, release nutrients, and improve soil aggregation and water holding capacity.

Calcium and magnesium must always be considered together and the balance between them kept correct at all times. An excess in one will cause deficiency in the other. In the soil, calcium should occupy between 60 to 80 percent of the positions on the soil colloid in terms of the exchange capacity. When this correct saturation level is achieved, calcium improves soil texture, makes phosphorus and micronutrients more available and improves the environment for microbial growth. Calcium tends to improve soil structure; therefore on a light soil structure the target for calcium would be nearer 60 percent, while on heavy clay it would be nearer to 80 percent.

Magnesium (Mg^{2+}): Magnesium is closely associated with calcium and therefore the two elements should be considered together. Fertilizer more readily inhibits magnesium than calcium, particularly super phosphates.

Magnesium is an essential component of the chlorophyll molecule, with each molecule containing 7 percent magnesium. Therefore magnesium is important to plants in photosynthesis. Magnesium also acts as a phosphorus carrier in plants. It is necessary for cell division and protein formation. Phosphorus uptake could not occur without magnesium and vice versa. Magnesium is essential for phosphate metabolism, plant respiration and the activation of several enzyme systems. Magnesium aids phosphate metabolism and activates several enzyme systems. It should be remembered that magnesium is far more reactive than calcium in the soil. Magnesium has far more influence on soil pH than calcium. Magnesium has 1.67 times more exchange capacity than an equal amount of calcium. It should occupy between 10 percent and 25 percent of the soil's cation exchange capacity. Magnesium helps to hold the soil together and tightens it up in terms of physical structure. Deficiencies occur most often in coarse-textured, acid soils.

Magnesium availability to plants is often related to soil pH. On soils with a pH below about 5.8, excessive hydrogen and aluminum can influence Mg availability and plant uptake. At pH values above 7.4, excessive calcium may have an overriding influence on Mg uptake by plants. Sandy soils with low cation exchange capacity have a low Mg supplying power. Application of high calcium lime can aggravate a Mg deficiency by increasing plant growth and increasing the demand for Mg. High applications of ammonium and potassium may also interfere with balanced nutrition through competitive ion effects. Magnesium tightens the soil and pulls it together, making it sticky. The higher the magnesium content, the stickier the soil will be when wet, the harder when dry. In a clay soil, the target for magnesium would be 10 percent.

For soils with a cation exchange capacity (CEC) higher than about 5 milliequivalents (Meq) per 100 grams, it may be desirable to maintain the soil Ca to Mg ratio at about 10 to 1. For sandy soils with a CEC of 5 Meq or less, it may be desirable to maintain the Ca to Mg ratio at about 5 to 1.

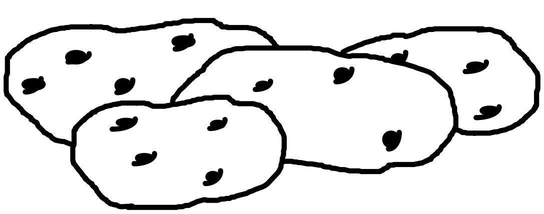
Potassium (K^{+}): Potassium is involved in the conversion of free air-borne nutrients -- carbon, hydrogen and oxygen -- into plant materials: starches, sugars, proteins, vitamins, enzymes or cellulose. Potassium is inhibited by a soil too high in iron or with a low pH. Both potassium and phosphorus benefit enormously, in the terms of availability to plants, from the decomposition of nutrients by soil microbes. Because potassium (K) is a cation, it can be measured like calcium and magnesium. Generally, K levels are 5 – 7 percent saturation.

Availability of Trace Elements: There are three forms in which plant nutrients can exist in soils: **unavailable, exchangeable (partly available) or soluble (readily available).** In the ***unavailable*** form the nutrient element is bound in a chemical compound that renders it unavailable so it is not free to be absorbed by plants. Decomposition of the compound is required to free the element for use. For example, nitrogen or other elements bound in plant residue or soil organic matter cannot be used until the organic compounds have been decomposed by soil micro organisms, which then release the nutrients in an available form for plant use. Phosphate added in a soluble form as fertilizer can be rendered useless to plants, as it precipitates into the highly insoluble iron and aluminum phosphates. The ***exchangeable*** form is when an element is "adsorbed" (attached to the surface of a colloid particle) and available for exchange. Most colloids are negatively charged and it is the positively charged cations that are attracted to them. In addition to macro elements, calcium, magnesium, sodium, potassium and hydrogen cations also include zinc, copper, manganese and iron as trace elements. Plants can exchange cations with the colloids freely. If elements, such as potassium, are not held by a colloid or plant root in exchangeable form, they are soon washed out of the soil. When soils become too acidic, some of the exchangeable cations become unavailable to plant roots. Sulfur, nitrogen, phosphorus, molybdenum and boron form negatively charged ions called anions. These are not held to any great extent by the soil in exchangeable form. These elements are mainly present in soluble form in soil solution, or in fairly insoluble substances such as calcium sulfate or dicalcium phosphate. A main source of these elements is in organic combination with plant residues and soil organic matter. Most fertilizers are designed to provide nutrients in the most ***available***, soluble form. However, if applied to soils that are imbalanced in terms of the cation exchange equilibrium, much of the product can be readily leached from the soil, only offering short-term benefit. The availability of minerals to the plant for uptake varies according to soil pH. Between 6.0 and 6.5 there is maximum availability for boron, copper, iron, manganese and zinc. However, this only holds true if, in addition to the correct pH (hydrogen level), there is also the correct balance of macro elements on the cation exchange sites of the soil colloid particles. In other words, calcium, magnesium, sodium and potassium must also be in correct balance to enable the trace elements to become available for uptake. Nitrogen, phosphate and sulfate must also be adequate.

The basic idea is that inadequate exchangeable Ca results in poor soil structure, characterized by "tightness," because the amount of pore space for air is less than optimal. Consequently, root health is compromised and nutrient availability and uptake reduced. A general rule often given is that the ratio of Ca to magnesium (Mg) should be about 5-7 to 1.

POTATO STORAGE REFRIGERATION WORKSHOP OFFERED

All potato growers and allied industry people are invited to attend a Potato Storage Refrigeration Workshop. The workshop will be held on Tuesday, January 8, 2002 at the Caribou Inn and Convention Center from 1:00 p.m. to 5 p.m. The featured speaker will be Jim Peary, Instructor of Refrigeration, Air Conditioning and Heating at Eastern Maine Technical College. He has many years experience teaching refrigeration and air conditioning and will provide a wealth of information in layman's terms. Mr. Peary will discuss Basic Refrigeration; Buying Equipment: Operating and Maintenance Tips; and Basic Maintenance. He will prepare handouts covering workshop material. This workshop is intended for growers who currently own refrigeration systems or who are planning to install refrigeration systems in the future. There will be no charge for the workshop, however attendance is limited and pre-registration is required. Pre-register by Friday, January 5 with Bart Bradbury, McCain Foods @ 488-1254 or with Steve Belyea, PMIF @ 764-2105.



CONSIDERATIONS AND DECISIONS WITH THE CHANGES COMING TO THE POTATO INDUSTRY

John Jemison, Ph.D.
Extension Water Quality and Soils specialist

It has been said that the only thing you can depend on is change. Change is clearly coming again to the potato industry, and the decisions we make today will strongly affect where we will be in a decade. Some say the change is growth in the potato industry because of the need for more processing potatoes. Others say that the industry is not going to grow but acreage in potatoes will remain constant. There are some things that potato growers should consider whether acreage significantly increases or not.

In the ten years that I have worked in Maine, the state's potato acreage has slowly declined. This decrease has been painful to many producers and to the agriculture infrastructure. However, the one benefit of the reduced potato production is that many growers have increased the number of years between potato crops in a given field. In the 1980's, the standard practice was to grow potatoes for two or three years and then rotate to a grain crop. With more land available, growers have moved to growing potatoes every second to third year. This beneficial rotation change has improved soil quality and potato productivity, providing an important lesson in sustainability.

Consider the number of soil disturbances that take place to produce a potato crop. Soil is worked in the spring to plant potatoes. Many growers cultivate once in the spring and then hill potatoes at least once during the year. Harvest involves another soil disturbance, and considerable traffic and compaction. If you fall-plow, the soil is disturbed yet again. Every time the soil is disturbed, you deplete your organic matter reserves. Organic matter is like fuel in your home's oil tank, and your rotation crop is like the oil delivery person. The combination of tillage plus the minimal amount of potato residue returned to the soil following potato production depletes soil organic matter. Stretching the oil tank analogy, back-to-back potato production is like having your oil delivery person take an extended vacation to Florida in January. Some soils are naturally better than others. Good productive soils provide the security of a well-insulated house with an extra 250-gallon oil tank in the basement, while other soils are more like a drafty old house with a small oil tank.

Growers looking at the possibility of increased potato production have three options:

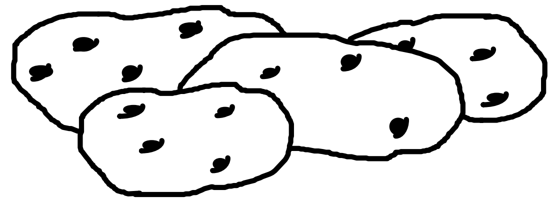
- Maintain the same land base and shorten the rotation to a potato-grain or potato-potato-grain.
- Bring marginal land back into production (possibly land set aside in the conservation reserve program [CRP]).
- Consider more sustainable approaches.

Looking at the first option, suppose that you currently farm 600 acres of land, of which 200 acres each year are in potatoes. You are offered a contract to produce 400 acres of potatoes, so you have to make some choices. You could shorten your rotation and start producing potatoes two years out of three on the same land base. Continuing with the oil tank analogy, that is like starting the year with less than a full tank of fuel oil. Over the next five to ten years, you will increasingly stress your soil resource. We know that poorer soils hold less water and require more nutrient and chemical inputs. If you go back to practicing short potato rotations, potato yield and quality will suffer.

If you are thinking about bringing more land back into production—going from 600 acres of total production to 1000 or 1200—you may be considering CRP land. You may be thinking that if these soils have been “retired” or “asleep” for five or ten years, organic matter levels should be high and productivity will have improved. This is probably not the case. In fact, chances are good that the organic matter levels have only changed significantly on CRP fields if you have added amendments to the soil over that time period. While some of this land was seeded down and maintained, most CRP land was allowed to revert to natural vegetation for wildlife habitat. The bulk of CRP land was set aside to begin with because it was marginal, steeply sloping, or contained highly erodible soil.

In order to consider more sustainable approaches, we’ll all need to get creative to make this increased potato production be a long-term agronomic and environmental win-win. The best way to approach the changing situation is to meet with your Extension and/or Soil and Water Conservation District staff to identify the best, most affordable fields to bring back into production. When you bring land back into production, start with the very best land possible. Think about how you can develop rotations that will minimize soil disturbance and erosion. A one-to-one rotation of potatoes and grain is only a slightly worse than a potato-soybean-grain rotation on erodible land. We will need to make use of the work by Greg Porter, Tim Griffin, and Wayne Honeycutt to find the best rotations to maintain soil quality, and be willing to forego some short-term profit in order to stay in the game for the long term. We will also need to get more livestock into Aroostook County. This will provide markets for quality hay and grain rotation crops, making longer rotations such as three years of hay followed by two years of potatoes feasible. Livestock manure used either on potatoes or the rotation crop will be critical to help build soil organic matter. As you plan for the future, consider rotations that minimize soil disturbance and return the greatest amount of organic material to the soil. Even if you can grow potatoes, rotate to barley under-sown with clover, and leave the clover there for a year. This will reduce the number of times that soil is stirred and exposed to erosion and organic matter mineralization.

Where do we as the potato industry want to be in five to ten years? I think increasing potato acreage by half is great for the industry, but it is only good if we can maintain the yield and quality. Preserving the long-term soil quality will help us keep the industry at 90,000 acres of potatoes over the long term.

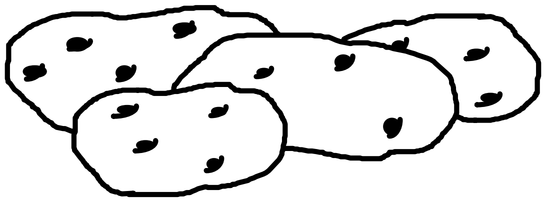


KNOW YOUR POTATO PESTS: FOXGLOVE APHID

Steven B. Johnson, Ph.D.
Crops Specialist

The foxglove aphid (*Aulacorthum solani*) is smaller than the potato aphid, but larger than the green peach aphid. This aphid is probably the least common aphid in Maine. The wingless foxglove aphid ranges in color from light green to yellow green, or may even be a shiny dark green. The thorax and head of the winged foxglove aphid are light yellow-brown or green-brown to dark brown in color. The abdomen color ranges from green to yellow-brown with darker bars and spots. The foxglove aphid has been known to spread potato leaf roll virus, and its feeding can induce curling, mottling, wrinkling, streaking, and premature death of the plant, especially during dry seasons. Yields can also be affected. The eggs of this insect overwinter on foxglove, hawkweed and plantain, where females hatch and then give birth to wingless females. Winged females occur in the second generation, and are the majority in the third generation. These then fly to other plants, including potatoes. During the summer, there are several generations.

Wingless males develop late in the fall. Egg-laying females develop, mating occurs and eggs are laid.



THE 2001 ANTI-BRUISE CAMPAIGN

Steven B. Johnson, Ph.D.
Crops Specialist

The Maine Potato Board again financed the Anti-Bruise Campaign for the 2001 harvest. Four inspectors rated 548 tuber samples during September and October. Skinning injury and slight or serious bruise were evaluated by four inspectors working under the supervision of the Agricultural Bargaining Council. The Agricultural Bargaining Council also compiled data for the program. This year, 153 additional samples were rated by an additional inspector using an "electronic potato," under the direction of the Agricultural Bargaining Council.

Bruise damage from the 2001 harvest was about like the previous year. The higher level of Ontario bruise-free potatoes during the 2001 harvest has reduced the bruise-related damage, especially the blackspot bruise that occurred the last two years with this variety. Table 1 lists bruise results from selected varieties. Samples from these eight varieties comprise 71 percent of the total samples. The complete report is available from both the Maine Potato Board and the Agricultural Bargaining Council.

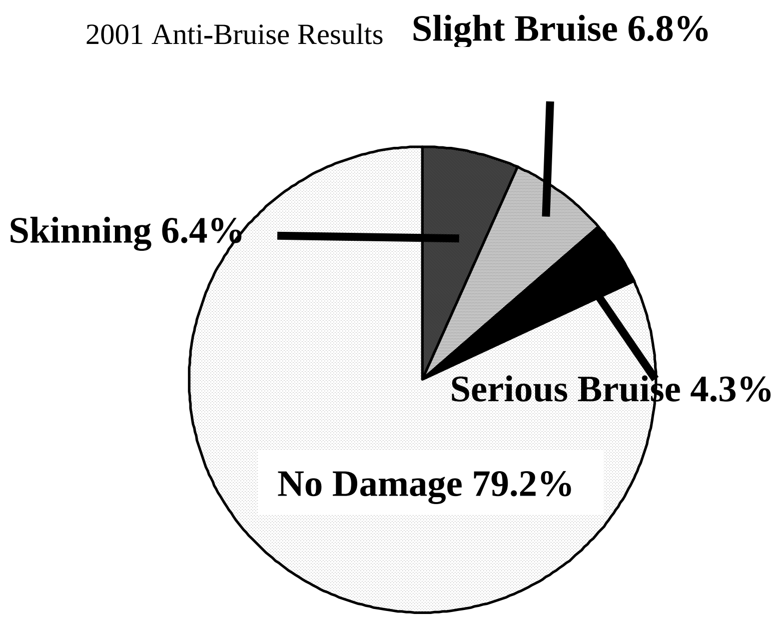
Table 1. Bruise Rating Selected Varieties.

Variety	Percent Bruise-Free 2001	Percent Bruise-Free 2000
Norkotah	98	93
Shepody	91	95
Russet Burbank	95	88
Superior	93	91
Atlantic	86	89
FL1625	86	70
FL1833	82	84
Ontario	96	72

Table 2. Bruise Ratings by Year.

Year	Percent Skinning	Percent Slight	Percent Serious	Sample Number
1994	7.6	5.2	8.4	606
1995	9.9	7.5	6.3	617
1996	2.2	4.9	4.8	519
1997	6.6	3.9	6.0	546
1998	3.5	3.8	2.2	569
1999	1.8	3.4	3.5	415
2000	10.7	4.3	5.8	653
2001	6.4	6.8	4.3	548

2001 Anti-Bruise Results



EARLY BLIGHT AND PDAYS

Steven B. Johnson, Ph.D.
Crops Specialist

Early Blight

Early blight of potatoes is caused by *Alternaria solani*, a fungus that overseasons as viable mycelium and as viable spores in infected crop refuse. *Alternaria solani* is generally thought to be a weak parasite. Plants that lack vigor or are maturing are predisposed to the pathogen. Early blight is often a disease of senescence, where the older leaves are infected first. The disease can progress upward, attacking newer tissue as the older leaves droop and dry up. In severe epidemics, leaves may be killed prematurely, resulting in a subsequent yield reduction. High temperatures and high humidity favor this development of this disease. Rain is not necessary for the development of Early Blight.

This disease first appears as oval or angular target-like spots on leaflets. The lesions on the stems are generally brown to black and are necrotic. The lesions on the leaves are generally dark brown in color, but may range to black. There is usually a narrow, chlorotic zone surrounding the lesions. The lesions tend to be limited in expansion by the larger leaf veins. This is often a disease of senescence, where the older leaves are infected before younger leaves. The disease generally progresses upward, attacking newer tissue as older leaves die. Under severe Early Blight epidemics, leaves may be killed prematurely resulting in a subsequent yield reduction.

Tuber infections, while less frequent than leaf infections, can cause major losses in storage. Tuber lesions are sunken spots, brown to black in color, and usually circular. The margin of the lesions is usually quite well defined. The tissue under the lesion can take on the appearance of a corky dry rot in the periderm. Tuber infections are not common in Maine.

Control of early blight can be greatly aided by crop rotation as this will help reduce potato refuse. Proper fertility levels will delay the onset and reduce the severity of the disease. Maintaining a protective fungicide program until the vines are totally dead will reduce losses from early blight.

Early Blight Prediction

The early blight prediction and control program is based on the potato plants being driven by temperature. Recent advances in timing of the initial spray for early blight control have been made possible with recording weather stations. Daily minimum and maximum temperatures are used to calculate Pdays (Sands, P. J., Hackett, C., and Nix, N. A., 1979, *Field Crops Research* 2:309-331.). Pdays are somewhat similar to growing-degree days but are based on optimal temperatures for potato growth. Potatoes do not grow above 86 degrees or below 44.6 degrees and grow best at 69.8 degrees. Pdays take this into consideration and are a temperature-unit measurement of how fast the weather is driving the growth of the potato plant. Pdays are a better measure of the physiological development of the potato plant than are calendar days. Calendar days do not take into consideration the effect of temperature on potato development. Each calendar day can accumulate from 0 to 10 Pdays, dependent on the temperature. Pdays can be used to determine the first application for early blight control.

The onset and control of early blight can be predicted with the aid of computers. I am merging weather data collection with disease prediction and simplifying the process. There are weather stations tied in with computers and computer models to forecast early blight. The weather stations are Davis Weather Monitor II; the computer program is named “NoBlight.”

Current information from observations, coupled with weather stations operating in Maine indicate that early blight control needs to be initiated from between 450 and 700 Pdays from emergence, depending on the season. The season-dependent thresholds for early blight are initially established for typical Maine conditions. Better identification of the onset of early blight will lead to better and more economical control of the disease.

SPUDLINES is published by the University of Maine Cooperative Extension to provide information for the Maine Potato Industry. The annual subscription rate is $5.00. The Educational Committee of the Maine Potato Board provides sponsorship of growers they represent and the allied industry needed to support their growers. For further information, contact: **Steven B. Johnson, UMCE, PO Box 727, Presque Isle, ME 04769; (207) 764-3361 or toll free in Maine 1-800-287-1462 or electronically at:**

sjohnson@umext.maine.edu

MEET PETER SEXTON

Peter Sexton joined the staff of the Cooperative Extension Potato Program in late June of this year. He will be working as an agronomist with potatoes and rotation crops. He fills the position previously held by Matt Kleinhenz. Peter has traveled a fair bit. He comes to Maine after working three years in a research position with Oregon State University (Department of Crop and Soil Science), where he was located at a branch experiment station near Madras in central Oregon. His research there included evaluating drip irrigation for seed production of onions and carrots, varied work with potential alternative crops, and nitrogen fertilization of wheat and sugarbeet. Prior to this he was at Iowa State University for three years studying sulfur metabolism and protein quality in soybean. Before going to Iowa, Peter worked for two years as a volunteer in a technical assistance program for small farmers in Bangladesh. He obtained his master's degree and doctorate at the University of Florida in Agronomy (with an emphasis on Crop Physiology), working with peanuts and dry beans.

In the coming year, Peter plans to focus his efforts on the use of micronutrients and growth regulators in potato production, as well as on canola as a potential rotation crop.

Peter hails from Minnesota. His wife Esther (whom he met in Bangladesh) is from Vermont. They have three children (Luke, Gabe, and Ruth), all in elementary school.

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