SPUDLINES

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CROP PRODUCTION ISSUE

THE UNIVERSITY OF MAINE Cooperative Extension

Dear Potato Grower,

This is the second issue of SPUDLINES for 2001. In this issue, the third of a series on plant hormones and plant growth regulators is presented. Jim Dwyer gives some recommendations on scouting for the upcoming season. John Jemison provides some herbicide recommendations and timely information on weed control. Read on for other topics of interest.

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

Upcoming Programming of Interest

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PLANT HORMONES AND PLANT GROWTH REGULATORS: GIBBERELLINS

Steven B. Johnson, Ph.D.
Crops Specialist

This is the third installment of a series of articles about plant hormones and plant growth regulators. Plant *hormones* are naturally produced substances that are produced in one part of a plant and transported to other parts, where they exert an effect that is disproportionate to their very small concentrations. Plant hormones exert an influence on plant growth, as do water and nutrients. Hormones exert an influence on plant growth when present in quantities of less than one part per million. *Plant growth regulators* (PGR) are substances synthesized outside of the plant but cause hormone-type activity when applied to plants.

History of Gibberellins

Japanese farmers first observed the phenomenon of abnormal elongation in certain rice plants early in the season. These plants often became unhealthy and sterile. The Japanese gave this disease many names but most commonly called it bakanae (foolish seedling). In 1898, the agent of the disease bakanae was deduced by Hori as being a fungal pathogen of the genus *Fusarium*. In 1926, Kurusawa discovered that the disease was caused by a substance secreted by the fungal species *Gibberella fujikuroi* resulting to controversy over the true pathogen. It was Wollenweber in 1931 who cleared up the controversy by correcting the taxonomy of the pathogen. He stated that the fungus *Fusarium moniliforme*, which is the asexual or imperfect stage of the ascomycete *Gibberella fujikuroi*, is the culprit for the disease bakanae. In 1935, Yabuta isolated the compound from *Gibberella fujikuroi* and called it gibberellin A. This compound was found to stimulate growth when applied to rice roots.

In the early 1950's Stodola *et al*. of the USDA and Brian *et al*. of the Imperial Chemical Industries in England discovered the early Japanese papers. In 1954, the British discovered an entirely new compound from *G. fujikuroi* and named it gibberellic acid. In 1955, The American scientists also isolated a new compound in addition to what they thought was gibberellin A from *G. fujikuroi* which they dubbed gibberellin X. Japanese scientists discovered at about the same time that gibberellin A was actually made up of three compound which they called GA_1, GA_2, and GA_3. Gibberellin X, GA_3, and gibberellic acid are all the same compound. The latter two are accepted in describing the compound and are synonymous terms today. In 1956, Radley, West and Phinney from UCLA independently described compounds similar to gibberellic acid in plants. In 1957, Takahashi isolated another compound from *G. fujikuroi* that he called GA_4. He also showed that GA_1 was identical to what Stodola *et al*. were calling gibberellin A. In 1958, Macmillan and Suter were the first to isolate and identify GA_1 from plants. The same year, West and Murashige also identified GA_1 in higher plants. In 1968, Macmillan and Takahashi proposed that gibberellins have assigned numbers in order to reduce confusion between compounds.

One of the most active of these and one found as a natural hormone in the plants themselves is gibberellic acid (GA). Gibberellic acid, a gibberellin, is found in both higher plants and fungi. GA has a number of effects on plant growth, but the most dramatic is its effect on stem growth. When applied in low concentrations to a bush or “dwarf” bean, the stem begins to grow rapidly. The length of the internodes becomes so great that the plant becomes indistinguishable from climbing beans. GA seems to overcome the genetic limitations in many dwarf varieties. One of the 7 pairs of traits that Mendel studied in peas as he worked out the basic rules of inheritance was dwarf-tall. The recessive gene - today called le - turns out to encode an enzyme that is defective in enabling the plant to synthesize GA. The dominant gene, Le, encodes a functioning enzyme permitting normal GA synthesis and making the "tall" phenotype.

Biosynthesis of Gibberellins

Gibberellins belong to a large group of naturally occurring compounds called terpenoids (*e.g*., carotinoids). Each of the steps in this pathway up to GA aldehyde are the same in all plants; however, from this point on different species use different pathways to form the more than 90 gibberellins known today. Once produced, there are a number of interconversions between gibberellins that can take place depending on the plant. Young leaves are thought to be the major site of gibberellin biosynthesis, which can subsequently be transported throughout the plant. Roots also have the ability to synthesize gibberellins that are transported to the shoots via the xylem sap. High levels of gibberellins have been found in immature seeds, and cell-free extracts from seeds possess the ability to synthesize gibberellins that are not transported out of the seeds.

Physiological Effect of Gibberellins

Gibberellins promote growth of intact plants. All of the more than 90 gibberellins known today are able to promote either stem elongation, cell division, or both, but their effectiveness varies greatly. The responsiveness of different plants to a chemical depends on many factors. It is not uncommon for one gibberellin to be more active in one plant system then another. In general, growth is promoted by gibberellins in many plant species, especially dwarfs and biennials in the rosette stage. Typically, gibberellins stimulate growth in intact plants more effectively than in excised sections, which is very different from auxins.

There are many gibberellin biosynthesis mutants that have been developed over the years. They are single gene mutations, the plants are generally about one-fifth the size of normal plants and they are characterized by shortened internode length. When gibberellins are externally applied to these mutants, there is a striking increase in size making them similar in appearance to their normal counterparts. There are also gibberellin sensitivity mutants, which do not respond to externally applied gibberellins and contain levels similar to their normal counterparts while still remaining dwarfs. Speculation on why this occurs is that there may be an excess of natural inhibitors contained within the plant or they may be receptor mutants which prevents their growth in response to gibberellins.

Gibberellins have been shown to be involved in the promotion of flowering in a wide range of higher plants. In rosette plants their leaf development is profuse and internode elongation is retarded; however, just prior to the reproductive stage of development the stem elongates five to six times the original height of the plant. If gibberellins are applied to rosette plants under noninductive conditions they will typically promote bolting and flowering. The involvement of gibberellins in the promotion of flowering came under some controversy when it was reported that the use of smaller dosages of GA induced bolting without flowering. This led some to believe that gibberellins had an indirect effect on flowering. Gibberellins have since been shown to be implicated in flowering of a wide range of plants, not only in the bolting response. The influence of gibberellins on bolting includes a stimulation of cell division and cell elongation. In general GA promotes cell division and cell elongation in the subapical region of the plant. Plant growth retardants that block gibberellin biosynthesis cause an inhibition of cell division in the subapical meristem region and induce lateral expansion of the apex.

In seeds, the aleurone layer is responsible for producing α-amylase in response to gibberellin. This enzyme was secreted into the endosperm causing a conversion of starch to sugar. It is thought that gibberellins promote growth by increasing plasticity of the cell wall followed by the hydrolysis of starch to sugar that reduces the water potential in the cell, resulting in the entry of water into the cell causing elongation. The basic steps involved are as follows: GA is produced in the embryo transferred to the aleurone layer of cells where α-amylase is produced via de novo synthesis, which promotes the conversion of starch to sugar and is used for growth of the seedling. Mobilization of endosperm starch in cereals that are initiated by GA-induced α-amylase can be inhibited at the transcriptional level by ABA. In addition to α-amylase there are many other hydrolytic enzymes that are produced in response to GA, gibberellins have also been shown to mimic the effect of red light in the stimulation of lettuce seed germination and to substitute for low temperatures or long days in order to break dormancy. It is now generally accepted that gibberellins are potent promoters of seed germination and possess the ability to break dormancy in a variety of crops.

Gibberellin-Imitating PGR-Type Materials Available for Potato Production

	Cytokinin	**GA**	IAA
	%	%	%
Triggrr	0.012	**0**	0
Early Harvest PGR	0.09	**0.03**	0.045
Stimulate	0.009	**0.005**	0.005

Other PGR-Type Materials Available for Potato Production:

	GABA %	l-glutamicAcid %
Auxigrow	29.2	29.2

Fertilizers:

ACA Plus (7-0-0)
acetic acid

Crop Set (0-0-0)

S	1.5%
Cu	0.2
Fe	0.5
Mn	1.5

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***

WEED CONTROL ISSUES WITH INTEGRATING CROP/LIVESTOCK OPERATIONS

John Jemison, Ph.D.
Water Quality Specialist

Over the past few years, the University of Maine Cooperative Extension has worked with farmers interested in integrating crop and livestock operations. The benefits integration are improved nutrient utilization, reduced feed costs, and improved soil conditions for the potato producer. However, when a potato producer begins working corn land, he/she often faces new weed control challenges. Weeds such as quackgrass (*Agropyron repens* L.), triazine resistant broadleaf weeds, and yellow nutsedge (*Cyperus esculentum* L.) are weeds that may pose additional challenges and call for potato producers to alter their weed management program to control these difficult weeds.

Both quackgrass and yellow nutsedge are perennial weeds, but control measures are quite different. Quackgrass spreads by seed and by rhizomes. If the soil is worked following harvest, fall weed control will be difficult. However, there are postemergence products available for potatoes that will control quackgrass. Yellow nutsedge reproduces by rhizomes, tubers and somewhat by seed. This weed has traditionally not been a real problem in potatoes as it prefers wet soils, but can survive well on all soil types. As growers start sharing land, this weed is becoming more of a problem. Yellow nutsedge can be moved on equipment from one field to another. Once established, yellow nutsedge is nearly impossible to get rid of. So, careful sanitation of field equipment is essential.

Triazine resistant lambsquarters and red rooted pigweed are also common on many dairy farms in Central Maine. While there are many herbicides available for corn to control these problem weeds, there are fewer options for potatoes. Rotate chemical families with different modes of action to reduce this problem.

I have evaluated several new products in potatoes to assess weed control and crop tolerance. Matrix is a relatively new low rate postemergence product for potatoes. Generally applied postemergence at 1.25 – 1.5 oz/ac, this product is moderately effective on nutsedge, triazine resistant broadleaves, and quackgrass. However, some potato varieties exhibit fairly serious overall plant yellowing for as long as a week. Experiments were conducted in 1998, 1999 and 2000 to evaluate whether the overall plant yellowing from Matrix would limit yield (Table 1). Other herbicide combinations such as Axiom (two rates) and Dual II magnum were compared against a standard gramoxone/metribuzin treatment. Crop injury, herbicide effectiveness and potato yield were rated. One aim of the project was to find out what degree of crop injury would cause yield reductions.

Table 1. Potato Herbicide Evaluations

Year	Location	Planting Date	Variety
1998	Corinna	April 27	Frito Lay
1999	Stillwater	May 5	Yukon Gold
2000	Stillwater	May 29	Superior

Year	PE Herbicide	Harvest
1998	May 2	Aug 17
1999	May 7	Sept 6
2000	May 31	Sept 20

Matrix was applied at 1.0, 1.25 and 1.5 oz/ac in 1998, 1.0, 1.5, and 2.0 oz/ac in 1999 and 2000. Crop injury was assessed using a SPAD meter made by Minolta. This hand held meter provides a non-destructive estimate of leaf color that is correlated to leaf chlorophyll. Matrix + Sencor applied postemergence was compared to standard preemergence weed control treatments of Dual II-Magnum + Sencor (1.5 pt/ac and 8 oz/ac) and/or Sencor + Gramoxone (10 oz/ac + 16 oz/ac).

Overall we found that if Matrix and Sencor are used in combination, weed control is as effective if Matrix and Sencor are used at 1.5 and 8 oz/ac respectively. Matrix used at 1.0 oz/ac did not provide adequate weed control, particularly of lambsquarters. We found over 95% control of most problem weeds with all the herbicides we evaluated. Matrix caused significant yellowing of the crop in both 1998 and 2000. However, in 1999, no significant yellowing was observed. In most years, slightly to significantly lower yields were measured presumably owing to this yellowing. In most years, this difference was not statistically significant, but the range in decreased yields ranged from 11 to 40 cwt US #1/ac compared to the standards. If this yellowing is assessed within four days of application, the crop response can be predicted with reasonable 75 percent confidence. From this information, my recommendation is to use Matrix postemergence at the recommended rate when difficult to control weeds are present. As a regular herbicide program, the potential injury may be significant enough in some years to cause yield loss. Alternating herbicide modes of action will keep these products effective over time.

TUNING POTATO PLANTERS FOR IMPROVED POTATO STANDS

Steven B. Johnson, Ph.D.
Crops Specialist

Potato planting time always seems rushed, what with rapid weather changes and associated changes in soil conditions. Erratic seed quality and erratic cutting can complicate the rush. The need for seed quality and proper handling and cutting of seed have been stressed heavily and growers have made major improvements in these areas. While these factors can result in poor stands, they are not the only factors that can influence stand. Poorly adjusted potato planters can seriously impact potato stands.

The modern potato planter is not one piece of equipment, but several pieces attached together. The potato planter consists of four or six individual planters and needs to viewed as such. ***Each individual planter needs to be calibrated.***

Hook up: The planter needs to be level while pulled. The planter draw bar should be level when hitched to the tractor. Fertilizer and seed may not be properly placed if the planter is not level.

Tire inflation: The operator's manual lists recommended tire pressure. Improper tire pressure can lead to tire slippage resulting in improper plant spacing.

Forward speed: The operator's manual lists recommended optimum operating speed. Many planters are operated too fast. Excessive seed movement in the furrow can result from excessive forward speed.

Fertilizer depth: Fertilizer contacting the seed is to be avoided. Fertilizer should be placed about one inch below and about two inches to the side of the seed piece. Jack up or drive the planter at least six inches off the floor. Lower the planting mechanism until the opening coulters for the fertilizer just touch the floor. The point of the opening shovel for the seed should be two inches from the floor. The opening coulters or the hydraulic cylinders can be adjusted until the opening shovel for the seed is two inches from the floor. Wobbling coulters should have the bearings replaced.

Fertilizer calibration: The proper rate of fertilizer delivery is as important as the location of the fertilizer. The planter wheel should be jacked off the ground and the rotated 10 times. Then weigh the collected fertilizer. Calibration tables are available from Cooperative Extension or the planter manufacturer. Fertilizer flow properties will change with each source and load of fertilizer, as well as weather. It may benefit the grower to calibrate the fertilizer delivery several times during planting.

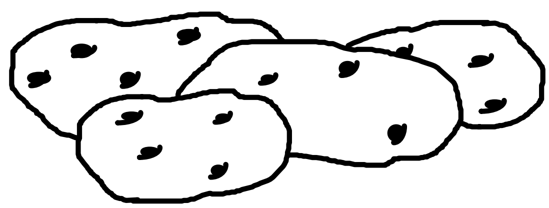
Opening shovel for the seed: The tip of the opening shovel should not be rounded from wear. Worn shovels will produce wide, flat furrows, encouraging seed pieces to tumble. A sharp triangular furrow reduces tumbling and provides better seed placement.

Furrow closing disks: There are two angle planes on closing disks and both should be adjusted. The goal is to cover the seed piece without disrupting the fertilizer band. The closing disks may have to be readjusted with changes in soil conditions, including texture, structure or moisture.

Chain drive: Loose chain drives can cause slippage, leading to erratic fertilizer delivery or seed placement. Chains need to be lubricated and grease needs to be liberally applied to bearings. Replace worn cams, belts and grease fittings.

Picker bowl: If the picker arm cam is worn or poorly adjusted, seed will be poorly picked up and poorly delivered to the planting furrow. Worn planter arm springs can result in poor performance.

Picks: Inspection and maintenance of picks are critical. Worn, or worse yet, broken or missing picks will quickly lead to erratic stands.



FIELD SCOUTING IS RISK MANAGEMENT

James D. Dwyer
Crops Specialist

As growers prepare for the 2001-growing season, several questions in relation to insect and disease pests come immediately to mind. What will the pressure be like? Will the Colorado potato beetle pressure be light or heavy? Will the leafhoppers get this far north? What will the aphid populations be like? Will late blight be a problem? These are all excellent questions with no real answers at this time. So what is a grower to do?

Be prepared! Growers need to have in place a management plan. This plan should include block rotating fields. This means moving this year's potatoes as far away from the fields where potatoes were planted last year as possible. In order to be effective, this may mean coordinating the rotation with neighbors. This distance may help in slowing and/or reducing population build-up. This will give the crop more time to become established, so plants can withstand more defoliation without resulting yield loss.

The grower also needs to have in place a consistent, organized scouting program. Field scouting needs to begin as soon as the crop emerges from the soil. The scouting program should be a regularly scheduled event. Field scouting can not be one of those things that happens only when there is time after everything else is done. Scouting is too important to leave to chance. The risk is too great.

Without knowing whether the insect and disease pressure will be high or low, or when insects or disease will become a problem, scouting becomes very important. Calendar-based treatments can be risky and expensive.

As we prepare for the 2001 growing season, remember this has been a rather mild winter. True, this year there was lots of snow but there was little frost in the ground before snow cover and few long sub-zero periods. This may have facilitated overwintering of both insects and diseases. With little or no frost, volunteer potatoes could be a problem. Volunteers will be unprotected potatoes that provide an opportunity for late blight, Colorado potato beetles and aphids to become established. Not to mention a possible inoculum source for late blight and viruses.

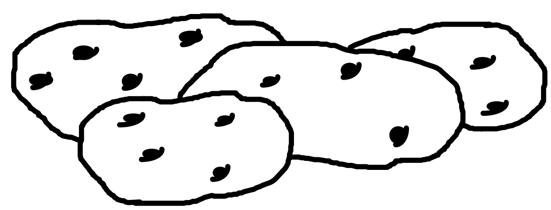
Potato virus levels in the 2000 seed crop are some of the lowest levels in years, creating some of the best seed readings in years. This is great information from a disease management standpoint. Since we are starting with low inoculum levels, there should be fewer viruses to spread. If the low aphid pressure trend continues, seed readings for the 2001 crop should be excellent also. But how do we insure those good readings? The best way to start is to plant quality seed. The second is to have a pest management plan, which includes a comprehensive scouting program. Knowing that aphids spread viruses and what aphids and population levels are in your fields are key to effective management.

Growers also need to be aware that populations can build very early in the season. Some years, Buckthorn aphid populations have been at significant levels in June. Research at the Maine Agricultural Experiment Station has indicated that these early season Buckthorn aphids can spread significant levels of PVY. Further demonstrating the need for consistent, season-long scouting and intervention only when and if warranted. Scouting for aphids should begin early and continue throughout the season as long as there is green tissue present in the field.

Potato leafhoppers are another question mark for the 2001-growing season. No one really knows whether or not leafhoppers will invade Maine or not, so growers need to be prepared. Watching weather patterns and regular scouting is a necessity. The population of leafhoppers can build to significant levels very quickly. Again, regular field scouting will provide the grower with information for informed decision making.

Late blight is another unknown for the up-coming season. Weather will be the determining factor. Disease forecasting is an excellent tool for assisting producers in initiating protective sprays and managing the subsequent spray schedule. Field scouting is also a very important tool in combating and managing the disease. Knowing if and where the disease is present provides the grower with management options that otherwise might not be available.

A regular, consistent field-scouting program is a major component to the farm's risk management program. Risk is best managed by information. It has been said that information is power. By having good pest information, informed decisions can be made. Informed decisions reduce risk, and reducing risk helps to protect your investment.



SUMMARIES OF SOIL TESTS, 2000

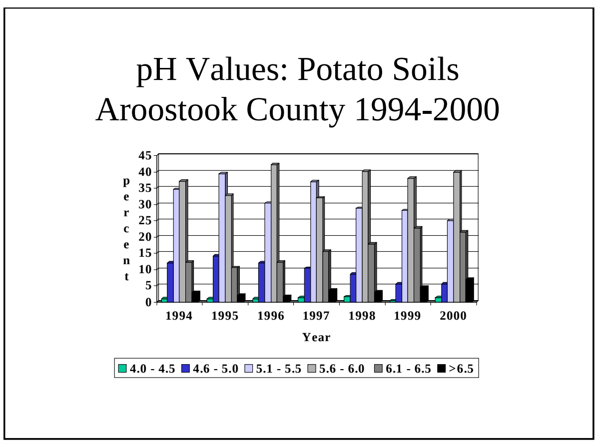
Steven B. Johnson, Ph.D.
Crops Specialist

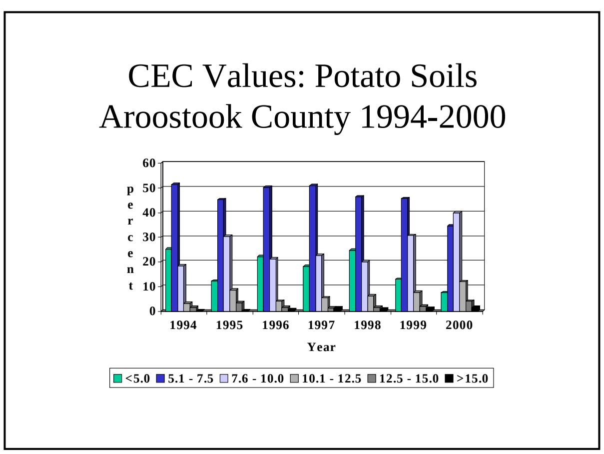
During 2000, the University of Maine at Orono Soil Testing Laboratory processed 1023 soil tests for soils to be planted to potatoes in Aroostook County. The yearly summaries provided provide a good general picture of the soil fertility and pH conditions in Aroostook County. I have produced charts of the CEC, pH, phosphorous, potassium, calcium, and magnesium levels of the soils tested by the University of Maine lab.

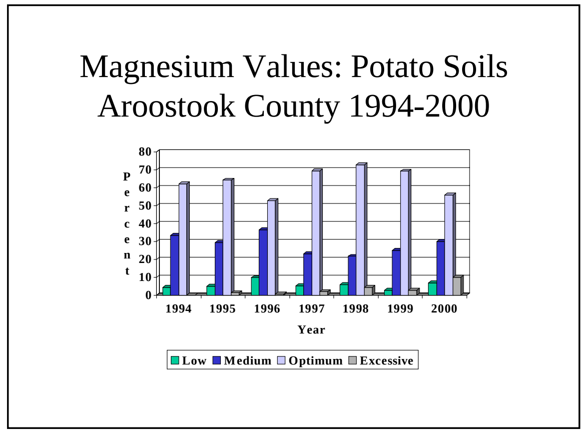
The chart of the pH ranges in Aroostook County shows that 70 percent of the soils tested are between 4.6 and 6.0, with 25 percent of them from 5.1 to 5.5 and 40 percent of them from 5.6 to 6.0. I think that the growers doing well maintaining the pH at a level most desirable for potatoes.

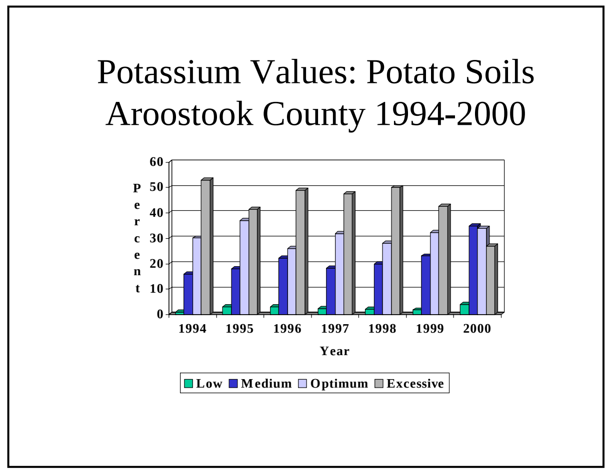
The charts of the nutrient levels of the soils show a tendency toward overfertilization with potassium. Fertilizer sold as 10-10-10 means that it is 10 percent by weight of N-P-K or nitrogen-phosphorous-potassium. One thousand pounds of 10-10-10 would add 100 pounds of nitrogen, phosphate, and potash to the soil. Soils with excess phosphorous or potassium do not need the addition of these elements for the next crop. Over 27 percent the soil tests showed excess levels of potassium. This is down from over 50 percent just 4 years ago. Reduction of potassium in the fertilizer may be appropriate for some of these soils.

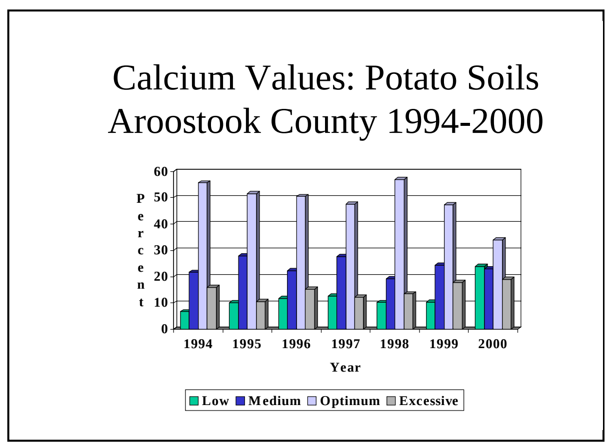
Just under 19 percent of the soil samples tested excessive for calcium. Trying to accomplish a major pH shift in one year is not the best approach.











REDUCING THE RISK OF IMPORTING POTATO WART

Steven B. Johnson, Ph.D.
Crops Specialist

Before anyone thinks about importing used machinery from an area where recent outbreaks of pests and diseases have occurred, they should think of foot and mouth disease and think of potato wart. Those considering importing or purchasing used machinery would be well advised to steer clear of areas where recent outbreaks of pests and diseases have occurred. Both of these diseases can be introduced to new areas by movement of contaminated materials. The speed at which the foot and mouth pathogen can spread and symptoms can occur is alarmingly fast. While the pathogen responsible for potato wart does not have the speed of spread and symptom development of Foot and Mouth Disease, it is a real threat to the US and to the Maine potato industry. A long-term sanitation process and prohibition of movement of soil and tubers has been had worked for decades to contain the potato wart pathogen in Newfoundland. Obviously, there has been a breakdown somewhere with the appearance of the disease in Prince Edward Island. At this time, the method of entry into Prince Edward Island has not been clearly established. Potato wart appears in new areas when the fungus is transported to new soil by infected tubers or by movement of contaminated materials: hence the severe restrictions placed on Newfoundland by the Canadian government. The movement of the disease to new sites in contaminated areas has been linked to foot traffic patterns as well as rail and automobile traffic patterns. The potato wart pathogen has been recovered from vehicles leaving contaminated areas.

Many trips have been cancelled because the risk is too high. Bringing plant material should be out of the question. Perhaps remembering how the Golden nematode was introduced into Long Island by introduction of contaminated vehicles would serve notice that this can and does indeed happen. **Still thinking about bringing in used equipment from an area where recent outbreaks of pests and diseases have occurred? Think again.**

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