SPUDLINES

DECEMBER 2005 **CONFERENCE ISSUE**
VOL. 43 NO. 3

THE UNIVERSITY OF MAINE Cooperative Extension

Dear Potato Grower,

We hope that this issue of *Spudlines* finds you well and that the market stays good for potatoes. We have articles on cull piles, seed-testing for late blight, Colorado Potato Beetles, effect of lime on soil, leaf sampling, and crop water use in this issue. Preventing late blight is a manageable problem, but it will take a community effort - food for thought.

The Maine Potato Conference and Trade Exhibit will be held on January 25 and 26 at the Caribou Inn and Convention Center. The agenda for the meeting is enclosed with this issue. Pesticide applicator recertification credits and CCA credits will be available for those attending the conference. It promises to be a good program and trade exhibit. We hope you will attend.

On behalf of all the folks in our office, let me extend our personal best wishes for a cheerful holiday season and a prosperous new year to you all.

All the best,

Peter Sexton, Crops Specialist

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.

Upcoming Programming of Interest

January 10-12	**Augusta Ag. Trade Show** Civic Center, Augusta
January 25-26	**Annual Maine Potato Conference** Caribou Inn and Convention Center, Caribou
February 6-7	**New England Regional Training for Ag. Service Providers** Wentworth Hotel, New Castle New Hampshire
March 24	**Maine Potato Board Annual Meeting** Presque Isle Inn and Convention Center, Presque Isle

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Cull Piles—Again?

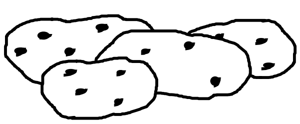
James Dwyer, Extension Crops Specialist

As we look toward the future and the 2006 Maine potato crop, cull piles should not be an issue. However, cull piles were an issue in 2005. The question that arises is "Why?" And how do we, as an industry, prevent them from being a continuing issue when everyone knows what needs to be done?

In 2004 our industry did an outstanding job working together to manage and minimize the risk from cull potatoes. Potatoes were disposed of using environmentally sound methods that minimized the risk of the spread of disease and negative environmental impacts. But in 2005 our industry personnel chased cull piles all season long. Hiding cull piles is not smart and does not save money in the long run. Such practices place the entire industry at risk, especially your neighbors.

In my experience, neighbors are usually very willing to help one another because this helps keep costly problems from developing. Prevention is the best method of controlling potato late blight. Remember that if culls are improperly disposed of and cause an environmental issue, the financial liability could be staggering.

We understand that investing money into discarding potatoes is costly and frustrating, but proper disposal is a good investment as a tool to protect the next crop and to protect the environment. The threat of late blight was real in 2005, and as we look towards the 2006 potato crop the threat of potato late blight will continue. The small amount of late blight that was present in 2005 continues to make the proper disposal of cull potatoes extremely important from a pest management standpoint. We all need to work together.



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Late Blight Seed Testing Available Again this Fall

Steven B. Johnson, Extension Crops Specialist

Late blight-infected potato seed initiates late blight epidemics early. The onset of such epidemics is difficult to predict and impossible to control. Early-starting epidemics are the most devastating and need to be avoided at all costs.

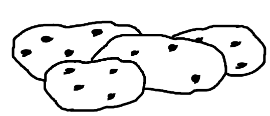
Potato growers in Maine have the opportunity to have their seed lots screened for late blight, caused by *Phytophthora infestans*. This program is a resurrection of the mid-1990s late blight seed-screening and should provide a measure of assurance to seed recipients. The Division of Plant Industry, Maine Department of Agriculture, is performing the screening.

Again this year, seed screening is a ***requirement*** for FSA clients. These clients need to have a late blight seed screening performed in Maine or elsewhere, but there are no exceptions. Seed screening is highly recommended for all.

The screening program is designed to find seed lots that have a high probability of becoming a late blight problem if planted. The test will not guarantee that the seed lot is free of late blight, only that it has been tested, and to a certain level of probability should not be a late blight source when planted.

Samples of seed potatoes grown in Maine will be charged $35.00 per sample. The remainder of the costs of the test are subsidized. The catch is that this price is good only through January 14, 2006. For requests after January 14, the subsidy will be reduced and the cost of the test will be $100.00. For those with seed from outside of Maine, the cost will be $150.00 and samples will be accepted based on workload. So submit your screening samples by January 14. For additional details, call Allison Todd at 764-2036.

This test is voluntary and the results will be reported back to the grower. The reported results will not be available to seed customers unless they are released by the seed grower. I wouldn't mind the test being mandatory this year. In fact, I feel that every seed recipient should insist that this test be performed and I will be encouraging this for all potato growers. Know your seed source and have it tested. You don't want to plant a problem.



New Hotspots of Imidacloprid Resistance in the Colorado Potato Beetle in Maine

Andrei Alyokhin, Asst. Prof. of Entomology
James Dwyer, Extension Crops Specialist

Since imidacloprid first became available in 1995, neonicotinoid insecticides have continuously provided one of the most effective and reliable chemical options available to the potato grower. High efficiency against target pests combined with low toxicity to nontarget organisms makes them superior to many other groups of chemicals. Unfortunately, Colorado potato beetle is notorious for its ability to adapt to a wide variety of insecticides. Therefore, it is reasonable to expect eventual failure of neonicotinoid compounds, similar to the earlier failure of other classes of insecticides (Fig. 1). Because all insecticides in that class have a fairly similar mode of action, resistance to a single member of the class would most likely mean resistance to all other members of the class as well. So far, our experiments with resistant beetles confirmed a considerable amount of cross-resistance to different neonicotinoid compounds.

The first instance of resistance to imidacloprid was reported in 1998 from a commercial potato farm on Long Island, New York. This was soon followed by several other reports of populations across the northeastern United States. In 2002, several pockets of resistant beetles were observed on two farms in southern Maine. In 2003, neonicotinoids completely failed to control beetles on those farms, indicating that the first resistant hotspot had formed in Maine. There were no other confirmed cases of resistance in Maine in 2004. Unfortunately, the situation began to change for the worse in 2005.

To monitor for possible signs of resistance, samples were collected during the 2005 growing season on farms that were using in-furrow applications of imidacloprid, and either reported Colorado potato beetle problems, or had high beetle populations based on scouting reports. Two different resistance assessment techniques were used.
Different beetle populations were tested using different techniques.

The first resistance assessment technique was the diet incorporation bioassay performed by Dr. Galen Dively at the University of Maryland. Adult beetles were collected and shipped overnight to the University of Maryland. Eggs laid by those beetles were incubated until hatching. The larvae were then fed on artificial diets containing a range of imidacloprid concentrations. Lethal concentrations that were killing 50% of the population were calculated based on larval mortality. A Colorado potato beetle strain never exposed to imidacloprid was used as a reference.

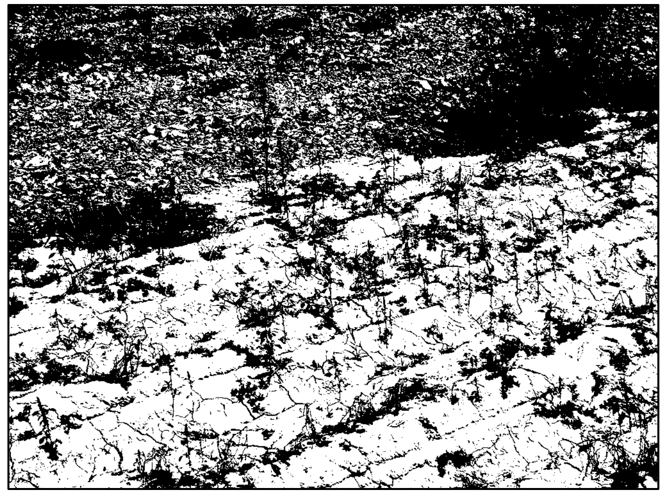


Fig. 1. *Defoliation by imidacloprid-resistant Colorado potato beetles on an Admire®-treated experimental plot on a commercial farm in southern Maine. The picture was taken on August 24, 2005.*

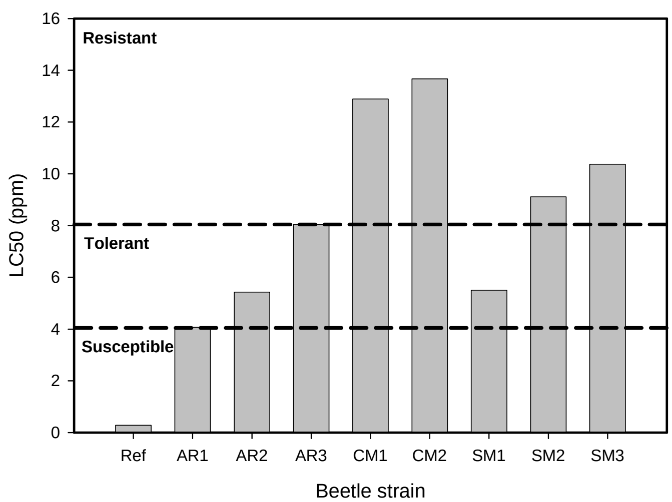


Fig. 2. *Concentration of imidacloprid required for killing 50% Colorado potato beetle larvae in diet incorporation bioassays. Beetles are considered to be susceptible when concentration is below 4 parts per million, tolerant when the concentration is between 4 and 8 parts per million, and resistant when the concentration is above 8 parts per million. Ref was a reference strain never exposed to neonicotinoids. SM2 and SM3 strains came from the immediately adjacent farms and can be regarded as a single population.*

The second assessment technique was developed by University of Maine Cooperative Extension. Adult beetles were collected, brought to the lab, and placed in

Petri dishes. Potato foliage was treated with Provado® at a label rate or at a double label rate and placed in the same dishes. The beetles were observed 24, 48, and 72 hours after exposure and rated as dead (on back, legs not moving), intoxicated (on side or back, legs moving), and not affected.

Both assessment methods confirmed the existence of new Colorado potato beetle populations with a varying degree of resistance to imidacloprid. Figure 2 summarizes the results of the diet incorporation bioassay. All beetle populations except one were either tolerant or resistant. The one population that was still within the susceptible range came from the farm that did not report any beetle problems following imidacloprid applications. The grower kindly agreed to leave several untreated rows for our research purposes. Yet, it is worth noticing that even on that farm the resistance level was on the very edge of entering the “tolerant” range.

The UMCE foliar exposure tests yielded similar results. In four out of five populations tested, even exposure to double label rate of Provado® for 72 hours caused virtually no beetle mortality. Furthermore, between 40% and 50% of the assayed beetles did not even show any signs of intoxication (Fig. 3). The fifth tested population was somewhat more susceptible. Still, beetle mortality did not exceed 30% on any given day of the assay (Fig. 4).

In summary, our results confirm the existence of at least eleven Colorado potato beetle populations that are either tolerant or resistant to imidacloprid. Of course, this should not be considered an indication of the widespread failure of neonicotinoid compounds to control Colorado potato beetles in Maine. The overwhelming majority of Colorado potato beetle populations still appear to be susceptible to neonicotinoid insecticides, including imidacloprid. Our sampling was specifically limited to the problem areas. If we took our samples at random from the pool of all Maine potato fields, results would have been different. Nevertheless, this is a ***ten-fold increase*** in the number of resistant populations compared to just one year ago.

Neonicotinoid insecticides remain a valuable tool for Colorado potato beetle control. However, their effectiveness can no longer be taken for granted. There is a clear and present danger of their failure, similar to the earlier failure of other classes of insecticides. This is no longer a theoretical prediction; now we have hard evidence that it is beginning to happen. Therefore, every grower who wants to continue using neonicotinoids for years to come should start paying serious attention to resistance management.

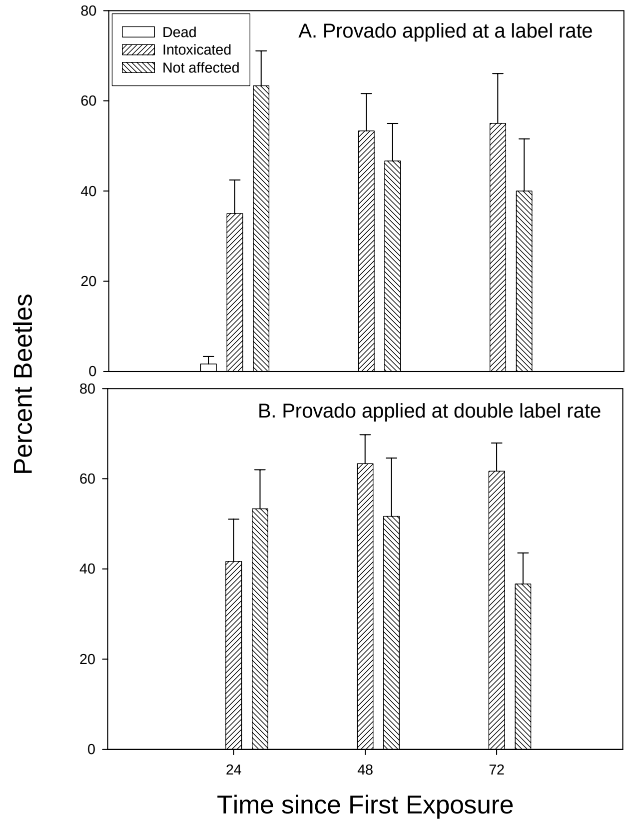


Fig. 3. *Effect of exposure to imidacloprid on field-collected Colorado potato beetle adults (average of four central Maine populations).*

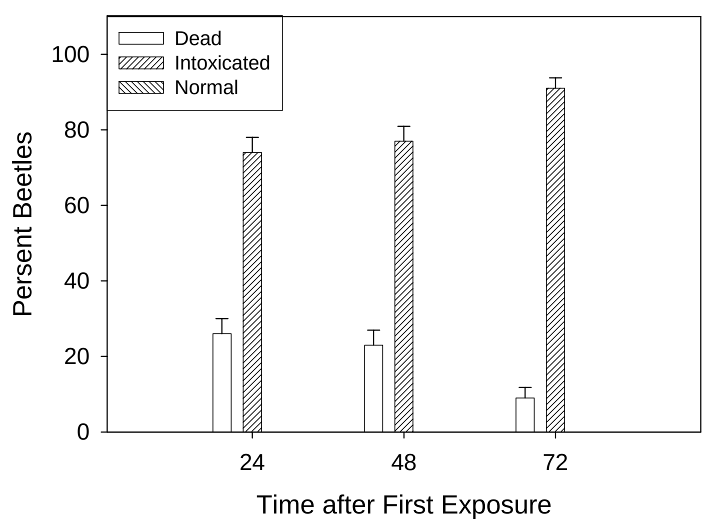
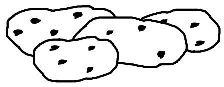


Fig. 4. *Effect of exposure to imidacloprid on Colorado potato beetle adults collected from a single field in Southern Aroostook County. Double label rate was not tested.*



Adding Lime to Potato Soils: Why Should We?

John M. Jemison, Jr., Extension Water Quality and Soil Specialist

In these financially challenging times, it can be difficult to see the benefit of investing in something that may not show immediate value. It can be even more difficult when much of the value to the potato producer may be for his or her rotation crop. For instance, a grower can often immediately see the benefit of adding nitrogen to a crop or making a timely spray application to control a pest. But investing in your soil is like investing in a good foundation when building a home: it is fundamentally important, but rarely does someone say, "Hey; nice foundation." However, adding lime will be a positive investment in three ways: 1) microbial activity and diversity will be increased; 2) nutrient holding capacity will be improved; and 3) yield and quality of most rotational crops will be improved.

Soil pH effects on soil properties. To understand what lime does for you, one needs to think about how it changes the soil and its nutrient holding properties. We fertilize plants—principally with nitrogen (N), phosphorus (P), and potassium (K)—for crop production because the soil provides only a portion of what the plant needs. But the amount the soil does supply is not trivial—it is significant. The amount of your crops' nutrients supplied by the soil (particularly N) comes principally from bacterial breakdown of soil organic material. We know that soil pH (or the amount of hydrogen and aluminum in the soil) affects bacterial numbers and activity. Acid soils favor the growth of fungi over bacteria. By liming, we create conditions more favorable for bacteria, conditions that are likely to lead to more nutrient release from the soil organic matter. Increasing soil pH one unit, for example from 4.8 to 5.8, will greatly improve conditions for bacterial activity, likely increasing nutrient release from organic matter, and likely improving crop yield. So, in this case, liming potato soils would directly improve your bottom line.

When one spends money on fertilizer, the hope is that most of the fertilizer will be absorbed by the plant or, at least, held by the soil like money in the bank. We used to refer to this as the buildup and maintenance program of soil fertility. The concept of the buildup part was that the soil would hold more than the crop would use, and one could start to build up the soil reserves of P and K to the optimum levels. Most of the nutrients that plants need have a positive charge and are attracted to the soil. This is because the soil is negatively charged. We call these positively charged nutrients "cations." We refer to the soil's potential to hold these positively charged nutrients as the cation exchange capacity (CEC). Two things work together to make up the soil's negative charge: one is a permanent charge and the other is a soil pH-dependent charge. We can really only influence the pH-dependent charge, and liming potato soils makes this negative charge more effective. A more effective negatively charged soil will do a better job of holding the nutrient cations. The other way to increase soil CEC is to increase the soil organic matter content. In another article, I'll discuss ways to accomplish both at the same time.

Changing soil chemical properties by liming soil. So if we elevate soil pH by a unit, we will significantly increase the CEC. If you can put up with me for a moment, I will use a home gardening example to illustrate my point. A decade ago, my wife and I bought our house in Orono. Our first soil test indicated a soil pH of 5.3, a CEC level of 6.1, and an organic matter content of 3.7%. By most standards, a CEC of 6 or lower is considered to be very infertile soil. We added lime to the garden, and we retested the soil the following fall. Our lime additions had raised our soil pH to 6.1 (not quite one unit), but we increased the CEC to 9.5, a level that does a much better job of holding soil nutrients. Then, we started adding wood ashes periodically; and compost and manure regularly to work on building the organic matter content. Over 10 gardening seasons, we have more than doubled the soil organic matter content, and our CEC is now 16.1! I hope this is useful to demonstrate how soil properties like soil CEC are influenced by soil organic matter and soil pH.

Liming effects on rotation crop yield. The other way liming soils can help your crop production is through rotation crop yield. First, let me say that if your rotation crop is oats or Japanese millet, don't expect higher yields with elevated soil pH. These crops do well over a wide range of soil pH and are grown more to break disease cycles than as particularly profitable rotation crops. However, barley (still low profitability), soybeans, and canola all yield better with soil pH at or approaching 6.0. Most of the soybeans grown in Aroostook County are sold out of country. Canola or rapeseed is grown for oil; it may someday replace a percentage of the diesel fuel used in Maine or the Northeast. So, increasing yields of these crops has definite value. Figure 1 shows how canola yield varied with soil pH in a trial conducted in Maine in 2002.

As you can see from the graphic, yields were optimized at a soil pH of 6.0. Soybeans and barley will perform similarly. Keeping potato soils at a soil pH of 5.8–6.0 will optimize rotation crop yield and improve overall soil quality. Unless you are growing a variety that is susceptible to common scab, this is a good pH range to target.

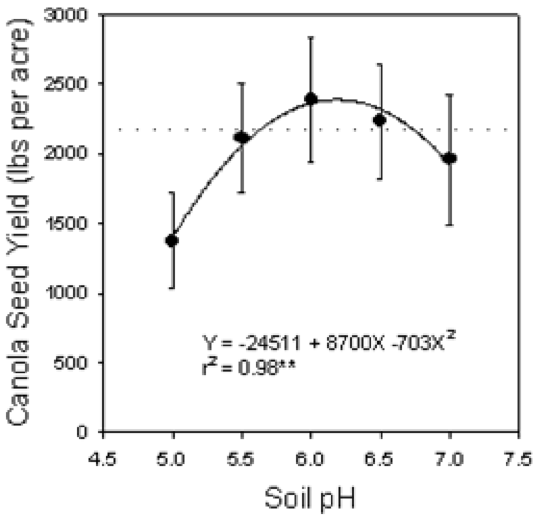


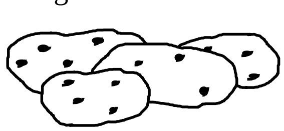
Fig. 1. *Canola seed yield as influenced by soil pH.*

Why so much lime? Have you ever wondered why it takes so much lime to change soil pH? When you add lime, you have to neutralize the acidity associated with the soil water as well as the acidity attached to the soil particle. When we first tested our soil at home, over half of the soil CEC was associated with hydrogen (H^+) and aluminum (Al^{3+}). Most crop plants do not grow well in soils dominated by these two cations. At soil pH's in the 6.0 range, there is very little free Al^{3+} in the soil; and when you lime, the H^+ becomes water, as shown below:

$CaCO_3$ (lime) + $H^+ \rightarrow Ca^{2+} + H_2O + CO_2$

There is H^+ associated with the soil water (active acidity), and H^+ which is associated with the soil particle (reserve acidity). It takes very little lime to dissolve the free H^+ in the soil water; but as that goes away, more H^+ comes off the soil to maintain the balance. So, depending on your soil CEC, it can sometimes take more than a ton of lime to neutralize the H^+ in the soil water and on the soil particle.

Conclusions. I hope this article will provide you with some information to help you decide when to lime your soils. Any potato soil with a pH of less than 5.0 will benefit from the addition of lime. Each addition of N fertilizer will continue to lower soil pH. So, if you haven't tested your soil in a while, it may be considerably more acidic than it was four or five years ago. Obviously, the first step is to test your soil. The next step is to figure out what liming material to use. I will cover this topic in the next issue of *Spudlines*.



Leaf and Petiole Sampling

Peter Sexton, Extension Crops Specialist
Gregory Porter, Professor of Agronomy

Leaf and petiole sampling can be useful tools for monitoring the nutrient status of the potato crop. Like soil sampling, or sampling of potatoes going into a processing plant, the data in petiole and leaf analysis is only good if the sample is representative of the whole area being evaluated. There are several factors to consider in collecting a good sample.

First, choose a representative area of the field to sample. The nutrient status of the crop will reflect the soil underneath it. Ideally, leaf samples should follow soil sampling in their location. Separate samples should be taken within a field where there are differences in soil type or in field history. Avoid low spots and shoulders of slopes. Also, avoid shaded areas and field edges. Collect your samples from parts of the field that represent most of the area in the field. Walk out into the field, making a large loop, and collect 30 to 40 leaves. Move diagonally across rows to avoid taking multiple samples from the same row. (This helps avoid bias from uneven fertilizer application.)

Sample the fourth or fifth leaf from the top of the plant. As leaves age, their composition changes. Recommendations for nutrient concentration are calibrated for the youngest fully expanded leaf. This should be the fourth or fifth leaf from the top of the plant. Samples should be kept cool in a paper bag and sent for analysis without delay. Protect the samples from contamination. If the leaves have been treated recently with a foliar nutrient application, or if they are dirty, briefly wash them off in phosphorus-free soap and rinse quickly (don't overdo it). Usually, washing is not critical for N, P, K, Ca, S, or Mg. For unwashed leaves, the elements that will give a false high reading are iron or aluminum concentration (because of dust), as well as any nutrients that have been recently applied in a foliar application.

Expected nutrient concentrations of petioles during early bulking (50 days after emergence) for 'Russet Burbank' potatoes are shown in Table 1. Expected nutrient concentrations for whole leaves are shown in Table 2. Nutrient values outside of the range suggest that the nutrient(s) in question need to be looked at more closely. A nutrient concentration greater than what is shown in the table suggests that the nutrient in question may be present in excessive amounts. Nutrient concentrations less than those shown indicate that the nutrients in question may be available in less than adequate amounts. However, nutrient concentrations outside the range don't automatically mean the nutrient is present at deficient or excessive levels in the soil. Sometimes, stress may influence nutrient concentrations. For example, drought stress may cause nitrates to accumulate; and it may decrease B levels. Or sometimes an excessive amount of one nutrient may inhibit uptake of another nutrient (e.g. P and Zn are antagonistic to each other; K and Mg may compete for uptake). So, a little thought is needed in interpreting values before changing your nutrient management program. The sufficiency ranges shown in these tables are based on our professional judgment using the information we have in hand. As more information is gained from trials done here in Maine and elsewhere, they may be modified.

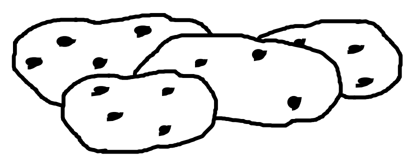
Time of season can have a large influence on leaf nutrient values. As the season progresses, N, P, K, and Zn tend to decrease in concentration in tops. These nutrients move from the shoot down to the developing tubers during bulking. Leaf Ca, Mg, and Mn tend to increase in concentration as the season progresses. Boron tends to remain fairly constant or decrease slightly over time.

Table 1. *Sufficiency range of several nutrients for petioles of 'Russet Burbank' potato at 45 to 50 days after emergence. Values for a given nutrient greater than the "high" value indicate that the nutrient may be present in excessive amounts; while values less than the "low" value indicate that the crop may be deficient in the given nutrient.*

Petiole - Expected Nutrient Concentration - early bulking -	
Element	Normal Range
N	2.5 to 4.0
P	0.22 to 0.60
K	7.7 to 9.3
Ca	0.5 to 1.5
Mg	0.25 to 1.1
S	0.2 to 0.5
Cu	5 to 30
Zn	20 to 100
Fe	40 to 300
Mn	30 to 200
B	20 to 40

Table 2. *Sufficiency range of several nutrients for whole leaves of 'Russet Burbank' potato before flowering and during early bulking. Values for a given nutrient greater than the "high" value indicate that the nutrient may be present in excessive amounts; while values less than the "low" value indicate that the crop may be deficient in the given nutrient.*

Whole Leaves - Expected Nutrient Concentration		
	Expected Range	
Element	Vegetative (plants 12" tall)	Early Bulking
N	4 to 6	3 to 5
P	0.2 to 0.7	0.2 to 0.4
K	4 to 6	3.5 to 4.5
Ca	0.6 to 2.0	0.6 to 2.5
Mg	0.45 to 1.1	0.45 to 1.0
S	0.2 to 0.5	0.2 to 0.5
Cu	7 to 25	7 to 20
Zn	20 to 250	20 to 200
Fe	50 to 200	30 to 150
Mn	30 to 450	20 to 250
B	20 to 60	20 to 60



Predicting Water Use by the Potato Crop in Maine

Peter J. Sexton, Extension Crops Specialist
Steven B. Johnson, Extension Crops Specialist

We have developed a simple software model for predicting water use for the potato crop in Maine using daily maximum and minimum air temperatures and rainfall as model inputs. Our goal was to create a useful tool that would help growers decide when to apply water to their potato crop.

The model we developed uses historic data on average daily water use by potatoes (reported from University of Maine's Aroostook Research Farm in Presque Isle) as an initial basis for predicting crop water use on any given day. The historic value of crop water use is then proportionally raised or lowered based on: (1) mean temperature for the day versus the historic average temperature for that day; (2) the range between maximum and minimum temperature versus the historic average range in temperature; (3) whether or not the crop is predicted to be under drought stress. For use with potatoes in Maine, the model assumes that the season starts with a full profile and 2.5 inches of available water at field capacity to a depth of 20 inches. Rainfall is added, and estimated crop water use is subtracted, from the soil water balance on a daily basis using weather data collected from Davis weather stations.

To evaluate the model, observed soil water balance (estimated from soil water potential measurements) was plotted against predicted soil water balance for the drought year of 2002. Across the whole range of soil water balance in the drying cycle, the model explained about 50% of the variation in soil water content. In the range where most irrigation decisions would be made (>1.5 inches of available soil water), the model explained about 90% of the observed variation in soil moisture. This means that the model works relatively well until the crop goes into severe drought stress, and then it becomes less accurate at predicting soil moisture. However, growers who irrigate should be most interested in predicting soil moisture just before the crop goes into stress (so they can irrigate accordingly), rather than what happens after the crop goes into stress.

The growers who have used the model in pilot studies have judged it a useful tool. This software has been bundled with other models for use with a Davis weather station, so growers can get information specific to their own farm. Contact Dr. Steve Johnson (207-764-3361) if you would like to discuss the possibility of setting up a weather station on your farm.

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