THE UNIVERSITY OF MAINE
Cooperative Extension

University of Maine at PRESQUE ISLE
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Maine Soil & Agronomy Workshop

February 22, 2017
UMPI, Campus Center

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Maine Soil and Agronomy Workshop

February 22, 2017, UMPI Campus Center

8:00 A.M. **Registration**

8:15 A.M. **Introductory Remarks**
Dr. Jason Johnston,
Professor, Department Chair, UMPI

General Soil and Agronomy Session

8:30 A.M. **Improving Farm Income: Rotational Crop and Potato Irrigation**
Dr. Lakesh Sharma,
Soil & Crop Specialist, UMCE & UMPI

9:00 A.M. **Wireworm Survival in Soil and Its Control**
Jim Dwyer, *Crop Specialist, UMCE*

9:20 A.M. **Economic Benefit of Using Precision Agriculture Tools**
Sukhwinder Bali,
Professional Educator, UMCE & UMPI

9:40 A.M. **Black Beans - Do They Have a Place in Maine Crop Rotations?**
Jake Dyer,
Agronomist, Maine Potato Board

10:00 A.M. **Nematodes Survival in Soil and their Control**
Dave Lambert,
Professor of Plant Pathology, UMaine

10:20 A.M. **Coffee Break**

Soil Health Session

10:30 A.M. **Soil Information SystemTM, Soil Mapping Technology**
Sam Delano, *McCain Foods*

10:50 A.M. **How to Determine Soil Health**
Will Brinton,
Woods End Laboratories Inc.

11:10 A.M. **Soil Health in the Potato and Grain Rotation**
Patrick Toner,
Soil Management Specialist, Agriculture, Aquaculture and Fisheries

11:30 A.M. **Fertilizer and Liming in Soil**
Dr. Lakesh Sharma,
Soil & Crop Specialist, UMCE

11:50 A.M. **Lunch** *(On your own)*

1:30 P.M. **Soil Health, Yield Stability, and an Overview of Soil Health Strategies**
Dr. Ellen Mallory,
Assoc. Professor & Sustainable Agriculture Specialist, UMaine

1:50 P.M. **Forms and Efficiency of Applied Phosphorus in Soil**
Bruce Hoskins,
Maine Soil Testing Service and Analytical Lab, UMaine

2:10 P.M. **Soil Productivity and No-Till in Potato Systems**
Sam Wright, *Cavendish Agri-Services*

2:30 P.M. **Cover Crops and Soil Moisture and Temperature Issues**
Tony Jenkins, *NRCS, Bangor*

2:50 P.M. **Nurse Crops - Strengths Weaknesses**
Dr. John Jamison,
Extension Professor, UMCE

3: 10 P.M. **Strategies to Keep Soil in Place**
Eric Giberson, *NRCS, Fort Kent*

3: 30 P.M. **Adjourned**

Improving Farm Income: Rotation Crop and Potato Irrigation

Lakesh Sharma and Sukhwinder Bali
University of Maine Cooperative Extension and University of Maine at Presque Isle

The Maine Potato Industry has a positive impact on Maine's economy. Potato yields over the last 20 years have been consistent, with little improvement compared to other potato producing states. Cost of potato production during this time has increased significantly, putting potato growers under intense pressure to compete in order to remain viable and sustainable. Nutrient management is a key for sustainable potato production. Extensive work has been done on nitrogen (N) management in Maine, but most of that work has been conducted exclusively at the Aroostook Research Farm where soils may not be typical of farmed soils throughout Aroostook or the rest of the state. An effective nutrient management program is required to increase production efficiency and yields. Using precision agriculture tools have been found successful in grain production system and high value crop. There is huge potential to use site specific farming approach in Maine to improve farm income by reducing input cost such as apply less fertilizers, pesticides, and use of farm machinery without affecting quality and yield. It has been documented in several studies that use of precision agriculture tools helped in improving yield, quality, and ultimately higher profit. Following are the feature of using precision agriculture tools:

- Provide Information on Crop health.
- Detect insect and diseases foot prints
- Help in scheduling nitrogen and water application

Figure 1: Use of GPS to protect inputs from overlapping. Photo Courtesy: Solberg et al., 2006

As a rotation crop, malt and feed barley has a huge potential. The barley industry in Maine has a crop value of $2.4 million and with the $874 million brewing industry, and a workforce development of more than 10,000 jobs, the economic impact of increasing Maine's barley production is significant. In Maine, the average barley yield is significantly lower (see Figure 1) (60 bu/acre average from last 16 years) than the national average (73 bu/acre) (USDA, NASS crop production). There has been no natural calamity of disease epidemic reported from the last sixteen years in barley. However, huge yield fluctuations (figure 1) indicate inappropriate cultural practices. Additionally, growers are using N and P recommendations from other states (North Dakota, Minnesota, Idaho, and Montana) resulting in poor synchrony between N application and plant N uptake.

Site-specific recommendations for Maine's production area are needed because available soil N and crop N uptake behavior vary with soil properties (texture, structure, and development). Regional climate conditions and their interactions also result in variation in N optimal rates within the field and among growing seasons (Melkonian et al., 2007; Zhu et al., 2009). Feed barley does not have any late season N requirement. However, malt barley requires small amounts of N at several growth stages for optimum protein development in grains. Excessive N in grain can lead to lodging, small grain size, lower yield, and head blight (Franzen and Goos, 2015). The malting industry rejects barley that has excessive N.

Because of different quality requirements, feed and malting barley require separate fertilizer recommendations. With a growing livestock market in southern Maine and brewing market near Portland and throughout Maine, northern Maine can be a source of barley for both feed and malt markets. Growers can adopt barley as a rotational crop with variable N and P rate management practices to improve yield (feed and malting barley), quality (malting barley), and reduce input costs.

In season N application could help in improving protein value in barley required for high malt quality. There are selected varieties for feed and malt barley starbdarized by Ellen Mallory, University of Maine Cooppertaive Extension. For more information please contact her on ellen.mallory@maine.edu.

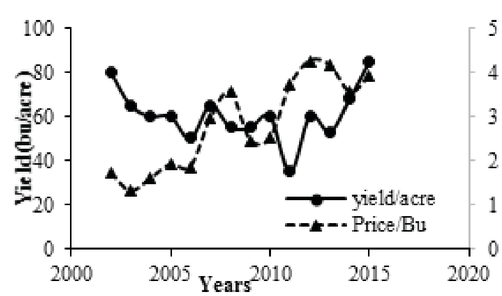

***Figure 1: Trend of barley yield per acre and price per bushels from last sixteen* years.** *Source: New England Agricultural Statistics, 2015.*

Wireworm Survival in Soil and Control Strategies

James D. Dwyer,
Crops Specialist/Extension Professor, University of Maine Cooperative Extension

The wireworm is the immature form of the click beetle. The wireworms associated with potatoes in Maine tend to be yellow-orange in color, hard bodied, which is wire-like and can vary in size from less than ¼ of an inch to about 2 inches. The adult form of this insect is the click beetle, so named because of its ability to create an audible "click" sound. Upon close examination of the adult one can see a spine-like projection on the prosternum of the thorax, which it can fit into a notch on the mesosternum and by manipulating these, it can jump to escape predators or right itself if on its back. When making this movement the insect makes a distinctive "click" sound, hence the name "click" beetle.

Wireworms, which attack potato tubers and other plants, are attracted to carbon dioxide. When seed germinates, the seed releases carbon dioxide into the soil. This is an attractant to the wireworm, which is how the wireworm locates the food source. The adult wireworm, the click beetle, is also attracted to grass species. Typically, each female click beetle can lay 200 to 400 eggs.

There are four common wireworm species found within the potato growing regions of Maine:

Agriotes mancus	Wheat wireworm
Hemicrepidius decoloratum	no common name
Hypnoidus abbreviates	Abbreviated wireworm
Melanotus spp.	Corn wireworm

Wireworm larvae have a characteristic hard, wire-like body, which consists of nine-segments with three pairs of thoracic legs. The ninth segment is considered the most important determinant of wireworm genus and species. Other structures useful in identification include the caudal notch, urogomphi (the structures surrounding the caudal notch), mandibles, and body shape.

Wireworms overwinter by burrowing deep into the soil and by secreting glycerol into their hemolymph (insect equivalent to blood). This survival strategy allows the wireworm to avoid some of the cold temperatures of winter and the glycerol acts as a natural antifreeze.

Wireworms will travel up through the soil profile in the spring being attracted to warmer surface temperatures and when close enough, to the CO2 being given off by germinating plant material. Wireworm management strategies should consider this behavior pattern, when planning management strategies.

Rotation and tillage strategies can also be an important component of a wireworm management plan. When chemistry is employed as a management component one should consider efficacy, timing, rates, residual, toxicity and the environmental aspects when planning to use a product. The application method is also an important consideration.

Economic Benefit of Using Precision Agriculture Tools

Sukhwinder Bali and Lakesh Sharma
University of Maine Cooperative Extension and University of Maine at Presque Isle

Precision agriculture is the technique of using the right amount of input (such as fertilizer, pesticide, water, seed) at the right time and at the right location to increase production, decrease inputs, and protect the environment. Precision agriculture is using both the technology and the techniques. Precision agriculture initially requires both time and investment. It gives short term pay off but will provide huge benefits in future. Site-specific databases and precision management tools will provide a long-run competitive advantage and profit. Precision agriculture technology is now used worldwide and provide decent return like three-hour extended workday from a GPS-linked guidance systems resulted in an additional $1.63/acre return (Griffi n et al., 2008) also save about 30 percent of the time by minimizing overlap. Environmentally, it reduces the fertilizer and pesticide use by about 2 percent. Koch et al. (2004), in Colorado, found that in irrigated corn zone-directed application require 6 to 46 percent less N and net returns ranged from $7/acre to $11.60/acre for the practice. The most robust savings that farmers can make in precision agriculture is the development of management skill and databases. The purpose of Precision agriculture is to manage adoption of precision agriculture technology for future payoff.

Black Beans – Do They Have a Place in Maine Crop Rotations?

Jake Dyer, *Maine Potato Board*

Dry beans come in several classes (kidney, pinto, navy, and black), seed sizes (800-2800 seeds per pound), growth habits (determinate or indeterminate), and types (I, II, III, and IV). Depending on seed size and plant architecture, some varieties of edible dry beans require specialized harvesting and handling equipment not common to Maine's potato and grain farm operations.

Black beans are a class of edible dry bean with a small seed size (2300-2800 seeds per pound), upright type II (short vine, narrow profile) indeterminate architecture, and relative maturity ratings of 98-100 days. Black beans can be planted in either narrow or wide rows (15-36 inches), have good resistance to lodging, and can be cut directly with a traditional grain combine without damaging the seed coat.

Although considered a warm season crop, black beans are produced in several cooler regions of the United States and Canada. Michigan and North Dakota are the largest US black bean producing states while New York, Minnesota, and the Canadian provinces of Manitoba and Ontario also produce several thousand acres.

This project will be an effort to develop best management plans for producing black beans in Maine. Collaborating growers throughout Aroostook County will plant field scale experiments to evaluate varieties, plant populations, fertility practices, crop protectants, and adaptability to direct cutting.

Average 5 year prices ranging from \$33 - \$37 per hundredweight and possible yields of 20-30 hundredweight per acre make black beans an attractive alternative crop option to Maine potato and grain producers. A market opportunity exists for black beans in New York and with the possibility of a local grain elevator as a delivery point, black bean production deserves a closer look.

Nematodes Survival in Soil and their Control

Dave Lambert, *Professor of Plant Pathology, UMaine*

Nematodes are roundworms, ubiquitous in terrestrial and aquatic habitats. About twenty-five thousand species are known, with many more suspected. Their life cycle includes adults, eggs and several larval stages accompanied by molting. In some species, eggs may survive for 20 years or more. Nematodes found in soil are generally thin, small (0.5 to 2 mm long) and include species adapted to feed on bacteria, fungi, other nematodes, larger fauna and plants. With numbers as great as one million per square meter, they are an important component of the soil food web. Species feeding on insects have been commercialized as biological controls. Species pathogenic to humans and other animals may also persist dormantly or actively in soil.

Nematodes develop more rapidly in warmer soils and tend to be a greater problem in areas with longer growing seasons. Coarser soils with larger pores facilitate movement. Adequate water films within pores are also a requirement that may limit spread. Host-specific species are often able to detect specific chemical attractants and hatching factors in their environments. Some plants, such as marigolds, produce compounds that hinder development.

Plant feeding nematodes have stylets that inject saliva and withdraw cell contents. Depending on species, they either feed at the root surface, invade and move through plants, or feed inside plant roots without moving. Surface-feeders generally have the widest host range, and all plants experience some root feeding. Certain species may vector viruses, including the agent causing "corky ringspot" in potato. Migrating nematodes include Ditylenchus, causing "garlic bloat" and Aphelenchoides, which infect the foliage of hundreds of plant species. Pratylenchus invades roots and increases the severity of "early dying" in potato. Stationary forms include cyst nematodes, which have precipitated potato-growing regulatory actions and restrictions in parts of New York and Idaho. Root knot nematodes infect numerous plants, including potato.

Damage to plants is roughly proportional to nematode numbers, and management efforts are directed towards reducing the size of populations. Regulations are designed to assure clean stock and to prevent transfer of contaminated soil, equipment and other material from infested areas. These measures include normal sanitation. Crop breeding strategies may reduce the production of plant species-specific attractants or the ability of nematodes to complete their life cycle. Use of parasitic bacteria and fungi as biological controls is not widespread, but "trap" or other crop strategies to actively reduce populations may be. Crop rotation is effective for nematodes having more restricted host ranges. Nematicides or insecticide/nematicides, such as Vydate and Mocap, also reduce populations.

Soil Information System™ "An Industry Leading Soil Mapping Technology" by Trimble

Sam Delano, *Agronomist, McCain Foods*

Soil Information System™ (SIS) is a soil mapping technology that using sensors, intelligence targeting, and geo-processing algorithms producing high resolution 3-D soil and topographic maps. McCain Foods and Trimble collaborated to trial this technology in Maine and New Brunswick in 2015 and 2016. Data was collected on approximately 300 acres and the information is being used to make operational decisions on the farm.

The process of collecting information using the SIS system can be divided into four on farm processes. Using GPS RTK technology the first step is to determine the boundary of the field. Boundary data can be imported into the system if the shapefiles already exist from previous field work.

The next step is "surfing" the field, the process of collecting electromagnetic conductivity of the soil by dragging a Dual EM sled across the field in a determined spacing width. In the project fields discussed a thirty foot (intermediate) spacing was used.

The software then uses the Dual EM data to determine variability within the field and develops zones that will be probed to collect further information, this is step three. In this step, also called "diving," a tractor mounted automatic soil sampler with four foot horizontal probe equipped with multiple sensors collects data such as horizontal and vertical compaction, moisture content, vertical electromagnetic conductivity, horizon thickness, and much more.

Using data collected in both step two (surfing) and step three (diving) the software will then determine of which locations soil analysis will be collected. This is step four of the field work and is called "coring." Coring is the process where using the tractor mounted automatic soil sampler with a four foot horizontal coring tube soil samples are taken.

In this project samples were taken from both the surface and sub-surface layers of the field. Determination of the break between the two layers was visually made by looking at the structure of the soil core. Coring soil samples can be sent to lab of your choice, in this project all chemical and physical analysis of soil was completed by the UM lab in Orono, ME. Normal chemical analysis was completed, as well as a textural analysis on both surface and subsurface samples. Analysis results from the lab, in excel format, where then forwarded to Trimble's SIS analyst who maps all the data. 3-D maps produced include a multiple array of information that helps to give a full analysis of on farm chemical and physical properties of the soil. The data can also be exported from the Trimble program via shapefile and imported into farm management software, thus producing zones to make variable rate decision.

Data collected on this trial was used to develop prescriptions for variable rate irrigation and variable rate seed spacing and fertility on a subsequent Russet Burbank crop. Further analysis and comparison of growers yield maps to data collected using the SIS technology will help to find the layers of data that are most limiting yield in Maine.

How to Determine Soil Health

Will Brinton,
Woods End Laboratories Inc

Soil health tests are of increasing interest to growers. One way to gauge health is by microbial respiration tests. Such tests are a means to determine biological functioning which relates to soil health. Soil labs across America including University of Maine are now able to perform CO2 testing through the use of the new available technology invented here in Maine, called Solvita®. The test measures the aggregate of soil biological response by nature of the fact that all soil organisms breathe in oxygen and give off CO2. The turnover of this CO2 is directly related to several important mechanisms: nitrogen mineralization or the supply of available N to crops, and aggregate structure building, or the ability of soil to resist water dispersion. The presentation will follow some of the developments in use of biology tests and relate them to each other and show some practical examples of value to farmers.

Soil Health in the Potato and Grain Rotation

Patrick Toner
Soil Management Specialist, Agriculture, Aquaculture and Fisheries

Results will be presented on a 2012-2013 trial conducted by the Eastern Canada Soil and Water Conservation Centre and NB Department of Agriculture, Fisheries and Aquaculture. A one hectare grid pattern was used on a total of six fields located in proximity to St Andre, Drummond and East Glassville NB, that were in grain 2012 and potatoes 2013. Grain yield monitors measured and mapped yield. Soil samples were taken at each grid point and assessed using Cornell Soil Health parameters. Statistical analysis of each of the sites was done to establish zones of individual soil health parameters along with grain yield zones and comparisons made to determine any relationships. In 2013, potato yield samples were taken by hand harvesting ten foot strips at each fields grid points. In addition to soil health parameters, historical land use patterns such as field consolidation were obtained from aerial photography and local knowledge. The spatial variability distributions of grain and potato yields across all fields did not appear to strongly relate with soil health test findings. However, soil pH, phosphorous levels, compaction, historical land use, topography and erosion all showed some potentially manageable crop-limiting patterns. Funding for this trial was only available for one rotation and several rotation cycles would be needed to provide more insight on potential benefits with relation to yield and soil health.

Since completion of the above trial, soil and potato productivity has been assessed with various BMP's 2014-2016. Some insight into influence on soil health parameters (i.e. infiltration, aggregate stability, soil moisture differences) along with impact on yield will be provided as a result of the use of compost across the same rotation cycle and nurse crops within the potato production year.

Fertilization and Liming in Soil

Lakesh Sharma and Sukhwinder Bali
University of Maine Cooperative Extension and University of Maine at Presque Isle

The potato industry has a significant impact on Maine's economy ($540 million impact annually), personal income (more than $233 million), State and local taxes ($32 million), and workforce development (6100 jobs) (USDA, 2003). Despite stable yield during the last 20 years, grower's profit has declined (Halloran, 2013). Growers can adopt variable N rate management practices to improve yield and reduce input cost; but there is a need to understand N behavior under different climate and soil conditions and development of improved N recommendations with accessible mobile application.

Soils differ in yield potential as well as in their potential for nitrogen mineralization and losses; therefore, fertilizer recommendations according to specific soil type are required to achieve target yield increases while also reducing fertilizer use. Soil series consists of groups of soils which possess the same characteristics across the landscape. A better understanding of soil series helps in proper fertilizer application management, as different classes of soils respond differently to the fertilizers. Available N and crop N uptake behavior varies with soil properties (texture, structure, and development), regional climate conditions, and their interactions which results in variability in optimal N rates spatially and temporally. To compensate for this variability, farmers struggle to apply optimum N. Geographically, Maine is in the areas of high inorganic N deposition but how much N is supplied by this pool is unknown. The potential soil available N, a reason for low nitrogen use efficacy, causes an environmental pollution from denitrification, volatilization, and ammonia leaching to surface and groundwater. National nitrogen use efficiency (NUE) across all crops is approximately 40%. The beneficial effect of N in potatoes is unquestionable, but excess N not only is an environmental pollutant but contributing reason for higher input costs and poor quality of produce.

Applying optimum N rates has potential to improve N use efficiency, profitability, and crop yield with low environmental health risks; however N rate application adjustment based on soil and weather conditions has not been established in potatoes. Most of the current N recommendations do not include temperature, rainfall, and soil as predictive variables. Weather and soil textures are the major determinant for soil organic matter decomposition and N response. Under wet climate conditions, yield and N response improves significantly on coarse, textured soil

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compared to fine textured soils due to high water holding capacity of fine textured soils resulting in N volatilization and denitrification.

The N is usually applied at planting; but holding N application until tuber initiation might help in increasing tuber bulking duration, thus improving yield. However, success of in-season N application also depends on weather and soil types because high rainfall after planting causes N loss and after in-season application helps in high N uptake, ultimately a yield increase. Also, using petiole sampling as a tool for inseason N application is limited and expensive. Determining the best N rate for specific field and variety of potato is challenging. The concept of "need basis" using sensing tools was proposed by Schepers et al. (1995) to aid in reducing environmental contamination from excess nitrate in corn production. This approach used the SPAD chlorophyll meter measurements which helped estimate the crop N status against a standard color and then applying N as required. This technique helped to maintain the optimum yield with less fertilizer application. The GBAO sensors have been successfully used in wheat, corn, cotton, sunflower, and sugar beet.

In conclusion, apply your fertilizer according to your soil types. On a sandy soils, inseaon N application is highly successful. On medium textured soils apply N according to the moisture soil levels or look at the weather predictions.

Using ammonium sulfate has a high potential to create acidic soils therefore more lime required to compensate for optimum pH. In Maine use of ammonium sulfate is common due to its slow release N characteristic but it highly recommended to use on acidic soils. It creates three time more acidity into the soil compared to any other N fertilizer. In conclusion we will recommend using blended N fertilizer with ammonium nitrate, poly-coated urea, or any avlaibility cheaper slow release N fertilizer to reduce the effect of ammonium sulfate towards soil acidity.

Availability and Efficiency of Phosphorus in Soil

Bruce Hoskins, *Maine Soil Testing Service and Analytical Lab, UMaine*

Phosphorus is one of the most environmentally sensitive nutrients that we manage. Widespread eutrophication of surface waters has given rise to increasingly restrictive regulation of P applications. Given the finite supply of phosphate resources and the ongoing problem of water quality issues, it is imperative that we manage phosphorus fertility as efficiently as possible.

Phosphorus chemistry in soil is exceedingly complex and variable. P will bond with whatever constituents are abundant and chemically active in the soil: aluminum, iron, and other metals in acidic soils, calcium and magnesium in alkaline soils, and with organic matter and humus at any soil pH. Plant uptake is restricted to free ionic phosphate (ortho-phosphate) in soil water. However, the vast majority of soil P is held in stable compounds or complexes, some of which are temporarily or permanently unavailable to plants. In simple terms, phosphorus fertility management consists of minimizing its loss to these unavailable forms. Dozens of extraction and fractionation methods have been developed to characterize the forms of P in the soil, its availability to growing plants, and the tendency of soil to hold or release P to plants and the environment.

Environmental test methods include Water-Soluble P (WSP) and the P Saturation Index (PSI). WSP is used to determine the relative risk of soil P loss to the environment during periods of surface flow or from eroded sediment in runoff. PSI is used to gauge the soil's capacity to safely hold applied P. A PSI greater than 15-25% has been associated with greatly increased WSP and potential environmental risk.

Routine soil test P (STP), such as the Morgan and Mehlich 3 methods, index plant available P to determine the likelihood of a positive yield response to further P application. The Fixation Index is an experimental method used to gauge potential loss of applied P & K, using maximum soil contact, to determine the relative efficiency of applied fertilizers. When measured on Maine Potato and Dairy soils, 70-95% of applied P can be lost according to this method. This points out the benefit of banding phosphate fertilizers, to limit soil contact and loss to unavailable forms.

Incubation studies also highlight the limits of applied P availability to plants. In a greenhouse study, Montgomery and Ohno (2004) contrasted identical rates of P applied from 3 types of manure, 4 types of biosolids, and triple superphosphate (TSP). Uptake of applied P by ryegrass was < 10% from all sources, but uptake from organic sources (up to 7%) was nearly double that from TSP (4%). Residual P availability in the soil after cropping was more than double for the organic sources (up to 7%) vs TSP (2.5%). A 2014 incubation of natural fertilizers also found 5 – 20% of applied P remained available at the end of 16 weeks. These studies point out the limited, but improved and extended

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availability of P from non-chemical sources, such as manures and cover crops.

The tendency of all soils to tie up applied P in unavailable forms is compensated for by the efficiency factors built into soil test recommendations. Maine recommendations assume 15 – 30% efficiency, depending on typical crop management scenario and crop removal allowances. In forage production, less P is recommended to build STP levels (assuming higher efficiency) than with other crops. Average Soil Test P levels for forage crops have shown no consistent trend over the past 20 years, but are showing some increase in the proportion of Below Optimum test levels. For Potato production, more P is recommended to build STP (assuming lower efficiency) than with many other crops. These soils have shown a small increase in the average Soil Test P level over the past 20 years, with a consistent majority in the Optimum test range in all years.

Because of uncertainty in the efficiency of applied P, phosphate is often recommended as an "insurance" application, even at Optimum soil test levels. In recent field trials on potatoes and field corn in Maine and the Northeast, significant yield responses to applied P have been rare. These attempts at refining the calibration of modified Morgan and other field soil tests have been of limited utility, due to the lack of low testing, P-responsive sites. Lack of response at Medium to Optimum STP levels indicates a need to eliminate insurance applications and aggressive buildup factors in some soil test phosphate recommendations.

Soil Productivity and No-Till in Potato Systems

Sam Wright, *Cavendish Agri-Services*

The rich soils of Aroostook County have been the backbone of potato production for many years. As potato cropping systems have developed rapidly with the changing world, how have our soils been considered and how can we maximize their effect in our system? The Maine Soil Health Team is looking at strategies that go beyond holding soil in place to realize the true potential of our soil and implement practices to reach this potential. One such practice is the use of No-Till in the non Potato years to determine if the reduction in disturbance in a two and three year rotation can provide positive changes in the soil and improve yield and quality.

Cover Crops, Soil Moisture, and Temperature Issues

Tony Jenkins, *NRCS, Bangor*

Cover crops affect soil moisture and temperature. The relationship is complex, but the effects on soil moisture and temperature from the amount and type of cover are important for farm management, especially in the spring. Some data will be explored, basic relationships examined, and general inferences made for potato rotation scenarios. In a "side-by-side" limited comparison, moderate to light cover appears to have negligible or even a slightly positive impact on soil warmup in spring (versus bare ground). However, at the whole-field scale, the presence of cover and better structure improve infiltration and reduce (meltwater and precipitation) runoff. This phenomenon could cause prolonged soil wetness and slower warmup relative to bare ground in the spring, as has been anecdotally reported. Farm trials to investigate this will be described.

Nurse Cropping in Potato Systems

John Jemison, *Extension Professor: Soil and Water Quality*

Issue: The time required for potatoes to emerge following planting is longer than any other major crop grown in Maine. During this time, the soil is subject to erosion loss. It would be beneficial to protect the soil during this time period. A nurse crop (NC) could be used to protect soils during this period, but information is needed on the following production decisions: 1) which crop species and sowing rate is optimum; 2) what is the optimum NC production period; and 3) is herbicide necessary to kill the nurse crop prior to incorporation.

Study: In the summer of 2016, a study was conducted at the Rogers Farm in Stillwater, Maine to study the effect of short-term nurse crops on potato yield and quality. The study was designed as a randomized complete block design with six replications. The study compared two sowing rates (winter rye at 100 vs. 200 lbs/ac) to 20 lbs of annual ryegrass or a check plot (no nurse crop). In addition, each of the win-

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ter rye treatments was either killed with an herbicide prior to one-pass hilling or just hilled. To address the question of how long to grow a NC, WR treatments were allowed to grow either three weeks or four weeks prior to being incorporated.

Methods: The field study was established on 18 May. The plots were established, and cereal or annual ryegrass seed was broadcast within the plot areas. A tine cultivator was run through the field to provide some seed to soil contact. Then, a potato planter was used to mark the rows, and 160 lbs/ac 10-10-10 fertilizer was banded in the row. Hand cut Snowden seed was planted by hand at 9 inch spacing, and red chieftain potatoes were planted in the four foot barrier between plots. The planter was used to cover the seed pieces. Admire was applied in furrow to protect against Colorado potato beetles and other insect pests. Nurse crop treatments were sampled 17 days after planting (DAP) for the 21-day NC production period and at 24 days for the 28-day NC production period. Samples were collected using a 1ft2 quadrat randomly placed twice within each plot. Samples of above ground biomass were cut with shears, and plants were counted prior to placing in the bag. Rimsulfuron was applied to specific nurse crop treatments at 18 DAP, and 21-day plots were incorporated at 19 DAP due to forecasted rain. Weeds were controlled with metribuzin and metolachlor at labeled rates following hilling, and plants were protected with fungicides weekly. The 28-day plots were treated similarly. Petioles were collected on 17 July and 18 August. The fourth leaflet from the top of the plant was sampled, leaves stripped off, and placed in a paper bag. Samples were ground and analyzed for nitrate. Plants were top killed 1 September 2016 and harvested three weeks later. The potatoes were washed, graded into four size categories, and sampled for skin surface and internal defect evaluation. Data were analyzed in JMP 11 – contracts were used to separate treatment differences.

Results: Winter rye sowed at 200 lbs/ac significantly increased plant number and biomass compared to 100 lbs/ac seeding rated. Interestingly, the 20 lb/ac annual rye treatment had similar plant numbers but they had significantly lower biomass than either the 100 or 200 lb/ac cereal rye NC treatments. Annual ryegrass would not be recommended for this use. Delaying incorporation did not significantly increase dry matter production in 2016, likely due to limited soil moisture in early June. We also didn't find any difference in petiole nitrate in either sampling period. This indicated that the WR did not tap into the fertilizer banded in the potato row. It also shows that WR does not tie up N when it breaks down following one-pass hilling. Potato yields were very low due to the lack of moisture. Delaying incorporation and not killing the nurse crop with an herbicide prior to incorporation led to lower marketable potato yields (10% level of confidence) and total yield at the 0.05% level for the 28-day growth period. The nurse crop was not completely buried by the hiller and likely competed with the potatoes for water and nutrients, which limited yield. Rimsulfuron effectively killed WR at 27 DAP, and as such, it did not compete with potatoes for limited water.

Discussion: Nurse cropping deserves further attention as a means to protect the soil before potatoes emerge from the soil. It appears as though one can let the NC grow as long as 25 – 30 days without hurting production so long as the NC is killed with an herbicide before 30 DAP; it does not appear to interfere with soil moisture relations, potato growth and development, or tie up fertilizer N. We didn't measure soil moisture, but Gil Moreau found a slight increase in available water for several weeks after incorporation. With the risk of intense precipitation events becoming increasingly common, the time is right to explore measures that might increase cropping system resilience. Looking to next year and beyond, growers have requested that we consider trials with barley in addition to WR. With low commodity pricing of barley, growers could grow seed for their own NC use. While they could also grow WR, most all are familiar with growing barley. In the summer of 2017, we look forward to comparing barley and WR at 100, 200, and 300 lbs/ac seeding rates. I also hope to find some growers interested in trying it in Central Maine production fields.

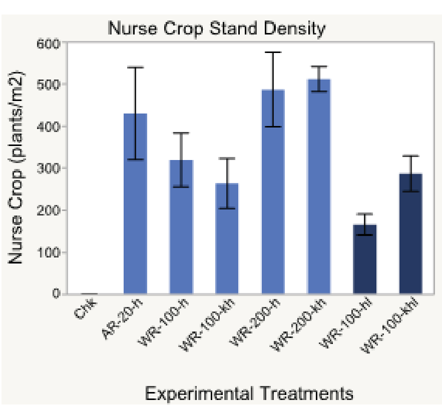

Figure 1. Nurse crop stand density

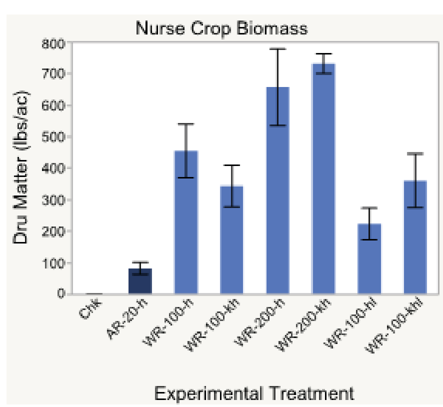

Figure 2. Nurse crop biomass at 17 DAP

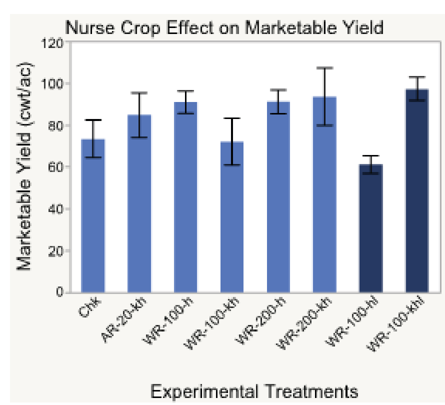

Figure 3. Marketable yield as influenced by nurse crops

Strategies for Keeping Soil in Place

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Healthy agricultural soils are the foundation of sustainable cropping systems. An overall strategy for long term soil health involves reducing the amount and intensity of tillage operations within the cropping system. In addition, a comprehensive soil health strategy must incorporate adequate soil cover through the use of living cover crops and plant residues to build soil organic matter and enhance beneficial soil biology.

Eliminating and/or reducing soil loss through water erosion and physical soil movement by agricultural machinery is key to the entire strategy of improving overall soil health. A comprehensive approach to soil management in cropping systems should include: **1.)** an assessment of the hydrology of the watershed in which the land unit is located; **2.)** an evaluation of the predominant soils that compose the land unit; **3.)** a determination of the erodibility of the topsoil; **4.)** an assessment of crop rotation history on the land unit; and **5.)** an inventory of the types of tillage operations regularly implemented throughout the cropping cycle.

Soil erosion falls within 3 basic categories: **1.)** classic gully erosion caused by excessive volumes of surface water eroding through the soil profile down to the subsoil; **2.)** ephemeral gully erosion, usually caused by lower volumes travelling at lower velocities that erode the upper layer of the topsoil; and **3.)** sheet and rill erosion most commonly caused by rainfall that pools on exposed soil surfaces, saturating the top 1”-2” of topsoil. Fine soil is then transported downslope by additional rainfall. Tillage operations utilized as part of a cropping system will always increase the risk and magnitude of these classes of soil erosion on a given land unit.

Conservation planning to address soil quality on private lands is a voluntary process, usually initiated by the landowner. The planning process is interactive and starts with identifying the management problem(s) the landowner is facing throughout the production cycle of the primary cash crop. The soil conservationist’s main responsibility is to then quantify the extent of soil erosion on the land unit and collect the watershed, soils and rotation data necessary to develop a comprehensive soil management plan.

In summary, a comprehensive soil management plan must: **1.)** be aligned with the landowner’s production goals; **2.)** address the hydrology and soil quality issues on the land unit that are causing erosion; and **3.)** present opportunities for the landowner to reduce or eliminate the most aggressive forms of tillage utilized, reduce the risk of soil erosion by changing the timing and intensity of tillage operations and mitigate the effects of tillage by increasing vegetative cover and crop residue on the soil surface.