Potato Progress

Research & Extension for the Potato Industry of Idaho, Oregon, & Washington

Andy Jensen, Editor. ajensen@potatoes.com; 208-939-9965

www.nwpotatoresearch.com

Volume XIV, Number 12 | *November 18, 2014*

41st Annual Hermiston Farm Fair, Seminars & Trade Show
Hermiston Conference Center, 415 S. Hwy 395
December 3-5, 2014

WEDNESDAY, December 3, 2014

- Potato Production AM 8:00 AM - 12:00 PM
- Potato Production PM 1:00 PM - 5:00 PM
- High Residue Farming Workshop 1:00 PM - 5:00 PM $15 fee pre-registration required

THURSDAY, December 4, 2014

- General Session 8:00 AM - 12:00 PM
- Cereal Session AM 8:00 AM - 12:00 PM
- Cereal Session PM 1:00 PM - 5:00 PM
- Core Program 1:00 PM - 5:00 PM $10 fee
- Farm Fair Banquet 6:00 PM $25 dinner ticket

FRIDAY, December 5, 2014

- Pest Management 8:00 AM - 12:00 PM
- Core Program 8:00 AM - 12:00 PM $10 fee

All sessions are free to attendees except for the Core Programs and High Residue Farming workshop. No pre-registration is required except for the workshop.

Oregon, Washington & Idaho pesticide credits will be available. The Trade Show is expected to include over 50 exhibitors of products and services of interest to the agricultural community.

Annual Northwest Potato Conferences

Idaho Potato Conference: January 20-22, Pocatello, Idaho

http://web.cals.uidaho.edu/potatoconference/

Washington-Oregon Potato Conference: January 27-29, Kennewick, Washington

http://www.potatoconference.com/

Soil Health After Fumigation

Louise-Marie Dandurand, Dept. Plant, Soil, and Entomological Sciences, U. of Idaho, Moscow
Guy R. Knudsen, Soil & Land Resources Division, U. of Idaho, Moscow

Healthy soils, healthy farms. Soil health, also referred to as soil quality, has been defined as "the continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans." (Letourneau, USDA). Healthy soils have important physical and chemical characteristics including good soil structure, high water-holding capacity, high infiltration rates, favorable pH levels, and adequate nutrient availability. Equally important, healthy soils also contain a thriving biological community of active organisms including earthworms, fungi, bacteria, protozoa and nematodes. Rather than being an inert growing medium for crops, a healthy soil is a living ecosystem that needs to be cared for in order to maintain productivity, ensure environmental quality, and promote plant, animal, and human health (Doran & Parkin 1994).

Organisms in soil, including earthworms, fungi, and bacteria, interact to cycle essential plant nutrients, break down plant residues, and (in the case of earthworms) open up soil pores needed for the flow of oxygen and water. Soil structure, the arrangement of soil textural components into aggregates, is a critical component of soil health, since it determines water holding capacity, nutrient availability, aeration, and root penetration. While plant pathogenic soil bacteria and fungi receive a great deal of attention in potato production, the majority of bacteria and fungi play beneficial and often vital roles in natural environments and agriculture. For example, bacteria and fungi both are extremely important in the formation of soil aggregates, since aggregates don't form by themselves, but are largely the result of microbial activity: fungal hyphae serve as microscopic threads that hold soil particles together, and the sticky polysaccharide materials on the outside of bacterial cell walls act as a kind of "glue" that helps hold aggregates together. Equally important, mycorrhizal fungi interact with plant roots to help make nutrients and water more available to the crop. Beneficial nematodes, whose diets include bacteria, fungi, and other nematodes, play a major role in soil nutrient cycling, and their abundance has been suggested as a useful indicator of soil health (Ristaino & Thomas 1997).

Additionally, a diverse group of soil bacteria and fungi plays an important role in suppressing the activity of soilborne plant pathogens, by competing for space and nutrients, through production of antimicrobial substances, or by inducing the plant's own natural defense system. This disease-suppressive function of the soil microbial community is a form of biological control, which can be broadly defined as the ability of non-pathogenic organisms to reduce the activities of plant pathogens. For example, natural enemies of plant parasitic nematodes include soil fungi that parasitize nematode eggs, or directly kill juvenile or adult nematodes. In research at the University of Idaho, fungi in the genera *Plectosphaerella*, *Paecilomyces*, *Trichoderma*, and *Arthrobotrys*, obtained from potato field soil, all show promise for control of nematode pests of potato including cyst and root knot nematodes. Beneficial fungi that attack plant parasitic nematodes have potential to provide a multipronged control strategy, since nematode-parasitic fungi attack and destroy eggs in cysts, and in some cases kill the infective second-stage juveniles as well. Biological plant disease control may result from either specific suppression, in which a beneficial organism directly suppresses a given pathogen, or more general suppressive activity, resulting from the high biodiversity of microbial populations that creates conditions unfavorable for plant disease development. It is important to realize that biological control is probably always taking place in healthy soils, though perhaps unrecognized and underappreciated until it's gone.

Together, healthy soils with their active biotic (living) communities generate nutrients for plant growth, efficiently absorb and hold water, filter and transform pollutants, and provide a firm foundation for successful agricultural production. However, along with good agronomic practices, it is unavoidable that large-scale production agriculture also relies heavily on chemical fertilizers and pesticides. These inputs have had dramatic effects on increasing crop yields and quality for more than a century. But agricultural chemicals, including soil fumigants used for control of insects, pathogens, and weeds, may have unintended consequences for soil health, through their adverse effects on the native soil microbial community. Recognizing these effects, and reducing them where possible, is an important component of maintaining healthy agricultural soils.

Soil fumigants. Currently, soil fumigants remain among our most effective and widely-used control measures for a number of pests and pathogens. Fumigants are small, volatile, toxic molecules that become gases at relatively low temperatures (e.g., 40 degrees Fahrenheit), and are effective against a wide range of pests including insects, nematodes, bacteria, fungi, and weeds. Application of fumigants is usually done pre-planting. Once applied (typically by injection or incorporation of granular formulations into soil), as gases these chemicals rapidly penetrate and move through soil, killing soil-borne pests and pathogens. After several days to a couple of weeks, most of the fumigant material will have dissipated, and planting can take place.

Soil fumigants with activity against potato pests and pathogens include methyl bromide, chloropicrin, 1, 3-dichloropropene (Telone[R]), metam sodium (Vapam[R], and others), metam potassium, and dazomet (Basamid[R]) (EPA 2005). In terms of total pounds used annually, metam sodium and metam potassium are the most widely used soil fumigants in the United States; for example, nationally more than 31 million pounds of metam sodium have been used each year in potato fields for control of fungal pathogens and nematodes, which is the largest amount of that fumigant used for any crop (EPA 2005). Idaho, along with California and Washington, ranked (in 2005) as one of the top three states in the country for total amount of metam sodium used in crop production (EPA 2005).

Methyl bromide (MeBr) is an odorless, colorless, and highly effective soil fumigant that has been used to control pests in a large number of crops, as well as for postharvest and quarantine applications. Chloropicrin, or “tear gas”, is commonly added as a warning agent to help fumigant applicators avoid accidental exposure to the more toxic but undetectable methyl bromide. Typically, methyl bromide fumigant is injected into soil at a depth of 12 to 24 inches prior to planting of a crop, then covered with a plastic tarp for one to several days to prevent escape of the volatilized gas.

Methyl bromide is a very effective insecticide, herbicide, nematicide, and fungicide, and has been used commercially in the United States for soil fumigation for almost a century (Ragsdale & Wheeler 1995). However, because MeBr was shown to play a role in depleting the stratospheric ozone layer, its use has been incrementally phased out by international agreement (Montreal Protocol of 1987) and under the Clean Air Act. Although its commercial use was officially phased out internationally as of 2005, the Montreal Protocol’s Quarantine and Pre-shipment (QPS) rule provides a limited exemption for production and use of MeBr. QPS applications are allowed to prevent the introduction, establishment, and/or spread of quarantine pests and diseases to ensure their official control. Official requirements are those which are performed by, or authorized by, a national plant, animal, environmental, health, or stored product authority, for example the Plant Protection and Quarantine (PPQ) division of USDA’s Animal and Plant Health Inspection Service (APHIS) (Enebak 2012).

APHIS-PPQ is responsible for preventing movement of quarantine pests that have already entered this country. In 2006, the pale cyst nematode (*Globodera pallida*), a Federal quarantine soil pest, was identified in a locality within the State of Idaho. Idaho growers are now prohibited under federal quarantine from planting potatoes or other host crops of the pale cyst nematode in identified infested fields, and in order to get those fields removed from quarantine and approved for potato production, they are being fumigated with methyl bromide. Soil from fumigated fields is assayed by APHIS personnel and then at University of Idaho greenhouse facilities, to confirm the efficacy of the methyl bromide treatment in eradicating the nematode. Research is also being conducted at the University of Idaho, collaborating universities, and by USDA Agricultural Research Service (ARS) personnel, to explore additional means of eradicating this quarantine pest, including the use of nematode trap crops, biologically-based fumigants, and biological control agents.

Fumigant effects on the soil community. Methyl bromide (and to a large extent, most other fumigants) is a “universal biocide,” it effectively sterilizes the soil, killing most or all soil organisms exposed to it. Because of this, soil fumigation can have negative effects on beneficial soil organisms, as well as on target pests and pathogens (Ibekwe, 2004). For example, mycorrhizal fungi were shown to be detrimentally impacted by methyl bromide fumigation in a number of cropping systems (Menge et al. 1978). Microbial communities, including beneficial bacteria, fungi, and nematodes in fumigated forest and pasture soils were depressed for up to six months after treatment (Yeates et al. 1991). Fumigated soils may increase opportunities for recolonization by plant pathogenic fungi, because the soil has been depleted of its naturally disease-suppressive biological community. For example, species of the pathogenic fungus *Fusarium* have been shown to rapidly colonize fumigated soils, where beneficial microorganisms were no longer present to out-compete them (Marois et al. 1983). Thus, a major challenge is how to re-establish the natural balance of beneficial organisms in soils that have effectively been sterilized by fumigation.

Sometimes, populations of beneficial microoganisms may re-establish naturally. In forest nursery soils where fumigation with MeBr was once a standard practice, and in some cases has continued under a “critical use exemption” (CUE), the loss of mycorrhizal fungi was not found to be a major problem, because spores of the beneficial fungi apparently were re-introduced on wind currents from surrounding forests. Also, fumigated soils may provide opportunities to selectively enhance populations of beneficial organisms. For example, application of biocontrol fungi in combination with low rates of fumigation with metam sodium was shown to effectively reduce the incidence of Verticillium wilt on eggplant (Fravel 1996). Formulation technology also may help beneficial microbes to effectively colonize fumigated soils and enhance control of plant pathogens (Knudsen et al. 1991), and one current research project at the University of Idaho is focused on development and commercialization of this approach.

As agriculturists, it is critical that we never forget our natural allies in the soil microbial community, because they continue to have great potential for plant disease control, if we can learn to effectively work with them and integrate them into other strategies including soil fumigation. To that end, industry, government, and university partnerships will lead to technological successes that any partner alone might not achieve, and will result in more sustainable and environmentally friendly methods of potato production.

REFERENCES

Doran,J.W. and T.B. Parkin. 1994. Defining and assessing soil quality. P. 3-21. In: J.W. Doran, D.C. Coleman, D.F. Bezdicek, and B.A. Stewart (eds.), Defining Soil Quality for a Sustainable Environment. SSSA Special Pub. No. 35. ASA, CSSA, and SSSA, Madison, WI.

Enebak, S.A. 2012. Soil fumigation: The critical use exemption, quarantine pre-shipment rules, re-registration decision and their effect on the 2012 growing season. USDA Forest Service Proceedings, RMRS-P-68. 2012.

EPA. 2005. Overview of the use and usage of soil fumigants. Available at: http://www.epa.gov/oppsrrd1/reregistration/x-soil-fum-HOLD/soil_fumigant_use.pdf.

Fravel, D.R. 1996. Interaction of biocontrol fungi with sublethal rates of metham sodium for control of *Verticillium dahliae*. Crop Prot. 15:115-119.

Knudsen, G. R., Eschen, D. J., Dandurand. L. M., and Wang, Z. G. 1991. Method to enhance growth and sporulation of pelletized biocontrol fungi. Appl. Environ. Microbiol. 57:2864-2867.

Letourneau, B.T. Soil Health. USDA Natural Resources Conservation Service, available at: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/ks/newsroom/?cid=nrcs142p2_033493.

Marois, J. J., Dunn, M. T., and Papavizas, G.C. 1983. Reinvasion of fumigated soil by *Fusarium oxysporum* f. sp. *melonis*. Phytopathology 73:680-684.

Menge, J.A., Munnecke, D.E., Johnson, E.L.V., and Carnes, D.W. 1978. Dosage response of the vesicular-arbuscular mycorrhizal fungi *Glomus fasciculatus* and *G. constrictus* to methyl bromide. Phytopathology 68:1368-1372.

Mousseaux, M. R., R. K. Dumroese, R. L. James, D. L. Wenny, and G. R. Knudsen. 1998. Efficacy of *Trichoderma harzianum* as a biological control of *Fusarium oxysporum* in container-grown Douglas-fir seedlings. New Forests 15:11-21.

Ragsdale, N. N., and Wheeler, W. B. 1995. Methyl bromide: Risks, benefits, and current status in pest control. Pages 21-44 in: Review of Pesticide Toxicology. R. M. Roe and R. J. Kuhr, eds. Toxic Communication Inc., Raleigh, NC.

Ristaino, J.B., and W. Thomas. 1997. Agriculture, methyl bromide, and the ozone hole: Can we fill the gaps? Plant Disease 81:964-977.

Yeates, G.W., Bamforth, S.S., Ross, D.J., Tate, K.R., and Sparling, G.P. 1991. Recolonization of methyl bromide sterilized soils under four different field conditions. Biol. Fert. Soils 11:181-189.