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PLANT SCIENCE SCAN

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BACKGROUND: The Plant Health Science Division of the Canadian Food Inspection Agency routinely scans external sources to identify information that might be of possible regulatory significance or interest to Canada's national plant health. This Plant Science Scan report was prepared by the Canadian Food Inspection Agency's staff as a mechanism to highlight potential items of interest, raise awareness and share significant new information related to plant health.

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Canada

Pathology

1 New Method: Reducing Brown Rot, *Monilinia fructigena,* Incidence During Long Term Storage

Some of the most economically important diseases of apples (*Malus* spp.) and stone fruit (*Prunus* spp.) are caused by brown rot fungi. *Monilinia fructigena* is one of a few different fungal species that are responsible for causing pre-and post-harvest fruit rot. Sound disease management of brown rot incidence in the orchard includes integration of cultural methods and chemical control measures. Cultural control methods include orchard sanitation (removal of sources of inoculum) as well as pruning to allow greater air movement and fungicide penetration and coverage. Chemical control measures include developmentally timed fungicidal applications. A recently published article shows that pre-harvest calcium applications and controlled atmosphere (CA) storage, along with minimization of fruit injury and infection, may help to reduce *M. fructigena* associated brown rot incidence in apple fruits during long term storage.

This particular species of brown rot fungus is not known to occur in North America and is listed by Canada as a regulated pest. As the fungus could be carried on fruit imported into Canada for consumption, the integration of various pre- or post-harvest treatments could be employed to reduce the overall likelihood that the fungus might be introduced on imports.

SOURCES:

Holba, I.J., B. Balla, A. Vámos, and J. M. Gáll, 2012. Influence of preharvest calcium applications, fruit injury, and storage atmospheres on postharvest brown rot of apple. Postharvest Biology and Technology Vol. 67:29–36. http://www.sciencedirect.com/science/article/pii/S0925521411003085

British Columbia Ministry of Agriculture. Brown Rot of Stone Fruits http://www.agf.gov.bc.ca/cropprot/tfipm/brownrot.htm#management

2 First report: The Potato Gangrene Pathogen, *Phoma foveata*, from China.

In a recent report from China, a potato tuber rot disease of unknown cause was found to be affecting 5 to 15% of potato tubers (*Solanum tuberosum*) in an area of Gansu Province. Based on symptomology, morphology, culturing and molecular methods, *Phoma foveata* was identified as the causal fungal agent. *P. foveata* causes a noxious tuber rot in potato called gangrene. Gangrene can lead to significant losses in stored potatoes. Infected tubers develop small dark depressions around wounds, eyes or lenticels. These depressions can enlarge to form "thumb mark" or larger irregularly shaped areas. The fungus can also cause an internal rot beneath these superficial depressions. The disease is widely reported from Europe and also occurs in part of Oceania, South America, and Asia. The authors indicate that management strategies for potato disease control should be adjusted for the presence and control of gangrene disease

Phoma foveata is not known to occur in Canada or the United States and is listed as a regulated pest for Canada.

SOURCE:

Yang, C., X. Chen, H. Jiang, and C. Pu, 2012. First Report of Potato Gangrene Caused by Phoma foveata in China. Plant Disease http://dx.doi.org/10.1094/PDIS-06-12-0528-PDN

3 First Report: Potato Spindle Tuber Viroid from Greenhouse Tomatoes in North Carolina

In the spring of 2012, several tomatoes (*Solanum lycopersicum*) in a research greenhouse facility in North Carolina were found to be suffering from a severe disease. In a recent report, researchers provide an account of the infection and the subsequent analysis used to identify the infectious agent. Symptoms of affected plants suggested a virus as the causal agent; however initial screenings for known viruses proved unsuccessful. Further analysis revealed positive signals from viroid screens. Sequence comparisons showed high sequence identity to Potato Spindle Tuber Viroid (PSTVd) isolates. This report provides the first ever find

of PSTVd from greenhouse tomato in North Carolina. In this case the diseased plants were contained, disposed of and PSTVd was eradicated.

PSTVd is a regulated pest in Canada relative to seed potato certification. This report adds to previous accounts concerning PSTVd associated with tomato and ornamental greenhouse crops in other parts of the World (e.g., Europe, UK, New Zealand, USA). In terms of the United States, this report from North Carolina adds to a similar report from California in 2010. If left uncontrolled, the impacts of PSTVd on greenhouse tomato can be potentially very significant; however, the possible risks PSTVd infected tomatoes or ornamental plants might pose to potato crops remain largely unknown.

SOURCE:

Ling, K.-S., R. Li, D. R. Panthee and R. G. Gardner, 2012. First Report of Potato Spindle Tuber Viroid Naturally Infecting Greenhouse Tomatoes in North Carolina. Plant Disease http://dx.doi.org/10.1094/PDIS-07-12-0679-PDN

Entomology

4 Update: Differential Persistence of Two Ash Species in Michigan Following Emerald Ash Borer, *Agrilus planipennis*, Attack

The emerald ash borer (EAB), *Agrilus planipennis*, is an invasive and destructive beetle in North America. Native to Asia, it poses a serious threat to the native ash tree (*Fraxinus* spp.) species on this continent. The first North American detection occurred in Michigan in 2002, though it is believed to have been present for several years prior to this detection. Since then, this pest has quickly spread throughout much of Eastern North America and is responsible for the loss of tens of millions of ash trees both in natural and urban environments. A recent report provides a study following the fate of two ash tree species once abundant in Michigan hardwood forests, ten years after the first detection of the EAB infestation. An inventory of the relative abundance of living and dead blue ash trees, *F. quadrangulata*, and white ash trees, *F. americana*, suggests that *F. quandrangulata* is relatively more resistant to the EAB. The authors suggest that further study of this *Fraxinus* species, including the morphological features and constitutive/inducible defence mechanisms which confer resistance, may allow for the potential propagation of these traits in other, more susceptible *Fraxinus* species.

EAB is a regulated pest in Canada. The CFIA has established regulated areas in Ontario and Quebec where EAB is known to be present. Movement restrictions on potentially infested material from these areas are implemented to slow the spread of EAB to new areas. While *F. quandrangulata* is listed as a rare species in Canada, present in only the most southern portions on Ontario, *F. americana* along with other highly susceptible *Fraxinus ispecies* are broadly distributed across many of Canada's hardwood forests.

SOURCES:

Tanis S. R. and D.G. McCullough, 2012. Differential persistence of blue ash and white ash following emerald ash borer invasion. Canadian Journal of Forest Research 42: 1542-1550.

Canadian Food Inspection Agency's Emerald Ash Borer webpage: http://www.inspection.gc.ca/plants/plant-protection/insects/emerald-ash-borer/eng/1337273882117/1337273975030

United States Department of Agriculture Animal and Plant Health Inspection Service's Emerald Ash Borer webpage: http://www.aphis.usda.gov/plant_health/plant_pest_info/emerald_ash_b/index.shtml

Scoggan, H. J. 1979. Flora of Canada. National Museums of Canada, Ottawa. 1711 pp.

Biotechnology

5 Update: Interface Between Nanotechnology and Plant Biotechnology

Nanotechnology is gaining increasing interest in the plant science community, for its potential applications to basic research but also to plant biotechnology. The delivery of various biomolecules, including proteins to the cell has increasingly become more feasible with the development of tailored nanoparticles capable crossing

dynamic barriers, such as cell membranes. Researchers at the University of Iowa have been refining the standard biolistic particle delivery system employed for plant transformation by incorporating the co-delivery, and *in-vivo* release of functional proteins using novel nanoparticles. The research team has developed a gold-functionalized mesoporous silica nanoparticle (Au-MSN) based platform which can; internalize and protect functional proteins during the transformation process, release the functional protein into the cell post transformation and also serve as a vector for the association of DNA for co-transformation into cells. The team has recently published on a proof-of-concept example of this technology, the first such account in a plant cell. This technology holds value for facilitating our understanding of cellular processes and signal pathways in plant systems by providing a new method to introduce functional proteins *in-vivo*. The technology could also find direct application in plant biotechnology. Application of this technology may improve the efficiency of plant transformations, specifically by including DNA-modifying enzymes into the transformation process (ie. recombinases, restriction enzymes, etc.) capable of targeting the DNA into specific regions of the receiving genome.

The CFIA conducts risk assessments for the unconfined release of plants with novel traits (PNTs). The CFIA's regulatory oversight for PNTs is triggered when a plant is developed which contains a trait that is both new to the Canadian environment and has the potential to affect the specific use and safety of the plant with respect to the environment and human health. Therefore, any PNT developed using this technology and intended for unconfined environmental release in Canada would require CFIA approval.

SOURCE:

Martin-Ortigosa, S., J.S. Valenstein, V. S.-Y. Lin, B.G. Trewyn and K. Wang, 2012. Gold Functionalized Mesoporous Silica Nanoparticle Mediated Protein and DNA Codelivery to Plant Cells Via the Biolistic Method. Adv. Funct. Mater., 22: 3576–3582.
doi: 10.1002/adfm.201200359

6 Update: Utilization of Applied Genetic Technologies to Support Forest Conversation and Sustainable Trade

The steady increase in demand on forest products, as well as better access to forest resources and the technical advance in transportation systems, has lead to globalization of trade in forest products. Some of this demand includes rare and desirable species, many of which are now protected under the auspices of a number of international initiatives, e.g., the Nagoya Protocol, a supplementary agreement to the Convention on Biological Diversity, and CITES, (the Convention on International Trade in Endangered Species of Wild Fauna and Flora). In many jurisdictions, the timber trade and the source tracking on the origins of timber are rudimentary at best, mainly paper based, and subject to questionable records management, especially when overlaid by illegal operators. Proving that mis-declared timber has not originated from a legal logging area is one of the biggest challenges to the timber industry and importing nations. In many cases, protected species are not visually distinguishable from similar species, especially after they have been processed. Extraction methods are such now, that sufficient levels of quality DNA can be extracted from a variety of samples, including highly processed wood samples such as those found in flooring and furniture. Recent advances and shrinking costs related to the development of applied genetic technologies have lead to the application of DNA fingerprinting and DNA barcoding as tools to support forest conservation and sustainable trade. With respect to the timber industry, DNA barcoding permits identification down to a particular species while DNA fingerprinting allows for the potential to identify an individual tree and/or source-of-origin for the wood product.

A number of international open source genographic mapping initiatives are now underway to identify and inventory large amounts of genetic data from tracts of rare and protected forest species in South America, Africa and Asia. One project of note is that operated by the Forest Research Institute of Malaysia (FRIM). Since 2010, FRIM researchers have been able to collect DNA barcodes for half of Malaysia's 408 commercially valuable and protected timber species. Aside from being able identify the species and origin of wood from a variety of sources, FRIM researchers state that the

primary application of the research is to provide enforcement agencies with the necessary tools to do their job when dealing with illegal logging operators who are harvesting trade restricted or endangered species of wood.

SOURCES:
The Star online – Malaysia's English Newspaper, "Barcoding for trees to curb illegal logging", Tuesday, July 31, 2012
http://thestar.com.my/lifestyle/story.asp?file=/2012/7/31/lifefocus/11287268&sec=lifefocus

Forrest Legality Alliance, Applied Genetics for Forest Conservation and Sustainable Trade – July 2011
http://www.forestlegality.org/files/fla/dh_applied_genetics_jul_11.pdf

7 First Report: Discovery of a Soybean Cyst Nematode Resistance Gene, a Potentially Novel Resistance Mechanism in Plants.

Soybeans (*Glycine max),* are a multi-purpose crop used worldwide as a source of protein for human and animal consumption as well as a feedstock for many industrial applications. Canada is a global exporter of food quality soybean. They are grown in several provinces including Prince Edward Island, Quebec, Ontario, Manitoba and Alberta. Soybean Cyst Nematode (SCN) *Heterodera glycines,* a parasitic roundworm, is the most yield limiting disease of soybean in Ontario and the northern United States. This parasite feeds on the roots of the soybean plants. The cysts, which develop in infected roots, are comprised of the enlarged body of the mated females and serve to encapsulate and protect the eggs during the non-growing season. SCN resistant cultivars of soybean are available to growers; however the specific genes and resulting resistance mechanisms were largely unknown.

Recently, a University of Missouri research team reported on the identification of a gene involved in SCN resistance. The team used mutational analysis, gene silencing and transgenic complementation, to produce convincing evidence that a serine hydroxymethyltransferase (SHMT) is involved in resistance to SCN. SHMT is a ubiquitous enzyme in nature. It is responsible for the interconversion of serine to glycine and is also imperative in cellular one-carbon metabolism. The identification of a SHMT based resistance mechanism is unprecedented in plants and offers a unique opportunity to study and improve nematode resistance in soybean. While future molecular and biochemical studies are required to elucidate the mechanism of resistance, the authors suggest that it may include alterations to folate one-carbon metabolism leading to a hypersensitive response in the cells attacked by SCN.

Understanding the mechanistic underpinning of the SHMT based SCN resistance may offer opportunities to modify the protein for further enhancement of overall resistance. Subsequent application of this strategy would prove useful to developers of novel SCN resistant cultivars. The CFIA is responsible for conducting risk assessments of plants with novel traits and has a history of performing assessments on novel varieties of soybean, including varieties that are resistant to herbicides. These commercially important varieties have helped to reduce costs and improve production efficiencies for growers and the application of this discovery could hold great potential for limiting yield loss attributed to SCN.

SOURCES:
Shiming L.., P.K. Kandoth, S.D. Warren, G.Yeckel, R. Heinz, J. Alden, C. Yang, A. Jamai, T. El-Mellouki, P.S. Juvale, J. Hill, T.J. Baum, S. Cianzio, S.A. Whitham, D. Korkin, M.G. Mitchum and K. Meksem. A soybean cyst nematode resistance gene points to a new mechanism of plant resistance to pathogens. Nature, 2012; doi:10.1038/nature11651
http://www.nature.com/nature/journal/vnfv/ncurrent/full/nature11651.html

CFIA biology document "*The Biology of Glycine max (L.) Merr. (Soybean) Biology Document BIO1996-10"*
http://www.inspection.gc.ca/plants/plants-with-novel-traits/applicants/directive-94-08/biology-documents/eng/1330723572623/1330723704097

Ontario Ministry of Agriculture Food and Rural Affairs Diseases of Field Crops: Soybean Diseases – Soybean Cyst Nematode
http://www.omafra.gov.on.ca/english/crops/pub811/14soybean.htm

Botany

8 First Report: Chilean Rhubarb, *Gunnera tinctoria*, an Invasive Plant in Ireland and New Zealand.

Chilean rhubarb, *Gunnera tinctoria*, is native to Argentina and Chile and is naturalised in the Azores, New Zealand, the Republic of Ireland and the United Kingdom. *G. tinctoria* is a member of the family Gunneraceae which, aside from introductions, is confined to the southern hemisphere. It is a giant perennial rhizomatous herb with large simple leaves. The thick leaf blades are 1-2 m across and covered with stiff prickles. The petioles are 1-1.5 m long. The species can grow on leached, disturbed soils because it harbours nitrogen-fixing cyanobacteria. The large leaves shade out native vegetation and form dense thickets in stream valleys. In Ireland, Chilean rhubarb is considered a "notable plant invader" where it disrupts native vegetation and grasslands but is limited by its need for constant water availability. In New Zealand, it invades stream valleys and cliffs where it suppresses native plants and alters normal plant succession. It is distributed widely, but locally in New Zealand, so much so that it was recognized as a weed of conservation land in the 1990's

Chilean rhubarb has not been reported from Canada, but is found in Marin county in California in the U.S. It has been spread as an ornamental plant for use beside water features. Based on its present range in New Zealand and Ireland, Chilean rhubarb can grow to NAPPFAST Plant Hardiness zone 8. Much of coastal British Columbia is within zone 8 or 9. Although the potential distribution is further limited by the narrow ecological requirements, the parts of British Columbia with suitable winter temperatures would also provide the necessary high rainfall to support populations of this species.

SOURCES:

Brouillet, L., Coursol, F., Favreau, M. and Anions, M. 2010+. VASCAN, the database vascular plants of Canada. http://data.canadensys.net/vascan/

Canadian Food Inspection Agency and Canadian Forest Service 2011. Plants of Canada Database. http://www.plantsofcanada.info.gc.ca/

Kartesz J.T, 2011. The Biota of North America Program (BONAP). Chapel Hill, N.C. Floristic Synthesis of North America, Version 1.0. Biota of North America Program (BONAP). North American Plant Atlas http://www.bonap.org/

Osborne B., M. Fennell and C. Armstrong, 2011.The riddle of *Gunnera tinctoria* invasions: a particularly Irish enigma. In *3rd International Symposium on Weeds and Invasive Plants* Ascona, Switzerland. http://www.wsl.ch/epub/ewrs/sessions/detail_EN?id=288&session=3&type=oralpresentations

Scoggan, H. J. 1979. *Flora of Canada.* Ottawa: National Museums of Canada. 1711 pp.

USDA-ARS 2012. Germplasm Resources Information Network - (GRIN) http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl

Weber E., 2003. Invasive plant species of the world: A reference guide to environmental weeds. Wallingford, UK: CABI Publishing. 548 pp.

Williams P.A., C.C. Ogle, S.M. Timmins, G.D.L Cock. and J. Clarkson, 2005. Chilean rhubarb (*Gunnera tinctoria*): biology, ecology and conservation impacts in New Zealand. New Zealand Department of Conservation. Wellington, NZ. http://www.doc.govt.nz/upload/documents/science-and-technical/drds210.pdf

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