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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 Host: Camphor tree (*Cinnamomum camphora*) a new host for *Phytophthora ramorum*

In California, U.S., *Phytophthora ramorum* was recently identified *from* camphor trees (*Cinnamomum camphora*) showing patchy irregular cankers, shoot blight, and branch dieback. *P. ramorum* was confirmed through molecular identification and pathogenicity testing. This may constitute a new host record for *P. ramorum.*

The CFIA's list of host plants regulated for *P. ramorum* can be found at http://www.inspection.gc.ca/english/plaveg/protect/dir/sodspe.shtml. *C. camphora* is not currently on the list of host plants regulated for *P. ramorum.*

SOURCE:
Rooney-Latham, S., Honeycutt, E., Ochoa, J., Grünwald, N.J. and C.L. Blomquist, 2013. First report of camphor tree *(Cinnamomum camphora)* as a host of *Phytophthora ramorum.* Plant Disease [online]. http://apsjournals.apsnet.org/doi/pdf/10.1094/PDIS-01-13-0096-PDN

2 Update: Survey for brown rot in Poland

In Poland, *Monilinia polystroma*, *M. fructicola*, *M. fructigena* and *M. laxa* were confirmed in fruit with brown rot symptoms from commercial stone and pome fruit orchards. Morphological characterization, multiplex PCR, sequence analysis, and pathogenicity testing confirmed species identification and pathogenicity. This study represents the first report of *M. polystroma* (from apple, peach, plum) and *M. fructicola* (from plum) in Poland. The authors recommend continued work to study the pathogenicity and potential competition between these *Monilinia* spp. in order to assist in predicting the impact of these new species on commercial fruit production in Poland. Brown rot fungi cause some of the most economically important diseases of apple, pear and stone fruits. *Monilinia fructicola* and *M. laxa* occur in North America where they cause blossom and twig blight and fruit rot. *Monilinia fructigena* and *M. polystroma*, two other brown rot fungi, are not known to occur in North America. Canada regulates the import of certain fresh fruit and nursery stock genera to prevent the introduction of *Monilia polystroma, M. fructigena, and M. mali.*

SOURCE:
Poniatowska, A., Michalecka, M. and A. Bielenin, 2013. Characteristic of *Monilinia* spp. fungi causing brown rot of pome and stone fruits in Poland. European Journal of Plant Pathology 135(4)855-865. http://link.springer.com/article/10.1007/s10658-012-0130-2

3 New Host: *Crataegus pinnatifida* Bge. var. *major* N a new host for brown rot

Monilinia yunnanensis was identified from *Crataegus pinnatifida* Bge. var. *major* N, an important economic fruit and herbal medicine in China. Morphological characteristics, molecular identification and pathogenicity testing confirmed the identification of isolates taken from fruit. This study represents the first report of *Crataegus pinnatifida* Bge. var. *major* N as a host for *M. yunnanensis*.

Monilinia yunnanensis was first described in China from peach, and this report expands upon the known host range for this species. Canada regulates the import of certain fresh fruit and nursery stock genera to prevent the introduction of several fungal brown rot species however *M. yunnanensis* is not currently amongst them. The CFIA has conducted a pest categorization on *M. yunnanensis* and determined this species is a potential quarantine pest for Canada.

SOURCES:
Hu, M-J., Cox, K.D., Schnabel, G. and C-X. Luo, 2011. *Monilinia* Species Causing Brown Rot of Peach in China. PLoS ONE 6(9): e24990. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3181254/pdf/pone.0024990.pdf

Zhao, Y.Z., Wang, D. and Z.H. Liu, 2013. First Report of Brown Rot on *Crataegus pinnatifida* var. *major* Caused by *Monilia yunnanensis* in China. Plant Disease 97(9) 1249. http://apsjournals.apsnet.org/doi/abs/10.1094/PDIS-01-13-0085-PDN?prevSearch=allfield%253A%2528Crataegus%2Bpinnatifida%2Bge.%2Bvar.%2Bmajor%2BN%2529&searchHistoryKey=

Botany

4 New Pest: Exotic bamboos escape cultivation

In 2012, populations of pygmy bamboo, *Pleioblastus fortunei* (Van Houtte) Nakai (a.k.a. *P. pygmaeus* (Miq.) Nakai) (Poaceae), a native of Japan, were discovered in Virginia, Maryland and the District of Columbia in the eastern U.S. These were the first report of this species outside of cultivation in North America. These occurrences are rather surprising, since the species is not known as a wild plant in the area of origin in Japan. All of the populations discovered in 2012 consisted of clonal patches in woodlands. One of the populations in Virginia was actually noticed in 2008, when the plants were only 50 cm high. This population now contains many canes up to 130 cm tall (Steury et al. 2013).

Pygmy bamboo grows 30 to 150 cm tall. The plants are not known to flower, so reproduction is vegetative. The plants do best in moist, well-drained soil in partial to full shade. On a local scale, it is considered very invasive, forming large patches. The species is classified as a dwarf running bamboo as the long rhizomes spread in all directions from the parent plant (MBG 2013).

Also in 2012, a single population of Japanese bamboo, *Pleioblastus argenteostriatus* (Regel) Nakai, was identified in the District of Columbia. It is interesting that these plants were *P. argenteostriatus* f. *glaber*, which is not the form which is known to be in cultivation in the U.S. The typical cultivated form has the leaves striped with white or yellow, unlike the feral population. It is possible that the non-striate form could be derived from the horticultural variety but this has not been tested. This species is also native to Japan. The introduced population in D.C. was growing along a disturbed forest edge (Steury et al. 2013). Japanese bamboo grows 20-40 cm tall with long, slender rhizomes (Clayton et al. 2006+).
Neither of these species has ever been found growing wild in Canada (Brouillet et al. 2010+), although both are offered for sale by Canadian nurseries (CFIA 2009). The populations in the U.S. are growing in NAPPFAST Plant Hardiness Zone 7, which suggests that both of these bamboo species will be able to grow in coastal British Columbia, southwestern Ontario and coastal Nova Scotia and southern Newfoundland.

SOURCES:

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

Clayton, W. D., Vorontsova, M., Harman, K. T. and Williamson, H. 2006+. GrassBase - The Online World Grass Flora. Royal Botanic Gardens, Kew. http://www.kew.org/data/grasses-db.html

MBG. 2013. Gardening Help. Missouri Botanical Garden. http://www.missouribotanicalgarden.org/gardens-gardening/your-garden/help-for-the-home-gardener.aspx

Steury, B. W., Triplett, J. K. and Parrish, J. 2013. Virginia, Maryland, and District of Columbia. Castanea 78(2):138-139.

5 Biological Control: Successful establishment of *Tetrastichus planipennisi* (Hymenoptera: Eulophidae) in Michigan

Tetrastichus planipennisi Yang is a gregarious larval endoparasitoid of emerald ash borer (EAB) (*Agrilus planipennis*). Native to China, *T. planipennisi* was introduced into the United States in 2007 as a classical biocontrol agent. A report by Duan et al. (2013) indicates that *T. planipennisi* has become well established in three Michigan counties, where it was introduced. The authors reported that between 2007-2010, *T. planipennisi* adults were released into each of six forest sites in the three counties (Ingham, Gratiot, and Shiawassee). By the fall of 2012, the proportion of sampled trees with one or more broods of *T. planipennisi* increased to 92 and 83% in the parasitoid-release and control plots, respectively, from 33 and 4% in the first year after parasitoid. Similarly, the mean number of *T. planipennisi* broods observed from sampled trees increased from less than one brood per tree in the first year to 2.46 (at control plots) to 3.08 (at release plots) broods by the fall of 2012. The rates of EAB larval parasitism by *T. planipennisi* also increased from 1.2% in the first year after parasitoid releases to 21.2% in the parasitoid-release plots, and from 0.2 to 12.8% for the control plots by the fall of 2012. These results demonstrate that *T. planipennisi* is well established in southern Michigan and its populations are increasing and expanding, an indication that this parasitoid has a high potential to suppress EAB populations (Duan et al. 2013).

EAB is a relatively new invasive forest pest that has killed tens of millions of ash (*Fraxinus*) trees in Canada and throughout the eastern United States since it was first detected in Ontario and Michigan in 2002. As of July 2013, this beetle has been confirmed to be present in 31 Ontario counties, and in seven areas in the province of Quebec. In Canada, as part of the long term strategy to manage EAB, the CFIA has recently approved the release of *T. planipennisi* into limited areas of southwestern Ontario by Natural Resources Canada.

SOURCE:
Duan, J. J., Bauer, L. S., Abell, K. J., Lelito, J. P. and R. van Driesche, 2013. Establishment and Abundance of *Tetrastichus planipennisi* (Hymenoptera: Eulophidae) in Michigan: Potential for Success in Classical Biocontrol of the Invasive Emerald Ash Borer (Coleoptera: Buprestidae). Journal of Economic Entomology, 106(3): 1145-1154. http://esa.publisher.ingentaconnect.com/content/esa/jee/2013/00000106/00000003/art00011

6 New Treatment: CATTS - A new regime to disinfest peach fruit moth (*Carposina sasakii*) Matsumura (Lepidoptera: Carposinidae)

A recent study in South Korea (Son et al. 2012) has explored the possibility of using Controlled Atmosphere Temperature Treatment System (CATTS) as an alternative to methyl bromide fumigation. Fumigation with methyl bromide is the current recommended phytosanitary treatment to disinfest fresh apple fruits being imported into Canada from the native areas of *Carposina sasakii*. As a signatory to the Protocol of the Vienna Convention on Substances that Deplete the Ozone Layer (Montreal Protocol, 1987), Canada has entered the phase-out period for the use of methyl bromide for quarantine purposes. Exporting countries are therefore encouraged to submit alternatives to methyl bromide fumigation for review.

CATTS uses a short-term high temperature treatment in combination with controlled atmospheres (CA), typically 15% carbon dioxide and 1% oxygen, to minimize the exposure time needed to kill insects while maintaining fruit quality. This technology has been used to disinfest insect pests from sweet cherries, apples, pears, peaches, and nectarines, and has resulted in 100% efficacy with acceptable market quality of the

fruits. In addition, two serious internal feeders of apples, *Cydia pomonella* and *Grapholita molesta*, have been shown to be effectively controlled by CATTS technology.

In the current study, it was reported that when apples infested with different stages of *C. sasakii* were treated under CATTS conditions (heating rate of 16°C/h, chamber temperature of 46°C, final core temperature of 44°C under 1% O_2/15% CO_2 atmosphere), young larvae (first-fourth instars) did not survive after 40 min exposure, but the fifth instars required an exposure of at least 60 min to attain 100% mortality. Tested apple fruits did not show any appreciable loss of quality in relation to fruit firmness, sweetness, and decay after a 60 min CATTS treatment. These results suggest that CATTS can be used as a reliable phytosanitary treatment to control *C. sasakii* in apples.

Carposina sasakii is regulated by the CFIA.

SOURCE:
Son, Y., Chon, I., Neven, L., and Y. Kim, 2012. Controlled Atmosphere and Temperature Treatment System to Disinfest Fruit Moth, *Carposina sasakii* (Lepidoptera: Carposinidae) on Apples. Journal of Economic Entomology, 105(5), 1540-1547. http://esa.publisher.ingentaconnect.com/content/esa/jee/2012/00000105/00000005

7 Update: Population genetics of emerald ash borer

This study used microsatellite markers to analyze the genetic variation in populations throughout the native and introduced range of emerald ash borer (EAB) (*Agrilus planipennis*). A total of 48 populations (Ontario and Quebec, Canada, Michigan, U.S., South Korea, and China) were genotyped using 7 microsatellite markers. The results demonstrated higher genetic variability in native EAB populations with a significant loss of alleles upon introduction to North America. The Quebec population (Carignan) is different than those in Michigan and Ontario; possible explanations are suggested by the authors. This study identified microsatellite markers with the highest number of alleles which can be used in future genetic studies on North American populations.

EAB is a regulated pest for Canada. The CFIA has established regulated areas in Ontario and Quebec where EAB is known to be present. Movement restrictions on regulated materials from these areas are implemented to slow the spread of EAB.

SOURCE:
Keever, C.C., Nieman, C., Ramsay, L., Ritland, C.E., Bauer, L.S., Lyons, D.B. and J.S. Cory, 2013. Microsatellite population genetics of the emerald ash borer (*Agrilus planipennis* Fairmaire): comparisons between Asian and North American populations. Biological Invasions 15(7): 1537-1559. http://link.springer.com/article/10.1007/s10530-012-0389-4

8 Update: Male mating behavior in citrus longhorned beetle (*Anoplophora chinensis*)

Note: White-spotted longicorn beetle (*Anoplophora malasiaca*), the name used in this paper, is a synonym for citrus longhorned beetle (*A. chinensis*).

In Japan, a new report examined male mating behavior of citrus longhorned beetles collected from three different host plant populations (*Citrus*, *Salix* and *Vaccinium*). Adult males responded more frequently to odours from their original host plants (*Citrus*, *Salix* and *Vaccinium*) suggesting the orientation behaviour of mating males is influenced by their developmental history. Male mating behaviour varied between populations as *Citrus* males were responsive to female extracts regardless of origin while *Vaccinium* males only responded to mature *Salix* and *Vaccinium* females but never to *Citrus* females. Overall, the results indicated that for certain populations, males were likely to approach females feeding on its original host plant.

Citrus longhorned beetle is a serious pest with a wide host range; this species poses a threat to natural areas, fruit trees and woody ornamental

plants. Symptoms include thinning crown, dead branches, callus tissue around injuries, and cracked or missing bark. Citrus longhorned beetle is not known to occur in Canada and is a regulated quarantined pest for Canada.

SOURCE:
Fujiwara-Tsujii, N., Yasui, H. and S. Wakamura, 2013. Population differences in male responses to chemical mating cues in the white-spotted longicorn beetle, *Anoplophora malasiaca.* Chemoecology 23(2):113-120. http://link.springer.com/article/10.1007/s00049-013-0126-1

9 New Treatment: Alternatives to methyl bromide for apple maggot fly (*Rhagoletis pomonella*)

Chloropicrin, Telone II, and chloropicrin + Telone II have been identified as potential alternatives to methyl bromide for successful post-harvest fumigation of apple maggot-infested apples. The study examined apple maggot (*Rhagoletis pomonella*) pupal mortality and adult emergence in response to fumigation with chloropicrin, Telone II, chloropicrin + Telone II, ECO_2FUME, Vapam and methyl bromide. Chloropicrin caused the highest absolute pupal mortality (100% mortality 7 days after a 4 hour exposure), however, there was no significant difference in adult emergence among all of the treatments. No adults emerged after chloropicrin, Telone II, and chloropicrin + Telone II treatments, while adults were observed emerging after ECO_2FUME, Vapam and methyl bromide treatments. The authors suggested further studies to investigate the toxic effect of these chemicals on nursery plants, as well as tests to determine whether they can be useful soil fumigants (e.g. for eradication efforts or for treating potted plants).

Apple maggot is native to North America and is a serious pest of apples in Canada. Maggots tunnel within the fruit resulting in fruit rot due to infection caused by secondary organisms. In 2006, apple maggot was detected in coastal British Columbia. The CFIA currently regulates the entry of host fruit, used bins and nursery stock from regulated areas into apple maggot-free areas of British Columbia.

SOURCE:
Yee, W. L., Chapman, P. S. and L.K. Tanigoshi, 2013. Alternative Fumigants to Methyl Bromide for Killing Pupae and Preventing Emergence of Apple Maggot Fly (Diptera: Tephritidae). Journal of Entomological Science 48(1):36-42.

Biotechnology

10 Update: Corn rootworm in eastern Iowa

Corn rootworm species (*Diabrotica* spp.) are among the most serious pests of maize in the United States, demonstrating remarkable adaptability to pest management strategies, including crop rotation. Recently, a study was undertaken to test a model predicting the invasion of rotation–resistant corn rootworm from Illinois into eastern Iowa by 2011. After determining an estimated economic injury level, corn rootworm rotation-resistance was quantified to determine if the rotation-resistance populations had passed the threshold to cause economic damage to corn crops in eastern Iowa. The levels of rotation resistance were much lower than predicted by the model, and the results confirm that crop rotation currently remains an effective pest management strategy in eastern Iowa for managing rootworm.

Among the corn hybrids available only the genetically modified varieties that have been engineered to be resistant to corn rootworm have sufficient protection to prevent yield loss. Identifying and monitoring changes in corn rootworm populations is important; if the prevalence of rotation-resistant populations of corn rootworm increases the demand for rootworm resistant corn varieties could also potentially increase, resulting in more pressure on

the corn rootworm resistant varieties both in terms of availability and ensuring the ongoing efficacy of the resistance traits . Since 2003, the CFIA has authorized the unconfined environmental release of a number of transgenic corn varieties expressing *Bt* toxins that target rootworm feeding. In order to ensure the responsible stewardship of these corn varieties, the CFIA requires an insect resistance management plan for all Bt corn varieties as a condition of authorization for environmental release.

SOURCE:
Dunbar, M.W. and A.J. Gassmann, 2013. Abundance and Distribution of Western and Northern Corn Rootworm (*Diabrotica* spp.) and Prevalence of Rotation Resistance in Eastern Iowa. Journal of Economic Entomology 106(1)168-180.
http://esa.publisher.ingentaconnect.com/content/esa/jee/2013/00000106/00000001/art00023

11 Update: Glyphosate-resistant kochia in western Canada

Glyphosate is a common herbicide for many producers as it controls a broad-spectrum of weeds and is affordable. When a herbicide is used repeatedly without other weed management practices or rotating with different herbicide modes of action, the selection pressure for resistant weed biotypes is increased. A recent study characterized three glyphosate-resistance (GR) kochia (*Kochia scoparia*) field populations from southern Alberta through dose-response experiments. A survey of fields surrounding the targeted populations confirmed seven additional glyphosate-resistant kochia populations which appear to have been spread by farm equipment and wind. One glyphosate-resistant kochia population was confirmed more than 100 km from the survey populations. All glyphosate-resistance kochia populations were resistant to acetolactate synthase (ALS)-inhibiting herbicide but susceptible to dicamba. Based on selection pressure, Kochia, wild oat and green foxtail were identified as being most as risk for selection of glyphosate-resistance in the Grassland region of the prairies. This study represents the first occurrence of a GR weed in western Canada.

The CFIA conducts risk assessments for the unconfined release of plants with novel traits (PNTs). For PNTs that express a herbicide tolerance trait, a herbicide tolerance management (HTM) plan is required. HTM plans are designed to delay weeds and species related to a herbicide-tolerant crop plant from developing tolerance to herbicides. HTM plans are also designed to address the occurrence of herbicide tolerant volunteers and volunteers with resistance to multiple herbicides. The economical and broad-spectrum weed control of glyphosate renders it a tool of choice for many production practices including chem-fallow weed control, no-till burndown, and Roundup Ready® crops. Therefore, management plans together with production practices are essential to ensure continued efficacy of this important product.

SOURCE:
Beckie, H.J., Blackshaw, R.E., Low, R., Hall, L.M., Sauder, C.A., Martin, S., Brandt, R.N. and S.W. Shirriff, (2013) Glyphosate- and Acetolactate Synthase Inhibitor–Resistant Kochia (*Kochia scoparia*) in Western Canada. Weed Science 61 (2): 310-318.
http://wssajournals.org/doi/abs/10.1614/WS-D-12-00140.1

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