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PLANT SCIENCE SCAN

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BACKGROUND: The Plant Health Science Directorate 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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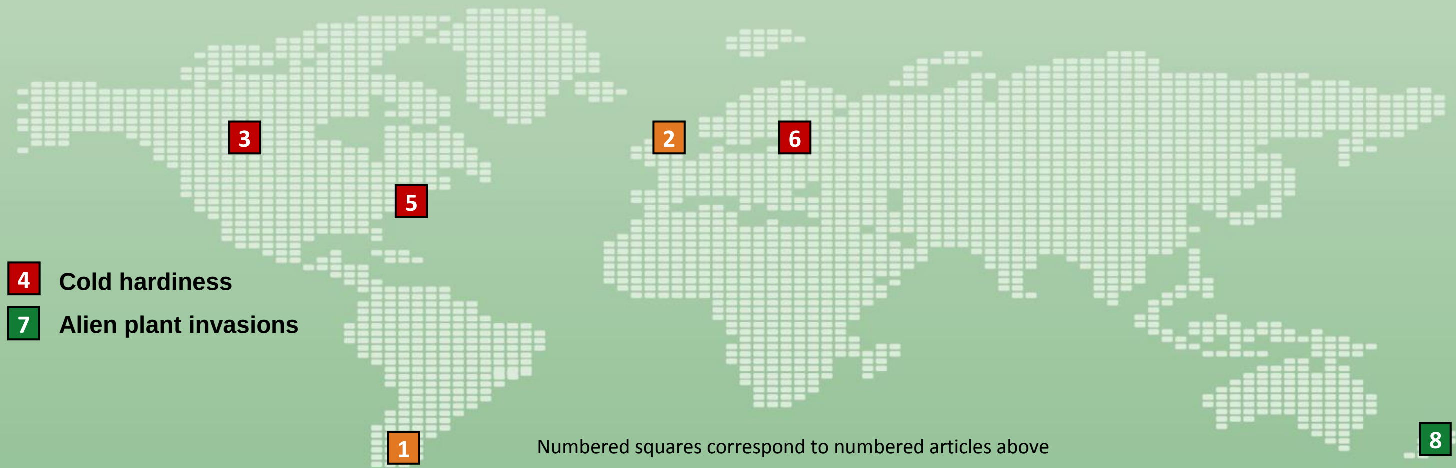

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Canada

Pathology

1 First report of *Pseudomonas syringae* pv. *actinidiae* on kiwifruit pollen from Argentina

In February 2015, bacterial colonies with morphological features similar to *P. syringae* pv. *actinidiae* (Psa) were isolated from kiwifruit pollen collected from the Mar del Plata area of Argentina. Morphological, biochemical, molecular and pathogenicity analyses confirmed the identity of the colonies as Psa. This is the first report of Psa in Argentina; it expands on the known distribution of this pathogen.

Pseudomonas syringae pv. *actinidiae* is the causal agent of bacterial canker of kiwifruit; symptoms include discolouration of buds and vascular tissues, leaf spots, wilting, stem and twig cankers with characteristic red exudate, fruit collapse, and eventually death of the plant. This pathogen is one of the most limiting factors for cultivating kiwifruit in South Korea, Japan and Iran and has caused considerable yield reductions in Italy. *Pseudomonas syringae* pv. *actinidiae* has also been reported in parts of Europe, Turkey, China, Australia, New Zealand and Chile but is not known to occur in North America. This bacterium is not transmitted by fruit or seed but can spread through international movement of plants for planting (including pollen).

Currently, *P. syringae* pv. *actinidiae* is not a regulated pest for Canada but a pest categorization conducted by the CFIA concluded that it met the definition of a quarantine pest as defined by the International Plant Protection Convention (IPPC) .

SOURCES: Balestra, G., Buriani, G., Cellini, A., Donati, I., Mazzaglia, A. and Spinelli, F. 2018. First Report of *Pseudomonas syringae* pv. *actinidiae* on Kiwifruit Pollen from Argentina. Plant Disease 102(1):237-237.

Balestra, G.M., Mazzagalia, A., Quattrucci, A., Renzi, M. and Rossetti, A. 2009. Current status of bacterial canker spread on kiwifruit in Italy. Australasian Plant Disease Notes 4: 34-36.

2 Predicted impact of climate change on pest status of *Globodera pallida* and *G. rostochiensis* in the United Kingdom

In a recent publication, the effect of temperature on growth of female *Globodera pallida* and *G. rostochiensis* was investigated, and the results showed that females per plant and their fecundity declined progressively with temperatures above 17.5 °C for *G. pallida*, while females per plant were optimal between 17.5 and 22.5 °C for *G. rostochiensis*. Similarly, reduced reproductive success of *G. pallida* at 22.5 °C relative to 15 °C was observed on nine potato cultivars. Moreover, exposure of *G. pallida* to diurnal temperature stress for one week during female growth significantly suppressed subsequent growth for one week at 17.5 °C but had no effect on *G. rostochiensis*. The differences in optimal temperatures for reproductive success may relate to known differences in the altitude of the origins of the two species. Future soil temperatures were simulated for medium- and high-emission scenarios and combined with nematode growth data to project future implications of climate change for the two species. Increased soil temperatures associated with climate change may reduce the pest status of *G. pallida* but benefit *G.*

rostochiensis especially in the southern United Kingdom.

Globodera pallida and *G. rostochiensis* (potato cyst nematodes) can cause extensive damage to potatoes and they are regulated by the CFIA.

SOURCE: Jones, L. M., Koehler, A. K., Trnka, M., Balek, J., Challinor, A. J., Atkinson, H. J. and Urwin, P. E. 2017. Climate change is predicted to alter the current pest status of *Globodera pallida* and *G. rostochiensis* in the United Kingdom. Global change biology 23(11):4497-4507.

Entomology

3 Probability of emerald ash borer impact for Canadian cities and North America

This is a new model that predicts the distribution of harm from emerald ash borer (EAB), a regulated pest that is devastating all ash stands and individual trees that it encounters. Using predicted measures of winter minima experienced underneath the bark of ash trees and estimated generation times, the authors were able to determine that, due to high mortality events and overall slower insect development, cities such as Edmonton, Saskatoon, Regina and Winnipeg are unlikely to suffer severe EAB harm. Prince George, Thunder Bay and Calgary may be at greater risk, but this is not certain. The results bode well for control options in Winnipeg, which was recently reported as infested. While 99% mortality events in Winnipeg are not expected very frequently (once every 90 years), high mortality (75%) is expected to occur more often than every 4 years. No major cities east of Thunder Bay seem to experience frequent enough deep cold to be thus protected, however. We can expect EAB to march on westward out of Winnipeg into the agricultural area, where windbreaks are largely composed of ash stands. If Winnipeg can control its outbreak, and prevent spread out of the city, perhaps climate may take care of significant harm in the city itself. The uncertainty, especially in light of climate change, is likely at least moderately high.

SOURCE: Cuddington, K., Sobek-Swant, S., Crosthwaite, J. C., Lyons, D. B. and Sinclair, B. J. 2018. Probability of emerald ash borer impact for Canadian cities and North America: a mechanistic model. Biological Invasions:10.1007/s10530-018-1725-0.

4 Cold hardiness of *Lymantria monacha* and *L. dispar* (Lepidoptera: Erebidae) eggs to extreme winter temperatures: implications for predicting climate change impacts

The authors of this study investigated if increasing temperatures due to climate change could shift the northern distributional limits of *Lymantria monacha* and *Lymantria dispar*. The results suggest a much more modest range expansion potential for both species at the northern boundary of their distribution than was previously predicted. Further knowledge on how increasing temperatures will affect the distribution of these two species is relevant to the CFIA as they are both regulated pests of Canada. *Lymantria dispar* is present so far in Ontario, Quebec, New Brunswick, Nova Scotia and Prince Edward Island (European gypsy moth), while the Asian gypsy moth is not known to occur in North America, although introductions of this pest have been detected but were successfully eradicated. *Lymantria monacha* does not occur in North America.

SOURCE: Fält-Nardmann, J. J., Ruohomäki, K., Tikkanen, O. P. and Neuvonen, S. 2018. Cold hardiness of *Lymantria* *monacha* and *L. dispar* (Lepidoptera: Erebidae) eggs to extreme winter temperatures: implications for predicting climate change impacts. Ecological Entomology.

5 First report of the East Asian metallic wood-boring beetle *Agrilus smaragdifrons* Ganglbauer in North America.

The jewel beetle genus *Agrilus* is a highly diverse group that is comprised of over 3,000 valid species. This genus has received much attention in recent years as one of its included species, the emerald ash borer (*Agrilus planipennis* Fairmaire), has become a highly destruction pest of ash trees in North America and “the mostly costly biological invasion by an exotic forest insect to date”. Recently, the East Asian metallic wood-boring beetle, *Agrilus smaragdifrons* Ganglbauer, was newly discovered in North America becoming the eleventh non-native *Agrilus* species reported in this region.

In 2015, unidentified specimens of *Agrilus* were found in two trap samples from two separate emerald ash borer trapping locations in New Jersey. They were later positively identified as *Agrilus smaragdifrons*. This species was also detected in at least one emerald ash borer trapping location in central Connecticut in 2015, as well as other state trapping surveys in 2016. The earliest known evidence of *A. smaragdifrons* in North America is from 2011 and is based on a photographed image of a specimen on BugGuide from Hudson County, Pennsylvania.

The only known host of *A. smaragdifrons* is *Ailanthus altissima,* commonly known as the tree of heaven. *Ailanthus altissimais* is native to China, but was introduced to North America in the late 1700s. In North American, the tree of heaven grows in multiple climates but is most common in the Northeast and California. It can be found in southern parts of Ontario, Quebec and British Columbia in Canada.

Agrilus planipennis, emerald ash borer, is a regulated pest of Canada. As this species is a destructive pest in North America, it is important for the CFIA to be aware of other *Agrilus* species that have been newly introduced to North America as they could potentially be invasive too.

Source: Hoebeke, E.R., Jendek, E., Zablotny, J.E., Rieder, R., Yoo, R., Grebennikov, V.V., and Ren, L. 2017. First North American records of the East Asian metallic wood-boring beetle *Agrilus smaragdifrons* Ganglbauer (Coleoptera: Buprestidae: Agrilinae), a specialist on tree of heaven (*Ailanthus altissima*, Simaroubaceae). Proceedings of the Entomological Society of Washington 119(3), 408–422.

6 A risk categorisation and analysis of the geographic and temporal dynamics of the European import of plants for planting

Prioritizing inspection efforts can have big payoffs in money spent vs. risks avoided. This paper proposes a method that is composed of a series of risk criteria meant to identify high risk commodities to which more resources can be dedicated for inspection. The criteria were based on the biological characteristics of the genus of plant, and on the dynamics of the trade in a commodity. These represent the two most important, easily measurable factors for risk categorization, making the method suitable for any country if the required data are available.

SOURCE: Eschen, R., Douma, J. C., Gregoire, J. C., Mayer, F., Rigaux, L., Potting, R. P. J. 2017. A risk categorisation and analysis of the geographic and temporal dynamics of the European import of plants for planting. Biological Invasions 19(11):3243-3257.

Botany

7 The changing role of ornamental horticulture in alien plant invasions

The number of alien plants escaping from cultivation into native ecosystems has been steadily increasing, likely the result of an increase in both the number and volume of traded species, as well as the increasing complexity of trade networks and trading methods. In order to interpret current trends and predict future developments regarding horticulture and alien plants, a recent study in Biological Reviews (van Kleunen et al. 2018) investigated the number and diversity of alien plants grown in horticulture and gardens, as well as plant introduction histories and pathways, and characteristics that promote both horticultural usage and potential invasiveness.

Integrating information from both invasion biology and horticulture, van Kleunen et al. (2018) performed a global comparison of naturalized alien plants and cultivated garden plants, drawing from a number of online databases including the Global Naturalized Alien Flora (GloNAF) as well as horticultural retailers like Dave's Garden and Plant Information Online. Additionally, a wide range of relevant issues such as plant introduction dynamics, the type of plant traits promoted by horticulture, as well as fashions in the garden industry were analyzed from both historical and contemporary perspectives.

The study determined that at least 75% and 93% of all naturalized alien flora across the globe is currently grown in domestic and botanical gardens, respectively. Species grown in gardens were shown to possess larger naturalized ranges than those that were not, which translated into increased potential for establishment in the event of escape. It was likewise observed that many of the plant traits promoted by horticulture, for example rapid growth, also promote invasiveness. Overall, ornamental horticulture was determined to be the primary introduction pathway of naturalized and invasive alien plants, a consequence of the emergence of a global plant trade network in the 18th and 19th centuries. With regard to future developments, the study predicted that social and technological changes, such as e-commerce and molecular genetic breeding techniques, as well as environmental and climate change, may lead to unforeseen patterns of plant introductions and changes in the invasive potential of already introduced species, requiring additional research efforts.

Many open questions remain on the role of horticulture in alien plant introductions. As the horticultural industry grows more complex and the number of alien plants escaping cultivation into native ecosystems continues to increase, the results of this study are important to keep in mind during the development of science-based regulatory frameworks designed to prevent future alien plant invasions.

SOURCE: van Kleunen, M., Essl, F., Pergl, J., Brundu, G., Carboni, M., Early, R., ... Dehnen-Schmutz, K. 2018. The changing role of ornamental horticulture in alien plant invasions. Biological Reviews. [In Press.] DOI: 10.1111/brv.12402

8 Accounting for intraspecific differences in weed risk assessment

Based on guidelines established by the International Plant Protection Convention (IPPC), weed risk assessments (WRAs) are typically conducted at the species level. The use of lower taxa is less common, and, according to the IPPC's ISPM 11 (Pest risk analysis for quarantine pests), should be justified by sound scientific rationale that demonstrates a significant difference in pest risk. In seeking to determine if species is the most appropriate level at which to evaluate invasion risk, Meffin et al. (2018) examined the issue of within-species variation in *Brassica* in a recent study in the Journal of Applied Ecology.

The authors conducted an experiment in which 25 taxonomically stratified varieties of three *Brassica* species (*B. napus*, *B. oleracea*, *B. rapa*) were introduced into roadside habitats in New Zealand. Performance was evaluated based on the resulting number of plants per quadrat. Their results indicated that, while taxonomic differences were small in comparison to variation within and among plots, variation in plant performance among varieties was greater by far than that among species. Accordingly, the authors suggested that species-level WRAs may fail to capture important within-species variation in invasion risk. Rather, they may reflect the average invasiveness of several intraspecific taxa or the invasiveness of only one or a few taxa that predominate in the literature sources. This may be especially relevant for species subject to substantial breeding efforts, which contain taxa that pose different risks as compared to the nominal species. Meffin et al. (2018) note that, while this study is limited in scope, further research is required to determine how often intraspecific variation in traits and performance translates into variation in invasion outcomes.

In keeping with ISPM 11, the CFIA conducts the majority of WRAs at the species level. Several WRAs have also been conducted at the subspecies level. One example is a preliminary WRA on *Hordeum vulgare* subsp. *spontaneum* (wild barley), which was conducted at the subspecies level to distinguish this wild weedy taxon *from H. vulgare* subsp. *vulgare* (barley), an important cereal crop. The CFIA has not conducted any WRAs at the variety level to date. Lack of information specific to the taxon in question can be a significant impediment to conducting WRAs at lower taxonomic levels. From a phytosanitary perspective, practical difficulties in visually distinguishing among intraspecific plants and seeds can also present a challenge.

SOURCE: Meffin, R., Duncan, R. P. and Hulme, P. E. 2018. Testing weed risk assessment paradigms: Intraspecific differences in performance and naturalisation risk outweigh interspecific differences in alien *Brassica*. Journal of Applied Ecology 55: 516-525.

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