ISSN 2369-4254

PLANT SCIENCE SCAN

Edition 18, January 2017

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.

Index of Articles

Numbered squares correspond to numbered articles above

Pathology

1 First report: New corn disease, *Xanthomonas vasicola* pv. *vasculorum,* causing bacterial leaf streak in the United States

Bacterial leaf streak caused by *Xanthomonas vasicola* pv. *vasculorum* (syn. *X. campestris* pv. *zeae and X. axonopodis* pv. *vasculorum*) has recently been reported from Colorado, Kansas, Illinois, Iowa, Minnesota and Nebraska (Flamini 2016; Jackson-Ziems et al. 2016). This pathogen has been reported to affect sugarcane (gumming disease) and corn in South Africa, but has never previously been reported in the U.S. Surveys are underway in order to know the extent of the distribution of the disease in the U.S. Some observations suggest that it may be present throughout the Corn Belt (The Grand Island Independent 2016).

Symptoms of bacterial leaf streak include brown to yellow narrow elongated lesions between leaf veins that can be short or very long. Symptoms are similar to those caused by other diseases such as the gray leaf spot, *Cercospora zeae-maydis*. Gray leaf spot has previously been reported from Ontario.

There is currently very limited information on this disease and its potential impact. Based on the absence of evidence of adverse impact on corn yield or quality, the United Stated Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) does not consider this pathogen as a quarantine pest (USDA-APHIS 2016).

There is currently no report of this pathogen occurring on corn in Canada.

SOURCES: Bacterial leaf streak of corn has been confirmed in Nebraska. The Grand Island Independent (2016) [Online] Available: http://www.theindependent.com/news/ag_news/bacterial-leaf-streak-of-corn-has-been-confirmed-in-nebraska/article_f6d0bf6c-715d-11e6-a509-875650898582.html [September 6, 2016].

Flammini, D. (2016) New corn disease discovered in the United States. [Online] Available: http://www.farms.com/ag-industry-news/new-corn-disease-discovered-in-the-united-states-166.aspx [September 7, 2016].

Jackson-Ziems, T., Korus, K., Adesemoye, T. and Meter, J. V. (2016) Bacterial leaf streak of corn confirmed in Nebraska, other corn belt states. Cropwatch. [Online] Available: http://cropwatch.unl.edu/2016/bacterial-leaf-streak-corn-confirmed-nebraska [September 6, 2016].

USDA-APHIS. (2016) Statement on *Xanthomonas vasicola* pv. *vasculorum*. [Online] Available: https://www.aphis.usda.gov/aphis/newsroom/news/sa_by_date/newsroom-2016/sa-08/statement-corn-xvv [September 6, 2016].

2 First Report: *Phytophthora quercina* on outplanted valley oak*, Quercus lobata*, in the U.S.

The latest issue of the California Oak Mortality Task Force (COMTF) newsletter reported that *Phytophthora quercina* had recently been isolated from valley oaks, *Quercus lobate*, on restoration sites managed by the Santa Clara Valley Water District in California. To confirm the detection, soil samples with roots from planted valley oak trees that showed symptoms of stunting in a restoration site near San Jose, California were collected by Santa Clara County agricultural officials and sent to the Plant Pathology Lab, California Department of Food and Agriculture (CDFA) for diagnosis. DNA was extracted from soil baits and determined to be a 100% match to *P. quercina*. The find was confirmed by the USDA-APHIS Beltsville lab in June. This IS the first officially confirmed detection of the pathogen in the U.S., although there are other reports of a *P. quercina* 'like' organism associated with oak decline in forests in Minnesota, Wisconsin and Missouri.

Phytophthora quercina is a pathogen associated with oak decline across Europe. Above-ground symptoms include dieback of branches and parts of the crown, formation of epicormics shoots, high transparency of the crown, yellowing and wilting of leaves and tarry exudates from the bark. Oak species affected by this pathogen include *Quercus robur*, *Q. petraea, Q. cerris, Q. pubescens,* and *Q. ilex.* In Turkey, it has also been found on *Q. hartwissiana*, *Q. frainetto* and *Q. vulcanica*.

Phytophthora quercina is a pest of concern for Canada because oaks are important amenity and forest trees in Canada and the pathogen is not present in the country. Of particular note, this species has been rated the # 1 *Phytophthora* species of concern for introduction into the U.S. in a USDA Plant Epidemiology and Risk Analysis Laboratory (PERAL) report.

SOURCES: Balci, Y. and Halmschlager, E. (2003) *Phytophthora* species in oak ecosystems in Turkey and their association with declining oak trees. Plant pathology 52(6):694-702.

California Oak Mortality Task Force (COMTF) (2016) California Oak Mortality Task Force Report , September 2016. [Online] Available: http://www.suddenoakdeath.org/wp-content/uploads/2016/09/COMTF-Report-September-2016-1.pdf [October 3, 2016].

Scheartzburg, K., Hartzog, H., Landry, C., Rogers, J. and Randall-Schadel, B. (2009) Prioritization of *Phytophthora* of concern to the United States. Plant Epidemiology and Risk Analysis Laboratory (PERAL), USDA-APHIS.

Jung, T., Cooke, D. E. L., Blaschke, H., Duncan, J. M. and Osswald, W. (1999) *Phytophthora quercina* sp. nov., causing root rot of European oaks. Mycological Research 103(7):785-798.

3 Update: USDA-APHIS amends Karnal bunt, *Tilletia indica,* regulated areas in Maricopa and Pinal Counties, Arizona

The USDA-APHIS has amended the Karnal bunt regulated areas in Maricopa and Pinal Counties in Arizona, reducing the regulated area in Maricopa County and increasing the regulated area in Pinal County.

Following a review of available information, USDA-APHIS determined that 131 fields qualify for deregulation. Consequently, restrictions are no longer required on the interstate movement of Karnal bunt regulated articles from these areas. Specifically, USDA-APHIS is removing a total of 5,189 acres from the list of regulated areas in Maricopa County, Arizona, including 1,612 acres of tribal land. In addition, USDA-APHIS is adding 12,292 field acres in Pinal County, Arizona, to the Karnal bunt regulated area in response to the detection of 36 Karnal bunt-positive fields. The additional area in the county includes 4,071 acres in the Queen Creek area and 8,221 acres, which includes 1,741 acres of tribal land, in the Maricopa area. Following the completion of field surveys of Karnal bunt regulated areas, USDA-APHIS determined that these fields meet the criteria for regulation.

This regulatory action is intended to prevent the spread of Karnal bunt from Arizona. While Karnal bunt can affect the quality of wheat, USDA-APHIS regulates this plant disease because many trading partners require that U.S. wheat be certified as grown in areas determined to be free of Karnal bunt. More information on Karnal Bunt can be found at: http://www.aphis.usda.gov/plant-health/kb

SOURCE: USDA-APHIS (2016) APHIS Amends Karnal Bunt Regulated Areas in Maricopa and Pinal Counties, Arizona [Online] Available: https://content.govdelivery.com/accounts/USDAAPHIS/bulletins/16907c8 [October 5, 2016].

4 First Report: Emerging pathogen, *Lonsdalea quercina subsp. populi*, reported for the first time in Spain

The most recent issue of the journal Plant Disease includes a new report of the emerging pathogen, *Lonsdalea quercina* subsp. *populi*, in Spain. The pathogen was found in nine hybrid poplar plantations in the northern part of Spain. The trees showed symptoms of bark cracking and the production of large amounts of white, frothy slime. Severely affected trees died after a few years of infection. Disease incidence was as high as 30% in some plantations (Berruete et al. 2016).

This bacterium has previously been reported from China (Li et al. 2014) and Hungary (Toth et al. 2013). *L. quercina* subsp. *populi* is not currently regulated in Canada.

SOURCES: Berruete, I.M., Cambra, M.A., Collados, R., Monterde, A., Lopez, M.M., Cubero, J. and Palacio-Bielsa, A. (2016) First report of bark canker disease of poplar caused by *Lonsdalea quercina* subsp. *populi*. Plant Disease 2159.

Li, Y., He, W., Ren, F.J., Guo, L.M., Chang, J.P., Cleenwerck, I., Ma, Y.C. and Wang. H.M. (2014) A canker disease of *Populus x euramericana* in China caused by *Lonsdalea quercina* subsp. *populi*. Plant Disease 98(3): 368-378.

Toth, T., Lakatos, T. and Koltay. A. (2013) *Lonsdalea quercina* subsp. *populi* subsp. nov., isolated from bark canker of poplar trees. International Journal of Systematic and Evolutionary Microbiology 63: 2309-2313.

Entomology

5 Pest Management: Mass-trapping of cherry fruit fly using a combination of food-lure dispensers and yellow sticky traps

Rhagoletis cerasi, the European cherry fruit fly, is widespread throughout most of Europe and is a serious pest of both sweet and sour cherries in its native area. Larvae of this fly feed inside the fruit, which can cause severe economic losses as fruit damage reaches 100% of fruit production. Control measures are essential for this pest. Insecticides that contain neonicotinoids and pyrethroids are commonly used; however, they require timely and precise application to work effectively. To achieve this, it is important to detect the first flight of *R. cerasi* through the use of yellow sticky traps and attractants such as ammonium salts. These sticky traps, in particular the Rebel trap, can also be used in the mass trapping of this fly as an alternative control measure for organic cherry orchards.

In this study, the authors tested the trap efficacy of two yellow sticky traps (yellow Rebell trap and standard sticky yellow panel trap) with different dispensers in sweet cherry orchards in Poland. The food-lure dispensers consisted of clear grip seal bags manufactured with different polyethylene densities (35 micron, ~60 micron and ~100 micron) and contained a mixture of two ammonium salts (3g ammonium acetate and 2.6g ammonium carbonate), either with putrescine added directly to the grip seal bag or placed in a separate container (200 µL Eppendorf type vial). The dispensers were compared against standard lures from Csalomon company as well as AgriSense-BCS that were used as a reference control. The most effective trap combination found was then evaluated for its use in mass trapping of this pest in an organic orchard in Poland.

It was found that the yellow Rebell trap captured significantly more flies than the sticky yellow panel trap, regardless of the type of dispenser used. Another significant finding from this study was that the yellow Rebell trap combined with the food-lure dispenser containing a blend of ammonium acetate and ammonium carbonate, as well as putrescine in a separate container, was the most successful in controlling populations of *R. cerasi*. In addition, this particular trap combination showed high efficacy in the mass trapping of this pest, which resulted in a significant reduction of damaged fruit in an organic sweet cherry orchard.

Rhagoletis cerasi is a regulated quarantine pest for Canada that was first recorded in North America in Mississauga, Ontario, in June 2016. New information pertaining to effective control measures for *R. cerasi* is useful to the CFIA to develop further mitigation measures, especially those needed to prevent this pest entering British Columbia – the main cherry-producing province of Canada. Further knowledge of controls that can be used in organic cherry orchards is also important for reducing potential chemical sprays used against this pest.

SOURCE: Grodner, J., Świech, K., Rozpara, E. and Danelski, W. (2016) Food attractant to control the population of *Rhagoletis cerasi* L. (Diptera: Tephritidae) and its use in organic sweet cherry orchard in Poland. Journal of Research and Applications in Agricultural Engineering 61(3):167-172.

6 Update: Impact of hemlock woolly adelgid and plant defence on native hemlock looper

Early-season herbivore attack on trees and plants can cause changes in tissues due to plant defence or offence mechanisms. These changes can alter host quantity or quality for subsequent attackers by acting as deterrents in some cases, while increasing the fitness of the later-arriving herbivores in other cases. The hemlock looper, *Lambdina fiscellaria* (Lepidoptera: Geometridae) is a native defoliator of numerous tree species in eastern North America. Early-instar larvae emerge in late May, feeding primarily on new growth and then consuming small portions of old-growth needles as late-instar larvae. The hemlock woolly adelgid, *Adelges tsugae* (Hemiptera: Adelgidae) is an invasive species from Japan that was introduced to Virginia in the 1950s. The sessile hemipteran has caused widespread mortality of eastern hemlock, *Tsuga canadensis,* and Carolina hemlock, *Tsuga caroliniana,* by feeding on the base of needles using a combination of enzymes that cause physiological changes in the tree.

Although the two species co-occur in the southern portion of the looper's native range, little is known regarding their interaction. To fill this knowledge gap, Wilson et al. (2016) assessed looper performance on and preference for both uninfested and infested foliage from adelgid-susceptible hemlocks, as well as uninfested foliage from a more rare eastern hemlock that is naturally adelgid-resistant. The authors found that infestation by the hemlock woolly adelgid provided a moderate benefit to hemlock looper feeding on susceptible eastern hemlock, resulting in a higher early-instar survival rate and pupal weight. Larvae reared on uninfested foliage from adelgid-susceptible hemlocks experienced 60% mortality within the first two weeks of the experiment compared to 6% on susceptible trees with adelgid larvae. This difference in performance could result from changes in plant defence induction as adelgid feeding can activate the salicylic acid (SA) pathway and suppresses the induction of jasmonic-acid (JA)-based defences that are particularly effective against chewing herbivores. It was also found that larvae fed naturally resistant hemlock foliage were more likely to pupate, mature quickly and weigh more as pupae than larvae from the other two treatments. The preference bioassay also showed that looper larvae consumed more resistant foliage than susceptible foliage regardless of the foliage type on which they were reared.

The hemlock woolly adelgid is currently a threat to eastern Canada due to its establishment in several states bordering that area of Canada. Two detections have occurred in Ontario, including in Etobicoke in 2012 and in Niagara Falls in 2013; however, the populations have since been destroyed and the region continues to be monitored (ISC, n.d.). The hemlock looper is already considered a serious native defoliator in Canada, occurring from the Atlantic coast west to Alberta. Over the years, it has destroyed several million hectares of conifer forests in eastern Canada (NRCan 2015). The described study provides another reason for the importance of preventing the introduction and spread of the hemlock woolly adelgid, as adelgid-driven selection could initially increase vulnerability of hemlocks to looper outbreaks.

SOURCES: Invasive Species Centre (ISC) (n.d.) Hemlock Woolly Adelgid. [Online] Available: http://forestinvasives.ca/Meet-the-Species/Insects/Hemlock-Wooly-Adelgid [January 4, 2017].

Natural Resources Canada (NRCan) (2015) Hemlock Looper. [Online] Available: https://tidcf.nrcan.gc.ca/en/insects/factsheet/8846 [January 4, 2017].

Wilson, C.M., Vendettuoli, J.F., Orwig, D.A. and Preisser, E.L. (2016) Impact of an invasive insect and plant defence on a native forest defoliator. Insects 7(3): article number 45 (doi: 10.3390/insects7030045)

7 Interception: U.S. Customs and Border Protection intercepts Khapra beetle in cargo shipment from India and in luggage from Nepal

On November 29th, 2016, agriculture specialists with U.S. Customs and Border Protection (CBP) in Michigan's Port Huron discovered the remnants of a khapra beetle, *Trogoderma granarium* (Coleoptera: Dermestidae), in a cargo shipment of split and washed mung beans from India. This is the fourth khapra beetle interception from a commercial shipment in Port Huron, all of which have been from commodities originating in India (CBP, 2016a).

Then on December 4th, 2016, the beetle was found in a traveler's luggage by CBP at Atlanta's Hartsfield-Jackson International Airport. After declaring food items, the woman travelling from Nepal was referred to a secondary examination where CBP agriculture specialists discovered the live beetle larva inside a bag of dry beans. CBP seized and destroyed the beans by steam sterilization to prevent introduction of the pest into the U.S. This finding is significant as it is the first time that CBP has encountered a khapra beetle from Nepal (CBP, 2016b).

The khapra beetle is one of the most destructive pests of stored grain and grain product and is a quarantine pest and regulated in many countries, including Canada. It is not currently established in the U.S. or Canada; however, if introduced it could have severe adverse effects on the grain and oilseed industries.

SOURCES: U.S. Customs and Border Protection (CBP) (2016a) Port Huron CBP Intercepts the Destructive Khapra Beetle. [Online] Available: https://www.cbp.gov/newsroom/local-media-release/port-huron-cbp-intercepts-destructive-khapra-beetle [January 4, 2017].

U.S. Customs and Border Protection (CBP) (2016b) CBP Atlanta Intercepts Khapra Beetle from Nepal. [Online] Available: https://www.cbp.gov/newsroom/local-media-release/cbp-atlanta-intercepts-khapra-beetle-nepal [January 4, 2017].

Botany

8 Weed Management: Climate change and the weed invasion debt

Although not in every case, climate change is expected to generally favour weeds. In a recent forum article, Sheppard et al. (2016) explore the synergistic effects between climate change and plant invasions, and discuss the general implications for weed management. Although the article focuses on New Zealand, much of the discussion is relevant to Canada as well, as both countries are undergoing reduced climatic constraints for many introduced species.

Climate change is expected to exacerbate New Zealand's 'weed invasion debt'. The concept of a weed invasion debt relates to the often delayed response of weeds to socio-economic activities affecting propagule pressure and to conditions favouring invasion. Over 25 000 alien plant species are currently present in New Zealand, of which over 2400 have already naturalized and an additional 20 naturalize per year. Of the naturalized and naturalizing species, a subset will become invasive. Among the massive pool of introduced species are many from warmer climates (e.g., subtropics) whose establishment and spread will be favoured as climatic constraints such as frosts are reduced. Climate change may also promote invasions by increasing the occurrence and frequency of extreme events, thereby creating disturbances that provide colonisation opportunities for introduced plants and also weaken healthy native communities, making them more susceptible to invasion. Warming temperatures may further facilitate the establishment of some alien plants by improving conditions for the specialist pollinators they require.

Two recent New Zealand Department of Conservation reports recognize this imminent threat, one of which states: 'arrival of new weeds and increased invasiveness of existing weeds is one of the most troubling likely consequences of climate change'. Sheppard et al. (2016) therefore urge a number of key actions to 'future-proof' New Zealand weed management for the effects of climate change. They stress the need to identify both current and potential future weeds as well as at-risk habitats by incorporating future climate into existing weed risk assessment and risk management tools, and then following up with pre-emptive actions such as banning, eradication and control. To support these tools, improved and more user-friendly predictions of future plant distributions are needed. A potentially cost-effective alternative approach to complex single-species distribution models is the use of ensemble forecast projections from multiple species distribution models in order to identify invasion hotspots. This approach may aid in management decision-making that simultaneously prevents the establishment and spread of numerous alien plant species. The authors also emphasize the importance of enhanced surveillance programs that prioritize suitable habitats and include species from warmer climates. They promote the support of these programs by well-managed citizen science projects, as well as educational campaigns that encourage a longer-term view of invasive weed issues.

Similar actions may be considered among Canada's initiatives to 'future-proof' weed management for the effects of climate change. Like New Zealand, thousands of alien plant species have been and continue to be introduced into Canada, either intentionally, for a variety of purposes, or unintentionally, as contaminants. Hundreds more have the potential to spread naturally into Canada from states that border Canada or the Great Lakes. This is of special concern for Canada because continental and temperate climates of the northern hemisphere are considered to be particularly at risk from increased numbers and spread of invasive alien species (Bellard et al.

2013). Many of the species that are intentionally planted at the edge or just beyond their traditional hardiness limit will have a head start to establish and spread as conditions permit. Climate change considerations such as those identified by Sheppard et al. (2016) are relevant to the upcoming development of a National Plant and Animal Health Strategy which focuses on prevention, a best practice for weed mitigation and a shift away from the traditional focus on response and recovery.

SOURCES: Bellard, C., Thuiller, W., Leroy, B., Genovesi, P., Bakkenes, M. and Courchamp, F. (2013) Will climate change promote future invasions? Global Change Biology 19: 3740-3748.

Sheppard, C. S., Burns, B. R. and Stanley, M. C. (2016) Future-proofing weed management for the effects of climate change: is New Zealand underestimating the risk of increased plant invasions? New Zealand Journal of Ecology 40(3): 398-405.

Biotechnology

9 Pest Resistance Management: Is stacking transgenic pest and herbicide resistances key to delaying pests from evolving resistance?

Despite our efforts, pests have rapidly evolved resistance to methods developed by humans to protect plants. The evolution of pest resistance to single transgenic traits engineered into crops for arthropod and herbicide resistances has been observed, and will likely be observed in pathogen resistances as they become more widely planted (i.e. papayas that are resistant to ringspot virus). The combination of multiple transgenes in a plant (known as gene stacking) against the same target pest is a potential method of delaying pest resistance; however, proper implementation is required to ensure effectiveness.

A recent study in Pest Management Science investigated the ability of stacked traits to delay the evolution of pest resistance, and proposed several criteria to optimize use of stacked traits based on common principles of population genetics and population biology (Gressel et al. 2016).

Gressel et al. (2016) proposed that stacked transgene partners should target the same pest species, be synchronously expressed in the same tissues, be in a tandem construct, and have similar tissue persistence. This ensures that two or more traits are simultaneously present in a plant. Target pest species should also be susceptible to at least two of the stacked transgene partners, as the efficacy of stacked traits can be diminished by the prior evolution of pest resistance to one or more of the traits. Additionally, Gressel et al. (2016) proposed that transgene products should not be degraded in the same manner, that there should be a lack of cross-resistance to stacked transgenes or to their products, and in the case of stacked herbicide resistance transgenes, both herbicides should be used and possess the same relative persistence.

If these criteria are followed, pest resistance may be considerably delayed. Depending on the type of crop and the type of resistance being evolved by pests, resistance management may require unique approaches and adherence to these criteria. Stacked traits should also be used within a broader strategy of integrated pest management (e.g. responsible pesticide use, monitoring, acceptable pest levels) to enhance the sustainability of transgenic crops.

As the biotechnology industry begins to acknowledge the importance of food security by engineering crop protection genes into major food crops like wheat, rice and sorghum, pest resistance evolution will need to be taken into consideration. The industry will need to shift away from the engineering of single gene traits which facilitate the evolution of pest resistance, and move towards the strategic implementation of stacked traits in conjunction with integrated pest management.

SOURCE: Gressel, J., Gassmann, A. J. and Owen, M. D. K. (2016) How well will stacked transgenic pest/herbicide resistances delay pests from evolving resistance? Pest Management Science. DOI: 10.1002/ps.4425

10 Insect Resistance Management: New Western corn rootworm RNAi targets

Controlling the Western corn rootworm (WCR) beetle is a major challenge for corn producers; WCR reportedly causes 1 billion dollars in damage annually in the United States. While there are multiple chemical and plant incorporated protectants (PIPs) for growers to choose from, crop rotation is the most effective WCR control strategy in Canada. But what are growers to do if their operations depend on, or they simply choose to repeatedly use the same control measures to control WCR? Use of the same control measures will increase the selection pressure for resistance development. Insect resistance management, including product design, can be structured to maximize the longevity of the trait while controlling insect pests.

Until recently, authorized corn PIPs targeting WCR only used *Bacillus thuringiensis* (Bt) genes encoding the toxins mCry3A, Cry3Bb1, eCry3.1Ab and Cry34/35Ab1. Some of the approved products contain a single Cry protein, but increasingly 'pyramids' expressing two Cry proteins are grown. Products that interfere with the fitness of living organisms by a single mode-of-action are overcome quickly in nature; a painful lesson that society has repeatedly learned while battling human diseases and agricultural pests. Resistance has developed to mCry3A and Cry3Bb1. This cross-resistance between mCry3A, Cry3Bb1 and eCry3.1Ab means that 'pyramids' may not have multiple independent modes-of-action. Corn PIP products using multiple modes-of-action to manage pests would help ensure the longevity of current and future traits.

Monsanto has added to the toolbox with maize varieties using RNA interference (RNAi) targeting a WCR gene – *dvsnf7*. This particular gene is involved in protein movement around the cell – an essential cell function. More RNAi modes-of-actions, including parental RNAi, may be in the pipeline if a recent Nature Scientific Reports article is any indication (Hu et al., 2016).

Scientists from DuPont Pioneer identified two insect genes from *Drosophila* which are called snakeskin and mesh. In *Drosophila*, these genes are important for fly development as well as gut barrier integrity. In WCR the genes are *dvssj1* and *dvssj2* and appear to have the same activities as in *Drosophila*. It was experimentally shown that interfering with *dvssj1* or *dvssj2* resulted in reduced WCR larval growth and ultimately death. The toxicity of *dvssj1* and *dvssj2* to WCR are similar to Monsanto's *dvsnf7* RNAi product, as measured by the LC_{50}.

The more modes-of-action, a PIP product demonstrates, the better. It contributes to a more effective product, and most importantly it limits the potential of resistance emerging in target insect populations; a key consideration of the pre-market environmental safety assessment of plants with novel traits.

SOURCE: Hu, X, Richtman, N, Zhao, J, Duncan, K., Niu, X., Procyk, L., Oneal, M., Kernodle, B., Steimel, J., Crane, V., Sandahl, G., Ritland, J., Howard, R., Presnail, J., Lu, A. and Wu, G. (2016) Discovery of midgut genes for RNA interference control of corn rootworm. Nature Scientific Reports 6: 30542.

Acknowledgments

Thanks to the following CFIA staff who contributed to this edition of the Plant Science Scan: M.-E. Auclair, K. Castro, H. Cumming, M. Damus, S. Davis, B. Day, F. Deng, C. Dollard, J.-F. Dubuc, M. Lafleur, D. Levac, M. Mander, A. Sissons and L. Vyvey.

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