IPM Institute of North America, Inc.

Harnessing Marketplace Power to Improve Health, Environment and Economics

April 20th, 2015

To: IPM Institute Board of Directors
From: Kelly Adams

Re: 2013-2014 Progress Report

Please review the following progress report for discussion on our call scheduled for Thursday, April 23rd at 2 PM CDT.

Overview

The IPM Institute saw continued growth in 2013-2014 with nine new projects including Tick IPM and Organic & IPM working groups; an ag-retailer pilot to improve water quality in the Sandusky River Watershed and expansion of that initiative to the entire Great Lakes Basin; and work updating existing and new IPM Elements for the IPM Centers website. We received funding for 21 out of 30 proposals and included among those is an on-going contract with Whole Foods Market (WFM) to continue development and verification of their Responsibly Grown produce rating system, which we helped successfully launch in WFM stores in October 2014. This project also provides support for further development of the Pesticide Risk Mitigation Engine tool (ipmprime.com) within the Responsibly Grown program. Other funded projects included an EPA grant through the University of Arizona to oversee development and implementation of a national school IPM certification program, a 2013 contract with the Natural Resources Defense Council (NRDC) to evaluate existing soil quality metrics, and 2013 and 2014 renewal funding for the NRCS and IPM and School IPM working groups. Our growing staff is currently 16 employees, including three recent hires to support the Partnership for Ag Resource Management program: project coordinator Jill Carlson, project team member Krysta Koralesky and junior software developer Justin Leatherwood.

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2013 – 2014 PROJECT PROGRESS

Sustainable Food Group (www.sustainablefoodgroup.org) -- IPM Institute continues to work with Whole Foods Market on the Responsibly Grown rating system for their produce and floral supply chains. In 2013, IPM Institute finalized standards development and piloted the program with a strategic sampling of suppliers to assess viability and identify opportunities for improvement. IPM Institute worked with project partners to facilitate development of the online rating system, focusing significant effort on ensuring that the Pesticide Risk Mitigation Engine, ipmprime.com, interfaced directly with the online system. IPM Institute worked with Whole Foods Market to introduce the rating system to the supply chain in September 2013 with a positive reception.

In March 2014, we invited select suppliers to the online rating system in preparation for the launch of the program in stores. IPM Institute reviews all vendor responses submitted in the online system before ratings are confirmed by Whole Foods Market. The Responsibly Grown rating system was successfully launched in Whole Foods Market stores on October 15, 2014 with almost 50% of the supply chain rated. The New York Times covered the new rating system in an October 2014 *Business Day* article found here: http://www.nytimes.com/2014/10/16/business/whole-foods-to-rate-its-produce-and-flowers-for-environmental-impact.html?_r=0. Details of the program, including the prohibited and restricted pesticides policy, have been made public and are available on the Whole Foods Market Responsibly Grown webpage: http://www.wholefoodsmarket.com/responsibly-grown.

IPM Institute will continue to support the Responsibly Grown rating system project management and updates, program evaluation and verification. The verification includes application inspections for 100% of the supply chain and desk and site audits for a percentage of the supply chain. Audits will be piloted in 2015.

In 2014, a group of collaborators including Penn State, the Southern Region IPM Center and theIPM Institute received a grant from Agriculture Food and Research Initiative (AFRI) to begin work on the Integrated Pest Information Platform for Extension and Education (iPiPE). Through collaboration with stakeholders, IPM Institute will develop IPM Elements (concise summaries of key IPM practices) for 32 crop-pest programs identified by the iPiPE project. The IPM Elements will be used to measure the change in IPM practices in each of the crop-pest programs across the span of the project. This work will continue through 2017.

As of late 2014, IPM Institute is in conversation with another national food company that hopes to expand the role sustainable agriculture plays in its global supply chain. The potential collaboration would be a significant opportunity for the IPM Institute to use its expertise to

contribute to efforts to improve the impacts of agriculture on the environment and human health and may include roles for the IPM Institute in program development and operation.

Partnership for Ag Resource Management (PARM) (www.partnershipfarm.org) --
From 2010 through 2014, PARM targeted communications to three overlooked audiences in the Western Lake Erie Basin (WLEB) key to influencing on-farm decisions that impact water quality: non-operator landowners, ag retailers and watershed organizations.

In collaboration with the Sandusky River Watershed Coalition, we identified and communicated with non-operator landowners in the watershed via six mailings about critical water quality issues and how landowners can contribute to progress by supporting improvements on their land. Over four thousand non-operator landowners were surveyed to learn more about trends in nutrient management planning and decision-making to gauge the impact of the communications campaign on behavior changes.

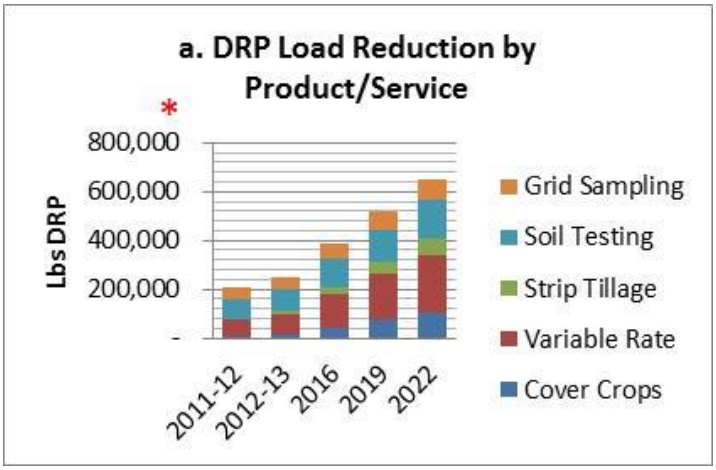
Through an Ohio Conservation Innovation Grant, the PARM team developed an Excel-based calculator to estimate phosphorus losses at the hydrologic response unit (HRU) level for the Sandusky River Watershed's agricultural retail agronomists and farmers. The tool allows users to compare environmental and financial impacts of specific products and services.
Targeted communication, via a webinar series, to watershed organizations and ag retailers focused on on-farm nutrient decisions and building partnerships.

Through funding from the National Fish and Wildlife Foundation, PARM also targeted communications to farmers in the WLEB region by hosting Technical Service Provider (TSP) training that certified 43 TSPs to write Nutrient Management plans in the WLEB. Also, we widely publicized the latest EQIP sign-ups for WLEB states through more than 200 newspaper, online, magazine and radio communications.

To date, we have contributed to more than 18,000 lbs. in annual dissolved reactive phosphorus (DRP) loss reductions in the Sandusky River Watershed via an innovative partnership with ag retailers. We identified profitable ag retail products and services that also reduce phosphorus (P) loading including cover crops, precision agriculture for soil sampling and applying inputs across a field according to need for specific zones within the field, applying nutrients within the root zone of the plant and limiting cultivation to the planting row.

We identified and educated ag retailers on the extent of the P problem, their potential role in solutions, and provided support information to help them market the profitable products and services we identified. Next, we surveyed ag retailers for annual sales of those products and services. The annual sales of products and services for 2011-2012 and 2012-2013 are shown in Figure 1a. We also developed trend lines and sales and revenue projections that lead to

achievement of International Join Commission P targets for the WLEB as shown below for 2016, 2019 and 2022.



Other support tools we developed include a nutrient management plan template that meets USDA Natural Resources Conservation Service (NRCS) requirements and better meets the needs of retailers; training for ag retail staff to become NRCS-certified planners, qualifying 31 ag retail planners to date; wallet cards to help ag retailers identify fields at high risk of P loss; and an *Agronomist Handbook* (http://partnershipfarm.org/wp-content/uploads/2014/08/Agronomist-Handbook-v0814-Fillable.pdf) including "sell sheets" to improve retailer effectiveness in marketing and selling key products and services; a unique calculator that allows agronomists to run scenarios to estimate loss reduction and profit estimates for specific products and services at field level; and an extensive contact list to distribute those resources along with a website to house them.

Currently, we are scaling up the successful ag retailer pilot in the WLEB to the entire Great Lakes Basin (GLB). Equipped with further funding from the Great Lakes Protection Fund in 2015, we are expanding efforts to activate ag retailers as change agents for targeted water quality improvements. Through our communications and outreach, ag retailers across the GLB will become more aware of nutrient, pesticide and sediment issues and their role in the solution.

We are working with the University of Georgia to develop a web-based version of the Excel phosphorus loss calculator initially developed under the Ohio CIG. Ag retailers can use this online calculator to test out location-specific scenarios of different products and services that reduce P losses from their grower client fields.

With ag retailer software companies and ag retailers, we will develop a software interface to receive product and service data from agricultural retailer software and convert into environmentally relevant reporting information for benchmarking water quality efforts and demonstrating compliance with nutrient management or conservation standards. We are working with a graphic designer to develop an infographic that displays the key concepts behind the ag

retailer software interface. This infographic will play a key role in quickly generating buy-in from ag retailers and retailer software companies by demonstrating the environmental and economic implications of such an innovative tool. We will be able to aggregate in real-time product and service delivery for the GLB that has implications for mitigating nutrient, pesticide and sediment losses. This interface can then fuel credible product and service target-setting for ag retailers.

We will establish a working group of agricultural retailers, USDA NRCS officials and Soil and Water Conservation Districts (SWCDs) to improve the NRCS planning process by optimizing the division of labor between NRCS and ag retailers to make most efficient use of skills, data, tools and time. The working group will also tackle identifying and promoting opportunities to enhance the success of the new NRCS Resource Stewardship Standard Framework.

ipmprime.com: Pesticide Risk Mitigation Engine (www.ipmprime.com) --
ipmprime.com is a web-based software tool designed to analyze pesticide risk to human and environmental health at the farm level. The tool uses best available science in a user-friendly interface. In the initial stages of ipmprime.com development, IPM Institute collaborated with Oregon State University (OSU) specialists as well as other independent scientists and pesticide researchers. In August 2013, IPM Institute and OSU collectively decided that it was in the best interest of each entity to pursue independent development of the ipmprime.com tool, and subsequently, a separation agreement was finalized in November 2013. IPM Institute now maintains ipmprime.com on cloud-hosted virtual machines and continues to work with a team of consultants on further developing the software. Several indices, in addition to the original ipmprime.com measures, including farmworker and consumer cancer, dermal, dietary and pollinator risk, will be launched in March 2015. Water modeling capability will be released later in 2015. Ipmprime.com outreach continues through 2015 to identify key potential users and to expand possibilities for ipmprime.com applications in supply chain sustainability.

IPM Institute received an initial investment from Whole Foods Market for a custom online version of the ipmprime.com tool designed to work within Whole Foods Market's Responsibly Grown produce rating system. The programming team at IPM Institute developed a custom interface for enhanced usability, with an improved user interface and simplified data entry based on the maximum rates of application across comprehensive production units. Whole Foods has committed to an additional investment in ipmprime.com through May 2015 supported by the vendors who subscribe to ipmprime.com within the Whole Foods produce rating system. The additional investment will cover costs of user training, site maintenance and ipmprime.com development including the additional risk indices listed above. For more information on the Whole Foods produce rating system, please see the Sustainable Food Group project overview above.

The EquiTable Food Initiative (EFI) contracted with IPM Institute in 2013 to implement ipmprime.com as part of the EFI certification standards. Staff at the IPM Institute carried out training for EFI members in spring 2014, and the tool was used successfully as part of the EFI

certification for the 2014 growing season. EFI is exploring the possibility of funding ipmprime.com development for greenhouse growing operations. The LA Food Policy Council's Good Food Purchasing Guide has also used ipmprime.com since 2012 and is considering expanding its use of the tool within the program.

Green Shield Certified (GSC) (www.greenshieldcertified.org) --
In 2013 and 2014, Green Shield Certified completed initial evaluations for one Pest Management Provider (PMP) company, three PMP services, one program and three facilities. Eleven PMPs and one IPM program were re-evaluated both years, with one additional facility evaluated in 2014, bringing the total number of certified pest management participants to 42 since 2007.

The IPM Institute completed a revision and update of the Wisconsin Army National Guard's Integrated Pest Management Plan in 2013. This project was an excellent opportunity to evaluate and incorporate advanced IPM principles and practices into an existing plan which was primarily based on IPM in theory.

2013 through 2014, the Green Shield Certified team saw personnel changes, welcoming Matt Neff as a new project team member for Green Shield Certified and IPM Star at the IPM Institute, and Carrie Foss and Wayne Walker as GSC Evaluators. Carrie Foss, based out of Puyallup, Washington, will support the program and its participants on the West coast, while Wayne Walker will work with evaluations in the Southeast. In 2014, IPM Institute also dedicated significant efforts to bring program participants up-to-date with certification and evaluation fees, by collecting almost $30,000 in outstanding fees.

IPM STAR for Schools and Childcare Centers (www.ipminstitute.org/ipmstar.htm) --
In 2013, IPM Institute collaborated with Carrie Foss of Washington State University (WSU) to evaluate four new Washington school districts: Marysville Public Schools, Kelso School District, Bellevue School District and Evergreen Public Schools. Marysville achieved certification within three months, which is extremely rare. Janet Hurley of Texas A&M AgriLife Extension Service conducted two new IPM STAR evaluations in Louisiana for Ascension Parish Schools and Orleans Parish Schools.

The Salt Lake City School District completed a re-evaluation in 2013. Outreach to lapsed school districts has been unfruitful; those who have responded cite a lack of funds to pursue IPM STAR recertification. Rebecca Maguire of WSU became a trained IPM STAR evaluator and will conduct additional IPM STAR evaluations in the Northwestern region going forward.

In 2014, Bellevue School District addressed their remaining requirements and achieved certification. A new evaluation was completed for Western Reserve Local Schools of Ohio, who also achieved certification within three months.

North Central NRCS and IPM Working Group: Growers Incentives for IPM (www.nrcs.ipm.msu.edu) -- Since 2006, the NRCS and IPM working group has provided outreach and program support to growers and encouraged their adoption of IPM through participation in NRCS programs. The working group's 2013-14 objectives reflected stakeholder identified priorities, including addressing impediments to IPM adoption, fostering partnerships and training for federal and state agencies and expanding enrollment in conservation programs in the North Central region and nationally. The North Central IPM Center (NCIPMC) provided renewal funding through 2014 to continue monthly working group conference calls and website updates including NRCS Environmental Quality Incentive Program (EQIP) updates and pertinent state and regional resources on agricultural IPM. In 2013, the working group secured an additional $10,000 from the NCIPMC Mini-grant program to address training needs for NRCS agency staff and TSPs. Working group outreach under this funding focused on engaging national NRCS EQIP program staff and TSP's to address training needs per the working group's objectives.

At the National Alliance of Independent Crop Consultants (NAICC) 2014 Annual Meeting, the NRCS &IPM working group piloted the IPM Practitioner Exam for the second time in an effort to continually enhance the exam's ability to test knowledge of overarching principles and practices of IPM. Based on participant feedback, the group will finalize the exam and work with NAICC to prepare for a Certified Professional Crop Consultant (CPCC) IPM designation and long-term proctoring opportunities.

In 2014, the NRCS & IPM Working Group worked on outreach to increase consultant participation in the TSP program. Through partnerships with Extension, State and Federal IPM specialists, consultants and consultant organizations, the working group spread awareness and opportunities for IPM by strengthening IPM consultant's participation in NRCS TSP programs for EQIP 595, IPM Conservation Activity Plans (CAPs) and Conservation Stewardship Program (CSP) enhancements. A specific outreach activity slated for 2015 includes the development of a webinar series highlighting opportunities for IPM implementation through EQIP 595, IPM CAPs and CSP. Specific focus will be on use of the Windows Pesticide Screening Tool (WIN-PST) to identify and mitigate pesticide risk. In addition to the working group's outreach efforts, the IPM Institute is currently providing technical services to five producers in Minnesota and one in Wisconsin to complete IPM CAPs as well as six Minnesota and four Wisconsin growers enrolled in EQIP 595 IPM implementation. The working group is also developing an herbicide resistant CAP template.

In 2014, the working group evaluated grower participation in EQIP IPM options over multiple years, documenting a steep, recent decline and developed recommendations for improvement. Despite initial success in opening up EQIP opportunities for specialty crop producers, IPM funding, grower contracts and land unit acres impacted by EQIP IPM contracts all sharply

declined from 2008 to 2012. The negative trends are attributed to a lack of outreach to potential new grower participants, poor communication between NRCS headquarters and state and local offices, few NRCS-qualified crop consultants and inconsistent program changes. Working group recommendations for expanding EQIP opportunities include streamlining the approach to qualify competent crop advisors and obtain a clear, firm commitment from NRCS to the need for and benefits of IPM for water quality, air quality, pollinator health and soil health. The commitment to IPM by NRCS can be made via staff training at all levels with quantitative expectations for participation.

2013-2014, the NRCS & IPM Working Group also published articles in the American Society of Agronomy's trade publication, Crops and Soils Magazine. Articles ranging in topic from herbicide resistance, brown marmorated stink bug, sprayer calibration, certification opportunities for growers and consultants, fungicides for plant health and effectiveness of conservation practices and IPM all improved the group's ability to reach CCA's with relevant information about emerging IPM issues. Crops and Soils has a readership of over 14,000 Certified Crop Advisor (CCA) members. Following these publications, Crops and Soils approached the working group about being an ongoing contributor on IPM topics.

The working group's 2015 renewal proposal to the NCIPM Center was unsuccessful due in large part to the group's inability to maintain or increase participation in NRCS programs for IPM. The working group is actively seeking additional funding sources and collaborators.

North Central IPM Working Group: Increasing Adoption of IPM in Schools (www.ipminstitute.org/NC_IPMIS_Working_Group/main.htm) **–** The North Central School IPM working group provides support for school districts in the North Central region seeking to adopt IPM. In 2013-2014, the working group made regular updates to the project's website and Facebook page, created monthly School IPM 2020 newsletters and continued to build a national database of school contacts from a variety of sectors.

IPM Institute received the NCIPM Center Renewal Grant in 2013 and 2014 which funded monthly North Central Working Group and National Steering Committee conference calls, updates to the school IPM 2020 Strategic Plan, support for school IPM coalitions in IN, NE and MI through marketing training resources and curriculum, support to two new SIPM coalitions in states without existing projects (ND and SD), development of a business plan for the National IPM Standard Certification Training Program for school staff "Stop School Pests" (http://cals.arizona.edu/apmc/StopSchoolPests.html#lessons), support for the development and review of modules for Stop School Pests and continued development of the Illinois IPM Association. Stop School Pests training materials will include both self-guided online learning modules and exams for key school staff to earn certificates or certifications, while also providing a rigorous exam process to pest management professionals and facility managers.

A 2013 mini-grant from the North Central IPM Center via the USDA National Institute of Food and Agriculture (NIFA) supported the completion of the EPA PRIA IPM School District survey (see additional details below, *School IPM 2020*) in all states in the North Central region (IL, IN, IA, KS, MI, MN, MO, NE, ND, OH, SD and WI). The working group's 2015 renewal proposal to the NCIPM Center was unsuccessful due to errors in the application submission, which resulted in the omission of key components of the proposal. Reviewers also indicated the working group needed to demonstrate more consistent progress each year to qualify for continued funding. The IPM Institute is recruiting for a community IPM manager to assist in development and fundraising for future school IPM projects.

School IPM 2020 (www.schoolipm2015.com) **–** In 2013, IPM Institute completed a 2010 EPA PRIA grant. The School District Survey under this grant asked districts to report asthma rates, pest management practices used, including IPM policies and plans, pest management staffing, pest complaints and pest management costs. The survey was successfully completed with a 20% or higher response rate in 41 states. Nine states had response rates lower than 20%, including: Alabama 12%, Kentucky 23%, Massachusetts 14%, Michigan 11%, New Jersey 18%, Oklahoma 6%, Pennsylvania 13%, Florida NA and D.C. NA. Nine other states leveraged funds to complete non-PRIA funded surveys including: CA, CO, MN, NC, NM, OR, TN, UT and WA.

The second tier survey developed under the 2010 PRIA 2 grant is an online Coalition Survey, which intends to gather year one and year two metrics for regional and statewide school IPM coalitions. The coalition survey has been completed by 17 school districts. The State IPM Report Card Survey was completed by 54 states and territories. Information was updated towards the end of 2014 via phone interviews.

In summer of 2013, the national school IPM steering committee included 11 regular members, 13 advisory members and one national-level consultant. A complete list of members and their roles and responsibilities can be found at: **http://www.ipminstitute.org/school_ipm_2015/steering_committee.htm**. The national school IPM steering committee continues to participate in monthly conference calls, which now regularly include a 20 to 30 minute educational component on topics such as children's health, currently funded programs and best practices.

The steering committee and four regional school IPM working groups coordinate and support coalitions, demonstration sites and related projects. We also promote outreach efforts (periodical School IPM 2015 newsletters, state-based and regional IPM training sessions, Facebook and Blogger accounts) and maintain a website with current school IPM-related news, resources and opportunities to join the national school IPM effort.

***Entomological Foundation (EF) (www.entfdn.org)* –** IPM Institute volunteered staff time to provide bookkeeping and administrative support for the Entomological Foundation in 2013 and 2014. IPM Institute staff organized the Entomological Foundation silent auction (at the Entomological Society of America annual meetings), board of director's member meetings, a counselor meeting and provided plenary session updates at the Entomological Society of America's (ESA) Annual Meeting in Portland, Oregon in November 2014. Staff also coordinated a teacher workshop for educators to learn about IPM curriculum they could bring back to their classrooms for the 2013 ESA annual meeting. All awards, funds, endowments and administrative responsibilities were transferred from the IPM Institute back to ESA in late 2014.

***Northeast Eco Apple (www.redtomato.org/ecoapple.php)* –** Red Tomato began the Eco Apple Project in 2005 as a third-party certification for New England orchards implementing advanced Integrated Pest Management. Certified growers use the program to differentiate their crop in the marketplace and increase access to new markets. IPM Institute continues our partnership with Red Tomato, providing scientific and technical expertise on IPM practices and updating the protocol annually. Changes to the protocol reflect advances in IPM technology and practices, or approval/restriction of newly released pesticides. In 2013 the program certified 15 growers and enrolled 905 acres, and 12 growers and 829 acres in 2014.

2014 marked the fourth year of the Eco Stone Fruit program. Using the Eco Apple Protocol and self-assessment format, this protocol identifies best practices for IPM in stone fruits, including peaches, nectarines, apricots and plums. We certified three growers and 86 acres in the Eco Stone Fruit Program.

Eco Apple is scheduled to incorporate a new, whole-farm protocol into the stone fruit program in 2015, which will include blueberries and other small fruits. This protocol will increase certified growers' ability to differentiate their products in the marketplace with increased use of evaluation metrics and new certification categories, including pollinator protection. The protocol is also designed to allow more crops to be certified under one program by identifying separate certification criteria applicable to all crops and those which are crop-specific criteria. In two years we anticipate certifying all Red Tomato eco trademarks with one primary protocol.

***Upper Midwest Apple IPM Programs* –** IPM Institute continues to offer technical and other IPM assistance to apple growers throughout southern Wisconsin and southeastern Minnesota through our pest scouting program, NRCS Technical Service Provider (TSP) services and IPM certification.

The Apple IPM Scouting Program continued its sixth season in 2014 with 16 growers and 456 acres of apples enrolled in our season-long program, which provides bi-weekly scouting visits. Four of these growers were enrolled in a limited scouting program which provided one to three

scouting visits or sprayer calibration consultations during the season. Visits support implementation of the grower's Environmental Quality Incentives Program (EQIP) contracts. We also offered three advanced IPM field days to growers, funded by the North Central Regional IPM grants program, two in 2013 and one in 2014. The 2014 workshop was held in Waukon Iowa, serving many growers we had not worked with previously. Essential activities included presentations and scouting exercises to improve growers' abilities to scout pests and make IPM-based management decisions.

TruEarth Certified (www.truearth.net), a market based IPM program first launched in 2010, certified 10 growers in 2014 under a new protocol developed with significant input from participating growers and influenced by our experience with the Red Tomato Eco Apple Program. Participants in the TruEarth Certified program wholesale fruit through Wescott Agri Products.

IPM Institute hired two new pest scouts in 2013-2014, to work with clients in the upper Mississippi River Valley. Scouts were successful in implementing a weekly scouting program over 13 weeks for their apple grower clients. They also played a part in completing three IPM Conservation Activity Plans for growers in Minnesota. The program will begin aggressively expanding outreach to wine, table grapes, strawberry and raspberry producers in response to the growing pest threat from spotted wing drosophila.

Potato Sustainability Project (www.nationalpotatocouncil.org/events-and-programs/environmental-stewardship/ipm-survey-and-information/) --
The potato sustainability project started as an IPM practice-based survey for three of McDonald's major potato processors. Since 2012, the project has acquired three additional potato processors. IPM Institute collaborates on project development with the six processors, McDonald's representatives, National Potato Council (NPC), Canadian Horticultural Council (CHC) and a group of potato growers.

In 2013, the potato sustainability team worked on expanding the scope of the survey to measure broad-based sustainability practices including environmental, social and economic sustainability. The team is now focused on developing outcome-based metrics to accompany the practice-based survey to launch with the 2014 growing year survey. The team is also developing an audit program to have in place for the 2016 growing year. The audit program will include a training program and pilot. Both the metrics and audit programs will be harmonized with Sysco's Sustainable Ag/IPM program, the Sustainable Agriculture Initiative (SAI) Platform and USDA Good Agricultural Practices (GAP) program.

Sysco Sustainable Agriculture/IPM Program -- The IPM Institute continues to facilitate adoption of IPM and other sustainable practices by Sysco's fruit and vegetable producers. The IPM Institute evaluates Sysco suppliers' written Sustainable Agriculture/IPM Programs on an ongoing basis and provides recommendations for improvement. We also assisted Sysco in

compiling 2012 and 2013 processing season environmental indicator reports, which revealed that Sysco's Sustainable Ag/IPM Initiative now includes 898,175 acres and nearly 5,000 growers of agricultural products worldwide. Suppliers continue to show their interest in and commitment to the program: in 2012, Sysco saw the highest number of suppliers to date report their annual environmental indicator data, and many suppliers that meet criteria to reduce the frequency of their Sysco Sustainable Agriculture/IPM audits have opted to continue with annual audits to keep improving management and outcomes. The IPM Institute has updated the Sustainable Ag/IPM program to include standards on pollinator protection. In January 2015, we will be training auditors.

Eighth International IPM Symposium (www.ipmcenters.org/ipmsymposium15) **–** The IPM Institute is coordinating final preparations for the Eighth International IPM Symposium, set to take place in Salt Lake City, Utah during the week of March 23, 2015. The Symposium has over 470 registered attendees, including international participation representing 28 countries to join in more than 85 plenary sessions, mini-symposia, workshops and discussion sessions focusing on solutions to global pest challenges in agriculture and communities. Volunteer planning committees worked to finalize the meeting format, plenary and concurrent program schedules, and coordinate field-trips and professional development sessions. We continue to provide both paid staff time plus Tom Green's pro bono assistance to Symposium organizer Elaine Wolff by participating on the Finance & Exhibits Committee, Steering Committee, coordinating monthly conference calls, organizing the first silent auction and managing financial administration.

Organic and IPM Working Group (organicipmwg.wordpress.com) **–** The Organic and IPM working group was formed following a roundtable workshop in November 2012, sponsored by Red Tomato and organized by the Northeast IPM Center, which gathered thirty national leaders from organic and IPM communities. Attendees exchanged ideas, vision and concerns, with the goal of increasing understanding and collaboration between organic and IPM constituents. One of the next steps identified at the conference was the need for a working group to continue collaboration and discussion.

The group secured $5000 of funding from an IR-4 grant in 2013. The objectives of the grant were to identify and recruit a diverse group of organic and IPM leaders, collaborate in the form of a working group, maintain a current and comprehensive master list of priorities on the working group webpage, develop action plans and timelines for completing top priorities and recommend policies and programs that foster a complimentary approach.

IPM Institute convened the first Organic IPM Working Group conference call on August 2, 2013. There was a general consensus among the eleven attendees that organic and IPM can constructively collaborate in many areas, especially in developing long-term systems approaches for pest management. The working group is now comprised of forty-seven members and meets monthly via conference call, with an average of eight participants per call.

In-line with IR-4 and North Central IPM Center grant objectives, a meta-analysis of regional and national organic and IPM priorities was conducted in July 2013, which defines areas of overlap and potential collaboration for a working group. Nine broad priorities were identified using information sourced from the National IPM Roadmap, Regional IPM Priorities and the National Organic Research Agenda. In November of 2014, the working group then further created a list of fifteen detailed priorities in Organic and IPM within the context of the initial nine broad priorities. A survey is currently underway to rank these priorities, the results of which will be posted on the working group's website.

In 2014 the working group began work on an authoritative white paper on IPM and Organic encompassing the history of both movements, the current state of cooperation and implementation between the groups, and opportunities for future collaboration. Eleven working group members stepped up to collaboratively author this document, led by Tom Green and Brian Baker as editors. Material from the paper will be presented in two sessions led by the Organic and IPM Working Group at the 8th International IPM Symposium in Salt Lake City in March 2015.

***IPM Voice (www.ipmvoice.org)* --** Board member Jim Cubie left the IPM Voice organization in early 2013. Following this, IPM Voice went through three strategic planning sessions to restructure the organization. During these sessions, the group decided that a stronger leadership team was needed to make IPM Voice a successful organization. In fall 2013, the Board of Directors reorganized on a volunteer basis. The new, consolidated board underwent internal strategic planning sessions in October 2013, culminating in an in-person board meeting in Washington D.C. in November 2014. At that session the board explored the opportunity to undertake a broad educational campaign to promote IPM by inviting speakers from Frameworks Institute to present their methods and approaches to the communication of complex scientific concepts. The board established monthly conference calls and convened in person at the 8th International IPM Symposium in Salt Lake City.

IPM Institute continues to provide support to the organization through financial administration, facilitating board discussions and meetings, maintaining website updates and writing monthly IPM Voice newsletters. The IPM Voice newsletters reach an audience of approximately 3,000 pest management professionals, researchers, scientists, decision makers and extension employees.

***Public Tick IPM Working Group (tickipmwg.wordpress.com)* —** The Public Tick IPM working group convened in October 2013 to promote the adoption of IPM practices aimed at reducing tick-borne disease incidence. The working group holds monthly conference calls and collaborates to disseminate information, share resources, reduce duplication of efforts and increase and accelerate impacts of Tick IPM nationwide.

IPM Institute received funding from the North Central IPM Center (NCIPMC) in 2014 for the Public Tick IPM working group to create and maintain stakeholder-identified priorities for research, education and regulation. Top priorities identified in 2014 were 1) develop and promote adoption of IPM strategies to reduce incidence of tick-borne disease by reducing risk of exposure to ticks and pathogens, 2) clarify and minimize risks associated with acaricides and other tick-borne disease management products and 3) facilitate collaborative initiatives within the working group, especially among academic, government and non-government organizations.

In 2015, the working group will assist Dr. Thomas Mather with the development of the TickSmart Web Portal. The portal is adapted from the TickEncounter Prevention Partner program and will be fully integrated with TickReport to provide interactive displays of aggregated data in the form of maps and tick infection query tools. The working group is also expanding outreach efforts to potential collaborators to organize a Tick IPM conference, aiming to have plans in place for 2016.

BMP CHALLENGE Performance Guarantee Program (www.bmpchallenge.org) **–** Operated by Agflex in collaboration with American Farmland Trust, the IPM Institute and others, the BMP CHALLENGE offers a risk free yield guarantee to corn producers in 20 states. The program works with farmers to reduce nutrient and sediment outputs to local waterways while offering a financial safety net in case of profit loss. In addition to expanding proven best management practices for silage and grain, Agflex continued specialty crop BMP CHALLENGE projects for broccoli in California and sweet corn in New York through partnerships with the Cachuma Resource Conservation District and Cornell University respectively. Agflex continues precision-ag outreach and technical assistance under the Maryland Conservation Innovation Grant ($75,000) for trials comparing farmers' conventional practices to Cornell University's Adapt-N online tool, a model that predicts fertilizer needs based on dynamic nitrogen processes, field conditions and weather. IPM Institute will complete currently-funded BMP Challenge activities and plans to phase-out the program within the next two years, allowing greater focus on targeted water quality efforts through the PARM project.

Natural Resources Defense Council (NRDC) Soil Metric **–** Under contract with NRDC, we evaluated existing soil quality metrics to explore the potential for developing a metric specifically for farmers in supply chain sustainability programs. The new metric would be used to benchmark, compare and communicate performance in improving soil quality, with results representing both agronomic and environmental targets for soil health. Our goal was to report on potential to develop an affordable metric that uses readily available soil testing facilities and can be implemented consistently in major growing regions worldwide. Our assessment did not identify an existing metric that would meet all of these needs. A new collaboration, the Soil Renaissance project, coordinated by the Farm Foundation and the Samuel Roberts Noble Foundation is likely to pursue an improved metric.

Other Activities

We continue to respond to unsolicited inquiries from the food supply chain, pest management professionals, facilities, retailers, parents, school administrators and media about IPM and pest-related issues. We keep our website content current with IPM-related news, job listings and resource links. Currently hits to the website average 1244 per month.

In addition IPM Institute:

- Served on the board of directors for the Entomological Foundation, which seeks to engage and sustain interest of school-aged children in science and insects. The Foundation seeks to establish an Educational Fund to distribute grants which help fund new programs, projects and services, as well as to expand the reach of the Foundation's programs and services. http://entfdn.org

- Reviewed and updated our employees loaded labor rates for charging staff time to grant and contract-funded projects. This rate allows us to recover all direct costs of having an individual perform tasks including salary, benefits, equipment and administrative support.

PRESENTATIONS

2014 Presentations

Entomological Foundation: Our Foundation for Exciting Young People about Science through Insects! Ensuring a Future for Entomology. Entomological Society of America, Portland, OR.

Entomological Foundation: Plenary Update. Entomological Society of America, Portland, OR.

Using IPM and Insects to Teach Science in the Classroom. National Science Teachers Association Annual Regional Meeting, Richmond, VA.

Pesticide Risk Mitigation Engine: A User-Friendly Online Tool for Pesticide Risk Assessment and Mitigation. Poster, Entomological Society of America, Portland, OR.

Stop School Pests: Standardized National School IPM Training. Poster, Entomological Society of America, Portland, OR.

(1) Facility IPM: Opportunities to Improve Pest Management, Food Safety and Sustainability; (2) Opportunities to Improve Pollinator Protection. Sysco Sustainable Ag/IPM Conference, Houston, TX. T.Green.

Implementing Successful IPM in Schools and Other Sensitive Environments. National Pest Management Association Southern Conference, Tunica, MS. T.Green.

Responsibly Grown Rating System. Whole Foods Market Produce Vendor Meetings. Munster, IN; Glendale, CA; Boston, MA; Savannah, GA; Maui, HI. T.Green.

BMP CHALLENGE. Crop Tech Client Meeting, Heyworth, IL. T.Green.

Advancing IPM with Midwest Apple and Grape Growers. North Central Region Extension IPM Meeting, Madison, WI. T.Green and P.Werts.

Opportunities for IPM. Northeast Region Extension IPM Technical Committee, Burlington, VT. T.Green.

Watershed Organizations: Engaging Ag Retailers in Nutrient Management Solutions via webinar. T.Green and M.Adelsperger.

Ag Retail Leading Improvements in Resource Management and Water Quality in the Western Lake Erie Basin. Ohio Agribusiness Association, Columbus, OH. T.Green.

Ideas for Improving Customer Service and Profitability. Western Lake Erie Basin ag retailers via webinar. T.Green, M.Adelsperger and K.Studer.

Improving Outreach to Growers and Non-Operator Landowners. Great Lakes Basin watershed groups via webinar. T.Green and M.Adelsperger.

Partnership for Ag Resource Management. Advisory Board via webinar. T.Green and J. Petzoldt.

Biopesticides in Conventional and IPM Production. New England Region IR-4 Stakeholders, Albany, NY. T.Green.

Implementing Successful IPM in US Schools. National IPM Coordinating Committee, Washington, DC. T.Green.

Partnership for Ag Resource Management. Certified Crop Advisor North American Board, Sacramento, CA. T.Green.

IPM and Sustainable Agriculture. Biopesticide Industry Alliance, Alexandria, VA. T.Green.

What's Driving Advanced IPM in Minnesota and Wisconsin Orchards? Bayfield Fruit Summit, Bayfield, WI. P.Werts.

Scouting and Monitoring for Orchard Insect Pests and Diseases. RIPM IPM Field Day, Waukon, IA. P.Werts.

Orchard-Airblast Sprayers: Optimize Performance & Save Money. RIPM IPM Field Day, Waukon, IA. P.Werts.

2013 Results: Pesticide Use and Sprayer Calibration. Wescott Growers Meeting, Winona, MN. T.Green and P.Werts.

2013 Presentations

The Eco Apple Project: Advanced IPM and Sustainability in the Northeast. Wescott Growers Meeting, Winona, MN. T. Green and P. Werts.

Opportunities to Reduce Pesticide Risk. Wescott Growers Meeting, Winona, MN. T.Green and P.Werts.

Reducing Asthma Triggers Using IPM Techniques. Green Shield Certified Webinar to pest management professionals. T.Green.

NRCS and IPM Working Group. Northeast Research, Extension and Academic Committee on IPM via Video Conference. T.Green.

Tick IPM: What Have We Learned and What Can We Learn from Others? US EPA – CDC Tick Borne Disease IPM Conference. Arlington, VA. T.Green.

Direction of Specialty Crop IPM in the North Central Region to US EPA Region V and American Farmland Trust. Chicago, IL. T.Green.

Sustainability Rating System. IPM Institute and IPM Voice Update. North Central IPM Coordinators Meeting, Madison, WI. T.Green.

Potato Sustainability Survey: Incorporating Metrics. Potato Sustainability Governance Committee, Denver, CO. T.Green.
Communicating with Non-Operator Landowners to Improve Resource Management. Webinar to conservation professionals. T.Green.

Ag Resource Management; Partnering with Ag Retailers to Make a Difference. Webinar to conservation professionals. T.Green, M.Adelsperger and R. Ressl.

Ag Retailer Tools and Services. Advisory Board via webinar. T.Green, M.Adelsperger and R.Ressl.

Sustainable Produce Rating System. Whole Foods Market Produce and Floral Sustainability Summit, Austin, TX. T.Green.

School IPM 2015: Status Report. Association of Structural Pest Control Professionals Annual Conference, Atlanta, GA. T.Green.

(1) Plenary Session: Entomological Foundation Update. (2) Translating Whole-Farm Ecosystem Approaches into Practice: Current Tools and Options for Agriculture. (3) Metrics for Success in School IPM Implementation. Entomological Society of America Annual Meeting, Austin, TX. T.Green.

(1) Keep it for the Crop 2015. (2) Sandusky Pilot and Specific Tools for Ag Retailers. Ag Retailers Leading Improvements in Resource Management for Water Quality, Toledo, OH. T.Green.

Sprayer Calibration & Optimizing Sprayer Performance. Wisconsin Berry Growers Association Field Day, Ripon, WI. P.Werts.

Scouting and Monitoring for Orchard Insect Pests and Diseases. IPM Field Day, Eau Claire and Bayfield, WI. P.Werts.

Orchard-Airblast Sprayers: Optimize Performance & Save Money, IPM Field Day. Eau Claire and Bayfield, WI. P.Werts.

Grower Opportunities for Integrated Pest Management through USDA NRCS Conservation Programs. North Central IPM Working Group Webinar. T.Green and P.Werts.

PUBLICATIONS

2014 Publications

(Refereed)

Hurley, J.A., T.A. Green, D.H. Gouge, Z.T. Bruns, T. Stock, L. Braband, K. Murray, C. Westinghouse, S.T. Ratcliffe, D. Pehlman and L. Crane. 2014. Regulating Pesticide Use in United States Schools. *American Entomologist* 60(2):105-114.

(Non-Refereed)

Murray, K., Mumm, K., and Green, T. 2014. Staying at the top of our IPM game to maximize benefits to clients. *Crops and Soils* 47(4): 12-15.

Werts, P., and Green, T. 2014. Spotted wing drosophila: Adding cost to fruit production. *Crops and Soils* 47:36-38. (Appendix F.)

Studer, K., Petzoldt, J., Adelsperger, M., and Green, T. 2014. Ag retailers and water quality solutions for the Western Lake Erie Basin. *Crops and Soils* 47(5): 14-16.

Green., T. 2014 Helping school districts with IPM: An opportunity for agriculture, IPM, and CCAs. *Crops and Soils* 47(6): 14-17.

2013 Publications

(Refereed)

Francis, C., M. Miller, M. Anderson, N. Creamer, M. Wander, J., Park, T. Green and B. McCown. 2013. Food webs and food sovereignty: Research agenda for sustainability. *J. Agriculture, Food Systems, and Community Development.* 3(4):95-101.

(Non-Refereed)

Miller, M., R. Hirsch, P. Werts and T. Green. 2013. Extending your business range and reaching new clients with low-cost communications technology. *Crops and Soils* 47(1):28-30.

Werts, P. and T. Green. 2013. University and industry scientists weigh in on fungicides for plant health in corn and soybeans. *Crops and Soils* 46(6): 24-27. (Appendix G.)

Werts, P., and Green. 2013. Another season of brown marmorated stink bug activity. *Crops and Soils* 46(5):14-17. (Appendix H.)

Green, T. 2013. NRCS assessments shed light on adoption and effectiveness of conservation practices and IPM. *Crops and Soils* 46(4):20-22.

Werts, P., and T. Green. 2013. Planning options for managing herbicide resistance. *Crops & Soils* 46(3):20-21. (Appendix I.)

Bruns, Z, S. Dibblee, T. Green, S. Miller, S. Ratcliffe and J. Schmitz. 2013. Why Integrated Pest Management is Important in Schools. *Illinois PTA Electronic Bulletin* 9(7): 14-15. http://www.illinoispta.org/Bulletins/2013/0313.pdf

Werts, P. and T. Green. 2013. Airblast sprayer calibration: Opportunities to improve performance and save money. *Crops and Soils* 46(1): 22-29. (Appendix J.)

Siefert, C. and T. Green. 2013. *Wisconsin Army National Guard Integrated Pest Management Plan Update.*

Schmitz, J., T. Green and C. Seifert. 2013. *Overseeding Turf in Northern Regions.* 2 pp. http://www.ipminstitute.org/school_ipm_2015/Overseeding_PP_031413.pdf

FUNDING OBTAINED

2014 Funding

2014 Grants: $1,202,371

Great Lakes Protection Funds, $728,781 to reduce nutrient and pesticide pollution in the Great Lakes Basin and improve outcomes for aquatic and other organisms in the Basin.

Southern IPM Center, $256,000 for a pest information platform for extension and education.

University of Arizona, $33,152 to develop and implement standardized training materials and IPM proficiency exams for certification.

North Central IPM Center, $12,032 to build an alliance between organic and IPM with an organic and IPM working group meeting.

North Central IPM Center, $12,032 to convene a public/private tick IPM working group.

North Central IPM Center, $30,000 renewal funding to increase adoption of IPM in schools in the North Central region.

North Central IPM Center, $30,000 renewal funding to increase collaboration among NRCS and IPM professionals in the North Central region, in collaboration with Michigan State University.

Heidelberg University, $100,374 to improve soil health and reduce nutrient and sediment exports from agricultural farms.

2014 Contracts: $937,575

Whole Foods Market, $292,956 to continue development of a sustainability rating system for international produce supply chain.

American Farmland Trust, $5,000 for a sweet corn BMP Challenge in Suffolk County New York.

Red Tomato, $15,235 for the Northeast Eco Apple Project.

NRDC, $10,000 to develop white paper on NRDC food company action to reduce pesticide risk.

Whole Foods Market, ~$400,000 third-year renewal for management of the Responsibly Grown Rating System for its international produce supply chain.

Entomological Foundation, $12,000 contract for project coordinator services by Mariel Snyder and bookkeeping and invest fund management services by Kelly Adams and Catherine Harris.

Sysco Corporation, ~$30,000 tenth-year renewal for management of the Sysco Sustainable Ag/IPM initiative.

Basic American, Cavendish, Lamb Weston, McCain's, Simplot, Heinz, $72,384 fourth-year renewal of management of the Potato Sustainability Initiative.

Apple IPM Programs, $30,000 in contracts with Wisconsin and Minnesota apple orchards for pest scouting services.

Green Shield Certified Program, $40,000 in contracts with certification participants in structural pest management industry and facility management.

Agflex, Inc., $30,000 contract for project coordinator services by Jane Petzoldt and bookkeeping and grants management services provided by Kelly Adams and Catherine Harris for the corn producer guarantee project.

2013 Funding

2013 Grants: $1,143,345

National Fish and Wildlife Foundation, $233,974 to increase and improve nutrient management planning in the Western Lake Erie Basin.

USDA NRCS Conservation Innovation Grant Programs, $594,371 for verification and enhancement of NRCS-USDA nutrient tracking tool with a suite of best management practices data.

US EPA, $250,000 to develop a sustainable IPM certification program for professionals working in school districts, in collaboration with the University of Arizona, Texas A&M University, Oregon State University, Washington State University and Indiana University.

Northeast IPM Center, $5,000 to convene a working group of organic and IPM professionals to identify common priorities.

North Central IPM Center, $30,000 renewal funding to increase adoption of IPM in schools in the North Central region.

North Central IPM Center, $30,000 renewal funding to increase collaboration among NRCS and IPM professionals in the North Central region, in collaboration with Michigan State University.

2013 Contracts: $201,435
Oxfam Equitable Food Initiative, $14,200 to develop PRiME features for Equitable Food Initiative's project with the food supply chain.

Red Tomato, $15,235 for the Northeast Eco Apple Project.

Entomological Foundation, $28,000 contract for project coordinator services by Mariel Snyder and bookkeeping and invest fund management services by Kelly Adams and Catherine Harris

Sysco Corporation, ~$10,000 ninth-year renewal for management of the Sysco Sustainable Ag/IPM initiative.

Cavendish, Heinz, Lamb Weston, McCain's, Simplot, ~$34,000 third-year renewal of management of the Potato Sustainability Initiative.

Apple IPM Programs, $30,000 in contracts with Wisconsin and Minnesota apple orchards for pest scouting services.

Green Shield Certified Program, $40,000 in contracts with certification participants in structural pest management industry and facility management.

Agflex, Inc., $30,000 contract for project coordinator services by Jane Petzoldt and bookkeeping and grants management services provided by Kelly Adams and Catherine Harris for the corn producer guarantee project.

Non Funded Proposals Submitted

2014 Unsuccessful Proposals: **$558,345**
North Central IPM Center ($20,000), submitted by IPM Institute for renewal funding to "Increase adoption of IPM in schools in the North Central region."

North Central IPM Center ($20,000), submitted by IPM Institute for renewal funding to "Increase collaboration among NRCS and IPM professionals in the North Central region."

North Central Sustainable Agriculture Research and Education Grant ($198,604), submitted by IPM Institute for "Developing a Systems Approach for Spotted Wing Drosophila for Small and Mid-sized Organic and IPM Growers."

USDA NIFA Agriculture and Food Research Initiative Grant ($50,000), submitted by Northeast IPM Center for "Organic and IPM: Finding Common Ground and Fostering Food Security."

Northeast IPM Center Grant ($25,000), submitted by the Rodale Institute for "Synergizing Organic and IPM with an Organic and IPM Working Group."

Ohio Environmental Education Fund ($1,716), submitted by IPM Institute for "Partnership for Ag Resource Management Working Group."

EPA Great Lakes Restoration Initiative (GLRI) ($243,025), submitted by the IPM Institute for "Demonstrating Strip Tillage Economics and Benefits."

2013 Unsuccessful Proposals: $1,468,716
US EPA STAR Grant ($1,000,000), submitted by IPM Institute for "Healthy School Communities through IPM and Expanded Partnerships: Reducing Pest and Pesticide Risks, Improving Asthma Outcomes and Furthering Environmental Justice."

USDA Conservation Innovation Grant ($468,716), submitted by Red Tomato for "Improving Soil Health and Plant Nutrition, and Enhancing Pollination in Perennial Tree Fruit."

2015 Objectives

1. Work with Whole Foods Market and project partners to pilot and launch desk audits for Responsibly Grown project, including site audits and residue testing programs. Complete program evaluation measures for Responsibly Grown and integrate the new ipmprime.com indices into the custom WFM interface.

2. Launch Sustainable Food Group website, including press release and communications to project collaborators. Complete outreach to prospective clients with a goal of securing new contracts for direct funding of SFG.

3. Scale up water quality efforts in the Western Lake Erie Basin to the entire Great Lakes Basin including expanding and diversifying the advisory board and expanding contact lists of ag retailers. Establish a working group of ag retailers, USDA NRCS officials and Soil and Water Conservation Districts (SWCDs) to improve NRCS conservation program delivery and facilitate communication of shared priorities and opportunities among stakeholders.

4. Scope and develop software interface for the PARM project to receive product and data from ag retailer software and convert into environmentally relevant reporting information for benchmarking water quality efforts.

5. Facilitate successful release of Nutrient Tracking Tool by Heidelberg University's National Center for Water Quality Research in the Sandusky River Watershed through development of training protocols, manuals and model verification worksheets.

6. Work with IPM Symposium coordinator and planning committees to oversee Eighth International IPM Symposium including symposium fund management and administration. Continue communications with potential donors about opportunities to contribute and exhibit in future symposiums.

7. Coordinate the National School IPM Steering Committee to review teaching materials and certification exams with input from project partners and stakeholders to develop, implement and promote a national School IPM certification program.

8. Pursue sustainable funding for ipmprime.com through increased user subscriptions and donations including working with existing partners to meet their requirements for the use of ipmprime.com

9. Develop site-specific pesticide fate and transfer capabilities for ipmprime.com; improve the data uploading features and data export options; develop a "master" account feature and identify next steps for the ipmprime.com project.

10. Continue to recruit and re-certify Green Shield Certified program participants. Focus on program improvements including creation of technician training materials and growth of program through articles in target publications in pest management, facility management and university housing.

11. Work with Extension School IPM partners to re-certify existing IPM STAR participants and recruit new schools to the program.

12. Complete work on currently-funded projects for BMP CHALLENGE.

12 Expand IPM Institute specialty crop program including implementation of scouting, calibration and TSP services to meet needs of participants in Illinois, Iowa, Minnesota and Wisconsin; certification and protocol development for Red Tomato and TruEarth eco-label programs; and Oneida integrated crop management for white corn production.

13. Continue development of the Potato Sustainability Initiative, including verification of potato grower survey responses and introduction of sustainability metrics. Increase outreach to customers and growers to expand the program, including potato markets other than processing.

14. Advance the Sysco Sustainable/IPM program by identifying and addressing opportunities for improvement in water quality and conservation standards, metrics, outcomes and reporting.

15. Work with IPM Voice stakeholders to overcome low levels of science literacy, increase awareness of IPM approaches and benefits, and improve adoption of and public support for IPM by pursuing opportunities to broaden outreach, including an education campaign for the general public.

Appendix A. Staff

Appendix A. Staff

Kelly Adams: May 2008; Financial and grant administration, employee services management, former School IPM Project Coordinator. Kelly has a communications/research background as an Art History major from the University of Wisconsin-Madison. She also attended certificate classes at the Nelson Institute of Environmental Studies, which fueled an interest in sustainable agriculture and environmental health issues, particularly school and community-based projects.

Mark Adelsperger: July 2011; Resource Management Specialist, Great Lakes Protection Fund Project. Mark has a degree in Business Administration from Tiffin University in Tiffin, Ohio and a background in agriculture, sales and customer service. Mark's immersion in agriculture and enjoyment of the rural lifestyle reinforces his viewpoint that farming is an ever evolving way of life.

Thomas Bernard: May 2014; Project Team Member: IPM and Conservation Programs. Thomas received his B.S. in Environmental Studies with a directed study in sustainable horticulture from Northland College in Ashland, Wisconsin. After graduation he guided sea kayakers on Lake Superior, built mountain bike trails in the Chequamegon region, and found his way to a well-known orchard in Bayfield, WI. While serving on the orchard's management team for two seasons, he developed a keen interest in the complexity of tree fruit production and found a source of understanding through the application of IPM technology. He and his partner Anna currently reside in the backwaters of Trempealeau County.

Alisha Bower: October 2014; Project Team Member: IPM Voice and School IPM. Alisha received her B.A. in Political Science and Spanish with a minor in Sustainability from the University of Minnesota. She grew up on a hobby farm in Wisconsin's beautiful Driftless Area and environmentally responsible agriculture has been her passion ever since. Working with several non-profits in sustainable agriculture education led her to continue her own studies around effective non-profit management and food systems policy while working on IPM policy and education communications with the IPM Institute. She is currently pursuing her Masters of International Public Affairs at the La Follette School of Public Affairs at UW Madison.

Zach Bruns: May 2008 – May 2013; Project Assistant, School IPM 2015, general IPM Institute Information Technology work. Zach earned a B.A. in Communications and Rhetoric from the University of Wisconsin-Madison with a background in instructional technology support. He is an active member of Blackhawk Church and participates in the Wisconsin Track Club.

Jill Carlson, M.S.: November 2014**;** Project Coordinator, Great Lakes Basin Projects. Jill grew up in Southeastern Ohio and received a B.S. in Chemistry from Ohio University in addition to

studying Spanish and Environmental Studies. Initially interested in renewable energy systems, but not completely fulfilled in the chemistry lab, Jill moved to Michigan to pursue an interdisciplinary master's degree in Natural Resources and the Environment. While at the University of Michigan, Jill worked on an urban farm, completed the City of Detroit's first greenhouse gas inventory with a team of fellow graduate students, and studied sustainable food, land, and energy systems. In all work, Jill hopes to create more ecologically-sound and just agricultural systems and is very excited to work on the Great Lakes Basin projects promoting nutrient management to protect the region's precious soil and water resources. Outside of work Jill loves cooking, watercolor painting, and soccer.

Emily Ciesielski: July 2013; Assurance Coordinator, Supply Chain Sustainability. Emily received her B.A. in Anthropology/Sociology and Spanish from Kalamazoo College. Her interest in sustainable food systems grew out of a passion for cooking. She pursued her interest in college where she worked at an educational organic garden and conducted outreach work with the migrant farm worker community in Southwest Michigan. Her interest in sustainable agriculture led her the IPM Institute where she currently coordinates verification programs for three projects, including a sustainability rating system for a national food retailer.

Catherine Harris: October 2013; Administrative Assistant, Catherine graduate of the University of Wisconsin Madison with majors in Community and Environmental Sociology and Music Performance, and a certificate in the Nelson Institute's Environmental Studies program. She has a diverse collection of background experiences in arts administration, social entrepreneurship, education and research, all contributing to her enthusiasm for working with nonprofit organizations.

Laura Geller: September 2012 - May 2013; Project Assistant, Sustainable Supply Chain Development. Laura is a recent graduate of Oberlin College, with a degree in Environmental Studies and an emphasis on environmental health. Laura is originally from Ashland, Missouri and has previously worked with the Missouri Department of Natural Resources, USGS Columbia Environmental Research Center and Oberlin College's Environmental Studies Department as a research and teaching assistant. In addition to her work with the IPM Institute, Laura enjoys volunteering with Community GroundWorks and the Troy Kids' Garden.

Samson Gimui, M.S.: September 2012 – February 2014; Software Developer, PRiME. Samson received a B.S. in Computer Science from the University of Wisconsin-Eau Claire, and an M.S. in Information Technology from the University of Central Missouri. His non-technology interests include world geography, history, and cultures.

Ariel Larson, M.S.: November 2013; Project Coordinator: Supply Chain Sustainability. Ariel received her M.S. in Conservation Biology and Sustainable Development from the University of Wisconsin-Madison in December 2013, with a certificate in Business, Environment, and Social

Responsibility. Her research background includes weed management in the establishment of switchgrass. Her interest in sustainable food production and socially responsible business led to her work at IPM Institute, where she will be working to implement a sustainability rating system for a national food retailer and their suppliers.

Matthew Neff: May 2014; Project Coordinator, Green Shield Certified and IPM STAR. Matthew received his B.A. in English Literature from Arizona State University. His background is in writing and rhetoric. Diverse professional experiences led him to the world of animal rescue, which fueled his belief in the power and necessity of organized nonprofit endeavor, particularly in areas of sustainability and ecological management.

Chloe Nelson: September 2014; Project Team Member, NRCS and IPM Working Group, Public/Private Tick IPM Working Group and IPM Symposium. Chloe received her B.A. in Geological Sciences from Carleton College in June 2014. She has a research background in structural geology, geochemistry and hydrology. Working as a cave tour guide, studying permaculture abroad and assisting in research labs have furthered her interests in environmental conservation and led her to the IPM Institute. Her interests include hiking, rock climbing and coaching volleyball.

Matthew Doyle Olson, M.A.: August 2012; Project Manager, Supply Chain Sustainability. Matthew coordinates the development and operation of a sustainability rating system for a national food retail partner, their suppliers and our project team. Before joining the IPM Institute, his interest in food led Matthew to professional experiences milking cows, flipping burgers, administering grants, assisting bakers and analyzing financials. He studied Cognitive and Neuroscience Studies in Minnesota and Human Ecology in Maine, culminating in a thesis on the intersection of food, business and community development.

Jane Petzoldt: July 2013 – January 2015; Project Coordinator, Public/Private Tick IPM Working Group, Organic-IPM Working Group, BMP CHALLENGE®, and Great Lakes Resource Management Initiatives. Jane received her B.A. in Biology and Environmental Studies from Wesleyan University. She has a research background in horticulture and entomology. Her interests include science outreach, environmental remediation, camping, and learning new crafts.

Leigh Presley: January 2010 – June 2013; Project Assistant, Sysco Sustainable Ag/IPM Initiative, McDonald's Potato IPM Project, IPM Voice, IPM Symposium and PRiME. Leigh received a B.S. in Landscape Architecture at the University of Wisconsin-Madison in 2009. Natural resource studies in landscape architecture and a summer internship in a county land and water conservation department piqued her interest in sustainable agriculture and conservation.

Wade Pronschinske: November 2007 – December 2013; Project Manager, PRiME. After working in airborne intelligence for the U.S., Army, Wade earned a B.A. from Northern Illinois University in Philosophy, followed by a M.A. in History and Philosophy of Science from Florida State University. His interest in environmental ethics led him to his current position as a project assistant in 2007, advancing through project coordinator to project manager in December 2009.

Rebecca Ressl, M.S.: November 2010 – November 2013; Project Coordinator, BMP CHALLENGE; Project Assistant, Great Lakes Protection Fund. Rebecca completed her M.S. in Water Resources Management with a certificate in Business, Environment and Social Responsibility from the University of Wisconsin-Madison in 2012. Her interest in sustainable risk management led her to this position working with corn producers to implement conservation measures while optimizing net returns.

Jodi Schmitz: June 2011 – July 2013; Administrative assistant, Green Shield Certified and IPM STAR, School IPM 2015 and IPM Institute Newsletters. Jodi is originally from Helena, Montana and received a B.A. in English Writing from Carroll College. She then went on to complete the publishing program at the University of Denver Publishing Institute. She is passionate about reading, writing, and yoga.

Caitlin Seifert: May 2011 – December 2013; Project Coordinator, Green Shield Certified and IPM STAR. Caitlin has a communications background as a Media Communications major from Webster University and an outreach background as a Madison community organizer. Prior to joining the IPM Institute, she worked in K-12 education for two years which sparked an interest in school IPM.

Patrick Shannon-Hughes: March 2014; Project Coordinator, ipmprime.com. Patrick received his BS in Environmental Sciences, with a focus on sustainable food systems from the University of East Anglia (UK). After graduation Patrick followed his interest in sustainable agriculture by working on organic farms in Argentina and Chile. He then worked in London promoting recycling in low income areas, before moving to Madison with his wife, Breana. Outside of work Patrick's interests include cooking, swimming, geography and football (soccer). Daniel Skolnik: December 2013; Senior Software Engineer. Daniel received a B.S. in Engineering and a Master's degree in Information Technology, both from the University of Wisconsin. Daniel has software development experience working in industry including work at a sub-contractor for NASA and working on vision software for manufacturing and quality control applications. His present focus is primarily on the software that runs the Pesticide Risk Mitigation Engine (PRIME). His interests include biking, cooking, golf and skiing.

Daniel Skolnik: December 2013; Senior Software Engineer, ipmprime.com. Daniel received a B.S. in Engineering and a Master's degree in Information Technology, both from the University

of Wisconsin. Daniel has software development experience working in industry including work at a sub-contractor for NASA and working on vision software for manufacturing and quality control applications. His present focus is primarily on the software that runs the Pesticide Risk Mitigation Engine (PRIME). His interests include biking, cooking, golf and skiing.

Mariel Snyder, M.S.: March 2013- March 2015; Project Assistant, School IPM and Entomological Foundation. After earning her B.S. in Agricultural Communication from the University of Illinois, Mariel spent time interning for various environmental organizations, working on an organic farm, and gaining experience as an administrative assistant. Her love for the outdoors and recreation led her to pursue a Masters degree in Parks and Recreation from Western Illinois University. Mariel's passion for environmental conservation and community development make The IPM Institute a perfect fit. Her interests also include spending time with her dog Ottis and reading.

Peter Werts: May 2009; Project Coordinator, Apple IPM Program, NRCS-IPM Working Group: Growers' Incentives for IPM, Red Tomato Eco Apple Project and NRCS TSP services. Peter has a B.S. in Environmental Studies from Northland College in Ashland Wisconsin. Before coming to the IPM Institute he worked as one of the regional interns with the Wisconsin Eco-Apple project in the Bayfield region. His interest in IPM has been a natural progression building upon his knowledge and skills from his days working on the fruit farms in Bayfield Wisconsin while in college.

Spotted wing drosophila

adding cost to fruit production

By Peter Werts, Specialty Crop IPM Coordinator, and **Thomas Green**, Ph.D., CCA, TSP, and President, IPM Institute of North America

Spotted wing drosophila (SWD), *Drosophila suzukii* (Matsumura), was first detected in California in 2008. The pest continues to catch growers by surprise as it spreads across North America and has now been confirmed in 41 U.S. states (Fig. 1) and seven Canadian provinces (Alberta, British Columbia, New Brunswick, Newfoundland, Nova Scotia, Ontario, and Quebec). In 2008, infestations in California and the Pacific Northwest were estimated to cause $511 million in losses to the blueberry, cane berry, cherry, and strawberry industry.

These softer fruits, including plums, grapes, and figs, are particularly susceptible to egg deposition. Larvae developing in fruit make it unmarketable. Apples, pears, peaches, and nectarines are potentially susceptible but are typically harvested before fruit are soft enough for egg laying. All commercially produced fruits are managed for SWD in such a way to meet a zero tolerance for infested fruit in the fresh market. Management has been a challenge because of difficulties detecting and predicting infestations as well as the very short lifecycle of the pest. Under ideal temperatures, eggs deposited one day can become new adults in as little as 10 days.

"SWD has significantly changed the model of small-fruit production," according to Vaughn Walton, research entomologist at Oregon State University and director of a team of scientists working on SWD. "There are growers now spending $250 to $350 per acre on materials just to manage SWD, and this does not include labor or fuel to make the applications." Growers in eastern states have reported insecticide costs up to $400 per acre.

The affected small-fruit industries in Oregon have an annual farm-gate value of around $200 million. Before SWD, less than $1 million was spent on pest management, primarily on fungicides, but last year, the costs to these industries to manage SWD were estimated to be $15 million.

Key biology

The SWD is native to Southeast Asia, first detected in Japan in 1916, and has been established in Hawaii since the 1980s. SWD surfaced in Spain in 2008 and is now established in many countries in western Europe. Its ability to be transported in infested fruit speeds its spread.

Typically, *Drosophila* species infesting fruit deposit eggs in only overripe or damaged fruit. SWD females however, have a serrated ovipositor (Fig. 2a), allowing them to lay eggs under the skin of ripening fruit. Freshly injured fruit may be marred by oviposition scars, but these are difficult to detect without magnification.

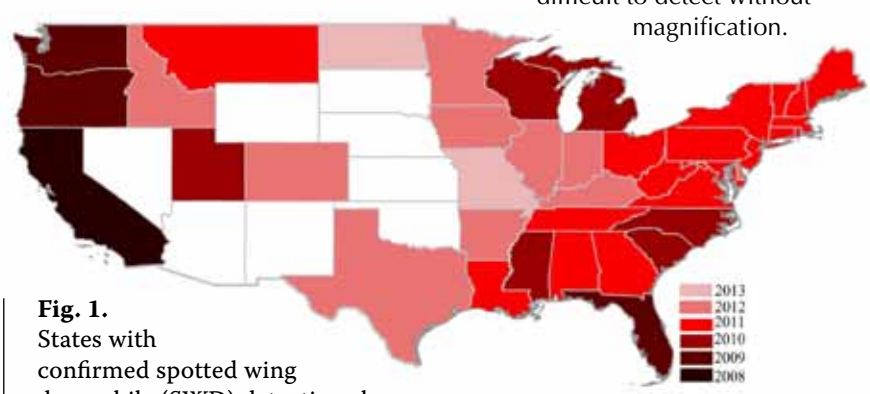


Fig. 1. States with confirmed spotted wing drosophila (SWD) detections by year.
Source: Hannah Burrackand and colleagues.

doi:10.2134/cs2014-47-2-12

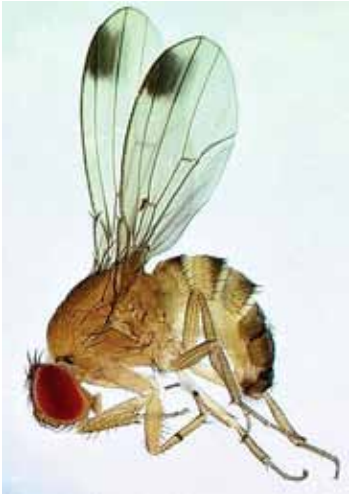


Fig. 2a, left: On female SWD, the serrated ovipositor is a distinctive morphological feature, longer than other Drosophila species and with two rows of serration. Photo by Martin Hauser. **Fig. 2b, center:** Males have distinct dots on tips of wings; females do not. Photo by Gevork Arkelian. **Fig. 2c, right:** Males also have two dark bands on the forelegs. Photo by Martin Hauser.

Rot spots may develop within a day or two as secondary pathogens infect the oviposition site. Fruit begin to collapse as developing larvae feed on the flesh, and fruit typically drop if not harvested.

SWD adults are 2 to 3 mm long. Males have one distinctive spot on the leading edge of each wing (Fig. 2b) and two dark bands on each foreleg (Fig. 2c). Females do not have these characteristics but have the distinctive ovipositor. A 10 to 30x hand lens is sufficient to identify males; females are typically identified using a microscope.

Adults emerge and mate when ambient temperatures are above 50°F, and they survive for 20 to 30 days. Females lay in excess of 350 eggs, which hatch within 12 to 72 hours. Larval feeding lasts five to seven days. Pupation occurs either inside or outside of the fruit. Adults emerge from pupae in 4 to 15 days, for a total egg to adult lifecycle of 10 to 25 days.

SWD overwinter as mature adults and have been found harboring in moss, tree bark, and other protected sites in and around fruit plantings. Peak activity occurs when ambient temperatures are around 68°F; activity drops below 50°F and above 86°F.

Monitoring and management

Key advances have been made in integrated pest management strategies. "We now know that in blueberries and raspberries, the susceptible stage does not begin until the crop starts to ripen. Earlier than that, when there is green or immature fruit, the crop is not susceptible," Walton reports.

If growers have a susceptible crop in an area where SWD is established, they should be monitoring for the pest and be prepared to manage it, according to Hannah Burrack, researcher and coordinator of the eFly Southeast SWD monitoring network at North Carolina State University.

Growers and researchers have been monitoring with traps constructed out of lidded, one-quart clear plastic deli containers with a series of 3/16-inch holes drilled around the outside of the container. These traps are filled with an attractant, fitted with a wire hanger, and suspended in or near the crop. Traps should be located in a shady area under the crop canopy and checked at least weekly. Old attractant should be removed from the field to avoid drawing SWD to the area.

A recent multi-state trial coordinated by Burrack found that a fermented liquid made from a mix of whole-wheat flour, sugar, yeast, and apple cider vinegar was the most attractive; however, sugar, yeast, and water works adequately and improves the clarity of the mixture, making identification of captures

Drosophila trap. Source: Hannah Burrack, North Carolina State University, Bugwood.org.

easier. These traps are not selective for SWD and will catch high numbers of other non-target insects. A synthetic bait is being tested and may be available later this year.

Trapping is not a foolproof monitoring strategy and is inadequate for control. No trap-capture threshold for treatment is available as of yet. "Traps are not always as attractive as the host crop and sometimes fail as an early warning tool," Vaughn admits. Monitoring requires multiple strategies, including evaluating crop susceptibility based on ripening, which will be especially true for late-season crops, where SWD may be present weeks or months before susceptibility.

Mike Biltonen, eastern region operations manager for crop consulting firm Apple Leaf reported, "One of our farms had their first catch in June 2013 but did not have any infestations in fall raspberries until August 1."

A population model under development may provide some guidance going forward. "This fly is producing about 10 generations in the Willamette Valley, Oregon, and maybe more in North Carolina," Vaughn says. In 2013, locations in California, the southeastern U.S., and a few other regions experienced brief summertime population drops due to high temperatures. "The model is showing us that when we have very high temps, we have less pressure due to lower rates of egg laying, even though we have more generations."

Outlook for 2014

This winter has brought unseasonably cold temperatures to many U.S. fruit-growing regions. "If we see an increase in mortality, this may delay infestations in early crops," Burrack suggests. "Since SWD turns a generation in a week to a couple of weeks, by midsummer, any effects of the winter may be less relevant since SWD will have had an opportunity to reproduce."

Due to the unpredictability of populations from one year to the next, and the potential for severe crop damage, consultants are encouraged to stay on top of developments for this pest. Researchers funded by the USDA Specialty Crop Research Initiative and the Southern IPM Center have established a clearinghouse for the latest information at www.spottedwing.org and http://swd.ces.ncsu.edu. The phenology and degree day calculator for spotted wing is available at http://uspest.org/cgi-bin/ddmodel.us?spp=swd. Instructions for trapping can be found at http://ncsmallfruitsipm.blogspot.com/2013/04/spotted-wing-drosophila-monitoring.html and may be updated if the anticipated new commercial lure proves effective.

"SWD is manageable in the short term, through pretty intense use of pesticides," Burrack says. "We don't have examples of growers who have maintained larva-free fruit without pesticides." Effective active ingredients include spinosyns, some neonicotinoids, synthetic pyrethroids, malathion, and carbaryl. Products labeled for SWD can vary by state and crop. Growers who need to treat should review Extension guidelines for labeled products in their state. Due to the number of generations of SWD each year, resistance is a particular concern, and product modes of action should be rotated throughout the season.

Ontario conference

[continued from p. 14]

and worked there for approximately 12 years. He then went on to establish a crop consulting venture for Cargill in 1985, and this program is still running across Ontario and western Canada. He has been responsible for hiring hundreds of university students to work as crop scouts in the crop consulting program.

Pat is currently an independent consultant working with a small group of growers. He also does numerous speaking engagements, writes in a weekly and bi-weekly newsletter for Cargill, puts on dealer training meetings as well as other meetings, has a regular column in *Better Farming* magazine, helps with the demonstrations for the Outdoor Farm Show, and is on the Ontario Soil Fertility Committee. Most recently, Pat was asked to speak in South Africa on behalf of John Deere about soybeans.

Pat is very involved with the CCA program. In fact, he was on the committee that originally introduced the program to Ontario and was part of the initial team that put together the first performance objectives and exam questions. He was also a member of the first group to write the CCA exams. One of his goals was to have the Ontario CCA program run by CCAs, and that led to the majority of seats on the Ontario Board being designated for CCAs elected by their peers. He also advocated for set term limits for board directors and establishing the program as an independent organization with its own executive director. Pat has taken his turn as the CCA chair as well as being on numerous committees within the program. We congratulate him for being selected as the recipient of this year's CCA Award of Excellence.

University and industry scientists weigh in on fungicides for plant health in corn and soybeans

By Peter Werts, Specialty Crop IPM Project Coordinator, and **Thomas Green,** Ph.D., CCA, TSP, and President, IPM Institute of North America

As the last of the corn and soybean harvest leaves the fields, growers and consultants may be wondering if extra dollars spent on fungicides paid off this season. Fungicide applications to corn and soybean have been increasing in recent years as a result of industry marketing and a number of field trials showing plant health and yield benefits.

Especially with higher yields this year putting downward pressure on corn prices, "Producers need to look at their budgets and make sure they are implementing practices that have a consistent return on investment," suggests Bryan Jensen, University of Wisconsin Extension IPM coordinator.

History

Routine fungicide use in corn and soybean is a relatively new trend. In the past, producers typically managed diseases through crop rotation, disease-resistant hybrid selection, optimum planting timing, and post-harvest tillage to hasten decomposition of potentially contaminated plant residue. There was little marketing or research attention given to fungicide use. "In corn, there are a lot of great disease-resistant hybrids, and the joke in the industry is if you have a disease, you chose the wrong hybrid," says Damon Smith, University of Wisconsin field crops pathologist.

This changed when soybean rust, a devastating pathogen caused by the fungus *Phakopsora pachyrhizi*, was first discovered in 2004. Early estimates predicted potential losses of 50% in the Southeast and 10% in the upper Midwest and Canada. Industry ramped up fungicide production to be ready to help growers prevent potentially steep losses.

However, after nine years of living with the threat, economic damage from soybean rust has been largely limited, in part due to the Soybean Rust IpmPIPE. This collaborative effort by USDA, universities, and the soybean industry includes a forecasting system that uses scouting and sentinel plots to alert growers to rust movement northward from overwintering sites in the Deep South. With less-than-expected need for the expanded fungicide inventory, attention turned towards research trials to identify potential uses and benefits.

Claims of improved plant health and higher yields soon followed. Bond McInnes, DuPont's Fungicide Technical Manager reports, "We found that strobilurins have physiological effects. They reduce senescence, and this greening effect increases shoot and root

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growth. The sterol inhibitor fungicide class has not demonstrated the same effect, so we are really just talking about strobilurins." Other claims suggested strobilurins improve efficient use of water and nitrogen, and improve stalk strength, minimizing yield losses at harvest due to lodging.

Disease management challenges have also increased as producers plant more continuous corn in response to higher corn prices. Continuous corn and other practices, including reduced tillage, increase pressure from diseases like gray leaf spot, northern leaf blight, and in soybeans, frogeye leaf spot. Responding with preventative fungicides before a disease is present is a strategy being employed to manage this risk.

Economic thresholds to guide fungicide application decisions are lacking. "If we have an infection on a leaf or pod, there is such a short window to take curative action," McInnes says. "The worst way to control a plant disease is by playing catch-up. It's far better to control a disease at 1% than 20 to 30%."

Industry recommendations to manage disease and increase plant health have included a single application at VT to R3 in corn and R1 to R4 in soybeans. A two-pass recommendation for high disease pressure and high-risk continuous corn includes a fungicide early in the vegetative growth stages and then again during flowering or tasseling. "Early applications protect the leaf tissue, which then protect the developing ear and pod. Plant pathogens can reduce photosynthesis in plants, which will then impact plant growth and yield," McInnes says. The first application can be tank-mixed with herbicides.

Data inconclusive

Some scientists are skeptical of claims that strobilurins enhance plant health. "I don't think industry results are biased, there is just something going on we don't understand," says Paul Vincelli, plant pathologist and Provost's Distinguished Service Professor at the University of Kentucky. "I don't like the uncertainty of not knowing where fungicide applications fit."

Typically, research trials are replicated in many small, randomized blocks to reduce variability in treatment conditions. "When we look at data from small-plot trials, it is clear yield benefits only apply where there is high disease pressure," Vincelli reports.

In 2011, to investigate whether small plot size might be a complicating factor, Vincelli designed a randomized, replicated trial with three very large blocks and controls. The blocks were 120 ft wide and ran the length of the field. Headline, a stobilurin fungicide, was applied at R1-R2 at 6 oz/ac. "I thought I was going to put the nail in this coffin for good," he says.

One trial showed no significant increase in corn yield or stalk health. The other two trials found a 20 and 27 bu yield increase. One of those two also showed a 20% improvement in stalk health. Due to drought conditions, no trials were completed in 2012. Results for 2013 are anticipated soon.

Data from other independent research also suggest fungicides do not consistently increase profits. Iowa State plant pathologist Daren Mueller and his Purdue colleague Kiersten Wise completed a meta-analysis of 39 trials from 2000 to 2010 that examined efficacy of strobilurin and sterol inhibitor fungicides. The strobilurin fungicide applications had a statistically significant effect on yield in only 18 of 39 trials (Wise and Mueller, 2011). A more targeted analysis including only strobilurin fungicides applied between V14 and R5 in corn, and only where foliar diseases were present, showed 80% of 472 treatment comparisons demonstrated a positive yield response.

However, only 48% of these comparisons generated a sufficient yield gain to cover the fungicide costs. Despite this less than 50% chance of return on investment, "There is obviously something going on worth keeping this conversation going," Mueller notes.

Resistance concerns

Pathogen resistance to fungicides weighs heavily on the minds of both industry and university scientists. "We have a lot of great products, and the last thing we want to do is follow the path of glyphosate resistance in weeds," Mueller says.

Rotating fungicide mode of action is a good way to manage resistance. However, "We only have three fungicide groups to work with," Smith reports. "As recently as three years ago, we only had two, the sterol inhibitors and

Photo courtesy of Wikipedia

Kiersten Wise, Purdue University, shows a diseased leaf at the university's Crop Diagnostic and Research Training Center. Photo courtesy of Extension Entomology, Purdue University.

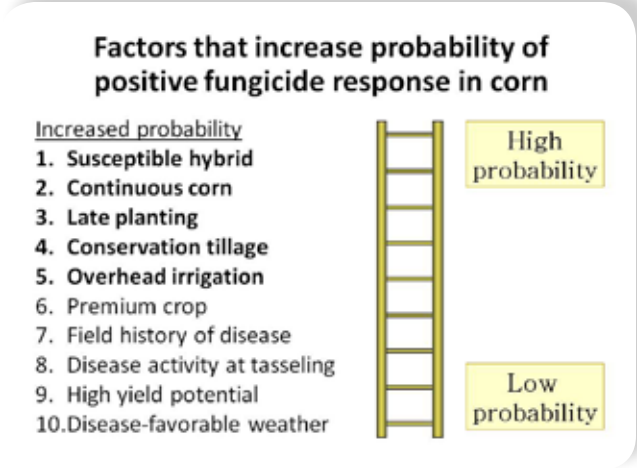

Fig. 1. Hierarchy of risk factors for disease and potential for a positive yield response from fungicide applications to corn. Courtesy Paul Vincelli, University of Kentucky.

strobilurins. Now we have the SDHIs. There is a big push for premixed products, but remember, we only have three groups. If we apply a product that is mixed with multiple modes of action, what do we rotate with?"

McInnes agrees that growers need to be concerned about resistance. "The number one way to reduce resistance is to reduce the number of applications. Most growers traditionally will only make one." If a two-pass system is used, McInnes recommends applying the strobilurin in the first application. "During the second application, a grower could rotate to one of the other fungicide classes."

Are fungicides the right investment for your clients?

"Industry and university pathologists have not identified the best path forward. There is no black and white, it's all gray," Mueller explains. He encourages consultants and growers to scout their fields and to pay attention to what is going on elsewhere. "In 2013, soybean rust was a problem in several southern states. Keeping up on the regional reports and crop susceptibility is critical."

Consultants can also perform a simple assessment to help judge where fungicide applications have the greatest potential to generate a positive return on investment. Planting a susceptible hybrid tops the list for disease risk and potential for return (Fig. 1). Disease-favorable weather is surprisingly not a good predictor.

Jensen recommends reading testimonials and product trial reports with a critical eye. "Ask questions about study design. Was it replicated? Was disease severity evaluated? Was a susceptible hybrid/variety used?"

Consultants might also consider evaluating fungicide recommendations by setting up replicated on-farm trials with clients. Spray four passes and skip two," Vincelli suggests. "Repeat this across the field. With this replication, you can see at harvest if the applications made financial sense."

Learn more about soybean rust at http://sbr.ipmpipe.org/cgi-bin/sbr/public.cgi and managing fungicide resistance at http://ipcm.wisc.edu/download/pubsPM/A3878FungicideResistance.pdf.

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Digital Extra

Visit the Enhanced Digital Version of *Crops & Soils* magazine (at www.agronomy.org/publications/crops-and-soils or via the app) to watch a video of Daren Mueller discussing fungicide resistance for soybean diseases.

Another season of brown marmorated stink bug activity

By **Peter Werts,** Specialty Crop IPM Project Coordinator, and **Thomas Green,** Ph.D., CCA, TSP, and President, IPM Institute of North America

Three years after a population explosion in six Mid-Atlantic states resulted in apple crop losses estimated at $37 million, much has been learned about the brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål). Knowledge has advanced in biology, monitoring, and management, with exciting developments to come.

BMSB is an excellent hitchhiker, readily transported on or in vehicles and shipping containers. Its wide host range includes more than 170 plant species, posing an economic threat to corn, soybeans, grapes, small fruits, vegetables, orchard crops, and ornamentals. As of last December, nuisance reports had been recorded in 18 states and Ontario as bugs entered homes and other structures in the fall to overwinter (Fig. 1). Damage to agricultural crops had been reported in 10 states.

This stink bug is thought to have first arrived in the U.S. from Asia in the mid-1990s. The species was officially confirmed in 2001 in Allentown, PA. Without its complement of natural enemies, populations gradually grew and spread. The unexpected severe crop damage in 2010 was followed by a population crash, possibly encouraged by a period of drought followed by extremely wet weather in the Mid-Atlantic in the fall of that year.

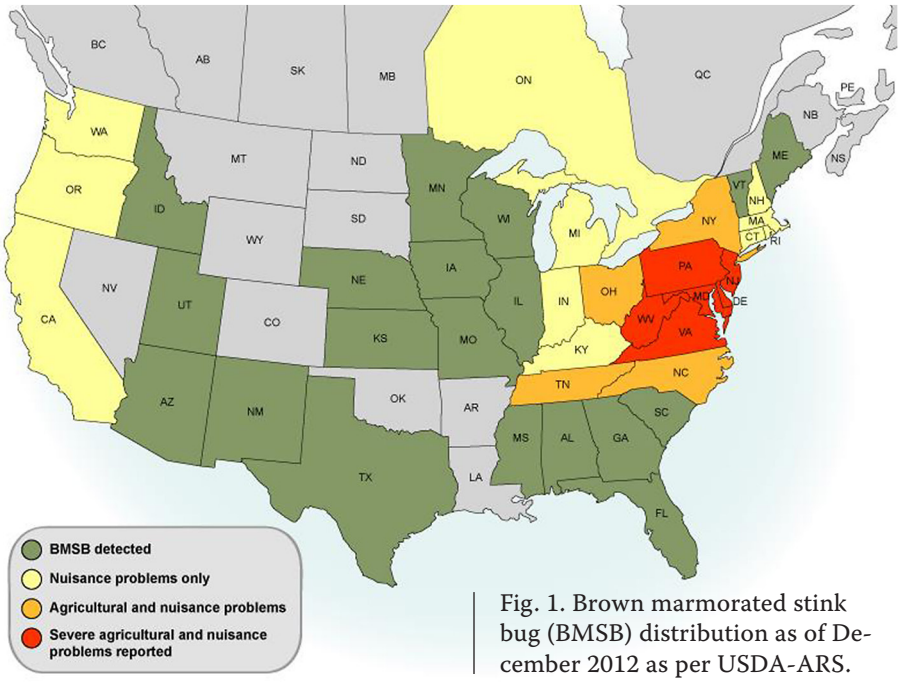

Fig. 1. Brown marmorated stink bug (BMSB) distribution as of December 2012 as per USDA-ARS.

Key biology

Like other stink bugs, this insect feeds by inserting its proboscis into plant parts including buds, leaves, and fruit to withdraw phloem. Feeding typically results in necrotic or corky areas on and/or under the surface of the plant at the feeding site and may also cause "catfacing," or deformed shrunken areas on fruit and vegetables. In apples, necrotic areas from late-season feeding may not be apparent until after fruit is pulled from cold storage. In soybeans, BMSB feed on developing seed, delaying maturity and reducing yield and quality. BMSB feeding on corn kernels results in shriveled kernels.

BMSB overwinter as adults and can often be found on warm days in early spring basking in the sun on exposed surfaces on or near overwintering sites including structures or standing-dead trees. Mating begins about two weeks after emergence.

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Fig. 2. From l to r: second through fifth instar nymphal stages, adult male and adult female. Photos by W. Hershberger (www.stopbmsb.org).

By late summer, multiple overlapping generations are often present.

BMSB adults have a mottled brown "shield" forming the upper surface of its thorax and abdomen (Fig. 2). A foul odor ensues when bugs are startled or crushed. BMSB is sometimes confused with the dusky stink bug, native brown stink bug, green stink bug, rough stink bug, spined soldier bug, western conifer seed bug, or the boxelder bug. It is significantly larger than native stink bugs and is additionally distinguished by rounded shoulders, a brown-grey underbelly, and alternating light and dark bands on the last two antennal segments (Fig. 3). Nymphs have bright coloring and dark red eyes.

Monitoring and management

A team of more than 50 researchers and 10 institutions, led by Dr. Tracy Leskey of USDA-ARS, has been working with more than $12 million in federal and matching funds to develop and deploy monitoring and management strategies for BMSB.

Monitoring is critically important because BMSB is highly mobile and past populations are a very weak predictor of future problems. As a host becomes less suitable, for instance, when corn begins to dry down, BSMB moves to other hosts. In corn and soybeans, BMSB may enter fields in large numbers but concentrate in the outer rows. Within-field populations decline rapidly 30 ft from the field edge. Producers can use this edge effect to their advantage by only applying insecticides on borders. In 2012, producers working with Virginia Tech entomologist Dr.

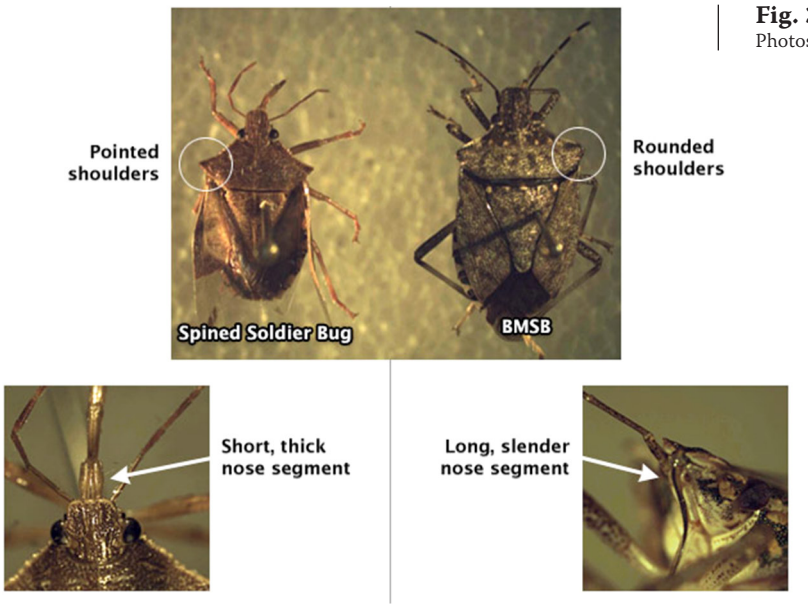


Fig. 3. Identifying characteristics of BMSB adults. Photos by Brent Short, USDA-ARS-AFRS (www.stopbmsb.org).

Ames Herbert successfully managed BMSB by treating only the outer rows in corn and soybean fields. Herbert's research also suggests tree of heaven (*Ailanthus altissima*) adjacent to field crops may be a good indicator of high potential for BMSB movement into those fields.

"Traps are commercially available that are a good early warning system," says Dr. Krawczyk, fruit crop entomologist at Penn State. "They provide enough information to indicate if there is a problem. Unfortunately, the traps are not very effective in the early part of the season. In Pennsylvania, they don't start working until mid-July."

Pesticide efficacy varies widely, even within chemical classes. A lethality index developed by Leskey's lab in Kearneysville, WV identifies dimethoate, malathion, bifentrhin, and endosulfan as some of most effective chemical controls. Azinphos-methyl, beta-cyfluthrin, lambda-cyhalothrin, esfenvalerate, and phosmet are not as effective.

Dinotefuran, sold under the trade names Scorpion and Venom, is available for use under a FIFRA Section 18 emergency approval. The neonicotinoids thiamethoxam and clothianidin offer some efficacy.

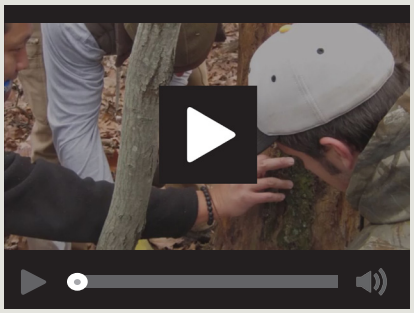
Ongoing research and 2014 outlook

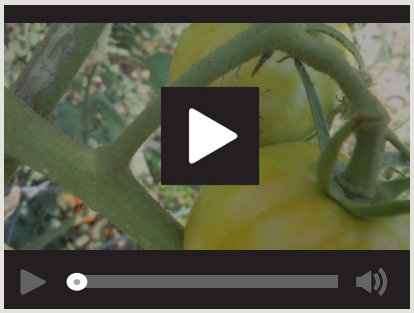
Progress continues to be made, Leskey says. "One of the advances this year is a pheromone-synergist combination that has improved our capacity to detect stink bugs and estimate relative numbers. It also appears we may be closer to a strong stimulus that can attract and aggregate stink bugs. We're conducting trials to test dose response and attracting and aggregating thousands of nymphs and adults. Even nymphs will move 20 meters or more, and if we can attract them, we can kill them."

Due to the unpredictability of populations from one year to the next, and the potential for severe crop damage, consultants are encouraged to stay on top of developments for this pest. A clearinghouse for the latest information on BMSB is available at **www.stopbmsb.org**. For those working in field crops, a webinar by Ames Herbert is available at **www.plantmanagementnetwork.org/edcenter/seminars/soybean/BMSB**.

Digital Extra

Learn more about the brown marmorated stink bug through a series of videos in the new Enhanced Digital Version of *Crops & Soils* magazine (www.agronomy.org/publications/crops-and-soils) on overwintering and spread, monitoring and mapping, and host plants and damage.





Planning options

for managing herbicide resistance

By **Peter Werts**, Specialty Crop IPM Project Coordinator, and **Thomas Green**, Ph.D., CCA, TSP, President, IPM Institute of North America

The March–April *Crops & Soils magazine* feature, "Choosing the Path of Least [Herbicide] Resistance," emphasized that successful management of herbicide-resistant weeds requires an integrated, multi-strategy approach. A variety of tactics are available, including rotating herbicide modes of action, cover crops, tillage, crop rotation, and cleaning equipment when moving from infested to clean fields.

Careful planning is required to make sure the suite of approaches is tailored to the site. Which weeds are present and where? Which scouting techniques will generate the most useful information? Which suppression tactics are effective for each weed? Which approaches are the best fit for the farmer and the time and equipment available? What natural resources are present and need to be considered to minimize impacts?

Collecting all of the appropriate information and assembling a cost-effective plan can be a time-consuming task for any consultant, especially when working with a new client. A USDA-NRCS program provides a new option that is making a difference in Arkansas.

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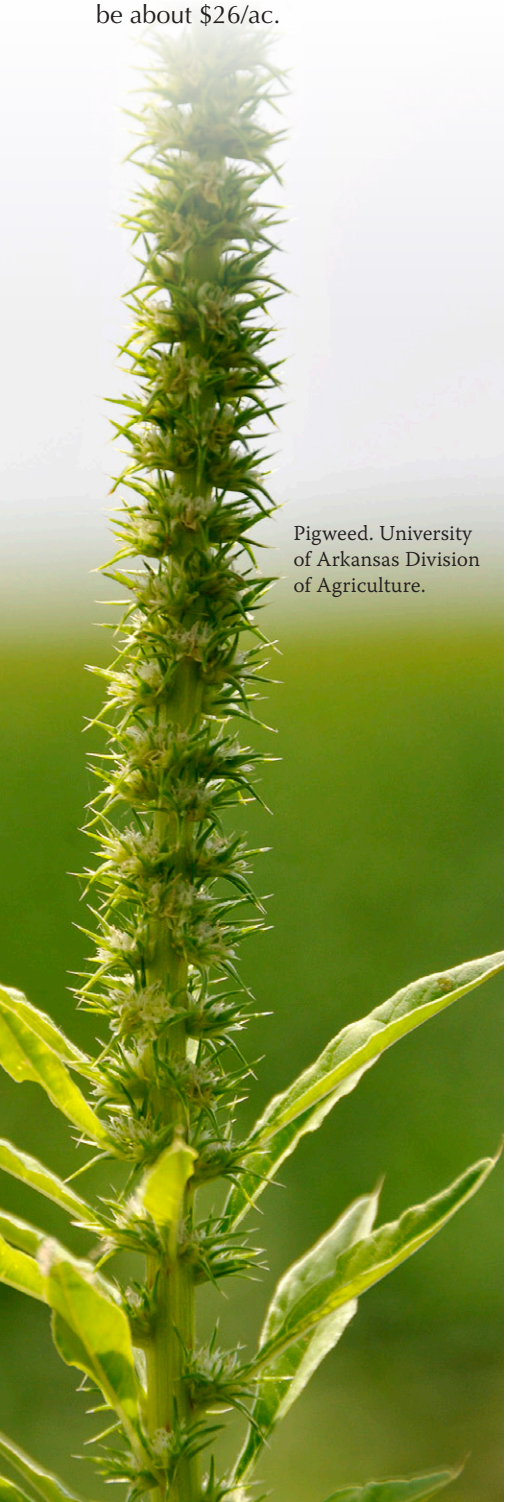
Conservation Activity Plans

"When resistant pigweed first came out a few years back, old mindsets made it difficult to control," reports Arkansas NRCS agronomist John Lee. "We were being reactive in a lot of cases and not proactive. In 2012 when I drove across the state, control looked a lot better." To help make that improvement, Lee reports that NRCS relied on assistance from more than 35 crop advisers who become qualified as NRCS Technical Service Providers (TSPs).

Each TSP worked with farmer clients enrolled in NRCS's Environmental Quality Incentives Program (EQIP) to develop integrated Pest Management (IPM) Herbicide Resistance Weed Conservation Activity Plans (CAPs). These plans comprehensively address resistant-weed management on each farm, and identify and protect natural resources, to successfully solve weed control failures. Each plan includes weed management practices, conservation practices, and guidelines for implementation. NRCS provides financial assistance to help cover the costs of plan development for enrolled farmers.

In fiscal year 2012, Arkansas NRCS awarded 138 Herbicide Resistance Weed CAP contracts to farmers, totaling $182,868 in financial assistance covering more than 100,000 acres. Once a CAP is complete, farmers can apply for additional assistance through EQIP to implement conservation and weed management practices identified in the plan.

Arkansas produces a full range of commodities and is number one in the nation for rice production and 10th in soybeans. Cotton, corn, and wheat are also economically important. Across all commodities, Arkansas has 19 weeds resistant to one or more herbicide modes of action. The additional cost to manage resistant barnyardgrass alone in Arkansas rice has been estimated to be about $26/ac.



Pigweed. University of Arkansas Division of Agriculture.

Recruiting crop advisers

According to Lee, "Arkansas has one of the worst pigweed problems in the country. When NRCS decided we needed to offer CAPs, our first thing we realized is that we have a problem because there was no one who can help get the work done."

Becoming qualified as a TSP can be a lengthy process. Candidates start by obtaining USDA eAuthentication and are required to complete online training modules. They must also meet criteria for experience. A valid CCA credential or a state-issued pesticide applicator or pest control adviser license can serve to meet those criteria. Finally, consultants must demonstrate knowledge and proficiency in IPM and conservation planning by submitting a sample CAP for approval by NRCS.

Recognizing that no consultants had pursued TSP certification for the CAP, John Lee and colleagues investigated the potential to develop an intensive training. The proposal was strongly supported by stakeholders including the Arkansas Association of Conservation Districts (AACD) and the University of Arkansas weed sciences program. Financial support for hotel, food, registration, and materials was provided by BASF, Bayer, Dow, DuPont, MANA, Monsanto, and Valent.

The initial three-day TSP training was expected to attract 20 CCAs working in the state; 51 participants enrolled, including CCAs from several ag retailers. "The training was designed to accomplish, in a very short time frame, what can take weeks or months to complete on your own," wrote Andrew Wargo, AACD board delegate, in a memo summarizing the training.

Not all "graduates" were immediately ready to develop CAPs. "It's a lot to develop an understanding of how to use mapping and GIS to manage fields and become efficient in IPM planning," according to Lee. Subsequent trainings have addressed RUSLE2 and WIN-PST, required software for conservation and IPM planning that helps predict soil and pesticide losses from cropland.

Expanding opportunities for farmers, consultants, and resource protection

"We're hoping as TSPs get new clients, they will get farmers who don't have current access to consultants," Lee says. "These farmers are probably less likely to be having success managing resistant weeds."

NRCS CAP payment rates to participating farmers begin at $1,697 per farm. The average row crop farm in Arkansas is between 700 and 1,400 acres, which qualifies for the maximum payment of $3,393. Higher payments are available for historically underserved or limited-resource farmers.

After this initial round of CAPs training is completed, Lee plans to organize more trainings to encourage crop advisers to become qualified for IPM, nutrient management, irrigation management, and other CAP and EQIP implementation contracts. He looks forward to having a strong network of TSPs offering comprehensive conservation planning services to address needs not only in Arkansas, but also Louisiana, Mississippi, and Tennessee, which face similar resource and management challenges.

With the growing season well on its way, farmers in Arkansas and across the country will be busy fighting resistant weeds. Learn more about your client's opportunities with NRCS, and consider becoming a TSP to provide the necessary technical services. Information on becoming a TSP is available on the USDA's TSP Registry at http://techreg.usda.gov. Each state NRCS office also has a TSP coordinator who can help. For a directory of coordinators, visit http://techreg.sc.egov.usda.gov/CustLocateTSP.aspx. &

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Airblast sprayer calibration:

Opportunities to improve performance and save money

By Peter Werts, Specialty Crop IPM Project Coordinator, IPM Institute of North America, Madison, WI; and **Thomas Green**, Ph.D., CCA, TSP, and President, IPM Institute of North America, Madison, WI

Is sprayer calibration on the top of the "to do list" for your clients next spring? Proper calibration verifies that materials are applied at the intended rate. Too little could result in a crop failure, and too much could exceed legal rates and waste valuable dollars.

Dr. Andrew Landers, a world leader in pesticide application technology, has demonstrated that 10–15% of spray material is routinely lost to drift and 40–60% to the ground during early-season applications (Hutton-Squire, 2010). These inefficiencies cost growers thousands of dollars each year and increase risks to human and environmental health.

For example, based on current prices for a commonly used fungicide tank mix, a grower can expect to spend $45/ac at recommended label rates. Sprays where an insecticide, fungicide, and foliar nutrients are included could cost upwards of $100/ac. Using an average $70/ac cost, a 10% improvement in sprayer performance on a 20-ac orchard would generate $140 in savings per spray. A 30% improvement would potentially save $420 per application in the same 20-ac orchard.

During visits with apple producers in Minnesota and Wisconsin this year, we emphasized that Extension and manufacturer-recommended calibration procedures are essential to the success of integrated pest management (IPM) programs. Grower reactions were varied. Most were skeptical. One grower suggested that if we know exact measurements of the orchard and the volume of water in the tank, it should be more than adequate to calibrate by observing how many acres it takes to empty the tank. Another indicated the sprayer was brand new and delivered ready to go, even though the dealer never inquired about the orchard's row spacing or tractor forward speed—essential for calibrating an airblast sprayer (Hamilton, 2012).

When we calibrate, the goal is to optimize performance and prevent equipment failure. Are nozzles worn, increasing orifice size and application rate? Are other mechanical problems present? This season, we calibrated air-blast sprayers for 11 tree fruit producers in Minnesota and Wisconsin with funding from the USEPA Strategic Agricultural Initiative. Results suggest that growers generally do not know proper calibration methods and do not routinely evaluate sprayer performance. The USDA-NRCS recommends that application rates should be within 5% accuracy (USDA-NRCS, 2006). Ninety-six percent of the application scenarios we calibrated were outside of this range.

Airblast sprayers are the industry standard for applying crop protection materials in citrus groves, orchards, tree nuts, and vineyards. These axial-fan-driven sprayers deliver materials to the target by displacing air and creating turbulence in the canopy. This design has changed little since it was patented by George Daugherty in 1949 (Fox et al., 2008). Sixty-three years later, 95% of the industry is still using Daugherty's basic airblast sprayer design (USDA, 2010).

Effective Vineyard Spraying: A Practical Guide for Growers (Landers, 2010) provides an excellent step-by-step approach to calibrating airblast and boom sprayers and outlines strategies to minimize drift and improve pesticide deposition. Here we summarize key information consultants can share with clients.

First, determine the make and model of all of the pesticide application equipment that will be used, and collect the manufacturer recommendations for maintenance and calibration. Review the instructions, and ensure they are

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followed, including recommended intervals for inspection, maintenance, and replacement of key parts.

Second, address three key questions:

1. **What's your speed?** Tractor forward speed impacts the application rate and the volume applied per acre and should be calibrated prior to first use each season. We found actual travel speeds were off by two- to three-tenths of a mile per hour, resulting in sprayer output differences of about 5%, risking exceeding USDA-NRCS standards for accuracy.

Applicators relying on charts that estimate travel speed based on gear setting and tachometer reading need to make ground speed calibration a top priority. Tractors equipped with speedometers also need calibration. When calibrating speed, it is important to accurately measure the distance and not to rely on pacing. A tape measure or a measuring wheel is the right tool for this job (Landers, 2010).

2. **What's your nozzle size?** Nozzles determine the droplet size and spray pattern. Droplets that are too large will not stick to the foliage; droplets that are too small are prone to drift. The ideal droplet size depends on the target. Airblast sprayers applying materials for insects and diseases on foliage should use fine (183–280 μ) or medium (281–429 μ) textured sprays (Landers, 2010).

Applicators can influence how much spray is directed to different parts of the canopy by adjusting nozzle orientation and varying the gallon-per-minute (GPM) nozzle flow rate. For example, nozzles on the bottom and very top of the boom can be set for lower GPM than nozzles in the middle of the array.

Spray material and tank sediments can accelerate nozzle wear and even plug nozzles. All nozzles—ceramic, brass, aluminum, stainless steel, and plastic—will wear over time, thereby changing the application rate. GPM for each sprayer nozzle should be measured at least once per season, including new nozzles. Any that deviate 10% or more from manufacturer specifications should be replaced and recalibrated immediately (Landers, 2010).

3. **What's your pressure?** We frequently encountered broken or missing pressure gauges. These are prone to corrosion from exposure to agrichemicals and damage from improper storage. Maintaining the right pressure influences droplet size. Higher pressure creates a finer droplet; as pressure decreases, droplet size increases. Pressure also impacts the rate of nozzle wear; set pressure within the recommended range for the nozzle. Pressure can also influence GPM; a fourfold increase in pressure doubles nozzle output (Landers, 2010).

Row spacing

The area covered with a sprayer is measured in linear acres traveled, not the square acres of the planting. To accurately determine area covered, tree-row spacing must be considered. Many orchards and vineyards have transitioned to high-density plantings, and many have a variety of row widths on the farm. Applicators need to be aware that as they travel between plantings, application rate changes as row spacing changes unless they adjust travel speed and/or GPM.

Minimizing drift and improving spray deposition

Crop protection materials are applied to prevent crop loss from pests. If materials do not reach their target, what purpose has the application served? Assessing the quality of coverage with water or oil-sensitive cards, ultraviolet dyes, or kaolin clay allows an applicator to determine if the material is reaching the target and if the droplet size is adequate. Droplet sizing charts and instructions are included with water-sensitive paper designed for spray coverage assessments. Digital imaging software is also available for more precise measurement.

This AgTech sprayer is equipped with a Raven spray control system to maintain application rates in the uneven orchard topography of Wisconsin's Driftless region. Peter Werts/IPM Institute of North America, Inc.

Taking the technology to the next level

Complete spray control systems that maintain a constant application rate regardless of changes in speed,

[continued on p. 29]

Airblast sprayer calibration

[continued from p. 23]

terrain, or boom sections in operation are available to retrofit existing equipment for as little as $1,650. Tower booms and airflow regulators are also available with new equipment and as retrofits. Michigan State University researchers report tower sprayers have lower operating costs over conventional airblast sprayers (Swinton et al., 1997). Cornell University research indicates airflow modifications can improve pesticide deposition by 30% (Landers, 2012). Finally, Smart Spray technology relies on ultrasonic sensors to regulate pesticide delivery based on tree size and canopy shape and can turn off nozzles where gaps in tree rows are present.

Training

Are you confident in your abilities to help your clients ensure accurate application rates with all of their equipment? If not, seek professional training. In our case, Peter Werts was trained by Landers in a small-group workshop, organized and hosted by Regina Hirsch of the Center for Integrated Agricultural Systems at the University of Wisconsin. This training was critical to open our eyes to the opportunities for improving and developing the skills necessary to effectively deliver this service to our clients. On average, our 11 sprayers were overapplying water and pesticide by 52%. Correcting these errors was a remarkable return on our investment in training and time on this project and a great service to our clients. We plan to expand the project this coming year.

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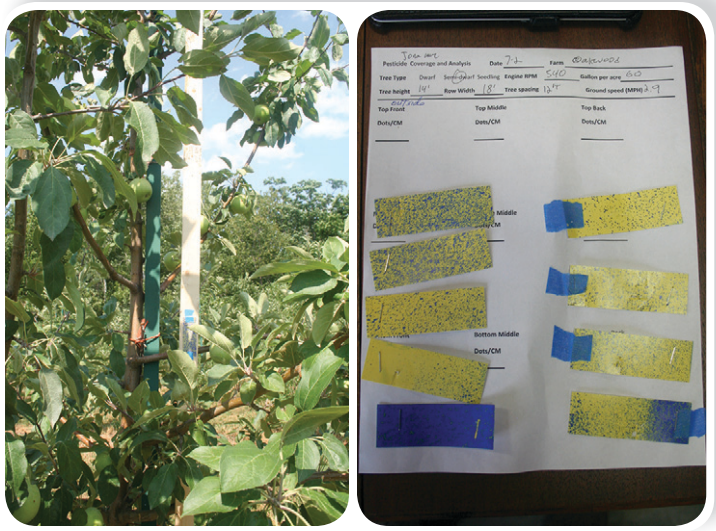
Calibration resources

Calibration worksheet: http://extension.psu.edu/fruit-production/files/air-blast-sprayer-worksheet/view

Pre-calibration instructions: http://extension.psu.edu/fruit-production/files/sprayer-calibration-instructions/view

Water-sensitive paper for monitoring spray distribution: www.qinstruments.com/uploads/media/wsp_use-it-in-agriculture.pdf



Left: Water and oil-sensitive paper was hung in this high-density planting by dividing the canopy into nine zones and using furring strips to locate the paper in through the canopy. **Right:** Overspray is observed where water-sensitive paper turned completely blue and can result in pesticide sheeting off the leaf surface. Peter Werts/IPM Institute of North America, Inc.

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