

## 2018-2019 PROGRAM SUMMARY

### Penn State Extension Tree Fruit Team

#### Major Team Impacts and Outcomes

##### Trainings and Outreach Summary

The tree fruit team conducts detailed surveys and evaluations during the winter conference season. In the areas of disease management, pest management, and physiological control, 96% of 227 respondents found Extension programming and products to be effective and profitable (averaged across the three disciplines). When asked to estimate profits or losses based on recommendations supplied by tree fruit team researchers and educators, respondents reported a \$151 per acre median increase in profitability. Prior surveys conducted by Extension and the Pennsylvania Department of Agriculture, and the mean value obtained by the 2019 survey, estimate 22,000 acres currently under cultivation in tree fruit. Taken together, this represents a median increase in profitability of \$3.3M across the entire state due to Extension programming.

Extension programming and products originating from the tree fruit team include just some of the following things. Nine full-day winter commercial tree fruit schools consisting of six or more talks by a minimum of three tree fruit team researchers, one educator, and at least one representative from Pesticide Education, offered in nine regions throughout the state. These meetings provided the tree fruit industry with guidance and training in the latest orchard management practices and research. Additional team programming includes: nine spring orchard meetings (“twilight meetings”) hosted at eight orchards in Pennsylvania and one in Maryland as a collaborative effort with University of Maryland Extension (featuring the same suite of speakers as the winter fruit schools); one spring orchard meeting dedicated to the underserved plain community; eight videos on cider and innovations in the fruit industry in English and one in Spanish on bioremediation; twelve print and electronic monthly releases of the *Fruit Times* newsletter (electronic circulation: 3,040 individuals, print 435 individuals); 25 seasonal alerts detailing timely disease, pest, and weather issues; 45 new or updated website articles listed below in the references section; and, 68 pesticide credits available to Pennsylvania growers.

Pennsylvanians availed themselves of Extension resources in 2018-2019. Over 2,194 people participated in tree fruit industry-related workshops (1,254), conferences (847), and webinars (93). These numbers do not reflect the activity of members of the plain community who eschew registrations and surveys. Indeed, of the 3,814 contacts reported by the team, some must be associated with plain community involvement in public workshops and conferences. Reviewing the 34 participant activities documented in Salesforce, the most popular were the Mid-Atlantic Fruit & Vegetable Convention (810 participants) and the Adams and Franklin Counties’ winter commercial tree fruit schools (320). This number demonstrates the significance of the Adams/Franklin areas of the Pennsylvania fruit belt: the next highest fruit school attendance was 82 individuals.

Seventy-nine articles, “Learn Now” videos, and news items attributed to the tree fruit team were released on extension.psu.edu between October 1, 2018, and September 30, 2019. Many of these articles were written as part of our monthly newsletter *Fruit Times*. During that time span, these resources were accessed a minimum of 34,328 times. Ironically, the top two most-requested documents have little to do with tree fruit; rather, they are articles by tree fruit team entomologist David Biddinger, et al., concerning spotted lanternfly. Rounding out the top five are articles about blossom thinning, drip irrigation, and the disease Marssonina blotch. The top four countries accessing tree fruit media outside the United States are India, Canada, the United Kingdom, and Australia. A total of 158 different mappable localities accessed this information, though it is impossible to

determine given the tools available how this information was used, or how many of those hits were due to indexing spiders.

## **Team Goal 1: Advanced Integrated Pest and Cultural Management**

### **Entomology**

**Evaluation of Extension Programs:** Surveys conducted at the winter commercial tree fruit schools revealed that 97% of respondents (223 total) have found Extension workshops, newsletters, and alerts to be an effective means of receiving profitable information regarding integrated pest management (IPM) programs. The median savings achieved state-wide in response to following recommendations provided by Extension entomologists was reported as \$37.50 per acre (172 respondents). Using the estimate of 22,000 acres currently under cultivation in tree fruit, this represents a savings of \$825,000 statewide for the industry due.

**Native Pollinators and Tree Fruit Production (Biddinger, López-Uribe):** Research on the effectiveness of native pollinators among apple tree blossoms suggests that reliance on native pollinators and the corresponding reduction of hive rentals could save growers up to \$4.4M throughout Pennsylvania. At a recommended rate of two hives per acre, the estimated 22,000 acres currently under production would require 44,000 hives. Hive rentals range from \$65 to \$100 per colony depending upon source and location. If growers relied on native pollinators instead, growers statewide would save an estimated \$2.86M - \$4.4M per season.

**Spotted Lanternfly Outreach (Seifrit, Biddinger, Krawczyk):** Extension Educator Don Seifrit directly interacted with 795 adults and children to discuss Spotted lanternfly control measures, especially tree banding, and had indirect contact with 3253 individuals through video views on YouTube. Most of the in-person contacts were with students at the Wilson West Middle School, part of the Wilson School District in Berks County.

**Spotted Lanternfly Management Through Tree Banding (Seifrit, Biddinger, Krawczyk):** Mr. Seifrit encourages homeowners to use tree banding as a means to decrease homeowner pesticide use. Commercial application of pesticides runs between \$45/hour (including general landscaping services) to \$500+/year (dedicated pesticide control) in Berks County. Banding is not intended to eliminate the use of insecticides and should be utilized as one facet of a complete integrated pest management approach. However, if used alone and by just 10% of the individuals described above, it would save Pennsylvanians between \$202,500 and \$510,300. These numbers were calculated assuming the elimination of \$500 per year of dedicated pest control services ( $\$500 \times 405$  individuals) and the elimination of one hour per week of pesticide-based control at a per hour rate of \$45 during the months of SLF activity (May-October) ( $\$45 \times 405$  individuals  $\times$  28 weeks).

**Spotted Lanternfly (SLF) Management (Biddinger):** Thirty-five different pesticides were tested for residual activity on spotted lanternfly on grape and peach within the quarantine zone at the PSU Berks campus. This research resulted in the first recommendations for control in both crops. The data was used for a dozen 2(e) label amendments to include SLF on the label by several companies.

**Spotted Lanternfly Control on Black Walnuts (Biddinger):** Collaboration with the PDA, EPA, and USDA Office of Pest Management Policy (OPMP) resulted in a ruling that black walnuts were considered to be shade trees and not nut trees. With this ruling, it is not possible to treat an SLF infestation using any products labeled for shade trees. As black walnuts have been shown to be a favored host by SLF, this provides another avenue towards control and eradication of this invasive pest.

**Alternative Methods to Monitor and Manage Insect Pests (Krawczyk):** Applied research and extension programs in entomology concentrated on the development and validation of alternative management methods of insect pests affecting fruit. One of the main projects included evaluations of long-lasting insecticide treated nets to manage brown marmorated stink bug (BMSB) and spotted

lanternfly (SLF) in fruit systems. By deploying nets baited with BMSB attractant around orchards, growers should be able to reduce or even eliminate insecticide applications targeting this pest. The same net as deployed against BMSB is also effective in killing SLF. However, the current lack of an effective SLF attractant makes this method less useful for this pest. These alternative pest management methods were presented at various regional, national and international research conferences. Activities under the USAID REAP Program in the Republic of Georgia resulted in the development of a national BMSB management program in the Republic of Georgia, which is generally based on the alternative management of BMSB. Additional collaboration has occurred with researchers from Croatia, Italy, Spain, Australia and New Zealand.

This work is supported by the USDA National Institute of Food and Agriculture and Smith-Lever Appropriations. An additional eight active grant sources provide support for this research – including funding from the USDA ARS – and two additional proposals are pending for future funding. During the 2018-2019 season Dr. Krawczyk had the opportunity to employ and support seven undergraduate students (interns and summer assistants), two technicians and two part time employees.

**Tortricid Apple Pest Flight Monitoring (Biddinger):** Thirty-six years of tortricid apple pest flight monitoring records was analyzed, looking at the effects of global warming in one of the longest studies on insect pests. Tortricids (which include the apple leafrollers) are serious pests of tree fruit crops. Spring temperatures were found to be the most significant climate variables in determining the timing of the spring flights. These findings suggest that the inclusion of large-scale climate oscillations can provide important insights into how climate conditions can influence insect phenology. This research will enable the development of models to predict spring emergence, allowing growers to fine-tune their management programs.

## **Plant Pathology**

**Evaluation of Extension Programs:** Surveys conducted at the winter commercial tree fruit schools revealed that 98% of respondents (228 total) found Extension workshops, newsletters, and alerts to be an effective means of receiving profitable information regarding disease management. The median savings achieved state-wide in response to following recommendations provided by Extension pathologists was \$75.50 per acre (177 respondents). Using 22,000 acres as the baseline acreage under cultivation, this represents a savings of \$825,000 statewide for the industry.

**New Fungicides for Pennsylvania Growers (Peter):** Fungal diseases are endemic in Pennsylvania orchards. Cultural controls, such as eliminating leaf litter on the orchard floor in the winter to reduce the initial spread of scab inoculum in the spring, are insufficient to completely control fungal diseases. Chemical control is part of a robust Integrated Pest Management toolbox, and all growers need to use some form of chemical control in Pennsylvania to produce quality produce, including organic growers. Dr. Kari Peter completed an evaluation of three new fungicides and found them to be effective at controlling scab, powdery mildew, and rust. These three products have two different fungicide resistance action committee (FRAC) codes: Cevya® (FRAC group 3), Excalia™ (FRAC group 7), and Miravis® (FRAC group 7). Use of these products as part of a responsible pest management program – as described in the forthcoming *2020-2021 Penn State Tree Fruit Production Guide* – will help growers reduce the deleterious effects of these pathogens without triggering an increase in fungicide resistance.

**Pre-Plant Bioremediation in Commercial-Scale Demonstration Plots (Baugher, Seifrit, Chawner):** Pre-plant bio-remediation practices were evaluated in model apple plots supported by a USDA NIFA Beginning Farmer and Rancher Development Program grant and a PDA Specialty Crop Block grant. Dagger nematodes were decreased to the zero-tolerance level, and several soil health indicators were improved. Tree growth and fruit yield were also higher than in control plots.

Plant parasitic nematodes transmit viruses, such as tomato ringspot virus that causes decline of apple trees. Nematodes were sampled before and after the cover crops were incorporated. After two seasons of cover cropping the apple model plot sites, populations of parasitic nematodes across all sites were zero. Several nematodes that feed on roots, resulting in stunted tree growth, were also reduced to zero. During the final sampling, two replant sites adjacent to two plot sites that remained fallow were also sampled for nematodes. These adjacent fields each contained high numbers of dagger nematodes, the principle vector for fruit tree viruses. The reduction in need for pre-plant nematicide applications represents an economic savings of \$1,000 to \$2,000 per acre. The environmental impact quotient (EIQ), a formula created to provide growers with data regarding the environmental and health impacts of their pesticide options, for a nematicide is over 78, which is two to three times higher than most pesticides. Nearly 100,000 acres of apple and peach are grown in the Northeast. Producers replant approximately 3% of their acreage each year. If the recommendations developed through this research were applied on 1% of acreage, the cost savings would be a minimum of \$1,000,000. This does not account for the environmental and health benefits of reducing chemical applications.

A healthy orchard soil needs to have good soil tilth, soil depth, and water holding capacity, while providing adequate drainage. Since soil health indicators improve slowly following bioremediation, we assessed soil health following each rotation and for two seasons following tree planting. Soil organic matter improved in all sites by the year following planting. Other soil health indicators that improved at all sites were surface hardness, subsurface hardness, and pH, while water capacity, aggregate stability, soil protein index, and respiration fluctuated from year to year, even though we collected samples during the same timeframe each season (early June). Overall soil health score improved from sub-optimal to excellent or from excellent to optimal. The average biomass added to each model plot, based on weights of 5-subplot samples, was 15,600 lbs per acre.

Prior research on soil health in orchards indicates two of the best indicators of improved soil health are early tree growth and yield. Comparisons of the model plot trees that received bioremediation and control trees that were planted the spring following orchard removal showed that tree height, trunk diameter, yield, and crop load (yield/trunk cross-sectional area) were significantly greater as a result of bioremediation. Yield in the second leaf increased by 34%, an approximate average increase in net return of \$2000 per acre. Partial budget analyses indicated the cost of rotation crop establishment was \$338 per acre. A 20 lb nitrogen credit was earned for each 1% increase in organic matter over 2%. Data tables and additional information are available at <https://extension.psu.edu/models-for-the-future-apple-plots-benefits-of-pre-plant-bio-remediation>.

Penn State Extension “Learn Now” videos about this process are available in Spanish and English:

<https://extension.psu.edu/preparacion-del-sitio-del-huerto-bio-renovacion> and

<https://extension.psu.edu/orchard-site-preparation-bio-renovation>.

This work was supported by the USDA National Institute of Food and Agriculture and Smith-Lever Appropriations.

## **Horticulture**

**Evaluation of Extension Programs:** Surveys conducted at the Winter commercial tree fruit schools revealed that 92% of respondents (219 total) found Extension workshops, newsletters, and alerts to be an effective means of receiving profitable information regarding physiological and horticultural orchard practices. The mean savings achieved state-wide in response to following recommendations provided by the pomologists and physiologists was reported as \$37.50 per acre (165 respondents). Using 22,000 acres as the baseline acreage under cultivation, this represents a savings of \$1.65M statewide for the industry due to recommendations made by Extension pomologists and horticulturists.

**Exploring High Density Pear Systems (Seifrit, Schupp):** SHAP awarded Extension \$3,500 to organize three workshops on the topic of high-density pear systems. Pear production for fresh eating in Pennsylvania is slightly more than 0.7% of apple production for the fresh market (1,970 tons of pears to 264,000 tons of apples in 2017), according to the Pennsylvania Department of Agriculture. Despite having a nearly ideal climate for growing pears, Pennsylvania growers are regularly frustrated by disease problems (primarily fire blight and pear scab) and a lack of dwarfing rootstocks comparable to what is available for apples. Breeding efforts have produced varieties currently undergoing trials that are much more resistant to disease while retaining (or exceeding) the flavor and storage characteristics of the industry standard 'Bartlett'. And while true dwarfing rootstocks have yet to be developed, pruning and training techniques suggest that pears could successfully be grown using trellised systems, increasing production levels and reducing the cost of harvest. These developments have attracted grower interest, suggesting that pears could once again be a viable commodity for Pennsylvania growers.

Two of the three pear workshops were conducted in the summer of 2019, with the third to be conducted in November 2019. The purpose of these production tours is to show trellised pear trees currently being grown in commercial orchards and at the Penn State Fruit Research and Extension Center at different stages of development. The first was held in late May, once fruit thinning was complete, at Kauffman's Fruit Farm in Ronks, Pennsylvania. This workshop attracted twenty-three growers, twelve of them from the plain communities in the Lancaster area. Dr. Jim Schupp discussed training principles and crop load management. The second workshop was held at Frecon Orchards in Boyertown, Pennsylvania, in late July. This meeting attracted seventeen growers, including representatives from the Rodale Institute, and some members of the plain community who had attended the first tour. Designed to coincide with harvest, Dr. Schupp discussed new pear varieties and their characteristics, and highlighted the different production methods employed at Frecon's as compared to Kauffman's. Feedback from those attending the workshop indicates that there is significant interest in the topic, and that growers may consider diversifying their operations by adding some pear blocks in the near future.

### **Pesticide Safety**

**Pesticide / Spray Tracking Workbook (Winzeler, Weber):** The Penn State pesticide and spray tracking workbook experienced a major update to two of its primary databases and included the addition of a simpler interface for making entries. This represents an increase of 34 products for apples (total of 555 spray compounds listed) and a decrease of 17 products for peaches (total of 454 listed). The updating of these listings ensures growers have a current database of registered products for our two major tree fruit crops, eliminates the suggestion that de-listed or unregistered products are safe to use, and assists growers with federal and regional regulations. The updates for pears and cherries is approximately 50% completed at the time of this writing and will be released in the spring of 2020.

**Pesticide Calibration Service (Weber, Seifrit):** In cooperation with the Pesticide Education group, a second airblast sprayer calibration system is now housed at the Fruit Research and Extension Center in Biglerville. This provides growers in the primary fruit belt with more convenient access to calibration services. A properly calibrated sprayer helps to prevent over-applications of chemical compounds, saving the growers money and reducing off-target effects of pesticides in the environment and watershed. In the initial six months of offering the service, seven area orchards took advantage of the service resulting in the calibration of nine different airblast sprayers. The program is expanding in the future to include limited servicing of the equipment and pH testing of water supplies, a practice emphasized in the forthcoming *2020-2021 Penn State Tree Fruit Production Guide*.

## **Team Goal 2: Precision, Automated, and Labor-saving Technologies**

### **Engineering**

**Precision Irrigation Systems (He, Weber):** Building upon prior research sponsored by SHAP, four Adams County orchards are participating in a trial of soil moisture sensing equipment in their production blocks. Data collected by these sensors representing real-time soil moisture conditions may be observed by the growers online as it is acquired. Growers are free to use this information to determine the most appropriate time to manually operate existing irrigation machinery, though most are simply observing the data and correlating it with their traditional method of gauging irrigation needs. In the next phase of this research, slated for the 2020-2021 growing seasons, these sensors will be connected to irrigation hardware, allowing custom software to automatically control irrigation.

**Intelligent Spraying Systems (He, Weber, Peter, Krawczyk):** In collaboration with USDA/ARS research scientist Dr. Heping Zhu, Extension offered a one-day workshop on the latest developments in intelligent spraying systems technology. Dr. Zhu provided a demonstration of his laser-guided intelligent spraying system for an audience of 25 growers, chemical company representatives, engineers, and the press. Dr. He provided an update on the latest available chemical application technologies. A discussion of the challenges of per-plant-based spraying was held, with Dr. Peter and Dr. Krawczyk offering insight into techniques for estimating spray coverage in terms of traditional airblast spraying technology. Intelligent spraying technologies have been demonstrated to reduce chemical consumption by over 50%, reduce drift by as much as 87%, and reduce losses due to ground misapplications of up to 90%. These reductions will not only save producers of tree fruit money, they will also reduce the amount of pesticides affecting non-target organisms and the environment.

## **Team Goal 3: Support for New, Young, Minority, and Underserved Growers and Communities:**

**Mid-Atlantic Fruit and Vegetable Convention Session in Spanish (Baugher, Gorgo, Seifrit):** Over the past decade, the Mid-Atlantic Fruit and Vegetable Convention (MAFVC) has developed a strong program track for Spanish-speaking individuals working in horticulture. Supported by a PDA block grant, the 2019 day-long workshop featured training on a variety of horticulture-related subjects taught entirely in Spanish. Topics included soil testing and fertilization; avoiding contamination of food sources; invasive and problematic insects and diseases, their identification, and their management; native pollinators; pesticide safety and worker protection; and the pruning of peach trees.

Post-program evaluation provided valuable information about the demographics of the group and revealed information about learning preferences which will help Extension develop more suitable programming in the future.

Of the 32 participants who participated in the post-program survey for the 2019 Spanish session during the Mid-Atlantic Fruit and Vegetable Convention, 29 were male, two female, and one had no response. Ages ranged from 28 to 55 years old with the average being 39 years old. On average their reported length of stay in these U.S. states is thirteen years with some only having been here for two years and others for 33 years. Previous attendance ranged from one to ten times. Organizers are aware that at least seven people have attended every year since the session was first offered ten years ago. Thirty consider themselves farmworkers with two individuals considering themselves both farmworkers and farmers. Participants responded that the farm or a workplace is their preferred location for learning new abilities, with specific events being their next favorite. A workshop (hands-on) or class (listening) are their two preferred ways of learning. When it comes to obtaining information, participants prefer word of mouth the most.

Attendees repeatedly expressed gratitude at having educational opportunities made available to them in Spanish, and in a welcoming environment. Some of the comments include: “It is something that makes me feel good, especially that you care about all the Latino[s].”, “Excellent and very educational. That they consider the Hispanic community and the importance of our presence in this country.”, and “Special, proud of organizers for making a big effort to provide us help and knowledge about different agricultural activities.”

Other feedback praised the opportunity to learn about new topics each year, and that it helps them “understand a little more about the type of work we do”. One recommendation was to organize a tour to visit other farms in the area so they could gather experience from the different environments. This recommendation, combined with the knowledge that participants’ preferred learning environment is on the farm or in the workplace with hands-on activities, will help the tree fruit team design additional educational opportunities for the Latinx community.

**Outreach to the Plain Community (Ford, Weber, et al):** For reasons that are unclear, members of the plain community – or more precisely, certain segments of the plain community – have in recent decades become unreceptive to educational programs offered by the tree fruit team, turning instead to production advice from biased sources (typically agents of chemical companies pushing particular products). Recently, the tree fruit team has made concerted efforts to reach this community by developing programs and products that present evidence-based information in a format that meets plain community standards. Spearheaded by Extension Educator Tom Ford, this effort includes the development of print versions of our electronic resources re-written and illustrated using plain language (when necessary); the development of lending library kiosks based in auction houses and community centers; the production of educational posters containing concise production recommendations; and the sponsoring of on-site educational meetings hosted in orchards owned by members of the community selected to be within range of horse-drawn buggies. Two on-site training meetings were conducted in 2018-2019. Both meetings were held in Bedford County, a center of anabaptist settlements. These meetings were attended by approximately 50 members of the plain community and featured hands-on demonstrations and discussions by research scientists Robert Crassweller, Greg Krawczyk, Rich Marini, and Kari Peter, and educators Tom Ford and Daniel Weber. An estimated 75 plain sect members in the Berks County area attended the spring orchard meeting held in Kempton.

**Assessing the Needs of the Plain Community (Ford, Weber, et al):** To understand the root causes of the apparent reduced acceptance of Extension programming and content, a state-wide plain community survey was initiated in the summer of 2019. Initially developed by educators Tom Ford and Daniel Weber and targeted to producers of tree fruit, this survey has been extended to include vegetable and small fruit producers as well. To increase our ability to acquire actionable information, respected community leaders will be interviewed individually by Extension educators using the survey as a guide for inquires. These interviews will be conducted during the winter months of 2019-2020. In the interim, educators have been collating recommendations freely offered by clients in order to establish additional lines of inquiry during the official interviews. It is believed that the data collected from these visits and interviews will help us develop new programs and products over the next two years for this community.

**Grants to Support the Next Generation of Growers (Baugher, Seifrit, Weber):** Our tree fruit team received two Extension Impact Grants and one PDA Specialty Crop Block Grant to expand its outreach to a promising next generation of specialty crop growers from diverse backgrounds. Extension programs for the Young Grower Alliance include leadership training, specialty crop tours and in-depth workshops. Bilingual certificate programs provide horticultural and safety training for orchard employees and aspiring beginning farmers.

**Young Growers Estimate the Value of Extension Programing (Seifrit, Weber):** This year the Young Grower Alliance (YGA) mailing list totaled 390 subscribers while their Facebook page had 424 followers, and 333 “likes”. 11.76% of growers that took part in YGA programming surveyed in 2018-2019 estimated the annual value of that programming as worth between \$50 - \$100, taking into consideration new crop management concepts learned, new business management skills acquired, and new trends in production research. An additional 11.76% of growers estimated the annual value to be worth between \$100 - \$500, with a further 11.76% valuing programming between \$500 - \$1000. Finally, another 23.53% estimated that YGA programming is worth more than \$2000 annually. Additionally, 58.8% of growers surveyed said they were “greatly” better equipped to contribute as a “Next Generation” member of the fruit industry, and 100% of participants said they were at least “moderately” better equipped to contribute.

**Young Grower Alliance Specialty Crop Tours (Seifrit, Weber):** The YGA sponsored trips throughout the Mid-Atlantic in 2019. Destinations included the Rutgers Agricultural Research and Extension Center and Larchmont Farms in New Jersey, and Bennet Orchards and Adams County Nursery’s production fields in Delaware. Over 45 YGA members and newcomers attended these tours.

**Young Apple Leader (YAL) Program (Baughter):** A record twenty-one young professionals participated in the US Apple Young Leader Program which Penn State Extension helped initiate. Alexandra Roberts from Rice Fruit Company, and Carena Guise from Knouse Foods Cooperative, represented Pennsylvania and participated in apple association meetings and the US Apple Capitol Hill Day. Ms. Roberts and Ms. Guise, along with veteran apple leaders, visited with elected Pennsylvania officials to discuss the export market, labor concerns and other important issues affecting the apple industry. Recognizing the importance of developing leadership skills among the next generation of industry professionals, the Young Grower Alliance is planning a full-day workshop on leadership development in conjunction with the 2020 Mid-Atlantic Fruit and Vegetable Convention.

**Bilingual Training at the Adams County Winter Commercial Tree Fruit School (Baughter, Gorgo, Pate, Quesada):** Hands-on trainings on orchard equipment safety were offered in English and Spanish at the Adams County fruit school. One hundred percent of participants (9 English-speaking; 41 Spanish-speaking) indicated they increased their operational knowledge, and 86% and 90%, respectively, indicated they plan to adopt a new practice as a result of the training. New practices included use of hand signals, checking tractors before operation, and proper shielding of PTO units.

**Extension Education and Outreach Specific to the Needs and Learning Preferences of Latinx Growers (Baughter, Gorgo):** Latinx and young growers were interviewed about impacts of Penn State Extension initiatives to bring in a next generation of specialty crop growers from diverse backgrounds, and the highlights are presented in this impact video:

<https://agsci.psu.edu/research/extension-centers/frec/news/extension-outreach-for-a-promising-next-generation-of-specialty-crop-growers>.

**Latinx Outreach Strategic Planning Meeting (Baughter, Seifrit, Weber):** This strategic planning meeting brought together Latinx community leaders and Penn State Extension educators to discuss Extension’s engagement with the broader Latinx community across Pennsylvania. This initiative is a long-range outcome from three consecutive USDA Specialty Crop Block Grants in support of Latino growers. An article has been published on what is now a college-wide initiative:

<https://news.psu.edu/story/592288/2019/10/09/academics/latinx-agricultural-network-formed-penn-state-address-communitys>. Training tools, in English and Spanish, developed for specialty crop producers were catalogued for the strategic planning meeting and also as an on-line resource: <https://extension.psu.edu/tree-fruit-training-and-self-paced-learning-resources-in-english-and-spanish>.

**Master Gardener Advanced Diagnostics Workshop (Peter, Weber, Ryan):** On June 29th, the Adams County Master Gardeners sponsored an Advanced Diagnostics Workshop dealing with the subject of



how to approach disease diagnoses with an emphasis tree fruit pathology. The primary speaker was Penn State University Pathologist Dr. Kari Peter, with Dr. Daniel Weber providing an introduction to the field of plant pathology. Dr. Peter used multiple pedagogical methods to “train the trainers” including a standard lecture-based presentation, an hour-long field diagnostics lab held in the Fruit Research and Extension Center orchards, and a “case studies” lab replete with diseased trees, collected specimens, and photographs. The “case studies” lab was the most popular portion of the workshop, as it represented the types of questions and situations a Master Gardener might expect from a walk-in client. Analysis of the post-workshop evaluation revealed strong support for this type of event, with many Master Gardeners indicating they felt better equipped to deal with disease issues when working on the hotline.

**Leveraging Digital Communications (Weber):** The next generation of growers are far more tech savvy than their predecessors and are more comfortable using technology to interact with their peers. To leverage this trend, instant messaging methods (iMessage and other SMS messaging apps) were adopted during the Adams County Winter Fruit School to encourage audience participation in the question and answer periods. This pilot endeavor demonstrated the feasibility of this method for interacting with the audience, with eleven questions submitted in the two trials versus seven asked from the floor. This form of polling the audience for responses will be implemented in the largest sessions of the 2020 Mid-Atlantic Fruit & Vegetable Convention.

### **External Factors the Affected Team Efforts**

**Natural Disasters:** The wet season of 2018 continued through the fall, posing a continued challenge for apple harvest. Extension was called upon to provide recommendations for mitigating post-harvest diseases and disorders. Extension advice was also sought on potential fallout from the abnormal season, and how to prepare for the 2019 growing season when new flushes of growth caused by the late, wet, warm fall failed to properly harden off for the winter. The spring and early summer of 2019 promised to be just as wet as 2018, but thankfully the weather in most regions stabilized, resulting in fewer concerns. Localized flooding, particularly in the Berks County area, resulted in consultations with educators and experts about how to stabilize flooded orchards and damaged infrastructure.

**Natural Disasters:** Growers in Pennsylvania experienced severe losses due to rapid apple decline (RAD), a disease/disorder complex of unknown specific origin. Losses exceeding 70% have been documented in individual orchards. One orchard alone in Adams County was forced to destroy over 20,000 dead or dying trees. It is difficult to report precise numbers of apple trees lost due to RAD for two reasons: 1) the wet season resulted in soil-borne disease outbreaks that also caused significant losses which is easily mistaken for RAD, and 2) for private reasons, growers are often reluctant to share the extent of the damage with outsiders. In response to this emergency, Penn State Pathologist Kari Peter has begun organizing a Mid-Atlantic coalition of scientists, educators, and growers in an attempt to document the spread of RAD, identify causal agents, and develop effective mitigation methods. Extension has also begun producing materials to assist growers affected by these losses in the filing of crop insurance claims and in seeking relief from the USDA tree assistance program (TAP).

**The Economy:** Despite continued economic growth, concerns over a pending recession have caused growers to question the financial security of their tree fruit enterprises. Extension has been encouraged to develop additional programming and products associated with budgeting, planning, and crop insurance. Planning began in the summer of 2019 to develop tools to enable growers to assess the vitality of various aspects of their production process. Next generation growers will be the target of our initial public offering of these tools as they are in or will be in a position to make business decisions that will affect profitability for the coming decades.

**Public Policy Changes:** Public policy changes with respect to the guest worker communities and immigration in general require growers to maintain accurate and precise records of their employees. Participation in the H-2A program has resulted in a significant increase in federal paperwork. Correspondingly, Extension has observed an increase in questions regarding compliance with the new regulations. The tree fruit team has sponsored, and will continue to develop, resources for orchard owners whose businesses depend upon guest workers to assist them with the process.

**Population Changes:** The presence of a large and vibrant Latinx community that has emerged as a result of the need for guest workers in agriculture has encouraged Extension to develop new products and programs. For over a decade, the tree fruit team has encouraged the development of resources appropriate for the Latinx community, to provide them with information not only regarding the tree fruit industry and its practices, but also how to access community wellness and welfare resources. Three members of the tree fruit team participated in the first Latinx strategic planning meeting in September and will be involved in the implementation of the recommendations resulting from that summit. Similar efforts are being dedicated to the plain community as the horticulture team as a whole seeks to discover and address their needs.

**Competing Public Priorities and Competing Programmatic Priorities:** Competing programmatic priorities – particularly for team members vested in multiple horticulture teams – reduces educator impact on the tree fruit team as a whole. The emphasis on spotted lanternfly monitoring and surveying for the general public has taken time away from developing tree-fruit specific programming and products.

**Extramural Funding:** Extramural funding in the form of grants from agencies outside the USDA have continued to support the on-going research efforts of the scientists at the Fruit Research and Extension Center. Extension educators have also benefitted from extramural funding, which has enabled the development of new products, particularly in the form of specialty crop workshops and tours.

### **Most Notable Evaluation Results**

**Evaluations of Winter Commercial Tree Fruit Schools:** When evaluating the usefulness of program content at the 2019 fruit schools, an average of 47% of 224 respondents reported they would adopt a new management technique, cultural practice, or technology based on content provided. An additional 40% would consider adoption based on what they learned. Over 90% of respondents would consider adopting or would plan on adopting new strategies to manage diseases (93%) and pests (94%), and to prioritize pollinator safety (98%). These results are encouraging, as protecting the environment while maintaining the production of high-quality fruit is paramount for the tree fruit team. Additional information gleaned from these evaluations was provided in Question 6.

**Evaluations of Programs for Latinx Growers.** Bi-lingual courses for a next generation of Latinx horticulturists with potential interest in becoming specialized managers or start-up farmers are on-going. Forty-three Latinx horticulturists participated in an orchard safety training in Spanish. One-hundred percent of participants gained knowledge about farm safety and health. Eighty-six percent of participants indicated they planned to adopt five or more practices to improve safety based on what they learned at the workshop. Latinx horticulturists and bi-lingual instructors celebrated ten years of sessions in Spanish during the 2019 Mid-Atlantic Fruit and Vegetable Convention. Participants were surveyed about the value of the program, and 78% felt the opportunity to learn in their native language made it more welcoming to attend than other educational events.

<https://news.psu.edu/story/572970/2019/05/06/impact/penn-state-extension-marks-milestone-outreach-spanish-speaking>.

## Additional Stakeholder Feedback

**State Horticultural Association of Pennsylvania (SHAP) Extension Committees:** SHAP continues to provide guidance to the tree fruit team through the Extension Advisory Committees. The Research and Education Committees independently developed a list of 38 priorities for research, education, and outreach, distributed among the subjects of horticulture, pathology, entomology, engineering, business management, and various interdisciplinary needs. SHAP approved 20 different grants submitted by the tree fruit team, funding a total of \$261,158 in support of tree fruit research and education. From the *Pennsylvania Fruit News* (99(4)): “SHAP research funding has grown significantly due to the combined commitments of growers, packers, processors, retail marketers, and volunteers who sell apples and apple products at the Pennsylvania Farm Show.” Each of these segments of the industry has provided feedback to Extension via the Extension Committees.

**Response to Rapid Apple Decline (Peter, Schupp, Crassweller, Weber, Seifrit):** Frustration with the seemingly unstoppable rapid apple decline (RAD) led growers to communicate the urgent need for action from Extension to solve the problem and prevent enterprise insolvency. Collaboration with the Pennsylvania Department of Agriculture and their counterparts from Washington State resulted the collection of numerous tissue samples and laboratory tests in an effort to identify the causal agent or agents devastating the industry. As of this writing, no single agent has been found suggesting the decline is caused by a complex of biological and environmental factors. In response to this null result, a Kari Peter organized the first RAD summit to build a coalition of concerned researchers, industry representatives, and educators. This summit will meet in the fall of 2019, so quantitative and qualitative results are pending.

**Organic Control of Japanese Beetles (Ford):** Following recommendations provided by Extension, a new organic tree fruit grower utilized Surround (a kaolinite clay particle film product used to coat leaf surfaces and thereby manage certain pest problems). The grower was interested in managing Japanese Beetles in a newly set orchard. The grower reported less injury following application of the product per Extension recommendations resulting in reduced usage of pyrethrum pesticide sprays in the orchard.

## Publications and Presentations

### Peer-Reviewed Journals

- Acebes-Doria, A. L., Agnello, A. M., Alston, D. G., Andrews, H., Beers, E. H., Bergh, J. C., ... Leskey, T. C. (2019). Season-long monitoring of the brown marmorated stink bug (Hemiptera: Pentatomidae) throughout the United States using commercially available traps and lures. *Journal of Economic Entomology*, 1–13. <https://doi.org/10.1093/jee/toz240>
- Bell, T. H., Hockett, K. L., Alcalá-Briseño, R. I., Barbercheck, M., Beattie, G. A., Bruns, M. A., ... Yergeau, E. (2019). Manipulating wild and tamed phytobiomes: Challenges and opportunities. *Phytobiomes Journal*, 3(1), 3–21. <https://doi.org/10.1094/PBIOMES-01-19-0006-W>
- Biddinger, D. J.** (2018). Conserving predatory mites in apple orchards (or mighty mites conquer mite pests). In *Natural Enemies: An Introduction to Biological Control* (pp. 88–89). Cambridge University Press.
- Crassweller, R. M., Kime, L. F., Marini, R. P., & Smith, D. E.** (2018). Orchard architecture effects on yield & economics of two apple cultivars. *Acta Horticulturae*.
- Crassweller, R. M., Marini, R. P., Baugher, T. A., & Smith, D. E.** (2019). Five-year nutritional study of apples in commercial high density orchards. *Acta Horticulturae*, (1253), 163–168. <https://doi.org/10.17660/ActaHortic.2019.1253.22>

- Crassweller, R., & Smith, D.** (2018). Rootstock trials at Penn State University – Rock Springs. 94<sup>th</sup> *Proceedings of Cumberland Shenandoah Fruit Workers Conference*, 43–47.
- Feng, J., Zeng, L., & **He, L.** (2019). Apple fruit recognition algorithm based on multi-spectral dynamic image analysis. *Sensors*, 19(4), 949. <https://doi.org/10.3390/s19040949>
- He, L., & Schupp, J.** (2018). Sensing and automation in pruning of apple trees: A review. *Agronomy*, 8(10). <https://doi.org/10.3390/agronomy8100211>
- He, L.,** Zhang, X., Ye, Y., Karkee, M., & Zhang, Q. (2019). Effect of shaking location and duration on mechanical harvesting of fresh market apples. *Applied Engineering in Agriculture*, 35(2), 175–183. <https://doi.org/10.13031/aea.12974>
- Jarvinen, T. D., Choi, D., Heinemann, P., **Schupp, J., & Baugher, T. A.** (2019). Tree trunk position estimation for accurate fruit counts in apple yield mapping. *2019 ASABE Annual International Meeting*. <https://doi.org/10.13031/aim.201900918>
- Joshi, N. K., Leslie, T. W., & **Biddinger, D. J.** (2019). Parasitism of the invasive brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae), by the native parasitoid, *Trichopoda pennipes* (Diptera: Tachinidae). *Biology*, 8(66).
- Jurick, W. M., Macarasin, O., Gaskins, V. L., Janisiewicz, W. J., **Peter, K. A.,** & Cox, K. D. (2019). Baseline sensitivity of *Penicillium* spp. To difenoconazole. *Plant Disease*, 103(2), 331–337. <https://doi.org/10.1094/PDIS-05-18-0860-RE>
- Klee, S. M., Sinn, J. P., Finley, M., Allman, E. L., Smith, P. B., Aimufua, O., ... McNellis, T. W. (2019). *Erwinia amylovora* auxotrophic mutant exometabolomics and virulence on apples. *Applied and Environmental Microbiology*, 85(15). <https://doi.org/10.1128/AEM.00935-19>
- Klee, S. M., Sinn, J. P., Holmes, A. C., Lehman, B. L., **Krawczyk, T., Peter, K. A.,** & McNellis, T. W. (2019). Extragenic suppression of elongation factor P gene mutant phenotypes in *Erwinia amylovora*. *Journal of Bacteriology*, 201(11). <https://doi.org/10.1128/JB.00722-18>
- Kon, T. M., & **Schupp, J. R.** (2018). Apple crop load management with special focus on early thinning strategies: A US perspective. In I. Warrington (Ed.), *Horticultural Reviews* (Vol. 46, pp. 255 – 298). Oxford, UK: Wiley.
- Leach, H., **Biddinger, D. J., Krawczyk, G.,** Smyers, E., & Urban, J. M. (2019). Evaluation of insecticides for control of the spotted lanternfly, *Lycorma delicatula*, (Hemiptera: Fulgoridae), a new pest of fruit in the Northeastern U.S. *Crop Protection*, 124, 104833. <https://doi.org/10.1016/j.cropro.2019.05.027>
- López-Uribe, M. M.,** Jha, S., & Soro, A. (2019). A trait-based approach to predict population genetic structure in bees. *Molecular Ecology*, 28(8), 1919–1929. <https://doi.org/10.1111/mec.15028>
- López-Uribe, M. M.,** & Simone-Finstrom, M. (2019). Special issue: Honey bee research in the US: current state and solutions to beekeeping problems. *Insects*, 10(1), 22.
- Marini, R. P., & Schupp, J. R.** (2019). How pruning affects cold hardiness. *American Fruit Grower*, 139(1), 24–25.
- Marini, R. P., Schupp, J. R., Baugher, T. A., & Crassweller, R.** (2019a). Estimating apple fruit size distribution from early-season fruit diameter measurements. *HortScience*, 54(11), 1947–1954.
- Marini, R. P., Schupp, J. R., Baugher, T. A., & Crassweller, R.** (2019b). Relationships between fruit weight and diameter at 60 days after bloom and at harvest for three apple cultivars. *HortScience*, 54(1), 86–91.
- Marini, R. P., Schupp, J. R., Baugher, T. A., & Crassweller, R.** (2019c). Sampling apple trees to accurately estimate mean fruit weight and fruit size distribution. *HortScience*, 54(6), 1017–1022.

- Murvanidze, M., **Krawczyk, G.**, Inasaridze, N., Dekanoidze, L., Samsonadze, N., Macharashvili, M., ... Shengelaia, S. (2018). Preliminary data on the biology of brown marmorated stink bug *Halyomorpha halys* (Hemiptera, Pentatomidae) in Georgia. *Turkish Journal of Zoology*, *42*, 617 – 624. <https://doi.org/10.3906/zoo-1802-34>
- Pak, D., **Biddinger, D.**, & Bjørnstad, O. N. (2019). Local and regional climate variables driving spring phenology of tortricid pests: A 36 year study. *Ecological Entomology*, *44*(3), 367–379. <https://doi.org/10.1111/een.12712>
- Roper, T., Black, B., Stasiak, M., **Marini, R.**, Cline, J., Robinson, T., ... Perry, R. (2019). Performance of Montmorency sour cherry (*Prunus cerasus* L.) on size controlling rootstocks at six NC-140 trial locations in North America. *Journal of the American Pomological Society*, *73*, 168–177.
- Ryan, S. F., Adamson, N. L., Aktipis, A., Andersen, L. K., Austin, R., Barnes, L., ... Dunn, R. R. (2018). The role of citizen science in addressing grand challenges in food and agriculture research. *Proceedings of the Royal Society B*, *285*(1891). <https://doi.org/10.1098/rspb.2018.1977>
- Schupp, J. R., Winzeler, H. E., & Schupp, M. A.** (2019). Stub length and stub angle did not influence renewal shoot number or branch angle of tall spindle 'Gala'/Malling 9 apple trees. *HortTechnology*, *29*(1), 46–49.
- Underwood, R. M., Traver, B. E., & **López-Urbe, M. M.** (2019). Beekeeping management practices are associated with operation size and beekeepers' philosophy towards in-hive chemicals. *Insects*, *10*(1), 10.
- Wu, G., Jurick II, W. M., Lichtner, F. J., Peng, H., Yin, G., Gaskins, V. L., ... Bennett, J. W. (2019). Whole-genome comparisons of *Penicillium* spp. Reveals secondary metabolic gene clusters and candidate genes associated with fungal aggressiveness during apple fruit decay. *PeerJ*, *7*, e6170. <https://doi.org/10.7717/peerj.6170>
- Zahid, A., **He, L.**, & Zeng, L. (2019). Development of a robotic end effector for apple tree pruning. *2019 ASABE Annual International Meeting*. <https://doi.org/10.13031/aim.201900964>
- Zhang, J., **He, L.**, Karkee, M., Zhang, Q., Zhang, X., & Gao, Z. (2018). Branch detection for apple trees trained in fruiting wall architecture using depth features and regions-convolutional neural network (R-CNN). *Computers and Electronics in Agriculture*, *155*, 386–393. <https://doi.org/10.1016/j.compag.2018.10.029>

### **Pennsylvania Fruit News**

The *Pennsylvania Fruit News* is a publication of the State Horticultural Association of Pennsylvania (SHAP). While not peer reviewed, it is where research reports are published for all SHAP-supported research. References to these articles are given here to represent the “hidden” work of the researchers and educators since there is no place in which to include them since they are certainly not “Popular Media”. There were 36 publications in *Pennsylvania Fruit News* from October 1, 2018, to September 30, 2019.

- Choi, D., **Baughner, T., Schupp, J., & He, L.** (2019). Evaluation of effective canopy depths of apple trees for optimal machine sensing performance – Year 1/2. *Pennsylvania Fruit News*, *99*(1), 52–54.
- Crassweller, R., Kime, L., Marini, R., & Smith, D.** (2018). Orchard architecture effects on yield & economics of two apple cultivars (Abstract). *Pennsylvania Fruit News*, *98*(11), 10.
- Crassweller, R., & Smith, D.** (2019a). Effects of conversion of training systems to a hedgerow. *Pennsylvania Fruit News*, *99*(1), 37–38.

- Crassweller, R., & Smith, D.** (2019b). Rootstock evaluations at Penn State University – Rock Springs. *Pennsylvania Fruit News*, 99(1), 34–36.
- Crassweller, R., & Smith, D.** (2019c). Third generation apple system trials 2018. *Pennsylvania Fruit News*, 99(1), 36–37.
- Crassweller, R.** (2018a). Editorial views: A review of the year. *Pennsylvania Fruit News*, 98(11), 4.
- Crassweller, R.** (2018b). Editorial views: Comments on the fruit harvest. *Pennsylvania Fruit News*, 98(9), 4–5.
- Crassweller, R.** (2018c). Editorial views: NC-140 annual meeting. *Pennsylvania Fruit News*, 98(10), 4–5.
- Crassweller, R.** (2019a). Editorial views: “bits & pieces.” *Pennsylvania Fruit News*, 99(1), 1.
- Crassweller, R.** (2019b). Editorial views: Bits & pieces along with some observations. *Pennsylvania Fruit News*, 99(2), 4.
- Crassweller, R.** (2019c). Editorial views: More observations from historic ag census publications. *Pennsylvania Fruit News*, 99(5), 1–4.
- Crassweller, R.** (2019d). Editorial views: Statistics on the Pennsylvania tree fruit industry. *Pennsylvania Fruit News*, 99(3), 1–4.
- Crassweller, R.** (2019e). Editorial views: Summer peach production time. *Pennsylvania Fruit News*, 99(6), 4–5.
- Crassweller, R.** (2019f). Editorial views: The apple harvest season so far... *Pennsylvania Fruit News*, 99(8), 4.
- Crassweller, R.** (2019g). Editorial views: Tree stress in apple plantings. *Pennsylvania Fruit News*, 99(4), 4–5.
- Crassweller, R.** (2019h). Extending Cornell carbohydrate model to Pennsylvania growers for determining apple tree response to chemical thinners for 2018. *Pennsylvania Fruit News*, 99(2), 18–19.
- He, L., Choi, D., Schupp, J., & Baugher, T.** (2019). A sensor-based irrigation test system for apple orchards (Year 1 report). *Pennsylvania Fruit News*, 99(1), 43–45.
- Hockett, K., **Peter, K.**, & May, A. (2019). Understanding why biocontrol fails to protect against fire blight in the eastern U.S. *Pennsylvania Fruit News*, 99(1), 41–42.
- Jurick II, W. M., & **Peter, K. A.** (2019). Evaluating the efficacy of a new postharvest fungicide and developing tools to monitor fungicide resistance in blue mold populations. *Pennsylvania Fruit News*, 99(1), 32–34.
- Kon, T. M., **Schupp, J. R.**, Yoder, K. S., Combs, L. D., & **Schupp, M. A.** (2018). Comparison of chemical blossom thinners using “Golden Delicious” and “Gala” pollen tube growth models as timing aids (Abstract). *Pennsylvania Fruit News*, 98(8), 14.
- Krawczyk, G.**, Peterson, H., & Hirt, C. (2019). Utilization of insecticide treated nets as an alternative method to monitor and manage brown marmorated stink bug, *Halyomorpha halys* (Stal). *Pennsylvania Fruit News*, 99(1), 15–17.
- Lee, R.** (2019). YGA tour to southern Delaware showcases efficiency and quality. *Pennsylvania Fruit News*, 99(6), 10.
- Marini, R.** (2018). The NC-140 multi-location peach physiology trial: Relationships between peach fruit weight, crop density and early season temperature (Abstract). *Pennsylvania Fruit News*, 98(9), 13.
- Marini, R. P., Schupp, J. R., Baugher, T. A., & Crassweller, R.** (2019a). Estimate mean fruit weight & fruit size distribution (Abstract). *Pennsylvania Fruit News*, 99(6), 14.

- Marini, R. P., Schupp, J. R., Baugher, T. A., & Crassweller, R.** (2019b). Relationships between fruit weight & diameter at 60 days after bloom & at harvest for 3 apple cultivars (Abstract). *Pennsylvania Fruit News*, 99(6), 15.
- Marini, R., & Crassweller, R.** (2019). Validating the “Honeycrisp” bitter pit model in 2018. *Pennsylvania Fruit News*, 99(2), 21–22.
- Martin, P., **Krawczyk, T.**, Lehman, B., & **Peter, K.** (2019). Assessment of resistance to pre- and postharvest site-specific fungicides in populations of fungi that cause bitter rot in Pennsylvania orchards. *Pennsylvania Fruit News*, 99(1), 30–31.
- Peter, K.** (2019). Investigating the role of viruses in rapid apple decline. *Pennsylvania Fruit News*, 99(1), 25–26.
- Peter, K.**, McNellis, T., Lehman, B., Sinn, J., & Klee, S. (2019). Exploration and development of novel fire blight management strategies: Bacterial antagonists and plant immune stimulation. *Pennsylvania Fruit News*, 99(1), 27–29.
- Peterson, H., & **Krawczyk, G.** (2019). Utilizing the samurai wasp as a potential control tool against brown marmorated stink bug. *Pennsylvania Fruit News*, 99(1), 19–21.
- Schupp, J.** (2019). Apple plant growth regulators: Promoting return bloom. *Tree Fruit News*, 7(4), 1–2.
- Schupp, J., Winzeler, H. E., & Schupp, M.** (2019). Development of a high density, highly mechanized, pedestrian peach system. *Pennsylvania Fruit News*, 99(1), 24–25.
- Seifrit, D., Weber, D. E., & Baugher, T.** (2019). The next generation of fruit growers – building leadership and coalitions. *Pennsylvania Fruit News*, 99(2), 24.
- Sommer, H. J., **Crassweller, R.**, & **Smith, D.** (2019). Buy-and-fly orchard management using unmanned aircraft (UA) – Year 2. *Pennsylvania Fruit News*, 99(1), 39–40.
- Walsh, C. S., Bissett, A. E., Hunt, K. W., **Baugher, T. A.**, & Young, N. J. (2019). Monitoring and utilizing fruit maturity to improve harvest and storage decisions of new apple cultivars and reduce storage disorders of Honeycrisp – 2018 growing season report. *Pennsylvania Fruit News*, 99(1), 49–52.
- Wiep, R. J., **Schupp, J. R., Schupp, M. A., & Winzeler, H. E.** (2019). Research and applications of artificial spur extinction in Pennsylvania orchards. *Pennsylvania Fruit News*, 99(1), 22–23.

### **Invited Talks**

The following is a list of professional presentations given by members of the tree fruit team. The informational content of these talks, and the effort that goes into preparing them deserve to be noted in an annual program summary. There were 44 invited talks, if discounting the multiple occurrences of the winter fruit schools and spring orchard meetings.

- Biddinger, D. J.** (2019). Spotted lanternfly & other invasive pests: Controls to minimize effects on IPM & beneficial insects. In *Adams County Winter Commercial Tree Fruit School*. Biglerville, PA: Penn State Extension.
- Biddinger, D.**, Leach, H., & Urban, J. (2018). Residual control of spotted lanternfly nymphs and adults with various insecticides. 94<sup>th</sup> *Cumberland Shenandoah Fruit Workers Conference*. Presented at the Winchester, VA. Winchester, VA.
- Biddinger, D.**, Rajotte, E., Joshi, N., & Leach, H. (2019). Challenges of integrated pest management (IPM) in high value commodities. *Eastern Branch Entomological Society of America 90<sup>th</sup> Annual Meeting*. Presented at the Blacksburg, VA. Blacksburg, VA.

- Biddinger, D.**, Rajotte, E., Phan, N., & Joshi, N. (2018). Understanding and mitigating the risks of pesticide exposure for pollinators and other beneficial insects. *Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- Crassweller, R. M.** (2018). Master Gardener training: Tree fruit production. *Centre County Cooperative Extension*. Presented at the University Park, PA. University Park, PA.
- Crassweller, R. M.** (2019a). Changes to herbicides, growth regulators, & utilizing the NEWA system. In *Regional Winter Commercial Tree Fruit Schools*. St. Thomas, PA: Penn State Extension.
- Crassweller, R. M.** (2019b). Grower evaluations of new apple rootstocks. *2019 Mid-Atlantic Fruit and Vegetable Convention*. Presented at the Hershey, PA. Hershey, PA.
- Crassweller, R. M.** (2019c). Responses to a wet season: Herbicide, nutrient, & tree management strategies. In *Regional Winter Commercial Tree Fruit Schools*. Biglerville, PA: Penn State Extension.
- Crassweller, R. M.**, & Gorgo, M. (2019). El sistema de poda en huertos de durazno. *2019 Mid-Atlantic Fruit and Vegetable Convention*. Presented at the Hershey, PA. Hershey, PA.
- Crone, M., Phan, N., **Biddinger, D.**, & Grozinger, C. (2018). The effects of diet on honey bee (*Apis mellifera*) pesticide sensitivity. *2018 Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- He, L.** (2019). Precision farming: Progress with vision & irrigation technologies. In *Adams and Franklin Counties Winter Commercial Tree Fruit School*. Biglerville, PA: Penn State Extension.
- Joshi, N., Rajotte, E., Nathani, K., & **Biddinger, D. J.** (2018). Foraging and dispersal behavior of *Osmia cornifrons* in an apple orchard ecosystem. *2018 Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- Kilpatrick, S., Gibbs, J., Mikulas, M., Spichiger, S., Ostiguy, N., **Biddinger, D.**, & **López-Uribe, M. M.** (2018). An updated checklist of the bees (Hymenoptera: Apoidea: Anthophila) of Pennsylvania, United States. *2018 Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- Kilpatrick, S., Gibbs, J., Mikulas, M., Spichiger, S.-V., Ostiguy, N., **Biddinger, D.**, & **López-Uribe, M. M.** (2019). An updated checklist of the bees (Hymenoptera: Apoidea: Anthophila) of Pennsylvania. *Eastern Branch Entomological Society of America 90<sup>th</sup> Annual Meeting*. Presented at the Blacksburg, VA. Blacksburg, VA.
- Krawczyk, G.** (2019a). BMSB in Georgia – perspective on challenges and solutions. *International Conference on BMSB (Halyomorpha Halys) – Global Challenge, International Experience and Best Solutions*. Presented at the Tbilisi, Georgia. Tbilisi, Georgia.
- Krawczyk, G.** (2019b). Brown marmorated stink bug, *Halyomorpha halys*—A case of invasive pest and integrated pest management. *International Conference Brown Marmorated Stink Bug (BMSB) – Phytosanitary Regulatory Framework*. Presented at the Tbilisi, Georgia. Tbilisi, Georgia.
- Krawczyk, G.** (2019c). Brown marmorated stink bug in fruit orchards. *Embrapa Uva e Vinho, Empresa Brasileira de Pesquisa Agropecuária (Embrapa)*. Presented at the Vacaria, Brazil. Vacaria, Brazil.
- Krawczyk, G.** (2019d). Challenges of managing oriental fruit moth in apple orchards. *IV Orchard International Conference*. Presented at the Vacaria, Brazil. Vacaria, Brazil.
- Krawczyk, G.** (2019e). Revisiting monitoring & management options for common fruit pests. In *Regional Winter Commercial Tree Fruit Schools*. Biglerville, PA: Penn State Extension.
- Krawczyk, G.** (2019f). Spotted lanternfly & other invasive pests: Controls to minimize effects on IPM & beneficial insects. In *Regional Winter Commercial Tree Fruit Schools*. St. Thomas, PA: Penn State Extension.



- Krawczyk, G.** (2019g). Update on mating disruption. *2019 Mid-Atlantic Fruit and Vegetable Conference*. Presented at the Hershey, PA. Hershey, PA.
- Krawczyk, G.,** Leach, H., Hirt, C., Rice, H., & Urban, J. (2019). Potential new invasive pest species in United States – spotted lanternfly, *Lycorma delicatula*. *PheroFip 19*. Presented at the Lisbon, Portugal. Lisbon, Portugal: Joint Meeting of IOBC/WPRS Working Groups.
- Krawczyk, G.,** Morrin, H., & Hirt, C. (2019). Alternative methods to manage brown marmorated stink bug, *Halyomorpha halys*. *PheroFip 19*, 98. Retrieved from [https://www.isa.ulisboa.pt/cong/iobc2019/files/PheroFip%2019\\_Book%20of%20abstracts%20\\_final.pdf](https://www.isa.ulisboa.pt/cong/iobc2019/files/PheroFip%2019_Book%20of%20abstracts%20_final.pdf)
- Krawczyk, G.** (2019). Integrated pest management for the 2019 season. *Orchard Pest Management and Intelligent Spraying Technologies*. Presented at the Biglerville, PA. Biglerville, PA.
- Leach, H., **Biddinger, D.,** & Urban, J. (2019). Management of spotted lanternfly in fruit crops. *Eastern Branch Entomological Society of America 90<sup>th</sup> Annual Meeting*. Presented at the Blacksburg, VA. Blacksburg, VA.
- Leach, H., Centinari, M., **Biddinger, D.,** & Urban, J. (2018a). Response and management of the invasive, spotted lanternfly, in grape. *2018 Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- Leach, H., Centinari, M., **Biddinger, D.,** & Urban, J. (2018b). Spotted lanternfly damage and phenology in Pennsylvania vineyards. *94<sup>th</sup> Cumberland Shenandoah Fruit Workers Conference*. Presented at the Winchester, VA. Winchester, VA.
- Marini, R.,** Cramer, M., Demchak, K., & Lesky, T. (2019). Novel cultural management techniques for Japanese beetles and SWD in high tunnel raspberries. *Mid-Atlantic Fruit & Vegetable Conference*.
- Marini, R.** (2019a). Continuing evolution of the intensive orchard. *Maine State Pomological Society Preseason Tree Fruit Meeting*.
- Marini, R.** (2019b). Factors influencing bud hardiness of tree fruit. *New Hampshire Fruit Growers Association Annual Meeting*.
- Marini, R.** (2019c). Improving Honeycrisp fruit quality with emphasis on bitter pit management. *Maine State Pomological Society Preseason Tree Fruit Meeting*.
- Marini, R.** (2019d). Managing bitter pit in Honey crisp. *New Hampshire Fruit Growers Association Annual Meeting*.
- Peter, K. A.** (2019a). 2018 season surprises: Soil-borne diseases for the grower's radar. In *Regional Winter Commercial Tree Fruit Schools*. Biglerville, PA: Penn State Extension.
- Peter, K. A.** (2019b). Optimizing disease management strategies for a very wet season. In *Regional Winter Commercial Tree Fruit Schools*. Biglerville, PA: Penn State Extension.
- Peterson, H., Ali, J., & **Krawczyk, G.** (2019). Biocontrol of invasive *Halyomorpha halys*. *PheroFip 19*, 103. Retrieved from [https://www.isa.ulisboa.pt/cong/iobc2019/files/PheroFip%2019\\_Book%20of%20abstracts%20\\_final.pdf](https://www.isa.ulisboa.pt/cong/iobc2019/files/PheroFip%2019_Book%20of%20abstracts%20_final.pdf)
- Phan, N., Rajotte, E., & **Biddinger, D.** (2018). Sublethal pesticide exposure increases developmental time and reduces rate of weight gain in *Osmia cornifrons* larvae. *2018 Entomological Society of America Annual Meeting*. Presented at the Vancouver, BC, Canada. Vancouver, BC, Canada.
- Schupp, J. R.** (2019). Managing scarf skin on red strains of Gala. In *Adams County Winter Commercial Tree Fruit School*. Biglerville, PA: Penn State Extension.

- Schupp, J. R., & Weber, D. E.** (2019). Managing scarf skin on red strains of Gala. In *Franklin County Winter Commercial Tree Fruit School*. St. Thomas, PA: Penn State Extension.
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### **Changes in Programming to better Serve Stakeholder Needs**

The tree fruit team works very well together with excellent communication flowing from specialists to educators to industry. The team is also making an extra effort to work with plain sect audiences and is holding programs at the community level using plain sect orchards as host sites.

The tree fruit team received feedback from our clients that crucial information concerning actionable items – such as appropriate responses to extreme weather events such as hailstorms or weather conditions promoting the rapid establishment of disease – were being delayed. These delays rendered the information at best useless or uninformative or at worst, dangerous in that losses would occur if quick action not taken. After working closely with the marketing team this issue has been resolved satisfactorily. Timely alerts written by our staff of experts now reach their target audience’s mailbox in 2.5 hours on average, a reduction of over ten times previous delivery measurements.

Similarly, our commercial producers reported a significant increase in off-target messages from programs dissociated from their primary interests. The concern expressed by stakeholders is that crucial messages – such as the alerts previously discussed – would be lost among “spam”. Following cooperation with the marketing team, the number of unwanted messages reported to us has declined for most users significantly. Grower feedback to these changes has been mostly positive.

### **Press Releases, Articles and Webpages that Highlight Significant Activities and Impacts**

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13. Provide any additional comments/notes that you think may be pertinent that are not included above. (Please keep it short & sweet!)

**Professional Service:** Dr. Robert Crassweller served as the Education Program Chair for the 2019 Mid-Atlantic Fruit & Vegetable Convention. He was served the Program Chair for the 2019 Mid-Atlantic Cider Competition. Dr. Crassweller is also editor of the *Pennsylvania Fruit News*, a journal of the State Horticultural Association of Pennsylvania journal. Drs. James Schupp, Greg Krawczyk, David Biddinger, Kari Peter, and Daniel Weber, and Extension Educator Don Seifrit served as ex-officio members of the State Horticultural Association of Pennsylvania board of directors.