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| **SAES-422 Multistate Research Activity Accomplishments Report** |   |

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| **Project No. and Title:** | [**W2008**](http://lgu.umd.edu/lgu_v2/pages/showInfo.cfm?trackID=9416)**/3008 Biology and Management of *Iris yellow spot virus* (IYSV), Other Diseases, and Thrips in Onions**  |
| Period Covered: | January 1, 2017 to December 31, 2017 |
| Date of Report: | January 31, 2018 |
| Annual Meeting Date:  | December 4, 2017 |

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1. **Participants at the Annual Meeting in Grand Rapids, MI:**

**W2008 Executive Committee Officers for 2017:**

**Chair:** Lindsey du Toit, Washington State University

**Vice-Chair:** Christy Hoepting, Cornell University

**Secretary:** Beth Gugino, Pennsylvania State University

**Past Chair:** Tim Waters, Washington State University

**Participants:**

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1. **Brief Summary of Minutes of the Annual Meeting**

Chair Lindsey du Toit called the meeting to order at 8:30 am.

**Special thanks to our meeting sponsors:** Robert Sakata, Rick Jones representing Seminis/Monsanto, Kristin Oomen representing Bejo Seeds, Wayne Mininger representing the National Onion Association, Dave Whitworth representing Crookham Seed Co., Megan Lewien and Juan Carlos Brevis representing Nunhems/Bayer, Dave Brink of Brink Muck Farms in Grant, MI, and Steve Loring, NMSU.

**Update from Steve Loring, Administrative Advisor:**

* This is a joint meeting that represents the conclusion of the W-2008 project, which ended in September 2017, and the start of the new project, W-3008.
* The termination report for W-2008 is due this year with a particular emphasis on impacts. Frame the impacts around their importance to the onion industry. These are used to justify continued funding. Steve shared handouts about what makes a good impact statement (see attachments).
	+ Steve is looking for good photographs that can be included in the report. We will likely be chosen for a national impact statement – Steve said “Help me tell your story”.
* Nomination for multistate award of excellence – first step is review by the regional associations and then second step is being put forward for the national award. Steve was encouraged to nominate our project again this year. The 3-page nomination form emphasizes outputs, outcomes and impacts; added value and synergistic activities – how working together and with industry has benefited the project; leveraged funding – include specific examples – What have we done, what is the impact and how have we leveraged funding. The nominations are due to the western regional association by Feb 28th.
* We have 30 days from this meeting to get the termination report submitted.

**Other notes:** [Onionbusiness.com](http://onionbusiness.com/) has a newsletter that might be of interest to this group. Kerrick Bauman submitted a report on this meeting.

**State reports and other project updates:**

Participating members made presentations representing Colorado (by Mark Uchanski), Georgia (by Bhabesh Dutta), Michigan (by Beth Brisco representing Mary Hausbeck), New Mexico (by Chris Cramer), New York (by Christy Hoepting, Ashley Leach, Steve Beer, Brian Nault), Oregon/Idaho (Treasure Valley) (nobody from this region was able to attend but Lindsey du Toit and Kerrick Bauman shared information received from growers and extension specialists from this region), Pennsylvania (by Beth Gugino), Texas (by Subas Malla), Utah (by Claudia Nischwitz), Washington (by Tim Waters), and Ontario, Canada (by Zach Telfer). Refer to the details covered in 12 pages of the minutes of the annual meeting for information from each state related to onion research and extension activities.

**Organizational and Planning Items**

**Onion research & extension needs, proposals (USDA SCRI, others)**

* Pappu et al. are proceeding with a USDA NIFA SCRI proposal – this is their third submission attempt – Objectives include of onion thrips, IYSV and white rot management
* du Toit et al. are preparing a USDA NIFA SCRI proposal with a focus on bacterial diseases. The pre-proposal was submitted the week of this meeting.

**Alliumnet website – Joe LaForest and Bhabesh Dutta (want to launch at beginning of 2018)**

* Southern IPM center has focused on technology in the southern regions; however, the center will support national efforts when possible.
* Southern IPM center will pick up the support and customization of the Alliumnet website but the site must have a purpose and/or well-articulated objectives.
* Aliumnet.com is the old site; <http://alliumnet.bugwoodcloud.org> is the new site – provides a list of research and extension specialists working on pests and diseases; focuses on collaboration among research, extension and industry; this is not currently a venue for growers to find management information.
* Project information will be pulled directly from the NIMSS site for the W-3008.
* What’s changing as a result of support from Southern IPM Center:
	+ Site is not a content management network – multiple people can add content using a web browser
	+ Site navigation – focus on Projects, meetings, resources
	+ Mobile tablet and desktop responsive
	+ Google analytics added
	+ Again it will have information obtained from the NIMISS and PMSP/CP websites
* Questions
	+ Who is the current audience? Are the message and purpose acceptable? Changes needed?
	+ Who needs/wants access to edit?
	+ Call for content
		- 2012/2010 NARC Proceedings are missing
		- 2018 NARC information
		- Old WERA 1008/W-2008 information could be added, including minutes of the annual meetings
		- Suggestions? Please contact Bhabesh and Joe with ideas/recommendations.

**Election of new officers, future annual meeting locations, dates, etc.**

* Nomination for Secretary – Bhabesh Dutta was nominated last year and agreed to be Secretary elect. He confirmed his willingness to serve as the next secretary so the membership voted and he was approved as the 2018 Secretary.
* W-3008 meeting in 2018
	+ We could combine this meeting with one of the NOA meetings in 2018: July 18 to 21 in Bakerfield, CA or Nov 28-Dec 2 in Hawaii? The group decided against the latter option due to cost, and the former option because it’s too soon after this meeting.
	+ The 2018 W3008 meeting will be held in conjunction with the Pacific Northwest Vegetable Association Annual Convention & Trade Show the week before Thanksgiving (Nov. 14-15) in Pasco or Kennewick, WA. Our W3008 meeting will be on Tuesday, November 13, 2018 before the PNVA conference. Some of the meeting participants can then be invited to speak at the PNVA meeting, similar to many attendees of this year’s W3008 meeting speaking at the Great Lakes Expo.
	+ The 2019 meeting will be held in conjunction with the International Allium meeting in Madison, WI in July.

**2018 officers:**

**Chair:** Christy Hoepting, Cornell University (responsible for chairing the 2018 W3008 Annual Meeting)

**Vice-Chair:** Beth Gugino, Pennsylvania State University (responsible for writing/submitting the 2018 annual project report)

**Secretary:** Bhabesh Dutta, University of Georgia (responsible for writing/submitting the 2018 annual meeting minutes)

**Past-Chair:** Lindsey du Toit, Washington State University

Lindsey du Toit adjourned the meeting at 5:00 pm.

1. **Accomplishments (limited to 30,000 characters with spaces)**

**Objective 1. Evaluate onion germplasm for greater levels of tolerance to *Iris yellow spot virus* (IYSV), other pathogens and thrips.**

**Colorado -** Variety trials were set up at Ft. Lupton and Rocky Ford, CO. Thrips populations and IYSV were very low. A post-harvest bacterial rot preliminary study was set up at the ARDEC S. research station where four onion cultivars were placed into cold storage in November 2017. Rot data was collected in December and ranged from 0% for ‘Red Beret’ to 100% in ‘Cometa’.

**Georgia** – Currently, genetic resistance to center rot in commercially available cultivars has not been identified. The genetic diversity of the pathogen must be elucidated to successfully breed for genetic resistance. Georgia researchers are making progress towards this goal with *Pantoea ananatis.*

**Relative susceptibility of onion growth stage to bulb infection.** The results of studies conducted under greenhouse conditions indicate that total bulb center rot incidence was significantly higher for Granex YPRR (84%) and significantly lower for 1518 (49%) and 1407 (33%) compared to other tested cultivars. Onions were significantly more susceptible to bulb infection when inoculated during first leaf senescence (62%) as compared to bulb initiation (37%) and bulb swelling (31%) stages. **The outcomes of this study may have implications in devising management strategies aimed at protecting most susceptible onion growth stages against *P. ananatis*.**

**New Mexico** - Seeds of original, intermediate, and advanced Fusarium basal rot (FBR)-selected populations and one resistant and one susceptible check were evaluated for resistance to FBR. The inoculation method of 3 x 104 sporesml-1 of FOC placed on a cut basal plate was very effective at causing disease in most bulbs. Of the FBR-selected populations, recent selections of ‘NuMex Mesa’ exhibited less disease than the previous generations. Conversely, selections of ‘NuMex Chaco’ exhibited a similar amount of disease as those generations that were not selected for FBR resistance. Seed was produced from 60 different germplasm lines of FBR-resistant selections made in 2016, which will be used for further evaluations to ascertain additional progress made for resistance to FBR.

**Oregon –** Fifty-nine direct-seeded yellow, white, and red onion varieties were evaluated in the Treasure Valley for plant disease, thrips, maturity, bolting, and bulb single centers. The varieties were evaluated out of storage for yield, grade, and bulb decomposition. The varieties had substantial variation in thrips damage and ranges of IYSV, neck rot, black mold, and plate rot. Few bacterial diseases were noted. Seven transplanted varieties were evaluated in a similar fashion.

**Pennsylvania -** Four replicated field trials were conducted to **evaluate the susceptibility and yield potential of ‘Spanish Medallion’ compared to the commercial standard ‘Candy’**. Across all three on-farm trials there were no significant differences in total marketable yield between Candy and Spanish Medallion. There was no difference in center rot incidence between the cultivars within each location or across the three locations within each cultivar. The higher disease pressure that resulted from toothpick inoculating a subset of plants in the research farm trial resulted in significantly higher center rot incidence compared to the plots characterized as having low or moderate disease pressure. However this trend was only significant for Candy and resulted in a significantly lower total marketable yield compared to Spanish Medallion plants also subjected to high disease pressure.

**Objective 2. Investigate thrips biology and IYSV epidemiology to improve management strategies.**

**Colroado & Utah** - A replicated study was set up **to evaluate the effect of two potassium fertilizers and three different rates to elucidate their relationship with IYSV symptom development and disease incidence.** In 2016, IYSV incidence (% plants by ELISA) was higher than the control for both rates of muriate of potash. IYSV incidence was lower than the control for both rates of potassium sulfate indicating a possible potassium/IYSV relationship. In 2016 and 2017, bulb yield was not significantly different than the control. However, IYSV was very low in 2017.

**New York –** **Control of onion thrips with insecticides.** Among the four application frequency x action threshold combinations evaluated, two applications of Movento with the first timed at 1 thrips per leaf and the second application one week later reduced the infestation to the lowest level for the longest period. **Movento will continue to be recommended when thrips populations reach 1 per leaf, rather than densities below this level. Two applications of the high rate of Minecto Pro provided the highest level of control and may be a good alternative to Radiant SC.**

 **Integrated management of thrips.** Combinations of nitrogen fertilizer and insecticide use were evaluated for thrips management in onion. All fertilized treatments received 60 lbs of urea per acre at planting, and a split application of either 0, 15, 45 or 75 lbs of urea per acre applied when onions had between 3-5 leaves. An unfertilized treatment was included as a control. Plots were either sprayed with insecticides using an action threshold or were not treated. Thrips pressure was extremely low. While we did not detect differences in onion thrips densities among the four urea treatments, **we observed significantly greater levels of internal bulb decay in treatments receiving nitrogen (regardless of rate) compared with the untreated control (no nitrogen).**

**Oregon – Control of onion thrips and IYSV with insecticides.** Field trials were conducted in the Treasure Valley to evaluate different insecticide management programs. In total, 36 treatment regimens with both drip irrigation and foliar applications were evaluated. Our standard reference program of two applications of Movento, followed by two each of Agrimek, Radiant and Lannate still performed well. As reported previously, Movento does not show good activity until after a second application is made. **Applying Movento later in the season helps take advantage of its efficacy against larvae when populations peak in late June/early July. Movento should be combined with an adulticide to control dispersing adults.** Minecto Pro provided slightly better control than abamectin alone. **Radiant was the most effective insecticide and Lannate may be losing its efficacy.**

**Washington – Onion thrips control with insecticides. Warrior was ineffective.** Lannate was effective for the first three applications, but was ineffective on applications 4-6. **It** **is possible that thrips are building resistance to Lannate.** **Radiant was the most effective insecticide.** Minecto Pro outperformed the two active ingredients alone. Torac and Movento were less effective than the other treatments. Minecto Pro was more effective than Exirel, but had the same efficacy as Agrimek, Lannate, and Radiant, which did not differ from one another. **In order of effectiveness by all metrics evaluated: Effective: Radiant, Minecto Pro, Exirel, Agrimek. Moderately Effective: Lannate, Movento, Torac. Ineffective: Warrior.**

In another experiment, sequential applications of several insecticides were evaluated to help producers formulate thrips management programs for season long thrips control. Each product listed was applied twice before switching to another. **The program that began with Minecto Pro followed by Radiant, Movento and Lannate was the most effective.** For percent thrips-damaged area, the programs that began with Movento performed best, while those with Lannate third in the sequence performed the worst toward the end of the season. The program that began with Movento, followed by Minecto Pro, Radiant, and Lannate had the highest yield. **Using effective insecticides will improve size profile and yield, and sequence of insecticides is probably less important at low population levels**. Lannate should be placed early or late in the season for best results.

**Green bridge effect survey.** In the Columbia Basin annual onion bulb crops are produced in relatively close proximity to biennial onion seed crops, which facilitates survival and buildup of thrips and IYSV, known as the green bridge effect. A survey was continued to monitor thrips and IYSV in 3 pairs of nearby (within 1 mile) onion bulb and seed crops. Data is being analyzed.

**Objective 3. Investigate the biology, ecology and epidemiology of other pathogens to improve management strategies.**

**Colorado – Biological nematicide evaluation.** The efficacy of MeloCon bio-nematicide (*Paecilomyces lilacinus* strain 251) on plant parasitic nematodes was demonstrated in a commercial onion ‘Delago’ field. Onion seed was planted immediately after MeloCon application, which was followed by 0.5” irrigation. There were no statistical differences between the treated and untreated in any of the evaluations and the level of plant parasitic nematodes present was low.

**Georgia - Identification of *Pantoea stewartii* subsp. *indologenes*.** Two bacterial strains were isolated from onion expressing symptoms indicative of center rot from two different outbreaks in Toombs County, Georgia in 2003 (PNA 03-3) and 2014 (PNA 14-12). These strains were initially identified as *P. ananatis* based on physiological and specific polymerase chain reaction (PCR) assays. However, further testing using 16S rRNA, multi-locus sequence analysis (MLSA), phylogenetic analysis, PCR assay, indole test, and pathogenicity on onion and pearl millet **suggest that these onion strains an potentially be novel *P. stewartii* subsp. *indologenes* strains capable of producing symptoms on onion. Hence, we recommend the inclusion of *P. stewartii* subsp. *indologenes* as the fourth member in the center rot complex of onion along with *P. ananatis*, *P. agglomerans* and *P. allii*.**

**Effect of timing of chemical treatment and thrips on control of *P. ananatis.*** In geenhouse studies, chemical treatments with Actigard, Kocide 3000 and Actigard + Kocide were evaluated for their effectiveness at bulb initiation and swelling. It was also evaluated if thrips infestation can result in reduced efficacy of protective treatments against *P. ananatis*. The results indicate that there was a **significant effect of protective applications at two onion-growth stages on the bulb incidence of center rot in absence of thrips.** At bulb initiation, Kocide 3000 (12.4%) and Kocide 3000 + Actigard (14.8%) had significantly lower center rot than Actigard (38.2%). In contrast, these treatments at two growth-stages did not significantly reduce center rot bulb incidence (*P*>0.05) after onion seedlings were exposed to thrips. **The results indicate that thrips infestation can reduce the efficacy of protective chemical treatments against *P. ananatis*.** Hence, it is critical to implement an effective management strategy including thrips management and protective chemical treatments against *P. ananatis* at susceptible growth stages of onion. In a field study, which was aggressively protected with insecticides for thrips control, Kocide 3000 and Kocide 3000 + Actigard applied at the bulb initiation and bulb swelling stages resulted in significantly lower center rot and higher marketable yield compared to Actigard and the untreated check.

**Role of weeds and thrips in center rot epidemic.** Weeds supporting epiphytic populations of *P. ananatis* were collected and established under greenhouse conditions. **Our results indicated that thrips can acquire *P. ananatis* from weeds and can efficiently transmit the pathogen to onion seedlings.** Considering the prevalence of weeds harboring *P. ananatis*, it is important to investigate the role(s) of these inoculum sources in center rot epidemics.

**New York – Stemphylium leaf blight (SLB) fungicide evaluations.** In recent years, SLB caused by *Stemphylium vesicarium* has emerged as the main foliar pathogen of onion in New York. SLB occurs in most onion crops in NY and is associated with premature senescence of foliage. Key findings from on-farm fungicide trial evaluations in direct seeded onions grown in muck soil in Elba, NY included: 1) Luna Tranquility had significantly the lowest SLB severity, highest % green foliage and highest yield than all other treatments with no difference between 12 and 16 fl oz rates. 2) Generally, fungicides belonging to FRAC 7 (Luna Tranquility, Merivon, Sercadis) provided best SLB control, except for Endura, which had significantly more SLB and less green foliage compared to the other FRAC 7s. 3) There were no significant differences in SLB severity or green foliage between the high and low rates of Merivon (5.5 vs. 9 fl oz), Inspire Super (16 vs. 20 fl oz) and Tilt (4 vs, 8 fl oz), although numerically the high rates yielded 34% more jumbo-sized bulbs. 4) Rovral 1 pt (FRAC 2) + Scala 9 fl oz (FRAC 9) provided as good control of SLB as the second-most effective treatments. 5) Following FRAC 7 and Rovral + Scala, FRAC 3 fungicides (Inspire Super, Viathon and Tilt) also provided good control of SLB. 6) Tanos (FRAC 27, 11) and Serifel (FRAC 44) were not significantly different than the untreated. 7) Critical timing to apply fungicides for SLB control appeared to be once the onion had reached 1” bulb from mid- to late-July. Spraying only before 1” bulb was too early and waiting until SLB had already set in before starting spraying was too late. 8) Using low rates of Luna Tranquility and Merivon can reduce application costs by 20-60% per application. Using Tilt at $3.50-$8 per acre with high-performing fungicides like Luna Tranquility may reduce cost of fungicide program by 50% or more. **For long-term fungicide-resistance management, growers are being encouraged to use no more than three applications of a single FRAC group per growing season.**

 **SLB Fungicide resistance.** Fungicides based solely on FRAC 11 active ingredients (e.g. azoxystrobin or pyraclostrobin) have shown poor efficacy against SLB in field trials in recent years. In conidial germination assays, **86.5% of *S. vesicarium* isolates (*n* = 74) collected from 12 conventional fields were insensitive to azoxystrobin** (EC50 > 0.5 µg/ml). The presence of the G143A mutation associated with FRAC 11 resistance was confirmed in isolates with EC50 > 0.5 µg/ml. **Some 25% of *S. vesicarium* isolates (*n* = 55) were highly insensitive (EC50 > 50.0 µg/ml) to boscalid *in vitro*.**  FRAC 9 fungicides have provided moderate control of SLB in field trials. **Approximately 25% of isolates (*n* = 71) of *S. vesicarium* were insensitive (EC50 > 5.0 µg/ml) to FRAC 9 (cyprodinil) *in vitro* with some isolates highly insensitive** (EC50 > 50.0 µg/ml). **Laboratory testing has failed to detect evidence of insensitivity in *S. vesicarium* to FRAC 2 (iprodione), FRAC 3 (difenoconazole), and FRAC 7 (fluxapyroxad and fluopyram).** The development of resistance to some FRAC groups will make management of SLB and fungicide resistance management in NY more challenging.

**SLB epidemiological studies.** To determine sources of inoculum and pattern of spread of SLB, epidemiological studies of SLB were undertaken in three commercial fields in Elba, NY. *S. vesicarium* was detected at low incidence in all fields at the first sampling time (Jun 26) with a large increase in incidence between Jul 7 and Jul 24. Studies were also undertaken to determine the survival of *S. vesicarium* in leaf debris over winter in NY. **Preliminary trial suggests that *S. vesicarium* survives in leaf debris over winter in NY, and that this contributes to initial inoculum the following year.**

**Oregon - Characterization and management of internal dry scale.** In 2014 and 2015, there was an increase in internal dry scale in onion bulbs grown in the Treasure Valley. It is difficult to detect externally and can result in quality issues in marketing. **Trials were conducted to determine whether heat is a factor in internal dry scale.** Four treatments including untreated check, artificial heat, kaolinite and straw mulch were evaluated in a split-plot design with varieties ‘Joaquin’ and ‘Granero’. Onions in each plot were evaluated weekly in the field from Jul 7 to Sep 15. After harvest, the onions from each plot were evaluated out of storage monthly starting in mid-November. Five bulbs per plot were rated for presence of incomplete scales, dry scales, and internal decay caused by, bacteria, neck rot, black mold, or *Fusarium proliferatum*. Incomplete scales were defined as scales that had more than 0.25 inch from the center of the neck missing or any part missing lower down on the scale. Dry scales were defined as scales inside the bulb either near the top of the neck or lower down on the scale. In another field trial, 100-ppm Cl solution derived from calcium hypochlorite and diatomaceous earth were broadcast at 44.5 gpa and at 37 lb/A in 148 gpa water, respectively. Both solutions were applied three times during bulb maturation and curing. Onions were evaluated out of storage as previously described.

**Management of white rot using sclerotial germination stimulants.** White rot is a major concern to onion and garlic growers in major *Allium*-producing regions in the western US. White rot sclerotia germinate only in the presence of volatile sulfur compounds produced by *Allium* spp., an aspect of this pathogen biology that can be exploited for management of the disease. Previous research demonstrated that germination stimulants coupled with in-furrow fungicide applications could provide effective control of white rot. However, new sources of stimulants need to be identified and tested.

Two laboratory trials were conducted to evaluate potential sclerotial germination stimulants. Thirty treatment combinations (8 stimulants at 3-4 concentrations) were tested in the first trial and 8 stimulants were tested in the second trial. Treatments were applied into petri plates containing soil and white rot sclerotia. Several compounds (diallyl disulfide, dimethyl disulfide, diethyl disulfide, isopropyl disulfide, and dipropyl disulfide) significantly increased sclerotia germination compared to the non-treated control and some stimulants exhibited prolonged activity. **Significant dose x stimulant interactions were observed, indicating that the rate of stimulant applied is an important factor for sclerotia germination.**

Field trials were conducted in Tulelake, CA (processing onions) and Fresno, CA (garlic) to evaluate natural sources of sclerotial germination stimulants (e.g., garlic juice, garlic oil, allyl isothiocyanate) with and without in-furrow fungicides for white rot control. **Stimulant treatments reduced sclerotia counts up to 61% in the Tulelake trial and up to 73% in the Fresno trial.** At the Tulelake site, diallyl disulfide and a dual application of garlic oil reduced leaf dieback in-season and the number of symptomatic bulbs at harvest. **Tebustar significantly increased total and marketable bulb yields at both sites, which is consistent with results obtained in previous research using in-furrow tebuconazole to suppress white rot.**

**Pennsylvania - Effect of nitrogen on center rot and marketable yield**. There was a significant positive correlation between the increase in foliar disease severity and the percent of incidence of bulb rot at harvest. Foliar disease severity over the course of the season increased significantly as nitrogen rate increased with foliar disease severity being 2.5-fold higher in 160 lb N/A than those which did not receive any in-season nitrogen applications. Not surprisingly, increasing the total amount of nitrogen applied up until early July during bulb initiation significantly increased the percent of marketable onions that graded as jumbo and colossal in size at harvest, although no significant differences were observed between the two higher nitrogen rates (105 and 160 lb/A).

**Washington – Effect of irrigation on internal dry scale and bacterial bulb decay.** During the very hot seasons of 2013-2015 in the Columbia Basin, many onion bulb crops were diagnosed with a physiological disorder called internal dry scale, which appears to be associated with extreme heat stress. Some affected bulbs also were colonized internally by bacterial pathogens. Losses were severe in some crops, particularly in 2015. A repeat of a 2016 trial was conducted in 2017 to determine if irrigation frequency and amount, combined with application of copper hydroxide (Kocide DF), can reduce the severity of internal dry scale and/or bacterial bulb rots. The trial was conducted at the WSU Commercial Vegetable Research Farm in Pasco, WA with ‘Calibra’. Commercial practices were used for agronomic inputs until the onset of air temperatures >95oF (Jul 3), after which plots were overhead-irrigated until late August. Half the plots received excess water (+0.1 inch) at each irrigation, so that the ‘wet’ and ‘dry’ plots received 6.1” and 4.5” in total whereas, respectively, during the heat stress period. ManKocide (2.25 lb/A) + 0.25% v/v NIS was applied in 40 gpa water in the mornings of Jul 31 and Aug 4. The trial was irrigated each of those afternoons, and the relevant plots inoculated with a mixed suspension of *Pantoea agglomerans* and *Burkholderia gladioli* each of those evenings in 20 gpa water with a CO2 plot sprayer. Harvested bulbs were rated for dry scale severity (0 to 3), bacterial rot, black mold, and double centers. **Onion plots irrigated excessively (‘wet’ plots) produced fewer jumbo bulbs and more culled bulbs, and had more severe internal dry scale symptoms than plots that received optimal irrigation (‘dry’ plots). Incidence of bacterial bulb rot was 21% in inoculated plots vs. 5% in non-inoculated plots. Inoculated plots also had fewer jumbo bulbs and less total yield than non-inoculated plots.** **ManKocide applications did not affect bulb yield (size, culled, or total yield), or the incidences of bacterial rot, black mold, and double centers.**

**Arbuscular mycorrhizal fungi (AMF).** Onions are highly responsive to the presence of symbiotic AMF. Commercial AMF inoculants (Mykos Gold Granular, AGTIV Granular, and Mycoapply Ultrafine Endo) were evaluated in 7 grower-cooperator onion trials in 2017 to determine if the products and application methods enhance onion production and reduce severity of soilborne diseases such as pink root. **None of the products improved onion production in the 2017 trials or reduced the severity of pink root significantly**, even in trials in which the AMF products were applied to plots that did not receive fertilizer at planting. Each field also received pre- and post-planting fertilizer applications to assess if the relatively high rates of fertilizer used by many onion growers applied at planting might have adverse effects on AMF colonization of onion roots. Growth chamber trials in which field soil was amended to contain 20, 40, and 80 ppm P, and then treated with Mykos Gold Granular and planted with onion seed, **demonstrated a significant reduction in AMF colonization of onion roots as soil P level increased. The relatively high rates of P fertilization commonly used in onion crops in the Columbia Basin may negate potential benefits of applying AMF inoculants.**

**Objective 4. Facilitate interaction and information transfer between W2008 participants, the onion industry and other stakeholders.**

**W2008 provided tremendous educational opportunities for stakeholders.** W2008 participants were extremely active in disseminating latest research findings and management recommendations to onion growers and other allied stakeholders across the country through presentations at grower meetings, hosting trial tours and field days, publishing newsletter articles and other resources, onion scouting programs and one-on-one communication. This is evident by the dozens of contributions cited in the “Other Activities” section of this report.

**Website re-instated.** The Alliumnet website was originally developed by the founder of W1008, Dr. Howard Schwartz, Colorado State University. The website was dedicated to information and resources on onion pest management and/or thrips and IYSV. However, since Schwartz’s retirement in 2015, it was abandoned In 2017, W2008 members decided that the rejuvenated Alliumnet website would be under the direction of Dr. Bhabesh Dutta, University of Georgia, who enlisted Joe LaForest at the Southern IPM center to pick up the support and customization of Alliumnet. The new website will provide a list of research and extension specialists working on pests and diseases, and will focus on collaboration among research, extension and industry, rather than be a venue for growers to find management information. Multiple people will be able to add content using a web browser, google analytics were added and it will be tablet and desktop responsive. It is expected to be available in January 2018.

**W2008 meet new stakeholders in Michigan.** To honor the commitment of W2008 to facilitate interaction and information transfer between W2008 participants, the onion industry and other stakeholders, the 2017 annual meeting of W2008 deliberately met in conjunction with the Great Lakes Fruit and Vegetable Expo (GLExpo) in Grand Rapids, MI. As a result, nine new onion growers, researchers/Extension and private industry representatives attended the W2008 who had previously never attended a meeting. Several W2008 participants were invited to speak in several GLExpo sessions. For the 2018 W3008 annual meeting, the group plans to meet in conjunction with the Pacific Northwest Vegetable Growers convention in Kennewick, WA to capitalize further on onion grower/stakeholder-W3008 interactions.

**W2008 participants collaborate on USDA SCRI grant research proposals.** These are muli-year, multi-state, multi-disciplinary and multi-million dollar projects designed to make significant progress towards finding solutions to issues threatening the viability of specialty crops. In 2017, W2008 members worked on two grant proposals, which will be submitted for funding in 2018: 1) Pappu et al. are proceeding with their third submission attempt on a project to include onion thrips, IYSV and white rot management; and 2) du Toit et al. are focusing on bacterial diseases. Stakeholder support and advisory are instrumental to the success of these projects.

1. **Impacts**

**New Research in Georgia Sets Stage For Management of Center Rot**

**ISSUE:** Vidalia sweet onion is a specialty vegetable crop, which accounts for 40% of the national spring onion production and has an annual farm-gate value of $139 million (2014).  Center rot is the most damaging bacterial disease affecting onions in Georgia, with severe losses occurring both in the field and in storage. Since its first report in Georgia (1997), center rot has been a constant threat to onion producers in GA and other onion producing states. Based on crop-loss estimates in 2014, center rot epidemic resulted in $3.5 million dollars in losses in GA.

The disease is primarily caused by a Gram-negative bacterium, *Pantoea ananatis*, which is endemic to Georgia as >20 weed species have been reported as possible inoculum reservoirs. Other *Pantoea* species such as *P. agglomerans* and *P. alli* can also cause center rot symptoms and all three bacterial species have been reported in Georgia. Center rot symptoms include necrotic and bleached streaks on young leaves and in severe cases, it may lead to wilting of plants. The bacterium may also progress to the bulb and predispose bulbs to rot in storage. Under favorable conditions, this disease has potential to cause yield losses up to 100%.

In Georgia, center rot has been reported to be transmitted by tobacco thrips, *Frankliniella fusca*. However, we recently demonstrated that onion thrips, (*Thrips tabaci*), which is also prevalent in GA, can also acquire and transmit two of the center rot pathogens, *P. ananatis* and *P. agglomerans*. Because the mode of transmission is non-specific, it is likely that both species of thrips can also transmit the less prevalently occurring *P. alli*. Considering the prevalence of weeds harboring *P. ananatis* and the ability of thrips to acquire and transmit these bacteria, it was important to investigate the role(s) of these inoculum sources in center rot epidemics. There is a considerable knowledge gap on interactions between thrips, weeds, and bacteria (*P. ananatis*) in center rot epidemics. Specific knowledge on these interactions is critical for disease management based on vector and weed control. In addition, basic information on the genetic diversity of strains, genetic determinants of bacterial virulence, susceptibility of onions at different growth stages and effective chemical management were lacking.

**RESPONSE:** Extensive cooperation between research faculty members and extension specialists in the department of plant pathology and entomology, postdoctoral research associates, and public service faculty were made to address the above mentioned issue. Greenhouse, laboratory and field studies were designed to investigate above research questions.

**IMPACTS:**

Our findings indicate that *P. ananatis* strains pathogenic to onion possess a specific-plasmid borne gene cluster (OVR A-D) that majority of the non-pathogenic strains lack. These regions can be utilized for designing specific diagnostic assays helping in accurate diagnosis of pathogenic *P. ananatis* strains.

Susceptible growth stages of onion that can cause bulb symptoms were also identified and further investigations indicate that chemical treatments with Kocide 3000 at these stages can greatly reduce bulb infection. However, in situations with thrips infestation, any chemical management against *P. ananatis* would be ineffective. Hence, rigorous thrips management is required for effective management of *P. ananatis* with bactericides.

**New York Onion Growers Adopt Insecticide Resistance Management Tactics for Onion Thrips**

**ISSUE:** Onion thrips (*Thrips tabaci*) is a perennial pest of onion in New York and infestations often lead to significant reductions in bulb yield and quality. Growers often use insecticides to control onion thrips; however, thrips have developed resistance to a variety of insecticide classes. In 2015, Cornell Cooperative Extension (CCE) educators and Cornell entomologists surveyed New York onion growers about their onion thrips management tactics. Only 40% of growers used an action threshold to determine if and when to apply an insecticide to manage thrips. Additionally, only 52% of growers rotated insecticide classes during the season, which is another important insecticide resistance management tactic.

**RESPONSE:** CCE educators and entomologists implemented a three-year onion thrips management program to increase adoption of insecticide resistance management tactics. The program included 17 onion growers from six major onion-producing counties in New York. Growers who participated in the management program received weekly reports about onion thrips densities in their fields and a corresponding recommendation on whether to use an insecticide based on an action threshold and what product to use in the season-long rotation.

**IMPACT:** Participating growers increased adoption of both insecticide resistance management strategies, with a 39% increase in following an appropriate rotation of insecticide classes and a 42% increase in using the action threshold from 2015 to 2017. Onion growers who followed the action threshold successfully controlled onion thrips infestations, and applied 2-4 fewer insecticide applications compared with those growers who did not use the action threshold. Cost savings from using the action threshold recommendations averaged $42/acre in 2016 and 2017.

**Cornell Onion Specialists Identify Cause and Find Cure for New Disease of Onion in New York**

**EXECUTIVE SUMMARY:**

Cornell University Onion Specialists identify cause of excessive leaf dieback in muck grown onions as a new aggressive form of Stemphylium leaf blight, and determine the cure lies in a revised fungicide program, which has resulted in almost 100% grower adoption, 80% improved plant health and increased yield by up to 33%.

**ISSUE:**

Onions are one of the most valuable vegetable crops grown in New York with an average annual value of $34.6 million. With over 232 million pounds of onions produced, New York accounts for 97% of the production in the Northeast United States and ranks fifth in the Nation. According to the 2012 Census of Agriculture, 7,400 acres of onions are produced on 73 farms in organically rich muck soils where production practices are unique and intensive.

A mysterious situation occurred during the 2013 growing season, which had been increasing in severity for a few years, where despite very favorable conditions for growing onions, several fields across the state suffered from excessive leaf dieback, which caused the onion plants to “die standing up”. When onion plants finish with what is left of their leaves remaining upright instead of lodging properly, maturation is halted at the expense of bulb size and quality. Yield can be reduced by as much as one-third and incidence of bacterial bulb decay can double. The New York onion industry needed to know the cause and find the cure for this mysterious leaf die back of their onions.

**RESPONSE:**

As a specialist in onions, Christy Hoepting, Senior Extension Associate with the Cornell Cooperative Extension Cornell Vegetable Program (CVP), had been staying abreast of new and emerging issues in onion production and had been following developments of a disease that had been causing excessive leaf dieback to the north in Ontario, Canada. Stemphylium leaf blight (SLB) was generally considered a weak pathogen of onion, always present, but rarely causing economic losses, until something changed around 2010 when it moved into the front seat as an aggressive primary pathogen.

From 2013 to 2017, Hoepting collaborated with Cornell NYSAES Plant Pathologists Sarah Pethybridge and Frank Hay and together acquired $264,306 in funds to support research projects on various aspects of onion leaf diseases. During this period, 13 individual on-farm small-plot trials were conducted to evaluate relative performance of fungicides for control of SLB, downy mildew (DM) and Botrytis leaf blight (BLB). Hundreds of SLB isolates from across the state were collected and tested for their sensitivity to different fungicide active ingredients.

To preserve the useful longevity of fungicides at risk for developing resistance, Cornell specialists developed an educational program nicknamed “spray by number for fungicide resistance”. For simplicity, it uses fungicide resistance numbers instead of their complicated names, which includes the popular fungicide “Cheat Sheet” as a resource. Cornell Specialists, wrote 12 newsletter articles for growers providing research updates and new recommendations regarding managing onion leaf diseases with fungicides, and held three fungicide trial tours with growers and industry representatives.

The effectiveness of growers’ fungicide programs was measured in 8 to 20 commercial onion fields per year via Hoepting’s onion “research scouting” program, which was complimented by weekly fungicide recommendations and discussions with the 15 growers participating in the project, representing over 85% of muck onion production within the CVP region in Genesee, Orleans, Oswego, Wayne and Yates counties.

**IMPACTS:**

In 2013, Cornell confirmed that SLB was the cause of excessive leaf dieback and onion plants dying standing up. In 2014, via an on-farm fungicide trial, Hoepting identified that effective management of SLB was imperative when managing DM, because SLB readily invades leaf tissue once it has been attacked by DM and the resulting DM-SLB complex was more aggressive than ever with the new form of SLB.

The most effective fungicides for controlling SLB and DM were identified through on-farm fungicide trials. Fungicides that were once effective for managing the onion leaf complex such as Bravo, mancozeb and Rovral failed to protect plants from the new SLB. Instead, fungicides belonging to FRAC (Fungicide Resistance Action Committee) group 7 were the most effective with the ability to keep 80% of the leaves green and healthy compared to only 10% with the old fungicides. Fungicides belonging to FRAC group 3 also provided very good control of SLB.

Unfortunately, the top two performing products for SLB control were not labeled for use on onion in New York. Hoepting was able to leverage her research data and successfully advocate for use of FRAC 7 fungicides, Luna Tranquility and Merivon, for which the New York State Department of Conservation and Environment (NYSDEC) issued Section 24(c) Special Local Needs (SLN) labels allowing for their use in onion in New York until they received full registration.

Collaborative work between Hoepting, Pethybridge and Hay revealed that SLB had developed resistance to FRAC group 11 fungicides; fungicides that were once top performing products had become completely ineffective. After learning this, onion growers no longer wasted $25 per acre per spray on products that did not work.

In 2017, onion growers reported being very satisfied with their ability to manage leaf diseases in a year when conditions were very favorable for disease, thanks to their adoption of Hoepting’s considerably revamped fungicide recommendations to include new fungicides that effectively control the new aggressive form of SLB.

Today, onion growers proudly know which resistance groups different fungicide products belong to and how many sprays they may make before rotating to a different resistance group. In 2017, out of the 174 individual fungicide applications made in 20 spray programs representing the majority of CVP onion acreage, an outstanding 99% followed rotation restrictions and maximum use rates for best fungicide resistance management practices to ensure their useful longevity.

**Pennsylvania Onion Growers Implement Tactics to Reduce Soil Temperature To Reduce Losses From Center Rot**

**ISSUE:** In Pennsylvania, the majority of onions grown are marketed through the PA Simply Sweet Onion Program, the state’s only trademarked crop. In 2017, 89 growers produced program onions on 125 acres which were valued at over $1.4M; over quadruple the production since the program’s inception in 2004. Unfortunately, onion growers in Pennsylvania and elsewhere are constantly challenged by yield losses due to bacterial diseases, even when actively trying to manage the disease. In some fields losses due to the bacterial disease center rot can approach 50% under favorable disease conditions.

**RESPONSE:** Through replicated field and commercial on-farm trials over several years, a strong positive correlation between increased soil temperature when the onions start bulbing in late June and increased losses due to bacterial disease has emerged.

**IMPACTS:** Growers are shifting from producing onions on standard black plastic mulch to reflective silver mulch, which can significantly reduce soil temperatures and therefore losses due to center rot. In one on-farm trial, the marketable onion yield on silver mulch was over three times that of black plastic. The incorporation of silver plastic into the integrated pest management toolbox provides growers with another tactic that they can employ to reduce losses due to bacterial disease.

**Improving Insect Management in Dry Bulb Onions in the Columbia Basin**

* [2015](http://ext100.wsu.edu/wp-content/uploads/2015/06/improving-insect-management-in-dry-bulb-onions-in-the-columbia-basin-2015.pdf)

**ISSUE**

Dry bulb onions are grown on 24,000 acres in Washington and the crop is valued at about $199 million annually. Dry bulb onions are a high-value vegetable crop in which insect pest damage can have a significant negative impact on crop yield and quality. Prior to 2006, producers had very few options for effective control of onion thrips (*Thrips tabaci*), a persistent insect pest that requires as many as 10 insecticide applications per growing season for adequate control. Feeding by onion thrips can decrease crop yield by as much as 35% when ineffective treatments are used. Thrips also can vector Iris yellow spot virus, a devastating plant disease that can further decrease yield and profitability for producers.

**RESPONSE:**

The overall goal of this project was to improve Integrated Pest Management in dry bulb onions in the Columbia Basin. Research projects have been conducted with grant funding secured from the Washington State Commission on Pesticide Registration, the Pacific Northwest Vegetable Growers Association, and private sources. The research projects have focused on evaluating new insecticides, documenting chemical resistance, and evaluating use patterns and application techniques of currently registered insecticides. This project identified that utilizing the proper insecticide at the correct timing can improve onion yield by greater than 25%.

After the research projects are completed, the information was shared with producers so they can implement these strategies on their farms. More than 50 formal presentations and 6 field days have been conducted over the last 9 years to disseminate results of this project. Each season more than 120 industry members from the Pacific Northwest attend the WSU Onion Field Day and the presentations made at the Pacific Northwest Vegetable Growers Association annual meeting are heard by more than 250 attendees representing onion farms in Washington, Oregon, and Idaho. Additionally, 2 extension publications, 1 referred journal article, and 3 popular press articles have been published. Three Section 18 Emergency Pesticide Labels were granted for thrips control on dry bulb onions during the early years of this project to help growers better manage this devastating insect pest.

**IMPACTS:**

As a result of this project demonstrating that pyrethroid insecticides are ineffective and, in fact, thrips are resistant to this commonly used class of insecticides, producers have ceased use of this insecticide and have shifted to using the more effective insecticides identified by this research.

The WSU Extension Commercial Vegetable program determined the best timing and application methods for new narrow-spectrum insecticides, which often are slower acting than previously used broad-spectrum insecticides and would be ineffective if used in the same manner. The new insecticides are applied at lower rates and are safer for the environment and non-target organisms than the older insecticides. Additionally, the improved application methods (applying via drip or center pivot irrigation) are less expensive and more effective than foliar applications. **Narrower spectrum insecticides now account for greater than 60% of insecticide applications in the Columbia Basis.** Furthermore, producers have shifted from using broad-spectrum insecticides early in the season to using them late in the season, or not at all in order to preserve beneficial insects in onion fields.

**More than 80% of the onion growers in Washington have altered their IPM strategies for managing thrips in onions as a result of research conducted by WSU Extension.** Studies showed that when the most effective insecticides were utilized in thrips management programs in onions, yields increased by 25%. A 25% increase in onion yield translates to at least $2,400 more in net profit per acre for growers who use these treatments, using the 2015 onion market value. With 24,000 acres of onions in WA, if 20% of users implement these changes, the WA onion crop value would increase by $11.5 million annually.

**Quotes**

*"The Sunheaven Farms growers put a high value on the thrips research and advice that Tim Waters of WSU Extension provides. Thrips are a major pest on our farms, and controlling them has become a challenge. Without successful thrips control the value of our produce would drop drastically. ... Tim's research and screening of new pesticides and application techniques has been a lifesaver for us. Before Tim was here, we depended on research from other areas, which sometimes was not pertinent to the Columbia Basin. Tim's work is done with local cultural practices in mind and his program is integral to the success of controlling insect pests on our farm and many others in the Columbia Basin."* -  Wes Locke, Agronomist, Sunheaven Farms

*"Much of the research WSU’s team and the local people, Tim Waters and Carrie Wohleb, have conducted helped us to improve the quality of our crop. The ongoing work on thrips control and timing of these newer pesticides are very important. Tim and Carrie have developed respect with the independent-minded onions growers and I know they will continue to be helpful in the future."* - Larry Bauman, L and L Ag Production

**Major IMPACTS to onion producers, packers, and shippers in the Columbia Basin of central Washington and northcentral Oregon resulting from participation by L. du Toit and T. Waters in the W-2008 project:**

1. The very significant benefits to onion growers resulting from research and extension by T. Waters and L. du Toit’s programs over the last 10+ years, including work directly related to the W-1008, W-2008, and now the W-3008 multistate projects, increased awareness among onion producers, packers, and shippers of the need to support onion research. As a result, the **Columbia Basin Onion Research Commission** was formed in 2016, based on a voluntary contribution of $5/acre to support research efforts in the Columbia Basin of central Washington and northcentral Oregon, where ~24,000 acres of onion bulb crops are grown annually. This has equated to **approximately a $100,000/year new investment in funding for regional onion research and extension, with the first year of funding in 2017**.
2. An increasing number of onion farms in the Columbia Basin are using microbial inoculants such as AMF in an attempt to increase environmental sustainability of their production practices and, potentially, reduce the reliance on soil fumigation, pesticide applications, etc. However, the lack of independent data on efficacy of these products has results in fairly widespread use of some products that have not provided an evident benefit to the crops. Feedback from onion growers who have participated in the arbuscular mycorrhizal fungi (AMF) research project by du Toit and Waters indicated significant savings to some farms that were using liquid formulations of commercial AMF inoculants that this project demonstrated did not cause any increase in AMF colonization of onion roots compared to granular formulations. **One farm alone indicated that the results have saved the operation $50,000/year, demonstrating the tremendous value of grower-cooperator trials, even when the results indicate a product is not providing benefits.**
3. Research trials on Rhizoctonia stunting in the Columbia Basin identified some highly effective management practices that significantly reduce the impact of this disease. Onion crops on coarse, sandy soils can average ~3% stunted patches. The average center-pivot irrigated onion crop is valued at a minimum of $500,000, 3% of which is $15,000. Even if only one-quarter of the ~200 onion fields in the Columbia Basin experience Rhizoctonia stunting, $15,000 x 200/4 = **$750,000/year in yield loss to Rhizoctonia stunting that has been prevented** as a result of growers implementing the management practices developed as a result of this research.
4. Onion thrips research projects have identified the most effective insecticides and proper use patterns for these products. Producers that utilize this information can achieve an average 10% increase in crop yield via increased onion bulb size. It is estimated that at least half of the producers utilize this information. **As such, each season, $5 million worth of onion crop is preserved by using the proper insecticides and timing of those products.**

**Other Impacts:**

In the **Treasure Valley**, Oregon State University and Industry partners developed the **Pest Management Strategic Plan (PMSP).** It is benefiting the industry by 1) providing regulators with information on actual pest management practices and therefore reducing errors in formulating risk assessments; 2) documenting stakeholder needs to support funding requests; and 3) providing information for growers to facilitate their transition to alternative pest management practices. These benefits will help assure the sustainability of onion production in the Treasure Valley.

In **Oregon**, **new compounds were identified that can be used to induce white rot sclerotia germination and reduce inoculum prior to planting.** The identification of dose x treatment interactions will inform decisions on treatment-rate combinations to test in future studies. Field trials demonstrated that the combined use of sclerotial germination stimulants to reduce initial inoculum levels and in-furrow applications to suppress white rot in-season could form the basis of an IPM approach for white rot.

In **New Mexico**, if the **new inoculation protocol developed by New Mexico onion breeder, proves** **successful at identifying onion bulbs that are resistant to Fusarium basal rot (FBR**), then FBR resistance will finally be realized and the protocol could be used by other onion breeding programs to develop FBR resistant cultivars.

**In Utah, more onion growers are getting soil tests done prior to planting** rather than just applying a set amount of fertilizer regardless of what is present in the soil. Research by Dan Drost and Diane Alston showed that thrips populations are often higher on onions grown with high nitrogen levels and Claudia Nischwitz showed that potassium levels can affect IYSV symptom expression.

1. **Publications (2017) 50,000**

Buckland, K., D. Alston, J. Reeve and C. Nischwitz. 2017. Trap crops in onion to reduce onion thrips and Iris yellow spot virus. Southwestern Entomologist 42(1): 73-90. http://dx.doi.org/10.3958/059.042.0108.

Cramer, C.S. 2017. Evaluating Iris yellow spot disease incidence and severity in onion germplasm of varying leaf characteristics. HortScience 52:527-532.

Dung, J. and R. Wilson. 2017. In search of the next DADS: continuing research on fungicides and sclerotia germination stimulants for White Rot control. Onion World (May/June 2017):4-6.

Dutta, B., F. Anderson, S. Smith, and R.D. Gitaitis. 2017. Epiphytic survival of *Pantoea ananatis* on *Richardia scabra* in Georgia. Plant Disease 101:613-618.

Henrichs, B., M.L. Derie, T.D. Waters and L.J. du Toit. 2017. The effects of arbuscular mycorrhizal inoculants on onion root colonization and growth in field trials near Connell, WA, 2016. Plant Disease Management Reports 11:V137.

Henrichs, B., T.D. Waters, and L.J. du Toit. 2017. The effect of soil phosphorus levels on colonization of onion roots by arbuscular mycorrhizal fungi, 2016-2017. Plant Disease Management Reports 11:V125.

Hoepting, C.A. 2017. Efficacy of foliar nutrient feeding on Stemphylium leaf blight on onion, 2016. Plant Disease Management Reports 10:V129. Doi: 10.1094/PDMR11.

Hoepting, C.A. 2017. Efficacy of fungicide timing on Stemphylium leaf blight on onion, 2016. Plant Disease Management Reports 10:V130. Doi: 10.1094/PDMR11.

Hoepting, C.A.2017. Efficacy of fungicide treatments for control of Botrytis leaf blight and Stemphylium leaf blight on onion, 2016. Plant Disease Management Reports 10:V127. Doi: 10.1094/PDMR11.

Hoepting, C.A. 2017. Efficacy of fungicide treatments for control of Stemphylium leaf blight on onion, 2016. Plant Disease Management Reports 10:V128. Doi: 10.1094/PDMR11.

Johnson, W.,B. Dutta, F.H. Sanders, and X. Luo. 2017. Interactions among cultivation, weeds and a bio fungicide in organic Vidalia sweet onion. Weed Technology 31:890-896.

Leach, A., M. Fuchs, R. Harding, R. Schmidt-Jeffris and B.A. Nault. 2017. Transplanted onion fields host abundant dispersing viruliferous onion thrips early to mid-season for late season *Iris yellow spot virus* epidemics in New York. Plant Disease (in press) <https://doi.org/10.1094/PDIS-06-17-0793-RE>.

Leach, A., S. Reiners, M. Fuchs and B.A. Nault. 2017. Evaluating integrated pest management tactics for onion thrips and pathogens they transmit to onion. Agriculture, Ecosystems & Environment 250: 89-101.

Mazzone, J.E. 2017. Responding to growers’ needs: evaluation of management strategies for onion center rot, caused by *Pantoea ananatis* and *Pantoea agglomerans*. M.S. Thesis, The Pennsylvania State University, University Park, PA, May 2017.

Moloto, V.M., T. Goszczynska, L.J. du Toit, and T.A. Coutinho. 2017. A new pathovar of *Pseudomonas syringae*, pathovar *allii*, isolated from onion plants exhibiting symptoms of blight. Europ. J. Plant Pathol. 146:591-603.

Murray, M.K., P. Jepson, S. Reitz. 2017. An integrated pest management strategic plan for treasure valley onions: Oregon and Idaho. Western Region Integrated Pest Management Center. <https://ipmdata.ipmcenters.org/documents/pmsps/Onion_IPMSP_June_2017.pdf>

Reitz, S.R. 2017. Evolution of onion pest management in the treasure valley. Onion World (February 2017) pp. 6-8.

Rinehold, J., N. Bell, T.D. Waters and D. McGrath. 2017. Vegetable insect pests. In Craig Hollingsworth (Eds.), 2015 Pacific Northwest Insect Management Handbook Corvallis, OR: Oregon State University.

Smith, E.A., E.J. Shields, and B.A. Nault. 2017. Onion thrips colonization of onion fields bordering crop and non-crop habitats in muck cropping systems. Journal of Applied Entomology 141(7): 574-582.

Stumpf, S., R. Gitaitis, T. Coolong, C. Riner, and B. Dutta. 2017. Interaction of onion cultivar and growth stages on incidence of *Pantoea ananatis* bulb infection. Plant Disease 101:1616-1620.

Waters, T.D. and J.K. Darner. 2017. Thrips managment on dry bulb onions with the use of foliar insecticide applications, 2016. Arthropod Management Tests 2017; 42 (1): tsx081. doi: 10.1093/amt/tsx081.

Zhao, X., S.R. Reitz, H. Yuan, Z. Lei, D.R. Paini, and Y. Gao. 2017. Pesticide-mediated intraspecific competition between local and invasive thrips pests. Nature Scientific Reports. 7:40512 | DOI: 10.1038/srep40512.

**Other Activities**

**1. Abstracts and Papers at International Professional Meetings**

Foley, K., C.C. Shock, and M. Santelmann. 2017. Drivers and barriers to producers’ voluntary adoption of practices that protect water quality. International Irrigation Show. Orlando, Florida: November 8, 2017.

Moloto, V.M., T. Goszczynska, L.J. du Toit, and T.A. Coutinho. 2017. Analysis of bacterial communities associated with onion (*Allium cepa*) seeds through culture dependent and culture independent methods. Poster presented at 50th Congress of Southern African Soc. Plant Pathology. Drakensburg, South Africa: January 15-18, 2017.

Reitz, S.R. Emerging Developments in Insecticide Resistance Management for Thrips. Beijing Academy of Agriculture and Forestry Sciences. Beijing, China: November 27, 2017.

Shock, C.C. 2017. Are field experiments easy? How to design, manage, and evaluate field experiments. China Agricultural University. Beijing, China: June 6, 2017.

Shock, C.C. 2017. Climate-smart agriculture. Jain Irrigations Systems. Jalgaon, India: January 24, 2017.

Shock, C.C. 2017. Creation and adoption of smart agriculture innovations to cope with climatic uncertainty. Keynote address at the International Conference on Biodiversity, Climate Change Assessment and Impacts on Livelihood. Kathmandu, Nepal: January 10-12, 2017.

Shock, C.C. 2017. Irrigation management for climate-smart agriculture. Keynote address at the International Conference on Technological Advances in Climate-Smart Agriculture and Sustainability (TACSAS 2017). Nanded, India: January 16-18, 2017.

**2. Abstracts and Papers at National Professional Meetings**

Dutta, B. 2017. Diversity of *Pantoea ananatis* in Georgia. In W3008 Multi-state Project Meeting on Onion. Grand Rapids, Michigan: December 4, 2017.

Dutta, B. 2017. State Update: Management of important diseases of onion in Georgia. In W3008 Multi-state Project Meeting on Onion. Grand Rapids, Michigan: December 4, 2017.

Foley, K., C.C. Shock, and M. Santelmann. 2017. Drivers and barriers to producers’ voluntary adoption of practices that protect water quality. Annual meeting of the American Society of Horticultural Science. Waikoloa, Hawaii: September 21, 2017.

Hoepting, C.A. 2017. New York report. Multi-State Project W2008 Annual Meeting: Biology and management of Iris Yellow Spot Virus (IYSV), other diseases and thrips in onions. Grand Rapids, Michigan: December 4, 2017.

Hoepting, C.A. 2017. Onion leaf disease update featuring Stemphylium leaf blight. Multi-State Project W2008 Annual Meeting: Biology and management of Iris Yellow Spot Virus (IYSV), other diseases and thrips in onions. Grand Rapids, Michigan: December 4, 2017.

Leach, A., M. Fuchs, R. Harding, R. Schmidt-Jeffris and B. Nault. 2017. Evaluating major sources of *Iris yellow spot virus* in New York. Entomological Society of America Annual Meeting. Denver, Colorado: November 6, 2017.

Mazzone, J., M. Mansfield, and B.K. Gugino. 2017. Optimizing the timing and rate of nitrogen applications to reduce onion center rot losses in Pennsylvania. American Pathological Society of Northeastern Division Meeting. Ithaca, New York: October 19-21, 2016. Phytopathology 107:S2.11. <http://dx.doi.org/10.1094/PHYTO-107-11-S2.11>.

Nault, B.A. 2017. Managing onion insect pests and associated diseases, pp. 2-7. Great Lakes Fruit, Vegetable and Farm Market EXPO. Grand Rapids, Michigan: December 6, 2017. <http://glexpo.org/summaries/2017summaries/Onion.pdf>.

Nault, B.A., S. Reitz and T. Waters. 2017. Current and future management of onion-thrips transmitted *Iris yellow spot virus* in onion. In PIE Section Symposium: Inspiring a new cadre of vegetable specialists by sharing expertise related to piercing-sucking insects of economic importance in vegetable production. Entomological Society of America Annual Meeting. Denver, Colorado: November 8, 2017.

Shock, C.C., E.B.G. Feibert and N.L. Shaw. 2017. Oregon report to W3128, scaling microirrigation technologies to address global water challenges. Annual meeting of the W3128 working group. Orlando, Florida: November 5, 2017.

Shock, C.C. and F.X. Wang. 2017. Controlling Irrigation Onset by Soil Water Tension. Annual meeting of the American Society of Horticultural Science. Waikoloa, Hawaii: September 22, 2017.

Shock, C.C., F.X. Wang, A.D. Campbell, and H. Dominguez-Aguire. 2017. Triggering drip irrigation onset by soil water tension. International Irrigation Show. Orlando, Florida: November 7, 2017.

Stice, S., B. Kvitko and B. Dutta. 2017. *Pantoea ananatis* comparative genetics and in planta kinetics. 2017 American Pathological Society Annual Meeting. San Antonio, Texas: August 5-9, 2017. Phytopathology (S5) 136.

Stumpf, S., R. Gitaitis, T. Coolong, C. Riner, and B. Dutta. 2017. Interaction of onion cultivar and growth stages on incidence of *Pantoea ananatis* bulb infection. 2017 American Pathological Society Annual Meeting. San Antonio, Texas: August 5-9, 2017. Phytopathology (S5) 74.

Waters, T.D. 2017. Management strategies for thrips in onions: a major pest in a minor crop. Pacific Branch of the Entomological Society of America. Portland, Oregon: January 9-10, 2017.

Waters, T.D. 2017. Thrips control in dry bulb onions. Pacific Northwest Insect Management Conference. Portland, Oregon, U.S.A.: 9-10 January 9-10, 2017.

**3. Reports at Grower Meetings**

du Toit, L.J. 2017. Downy mildew in onion seed crops. Columbia Basin Vegetable Seed Association Annual Meeting. Moses Lake, Washington: February 1, 2017.

du Toit, L.J. 2017. It takes two to tango: Management of Stemphylium leaf blight and downy mildew in the onion leaf blight complex. Wisconsin Potato & Vegetable Growers’ Association Grower Education Conference. Stevens Point, Wisconsin: February 7-9, 2017.

du Toit, L.J. 2017. Lessons from onion downy mildew and Stemphylium leaf blight. Pacific Northwest Vegetable Association Annual Convention & Trade Show. Kennewick, Washington: November 15-16, 2017.

du Toit, L.J. 2017. Managing Botrytis neck rot of onion based on Achilles’ heel. 44th Annual Hermiston Farm Fair. Hermiston, Oregon: November 29 - December 1, 2017.

du Toit, L.J. 2017. Pink root and mycorrhizal inoculants in onion production in the Pacific Northwest. Great Lakes Expo. Grand Rapids, Michigan: December 6, 2017.

du Toit, L.J. 2017. What? Why? And How? Of Onion Disease Management in the Columbia Basin. National Onion Association Summer Meeting. Richland, Washington: July 20, 2017.

du Toit, L.J. and T.W. Waters. 2017. Evaluating irrigation management and bactericides for internal dry scale and bacterial bulb rots of onion. Pacific Northwest Vegetable Association Annual Convention & Trade Show. Kennewick, Washington: November 15-16, 2017.

Dung, J.K.S. 2017. Sclerotia germination stimulants for white rot control: A research update. Onion White Rot Field Tour and Research Meeting. Tulelake, California: September 19, 2017.

Dung, J.K.S. 2017. Evaluation of sclerotia germination stimulants for white rot control. California Garlic and Onion Research Advisory Board Allium Research Symposium. Tulare, California: February 13, 2017.

Dutta, B. 2017. Research progress and future challenges in managing center rot of onion. In Great Lakes Expo (Onion Session). Grand Rapids, Michigan: December 6, 2017.

Gugino, B.K. 2017. Allium pests and diseases from Allium leafminer to rot. Pennsylvania Sustainable Agriculture Farming for the Future Conference. University Park, Pennsylvania: February 3, 2017.

Gugino, B.K. 2017. Foliar disease management of onion. Mid-Atlantic Fruit and Vegetable Convention. Hershey, Pennsylvania: February 1, 2017.

Gugino, B.K. 2017. Growing onions? Options for disease management. Northeast Vegetable Growers Meeting. Clarks Summit, Pennsylvania: January 25, 2017.

Hay, F.S., C. Hoepting, E. Maloney, & S.J. Pethybridge. 2017. Management of Stemphylium leaf blight. Cornell Cooperative Extension Orange County Onion School. Middletown, New York: February 28, 2017.

Hoepting, C.A.2017. 2016 Fungicide trial results and recommendations. Orange County Cornell Cooperative Extension Onion School. Middletown, New York: January 28, 2017. (53 participants).

Hoepting, C.A. 2017. Controlling Stemphylium on onions in New York State. 66th Annual Bradford MuckVegetable Growers Conference. Bradford, Ontario, Canada: April 13, 2017. (60 participants).

Hoepting, C.A. 2017. Onion leaf disease management, 2016 research update. March Onion School - Elba Region. Albion, New York: March 8, 2017. (36 Participants)

Hoepting, C.A. 2017. Onion leaf disease management 2016 research update. March Onion School - Oswego Region. Oswego, New York: March 16, 2017. (43 Participants)

Leach, A., S. Reiners, M. Fuchs, C. Hoepting and B.A. Nault. 2017. Advancing onion thrips management in onion and challenges in implementation. Larry Larson Award Presentation. Indianapolis, Indiana: February 24, 2017.

Nault, B.A. 2017. Allium leafminer management meeting. Orange County Twilight Meeting. Cornell Cooperative Extension Eastern New York Commercial Horticulture. Goshen, New York: October 19, 2017.

Nault, B.A. 2017. Integrated pest management for onions. Orange County Onion School. Cornell Cooperative Extension Eastern New York Commercial Horticulture. Middletown, New York: February 28, 2017.

Nault, B.A. 2017. Onion insect management 2016 research update. Winter Elba Onion School and Advisory Meeting. Cornell Cooperative Vegetable Program. Albion, New York: March 8, 2017.

Nault, B.A. 2017. Oswego winter onion school and advisory meeting. Cornell Cooperative Extension Cornell Vegetable Program. Oswego, New York: March 16, 2017.

Qian, M. and J.K.S. Dung. 2017. Efficacy of organic sulfur compounds from garlic/onion on white rot scleratia germination. California Garlic and Onion Research Advisory Board Allium Research Symposium. Tulare, California: February 13, 2017.

Reitz, S., C.C. Shock, E.B.G. Feibert, A. Rivera, L.D. Saunders, and E. Jemmett. 2017. Thrips and Iris yellow spot virus management in the Treasure Valley. Idaho-Eastern Onion Growers’ Association Annual Meeting. Ontario, Oregon: February 7, 2017.

Shock, C.C. 2017. Drip irrigation for onion: growers’ adoption of innovations. Clearwater Supply Annual Drip irrigation Meeting. Ontario, Oregon: January 8, 2017.

Shock, C.C. 2017. Precision irrigateion can optimize yields and reduce input costs. Hermiston Farm Fair. Hermiston, Oregon: November 30, 2017.

Shock, C.C., S.R. Reitz, E. Feibert, A. Rivera, H. Kreeft, and J. Klauzer. 2017. Overview of research on the Food Safety Modernization Act. Idaho-Eastern Oregon Onion Growers’ Association Annual Meeting. Ontario, Oregon: February 7, 2017.

Turini, T. 2017. Fresno County White Rot management field trial results. California Garlic and Onion Research Advisory Board Allium Research Symposium. Tulare, California: February 13, 2017.

Waters, T.D. 2017. Utilizing new insecticides to manage thrips in onions. Syngenta Onion Grower and Consultants Meeting. Pasco, Washington.

Waters, T.D., C. Wohleb, L. duToit, and M. Derie. 2017. Thrips and IYSV management in onion seed. Columbia Basin Vegetable Seed Growers Annual Meeting. Moses Lake, Washington: February 1, 2017.

Wohleb, C.H. 2017. Growing onions in the Columbia Basin: growth & development, planning ahead, and problem solving. 2017 Columbia Basin Crop Consultants Association Short Course. Moses Lake, Washington: January 19, 2017.

Wohleb, C.H. and T.D. Waters. 2017. Thrips biology and IYSV basics. Pacific Northwest Vegetable Association 31st Annual Conference and Trade Show. Kennewick, Washington: November 15, 2017.

1. **Grower Field Days:**
* **Garlic White Rot Field Day**, Five Points, California: June 15, 2017.
* **Summer Farm Festival and Malheur Experiment Station Field Day**, Malheur Experiment Station, Oregon State University, Ontario, Oregon: July 12, 2017.
* **Intermountain Research and Extension Center Field Day***,* Intermountain Research and Extension Center, Tulelake, California: July 26, 2017*.*
* **2017 Washington State University Onion Field Day,** Weyns Farms, Bruce, Washington: 24 August 2017.
* **Colorado State University Specialty Crops Field day**, Fort Collins, Colorado: August 23, 2017
* **Onion Variety Day**, Malheur Experiment Station, Oregon State University, Ontario, Oregon: August 22, 2017.
* **Onion White Rot Field Tour and Research Meeting**, Intermountain Research and Extension Center,
* Tulelake, California: September 19, 2017.
* **Treasure Valley Irrigation Conference**, Ontario, Oregon: December 14, 2017.
1. **Newsletter Articles**

Alston, D. 2017. High tunnel arthropod pest management. Utah Pests News 11(Summer): 1-2. Utah State University and Utah Plant Pest Diagnostic Laboratory, Logan, Utah.

Hoepting, C.A. 2017. Fungicide program for Stemphylium leaf blight in onion- plan now! Veg Edge 13(13): 4-5.

Hoepting, C.A. 2017. Fungicide recommendations for Botrytis leaf blight in onion featuring 2016 fungicide trial results. Veg Edge 13(10): 4-5.

Hoepting, C.A. 2017. Onion thrip management after the ride with movento is over. Veg Edge 13(15): 8-9

Hoepting, C.A. 2017. Scouting Tips for Onion Thrips in Onions. Veg Edge13(9): 7.

Hoepting, C.A. 2017. Scouting Tips for Botrytis Leaf Blight in Onions. Veg Edge13(9): 7.

Leach, A., B.A. Nault, and C.A. Hoepting. 2017. 2017 Insecticide Treatment Options for Onion Thrips Management in Onions. Veg Edge 13(12): 8-9.

Wohleb, C.H. and T.D. Waters. (2017, June-Sept.) WSU Onion Alerts. Six issues sent to 557 subscribers.

1. **Annual Reports**

Buhrig, W., C.C. Shock, E.B.G. Feibert, and L.D. Saunders. 2017. Wireless sensor network for ‘on farm’ soil moisture data acquisition and irrigation scheduling. p 231-237. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Shock, C.C., E.B.G. Feibert, A. Rivera, and L.D. Saunders. 2017. 2016 onion variety trials. p 14-31. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Shock, C.C., E.B.G. Feibert, A. Rivera, and L.D. Saunders. 2017. Evaluation of chlorine and diatomaceous earth for control of internal decay in onion bulbs. p 63-66. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Shock, C.C., E.B.G. Feibert, A. Rivera, and L.D. Saunders. 2017. Onion internal quality in response to artificial heat and heat mitigation during bulb development. p 43-53. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Shock, C.C., E.B.G. Feibert, A. Rivera, and L.D. Saunders. 2017. Timing of Internal quality problems in onion bulbs. p 54-62. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Shock, C.C., E.B.G. Feibert, A. Rivera, L.D. Saunders, and B. Simerly. 2017. Onion production from Transplants in 2016. p 32-42. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Reitz, S. R., J. Noble, C.C. Shock, E.B.G. Feibert, A. Rivera, and L.D. Saunders. 2017. Thrips and iris yellow spot virus management in the Treasure Valley. p 99-119. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

Reitz, S. R., C.C. Shock, E.B.G. Feibert, A. Rivera, L.D. Saunders, H. Kreeft, and J. Klauzer. 2017. Safe production of onion – 2016, understanding the fate of *Escherichia coli* in the soil. p 82-92. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2016, Department of Crop and Soil Science Ext/CrS 157.

1. **Internet Resources**

Alliumnet.com: Provides a list of research and extension specialists working on pests and diseases; focuses on collaboration among research, extension and industry <http://alliumnet.bugwoodcloud.org>

Colorado State University onion disease management strategies, reports and publications, including those on IYSV and thrips and other diseases. <http://www.colostate.edu/Orgs/VegNet/vegnet/onions.html>

CSU Specialty Crops: http://specialtycrops.agsci.colostate.edu/

Pacific Northwest Vegetable Extension Group (PNW VEG) website (<http://mtvernon.wsu.edu/path_team/vegpath_team.htm>) with sections on onion diseases, pests, and other problems, as well as IPM resources:

 <http://mtvernon.wsu.edu/path_team/onion.htm> and

 <http://mtvernon.wsu.edu/path_team/ipmResources.htm#onion>

Schwartz, H.F., du Toit, L.J., and Coutinho, T. Diseases of Onion and Garlic (*Allium* *cepa* L. and *A. sativum* L., respectively). APS Common Names of Plant Diseases. American Phytopathological Society, St. Paul, MN. <http://www.apsnet.org/publications/commonnames/Pages/OnionandGarlic.aspx>

Hoepting, C.A.2017. Cornell Onion Fungicide “Cheat Sheet” for Leaf Diseases in New York, 2017. Online: <https://rvpadmin.cce.cornell.edu/uploads/doc_583.pdf>