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

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| |  |  |  | | --- | --- | --- | | **Project No. and Title:** | [**W3008**](http://lgu.umd.edu/lgu_v2/pages/showInfo.cfm?trackID=9416) **Integrated Onion Pest and Disease Management** | | | Period Covered: | October 1, 2017 to September 30, 2018 | | Date of Report: | January 7, 2019 | | Annual Meeting Date: | November 13, 2018 | |

1. **Participants at the Annual Meeting in Kennebec, WA:**

**W3008 Executive Committee Officers for 2018:**

**Chair:** Christy Hoepting, Cornell University

**Vice-Chair:** Beth Gugino, Pennsylvania State University

**Secretary:** Bhabesh Dutta, University of Georgia

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

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

Chair Christy Hoepting called the meeting to order at 8:30 am.

Participants introduced themselves to the group. Steve Loring, Administrative Adviser, joined us via phone assisted by Tim Waters. He congratulated us on the 2018 Excellence in Multistate Research-Western Region Award. Also, reminded us that the annual report, list of the W3008 attendees and minutes of the meetings are due within 60 days of this meeting. The report should be emailed to Steve and he will upload it into the NMISS system.

**State reports and other project updates:**

Participating members made presentations representing California (Tom Turini, Rob Wilson), Georgia (Bhabesh Dutta), Pennsylvania (Beth Gugino), Colorado (Mike Bortolo), Utah (Dan Drost), New Mexico (Chris Cramer), Texas (Subas Malla), Idaho (James Woodhall), Oregon (Stuart Reitz), Washington (Tim Waters), and New York (Christy Hoepting).

**Organizational and Planning Items**

**Onion research and extension needs**: Pink root USDA AFRI project was submitted by Subas Malla, TAMU. Other interests shared by participants include: Fusarium basal rot, tolerance to soil salinity, economics on marketing (“market blight”), importance of soil health, precision/digital ag technology in onion integrating IPM, variety development and labor issues as well as exploring non-traditional growing regions to compensate for climate change and suburbanization and improving consistency in seed production/seed reproducibility (inbreeding depression with inbreed lines).

**Alliumnet update**: Provided by Bhabesh Dutta (University of Georgia)

Current website: [www.alliumnet.com](http://www.alliumnet.com)

* **The current audience for Alliumnet include:** Research and Extension specialists working on pests and diseases affecting Onion and other Allium**,** Individuals and groups interested in a specific project. This primarily includes funding agencies and policy makers but may include growers/producers. National Allium Research Conference Participants.
* **Data analytics**: At present, Alliumnet has 667 subscribers with 70% of them are from the US. The total page views from 9 Feb to 10 Nov 10 2018 is 520 with >30% of the views for future and current meeting information. Bhabesh Dutta is willing to give web-access to all onion specialists across the country to upload following information regarding onion: peer-review journal articles, extension publications (bulletins, newsletters), Plant disease management reports, pest and disease alerts, and current projects on onion.

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

**Nomination for Secretary** – The importance of balancing leadership with both academic and industry partners was discussed. Both Peter Rogers and David Burrel were nominated and both agreed to serve in this role. Peter confirmed his willingness to serve as the next secretary in 2019-20 so the membership voted, and he was approved as the 2019 Secretary. David Burrel agreed to start serving his term in 2020.

**2019 officers:**

**Chair:** Beth Gugino, Pennsylvania State University (responsible for chairing the 2019 W3008 Annual Meeting)

**Vice-Chair:** Bhabesh Dutta, University of Georgia (responsible for writing/submitting the 2019 annual project report)

**Secretary:** Peter Rodgers, Nunhems/Bayer Vegetable Seed (responsible for writing/submitting the 2019 annual meeting minutes)

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

**Secretary-Elect**: David Burrel, National Onion Labs

**2019 W3008 Meeting** – Steve Loring stated that we are mandated to meet once a year, but the timing of that meeting was up to the project team.

**Meeting Options:**

* Hold jointly with the NOA/NARC/IARS meeting in Madison, WI from 18 to 20 July 2019.
* Hold jointly with NOA meeting in Naples, FL in Dec 2019

After discussion, it was decided that it was most time and cost effective to meeting with the NOA/NARC/IARS meeting in July 2019. Beth Gugino will coordinate with Mike Havey to identify a 1 to 2-hour block of time to hold the business portion of the W3008 meeting. Research updates will be captured via presentations at the larger joint meeting.

Christy Hoepting adjourned the meeting at 2:30 pm.

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

**Obj 1. Evaluate onion germplasm for resistance to pathogens and insects**

**Colorado (**Uchanski, Bartolo, Gourd): An onion variety trial was conducted at Sakata Farms near Brighton, CO. Research evaluations included emergence, thrips severity, and pink root severity. Thrips populations were counted on Jul 13 and ave 4.2 thrips/plant. The pink root severity evaluation was conducted on Aug 20 and ave 30% infection. Some onion varieties showed some disease tolerance. A significant hail and rain event on 14 Aug with 0.81 in of precipitation in a very short time stripped most the plant leaves and bruised the bulb therefore, no yields were taken.

**Idaho** (Schroeder, Woodhall, Thornton): A total of 20 cultivars grown in the 2018 Onion Variety Trial at the OSU Malheur Experiment Station were harvested and inoculated with a spore suspension of *Fusarium proliferatum* (*Fp*) to evaluate for resistance to *Fp* storage rot. Bulbs were cured, stored under commercial storage conditions and evaluated for bulb rot four months later. Results indicate that the cultivars exhibited a range of resistance responses. Cultivars Oloroso, Vaquero, Tucannon, Sedona, Pandero and SV6646 were most susceptible. While cultivars 16000, Avalon, and Grand Perfection were the least susceptible. This trial will need to be repeated. Knowing cultivar response to *Fp* will help inform cultivar choice to help manage *Fp* storage rot.

**New Mexico** (Cramer): Seeds of original, intermediate, and advanced Fusarium basal rot (FBR)-selected populations and one resistant and two susceptible checks were evaluated for resistance to FBR. The inoculation method of 3 x 104 spores per ml placed on a cut basal plate was very effective at causing disease in most bulbs which is important for selecting for resistance. The susceptible check exhibited a high level of disease while the resistant check exhibited less. Of the FBR-selected populations, recent selections of NuMex Crimson, NuMex Mesa, and Serrana exhibited less disease consistently over the years than previous generations. The most recent FBR-resistant selection of NuMex Mesa, NuMex Sweetpak, and NuMex Vado exhibited less disease than previous generations and the susceptible checks. In some instances, the most recent selection exhibited less disease than the FBR-resistant check. In addition, seed was produced from a total of 40 different FBR-resistant germplasm lines selected in 2017 and will be used for further evaluations to ascertain additional progress made for resistance to FBR.

**New York** (Nault, Hoepting, Pethybridge, Hay):A 2018 study was conducted to evaluate multiple tactics to manage onion thrips in organic onion production. Two mulch types (reflective and white), two semi-glossy “thrips-resistant” cultivars (Rossa di Milano and B5336 x B5351) and one waxy “thrips-susceptible” cultivar (Bradley), and two insecticide treatments (Entrust and untreated control) were evaluated. Season total numbers of thrips larvae were higher on onions grown on reflective mulch than white mulch, more in the Bradley than the thrips-resistant cultivars, and more in untreated control plots than Entrust-treated plots. Adult thrips were highest in untreated control plots only. Marketable yields were highest on onions grown on reflective mulch compared to white mulch, higher in Bradley and B5336 x B5351 than Rossa di Milano, and higher in Entrust than the untreated control. Overall, the most effective tactics for reducing onion thrips infestations while maintaining acceptable marketable yields were to use either Bradley or B5336 x B5351, reflective mulch and Entrust. These treatments, along with an effective fungicide program, will be evaluated in a 2019 on-farm trial.

**Texas** (Malla):One hundred thirty-seven onion lines, including cultivars as checks, were evaluated in Uvalde, TX during the 2017-18 season. Data on disease, yield and other agronomic traits were recorded. Pink root rot (*Phoma terrestris*) was observed during the season and disease severity recorded based on the percentage of root infection where 0% = immune and 100% = highly susceptible. Germplasm showed variation for pink root (15 to 60%). Yellow H6 developed the least disease (15%), followed by Texas A&M (TAM) Expt# 50084 (17.5%) and TAM Expt# 50014 (17.5%).

Twenty-four TAM elite onion germplasm were screened for thrips tolerance in Weslaco, TX. Destructive sampling was done to count thrips back in the lab. TAM short day sweet onion germplasm showed variation for thrips tolerance when the thrips population was highest, 18 April, just before the harvest. TAM Ext# 50084 had the least (28 thrips/plant), whereas TAM Expt# 43054 had the highest (222 thrips/plant) number of thrips.

**Washington** (du Toit, Waters, Pappu): Efforts were continued to improve the transmission efficiency of IYSV to onion with a goal to increase the efficiency of screening of onion germplasm for virus resistance under controlled conditions. Successful reproduction of disease symptoms by mechanical inoculation was obtained.

**Obj 2. Investigate the biology, ecology and management of onion thrips and other pests**

**CO**: A thrips management study was conducted at Colorado State University’s Arkansas Valley Research Center (AVRC), in a Rocky Ford, CO to determine the efficacy of a tolfenpyrad insecticide in an integrated thrips management program. Several treatment programs were evaluated and compared to an untreated control and a standard grower program. Thrips levels, onion yield and market-class distribution were evaluated. Overall, onion stands, and yields were excellent. Thrips populations were relatively low and non-persistent throughout the season and all treatments programs in the study had similar degrees of efficacy.

**NY**: A 3-year study was conducted to identify the optimal use of Movento (spirotetramat) to manage early-season infestations of onion thrips. Two application treatments (1 vs 2) and two action thresholds (0.1 vs 1 thrips/leaf) were evaluated to determine the highest level and longest period of control. Among the four-application frequency x action threshold combinations evaluated, two applications of Movento with the first timed at 1 thrips/leaf and the second application one week later reduced the thrips infestation to the lowest level for the longest period. Movento will continue to be recommended when thrips populations reach 1/leaf followed by a second application, 7-10 days later, rather than densities below this level or a single application.

To identify an insecticide and rate that most effectively reduces a very high onion thrips infestation, Minecto Pro (abamectin plus cyantranilprole), Exirel (cyantraniliprole) and Radiant SC (spinetoram) were evaluated at their lowest and highest recommended rates. All treatments were applied twice one week apart beginning when the thrips larval density was 3-4/leaf. One week after the second application, only Radiant at 10 fl oz/acre reduced the thrips density to below 2 larvae per leaf; densities of larvae in the Minecto Pro and Exirel treatments were all above 4 larvae/leaf and 2.7/leaf in the low rate of Radiant. Radiant SC continues to demonstrate that it is the best product to manage a high thrips infestation.

A 2-year study was designed to evaluate the susceptibility of onion thrips populations to Radiant SC in NY. Populations of onion thrips collected from seven commercial onion fields representing four counties were assessed. LC50s generated from feeding assays ranged from 2.07-5.08 ppm, and variation between populations was minimal, both regionally and temporally. The estimated field rate ranges from 141-374 ppm, suggesting that onion thrips populations in the areas sampled remain highly susceptible to Radiant, despite its annual use spanning a decade.

Combinations of nitrogen fertilizer and insecticide use were evaluated for onion thrips and thrips-related disease management in a partially thrips-resistant (Avalon) and thrips-susceptible onion cultivar (Bradley) in 2018. All fertilized treatments received 60 lb of urea per acre at planting, and a split application of either 0 lb, 15 lb, 45 lb, or 75 lb 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 following an action threshold or were not treated. The rate of nitrogen did not impact onion thrips densities, incidence of Iris yellow spot (IYS) disease, leaf dieback, the incidence of bacterial rot or marketable yield. Insecticide use reduced thrips densities, the incidence of IYS disease, leaf dieback and bacterial bulb rot. Marketable yield also was highest in the insecticide treatments for both cultivars. Cultivar Avalon had significantly lower onion thrips densities and IYS disease than Bradley, but Avalon had significantly more leaf dieback and bacterial bulb rot than Bradley.

The best combinations of OMRI-listed insecticides and adjuvants were evaluated for managing onion thrips in organically produced onions. Four insecticides (Azera, Entrust, Neemix and PFR 97) and three adjuvants (M-Pede, Nu-Film and Trilogy) were applied weekly. Entrust co-applied with either M-Pede or Trilogy were the most effective insecticide and adjuvant combinations. Neemix and PFR-97 co-applied with NuFilm also provided some control of onion thrips.

Insecticide seed treatment performance was evaluated for managing very high onion maggot infestations in 2017 and 2018. FarMore FI500 (thiamethoxam + spinosad), Regard and FarMore OI100 (both spinosad), Trigard (cyromazine) and Sepresto (clothianidin + imidacloprid) and a fungicide-only control were evaluated. None of the insecticide seed treatments provided a commercially acceptable level of maggot control in either year. Trigard was the only product that ranked among the best treatments for reducing onion maggot damage in both years. While the current industry standard, FarMore FI500, performed among the best treatments in 2017, it did not in 2018.

Eight conventional and three OMRI-listed products being evaluated to protect leeks from Allium leafminer (ALM), were applied weekly for six weeks from 19 Sept to 25 Oct 2018. Pressure was very high with nearly 100% plants infested and an average of nearly 8 larvae/plant in the untreated control. While all of the conventional products significantly reduced ALM densities in leek compared with levels in the untreated control, all performed statistically similar. The best treatments in descending order were Scorpion (dinotefuran), Exirel, Radiant, Warrior II with zeon technology (lambda-cyhalothrin) and Assail (acetamiprid). The best OMRI-listed product was Entrust (spinoad), while Pyganic Specialty (pyrethrin) and Aza-Direct (azadirachtin) failed to significantly reduce ALM densities compared with those in the untreated control.

**Oregon** (Reitz, Shock): Thrips and IYSV are the most important pests of onions grown in the Treasure Valley of eastern OR and southwest ID. Ongoing insecticide efficacy trials demonstrated effectiveness of new insecticide use programs to better manage thrips and IYSV. In addition, a regional pest monitoring program provided information to growers on seasonal pest trends, including changing patterns in thrips and IYS incidence in the Treasure Valley.

**TX**: Insect monitoring in Uvalde and Weslaco, TX showed that thrips were prevalent at both locations. Texas A&M Entomologists differentiated thrips species bases on taxonomy. *Frankliniella occidentalis* was the most predominant thrips species in Uvalde and Weslaco. *Thrips tabaci* and *F. fusca* were also observed in Uvalde but not in Weslaco.

Yellow sticky traps were used to monitor the thrips population on a weekly basis during onion crop season. Onion seedlings were transplanted on the second week of Nov 2017 and harvested on the second week of May 2018. The insect population started to decline after the fourth week of Nov (142 thrips/trap) and reached the lowest (1 thrips/trap) on the second week of Jan. Three population bumps were observed; the first during the third week of Feb (288 thrips/trap), a second during the fourth week of March (1091 thrips/trap) and a final during the second week of April (1600 thrips/trap). Based on thrips monitoring data, growers need to inspect fields toward the end of the winter and start insect management practices.

**WA**: Several conventional and organic pesticides were evaluated for their ability to manage onion thrips populations. The organic product Entrust was found to be the most efficacious of the organic materials tested. For the conventional products, Radiant, Agrimek, Exirel, Minecto Pro, and Lannate were the most efficacious products. Movento and Torac provided a moderate level of control.

Thrips from commercial onion fields were evaluated for their level of resistance to the commonly used insecticide Lannate (methomyl). Varying levels of resistance were detected, presumably based on the frequency of use of the product. The organic field, that has not had the product applied contained thrips that were completely susceptible to the field dose of the product. The four conventional fields that were evaluated ranged from 58 to 80% mortality at the field dose. These levels of control at the field dose suggest the onset of field resistance to Lannate. This information will be used to help producers modify their insect management strategies to mitigate further resistance development and achieve adequate control of onion thrips.

**Obj 3. Investigate the biology, epidemiology and management of onion plant pathogens**

**California** (Putnam): In Oct 2017, a field trial was initiated in Holtville, CA to evaluate the utility of weather-based models to schedule fungicide applications to manage downy mildew of onions for processing. A weather station was established within the trial to measure standard parameters at a height of 2 m, plus temperature, relative humidity, and leaf wetness within the plant canopy. Four disease models were (DOWNCAST, DOWNCAST modified by de Visser, DOWNCAST used by the University of Guelph, and ONIMIL) into a single computer script to allow output from the models to be produced simultaneously. Fungicide applications for model-based treatments were made from 0 to 2 times over the course of the growing season, whereas 4 applications were made for the standard calendar-based treatment. Downy mildew was not observed in the study area, consistent with overall very low downy mildew pressure in the CA desert in the winter of 2017-2018. Under low disease pressure, 4 applications were made for the standard calendar-based treatment, whereas weather-based models triggered from 0 to 2 applications.

**CO**: Uchanski evaluated the effect of potassium fertility on *Iris yellow spot virus* (IYSV) severity in onion in 2016 and 2017. Four potassium treatments were applied to field grown onions in Fort Collins, CO: treatment 1: 250g muriate of potash/10 ft of row; treatment 2: 750g muriate of potash/10 ft of row; treatment 3: 250g potassium sulfate/10 ft of row; treatment 4: 750g potassium sulfate/10 ft of row; control: no additional potassium added.

In both years, IYSV incidence (percentage as determined by ELISA) increased numerically in treatments 1 and 2. However, after further analysis those differences were not found to be statistically significant. In addition, IYSV incidence was low (i.e. < 15%) in both years, so the numerical difference was likely not biologically relevant. From these two studies we conclude that elevated soil potassium levels do not appear to significantly increase the incidence of IYSV in northern CO.

**Georgia** (Dutta): Greenhouse trials were conducted to protect susceptible onion growth stages with Kocide 3000 (copper bactericide) or a plant defense inducer (Actigard) or both. Protective treatments with Kocide 3000 or Kocide 3000+Actigard at bulb initiation and bulb swelling growth stages significantly reduced bulb incidence of center rot. In contrast, applications of Kocide 3000 or Actigard, or Kocide 3000 + Actigard did not significantly reduce bulb incidence after onion seedlings were exposed to thrips indicating that thrips infestation can reduce the efficacy of protective chemical treatments against *P. ananatis*. Multi-year field trials were conducted to evaluate if onion growth stage directed chemical protection could reduce center rot bulb incidence. Onion plants were protected with (Kocide 3000 or Actigard, or Kocide 3000 + Actigard) at all three growth stages (first leaf senescence, bulb initiation and bulb swelling). The field plots were protected with insecticides for thrips control. The results indicate that Kocide 3000 or Kocide 3000+ Actigard when applied at either bulb initiation or bulb swelling stage can significantly reduce disease incidence in bulbs compared to Actigard only and the untreated control. Marketable yield was also significantly higher when Kocide 3000 and Kocide 3000+Actigard treatments, applied at the bulb initiation and bulb swelling stages.

Researchers at the UGA determined the whole genome sequences of a panel of ten GA Pantoea strains which included both pathogenic as well as non-pathogenic strains. Filtering the genetic content of these strains based on their capacity to cause lesions on onion leaves and create a zone of clearing on red onion bulb scales revealed a small collection of genes that were strongly correlated with onion pathogenicity. There is genetic support that pathogenic isolates produce a plant toxic compound, likely a phosphonate compound, which is responsible for killing onion cells.

Onion cells produce a complex mixture of reactive sulfur compounds against biotic and abiotic stress. These sulfur compounds have been shown to have antibacterial and antifungal properties under laboratory culture conditions. From the comparative genomic analysis, onion pathogenic Pantoea strains predominantly carry a block of nine accessory genes that confers tolerance to onion antimicrobials. This allows the pathogens to survive and thrive in matured onion tissue. Strains that either naturally lack these tolerance genes or have been engineered to inactivate these genes display serious defects in their capacity to colonize onion bulb scales and grow at least 100-fold less than strains possessing these nine tolerance genes. Most of the tolerance genes are predicted to encode enzymes involved in sulfur metabolism.

**ID**: A validated real-time PCR detection method *for Fusarium proliferatum* (*Fp*) was developed to determine the presence and amount of pathogen present. From three experiments the reaction efficiency was between 90 and 104%. The assay was tested on 6 *Fp* isolates and consistent detection was observed. In addition, 20 other fungal species were tested including related Fusarium species and no cross reaction was observed. The assay was successfully used to detect the pathogen in onion bulbs including asymptomatic bulbs. Over half the bulbs tested were positive for *Fp* although there was no relationship between symptoms and presence of the pathogen.

The presence of airborne inoculum of *Fp* was tested using a Burkard multi-vial sampler and qPCR. Spore samplers at Parma and Kimberly were used to compare onion producing and non-producing areas. No *Fp* was detected in the air samplers between May and Sept. Soil is therefore the most likely source of inoculum since seed is already treated for potential fungal pathogens. DNA was extracted from soil and *Fp* was detected in 39% of soils in 2017 and 33% in 2018 and therefore, is likely to be the main source of inoculum.

To determine the infection window of *Fp* on onions, bulbs were removed from a field at Parma at four different dates, inoculated with *Fp* spores and incubated at 90% RH and 39°C for two weeks. Bulbs were then cut open and scored for presence of internal defects. Disease levels were slightly higher in mid-Jul and early Aug although disease was observed at all times. This is consistent with rain events that occurred in 2015 and 2016 during a similar period. The initial theory that high temperatures in Jul and Aug were the cause of the disease is unlikely since similar temperatures were high in all years between 2015-2018. To confirm this, monitoring of the disease and weather will continue as several years data will be required to support this hypothesis.

To determine the impact temperature and curing parameters on progress of *Fp* in onion bulbs during storage, bulbs were inoculated and cured at 77, 86, 95 or 104°F for two days and stored at 41°F. Bulbs were destructively harvested at 4 or 6 mo. of storage and evaluated for bulb rot (%). In general, less rot occurred when bulbs were cured at the higher temperatures, regardless of storage length. In addition, less rot occurred when bulbs were stored for 4 months rather than 6 months irrespective of curing temperature. The notable exception was bulbs cured at 104°F for two weeks exhibited significant rot most likely resulting from additional tissue damage due to long-term high temperature exposure.

**NY**: A 2018 study was conducted to evaluate OMRI-listed fungicides for managing *Stemphylium vesicarium* on three onion cultivars (Bradley, Ailsa Craig, and Avalon). Plots were assessed visually three times during the season for percent leaf length blighted and bulbs were graded by number and weight into boiler, standard, jumbo, colossal or cull size classes. Badge X2, Kocide 3000-O and the non-OMRI-listed product Oso were all effective at reducing the incidence of SLB. Cultivars Bradley and Ailsa Craig had significantly less disease incidence than Avalon. Avalon had significantly higher marketable yield than Bradley, which in turn had significantly higher yield than Ailsa Craig. Thrips populations in the field may have resulted in lower yields of Bradley (thrips-susceptible) compared with Avalon (thrips-resistant). The OMRI-listed fungicides, Badge X2 and Kocide 3000-O, will be evaluated in 2019 in an on-farm field trial.

**OR**: Recent increases in internal onion bulb decomposition of onion bulbs with underdeveloped scales in the neck region are thought to have resulted from unusually warm growing seasons. A field trial was conducted to determine whether heat is a factor in bulb decomposition and whether or not treatments that increase or reduce the heat load in the soil and onion bulbs would affect the expression of internal bulb decomposition. Results show that total yield, marketable yield, and yield of bulbs larger than 4 in decreased with increasing bulb and soil temperature although differences among treatments in bulb rots was not evident.

**Oregon/California** (Dung (OR), Wilson (CA), Turini (CA)): White rot is a major fungal disease of onion and garlic in the western U.S. Onion and garlic field studies were conducted in Tulelake, CA and western Fresno County, CA, respectively, to investigate an IPM solution that integrates sclerotia germination biostimulants and in-furrow fungicides. Main plot treatments consisted of sclerotia germination biostimulants (garlic juice or garlic oil) that were shank-injected in the spring and/or fall prior to planting. The Tulelake site also included allyl isothiocyanate (AITC) and metam sodium treatments. Sclerotia germination biostimulants were compared to non-treated plots and plots treated with diallyl disulfide (DADS) at both sites. Tebuconazole was applied in-furrow as a split-plot treatment at both sites at planting.

At the Tulelake site, the greatest reductions in sclerotia populations were observed in plots treated with garlic oil in the spring and fall (76%), DADS (70%), and garlic oil (spring) + AITC (fall) (66%). In-furrow applications of tebuconazole significantly increased onion stand and reduced late season onion leaf dieback and AUDPC values compared to the no-fungicide control (*P* ≤ 0.0002). Although not significantly greater than the untreated control, garlic oil (spring) + AITC (fall), garlic juice (spring), and garlic oil (spring and fall) exhibited the highest yields of healthy onion bulbs. In-furrow applications of tebuconazole increased healthy onion yield compared to the no-fungicide control (*P* < 0.0001). At the Fresno site, significant effect of germination stimulant on pre-plant sclerotia counts was not observed (*P* = 0.62), which may have been due to variability among plots in the commercial field. In-furrow applications of tebuconazole increased total garlic yield (*P* < 0.0001) and decreased the number of garlic bulbs with severe symptoms (*P* = 0.049). Sclerotia populations increased greatly from onion and garlic planting to harvest at both sites in plots not treated with an in-furrow application of tebuconazole at (*P* < 0.04), suggesting that tebuconazole may help prevent the buildup of sclerotia in fields after an *Allium* crop.

**Pennsylvania** (Gugino): A replicated multi-factorial center rot (*P. agglomerans* and *P. ananatis*) research trial was established to evaluate several bacterial inoculation methods (three methods) and inoculation timing (three plant growth stages). The goal was to identify a consistent inoculation method and time to inoculate the plants to achieve uniform disease distribution throughout the plots. This in turn would reduce variability in disease pressure across the trial and facilitate the more standardized evaluation of management tactics which could then be employed in multiple onion growing regions across the U.S. Unfortunately, the trial was terminated prematurely due to the extreme wet weather in the central and eastern parts of PA this past season.

**Texas**: Botrytis and Stemphylium leaf blight were observed in a seed production nursery where bulbs were transplanted in Uvalde, TX. Bravo (2 pt/A) was sprayed once early in the season when plants were at 3 to 4 leaf stage. Fungicide was not effective in controlling disease. Majority of seed scapes died late in the crop season. A study is needed to develop a better fungicide program to manage foliar diseases in onion.

Due to high thrips population in Uvalde, TX, leaf samples were sent to test for the tospovirus, *Iris yellow spot virus*, at Nischwitz Lab (Utah State University). All of the leaf samples were tested negative for IYSV. TAM researchers were also not able to detect tospovirus in tomato, pepper and melon in Uvalde and Weslaco, TX.

**WA**: Finished a 3-year WSDA SCBG project on evaluating arbuscular mycorrhizal fungi (AMF) inoculants for enhancing onion production and management of soilborne pathogens in the Columbia Basin. Published results showing that that moderate to high soil P levels typically used by onion growers in this region significantly reduce root colonization by AMF, negating the benefits of AMF inoculants in onion crops.

A field trial was established in Pasco, WA to evaluate products for control of downy mildew in onion bulb production using infected plants that were generated using inoculum obtained from an infected, overwintered onion seed crop. Warm, dry conditions in the Columbia Basin in 2018 limited development of downy mildew to the point there was inadequate disease to differentiate efficacy of the products.

du Toit provided diagnosis and associated management recommendations for 30 onion samples from growers in the Pacific Northwest and western USA. Waters visited 20 commercial onion fields in Washington State to help producers identify pest and diseases issues and help develop control recommendations.

**Obj 4. Facilitate discussions between W3008 participants and onion industry stakeholders that will advance onion pest and disease management**

**CA**: Putnam was approached by one seed company to expand this project into onion seed fields in other regions of California as well as by an agricultural services company about possibilities for collaboration.

**CO**: In Southern CO at Colorado State University’s AVRC, a Field Day event was conducted with a total of 150 participants. The tour included a mixture of growers, seed company representatives, and federal and state agency personnel. Research results will also be made available at the Colorado Fruits and Vegetable Growers Association on Feb 25 and 26, 2019. The 2017 results were shared at the 2018 CFVGA conference, also in Denver.

**NY**: Results from our work were presented at various meetings throughout NY and beyond and will be used by the national onion industry, growers, seed company breeders and pathologists, and integrated pest management specialists to select more effective insect, virus and disease management strategies. Details of these interactions are included in the Presentations section.

**OR**: An onion pest monitoring program and new insecticide recommendations allowed growers to reduce insecticide applications.

**PA**: In the first year of this project, emphasis was placed on disseminating results from the previous W2008 regional project at a number of local winter grower meetings and summer pest and disease walks. A total of five presentations reaching over 490 participants were given that included at least impart the identification and management of bacterial diseases of onion.

**WA**: W-3008 annual meeting was held in Kennewick, WA on 13 Nov 2018 with approximately 60 participants from across the US. Attendees shared updates on onion production in various states, and progress reports on onion research and extension projects. The meeting was followed by a field tour and packing facility/storage facility tour outside Pasco. Waters and du Toit were the local arrangements committee. du Toit served as past chair of the W-3008 multi-state project in 2018 and prepared a summary of the W-3008 annual meeting for publication in the Jan/Feb 2019 issue of *Onion World* based on the meeting minutes.

Washington State University Extension Onion Alerts, issued through the 2018 growing season, contributed timely information on diagnosis and management of insect pests and diseases in the Columbia Basin and Walla Walla production regions. Eight [onion Alerts](https://us13.campaign-archive.com/?u=2eff8714011ff4bfba18a0704&id=d75dc96e7f) were released online in 2018 to over 600 subscribers.

1. **Impacts**

In 2018, the W-3008 onion multi-state team received the USDA CSREES Excellence in Multistate Research Award for the Western Region for the previous iteration of this team, the W-2008.

During the W-3008 annual meeting, Dan Drost commented that during his sabbatical in UK and New Zealand, he shared about the W-2008 efforts and impacts. Stakeholders in those countries were excited to learn how the W-2008 multi-state project has been a success for US onion researchers and stakeholders, which demonstrates an international project impact.

**California** (Putnam): One onion processor requested information that the four DOWNCAST models gathered as part of this work to assist with management of downy mildew their crop.

**Georgia** (Dutta): In Georgia the results from the multi-year field trials suggest that an onion-growth stage based targeted spray under minimum thrips pressure can reduce frequency/number of copper sprays (at least 8 to 9), which may account for $80-100/A in savings in product. If labor and equipment operation are included, then the total savings may reach $150-$200/acre.

The identification of two distinct virulence loci (plant toxin and reactive sulfur tolerance genes) that contribute in two distinct ways to the ability of the bacteria Pantoea to cause center rot has revolutionized our understanding of the pathogen. We believe the distribution of these virulence loci in the Pantoea population will serve as an excellent indicator for potential risk of post-harvest disease and yield loss. Diagnostic assays based on these loci are being developed to aid onion growers in their management decisions. Studies on the roles of plant toxin and reactive sulfur tolerance in the virulence of Pantoea will provide new avenues for the development of novel management strategies and potentially for the development of resistant onion cultivars.

**Idaho** (Schroeder, Woodhall, Thornton): A real-time PCR assay was developed and technically validated and used in the other objectives for detection in soil, plant and air sample material. Soil was identified as the primary source of *Fusarium proliferatum* inoculum and a methodology for air sampling of spores developed. Evidence that the infection window for *F. proliferatum* occurs in July and August and is associated with soil-borne inoculum and rain splash events was collected. Bulb assays indicate that if the harvested onion bulb exposure to the temperature is short, then as the exposure temperature increases disease severity in storage decreases. However, if temperature exposure is lengthened, then disease severity increases. The second trial confirms that the results of the first year are supported by the year 2 data. Petri dish assays indicate that the growth of *F. proliferatum* in culture is reduced at higher temperatures.

**New Mexico** (Cramer): Breeding for FBR resistance has been successful in producing germplasm that is more resistant than currently-available short-day commercial cultivars. If the levels of FBR resistance observed this past year is consistent over years, FBR-resistant germplasm will be released to commercial breeding programs for the development of FBR-resistant cultivars. The developed inoculation protocol has proved successful at identifying resistant bulbs, so it could be used by other onion breeding programs to develop FBR resistant cultivars.

**Oregon** (Reitz, Shock): An onion pest monitoring program and new insecticide recommendations allowed growers to reduce insecticide applications.

**Oregon/California** (Dung (OR), Wilson (CA), Turini (CA)): Sclerotia germination stimulants alone were not able to reduce white rot infested yield to less than 10% of total yield, a figure many industry professionals feel is needed for viable commercial production in infested fields. However, combiningsclerotia germination stimulants and tebuconazole suppressed white rot and increased healthy onion and garlic yields, increasing crop revenue by hundreds of dollars per acre using current crop prices. Additionally, results from this study strongly suggest that in-furrow applications of tebuconazole at planting can reduce post-harvest sclerotia levels in fields and reduce white rot risk for future *Allium* crops.

**Washington** (du Toit, Waters, Pappu): Detection of what appears to be development of resistance in onion thrips populations to the widely used insecticide Lannate (methomyl) has had very important ramifications for onion growers in WA to modify their thrips insecticide programs to reduce this risk and to recognize the potential for reduced efficacy of their spray programs if they do not modify their programs to address this reduced sensitivity.

The approximately 20 grower-cooperator trials with mycorrhizal inoculants demonstrated the very limited ability for the commercial products evaluated to have a benefit to growers under the typical commercial production practices of the Columbia Basin. One farm indicated the research has saved their operation at least $50,000 annually. Another large onion farm indicated the research addressed their key questions regarding the use of AMF inoculants and the interactions of their fertilization practices with these products. The research also demonstrated that the liquid formulations of AMF products evaluated resulted in no increase in root colonization by AMF.

Onion field visits (20) and diagnoses of samples (30) by Waters and du Toit, along with Onion Alerts published by Wohleb, Waters, and du Toit on insect pests and diseases released online over eight dates during the 2018 growing season to >600 subscribers, provided timely information that helped growers and consultants manage onion crops and storage more effectively.

Pappu trained one PhD student in biological and molecular aspects of IYSV, who graduated in fall 2018.

1. **Publications (Oct 1, 2017 to Sept 30, 2018) 50,000 characters**

du Toit, L.J., Derie, M.L., Holmes, B.J., Henrichs, B.A., Winkler, L.R., Waters, T.D., and Darner, J. 2018. The effects of arbuscular mycorrhizal fungal inoculants on pink root and yield in an onion crop near Paterson, WA, 2016. Plant Disease Management Reports 12:V102.

du Toit, L., and Yorgey, G. 2018. Onion stunting after cereal cover crops. Page 6. Timing of glyphosate applications to wheat cover crops to reduce onion stunting caused by *Rhizoctonia solani*. Page 7. Efficacy of fungicide applications to manage onion stunting caused by *Rhizoctonia* spp. Pages 7-8.In: Strip-tillage for onions and sweet corn, Lorin Grigg. Farmer to Farmer Case Study Series on Increasing Resilience among Farmers in the Pacific Northwest. Washington State University Extension PNW702.

du Toit, L.J., Waters, T., Derie, M., Holmes, B., Darner, J., Henrichs, B., Knerr, J., Miller, C.E., Morgan, P., and Brouwer, L. 2018. Do AMF inoculants help onion crops? Pp. 11-12 in: 2018 Washington State University Onion Field Day Handouts. 13 pp.

Dutta, B., C. Riner, J. Edenfield, C. Tyson, S. Tanner, Z. Williams, A. Shirley, C. Earls. 2018. Evaluation of onion growth stage specific chemical protection on center rot incidence in onion bulbs. Plant Disease Management Reports 12:V058.

Hajihassani, A., Hamidi, N., Dutta, B, and Tyson, C. 2018. First report of stubby root nematode, *Paratrichodorus minor*, on onion in Georgia, U.S.A. Journal of Nematology 50:453-455.

Hoepting, C.A. 2018. Effect of fungicide timing on Stemphylium leaf blight on onion, 2017. Plant Disease Management Reports 12: V101.

Hoepting, C.A. 2018. Efficacy of selected products for control of bacterial bulb decay in onion, 2017. Plant Disease Management Reports 12: V143.

Hoepting, C.A. 2018. Effect of fungicide programs for control of Stemphylium leaf blight on onion, 2017. Plant Disease Management Reports 12: V144.

Hoepting, C.A. 2018. Efficacy of Fontelis for control of pink root in onion, 2017. Plant Disease Management Reports 12: V145.

Hoepting, C.A. 2018. Efficacy of fungicide treatments for control of Stemphylium leaf blight on onion, 2017. Plant Disease Management Reports 12: V146.

Hoepting, C.A. 2018. Efficacy of seed and in-furrow treatments for control of onion smut and damping off in onion, 2017. Plant Disease Management Reports 12: ST007.

Kamal, N. and C.S. Cramer. 2018. Selection progress for resistance to Iris yellow spot in onions. HortScience 53:1088-1094.

Knerr, A.J., Wheeler, D., Schlatter, D., Sharma-Poudyal, D., du Toit, L.J., and Paulitz, T.C. 2018. Arbuscular mycorrhizal fungal communities in organic and conventional onion crops in the Columbia Basin of the Pacific Northwest USA. Phytobiomes 2: *in press*. <http://dx.doi.org/10/.1094/PBIOMES-05-18-0022-R>

Leach, A. B., C. A. Hoepting and B. A. Nault. 2018. Grower adoption of insecticide resistance management practices increase with extension-based program. Pest Management Science: DOI 10.1002/ps.5150.

Leach, A., M. Fuchs, R. Harding, R. Schmidt-Jeffris and B. A. Nault. 2018. Importance of transplanted onions contributing to late-season *Iris yellow spot virus* epidemics in New York. Plant Dis. 102: 1264-1272.

Leach, A., B. A. Nault, and C. Hoepting. 2018. Insecticide sequences to manage onion thrips in onion in 2018. Cornell Cooperative Extension, Cornell Vegetable Program Veg Edge. 14(10): 8-9.

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>.

Pfeufer, E.E. and B.K. Gugino. Environmental management factors associated with bacterial diseases of onion in Pennsylvania. Plant Disease. doi.org/10.1094/PDIS-11-17-1703-RE.

Stice, S., Stumpf, S., Gitaitis, R.D., Kvitko, B.H., and Dutta, B. 2018. *Pantoea ananatis* genetic diversity analysis reveals low core genome diversity and accessory genes correlated with onion pathogenicity. Frontiers in Microbiology <https://doi.org/10.3389/fmicb.2018.00184>.

Stumpf, S., Kvitko, B., Gitaitis, R., Dutta, B. 2018. Isolation and characterization of *novel Pantoea stewartii* subsp. *indologenes* strains exhibiting center rot in onion. Plant Disease 102:727-733.

Waters, T.D., Darner, J., Adesanya, A., Walsh, D. and Kinion, D. Entomology Research Report for Onions. In: 2018 Washington State University Onion Field Day Handouts. 13 pp.

Winkler, L., du Toit, L., and Waters, T. 2018. Do onion growers benefit from mycorrhizal inoculants ? The effects of mycorrhizal inoculants on onion crops in the Columbia Basin. Onion World Nov. 2018: *in press*.

**Other Activities**

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

du Toit, L.J., and Correll, J.C. 2018. Case studies of the complexity of seedborne and seed transmitted fungi affecting regional and global seed trade. Guest speaker, joint symposium of American Phytopathological Society (APS) and Società Italiana di Patologia Vegetale (SIPaV), 24th National Congress of SIPaV, 5-7 Sep. 2018, Ancona, Italy.

Leach, A., F. Hay, R. Harding, and B. Nault. 2018. Relationship between *Stemphylium vesicarium* and onion thrips (*Thrips tabaci*) in the development of Stemphylium leaf blight disease. Poster Presentation. International Congress of Plant Pathology. Boston, MA. July 29-August 3, 2018.

Leach, A., C. Hoepting and B. Nault. 2018. Successful adoption of action threshold-based insecticide programs for thrips management in onion. 9th International IPM Symposium. Baltimore, MD. March 21, 2018.

Tabassum, A., S.V. Ramesh, Y. Zhai, and H.R. Pappu. 2018. Molecular evolutionary genomics and population structure of Iris yellow spot virus (Family: Tospoviridae; Genus: Orthotospovirus). 11th International Congress of Plant Pathology, Boston, MA. July 29-August 3, 2018.

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

Fleischer, S., T. Elkner, C. McGrady, D. Roberts, B. A. Nault, T. Rusinek, E. Grundberg, J. Ali, S. Ray and B. Lingbeek. 2018. Allium leafminer: A new invasive threat to Allium crops in North America. ESA, ESC, and ESBC Joint Annual Meeting, Vancouver, CA. November 13, 2018

Leach, A., S. Reiners, M. Fuchs, C. Hoepting and B. A. Nault. 2018. IPM and the human element: developing programs to control onion thrips in onion. Purdue University entomology department seminar series, West Lafayette, IN. December 6, 2018.

Leach, A., C. Hoepting and B. A. Nault. 2018. Increasing use of action thresholds in managing onion thrips on New York onion farms. ESA, ESC, and ESBC Joint Annual Meeting, Vancouver, CA. November 11-14, 2018.

Leach, A., S. Reiners and B. Nault. 2018. Evaluating effects of nitrogen fertilizer and insecticide use in managing onion thrips (*Thrips tabaci*) in onion. Entomological Society of America’s Eastern Branch meeting. Annapolis, MD. March 18, 2018.

Malla, S., M. Khanal, D. Silwal, J. Jifon, B. Patil, K. Crosby, and E. Correa. Short Day Onion Germplasm Evaluation in Southern Texas. American Society for Horticultural Science, Washington, D.C. 31 July – 3 Aug. 2018.

Mandal, S. and C.S. Cramer. 2018. Breeding for Fusarium basal rot resistance in short-day onions, p. 106. In: Proc. 2018 American Society for Horticultural Science Annual Conf., C. Sams (Ed.) Washington, DC. (Abstr.)

Nault, B. A., A. Leach, C. Hoepting, E. Moretti, and J. Scott. 2018. Adoption and Success of an IRM Program for onion thrips in onion: So good so far! ESA, ESC, and ESBC Joint Annual Meeting, Vancouver, CA. November 12, 2018

Nault, B. A., S. Fleischer, E. Grundberg, T. Rusinek, D. Roberts and T. Elkner. 2018. Biology and management of *Phytomyza gymnostoma*: a new invasive pest of Allium crops in the eastern US. Entomological Society of America’s Eastern Branch meeting. Annapolis, MD. March 19, 2018.

Nault, B.A., S.R. Reitz, T.D. Waters. 2017 Current and Future Management of Onion Thrips-Transmitted Iris yellow spot virus (IYSV) in Onion. Symposium on P-IE 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, Denver, CO, November 2017.

Silwal, D., S. Malla, and M. Khanal. 2018. Short Day Onion (Allium cepa) Germplasm Evaluation for Agronomic and Disease Tolerance in South Texas. Southern Region American Society for Horticultural Science Meeting, Jacksonville, FL. 2-4 Feb. 2018.

**3. Reports at Grower Meetings and Field Days**

Bartolo, M. Colorado Produce Day, January 2018.

Bartolo, M. AVRC Field Day, September 2018.

Bartolo, M. Specialty Crops Program Field Day, August 29, 2018.

Cramer, C.S. 2017. Control of onion thrips and IYS through interplant *N. cataria* during onion seed production. Multistate Research Project W3008: Integrated Onion Pest and Disease Management, Annual Meeting, and 2017 Great Lakes Fruit and Vegetable Expo, Grand Rapids, MI, Dec. 4, 2017.

Cramer, C.S. 2017. Progress for breeding for Fusarium basal rot resistance in onions. Multistate Research Project W3008: Integrated Onion Pest and Disease Management, Annual Meeting, and 2017 Great Lakes Fruit and Vegetable Expo, Grand Rapids, MI, Dec. 4, 2017.

du Toit, L.J. Management of Fusarium basal rot of onion. Invited presentation, Onion Session of the Pacific Northwest Vegetable Association Annual Convention & Trade Show, 14-15 Nov. 2018, Kennewick, WA. (200 people).

du Toit, L.J. Regionally appropriate fungicide programs for common onion pathogens in the Columbia Basin. Invited presentation, Onion Session of the Pacific Northwest Vegetable Association Annual Convention & Trade Show, 14-15 Nov. 2018, Kennewick, WA. (200 people).

du Toit, L.J. Impact of fungicides on plant health. Invited presentation, Pest Management Session of the Pacific Northwest Vegetable Association Annual Convention & Trade Show, 14-15 Nov. 2018, Kennewick, WA. (175 people).

du Toit, L.J. Complexities and synergies in large-scale conventional and organic agriculture in Washington. Invited presentation, Organic Session of the Pacific Northwest Vegetable Association Annual Convention & Trade Show, 14-15 Nov. 2018, Kennewick, WA. (150 people).

du Toit, L.J. Case studies of the complexity of seedborne and seed transmitted fungi affecting regional and global seed trade. Guest speaker at the joint symposium of the American Phytopathological Society (APS) and the Società Italiana di Patologia Vegetale (SIPaV), 24th National Congress of SIPaV, 5-7 Sep. 2018, Ancona, Italy. (see Abstracts above) (~250 people).

du Toit, L.J. Conventional and organic disease control strategies for specialty crops. Invited presentation at 2018 Colorado Fruit & Vegetable Growers’ Association Annual Meeting, 19-20 Feb. 2018, Denver, CO (50 people).

du Toit, L.J. Allium, bean, and crucifer seed quarantines in Washington: Current status and future needs. Annual Basin Producers’ 2018 Pesticide Recertification Day, 19 Jan. 2018, Moses Lake, WA (175 people).

du Toit, L.J. A review of onion diseases – identification and management. 4-hour invited presentation at the 2018 Walla Walla Onion Growers’ Meeting organized by CHS Primeland, 18 Jan. 2018, Walla Walla, WA (12 people).

du Toit, L.J. Allium, bean, and crucifer seed quarantines in Washington: Current status and future needs. Columbia Basin Crop Consultants’ Assoc. Short Course, 17 Jan. 2018, Moses Lake, WA (150 people).

du Toit, L.J. Seedborne and seed transmitted plant pathogens. Columbia Basin Crop Consultants’ Assoc. Short Course, 17 Jan. 2018, Moses Lake, WA (100 people).

Gugino, B.K. Managing bacterial diseases in vegetables, Instructor, Extension Program, New Holland Vegetable Day, Yoder's Restaurant and Buffet, 15 Jan 2018, New Holland, PA (50 participants).

Gugino, B.K. Vegetable disease management, Instructor, Extension Program, Ephrata Agway Vegetable Grower Meeting, Shady Maple Banquet Center, 20 Dec, 2017, East Earl, PA (250 participants).

Gugino, B.K. Disease management 101: Problems from 2017 and management recommendations, Quarryville Produce Growers Meeting. Hoffman Building at Solanco Fairgrounds, 14, Dec 2017, Quarryville, PA, (100 participants).

Gugino, B.K. Vegetable disease update and field walk, Instructor, Extension Program, Central Susquehanna Vegetable Twilight Meeting, Amos Martin Farm, 17 Jul 2018, Middleburg, PA., (72 participants).

Gugino, B.K. Pest and disease walk, Instructor, Extension Program, Sugar Valley Vegetable Grower Twilight Meeting, Amos Glick Farm, 16 July 2018, Loganton, PA, (15 participants).

Hoepting, C.A. 2018. Putting it all together; Improved SLB fungicide program – Effective, affordable and with Best Resistance Management Practices. Empire State Producers Expo – Onion SLB Fungicide Resistance Workshop. Syracuse, NY, USA: January 16, 2018 (61 participants).

Hoepting, C.A. 2018. Managing Stemphylium leaf blight of onion with fungicides in New York. Empire State Producers Expo – Onion SLB Fungicide Resistance Workshop. Syracuse, NY, USA: January 16, 2018 (61 participants).

Hoepting, C.A. 2018. Managing Stemphylium leaf blight of onion with fungicides in New York. Orange County Onion School. Middleton, NY, USA: February 28, 2018 (50 participants).

Hoepting, C.A. 2018. Fungicide trial demonstration in direct-seeded onion for control of Botrytis leaf blight and Stemphylium leaf blight. Annual Oswego County Onion Growers Twilight Meeting. Oswego, NY, USA: August 22, 2018 (45 participants).

Hoepting, C.A. 2018. New seed treatment for control of onion smut. Annual Oswego County Onion Growers Twilight Meeting. Oswego, NY, USA: August 22, 2018 (45 participants).

Hoepting, C.A. 2018. Noueautés sur le contrôle des ennemis de l-oignon/New arrivals on the control of the enemies of the onion. Les Journées Horticoles & Grandes Cultures. St. Rémi, Quebec, Canada: December 4, 2018 (105 particpants).

Jepson, P. and S. Reitz. 2018. Pesticide Resistance Management. Idaho-Malheur County Onion Growers Associations Annual Meeting.

Leach, A., R. Harding, M. Fuchs and B. A. Nault. 2018. Impacts of nitrogen fertilizer in muck onion production. Poster presentation. Great Lakes Fruit and Vegetable Expo, Grand Rapids, MI. December 4-6, 2018.

Leach, A., E. Moretti and B. A. Nault. 2018. First look at 2018 results for onion thrips and onion maggot management. Oswego onion grower twilight meeting, Oswego, NY. August 22, 2018.

Leach, A., S. Reiners, F. Hay, M. Fuchs, R. Harding, and B. A. Nault. 2018. Evaluating interactions between onion thrips and associated plant pathogens for improved management in onion. Sixty-seventh **Annual Muck Vegetable Growers Conference. Bradford, Ontario Canada.** March 28-29, 2018.

Leach, A., S. Reiners, M. Fuchs and B. A. Nault. 2018. Unravelling the interactions among variety, fertility, yield, onion thrips and diseases, and implications for improved management practices. Empire State Producers EXPO, January 17, 2018. Syracuse, NY. <http://www.hort.cornell.edu/expo/proceedings/2018/Onions%20Unravelling%20Interactions%20Ashely%20Leach.pdf>

Nault, B. A. 2018. Onion insect pest management update. Orange County Onion School. Middleton, NY. February 28, 2018.

Putnam, A. Evaluation of weather-based models for management of onion downy mildew. California Garlic and Onion Symposium, UC Cooperative Extension, 12 Feb 2018, Tulare, CA.

Putnam, A. Downy mildew and other diseases of vegetables in desert production. Desert Research Symposium, UC Cooperative Extension and California Association of Pest Control Advisors, 28 Feb 2018, Palm Desert, CA.

Putnam, A. Management of downy mildew of vegetables in the Imperial Valley. Agronomic Crops and Irrigation Water Management Field Day, UC Cooperative Extension, 28 April 2018, Holtville, CA.

Putnam, A. Evaluation of weather-based models for management of onion downy mildew. Agronomic Crops and Irrigation Water Management Field Day, UC Cooperative Extension, 18 April 2018, Holtville, CA.

Reitz, S.R. 2018. Onion production tour. Malheur Summer Farm Festival, July 2018.

Reitz, S. 2018. Thrips/IYSV Management. Idaho-Malheur County Onion Growers Associations Annual Meeting.

Reitz,S. 2018. Thrips and IYSV Management in the Treasure Valley. Pacific Northwest Vegetable Association Annual Meeting.

Schroeder, B.K. Impact of temperature on *Fusarium proliferatum* and the development of bulb rot in storage. Idaho and Malheur County Onion Growers’ Association 58th Annual Meeting. 6 Feb 2018.

Shock, C. 2018. Incomplete Scale and heat enhance the infection of onion bulbs. Pacific Northwest Vegetable Association Annual Meeting.

Waters, T.D. Thrips Control in Dry Bulb Onions. Pacific Northwest Insect Management Conference, January 8, 2018 Portland, OR. (45 people).

Waters, T. D. Insect IPM Update. Simplot Grower Solutions Meeting, February 6, 2018. Pasco, WA. (65 people).

Waters, T. D. Potato and Onion Insect IPM Update. Agrinorthwest Agronomy Meeting. February 6, 2018. Kennewick WA. (45 people).

Waters, T.D. Insect Control in Potato and Onion. Corteva Regional Customer Meeting, February 15, 2018. Las Vegas, NV. (125 people).

Waters, T. D. Thrips and Seedcorn Maggot Control in Onions. 2018 Walla Walla Onion Growers’ Meeting organized by CHS Primeland, 18 Jan. 2018, Walla Walla, WA (12 people)

Waters, T.D. and L. duToit. WSU Extension Onion Field Day, 30 Aug. 2018, Hartley Farms, Benton City, WA. Presented onion mycorrhizae research update to growers, seed industry, extension personnel, researchers, etc. (125 people).

Water, T.D. Washington Pest Control Tour or central WA, Washington State Commission on Pesticide Registration, 24-26 Jul. 2018. Presented on vegetable seed production and research needs, including pathology research, to ~50 federal/state legislators or staff, agricultural industry representatives, WA State Dept. of Agriculture, Ecology, and Labor & Industries; WSU CAHNRS administrators, National Marine Fisheries Service, US Environmental Protection Agency, etc. on 25 Jul. near Othello, WA. (75 people).

Water, T.D. WSU Extension Onion Field Day, 30 Aug. 2018, Hartley Farms, Benton City, WA. Presented onion thrips research update to growers, seed industry, extension personnel, researchers, etc. (125 people).

1. **Newsletter/Popular Press/Extension Articles**

Boyhan, G.E., Culpepper, A.S., Fonsah, E.G., Sparks, A., Coolong, T., Dutta, B., Riley, D.G., Hurst, W. 2018. Onion production guide. University of Georgia Cooperative Extension Bulletin B1198.

Dutta, B. 2018. Biology, epidemiology and management of center rot if onion in Georgia. In: Onion World Magazine. November 2018.

Dutta, B. 2018. Research progress in combating center rot of Vidalia onion. In: Vegetable and Specialty Crop News. February 2018.

Hoepting, C.A. 2018. Fungicide recommendations for Botrytis leaf blight in onion. Veg Edge, 14(12): 9-10.

Hoepting, C.A. 2018. New developments for managing Stemphylium leaf blight in onion: Managing fungicide resistance is crucial. Veg Edge, 14(13): 6-8.

Hoepting, C.A. 2018. New recommendations for using Surchlor (a.i. sodium hypochlorite), as in “pool chlorine”) for bacterial diseases of bulb onion. Veg Edge, 14(14): 6-7.

Hoepting, C.A. 2018. Onion thrips management after Movento. Veg Edge, 14(15): 5-6.

Hoepting, C.A. 2018. Time to protect onions from downy mildew. Veg Edge, 14(16): 3-4.

Hoepting, C.A. 2018. Leafminers in onion: Native vs. Invasive species. Veg Edge, 14(16): 6-7.

Hoepting, C.A. 2018. The rot race: Trying to avoid bacterial bulb rot in onion at harvest. Veg Edge, 14(18): 1-3.

Hoepting, C.A. 2018. Harvest and post-harvest tips for best onion quality. Veg Edge, 14(18): 6-7.

Hoepting, C.A. 2018. Artificial curing significantly reduces onion bacterial bulb rot. Veg Edge, 14(22): 4-5.

Hoepting, C.A. 2018. EverGol Prime – New seed treatment for onion smut available now. Veg Edge, 14(23): 6-7.

Hoepting, C.A. 2018. Onion growers should make 2019 a Trigard a seed treatment year for onion maggot control. Veg Edge, 14(23): 8-9.

1. **Annual Reports**

Reitz, S. R. 2018. Monitoring Onion Pests Across the Treasure Valley - 2017. pp. 128-131. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2017, Department of Crop and Soil Science Ext/CrS 159. <http://www.cropinfo.net/pdf/ar/2017/2017-013-OPMReport.pdf>

Reitz, S. R., Shock, C. C., Feibert, E. B. G., Rivera, A., and Saunders, L. D. 2018. Thrips and Iris Yellow Spot Virus Management in the Treasure Valley. pp. 113-127. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2017, Department of Crop and Soil Science Ext/CrS 159. <http://www.cropinfo.net/pdf/ar/2017/2017-012-InsecticideRotation.pdf>

Shock, C. C., Feibert, E. B. G., Rivera, A., Wieland, K. D., & Saunders, L. D. 2018. Onion internal quality in response to artificial heat and heat mitigation during bulb development. pp. 42-59. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2017, Department of Crop and Soil Science Ext/CrS 159. <http://www.cropinfo.net/AnnualReports/2017/2017-004-OnionIntRotHeat.php>

Shock, C. C., Feibert, E. B. G., Rivera, A., & Saunders, L. D. 2018. Timing the Occurrence of Internal Quality Problems in Onion Bulbs. pp. 60-72. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2017, Department of Crop and Soil Science Ext/CrS 159. <http://www.cropinfo.net/AnnualReports/2017/2017-006-OnionDiatom.php>

Shock, C. C. Feibert, E. B. G., Rivera, A., & Saunders, L. D. 2018. Evaluation of Chlorine and Diatomaceous Earth for Control of Internal Decay in Onion Bulbs. pp. 73-79. In Shock C.C. (Ed.) Oregon State University Agricultural Experiment Station, Malheur Experiment Station Annual Report 2017, Department of Crop and Soil Science Ext/CrS 159. <http://www.cropinfo.net/AnnualReports/2017/2017-006-OnionDiatom.php>

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 Research results are available on our web site: <http://adamscountextension.com>

CSU Specialty Crops: <https://specialtycrops.agsci.colostate.edu/research-and-projects/>

Hoepting, C.A. 2018. Cornell onion fungicide “cheat sheet” for leaf diseases, 2018. Cornell Cooperative Extension - Cornell Vegetable Program. Online: <https://rvpadmin.cce.cornell.edu/uploads/doc_689.pdf>.

Nault, B.A. and A. Leach. 2018. Guidelines for 2018 Onion thrips management in Onion. Decision Diagram. Cornell Cooperative Extension - Cornell Vegetable Program. Online: <https://rvpadmin.cce.cornell.edu/uploads/doc_685.pdf>.

Oregon State University Malheur Experiment Station: [Cropinfo.net](http://Cropinfo.net)

Pacific Northwest Vegetable Extension Group (PNW VEG), a tri-state (OR, WA, ID) consortium of 25 university and USDA ARS vegetable researchers and extension specialists met monthly by conference call during the 2018 field season, from May through October, to discuss vegetable production status in the region, including pest, disease, and other issues affecting production of onion and other vegetables. The team website was updated regularly, including the Photo Gallery and other resources for vegetable stakeholders : <http://mtvernon.wsu.edu/path_team/diseasegallery.htm>

Wohleb, C.H., Waters, T.W., and du Toit, L.J. 2018. Washington State University Extension Onion Alerts. Contributed disease information and photos for WSU Onion Alerts released online on 24 Apr., 23 May, 31 May, 3 Jul., 16 Aug., 27 Aug., 1 Oct., and 31 Oct. 2018. <https://us13.campaign-archive.com/?u=2eff8714011ff4bfba18a0704&id=d75dc96e7f>