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

Project No. and Title:	**W1008 Biology and Management of Iris yellow spot virus (IYSV) and Thrips in Onions**
Period Covered:	01-2009 to 12-2009
Date of Report:	3-Mar-2010
Annual Meeting Dates:	3-Dec-2009

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W1008 Meeting Attendees – 2009

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- *Krishna S. Mohan, University of Idaho, Parma, ID, kmohan@uidaho.edu
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- Tom Gordan, American Takii, tgordan@takki.com
- Lee Sommers, Colorado State University, Lee.Sommers@colostate.edu
- Brent Clements, Onion World, dbrent@columbiapublications.com

**** denotes W1008 Participant***

Brief Summary of Minutes of Annual Meeting

The W1008 Annual Meeting was held on December 3, 2009 in conjunction with the National Onion Association Annual Winter Meeting at the Marriot Plaza Hotel in San Antonio, Texas.

At 8:30 am, Chair Stuart Reitz opened the meeting and welcomed the participants. Approximately 30 people attended the meeting throughout the day.

Dr. Lee Sommers, Colorado State University, and Administrative Advisor for W1008 gave an update on the reorganization of USDA and the new priority areas for agricultural research. The National Institute for Food and Agriculture (NIFA) replaces CSREES (http://nifa.usda.gov). The 5 major issues and institutes that will be developed are 1) climate change, 2) bioenergy, 3) food safety, 4) nutrition, and 5) international food security. Sommers mentioned that this is the third year of the W1008 project so this year's annual report is especially important because it will be reviewed at an annual level. The W1008 will need to submit a 5-year renewal during 2011.

During the meeting, participants gave reports on their recent activities, including updates on the spread of IYSV, IPM programs for thrips and IYSV, varietal tolerance to onion thrips and IYSV, yield loss, and improvements in virus detection. Details are in the minutes.

Howard Schwartz, Colorado State University, shared with the group two Specialty Crops Research Initiative (SCRI) projects relating to onions that were funded in 2009. 1) Ensuring US onion sustainability: breeding and genomics to control thrips and IYSV – Project director Mike Havey at USDA-ARS/University of Wisconsin. Co-PIs: Howard Schwartz, Chris Cramer, Hanu Pappu, Foo Cheung. Objective: to identify germplasm with resistance to IYSV and/or thrips, and to initiate genomics work to identify genetic markers for improvement of future onions. 2) Advancing onion postharvest handling efficiency and sustainability by automated sorting, disease control, and waste stream management – Project director Charlie Li, University of Georgia. Co-PIs: E.W. Tollner, Ron Gitaitis, G. Hawkins, R. Shewfelt, Dan Maclean, C Thai, Howard Schwartz, K. Morgan, J. Molnar and Krishna Mohan. Objective: to identify bad onions with x-ray and multispectral imaging and then using waste stream management to dispose of culls and provide energy source for the warehouse.

Schwartz will also be submitting a new proposal,"ipmPIPE and innovative disease diagnostic tools for onion growers. PIPE = Pest Information Program for Extension and Education.

Krishna Mohan shared with the committee that the Experiment Station at Parma was to be closed in June 2010. They may not be able to participate in W1008 in 2010. A MOTION was passed by the W1008 Committee unanimously to draft a letter stating their concern about the future of the Parma Research Station and Krishna's continued participation on the W1008 Committee. See attachment for copy of the letter. (After the meeting, Simplot announced it will contribute funding to the Center for the next 5 years).

The 2010 Annual W1008 Meeting will occur in conjunction with the National Allium Research Conference in Sparks, Nevada (December 8-10, 2010).

Shannon Pike, Enxa USA was nominated and elected to be secretary for the W1008 Committee in 2010. Officers in 2010: Chair – Christy Hoepting, Cornell Cooperative Extension; Vice-Chair: Hanu Pappu, Washington State University, and Secretary – Shannon Pike, Enxa USA.

Stuart Reitz adjourned the meeting at 5:00 pm.

Attachments:
Meeting Minutes (submitted by Stuart Reitz, USDA-ARS
Letter of support for Parma Research Station

Accomplishments for Objectives

1. Screen onion germplasm for improved levels of tolerance to *Iris yellow spot virus* (IYSV) and thrips

Colorado – Howard Schwartz, Colorado State University, Ft. Collins, CO

- During 2009, the Colorado team identified the following cultivars and breeding lines with significantly greater plant vigor after season-long exposure to thrips and the virus: NUN7606ON, Mesquite, OLYS03-207, OLYS05N5, OLYS03-209, and OLYX06-25. Field losses from thrips pressure averaged 15 to 35 percent for cultivars such as Cometa, Gunnison, Arcero, and Red Bull, while other cultivars such as Colorado 6, Granero and Mesquite had less than 5 percent reduction in yield when not protected by multiple sprays of insecticides. The evaluation design verified that screening nurseries planted in fields with a history of problems from onion thrips and IYSV could provide moderate to severe pest and disease pressure to enable the identification of less susceptible onion entries (varieties or germplasm).

New Mexico – Chris Cramer, New Mexico State University, Las Cruces, NM

- Seventy-five onion plant introduction (PI) accessions from the U.S. germplasm collection and 31 intermediate- and long-day commercial cultivars and experimental breeding lines from the New Mexico State University breeding program were evaluated for the number of thrips per plant, leaf color, leaf waxiness, leaf axil pattern, Iris yellow spot (IYS) disease symptoms, and bulb yield. In general, thrips number per plant increased from 12 to 14 weeks post transplanting while the number decreased afterwards up to 20 weeks. At this time, there were fewer thrips per plant than at 12 weeks. At 14 weeks, PI 248753, PI 248754, PI 274780, and PI 288272 averaged less than three thrips per plant that was less than most entries tested and less than the average number of thrips per plant for all entries, 21. These accessions produced dark green leaves that had a moderate amount of waxy coating. At this time, there were very few differences in thrips number per plant among the commercial cultivars and experimental breeding lines tested. OLYS 05N5 exhibited fewer thrips per plant than several entries. By 16 weeks, there were no differences among entries for thrips number per plant.
- Seventeen accessions were rated as having light to dark green leaf color, three were rated as having semi-glossy to glossy leaves, and one possessed an open leaf axil pattern. PI 239633 and PI 289689 possessed glossy foliage that was dark green in color. PI 258956, PI

546188, and PI 546192 possessed semi-glossy foliage that was dark green in color. Most of the commercial cultivars and experimental breeding lines tested were rated as having leaves that were light to dark green in color. Only two entries, NMSU 07-30-2 and 07-54-1, were rated as having semi-glossy to glossy leaves. There were very few differences in leaf axil pattern among the entries tested in this group. At 20 weeks, PI 239633, PI 264320, PI 321385, PI 546100, PI 546115, PI 546188, and PI 546192 exhibited less severe IYS symptoms than other accessions. Four weeks later, IYS symptoms became more severe on plants of these accessions, however; plants of PI 546115 and PI 546192 exhibited less severe symptoms than most other accessions that had not matured by this time. At each rating time, there were no differences in IYS disease severity and incidence among the commercial cultivars and experimental breeding lines tested. PI 239633, PI 258956, PI 264320, PI 321385, and PI 546100 exhibited a jumbo market class yield that was greater than the yield of other entries. Individual plants, that exhibited few IYS disease symptoms, were selected at bulb maturity from 14 different accessions and 12 different commercial cultivars and experimental breeding lines for a total of 265 bulbs. These bulbs are being self-pollinated and test-crossed to male-sterile lines in the hopes of finding individual progeny that possess a higher level of IYS tolerance.

New York – Brian Nault, Anthony Shelton and John Diaz-Montano, Cornell University, Geneva, NY

- Fifteen onion cultivars suspected to be resistant to onion thrips were examined in the field for potential resistance to IYSV. There were significantly fewer onion thrips larvae on these resistant varieties (e.g., NMSU 03-52-1, Peso, Medeo, Cometa, Granero, White Wing, Calibra, Colorado 6, Mesquite, Arcero, OLYS05N5, Vaquero, Delgado and T-433) compared with the susceptible cultivar 'Nebula'. However, there were no significant differences in the percentages of plants infected with IYSV among any of the cultivars, including Nebula, as determined by DAS-ELISA. The mean percentages of cultivars infected with IYSV varied from 37 to 70%. These results suggest that there is no resistance to IYSV among these thrips-resistant cultivars.
- A no-choice laboratory experiment was conducted to determine if the thrips resistance in the thrips-resistant cultivars was mediated in part by antibiosis. Plants representing each cultivar were individually caged and then infested with the same number of onion thrips adults and then the number of larvae was recorded 2 wks later. The thrips-resistant cultivars (e.g., Cometa, Colorado 6, Vaquero, White Wing, Delgado, Granero, OLYS05N5, NMSU 03-52-1 and several others) had significantly fewer larvae than susceptible cultivars. Therefore, these results suggest that antibiosis is responsible in part for the resistance against onion thrips.
- A choice-experiment also was conducted to determine if thrips resistance is also partially mediated by antixenosis. Plants representing each of the cultivars mentioned above were grouped into a cage and onion thrips adults were released into the cage. A couple of days later, the number of adults on each plant was recorded. Significantly more adults were found on the susceptible cultivar compared with all of the resistant ones. These results suggest that antixenosis is in part responsible for the resistance. These findings were consistent with previous research in which thrips-resistant cultivars with low numbers of thrips and low levels of thrips feeding damage had yellow-green leaf color, while susceptible cultivars had blue-green leaf color.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR

- Based on "on farm" and "on station" trials, onion varieties have been tentatively identified that are more and less tolerant to IYSV. Some of the apparently tolerant lines were not seriously considered by growers two years ago. As of last year, tissue samples were collected to relate variety IYSV symptoms with ELISA tests.

2. Study the biology and epidemiology of IYSV and thrips, and impacts of chemical, cultural and biological tactics that can reduce their impacts upon onions.

Colorado – Howard Schwartz, Colorado State University, Ft. Collins, CO

- The Colorado program compared methods to detect IYSV infection in onion tissue, and all methods were effective: ELISA, RT-PCR, TBIA (Tissue Blot Immuno Assay), and NA-hyb (Nucleic Acid Hybridization). Additional work is warranted to identify an efficient, effective and economical method to test onion and other materials for IYSV.
- Yield loss quantification was conducted in a preliminary Colorado greenhouse study to document the need for funding research on thrips and IYSV, and finding control options. Colorado 6 yield was reduced 15 percent by IYSV, 50 percent by thrips and 60 percent by IYSV and thrips; compared to the yield of Talon which was reduced 60 percent by IYSV, thrips, or IYSV and thrips. Other greenhouse studies determined that 5 viruliferous thrips infected plants within 2 days of feeding (preliminary results).

Idaho – Krishna Mohan and R.K. Sampangi, University of Idaho, Pharma, ID

- **Overwintering locations and emergence of thrips from soil:** Soils were sampled using soil augers at different locations in and around onion fields with disease [inside the field, outside the field on margins and borders] and stored in the green house in plastic tubes [thrips-proof mesh and sticky pads] and the emergence of thrips was recorded. A few thrips emerged only from soils collected from the outside the field and borders [2009]. This work will continue during 2010.
- **Hosts within onion fields before and after the onion growing season:** Volunteer onion plants collected in early spring 2008 and 2009 tested positive for IYSV in ELISA tests although they were symptomless. Thrips collected from these volunteers will be tested for IYSV in collaboration with WSU [Hanu's Lab].
- **Overwintering thrips on cull onions and cull abundance:** In spring 2009, two onion samples were collected from large cull piles [one each from OR and ID] in Treasure Valley region to determine whether cull piles could be a source of onion thrips. Very few thrips [2 to 3 thrips/5 onions] could be collected and these will be tested for IYSV in collaboration with WSU [Hanu's Lab].

- **Possible role of overwintering weeds:** Several weeds which can thrive in autumn [October-November] and winter [Dec-Feb] were collected, and the number of thrips associated with these weeds were counted. There was no discernible pattern in the number of thrips associated with different weed species. Mean number of thrips per weed varied among the fields. The thrips collected will be tested for IYSV in collaboration with WSU [Hanu's Lab]. Common groundsel [*Senecio vulgaris*], spiny sowthistle [*Sonchus asper*], Redstem filaree **[***Erodium cicutarium**]*** shepherd's-purse [*Capsella bursa-pastoris]* are some of the common winter weeds encountered in Treasure valley. A list of winter weeds in this region is being compiled in collaboration with Clint Shock [OSU, OR].

New York – Brian Nault, Cornell University, Geneva, NY

- **Performance of foliar-applied insecticides** – Products that worked best against onion thrips included cyantraniliprole (HGW86 10OD), spinetoram (Radiant SC), spirotetramat (Movento) and abamectin (Agri-Mek 0.15EC). Section 18s for Movento and Agri-Mek were granted by EPA in 2009 in New York; Section 18s for these products were submitted in early 2010 in New York.
- **Performance of new insecticides when tank mixed with fungicides containing spreader stickers**. Movento and Agri-Mek did not consistently work as well when tank mixed with fungicides that contained spreader stickers. The concern is that the spreader stickers in the fungicide formulation is interfering with the penetrant used to assist getting the insecticide into the plant tissue. There is also concern that the penetrant may allow the fungicide to enter plant tissues to cause phytotoxicity. Research is needed in 2010 to resolve this issue.
- **Action thresholds for new products –** Although Movento and Agri-Mek controlled the thrips population when applied following a 3 thrips larvae per leaf threshold, these results may not be applicable in a "bad" thrips year. The thrips infestation was low for half the season due to cold and wet weather. Thus, until more research is conducted, growers should consider using a more conservative threshold such as 1 thrips larva leaf. This more conservative approach will be even more important if these products are tank mixed with fungicides and spreader stickers.
- **Performance of at-plant treatments (seeded)** – Fipronil (Regent) applied in the furrow as a drench treatment was the only one that reduced the onion thrips infestation. Products that did not work included imidacloprid (Admire Pro), clorantraniliprole (Coragen) and cyantraniliprole (HGW86). Unfortunately, it is not likely that Regent will ever be labeled for use on onion.
- **Impact of nitrogen on thrips -** Nitrogen levels affected the size of larval populations in our onion plantings. The more nitrogen applied, the more larvae were found on plants with high nitrogen, indicating that either more eggs were laid on these plants, more larvae survived on these plants, or both. Research is planned to examine these thrips and nitrogen relationships further.
- ***Iris yellow spot virus* in New York** – After a significant increase in IYSV from 2007 to 2008 in the Elba Muck, the percentage of onions infected in 2009 dropped to a level similar to that in 2007. We suspect that the lower levels of IYSV were a consequence of a "mild" thrips season.

- We observed a significant reduction in bulb weight for onion plants (Red Bull and Milestone) infected with IYSV. On average, the reduction was about 0.1 lb for each cultivar. Because thrips damage was low to absent on these plants and did not differ between those infected and not infected, we suspect that this yield difference is due to the virus. Interestingly, IYSV symptoms were also low to absent for plants that tested positive for IYSV using DAS-ELISA.
- Late in 2009, we did not detect IYSV in weed hosts (common burdock and dandelion) known to be hosts for both IYSV and onion thrips. Again, we attribute this to a mild year for onion thrips.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR

- Management factors such as irrigation, fertilization, and straw mulching that reduce plant stress might reduce the intensity of thrips and IYSV infestations. The management trials test the response of four onion cultivars to water stress level, irrigation system, and nitrogen fertilizer rate. Soil temperature and soil water potential was monitored in all treatments. Onions were rated for many economic parameters, thrips, IYSV symptoms, and ELISA.
- The combined effects of variety, irrigation system, irrigation criterion, and nitrogen (N) rate on IYSV expression and onion yield and grade were evaluated in 2008. N fertilization at 224 kg/ha failed to improve disease incidence or yield over 112 kg/ha. Drier irrigation criteria (30 kPa) resulted in more severe IYSV symptoms and lower marketable, colossal, and colossal plus super-colossal bulb yield than the wetter irrigation criteria. There were no significant interactions between variety, irrigation criteria, and N rate either year. Some varieties demonstrated tolerance with clearly different performance in the presence of IYSV. Kaolin foliar treatments failed to suppress IYSV.
- Screening insecticides for those with efficacy against thrips and those which reduce the impact of IYSV were conducted. Formetanate hydrochloride and spirotetramat were two compounds that are not yet registered for use in onion that seem to be very effective in controlling thrips and reducing the incidence of iris yellow spot virus. They were particularly effective when applied in a rotation with other insecticides such as methomyl and spinetoram.

Washington – Hanu Pappu, Washington State University, Pullman, WA

- **Biological studies on IYSV -** Studies on biological characteristics of the virus have been limited due to difficulties in obtaining consistent and reproducible mechanical transmission and lack of indicator hosts. Several plant species were evaluated for their response to mechanical inoculation with IYSV. The following seedlings were used: *Arabidopsis thaliana* COL 1, *Capsicum annuum* (Serrano pepper), *Chenopodium quinoa, Datura innoxia, D. ferox, D. stramonium, Nicotiana benthamiana, N. tabacum, Solanum melongena* and *Vigna unguiculata* (Heirloom variety). Infection was verified by symptoms, ELISA and RT-PCR of inoculated, and younger, non-inoculated leaves. In *N. benthamiana,* chlorotic local lesions appeared 7 to 10 days post inoculation (DPI) which subsequently expanded leading to drying of leaves by 20-25 DPI. The virus spread systematically showing severe veinal necrosis and some stem necrosis. *D. stramonium* showed 25-30 small chlorotic local lesions initially of 2-5 mm 10 to 12 DPI. The numbers of local lesions gradually increased and spread throughout

the leaves within 20-25 days, and as the lesions coalesced the leaves dried 35-40 DPI. Infection remained localized. In *V. unguiculata,* symptoms appeared as diffuse and small necrotic spots in inoculated leaves 5 to 6 DPI. Chlorotic and necrotic ring spots developed in the inoculated leaves of *C. annuum,* which gradually increased in size and *C. quinoa* produced small concentric chlorotic rings spots,. Only the inoculated leaves were positive for IYSV in ELISA and RT-PCR, and no systemic infection could be seen. *A. thaliana* COL 1, *D. innooxia, D. ferox, N. tabacum* and *S. melongena* were symptomless and were negative for IYSV when tested by DAS-ELISA. There are no reports of natural infection of *C. annuum* by IYSV although *C. annuum* is a host for several other tospoviruses. Our studies showed that *C. annum* could be experimentally infected with IYSV.

- **Molecular characterization of IYSV -** The structure and organization of the large (L) RNA of *Iris yellow spot virus* (IYSV) was determined, and with this, the complete genomic sequence of IYSV has been elucidated. The L RNA was 8880 nucleotides in length and contained a single open reading frame (ORF) in the viral complementary (vc) strand. The primary translation product of 331.17 kDa shared many of the features of the viral RNA-dependent RNA polymerase (RdRp) coded by L RNAs of known tospoviruses. The 5$B!l(B and 3$B!l(B termini of IYSV L RNA (vc) contain two untranslated regions of 33 and 226 nucleotides, respectively, and both termini have conserved terminal nucleotides, another common feature of tospovirus genomic RNAs. Conserved motifs characteristic of RdRps of members of *Bunyaviridae* were present in the IYSV RdRp. These included DxxKWS (motif A); QGxxxxxSS (motif B); SDD (motif C); K (motif D); and EFxSE (motif E), Furthermore, three motifs TDF (Motif F1); KxQRTK (Motif F2) and DREIY (Motif F3) found in the RdRp of *Capsicum chlorosis virus* (CaCV) were also found in the IYSV RdRp. Phylogeny showed that the RdRp of IYSV is closer to the Eurasian group of tospoviruses: *Tomato zonate spot virus* from China, *Watermelon silver mottle virus* from Taiwan, CaCV from Thailand, *Groundnut bud necrosis virus* from India, and *Melon yellow spot virus* from Japan, whereas *Tomato spotted wilt virus* and *Impatiens necrotic spot virus* formed a different cluster (American), similar to that observed with the medium and small RNAs of IYSV and other tospoviruses.

- **New strategies for understanding the seasonal dynamics of thrips vectors -** IYSV is exclusively spread by thrips and there is no evidence of virus transmission through seed. Hence, infected plants and viruliferous thrips are the primary source and means of virus spread. There are limited options available for managing IYSV outbreaks. The ability to rapidly and accurately detect IYSV in thrips vectors for the purpose of estimation of the proportion of viruliferous thrips (=transmitters) from the field could potentially provide information that would be useful in more effective thrips management practices. A polyclonal antiserum was produced to the recombinant, *E. coli*-expressed nonstructural protein (NSs) coded by the small (S) RNA of IYSV. The recombinant fusion protein was obtained in the insoluble fraction, purified using a nickel column, and was used for the immunization of rabbits. When used in an antigen-coated plate ELISA, the antiserum, diluted up to 1:4,000, could detect the virus in a single adult thrips and in plants. Availability of antiserum to a non-structural protein of IYSV would be useful in epidemiological studies to better understand the role of thrips vectors in outbreaks of this important virus of onion.

- **Effect of selected cultural practices in suppressing *Iris yellow spot virus* in onion -** It is not known if management factors such as irrigation and fertilization that reduce plant stress

might reduce the impact of IYSV . The combined effects of variety, irrigation system, irrigation criterion, and N rate on IYSV expression and onion yield and grade were evaluatedin 2007 and 2008. Fertilization at 112 kg N/ha resulted in a higher onion yield and grade in 2007 than 224 kg N/ha. There were no differences in onion yield or grade between N rates in 2008, but failed to influence disease incidence either year. Symptoms were fewer in 2007 and no significant differences between treatments were observed. In 2008, averaged over varieties and N rates, drier irrigation criteria (higher SWT) resulted in significantly more severe IYSV symptoms. Averaged over varieties and N rates, drip irrigation at 30 kPa resulted in significantly lower marketable, colossal, and colossal plus supercolossal bulb yield than the wetter irrigation criteria in both 2007 and 2008, but the differences were more pronounced in the presence of IYSV in 2008. There were no significant interactions between variety, irrigation criteria, and N rate either year.

3. Transfer information on progress dealing with IYSV and thrips biology and IPM strategies to the onion industry and other interested parties

New York – Brian Nault, Cornell University, Geneva, NY

- Several meetings were held in 2009 to inform NY's onion industry about results from this project: the Annual Winter New York Onion Industry Council Meeting in Ithaca in January, the Empire State Fruit and Vegetable EXPO in Syracuse in February, the Onion School in Middletown in March, the Oswego Twilight Meeting in June, the Annual Summer New York Onion Industry Council Meeting in Potter in July and the Elba Muck Onion Meeting in Elba in August. Additionally, an annual workshop was held in Ithaca that included a session to update Cornell Cooperative Extension Educators about results from this project.
- Information pertaining to this subject was also presented at the Sixth International IPM Conference in Portland, OR, the Ninth International Symposium on Thysanoptera and Tospoviruses on the Gold Coast of Australia and the Annual Entomological Society of America Meeting in Indianapolis, IN.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR

- Results have been effectively communicated by fieldmen and grower participation in project planning and evaluation of results. Nine instructional events including classroom instruction and field tours were held for growers and fieldmen. These events were presented on May 19, June 30, July 8, Aug 3, Aug 25, Aug 28 and Dec 11. In addition, information was presented at grower meetings in February 2009, internet web sites, and results being retold by the reporters of Onion World.

Impacts

Colorado

- Outputs of this work will be used by Colorado and national onion industries, growers, seed company breeders and pathologist, and integrated pest management specialists to select more effective management strategies including the promotion of varieties that are less susceptible to damage by thrips and the virus.

Oregon

- In the last couple of years, IYSV seems to be less pronounced, although it is too early to tell. The benefits may be related to the current project. Some onion growers still had onions that were hard hit by IYSV this last year, especially near over-wintering onion crops.

  1. More growers are adopting onion varieties with apparent greater tolerance to IYSV. Seed availability is still a limiting factor for these new varieties.

  2. Due to better knowledge of the transmission of IYSV, growers are breaking the natural green bridge keeping IYSV pressure high from one production year to the next. Less of the Idaho-Oregon onion bulb production area combines summer bulb production with over-wintering and seed production crops. Growers are also practicing more vigilance in destroying onion culls. But some growers are still vexed with over-wintering onion bulb or seed fields close to their summer production fields.

  3. More growers are adopting drip irrigation and adopting careful irrigation scheduling. These carefully irrigated onion crops seem to be suffering less from IYSV.

  4. More growers are using soft insecticides to control trips early in the season, allowing natural predators to help control thrips, at least at the beginning of the summer.

New Mexico

- Germplasm was identified that possessed foliage characteristics that are associated with onion thrips feeding nonpreference. In addition, germplasm was identified that possessed a reduced number of thrips per plant than most entries. Both of these characteristics suggest that there is the genetic potential for reduced thrips feeding and possibly reduced *Iris yellow spot virus* spread. Entries were identified that exhibited less severe IYS disease symptoms than most entries. These entries may be a genetic source of increased IYS tolerance that may be incorporated into commercial cultivars. Individual plants, that exhibited few IYS disease symptoms, were selected and are in the process of being self-pollinated to produce a subsequent generation that may possess a higher level of IYS tolerance.

New York

- Research at Cornell University has identified new and selective insecticides and strategies to apply them enabling growers to keep onion thrips populations under control during the 2009 growing season. By following Cornell recommendations, it was possible for onion growers to decrease the frequency of sprays and reduce the number of insecticide sprays applied per season.

- Three years of epidemiological and IYSV sources studies have ruled out the likelihood that imported bare root transplants, volunteer onions (when rogued out of onion fields in a timely manner) and bulbs from out of state are major sources of IYSV in New York. Effective control of onion thrips remains the first line of defense against IYSV in New York. Business may continue as usual.
- Preliminary results indicating that growing onions with reduced nitrogen resulted in reduced colonization and reproduction of thrips led to the successful pursuit of USDA Pest Management Alternatives Program grant by Nault et. al, which will take an in-depth look at this relationship. If it is found that reduced nitrogen fertilizer results in reduced insecticide sprays without compromising yield, growers input costs can be drastically reduced.

Publications

1. Bag, S., and H.R. Pappu. 2009. Symptomatology of Iris yellow spot virus in selected indicator hosts. Plant Health Progress. doi:10.1094/PHP-2009-0824-01-BR.
2. Bag, S., J. Singh, R.M. Davis, W..Chounet, and H.R. Pappu. 2009. Iris yellow spot virus in Nevada and Northern California. Plant Disease 93:674.
3. Bag, S., K.L. Druffel, T. Salewsky, and H.R. Pappu. 2009. Nucleotide sequence and genome organization of the medium RNA of Iris yellow spot virus (genus Tospovirus, family Bunyaviridae) from the United States. Archives of Virology 154:715-718.
4. Bag, S., P. Rogers, R. Watson, and H.R. Pappu. 2009. First report of natural infection of garlic (Allium sativum) with Iris yellow spot virus in the United States. Plant Disease 93:839.
5. Diaz-Montano, J., M. Fuchs, B. A. Nault and A. M. Shelton. 2010. Evaluation of onion cultivars for resistance to onion thrips (Thysanoptera: Thripidae) and *Iris yellow spot virus*. J. Econ. Entomol. (in press).
6. Evans, C.K., S. Bag, E. Frank, J. Reeve, C. Ransom, D. Drost, and H.R. Pappu. 2009. Natural infection of Iris yellow spot virus in Twoscale saltbush (Atriplex micrantha) growing in Utah. Plant Disease 93:430.
7. Evans, C.K., S. Bag, E. Frank, J. Reeve, C. Ransom, D. Drost, and H.R. Pappu. 2009. Green foxtail (Setaria viridis), a naturally infected grass host of Iris yellow spot virus in Utah. Plant Disease 93:670.
8. Hsu, C., C. A. Hoepting, M. Fuchs, A. M. Shelton and B. A. Nault. 2010. Temporal dynamics of *Iris yellow spot virus* and its vector, *Thrips tabaci* (Thysanoptera: Thripidae), in seeded and transplanted onion fields. Environ. Entomol. (in press).
9. Multani, P.S., C.S. Cramer, R.L. Steiner, and R. Creamer. 2009. Screening winter-sown onion entries for *Iris yellow spot virus* tolerance. HortScience 44:627-632.
10. Pappu, H.R., R.A.C. Jones, and R.K. Jain. 2009. Global status of tospovirus epidemics in diverse cropping systems: Successes gained and challenges that lie ahead. Virus Research 141:219236.

11. Schwartz, H. F. Gent, D. H., Fichtner, S. M., Hammon, R., Cranshaw, W. S., Mahaffey, L., Camper, M., Otto, K., and McMillan. 2009. Straw mulch and reduced-risk pesticide impacts on thrips and Iris yellow spot virus on western-grown onions. Southwestern Entomologist 34:13-29.

Presentations

Research Reports: Abstracts and Papers at International Professional Meetings

1. Nault, B. A. 2009. Controlling onion thrips with insecticides. The IX International Symposium on Thysanoptera and Tospoviruses. Main Beach, Queensland, Australia. September 4, 2009.
2. Nault, B. A. 2009. Ecology of onion thrips and epidemiology of *Iris yellow spot virus*: Implications for management in New York onion fields. The IX International Symposium on Thysanoptera and Tospoviruses. Main Beach, Queensland, Australia. September 1, 2009.
3. Sampangi, R.K**,** S.K. Mohan and H.R. Pappu 2009. Weed hosts of Iris Yellow Spot Virus [IYSV] and implications for disease management in onion crops in the U.S. Pacific Northwest. Intl. Conf. on Plant Pathology in Globalized Era" New Delhi, India [Nov.2009]
4. Schwartz, H. F. 2009. Thrips and IYSV management in Colorado onion production systems. Key Note Speaker at a special symposium for northern Mexico onion growers and industry on Onion IYSV and Thrips in Delicias, Chihuahua, Mexico on September 2, 2009. The symposium was sponsored by various agricultural agencies and private industries.
5. Shock, C.C., E.B.G. Feibert, L.D. Saunders, L.B. Jensen, H.R. Pappu, S.K. Mohan, and R.S. Sampagni. 2009. Effect of selected cultural practices in Suppressing Iris yellow spot virus in Onion. IX International Symposium on Thysanoptera and Tospoviruses, 31 August – 4 September 4 2009, Sea World Resort, Gold Coast, Queensland, Australia.

Research Reports: Abstracts and Papers at National Professional Meetings

1. Cramer, C.S. Screening onion plant introduction accessions for *Iris yellow spot virus* resistance. National Onion Association Annual Convention. San Antonio, TX. Dec. 2-5, 2009.
2. Cramer, C.S. Screening winter-sown onion entries for *Iris yellow spot virus* resistance. W1008: Biology and management of *Iris yellow spot virus* (IYSV) and thrips in onions. Regional research project annual meeting. San Antonio, TX. Dec. 3, 2009.
3. Diaz-Montano, J., B. A. Nault, M. Fuchs and A. M. Shelton. 2009. Characterization of resistance to onion thrips (*Thrips tabaci* Lindeman) and incidence of *Iris yellow spot virus* in onion cultivars. Entomological Society of America Annual Meeting,

Indianapolis, IN. *(Note: Awarded second place in Student Competition for the President's Prize in the Section Plant-Insect Ecosystems: Host Plant Interaction, Resistance).*

4. Hoepting, C., M. L. Hessney and B. A. Nault. 2009. Onion thrips management update: New York. W-1008 Annual Meeting. San Antonio, TX. December 3, 2009.
5. Hsu, C. L., C. Hoepting, A. Shelton and B. A. Nault. 2009. New York update on onion thrips and *Iris yellow spot virus* research. W-1008 Annual Meeting. San Antonio, TX. December 3, 2009.
6. Hsu, C. L., C. Hoepting, S. Reiners and B. A. Nault. 2009. Effects of nitrogen fertilizer rates on onion thrips (*Thrips tabaci* Lindeman) populations in the field. Entomological Society of America Annual Meeting, Indianapolis, IN.
7. Schwartz, H. F. 2009. Update on national onion projects and impacts on the U.S. onion industry. Invited Speaker at the annual meeting of the National Onion Association on December 3, 2009 in San Antonio, TX.
8. Shock, C.C., E.B.G. Feibert, L.D. Saunders, L.B. Jensen, H.R. Pappu, S.K. Mohan, and R.S. Sampagni. 2009. Cultural practices to reduce the expression of Iris Yellow Spot Virus. American Society of Horticultural Science Annual Conference, 25 - 28 July, 2009, St. Louis, Missouri.
9. Smith, E. A., A. DiTommaso, C. L. Hsu, M. Fuchs, A. M. Shelton and B. A. Nault. 2009. Weed hosts of onion thrips (*Thrips tabaci*) and their role in *Iris yellow spot* virus epidemiology in onion. Entomological Society of America Annual Meeting, Indianapolis, IN. *(Note: Awarded first place in Student Competition for the President's Prize in the Section Plant-Insect Ecosystems: Plant Resistance).*

Research Reports: Abstracts and Papers at Statewide Meetings and Conferences

1. Nault, B. A. 2009. Onion thrips control in New York. *In* Great Lakes EXPO Educational Program Abstracts. December 7-8, 2009. Grand Rapids, MI. Michigan State University Extension.
2. Nault, B. A., C. Hsu, E. Smith, J. Diaz-Montano, M. L. Hessney, P. Marcella-Herrick, M. Fuchs, A. Shelton, A. DiTommaso and C. Hoepting. 2009. Onion thrips and *Iris yellow spot virus* in New York, pp. 62-66. *In*: Proceedings of the 2009 Empire State Fruit and Vegetable Expo. February 11-12, 2009. Syracuse, NY. Cornell Cooperative Extension and New York State Vegetable Growers Association.

Reports at Grower meetings and field days:

1. Nault, B. 2009. Control of onion thrips. Oswego County Onion Growers Twilight Meeting, Oswego, NY. June 17, 2009. Speaker, 45 minutes. Attendees: 80. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.
2. Nault, B. 2009. Do onion growers need to be concerned about *Iris yellow spot virus*? Elba Muck Onion Twilight Meeting, Elba, NY. July 29, 2009. Cornell Cooperative

Extension. Speaker, 10 minutes. Attendees: 50. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

3. Nault, B. 2009. New management strategies for controlling onion thrips. Elba Muck Onion Twilight Meeting, Elba, NY. July 29, 2009. Cornell Cooperative Extension. Speaker, 20 minutes. Attendees: 50. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

4. Nault, B. 2009. Onion insect management with an emphasis on onion thrips. Onion School for Orange County Onion Growers. Middletown, NY. March 16, 2009. Speaker, 40 minutes. Attendees: 50. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

5. Nault, B. 2009. Using spirotetramat (Movento) to manage onion thrips in onions. Movento Educational Meeting, Elba, NY. June 18, 2009. Speaker, 20 minutes. Attendees: 50. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

6. Nault, B. A. 2009. Onion insect management and *Iris yellow spot virus* research update for 2009. Cornell Cooperative Extension Agriculture and Food Systems November In-Service, Ithaca, NY. November 10, 2009.

7. Nault, B. A., C. Hsu, A. Shelton, M. Fuchs, A. Taylor, J. Diaz-Montano, E. Smith, and M. Hessney. 2009. Research summary on research on management of onion insect pests and *Iris yellow spot virus*. New York Onion Industry Council Winter Meeting, Ithaca, NY. January 21, 2009. Speaker, 30 minutes. Attendees: 20. Onion growers, CCE educators and Cornell faculty.

8. Nault, B. and C. Hoepting. 2009. New developments in managing onion maggot in direct-seeded and transplanted onions. Elba Muck Onion Twilight Meeting, Elba, NY. July 29, 2009. Cornell Cooperative Extension. Speaker, 15 minutes. Attendees: 50. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

9. Nault, B., C. Hsu, T. Shelton, M. Fuchs, E. Smith and J. Diaz-Montano, M. L. Hessney, S. Reiners and A. Taylor. 2009. Onion insect management and *Iris yellow spot virus*. New York State Onion Industry Council Summer Tour and Meeting, Potter, NY. July 23, 2009. Cornell Cooperative Extension. Co-speaker, 45 minutes. Attendees: 60. Onion growers, vegetable industry representatives, crop consultants, CCE educators and Cornell faculty.

10. Schwartz, H. F. 2009 Onion virus management and updates. Annual Education Meeting of the Colorado Onion Association on January 29, 2009 at Eaton, CO

11. Shock, C.C. and E.B.G. Feibert*. 2009. Irrigation, fertilization, and cultivar to manage IYSV. OSU Malheur Experiment Station Field Day, 8 July 2009, Ontario, OR.

12. Shock, C.C. and E.B.G. Feibert. 2009. Cultural practice options to reduce IYSV risks. OSU Malheur Experiment Station Onion Variety Day, 25 August 2009, Ontario, OR.

13. Shock, C.C. E.B.G. Feibert, L.D. Saunders, L.B. Jensen, S.K. Mohan, R.S. Sampangi, and H. Pappu. 2009. How Do IYSV and Cultural Practices Affect Onion Performance? 48th Annual Meeting of the Malheur Onion Growers Association and Idaho Onion Growers Association, 3 February 2009, Ontario, OR.

Magazine and Newsletter Articles

1. Nault, B. A. 2009. Cornell team looks at onion thrips and *Iris yellow spot virus* in New York. Onion World. 25(4): 6-8.
2. Nault, B. A. and A. M. Shelton. 2009. Onion thrips management: New insecticides and timing strategies. Cornell University Cooperative Extension Vegetable Program. Veg Edge 5(7): 10-11.

Internet Resources

1. Jensen, L., C.C. Shock, and L.D. Saunders. 2009. 2008 Managing insecticides for maximum efficacy against thrips in dry bulb onions. Oregon State University Agricultural Experiment Station, Special Report 1094:67-76. http://www.cropinfo.net/AnnualReports/2008/ManagingInsecticidesForMaximumEfficacyOnions.html
2. Jensen, L.B. 2009. 2008 Insecticide efficacy trial for thrips in control in dry bulb onions. Oregon State University Agricultural Experiment Station, Special Report 1094:61-66. http://www.cropinfo.net/AnnualReports/2008/InsecticideEfficacyTrialsForThripsInOnions.html
3. Onion Disease Management strategies, reports and publications, including those on IYSV and thrips. http://www.colostate.edu/Orgs/VegNet/vegnet/onions.html
4. Schwartz, H. F. 2009. Web site dedicated to information and resources on onion pest management and/or thrips and IYSV. http://www.alliumnet.com/index.htm
5. Shock, C.C. E.B.G. Feibert, and L.D. Saunders. 2009. Performance of onion varieties in a field with high iris yellow spot virus presence. Oregon State University Agricultural Experiment Station, Special Report 1094:29-31. http://www.cropinfo.net/AnnualReports/2008/PerformanceOfOnionVarietiesWithHighIrisYellowSpotVirusPresence.html
6. Shock, C.C., E.B.G. Feibert, L.D. Saunders, L.B. Jensen, S.K. Mohan, R.S. Sampagni, and H.R. Pappu. 2009. Management of onion cultural practices to control the expressions of iris yellow spot virus. Oregon State University Agricultural Experiment Station, Special Report 1094:41-60. http://www.cropinfo.net/AnnualReports/2008/ManagementOfOnionPracticesToControlTheIrisYellowSpotVirus.html
7. Shock, C.C., E.B.G. Feibert, L.D. Saunders, L.B. Jensen, S.K. Mohan, and H.R. Pappu. 2009. 2008 Onion variety trials. Oregon State University Agricultural Experiment Station, Special Report 1094:20-28. http://www.cropinfo.net/AnnualReports/2008/2008OnionVarietyTrials.html

Other Related Activities

2009 - Submitted a package to the New York State Department of Environmental Conservation for their consideration of a **Specific Emergency Exemption (FIFRA Section 18)** for the use of spirotetramat (Movento) on onion for onion thrips control for the 2009 season. The Crisis Exemption request was granted by NYSDEC from June- September 2009.

2009 - Submitted a package to the New York State Department of Environmental Conservation for their consideration of a **Specific Emergency Exemption (FIFRA Section 18)** for the use of abamectin (Agri-Mek 0.15EC) on onion for onion thrips control for the 2009 season. The Crisis Exemption request was granted by NYSDEC from June- September 2009.

2009 - Submitted a package to the New York State Department of Environmental Conservation for their consideration of a **Specific Emergency Exemption (FIFRA Section 18)** for the use of formetanate hydrochloride (Carzol SP) on onion for onion thrips control for the 2009 season. The Crisis Exemption request was NOT granted by NYSDEC