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:	10-2009 to 09-2010
Date of Report:	9-Nov-2011
Annual Meeting Dates:	08-Dec-2010

Participant Name	Company/Affiliation	Email
Lee Sommers	Colorado State University	lee.sommers@colostate.edu
Brent Clement	Onion World	dbclement65@gmail.com
Steven Beer	Cornell Plant Path, Ithaca	svb1@cornell.edu
Chris Cramer	New Mexico State University	cscramer@nmsu.edu
Robert T. Sakata	Sakata Farms	rtsakata@aol.com
Howard F. Schwartz	Colorado State University	howard.schwartz@colostate.edu
Stuart Reitz	USDA-ARS	stuart.reitz@ars.usda.gov
Heleen Bukman	Bejo Zaden	h.bukman@bejo.nl
Mary Ruth McDonald	University of Guelph	mrmcdona@uoguelph.com
Silvamani Sundaray	University of Georgia	sivamani@uga.edu
Juan Carlos Brevis	Enza Zaden	juan.brevis@enzausa.com
Shannon Pike	Enza Zaden	shannon.pike@enzausa.com
Steve McArthur	Vigour	steve@vigour.co.nz
David O'Connor	Allium & Brassica Ctr. Ltd.	abcenter@aol.com
Mike Derie	Washington State University	derie@wsu.edu
Kaz Tsutsui	Shippo Seed Company	onion@ruby.ocn.ne.jp
Takashi Iwata	Kagana University	choror-2000jp@yahoo.co.jp
Satoshi Iwata	Yamaguchi University	k007gd@yamaguchi-u.ac.jp
Jim Lorbeer	Cornell University	jwls@cornell.edu
Agustin Agraz	OLAM Spices & Vegetables	cornucopia72@hotmail.com
Cesar Saray	OLAM Spices & Vegetables	cesar.saray@olamnet.com
George Malm	OLAM Spices & Vegetables	george.malm@olamnet.com
Dan Maclean	University of Georgia	dmaclean@uga.edu
Shane Shelton	Tanimura & Antle	shane@taproduce.com
Clint Shock	Oregon State University	clinton.shock@oregonstate.edu
Charles Webber	USDA-ARS	cwebber-usda@lane-ag.org
Phil Sarasqueta	Bayer Crop Science	phil.sarasqueta@bayer.com
Mike Bowman	Nunhems (USA)	mike.bowman@bayer.com
Joel Canestrino	NiZ-HAG	jcanestrino@hazerainc.com

Charles Boateng	Colorado State University	cobakgh@yahoo.com
Jagtar Singh	Peri & Sons Farms	jagtar@periandsons.com
Neel Kamal	Monsanto Vegetable Seeds	neel.kamal@monsanto.com
Beth Gugino	Pennsylvania State University	bkgunino@psu.edu
David Whitwood	Crookham Company	davew@crookham.com
Peter Boches	Nunhems	peter.boches@bayer.com
Rick Watson	Nunhems	rick.watson@bayer.com
Rene Emch	Nunhems	rene.emch@bayer.com
Jim Christopherson	L & L Ag Production, LLC	jim@llagprod.com
Kerrick Bauman	L & L Ag Production, LLC	kerrick@llfarms.com
Kevin Kudsh	L & L Ag Production, LLC	kevin@llfarms.com
Michael Havey	USDA - University of Wisconsin	mjhavey@wisc.edu
Andrew Taylor	University of Warwich	andrew.taylor@warwick.ac.uk
Stephanie Szostek	Colorado State University	stephasp@rams.colostate.edu
Mike Bartolo	Colorado State University	michael.bartolo@colostate.edu
Kent Welsh	OLAM Spices & Vegetables	kent.welsh@alomnet.com
Dan Drost	Utah State University	dan.drost@usu.edu
Andres Casas	Univ. Nac. Agrario-La Molina	cda@lamolina.edu.pe
Christy Hoepting	Cornell Cooperative Extension	cah59@cornell.edu
Brian Nault	Cornell University	ban6@cornell.edu
Erik Smith	Cornell University	eas56@cornell.edu
Cynthia Hsu	Cornell University	clh33@cornell.edu
John Calandri	Son Rise Farms	donna@calandrisonrisefarms.com
Mark Proutor	DST, Inc	dstincorp@aol.com
Cloudia Nischwitz	Utah State University	claudia.nischwitz@usu.edu
Ron Gitaitis	University of Georgia	dronion@uga.edu

Accomplishments

Objective 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 2010 the Colorado team identified the following germplasm with significantly greater plant vigor after season-long exposure to thrips and the virus: Plant Introduction (PI) lines 258956,264320, 546140, 546188 and 546192. These lines were selected as candidates for the translational genomics study coordinated by colleagues involved with the USDA-SCRI Project 2008-04804. 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, breeding lines or germplasm).

New Mexico Chris Cramer, New Mexico State University, Las Cruces, NM - Forty-eight onion plant introduction (PI) accessions from the U.S. germplasm collection and 32

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. Of those PI accessions that had not matured yet, thrips number per plant was highest at 12 weeks post transplanting while the number decreased afterwards up to 16 weeks. At 12 weeks, plants of PI 165498 had fewer thrips per plant than plants of other accessions. For the commercial cultivars and experimental breeding lines tested, thrips number per plant was similar at 12, 16, and 20 weeks. At 12 weeks, there were very few differences in thrips number per plant among entries. At 16 weeks, plants of NMSU 07-54-1 had fewer thrips per plant than plants of other entries. At 20 weeks, plants of 'Early Red Burger', NMSU 07-56-2, NMSU 07-57-2', 'Stockton Early Yellow', and 'Stockton Red' averaged less than 10 thrips per plants and had fewer thrips per plants than plants of most other entries.

Twelve 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 165498, PI 258956, and PI 264320 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. Plants of 07-54-1 were rated as having glossy leaves while 39 entries were rated as having semi-glossy leaves. There were no differences in leaf axil pattern among the entries tested in this group. At 16 weeks, PI 249899, PI 288073, and PI 391509 exhibited less severe IYS symptoms than other accessions. For the commercial cultivars and experimental breeding lines tested, IYS disease severity was low generally for most entries at 16 weeks. Disease symptoms became more severe by 20 weeks. At this time, NMSU 08-43, NMSU 07-54-1, and NMSU 09-58 expressed IYS symptoms that were less severe than symptoms observed on plants of other entries. The disease incidence at 16 weeks was lower for NMSU 07-33-1, NMSU 09-58, and 'NuMex Centric' than other commercial cultivars and experimental breeding lines. Of the accessions tested, PI 264320 and PI 546100 exhibited a jumbo market class yield that was greater than the yield of other entries. Of commercial cultivars and experimental breeding lines tested, NMSU 07-30-2, NMSU 07-32-2, NMSU 07-33-1, NMSU 07-54-1, NMSU 09-58, and SBO 5508 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 4 different experimental breeding lines for a total of 7 bulbs. These bulbs are being self-pollinated in the hopes of finding individual progeny that possess a higher level of IYS tolerance. In addition to the onion germplasm being screened, several onion-related Allium species were also screened for tolerance to *Iris yellow spot virus*. *A. altaicum*, *A. galanthum*, *A. schoenoprasum*, and *A. tuberosum* developed mild IYS disease symptoms and were confirmed to be positive for IYSV by ELISA. *A. roylei* and *A. vavilovii* developed severe IYS disease symptoms and were confirmed to be positive for IYSV.

New York Brian Nault, Anthony Shelton and John Diaz-Montano, Cornell University, Geneva, NY - The effect of leaf color on onion thrips preference was investigated. The reflectance spectrum of leaves from 11 onion-thrips resistant cultivars, along with 6 other cultivars, was measured using a spectrometer to determine if color and/or light reflectance were associated with resistance to *T. tabaci*. Two susceptible cultivars had the highest values of leaf reflectance in the first (275-375nm) and second (310-410nm) theoretical photopigment-system of *T. tabaci* and these values were significantly different from most resistant cultivars. Because the

two susceptible cultivars always had the highest number of thrips compared with the resistant onion cultivars in previous studies, these results suggest a strong response of *T. tabaci* to onion cultivars with higher light reflectance in the UV range (270-400nm). If genes that confer leaf color are identified they could be integrated in onion breeding programs to develop plants that would elicit behavioral responses by *T. tabaci* that would result in non-preference for onion cultivars.

Steven Beer reported on the biology of *Pantoea ananatis* and the center rot disease that it causes in onions. Earlier, we had documented that this bacterial pathogen occurs in onions in New York and is responsible for considerable damage to the onion crop. The connection to W1008 is that thrips are suspected to vector the pathogen. Thrips that are common in Georgia onion-growing areas are tobacco thrips, *Thrips tabaci*. These thrips have been implicated as vectors of *P. ananatis*, based on finding the bacterium in the gut of thrips. However, the thrips common in New York onions are onion thrips, *Frankliniella fusca*. Their role as vectors of the center rot pathogen is hypothesized, but not documented or proven. In earlier work in New York, *P. ananatis* was confirmed as the cause of center rot in onions that had been stored by growers for 4 to 6 months following harvest. More recently, we documented the presence of the pathogen in symptomatic mid-season growing onions. Thus, apparently the pathogen that results in unmarketable stored onions begins to develop in the field. Furthermore, this relationship was confirmed experimentally by inoculating growing onions in the greenhouse and following the development of the infection over several weeks from leaves, to the neck and into the corresponding bulb scales.

In limited analyzes of thrips collected from onion foliage, we identified strains of *P. ananatis.* The center rot pathogen was present on the exteriors of thrips. No strains of were detected in the homogenates of a limited number of surface-disinfested thrips that were analyzed. However, further analyses are indicated before reaching a definite conclusion in regard to the possible presence of *P. ananatis* in the gut of *Frankliniella fusca*. Prior to and during the 2010-growing season in New York, we endeavored to determine possible sources of inoculum of *P. ananatis.* Thus, in collaboration with Cornell Cooperative Extension Educators, we collected samples of onion seed, transplants and muck soil. These materials were plated or otherwise extracted for *P. ananatis* using an onion extract medium (OEM) that we developed; several well-described pathogens of onion grow well on OEM. *Pantoea ananatis* was discerned from a few samples of soil. However, there was no clear source of inoculum that explained the rather widespread distribution of center rot seen in onions following storage. Inoculation of sets with toothpicks contaminated with test bacteria proved to be a rapid and effective means of testing for the symptoms induced by some, but not all, strains of these bacterial pathogens.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR - The onion trials were conducted in 2008, 2009, and 2010 as planned. Results from 2008 and 2009 trials have been compiled and distributed to growers and the public. Onions from the 2010 season and stored in the 2010-2011 storage season are being graded and the data will be analyzed, reported, and published in the near future. Based on the first two years of the project, preliminary results indicate the following: Based on “on farm” and “on station” trials, onion varieties have been identified that are more and less tolerant to IYSV. The 2009 onion variety

trial strongly sorted varieties for IYSV since the infection rate was severe. Irrigation systems and irrigation criteria have been tested as planned.

Washington Hanu Pappu, Washington State University, Pullman, WA - Varietal trials. In cooperation with Clint Shock at Oregon State determined the virus levels using ELISA to see if there is any correlation between host response to natural infection by the virus under field conditions (=symptom expression) and virus levels as determined by ELISA.

Objective 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 - Two populations of *Thrips tabaci* infested with *Iris yellow spot virus* (IYSV) were reared on either radish (Alta Globe variety) or onion plants (grown from Gurney's yellow onion sets). Plant and thrips samples were removed at two week intervals for twelve weeks and IYSV presence was monitored by PCR. Thrips reared on onion retained IYSV over subsequent generations, while thrips reared on radish lost the virus. This method of generating IYSV-free *T. tabaci* may be useful in comparative studies between IYSV-infected and IYSV non-infected *T. tabaci*. Quantitative Real Time Reverse Transcriptase PCR (QRT-RT-PCR) can be used to quantify the amount of IYSV nucleoprotein genes at different points within the onion plant. Preliminary data shows that the amount of IYSV nucleoprotein gene present in 2 cm leaf samples taken from symptomatic onion leaves varies along the length of the leaf, with the highest concentration of IYSV at the lesion.

There was no cultivar difference for either onion bulb weight or bulb size in a thrips and IYSV study in the greenhouse. However, there was significant treatment difference for weight (probability less than 0.0001), with the Healthy Control giving the highest bulb weight of 0.128 pounds per bulb, followed by Virus infection only plants with 0.08 pounds per bulb, then Thrips only with 0.044 pounds per bulb and finally Thrips plus Virus infected plants with 0.031 pounds per bulb. There also was a significant bulb size difference between the treatments (probability less than 0.001) with Healthy Control having the largest bulb diameter of 1.77 inch, followed by Virus, then Thrips and finally by Thrips plus Virus with sizes 1.61, 1.38 and 1.22 inches, respectively.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR - Small increments of water stress on onion were very detrimental to onion yield and grade in the presence of IYSV in 2008. In 2009 the IYSV pressure at the irrigation trial site was less than in 2008 and the effects of water stress were less dramatic. Additional growers are adopting drip irrigation systems and carefully monitoring soil water tension. The growers' notion that sprinkler irrigation would aid in the reduction of onion thrips has not been substantiated. There seems to be no difference in thrips pressure between irrigation systems. Consistent with the results from 2008, extra N fertilizer in 2009 was not of any benefit to help onions continue growing in the presence of IYSV. No interactions have yet been observed between varieties, water stress, and N fertilizer rates. "On farm" attempts to reduce IYSV effects through the application of kaolin clay have not been successful and growers have stopped trying this option.

Florida Stuart Reitz, USDA-ARS, Tallahasse, FL - Kaolin can increase UV reflectance, which has been shown to repel *Frankliniella* thrips. Field trials were conducted to determine if kaolin could reduce thrips damage in onion in the southeastern USA, where tobacco thrips *Frankliniella fusca* and onion thrips *Thrips tabaci* are the most common species. Significantly more thrips, primarily *F. fusca,* were found on untreated onion. Also, the end of season evaluation of feeding damage showed kaolin treated plants had significantly less damage than did untreated plants (Fig. 1) and had lower incidence of purple blotch. Spray coverage was not uniform, but did exceed 70% of the leaf surface area. In the absence of rainfall, kaolin tended to persist on onion foliage, with no decrease in residue from 1 to 5 days after treatment.

Idaho Krishna Mohan and R.K. Sampangi, University of Idaho, Parma, ID – Thrips samples collected from the overwintering onions, cull piles and overwintering weeds from different locations during 2009-2010 are awaiting analysis in Dr. Hanu Pappu's (WSU) laboratory. We are collaborating with Dr. Clint Shock (MES, OSU) on the Western SARE project to evaluate the effect of selected cultural practices in suppressing IYSV symptom severity in onion.

New York Brian Nault, Cornell University, Geneva, NY - **Performance of foliar-applied insecticides** – Products that worked best against onion thrips included spinetoram (Radiant SC), spirotetramat (Movento), cyantraniliprole (HGW86 10OD) and abamectin (Agri-Mek 0.15EC). Section 18s for Movento and Agri-Mek were granted by EPA in 2010 in New York; Section 18s for these products were submitted again and approved in early 2011 in New York. (a) Performance of new insecticides when tank mixed with fungicides containing spreader stickers. Inclusion of the fungicide, Chloronil, with Agri-Mek, Movento or Radiant as a tank mix reduced the efficacy of thrips control compared with using each insecticide without Chloronil. The reason for this phenomenon is not known. Results from this study also revealed that the reduction in thrips control that occurred when Chloronil was included in the tank mix can be mitigated if a penetrating surfactant is included. Therefore, a tank mix that includes the insecticide, Chloronil and a penetrating surfactant should provide an acceptable level of thrips control. More research is needed to determine if rate of the penetrating surfactant used in the insecticide and fungicide tank mix is important for controlling thrips. (b) Action thresholds for new products – Movento controlled the thrips population when applied following a 3 thrips larvae per leaf threshold, whereas an action threshold of no more than 1 thrips larva per leaf should be used for Agri-Mek. (c) Impact of nitrogen on thrips - Preliminary analyses of one of the fields confirmed the results found in the earlier experiment, plots receiving lower amounts of N fertilizer had significantly fewer larval onion thrips compared with plots receiving higher rates of N fertilizer. This may be due to possible negative effects that lower nitrogen levels in plant tissue could have on thrips colonization, reproduction, survival or emigration behaviors. Future analyses will estimate whether this reduction in larval populations can affect the number or timing of insecticide applications. Bulb weights were not significantly different between plots receiving 74-125 lbs N/ac. We found a higher number of total bulbs > 2 inches in diameter in the highest N treatments (data not shown) but final marketable yield estimates will not be calculated until bulbs placed in storage are graded for rot. There was a trend for higher levels of rot in sprayed plots that received the highest levels of N fertilizer, but the differences were not significant. We anticipate that the cumulative pre- and post-storage percentage of bulbs with rot will result in significant differences in rot levels between the N treatment plots. Final counts of marketable bulbs after subtracting bulbs with rot could eliminate differences in preliminary

estimates of bulb yields between the higher N treatments. While more plants lodged earlier in the plots receiving the highest levels of N fertilizer, this did not appear to affect bulb weight, since the mean bulb weights were highest in the plots that had the highest percentage of plants that had lodged. The 2010 growing season was warm and onion plants matured sooner than usual resulting in almost no bulbs reaching large sizes (e.g. there were almost no jumbo-sized bulbs). This trial will be repeated 2011 and, in a cooler and longer growing season, plants that lodge sooner may affect final bulb weights. (d) *Iris yellow spot virus* in New York – Comparisons were made between number bulb yield of onions that tested positive and negative for IYSV using DAS-ELISA. In 2 of the 4 fields surveyed, bulb weight from infected plants was lower than weight from non-infected ones. No differences in bulb weight between IYSV-infected and non-infected plants were observed in the other two fields.

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 - Seasonal dynamics of thrips vectors: In cooperation with Silvia Rondon of Oregon State. Year 3 of a study to determine the seasonal dynamics of onion thrips as IYSV vectors: we have developed an ELISA test for detecting the virus in the insect using an antiserum that detects a viral protein that will be present in the thrips only if the virus had replicated. Presence of this protein is an indication that the particular adult is capable of transmitting the virus. Testing of the collected thrips by ELISA is ongoing. Biological characterization and genetic diversity of virus strains; in cooperation with Chris Cramer and Howard Schwartz. We are evaluating several field isolates of IYSV to define and determine biological properties in terms of severity/virulence using a set of indicator hosts such as datura and Nicotiana benthamiana. Preliminary findings suggest that there are severe and mild strains of the virus that differ in their virulence when inoculated on these hosts. Genetic diversity studies of the virus isolates from different parts of the US and the world are continuing. Results show that there are clades suggesting some influence of geographic delineation on the sequence diversity of these isolates. Genetic diversity studies would help us better understand the introductions, movement and evolution of the virus and virus populations.

Objective 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 2010 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 Middleburg in March, the Oswego Twilight Meeting in June, the Annual Summer New York Onion Industry Council Meeting in Pine Island 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 National Allium Research Conference in Reno, NV in December and at the Annual Entomological Society of America Meeting in San Diego, CA also in December.

Oregon - Lynn Jensen, Clint Shock, Erik Feibert, and Monty Saunders, Oregon State University, Ontario, OR - The project has continued to effectively transfer information pertinent to IYSV and thrips biology to growers, other onion industry parties, and the public through numerous meetings, field days, publications, and the internet. Results have been effectively communicated by grower and fieldman participation in the project planning and evaluation of results, field days for growers July 14, 2010 and August 29, 2010, grower meetings on February 2, 2010, internet web sites, and results being reported in Onion World. An extension brochure was written describing how to optimize onion irrigation scheduling, including how to minimize IYSV through irrigation management. The extension brochure was published in September, 2010. An early version of the extension brochure was published for worldwide distribution in Onion World.

Impacts

1. Colorado outputs of this work posted on web sites and presented at various meetings will be used by the Colorado and national onion industries, growers, seed company breeders and pathologists, 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.
2. Germplasm was identified in New Mexico (and Colorado) 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
3. 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.

4. Research in Oregon has shown than damage of IYSV is less pronounced. It is hard to tell if the benefits are related to the current project or fluctuations in weather and thrips populations. More growers are adopting onion varieties with greater tolerance to IYSV. Seed availability is still a limiting factor for these new varieties. Due to better knowledge of the transmission of IYSV, fewer growers are planting over-wintering onions. With fewer overwintering onions and better cull onion disposal, growers are breaking the natural green bridge keeping IYSV pressure high from one production year to the next. Some growers continued to suffer IYSV related yield losses due to over-wintering onion bulb or seed fields close to their summer production fields. Increasing numbers of growers are adopting drip irrigation and careful irrigation scheduling. These carefully irrigated onion crops seem to be suffering less from IYSV. 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. These insecticide use strategies have recently been proven to be effective in replicated field tests.

Publications

Beer S. V., Zaid, A. M., and Bonasera, J. M. 2011. Studies of bacterial problems of onion in New York – 2010**.** Proceedings of the 2011 Empire State Fruit & Vegetable Expo. Pages 105-107.

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Other Activities

1. Research Reports: Abstracts and Papers at International Professional Meetings
Bag, S., Cramer, C., Schwartz, H.F., and Pappu, H.R. 2010. Biological Characterization of Distinct Strains of Iris yellow spot virus. Poster presentation at the Australasian Plant Virology Workshop, Melbourne, Australia. Nov. 16-19, 2010.

Szostek, S. A., and Schwartz, H. F. 2010. Iris Yellow Spot Virus of Onion. Fact Sheet, 4 pp. (*The Global Specialist*, in collaboration with Nunhems Seed Co.); printed in English & Spanish. Spanish translation provided by my former student, Dr. Rodolfo Velazquez, INIFAP-Zacatecas, Mexico.

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2. Research Reports: Abstracts and Papers at National Professional Meetings
Boateng, C.O., Schwartz, H.F., and Otto, K. 2010. Evaluation of Onion Cultivars for Resistance to *Iris yellow spot virus* and Onion Thrips. Proc. 2010 National Allium Research Conference, Reno, Nevada, Dec. 9-10, 2010. Oral Paper. http://www.unce.unr.edu/adhoc/narc2010/agenda/

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Szostek, S.A., and Schwartz, H.F. 2010. Generating Clean Thrips Colonies and Quantifying IYSV at Onion Leaf Locations. Proc. 2010 National Allium Research Conference, Reno, Nevada, Dec. 9-10, 2010. Oral Presentation. http://www.unce.unr.edu/adhoc/narc2010/agenda/

3. Reports at Grower meetings and field days

Cramer, C.S. Screening winter-sown onion entries for *Iris yellow spot virus* resistance. New Mexico Dry Onion Commission meeting. Las Cruces, NM. March 24, 2010.

Cramer, C.S. Screening onion entries for tolerance/resistance to Iris yellow spot virus. NM Onion Field Day. Las Cruces, NM. July 21, 2010.

Hsu, C., and Nault, B. A. 2010. Demonstration of the interaction between nitrogen and onion thrips. Elba Muck Onion Twilight Meeting. Elba, NY. Cornell Cooperative Extension Vegetable Program.

Hsu, C. L., C. A. Hoepting, S. Reiners and B. A. Nault. 2010. Impact of nitrogen on onion thrips populations and implications for management. Empire State Fruit and Vegetable Expo. Syracuse, NY.

Nault, B. A. 2010. Onion insect management. Cornell Cooperative Extension Agriculture and Food Systems November In-Service, Ithaca, NY. November 16, 2010.

Nault, B. A. and C. A. Hoepting. 2010. Onion thrips management in onion using Agri-Mek. 2010 – Disease and insect update meeting sponsored by Syngenta Crop Protection. Dundee, NY.

Nault, B. A. 2010. Tank mix interactions among insecticides, fungicides and adjuvants for control of onion thrips. Elba Muck Onion Twilight Meeting. Elba, NY. Cornell Cooperative Extension Vegetable Program.

Nault, B. A., C. L. Hsu, A. Shelton and M. L. Hessney. 2010. Onion insect management update. New York State Onion Industry Council Summer Tour and Meeting, Pine Island, NY. Cornell Cooperative Extension.

Nault, B. A. 2010. Update on onion thrips management and IYSV. Onion School. Middletown, NY. Cornell Cooperative Extension.

Nault, B. A., C. L. Hsu, E. A. Smith, M. L. Hessney, M. Fuchs and A. M. Shelton. 2010. Managing onion thrips and status of *Iris yellow spot virus* in New York. Empire State Fruit and Vegetable Expo. Syracuse, NY

Nault, B. A., C. Hsu, A. Shelton, M. Fuchs, A. Taylor, J. Diaz-Montano, E. Smith, S. Reiners, and C. Hoepting. 2010. Onion insect management and *Iris yellow spot virus* research highlights from 2010. New York Onion Industry Council Winter Meeting, Ithaca, NY.

Schwartz, H. F. 2010 Onion virus management and updates. Annual Education Meeting of the Colorado Onion Association on January 28, 2010 at Eaton, CO.

Schwartz, H. F. 2010. Onion virus management and updates. Annual Field Day of the Colorado Onion Association on September 9, 2010 at Brighton, CO.

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Shock, C.C., E.B.G. Feibert*, L.D. Saunders, L.B. Jensen, K.S. Mohan, R. Sampangi, and H. Pappu. 2010. Comparison of irrigation systems and irrigation criteria for onion production under IYSV pressure. Summer Farm Festival and Annual Field Day, OSU Malheur Experiment Station. 13 July 2010. Ontario, OR.

Shock, C.C. E.B.G. Feibert, L.D. Saunders, L.B. Jensen, S.K. Mohan, R.S. Sampangi, and H. Pappu. 2010. Onion variety trial report 2009. 49th Annual Meeting of the Malheur Onion Growers Association and Idaho Onion Growers Association, 2 February 2010, Ontario, OR.

Shock, C.C. and E.B.G. Feibert. 2009. Onion Drip Irrigation, Pacific Northwest Vegetable Association, Kennewick, WA. November 11, 2009.

Internet Resources

Schwartz, H. F. 2010. Web site dedicated to information and resources on onion pest management and/or thrips and IYSV. http://www.alliumnet.com/index.htm

Schwartz, H. F. 2010. Onion Disease Management strategies, reports and publications, including those on IYSV and thrips. http://www.colostate.edu/Orgs/VegNet/vegnet/onions.html

Update on onion thrips management: http://www.growingproduce.com/gptv/?vid=216

Other Related Activities

2010 - 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 2010 season. The Crisis Exemption request was granted by NYSDEC from June- September 2010.

2010 - 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 2010

season. The Crisis Exemption request was granted by NYSDEC from June- September 2010.