Project Type: Research and Development

Title: Phenology and spatial distribution of adult and larval spotted wing drosophila in small fruit, stone fruit, and wild hosts in New York

Project Leaders:
Dr. Greg Loeb, Professor, Dept. Entomology, Cornell University, Geneva, NY 14456; Phone: 315-872345; Fax: 315-787-2326; Email: gme1@cornell.edu
Dr. Juliet Carroll, Fruit IPM Coordinator, NYS IPM Program, Cornell University, Geneva, NY 14456; Phone: 315-787-2430; Fax: 315-787-2360; Email: jec3@cornell.edu
Cooperators:
Dr. Art Agnello, Professor, Dept. Entomology, Cornell University, Geneva, NY
Peter Jentsch, Senior Ext Assoc, Dept. Entomology, Hudson Valley Lab, NY

Cooperating Growers:
1. Mr. Gary Craft, G & S Orchards, Walworth, NY; Phone: 315-524-3823
2. Mr. Mark Lagoner, Lagoner Farms, Williamson, NY; Phone: 315-589-4899
3. Mr. Mike Biltonin, Farm Manager, Red Jacket, Geneva, NY; Phone: 315-787-0135
4. Mr. Robert Brown, Brown's Berry Patch, Waterport, NY; Phone: 585-682-5569
5. Mr. Gordie Gallop, Silver Queen Farm, Trumansburg, NY; Phone: 607-387-6502
6. Mr. Mark Russell, Whittier Fruit Farm, Rochester, NY; Phone: 585-659-2206
7. Mr. Mike Zingler, R.M. Zingler Farm, Kendall, NY; Phone: 585-659-2206
8. Mr. Gary Orbaker, Orbaker Fruit Farm, Williamson, NY; Phone: 315-945-6311
9. Mr. Ken Trammel, Trammel Farm, Phelps, NY; Phone: 315-521-1756
10. Mr. Jack Pennings Sr., Pennings Orchard, Warick, NY; Phone: 845-986-5959
11. Mr. Chuck Mead, Meads Orchards, Tivoli, NY; Phone: 845-756-5641

Abstract

Spotted wing drosophila (SWD) *Drosophila suzukii*, originally from Asia, is a new invasive fruit pest that became established in NY and surrounding states in 2011. Unlike other fruit flies that typically only infest overripe and rotten fruit, female SWD oviposit in ripe fruit thereby making them unmarketable. Soft-skinned fruit are at greatest risk. We monitored adult SWD and larval infestations for small fruit and stone fruit crops, and potential wild hosts through the season to determine crops at most risk, timing of infestation, spatial variability, relationship between adult captures and larval infestations, and role of wild hosts. Crops at most risk include fall raspberries, blackberries, and blueberries. Peaches and day-neutral strawberries appear to support SWD infestation, though damage was not as great as was found for raspberries and blueberries. Data for cherries was incomplete due to the spring freeze that destroyed crops on all but two of the cooperator's farms. By mid-August severe infestations were found and were reported across NY with timing of infestation development being rapid. Additional farms with raspberry and grape were added to the survey at this point. Across most farms, traps located in the wooded perimeter consistently captured the most adult SWD throughout the season. Traps within crops did not indicate an edge effect, or a noticeable shift from one crop to another. Trap captures did not provide an early indication for fruit infestation in time for spray intervention. Wild hosts including dogwood, bush honeysuckle, pokeweed and buckthorn supported large populations of SWD.

Background and Justification

The invasive species Spotted Wing Drosophila (SWD) *Drosophila suzukii* has exploded onto the scene in most, if not all, states in the Northeast Region in the past year, including NY, causing significant injury to some fruit crops. SWD first appeared in California in 2008 and has been rapidly expanding its distribution ever since. Unlike many other fruit flies, SWD has the capacity to lay eggs into intact and marketable fruit. Small fruit and stone fruit crops, particularly brambles, blueberries, day-neutral strawberries, cherries, and peaches, are vulnerable, although SWD has been reported from many other crops and wild plants. In 2011 serious economic losses were reported in fall raspberries in NY and neighboring states.

As internal feeders, immature stages of SWD are well protected within fruit from pesticides. Therefore, insecticides, for the most part, target the adult flies. Because the flies continually emerge or immigrate into a planting, repeated insecticide applications to maintain clean fruit may be required. In addition to the economic costs, many of the compounds being used are detrimental to beneficial insects. In the absence of insecticides, losses of 100% due to SWD have been observed. The fear of the economic consequences of selling infested fruit may lead many growers to pre-emptive and excessive use of insecticides, disrupting well-established IPM programs. Growers need reliable tools to monitor for the presence of SWD, information on horticultural and environmental risk factors, and alternative approaches to control other than insecticides. Because SWD has only been present in NY since 2011, we know relatively little about seasonal biology, spatial distribution, crops at greatest risk, and the role of wild hosts as sources of infestations. This information is necessary to develop more sustainable approaches involving reliable monitoring and effective management based on cultural, biological and chemical tactics.

Objectives

Objective 1: Monitor adult SWD and larval infestations in small fruit and stone fruit crops and wild hosts in New York through the season at multiple landscapes

Objective 1: Project evaluation.

Procedures

Objective 1: The abundance of SWD adults and larvae were monitored from spring, starting prior to first ripe crop, through the fall at multiple sites in NY, including the Finger Lakes, Lake Ontario, and Hudson Valley. The list of cooperating growers is included above. Farms were chosen that included at least one of the following fruit crops: strawberries (June-bearing and day neutral), blueberries, raspberries (floracane and primocane), blackberries, sweet cherries, and peaches. In mid-August, when populations of SWD exploded and concerns were being raised by growers additional farms were added to the survey.

Adult SWD were monitored in each crop using standardized plastic cup traps baited with apple cider vinegar, with traps paced on the edge and the interior of the crop, and in the adjacent non-crop habitat near potential wild hosts. In the adjacent non-crop habitat, we focused on plants producing soft-skinned fruit, which had been reported to support SWD infestations. These include *Prunus*, *Rubus*, *Vaccinium*, *Phytolacca*, *Cornus*, *Crataegus, Parthenocissus* and *Rhamnus* species among others. Species evaluated varied by region and farm ecosystem. In some farms no hedgerows were present, precluding wild host monitoring. Contents of traps were checked, lures changed, and flies enumerated weekly. Fruit flies were separated into SWD males, SWD females, and other *Drosophila* species.

Ripe and ripening fruit samples, from the edge and interior, were collected when available (approximately 50 g total fruit pooled from five source plants) and used to rear larvae to the adult stage to determine drosophila species (male SWD, female SWD, and other). Fruit for rearing was weighed and placed in standardized, vented, plastic containers with clean sand (or sponge) and a yellow sticky card to collect adult flies as well as adult parasitoids.

The pattern of adult SWD and larval abundance through time as a function of different crops or non-crop habitat and with respect to edge or interior of plantings was assessed graphically and preliminary analyses are presented in this report. Time series analysis is ongoing as are the regression analyses of the relationship between distance among different crop and non-crop habitat, fruiting period and timing and abundance of SWD adults and larvae.

Objective 2. The project provided essential knowledge of the basic biology of SWD and improved perspectives on the crops at risk and wild hosts, providing a solid foundation for future IPM strategies. This project paved the way for critical research and extension activities for the coming years and contributed to the development of campus-, regional-, and county-based Cornell Cooperative Extension research and extension teams to address SWD in NY. We presented ten talks on SWD, one webinar, developed three press releases, wrote an article for the NY Fruit Quarterly, contributed to a berry pest alert blog, a fruit blog, a distribution map for SWD in NY and submitted four grants to source funding to continue this effort. This grant was instrumental in laying a solid foundation for coordinated efforts on SWD in NY.

Results and Discussion

Objective 1: The seasonal occurrence of SWD in adult traps followed a similar pattern as had been observed in other growing regions following detection in the previous season. First capture occurred the week of 2-Jul (Figure 1). The population quickly grew as the season progressed, reaching relatively abundant numbers the week of 20-Aug. Occurrence of SWD was similar throughout the season in traps located in either crop edge or interior. Traps located in wooded perimeters of farms consistently captured more flies than traps located within farm plantings. This was particularly evident in the late-season traps set out in response to grower concerns in which the mean trap catch exceeded 400 SWD the week of 5-Nov (Figure 2). Contributing to this increase were two traps set in Norway spruce adjacent to a vineyard block in which 1590 and 3610 SWD were caught. Percentage of SWD in ACV traps, in relation to other fruit flies captured, peaked around 20-Aug at 53% and stayed relatively consistent for the remainder of the season with a range of 36% to 53%.

Ripe fruit samples that were collected and held under insectary conditions provided some indication of host utilization and the ability of various fruit crops to support development of SWD (Table 1). Rearing results should be interpreted keeping in mind factors related to the population dynamics of the SWD in relation to the fruiting season of the various crops and wild hosts. Fall raspberry and blueberry appeared to be the most utilized by SWD, but we reared SWD from a number of other fruit crops at lower levels. June-bearing strawberry escaped SWD infestation in 2012 while day-neutral strawberries in late summer were exploited. The most important wild hosts at the farms studied included dogwood, buckthorn, pokeweed and bush honeysuckle. The importance of wild cherry (*Prunus sp*) is unclear since only a few samples were collected from this host.

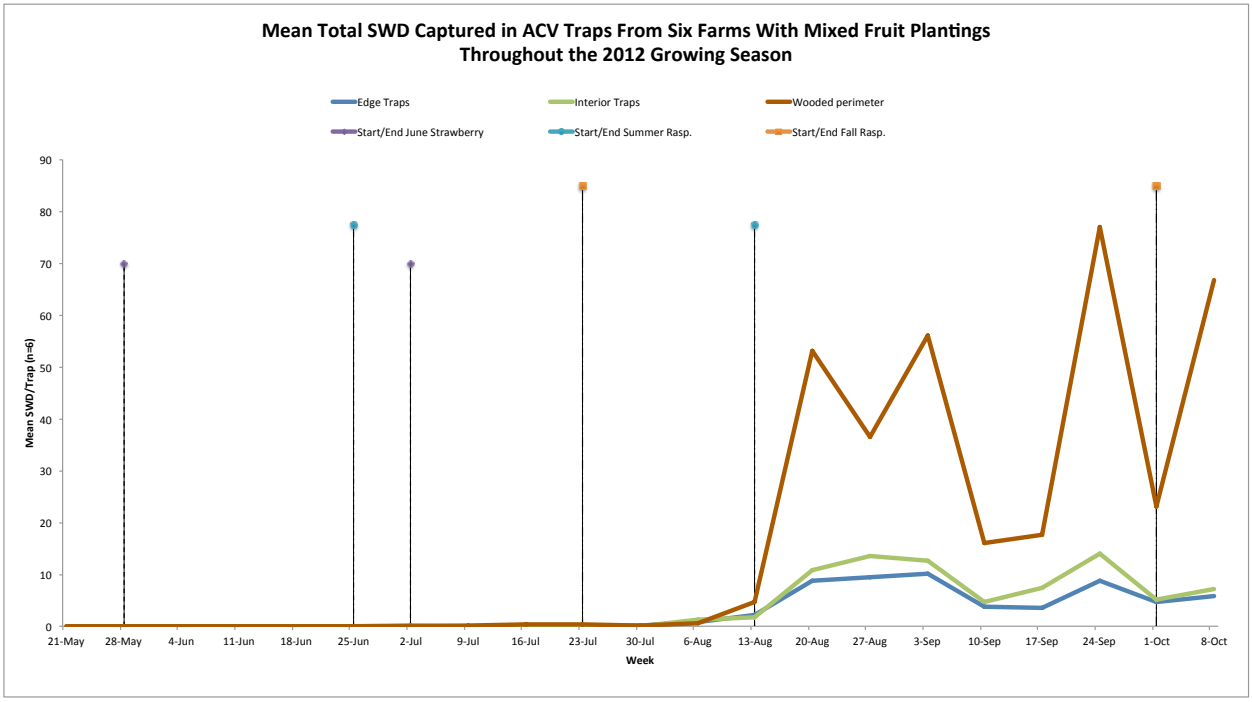

Figure 1. Mean total SWD captured in various fruit crop (combined for this figure) edges and interiors, and from wooded farm perimeters, from six Finger Lakes and Lake Ontario region farms, throughout the 2012 growing season. Standard ACV deli-cup traps were used and checked weekly.

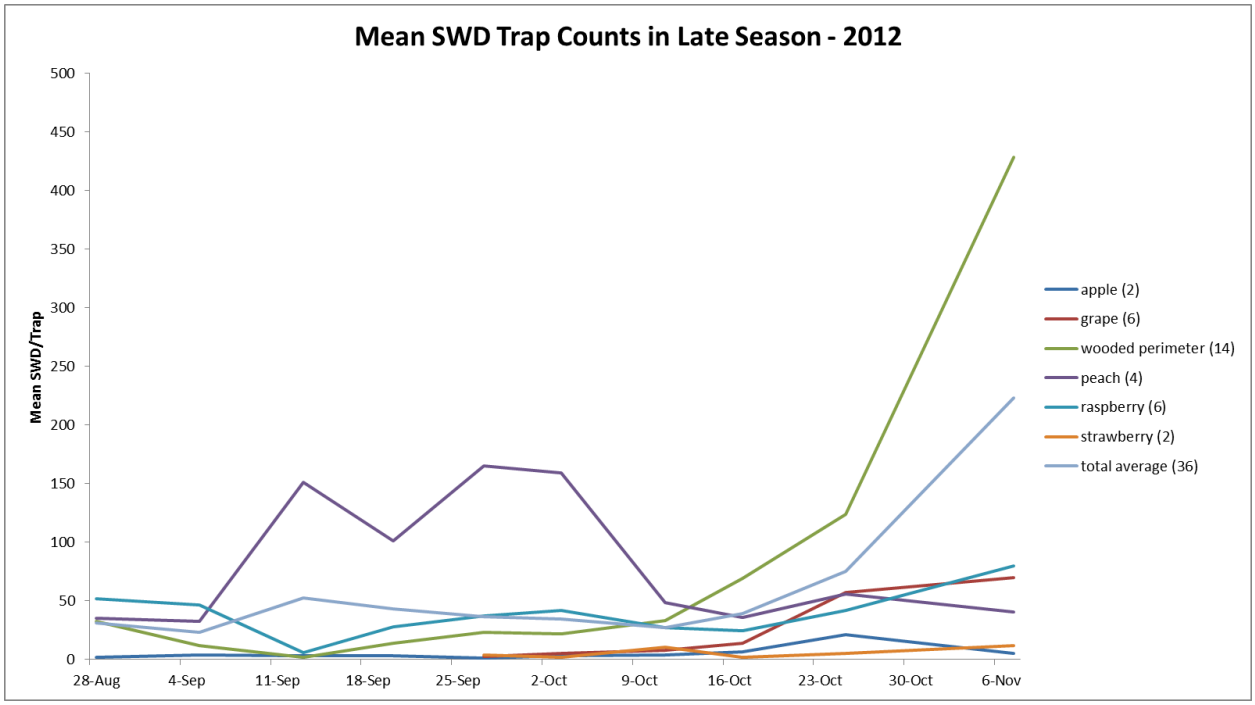

Figure 2. Mean total SWD captured in traps set in late August and monitored through early November in apple, grape, peach, raspberry, day-neutral strawberry and the wooded farm perimeter (number of traps in parentheses), in nine Finger Lakes and Lake Ontario region farms, during the 2012 growing season. Standard ACV deli-cup traps were used and checked weekly.

Table 1. Mean ± SE SWD per sample, other Drosophila per sample, and proportion of SWD reared from various possible SWD fruit hosts. Sampled from 7 different farms in the Finger Lakes Region, NY.

Host	N Rows	SWD Rank	Total SWD Mean/g ± SE	Total Other Fruit Flies Mean/g ± SE	Proportion SWD mean ± SE
Fall Raspberry	63	1	1.05 ± 0.22	0.17 ± 0.05	0.76 ± 0.04
Wild-Buckthorn	29	2	0.54 ± 0.16	0.06 ± 0.04	0.82 ± 0.09
Fall Raspberry (overripe)	2	3	0.49 ± 0.34	0.03 ± 0.03	0.96 ± 0.035
Blueberry	68	4	0.38 ± 0.12	0.08 ± 0.03	0.73 ± 0.06
Wild-Pokeweek	10	5	0.30 ± 0.12	0.07 ± 0.05	0.86 ± 0.09
Summer Raspberry	82	6	0.25 ± 0.07	0.11 ± 0.04	0.59 ± 0.07
Wild-Dogwood	5	7	0.17 ± 0.09	0.04 ± 0.02	0.86 ± 0.07
Grape-Syrah(damaged)	2	8	0.13 ± 0.13	0.0 ± 0.0	1
D-N Strawberry	58	9	0.09 ± 0.03	0.37 ± 0.16	0.34 ± 0.08
Grape-Concord (damaged)	37	10	0.08 ± 0.02	0.47 ± 0.07	0.14 ± 0.04
Wild-Cotoneaster	2	11	0.06 ± 0.06	0.0 ± 0.0	1
Grape-Catawba (damaged)	1	12	0.04	0	1
Wild-Honeysuckle	53	13	0.03 ± 0.02	0.10 ± 0.07	0.45 ± 0.21
Tunnel Raspberry	47	14	0.02 ± 0.007	0.37 ± 0.08	0.31 ± 0.06
Grape-Cabernet Franc (damaged)	18	15	0.02 ± 0.007	0.15 ± 0.06	0.25 ± 0.08
Grape-Baco	14	16	0.02 ± 0.008	0.017 ± 0.007	0.41 ± 0.16
Grape-Cayuga White (damaged)	6	17	0.01 ± 0.007	0.67 ± 0.41	0.20 ± 0.16
Peach	30	18	0.01 ± 0.008	0.14 ± 0.12	0.15 ± 0.14
Grape-Cabernet Franc	44	19	0.009 ± 0.005	0.11 ± 0.06	0.27 ± 0.11
Peach-drops	30	20	0.0029 ± 0.0023	0.11 ± 0.06	0.05 ± 0.05
Apple	9	21	0.003 ± 0.003	0.0 ± 0.0	1
Wild-Sumac	14	22	0.002 ± 0.002	0.0 ± 0.0	1
Grape-Cayuga White (damaged)	18	23	0.0019 ± 0.0015	0.02 ± 0.009	0.08 ± 0.07
Grape-Cayuga White	24	24	0.0009 ± 0.0007	0.78 ± 0.77	0.01 ± 0.0099
Grape-Concord	37	25	0.0008 ± 0.0005	0.087 ± 0.068	0.08 ± 0.07
Grape-Chardonnay	24	26	0.0007 ± 0.0007	0.094 ± 0.092	0.17 ± 0.17
Apple-drops	14	27	0.0006 ± 0.0006	0.071 ± 0.04	0.02 ± 0.02
Grape-Niagara	25	28	0.0004 ± 0.0004	0.032 ± 0.030	0.08 ± 0.08
Apricot	2	29	0.0 ± 0.0	0.0 ± 0.0	
Grape-Aurore	1	29	0	0.039	0
Grape-Cabernet Sauvignon	2	29	0.0 ± 0.0	0.0 ± 0.0	
Grape-Catawba	1	29	0	0	
Grape-Niagara (damaged)	1	29	0	0	
Grape-White Table Grape	2	29	0.0 ± 0.0	0.0 ± 0.0	
June Strawberry	33	29	0.0 ± 0.0	0.28 ± 0.18	0.0 ± 0.0
Peach-Mummy	2	29	0.0 ± 0.0	0.017 ± 0.017	0.0 ± 0.0
Plum	2	29	0.0 ± 0.0	0.0 ± 0.0	

Host	N Rows	SWD Rank	Total SWD Mean/g ± SE	Total Other Fruit Flies Mean/g ± SE	Proportion SWD mean ± SE
Plum-drops	1	29	0	0	
Summer Raspberry - Market	1	29	0	1.09	0.0 ± 0.0
Sweet Cherry	7	29	0.0 ± 0.0	0.17 ± 0.17	0.0 ± 0.0
Sweet Cherry - Market	1	29	0	0	
Wild-Black Cap Raspberry	1	29	0	0	
Wild-Cherry	1	29	0	0	
Wild-Climbing Nightshade	2	29	0.0 ± 0.0	0.0 ± 0.0	
Wild-Mushroom	2	29	0.0 ± 0.0	0.0 ± 0.0	
Wild-riparia	19	29	0.0 ± 0.0	0.0 ± 0.0	
Wild-Rosa spp.	6	29	0.0 ± 0.0	0.0 ± 0.0	
Wild-viburnum	1	29	0	0	
Wild-Virgina creeper	1	29	0	0	
Wild-Washington hawthorn	2	29	0.0 ± 0.0	0.0 ± 0.0	

Distinct patterns of SWD population shifts from one commercial crop to another were not obvious (Figure 3). Figure 3 represents data from a single farm in the study, but is representative of most farms in regards to timing and abundance of SWD populations detected in different commercial crops and wooded perimeters. Higher numbers of SWD adults were consistently captured in the wooded perimeter of farms that were included in this study. Further spatial analysis will be completed to support this initial impression.

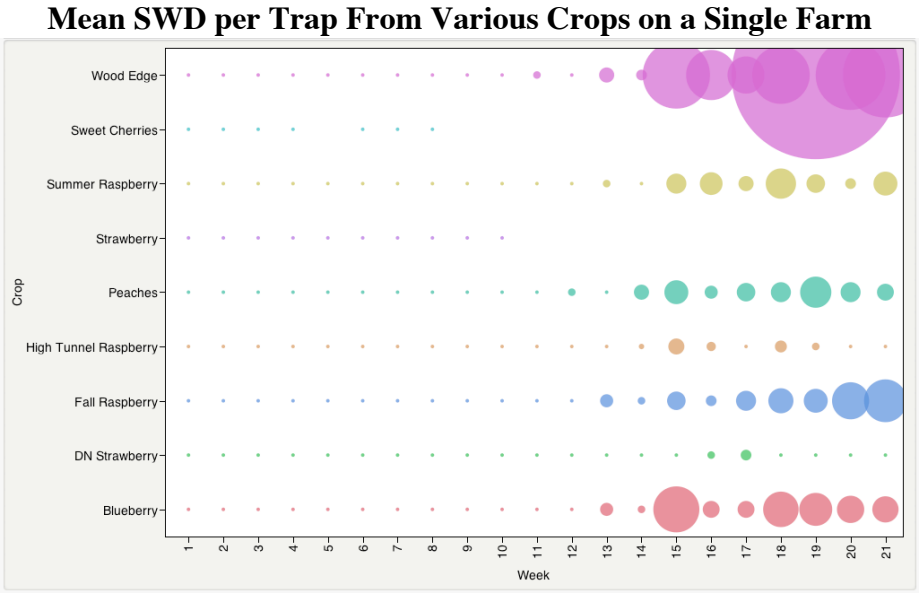

Figure 3. Bubble diameter represents mean total SWD captured in standardized apple cider vinegar bated traps from various fruit crops and habitats of a single farm throughout the 2012 growing season (21-May thru 8-Oct). Lake Ontario Region, NY.

Outcomes

At the completion of this project we have greatly increased our knowledge of SWD phenology in different crops and determined which crops are at highest risk of infestation and crop loss under NY conditions. Our research has allowed us to improve monitoring capabilities for growers to better assess risk from SWD. The research on wild hosts has provided information that growers may be able to use to help assess and minimize risks from SWD infestation or harborage from wild hosts adjacent to their fruit crops. We had hoped that adult captures in traps placed in wild habitat with preferred SWD hosts could provide an early-warning for infestation in cash crops. Howerver, the apple cider vinegar lure is not sufficiently effective to provide early warnings of SWD arrival to a planting and therefore, better lures need to be deployed in 2013.

Our efforts in 2012 fell short of protecting fall raspberries, blackberries and late varieties of blueberry. We know from reports and a survey of berry growers that many abandoned these crops rather than continually spraying insecticides, removed the crops from their farm, or decided against planting additional acreage of these crops. It is imperative that we develop IPM practices to combat SWD. Results from this work will benefit all small fruit and stone fruit growers in NY, including 2,000 acres of strawberries, 500 acres of raspberries, 900 acres of blueberries, and over 3,800 acres of peaches and sweet cherries.

Project location(s)

This project occurred in the Hudson Valley, Lake Ontario, and Finger Lakes regions of NY. The results are applicable in comparable climate regions of the Northeastern USA and Canada.

Resources developed

Web resources

Cornell Fruit Blog – Alerts about SWD findings on this blog, blogs.cornell.edu/fruit/

Cornell Berry Pest Alerts – Alerts about SWD findings in berries on this blog, www.fruit.cornell.edu/berry/pestalerts/

SWD Distribution in NY – Maps of SWD traps and infestations, hudsonvf.cce.cornell.edu/NY%20SWD%20Monitoring.html

NYS IPM Program, Spotted Wing Drosophila, nysipm.cornell.edu/invasives_exotics/swd/

NYS IPM Program, Spotted Wing Drosophila fact sheet, nysipm.cornell.edu/invasives_exotics/swd/swd.pdf

Presentations

Loeb, G. April 27, 2012. ***Getting ready for spotted wing drosophila: understanding risks for small fruit crop and current management strategies.*** Webinar, sponsored by CCE. http://www.fruit.cornell.edu/berry/webinar/archive.html

Loeb, G. July 24, 2012. ***Spotted wing drosophila, new threat to some small fruit crops.*** Lake Ontario Field Day for Fruit Crops, Walcott, NY.

Carroll, J. and Loeb, G. Oct 13, 2012. ***Invasive fruit fly destroys berry crops.*** Cornell Alumni Breakfast Meeting, NYSAES, Geneva, NY.

Carroll, J., Jentsch, P., Agnello, A., and Loeb, G. Oct 23, 2012. ***Orchard survey for exotic pests helps reveal spotted wing drosophila infestations and identify streptomycin-resistant***

fire blight in New York. New England, New York, and Canada Tree Fruit Pest Management Meeting, Burlington, VT.

Carroll, J. Nov 1, 2012. ***Northeast field update, New York, spotted wing drosophila.*** Spotted Wing Drosophila IPM Working Group Meeting, Geneva, NY.

Loeb, G. Nov 1, 2012. ***Research update from NY.*** Spotted Wing Drosophila IPM Working Group Meeting, Geneva, NY.

Loeb, G., Heidenreich, C., Dermott, L., and Carroll, J. Nov 1, 2012. ***Northeast IPM spotted wing drosophila damage assessment for 2012.*** Spotted Wing Drosophila IPM Working Group Meeting, Geneva, NY.

Zaman, F., Loeb, G., and **Carroll, J**. Nov 12, 2012. ***Spotted wing drosophila's 2012 impact on grapes in NY.*** Cornell Recent Advances in Viticulture & Enology, November Food and Agriculture In-Service, Ithaca, NY.

Carroll, J. and Loeb, G. Nov 13, 2012. ***Spotted wing drosophila, assisting dealing with an important invasive insect.*** Agricultural Invasive Species, November Food and Agriculture In-Service, Ithaca, NY.

Publications

Carroll, J., Zaman, F., and Loeb, G. 2012. This "Ninja" Fruit Fly Cuts into Perfect Fruits – Spotted Wing Drosophila. New York Fruit Quarterly. 20:17-20.

Carroll, J., and Peterson, K. 2012. Spotted wing drosophila. Invasive Species & Exotic Pests, NYS IPM Program, Cornell University. 2 p. nysipm.cornell.edu/invasives_exotics/swd/swd.pdf.

Photographs

Carroll and Loeb have photos of SWD, traps in the field and people sampling traps.