scaffolds
Update on Pest Management and Crop Development
F R U I T J O U R N A L
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DISEASES

BITTER WITH THE SWEET

PREVENTING BITTER ROT IN APPLES

(Dave Rosenberger and Kerik Cox, Plant Pathology, Highland and Geneva; dar22@cornell.edu and kdc33@cornell.edu)

❖❖ Bitter rot is an increasingly common problem for apple producers in New York and New England. Forty years ago, bitter rot was considered a "southern disease" and apples with bitter rot were rare in New York. Today, nearly all growers in New York and New England need to be aware of the threats posed by this pathogen.

Bitter rot appears on apple fruit as a pale brown decay with a saucer-like depression. During wet weather, orange spore masses exuding from the center of the decayed area are dispersed by insects and splashing rain. The center of the lesions appear to have black pustules in dry weather, but these will turn orange again if the decayed fruit is stored in a closed container with a wet towel for a day or two. The bitter rot pathogens are the only pathogens that produce orange spores on fruit decays that develop in the field in late summer. Quince rust can produce orange lesions and orange spores earlier in the summer, but quince rust does not produce decay unless it is accompanied by other pathogens. Bull's-eye rot and Nectria rot can produce orange spores, but they generally develop only as postharvest pathogens. A further diagnostic for bitter rot is that the decay progresses toward the seed cavity in a distinctive V-pattern that is evident when fruit are cut through the center of the decay (Fig. 1).

Three factors have probably contributed to the increasing incidence of bitter rot in northeastern United States. First, as a result of

Figure 1: Honeycrisp with bitter rot showing black pustules on the surface of the decay as they appear in dry weather and the V-shaped progression of the decay toward the seed cavity.

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global warming, we have more days during summer with warm wetting events that are essential for initiating bitter rot infections. Second, new cultivars (e.g., Honeycrisp) that have been introduced are very susceptible to natural infections in the field. Finally, we are also growing more late-maturing cultivars such as Cripps Pink, and these cultivars may need additional fungicide sprays during September and/or early October if they are to be fully protected from bitter rot.

Bitter rot in apples in northeastern United States is usually caused by the fungus *Colletotrichum fioriniae*, a member of the *Colletotrichum acutatum* species complex (Wallhead et al. 2014). Understanding bitter rot in apples is complicated by the fact that, over the past several decades, modern methods have allowed taxonomists to identify at least 11 different species or subspecies of *Colletotrichum* can cause bitter rot diseases in apples, and those species belong to three different clades or species complexes within the genus *Colletotrichum*. The fruit decays caused by the various pathogens are virtually identical, but the pathogen biology and the recommended management strategies can differ significantly among the species. For example, the *Colletotrichum* species present in Brazil can cause a leaf spot disease that rapidly defoliates Gala trees (Velho et al. 2015) whereas *C. fioriniae* in NY has only occasionally been found in leaf spots, and then probably only as a secondary invader. The *Colletotrichum* species found in Norway and some other countries causes significant postharvest losses (Børve and Stensvand 2015), whereas the species in eastern United Sates purportedly do not grow at temperatures below 41°F (Books and Cooley 1917). Research in Norway has shown that the pathogens there commonly overwinter in apple buds, whereas prevailing evidence in the US suggests that *C. fioriniae* overwinters primarily in dead wood within trees (it likes to invade fire blighted wood) or in infected fruit left on the orchard floor.

Because of these differences among species, and because species differences have only recently been recognized, research on bitter rot from other regions of the US and the world may not be relevant in Northeastern United States. Also, interpreting the older literature is complicated by uncertainties about which species were being investigated. In some of the older literature, especially European literature on postharvest diseases, there has even been some potential for confusing bitter rot with other fruit rots (*Gloeosporium* species) that behave more like bull's eye rot and/or storage decays caused by *Nectria galligena*, the cause of European apple tree canker. Initial symptoms of these fruit decays are all very similar to the initial symptoms of bitter rot on fruit. When decays show up in stored fruit, the causal agent can be identified with certainty only by making isolations and then using PCR or other molecular techniques to identify the pathogen.

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scaffolds
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scaffolds FRUIT JOURNAL
Dept. of Entomology
NYSAES, Barton Laboratory
Geneva, NY 14456-1371
Phone: 315-787-2341
FAX: 315-787-2326
E-mail: ama4@cornell.edu

Editor: A. Agnello

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A low incidence of bitter rot is not uncommon in Honeycrisp orchards today, but occasionally bitter rot contributes to massive and repeated losses in specific blocks of other cultivars. The trigger for these epidemics has not been determined, but in at least several cases we suspect that the initial inoculum came from other tree species on the orchard perimeters (horse chestnut, sycamore maple, cottonwood, etc.), or from bitter rot invading heat-damage fruit (Rosenberger 2014). There is some evidence that once an epidemic becomes established in an apple block, the pathogen may overwinter on fallen fruit and the huge amount of inoculum persisting in the orchard may contribute to continued losses in subsequent years. Thus, decayed fruit should be removed from beneath trees in blocks where bitter rot was a problem the previous year. It may be best to collect and remove decayed fruit from the orchard, but we suspect that if decayed fruit are tossed into the sodded row middles, they will break down quickly enough to eliminate their threat as an inoculum source. Fruit mummies left to overwinter in the "biological desert" of a clean herbicide strip are more likely to persist from year to year.

Unfortunately, traditional summer fungicide programs used to protect fruit from sooty blotch, flyspeck, and black rot frequently fail to control bitter rot where inoculum is abundant. Mancozeb was very effective against bitter rot, and season-long use of mancozeb prior to the label change in the early 1990s may help to explain why we rarely saw bitter rot in NY orchards 25 or 30 years ago. Captan is also very effective when applied at full label rates, but mid-label rates may fail to control bitter rot in high-inoculum orchards or when weather conditions are especially favorable for bitter rot infection. The QoI fungicides (Flint, Sovran, and the pyraclostrobin component of Pristine and Merivon) also provide some protection, although they should be used in combinations with at least mid-label rates of Captan to control bitter rot under high-pressure situations. Ziram at high rates is also effective but leaves more visible residues on fruit than does Captan. Topsin M and the DMI fungicides are not very reliable for bitter rot control under high disease pressure.

Recently, we have fielded complaints about bitter rot decays in fruit coming out of storage. Isolations made from stored fruit last winter in the Cox lab verified that the decays were still being caused by *C. fioriniae* rather than some other introduced species of *Colletotrichum* associated with storage decays elsewhere in the world. The most likely explanation for development of bitter rot in storage is failure of growers to maintain fungicide coverage on apples right up until harvest and failure of storage operators to cool fruit quickly. The bitter rot pathogens can infect fruit very efficiently during hot periods in summer, but they can also infect stem and calyx ends of fruit during long and cool wetting periods that can occur in late fall when water and spores collect in the calyx and/or the stem cups of fruit following fall rains.

In fungicide trials with sooty blotch and flyspeck, we found many years ago that none of the fungicides, not even Pristine, remained effective following 2.2 inches of rainfall (Rosenberger & Meyer 2007). Thus, if heavy rains in mid- or late September remove fungicide residues, then fruit may become infected in late September or October if no follow-up fungicide is applied and if the subsequent weather favors infection. With cultivars such as Cripps Pink, which appears susceptible to bitter rot and sometimes is not harvested until early November, growers may need to consider applying fungicide sprays as late as October in some years. Postharvest treatment with fungicides

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such as fludioxonil (Scholar) may eliminate infections that occurred just several days before harvest, but postharvest fungicides cannot eradicate incubating infections that were established in the fruit more than a few days prior to infection (Rosenberger & Rugh 2013).

More research is needed on the abilities of *C. fioriniae* to grow at low temperatures. Old literature suggests that the bitter rot pathogens in eastern United States (presumably either *C. fioriniae* or *C. gloeosporioides*, the latter being common in southeastern United States) do not grow below 40°F. If that is true, then fruit that are cooled rapidly after harvest should not develop bitter rot during storage. However, in too many cases, fruit temperatures in the center of bin stacks may remain above 40°F for several weeks after harvest because refrigeration capacity and/or air movement with storage rooms result in delayed cooling. Such delayed cooling might provide adequate time for decays to develop from quiescent infections that were present at harvest.

To summarize, bitter rot is a potential problem on Honeycrisp nearly everywhere in the northeast, but it occasionally causes big problems on other cultivars as well. Where bitter rot was a problem last year or where infected fruit are already evident in the orchard, growers should adopt the following strategies:

1. Remove all dropped fruit from the herbicide strip after harvest to minimize inoculum for next year.
2. Protect fruit from mid-July through harvest with full label rates of captan or with combinations of a QoI fungicide plus mid-label rates of captan. Captan-QoI combinations are preferred for the last spray or two prior to harvest.
3. Be alert to the need for additional fungicide sprays in September and October on late-maturing cultivars if trees have received more than 2.2 inches of rain since the last fungicide was applied.
4. Cool fruit to below 40°F as quickly as possible after harvest so as to minimize decay development during storage. ❖❖

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INSECTS

SUMMERY SUMMARY

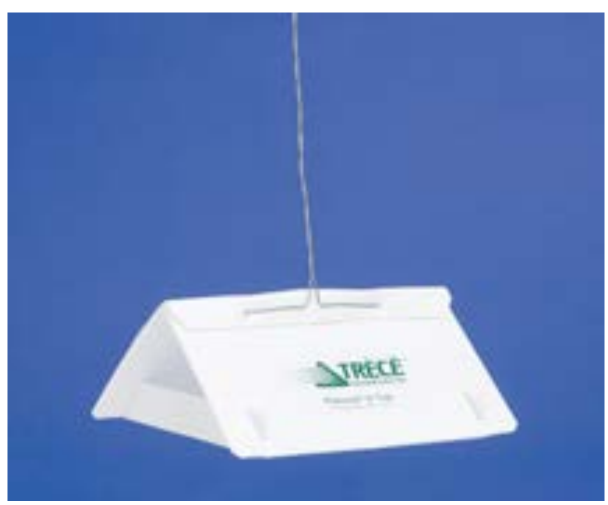
2016 FRUIT ARTHROPOD PEST REVIEW

(Art Agnello, Entomology, Geneva; ama4@cornell.edu)

❖❖ We started out this year's run of Scaffolds with some wary observations about the oddly warm winter weather and its anticipated impact on orchard insects (a common theme, as noted from an inspection of back issues), and it seems that this was destined to be one of those seasons where the weather superceded most other things capable of influencing fruit and tree health, including insects. A cold and rainy late March and early April (with some obligatory single-digit plunges that took out most of our peaches and abused several apple varieties) transitioned into irregular May weather patterns, but by the end of the month we were already running a rainfall deficit and the temperatures were starting to mimic the southeastern states; things haven't reverted to "NY normal" since.

As often happens during variable petal fall periods, **plum curculio** posed something of a challenge around the state, with some growers unable to beat the beetles to the fruitlets on the front end, and not always protecting them long enough at the end of the egg-laying period. **Codling moth** and **oriental fruit moth**, the internal leps that have established themselves as primary drivers of many insect management programs, were initially somewhat delayed in their normal mid-May appearance, but soon reached their normal flight patterns in June and required the typical level of attention we've come to expect. **Obliquebanded leafroller** was present as usual, but didn't appear to pose too many real problems in most areas. Predictably, mites responded to the continued high temperatures with outbreaks of both **European red mites** and **twospotted spider mites** reported in various sites. **Apple maggot** was somewhat delayed in its normal first occurrence, probably owing to the dry soil conditions, but has been continuing to fly and generate some concern in most parts of the state. **Brown marmorated stink bug** has essentially been a no-show in NY this season, although some nymphs are starting to appear in WNY traps located near packinghouses, so the game's not over yet.

Some of our major-minor pests, like **San Jose scale** and **woolly apple aphid**, have shown up here and there, but it's a little too early to assess their level of severity just now. Some normally marginal species, like **apple leafcurling midge** and **Japanese beetle**, caught the attention of observers in various plantings, which doesn't happen regularly, but then this season has been anything but regular. Finally, this season has generated continued concern over the troublesome **black stem borer**, an ambrosia beetle that has been found as the cause of tree decline and death in numerous plantings around the state. Regrettably, we don't appear to be any closer to finding a good solution to this problem, and the stress caused by drought conditions this year has only heightened our awareness of how easily the stressed trees can become targets for attack. ❖❖



TRENDING NOW

HEAT UNITS
(Art Agnello, Entomology, Geneva;
ama4@cornell.edu)

❖❖ Not to dwell excessively on the historic high temperatures of the 2016 season, but it seems that our longstanding pheromone trap records appear to be reflecting some definite early flight patterns in our regular insect mileposts this year, although no actual early records were set. Still, it's interesting to note how many cases exhibited 1st captures in 2016 considerably earlier than the "normal" occurrences. Following are summarized comparative listings of some of the pest events (for the "usual" species) and crop development stages that occurred this season (in Geneva) with calendar and degree-day normals. The values and dates are given +/- one standard deviation; i.e., events should occur within the stated range approximately 7 years out of 10.

	DATE		DEGREE DAYS(BASE 43 °F)	
EVENT	Normal (+/-days)	2016	Normal (+/-DD)	2016
APPLE MAGGOT				
1st catch	2-Jul(+/-10)	16-Jun	1443(+/-218)	1008
AMERICAN PLUM BORER				
1st catch	16-May(+/-7)	26-May	457(+/-64)	550
CODLING MOTH				
1st catch	20-May(+/-7)	20-May	436(+/-85)	425
1st flight peak	2-Jun(+/-12)	31-May	764(+/-207)	700
1st flight subsides	5-Jul(+/-13)	8-Jul	1542(+/-278)	1604
2nd flight start	20-Jul(+/-14)	15-Jul	1904(+/-330)	1815
2nd flight peak	6-Aug(+/-14)	25-Jul	2321(+/-373)	2013
DOGWOOD BORER				
1st catch	13-Jun(+/-10)	3-Jun	998(+/-245)	766
Peak	9-Jul(+/-10)	30-Jun	1649(+/-215)	1375
GREEN FRUITWORM				
1st catch	6-Apr(+/-7)	25-Mar	99(+/-50)	105
Peak	18-Apr(+/-8)	22-Apr	156(+/-56)	226
Flight subsides	9-May(+/-10)	23-May	366(+/-99)	475
LESSER APPLEWORM				
1st catch	13-May(+/-12)	23-May	420(+/-144)	475
1st flight peak	22-May(+/-13)	31-May	569(+/-205)	700
1st flight subsides	25-Jun(+/-11)	8-Jul	1270(+/-268)	1604
2nd flight begins	14-Jul(+/-12)	25-Jul	1768(+/-339)	2103
LESSER PEACHTREE BORER				
1st catch	24-May(+/-8)	26-May	577(+/-96)	550

	DATE		DEGREE DAYS(BASE 43 °F)	
EVENT	Normal (+/-days)	2016	Normal (+/-DD)	2016
OBLIQUEBANDED LEAFROLLER				
1st catch	8-Jun(+/-7)	31-May	887(+/-93)	700
1st flight peak	16-Jun(+/-7)	21-Jun	1030(+/-191)	1144
1st flight subsides	16-Jul(+/-7)	15-Jul	1832(+/-209)	1815
2nd flight begins	8-Aug(+/-9)	8-Aug	2435(+/-200)	2521
ORIENTAL FRUIT MOTH				
1st catch	2-May(+/-8)	2-May	273(+/-51)	270
1st flight peak	14-May(+/-11)	12-May	432(+/-102)	345
1st flight subsides	12-Jun(+/-8)	9-Jun	967(+/-139)	887
2nd flight begins	29-Jun(+/-5)	24-Jun	1376(+/-120)	1206
2nd flight peak	10-Jul(+/-9)	11-Jul	1701(+/-253)	1684
2nd flight subsides	31-Jul(+/-7)	15-Jul	2278(+/-254)	1815
3rd flight begins	10-Aug(+/-9)	1-Aug	2542(+/-279)	2303
PANDEMIS LEAFROLLER				
1st catch	5-Jun(+/-6)	3-Jun	824(+/-68)	766
Peak	14-Jun(+/-8)	13-Jun	1039(+/-149)	959
Flight subsides	5-Jul(+/-6) 8-Jul	1567(+/-126)	1604	
PEACHTREE BORER				
1st catch	16-Jun(+/-11)	16-Jun	1063(+/-262)	1008
REDBANDED LEAFROLLER				
1st catch	16-Apr(+/-9)	15-Apr	145(+/-32)	156
1st flight peak	3-May(+/-10)	22-Apr	303(+/-75)	226
1st flight subsides	1-Jun(+/-8)	3-Jun	747(+/-146)	766
2nd flight begins	29-Jun(+/-6)	21-Jun	1385(+/-177)	1144
2nd flight peak	14-Jul(+/-7)	15-Jul	1759(+/-224)	1815
2nd flight subsides	8-Aug(+/-11)	1-Aug	2436(+/-276)	2303
3rd flight begins	20-Aug(+/-10)	5-Aug	2741(+/-218)	2428
SPOTTED TENTIFORM LEAFMINER				
1st catch	19-Apr(+/-9)	18-Apr	166(+/-49)	184
1st flight peak	7-May(+/-8)	5-May	338(+/-70)	288
1st flight subsides	5-Jun(+/-9)	9-Jun	812(+/-136)	887
2nd flight begins	16-Jun(+/-7)	13-Jun	1074(+/-86)	959
2nd flight peak	7-Jul(+/-9)	8-Jul	1586(+/-201)	1029
2nd flight subsides	28-Jul(+/-8)	28-Jul	2181(+/-179)	2193
3rd flight begins	7-Aug(+/-7)	1-Aug	2445(+/-189)	2303
3rd flight peak	20-Aug(+/-9)	12-Aug	2781(+/-221)	2652

CROP PHENOLOGY	DATE Normal (+/-days)	2016	DEGREE DAYS (BASE 43°F) Normal (+/-DD)	2016
APPLE (MCINTOSH)				
Silver tip	8-Apr(+/-7)	21-Mar	85(+/-23)	92
Green tip	12-Apr(+/-8)	31-Mar	121(+/-23)	123
Half-inch green	20-Apr(+/-8)	18-Apr	174(+/-24)	184
Tight cluster	27-Apr(+/-8)	22-Apr	232(+/-26)	226
Pink	3-May(+/-7)	29-Apr	291(+/-25)	253
Bloom	10-May(+/-6)	10-May	380(+/-36)	327
Petal fall	18-May(+/-6)	20-May	484(+/-39)	425
Fruit set	22-May(+/-6)	23-May	551(+/-45)	477
APPLE (RED DELICIOUS)				
Silver tip	9-Apr(+/-8)	21-Mar	97(+/-17)	92
Green tip	13-Apr(+/-9)	7-Apr	135(+/-25)	147
Half-inch green	20-Apr(+/-10)	18-Apr	189(+/-24)	184
Tight cluster	26-Apr(+/-10)	22-Apr	248(+/-29)	226
Pink	5-May(+/-8)	2-May	326(+/-38)	270
Bloom	13-May(+/-7)	16-May	421(+/-46)	392
Petal fall	21-May(+/-8)	20-May	529(+/-65)	425
Fruit set	23-May(+/-6)	23-May	570(+/-51)	477
APPLE (EMPIRE)				
Silver tip	8-Apr(+/-8)	21-Mar	89(+/-11)	92
Green tip	15-Apr(+/-4)	7-Apr	112(+/-15)	147
Half-inch green	18-Apr(+/-10)	18-Apr	167(+/-27)	184
Tight cluster	24-Apr(+/-11)	22-Apr	223(+/-28)	226
Pink	1-May(+/-9)	2-May	286(+/-27)	270
King Bloom	3-May(+/-8)	9-May	332(+/-24)	322
Bloom	9-May(+/-6)	16-May	382(+/-31)	392
Petal fall	18-May(+/-6)	20-May	487(+/-38)	425
Fruit set	22-May(+/-6)	23-May	541(+/-40)	477
PEACH				
Swollen bud	12-Apr(+/-8)	31-Mar	113(+/-29)	123
Bud burst	18-Apr(+/-11)	7-Apr	157(+/-33)	147
Pink	27-Apr(+/-10)	NA	229(+/-30)	NA
Bloom	2-May(+/-9)	NA	292(+/-35)	NA
Petal fall	13-May(+/-7)	NA	415(+/-50)	NA
SWEET CHERRY				
Swollen bud	10-Apr(+/-8)	31-Mar	106(+/-28)	123
Bud burst	19-Apr(+/-9)	18-Apr	166(+/-25)	184
White bud	27-Apr(+/-8)	24-Apr	222(+/-25)	239
Bloom	2-May(+/-8)	29-Apr	279(+/-23)	253
Petal fall	10-May(+/-6)	16-May	389(+/-32)	392

GENERAL INFO

CORNELL FRUIT PEST CONTROL FIELD DAYS

The N.Y. Fruit Pest Control Field Days will take place during Labor Day week on Sept. 7-8 this year, with the Geneva portion taking place on Wednesday Sept. 7, and the Hudson Valley installment on the second day (Thursday Sept. 8). Activities will commence in Geneva on the 7th, with registration, coffee, etc., in the lobby of Barton Lab at 8:30 am. The tour will proceed to the orchards to view plots and preliminary data from field trials involving new fungicides, bactericides, miticides, and insecticides on tree fruits. It is anticipated that the tour of field plots will be completed before noon. On the 8th, participants will register at the Hudson Valley Laboratory starting at 8:30, after which they will view and discuss results from field trials on apples and other fruit crops. No pre-registration is required for either event.

UPCOMING PEST EVENTS

	43°F	50°F
Current DD accumulations (Geneva 1/1–8/29/16):	3174	2236
(Geneva 1/1–8/29/2015):	2851	1961
(Geneva "Normal"):	3049	2109
(Geneva 1/1-9/5, predicted):	3339	2352
(Highland 1/1–8/29/16):	3696	2628

Coming Events:	Ranges (Normal ±StDev):	
American plum borer 2nd flight subsides	2927-3353	2018-2372
Codling moth 2nd flight subsides	2846-3462	1923-2447
Lesser appleworm 2nd flight subsides	2794-3488	1918-2422
Lesser peachtree borer flight subsides	2996-3446	2017-2433
Obliquebanded leafroller 2nd flight subsides	3108-3468	2126-2448
Oriental fruit moth 3rd flight subsides	2928-3412	1978-2310
Redbanded leafroller 3rd flight subsides	3124-3436	2142-2422
Spotted tentiform leafminer 3rd flight subsides	3244-3480	2258-2462

all DDs Baskerville-Emin, B.E.

INSECT TRAP CATCHES
(Number/Trap)

Geneva, NY

	8/19	8/25	8/29
Redbanded leafroller	19.0	19.0	6.5
Spotted Tentiform Leafminer	40.0	24.5	5.5
Oriental Fruit Moth	3.0	4.0	2.0
Lesser Apple Worm	4.5	2.0	0.0
Codling Moth	8.5	7.5	2.0
Lesser Peachtree Borer	4.0	1.5	3.0
Obliquebanded Leafroller	0.0	0.0	0.5
Pandemis Leafroller	1.0	0.5	0.0
Dogwood Borer	0.0	0.0	0.0
Peachtree Borer	2.0	3.0	0.0
Apple Maggot	0.3	0.3	1.7

Highland, NY

	8/22	8/29
Redbanded leafroller	18.0	36.5
Spotted Tentiform Leafminer	13.0	13.5
Oriental Fruit Moth	8.5	11.0
Lesser Appleworm	19.5	36.5
San Jose Scale	481.5	107.5
Codling Moth	20.0	12.0
Obliquebanded Leafroller	11.5	11.0
Dogwood Borer	4.5	1.5
Brown Marmorated Stink Bug	0.0	0.0
Apple Maggot	4.8	8.0

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