APPLE: *Malus domestica* Borkhausen ‘Empire’, ‘Cortland’, ‘Jonagold’, and ‘Delicious’

EVALUATION OF SEASONAL INSECTICIDE PROGRAMS AGAINST NEW YORK APPLE PESTS, 2017

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Oriental fruit moth (OFM): *Grapholita molesta* (Busck)
Lesser appleworm (LAW): *Grapholita prunivora* (Walsh)
Codling moth (CM): *Cydia pomonella* (L.)
Internal fruit-feeding Lepidoptera (IL): OFM, LAW, CM
Obliquebanded leafroller (OBLR): *Choristoneura rosaceana* (Harris)
Plum curculio (PC): *Conotrachelus nenuphar* (Herbst)
Apple maggot (AM): *Rhagoletis pomonella* (Walsh)
Tarnished plant bug (TPB): *Lygus lineolaris* (Palisot de Beauvois)
Green apple aphid (GAA) - *Aphis pomi* (De Geer)
Rosy apple aphid (RAA) - *Dysaphis plantaginea* (Passerini)
Green stink bug (GSB) - *Chinavia halaris* (Say)
Brown stink bug (BSB) - *Euschistus servus* (Say)
Brown marmorated stink bug (BMSB) - *Halyomorpha halys*
Stink Bug (SB) – GSB, BMSB, BSB
European apple sawfly (EAS) - *Hoplocampa testudinea* (Klug)
San Jose scale (SJS): *Quadraspidiotus perniciosus* (Comstock)

The objective of this test was to determine the effectiveness of seasonal applications against a variety of apple pests. Seasonal insecticide programs were applied with a Durand-Wayland air-blast sprayer at 100 gpa. Treatments were applied at various rates and timings from bud stage ‘tight cluster’ (26 Apr), ‘pink’ (27 Apr) or ‘petal fall’ (23 May) and then approximately every 14d depending on weather conditions until 15 Aug. A full list of materials, rates and timings is listed in Table 1. Treatments, including an untreated check, were replicated 3 times in 4-tree blocks and arranged in a RCB design. Cultivars within the treatment blocks were 'Empire', 'Cortland', 'Jonagold', and 'Delicious'. The internal Lepidoptera complex of codling moth (CM), oriental fruit moth (OFM) and lesser appleworm (LAW) was assessed on 23 Jun by inspecting fruit on the tree. Plum curculio (PC) oviposition scars were also assessed on 23 Jun also by inspecting fruit on the tree. Foliar damage from green apple aphid (GAA) was taken on 10 Jul. Fruit damage from San Jose scale (SJS) and foliar damage from obliquebanded leaf roller (OBLR) were sampled on 14 Jul. Harvest samples were taken by picking and destructively sampling 100 fruits in each replicate on 18-20 Sep. All data was transformed and subjected to an AOV with JMP. Means were separated with Student’s t-test. Phytotoxicity was not observed in the any of the treatments. This research was supported in part by industry gift(s) of pesticides and research funding

First generation internal Lepidoptera samples are often low in the test orchard, and damage generally increases substantially at harvest. The 2017 season was unusually wet and cool, and similar weather patterns in the past have led to poor conditions for these pests. However, the damage found at harvest would indicate that weather did not significantly affect flight conditions enough to decrease populations found at harvest (37.7% UTC). While all treatments separated significantly from the untreated plot, several programs gave excellent control against internal leps. Treatments that had Delegate 25WG applied at 5th and 6th cover generally separated from those that did not. This efficacy against internal leps improved when it was combined with Cormoran at either PF and 4th cover, or at 1st and 2nd cover, as well as when it was combined with Rimon 0.83EC at PF and 4th cover. Evaluations for these pests include verifying that the exterior damage is in fact caused by internal leps by cutting each fruit. Damage that does not exceed ¼" is scored in a secondary category. In 2017, there are few significant differences among the treatments under ¼"; however, treatment 6 is unexplainably high. Over-wintering damage from OBLR has traditionally been sparse in the research orchard; however, damage from the summer generation seems to be more consistent this year. Treatments that received Altacor 35WDG at 1st and 2nd cover or Harvanta 50SL at PF and 1st cover had the lowest amounts of damage. There was variation and separation between these treatments, and many plots did not separate from the untreated plot. PC has been sporadic since efficacy testing was initiated in the research orchard. In 2017, pressure from PC increased significantly throughout the entire block. MinectoPro in combination with Avaunt seemed to have a positive rate response against PC, Cormoran applied at 1st cover also seemed to have good efficacy, as well as Harvanta applied at PF and 1st cover. SJS populations have also declined in the last several years. Populations are now starting to appear again after several years, and determining efficacy with low populations will likely be difficult. One exception is the treatment consisting of only 2 applications of Cormoran at PF and 4th cover, where SJS damage was exceedingly higher than the remainder of the treatments, indicating that this material does not have any effect on this pest. The damage levels of AM, TPB, EAS and SB were too low to indicate any reasonable amount of efficacy from any of the treatments in 2017. There was an abundance of GAA this season, likely due to the increased succulent green tissue brought about from higher than average rain fall.

Table 1.

Treatment	Material	Rate/A	Timing	TC	Pink	PF	1C	2C	3C	4C	5C	6C
1	Venerate XC	64.0 oz	2 apps/each summer gen/7d apart						6/29-7/3		8/1-8/7	
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
2	Venerate XC	64.0 oz	1 app/each summer gen						6/29		8/1	
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
3	Venerate XC	128.0 oz	TC	4/26								
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
4	Minecto Pro+	8.0 oz	PF, 2C			5/23		6/21				
	LI-700	32.0 oz										
	Avaunt 30WG	5.0 oz	1C, 3C-6C				6/5		6/29	7/17	8/1	8/15
5	Minecto Pro+	10.0 oz	PF, 2C			5/23		6/21				
	LI-700	32.0 oz										
	Avaunt 30WG	5.0 oz	1C, 3C-6C				6/5		6/29	7/17	8/1	8/15
6	Minecto Pro+	12.0 oz	PF, 2C			5/23		6/21				
	LI-700	32.0 oz										
	Avaunt 30WG	5.0 oz	1C, 3C-6C				6/5		6/29	7/17	8/1	8/15
7	Exirel 0.83 EC+	16.0 oz	PF, 2C			5/23		6/21				
	LI-700	32.0 oz										
	Avaunt 30WG	5.0 oz	1C, 3C-6C				6/5		6/29	7/17	8/1	8/15
8	Cormoran (ADA11280)	21.0 oz	PF, 4C			5/23				7/17		
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
9	Cormoran (ADA11280)	21.0 oz	PF, 4C			5/23				7/17		
10	Altacor 35 WDG	4.5 oz	PF, 1C, 2C			5/23	6/5	6/21				
	Cormoran (ADA11280)	21.0 oz	4C							7/17		
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
11	Assail 30SG	4.7 oz	PF, 4C			5/23				7/17		
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
12	Rimon 0.83EC	30.0 oz	PF, 4C			5/23				7/17		
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	5C, 6C								8/1	8/15
13	Altacor 35 WDG	4.5 oz	PF			5/23						
	Cormoran (ADA11280)	21.0 oz	1C, 2C				6/5	6/21				
	Delegate 25WG	6.5 oz	4C, 5C, 6C							7/17	8/1	8/15
14	Delegate 25WG	5.2 oz	PF, 1C			5/23	6/5					
	Closer	5.75 oz	2C, 4C					6/21		7/17		
	Exirel 0.83 EC	13.5 oz	4C, 5C							7/17	8/1	
15	Delegate 25WG	5.2 oz	PF, 1C			5/23	6/5					
	Closer	5.75 oz	2C, 4C					6/21		7/17		
	Harvanta 50SL	22.0 oz	4C, 5C							7/17	8/1	
16	Harvanta 50SL	16.0 oz	PF, 1C			5/23	6/5					
	Exirel 0.83 EC	13.5 oz	4C, 5C							7/17	8/	

Treatment	Material	Rate/A	Timing	TC	Pink	PF	1C	2C	3C	4C	5C	6C
17	Harvanta 50SL	22.0 oz	PF, 1C			5/23	6/5					
	Exirel 0.83 EC	13.5 oz	4C, 5C							7/17	8/1	
18	Sivanto 250SC+	14.0 oz	pink		4/27							
	LI-700		32.0 oz									
	Avaunt 30WG	5.0 oz	PF			5/23						
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Proclaim 5SG	4.8 oz	3C						6/29			
	Delegate 25WG	6.5 oz	4C, 5C							7/17	8/1	
19	Sivanto 250SC+	14.0 oz	pink, 2C		4/27			6/21				
	LI-700		32.0 oz									
	Avaunt 30WG	5.0 oz	PF			5/23						
	Altacor 35 WDG	4.5 oz	1C, 2C				6/5	6/21				
	Proclaim 5SG	4.8 oz	3C						6/29			
	Delegate 25WG	6.5 oz	4C, 5C							7/17	8/1	
20	Imidan 70WSB	3.0 LB	PF, 1C-6C				5/23	6/5	6/21	6/29	7/17	8/1
21	Untreated Check											

Table 2.

Treatment	mean % fruit damage from internal Lepidoptera 14 Jul
1	0.0
2	0.0
3	1.7
4	0.0
5	0.0
6	0.0
7	0.0
8	0.0
9	0.0
10	0.0
11	0.0
12	0.0
13	0.7
14	0.3
15	0.0
16	0.0
17	0.0
18	0.0
19	0.0
20	0.0
21	0.3

Table 3.

Treatment	mean % fruit damage PC 14 Jul
1	0.0
2	0.0
3	0.0
4	0.0
5	0.3
6	0.0
7	0.0
8	1.3
9	3.3
10	0.3
11	0.0
12	0.7
13	0.3
14	0.0
15	0.0
16	0.7
17	0.3
18	2.7
19	0.0
20	0.0
21	0.0

Table 3.

Treatment	mean % foliar damage from OBLR 23 Jun
1	1.0
2	2.7
3	1.7
4	1.0
5	0.7
6	0.3
7	2.0
8	1.0
9	2.0
10	0.3
11	1.0
12	0.7
13	1.0
14	1.3
15	1.7
16	0.0
17	1.3
18	1.0
19	2.0
20	0.0
21	3.3

Table 4.

Treatment	mean % fruit damage from 1st gen SJS 23 Jun
1	0.3
2	0.3
3	0.7
4	2.7
5	0.7
6	0.0
7	3.3
8	0.3
9	0.7
10	1.3
11	1.0
12	0.7
13	0.3
14	0.7
15	0.7
16	3.7
17	0.7
18	0.0
19	0.3
20	0.0
21	2.0

Table 5.

Treatment	mean % terminals w/ GAA colonies 10 Jul
1	4.0
2	3.3
3	6.0
4	2.3
5	0.7
6	0.3
7	3.0
8	4.0
9	3.3
10	0.3
11	0.3
12	4.7
13	4.7
14	7.3
15	3.0
16	3.3
17	5.3
18	5.0
19	6.7
20	1.7
21	2.7

Trt	Int. Lep > ¼"		Int. Lep < ¼"		Over-winter OBLR		Summer OBLR		Apple Maggot		Plum Curculio		Tarnished Plant Bug		Rosy Apple Aphid		San Jose Scale		Euro. Apple Sawfly		Stink Bug		Clean	
1	7.0	defgh	6.0	b	0.0	b	3.0	def	0.3	ab	6.3	abcdef	8.0	abcd	1.0	bc	2.7	b	0.3	ab	0.7	bc	67.0	abc
2	6.7	defgh	8.7	ab	0.0	b	3.3	cdef	0.3	ab	12.0	a	7.0	abcd	1.3	bc	0.0	b	0.0	b	1.0	bc	62.0	bcd
3	8.7	cdefg	7.0	b	0.7	a	4.7	abcdef	1.0	ab	10.0	abc	4.3	bcde	2.7	ab	1.3	b	0.3	ab	0.7	bc	64.0	abc
4	19.0	b	9.3	ab	0.0	b	8.3	abc	2.3	a	7.3	abcde	3.3	e	2.3	abc	3.7	ab	0.3	ab	0.3	bc	51.0	d
5	11.0	cdef	9.0	ab	0.0	b	4.0	abcdef	1.3	a	5.0	abcdef	5.7	abcde	0.3	bc	1.3	b	0.0	b	0.0	c	66.3	abc
6	7.7	cdefg	24.3	a	0.0	b	3.0	def	0.7	ab	4.0	cdef	8.7	abcd	4.7	a	0.7	b	0.3	ab	0.7	bc	64.7	abc
7	9.0	cdef	5.0	b	0.0	b	4.0	bcdef	0.3	ab	5.3	abcdef	6.3	abcde	0.3	bc	5.3	b	0.0	b	1.0	ab	66.7	abc
8	0.7	i	6.3	b	0.0	b	3.3	ef	0.7	ab	10.3	abc	8.7	abc	0.0	c	0.7	b	0.0	b	0.0	c	70.7	abc
9	12.3	bcde	7.7	b	0.0	b	9.7	ab	1.0	ab	8.7	abcd	5.0	bcde	0.7	bc	20.3	a	0.3	ab	0.3	bc	59.0	cd
10	4.7	fgh	4.3	b	0.0	b	4.0	abcdef	0.0	b	3.0	def	8.7	abcd	0.3	bc	0.3	b	0.3	ab	0.3	bc	75.3	a
11	6.0	efgh	8.0	b	0.0	b	4.3	abcdef	1.3	ab	7.0	abcde	6.0	abcde	1.0	bc	2.3	b	0.0	b	0.3	bc	68.7	abc
12	2.0	hi	6.0	b	0.0	b	2.7	ef	0.7	ab	10.3	abc	8.7	ab	0.0	c	0.3	b	0.3	ab	0.3	bc	70.0	abc
13	3.0	ghi	7.7	b	0.0	b	6.3	abcdef	0.7	ab	2.0	f	6.0	abcde	0.7	bc	0.7	b	1.0	a	0.3	bc	72.3	ab
14	6.3	defgh	8.0	b	0.0	b	8.0	abcd	0.7	ab	7.3	abcde	3.7	de	1.3	abc	0.3	b	0.0	b	0.3	bc	65.0	abc
15	8.3	cdefg	6.0	b	0.0	b	6.7	abcde	0.0	b	5.0	bcdef	9.0	ab	0.3	bc	1.0	b	0.3	ab	1.3	ab	64.0	abc
16	9.0	cdefg	8.0	b	0.0	b	2.7	f	0.7	ab	2.7	ef	4.0	cde	1.3	abc	0.7	b	0.0	b	0.3	bc	73.3	ab
17	9.0	cdef	8.0	b	0.0	b	2.3	ef	0.3	ab	4.7	bcdef	6.3	abcde	1.3	bc	4.0	ab	0.0	b	0.0	c	66.0	abc
18	10.7	bcdef	6.7	b	0.0	b	2.7	ef	1.3	ab	9.7	abc	4.3	bcde	0.0	c	2.3	b	0.0	b	0.3	bc	62.7	bcd
19	14.0	bcd	8.7	ab	0.0	b	6.0	abcde	2.0	a	6.0	abcdef	8.7	ab	0.0	c	1.7	b	0.0	b	0.0	c	59.0	cd
20	15.0	bc	4.3	b	0.0	b	4.7	abcdef	0.7	ab	3.0	ef	6.0	abcde	0.0	c	1.3	b	0.0	b	0.7	bc	64.7	abc
21	37.7	a	10.0	ab	0.0	b	9.7	a	1.7	a	10.7	ab	10.3	a	0.3	bc	1.3	b	1.3	ab	2.3	a	29.7	e

Means within a column followed by the same letter are not significantly different (Student's t Test, $P \leq 0.05$).

Data was transformed arcsine (Sqrt *x*) prior to analysis