Susceptibility of New Apple Cultivars to Various Arthropod Pests

Dick Straub

Department of Entomology, NYSAES and Cornell's Hudson Valley Laboratory, Highland, NY

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The NE-103 Multistate Research Project was initiated in 1995 to coordinate multi-disciplinary evaluations of new apple cultivars at multiple locations throughout the United States and Canada. Regional research projects such as NE-183 are organized under the auspices of the USDA and are funded using a portion of the Federal Formula Funds that are allocated to land-grant universities each year. Currently, 68 scientists from 21 states and three Canadian provinces are listed as participants in the NE-183 multistate project. Two separate plantings were established during 1995 and 1999 at Cornell's Hudson Valley Lab in Highland to study susceptibility to native diseases and arthropod pests. More detailed background regarding this project, the cultivars, and particulars about the Highland plantings, can be found in previous *Fruit Quarterly* articles (Brown and Maloney, 2002; Rosenberger, 2003). Thus far, data on arthropod pests have been taken only from the 1995 planting and the results are reported here.

Although apple cultivars are generally not developed with the intended goal of resistance or tolerance to particular arthropod infestations, nonetheless, our research shows that varieties differ in various unidentified resistance or susceptibility factors. Cultivars that are highly susceptible to particular pests will probably require extra applications of pesticide each year, while some relatively pest tolerant cultivars may require less attention.

TABLE 1

Incidence of phytophagous mites[1] in NE-183 planting#1 that was established at the Hudson Valley Laboratory during 1995.

Variety	No. European red mite per leaf	No. two spotted spider mite per leaf	Combined no./leaf
Braeburn/M.9	1.6 a b c d e f	5.6 a	7.2
Senshu	0.5 c d e f	6.0 a	6.5
Ginger Gold	1.3 e f	3.3 a	4.6
Golden Del./M.9	0.8 d e f	3.3 a	4.1
Cameo	0.6 c d e f	3.5 a	4.1
NY 75414-1	0.7 d e f	3.2 a	3.9
Fortune	0.3 a b c d	3.4 a	3.7
Shizuka	0.2 a b c	3.5 a	3.7
McIntosh (Pioneer)	0.2 a b c	3.5 a	3.7
Yataka/M.9	0.3 a b c d	3.3 a	3.6
Fuji (BC #2)	0.2 a b c	2.9 a	3.1
Enterprise	0.1 a b	2.8 a	2.9
Creston	0.7 d e f	1.8 a	2.5
Honeycrisp	0.1 a b	2.3 a	2.4
SunCrisp	0.0 a	2.4 a	2.4
GoldRush	0.1 a b	2.2 a	2.3
Golden Supreme	0.3 a b c d	2.0 a	2.3
Sansa	0.1 a b	1.9 a	2.0
Pristine	0.4 b c d e	1.5 a	1.9
Sunrise	0.4 b c d e	1.2 a	1.6
Gala Supreme	0.2 a b c	1.5 a	1.7
Orin	0.1 a b	1.3 a	1.4
Arlet	0.1 a b	0.4 a	0.5

Means followed by the same letter are not significantly different (P<0.05; Fisher's Protected LSD).
Data transformed by Log_{10} (X+1) prior to analysis.
[1]Twenty-five leaves per tree were sampled in five reps on 29 June, 1999.
June threshold is 2.5 mites/leaf.

Experimental Design

The 1995 planting contained five-single tree replicates for each cultivar / selection that was tested. Within each planting, cultivars were planted in a randomized, complete-block design. Trees evaluated for this report were on either M.9 or Mark rootstock and were trained as vertical axe trees. Trees were tied to steel conduit posts, and posts were connected with a single high-tensile wire. Trees were planted approximately 7 ft x 20 ft and trickle irrigated. Herbicides were used to control vegetation beneath the trees.

Evaluations and Data Analysis

No insecticides or miticides were applied to the test plots during the years when trees were evaluated for arthropods. Regular fungicide applications were employed to maintain disease-free trees. Incidence of infestation by arthropods was determined by various methods during 1999 and 2001. Foliar damage by phytophagous mites was assessed by sampling 25 leaves from each plot. Leaves were removed to the laboratory where they were brushed with a mite-brushing machine, and the mites and eggs examined using a binocular scope. Mites monitored were European red mite, *Panony-*

chyus ulmi (Koch), and two spotted spider mite, *Tetranchus urticae* (Koch).

Damage to fruit by insects was assessed by randomly selecting 25 fruit at harvest maturity (13 August) that were examined for external damage by each pest; subsequently, fruits were dissected to detect internal damage. All entries could not be evaluated for fruit damage during 2001 because fruit loads were low or nonexistent due to the biennial characteristic of some cultivars—those included Creston, Fuji Red Sport, Fulford Gala and Sansa. Insects monitored included apple maggot, *Rhagoletis pomonella* (Walsh); plum curculio, *Conotrachelus nenuphar* (Herbst); codling moth, *Cydia pomonella* (Linnaeus); and oblique banded leafroller, *Choristoneura rosaceana* (Harris). Although damage from European apple sawfly, San Jose scale, a leafhopper complex, an aphid complex and a plant bug complex was evident, it was not consistent or serious among entries, and those data are therefore not presented.

Significance of differences among cultivars was determined by Fisher's Protected LSD. In all data tables, columnar numbers followed by the same letter do not differ significantly ($P \leq 0.05$). Where appropriate, the arcsine or log transformation was used prior to analysis to stabilize variance, but arithmetic means are shown in the tables.

Phytophagous mites: Relative to all cultivars, Braeburn and Ginger Gold were notably more susceptible to European red mite (Table 1), but no cultivar exceeded the June threshold of 2.5 mites / leaf. For two spotted spider mite however, approximately half of the cultivars exceeded the June threshold, with Braeburn / M.9 and Senshu being the most susceptible. Based on all categories, Pristine, Sunrise, Gala Supreme, Orin and Arlet appeared to be the most resistant to infestation by both species combined. Arlet was unique in that infestation by both species was sufficiently low to perhaps preclude the use of chemical management.

Plum curculio: Entries that sustained less than 5 percent damage from plum curculio are considered to be tolerant—approximately 38 percent of the cultivars were in this category (Table 2). Very noteworthy for tolerance were Arlet, Enterprise and Mutsu. Cultivars that were very susceptible to curculio were Cameo, Braeburn / Mark, Yataka / M.9 and SunCrisp.

Codling moth: Pristine, Sunrise, McIntosh (Pioneer) and Braeburn / M.9 were remarkably resistant to infestation by codling moth (Table 3). NY 75414,

TABLE 2

Incidence of plum curculio damage[1] in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with ovipositional scars	
Cameo	31.5	i
Braeburn/Mark	28.4	h i
Yataka/M9	22.8	g h i
SunCrisp	20.6	g h i
Yataka/Mark	16.1	f g h i
Sunrise	13.0	e f g h
Fortune	11.4	d e f g
McIntosh (Pioneer)	11.4	d e f g
Gala Supreme	10.7	c d e f g
Golden Del/Mark	10.6	c d e f g
NY 75414-1	8.8	c d e f g
Fuji (BC #2)	8.7	c d e f g
Pristine	8.2	b c d e f g
Golden Supreme	8.1	b c d e f g
GoldRush	5.5	a b c d e f
Ginger Gold	5.0	a b c d e f
Braeburn/M.9	4.3	a b c d e f
Honeycrisp	3.7	a b c d e
Senshu	3.6	a b c d e
Orin	2.3	a b c d
Shizuka	1.9	a b c d
Arlet	1.5	a b c
Enterprise	0.7	a b
Mutsu	0.2	a

Means followed by the same letter are not significantly different ($P<0.05$; Fisher's Protected LSD). Data transformed by arsine prior to analysis.

[1]Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

TABLE 3

Incidence of codling moth damage[1] in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with larval tunnels	
GoldRush	20.9	i
Yataka/Mark	17.5	h i
Gala Supreme	16.9	h i
Senshu	16.0	h i
Braeburn/Mark	15.9	h i
Arlet	15.0	g h i
Fuji (BC #2)	14.1	f g h i
Enterprise	14.0	f g h i
Mutsu	13.3	f g h i
Shizuka	12.7	f g h i
Golden Del/Mark	10.8	e f g h i
Fortune	10.4	e f g h i
SunCrisp	10.0	e f g h
Orin	9.5	d e f g h
Cameo	8.5	d e f g h
Golden Supreme	8.5	d e f g h
Ginger Gold	8.3	d e f g h
Yataka/M9	6.2	c d e f g
NY 75414-1	5.5	c d e f
Honeycrisp	4.4	b c d e
Braeburn/M.9	2.8	a b c d
McIntosh (Pioneer)	1.5	a b c
Sunrise	0.5	a b
Pristine	0.2	a

Means followed by the same letter are not significantly different ($P<0.05$; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.

[1]Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

TABLE 4

Incidence of obliquebanded leafroller damage[1] in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with surface feeding	
Cameo	20.2	i
Sunrise	19.0	i
Pristine	17.2	h i
Golden Supreme	16.6	g h i
Honeycrisp	15.8	g h i
Fortune	12.0	f g h i
Ginger Gold	8.5	e f g h
Enterprise	7.6	d e f g
Braeburn/Mark	7.5	d e f g
Gala Supreme	5.7	c d e f
Golden Del/Mark	5.5	c d e f
SunCrisp	5.5	c d e f
Mutsu	5.3	c d e f
Yataka/M9	4.4	c d e f
GoldRush	4.3	c d e
Orin	4.3	c d e
Senshu	3.9	b c d e
NY 75414-1	3.1	b c d e
Shizuka	3.1	b c d e
Fuji (BC #2)	2.3	b c d
Yataka/Mark	2.8	b c d e
McIntosh (Pioneer)	1.5	a b c
Braeburn/M.9	0.3	a b
Arlet	0.0	a

Means followed by the same letter are not significantly different (*P*<0.05; Fisher's Protected LSD). Data transformed by arsine prior to analysis.
[1]Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

TABLE 5

Incidence of apple maggot damage[1] in NE-183 planting #1 that was established in 1995.

	Mean percentage of fruit with larval tunnels	
Arlet	99.3	k
Cameo	93.1	j k
Honeycrisp	90.9	i j
Braeburn/Mark	90.8	i j
Braeburn/M.9	89.7	h i j
Orin	78.5	g h i
Mutsu	78.4	g h i
Golden Supreme	75.3	f g h
SunCrisp	69.6	e f g
Shizuka	66.6	e f g
Gala Supreme	65.9	e f g
Ginger Gold	62.7	e f g
Yataka/M.9	59.9	d e f
Fortune	58.5	d e f
Senshu	57.8	d e f
Golden Del/Mark	55.8	d e
Sunrise	40.6	c d
Enterprise	35.9	c
Yataka/Mark	35.2	c
Fuji (BC #2)	32.9	c
Pristine	32.3	c
McIntosh (Pioneer)	26.9	b c
GoldRush	13.0	a b
NY 75414-1	11.5	a

Means followed by the same letter are not significantly different (*P*<0.05; Fisher's Protected LSD). Data transformed by arcsine prior to analysis.
[1]Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.

Honeycrisp and Yataka/M.9 appeared somewhat tolerant to infestation, while all others were susceptible to very susceptible (8.3 – 20.9 percent infested).

Oblique banded leafroller: Approximately 54 percent of the cultivars sustained less than 5 percent damage from the fruit feeding stage of OBLR—Arlet, Braeburn/M.9 and McIntosh were the most resistant to damage (Table 4). Remarkably susceptible to damage were Cameo, Sunrise, Pristine, Golden Supreme, Honey Crisp and Fortune.

Apple maggot: Infestation pressure from this pest was extreme during 2001—approximately 67 percent of the cultivars sustained greater than 50 percent infestation (Table 5). NY 75414, Goldrush and McIntosh (Pioneer) were less susceptible to apple maggot than other entries. All other entries were susceptible, with Arlet and Cameo being extremely so. Susceptibility to maggot infestation was apparently independent of fruit color or earliness of maturity. Generally, firm varieties are less susceptible to larval establishment than soft varieties but in these evaluations, firmness had no apparent effect.

Relative Damage by All Insects

This summary (Table 6) includes the assessment of damage by all insects encountered, even though such data were not presented in the previous tables (e.g., leafhoppers, aphids, etc.). On the basis of percent clean fruit, only NY 75414-1 (60 percent clean) and McIntosh (39 percent clean) had a general tolerance to insect damage, displaying low relative damage in all categories.

Significance of Differences in Susceptibility

Apple cultivars, including those included in this assessment, are generally not developed with the intended goal of resistance or tolerance to particular arthropod infestations. In most cases, genetic resistance to specific pests has not yet been discovered, or not yet bred into apple cultivars. Nonetheless, there appear to be various unidentified resistance or susceptibility factors that are inherent to some cultivars. Cultivars that are highly susceptible to particular pests may require extra applications of pesticide each year. If cultivar susceptibilities to pests were known prior to orchard establishment, growers could plan for the concomitant costs of pest control. For example, data presented here suggest that Braeburn or Senshu trees are likely to require additional miticide sprays, compared to cultivars having minimal susceptibility to arthropods such as Orin or Arlet. In areas where infestations by internal leps are of concern, the selection of Pristine or Sunrise would be logical over Gold Rush or Yataka. If one were seeking a single cultivar that would require less attention to general damage by all insects, these results would suggest that NY 7541 should be selected.

Literature Cited

Brown, S., and K. Maloney. 2002. Apple cultivars: a Geneva perspective. NY Fruit Quarterly 10(2):21-27.

Rosenberger, D. 2003. Susceptibility of New Apple Cultivars to Various Diseases and Arthropod Pests. N. Y. Fruit Quarterly 11(2):xx-xx.

Richard Straub is research and extension professor of entomology at Cornell University's Hudson Valley Laboratory in Highland, NY. He specializes in fruit and vegetable insect management.

TABLE 6

Incidence of fruit undamaged by insects[1] in NE-183 planting #1 that was established in 1995.

	Mean percentage of undamaged fruit	
Arlet	0.0	a
Braeburn/Mark	1.0	a b
Cameo	1.5	a b
Honeycrisp	2.8	b c
Mutsu	3.9	b c d
Braeburn/M.9	5.5	b c d e
Fortune	5.9	b c d e f
Orin	8.5	c d e f g
Senshu	8.5	c d e f g
Ginger Gold	8.6	c d e f g
Shizuka	10.3	d e f g
Golden Supreme	10.3	d e f g
Yataka/Mark	12.6	e f g h
Sunrise	14.1	e f g h
Gala Supreme	14.3	f g h
Fuji (BC#2)	16.3	g h i
SunCrisp	17.2	g h i
Pristine	18.0	g h i
Yataka/M.9	22.1	h i j
Enterprise	24.0	h i j
Golden Del/Mark	27.0	i j k
GoldRush	33.2	j k
McIntosh (Pioneer)	39.8	k
NY 75414-1	60.0	l

Means followed by the same letter are not significantly different ($P<0.05$; Fisher's Protected LSD). Data transformed by arsine prior to analysis.

[1]Twenty-five fruit per tree were sampled between 15 July and 25 September 2001.