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Susceptibility of New Apple Cultivars to Common Apple Diseases

Dave Rosenberger,
Department of Plant Pathology
Cornell's Hudson Valley Laboratory
Highland, NY.

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. The Cornell Agricultural Experiment Station web site provides the following statement concerning multistate research projects:

> *The mission of the multistate research program is to enable research on high -priority topics among the State Agricultural Experiment Stations (SAES) in partnership with the Cooperative State Research, Education, and Extension Service (CSREES) of the U.S. Department of Agriculture, other research institutions and agencies, and with the Cooperative Extension Service. In this way, technological opportunities and complex problem solving activities which are beyond the scope of a single SAES, can be approached in a more efficient and comprehensive way.*

Currently, 68 scientists from 21 states and three Canadian provinces are listed as participants in the NE-183 multistate project. In spring of 1995, uniform plantings containing 21 new cultivars and selections were established at 28 locations from Missouri to Maine and from New York to Washington State. Some of the plantings are being used to assess horticultural qualities of the new cultivars whereas other plantings are being used to evaluate susceptibility to diseases, insects, and mites.

At Cornell's Hudson Valley Lab in Highland, cultivars in the 1995 trial are being evaluated for susceptibility to diseases and arthropod pests. Not all pests can be monitored in the same year because severe infestations of one pest can make it impossible to monitor for other pests in that same year. To simplify management of these plantings, disease data has been collected during the early years of the planting whereas evaluations for insect damage were generally delayed until trees were older.

This paper presents some of the results of disease and arthropod evaluations conducted at the Hudson Valley Lab since 1996. Background information on the cultivars has not been included in this paper but is accessible at the NE-183 web site, http://www.ne183.org/cultivars/cultivars.html. Horticultural characteristics for some of these cultivars have also been summarized in a previous *N.Y. Fruit Quarterly* article (Brown and Maloney, 2002).

Experimental design: The 1995 planting contained five single-tree replicates for each cultivar or selection being evaluated. Cultivars were planted in a randomized, complete-block design. Trees evaluated for this report were all on M.9 rootstock and were trained as vertical axe trees. Trees were tied to conduit posts, and posts were connected with a single high-tensile wire. Trees were planted approximately 7 ft apart within the row, and herbicides were used to control weeds and grass beneath trees. Tree rows in the 1995 planting are 20 ft apart. Both plantings have trickle irrigation. Golden Delicious (Gibson strain), McIntosh (Pioneer strain), and Mutsu were used as standard cultivars.

Disease evaluations and data analysis: No early-season fungicides were applied to the test plots in years when trees were evaluated for apple scab, powdery mildew, or rust diseases. Incidence of various diseases was determined by counting the number of leaves with disease on a specified number of terminals per tree or by evaluating up to 100 fruit per tree. Where similar data was collected for more than one year, a statistical procedure known as repeated measures analysis was used to determine means and mean separations for the entire multi-year data sets. In all of the data tables, numbers followed by the same small letters do not differ significantly ($P \leq 0.05$) as

determined by applying Fisher's Protected LSD test to either the simple means (data from a single year) or to the grand means from repeated measures analysis for multiple years. The arc-sine transformation was used for statistical analyses to determine mean separations, but arithmetic means are shown in the tables.

Because of the transformation used for statistical analyses and the rounding of means to whole numbers, cultivars with the identical means in the data tables sometimes fall into different statistical groupings. Also, the rankings of means may differ slightly from the ranking based on statistical groupings as designated by small letters that follow the means.

Apple scab: Only Orin developed as much leaf scab as McIntosh when cultivars were compared over three years (Table 1). In 1997, the only year that susceptibility to fruit scab was evaluated, McIntosh, Orin, Cameo, Sunrise, Shizuka, Gala, and Golden Supreme all had similar levels of fruit scab. Trees were too young to carry fruit in 1996, and many trees carried no fruit in 1998 because of the severe scab infection that was allows to develop in 1997.

Pristine, Enterprise, GoldRush, and NY75414-1 are all considered scab-resistant cultivars. The trace of leaf scab reported for these cultivars resulted either from misidentified lesions or from a trace of scab caused by fungal strains that are not completely controlled by the Vf gene for resistance. The scab lesions reported for these cultivars were not examined in the lab to verify that the lesions actually represented apple scab

Powdery mildew: None of the cultivars proved totally resistant to mildew (Table 2). However, the more resistant cultivars are likely to develop less mildew in commercial plantings than they did in than in these randomized plantings where they were constantly exposed to large amounts of inoculum produced by the adjacent susceptible cultivars.

Rust diseases: Three different rust diseases caused by *Gymnosporangium* species are common on apples in southeastern NY. Cedar apple rust (CAR), caused by *G. juniperi-virginianae*, infects both leaves and fruit of susceptible cultivars. Leaf infections are far more common than fruit infections for CAR. Hawthorn rust caused by *G. globosum*, only infects leaves and is generally less abundant than CAR. Quince rust (*G. clavipes*) infects fruit but does not cause leaf lesions.

On infected leaves, the early symptoms of CAR and hawthorn rust are so similar that the two species cannot be easily differentiated. Therefore, rust evaluations completed during early-summer produced leaf ratings that represented a combination of CAR and hawthorn rust infections. By mid August, the two species of rust can be differentiated based on the appearance of aecia that form on the bottom sides of infected leaves. Aecia produce the aeciospores that can infect only cedar trees, thereby completing the rust disease cycle. Lesions caused by *G. juniperi-virginianae*, the CAR fungus, develop short aecial tubes that split apart and roll back whereas aecial tubes of *G. globosum* are longer, split open unevenly, and often appear tangled.

In Planting #1, Shizuka, Mutsu, GoldRush, BC8M 15-10, and Golden Delicious all had rust lesions on at least 20% of terminal leaves over two years (Table 3). By comparison, NY75414-1, Gala Supreme, Golden Supreme, McIntosh, Fortune, Sunrise, Suncrisp, Enterprise and Sansa all had less than 3% of leaves with rust lesions. Susceptibility to quince rust could not be determined because little quince rust developed in any of the plots during the years when there was sufficient fruit to evaluate.

Fire blight: Streptomycin sprays were used to protect trees in the Hudson Valley plantings from fire blight, and no blight symptoms developed in any of the trees at this location. However, natural fire blight epidemics developed in NE-183 plantings in several other states. In the 1995 plantings, Arlet, Braeburn, Cameo, Creston, Fortune, Gala Supreme, Ginger Gold, Golden Delicious, Golden Supreme, GoldRush, Honeycrisp, NY 75415-1, Pristine, Sansa, Shizuke, Suncrisp, and Sunrise have all been severely damaged by fire blight in one or two locations. Many of the trees killed by fire blight died from rootstock blight after the M.9 rootstocks became infected.

Significance of differences in susceptibility: Most apple growers decide which apple cultivars to plant based on their perceptions of whether or not the apples from those cultivars can be marketed at a profit. Susceptibility to insects and diseases is usually not a limiting factor in cultivar selection, although organic producers may avoid highly-susceptible cultivars. Cultivars that are highly susceptible to particular pests may require extra applications of pesticide each year, and the costs associated with those applications should be considered before trees are planted. For example, Ginger Gold trees frequently require one or two additional mildewcide sprays per year as compared to less susceptible cultivars such as McIntosh whereas McIntosh may require more sprays to

control apple scab. Knowing what to expect from new cultivars can help in planning pest control strategies for orchards that contain these cultivars.

Literature cited:

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

Table 1. Apple scab incidence, Highland, NY.

Variety	Percent terminal leaves with scab over three years 1996-1997-1998*	Percent fruit with scab at harvest in 1997
McIntosh (Pioneer)	46 i**	88 h i
Orin	48 i	87 h i
Ginger Gold	31 h	53 d e
Golden Delicious	30 g h	64 e f g
Cameo	29 g h	84 g h i
Sunrise	29 g h	70 e f g h
Braeburn	29 g h	84 g h i
Shizuka	27 f g h	93 i
Mutsu	26 f g h	63 d e f g
Fuji (BC #2)	26 f g h	57 d e
SunCrisp	25 f g h	55 d e
Gala (Fulford)	25 f g h	72 e f g h
Yataka	23 f g	26 b c
Arlet	23 f g	62 d e f
Creston	20 e f	54 d e
Fortune	20 e f	60 d e f
Senshu	15 d e	41 c d
Golden Supreme	15 d e	73 e f g h
Honeycrisp	12 d	no data
Sansa	7 c	0 a
Gala Supreme	2 b	11 b
Pristine	<1 a	0 a
NY75414-1	<1 a	0 a
Enterprise	<1 a	0 a
GoldRush	<1 a	0 a

* All leaves on 5, 15 and 10 terminals per tree were evaluated on the 2 Aug 1996, 14 July 1997 and 11 June 1998 respectively.

**Numbers within columns followed by the same small letters do not differ significantly ($P \leq 0.05$).

Table 2. Powdery mildew incidence, Highland, NY

Cultivar	Percent terminal leaves with mildew over three years 1996-1997-1998
Ginger Gold	44 l
GoldRush	32 k
SunCrisp	26 j k
Gala (Fulford)	23 i j
Braeburn	21 g h i j
Mutsu	21 h i j
Shizuka	20 e f g h i j
BC 8M 15-10	19 f g h i j
Orin	18 e f g h i j
Carousel	17 e f g h i j
Gold Delicious	17 e f g h i j
Sunrise	17 d e f g h
Honeycrisp	17 e f g h i
McIntosh (Pioneer)	15 d e f g h
Golden Supreme	15 d e f g h
Sansa	14 d e f g
Fortune	13 d e f
Arlet	11 c d e
Pristine	9 b c d
Senshu	8 a b c
Fuji (BC #2)	7 a b c
Enterprise	6 a b
NY 75414-1	5 a b
Yakata	4 a
Gala Supreme	4 a

* Ratings were made by evaluating all leaves on five terminals per tree on 28 June 1996 and the eight youngest leaves on 15 terminal per tree on 3 July 1997 and on 10 terminal per tree on 11 June 1998. Numbers followed by the same small letters do not differ significantly ($P \leq 0.05$).

Table 3. Incidence of rust lesions on leaves (cedar apple rust and hawthorn rust), Highland, NY.

Cultivar	Percent terminal leaves with rust (1996 & 1997)											
Shizuka	28											k
Mutsu	28											k
GoldRush	24										j	k
BC 8M 15-10	21									i	j	
Golden Delicious	20								h	i	j	
Ginger Gold	18							g	h	i		
Carousel	17						f	g	h	i		
Arlet	17						f	g	h			
Fuji (BC #2)	14					e	f	g				
Senshu	14					e	f	g				
Orin	14				d	e	f	g				
Braeburn	14				d	e	f					
Yakata	13					e	f	g				
Pristine	13				d	e	f					
Honeycrisp	11				d	e						
Gala (Fulford)	9				d							
Sansa	2			c								
Enterprise	2		b	c								
SunCrisp	1		b	c								
Sunrise	1	a	b	c								
Fortune	1	a	b	c								
McIntosh (Pioneer)	<1	a	b	c								
Golden Supreme	<1	a	b	c								
Gala Supreme	<1	a	b									
NY 75414-1	0	a										

*Ratings are from all leaves on 5 terminals per tree on 2 Aug. 1996 and all leaves on 15 terminals per tree on 14 July 1997. Numbers followed by the same small letters do not differ significantly ($P \leq 0.05$).