APPLE (*Malus domestica* 'Honeycrisp', 'McIntosh')
Apple Scab; *Venturia inaequalis*

Z. A. Noel, T. L. Bradshaw, S. L. Kingsley-Richards and L. P. Berkett.
Department of Plant and Soil Science,
University of Vermont,
Burlington VT 05405

Evaluation of the efficacy of natural resistance in 'Honeycrisp' to reduce fungicide applications for *Venturia inaequalis*, 2012-2013

The objective of this study was to evaluate the efficacy of natural resistance inherent in 'Honeycrisp' apples to determine if reducing fungicide applications for apple scab is possible without significantly increasing disease incidence or severity. The study was conducted at the University of Vermont Horticultural Research Center in South Burlington, VT, in an orchard planted in 2011, which contained rows of 'Honeycrisp' and 'McIntosh' trees. In 2012, the experiment was conducted on 'Honeycrisp' trees using a completely randomized design of six replications of three-tree plots per fungicide treatment. In 2013, the study was conducted separately on both 'Honeycrisp' trees and 'McIntosh' trees. In both years, there were six fungicide treatments. Treatments were designed to determine if specific applications could be reduced during the primary scab infection period without a significant increase in scab incidence or severity. Based on actual weather conditions and resulting infection periods during the growing seasons (Table 1), the treatments consisted of a non-treated control (NTC=N1), a treatment that covered all primary infection periods, and treatments where applications were delayed and only applied after one, two, or three primary infection periods had occurred (Tables 2, 3, 4). In both seasons, the fungicides captan (Captan 80WP, Arysta LifeScience, Cary, NC) and mancozeb (Manzate 75DF, DuPont, Wilmington, DE) were combined and applied at a rate of 1.14g/liter and 1.8g/liter, respectively. After April 30, 2012 and May 15, 2013, only captan was used in treatments because of label restrictions that limit preharvest use of mancozeb. Fungicides were applied with a handgun sprayer (ATV-25, Fimco Industries, North Sioux City, SD) at 275.8kPa to drip before an infection period was predicted to occur. The Network for Environment and Weather Applications (NEWA, NYS IPM Program, Cornell University, Geneva, NY), and the "revised" Mill's table, were used to forecast infection periods and to estimate ascospore maturity. An on-site weather station (Davis Instruments, Vantage Pro2, Hayward, CA) was also used as a backup data source to determine when infection periods had occurred. Trees were only sprayed for scab management during the primary infection season; no fungicides were applied during the remainder of the growing seasons. Five apical, vegetative terminals were selected from the middle tree of each three-tree plot and each leaf was evaluated for scab incidence in June, and scab incidence and severity in July/August in both years. In 2013, ten fruit per replication were also selected and evaluated for scab incidence.

There were no significant differences in foliar scab incidence or severity among the different treatments on 'Honeycrisp' in the June or July/August foliar assessments in both years (Tables 2, 3). Foliar scab levels on trees receiving from three to seven fungicide sprays in 2012, and from one to five applications in 2013, were not different than the level on trees not treated. The inclusion of 'McIntosh' trees in 2013 was intended to demonstrate how a well known, scab susceptible cultivar would perform under the same treatments as were applied to 'Honeycrisp' in this study. In July 2013, foliar scab incidence ranged from 29.91% on 'McIntosh' trees receiving all fungicide applications to 51.32% on non-treated trees (Table 4). In September 2013, fruit scab incidence ranged from 28.33% on 'McIntosh' trees receiving all fungicide applications to 93.33% on non-treated trees (Table 4). This is in stark contrast to the level of scab on 'Honeycrsip' trees receiving the same treatments (Table 3). The incidence of apple scab that developed on the 'McIntosh' trees indicate that inoculum was present in the orchard and that conditions were favorable for infection and disease development. Despite this, 'Honeycrisp' did not develop high scab levels on fruit or foliage. This research documents that fungicide applications can be reduced during the growing season with no significant increase in foliar scab incidence or severity and that the natural, inherent resistance of 'Honeycrisp' to scab is effective in preventing the development of commercially significant fruit and foliar scab levels.

Table 1. Primary scab infection periods for 2012 and 2013

Year	NEWA IP*	IP Start Date/Time**	IP End Date/Time	Leaf Wet Hours	Temp Ave. (^{o}C)	Rain (cm)	IP Intensity
2012	1	4/9/12 23:01	4/11/12 12:00	25	5.00	0.58	Low–Moderate
	2	4/21/12 13:00	4/25/12 15:00	44	3.89	6.20	Low–Moderate
	3	5/1/12 3:01	5/5/12 1:00	42	10.00	2.11	High
	4	5/8/12 7:01	5/11/12 1:00	33	11.11	3.76	High
	5	5/15/12 3:01	5/16/12 18:00	16	16.11	1.73	High
	6	5/22/12 0:01	5/23/12 7:00	21	16.11	0.36	High
2013	1	5/8/13 17:01	5/11/13 8:00	32	15.56	1.07	High
	2	5/19/13 17:01	5/26/13 19:00	112	11.11	17.25	High
	3	5/30/13 1:00	5/30/13 11:00	8	13.89	0.99	Low

*NEWA=the Network for Environmental Weather Applications

**IP=Infection Period

Table 2**.** The average percentage of leaves with at least 1 scab lesion (incidence) and the average number of lesions per leaf of leaves sampled (severity) on 'Honeycrisp' in 2012.

Treatment	Dates Sprayed	IP not covered[z]	% Foliar Incidence 19 June[y]		% Foliar Incidence 7, 8, 9 August		Foliar Severity 7, 8, 9 August[x]	
NTC=N1	–	1, 2, 3, 4, 5, 6	0.56[w]	a	0.00	a	0.00	a
N2	8, 20, 25, 30 April; 7, 14, 21 May	0	0.00	a	0.00	a	0.00	a
N3	20, 25, 30 April; 7, 14, 21 May	1	0.00	a	0.00	a	0.00	a
N4	25, 30 April; 7, 14, 21 May	1, 2 (partially not covered)	0.33	a	0.00	a	0.00	a
N5	30 April; 7, 14, 21 May	1, 2	0.22	a	0.30	a	0.00	a
N6	7, 14, 21 May	1, 2, 3	0.30	a	0.58	a	0.06	a

[z]IP=Infection Period and refers to the NEWA infection periods (Table 1).

[y]Incidence values represent the mean percentages of six replications per treatment of five vegetative terminals per replication.

[x]Severity values represent the mean number of lesions per leaf of leaves sampled.

[w]Means followed by the same letters within columns do not have significant F-value, Analysis of Variance, $P \leq 0.05$

Table 3. The average percentage of leaves or fruit with at least 1 scab lesion (incidence) and the average number of lesions per leaf of leaves sampled (severity) on 'Honeycrisp' in 2013.

Treatment	Dates Sprayed	IP not covered[z]	% Foliar Incidence 19, 20 June[y]		% Foliar Incidence 26 July		Foliar Severity 26 July[x]		% Fruit Incidence 13, Sep.	
NTC=N1	–	1, 2, 3	0.00[v]	a	0.00	a	0.00	a	0.00	a
N2	8, 15, 20, 22, 27 May	0	0.00	a	0.00	a	0.00	a	0.00	a
N3	15, 20, 22, 27 May	1	0.00	a	0.00	a	0.00	a	0.00	a
N4	20, 22, 27 May	1, 2 (partially not covered)	0.00	a	1.67	a	0.11	a	0.00	a
N5	22, 27 May	1, 2 (partially not covered)	0.00	a	1.11	a	0.01	a	0.00	a
N6	27 May	1, 2	0.00	a	1.33	a	0.10	a	0.00	a

[z]IP=Infection Period and refers to the NEWA Infection Periods (Table 1).

[y]Incidence values represent the mean percentages of six replications per treatment of five vegetative terminals per replication.

[x]Severity values represent the mean number of lesions per leaf of leaves sampled.

[w]Incidence values represent the mean percentages of six replications per treatment of ten fruit per replication.

[v]Means followed by the same letters within columns do not have significant F-value, Analysis of Variance, $P \leq 0.05$

Table 4. The average percentage of leaves or fruit with at least 1 scab lesion (incidence) and the average number of lesions per leaf of leaves sampled (severity) on 'McIntosh' in 2013.

Treatment	Dates Sprayed	IP not covered[z]	% Foliar Incidence 19, 20 June[y]		% Foliar Incidence 26 July		Foliar Severity 26 July[x]		% Fruit Incidence 13 Sep.[w]	
NTC=N1	–	1, 2, 3	14.60[v]	a	51.32	a	3.15	a	93.33	a
N2	8, 15, 20, 22, 27 May	0	3.12	b	29.91	a	0.93	a	28.33	b
N3	15, 20, 22, 27 May	1	4.49	b	47.36	a	2.72	a	65.00	ab
N4	20, 22, 27 May	1, 2 (partially not covered)	6.74	b	43.10	a	3.12	a	60.00	ab
N5	22, 27 May	1, 2 (partially not covered)	4.24	b	39.39	a	1.87	a	61.67	ab
N6	27 May	1, 2	9.41	ab	50.77	a	3.27	a	86.67	a

[z]IP=Infection Period and refers to the NEWA Infection Periods (Table 1).

[y]Incidence values represent the mean percentages of six replications per treatment of five vegetative terminals per replication.

[x]Severity values represent the mean number of lesions per leaf of leaves sampled.

[w]Incidence values represent the mean percentages of six replications per treatment of ten fruit per replication.

[v]Means followed by the same letters within columns do not have significant F-value, Analysis of Variance, $P \leq 0.05$