File Copy

NOT FOR PUBLICATION

1988 RESULTS OF APPLE FUNGICIDE TRIALS IN THE HUDSON VALLEY

David A. Rosenberger, Plant Pathologist

Cornell University, N. Y. State (Geneva)
Agricultural Experiment Station

Hudson Valley Laboratory, PO Box 727
Highland, NY 12528

Technical Assistants

Frederick W. Meyer
Susan M. Rondinaro

Summer Assistants

Anne F. Borchert
Eldeva M. Tofte
William J. Bligh

FINAL REPORT

December 1, 1988

CONTENTS

ACKNOWLEDGMENTS

The research reported here would not be possible without the continued support of the agrichemical industry. I especially wish to thank Ciba-Geigy, E.I. Dupont de Nemours & Company, Elanco Products Company, KenoGard AB, Mobay Corporation, Rohm and Haas Company, United Agri Products, and Uniroyal Chemical Company, Inc. for their support. I am also indebted to my research techinicians, Fritz Meyer and Susan Rondinaro, and to my summer assistants, Anne Borchert, Eldeva Tofte, and Bill Bligh, for the many hours they spent collecting and analyzing the data and assisting in the preparation of these reports.

1988 HUDSON VALLEY MCINTOSH GROWTH STAGES, WETTING PERIODS, AND APPLE SCAB INFECTION PERIODS

Date	McIntosh growth stage	Scab ascospore information [1]: % mature spores	Scab ascospore information [1]: cumm. % dis-charged	Wetting periods[2]: date	% of total season's ascospores[3]	start time	dura-tion	avg. temp (F)	Rain-fall (in.)	Mill's rating 1°	Mill's rating 2°
Mar 30	Silver tip	2	0	Apr 1	1.7%	10:00	26	48		M	
Apr 4	Green tip	-	-	Apr 3	0.0%	23:00	14	57		M	
Apr 5	1/4-in green	19	1								
Apr 9	1/2-in. green										
Apr 12	3/4-in green	33	1								
Apr 15	3/4-in green			Apr 15	2.9%	6:30	32	38	0.38	-	
				Apr 18	3.5%	3:00	16	38	0.02	-	
Apr 19		48	7	Apr 23	1.2%	14:30	23	46	0.10	L	
				Apr 27	13.8%	22:00	18	50	0.11	M	Split
Apr 28	Tight cluster	29	10	Apr 28	0.0%	21:00	12	42	1.23		
				May 2	5.2%	15:00	17	46	0.11	-	
May 5	Pink			**May 5**	**14.4%**	**14:00**	**42**	**54**	**0.84**	**H**	
May 8	King bloom	32	25	**May 10**	**29.9%**	**0:15**	**34**	**58**	**0.17**	**H**	Split
May 11	50% bloom, 5-6 lvs.										
May 12	Full bloom			May 13	1.2%	19:00	13	51	0.54	L	
May 16		36	26								
May 17	50% petal fall			**May 17**	**24.1%**	**1:00**	**80**	**54**	**2.37**	**H**	H
May 19	Full petal fall			May 21	1.1%	21:00	29	61	0.07	H	H
				May 22	0.0%	23:00	12	61	0.02	L	M
May 23		14	71	May 25	1.2%	0:00	32	49	1.24	H	H
				Jun 1	0.0%	17:00	6	59	Tr.	-	-
Jun 2		5	92	Jun 3	0.0%	14:00	19	51	0.41	-	H
				Jun 9		5:30	9	52	0.20	-	L
				Jun 16		20:00	13	64	0.43	-	H
				Jun 23		4:30	7	75	0.02	-	L
				Jul 1		16:00	18	58	0.06	-	H
				Jul 9		01:00	33	78	1.54	-	H
				Jul 12		23:00	13	69	0.26	-	H
				Jul 14		22:30	14	69	0.75	-	H
				Jul 17		17.45	18	74	0.49	-	H
				Jul 19		08:00	9	80	0.82	-	L
				Jul 21		1:00	36	68	2.29	-	H
				Jul 23		20:00	14	69	1.98	-	H
				Jul 24		18:00	15	70	0.03	-	H
				Jul 26		11:00	22	67	0.26	-	H
				Jul 27		20:00	9	71	0.09	-	M
				Jul 28		20:00	12	69	Dew	-	H
				Jul 30		2:00	7	73	0.01	-	L
				Jul 31		4:00	8	73	0.12	-	M
				Jul 31		23:00	10	73	Dew	-	M
				Aug 2		1:00	8	71	0.01	-	M

1988 HUDSON VALLEY MCINTOSH GROWTH STAGES, WETTING PERIODS, AND APPLE SCAB INFECTION PERIODS, continued

date	start time	duration	avg. temp (F)	Rainfall (in.)
Aug 7[4]	02:00	9	75	.24
Aug. 11	07:00	4	79	dew
Aug. 23	22:00	13	56	1.59
Aug. 25	02:00	8	57	dew
Aug. 26	05:00	7	60	dew
Sept. 4	04:00	31	63	1.41
Sept. 7	06:00	6	?	dew
Sept. 8	10:00	3	?	dew
Sept. 13	07:00	8	68	0.11
Sept. 17	15:00	2	58	dew
Sept. 17	23:00	11	60	dew
Sept. 19	02:00	11	67	dew
Sept. 20	02:00	15	69	0.03
Sept. 21	03:00	5	64	dew
Sept. 23	07:00	5	63	0.08
Sept. 26	05:00	8	56	dew
Oct. 2	20:00	12	58	0.20

[1]Ascospore maturity and cummulative percent of ascospores discharged were determined by performing pseudothecial squash mounts using leaves from the lab orchard collected on the dates indicated. [2]Wetting periods were determined using a DeWitt Leaf Wetness meter. Rainfall was measured with a tipping bucket rain gauge, and mean temperatures were calculated using data from hygrothermograph charts. [3]The percent of the total season's ascospores discharged was determined by counting apple scab ascospores trapped with a Burkard spore trap. [4]Rainfall and wetting periods from August 7 until October 2 include some estimates where data were incomplete.

1988 MAXIMUM AND MINIMUM TEMPERATURES AND PRECIPITATION: Hudson Valley Laboratory, Highland, NY

All readings were taken at 0800 EST on the dates indicated

	April			May			June			July			August			September		
Date	Max	Min	Precip	Max	Min	Precip	Max	Min	Precip	Max	Min	Precip	Max	Min	Precip	Max	Min	Precip
1	59	23		58	41		79	47		70	47		86	67		76	50	
2	48	42		55	42	0.03	62	45		70	52	0.06	90	67		78	50	
3	59	46		55	42		64	48		78	50		94	72	0.01	82	56	
4	58	47		58	36		63	48		86	58		93	72		78	60	0.08
5	73	42		70	48	0.15	66	47		90	63		91	71		76	62	1.91
6	62	38		67	52	0.48	82	58	0.41	92	63		89	68		76	42	
7	58	41		65	54	0.34	78	55		96	66		84	67	0.22	68	40	
8	55	43		71	40		75	41		98	86		84	57		72	43	
9	53	43		70	38		75	49	0.24	99	72	0.21	82	59		75	50	
10	58	42		68	46	0.01	70	40		84	68	0.81	87	66		80	55	
11	59	36		57	48		76	49		95	70		88	69		81	51	
12	56	38		63	39	0.52	74	48		94	70	0.46	90	72		72	46	
13	55	29		72	46		89	57		84	64	0.27	95	70		72	57	0.11
14	57	28		81	46		92	55		87	66		96	76		77	46	
15	55	36		70	41		98	66		92	66	0.72	95	77		74	48	
16	46	29	0.26	73	47	0.26	96	62		85	62		96	70		66	38	
17	47	32		73	55	0.01	71	56		96	71	0.05	86	60		68	44	
18	64	44		68	51	0.15	84	53		92	66	0.44	82	67		63	48	
19	59	27		60	52	1.30	90	62		91	70	0.27	78	52		78	60	
20	51	30		64	57	0.82	89	74		80	71	0.58	76	49		81	58	
21	55	36		73	59		92	71		84	65	1.75	76	52		76	60	0.03
22	53	31		66	57		94	62		75	65	0.57	80	43		71	56	
23	57	29		73	57	0.13	92	70	0.02	78	64		69	43		72	54	0.08
24	53	41		84	62	0.01	81	50		85	65	1.98	72	54	1.58	77	49	
25	56	42	0.01	77	51		76	58		80	66	0.03	58	54	0.02	73	50	
26	59	29		57	43		78	64		86	64		76	56		67	43	
27	67	42		68	42	1.25	85	54		83	64	0.26	83	61		72	42	
28	72	48	0.11	87	53		80	50		83	67	0.09	84	69		75	50	
29	55	38	0.15	86	57		85	57		82	66		87	70		73	34	
30	54	42		88	62		78	44		92	70	0.01	74	58		64	43	
31				90	61					95	72	0.12	72	50				

1988 FUNGICIDE TRIAL #1: M.26 Orchard
APPLE DISEASE CONTROL WITH DODINE AND SI FUNGICIDES

APPLE (Malus domestica McIntosh, Cortland,
Golden Delicious, Rome, Paulared)
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Cedar apple rust; Gymnosporangium juniperi-virginianae
Frog-eye leafspot: Physalospora obtusa
Sooty blotch; Gloeodes pomigena
Flyspeck; Zygophiala jamaicensis
Effects on fruit finish

Hudson Valley Lab
Highland, NY

Fungicide treatments were replicated three times in plots containing one tree of each cultivar on M.26 rootstock. Fungicides were sprayed to runoff (= approximately 2805 liters/ha or 400 gal/A for similar trees on a commercial spacing) using a handgun at approximately 2070 kPa (300 psi). Spray dates and corresponding McIntosh growth stages were April 26 (tight cluster), May 5 (pink); May 16 (bloom), May 27 (petal fall), June 13, July 7, and August 4, except that the first application was omitted for one of the Rubigan treatments. Eleven Mill's apple scab infection periods were recorded between green tip April 1 and the end of the primary apple scab season on May 25. However, most primary infections resulted from three major infection periods which occurred May 5-6, 10-11, and 17-20 and accounted for 14, 30, and 24% respectively, of the total season's ascospores captured in a Burkard spore trap. Cedar apple rust galls were abundant in cedar trees interplanted with the apples in the test orchard. Powdery mildew inoculum was introduced to the block on May 17-23, May 31-June 2, and June 14-20 (periods favorable for mildew infection) by placing heavily-mildewed, potted Rome trees from the greenhouse beneath each Cortland tree. Data were collected from all leaves on 25 clusters or terminals per tree and from approximately 100 fruit/tree. Leaves were considered infected even if lesions appeared inactivated. Frog-eye leafspot is non-randomly distributed in Cortland trees because it is usually associated with retained fruitlets killed by the previous season's thinning sprays. We therefore evaluated leafspot by determining the percent of leaves infected on 25 clusters or terminals in the most severely affected parts of the trees. Fruit finish on Golden Delicious was rated on a scale of 1-5 where 1 = very smooth finish, 2 = enlarged lenticels, 3 = slight russetting between lenticels, 4= moderate russetting, and 5 = severe russetting.

Of the three major infection periods, those on May 5-6 and May 17-20 occurred immediately after sprays had been applied. As a result, all treatments provided excellent control of apple scab, powdery mildew, and cedar apple rust except that the Syllit/Manzate treatment failed to adequately control mildew and the Procure/Sulfur treatment was weak against rust. Three applications of Bayleton applied with the Syllit or Dodine provided mildew and rust control comparable to that achieved with most other treatments where SI fungicides were applied 5-7 times. Folicur, Nova, and Rubigan (when applied starting at tight cluster) provided the best control of leafspot. There were no significant differences in the incidence of roughened lenticels on McIntosh or in the finish ratings for Golden Delicious. At harvest, 24% of the Golden Delicious fruit and 69 % of the Rome fruit from the controls were infected with cedar apple rust. Rust infection was less than 0.3% for all treatments except for 1.0% and 2.2% in Romes treated with Procure/Polyram and Procure/Sulfur, respectively. However, the differences between the Procure treatments and the other fungicide treatments were not statistically significant.

1988 FUNGICIDE TRIAL #1, M.26 Orchard: Apple Disease Control with Dodine and SI Fungicides

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% cluster leaves infected with scab[2]			% terminal leaves infected with scab[2]			
	McIntosh 6/6	Rome 6/8	both cultivars combined[3]	McIntosh 6/21	Cortland 6/22	Both cultivars combined[3] 6/22	Both cultivars combined[3] 8/17
1. Control	49.9 b	18.4 c	33.2 b	42.3 c	32.3 c	37.2 d	83.2 c
2. Dodine 65W (FMC) 45 g (6 oz) & Byltn[4]	0.0 a	0.2 ab	0.1 a	0.1 a	0.2 ab	0.2 abc	<0.1 a[7]
3. Syllit SC 4F 62.5 ml (8 fl oz) & Byltn[4]	0.1 a	0.0 a	<0.1 a	0.1 a	0.1 ab	0.1 ab	<0.1 a
4. Syllit SC 4F 46.8 ml (6 fl oz) & Byltn[4]	0.1 a	0.3 ab	0.2 a	0.2 ab	0.0 a	0.1 ab	0.1 ab
5. Syllit SC 4F 46.8 ml (6 fl oz) & Mz[5]	0.1 a	0.1 ab	0.1 a	1.0 b	0.4 b	0.7 c	0.2 ab
6. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5]	0.1 a	0.0 a	<0.1 a	<0.1 a	<0.1 ab	<0.1 ab	0.0 a
7. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5] (PK[7] to Aug 4)	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	2.1 b
8. Procure 50W 22.5 g (3 oz) & Polyram 80DF 120 g (1 lb)	0.1 a	0.3 ab	0.2 a	0.1 a	0.1 ab	0.1 ab	<0.1 a
9. Procure 50W 22.5 g (3 oz) & Sulfur 180 g (1.5 lb)	0.0 a	1.0 b	0.3 a	0.1 a	0.1 ab	0.1 ab	0.1 a
10. Nova 60DF 6 g (0.8 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	0.0 a	0.0 a	0.0 a	0.0 a	<0.1 ab	<0.1 a	0.0 a
11. Nova 60DF 9 g (1.2 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	0.3 a	0.1 ab	0.1 a	0.0 a	0.0 a	0.0 a	<0.1 a
12. Nustar 20DF 7.5 g (1 oz) & Mz[5] (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.1 a	0.0 a	<0.1 a	0.0 a	0.0 a	0.0 a	<0.1 a
13. Nustar 20DF 7.5 g (1 oz) & Mz[5] & LI700 125 ml (16 fl oz) (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.1 a	0.0 a	<0.1 a	0.0 a	0.2 ab	<0.1 ab	<0.1 a
14. Nustar 20DF 12.5 g (1.67 oz) & Mz[5] (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.1 a	0.0 a	<0.1 a	0.0 a	<0.1 ab	<0.1 ab	<0.1 a
15. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (Jul 7 & Aug 4)	0.1 a	0.0 a	<0.1 a	<0.1 a	<0.1 ab	<0.1 a	0.1 a
16. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (PF-Aug 4)	0.1 a	0.1 ab	0.1 a	0.2 ab	0.6 b	0.4 bc	<0.1 a

[1]Treatments were replicated in three plots containing one tree of each cultivar except that the Paulared tree was missing from replicates along the center cross-drive. Treatments were applied to run-off using a handgun with pressure adjusted to 300 psi. Applications were made on Apr 26 (TC), May 5 (PK), May 16 (BL), May 27 (PF), Jun 13, Jul 7, and Aug 4. [2]Data were collected on the dates indicated from 25 randomly selected clusters or terminals on each tree. Mean separations were determined using LSD (P=0.05) if the F-test indicated significant differences existed between treatments. The arcsin transformation was used for statistical analyses of data expressed as percentages. [3]Split plot design was used for statistical analysis of combined data from both cultivars. [4]Bayleton 50DF 7.5 g (1 oz) was added May 16, 27, and June 13. [5]Combined with Manzate 200 75DF 90 g (12 oz). [6]Benlate 50DF 15 g (2 oz) & Manzate 200 75DF 90 g (12 oz). [7]Abbreviations: GT=green tip, TC=tight cluster, PK=pink, BL=bloom, PF=petal fall.

1988 FUNGICIDE TRIAL #1, M.26 Orchard: Apple Disease Control with Dodine and SI Fungicides

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% of last 8 terminal leaves with mildew[2]			% termminal leaves with rust[2]		% Cortland leaves with leafspot June 7[2]	
	Paulared	Cortland		Gold Del	Rome		
	6/14	6/14	6/30	7/20	7/20	cluster lvs.	terminal lvs.
1. Control	13.1 b[3]	25.8 d	42.0 d	29.1 c	26.4 g	30.4 g	14.9 e
2. Dodine 65W (FMC) 45 g (6 oz) & Byltn[4]	0.1 a	1.8 ab	0.1 a	<0.1 a	2.6 e	8.4 d	5.6 cd
3. Syllit SC 4F 62.5 ml (8 fl oz) & Byltn[4]	0.1 a	4.5 b	0.6 ab	0.0 a	0.6 bcd	9.7 de	8.1 de
4. Syllit SC 4F 46.8 ml (6 fl oz) & Byltn[4]	0.1 a	0.5 a	0.8 ab	0.0 a	1.3 de	18.6 efg	8.3 de
5. Syllit SC 4F 46.8 ml (6 fl oz) & Mz[5]	9.8 b	13.1 c	7.0 c	0.0 a	0.1 abc	11.3 def	5.0 bcd
6. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5]	1.4 a	1.8 ab	0.1 a	0.0 a	<0.1 ab	1.7 abc	2.3 abc
7. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5] (PK[7] to Aug 4)	0.7 a	2.1 ab	0.1 a	0.0 a	<0.1 ab	7.5 cd	2.3 abc
8. Procure 50W 22.5 g (3 oz) & Polyram 80DF120 g (1 lb)	1.2 a	1.5 ab	0.3 ab	0.3 a	0.8 cde	5.9 bcd	3.2 bcd
9. Procure 50W 22.5 g (3 oz) & Sulfur 180 g (1.5 lb)	0.2 a	1.4 ab	0.3 ab	2.6 b	10.1 f	20.8 fg	6.6 cd
10. Nova 60DF 6 g (0.8 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	0.0 a	0.2 a	0.1 a	0.0 a	0.0 a	5.3 bcd	1.7 abc
11. Nova 60DF 9 g (1.2 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	0.1 a	1.5 ab	0.0 a	0.0 a	0.1 abc	1.1 ab	2.1 abc
12. Nustar 20DF 7.5 g (1 oz) & Mz[5] (GT-Jun 13) Benlate & Mz [6] (Jul 7 & Aug 4)	1.5 a	2.0 ab	0.3 ab	0.3 a	0.2 abcd	7.8 d	4.3 bcd
13. Nustar 20DF 7.5 g (1 oz) & Mz[5] & LI700 125 ml (16 fl oz) (GT-Jun 13) Benlate & Mz [6] (Jul 7 & Aug 4)	0.4 a	0.4 a	0.0 a	0.1 a	0.1 abc	5.6 bcd	3.1 bcd
14. Nustar 20DF 12.5 g (1.67 oz) & Mz[5] (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	1.4 a	1.2 ab	0.1 a	0.0 a	0.0 a	8.0 d	6.2 cd
15. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (Jul 7 & Aug 4)	0.7 a	1.1 ab	0.8 ab	0.0 a	0.2 abc	0.7 a	0.1 a
16. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (PF-Aug 4)	0.3 a	1.5 ab	3.1 bc	0.0 a	0.0 a	1.3 ab	1.1 ab

[1]Treatments were replicated in three plots containing one tree of each cultivar except that the Paulared tree was missing from 10 plots along the center cross-drive. Treatments were applied to run-off using a handgun with pressure adjusted to 300 psi. Applications were made on Apr 26 (TC), May 5 (PK), May 16 (BL), May 27 (PF), Jun 13, Jul 7, and Aug 4. [2]Data were collected on the dates indicated from 25 randomly selected clusters or terminals on each tree, except that for leafspot ratings the most severely infected portions of the tree were selected for evaluation. [3]Mean separations were determined using LSD (P=0.05) if the F-test indicated significant differences existed between treatments. The arcsin transformation was used for statistical analyses of data expressed as percentages. [4]Bayleton 50DF 7.5 g (1 oz) was added May 16, 27, and June 13. [5]Combined with Manzate 200 75DF 90 g (12 oz). [6]Benlate 50DF 15 g (2 oz) & Manzate 200 75DF 90 g (12 oz). [7]Abbreviations: GT=green tip, TC=tight cluster, PK=pink, BL=bloom, PF=petal fall.

1988 FUNGICIDE TRIAL #1, M.26 Orchard: Apple Disease Control with Dodine and SI Fungicides

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% fruit with scab at harvest[2] McIntosh	Cortland	Golden Delicious	% Golden Del. with[2] sooty blotch	fly-speck	% McIntosh with raised lenticels[8]	Golden Delicious finish rating[9]
1. Control	95.8 b[3]	50.3 c	78.5 c	14.7 c	40.5 d	9.7 a	2.2 a
2. Dodine 65W (FMC) 45 g (6 oz) & Byltn[4]	0.2 a	0.0 a	0.1 a	1.3 ab	2.7 bc	23.1 a	2.2 a
3. Syllit SC 4F 62.5 ml (8 fl oz) & Byltn[4]	0.2 a	0.0 a	0.6 a	0.4 ab	4.2 c	16.8 a	2.3 a
4. Syllit SC 4F 46.8 ml (6 fl oz) & Byltn[4]	0.3 a	0.0 a	0.0 a	0.2 ab	1.8 abc	5.1 a	2.2 a
5. Syllit SC 4F 46.8 ml (6 fl oz) & Mz[5]	0.0 a	0.1 ab	0.0 a	0.0 a	0.0 a	12.4 a	2.2 a
6. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5]	0.1 a	0.1 ab	0.1 ab	2.1 b	0.3 ab	12.0 a	2.2 a
7. Rubigan 1EC 23.4 ml (3 fl oz) & Mz[5] (PK to Aug 4[7])	0.0 a	0.0 a	0.1 ab	0.1 ab	0.1 ab	8.6 a	2.1 a
8. Procure 50W 22.5 g (3 oz) & Polyram 80DF 120 g (1 lb)	0.0 a	0.1 ab	0.0 a	0.2 ab	0.0 a	31.4 a	2.1 a
9. Procure 50W 22.5 g (3 oz) & Sulfur 180 g (1.5 lb)	0.8 a	0.0 a	1.0 b	0.9 ab	0.4 abc	21.0 a	2.2 a
10. Nova 60DF 6 g (0.8 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	1.1 a	0.6 b	0.0 a	0.1 ab	0.1 ab	30.3 a	2.2 a
11. Nova 60DF 9 g (1.2 oz) (GT-Jun 13) Dikar 120 g (1 lb) (GT-Aug 4, except BL)	0.3 a	0.0 a	0.0 a	0.4 ab	0.0 a	11.8 a	2.1 a
12. Nustar 20DF 7.5 g (1 oz) & Mz[5] (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	16.2 a	2.1 a
13. Nustar 20DF 7.5 g (1 oz) & Mz[5] & LI700 125 ml (16 fl oz) (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	15.6 a	2.2 a
14. Nustar 20DF 12.5 g (1.67 oz) & Mz[5] (GT-Jun 13) Benlate & Mz[6] (Jul 7 & Aug 4)	0.0 a	0.0 a	0.0 a	0.0 a	0.0 a	13.0 a	2.1 a
15. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (Jul 7 & Aug 4)	0.0 a	0.0 a	0.1 ab	0.0 a	0.2 ab	15.4 a	2.2 a
16. Folicur 45DF 15 g (2 oz) (GT-Jun 13) Manzate 75DF 120 g (1 lb) (PF-Aug 4)	0.6 a	0.0 a	0.1 ab	0.1 ab	0.0 a	6.1 a	2.1 a

[1]Treatments were replicated in three plots containing one tree of each cultivar. Treatments were applied to run-off using a handgun with pressure adjusted to 300 psi. Applications were made on Apr 26 (TC), May 5 (PK), May 16 (BL), May 27 (PF), Jun 13, Jul 7, and Aug 4. [2]Data were collected at harvest from 100 fruit/tree. [3]Mean separations were determined using LSD (P=0.05) if the F-test indicated significant differences existed between treatments. The arcsin transformation was used for statistical analyses of data expressed as percentages. [4]Bayleton 50DF 7.5 g (1 oz) was added May 16, 27, and June 13. [5]Combined with Manzate 200 75DF 90 g (12 oz). [6]Benlate 50DF 15 g (2 oz) & Manzate 200 75DF 90 g (12 oz). [7]Abbreviations: GT=green tip, PK=pink, BL=bloom, PF=petal fall. [8]Rated for roughening due to raised or cracked lenticels. [9] Rated on a scale of 1 (no russet) to 5 (severe russet).

1988 FUNGICIDE TRIAL #2: M.9 Orchard (North End)
Evaluation of New and Standard SI Fungicides Used Alone

APPLE (Malus domestica 'Jerseymac', 'Redcort', 'Smoothee')
Scab; Venturia inaequalis
Powdery mildew; Podosphaera leucotricha
Cedar apple rust; Gymnosporangium juniperi-virginianae
Sooty blotch; Gloeodes pomigena
Flyspeck; Zygophiala jamaicensis

Hudson Valley Lab
Highland, NY 12528

Test fungicides, including the unidentified proprietary Compounds X and Y, were applied to 3-yr old trees on M.9 rootstock using a Solo hand-pumped back-pack sprayer which generated about 30 PSI. Trees were sprayed to drip. Treatments were replicated four times in plots containing one tree of each cultivar. Application dates and corresponding Jerseymac phenological stages were April 13 (half-inch green), 22 (>half-inch green), May 4 (pink), 16 (bloom), 26 (petal fall), June 10, and 28. Data were collected from 20 clusters and 20 terminals on the dates shown on the tables. We evaluated scab infection on all fruitlets on approximately 20 clusters per tree in early June. Because a heavy June drop occurred shortly after our early evaluations, only small numbers of fruit were available for harvest evaluations. Whenever feasible, we collected comparable data from two cultivars and then combined the data in split-plot analyses to determine statistically significant differences between treatments. We used Jerseymacs and Smoothee for early scab data because the phenological progression was similar on these two cultivars, whereas Redcort developed more slowly. Jerseymac and Redcort were used for later-season scab evaluations. For the early scab ratings on clusters and terminals, we tried to distinguish between active and inactive scab lesions in order to determine the proportion of infected leaves with apparently normal lesions. Scab lesions were judged active if they appeared similar to those on control trees and inactive if they had a reddish color and lacked the velvety appearance of normal lesions. Differentiation was somewhat subjective. Leaves with both active and inactive lesions were counted as active leaves. The late-season terminal ratings were made more than a month after the last application of fungicides, so some under-leaf scab had started to develop.

The most important primary scab infection period of the year occurred May 10, midway through a 12-day spray interval, and provided an excellent test of fungicide activity. Unfortunately, we cannot separate protectant from kick-back or eradicant activity in this field trial. For example, both Dithane M-45 and Rubigan provided good control of scab. From what we know about these compounds, we assume Dithane M-45 controlled scab via the protective mode whereas Rubigan's activity against the infections that occurred May 10 is probably attributable to eradicant or presymptom activity. The high incidence of burnt-out lesions observed on trees treated with Compound X suggests good eradicant activity but limited protectant activity. Rubigan and Compounds X and Y were less effective than Dithane M-45 against rust infections on leaves. The mediocre performance of Rubigan and X & Y against rust is probably attributable to limited protectant activity with these fungicides and to the long spray intervals in mid- and late-May (over the May 10 and June 3 infection periods). Sprays following these long intervals may have stopped growth of some of the rust infections, but infections were far enough advanced to produce orange spots on the leaves before they were inactivated. We counted any orange lesions, regardless of size, as rust infections. The incidence of rust infection on Smoothee fruit was 1% or less in all treatments including the control. Control of foliar rust and fruit scab with Rubigan, Nustar, and Compounds X & Y might have been better if these fungicides had been applied in combination with a contact fungicide. Compare the control achieved in this test with control achieved with Rubigan and Nustar in Experiment #1 where they were used in combinations with contact fungicides. Inoculum density and spray dates immediately before and after the critical May 10 infection period were similar for both experiments.

Considering the limited number of fruit available for evaluation at harvest, we cannot use the results of this test to formulate definitive conclusions about fruit finish and control of summer diseases. However, Compound Y appeared very effective against sooty blotch and reasonably effective against flyspeck. In addition to the numerical finish ratings presented for Smoothee, we also made subjective visual checks on the other cultivars and found that none of the treatments affected the fruit finish of Jerseymac or Redcort.

1988 FUNGICIDE TRIAL #2, M.9 Orchard (North End):
Evaluation of New and Standard SI Fungicides Used Alone

Table 1: Incidence of apple scab on cluster leaves

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% leaves infected with scab (including both active and inactive lesions)[2] Jerseymac June 8	Smoothee June 17	2 cultivars combined[4]	Incidence of active vs. inactive scab lesions (grand means, 2 cultivars)[4] active[3]	inactive[3]
1. Control	39.8 c[5]	32.3 d	36.0 c	35.2 c	0.3 a
2. Rubigan 1EC 15.6 ml (2 fl oz)	2.1 a	7.7 bc	4.5 a	1.5 a	1.8 a
3. Nustar 20DF 7.5 g (1 oz)	3.8 ab	0.7 a	2.0 a	0.3 a	1.5 a
4. Dithane M-45 180 g (1.5 lb)	1.0 a	3.3 ab	2.0 a	1.3 a	0.5 a
5. Compound X 12 g (1.6 oz)	9.6 b	16.7 c	12.9 b	6.3 b	6.2 b
6. Compound X 24 g (3.2 oz)	1.4 a	5.6 ab	3.2 a	1.1 a	1.6 a
7. Compound Y 25 ml (3.2 fl oz)	1.2 a	5.1 ab	2.8 a	1.0 a	1.7 a
8. Compound Y 50 ml (6.4 fl oz)	0.8 a	2.9 ab	1.7 a	0.3 a	1.0 a

Table 2: Incidence of apple scab on early terminal leaves

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% leaves infected with scab (including both active and inactive lesions)[2] Jerseymac June 22	Redcort June 13	2 cultivars combined[4]	Incidence of active vs. inactive scab lesions (grand means, 2 cultivars)[4] active[3]	inactive[3]
1. Control	33.5 c	20.7 c	26.8 c	26.8 c	0.0 a
2. Rubigan 1EC 15.6 ml (2 fl oz)	1.6 a	1.2 a	1.4 a	0.8 a	0.3 b
3. Nustar 20DF 7.5 g (1 oz)	0.9 a	0.3 a	0.6 a	0.4 a	0.1 ab
4. Dithane M-45 180 g (1.5 lb)	1.2 a	0.5 a	0.8 a	0.7 a	Tr. ab[5]
5. Compound X 12 g (1.6 oz)	9.2 b	5.7 b	7.3 b	5.3 b	1.0 c
6. Compound X 24 g (3.2 oz)	2.8 a	0.5 a	1.4 a	0.9 a	0.3 b
7. Compound Y 25 ml (3.2 fl oz)	0.5 a	Tr. a	0.2 a	0.1 a	0.1 ab
8. Compound Y 50 ml (6.4 fl oz)	0.9 a	0.3 a	0.5 a	0.2 a	0.1 ab

Table 3: Incidence of apple scab, powdery mildew, and cedar apple rust on terminal leaves

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% terminal leaves infected with scab (late-season evaluation)[2] Jerseymac Aug. 9	Redcort Aug. 10	2 cultivars combined[3]	% Redcort terminal leaves with mildew June 30[2]	% Smoothee term. leaves with rust July 22[2]
1. Control	50.2 c	60.4 e	55.4 e	10.0 d	33.3 d
2. Rubigan 1EC 15.6 ml (2 fl oz)	4.2 ab	9.9 bcd	6.7 bc	2.2 bc	13.5 c
3. Nustar 20DF 7.5 g (1 oz)	1.0 a	0.1 a	0.5 a	0.1 a	2.2 a
4. Dithane M-45 180 g (1.5 lb)	3.4 ab	12.6 cd	7.3 bc	4.6 cd	2.3 a
5. Compound X 12 g (1.6 oz)	16.0 b	28.6 d	21.9 d	6.0 cd	16.5 c
6. Compound X 24 g (3.2 oz)	7.3 ab	10.7 bcd	8.9 cd	5.1 cd	14.4 c
7. Compound Y 25 ml (3.2 fl oz)	1.4 a	0.8 ab	1.1 ab	0.8 ab	7.5 b
8. Compound Y 50 ml (6.4 fl oz)	4.5 ab	1.9 abc	3.1 abc	0.1 a	10.2 bc

1988 FUNGICIDE TRIAL #2, M.9 Orchard (North End):
Evaluation of New and Standard SI Fungicides Used Alone, continued

Table 4: Incidence of early-season fruit scab and scab on Jerseymac at harvest

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% fruitlets with scab[6]: Jersey-mac June 13	Smoothee June 17	Both cultivars combined[4]	Jerseymac fruit infections Aug 9: % fruit with scab[7]	lesions/infected fruit: large lesions[8]	total lesions
1. Control	77.5 c[5]	39.3 c	59.2 c	92.1 c	4.8 c	8.6 c
2. Rubigan 1EC 15.6 ml (2 fl oz)	6.2 ab	0.3 ab	2.3 a	8.7 a	0.5 a	1.3 a
3. Nustar 20DF 7.5 g (1 oz)	4.4 ab	0.0 a	1.1 a	8.3 a	0.4 a	1.4 a
4. Dithane M-45 180 g (1.5 lb)	2.8 a	0.6 ab	1.5 a	8.7 a	0.9 a	1.9 a
5. Compound X 12 g (1.6 oz)	30.8 b	18.8 bc	24.5 b	43.9 b	2.9 b	5.0 b
6. Compound X 24 g (3.2 oz)	12.3 ab	1.9 ab	6.1 ab	12.6 a	1.3 ab	1.8 a
7. Compound Y 25 ml (3.2 fl oz)	11.7 ab	1.7 ab	5.6 ab	40.1 b	1.3 ab	2.5 ab
8. Compound Y 50 ml (6.4 fl oz)	19.2 ab	1.4 ab	8.1 ab	27.5 ab	1.1 ab	1.6 a

Table 5: Incidence of apple scab and summer diseases on fruit, and evaluation of fruit finish on the "Smoothee" strain of Golden Delicious

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% fruit with scab[4]: Red-cort Sept. 1	Smoothee Golden Del. Sept. 22	% Smoothee fruit with: sooty blotch Sept. 22	fly-speck Sept. 22	Fruit finish rating for Smoothee fruit[9]	Total number of fruit available for harvest evaluation: Redcort	Smoothee
1. Control	70.5 b	36.7 b	33.9 c	21.5 c	2.2 a	21	32
2. Rubigan 1EC 15.6 ml (2 fl oz)	2.1 a	0.0 a	36.2 c	8.7 bc	2.4 a	20	74
3. Nustar 20DF 7.5 g (1 oz)	0.1 a	0.0 a	31.3 c	10.8 bc	2.4 a	31	61
4. Dithane M-45 180 g (1.5 lb)	0.3 a	0.0 a	0.3 a	0.0 a	2.3 a	76	62
5. Compound X 12 g (1.6 oz)	10.2 a	2.4 a	20.8 bc	9.3 bc	2.6 a	36	36
6. Compound X 24 g (3.2 oz)	1.7 a	0.8 a	26.1 c	1.4 ab	2.5 a	29	50
7. Compound Y 25 ml (3.2 fl oz)	1.2 a	0.0 a	2.4 ab	0.2 ab	2.2 a	17	53
8. Compound Y 50 ml (6.4 fl oz)	1.1 a	0.4 a	1.1 a	4.0 abc	2.5 a	23	46

Footnotes for Tables 1-5:
[1]Treatments were replicated in four plots containing one tree of each cultivar. Treatments were applied to run-off using a handgun on a Solo hand-pumped back-pack sprayer with a nozzle pressure of approximately 30 psi. Applications were made Apr 13 (half-inch green), 22 (>half-inch green), May 4 (pink), 16 (bloom), 26 (petal fall), Jun 10, and 28. [2]Data were collected on the dates indicated from 20 randomly selected clusters or terminals on each tree. Mildew data were collected only from the last eight terminal leaves. [3]Scab lesions were judged active if they appeared similar to those on control trees and inactive if they had a reddish color and lacked the velvety appearance of normal lesions. Differentiation was somewhat subjective. Leaves with both active and inactive lesions were counted as active leaves. [4]A split-plot design was used for statistical analysis of combined data from both cultivars. [5]Mean separations were determined using LSD (P=0.05) if the F-test indicated that significant differences existed between treatments. The arcsin transformation was used for statistical analyses of data expressed as percentages. [6]Data were collected from all fruitlets (2-6 per cluster) on 20 clusters/tree before June-drop and chemical thinning reduced fruit numbers. [7]Fruit data were collected from all available fruit. [8]Large lesions are lesions >1 cm in diameter. [9]Fruit finish was rated on a scale of 1 (no russet) to 5 (severe russet).

1988 FUNGICIDE TRIAL #3: M.9 Orchard (South End)
Evaluation of Presymptom Activity of SI Fungicides

APPLE (Malus domestica 'Jerseymac', 'Redcort', 'Smoothee')
Scab; Venturia inaequalis

Hudson Valley Lab
Highland, NY 12528

Our objectives in this trial were (i) to compare the scab control achieved with dodine, benomyl, and several SI fungicides when the first application is made 7-10 days after the first major infection period; (ii) to compare the effectiveness of two versus three eradicant sprays where the 2-spray schedule is followed by a Dithane cover spray; and (iii) to determine if presymptom activity is effective for controlling fruit scab as well as foliar scab. Treatments were applied to 3-yr old trees on M.9 rootstock, were replicated in three plots containing one tree of each cultivar, and were sprayed to run-off using a handgun at approximately 2070 kPa (300 psi). The first applications were made at bloom on 12 May, 7 days after the first major infection period on 5-6 May, but prior to development of any visible scab symptoms. Two more severe scab infection periods occurred 10-11 and 17-20 May. The same fungicides used for the first application were reapplied to all plots on 23 May. On 3 Jun, Dithane M-45 80W 180 g (24 oz) was applied to all plots listed under double application of test fungicides, whereas the remainder of the plots were sprayed a third time with the indicated fungicides. No additional fungicides were applied for the duration of the season. Data were collected from 20 randomly selected clusters or terminals on each tree. Fruitlet evaluations were made in early June using all fruitlets (2-6 per cluster) on 20 clusters/tree before June drop and chemical thinning reduced fruit numbers. Leaves and fruit were considered infected even if the scab lesions appeared inactivated. On the cluster leaves and June fruitlet evaluations, many of these lesions were abnormal and appeared "burnt out". Whenever feasible, we collected comparable data from two cultivars and then combined the data in split-plot statistical analyses. The late-season terminal ratings were made about 8 weeks after the last application of fungicides to determine if any active lesions remaining in the trees would contribute to development of scab during the summer.

For all scab-control parameters measured, Nova, Nustar, and Rubigan were either as effective as or more effective than Benlate or Dodine. Two applications of the SI fungicides followed by an application of Dithane were just as effective as three applications of SI fungicides. For both cluster leaves and final fruit evaluations, there was a trend for three sprays of Benlate to give less control than two sprays followed by a Dithane spray. This effect may be attributable to a low percentage of the benomyl-resistant (BR) inoculum in the orchard.

We conclude that where growers miss a scab infection period and cannot apply SI fungicides within 72-96 hours after the infection period, the SI fungicides will still provide better presymptom scab control than any other fungicides available. Two applications of SI fungicides 8-12 days apart will arrest scab development just as effectively as three applications. The presymptom activity of SI fungicides appeared equally effective against fruit scab and foliar scab. However, with the spray timing used in this trial none of the SI fungicides provided acceptable control of cluster leaf scab and fruit scab on the highly susceptible Jerseymac cultivar.

1988 FUNGICIDE TRIAL #3, M.9 Orchard (South End): Evaluation of Presymptom Activity

Fungicide and rate of formulated material per 100 liters (100 gal)	% cluster leaves with scab[2] Jerseymac June 14	Redcort June 14	2 cultivars combined[4]	% early terminal leaves with scab[2] Jerseymac June 22	Redcort June 22	2 cultivars combined[4]	% terminal lvs with scab in Aug.[2] Jerseymac Aug. 9	Redcort Aug. 10	2 cultivars combined[4]
Double application of test fungicides[1]									
Nova 60DF 7.5 g (1 oz)	9.4 a	3.0 ab	5.8 a	1.1 a	0.0 a	0.3 a	2.8 ab	0.9 ab	1.7 a
Nustar 20DF 7.5 g (1 oz)	5.3 a	3.6 ab	4.4 a	2.3 ab	<0.1 a	0.7 a	2.0 a	0.5 a	1.1 a
Rubigan 1EC 15.6 ml (2 fl oz) & Dith.[5]	7.8 a	0.8 a	3.4 a	1.3 a	0.1 a	0.5 a	1.9 a	1.2 ab	1.5 a
Benlate 50DF 15 g (2 oz) & Dith.[5]	28.6 b	9.2 bc	17.8 b	18.9 c	1.5 ab	8.0 bc	13.7 c	4.8 bcd	8.7 bc
Dodine 65W 60 g (8 oz)	46.7 b	24.8 cd	35.4 c	8.3 bc	1.3 ab	4.0 b	6.2 abc	2.3 abc	4.0 ab
Triple application of test fungicides[1]									
Nova 60DF 7.5 g (1 oz)	10.0 a	2.6 ab	5.7 a	0.5 a	0.1 a	0.2 a	2.8 ab	3.8 abcd	3.3 ab
Nustar 20DF 7.5 g (1 oz)	3.9 a	3.8 ab	3.9 a	1.1 a	<0.1 a	0.4 a	2.2 a	1.7 ab	1.9 a
Rubigan 1EC 15.6 ml (2 fl oz) & Dith.[5]	10.6 a	1.6 ab	5.1 a	1.4 ab	<0.1 a	0.5 a	2.3 ab	1.1 ab	1.7 a
Benlate 50DF 15 g (2 oz) & Dith.[5]	38.6 b	22.1 cd	30.0 bc	11.0 c	5.5 bc	8.1 bc	8.1 bc	7.3 cd	7.7 bc
Dithane M-45 80W 180 g (24 oz)	43.8 b	31.7 d	37.6 c	18.1 c	8.8 c	13.1 c	12.7 c	9.0 d	10.8 c

Fungicide and rate of formulated material per 100 liters (100 gal)	% fruitlets with scab in June[3] Jersey-mac June 13	Red-cort June 13	both cultivars combined[4]	% fruit with apple scab at harvest Jersey-mac Aug. 9[6]	Red-cort Sept. 1	Smoo-thee Sept. 28	three cultivars combined[4]	% Smoo-thee fruit with rust	Mean number fruit harvested/tree Jersey-mac	Red-cort	Smoo-thee
Double application of test fungicides[1]											
Nova 60DF 7.5 g (1 oz)	3.1	0.9	1.8	7.7 ab	0.1 a	0.4	0.8 a	0.0	35	6	23
Nustar 20DF 7.5 g (1 oz)	3.3	7.3	5.1	10.0 ab	0.0 a	0.5	1.4 ab	1.0	65	29	22
Rubigan 1EC 15.6 ml (2 fl oz) & Dith.[5]	4.9	1.1	6.2	5.9 ab	5.3 abc	0.0	2.6 abc	0.0	47	6	8
Benlate 50DF 15 g (2 oz) & Dith.[5]	5.9	1.2	3.1	2.9 ab	0.7 ab	0.6	1.2 a	0.6	26	9	11
Dodine 65W 60 g (8 oz)	9.9	6.2	7.9	22.9 bc	1.2 ab	16.9	11.5 bcd	7.1	30	18	25
Triple application of test fungicides[1]											
Nova 60DF 7.5 g (1 oz)	20.6	7.2	13.2	1.1 a	0.0 a	0.3	0.3 a	0.0	27	18	34
Nustar 20DF 7.5 g (1 oz)	4.0	4.5	4.3	4.0 ab	0.0 a	0.8	1.0 a	0.0	26	8	22
Rubigan 1EC 15.6 ml (2 fl oz) & Dith.[5]	10.3	2.2	5.6	17.7 abc	3.3 abc	14.4	13.0 cd	0.0	10	15	14
Benlate 50DF 15 g (2 oz) & Dith.[5]	9.9	0.5	3.8	9.7 ab	8.3 bc	2.8	6.5 abcd	3.6	31	8	16
Dithane M-45 80W 180 g (24 oz)	7.4	8.9	8.2	44.8 c	16.0 c	5.7	19.9 d	4.1	15	23	11

[1]The treatments shown were applied May 12 (bloom) and May 23. For the third spray on June 3, Dithane M-45 80W 180 g (24 oz) was applied to those treatments listed under double application of test fungicides whereas the the tripple application plots were sprayed a third time with the indicated fungicides. No additional fungicides were applied to any plots for the duration of the season. [2]Data were collected on the dates indicated from 20 randomly selected clusters or terminals on each tree. Mean separations were determined using LSD (P=0.05) if the F-test indicated that significant differences existed between treatments. Where no letter separations are shown, differences were not significant. The arcsin transformation was used for statistical analyses of data expressed as percentages. [3]Data were collected from all fruitlets (2-6 per cluster) on 20 clusters/tree. [4]A split-plot design was used for statistical analysis of combined data from multiple cultivars. [5]Dith. = Dithane M-45 80W 90 g (12 oz). [6]Harvest data were collected using all fruit on each tree. [7]Large lesions are lesions >1 cm in diameter.

1988 FUNGICIDE TRIAL #4: East Entomology Orchard
Evaluation of a Reduced Spray Program with SI Fungicides

APPLE (Malus domestica 'Jerseymac', McIntosh', 'Cortland', 'Empire', 'Golden Delicious')
Scab; Venturia inaequalis

Hudson Valley Lab
Highland, NY 12528

A minimal spray program was evaluated to determine if apple scab can be adequately controlled with three or four applications of SI fungicides timed to coincide with the tight cluster oil spray for mites and the pink and petal fall insecticide sprays. Trees in the test orchard were on M.2 rootstock and were planted in 1964. Each treatment was replicated six times in plots consisting of one tree of each of eight cultivars, but data was collected only from four cultivars. Test materials were applied with a handgun starting either at McIntosh tight cluster or pink as shown in the table below. The control plots received Rubigan at petal fall and first cover but had no sprays prior to petal fall. As the result of an application error, the April 27 Rubigan spray was applied at 6 oz instead of 2 oz per 100 gal as originally intended. All plots received two additional sprays of Dithane M-45 during June. Jerseymac and McIntosh trees had 6-10% of terminal leaves infected with apple scab in 1987, but the entire orchard was treated just prior to leaf fall in 1987 with Benlate at 8 oz/100 gal to reduce ascospore production. Inoculum levels for this orchard in 1988 were therefore considered moderate to low.

Because of a long bloom period and the presence of multiple cultivars in the same plots, the interval between the pink and petal fall sprays was 16 days. The three major infection periods for the season occurred May 5-6, 10-11, and17-20. Protectant activity from the May 4 spray covered the May 5-6 infection period, and eradicant activity of the SI's applied on May 20 took care of the May 17-20 infection period. However, the May 10-11 infection period occurred mid-way between the pink and petal fall sprays.

Because of the long interval between the pink and petal fall sprays, none of the fungicide programs we tested provided adequate control of apple scab on fruit for the Jerseymac and Golden Delicious cultivars. The fact that fruit scab incidence was similar for the Rubigan plots first sprayed at tight cluster and those first sprayed at pink is evidence that scab resulted from the long spray interval at bloom and not from the prebloom delay in initiating sprays. The high incidence of fruit scab on Golden Delicious may have developed because some of the clusters on this cultivar were not yet separated when the pink spray was applied May 4. As a result, spray coverage of the hypanthium beneath the flower buds was probably inadequate on Golden Delicious. This experiment provides further evidence that some prebloom fungicide sprays can be safely omitted if SI fungicides are used for the first several applications. However, extended spray intervals during bloom may result in development of significant fruit scab even when SI fungicides are used at petal fall.

	Spray dates with fungicide rates and combinations			
Fungicide and rate of formulated material per 100 liters (100 gal)	27 Apr tight cluster	4 May pink	20 May petal fall	26 May first cover
Rubigan 1EC 15.6 ml (2 fl oz)	+6 fl oz*	+MZ**	+	+MZ
Rubigan 1EC 23.4 ml (2-3 fl oz)	-	+3 fl oz & MZ	+3 fl oz	+2 fl oz & MZ
Nova 60DF 7.5 g (1 oz)	-	+	+	+MZ
Nustar 20 DF 7.5 g (1 oz)	-	+	+	+MZ
Dithane M-45 80W 180 g (24 oz)	+	+	+	+
Control/Rubigan 23.4 ml (2-3 fl oz)	-	-	+3 fl oz	+2 fl oz & MZ

*Pluses indicate dates sprays were applied. Rubigan was inadvertently applied at 6 instead of 2 fl oz in the first application only. **MZ = mancozeb (Dithane M-45 120 g [=1 lb/100 gal]) was used in combination with the SI fungicide.

1988 FUNGICIDE TRIAL #4: East Entomology Orchard

Evaluation of a Reduced Spray Program with SI Fungicides

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% cluster leaves with scab[2] Jerseymac June 16	McIntosh June 16	Combined[6]	% terminal leaves with scab[2] Jerseymac June 29	McIntosh June 29	Combined[6]
Rubigan 1EC 15.6 ml (2 fl oz) **TC**[1]	0.3 a[5]	0.3 a	0.3 a	0.2 a	0.4 a	0.3 a
Rubigan 1EC 23.4 ml (2-3 fl oz) **PK**	1.3 a	0.8 a	1.0 a	0.2 a	0.4 a	0.3 a
Nova 60DF 7.5 g (1 oz) **PK**................	1.2 a	1.5 a	1.3 a	0.1 a	0.2 a	0.1 a
Nustar 20 DF 7.5 g (1 oz) **PK**................	1.1 a	1.1 a	1.1 a	1.1 ab	0.8 ab	1.0 a
Dithane M-45 80W 180 g (24 oz) **TC**.......	1.6 a	2.0 a	1.8 a	2.8 b	13.9 c	7.4 b
Control/Rubigan 23.4 ml (2-3 fl oz)**PF**...	20.2 b	15.4 b	17.7 b	7.5 c	2.6 b	4.8 b

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% terminal leaves with scab in late July[2] Jerseymac Aug. 8	McIntosh July 26	Empire July 28	Golden Del. July 27	four cultivars combined[6]
Rubigan 1EC 15.6 ml (2 fl oz).............	4.1 a	5.0 a	0.5 ab	0.1 a	1.7 a
Rubigan 1EC 23.4 ml (2-3 fl oz)[3]	5.1 ab	4.6 a	0.1 a	Tr. a	1.5 a
Nova 60DF 7.5 g (1 oz)......................	2.4 a	3.0 a	0.9 ab	0.7 ab	1.6 a
Nustar 20 DF 7.5 g (1 oz)...................	4.8 ab	3.6 a	0.3 a	0.4 ab	1.8 a
Dithane M-45 80W 180 g (24 oz).......	16.0 c	24.9 c	5.7 c	2.6 b	10.7 c
Control/Rubigan 23.4 ml (2-3 fl oz)	9.9 bc	13.1 b	2.6 bc	0.8 ab	5.4 b

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% fruitlets with scab[3] Jerseymac June 10	McIntosh June 10	Combined[6]
Rubigan 1EC 15.6 ml (2 fl oz)................................	3.5 a	1.0 a	2.0 ab
Rubigan 1EC 23.4 ml (2-3 fl oz)[3]	0.5 a	0.2 a	0.3 a
Nova 60DF 7.5 g (1 oz)...	3.3 a	Tr. a	1.1 a
Nustar 20 DF 7.5 g (1 oz).....................................	3.2 a	0.1 a	1.1 a
Dithane M-45 80W 180 g (24 oz)........................	18.3 b	1.7 a	8.0 b
Control/Rubigan 23.4 ml (2-3 fl oz)	45.5 c	16.4 b	29.8 c

Fungicide and rate of formulated material per 100 liters (100 gal)[1]	% fruit with scab in mid-August[4] Jerseymac Aug. 10	McIntosh Aug. 17	Empire Aug. 18	Golden Del. Aug. 17	four cultivars combined[6]
Rubigan 1EC 15.6 ml (2 fl oz)............	6.5 ab	0.8 a	Tr. a	9.4 a	2.8 a
Rubigan 1EC 23.4 ml (2-3 fl oz)..........	3.1 a	1.3 a	0.1 a	4.1 a	1.8 a
Nova 60DF 7.5 g (1 oz)......................	2.9 a	0.6 a	0.0 a	8.5 a	1.9 a
Nustar 20 DF 7.5 g (1 oz)...................	8.3 ab	0.4 a	0.0 a	4.3 a	2.0 a
Dithane M-45 80W 180 g (24 oz)......	14.3 b	3.6 a	1.5 a	7.8 a	6.0 a
Control/Rubigan 23.4 ml (2-3 fl oz) .	46.3 c	26.1 b	12.2 b	20.1 b	25.2 b

[1]Treatments were applied with a handgun at 300 psi to 6 replicates containing one tree of each cultivar. Bold-face abbreviations following treatment description indicate bud-stage at which treatment was started. For details of application dates and rates, see page 14. [2]Data were collected from all leaves on 25 clusters or terminals on the dates indicated. [3]Data were collected from all fruitlets on 25 clusters per tree before June drop reduced fruitlet numbers. [4]Data were obtained by observing 100 fruit per tree. [5]Mean separations were determined using LSD (P=0.05) if the F-test indicated that significant differences existed between treatments. Where no letter separations are shown, differences were not significant. The arcsin transformation was used for statistical analyses of data expressed as percentages. [6]A split-plot design was used for statistical analysis of combined data from multiple cultivars.

1988 FUNGICIDE TRIAL #5: Pond Block Orchard
Effect of Application Method on Scab Control with Nustar

This experiment was designed to determine if the efficacy of Nustar is affected by application method and concentration of the spray solution. The test was conducted in a block of 7-yr-old McIntosh trees on M.26 rootstock. Nustar 20DF 0.8 oz/100 gal & Manzate 200 75DF 12 oz/100 gal was applied either with a handgun to run-off, or at dilute or 4X concentrations using an airblast sprayer. Standard tree-row volume calculations were used to determine that the dilute rate for this orchard was 192 gal/A. The airblast sprayer was calibrated to deliver 192 gpa for the dilute spray and 48 gpa for the 4X spray. Sprays were applied with a truck-mounted Friend airblast sprayer equipped with a Dickey-John spray monitor/controller which controlled spray output by regulating pressure at the nozzle to compensate for variations in ground speed. Sprays were applied at 2.5 mph and 150 psi nozzle pressure. The same 5 nozzles were used for both the dilute and the 4X concentrations, but disks and whirl plates were changed to effect the change in sprayer output. The same tank of material was used for all three treatments by mixing and applying the 4X treatment first, then making the appropriate dilution before applying the dilute airblast and handgun treatments. Each spray treatment was applied to 5 two-tree plots. A buffer row between test rows and a 7-meter in-ro spacing between plots minimized spray drift. Sprays were applied April 26, May 10, May 23, and June 1.

Scab pressure was light in this block. Despite using a low rate of Nustar and a 14 day spray interval, scab was well-controlled in all treatments. No differences between treatment methods was detected.

Treatment	% McIntosh leaves with apple scab June 15		% McIntosh fruit with apple scab
	cluster lvs	terminal lvs	August 1
Control	21.0 b	17.3 b	52.4 b
Handgun (dilute to run-off)	<0.1 a	0.2 a	<0.1 a
Airblast 192 gpa (dilute)	0.4 a	0.0 a	0.5 a
Airblast 48 gpa (4X)	0.4 a	0.6 a	1.0 a

1988 FUNGICIDE TRIAL #6: Clintondale, NY
Comparison of Benlate and Bayleton for Mildew Control

The effectiveness of Benlate and Bayleton for controlling powdery mildew was compared in a 1.5-acre commercial orchard of 6-yr old Rome trees on MM.111 rootstock. Trees were severely infected with mildew in 1987. The block was divided in half, with one half receiving Benlate and the other receiving Bayleton as mildewcide. Applications were made by the grower using a large Bean airblast sprayer. Mildewcide treatments were applied to both sides of the rows on May 9, 27, June 8, 21 and July 5. For scab control, mancozeb was added to treatments on the first four spray dates and captan was added on the last two dates. Additional scab sprays of mancozeb alone were applied April 7, 28, May 5, 16 (one side only), and 20 (opposite side). Treatments were not replicated, but mildew infected twigs appeared evenly distributed throughout the orchard when it was examined before bud break in 1988. The eradicant effect of the 1988 treatments on primary infections was evaluated on June 7 by counting all visible primary infections. Control of secondary mildew infections was evaluated by determining the incidence of infection on the youngest seven terminal leaves on 20 terminals per tree. For all evaluations, we collected data from 10 randomly-selected trees in each treatment.

Many of the primary infections in Bayleton treated trees were suppressed (showed near-normal foliage) and were therefore more difficult to spot. Benlate had very little effect on mildew in this orchard. Because this grower has used Benlate virtually every year since its commercial introduction, we suspect powdery mildew in this test block was resistant to Benlate.

Treatment	No. primary infections found/tree on June 7	% of last 7 terminal leaves with mildew		
		June 7	June 29	Aug 4
Benlate (2.4 oz/100)	7.4±4.2	13.1 ±6.5	61.5 ±10.7	81.5 ±8.4
Bayleton (1 oz/100 gal	2.5±1.8	1.3 ±0.9	3.7 ± 2.5	13.1 ±7.1

1987-88 FUNGICIDE TEST: Virus Orchard
EFFECTS OF TANK MIXING OIL WITH MANCOZEB IN A PREBLOOM SPRAY

(Malus domestica 'Delicious')
Scab; Venturia inaequalis

Hudson Valley Lab
Highland, NY

(This report is a combination of work reported last year and additional data from a 1988 experiment.)

According to an anonymously-developed rule-of-thumb widely used in New York, prebloom oil (for mite control) tank-mixed with contact fungicides will limit redistribution of the fungicide and reduce the duration of effective fungicide protection by about 50%. We tested this hypothesis in 1987 and again in 1988 by applying treatments in a long double-row of Delicious trees on MM.106 rootstock. Our objective was to apply the test treatments one time between the half-inch green and tight cluster bud stages and then delay application of subsequent contact fungicides until treatments were exposed to at least one subsequent infection period. In both years, treatments were replicated 4 times in plots consisting of 6-8 adjacent trees in the double row.

In 1987, Manzate 200 80W was applied alone or with 2% oil on April 9 (half-inch green bud stage). Sprays were applied using an airblast sprayer calibrated to deliver 100 gallons per acre. On April 12-13, plots received 1.19 inches rainfall in a wetting period too short to allow infection. A severe Mill's infection period occurred April 17-19 when trees were at the early tight-cluster bud stage. This infection period involved 34 hr wetting at mean of 51 F, 0.57 inch rain, and 26% of season's ascospores as determined by Burkard trapping. The opportune timing of this infection period 8 days after treatments were applied provided an ideal test of the redistribution capabilities of mancozeb applied with oil. All plots including controls were subsequently sprayed April 21 and 27 (Dithane M-45 80W 1.5 lb), May 7 (Rubigan 3 fl oz & Dithane M.45 1 lb), May 14 (Benlate 50W 4 oz & Zineb 65W 1 lb) and May 28 (Rubigan 2 fl oz & Captan 80W 0.4 lb/A). On May 26, 25 clusters/tree on the two center trees in each plot were evaluated for apple scab. Incidence of fruit scab was determined July 29 by observing 100 fruit/plot.

In 1988, Dithane M-45 was applied alone or with 1.5% oil on April 12 when trees were at 3/4 inch green. Treatments were applied with a handgun. Short wetting periods between April 12 and 27 contributed 0.5 inch rain. A moderate Mill's infection period (30 hrs wetting, 47 F, 1.34 inch rain, 14% of the season ascospores as determined by Burkard trapping) occurred April 27-28 when trees were at tight cluster. Subsequent fungicide treatments were applied to all plots on May 4 (Dithane M-45 80W 1.4 lb), May 12 and May 23 (Captan 50W 2 lb & Funginex 18.2 EC 10 fl oz). Disease incidence on cluster leaves was too low to warrant data collection. A total of 200 fruit per plot were evaluated for apple scab at harvest.

Manzate 200 applied on April 9 in 1987 did not completely control cluster leaf scab because 3 Mill's infection periods had occurred prior to April 9 and because the residual effectiveness of the April 9 spray was not adequate to completely protect against the severe infection period April 17-19. However, the mancozeb + oil tank mix was just as effective as mancozeb applied alone. Treatment differences were not statistically significant in 1988, but disease incidence followed the trend observed in 1987. We therefore have two years of data to refute the hypothesis that oil limits redistribution of mancozeb when the two materials are applied in a tank mix.

Materials applied April 9, 1987 or April 12, 1988 and rate/100 gal	% infected with apple scab 1987 cluster leaves	1987 fruit	1988 fruit
Control: no fungicide or oil	69.5 b**	7.6 b	4.9 a
mancozeb 80W 1.5 lb	21.7 a	1.2 a	2.5 a
mancozeb 80W 1.5 lb & Spray Oil 6E*	20.5 a	2.4 a	2.5 a

*Spray oil was applied at 2 gal/100 in 1987 and 1.5 gal/100 in 1988.

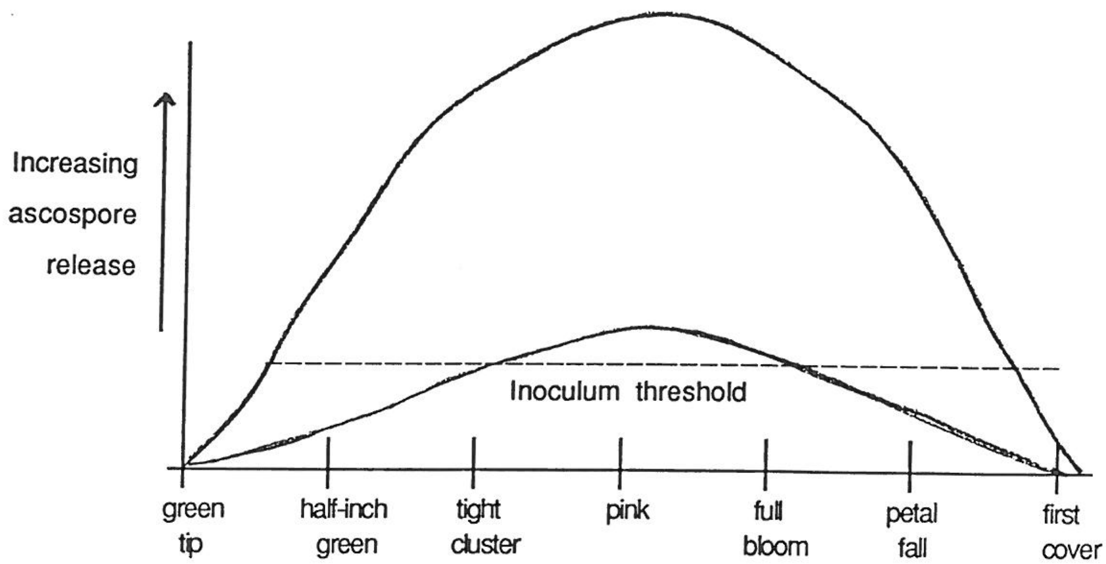
**Arcsine square root transformations were used for all statistical analyses, and mean separations were determined using LSD (P = 0.05) if the F-test indicated significant differences between treatments.

1986-1988 SUMMARY REPORT

USING FALL INOCULUM LEVELS TO PREDICT SAFE DELAYS IN THE TIMING OF PREBLOOM APPLE SCAB SPRAYS

Over the past three years, detailed experiments were carried out in seven Hudson Valley orchards to determine if the incidence of apple scab on leaves in the fall could be used to predict when the first prebloom scab spray would be needed the following year. We used methods and a mathematical model developed by Gadoury and MacHardy in New Hampshire (Phytopathology 76:112-118). In simple terms, the model assumes that ascospore concentrations in commercial orchards must reach a certain undefined threshold level before a serious scab problem will develop. We know that plotting the incidence of scab spores released against time during the primary infection period usually results a bell-shaped curve. the incidence starts out low at about the green-tip stage of apple tree bud development, peaks near pink or full bloom, and drops back to zero by first cover. The amount of over-wintering inoculum in the orchard determines the height of the curve. If a theoretical threshold line is now imposed across the bell curves for a high inoculum orchard and low inoculum orchard, it becomes apparent that the high-inoculum orchard will reach the threshold before the low inoculum orchard (Figure 1).

Figure 1.



The model we tested uses fall inoculum levels to predict how many days beyond green-tip sprays can be safely delayed without crossing the threshold. The only information required by the model is an accurate fall assessment of scab incidence (% leaves infected) and intensity (number of lesions per infected leaf), and a springtime assessment of leaf litter density (how much of the orchard floor is covered by overwintering leaves). The leaf litter density determined by taking several transects through the orchard with a 100 foot tape and recording how many of the 1-ft marks fall on overwintering apple leaves.

We evaluated the model by setting up replicated plots in four commercial orchards each of the last three years and in an experimental orchard in 1986 and 1987. The appropriate scab infection data was collected each fall and the leaf litter density was determined in spring. At each site, varying starting times for the first scab spray were compared. Starting times varied from the half-inch green bud stage to full bloom. The first sprays applied were mancozeb sprays (no eradicant or systemic activity). The sprays were applied with a hand-gun to small plots consisting of 2-10 trees. Incidence of scab in the plots was carefully evaluated throughout the season. Treatments were judged successful if fruit scab incidence at harvest was less than 1% and if terminal leaf scab in August was less than 2%.

In Table 1, we have summarized our results for each orchard by showing the incidence of apple scab which resulted from a conservative delay and from a more extended delay in the timing of the first scab spray. The conservative delay is comparable to what many commercial growers are already doing based on their own field experience. The extended delay generally exceeded what the model predicted as a safe delay. In 1986 and 1988 adequate scab control was achieved even with the extended delays because apple scab ascospore maturity was delayed and/or no infection periods occurred immediately after the period around tight cluster when ascospores tend to mature very rapidly. In 1987, three Mill's periods occurred between green tip on March 30 and quarter-inch green on April 8 and another major infection period occurred April 17-18 (tight cluster, 34 hr wetting at 51 F, 26% of season's total ascospores caught with a Burkard trap).

In 1987, the incidence of cluster-leaf scab was significantly different for the conservative and extended delays in orchards A, C, D, and E. In most cases, the mathematical model provided a conservative estimate of the number of days that sprays could safely be delayed. Serious scab problems developed in 1987 in orchards E and F when even the conservative delays exceeded the safe delay predicted by the model. The only place the model failed to give a safe prediction was in orchard D in 1987. In this orchard we found 1.9% of the fruit infected when the first spray was applied within the predicted safe period. However, we used August 1986 leaf counts to determine our 1987 predicted inoculum levels for this orchard. In retrospect, we suspect that the wet fall weather in 1986 may have contributed to development of late-season under-leaf scab in this orchard, and the late-season scab may have boosted inoculum levels well beyond those we calculated from our August counts. We had checked several other orchards in October of 1986 and found no increase over August scab levels. Because Orchard D was less accessible, we failed to recheck it in October and therefore we cannot be certain whether the error in this orchard is attributable to error in the model or error in determing fall scab incidence.

We conclude that the model developed by Gadoury and MacHardy provides a fairly conservative estimate of how far beyond green tip scab sprays can be delayed. In the Hudson Valley, practical experience has led many growers to delay their initial sprays even further than the model would predict as safe. Improved accuracy (less error on the conservative side) might be possible if on-line spore maturity information could be used in the predictive process.

To minimize the risks involved in delaying early scab sprays, growers who choose to eliminate early sprays should use fungicides with eradicant activity when they do start spraying. An eradicant fungicide applied sometime between tight cluster and pink (depending on the season) and then again 8-10 days later will effectively stop development of any scab lesions which might have "slipped through" during early infection periods in a relatively clean orchard. The only fungicides currently available which can be relied upon for the appropriate eradicant activity are the sterol-inhibitor fungicides.

Footnotes for Table 1 (continued from the bottom of the next page):

[b]TC= tight cluster.

[c]Predicted delay is the Δt as determined according to the Gadoury/MacHardy model. The actual delay is the number of days which elapsed between green tip and the last unprotected infection period, i.e., the last infection period before the first spray of the season was applied.

[d]Asterisks (*) indicate that scab incidences for the short and long delay for that block and year were significantly different (LSD, P=0.05).

[e]This PAD probably was inaccurate: it was based on August evaluations, but wet fall weather in 1986 and benomyl-resistance problems are believed to have contributed to a late-season build-up of scab in 1986 after our evaluations were made.

[f]No data were collected from trees with conservative delays in 1988 because scab incidence was extremely light even on trees with longer delays.

[g]Fruit data were not collected in several orchards either because we didn't get to the orchard before fruit was harvested or because (in the case of the HVL orchard used for entomology experiments) the fruit was too badly damaged by insects to allow accurate rating at harvest.

Table 1. Summary of work on delaying early-season apple scab sprays in eastern New York, 1986-1988

Orchard & year[a]	Tree phenology at the time of the first spray[b]	Predicted delay/ actual delay[c]	No. of unprotected scab infection periods	% scab infection: leaves: cluster	% scab infection: leaves: terminal	% scab infection: fruit	PAD
A 1986	Early tight cluster	19/15	1	<0.05	0.2	0.0	45
A 1986	Bloom	19/21	2	0.0	0.0	0.0	
A 1987	Early tight cluster	14/9	3	0.1	1.5	0.1	381
A 1987	Pink	14/20	4	1.4*[d]	1.4	0.5	
A 1988	1 cm green	11/6	2	-.-[f]	-.-	-.-	1351
A 1988	Tight cluster	11/27	3	0.0	0.9	0.0	
B 1986	Early tight cluster	15/15	1	<0.05	0.6	0.2	303
B 1986	Bloom	15/21	2	0.1	0.6	<0.05	
B 1987	Early tight cluster	12/9	3	0.8	2.0	0.0	699
B 1987	Pink	12/20	4	0.6	2.8	0.3	
B 1988	1 cm green	6/6	2	-.-	-.-	-.-	7880
B 1988	Tight cluster	6/27	3	0.1	1.1	0.3	
C 1986	Early tight cluster	16/15	1	0.1	0.8	<0.05	180
C 1986	Bloom	16/21	2	0.9	0.9	<0.05	
C 1987	Early tight cluster	12/9	3	1.4	1.0	0.2	902
C 1987	Pink	12/20	4	25.8*	4.2*	10.4*	
C 1988	1 cm green	9/6	2	-.-	-.-	-.-	3236
C 1988	Tight cluster	9/27	3	0.2	0.4	0.0	
D 1986	Early tight cluster	14/15	1	0.6	0.3	–.–[g]	336
D 1986	Bloom	14/21	2	0.6	0.5	–.–	
D 1987	Early tight cluster	13/9	3	7.2	1.6	1.9	520[e]
D 1987	Pink	13/20	4	55.4*	14.8*	34.3*	
E 1986	Early tight cluster	12/15	1	4.6	0.2	–.–	1015
E 1986	Bloom	12/21	2	9.5*	0.8	–.–	
E 1987	Early cluster	8/9	3	13.1	5.3	6.9	3711
E 1987	Pink	8/20	4	62.3*	8.7	21.3*	
F 1987	1 cm green	6/17	3	18.5	1.6	-.-	7728
F 1987	Pink	6/26	4	36.4	2.7	-.-	
G 1988	1 cm green	11/6	2	-.-	-.-	-.-	571
G 1988	Tight cluster	11/27	3	0.1	0.0	0.5	

[a]Orchards were as follows: A= B. Coy, McIntosh on M.7, 6 yrs old in 1986; B= G. Coy, McIntosh on seedling, >15 yrs old; C= L.Cosman, McIntosh on seedling, >15 yrs old; D= R. Dressel, Jonamac on M.7, 6 yrs old in 1986; not used in 1988 because of high inoculum levels; E= Hudson Valley Lab, McIntosh in a mixed variety experimental block planted 1964, M.2 rootstock; F= D. Fraleigh, Jerseymacs on M.26, ca. 5 yrs old, sprays applied to unreplicated plots by grower; G= M. Zimmerman, McIntosh on MM.106, 8 yrs in 1988.

(Footnotes are continued the on bottom of the preceding page.)

Effectiveness of Benlate/DPA Postharvest Treatments for Controlling Two Common Penicillium Species in Apples Storages

Penicillium populations in water dump tanks were monitored in four commercial apple storages during the 1985-1986 packing season. A total of 370 isolates were collected from dilution plates and evaluated. Of these, only 23 (or 6.2%) were non-pathogenic when inoculated into apple fruit and incubated on the lab bench. The remaining isolates were classified as high-pathogenicity isolates if they produced decays with diameters of 50-70 mm 12 days after inoculation into fruit or as low-pathogenicity isolates if they caused decays of only 15-30 mm diameter after 12 days. None of the isolates caused decays with diameters in the 30-50 mm range. Isolates were further categorized for their sensitivity to MBC (the active moiety in Benlate and Topsin M) and diphenylamine (DPA). Isolates which failed to grow on any of the MBC-amended media after 3 days were considered MBC-sensitive. Isolates categorized as having low MBC resistance were able to grow on PDA amended with 5 but not 30 µg MBC/ml. Isolates with moderate and high MBC-resistance showed 10-90% and 0-10% inhibition, respectively, on plates amended with MBC at 100 µg/ml. Isolates failing to grow on media amended with 10 µg DPA/ml after 10 days incubation were considered DPA-sensitive whereas isolates with visible growth were considered resistant.

We initially assumed that all of the pathogenic isolates we collected were P. expansum. However, when we sent representative isolates to Dr. Wicklow at the U.S.D.A. Fermentation Lab in Peoria, IL, he identified most of the low-pathogenicity isolates as P. aurantiogriseum. Although P. aurantiogriseum has been previously reported as an apple decay pathogen, it has never been assigned major importance in apple storages. We found that 81% of the isolates we recovered from water dumps were P. aurantiogriseum and only 19% were P. expansum. Of the 65 P. expansum isolates, only 7 isolates were resistant to both MBC and DPA. Ninety-five percent of the 277 P. aurantiogriseum isolates were resistant to both MBC and DPA. The prevalence of P. aurantiogriseum increased as the packing season progressed (Table 1).

A postharvest test was conducted to determine how P. expansum and P. aurantiogriseum with varying sensitivities to MBC and DPA would respond to Benlate/DPA treatments. Empire apples were harvested September 22, 1986, and kept in cold storage at 2.2 C until the experiment was initiated December 10. Fifty apples were used for each isolate/inoculum/fungicide combination. Apples were wounded 5 mm deep at three widely-separated sites on a single hemisphere by using a 2-mm finishing nail mounted in a large cork. Fruit were inoculated by dipping the baskets for 20 seconds into conidial suspensions containing 0.01% Tween 80 and 10,000 or 50,000 conidia/ml. After drying for approximately 3 hours, fruit were treated by dipping the baskets containing 50 fruit into water, benomyl (Benlate 50W) at 300 µg a.i. per ml, or benomyl at 300 µg/ml plus DPA (Decco No-Scald DPA) at 2,000 µg/ml. Fruit were kept overnight at 9 C, divided into replicates of 12 apples each, placed wounded-side-up on spring cushion trays, grouped by replicates, and stored at 2.2 C. We used 4 replicates for most isolate groups but 8 replicates for the P. aurantiogriseum isolates with moderate and high levels of MBC-resistance. Apples were observed for decay after 60 and 80 days in storage and incidence of decay at each inoculation site was recorded. The few inoculation sites which became infected with Botrytis cinerea were eliminated from the totals used to calculate results of the experiment.

As in previously published tests, both the MBC-sensitive and highly MBC-resistant isolates of P. expansum were adequately controlled by the Benlate/DPA combination. (Benlate/DPA did not provide perfect control of the MBC-sensitive "wild type" isolates in our test because we used high inoculum concentrations and wounded fruit.) The moderately MBC-resistant isolates of P. expansum were not controlled by Benlate/DPA, but only seven of the 347 pathogenic Penicillium isolates we recovered were in this category. P. aurantiogriseum isolates in all the categories we tested caused less decay than the P. expansum isolates. Isolates of P. aurantiogriseum sensitive to MBC caused the highest incidence of decay and isolates highly-resistant to MBC caused the least infection (Table 2).

Based on results of our storage survey and apple inoculation trials, we conclude that the combination of MBC and DPA is still highly effective for controlling storage decays caused by Penicillium species in eastern NY apple storages. Only 2% of the 347 pathogenic Penicillium isolates we recovered from water dumps were capable of causing more decay that wild-type P. expansum isolates in fruit treated with benomyl plus DPA.

Table 1: Relative abundance of the four most common Penicillium spp./resistance categories for isolates recovered from water dumps in apple packinghouses on each of five collection dates.

Penicillium species	MBC/DPA sensitivity category[y]	14 Nov	12 Dec	10 Jan	28 Feb	21 Mar
		% of the total isolates collected on each date attributable to each Penicillium spp./resistance category[z]				
P. expansum	SR	13	12	2	10	1
	HS	34	0	4	0	0
P. aurantiogriseum	MR	1	12	6	10	5
	HR	40	54	79	73	87
Total number of isolates collected on each date		71	42	83	76	75

[y] The first and second letters in the sensitivity category designations refer to sensitivity to MBC and to DPA, respectively. For MBC, S = sensitive (wild type); M = moderate resistance; H = high-level resistance. For DPA, R = resistant (wild type); S = sensitive.

[z] Columns may not total 100% because genetic groups occurring only infrequently are not included in the table

Table 2: Effects of inoculum concentration and postharvest treatment on percent of inoculation sites in 'Empire' apples infected by Penicillium expansum and P. aurantiogriseum with varying sensitivities to MBC and diphenylamine (DPA).

Penicillium inoculum category: Penicillium species	MBC/DPA sensitivity[u]	No. of isolates used[v]	Untreated fruit: inoculum concentration (conidia/ml) 10,000	50,000	Grand mean[w]	Grand means[w] for fruit treated with benomyl[x]	benomyl & DPA[y]
After 60 days:							
P. expansum	SR	(2)	12.8 bc[z]	22.3 c	17.3 c	0.5 a	4.3 a
	MR	(2)	15.7 c	21.8 c	18.6 c	24.9 b	20.3 b
	HS	(3)	19.4 c	17.2 bc	18.3 c	23.2 b	2.7 a
P. aurantiogriseum	SR	(3)	4.2 ab	6.6 ab	5.4 b	0.5 a	3.5 a
	MR	(6)	4.3 ab	2.5 a	3.4 ab	0.5 a	5.5 a
	HR	(6)	0.9 a	1.6 a	1.2 a	0.5 a	2.2 a
After 80 days:							
P. expansum	SR	(2)	31.9 cd	42.1 c	37.0 d	2.0 a	7.8 ab
	MR	(2)	24.5 bcd	41.1 c	32.5 d	49.7 b	30.8 c
	HS	(3)	36.7 d	39.9 c	38.3 d	42.9 b	8.0 ab
P. aurantiogriseum	SR	(3)	16.6 bc	21.6 b	19.0 c	4.4 a	10.5 ab
	MR	(6)	14.3 b	5.1 a	9.2 b	4.7 a	10.8 b
	HR	(6)	4.9 a	4.3 a	4.6 a	3.1 a	5.7 a

[u]The first and second letters in the sensitivity category designations refer to sensitivity to MBC and to DPA, respectively. For MBC, S = sensitive (wild type); M = moderate resistance; H = high-level resistance. For DPA, R = resistant (wild type); S = sensitive. [v]The numbers in parentheses indicate the number of isolates used to make up the inoculum spore suspensions. [w]Grand mean for split plot analysis of both inoculum concentrations. [x]Treatments were applied by dipping inoculated fruit into solutions containing 300 µg/ml of benomyl. [y]Treatments were applied by dipping inoculated fruit in solutions containing 300 µg/ml of benomyl plus 2000 µg/ml of DPA. [z]Range separations were determined from the LSD (P=0.05) for arcsin square-root transformed data. Numbers within columns for the same observation date and followed by the same letters do not differ significantly.