Part (B) of 2020 Report on Disease Efficacy Trials at HVRL:

1. Sooty Blotch & Flyspeck,

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1. EVALUATION OF BURAN IN MIX WITH PURESPRAY GREEN OR WITH AGRAL 90 FOR CONTROL OF SOOTY BLOTCH AND FLYSPECK

Inoculum. Natural inoculum of various fungal species on infected branches of surrounding wood lots around the experimental apple orchard (ascopores and conidia).

Apple varieties, experiment design, disease rating. Efficacy of Buran (garlic powder 15%, liquid formulation, AEF Global Inc) was evaluated in management of sooty blotch and flyspeck (SBFS) at Hudson Valley Research Laboratory in Highland, NY. We used 21 years old trees of 'Gingergold', 'MacIntosh' and 'Golden Delicious'. Each treatment consisted of five replicate trees arranged in a completely randomized design (CRD). Fungicide and insecticide spray applications were applied during early spring to protect apple fruit from severe infections of endemic diseases such as apple scab, cedar apple/quince rust and fire blight typical for New York climate and geographic conditions. The last spray application in this batch of spray applications was performed on 12 May (start of petal fall). The actual petal fall date (PF) in the trial block was 5/16/2020 and was used in the SB&FS NEWA model.

The first application of each treatment listed below was applied according to the SBFS model for Northeastern US (New York State Integrated Pest Management Program, Network for Environment and Weather Applications i.e. NEWA: http://newa.cornell.edu/index.php?page=apple-diseases). See model outputs below from NEWA and RIMpro. The first application of each treatments was performed just before the accumulated leaf wetness (ALW) since petal fall has reached 190 hours. To estimate when this 190 h ALW will be reached in the near future, we used national Weather Service i.e. NWS weather forecast for the probability of rain (incorporated in NEWA, https://www.weather.gov/). The trial was initiated under the assumption that the early spring fungicide applications prevented first seasonal infections from SBFS spores that would have flown into the orchard from the hedgerows during the early spring.

All the early-season fungicide sprays and the maintenance insecticides sprays were delivered with an airblast sprayer to the whole orchard including the control trees using a Unigreen Turboteuton Mistblower air-blast sprayer (Unigreen Crop Protection, S.p.A., Reggio Emilia, Italy) delivering 49 gal of spray solution per acre. We applied the treatments listed below on a 14-21-day schedule, except if 2 inches of rain occur, when these intervals would be shorter.

Equipment. Treatments were delivered with the right bank of a "medusa" i.e. tower style Unigreen Turboteuton Mistblower air-blast sprayer using red nozzles (Uni–green Crop Protection, S.p.A., Reggio Emilia, Italy) delivering 99.5 gal of spray solution per acre, assuming 18 ft between row spacing.

Spray dates. Dates of the treatment applications according to NEWA SB&FS model are presented below. Spray intervals were: 14 days, 13 days, 15 days, 16 days, 18 days, 10 days:

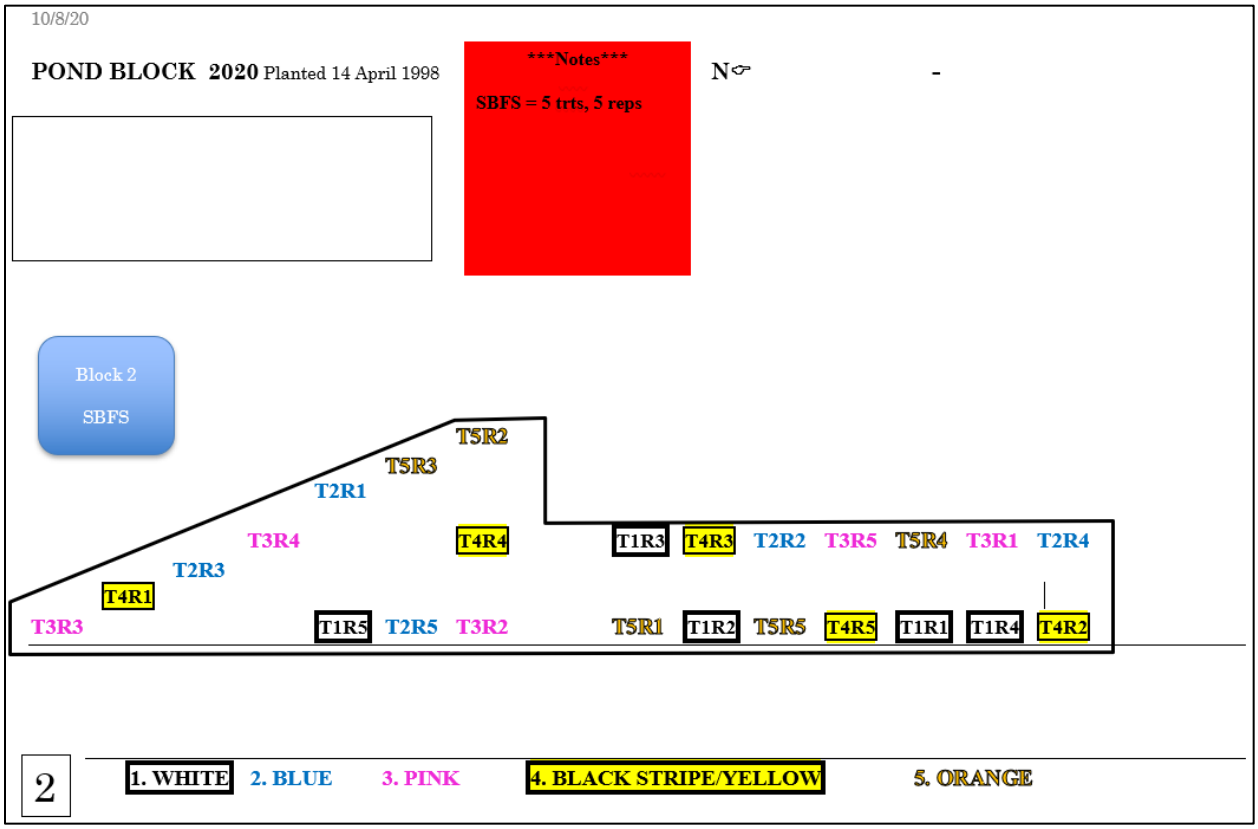
7/7/2020 – at 135 ALWH counting from PF
7/21/2020 – at 181 ALWH counting from PF
8/3/2020 – one day before expected 3+ inches of rain over following 36 hours
8/18/2020
9/3/2020
9/21/2020
10/1/2020

Spray programs lineup: Buran (Garlic powder 15%), Agral 90 non-ionic liquid wetting and spreading agent (nonylphenoxy polyethoxy ethanol 90%), PureSpray GREEN (mineral oil 98%):

1. Untreated control
2. Buran @ 153.6 fl oz/100 Gal (1.2%) + Agral 90 @12.8 fl oz/100 Gal (0.1%)
3. Buran @ 153.6 fl oz/100 Gal (1.2%) + PureSpray GREEN @ 128 fl oz/100 Gal (1%)
4. PureSpray GREEN @ 128 fl oz/100 Gal (1%)
5. Captan @ 2.67 lb/A (42.7 oz/100 Gal)

Disease rating. The incidence of SB and FS symptoms on apple fruit was rated on 50 fruits per tree replicate. First rating was conducted at the usual harvest dates for the cultivars listed above. Following the harvest rating, fruit were incubated at ca. 70 F in bagged crates with moist paper towels on the crate-bottoms to create a high humidity environment that promoted SB&FS development. Fruit was rated the second time 14 days after storage in crates. Rating was conducted for fruit rots at that second rating time. The percent incidence of both diseases on fruit will be calculated from the number of fruit with SB or FS versus the fruit without these symptoms. Disease incidences will be subjected to LSD test ($\alpha = 0.05$), for a completely randomized design using PROC MIXED statistical procedure in SAS Studio (SAS Institute Inc., Cary, NC). Ginger Gold harvest rating was 09/1-2/2020, 2-weeks after harvest rating was 09/15-16/2020. McIntoch harvest rating was 09/19-20/2020, 2-weeks after harvest rating was 10/03-04/2020. Golden Delicious harvest rating was 10/16-17/2020, 2-weeks after harvest rating: 10/30-31/2020.

Experimental plot map. 1. White = untreated control; 2. Blue = Buran + Agral 90; 3. Pink = Buran + PureSpray GREEN; 4. Black Stripe Yellow - PureSpray GREEN; 5. Orange = Captan:



Summary of weather conditions in 2020 and natural disease infection periods, respectively:

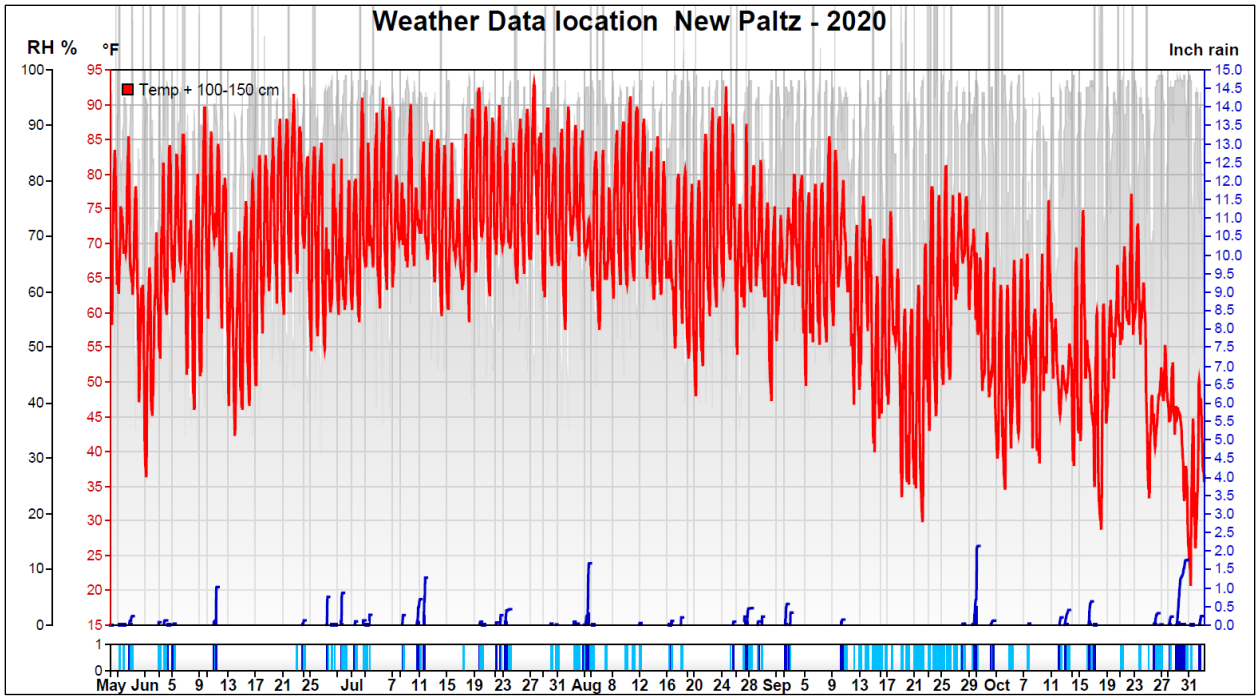
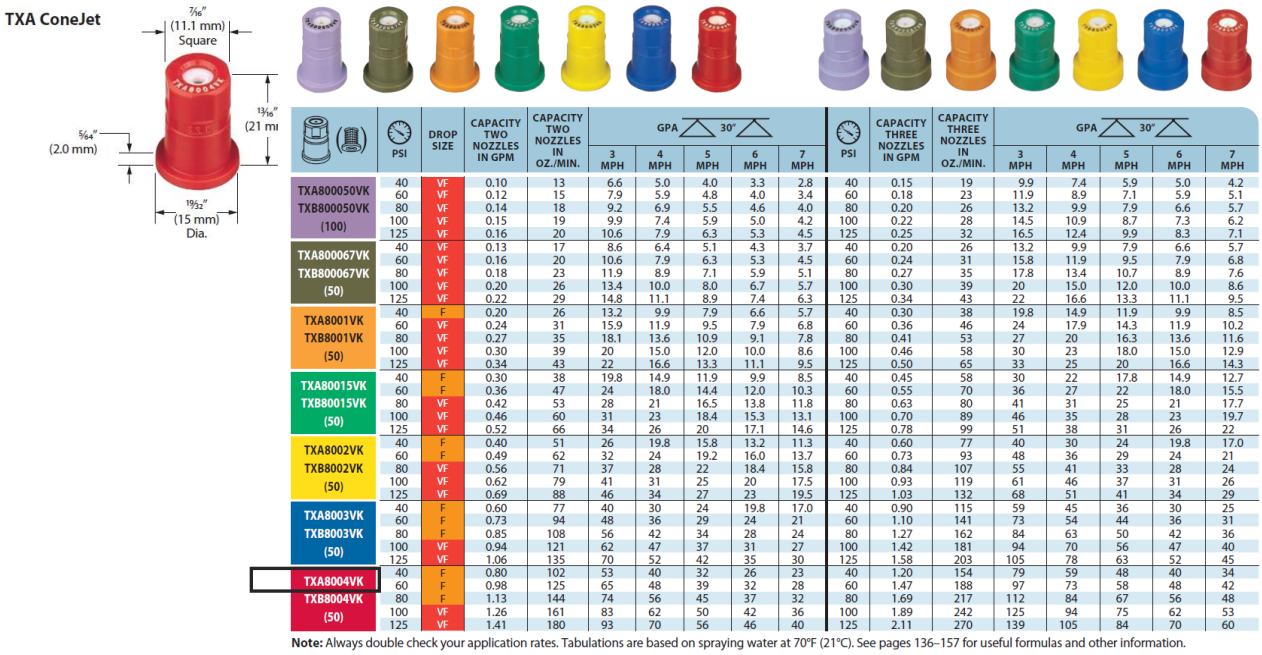


Figure 1. Weather conditions during the SB&FS fungicide trial in 2020 in Highland, NY, recorded by a nearby NEWA weather station in New Paltz, NY. Top graph: red line shows temperatures (left y-axis in red), blue curved lines show rain lengths and amounts in inches (right y-axis in blue), grey background represent relative air humidity (RH) in % (far left y-axis in black). Bottom graph with dates shows the length of rain (dark blue) and of wetting periods after the rain stopped or from dew (light blue). Source: RIMpro Cloud Service: https://rimpro.eu/ (RIMpro B.V., Zoelmond, Netherlands).

Table 1. Application details: application date, application equipment, operating pressure, nozzle type and size, spray volume and quality, temperature, relative humidity, wind velocity and dew presence. Roughly 3 h was needed to apply all the spray programs in one day.

Spray #	Date M/D/Y	Operating Pressure	Nozzle type	TeeJet Nozzle type size*	Temp (F)	Relative Humidity (%)	Wind (mph)	Dew	Time of day spray start
1	7/7/2020	8.5 Bar	Conical	TXA8004VK	80	66	1.2	None	4 – 7 PM
2	7/21/2020	8.5 Bar	Conical	TXA8004VK	78	57	0	None	8:10 PM
3	8/3/2020	8.5 Bar	Conical	TXA8004VK	87	47	1.5	None	11:20 AM
4	8/18/2020	8.5 Bar	Conical	TXA8004VK	76	47	0.8	None	6:15 PM
5	9/3/2020	8.5 Bar	Conical	TXA8004VK	77	45	1.2	None	12:00 PM
6	9/21/2020	8.5 Bar	Conical	TXA8004VK	62	38	3.1	None	2:00 PM
7	10/1/2020	8.5 Bar	Conical	TXA8004VK	62	51	0	None	6:30 PM



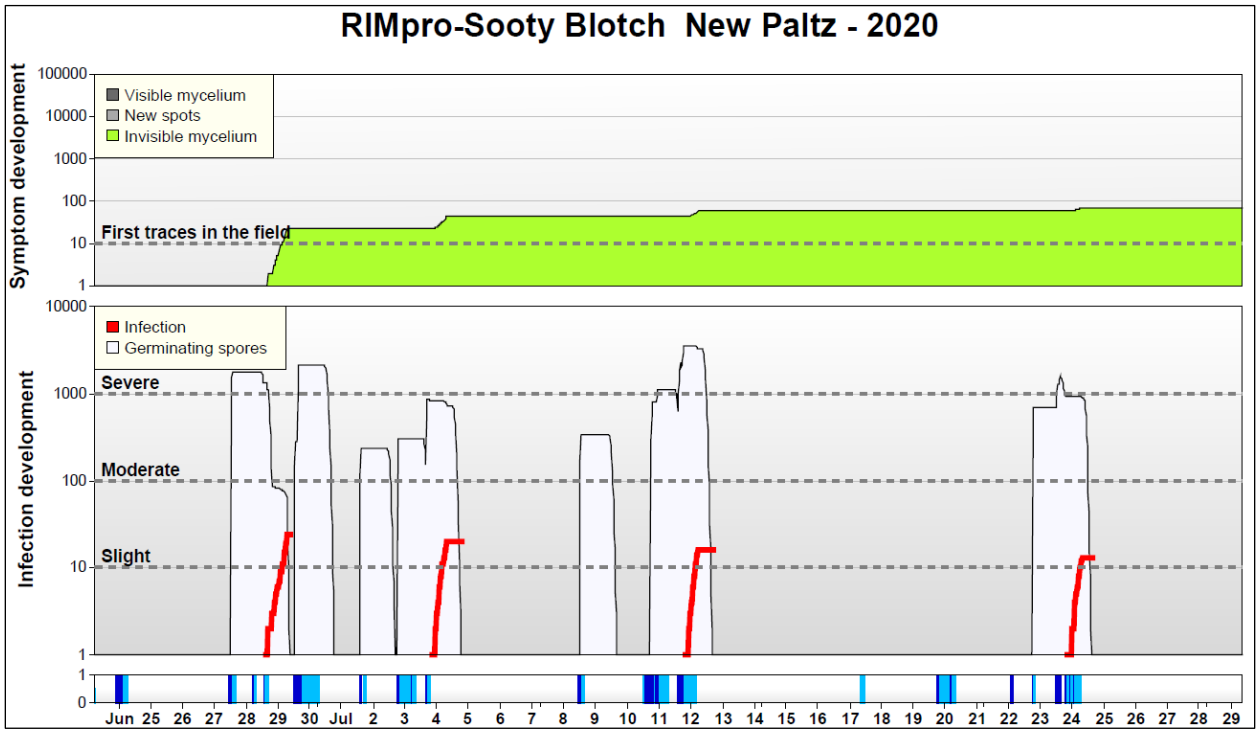
	PSI	DROP SIZE	CAPACITY TWO NOZZLES IN GPM	CAPACITY TWO NOZZLES IN OZ./MIN.	GPA 30" 3 MPH	4 MPH	5 MPH	6 MPH	7 MPH	PSI	CAPACITY THREE NOZZLES IN GPM	CAPACITY THREE NOZZLES IN OZ./MIN.	GPA 30" 3 MPH	4 MPH	5 MPH	6 MPH	7 MPH
TXA800050VK TXB800050VK (100)	40	VF	0.10	13	6.6	5.0	4.0	3.3	2.8	40	0.15	19	9.9	7.4	5.9	5.0	4.2
	60	VF	0.12	15	7.9	5.9	4.8	4.0	3.4	60	0.18	23	11.9	8.9	7.1	5.9	5.1
	80	VF	0.14	18	9.2	6.9	5.5	4.6	4.0	80	0.20	26	13.2	9.9	7.9	6.6	5.7
	100	VF	0.15	19	9.9	7.4	5.9	5.0	4.2	100	0.22	28	14.5	10.9	8.7	7.3	6.2
	125	VF	0.16	20	10.6	7.9	6.3	5.3	4.5	125	0.25	32	16.5	12.4	9.9	8.3	7.1
TXA800067VK TXB800067VK (50)	40	VF	0.13	17	8.6	6.4	5.1	4.3	3.7	40	0.20	26	13.2	9.9	7.9	6.6	5.7
	60	VF	0.16	20	10.6	7.9	6.3	5.3	4.5	60	0.24	31	15.8	11.9	9.5	7.9	6.8
	80	VF	0.18	23	11.9	8.9	7.1	5.9	5.1	80	0.27	35	17.8	13.4	10.7	8.9	7.6
	100	VF	0.20	26	13.4	10.0	8.0	6.7	5.7	100	0.30	39	20	15.0	12.0	10.0	8.6
	125	VF	0.22	29	14.8	11.1	8.9	7.4	6.3	125	0.34	43	22	16.6	13.3	11.1	9.5
TXA8001VK TXB8001VK (50)	40	F	0.20	26	13.2	9.9	7.9	6.6	5.7	40	0.30	38	19.8	14.9	11.9	9.9	8.5
	60	VF	0.24	31	15.9	11.9	9.5	7.9	6.8	60	0.36	46	24	17.9	14.3	11.9	10.2
	80	VF	0.27	35	18.1	13.6	10.9	9.1	7.8	80	0.41	53	27	20	16.3	13.6	11.6
	100	VF	0.30	39	20	15.0	12.0	10.0	8.6	100	0.46	58	30	23	18.0	15.0	12.9
	125	VF	0.34	43	22	16.6	13.3	11.1	9.5	125	0.50	65	33	25	20	16.6	14.3
TXA80015VK TXB80015VK (50)	40	F	0.30	38	19.8	14.9	11.9	9.9	8.5	40	0.45	58	30	22	17.8	14.9	12.7
	60	F	0.36	47	24	18.0	14.4	12.0	10.3	60	0.55	70	36	27	22	18.0	15.5
	80	VF	0.42	53	28	21	16.5	13.8	11.8	80	0.63	80	41	31	25	21	17.7
	100	VF	0.46	60	31	23	18.4	15.3	13.1	100	0.70	89	46	35	28	23	19.7
	125	VF	0.52	66	34	26	20	17.1	14.6	125	0.78	99	51	38	31	26	22
TXA8002VK TXB8002VK (50)	40	F	0.40	51	26	19.8	15.8	13.2	11.3	40	0.60	77	40	30	24	19.8	17.0
	60	F	0.49	62	32	24	19.2	16.0	13.7	60	0.73	93	48	36	29	24	21
	80	VF	0.56	71	37	28	22	18.4	15.8	80	0.84	107	55	41	33	28	24
	100	VF	0.62	79	41	31	25	20	17.5	100	0.93	119	61	46	37	31	26
	125	VF	0.69	88	46	34	27	23	19.5	125	1.03	132	68	51	41	34	29
TXA8003VK TXB8003VK (50)	40	F	0.60	77	40	30	24	19.8	17.0	40	0.90	115	59	45	36	30	25
	60	F	0.73	94	48	36	29	24	21	60	1.10	141	73	54	44	36	31
	80	F	0.85	108	56	42	34	28	24	80	1.27	162	84	63	50	42	36
	100	VF	0.94	121	62	47	37	31	27	100	1.42	181	94	70	56	47	40
	125	VF	1.06	135	70	52	42	35	30	125	1.58	203	105	78	63	52	45
TXA8004VK TXB8004VK (50)	40	F	0.80	102	53	40	32	26	23	40	1.20	154	79	59	48	40	34
	60	F	0.98	125	65	48	39	32	28	60	1.47	188	97	73	58	48	42
	80	F	1.13	144	74	56	45	37	32	80	1.69	217	112	84	67	56	48
	100	VF	1.26	161	83	62	50	42	36	100	1.89	242	125	94	75	62	53
	125	VF	1.41	180	93	70	56	46	40	125	2.11	270	139	105	84	70	60

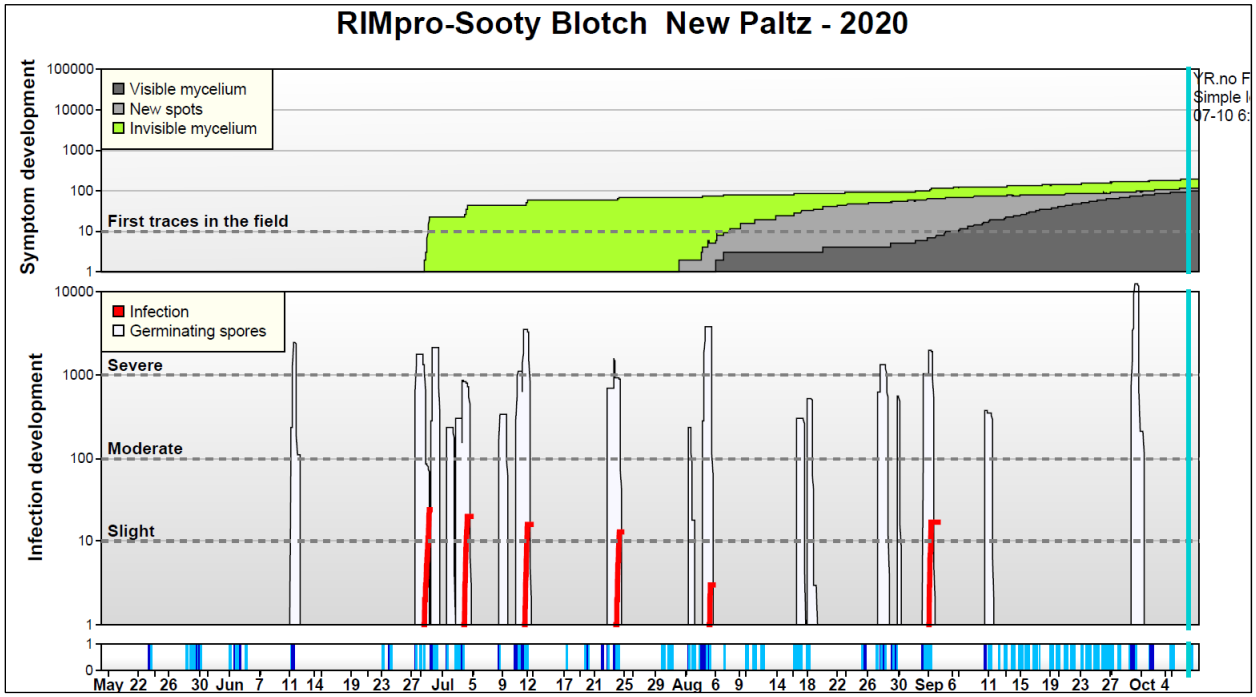
Note: Always double check your application rates. Tabulations are based on spraying water at 70°F (21°C). See pages 136–157 for useful formulas and other information.

Table 2. Maintenance spray applications of all chemicals used to protect trial integrity from other diseases and insects.

Date M/D/Y	Equipment	Material	Rate
3/31/2020	Unigreen Tower	Manzate Pro-Stick	3LB/A
4/7/2020	Unigreen Tower	Captan 80 WDG, Manzate Pro-Stick	3LB/A, 3LB/A
4/15/2020	Unigreen Tower	Biocover MLT	2% v.v.
4/15/2020	Unigreen Tower	Manzate Pro-Stick	3LB/A
4/25/2020	Unigreen Tower	Vanguard, Manzate Pro-Stick	5 oz/A, 3LB/A
5/2/2020	Unigreen Tower	Inspire Super, Manzate Pro-Stick, Warrior II	12 fl oz/A, 3LB/A
5/7/2020	Unigreen Tower	Merivon Xenium, Manzate Pro-Stick	5.5 fl/oz/A, 3LB/A
5/14/2020	Unigreen Tower	Topsin M WSB, Sercadis	1LB/A, 4.5 fl. oz/A
5/17/2020	Slimline	Agri-Mycin 50	8 oz/A
5/22/220	Unigreen Tower	Carbaryl 4L, Fruitone L (NAA)	1 qt/A, 7.5 ppm
5/24/2020	Unigreen Tower	Manzate Pro-Stick, Inspire Super, Warrior II	3lbA, 12 fl oz/A, 2.56 fl oz/A
5/25/2020	Unigreen Tower	Harbour	1.5 lb/A
5/26/2020	Unigreen Tower	Topsin M WSB	1 LB/A
6/1/2020	Unigreen Tower	Actara 25WG, Warrior II	5.5 oz/A, 2.56 fl oz/A
6/14/2020	Unigreen Tower	Warrior II, Avaunt	2.56 fl oz/A, 6 oz/A
6/16/2020	Unigreen Tower	Warrior II,	2.56 fl oz/A
6/29/2020	Unigreen Tower	Warrior II, Avaunt, Actara,	5.5oz/A, 6 oz/A, 2.56 fl oz/A
7/27/2020	Unigreen Tower	Asana XL	14.5 fl oz

Critical outputs from SB model in RIMpro: https://rimpro.eu/. Source: RIMpro Cloud Service: https://rimpro.eu/ (RIMpro B.V., Zoelmond, Netherlands). The first natural SB infection of the growing season was reported by RIMpro on 28 June 2020:





Critical outputs from NEWA's SBFS model: http://newa.cornell.edu/index.php?page=apple-diseases

State: New York

Weather station: Highland HVL 2

Date of Interest: 07/20/2020

Calculate

Sooty Blotch and Flyspeck Risk Predictions for Highland HVL 2

Petal fall date for McIntosh: 5/16/2020 Click if petal fall has not occurred

Petal fall date above is estimated based on degree day accumulations or user input.
Enter the actual date for blocks of interest and the model will calculate the accumulated leaf wetness hours since 10 days after petal fall more accurately.

Most recent fungicide application date: Click to enter

If petal fall has passed, enter the date of your most recent fungicide application.
If no fungicide applications have been made, do not enter a date.

In the Risk Summary table, note the accumulated leaf wetness hours since petal fall (Leaf Wetness Hours) and the Risk Level. Leaf wetness hours, rain events, and the last fungicide application date are taken into consideration in assessing risk level. To estimate risk in the near future, look at the probability of rain.

Consult the Risk Level IPM Guidelines below the **Risk Summary** table.

Sooty Blotch and Flyspeck Risk Summary - Northeastern US Model

	Past	Past	Current	Ensuing 5 Days				
Date	7/18	7/19	7/20	7/21	7/22	7/23	7/24	7/25
Days since petal fall	63	64	65	66	67	68	69	70
Accumulated Leaf Wetness Hours - ALWH	172	175	181	181	183	186	197	197
Risk Level	High	High	High	High	High	High	High	High
Rain Events								
Daily rain amount (inches)	0.00	0.27	0.03	0.00	0.08	0.06	0.02	0.00
Rain probability (%) Night|Day			- | -	- | -	- | -	- | -	- | -	- | -

NA - data not available. Download Time: 7/26/2020 23:00

State: New York

Weather station: Highland HVL 2

Date of Interest: 07/25/2020

Calculate

Sooty Blotch and Flyspeck Risk Predictions for Highland HVL 2

Petal fall date for McIntosh: 5/16/2020 Click if petal fall has not occurred

Petal fall date above is estimated based on degree day accumulations or user input.
Enter the actual date for blocks of interest and the model will calculate the accumulated leaf wetness hours since 10 days after petal fall more accurately.

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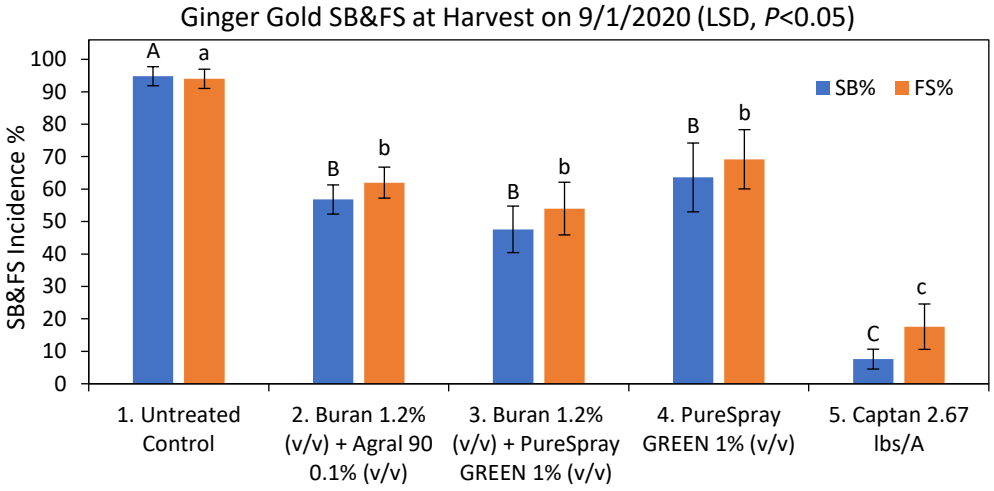
Consult the Risk Level IPM Guidelines below the **Risk Summary** table.

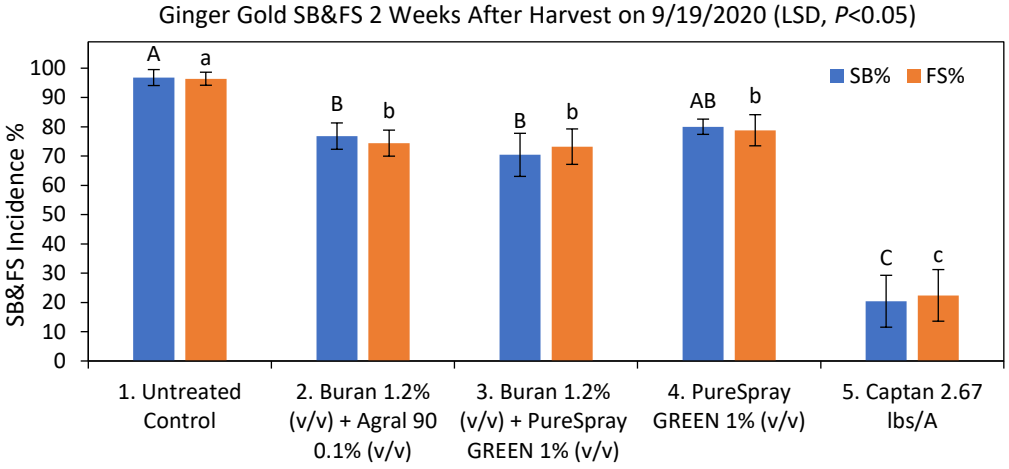
Sooty Blotch and Flyspeck Risk Summary - Northeastern US Model

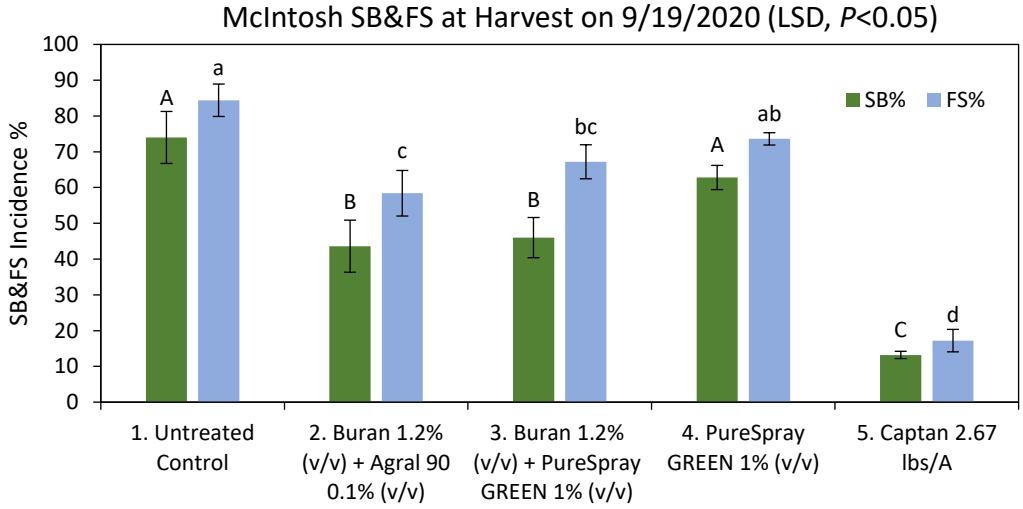
	Past	Past	Current	Ensuing 5 Days				
Date	7/23	7/24	7/25	7/26	7/27	7/28	7/29	7/30
Days since petal fall	68	69	70	71	72	73	74	75
Accumulated Leaf Wetness Hours - ALWH	186	197	197	197	197	197	197	205
Risk Level	High	High	High	High	High	High	High	High
Rain Events								
Daily rain amount (inches)	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.03
Rain probability (%) Night|Day			- | -	- | -	- | -	- | -	- | -	- | -

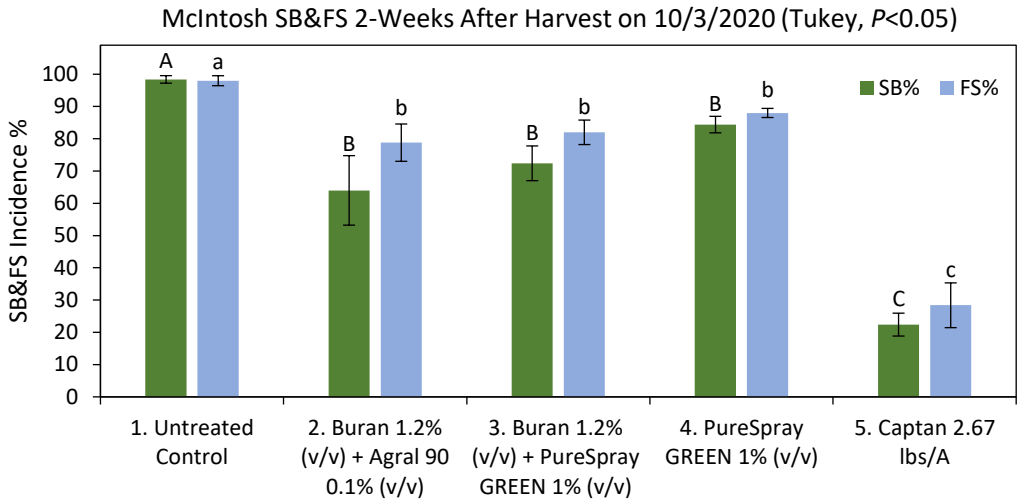
NA - data not available. Download Time: 7/31/2020 23:00

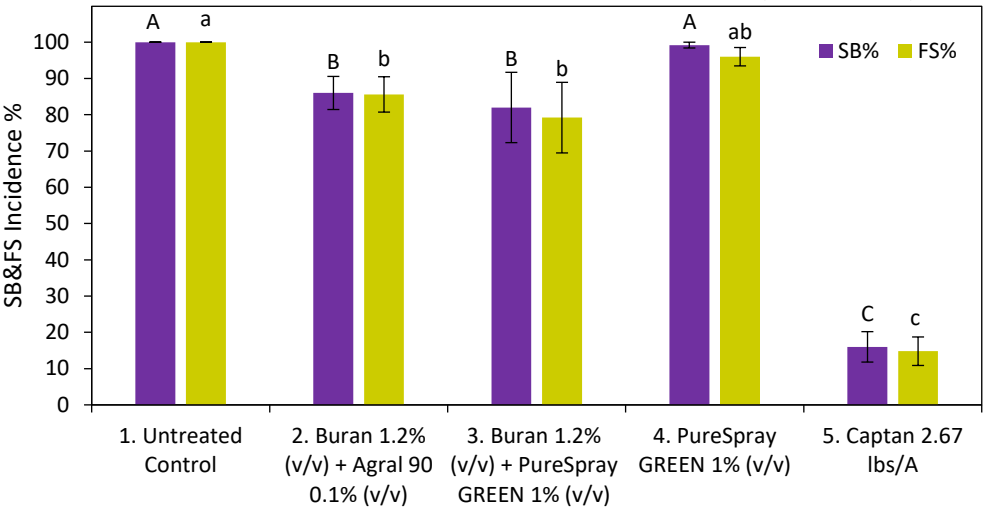
Results. (A) SB and FS incidence control. In all graphs, incidence means followed by different type of letters within the same disease i.e. bar color are significantly different ($p < 0.05$). Error bars represent standard error of the mean (SEM). Each mean consists of 5 replicate trees.

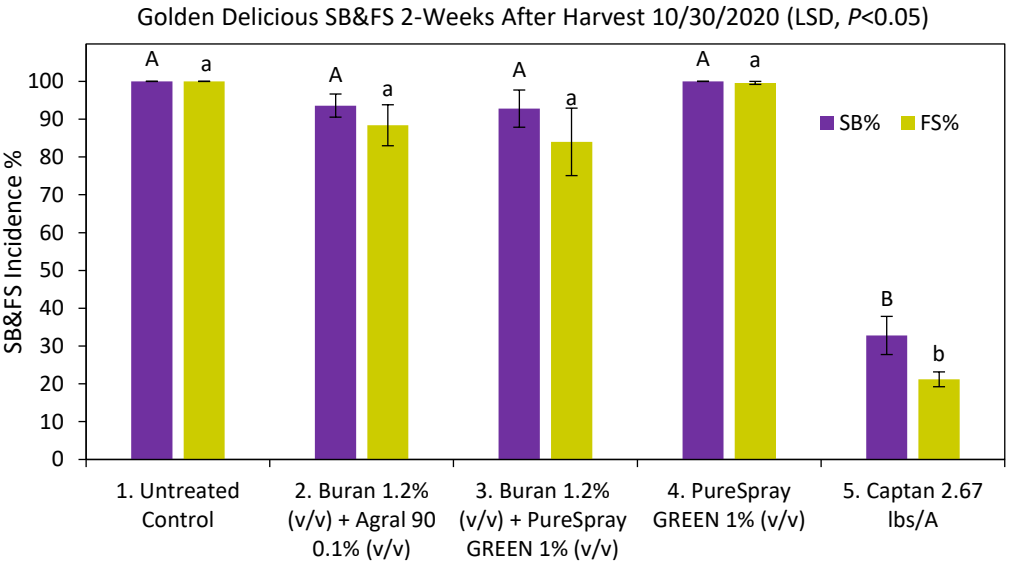




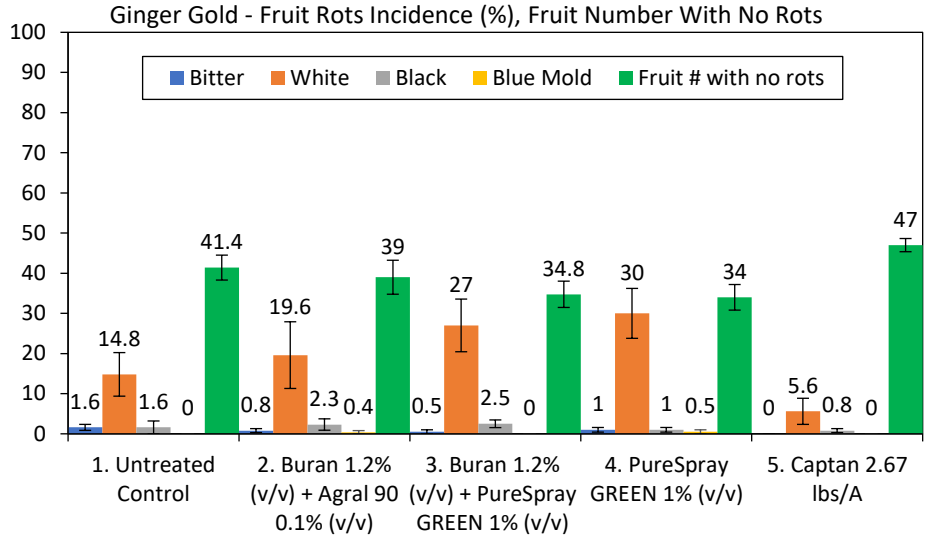


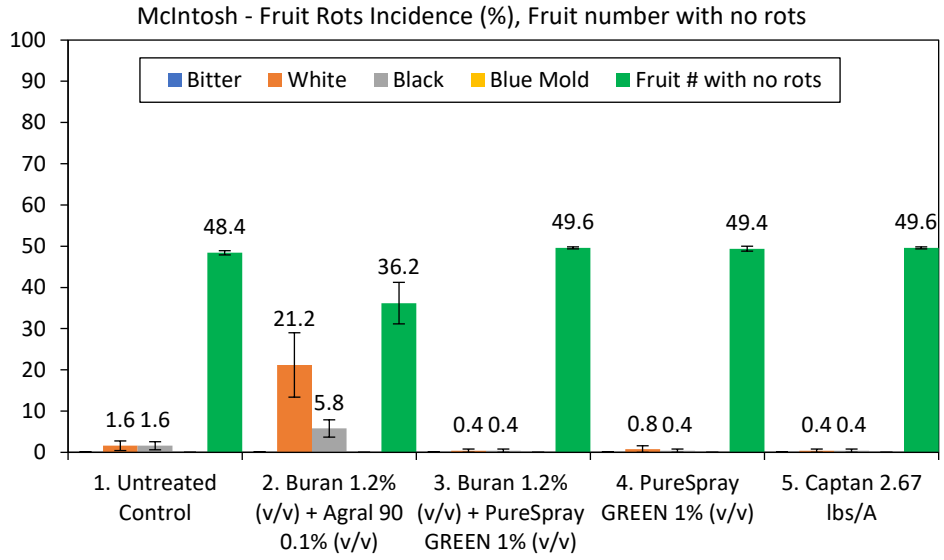

McIntosh SB&FS 2-Weeks After Harvest on 10/3/2020 (Tukey, P<0.05)
SB&FS Incidence %
SB%
FS%
1. Untreated Control
2. Buran 1.2% (v/v) + Agral 90 0.1% (v/v)
3. Buran 1.2% (v/v) + PureSpray GREEN 1% (v/v)
4. PureSpray GREEN 1% (v/v)
5. Captan 2.67 lbs/A

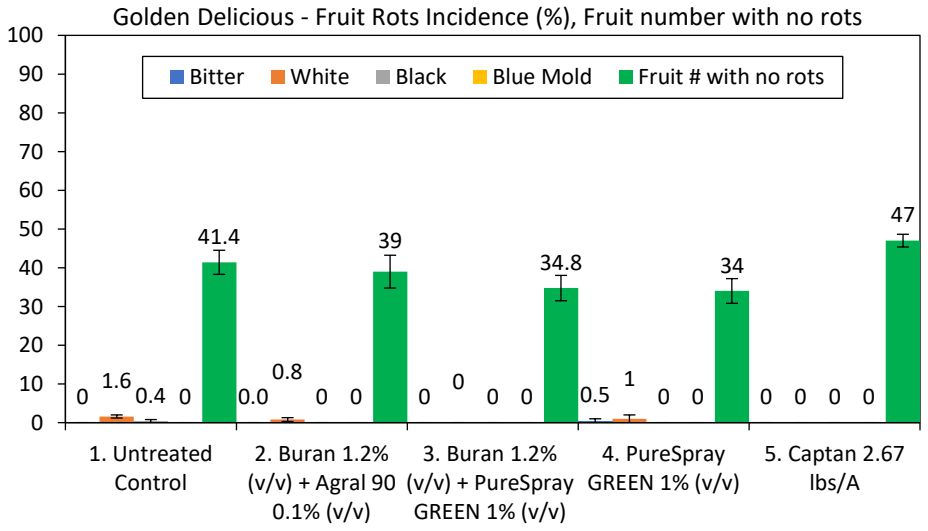

Golden Delicious SB&FS at Harvest on 10/16/2020 (LSD, P<0.05)
SB&FS Incidence %
SB%
FS%
1. Untreated Control
2. Buran 1.2% (v/v) + Agral 90 0.1% (v/v)
3. Buran 1.2% (v/v) + PureSpray GREEN 1% (v/v)
4. PureSpray GREEN 1% (v/v)
5. Captan 2.67 lbs/A

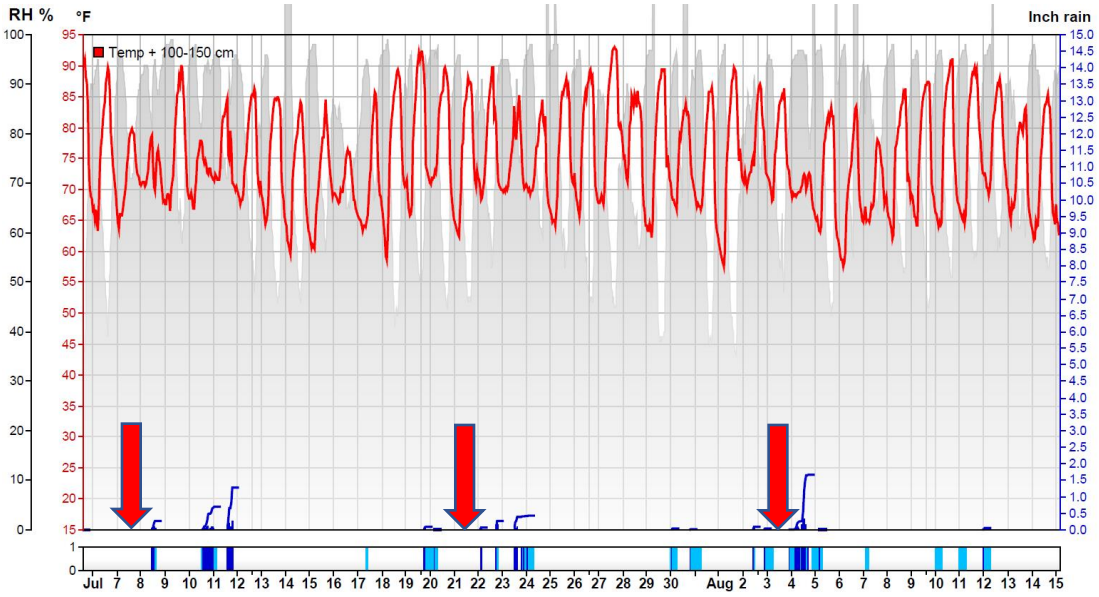

Golden Delicious SB&FS 2-Weeks After Harvest 10/30/2020 (LSD, P<0.05)
SB&FS Incidence %
SB%
FS%
1. Untreated Control
2. Buran 1.2% (v/v) + Agral 90 0.1% (v/v)
3. Buran 1.2% (v/v) + PureSpray GREEN 1% (v/v)
4. PureSpray GREEN 1% (v/v)
5. Captan 2.67 lbs/A

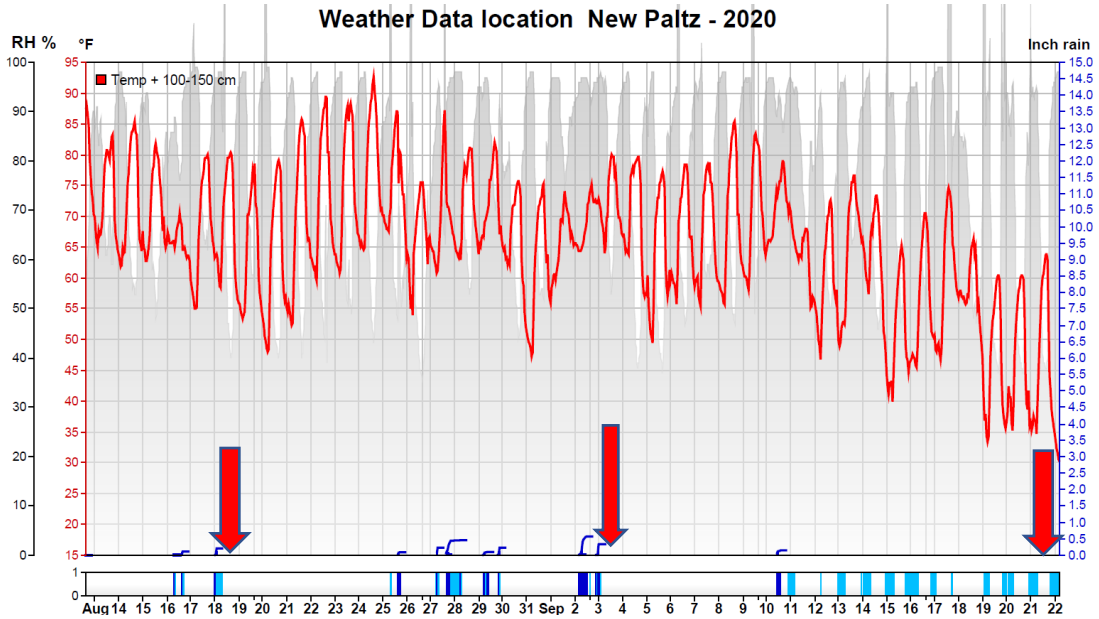
(B) Fruit rots and amount of fruit with no rots (statistical analysis not performed due to trends):

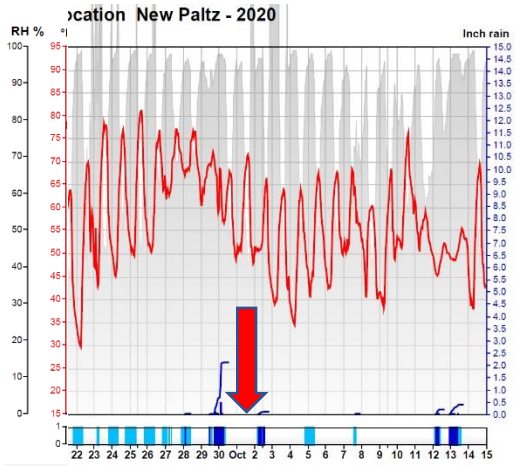












Red arrows indicate spray dates:
7/7/2020 – at 135 ALWH counting from PF
7/21/2020 – at 181 ALWH counting from PF
8/3/2020
8/18/2020
9/3/2020
9/21/2020
10/1/2020

Results and interpretation. On Ginger Gold, Buran in mix with Agral 90 or Pure SprayGreen significantly reduced SB&FS at harvest and 2-weeks after harvest, however, the disease incidence in both Buran treatments was economically unacceptable leading to fruit losses of 48 to 62% at harvest and 70 to 77% 2-weeks after harvest. On McIntosh, the pattern and significant effects were similar for Buran mixes, except that Pure SprayGreen alone (#4) gave statistically significant SB reduction only at harvest and SB&FS reduction 2-weeks after harvest. Similar reduction trend in Buran treatments was observed on late maturing 'Golden Delicious' at harvest, but this effect vanished 2 weeks postharvest. Due to lack of enough rain events from mid-July till 20 August, effectively creating drought conditions, SB&FS was significantly delayed in infecting and expressing its symptoms in 2020 on the early-maturing 'Ginger Gold' and mid-term maturing 'McIntosh', but by the last week of August and into September, rain and due events allowed severe SB&FS infections of late maturing 'Golden Delicious', which led to 100% incidence on fruit in untreated control. Consistently through both harvest and postharvest ratings, Grower standard, provided the best SBFS control but still allowed 1.2 to 11.9% SB incidence and 3.2 to 22.8% FS incidence. Captan provided the best SBFS control but still allowed 7.6 to 32.8% SB incidence and 14.8 to 28.4% FS incidence. This imperfect control by captan is likely due to the combination of multiple factors: (a) lower rate of 2.67 lb/A used according to captan label in Canada in comparison to the $\geq$ 3 lb/A recommended when captan is used alone, (b) a contact nature of this fungicide, and (c) a known fact that FS fungi can grow through a bit more fungicides residues than SB can. In addition, more SB and FS incidence detected on Golden Delicious in captan spray program could be due to the rain events on 29-30 Sep totaling to a 2.6 inches that severely reduced or completely washed off captan residues allowing some SBFS infections (depending on weather conditions, the application on 1 Oct was the last on cv. Golden Delicious before harvest on 16 Oct, the spray application on 18 Aug was the last for cv. Ginger Gold before harvest on 1 Sep, and the application on 3 Sep was the last on cv. McIntosh before harvest on 19 Sep). Please see more detailed weather data below. Statistical analysis was not performed for fruit rots as no interesting trends were visible indicating that the weather conditions during summer 2020 were not favorable for natural infections of any endemic fruit rot fungi. This is likely due to the drought conditions interspersed with very small amounts of rain in July and August and the data incidence trends point to the effect of drought on both SB&FS and fruit rots. However, fruit rots require to build up inoculum in the orchard during the early and late spring to allow severe infections over the summer and this was not possible due to applied fungicides for apple scab and cedar apple/quince rust early in the spring and drought from mid-July till 20 August. This buildup of inoculum in orchard was not needed for SB&FS as the abundant infection sources are present in woodlots around outside the trial apple orchard.

Report compiled by Dr. Srdjan G. Acimovic, plant pathologist at Cornell University's Hudson Valley Research Laboratory, from: 10/1/2020 – 11/10/2020. Detailed weather data records for Highland NY during 2020 can be accessed at http://newa.cornell.edu/index.php?page=all-weather-data. This report will be available from October 2020 on this link: http://blogs.cornell.edu/acimoviclab/pesticide-efficacy-trials/.