

# Management of rusts and other diseases in organically-grown scab-resistant apple cultivars with biopesticides and copper

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THE 78TH ANNUAL NEW ENGLAND, NEW YORK AND CANADIAN FRUIT PEST MANAGEMENT WORKSHOP  
OCTOBER 18-19, 2016  
BISHOP BOOTH CONFERENCE CENTER, BURLINGTON, VT



# Treatment schedule

Act=Actinovate AG @ 12 oz/A

Cuv=Cuveva @ 2 gal/A

DnC=Double Nickel LC @ 3qts/A

Ser=Serenade Max @ 3 lb/A



Five replicates/treatment RCBD  
All eight cultivars in each replicate\*\*\*

TRT #	Pink	Petal Fall	1st Cover	2nd Cover	3rd Cover	4th Cover
1	Control- No Treatment					
2	Cuv	Cuv	Cuv	Cuv	Cuv	Cuv
3	Act	Act	Act	Act	Act	Act
4	DnC	DnC	DnC	DnC	DnC	DnC
5	Ser	Ser	Ser	Ser	Ser	Ser
6	Act	Cuv	Act	Cuv	Act	Cuv
7	DnC	Cuv	DnC	Cuv	DnC	Cuv
8	Ser	Cuv	Ser	Cuv	Ser	Cuv

# Treatment map

UVM Horticulture Research Center

Orchard 4 (Trellised Vertical Axis Planting, planted 2011)

2015 Biofungicide Organic Apples Project

South

Rows	1	2	3	4	5	6	7	8
<b>Sect.</b>								
12	12	24	36	48	60	72	84	96
11	11	23	35	47	59	71	83	95
10	10	22	34	46	58	70	82	94
9	9	21	33	45	57	69	81	93
8	8	20	32	44	56	68	80	92
7	7	19	31	43	55	67	79	91
6	6	18	30	42	54	66	78	90
5	5	17	29	41	53	65	77	89
4	4	16	28	40	52	64	76	88
3	3	15	27	39	51	63	75	87
2	2	14	26	38	50	62	74	86
1	1	13	25	37	49	61	73	85




# Assessed parameters

- Foliar disease incidence & severity
  - Rust, necrotic leaf spot, clean of disease
- Fruit disease incidence and abiotic (?) faults
  - Rust, rots, sooty blotch, flyspeck, Brooks spot
  - Lenticel spotting, russet, US#1 grade
- Yield parameters
  - Fruit weight, number of fruit on tree at harvest, total kg fruit, percent dropped fruit





# Treatment effects on foliar disease

trt	n lvs on terminal	% lvs no disease	% lvs w/ rust infected leaf	n rust lesions / rust infected leaf	% lvs w/ FELS	n FELS lesions / infected leaf
NTC						
Cueva						
Actinovate						
Double Nickel 55						
Serenade						
Actinovate/Cueva						
Double Nickel 55 / Cueva						
Serenade / Cueva						
trt						
trt*cvr						

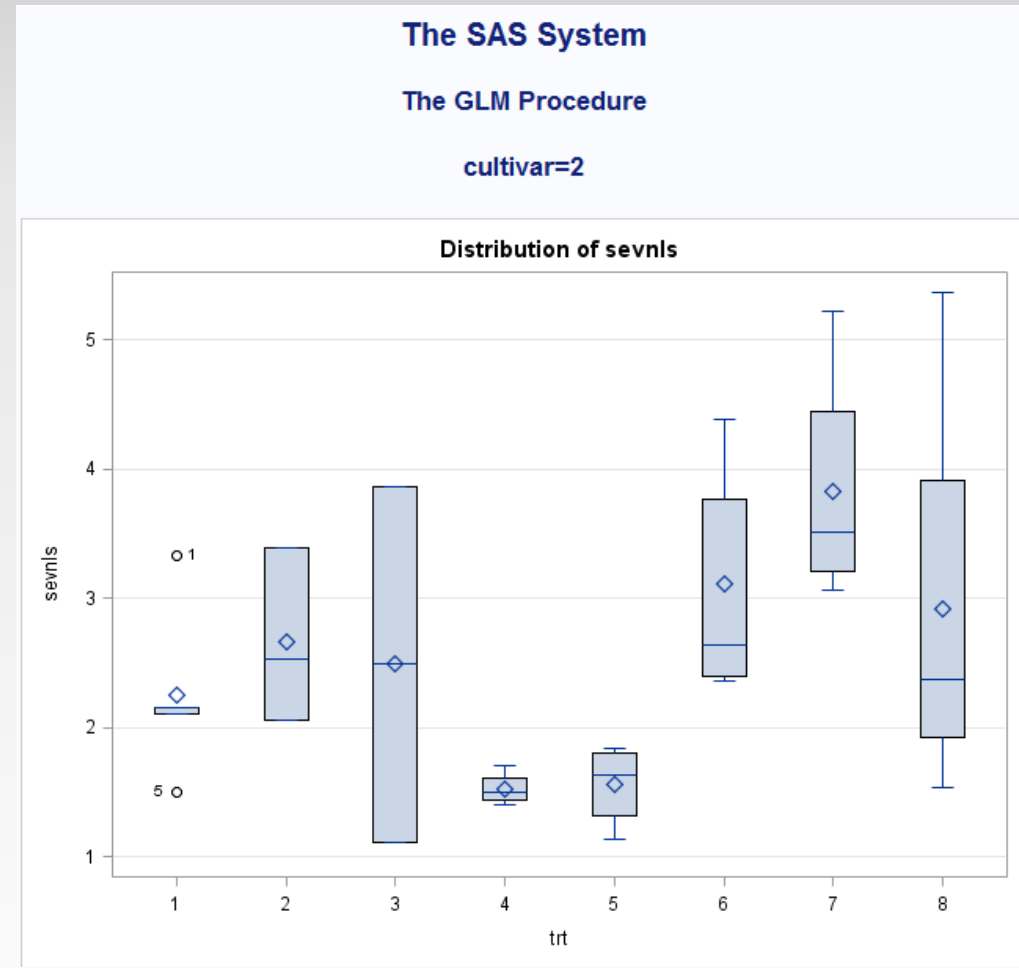
# Treatment effects on foliar disease

trt	n lvs on terminal	% lvs no disease	% lvs w/ rust infected leaf	n rust lesions / rust infected leaf	% lvs w/ FELS	n FELS lesions / infected leaf
NTC	19.6ab	34.5	43.5a	4.3a	11.1	1.5c
Cueva	17.3b	33.6	31.3b	3.1b	15.9	2.2ab
Actinovate	19.8ab	35.4	39.2ab	3.9a	12.7	1.6bc
Double Nickel 55	21.0a	30.1	39.9ab	4.1a	11.4	1.9abc
Serenade	18.6ab	31.8	38.6ab	3.9a	13.3	1.6bc
Actinovate/Cueva	19.2ab	36.3	31.7b	3.8ab	13.2	2.1abc
Double Nickel 55 / Cueva	19.9ab	37.6	34.8b	3.8ab	13.2	2.3a
Serenade / Cueva	19.1ab	30.5	31.6b	3.7ab	14.1	1.9abc
trt	<b>0.0244</b>	0.1636	<b>0.0001</b>	<b>0.0001</b>	0.2278	<b>0.0005</b>
trt*cvr	0.9705	0.8892	0.4695	0.1404	0.0116	<b>0.0001</b>



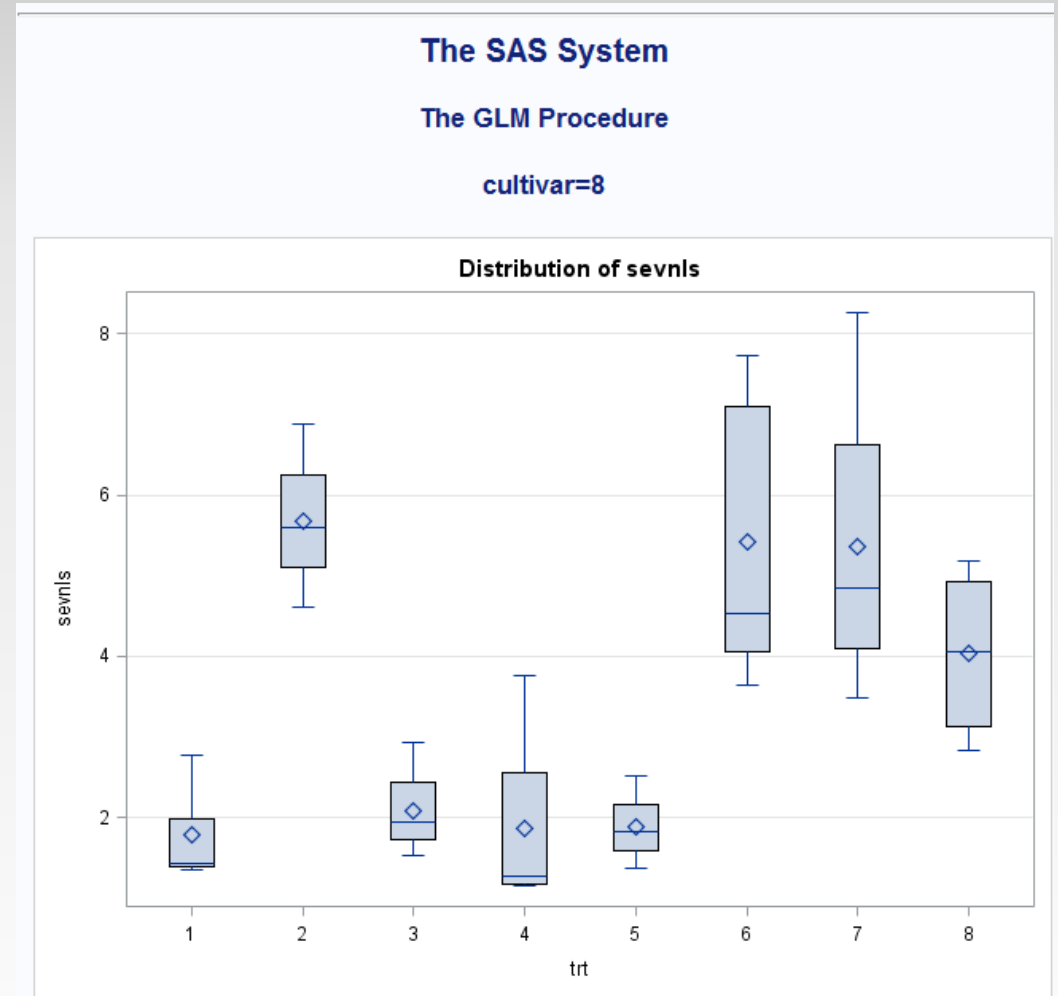
# Treatment effects on necrotic leaf spot severity for cultivars with significant trt\*cvr interaction

trt	n nls lesion / infected leaf
<b>NTC</b>	<b>2.3ab</b>
<b>Cueva</b>	<b>2.7ab</b>
<b>Actinovate</b>	<b>2.5ab</b>
<b>Double Nickel 55</b>	<b>1.5b</b>
<b>Serenade</b>	<b>1.6b</b>
<b>Actinovate/Cueva</b>	<b>3.1ab</b>
<b>Double Nickel 55 / Cueva</b>	<b>3.8a</b>
<b>Serenade / Cueva</b>	<b>2.9ab</b>
<b>trt</b>	<b>0.0300</b>



# Treatment effects on necrotic leaf spot severity for cultivars with significant trt\*cvr interaction

trt	n nls lesion / infected leaf
<b>NTC</b>	<b>1.788b</b>
<b>Cueva</b>	<b>5.674946a</b>
<b>Actinovate</b>	<b>2.082421b</b>
<b>Double Nickel 55</b>	<b>1.868333b</b>
<b>Serenade</b>	<b>1.880179b</b>
<b>Actinovate/Cueva</b>	<b>5.412661a</b>
<b>Double Nickel 55 / Cueva</b>	<b>5.361563a</b>
<b>Serenade / Cueva</b>	<b>4.030714ab</b>
<b>trt</b>	<b>0.0001</b>





# Treatment effects on fruit disease, defects, and grade

trt

NTC

Cueva

Actinovate

Double Nickel 55

Serenade

Actinovate/Cueva

Double Nickel 55 /  
Cueva

Serenade / Cueva

trt

trt\*cvr

rust



rot



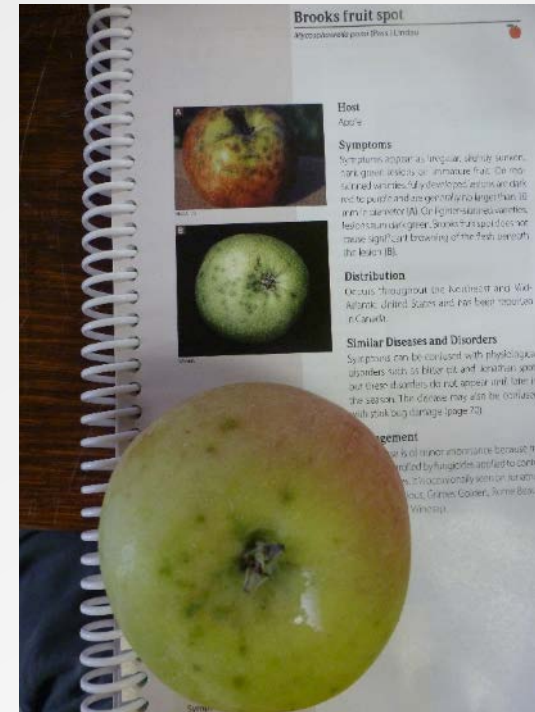
sb



fs



brooks



lentsp

russet

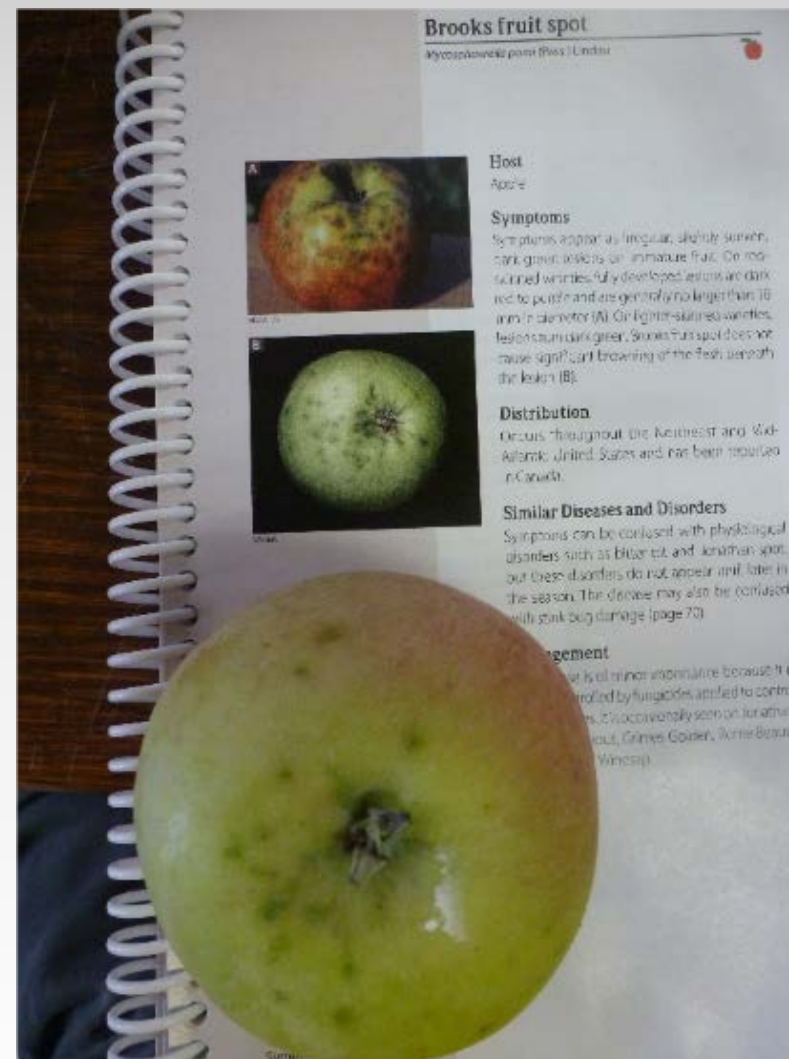
us1 grade

# Treatment effects on fruit disease, defects, and grade

trt	rustf	rot	sb	fs	brooks	lentsp	russet	us1all
<b>NTC</b>	22.1a	4.2a	38.8a	52.4a	21.8a	23.9a	19.5c	35.5abc
<b>Cueva</b>	8.7c	1.6ab	12.6c	28.3b	3.5d	3.5c	61.9a	25.3c
<b>Actinovate</b>	20.3ab	5.1ab	22.3bc	40.2a	11.6bc	23.5a	22.3c	41.8abc
<b>Double Nickel 55</b>	17.4bc	5.2ab	24.4abc	28.0b	12.6bc	15.6abc	20.4c	50.8a
<b>Serenade</b>	21.6a	3.7ab	38.1ab	49.0a	17.2ab	22.7a	15.4c	37.4bc
<b>Actinovate/Cueva</b>	10.3bc	1.0b	12.9c	25.2b	7.1cd	12.8bc	41.0b	38.7bc
<b>Double Nickel 55 / Cueva</b>	10.2bc	3.4ab	18.5c	34.6b	5.1cd	8.6bc	45.1b	43.8ab
<b>Serenade / Cueva</b>	7.9c	2.2ab	29.3ab	49.9a	7.2cd	19.3ab	44.8b	31.3bc
<b>Trt</b>	0.0001	0.0357	0.0001	0.0001	0.0001	0.0001	0.0001	0.0007
<b>Cvr</b>	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
<b>Trt*cvr</b>	0.4531	0.2497	0.8554	0.3128	0.0424	0.0001	0.0015	0.0015

# Treatment effects by cultivar for Brooks spot

trt	Crimson Gold	Crimson Topaz	Liberty	Fl Querina
NTC	20.0ab	30.0a	28.0ab	34.0b
Cueva	0.0ab	2.5b	0.0c	5.0a
Actinovate	5.0ab	18.8ab	16.7abc	19.1ab
Double Nickel 55	20.0ab	12.5ab	33.0abc	11.3ab
Serenade	20.0a	17.5ab	34.2a	23.8ab
Actinovate/Cueva	0.0b	14.0ab	8.0abc	12.0ab
Double Nickel 55 / Cueva	3.8ab	5.0b	1.4bc	13.8ab
Serenade / Cueva	2.5ab	15.0ab	3.9abc	10.0ab
	<b>0.0105</b>	<b>0.0172</b>	<b>0.0029</b>	<b>0.0228</b>



# Treatment effects by cultivar for lenticel spotting

trt	Crimson Crisp	Crimson Topaz	Galarina	Liberty
NTC	47.2ab	44.0a	73.0a	2.0b
Cueva	10.1b	7.5abc	5.0b	0.0b
Actinovate	91.7a	28.8abc	52.5ab	4.2ab
Double Nickel 55	51.5ab	12.5abc	52.5ab	1.9ab
Serenade	38.3ab	33.8ab	65.3a	17.5a
Actinovate/Cueva	38.7ab	6.0c	35.4ab	0.0b
Double Nickel 55 / Cueva	23.8ab	6.3bc	35.0ab	0.0b
Serenade / Cueva	82.1a	12.5abc	45.0ab	0.0b
trt	0.0232	0.0023	0.0032	0.0036



# Treatment effects by cultivar for russeting

trt	Crimson Gold	Galarina	Liberty	Fl Querina
NTC	20.0b	0.0c	4.0d	8.0b
Cueva	80.0a	31.3a	83.3a	85.0a
Actinovate	16.7c	3.8abc	8.3cd	12.2b
Double Nickel 55	15.0c	2.5abc	5.2cd	16.3b
Serenade	15.0c	0.0c	9.6cd	7.5b
Actinovate/Cueva	82.0a	9.7abc	32.0bc	24.0b
Double Nickel 55 / Cueva	66.3b	20.0abc	61.4ab	31.5b
Serenade / Cueva	56.3b	10.0ab	58.9ab	26.3b
trt	0.0001	0.0001	0.0001	0.0001





# Treatment effects on fruit weight and crop yield

trt	frtwt	ntree	kgtree	ndrop	kgdrop	kgtot	pctdrop
NTC	135.0ab	30.1	3.7	12.0	1.5	5.4	18.5
Cueva	129.9ab	34.6	4.2	12.7	1.3	5.5	16.7
Actinovate	144.2ab	33.4	4.5	8.2	1.0	5.5	17.8
Double Nickel 55	133.6ab	26.5	3.0	11.8	1.3	4.9	16.3
Serenade	146.5a	29.5	4.1	8.6	1.1	5.2	15.7
Actinovate/Cueva	133.3ab	28.2	3.5	11.7	1.3	4.8	15.9
Double Nickel 55 / Cueva	126.5b	33.5	3.8	8.4	1.0	5.0	14.6
Serenade / Cueva	138.5ab	32.2	4.2	6.9	0.9	5.1	16.7
trt	<b>0.0115</b>	0.3911	0.0706	0.3074	0.4024	0.8556	0.7546
trt*cvr	0.5746	0.938	0.6473	0.7819	0.8384	0.8253	0.1988

# Conclusions

- Cueva (copper octanoate):
  - Reduced foliar rust incidence & severity
  - Phytotoxicity?
    - Reduced terminal leaf number
    - Increased necrotic leaf spot severity w. Double Nickel55
    - Reduced fruit weight w/ Double Nickel 55
  - Improved control of most fruit diseases over NTC and biologicals
    - Rust, sooty blotch, flyspeck, brooks rot
    - Generally better alone (full-season, full-rate)
  - Fruit finish problems
    - Increased russeting
    - Decreased US#1 grade



# Conclusions

- Biologicals
  - Rarely effective on their own
  - Actinovate:
    - Sooty blotch, Brooks spot
  - Double Nickel 55:
    - Fruit rust, flyspeck, Brooks spot, fruit grade
  - Serenade
    - Increased fruit weight over Double Nickel 55 + Cueva
- Rotation with copper tended to have similar but lesser disease control effects than full copper treatment

