Minimizing Fruit Russet and Captan Injury on Apples

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Causes of fruit russet

- Frost
- Copper or other chemicals
- Powdery mildew (Susceptibility varies by cultivar)
- *Aureobasidium pullulans*

> *Most common leaf epiphyte on apples*

Andrews, J.H. Spear, R.N., and Nordheim, E.V. 2002. Population biology of *Aureobasidium pullulans* on apple leaf surfaces. Can. J. Microbiol 48:500-513. (and 17 related articles on *A. pullulans*).

> *Suppressed by some fungicides, but not fully controlled by any fungicides.*

> *Identified as a cause of fruit russet*

Heidenreich, M.C.M, Corral-Garcia, M.R., Momol, E.A., and Burr, T. J. 1997. Russet of apple fruit caused by *Aureobasidium pullulans* and *Rhodotorula glutinis*. Plant Disease 81(4):337-342.

> *A. pullulans* is probably the major cause of russet on Golden Delicious, Ginger Gold, SweeTango, Arlet, and other russet susceptible cultivars.

Frost rings on apples and pears

Frost damage where frozen petals touched and damaged fruit

Russet on Golden Delicious presumably caused by *A. pullulans*.

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Factors favoring severe russet by *A. pullulans*

- Susceptible cultivar.
- Extended wetting with limited rainfall between full bloom and 2nd cover.
  - > Dry weather presumably does not allow *A. pullulans* to multiply.
  - > Heavy rains may remove both *A. pullulans* and the surface nutrients it needs to thrive.
- Lack of fungicide protection.

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Impact of fungicides on russet

Results from a field trial at Highland in 2009.

Table 1. Spray timing and effects of treatments on fruit out-of-grade due to russet in a 2009 trial at Highland, NY

	Spray timing dates[y]				Fruit (%) out-of-grade: russet[x]	
Fungicide and amount/100 gal	4/30 bloom	5/8 PF	5/20 1C	5/30 2C	Ginger Gold	Golden Delicious
1. Control	--	--	--	--	**n.d.**[w]	**77.0 b**
2. Dithane 75 DF 1 lb	Dth[z]	Dth	Dth	Dth	16.2 ab[v]	34.0 a
3. Rally 40WSB 1.33 oz (2 times	Dth	X	X			
Captan 80WDG 10 oz		Capt	Capt[z]	Capt	14.6 a	47.5 a
4. Inspire Super 338 SE 3.97 fl oz (2 times)	**Dth**	**X**	**X**	**Capt**	**70.3 c**	**79.2 b**
5. Inspire Super 338SE 3.97 fl oz (3 times)	X	X		X		
Dithane 75 DF 1 lb	Dth	Dth	Capt		28.4 b	46.7 a
6. Inspire Super 338SE 3.97 fl oz (1 time)	Dth	Dth	Capt	X	22.5 ab	43.7 a

[z] Dth = Dithane 75DF 1 lb/100 gal; Capt = Captan 80WDG 10 oz/100 gal.

[x] Fruit that failed to meet the standards for USDA Extra Fancy grade because of russet.

[w] No data: fruit were too severely diseased to allow rating for russet.

[v] Means followed by the same letter are not significantly different (Fishers Protected LSD, $P \leq 0.05$).

Trt #4 had no contact fungicide at PF or 1st cover.
Fruit had severe russet, as did control fruit.

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One of the new biocontrols for fire blight consists of *A. pullulans*

Blossom Protect™

A BIOLOGICAL AGENT FOR PREVENTING FIRE BLIGHT IN POME FRUITS

Active Ingredients:
Aureobasidium pullulans strain DSM 14940*..... 25.8%
Aureobasidium pullulans strain DSM 14941*..... 25.8%
Other Ingredients:.....48.4%
Total.....100.0%

*Contains a minimum of 8.8 x 10^8 cfu/gram of active ingredient.

KEEP OUT OF REACH OF CHILDREN

CAUTION

EPA Reg. No. 86174-4
EPA Est. No. 86174-AUT-001

Net Contents: 2.5 Lbs (1.1 kg)

Application Instructions: Apply the spray mixture while maintaining agitation. Use the prepared Blossom Protect Spray Mixture within 8 hours after tank-mixing. Four applications provide optimum protection against Fire Blight. Spray Blossom Protect at 10%, 40%, 70%, and 90% open flower, according to the BBCH-scale: BBCH 61-69. Apply Blossom Protect to thoroughly wet the blossoms and foliage. For susceptible varieties, the product may, in some seasons, enhance russeting when applied during late blossom. For application rates refer to the Application Table below. Apply as a foliar

Compatibility: Not all chemicals or fertilizers can be mixed with Blossom Protect during application. Check with your state agricultural extension specialist before mixing with pesticides. When tank-mixing Blossom Protect with any other products, always read and follow all use directions, restrictions, and precautions of both Blossom Protect and the tank-mix partner(s). The resulting tank mix must be in accordance with the most restrictive of labeling limitations and precautions of all products used in mixtures. Do not exceed label dosage rates. For further product compatibility information, contact Westbridge Agricultural Products.

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Trial to evaluate impacts of Blossom Protect on fruit russet

Table 1: Timing of BP sprays and fungicides applied during bloom in 2013.

Treatments (italics indicate copper treatments)	3 May 10% bloom	6 May 40% bloom	7 May air-blast	8 May 80% bloom	15 May air-blast	15 May after V-R* trt
1. Control: no blight or russet suppression			V*		V-R	
2. Control: no russet suppression		FW*	V		V-R	
3. Manzate + Fire Wall standard trt		Mz+FW*	V		V-R	Mz
4. Manzate + Fire Wall standard trt		Mz+FW	V		V-R	Mz
5. BP (2-sprays) // Manzate (2 sprays)	**BP***	**BP**	V	Mz*	V-R	Mz
6. BP (2 sprays)	**BP**	**BP**	V		V-R	
7. BP (4 spring sprays)	**BP**	**BP**	V	**BP**	V-R	**BP**
8. BP (3-sprays)	**BP**	**BP**	V	**BP**	V-R	
9. BP (3-sprays) // Manzate (1 spray)	**BP**	**BP**	V	**BP**	V-R	Mz
10. Manzate (1 spray) // BP (2 sprays)		Mz	V	**BP**	V-R	**BP**
11. Phyton 27AG 1.92L 25 fl oz/100gal		*X*	*V*		*V-R*	*Mz*
12. MagnaBon CS2005 1.79L 25.6 fl oz/100 gal		*X*	*V*		*V-R*	*Mz*
13. Cueva Fung. Conc 10%L 77.2 fl oz/100 gal		*X*	*V*		*V-R*	*Mz*

V = Vangard 50W 5 oz/A, V-R = Vangard 5 oz/A plus Rally 40WSB 6 oz/A, InsSup = Inspire Super 2.83EW 12 fl oz/A, FW = Fire Wall 17WP 8 oz/100 gal, Mz = Manzate 75DF 1 lb/100 gal, BP = Blossom Protect, X = the listed product was applied.

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Trial to evaluate impacts of Blossom Protect on fruit russet

Table 4: Impact of blossom sprays on fruit russet evident on Golden Delicious fruit that were evaluated 8 Aug.

Material and amount of formulated product per 100 gal of spray	Fruit (%) with russetting that exceeded standards for USDA Extra Fancy grade[z]	Golden Delicious fruit affected by russet			
		Fruit (%) with russet[y]		Russetted area (%)[x]	
		Stem end	Calyx end	Stem end	Calyx end
1. Control: no blight or russet suppression	29.5 bcde[w]	15.0	33.6 bcd	4.7	10.2 abc
2. Control: no russet suppression	33.1 bcde	14.9	35.0 abcd	4.2	12.3 abc
3. Manzate + Fire Wall standard trt	10.5 a	14.1	11.9 a	3.8	3.2 a
4. Manzate + Fire Wall standard trt	15.8 ab	6.0	22.8 ab	1.7	6.1 a
5. BP (2-sprays) // Manzate (2 sprays)	15.0 ab	5.3	23.3 ab	1.4	6.8 a
6. BP (2 sprays)	23.2 abcd	16.4	30.3 abcd	5.0	9.4 abc
7. BP (4 spring sprays)	38.2 cde	21.8	46.6 d	6.5	16.5 cd
8. BP (3-sprays)	37.3 cde	21.0	43.5 d	7.1	15.0 cd
9. BP (3-sprays) // Manzate (1 spray)	46.0 e	22.5	47.9 d	7.5	21.5 d
10. Manzate (1 spray) // BP (2 sprays)	41.1 de	26.1	43.5 cd	8.0	15.6 bcd
11. Phyton 27AG 25 fl oz[x]	19.8 *ab*	14.0	21.8 *ab*	*4.1*	*6.7 a*
12. MagnaBon CS2005 25.6 fl oz	16.6 *ab*	10.7	18.7 *ab*	*2.9*	*5.1 a*
13. Cueva Fungicide Concentrate 77.2 fl oz	21.3 *abc*	11.7	24.9 *abc*	*4.1*	*7.5 ab*
P-values	0.003	0.086	0.009	0.057	0.005

[z] Percentage of fruit that, when rated for surface russet, did not meet the criteria for USDA Extra Fancy grade.

[y] Percentage of fruit that, when viewed from either stem end or calyx end, had visible russet.

[x] Estimated percentage of the fruit surfaces covered with russet when fruit were viewed from either the stem or calyx ends. Means include fruit that had no russet at all.

[w] Means followed by the same letter are not significantly different (Fishers Protected LSD, $P \leq 0.05$).

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Trial to evaluate impacts of Blossom Protect on fruit russet

Table 5. Impact on fruit russet on Golden Delicious when comparing five pairs of similar treatments.

Material and amount of formulated product per 100 gal of spray	Fruit (%) with russetting that exceeded standards for USDA Extra Fancy grade[z]	Golden Delicious fruit affected by russet			
		Fruit (%) with russet[y]		Russetted area (%)[x]	
		Stem end	Calyx end	Stem end	Calyx end
Controls: no Manzate or BP (Treatments 1 and 2 combined)	31.3 bc	14.9 abc	34.3 bc	4.4 abc	11.3 bc
Manzate on 6 May, no BP (Treatments 3 and 4 combined)	13.1 a	10.1 a	17.4 a	2.7 a	4.6 a
BP on 3 & 6 May only (Treatments 5 and 6 combined)	19.1 ab	11.9 a	26.8 ab	3.2 a	8.1 ab
BP on 8 May; no Manzate) (Treatments 7 & 8 combined)	37.7 cd	20.9 bc	45.1 c	6.8 bc	15.7 cd
BP on 8 May + one Manzate) (Treatments 9 & 10 combined)	43.6 d	24.3 c	45.7 c	7.7 c	16.6 d
Copper sulfate treatments (Treatments 11 & 12 combined)	18.2 a[w]	12.4 ab	20.3 ab	3.5 ab	5.9 ab
P values	<0.001	0.044	<0.001	0.022	<0.001

[z] Percentage of fruit that, when rated for surface russet, did not meet the criteria for USDA Extra Fancy grade.

[y] Percentage of fruit that, when viewed from either stem end or calyx end, had visible russet.

[x] Estimated percentage of the fruit surfaces covered with russet when fruit were viewed from either the stem or calyx ends. Means include fruit that had no russet at all.

[w] Means followed by the same letter are not significantly different (Fishers Protected LSD, $P \leq 0.05$).

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Trial to evaluate impacts of Blossom Protect on fruit russet

Figure 3. Russet evident on harvested Golden Delicious fruit:

Trt 2—controls with no russet suppression (upper left)

Trt 8—BP applied on 8 May (upper right)

Trt 12—Magnabon (lower left)

Trt 4-standard mancozeb program (lower right)

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Trial to evaluate impacts of Blossom Protect on fruit russet

Conclusions:

1. Application of BP did not “overload” the ecology enough to cause russetting greater than what might otherwise be seen (e.g., caused no russet at all on Jerseymac and Redcort trees in the same plots).
2. Applications on 3 and 6 May had no impact on russetting, but applications on 8 May were critical. Thus, timing is important.
3. Applying mancozeb before or after the critical BP applications did not “eradicate” russet initiated by the 8 May application.
4. Nevertheless, because fungicides that control natural russet presumably are not compatible with BP, it will likely prove impossible to get blight control with BP while also avoiding fruit russet, especially if blossom blight applications are needed during late bloom and extended wet weather favors russet development.

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Do early-season sprays impact development of necrotic leaf blotch (NLB) on Golden Delicious?

Table 7. Impact of treatments on necrotic leaf blotch on Golden Delicious as determined by comparing five pairs of similar treatments.

Material and rate of formulated product per 100 gal of spray	% nodes with abscised or yellowed leaves on Golden Delicious terminal shoots on 12 Sept. [z]
Controls: no Manzate or BP (Treatments 1 and 2 combined).....	9.2 ab [y]
Manzate on 6 May, no BP (Treatments 3 and 4 combined)	4.6 a
BP on 3 & 6 May only (Treatments 5 and 6 combined)	11.0 b
BP on 8 May; no Manzate) (Treatments 7 & 8 combined).....	9.3 b
BP on 8 May + one Manzate) (Treatments 9 & 10 combined).....	8.8 b
Copper treatments (Treatments 11 & 13 combined).....	7.6 b

[z] Data from observing all full-sized leaves on 15 terminal shoots per tree. Leaf abscission occurred due to necrotic leaf blotch. Yellowed leaves are those expected to drop in the near future.

[y] Means followed by the same letter are not significantly different (Fishers Protected LSD, $P \leq 0.05$).

How treatments applied at petal fall can impact appearance of NLB in Aug or Sept remains a mystery.

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Impact of fungicides on russet

Results from a field trial at Highland in 2013.

Table 5. Effects of treatments on fruit russet in at 2013 trial in Highland, NY.

Material and amount of formulated product per 100 gal	Fruit out-of-grade due to russetting (%)[z] Ginger Gold 14 Aug	McIntosh 22 Aug	Golden Del. 26 Aug	Grand means for all three cultivars
1. Control	97.1 c[y]	53.3 d	86.8 c	79.1 d
2. Flint 0.67 oz +LI 700 8 fl oz	10.3 a	13.7 ab	46.2 ab	23.5 ab
3. Inspire Super 4 fl oz + LI 700 8 fl oz	41.3 b	27.2 bc	66.3 bc	44.9 c
4. Flint 0.67 oz + ProPhyt 21.3 fl oz	5.5 a	4.6 a	27.5 a	12.6 a
5. Inspire Super 4 fl oz +ProPhyt 21.3 fl oz	47.5 b	26.6 c	59.6 b	44.6 c
6. ProPhyt 21.3 fl oz	54.4 b	20.4 abc	59.5 b	44.8 c
8. AgriFos 21.3 fl oz	35.1 b	9.5 ab	31.3 a	25.3 b

[z] From observations of 60 fruit/tree for McIntosh and Golden Delicious and 75 fruit/tree for Ginger Gold. Fruit out-of-grade due to russet failed to meet the criteria for the USDA Extra Fancy grade fruit.

[y] Mean separations were determined using LSD ($P \leq 0.05$) applied to the results from a split-plot analysis of data from three cultivars. *P*-values from the split-plot analysis were <0.001, <0.001, and 0.001 for effects of treatment, cultivar, and the treatment-cultivar interaction, respectively.

Conclusion: Flint was more effective than Inspire Super for suppressing russet.

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Injury from Captan with Fontelis

- At petal fall, growers who applied Fontelis with Captan noted injury.
- Jeff Alicandro found that Fontelis is formulated with mineral oil.
- Jeff also found that Fontelis labels in other countries warn against combining it with captan.

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Captan Injury with Syllit

SYLLIT:
Spartan (Acey Mac) damaged by a Syllit-captozeb combination applied on 26-27 May near Peru, NY.

Applications on Sunday 5/26 and finished late in the evening on Monday 5/27. Applied 50 gals/A of a tank mix (for 10 A) containing 30 lb Captan-50, 20 qt Manzate Flowable, 30 lb sulfur, 15 pints Syllit.

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Consequences of captan injury

1. Syllit label will be changed to allow applications on apples only from green tip through pink bud.

2. Cornell recommends will be changed to suggest that no captan should be used in sprays at PF or 1st cover.

   Rationale:

   - Period of greatest susceptibility to injury due to rapid leaf growth and small fruit.
   - Period of the craziest tank mixes.

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Late-season captan injury?

Hypothesis: Fruit spotting caused by sub-lethal Captan uptake into lenticels with preharvest sprays followed by cell death during storage?

Caution: avoid captan with surfactants (including liquid calcium?) during preharvest period?

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Not all fruit damage is due to Captan

Phyto damage noted mid-August on trees sprayed with Captan plus LI-700 under slow drying conditions on Aug 3rd?

NO! Cause was black rot due to lax summer spray program

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