Final Project Report to the NYS IPM Program, Agricultural IPM 2000 – 2001

Title: Development of Integrated Pest Management Strategies for Apple Fruit Russet.

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Cooperator(s):

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Abstract: The goal of this work is to develop IPM strategies for control of apple fruit russet that is caused by *Aureobasidium pullulans* , a common fungal inhabitant of apple surfaces. We determined that the fungus is highly tolerant of pH changes and therefore attempting to alter the surface pH of the fruit is not likely to impact russet. Gibberellin applications significantly reduce the amount of fruit russet, however are not as effective as fungicides. *A. pullulans* varies considerably with regard to sensitivity to fungicides such as captan, polyram and the strobilurin group. This is likely to result in less than desireable russet control. Isolates of the fungus that were isolated from plants that were not likely to be sprayed with fungicides were more sensitive to the fungicides. This suggests that repeated use of the fungicides has resulted in a population of fungi that are tolerant of them. This is interesting because previously there were no reports of fungi developing tolerance to fungicides such as captan and polyram.

Background and justification:

Russet is a serious problem, causing significant reductions in fresh market fruit quality and profits. The United States Standards for Grades of Apple identifies acceptable amounts of russet for fresh fruit and most packing houses implement even more stringent requirements. Fruit that do not meet standards are downgraded, reducing their economic value significantly. For example, in some years no Golden Delicious apples are sold as fresh fruit because of russet (Fowler Brothers, personal communication). A survey that included growers, packers and consultants throughout NY was completed in 2000. It revealed that not only Golden Delicious develops significant russet but also prominent red cultivars such as Gala, McIntosh and Cortland. Losses of $20.00 to $100.00 per bin were reported in some years.

We have demonstrated that a common epiphytic fungus, *Aureobasidium pullulans* can cause russet of apple and it appears to be an important cause of russet in NY orchards. Growth of the fungus is inhibited by certain fungicides (and not by others) and application of these fungicides (i.e. captan, Polyram and Sovran) has significantly reduce the severity of russet in the orchard. However, russet is not always reduced to acceptable levels by fungicides, some of them such as captan are under scrutiny by FQPA, and we recently discovered that isolates of the fungus vary greatly in their sensitivity to captan.

Objectives:

1. Determine the effects of pH and the commercial gibberellin formulation, Provide, on the ability of *A. pullulans* to survive and to cause russet on apple fruit. This objective will lead to the use of alternatives to fungicides for russet control.

2. Determine the frequency of *A. pullulans* isolates that are tolerant to fungicides that have previously been shown to be inhibitory to the fungus and effective for russet control.

Procedures:

1. The effects of LI700 and pH on survival of *A. pullulans* were measured. Suspensions of the fungus were made in two rates of LI700 (3.12 and 6.24 ul/10 ml water) that correspond to rates that are reccomended for field applications. The pH of these solutions were both 3.6 as compared to 5.5 for the water control. Survival of the fungus was measured after one and 24 hours in the solutions. Both of the LI700 treatments reduced the survival of the fungus by about a factor of 100 in the first experiment and be a factor of about 10 in the second. Therefore either the LI700 or the pH effect was detrimental to survival of the fungus but did not completely eliminate it.

The effect of pH in water and the pH of a culture medium on survival of *A. pullulans* was also determined. The pH of water was varied betwee 5 and 7 and it was determined that the fungus survived equally well at all values. The pH of the culture medium was adjusted to pH 5, 7 and 9. Again within these values, no differences in the surival of the fungus were observed.

Field experiments were done to determine the effect of LI700 as compared to fungicides and to a commercial formulation of gibberellin (Provide) for russet control. The treatments were applied with a hand-gun sprayer as described in Table 1.

2. Because fungicides are not always effective for controlling russet, we tested the sensitivity of A. pullulans isolates to captan, Polyram and to a member of the stribilurin fungicide group. These experiments were run in the laboratory with a group of fungal isolates that originated from apple and from some plants that are not sprayed with captan. The growth of the isolates was measured on culture media in the presence of different concentrations of the fungicides that relate to concentrations that are used in the field.

Results and discussion:

LI700 did not provide significant control of stem-end or whole-fruit russet in any of the experiments. The incidence of russet was low on McIntosh, but much higher on Crispin making it possible to distinguish treatment effectiveness. Also, stem-end russet was not controlled by any of the treatments. It may be that russet at the stem end of fruit is not caused by *A. pullulans*. Captan and Polyram gave the greatest amount of control followed by Sovran and Provide. Further experiments are needed to determine why LI700 has reduced russet in the past, and is inhibitory to *A. pullulans* in solution but did not provide russet control in the field this year.

Table 1. Effect of LI700, fungicides and Provide on russet control, 2001.

	Orchard #1		Orchard #2	
	McIntosh		Crispin	
Treatment and rate/100 gal.	Whole fruit russet*	Stem end russet*	Whole fruit russet*	Stem end russet*
1. Captan 50WP 32 oz.	3.6 a	12.6 a	2.4 c	53.4 a
2. Sovran 1oz.	2.3 a	10.2 a	4.1 bc	61.4 a
3. Captan 50WP 32 oz. Sovran 1 oz. (applied bloom and PF) Captan 50WP 32oz.	1.8 a	8.4 a	3.4 bc	62.8 a
4. LI700 1 pt.	1.4 a	8.6 a	14.4 a	57.8 a
5. Provide 13 fl oz.	2.3 a	12.2 a	7.3 b	50.0 a
6. Captan 50 WP + Polyram 80DF 32 oz.	2.7 a	11.0 a	2.5 c	70.2 a
7. Nontreated	2.2 a	11.4 a	15.8 a	71.8 a
LSD	2.29	7.87	4.41	22.09

*Data were taken on an average of 50 fruit per tree from 5 trees on 9/13/01 and 9/19/01 respectively. Fruit were rated on a scale of 0 to 4 based on an approximation of the area of whole fruit surface with russet. Numerical ratings of 0 (0 to 3% of the fruit surface having russet); 1 (4 to 20% russet); 2 (21 to 45% russet); 3 (46 to 74% russet) and 4 (greater than 75% russet) were given to each fruit. Fruit were also rated on a scale of 0 to 2 based on an approximation of the fruit stem end surface with russet. Numerical ratings of 0 (0 to 10% of the stem end having russet); 1 (11 to 35% russet); 2 (36 to 100% russet) were given to each fruit. Stem end russet or whole fruit russet was calculated as : [∑ (rating x the number of fruit with the rating) / highest rating x total number of fruit] x 100**.** Percent stem end russet or percent

whole fruit russet equals the average stem end or whole fruit russet of 50 fruit samples. Values in same column followed by different letters differ significantly at $P= 0.05$ according to the SAS General linear Models *t* test.Spray dates and timings were: 4/19, green-tip airblast spray of entire orchard with Indar 75WSP (0.67 oz/100 gal) and Latron 1956B (16 fl oz/100gal) for early scab control (after that Indar and Latron were not applied to treatments 1, 2, 3 and 6); the different experimental treatments were initiated on 4/23, hangun sprays at tight cluster; 5/4, pink; 5/9, bloom; 5/16, petal-fall; 5/24, first cover; 6/4, second cover; 6/14, third cover; then on 6/28 airblast sprays resumed, fourth cover; 7/12, fifth cover; 7/27, sixth cover. After the 3rd cover spray, all treatments received Captan 50WP (1 lb/100 gal.) plus Benlate (2 oz/100 gal). A regular insecticide program was applied on all treatments.
Treatment 3 was sprayed with Captan on 4/23 and 5/4, with Sovran on 5/9 and 5/16 and with Captan for the remaining treatments through 3C. Treatment 5 (Provide) was applied twice, 5/9 and 5/16.

2. Isolates of *A. pullulans* differed greatly with respect to their sensitivities to captan, Polyram and the strobilurin, azoxystrobin. This is the first indication that fungi may become tolerant to captan and Polyram and probably explains why russet control with these fungicides is variable. Isolates from plants that were not likely to be sprayed with fungicides, e.g Norway Spruce and Swamp White Oak, were more sensitive to the fungicides that isolates from crops that are frequently sprayed.

Table 2. Sensitivity of *A. pullulans* isolates to captan and metiram

Strain	Host Plant	Captan	Polyram
ATTC 11942	Apple	4.17b	11.2a
YT 16	Apple	4.77b	5.90d
YT 167	Rhododendron	4.77b	7.57c
YT 170	Norway Spruce	8.57a	10.13ab
YT 175	Grape	1.67c	5.10de
YT 180	Swamp White Oak	6.90a	10.1b
YT 330	Apple	2.23c	5.90d
YT 333	Apple	1.07c	4.80e
YT 335	Apple	0.87c	6.13d
YT 337	Apple	1.33c	5.80de
LSD		1.88	1.10

* Values in same column followed by different letters differ significantly at $P= 0.05$.

Table 4. Sensitivity of *A. pullulans* isolates to the strobilurin fungicide, azoxystrobin.

Isolate	Percent growth inhibition
YT175	82a
YT335	80a
YT180	71b
ATCC11942	67bc
YT337	60cd
YT167	60cd
YT16	56d

YT330	54de
YT170	52de
YT333	46e

None of the isolates were completely inhibited by the fungicide.

Conclusion: Alternative methods for controlling fruit russet are needed. Although fungicides provide some control, it is apparent that the primary fungal cause, A. pullulans, is tolerant of the fungicides that are generally most effective. Other fungicides, such as the DMI group, dodine and benomyl are not effective against *A. pullulans*. Further research is needed to determine how *A. pullulans* causes russet and how the process can be prevented.