ORGANIC FARMING RESEARCH FOUNDATION

Grant Report

Grant #: 92-26

Title: *Peach Brown Rot Control*

Principal Investigator: Carl Rosato, owner, Woodleaf Farm, Oroville, CA

Co-Investigators: Cassie Martin, Katia Wilder, Kyra Evans, Amigo Cantisano

Amount Awarded: $1,800

Project Period: 1992

Report: 11 pp., including 5 figures. Received 1/3/94.

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1992 Treatment Substances

Eleven test substances were used during the 1992 pilot research on the O'Henry peaches. Each of the substances were applied once a week for the three weeks preceding harvest.

These 11 substances and their dilution rates were:

1. Algrow kelp, a cold processed dry kelp, at five (5) pounds per acre.
2. Shur-Crop, a liquid kelp product, at 1.25 gallons per acre.
3. Hydrogen peroxide, 35 percent farm grade was diluted to a 1 percent solution or three (3) gallons per acre.
4. Basalt rock dust mixed with one (1) gallon per acre of Shur-Crop.
5. Rado Rock, a glacial marine rock dust from British Columbia, was mixed with one gallon per acre of Shur-Crop.
6. Compost Tea #1: two (2) pounds of Algrow kelp, one (1) quart Shur-Crop, two (2) gallons basalt rock dust past through a 50 mesh screen, one (1) pint molasses and 10 gallons of finished compost per acre.
7. Compost Tea #2: Compost Tea 31 plus two (2) additional cups of molasses, one (1) gallon brewers malt and two (2) pounds of fish meal.
8. Azomite, a montmorillonite clay product from Utah, and one (1) gallon Shur-Crop per acre.
9. Citricidal, a grapefruit seed extract product, at 1000ppm or 1/3 gallon per acre.
10. Wine and raw apple cider vinegar mixed wit water to make a pH of 2.8, 300 gallons per acre.
11. Irrigation water with a high algae content, 300 gallons per acre.

A Report On:
The Peach Brown Rot Control Project for 1993 At Woodleaf Farm
Funded by The Organic Farming Research Foundation & The Kokaro Foundation

Woodleaf Farm is a small organic peach farm in the Sierra Foothills of Northern California. The farm contains 900 peach trees, including 20 white and yellow flesh varieties. The trees were planted in 1985 and the farm has been certified by the California Certified Organic Farmers since 1982.

Brown Rot

Brown rot (Monilinia Fructicola) is a very significant problem for both organic and conventional peach growers. Organic fruit growers, in particular, have very few options and almost no information available to them when confronted with brown rot in their orchards.

When brown rot is present it first attacks the blossom and later the fruit. The blossoms shrivel and die while the fruit becomes marked with spots of rot. In extreme instances on some peach varieties, brown rot can cause the loss of 100 percent of the fruit. In other cases, the standard yield loss in an orchard attacked by brown rot is between 10 and 30 percent.

The continuing goal of our research is to determine if the substances we spray will stop or slow the growth and spread of brown rot.

Summary of 1992 Research

The rows of O'Henry peaches selected for the pilot study - conducted July through August 1992 - were divided into 12 sections. Each section was sprayed with a different substance to determine which substance or combination of substances promoted a decrease in the incidence of brown rot. The different substances were sprayed once a week for four weeks preceding harvest.

In addition to the substances intentionally introduced into the orchard test site, other factors notably weather conditions and variety susceptibility to brown rot were observed.

Observations were made and recorded throughout the pilot research period and data was collected at weekly intervals.

Bio-assays counting the number of aerobic organisms and pink mucoid yeast on the surface of the fruit were conducted by Mid State Labs, Visalia Ca.

Tests were also conducted on:

- Fruit brix (soluble solids or sugar content)
- Fruit nitrate content
- Leaf brix and nitrate
- Soil pH, nitrate, oxygen, electrical conductivity and element analysis

We used 11 test substances for the 1992 pilot research. One section of the O'Henry peaches was a control section and did not receive any treatment.

Several of the substances significantly raised the levels of aerobic organisms and pink mucoid yeast, producing a micro environment possibly antagonistic to the growth of brown rot. These substances included:

- Algrow Kelp mixed with Basalt Rock Dust
- Compost Tea

- Hydrogen Peroxide

(For a complete listing of pilot test substances see "1992 Treatment Substances" attachment.)

These results gave us direction for our 1993 research.

1993 Research

Our 1993 research was conducted from March through September. The rows of O'Henry trees were divided into 10 test sites.

Each section included 15 trees and was tested with a different substance. All substances - except copper hydroxide, wettable sulfur and pink mucoid yeast - were applied once a week for the three weeks during bloom and once a week for four weeks preceding harvest. The copper hydroxide was applied once prior to bloom. The wettable sulfur was applied three times during bloom and three times during June, following several rainfalls in May and June. The pink mucoid yeast was applied three times during bloom.

All substances were applied with a tractor air blast sprayer.

All the peaches harvested from the research area were counted and divided into the following four groups:

- Mummies - 10 percent
- Less than 75 percent Brown Rot - 31 percent
- More than 75 percent Brown Rot - 25 percent
- Good (i.e. "saleable") - 34 percent

See Harvest Totals graph addendum for more detail.

1993 Test Treatment Substances:

The 10 test substance combinations, in descending order of effectiveness, were:

1. Algrow kelp and basalt rock dust milk
2. Algrow kelp, a cold processed dry kelp product.
3. Compost tea and pink mucoid yeast
4. Hydrogen peroxide and pink mucoid yeast
5. Blend/Yeast: algrow kelp, basalt rock dust, hydrogen peroxide compost tea, powdered sugar, pink mucoid yeast and white wine vinegar
6. Copper hydroxide and wettable sulfur
7. Farewell, an organism sold by Mid State Labs, Visalia.
8. Hydrogen peroxide
9. Blend: algrow kelp, basalt rock dust, hydrogen peroxide, powdered sugar, white wine vinegar and compost tea
10. Compost tea.

Dilution rates were:

- Algrow kelp - three (3) pounds per acre.
- Hydrogen peroxide - 35 percent farm grade diluted to a 1 percent solution or three (3) gallons per acre.
- Basalt rock dust milk - 40 gallons of the "milk" off the top of a mixture of 30 pounds of 1/8-inch and finer rock dust and water mixed in a 55 gallon drum, applied at a rate of 80 gallons per acre. The rock dust was obtained through Cal West Rock Co., Ione, Ca.
- Compost tea - 10 gallons of finished compost stirred into a 55 gallon drum of water for five minutes, then left to settle for 15 minutes and applied at 80 gallons per acre.
- Farewell - applied at 15 gallons per acre.

- Pink mucoid yeast - a natural yeast found on the leaves and fruit of peach trees, cultivated by Mid State Labs and applied at 10 gallons per acre, once a week for three weeks during bloom.
- Copper hydroxide - 15 pounds per acre.
- Wettable sulfur - 16 pounds per acre.
- Blend - two (2) pounds algrow kelp, 30 gallons basalt milk, 20 gallons compost tea, two (2) pounds powdered sugar, 1/2 gallon white wine vinegar and 1/2 gallon hydrogen peroxide per acre.

Non test-site substances

The orchard, not including test sites, received a pink mucoid yeast three times during bloom and the Blend 4 to 6 times preceeeding harvest.

In addition to the test substances, we also experimented with some other substances - including citricidal and fresh garlic - in non-test site areas of the orchard.

Citricidal is a grapefruit seed extract that functions as an antifungal. Citricidal was sprayed at a dilution of 1,000 ppm. Our theory was that it would kill all the organisms on the trees including brown rot. Based on the theory that it would eliminate everything, we sprayed pink mucoid yeast at 10 gallons per acre five days after applying the citricidal. This was done to repopulate the trees' natural yeast and fill the niches left by the elimination of the brown rot.

Although we did not document in detail the results of the citricidal since it was not part of the test, this area of the orchard showed a marked decrease in the occurrence of brown rot. We believe that citricidal may hold promise.

Fresh garlic, a proven anti-fungal, was applied at 12 pounds per acre. Our theory about the garlic was the same as our theory about the citricidal, that is it would kill everything including the brown rot. We again sprayed pink mucoid yeast at 10 gallons per acre five days after applying the garlic.

Again since garlic was not part of our test, we did not document in detail the results. However, the garlic appeared to have no impact on the brown rot.

We will continue testing the effectiveness of citricidal in non-test areas of the orchard, but will abandon our use of garlic.

Testing

Bio-assay testing of blossoms and fruit from each test area were conducted by Mid State Labs, Visalia. These tests were conducted to determine the levels of pink mucoid yeast, aerobic organisms and anaerobic organisms.

To determine the levels of fruit nitrate and fruit brix 10 peaches from each site were tested by the Woodleaf Farm research team.

The 1993 fruit brix level tests showed less of a difference between test site substances than did the 1992 tests. In 1992, five of the test site substances produced levels of fruit brix greater than 12 percent. The remaining six 1992 test solutions produced fruit brix levels between 10 and 11 percent.

All 1993 test sites showed average fruit brix levels of 12 to 14 percent.

There does not appear to be a correlation between increased levels of fruit brix and a decrease in brown rot. However, a side benefit of some of the substances producing higher levels of fruit brix is sweeter peaches.

The bio-assay testing indicated that higher levels of pink mucoid yeast and aerobic organisms lower the incident of brown rot. However, these results are inconclusive due to the low amount of blossoms and fruit tested from each site. More conclusive data could be garnered if 10 bio-assay tests, instead of one, were conducted on the blossoms and fruit from each test-site.

Without enough funding to conduct the necessary number of bio-assay tests in each site, we are forced to limit our bio-assay testing to one, possible two, test sites during our 1994 research.

See 1993 Bio-Assay Test Results addendum for details.

We also conducted our own survey for peach leaf curl in each test and throughout the entire orchard. Most varieties showed less than 5 percent of leaf curl.

We did not spray any copper in the orchard during the 1993 season, except in the one test site. Four rows in the orchard have had no copper applied since 1990, two of these rows containing Springcrest and White Haven varieties had very little leaf curl. Two different varieties of kelp solutions -- Shur-Crop and Algrow -- were the only sprays applied to these four rows. The sprays were applied twice during the orchard's dormant period and three times during the growing season each year.

Weather

Weather conditions during the 1993 season were conducive to growing brown rot. In March, during bloom, we had 3 inches of rain. In May and June 6 inches of rain fell. August was a cloudy, humid month overall with a total rainfall of 1.5 inches, just prior to the O'Henry harvest.

Results

The weather conditions contributed to the growth of blossom brown rot and fruit brown rot in the test sites. We had anticipated a 60 percent crop overall of O'Henry, but finally harvested only 34 percent. Our yearly harvest average has been 100 pounds of fruit per tree. This year our yield was 34 pounds per tree.

Other orchard varieties also suffered an increase in brown rot, however do to varietal differences our average harvest, not including the O'Henry and Cal Reds varieties, was 80 percent of our average yield.

The high incidence of brown rot in the O'Henry and Cal Reds, both late season peaches, brought the orchards average harvest down to 65 percent.

The 10 varieties of early and mid season peaches had less incidence of brown rot so the average harvest yield on these varieties was 90 percent. The three varieties with the least brown rot and highest yield were:

- Spring Crest, early season, 95 percent yield
- White Peaches (seven varieties), mid season, 90 percent yield
- Suncrest, mid season, 97 percent yield

The test site harvests varied in degrees of success. The test site where the algrow kelp and basalt rock dust milk solution was sprayed had the least amount of brown rot damage and therefore the highest yield. The test site where compost tea was used showed the highest incidence of brown rot and therefore the lowest yield.

In all cases where pink mucoid yeast was added to the test solutions the yield increased significantly - 58 to 94 percent. For example, the test site which received only compost tea yielded a 21 percent crop. When pink mucoid yearst was added to the compost tea and applied to another test site, the yield rose to 41 percent -- a 94 percent increase.

We believe that we may have more success with compost tea in 1994, it we "brew" the tea before application. The brewing process requires forcing air through the liquid with an air compressor.

The percentage of crop yield in the test sites based on a normal yield of 100 pounds of "saleable" fruit per tree was:

1. Algrow and basalt rock dust milk — 55 percent
2. Algrow kelp — 42 percent
3. Compost tea and pink mucoid yeast — 41 percent
4. Hydrogen peroxide and pink mucoid yeast — 40 percent
5. Blend and pink mucoid yeast — 37 percent

6.	Copper and sulfur	30 percent
7.	Farewell	28 percent
8.	Hydrogen peroxide	25 percent
9.	Blend	21 percent
10.	Compost tea	21 percent

Our 1993 research indicates that algrow kelp, basalt rock dust milk and pink mucoid yeast warrant further research in 1994.

Our theory is that pink mucoid yeast is antagonistic to brown rot and that algrow kelp and basalt rock dust milk are nutrients which enhance the health of the peach trees and promote the growth of pink mucoid yeast. We are basing our theory on our 1993 research combined with our 1992 pilot study which indicate that when the amount of naturally occurring pink mucoid yeast is increased the incidence of brown rot is decreased.

These findings give us impetus and direction for our 1994 research.

Advance Preparation for 1994 Research

The pH balance in the orchard's soil is currently too high, more than 7. To reduce the pH balance we are adding 400 pounds of soil sulfur per acre. We have added this same amount of soil sulfur for the last three years. This should reduce the pH level to an acceptable level of 6.8 or less.

Additionally we have added compost at the rate of five (5) tons per acre to the entire orchard for the last three years.

We have had poor results with spraying Farewell, an organism that eats organisms that contain chiten - such as brown rot, onto the trees. Since peach mummies left on the orchard floor produce apothecia, a mushroom-like fungus, in the spring which shoot brown rot producing spores, we are testing Farewell's effectiveness at inhibiting the growth of apothecia.

To conduct the Farewell test, we have taken 60 O'Henry variety peach mummies and divided them into six (6) test plots. These mummies of have been partially buried in the ground for this testing. Two of the plots are control sites. The other four sites are being sprayed with different dilution rates of Farewell. Our theory is that Farewell will flourish in the cool moisture of the soil and attack the chiten. These plots will be closely monitored through the spring of 1994.

The Cal Red variety trees have shown increasing levels of blossom brown rot during bloom. During moist periods in the summer, the brown rot wounds were full of growing brown rot spores.

To combat the brown rot problem in the Cal Red trees, we have cut away approximately 70 percent of the wood on all of these trees. This heavy pruning of the Cal Red trees should reduce the amount of brown rot.

Proposed 1994 Research

Our 1994 research will be conducted on the orchard's 55 Royal Glo peach trees. Each research block will consist of 17 trees. We are shifting our research to this variety for two reasons.

First, this variety appears to be the most susceptible to brown rot. In 1992, we lost 90 percent of the Royal Glo crop to brown rot and in 1993 we lost 65 percent of the crop.

Second, Royal Glo is a mid-season variety harvested in late July. By using Royal Glo, we will have information earlier in the season which will allow us to experiment with different solution sprays on some of our later varieties including the O'Henry and Cal Reds.

1994 Treatment Substances

We will continue to focus our attention on algrow kelp, basalt rock dust milk and pink mucoid yeast in our 1994 test solution mixes. Because of the promising results of these substances we will be working with three notable researches - Jill Auburn, Bob Bugg and Chuck Ingles - from the University of

California's Sustainable Agriculture Research and Education Program. Amigo Cantisano of Organic Ag Advisors, Colfax, will also be serving as a research consultant, assiting us with both field research and data interpretation. These professional scientists will assist us in establishing a highly controlled test site so that we can conduct scientifically valid research on trees treated with algrow kelp, basalt rock dust milk and pink mucoid yeast. We will also use their expertise to interpret the data we collect.

Research methods will be replicated in the three test blocks in order to give us scientifically valid results. In each of the blocks every other tree will be used as a test tree. Seven of these trees will be treated with a different test solution, one will remain as a control tree receiving no spray.

The entire orchard, including the trees in all test blocks, will receive a copper bordeaux spray -- once in December 1993 and again in early February 1994.

Test solutions for the three blocks include:

1. Basalt rock dust milk
2. Pink mucoid yeast
3. Algrow kelp and basalt rock dust milk
4. Algrow kelp and pink mucoid yeast
5. Basalt rock dust milk and pink mucoid yeast
6. Algrow kelp, basalt rock dust milk and pink mucoid yeast
7. Wettable sulfur

All of the solutions, except copper, will be applied by tractor sprayer three times during bloom and then every 7 to 14 days until harvest.

In order to continue our testing of a variety of substances, we will select one early variety tree for multiple substance testing. On this single tree we will select 50, one foot lengths of one-year-old fruiting wood. These wood lengths will be divided into test groups of 10. Within each test group, nine test solutions will be applied -- one solution per length of wood. One length of wood in each section will be left as a control, receiving no spray.

The following are the substances we plan to test on this tree:

1. Algrow kelp
2. Basalt rock dust milk
3. Apple cider vinegar and wettable sulfur mix
4. Sprayable calcium sulfate (a.k.a. superfine gypsum powder)
5. Sprayable calcium carbonate (a.k.a. superfine limestone powder)
6. Hydrogen peroxide
7. Compost tea
8. Copper and wettable sulfur
9. Pink mucoid yeast

Each of these substances will be applied with a hand sprayer.

In addition to the test substances, we will also mist the tree 12 times per day to encourage the growth of brown rot. We also will introduce brown rot to this test tree by spraying it with brown rot spores.

In 1992 we used vinegar as a test substance. In 1992 and 1993 we used wettable sulfur. Both of these substances are acidic, with sulfur being a proven antifungal. Although we have not had great success with either of these substances separately, we believe the combination of the two may prove successful. Our theory is that the vinegar will enhance the sulfur's effectiveness as an anti-fungal.

We know from others' testing that calcium solutions have had some effect in deterring the growth of funguses including apple scab and brown rot. This testing has been done using calcium formate, a

substance which is not approved for use by certified organic growers. Based on this testing, we believe it may be the calcium that deters the growth of fungus. Therefore, in our 1994 research we will test two different calcium solutions -- calcium sulfate and calcium carbonate. Both of these calcium-based substances are approved for use by certified organic growers.

Summary

To date, our two most successful test solutions in deterring the growth of brown rot have been:

- Pink mucoid yeast
- Algrow kelp and basalt rock dust milk.

Test sites where pink mucoid yeast was included in the test solutions showed an increase of 58 to 94 percent in good (non brown rot) peaches. Test sites where the algrow kelp and basalt rock dust milk solution was used without yeast showed the least incidence of brown rot, therefore the best overall performance of good peach production.

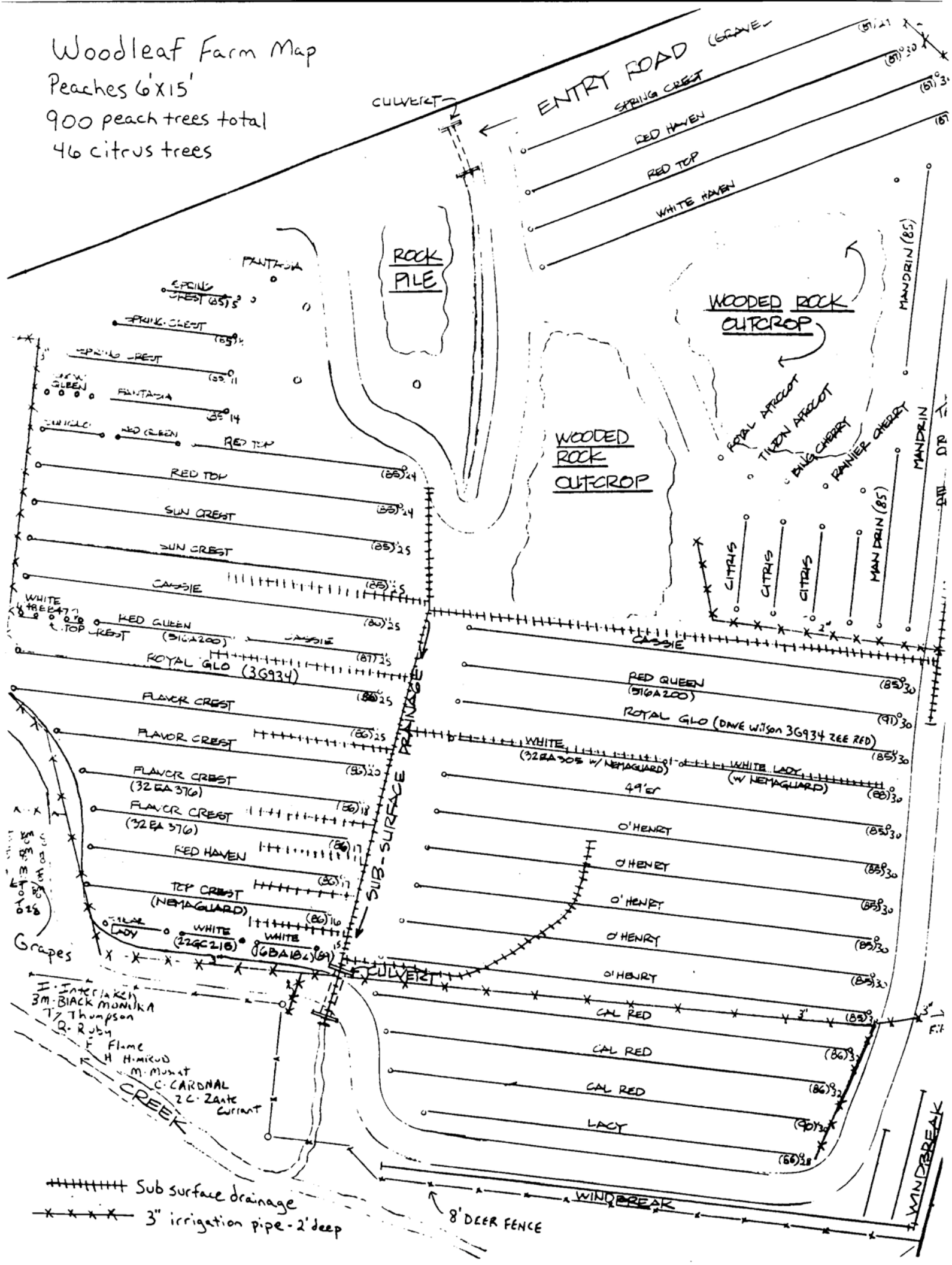
Based on these results we believe that a combination of all three substances -- pink mucoid yeast, algrow kelp and basalt rock dust milk -- may result in a solution which will out perform all others in deterring the growth of brown rot.

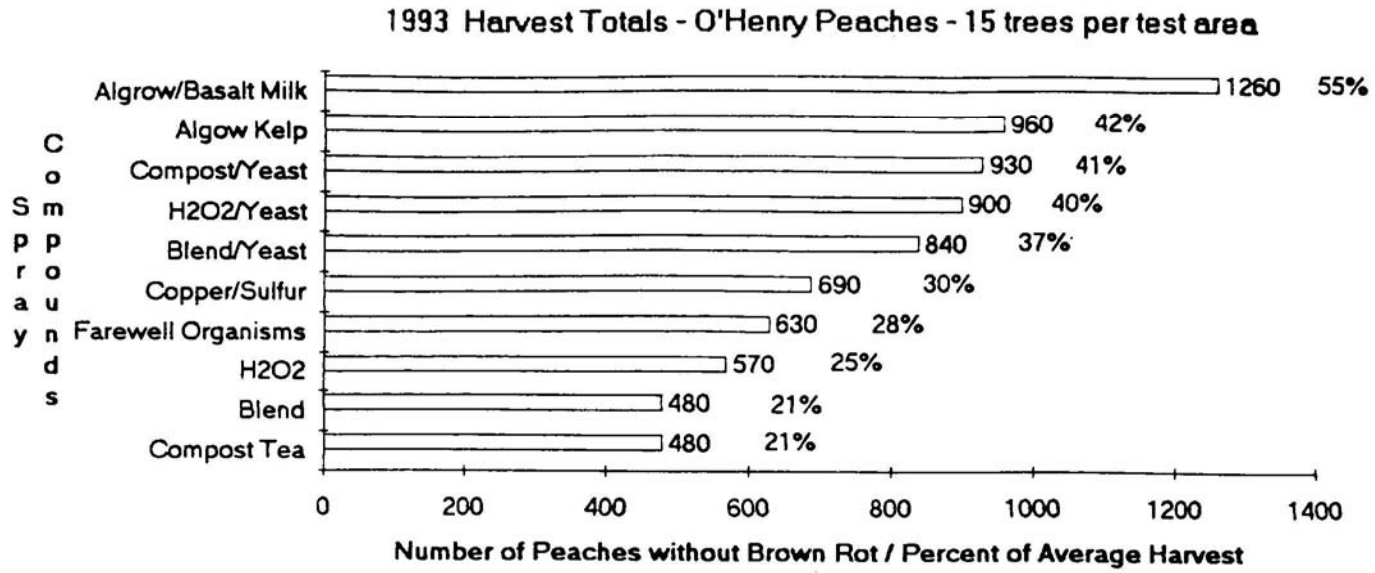
Therefore, in 1994 we will concentrate on the combined solution spraying a prepared per-acre mix of 3 pounds algrow kelp, 80 gallons basalt rock dust milk and 10 gallons pink mucoid yeast three times at bloom then every 7 to 14 days until harvest on one test site. With the assistance of notable scientists from the University of California's Sustainable Agriculture Research and Education Program, this designated site will be established as a valid research site allowing us to glean scientifically valid data.

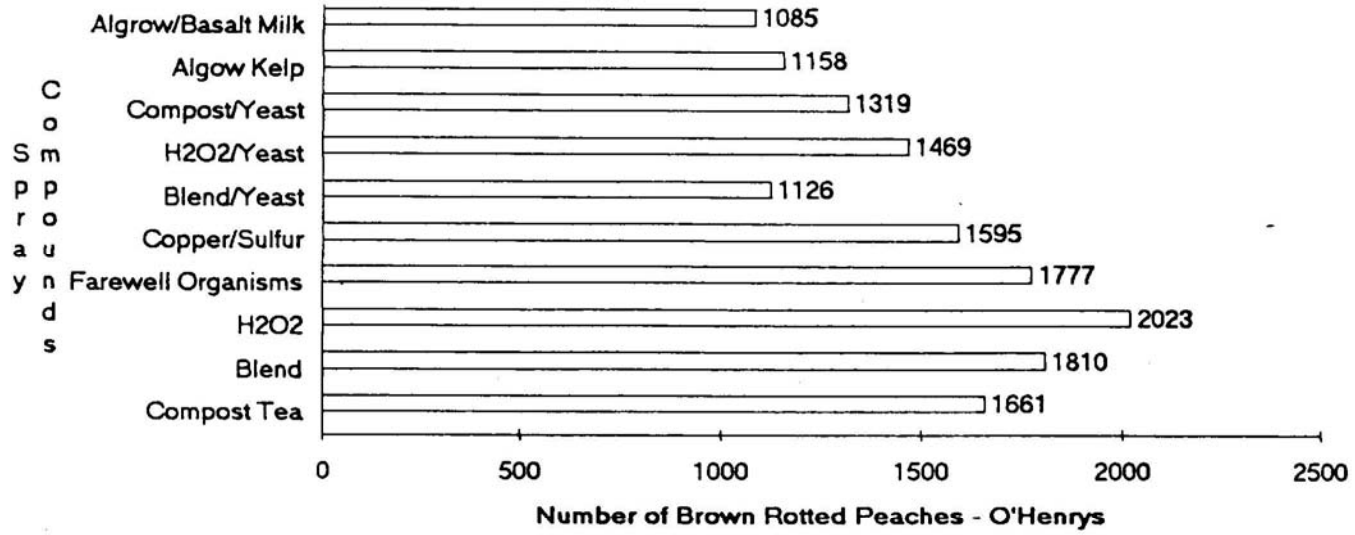
Woodleaf Farm Research Team

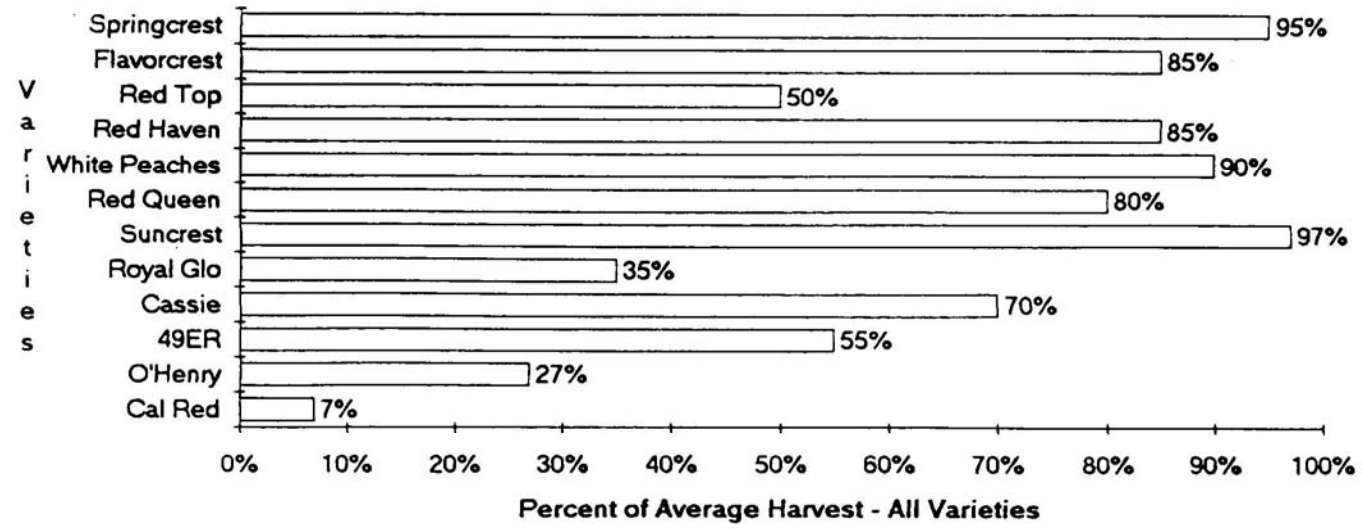
Carl Rosato, owner Woodleaf Farm and primary researcher
Cassie Martin, assistant field researcher
Katia Wilder, research advisor
Kyra Evans, research communications associate
Amigo Cantisano, research consultant from Organic Ag Advisors

For more information regarding Woodleaf Farm Brown Rot Research contact Carl Rosato, (916) 589-1696, 6176 Old Olive Hwy., Oroville, Ca. 95966.


Woodleaf Farm Map
Peaches 6'x15'
900 peach trees total
46 citrus trees
ENTRY ROAD
CULVERT
SPRING CREST
RED HAVEN
RED TOP
WHITE HAVEN
ROCK PILE
WOODED ROCK OUTCROP
WOODED ROCK OUTCROP
FANTASIA
SPRING CREST
FANTASIA
RED QUEEN
RED TOP
SUN CREST
SUN CREST
CASSIE
WHITE FREE
RED QUEEN (516A200)
CASSIE
ROYAL GLO (3G934)
FLAVOR CREST
FLAVOR CREST
FLAVOR CREST (32EA376)
FLAVOR CREST (32EA376)
RED HAVEN
TOP CREST (NEMAGUARD)
WHITE LADY
WHITE (22GC218)
WHITE (36BA184)
SUB-SURFACE DRAINAGE
CULVERT
Grapes
I. Interlaken
3M. BLACK MONUKA
T. Thompson
R. Ruby
F. Flame
H. HIMROD
M. Muscat
C. CARDINAL
2C. Zante Currant
CREEK
ROYAL APRICOT
TILTON APRICOT
BING CHERRY
RANIER CHERRY
MANDRIN (85)
MANDRIN
CITRUS
CITRUS
CITRUS
MANDRIN (85)
CASSIE
RED QUEEN (516A200)
ROYAL GLO (DAVE WILSON 3G934 ZEE RED)
WHITE (32EA305 w/ NEMAGUARD)
WHITE LADY (w/ NEMAGUARD)
49'er
O'HENRY
O'HENRY
O'HENRY
O'HENRY
CAL RED
CAL RED
CAL RED
LACY
WINDBREAK
WINDBREAK
Sub surface drainage
3" irrigation pipe - 2' deep
8' DEER FENCE


1993 Harvest Totals - O'Henry Peaches - 15 trees per test area
Spray Compounds
Algrow/Basalt Milk 1260 55%
Algow Kelp 960 42%
Compost/Yeast 930 41%
H2O2/Yeast 900 40%
Blend/Yeast 840 37%
Copper/Sulfur 690 30%
Farewell Organisms 630 28%
H2O2 570 25%
Blend 480 21%
Compost Tea 480 21%
0 200 400 600 800 1000 1200 1400
Number of Peaches without Brown Rot / Percent of Average Harvest


Spray Compounds
Algrow/Basalt Milk 1085
Algow Kelp 1158
Compost/Yeast 1319
H2O2/Yeast 1469
Blend/Yeast 1126
Copper/Sulfur 1595
Farewell Organisms 1777
H2O2 2023
Blend 1810
Compost Tea 1661
0 500 1000 1500 2000 2500
Number of Brown Rotted Peaches - O'Henrys


Varieties
Springcrest 95%
Flavorcrest 85%
Red Top 50%
Red Haven 85%
White Peaches 90%
Red Queen 80%
Suncrest 97%
Royal Glo 35%
Cassie 70%
49ER 55%
O'Henry 27%
Cal Red 7%
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Percent of Average Harvest - All Varieties

Woodleaf Farm Bio-Assays of Blossoms and Fruit 1993

Multiply Number By	1000000	1000000	1000	1000	1000	1000	1000	1000
4-1-93 Blossoms	Aerobic	Anaerobic	MAC L+	MAC L-	Mold	Yeast	Actinomycetes	Chitinase
Yeast/Compost/49ER	0.58	0.089		104	20	1	620	0.25
Compost	4.1	0.091	280	30	1	800	0.36	0.02
Yeast/Compost	3	2.7	2660	1800	1	800	0.45	0.02
Copper/Sulfur	16.1	0.1	4	4	1	790	0.02	0.01
Algrow Kelp	2.1	3	53	300	2	700	0.2	0.02
Farewell	30	3	1	35	1	1010	0.05	0.01
Algrow/Basalt Milk	30	3	19	11	2	780	0.05	0.01
Blend	4.5	2.5	20	3000	7	1030	0.07	0.01
Yeast/Blend	3	3	119	300	1	800	0.2	0.01
Yeast/Blend	0.42	0.25	109	70	4	930	0.13	0.01
H2O2	0.3	0.43	238	1	2	840	0.01	0.01
Yeast/H2O2	0.42	0.25	109	70	4	930	0.12	0.01
Citricidal/Yeast/H2O2	0.54	0.36	66	90	2	1100	0.01	0.01
8-1-93 Peaches-Fruit								
Cassie	0.0042	0.00301	15	1	0.1	2.1	0.34	0.01
Royal Glo	0.00001	0.00001	1	1	0.1	0.1	0.28	0.01
Suncrest	0.00003	0.00001	130	1	0.1	5.3	1.4	0.1
White Lady	0.00075	0.0007	300	1	0.1	2	2.4	0.03