ORGANIC
FARMING
RESEARCH
FOUNDATION

P.O. Box 440
Santa Cruz, CA 95061

tel ~(831) 426-6606
fax ~ (831) 426-6670

email ~ research@ofrf.org
web ~ www.ofrf.org

Organic farming research project report submitted to the Organic Farming Research Foundation:

Project Title:

Biological control of plant pathogens in raspberries using beneficial microorganisms, compost teas and nutritional management

PROJECT REPORT

Principal investigator:
Amigo Cantisano
Organic Ag Advisors
P.O. Box 1622
Colfax, CA 95713
916-637-5990

Cooperator:
Aptos Berry Farms, Aptos, California

Funding provided by OFRF: $5,502, awarded spring 1994

Project period: 1994-1995

Report submitted: August 1995

INTRODUCTION

From September of 1994 through June of 1995, with the financial assistance of OFRF, Organic Ag Advisors and Aptos Berry Farms conducted research on the biological, nutritional and cultural control of Botrytis and Powdery Mildew an Raspberries at the Aptos Berry Farm on Thompson Road in Watsonville CA The research took place in a raspberry operation that uses an integrated organic and conventional farming system, on a raspberry variety chosen because of it's history of trouble with these plant and fruit pathogens, These raspberries bear fruit in fall and spring, thus giving the opportunity to perform experiments at 2 distinct seasons.

RESEARCH OBJECTIVES

1) Collect and identify the presence of the pathogen and potential biological control microorganisms for the control of Botrytis, Powdery Mildew and Rust on the foliage and fruit of raspberries.

2) Identify the most promising, biocontrol agents and culture them in vitro and in vivo to obtain high populations of these microbes on the surface of the susceptible crop. Monitor the efficacy of establishing these microbes on the susceptible crops and their ability to suppress or control the target pathogen.

3) Identify factors which influence the resistance or susceptibility of particular cultivars of these crops, particularly nutritional and physical characteristics of Susceptible and-resistant varieties.

4) Culture compost teas and extracts in standardized species and concentrations for the application to the susceptible plant hosts for the biological and nutritional control of the target pathogens.

5) Identify plant nutrient thresholds for the establishment of pathogen biocontrol agents and the destruction or discouragement of the target pathogen.

6) Utilize organically acceptable nutrients for the management of desirable soil and plant tissue nutrient levels in relationship to the target plant pathogen.

7) Teach organic growers and consultants the techniques and materials necessary to grow & monitor these biocontrol agents on the farm.

SAMPLING PROTOCOL AND METHODOLOGY

We sampled. the raspberry plots at least once per month from September through June, with the exception of March when it was physically impossible to walk the fields and pull samples. We sampled from the control block, which was farmed using the standard practices of the farm, minus any fungicide applications and from the treated test block which was farmed using the standard practices of the farm, minus any fungicide applications. The test plot received foliar feeding compost tea and microbial biofungicide applications in addition to the normal farm cultural practices. Our observations included:

1) Visual monitoring of plant overall health,
2) Incidence and severity of the plant pathogens Botrytis, Powdery Mildew and Rust on leaves, flowers and fruit
3) Incidence and severity of leafhopper, aphids, whitefly
4) Weed types and frequency, soil moisture and compaction status, weather and cultural practices
5) Crop growth, yield and general quality

On each sampling date leaves, flowers and fruit were collected for microbial bioassay analysis as described in #1 of research objectives, above. In addition leaves were analyzed for Brix and Nitrate levels on each sample date. Standard laboratory plant tissue mineral analysis was performed on 4 sampling dates.

Soil sampling was performed on each sampling date. On all sample dates the soils were analyzed for ERGS, ORPS, pH, differential pH, Sodium, Nitrate, detectable soil odor. Standard laboratory mineral and organic matter soil analysis was performed on three sample dates.

Monitoring methodology included CEC/ Saturation Mineral Soil Analysis, Plant Tissue (Leaf) Nutrient Analysis, Refractometer and Cardy Nitrate Meter assessment of leaves and fruit. In addition soils were analyzed using ERGS, ORPS, pH and Na measurements.

The analysis reports from these samplings are available from us. Some of the actual analysis reports will be included in the final report issued this fall and winter.

MICROBIAL BIOASSAY LABORATORY WORK

As stated above numerous samples were shipped into the labs for nutrient analysis and biological activity analysis. Mid State Laboratory performed all of the microbial analysis. The bio assays included the following categories: Aerobic Plate Counts, Anaerobic Plate Count, Mac Conkey gram positive (Lactose oxidizers), Mac Conkey gram negative (Lactose non oxidizers), Mold, Yeast, Actinomycetes Total, Actinomyc s that produce extraeellularchitinase enzymes, Beta Hemolytic and Non Beta Hemolytic. In addition Biochem Identification of the Mac (L-) and Mac (L+) were carried out to identify specific microbes that might have biological control characteristics for the Botrytis and/ or Powdery Mildew.

FOLIAR FEEDING RESEARCH

As part of the research we experimented with high quality, organically acceptable, foliar feeding nutrients in an attempt to supplement fertility, increase plant sap and fruit Brix, convert excess Nitrates into complete proteins and ultimately to improve the plants resistance to the foliar diseases. Over the last twelve, years I have experimented with increasingly complex and active organic foliar feeding materials. During this experiment we applied my latest concoction, known commercially as the Brix Mix to the raspberries a total of four times. Two applications were made in late September and mid October. The next two applications were made in late March and mid April. The Brix Mix consists of a proprietary mixture of Kelp, Fish, Corn Calcium, Sulfur, Sulfate of Potash, Omega 2-7-7, Humic Acids, Chelated Trace Minerals, Yucca, Sugar, Hydrogen Peroxide, and Vinegar. This material was applied at the rate of 1 gallon of liquids and 10 pounds of dry materials per acre, per application, which was diluted with 50-gallons of well water per acre and applied with a standard Rears sprayer.

COMPOST TEA RESEARCH

We have been researching the manufacture and use of compost teas for the last seven years. Each year

we have made progress in improving the extraction process and performance of these teas. Very significant process was made in 1994 and spring 1995, as we improved the aerobic digestion extraction dramatically by modifying the digester mechanism, which as it turns out allowed the more rapid extraction of the teas and much higher concentrations of microbes and humic substances in the extracted teas. The performance of the teas was by far the best we have experienced on the many crops where they were tried this year. On this raspberry project we applied the tea 3 times. The first application was in October 1994. The tea was mixed with the foliar feeding materials outlined above. Five gallons per acre was applied in this first application. In the spring of 1995 two more applications were made, each in combination with the foliar feeding materials. In these applications we reduced the rate per acre to 2 gallons per application. In hindsight I believe this was a mistake, even though we had improved our extraction efficiency. I believe in the future work we will increase the application rates to 10 gallons per acre per application. The methodology for extraction and manufacture of the teas will be outlined in our final report and detailed in our presentations this winter.

RESULTS

The techniques employed generally produced positive to very positive results. For the spring harvested crop the Botrytis incidence on the foliage was reduced by 60-80% and the Botrytis damage on the harvested fruit was reduced 45-70% from the unsprayed control plot. In addition, the organic treatments were comparable to slightly (<10%) poorer compared to the chemical fungicide treatments on the remaining acreage.

Perhaps due to environmental factors, the incidence of powdery mildew was very low to non existent in all plots, so no valid comparison can be made in regards to the methods used for powdery Mildew management in our research plot,

Additionally, probably due to the extreme amount of rain and nearly continual cloudy, low light days in March thru April, a normally minor pathogen, rust (Puccinella sp.) had a tremendous outbreak in all plots. The farmer commented that this was by far the worst damage from rust he had seen in more than 15 years of growing raspberries. The rust damage generally caused plant decline, reduced photosynthesis, lower Brix readings in the leaves and harvested fruit and in heavily infested areas, actually caused plant death. In addition rust spores damaged much of the fruit making it cosmetically inferior and/or unmarketable in the fresh raspberry market. This pathogen deserves more study and we wish to include it in our 1995-1996 work..

It appears that the bulk of our success was due to a combination of applications of foliar applied compost tea and a sophisticated foliar feeding program. Our attempts to collect, identify, culture and apply biological control microbes collected from the research plot met with mixed results. We did identify 2 promising Botrytis biocontrol candidates, but were only able to culture one of these species successfully. The application of this species, *Klebsiella oxytoca,* was not successful in that it did not colonize into higher numbers as anticipated. We believe this may be as a result of improper application timing in conjunction with the heavy rain pressure this spring. Another possibility is that we did not apply the organisms with enough additional food for it to establish. A second year of research would be most useful to verify and/or modify these observations and results.

We were unable to identify any bio control microbes that appeared active against powdery mildew, quite possibly because the overall incidence of powdery mildew was

so low on the crop this year. A second year of looking for powdery mildew bioagents appears to be warranted. We did not do any bioassay work in regards to the rust biocontrol agents. This is fertile ground for a second years research effort.

We have made significant progress in improving the methods and quality associated with making compost tea. We believe that these improved aerobic extraction methods have improved the performance of the teas, an observation which has also been made by other growers clients who have similarly improved their compost tea making abilities. We believe that we underapplied the teas during the spring applications. We will increase the application rates and possibly the application frequency in the second year of this research.. We will detail the methods of manufacture, usage and results during this winter at talks I will be giving at the Ecological Farming Conference, OAA Organic Farming Seminars, Lighthouse Farm meetings and the Acres, USA conference.

In addition the application of an improved foliar feeding mixture, known as the Brix Mix, significantly raised the leaf sap Brix readings during the testing period. This increased Brix phenomenon was observed after both applications of the Brix mix, but the residual effect from the foliar applications was not long enough. The focus of this next round of research will be to increase the application frequency of the foliar feeding materials, and also the combined use of the Brix Mix with the compost tea, using the tea as a carrier, diluent and nutrient source.

The use of the laboratory plant tissue and soil analysis has been helpful in correlating the in field measurements we are obtaining using the refractometer, Cardy Nitrate Meter, ERGS, ORPS and pH. Generally we have seen that the Nitrate levels in the leaf sap negatively affect the Brix readings with the refractometer, i.e., the higher the Nitrate readings the lower the Brix readings. This higher Nitrogen /lower Brix relationship appears to exacerbate the incidence of Botrytis and possibly rust. There did not appear to be a relationship in this regards to mildew infestation. More work is warranted in this area, especially in regards to timing and quantity of nitrogen fertilizer applications.

In summation I believe we have made very substantial, positive progress in this first year of testing. A second year of research would be very helpful in order to confirm or alter our first year's observations and to study in more depth the areas outlined above. If I can answer any questions in regards to this report or our overall research plan please do ask. Thank you for your funding of our first year's research. I hope you can continue to assist this important research.