# PROJECT PROPOSAL
# COMPREHENSIVE RESEARCH ON RICE
January 1, 2012 – April 30, 2013

**PROJECT TITLE:** Rice Disease Research and Management

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**LEVEL OF 2012 FUNDING:** $32,104.00

## OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

The proposed research is a compilation of individual projects focused on multiple California rice diseases. The overall objective of the proposed research is to increase understanding of the biology of California rice diseases and to develop effective and economically viable management practices for these diseases.

Specific objectives of the proposed research are:

1) To evaluate timing and potential of fungicide applications (widely used as well as lesser known products) for aggregate sheath spot, stem rot and rice blast disease management.
2) To develop an effective method for comparing genetic relatedness among *P. grisea* isolates in California and to determine the relationship of historic California isolates to a newly identified race of the fungus which is pathogenic to M-208 rice.
3) To evaluate commercially available mycorrhizal products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor.
4) To evaluate commercially available seed treatment products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor. (Added post-proposal)

Objective 1: Evaluate timing and potential of fungicide applications
Over the past couple of years there have been several new fungicides registered for use in California rice but they are mostly reduced risk pesticides that have little or no efficacy data for California rice diseases or products that have only recently been made commercially available. Newer products that were evaluated included QuiltXcel (azoxystrobin + trifloxystrobin), Regalia (a natural plant extract that triggers a plant's natural defense systems to protect against a variety of fungal and bacterial pathogens), and Actinovate AG (a bacterial biological control organism). The proposed research will evaluate these new products alone and in combination with standard commercial fungicide programs to evaluate efficacy of these products and programs for disease management in California rice.

Four small plot fungicide trials were established in M-206 commercial rice fields (two in Colusa County, one in Sutter County, and one in Yuba County) in 2012 to evaluate these products alongside the industry standard Quadris fungicide (22.9% Azoxystrobin) for aggregate sheath spot (AGSS), stem rot (SR), and rice blast disease management. Application timing was targeted specifically to aggregate sheath spot and rice blast diseases (5-15% panicle emergence). In addition, applications of Quadris at 12.5 fl oz/Ac with and without Pro-Tron (IAP) were included in the trials to evaluate the benefits of the addition of a surfactant to the spray mix. Pro-Tron is a low-foaming nonionic surfactant which is reported to improve the deposition and penetration of active ingredients into the target plant.

Treatments were applied to 10' x 20' plots with a $CO_2$-powered backpack sprayer. Treatments were replicated four times at each location. Plots were harvested with the UC research combine (Almaco) to determine yield and collect subsamples for milling quality analysis. Milling quality analysis was conducted using an S21 Rice Statistical Analyzer (Agromay Soluciones Técnicas, S.L.) that inspects cereal grains through image processing and subsequent statistical analysis to allow quantification of defects in a sample. Total and whole (head) rice percentages were determined for each plot using this methodology. Random tiller samples were cut from three locations prior to harvest within each plot and a subset of 50 tillers from this bulked sample were evaluated per plot to determine disease incidence and severity. Fifty tillers were evaluated for aggregate sheath spot and rice blast diseases while 25 tillers were evaluated for stem rot disease. Visual ratings were conducted to divide tillers into different severity categories based upon disease severity.

Aggregate sheath spot disease is categorized mainly by movement of the disease up the tiller.

- Category 0 = no disease
- Category 1 = disease affecting second leaf below flag leaf or lower
- Category 2 = disease affecting leaf below flag leaf
- Category 3 = disease affecting flag leaf
- Category 4 = disease affecting panicle

Stem rot disease is categorized mainly by penetration of the culm by the disease.

- Category 0 = no disease
- Category 1 = disease lesions on outer leaf sheath
- Category 2 = disease lesions have penetrated into inner leaf sheaths
- Category 3 = disease lesions on culm
- Category 4 = culm is rotted through

- Category ratings were used to calculate:
  - Disease incidence = (# of tillers in categories 1-4) / Total tillers
  - Disease severity = [(#tillers in cat. 0 X 0) + (#tillers in cat. 1 X 1) + (#tillers in cat. 2 X 2) + (#tillers in cat. 3 X 3) + (#tillers in cat. 4 X 4) / Total # of tillers

Rice blast disease was categorized as neck blast or collar rot to calculate disease incidence.

**Table 1. Treatments for 2012 small plot fungicide trials**

| | |
|---|---|
| 1 | Untreated control |
| 2 | Quadris @ 12.5 fl oz/Ac at 5-15% panicle emergence |
| 3 | Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 4 | Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 5 | Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 6 | Quadris @ 12.5 fl oz/Ac + Regalia @ 1pint/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 7 | Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1pint/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 8 | Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence |
| 9 | Actinovate AG 9 oz/Ac + 3 pints/100 gal Pro-Tron at 5-15% panicle emergence fb 6 oz/Ac + 3 pints/100 gal Pro-Tron seven-ten days after first application |

<u>Objective 2: Develop an effective method for comparing genetic relatedness among *P. grisea* isolates in California</u>

The geographic distribution, incidence and severity of rice blast have been much greater in 2010 and 2011 than in recent years. There are several factors that may be contributing to this situation. M-208 is the only commercially available rice variety in California with a specific resistance gene to race IG-1 of the blast pathogen. IG-1 was the only race of this pathogen known to exist in California until recently. Unfortunately, confirmed cases of limited neck blast in 2010 M-208 fields and limited leaf and neck blast in 2011 and 2012 M-208 fields indicate that a new race of the pathogen has evolved through mutation or has been introduced into California. M-208 is still resistant to race IG-1 but is not resistant to this new race.

In previous collaborations with UC Riverside scientists, AFLP analysis with two primer pairs of the 2010 M-208 isolates indicated that these isolates were genetically similar to historic isolates from previous years. This evidence suggests that the new race of the pathogen has evolved through mutation/selection rather than through a new introduction from outside of the state. This information is important but more investigation is needed to determine the relationship of these M-208 isolates to each other as well as to those that do not infect M-208. This information will be critical in future monitoring of rice blast pathogen races in California as well as to breeders developing new rice blast resistant rice varieties.

In collaboration with Mike Davis (UC Davis Plant Pathology CE Specialist), we proposed to utilize genetic analysis resources on the UCD campus to study the pathogen population and identify genetic tools which will allow us to compare the M-208 isolate populations with historic isolates. Isolates from the 2012 season were collected in conjunction with California Crop Improvement and RES staff for culturing and storage of isolates. These isolates will be used for genetic analysis with the previously collected 2011 isolates. Genetic work was delayed and will be conducted in 2012. The goal is to identify genetic tools that will provide a better understanding of the loss of resistance in M-208 and provide us with a solid base for future population genetics studies of *P. grisea*.

<u>Objective 3. Evaluate commercially available mycorrhizal products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor</u>
Mycorrhizal organisms are known to form beneficial symbiotic relationships with plant roots and have been shown in many cases to increase nutrient uptake and mitigate stressors affecting plant growth and productivity. Much work has been done in recent years to study these organisms and more recently commercial products are being marketed and promoted for crop use. In addition, other seed treatment products are being promoted in California rice as stimulating increased rooting, stand establishment and yield. Some of these products are currently being used by California rice growers but there is little or no data available on their effectiveness.

MycoApply Liquid Endo is a concentrated liquid of 4 endomycorrhizal fungi in distilled water used as a soil drench or seed inoculant. MycoApply Liquid Endo contains mycorrhizal fungi that are promoted as colonizing plant roots and extending the root system into the surrounding soil to greatly enhance the absorptive surface area of root systems and form an essential link between plant and soil. These characteristics are reported to improve nutrient and water uptake, root health and result in superior field performance.

One small plot trial was established in an M-206 rice field at the Rice Experiment Station near Biggs, CA to evaluate MycoApply Liquid Endo as a seed soak treatment for California rice. One rate of MycoApply Liquid Endo was tested against a standard seed soak treatment of 2.5% Ultra

Clorox Bleach for 24 hours. 2.5% Ultra Clorox Bleach was also added to the MycoApply Liquid Endo seed soak solution.

**Table 2. List of Seed Soak Treatments**

| Seed Soak Treatments |
|---|
| 1) 2.5% Ultra Clorox Bleach for 24 hr |
| 2) MycoApply Liquid Endo 4.5 oz/150 lb seed - with 2.5% Ultra Clorox Bleach for 24 hr |

*Small plot trials* - Treatments were applied by mixing each seed soak solution in a separate bucket and placing cotton bags containing premeasured seed amounts into the appropriate treatment bucket. Treatments were replicated four times and a buffer area was left between each plot. All plots were fertilized only with pre-plant ammonium sulfate at 150 lb N/Ac in an effort to avoid excessive potassium and phosphorous that might interfere with results. Small plots measured 10'x20'. All plots were water seeded by hand.

Yield, seedling vigor, seedling count, tiller count, days to 50% heading, plant height, lodging, harvest grain moisture were evaluated for each of the experimental plots. Seedling vigor was estimated visually on a scale of 1-5 (5 = best) at approximately two weeks after seeding. Seedling count per square foot was determined by counting the established seedlings at the 2-3 leaf stage in a one square foot sampling unit within each plot. Tiller count per square foot was determined by counting tillers shortly after heading in a one square foot sampling unit within each plot. Days to 50% heading was estimated visually. Plant height just prior to harvest was determined by measuring from the soil line to the tip of the panicle for the tallest tiller of several plants in each plot. Percent lodging was estimated visually at harvest. Plots were harvested with a research combine (Sweco) to determine harvest grain moisture and yield. In each plot, a one square foot sample of plants were cut from each plot near the soil surface in order to quantify the number of panicles/square foot, total panicle weight per square foot, and the mean weight per panicle within each one square foot sampling unit.

<u>Objective 4. Evaluate commercially available seed treatment products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor (Added post-proposal)</u>

Essential Plus 1-0-1 is a 100% organic liquid that is promoted as a safe, effective root stimulant for plants in every stage of growth. Created by Growth Products, Ltd., Essential is derived from potassium humate, 20 natural L-amino acids, enzymes, simple & complex sugars, vitamins, kelp extracts, carbohydrates, hydrolyzed organic proteins, a natural wetting agent and natural biostimulants. According to the manufacturer's information, Essential increases both the percent of seed germination and the speed with which seeds germinate-even with difficult to germinate seeds. This is thought to be due to Essential's controlled mix of humic acids and natural wetting agents which increase seed coat permeability, and its other root stimulants.

One small plot trial was established in an M-206 rice field at the Rice Experiment Station near Biggs, CA to evaluate Essential Plus 1-0-1 (Essential) as a seed soak treatment for California rice. In addition, a germination board experiment was conducted to evaluate Essential seed soak effects on rice seed germination using different rice varieties. Two different rates of Essential were tested against a standard seed soak treatment of 2.5% Ultra Clorox Bleach for 24 hours in all experiments.

**Table 3. List of Seed Soak Treatments**

| Seed Soak Treatments |
|---|
| 3) 2.5% Ultra Clorox Bleach for 24 hr |
| 4) Essential Plus 1-0-1 32 oz/100 gal - with 2.5% Ultra Clorox Bleach for 24 hr |
| 5) Essential Plus 1-0-1 64 oz/100 gal - with 2.5% Ultra Clorox Bleach for 24 hr |

*Small plot trials* - Treatments were applied by mixing each seed soak solution in a separate bucket and placing cotton bags containing premeasured seed amounts into the appropriate treatment bucket. Treatments were replicated four times and a duplicate set of plots were established to allow destructive sampling in four plots for each treatment. Therefore, a total of eight replications per treatment were established. Small plots measured 10'x20'. All plots were water seeded by hand.

Yield, seedling vigor, seedling count, tiller count, days to 50% heading, plant height, lodging, and harvest grain moisture were evaluated for each of the 24 experimental plots. Seedling vigor was estimated visually on a scale of 1-5 (5 = best) at approximately two weeks after seeding. Seedling count per square foot was determined by counting the established seedlings at the 2-3 leaf stage in a one square foot sampling unit within each plot. Tiller count per square foot was determined by counting tillers shortly after heading in a one square foot sampling unit within each plot. Days to 50% heading was estimated visually. Plant height just prior to harvest was determined by measuring from the soil line to the tip of the panicle for the tallest tiller of several plants in each plot. Percent lodging was estimated visually at harvest. Plots were harvested with a research combine (Sweco) to determine harvest grain moisture and yield.

In one half of the plots, a one square foot sample of plants were cut from each plot near the soil surface in order to quantify the number of panicles/square foot, total panicle weight per square foot, and the mean weight per panicle within each one square foot sampling unit.

*Germination board trials* – The germination board experiment was a multi-factor experiment to investigate the effects of different seed soak treatments on six different California rice varieties, resulting in a total of 18 different seed treatment by variety combinations. Treatments were applied by mixing each seed soak solution in a separate bucket and placing cotton bags containing premeasured seed amounts into the appropriate treatment bucket. Treatments were replicated four times. Each replicate for a specific seed treatment by rice variety combination consisted of 10 seeds on an individual germination board. Germination boards were placed in a glass dish filled with water to allow wicking material to provide moisture to the germinating seeds. Germination boards were incubated at 85$^{o}$ F for two weeks prior to measuring shoot and root length. Mean shoot and root lengths for each seedling were used to calculate a mean for each germination board (replicate) which was used for statistical analyses.

**Table 4. List of Germination Board Treatments**

| Seed Soak Treatments | Rice Varieties |
|---|---|
| 2.5% Ultra Clorox Bleach for 24 hr | M-206 |
| Essential 32 oz/100 gal - with 2.5% Ultra Clorox Bleach for 24 hr | M-205 |
| Essential 64 oz/100 gal - with 2.5% Ultra Clorox Bleach for 24 hr | M-104 |
| | M-105 |
| | L-206 |
| | CH-201 |

## SUMMARY OF 2012 RESEARCH, BY OBJECTIVE:

<u>Objective 1: Evaluate timing and potential of fungicide applications</u>

*General Comments*

In general, 2012 was somewhat of an odd year for rice diseases in California. Both aggregate sheath spot disease and rice blast disease progress appeared to be hindered by an extended period of high temperatures mid-season. Of particular interest was a ten day period in early-mid August when temperatures exceeded 100$^{o}$ F and even approached 110$^{o}$ F on a couple of occasions. Prior to this episode, there were observations of leaf blast at both of the Colusa County trials and this was encouraging from a fungicide evaluation standpoint. However, excessive temperatures are not conducive to rice blast disease development and disease progress was halted for about a four week period with new lesions not being observed until approximately two weeks after the end of the excessive temperatures. In addition, no or very low levels of aggregate sheath spot disease were observed in each of the Colusa trial locations. This was an unexpected occurrence as we have never had a small plot fungicide trial with such low levels of aggregate sheath spot disease. Aggregate sheath spot disease typically progresses from the water-line and spreads up the tillers as the plant canopy closes towards the later part of the growing season. I speculate that in the warmer Colusa trial locations, the extreme heat dried out lower infected leaf sheaths and they sloughed off prior to disease progressing up the tiller to the higher leaf sheaths.

*North Colusa Location*

**Aggregate Sheath Spot (Table 5)**

With respect to aggregate sheath spot disease, disease pressure was negligible at this location and data were not sufficient to draw any conclusions about treatment efficacy.

**Stem Rot (Table 5, Figures 1 and 2)**

Stem rot disease pressure was high with (79% incidence in control) while severity was moderate. There were statistical differences among the treatments with respect to stem rot incidence and severity. All treatments containing Quadris or Quilt Xcel, alone or in combination with Regalia, resulted in significantly lower stem rot incidence than the control.

- Quilt Xcel @ 21 oz/Ac resulted in the lowest stem rot incidence but means were not significantly different than any of the three Quadris @ 12.5 ou/Ac treatments (including the Quadris @ 12.5 ou/Ac + Regalia @ 1 pt/Ac treatment).

All treatments other than Actinovate resulted in significantly lower stem rot severity than the control.

- Quilt Xcel @ 21 oz/Ac resulted in the lowest stem rot severity but means were not significantly different than any of the three Quadris @ 12.5 ou/Ac treatments (including the Quadris @ 12.5 ou/Ac + Regalia @ 1 pt/Ac treatment) or the Quadris @ 6 ou/Ac + Regalia @ 1 qt/Ac treatment.

**Rice Blast (Table 5, Figures 3 and 4)**

Rice blast disease incidence was very low in this trial location and data were not sufficient to draw any conclusions about treatment efficacy.

**Yield (Table 6, Figures 5 and 6)**

There were no statistical differences between treatments with respect to yield (range 8,402-9,254 lb/Ac).

**Milling Yield (Table 6, Figures 7 and 8)**

There were no statistical differences between treatments with respect to milling yield.

**Table 5. North Colusa 2012 Small Plot Fungicide Trial Results – Disease Data**

| Treatment | Aggregate Sheath Spot Incidence (%) | Aggregate Sheath Spot Severity | Stem Rot Incidence (%) | | Stem Rot Severity | | Neck Blast Incidence (%) | Collar Blast Incidence (%) |
|---|---|---|---|---|---|---|---|---|
| 1) Control | 0.000 | 0.000 | 79.0 | d | 2.100 | d | 0.0 | 1.0 |
| 2) Quadris @ 12.5 fl oz/Ac | 0.000 | 0.000 | 48.0 | abc | 1.130 | abc | 0.0 | 2.5 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 0.050 | 0.005 | 44.0 | ab | 0.980 | ab | 0.0 | 0.5 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 29.0 | a | 0.660 | a | 0.0 | 0.0 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 54.0 | bc | 1.260 | abc | 0.5 | 0.0 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 48.0 | abc | 1.080 | ab | 0.0 | 1.0 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 53.0 | bc | 1.350 | bc | 0.0 | 0.0 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 57.0 | bcd | 1.450 | bc | 0.5 | 0.5 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 0.000 | 0.000 | 69.0 | cd | 1.700 | cd | 1.0 | 2.5 |
| P-value | ---- | ---- | 0.0151 | | 0.0032 | | 0.6560 | 0.6007 |
| LSD | ---- | ---- | 23.8584 | | 0.206758 | | NS | NS |

**Figure 1. North Colusa 2012 Small Plot Fungicide Trial Results – Stem Rot Incidence**

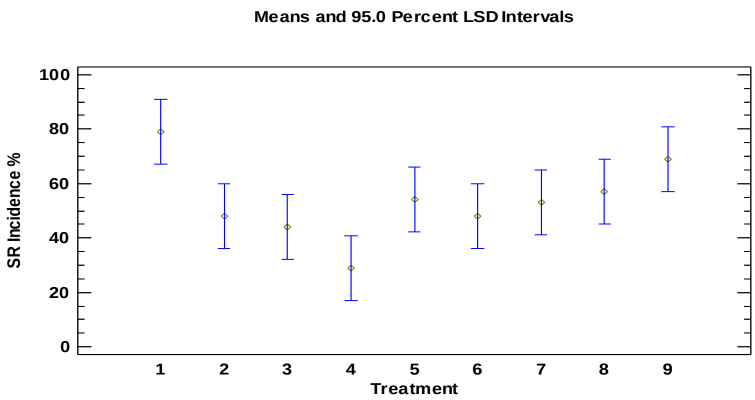



**Figure 2. North Colusa 2012 Small Plot Fungicide Trial Results – Stem Rot Severity**

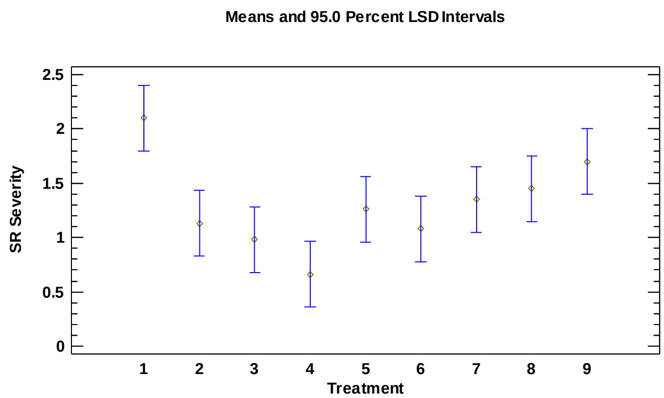



**Figure 3. North Colusa 2012 Small Plot Fungicide Trial Results – Neck Blast Incidence**

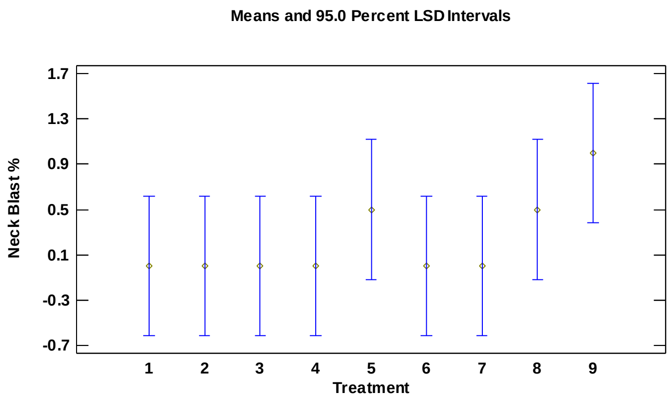



**Figure 4. North Colusa 2012 Small Plot Fungicide Trial Results – Collar Blast Incidence**

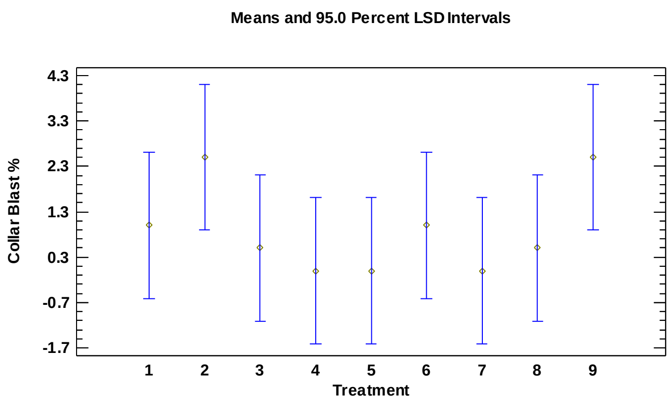


**Table 6. North Colusa 2012 Small Plot Fungicide Trial Results – Harvest Data**

| Treatment | Harvest Moisture (%) | | Yield (lb/Ac) | Milling Quality % Total | Milling Quality % Whole |
|---|---|---|---|---|---|
| 1) Control | 20.51 | abc | 9079 | 73.03 | 64.42 |
| 2) Quadris @ 12.5 fl oz/Ac | 21.07 | bc | 8402 | 73.00 | 65.48 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 21.70 | c | 8587 | 73.33 | 64.19 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 21.04 | bc | 8721 | 73.72 | 66.39 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 21.80 | c | 9254 | 72.57 | 65.90 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 21.11 | bc | 9252 | 73.02 | 65.61 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 20.94 | bc | 9251 | 73.22 | 65.15 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 18.90 | a | 8803 | 73.70 | 65.68 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 19.49 | ab | 8911 | 73.30 | 63.60 |
| P-value | 0.0437 | | 0.2570 | 0.1157 | 0.6313 |
| LSD | 0.616638 | | NS | NS | NS |

**Figure 5. North Colusa 2012 Small Plot Fungicide Trial Results – Harvest Grain Moisture (%)**

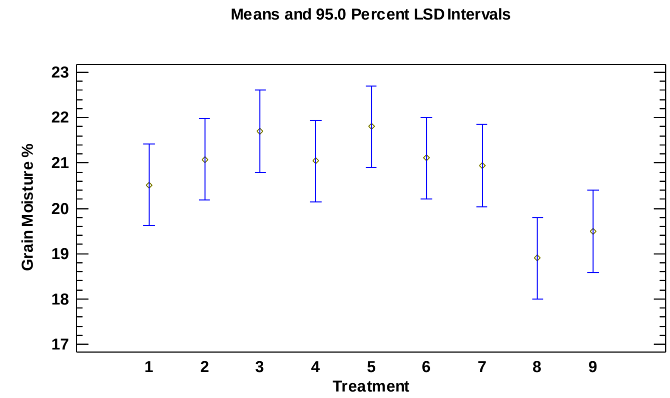



**Figure 6. North Colusa 2012 Small Plot Fungicide Trial Results – Yield (lb/ac @ 14% moisture)**

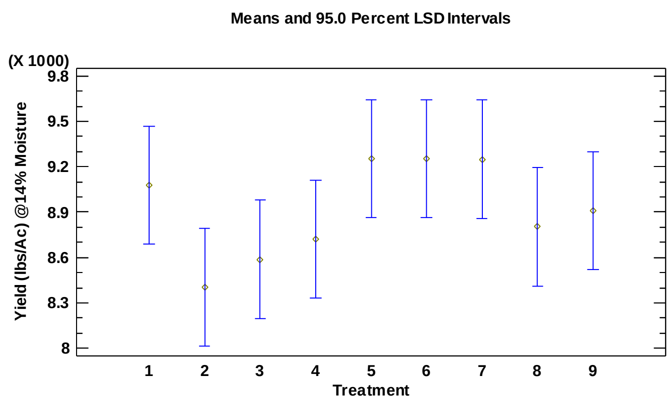



**Figure 7. North Colusa 2012 Small Plot Fungicide Trial Results – Milling – Total Rice (%)**

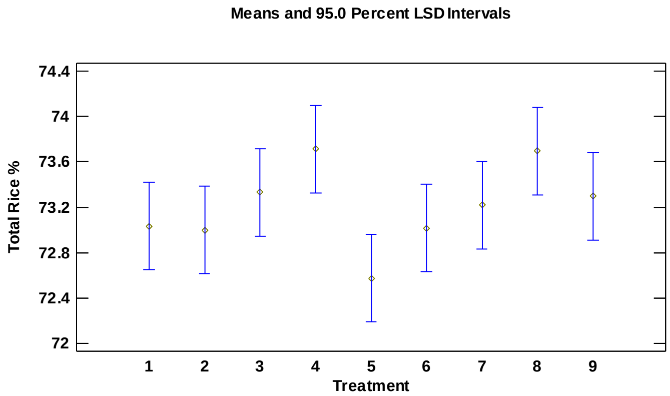
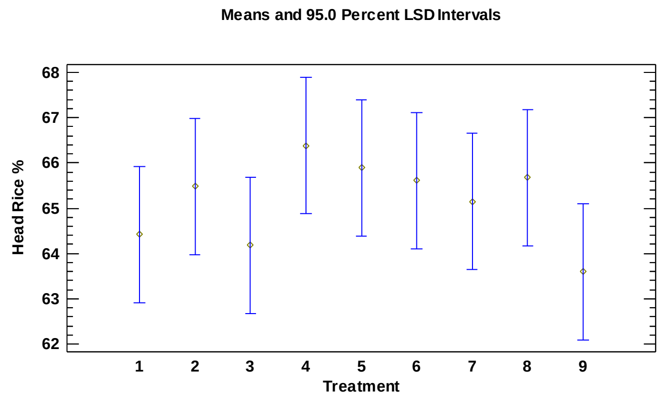



**Figure 8. North Colusa 2012 Small Plot Fungicide Trial Results – Milling – Whole Rice (%)**



*South Colusa Location*

**Aggregate Sheath Spot (Table 7)**

With respect to aggregate sheath spot disease, disease pressure was negligible at this location and data were not sufficient to draw any conclusions about treatment efficacy.

**Stem Rot (Table 7, Figures 9 and 10)**

Stem rot disease pressure was low with (29% incidence in control) while severity was low. There were no statistical differences among the treatments with respect to stem rot incidence and severity.

- While not statistically different than the control or the other treatments, Quilt Xcel @ 21 oz/Ac and the Quilt Xcel @ 21 oz/Ac + Regalia @ 1 pt/Ac treatments resulted in the lowest stem rot incidence means.
- While not statistically different than the control or the other treatments, Quilt Xcel @ 21 oz/Ac and the Quilt Xcel @ 21 oz/Ac + Regalia @ 1 pt/Ac treatments resulted in the lowest stem rot severity means.

**Rice Blast (Table 7, Figures 11 and 12)**

Rice blast disease incidence was very low in this trial location and data were not sufficient to draw any conclusions about treatment efficacy. This disease is quite sporadic on a spatial distribution level. There was a rice blast disease focus just outside of the fungicide trial plot area and this resulted in plots closest to the focus having higher incidences of neck blast and collar blast.

**Yield (Table 8, Figures 13 and 14)**

There were no statistical differences between treatments with respect to yield (range 8,829-9,755 lb/Ac).

**Milling Yield (Table 8, Figures 15 and 16)**

There were no statistical differences between treatments with respect to milling yield. In general, % whole rice means at this location are lower than what would normally be expected. This is most likely due to lower grain moistures and lodging at harvest that led to increased grain fissuring and breakage during the milling process.

**Table 7. South Colusa 2012 Small Plot Fungicide Trial Results – Disease Data**

| Treatment | Aggregate Sheath Spot Incidence (%) | Aggregate Sheath Spot Severity | Stem Rot Incidence (%) | Stem Rot Severity | Neck Blast Incidence (%) | Collar Blast Incidence (%) |
|---|---|---|---|---|---|---|
| 1) Control | 0 | 0 | 29.0 | 0.925 | 2.5 | 1.0 |
| 2) Quadris @ 12.5 fl oz/Ac | 0 | 0 | 22.5 | 0.635 | 0.0 | 6.0 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 29.5 | 0.810 | 1.5 | 3.5 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 18.5 | 0.510 | 0.0 | 1.5 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 27.5 | 0.835 | 0.0 | 1.0 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 22.5 | 0.640 | 0.0 | 2.0 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 18.5 | 0.525 | 0.0 | 1.5 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 37.5 | 1.165 | 7.5 | 7.5 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 0 | 0 | 28.5 | 0.870 | 0.5 | 10.0 |
| P-value | --- | --- | 0.1440 | 0.0593 | 0.4724 | 0.1365 |
| LSD | --- | --- | NS | NS | NS | NS |

**Figure 9. South Colusa 2012 Small Plot Fungicide Trial Results – Stem Rot Incidence**

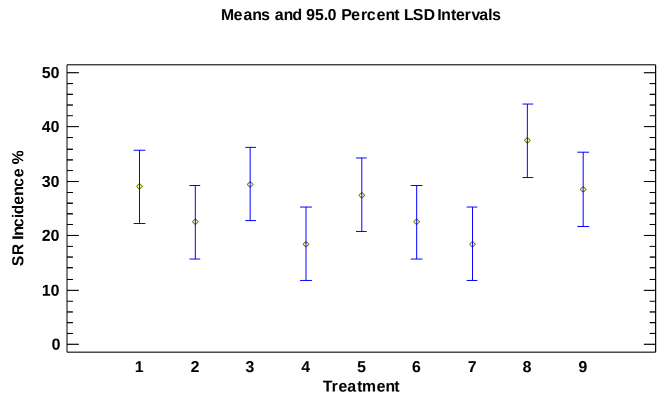



**Figure 10. South Colusa 2012 Small Plot Fungicide Trial Results – Stem Rot Severity**

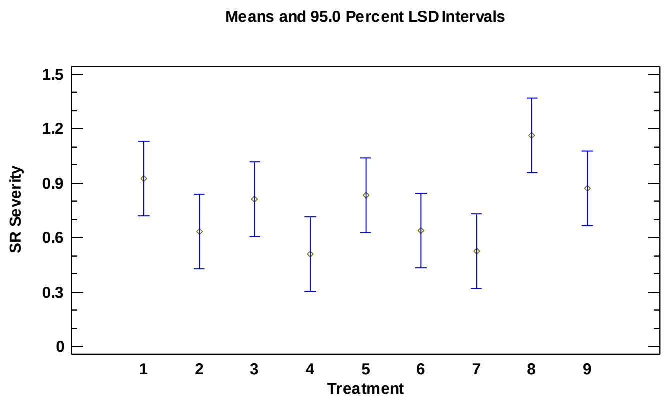



**Figure 11. South Colusa 2012 Small Plot Fungicide Trial Results – Neck Blast Incidence**

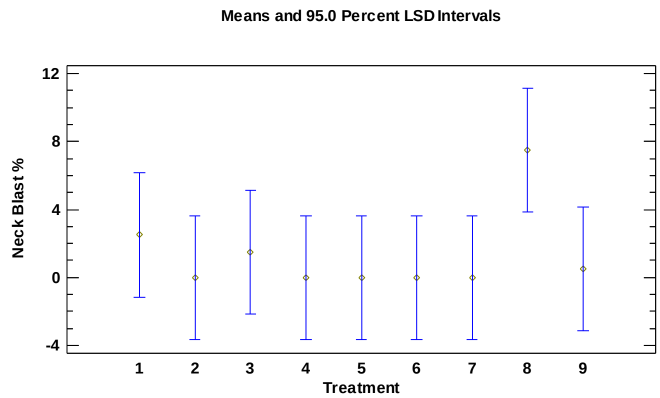



**Figure 12. South Colusa 2012 Small Plot Fungicide Trial Results – Collar Blast Incidence**

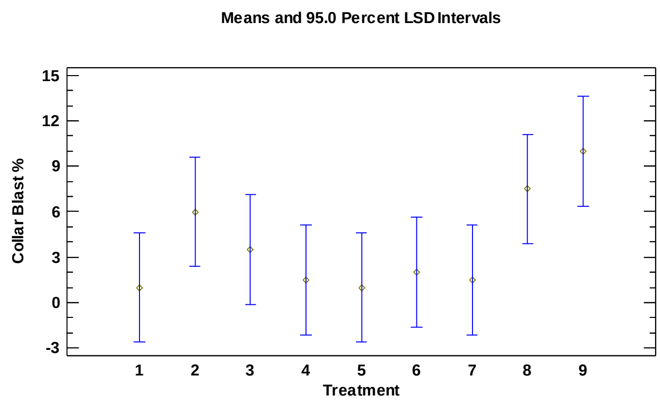


**Table 8. South Colusa 2012 Small Plot Fungicide Trial Results – Harvest Data**

| Treatment | Harvest Moisture (%) | Yield (lb/Ac) | Milling Quality % Total | Milling Quality % Whole |
|---|---|---|---|---|
| 1) Control | 18.01 | 8884 | 72.54 | 54.87 |
| 2) Quadris @ 12.5 fl oz/Ac | 18.31 | 9700 | 73.17 | 57.45 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 18.27 | 9432 | 72.83 | 56.76 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 18.41 | 9366 | 73.11 | 56.65 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 18.41 | 9294 | 72.88 | 55.85 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 18.83 | 8953 | 73.02 | 57.53 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 17.94 | 9755 | 73.60 | 56.13 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 18.24 | 9005 | 72.29 | 53.72 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 18.67 | 8829 | 72.80 | 55.40 |
| P-value | 0.4473 | 0.2044 | 0.2755 | 0.3545 |
| LSD | NS | NS | NS | NS |

**Figure 13. South Colusa 2012 Small Plot Fungicide Trial Results – Harvest Grain Moisture (%)**

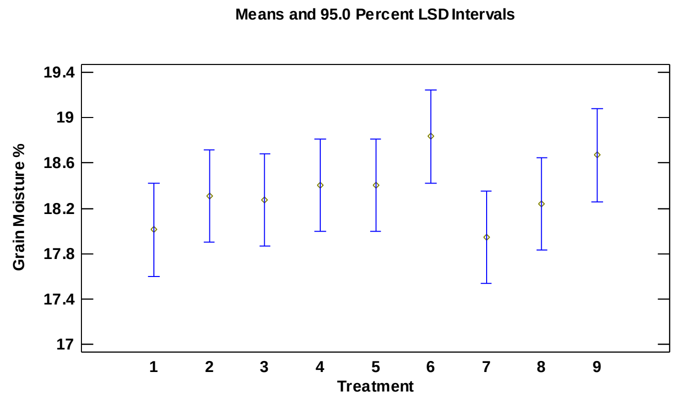



**Figure 14. South Colusa 2012 Small Plot Fungicide Trial Results – Yield (lb/ac @ 14% moisture)**

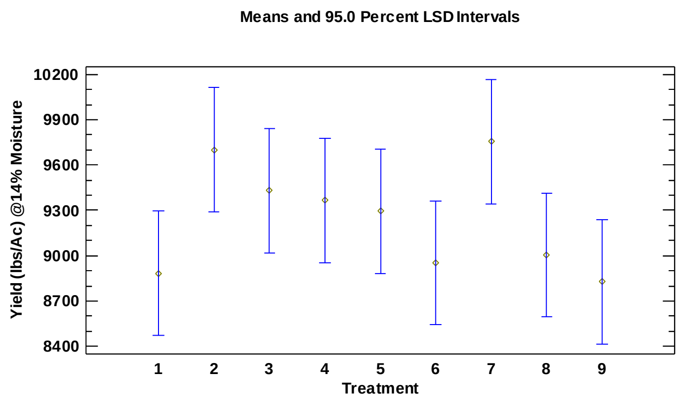



**Figure 15. South Colusa 2012 Small Plot Fungicide Trial Results – Milling – Total Rice (%)**

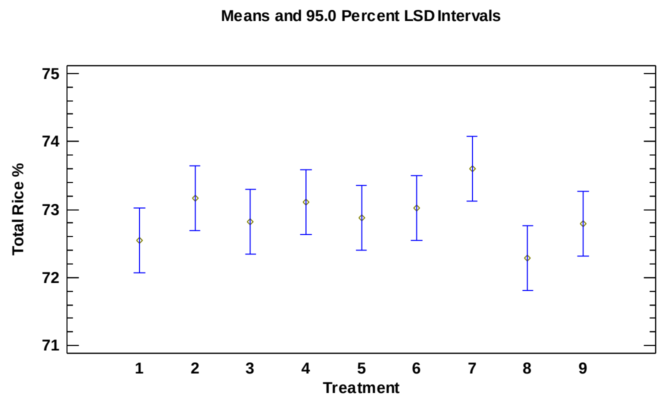
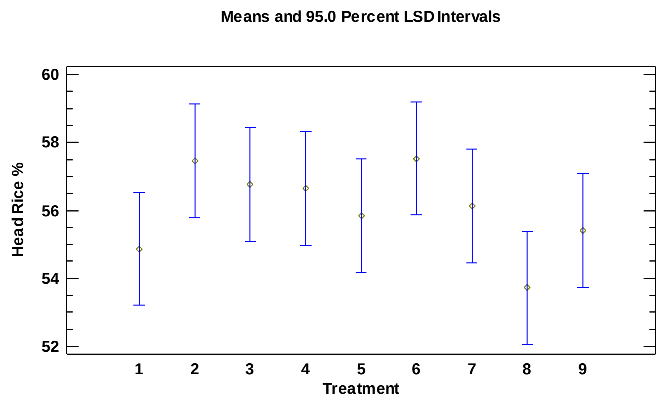



**Figure 16. South Colusa 2012 Small Plot Fungicide Trial Results – Milling – Whole Rice (%)**



*Yuba Location*

**Aggregate Sheath Spot (Table 9, Figures 17 and 18)**

With respect to aggregate sheath spot disease, disease pressure was high (79% incidence in control) and severity was low at this location. There were statistical differences among the treatments with respect to aggregate sheath spot incidence and severity. All treatments other than Actinovate resulted in significantly lower aggregate sheath spot incidence than the control.

- Quilt Xcel @ 21 oz/Ac resulted in the lowest aggregate sheath spot incidence but was not significantly different than Quadris @ 12.5 ou/Ac w/ProTron, Quadris @ 6 oz/Ac + Regalia @ 1 qt/Ac , or Quilt Xcel @ 21 oz/Ac + Regalia @ 1 pt/Ac .

All treatments other than Actinovate resulted in significantly lower aggregate sheath spot severity than the control.

- Quilt Xcel @ 21 oz/Ac resulted in the lowest aggregate sheath spot severity but the mean was only significantly less than the control, Regalia @ 1 qt/Ac , and Actinovate treatments.

**Stem Rot (Table 9, Figures 19 and 20)**

Stem rot disease pressure was low with (14% incidence in control) while severity was very low. There were statistical differences among the treatments with respect to stem rot incidence but not severity.

- Quadris @ 12.5 ou/Ac + Regalia @ 1 pt/Ac treatment was the only treatment that resulted in a significant reduction in stem rot incidence over the control treatment. However, this treatment was not significantly better than any of the other treatments with the exception of the Actinovate treatment.

There were no statistical differences between treatments with respect to stem rot severity.

**Rice Blast (Table 9)**

Rice blast disease was not observed in this trial location and data were not sufficient to draw any conclusions about treatment efficacy.

**Yield (Table 10, Figures 21 and 22)**

There were no statistical differences between treatments with respect to yield (range 8,706-9,421 lb/Ac).

**Milling Yield (Table 10, Figures 23 and 24)**

There were no statistical differences among the treatments with respect to total milling yield but there were statistically significant differences in whole rice milling yield between the treatments. These differences are small on a commercial/economic return basis and none of the treatment means were significantly different than that of the control.

**Table 9. Yuba 2012 Small Plot Fungicide Trial Results – Disease Data**

| Treatment | Aggregate Sheath Spot Incidence (%) | Aggregate Sheath Spot Severity | Stem Rot Incidence (%) | Stem Rot Severity | Neck Blast Incidence (%) | Collar Blast Incidence (%) |
|---|---|---|---|---|---|---|
| 1) Control | 79.0 f | 0.865 c | 14.0 bc | 0.390 | 0.0 | 0.0 |
| 2) Quadris @ 12.5 fl oz/Ac | 50.5 cd | 0.510 ab | 7.0 ab | 0.210 | 0.0 | 0.0 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 39.0 abc | 0.410 a | 10.0 ab | 0.270 | 0.0 | 0.0 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 35.5 a | 0.365 a | 11.0 ab | 0.260 | 0.0 | 0.0 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 37.0 ab | 0.375 a | 8.0 ab | 0.190 | 0.0 | 0.0 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 49.5 bcd | 0.500 ab | 5.0 a | 0.100 | 0.0 | 0.0 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 46.0 abcd | 0.460 a | 9.0 ab | 0.180 | 0.0 | 0.0 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 57.5 de | 0.645 b | 12.0 abc | 0.310 | 0.0 | 0.0 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 70.0 ef | 0.810 c | 19.0 c | 0.480 | 0.0 | 0.0 |
| P-value | 0.0000 | 0.0000 | 0.0465 | 0.0565 | ---- | ---- |
| LSD | 13.1226 | 0.147419 | 7.83397 | NS | ---- | ---- |

**Figure 17. Yuba 2012 Small Plot Fungicide Trial Results – Aggregate Sheath Spot Incidence**

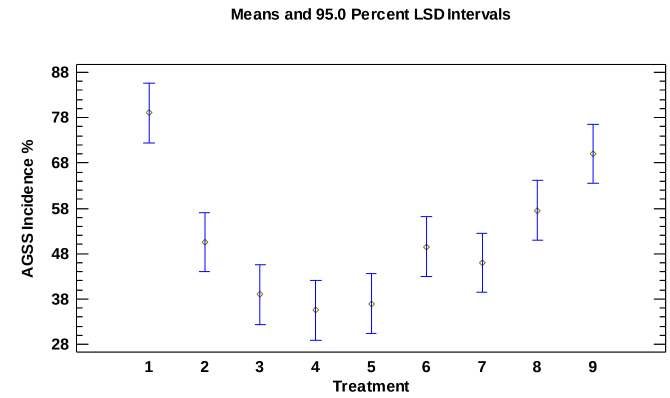



**Figure 18. Yuba 2012 Small Plot Fungicide Trial Results – Aggregate Sheath Spot Severity**

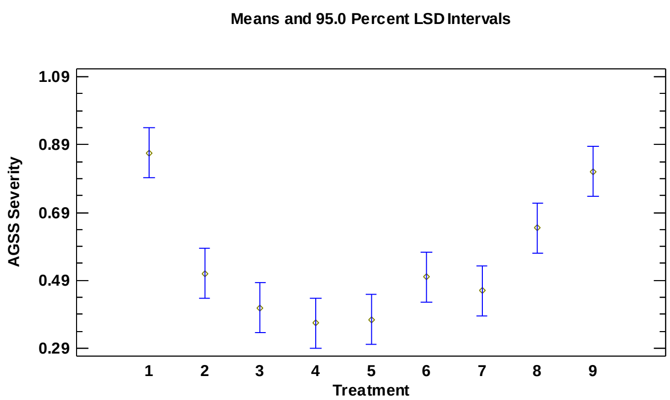



**Figure 19. Yuba 2012 Small Plot Fungicide Trial Results – Stem Rot Incidence**

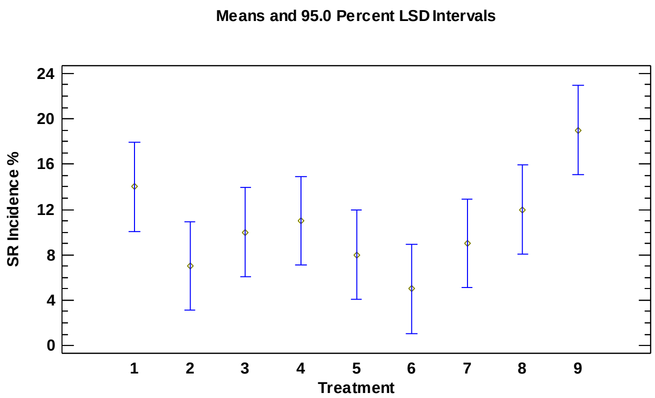



**Figure 20. Yuba 2012 Small Plot Fungicide Trial Results – Stem Rot Severity**

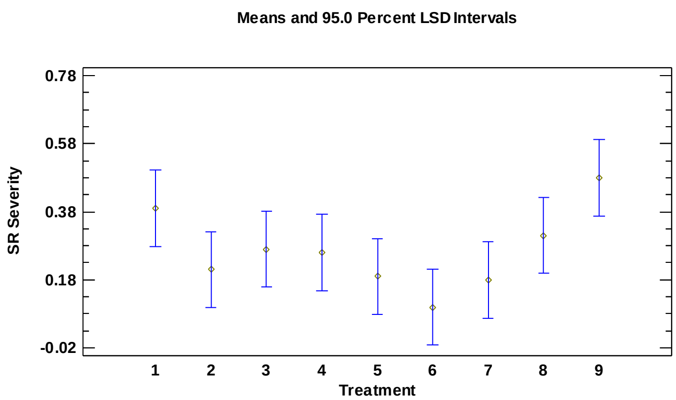


**Table 10. Yuba 2012 Small Plot Fungicide Trial Results – Harvest Data**

| Treatment | Harvest Moisture (%) | Yield (lb/Ac) | Milling Quality % Total | Milling Quality % Whole | |
|---|---|---|---|---|---|
| 1) Control | 20.09 | 8706 | 71.68 | 65.90 | abcd |
| 2) Quadris @ 12.5 fl oz/Ac | 19.10 | 9292 | 72.12 | 66.31 | bcd |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 20.74 | 9128 | 71.86 | 65.17 | ab |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 20.09 | 9184 | 71.67 | 65.28 | abc |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 19.92 | 9421 | 71.83 | 66.00 | bcd |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 19.69 | 9234 | 72.50 | 66.82 | cd |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 19.92 | 9171 | 72.35 | 66.97 | d |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 18.90 | 8940 | 71.50 | 64.42 | a |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 19.33 | 9139 | 72.10 | 65.24 | ab |
| P-value | 0.1890 | 0.4994 | 0.4646 | 0.0440 | |
| LSD | NS | NS | NS | 1.56919 | |

**Figure 21. Yuba 2012 Small Plot Fungicide Trial Results – Harvest Grain Moisture (%)**

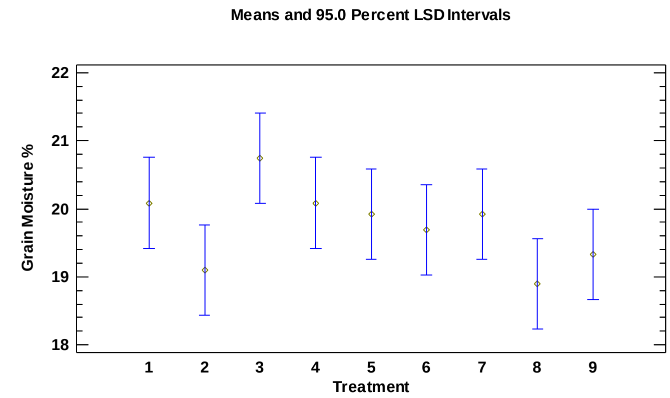



**Figure 22. Yuba 2012 Small Plot Fungicide Trial Results – Yield (lb/ac @ 14% moisture)**

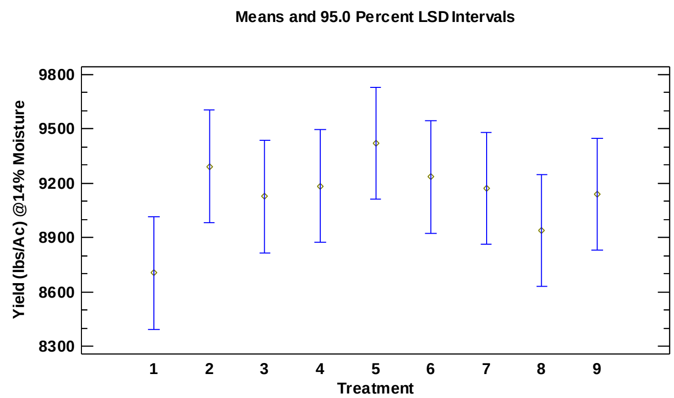



**Figure 23. Yuba 2012 Small Plot Fungicide Trial Results – Milling – Total Rice (%)**

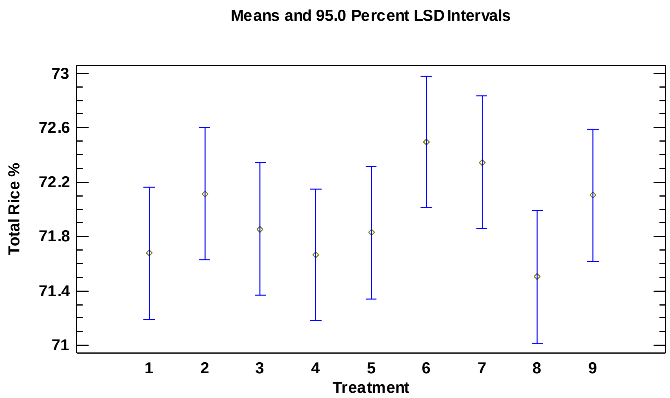
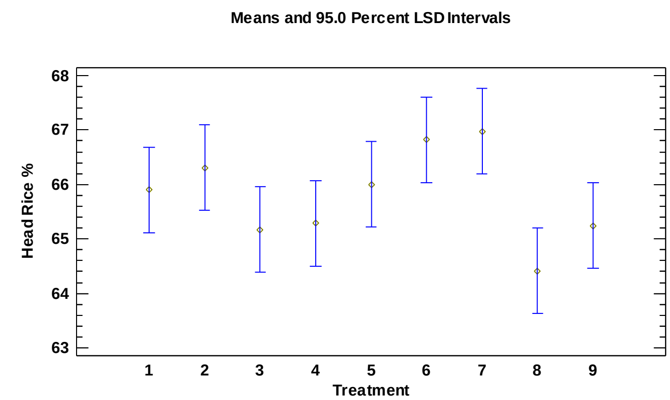



**Figure 24. Yuba 2012 Small Plot Fungicide Trial Results – Milling – Whole Rice (%)**



*Sutter Location*

**Aggregate Sheath Spot (Table 11, Figures 25 and 26)**

With respect to aggregate sheath spot disease, disease pressure was low (18% incidence in control) and severity was very low at this location. There were no statistical differences among the treatments with respect to aggregate sheath spot incidence and severity.

**Stem Rot (Table 11, Figures 27 and 28)**

Stem rot disease pressure was low with (10% incidence in control) while severity was very low at this location. There were no statistical differences among the treatments with respect to stem rot incidence and severity.

**Rice Blast (Table 11)**

Rice blast disease was not observed in this trial location and data were not sufficient to draw any conclusions about treatment efficacy.

**Yield (Table 12, Figures 29 and 30)**

There were no statistical differences between treatments with respect to yield (range 8,904-9,356 lb/Ac).

**Milling Yield (Table 12, Figures 31 and 32)**

There were no statistical differences between treatments with respect to milling yield at this trial location.

**Table 11. Sutter 2012 Small Plot Fungicide Trial Results – Disease Data**

| Treatment | Aggregate Sheath Spot Incidence (%) | Aggregate Sheath Spot Severity | Stem Rot Incidence (%) | Stem Rot Severity | Neck Blast Incidence (%) | Collar Blast Incidence (%) |
|---|---|---|---|---|---|---|
| 1) Control | 18 | 0.395 | 10.0 | 0.240 | 0.0 | 0.0 |
| 2) Quadris @ 12.5 fl oz/Ac | 4.5 | 0.085 | 13.0 | 0.240 | 0.0 | 0.0 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 9 | 0.12 | 10.0 | 0.230 | 0.0 | 0.0 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 9.5 | 0.145 | 6.0 | 0.120 | 0.0 | 0.0 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 20 | 0.375 | 8.0 | 0.180 | 0.0 | 0.0 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 15.5 | 0.225 | 6.0 | 0.120 | 0.0 | 0.0 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 1 | 0.015 | 12.0 | 0.270 | 0.0 | 0.0 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 3.5 | 0.055 | 7.0 | 0.150 | 0.0 | 0.0 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 9 | 0.15 | 13.0 | 0.320 | 0.0 | 0.0 |
| P-value | 0.7247 | 0.6764 | 0.2282 | 0.4822 | --- | --- |
| LSD | NS | NS | NS | NS | --- | --- |

**Figure 25. Sutter 2012 Small Plot Fungicide Trial Results – Aggregate Sheath Spot Incidence**

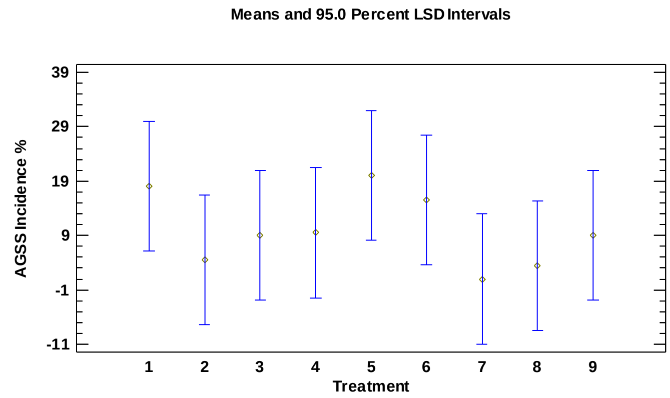



**Figure 26. Sutter 2012 Small Plot Fungicide Trial Results – Aggregate Sheath Spot Severity**

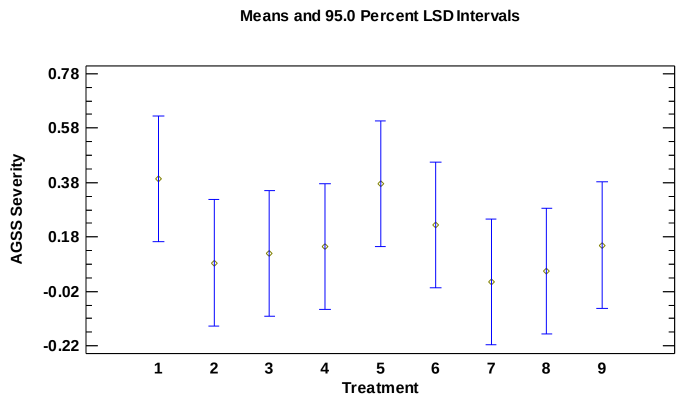



**Figure 27. Sutter 2012 Small Plot Fungicide Trial Results – Stem Rot Incidence**

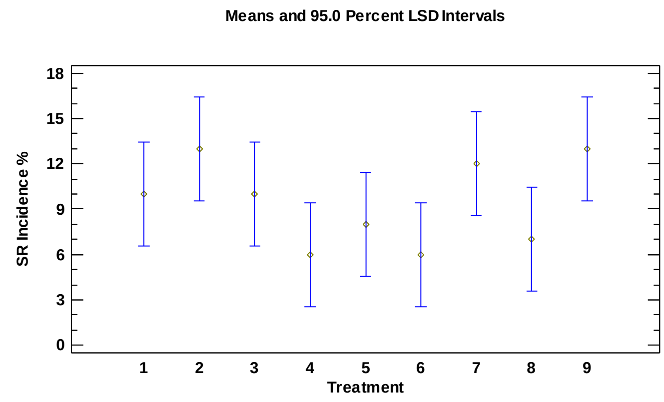



**Figure 28. Sutter 2012 Small Plot Fungicide Trial Results – Stem Rot Severity**

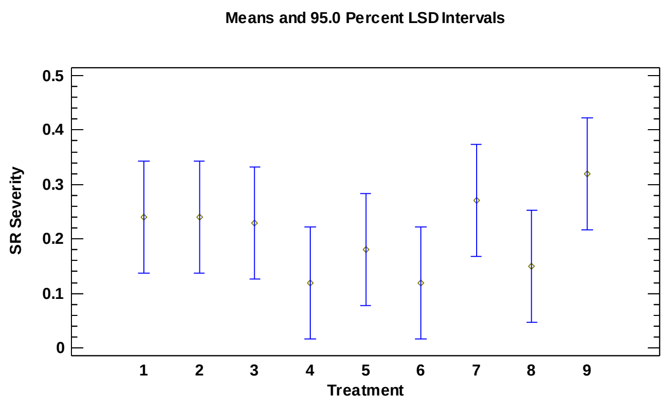


**Table 12. Sutter 2012 Small Plot Fungicide Trial Results – Harvest Data**

| Treatment | Harvest Moisture (%) | Yield (lb/Ac) | Milling Quality | |
|---|---|---|---|---|
| | | | % Total | % Whole |
| 1) Control | 19.36 | 8904 | 71.95 | 67.46 |
| 2) Quadris @ 12.5 fl oz/Ac | 20.22 | 8934 | 71.85 | 67.13 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 19.39 | 9066 | 72.18 | 67.79 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 19.43 | 9356 | 71.99 | 67.54 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 19.62 | 9007 | 71.66 | 67.36 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 19.76 | 9325 | 72.25 | 67.82 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 19.76 | 9345 | 72.28 | 67.64 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 19.26 | 9008 | 72.46 | 67.40 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 19.49 | 8910 | 71.86 | 66.68 |
| P-value | 0.2261 | 0.1378 | 0.7927 | 0.6095 |
| LSD | NS | NS | NS | NS |

**Figure 29. Sutter 2012 Small Plot Fungicide Trial Results – Harvest Grain Moisture (%)**

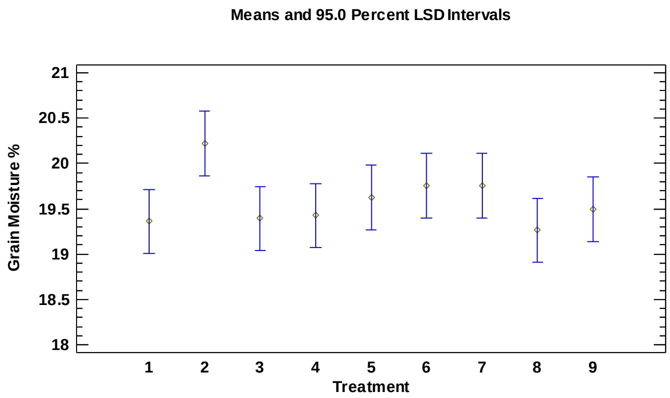



**Figure 30. Sutter 2012 Small Plot Fungicide Trial Results – Yield (lb/ac @ 14% moisture)**

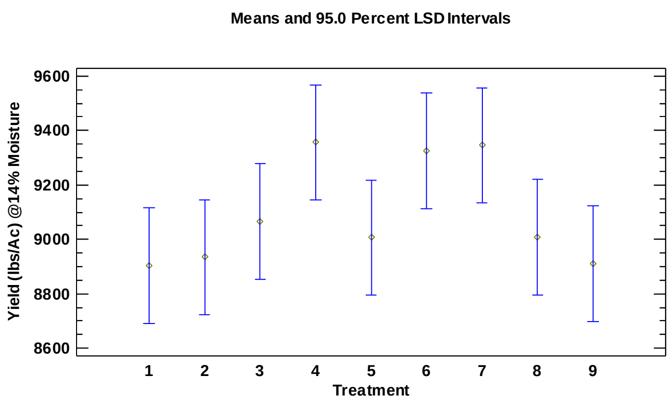



**Figure 31. Sutter 2012 Small Plot Fungicide Trial Results – Milling – Total Rice (%)**

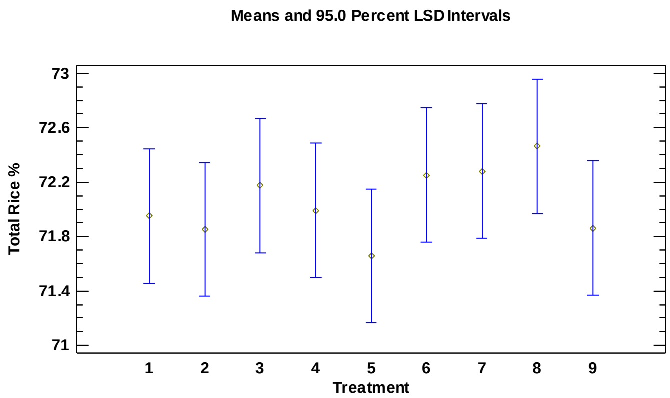
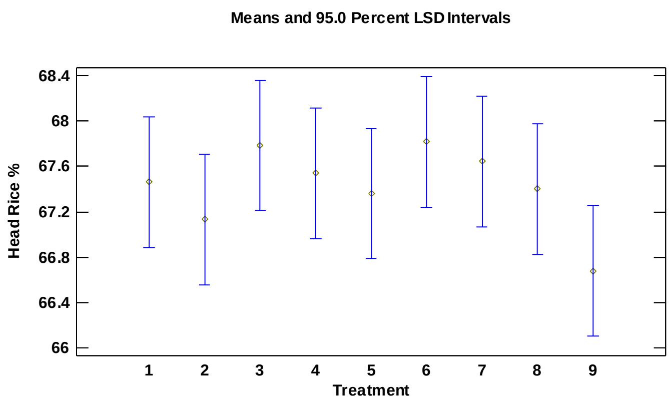



**Figure 32. Sutter 2012 Small Plot Fungicide Trial Results – Milling – Whole Rice (%)**



*Summary of Small Plot Fungicide Trials*
Extreme heat during an extended period made this a challenging year for evaluating rice disease control materials. These conditions influenced the progress of both rice blast and aggregate sheath spot diseases, especially in the warmer microclimates. We can gain some measure of efficacy of the tested materials by examining individual trials as well as taking a look at the bigger picture. Based upon disease pressure, the Yuba trial was probably the best evaluation of the materials for aggregate sheath spot management and the two Colusa trials were probably the best evaluation of the materials for stem rot management. Relative rankings of the tested materials for aggregate sheath spot and stem rot disease management by location are presented in Table 13. Relative rankings of the materials for yield data are presented in Table 14.

With respect to aggregate sheath spot, very little disease was observed at either one of the Colusa trial locations and disease pressure was low at the Sutter location, resulting in no significant differences among the treatment means. Aggregate sheath spot disease pressure at the Yuba location was high but the severity was somewhat lower than would normally be expected. All treatments other than Actinovate resulted in significantly lower aggregate sheath spot incidence and severity than the control. Quilt Xcel @ 21 oz/Ac resulted in the lowest aggregate sheath spot incidence but was not significantly different than Quadris @ 12.5 ou/Ac w/ProTron, Quadris @ 6 oz/Ac + Regalia @ 1 qt/Ac , or Quilt Xcel @ 21 oz/Ac + Regalia @ 1 pt/Ac . Quilt Xcel @ 21 oz/Ac resulted in the lowest aggregate sheath spot severity but the mean was only significantly less than the control, Regalia @ 1 qt/Ac , and Actinovate treatments.

With respect to stem rot disease, focus should be placed upon the two Colusa trial locations since they had a higher overall stem rot disease pressure than the other two locations. The North Colusa trial had the highest stem rot pressure with a 79% incidence in the control treatment. There were statistical differences among the treatments with respect to stem rot incidence and severity. All treatments other than Regalia alone or Actinovate resulted in significantly lower stem rot incidence than the control. Quilt Xcel @ 21 oz/Ac resulted in the lowest stem rot incidence but the mean was not significantly different than any of the three Quadris @ 12.5 ou/Ac treatments (including the Quadris @ 12.5 ou/Ac + Regalia @ 1 pt/Ac treatment). Stem rot incidence for the Quadris @ 6 oz/Ac + Regalia @ 1 qt/Ac treatment was significantly less than the control, significantly greater than the Quilt Xcel @ 21 oz/Ac treatment, and not statistically different from any of the other treatments. All treatments other than Actinovate resulted in significantly lower stem rot severity than the control. Quilt Xcel @ 21 oz/Ac resulted in the lowest stem rot severity but was not significantly different than any of the three Quadris @ 12.5 ou/Ac treatments (including the Quadris @ 12.5 ou/Ac + Regalia @ 1 pt/Ac treatment) or the Quadris @ 6 ou/Ac + Regalia @ 1 qt/Ac treatment.

The South Colusa trial had the next highest stem rot pressure with 29% incidence in the control treatment while severity was low. There were no statistical differences among the treatments with respect to stem rot incidence and severity at this location. While not statistically different than the control or the other treatments, Quilt Xcel @ 21 oz/Ac and the Quilt Xcel @ 21 oz/Ac + Regalia @ 1 pt/Ac treatments resulted in the lowest stem rot incidence and severity means.

With respect to yield data, there were generally no significant differences between treatments with respect to yield or milling yield means. The only exception was a statistically significant difference in whole rice milling yield between the treatments at the Yuba trial location. These differences are small on a commercial/economic return basis and none of the treatment means were significantly different than that of the control.

*Points of Emphasis*

- Variability in small plot yield data makes it difficult to uncover significant differences among treatments, especially with regards to yield even when mean differences may be as large as 800 lb/Ac or when disease pressure is low.
- Overall aggregate sheath disease pressure was quite low in 2012, most likely due to extreme heat during August. This is the first time in 15 years that I have evaluated a small plot fungicide trial with no observed aggregate sheath spot. Aggregate sheath spot at the Yuba trial location gave us a fairly good evaluation of the disease management materials.
    - Addition of Regalia to labeled rates of Quadris and Quilt Xcel did not generally result in increased efficacy of these products.
    - Quilt Xcel and Quadris applications resulted in a greater than 50% in aggregate sheath spot incidence and severity at the Yuba location.
- In prior years, Quadris treatments in small plot fungicide trials have shown little activity against stem rot disease of rice. Results of the 2012 trials indicate that Quadris and Quilt Xcel, either alone or in combination with Regalia, may significantly reduce stem rot incidence and severity.
    - The Quilt Xcel treatment resulted in the lowest or tied for lowest stem rot disease incidence and severity in three of the four trials.
    - The Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac treatment resulted in the lowest or tied for lowest stem rot disease incidence and severity in two of the four trials.
    - Quilt Xcel application resulted in a greater than 50% in stem rot incidence and severity at the Yuba location.
- The difficulty with rice blast is that small plot trials are not of much value unless you happen to get really lucky and end up in the perfect spot. This disease is usually not evenly distributed throughout the field so it is difficult to work with in small plot trials.
- It would be worthwhile to continue evaluation of Quadris and Quilt Xcel in 2013 to further examine activity under heavier aggregate sheath spot disease pressure.
- Quadris and Quilt Xcel should be evaluated in 2013 with a renewed focus on stem rot disease management in light of the results of the 2012 studies. In doing so, we should

evaluate two different fungicide timings and multiple applications to include an earlier mid-season timing that might have more of an impact on stem rot disease.

- Regalia tank mixed with below labeled rates of commercial fungicides may be pursued but I continue to have concerns about fungicide resistance management.

**Table 13. Relative Ranking of Treatments Across All Locations for Aggregate Sheath Spot and Stem Rot Management**

| | AGSS Incidence | | | | AGSS Severity | | | | SR Incidence | | | | SR Severity | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | NC | SC | Y | S | NC | SC | Y | S | NC | SC | Y | S | NC | SC | Y | S |
| 1) Control | --- | --- | 9 | 8 | --- | --- | 9 | 9 | 9 | 7 | 8 | 5 | 9 | 8 | 8 | 6 |
| 2) Quadris @ 12.5 fl oz/Ac | --- | --- | 6 | 3 | --- | --- | 6 | 3 | 3 | 3 | 2 | 8 | 4 | 3 | 4 | 6 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 3 | 4 | --- | --- | 3 | 4 | 2 | 8 | 5 | 5 | 2 | 5 | 6 | 5 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 1 | 6 | --- | --- | 1 | 5 | 1 | 1 | 6 | 1 | 1 | 1 | 5 | 1 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 2 | 9 | --- | --- | 2 | 8 | 6 | 5 | 3 | 4 | 5 | 6 | 3 | 4 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 5 | 7 | --- | --- | 5 | 7 | 3 | 3 | 1 | 1 | 3 | 4 | 1 | 1 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 4 | 1 | --- | --- | 4 | 1 | 5 | 1 | 4 | 7 | 6 | 2 | 2 | 8 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 7 | 2 | --- | --- | 7 | 2 | 7 | 9 | 7 | 3 | 7 | 9 | 7 | 3 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | --- | --- | 8 | 4 | --- | --- | 8 | 6 | 8 | 6 | 9 | 8 | 8 | 7 | 9 | 9 |

Relative Ranking Scale – 1=lowest incidence/severity for a location and 9 = highest incidence/severity for a location

Y = Yuba Location (AGSS Incidence Range = 35.5-79%, AGSS Severity Range = 0.365-0.865)
S = Sutter Location (AGSS Incidence Range = 1-20%, AGSS Severity Range = 0.015-0.395)
NC = North Colusa Location (SR Incidence Range = 29-79%, SR Severity Range = 0.660-2.100)
SC = South Colusa Location (SR Incidence Range = 18.5-37.5%, SR Severity Range = 0.510-1.165)
Y = Yuba Location (SR Incidence Range = 5-19%, SR Severity Range = 0.100-0.480)
S = Sutter Location (SR Incidence Range = 6-13%, SR Severity Range = 0.120-0.320)

**Table 14. Relative Ranking of Treatments Across All Locations for Yield Data**

| Treatment | Yield | | | | % Total Rice | | | | % Whole Rice | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NC | SC | Y | S | NC | SC | Y | S | NC | SC | Y | S |
| 1) Control | 4 | 8 | 9 | 9 | 6 | 8 | 7 | 6 | 7 | 7 | 5 | 5 |
| 2) Quadris @ 12.5 fl oz/Ac | 9 | 2 | 2 | 7 | 8 | 2 | 3 | 8 | 5 | 2 | 3 | 8 |
| 3) Quadris @ 12.5 fl oz/Ac + 3 pints/100 gal Pro-Tron | 8 | 3 | 7 | 4 | 3 | 6 | 5 | 4 | 8 | 3 | 8 | 2 |
| 4) Quilt Xcel @ 21 fl oz/Ac + 3 pints/100 gal Pro-Tron | 7 | 4 | 4 | 1 | 1 | 3 | 8 | 5 | 1 | 4 | 6 | 4 |
| 5) Quadris @ 6 fl oz/Ac + Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 1 | 5 | 1 | 6 | 9 | 5 | 6 | 9 | 2 | 6 | 4 | 7 |
| 6) Quadris @ 12.5 fl oz/Ac + Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 2 | 7 | 3 | 3 | 7 | 4 | 1 | 3 | 4 | 1 | 2 | 1 |
| 7) Quilt Xcel @ 21 fl oz/Ac+ Regalia @ 1 pint/Ac + 3 pints/100 gal Pro-Tron | 3 | 1 | 5 | 2 | 5 | 1 | 2 | 2 | 6 | 5 | 1 | 3 |
| 8) Regalia @ 1 quart/Ac + 3 pints/100 gal Pro-Tron | 6 | 6 | 8 | 5 | 2 | 9 | 9 | 1 | 3 | 9 | 9 | 6 |
| 9) Actinovate AG 9 oz/Ac fb 6 oz/Ac + 3 pints/100 gal Pro-Tron | 5 | 9 | 6 | 8 | 4 | 7 | 4 | 7 | 9 | 8 | 7 | 9 |

Relative Ranking Scale – 1=highest yield for a specific trial location and 9 = lowest yield for a specific location

NC = North Colusa (Yield Range = 8,402-9,254 lb/Ac, Total Rice Range = 72.52-73.72%, Whole Rice Range = 63.60-66.39%)
SC = South Colusa (Yield Range = 8,829-9,755 lb/Ac, Total Rice Range = 72.29-73.60%, Whole Rice Range = 53.72-57.53%)
Y = Yuba (Yield Range = 8,706-9,421 lb/Ac, Total Rice Range = 71.50-72.50%, Whole Rice Range = 64.42-66.97%)
S = Sutter (Yield Range = 8,904-9,356 lb/Ac, Total Rice Range = 71.66-72.46%, Whole Rice Range = 66.68-67.82%)

Objective 2: Develop an effective method for comparing genetic relatedness among *P. grisea* isolates in California

Isolates from the 2012 season were collected in conjunction with California Crop Improvement and RES staff for culturing and storage of isolates. These isolates will be used for genetic analysis with the previously collected 2011 isolates. Genetic work was delayed and will be conducted in 2012. The goal is to identify genetic tools that will provide a better understanding of the loss of resistance in M-208 and provide us with a solid base for future population genetics studies of *P. grisea*.

Objective 3. Evaluate commercially available mycorrhizal products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor

In general, no measurable benefits were measured or observed for rice plant growth or yield components under the prevailing experimental conditions when MycoApply Liquid Endo @ 4.5 oz/150 lb seed was added to the standard 24 hour seed soak using 2.5% Ultra Clorox Bleach. In the small plot field trial, no significant differences were observed for yield, seedling vigor, seedling count, tiller count, days to 50% heading, plant height, lodging, or harvest grain moisture (Table 15 and Figures 33-39). In addition, no significant differences were observed for the number of panicles per square foot, total panicle weight per square foot, or the mean weight per panicle (Table 16 and Figures 40-42).

In this evaluation of MycoApply Liquid Endo, using the product in the pre-plant rice seed soak, no statistically significant benefits were realized with respect to seed germination, seedling growth, vegetative growth, or yield components. Endomycorrhizae are often promoted for reducing drought stress, promoting rooting and nutrient uptake, and increasing yields. It is possible that under standard California cropping conditions of water seeded and proper nutrient management, measurable beneficial outcomes may be difficult to achieve with this products. Phosphate fertilizer was not applied pre-plant but it is likely that this nutrient was not limiting for optimal yield. These types of products may often benefit crops grown under less than optimal conditions such as intermittent irrigation or nutrient poor situations but may have as much impact on a crop grown under high input conditions. Further studies might focus on performance under poorer conditions; however, the utility of MycoApply Liquid Endo within the California rice industry is unknown under our current production practices.

**Table 15. MycoApply Liquid Endo Seed Soak Small Plot Results**

| Treatment | Seedling Vigor | Days to 50% Heading | Plant Height (cm) | Lodging (%) | Harvest Moisture (%) | Yield (lb/Ac) | Seedling Count (#/sq ft) | Tiller Count (#/sq ft) |
|---|---|---|---|---|---|---|---|---|
| 1) Untreated control - with Ultra Clorox soak | 4.725 | 91 | 92.25 | 58.75 | 17.675 | 9345 | 43.00 | 86.5 |
| 2) MycoApply Liquid Endo 4.5 oz/150 lb seed - with Ultra Clorox soak | 4.650 | 91 | 95.50 | 53.75 | 18.200 | 9203 | 43.25 | 89.5 |
| P-value | 0.0577 | --- | 0.0511 | 0.6986 | 0.6000 | 0.4634 | 0.9340 | 0.3832 |
| LSD | NS | --- | NS | NS | NS | NS | NS | NS |

**Table 16. MycoApply Liquid Endo Seed Soak Small Plot Results**

| Treatment | Panicle Count (#/sq ft) | Total Panicle Weight/sq ft (g) | Mean Panicle Weight (g) |
|---|---|---|---|
| 1) Untreated control - with Ultra Clorox soak | 83.50 | 162.97 | 1.95129 |
| 2) MycoApply Liquid Endo 4.5 oz/150 lb seed - with Ultra Clorox soak | 98.75 | 168.83 | 1.70565 |
| P-value | 0.1353 | 0.7738 | 0.0571 |
| LSD | NS | NS | NS |

**Figure 33. MycoApply Liquid Endo Seed Soak Small Plot Results – Seedling Vigor (1-5 Scale)**

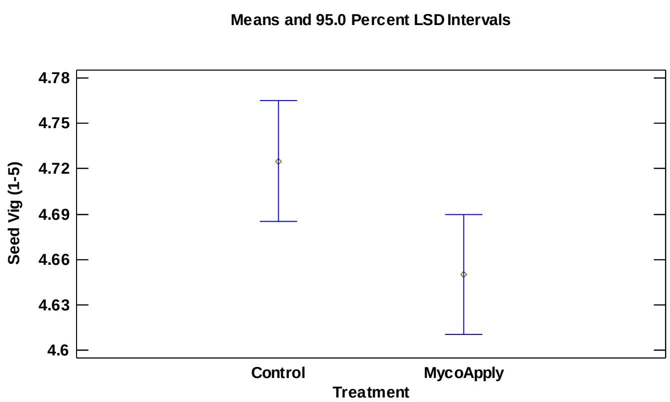



**Figure 34. MycoApply Liquid Endo Seed Soak Small Plot Results – Plant Height**

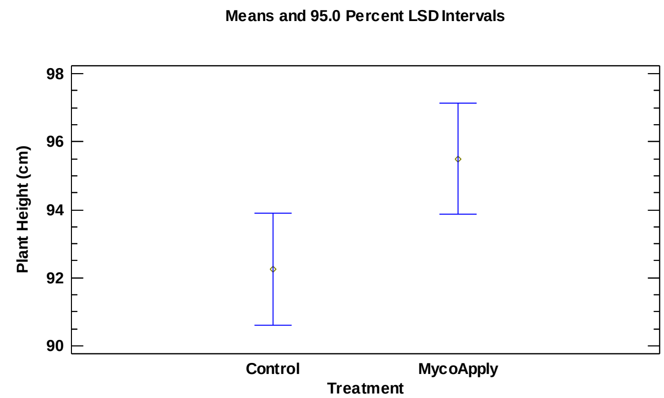



**Figure 35. MycoApply Liquid Endo Seed Soak Small Plot Results – Lodging**

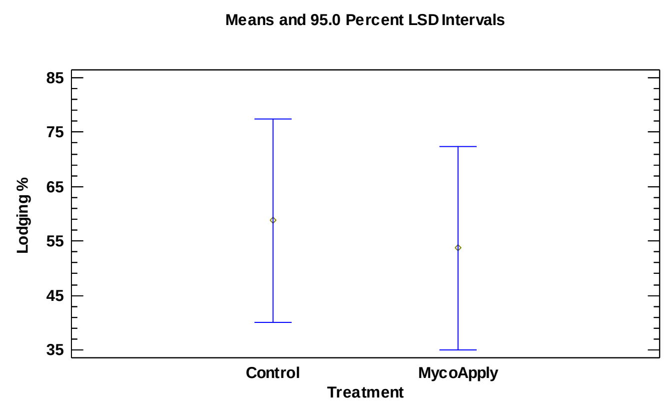



**Figure 36. MycoApply Liquid Endo Seed Soak Small Plot Results – Grain Moisture**

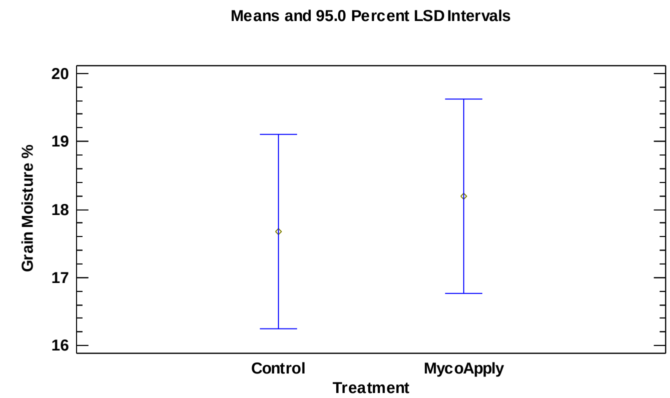



**Figure 37. MycoApply Liquid Endo Seed Soak Small Plot Results – Yield**

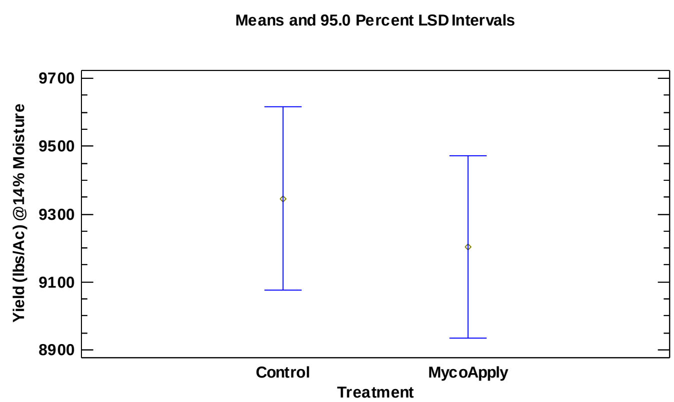



**Figure 38. MycoApply Liquid Endo Seed Soak Small Plot Results – Seedling Count (#/square foot)**

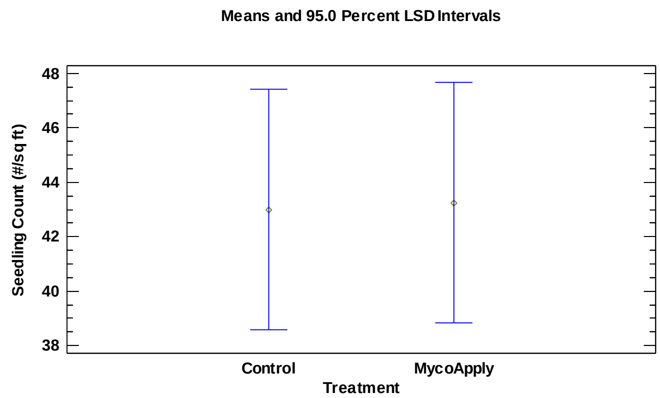



**Figure 39. MycoApply Liquid Endo Seed Soak Small Plot Results – Tiller Count**

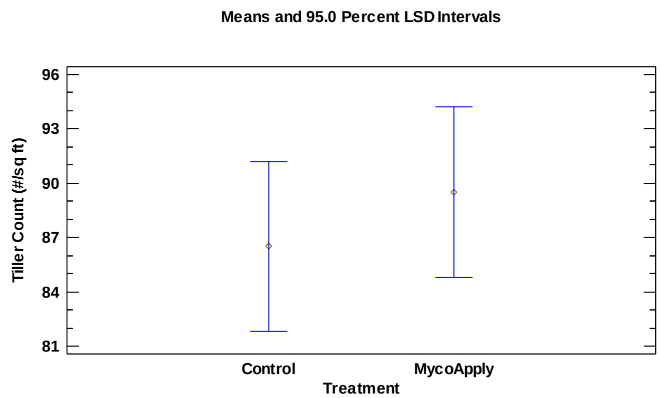



**Figure 40. MycoApply Liquid Endo Seed Soak Small Plot Results – Panicle Count**

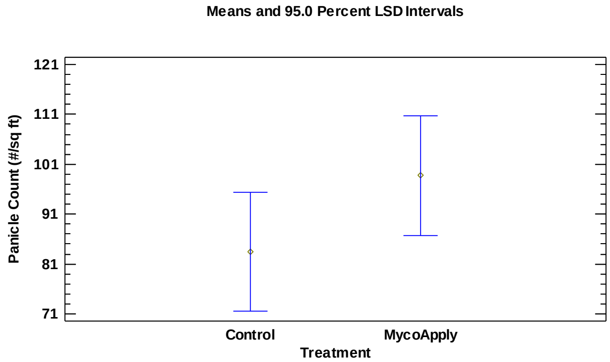



Figure 41. MycoApply Liquid Endo Seed Soak Small Plot Results – Total Panicle Weight

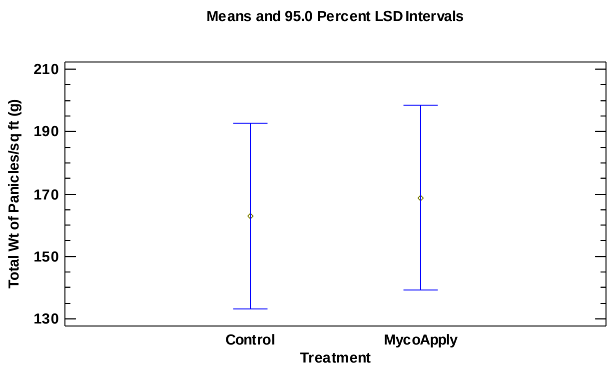
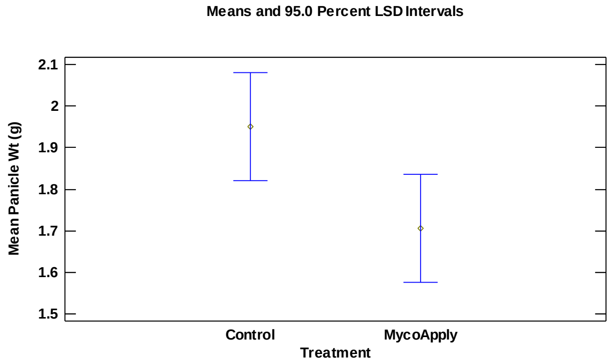



Figure 42. MycoApply Liquid Endo Seed Soak Small Plot Results – Mean Panicle Weight




Objective 4. Evaluate commercially available seed treatment products for their ability to improve growth and yield of rice plants through increased nutrient efficiency and general vigor (Added post-proposal)

In general, no measurable benefits were measured or observed for rice plant growth or yield components under the prevailing experimental conditions when Essential at 32 oz/100 gal or 64 oz/100 gal was added to the standard 24 hour seed soak using 2.5% Ultra Clorox Bleach. In the small plot field trial, no significant differences were observed for yield, seedling vigor, seedling count, tiller count, days to 50% heading, plant height, lodging, or harvest grain moisture (Table 17 and Figures 43-49). In addition, no significant differences were observed for the number of panicles per square foot, total panicle weight per square foot, or the mean weight per panicle (Table 18 and Figures 50-52).

With respect to the seed germination board experiment, no significant differences were observed for shoot or root length between the seed soak treatments (Table 19 and Figures 53-54). However, there were significant differences in shoot and root length for the different rice varieties (Table 20 and Figures 55-56). There was no statistically significant interaction between seed soak treatment and rice variety with regard to shoot or root length (P-value = 0.4781 and P-value = 0.9918 respectively).

In this evaluation of Essential, using the product in the pre-plant rice seed soak, no statistically significant benefits were realized with respect to seed germination, seedling growth, vegetative growth, or yield components. As a seed soak, I would expect to see the manifestation of any benefits in the seed germination and seedling development stages of plant growth. Early season growing conditions for the small plot trial and seed germination board experiment were optimal. It is possible that no improvements may be realized under ideal growing conditions. Further studies might focus on performance under poorer conditions, such as cooler temperatures, for seed germination and seedling establishment to determine if Essential has any utility within the California rice industry.

**Table 17. Essential Seed Soak Small Plot Results (Means of 8 replicates per treatment)**

| Treatment | Seedling Vigor | Days to 50% Heading | Plant Height (cm) | Lodging (%) | Harvest Moisture (%) | Yield (lb/Ac) | Seedling Count (#/sq ft) | Tiller Count (#/sq ft) |
|---|---|---|---|---|---|---|---|---|
| 1) Untreated control - with Ultra Clorox soak | 4.65 | 91 | 93.00 | 71.125 | 15.4875 | 9060 | 34.125 | 88.125 |
| 2) Essential 32 oz/100 gal - with Ultra Clorox soak | 4.69 | 91 | 94.63 | 72.375 | 15.5375 | 8865 | 39.875 | 84.000 |
| 3) Essential 64 oz/100 gal - with Ultra Clorox soak | 4.65 | 91 | 93.63 | 70.625 | 15.5875 | 8999 | 35.750 | 87.625 |
| P-value | 0.7026 | --- | 0.2350 | 0.9612 | 0.9718 | 0.5068 | 0.3565 | 0.5968 |
| LSD | NS | --- | NS | NS | NS | NS | NS | NS |

**Figure 43. Essential Seed Soak Small Plot Results – Seedling Vigor (1-5 Scale)**

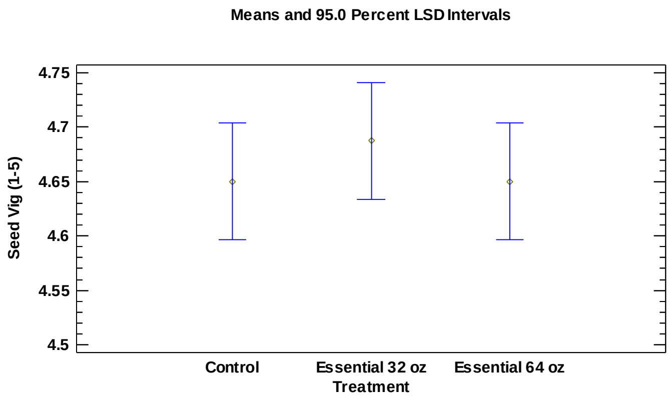



**Figure 44. Essential Seed Soak Small Plot Results – Plant Height**

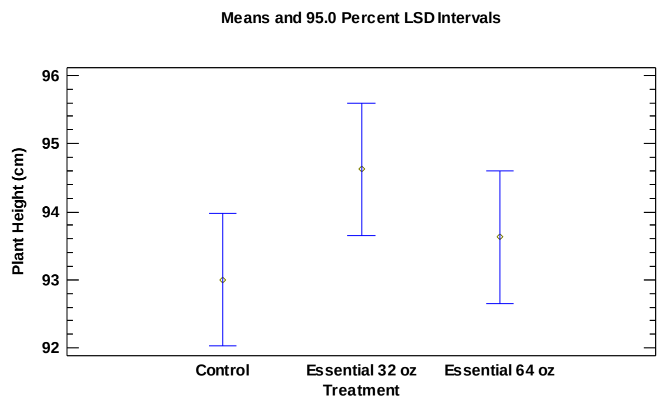



**Figure 45. Essential Seed Soak Small Plot Results – Lodging**

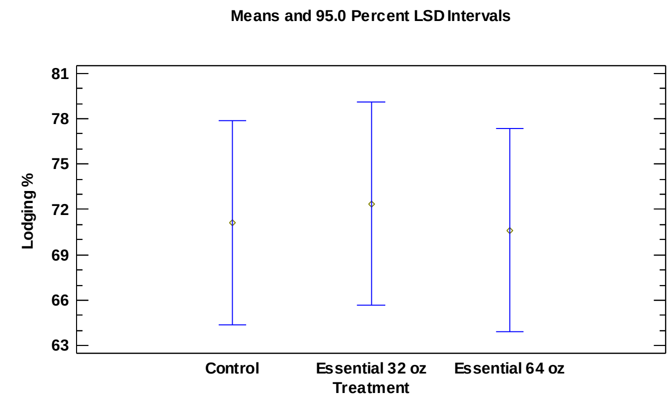



**Figure 46. Essential Seed Soak Small Plot Results – Grain Moisture**

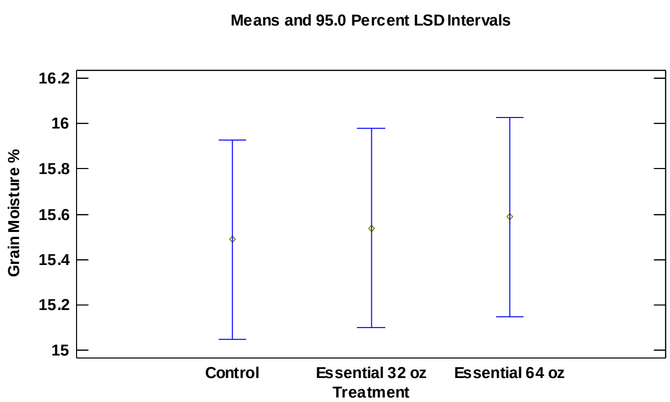



**Figure 47. Essential Seed Soak Small Plot Results – Yield**

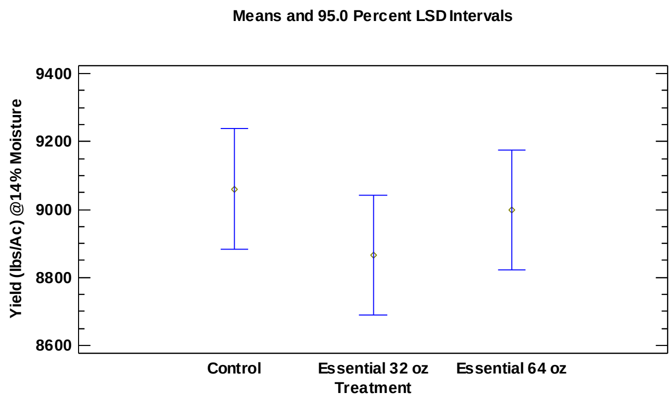



**Figure 48. Essential Seed Soak Small Plot Results – Seedling Count (#/square foot)**

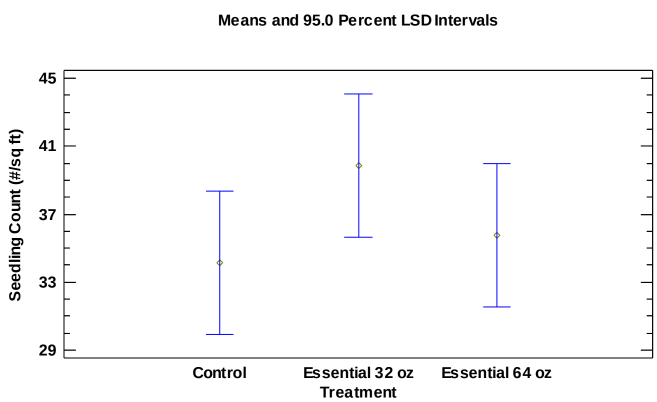



**Figure 49. Essential Seed Soak Small Plot Results – Tiller Count**

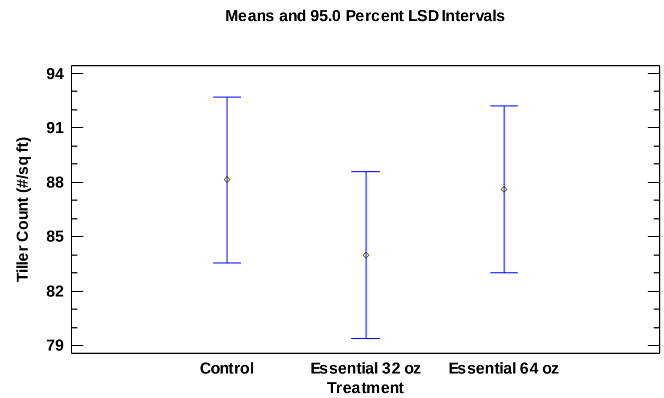



**Table 18. Essential Seed Soak Small Plot Results (Means of 4 replicates per treatment)**

| Treatment | Panicle Count (#/sq ft) | Total Panicle Weight/sq ft (g) | Mean Panicle Weight (g) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 1) Untreated control - with Ultra Clorox soak | 96 | 201.78 | 2.1144 |
| 2) Essential 32 oz/100 gal - with Ultra Clorox soak | 93 | 174.40 | 1.9073 |
| 3) Essential 64 oz/100 gal - with Ultra Clorox soak | 87 | 165.73 | 1.9020 |
| P-value<br>LSD | 0.6009<br>NS | 0.1068<br>NS | 0.3138<br>NS |

**Figure 50. Essential Seed Soak Small Plot Results – Panicle Count**

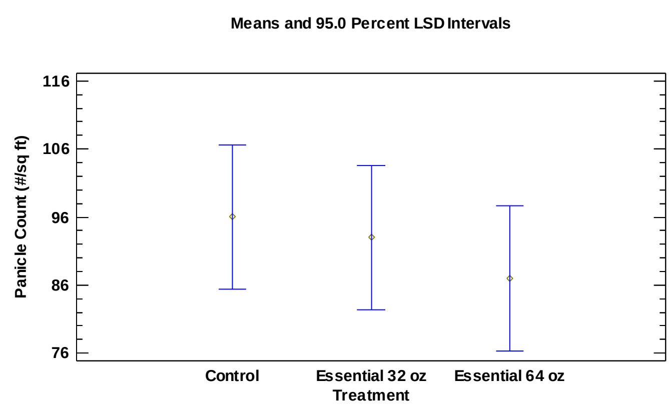



**Figure 51. Essential Seed Soak Small Plot Results – Total Panicle Weight**

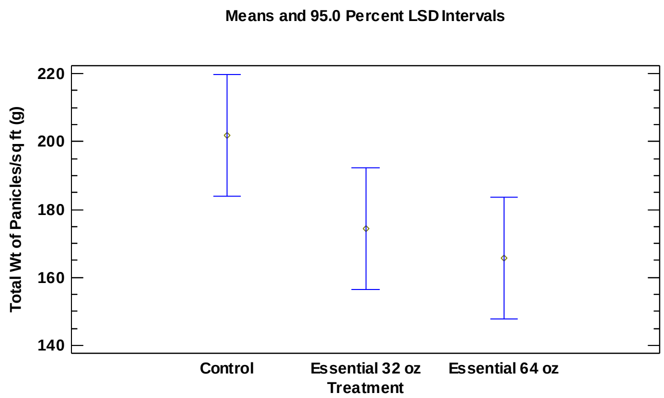



**Figure 52. Essential Seed Soak Small Plot Results – Mean Panicle Weight**

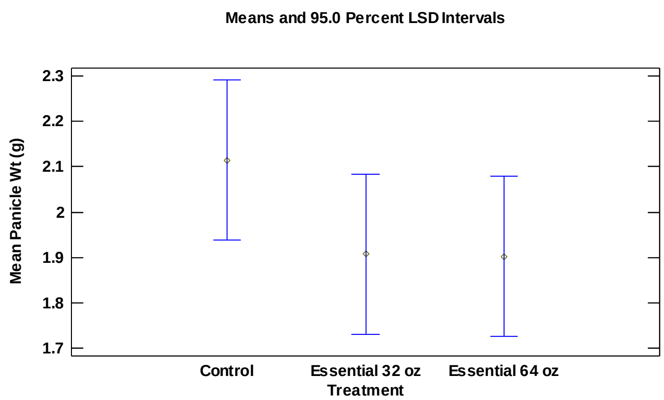


**Table 19. Essential Seed Soak Germination Board Results by Treatment**

| Treatment | Shoot Length (cm) | Root Length (cm) |
|---|---|---|
| 1) Untreated control - with Ultra Clorox soak | 19.8333 | 19.5833 |
| 2) Essential 32 oz/100 gal - with Ultra Clorox soak | 20.7917 | 19.0833 |
| 3) Essential 64 oz/100 gal - with Ultra Clorox soak | 19.8750 | 19.6667 |
| P-value | 0.1116 | 0.6054 |
| LSD | NS | NS |

**Figure 53. Essential Seed Soak Germination Board Results by Treatment – Shoot Length**

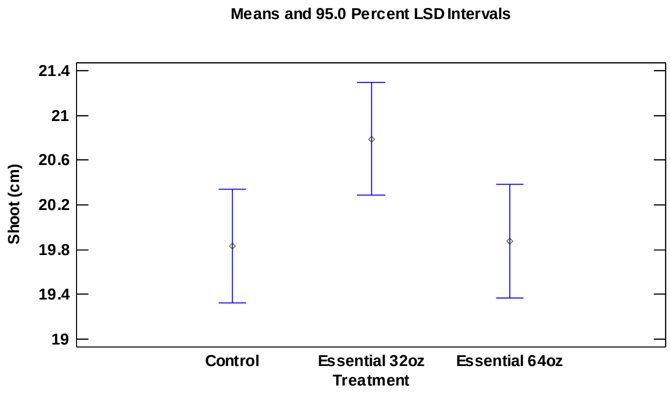



**Figure 54. Essential Seed Soak Germination Board Results by Treatment – Root Length**

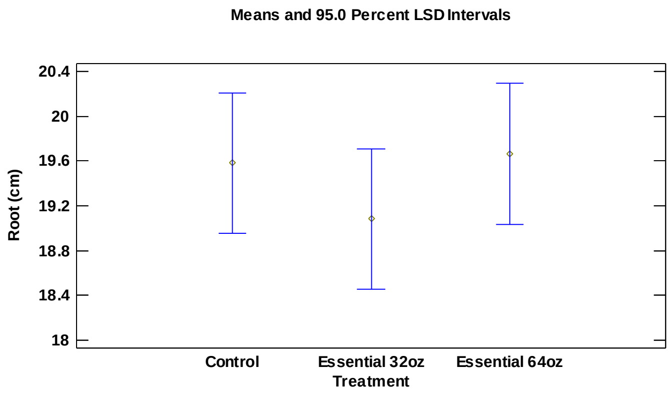



**Table 20. Essential Seed Soak Germination Board Results by Variety**

| Variety | Shoot Length (cm) | Root Length (cm) |
|---|---|---|
| M-206 | 22.5833 d | 19.4167 b |
| M-205 | 18.8333 a | 19.5000 b |
| M-104 | 21.1667 cd | 19.7500 bc |
| M-105 | 19.4167 ab | 20.5000 bc |
| L-206 | 18.1667 a | 16.0000 a |
| CH-201 | 20.8333 bc | 21.5000 c |

| | | |
|---|---|---|
| P-value | 0.0000 | 0.0000 |
| LSD | 0.506225 | 0.626731 |

**Figure 55. Essential Seed Soak Germination Board Results by Variety – Shoot Length**

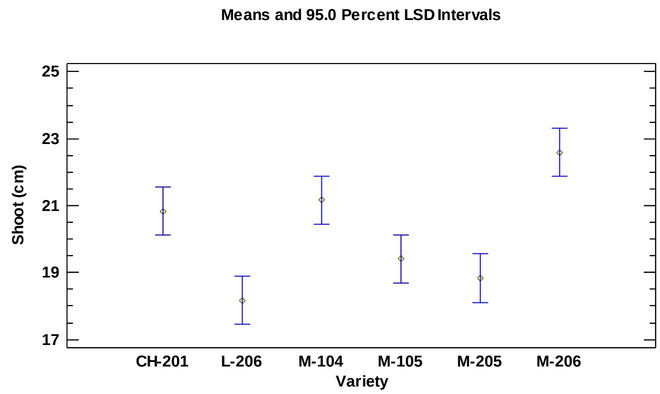
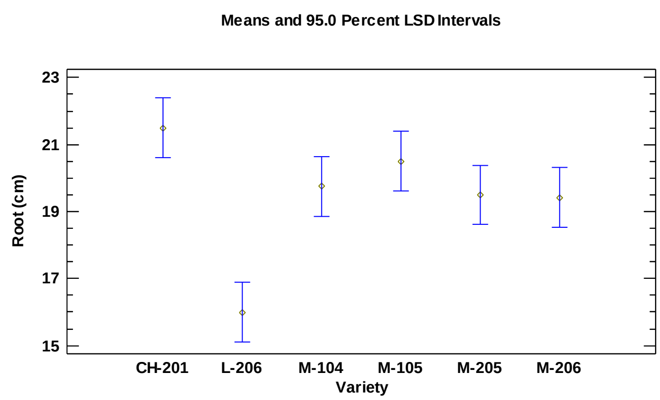



**Figure 56. Essential Seed Soak Germination Board Results by Variety – Root Length**




## CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Over the past couple of years there have been several new fungicides registered for use in California rice but they are mostly reduced risk pesticides that have little or no efficacy data for California rice diseases or are products that have only recently been made commercially available. Several of these products were evaluated for rice disease management in 2012. The products tested included Quadris (azoxystrobin commercial standard), QuiltXcel (azoxystrobin + trifloxystrobin), Regalia (a natural plant extract that triggers a plant's natural defense systems to protect against a variety of fungal and bacterial pathogens), and Actinovate AG (a bacterial biological control organism).

Extreme heat during an extended period in August 2012 made this a challenging year for evaluating rice disease management materials. These conditions influenced the progress of both rice blast and aggregate sheath spot diseases, especially in the warmer microclimates. However, successful evaluations of materials were made by examining individual small plot trials as well as taking a look at the bigger picture. Based upon disease pressure, the Yuba County trial provided the best evaluation of materials for aggregate sheath spot management and the two Colusa County trials provided the best evaluation of the materials for stem rot management.

Where aggregate sheath spot disease pressure was high, all fungicide treatments other than Actinovate resulted in significantly lower aggregate sheath spot incidence and severity than the control. Quilt Xcel and Quadris applications resulted in a greater than 50% in aggregate sheath spot incidence and severity. Where stem rot disease was highest, all fungicide treatments other than Regalia or Actinovate resulted in significantly lower stem rot incidence than the control. Quilt Xcel reduced stem rot incidence by 63% and 36% under the highest and second highest stem rot pressure respectively.

Regalia was tested alone and in tank mixes with labeled rates of Quadris and Quilt Xcel as well as in a tank mix with a reduced rate of Quadris. Addition of Regalia to labeled rates of Quadris and Quilt Xcel did not result in significantly increased efficacy of these products against aggregate sheath shot or stem rot. Concerns about fungicide resistance management put in doubt the utility of Regalia tank mixed with below labeled rates of Quadris.

Variability in small plot yield data makes it difficult to uncover significant differences among treatments, especially with regards to yield even when mean differences may be as large as 800 lb/Ac or when disease pressure is low. However, the most significant results of the 2012 small plot trials was the performance of Quadris and Quilt Xcel on stem rot disease incidence and severity. In prior years, Quadris treatments in small plot fungicide trials have shown little activity against stem rot disease of rice. Results of the 2012 trials indicate that Quadris and Quilt Xcel, either alone or in combination with Regalia, may significantly reduce stem rot incidence and severity.

Future research will continue to elucidate the biology of California rice pathogens to assist in developing effective management practices for these pests. This ultimate goal is to develop an integrated rice disease management program for California growers based on sound fungicide efficacy data and pathogen biology to define the conditions under which a fungicide application is beneficial and economical. Quadris and Quilt Xcel should be evaluated in 2013 with a renewed focus on stem rot disease management in light of the results of the 2012 studies. In doing so, evaluation of two different fungicide timings and multiple applications should include an earlier mid-season timing that may have more of an impact on stem rot disease.

Isolates from the 2012 season were collected in conjunction with California Crop Improvement and RES staff for culturing and storage. These isolates will be used for genetic analysis with the previously collected 2011 isolates. Genetic work will be conducted in 2012. The goal is to identify genetic tools that will provide a better understanding of the loss of resistance in M-208 and provide us with a solid base for future population genetics studies of *P. grisea*.

In the evaluation of MycoApply Liquid Endo, using the product in the pre-plant rice seed soak, no statistically significant benefits were realized with respect to seed germination, seedling growth, vegetative growth, or yield components. Endomycorrhizae are often promoted for reducing drought stress, promoting rooting and nutrient uptake, and increasing yields. It is possible that under standard California cropping conditions of water seeded and proper nutrient management, measurable beneficial outcomes may be difficult to achieve with this products. These types of products may often benefit crops grown under less than optimal conditions such as intermittent irrigation or nutrient poor situations but may not have as much impact on a crop grown under high input conditions. Further studies might focus on performance under poorer conditions; however, the utility of MycoApply Liquid Endo within the California rice industry is unknown under our current production practices.

In the evaluation of Essential Plus 1-0-1, using the product in the pre-plant rice seed soak, no statistically significant benefits were realized with respect to seed germination, seedling growth, vegetative growth, or yield components. As a seed soak, manifestation of any benefits would be expected in the seed germination and seedling development stages of plant growth. Early season growing conditions for the small plot trial and seed germination board experiment were optimal. It is possible that no improvements may be realized under ideal growing conditions. Further studies might focus on performance under poorer conditions, such as cooler temperatures, for seed germination and seedling establishment to determine if Essential Plus 1-0-1 has any utility within the California rice industry.