

1971 REPORT TO CALIFORNIA RICE RESEARCH BOARD

PROGRAM AREA: Crop protection.

PROJECT NUMBER & TITLE: CP-2, Cause and Control of Rice Diseases. 10-9

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OBJECTIVES: Activities under this project are directed toward determining the cause and factors which favor the occurrence and severity of rice diseases and, with the information obtained, develop economical control measures.

WORK IN PROGRESS:

- A. Seedling disease and seed treatment; further evaluation and development of formulations and methods of seed treatment to improve covering and protective capacity of fungicides registered for rice seed treatment.
- B. Crown rot and early dying: greenhouse experiments to determine cause and development of crown rot of rice.
- C. Stem Rot of Rice:
 1. Epidemiology of stem rot of rice including:
 - a. predisposition of rice plants to stem rot;
 - b. effect of nutritional status on stem rot severity,
 - c. screening rice introductions for sources of resistance to stem rot,
 - d. distribution of Sclerotium oryzae in California,
 - e. Biology of Sclerotium oryzae
 - i. Longevity of S. oryzae sclerotia in soil
 - ii. Vertical distribution of sclerotia and survival at different depths
 - iii. Determination of strains and role of the ascomycete stage of S. oryzae, i. e., mating capacity and virulence of strains
- D. Rice Residue Management - Effect of incorporation on inoculum level and stem rot severity:
 1. Residue incorporation under continuous rice cropping (Lindberg and Geer trials)
 2. Residue incorporation under alternate year rice cropping (Gorrill trial)
 3. Effectiveness of open burning and complete destruction (propane burners) of residue on minimizing stem rot inoculum
 4. Relation of temperature to inoculum increase in residue left in fields
- E. Chemical Control of Stem Rot of Rice:
 1. Laboratory and greenhouse screening trials to determine candidate fungicides
 2. Field trials with fungicides for control of stem rot

EXPERIMENTS COMPLETED, WORK PLANNED, AND MAJOR ACCOMPLISHMENTS:

- A. Seed treatment: Nine field trials comparing rates, formulations and new chemicals were conducted this year. Results showed that flowable formulations of Captan and Difolatan are the most effective seed treatments when used as recommended. Evershield CM, a commercial formulation containing Captan and a patented adherent, is effective and can be used at lower rates. Residue analysis of treated seed after soaking and of soak water revealed that treatment with Evershield CM resulted in a significantly greater amount of Captan remaining on the seed through the soaking process with subsequent lower amounts of fungicide detected in the soak water. Data obtained this year allowed a culmination of efforts to obtain registration for the use of Difolatan as a rice seed treatment.

In our opinion sufficient effort has been spent on rice seed treatment and satisfactory procedures have been developed. This season Difolatan or Captan has been recommended for use as rice seed treatment. We are confident that stand establishment problems due to seedling disease can be adequately and economically controlled by following the recommendations for rice seed treatment.

- B. Crown rot and early dying: This disease has been reproduced in greenhouse trials and the causal organisms are being identified. Field observations this past year indicate severity is closely related to water management both during the early and later part of the season. Further experiments on cause and control will be carried out this coming season.

C. Stem Rot of Rice:

1. Predisposition and effect of nutritional status on stem rot severity: Study has shown that stem rot may become a major problem in fields where inoculum is adequate and factors resulting in a weakening or predisposition of the plants occur during the early part of the growing season. Of prime consideration is damage to the rice due to untimely applications of herbicides for broadleaf weed control resulting in leaf burning. Greenhouse trials have shown that stem rot severity can be correlated with increasing amounts of MCPA damage.

Greenhouse and field trials were conducted to determine effects of various levels of Nitrogen, Phosphorus and Potassium on stem rot severity. Preliminary conclusions are as follows:

1. Where only preplant nitrogen was applied, foliar nitrogen, disease severity and yield increased significantly with increased nitrogen rates. The effect of the disease does not justify omitting or reducing presently recommended nitrogen practices.

- ii. Nitrogen absorption from early top dress applications of ammonium sulfate results in temporarily above normal nitrogen levels in leaves. Higher disease incidence was noted in these cases. When top dressing was delayed until 84 days after planting, disease was less severe and yield greater than in those treatments receiving earlier top dressings with similar amounts of total nitrogen.
- iii. Greenhouse trials yielded some evidence that phosphorus deficiency enhances stem rot severity.

All results obtained this year indicate nutritional status affects stem rot severity only when nitrogen is in excess of that required to obtain maximum yields or in the case of phosphorus, deficient levels. When N is applied both as a preplant and top dress to achieve total N desired, the timing of the top dress application may affect stem rot severity.

- 2. Search for Resistance to Stem Rot: This year we have continued to consult with and supply inoculum to personnel at the Biggs Rice Station in attempts to identify sources of stem rot resistance. These efforts are being continued.
- 3. Distribution of Sclerotium oryzae: The causal organism of stem rot, S. oryzae, was found to be wide spread in California rice producing areas. Over 30% of the fields examined were found to be infested with the most severe infestations being in Butte, Glenn and Colusa counties.
- 4. Biology of S. oryzae: Study on the biology of S. oryzae was continued during this year with emphasis on production and survival of sclerotia. These areas are considered important since we believe that there is a real possibility of controlling this disease through a better understanding of the life history of the causal organism. Experiments to determine the longevity of inoculum in soil as related to vertical distribution were initiated and have run for over 9 months. Results thus far indicate the following:
 - i. Sclerotia buried 4 or more inches deep lose viability 3 times faster than those in the top 4 inches. The significance of these findings is being related to methods of tillage and will be further pursued.
 - ii. Successful attempts to determine and develop varieties resistant to stem rot may be greatly influenced by a knowledge of existence of physiological strains of S. oryzae. Efforts to determine if strains differing in pathogenicity exist are being carried out in the greenhouse. Results thus far indicate that strains differing in virulence do exist. This information will be utilized in screening and evaluation of sources of resistance for incorporation into the rice breeding program.

D. Rice Residue Management - 1) The effect of total incorporation on inoculum level and stem rot severity. Rationale for including studies on rice residue management is based on the fact the inoculum level of S. oryzae has been shown to be positively correlated with stem rot severity and subsequent yield losses due to this disease. Long term studies to compare the effect of residue incorporation by various methods and fall and spring incorporation were initiated in the fall of 1969 at the Lindberg Ranch in Richvale. Observations include quantitative determinations of viable sclerotia (inoculum level in the fall and spring), disease severity (rated weekly throughout the growing season), nutritional status and yield. The results obtained during the 1970 and 1971 growing seasons are summarized as follows:

Treatment	<u>Viable sclerotia</u> ¹		<u>Disease</u>		<u>Nutritional</u>		<u>Yield cwt/A</u> ⁴	
	<u>100 g/soil</u>		<u>rating</u> ²		<u>status-75 da.</u> ³		<u>14% moisture</u>	
	1970	1971	1970	1971	% N	ppm P*	1970	1971
Burn:								
Fall Disc	24	28	1.72	1.59	3.31	829	59.0	54.6
No Burn:								
Fall Disc	16	52	1.84	1.92	3.10	987	59.0	50.2
Fall Plow	18	46	1.69	1.90	3.35	964	57.5	50.5
Spring Disc	20	56	1.97	2.32	3.32	934	57.0	50.8
Spring Plow	20	42	1.99	2.21	3.24	941	61.6	49.5
Rotovate	28	48	1.81	2.02	3.20	967	59.0	48.7

(*1971)

¹ \bar{X} values of 18 separate samples/rep.

² Disease rating of 1 is healthy. Mean values of rating taken just prior to draining water.

³ Determined by leaf sample analysis. In 1971 700 lbs/acre of 19-9-0 applied as preplant and incorporated with a disc harrow.

⁴ \bar{X} values of 4 replications.

⁵ In the fall of 1969 the entire field was burned. Results of 1970 season reflect only tillage differences. In the fall of 1970 only treatment #1 was burned. Entire residue remaining from harvest was incorporated in treatments 2 thru 6.

Briefly stated the results indicate that inoculum level and disease severity are increasing in treatments where residue is incorporated and remaining relatively constant where the residue was burned in the fall. At the same time yields were lower in all treatments in which the residue was incorporated. This trial will be continued for at least 3 more years.

Similar observations were made in the residue incorporation trial being conducted in Yolo County at the Geer Ranch. In this case no significant differences in inoculum, disease severity and yield were observed. The original stem rot level in this field was very low and was not considered to be a factor prior to initiation of the trial. Continued observations at this site will be invaluable in determining if incorporation allows the build up of stem rot in an area where it has not previously been a problem.

2) Residue incorporation under alternate year rice cropping. Since both of the above trials are directed toward determining the effect of residue incorporation on stem rot severity under continuous rice cropping culture, an additional large-scale trial was initiated this past season. This trial is located on the Gorrill Ranch in Butte County and will allow us to observe the effects of incorporation on stem rot severity and build up under alternate year rice cropping practices. This year the land is fallow. Thus observations have been limited to determining starting base level, inoculum rates and the effect of the various tillage practices.

3) Effectiveness of open burning and complete destruction (propane burners) of residue on minimizing stem rot inoculum. Although results obtained thus far indicate that stem rot severity is lower when residue is burned, they also indicate that open burning does not completely minimize the disease. The recent interest in finding methods in which burning could be carried out without offending the public prompted us to study effects of various methods of burning. The results of comparisons of stem rot inoculum levels in residue and soil before and after burning are summarized below:

Open Field Burning

Straw and stubble collected on same day as burn			Straw and stubble collected 20 days after burn		
Site No.	% Viability of Sclerotia		Site No.	% Viability of Sclerotia	
	Unburned	Burned Over		Unburned	Burned
1	44	0	1	49	13
2	80	2	2	14	0
3	14	0	3	32	4
4	80	0	4	55	1
5	82	0	5	76	12
6	72	0	6	64	3

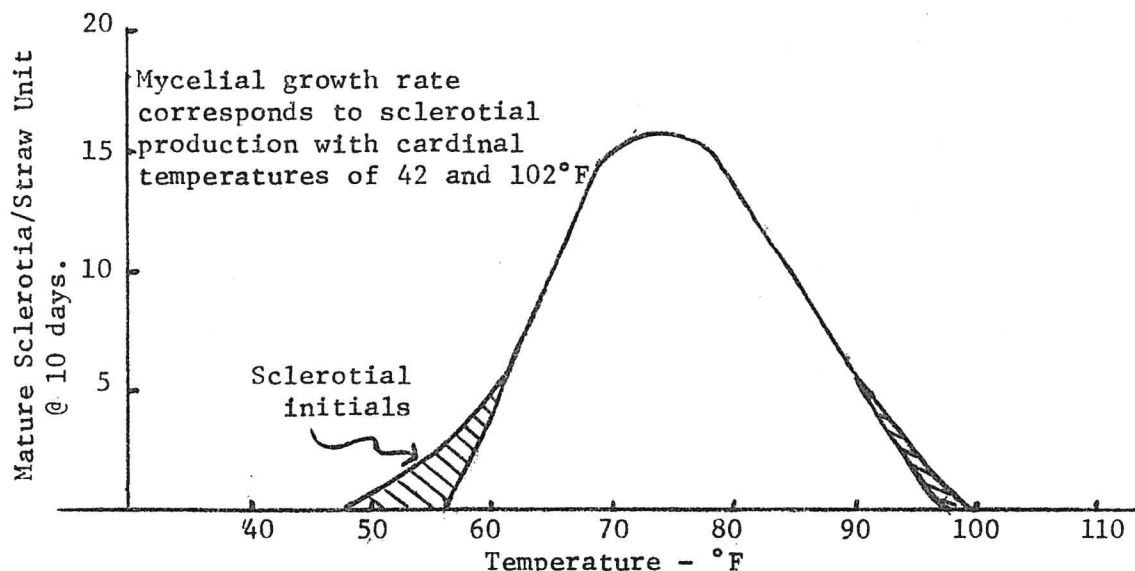
Simulated Total Burn - Propane Burners

Treatment	Viable sclerotia/100 g soil		Disease Index	Yield cwt/A 14% moisture
	Before Burn	After Burn		
With Propane Burner				
1. Single Passover	94.8	90.0	1.96	65.45
2. Double Passover	72.2	52.2	2.06	62.44
3. No Propane Burner	111.3	---	2.37	64.96

Conducted in a field with parallel levees, one check/treatment.
All sites had adequate N at 68 days.
A fourth check was topdressed at 68 days; yield 63.77 cwt/acre.

These results show that burning dramatically reduces inoculum levels in residue above the surface but that it has little effect on inoculum in the top two inches of the soil.

- 4) Relation of temperature to inoculum increase in residue left in fields. The increase of inoculum in unburned residue and burned over stubble is an important factor in determining whether burning and/or incorporation in the fall or spring would be most beneficial in minimizing stem rot inoculum levels. Since data shown earlier indicate that fall incorporation may be most beneficial, and temperature during the late fall, winter and early spring would have primary influence on saprophytic growth of *S. oryzae* in residue, experiments were carried out to measure inoculum increases under temperature regimes encountered between rice cropping seasons. Results obtained are summarized as follows:



The above shows that *S. oryzae* increases rapidly at temperatures from 55 to 90°F and very slowly if at all at the extremes when growing on unincorporated straw.

Results for sclerotial increase on incorporated straw are not yet available but thus far increases observed have been significantly lower.

- E. Chemical Control of Stem Rot: Two trials were conducted to determine if loss to stem rot could be controlled by the application of fungicides. Results obtained showed some promise but considerable more effort on chemicals to be used, mode and time of application will be required before this avenue becomes effective and economical.

IMMEDIATELY APPLICABLE RESEARCH RESULTS:

A. Seed Treatment

1. Proper seed treatment with Difolatan or Captan will minimize stand establishment problems due to seedling disease, reduce or eliminate possible needs to reseed, and provide more uniform stands. Seeding rates can be reduced substantially allowing savings beyond the cost of seed treatment. If Captan is used in the form of the Evershield CM formulation, less fungicide will be released into the environment thru the soaking process.

B. Stem Rot:

Careful adherence to recommended usages of fertilizer and herbicides will result in minimizing predisposition of the rice plants to infection by S. oryzae and subsequent losses to stem rot.

C. Residue Management:

When viewing the above results in total it appears that the presently available data indicate the following:

1. Open burning as currently practiced is as effective in minimizing stem rot inoculum levels as is total destruction of the residue.
2. In fields where stem rot is a problem, residue should be burned as soon after harvest as possible and the field tilled, either stubble disced or plowed.
3. In fields where open burning is allowed, spreading the straw behind the harvester will improve burning effectiveness in minimizing stem rot inoculum.
4. In fields where stem rot inoculum is sufficient to cause economic damage, burning the residue will aid in minimizing loss.

EVALUATION OF PROJECT

- A. Seed Treatment = research on seedling disease and seed treatment can be phased out at this time. We will continue to monitor effectiveness of currently recommended seed treatment practices.

- B. Time freed by phasing out seed treatment studies should be spent on studying crown rot and early dying of rice.
- C. Studies on stem rot and the effects of residue incorporation are at a critical point at this time. They must be continued if we are to obtain a true indication of the effects of incorporation on the over-all environment encountered in rice production and develop means of controlling stem rot.
- D. Information on Distribution of Stem Rot in California should be considered by persons formulating regulations regarding agricultural burning.

PUBLICATIONS OR REPORTS:

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