Project No. RP2

COMPREHENSIVE RESEARCH ON RICE
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PROJECT TITLE: Cause and Control of Rice Diseases

PROJECT LEADER AND PRINCIPAL UC INVESTIGATORS:
Project Leader: R. K. Webster
U.C. Investigators: J. Bolstad, Staff Research Associate
P. S. Gunnell, Research Assistant
T. Gordon, Post Graduate Researcher
C. M. Wick and S. Scardaci, Cooperative Extension

LEVEL OF 1984 FUNDING: 55,000 (includes augmentation for Kernel Smut project)

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

Long range objectives of research project RP-2 are to determine occurrence, nature and control of rice diseases in California. We are proceeding by identifying the diseases, determining the extent to which they occur, and studying factors that affect disease severity including biology of the pathogens and epidemiology of the diseases. Experiments to determine the best methods of control and disease management have recently emphasized interactions of various culture practices, i.e. residue management, fertilization, seeding rates and water management. The interaction of these factors and differences in cultivar susceptibility have been extensively studied to try to determine the most feasible methods of minimizing disease loss. Other areas of emphasis include experiments on time of application and rates of candidate fungicides for use in disease control and evaluation of rice germplasm sources for use by breeders in attempts to produce disease resistant cultivars. Many aspects of the project require consecutive years of study in the field and thus are continuing.

The recent identification of Kernel smut on rice in California resulted in an augmentation to the budget of RP-2 to initiate extensive studies on this disease. Continuation of these studies will be a primary goal during the coming year.

Specific Objectives For 1984:

1) Continue study of the biology of *R. oryzae sativae* (Aggregate Sheath Spot) and *R. oryzae* (sheath spot) in attempts to identify stages in their life cycle or disease cycle where control measures can be most effectively implemented.

2) Continue evaluation of sources for resistance to Aggregate Sheath Spot (Sheath Blight).

3) Evaluate rate and time of application of Tilt and other fungicides for effectiveness in controlling stem rot and Aggregate Sheath Spot diseases. Trials to collect fungicide residue data in rice and alternate crops for use in obtaining registration were continued.

4) Studies on interaction of cultivars with nitrogen level and stand density for effects on Aggregate Sheath Spot severity were carried out.

5) Kernel Smut of Rice. The research initiated this year on kernel smut centered on the following objectives:
   a) Determine the extent of infestation and feasibility of isolating sources of infestation to prevent further spread.
   b) Develop methods to eliminate Smut from infested seed.
   c) Study the disease cycle and biology of the kernel smut organism.
   d) Develop methods for inoculation of rice with the kernel smut organism for comparison of relative susceptibility between cultivars.
   e) Begin studies on control methods for rice kernel smut.

Experiments to accomplish the above objectives were carried out in the laboratories and greenhouses of the Department of Plant Pathology, University of California, Davis, at the Rice Research Facility at Davis and in growers fields in Colusa and Butte Counties.

Surveys for rice kernel smut, (objective 5) involved all rice producing counties in California.

SUMMARY OF 1984 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Objective 1: Aggregate Sheath Spot:

Aggregate Sheath Spot of rice (or Sheath Blight) is caused by the fungus *Rhizoctonia oryzae-sativae*. The disease has increased in frequency and severity over the past several years, paralleling the introduction and increased use of short statured rice cultivars, and is now endemic in Butte, Colusa, and Glenn Counties. The aim of our research has been to identify cultural practices which effect the development of Aggregate Sheath Spot and to investigate the biology of the pathogen, *R. oryzae-sativae*.

The Pathogen:

In August of this summer we found the sexual stage or perfect stage of *R. oryzae-sativae* on infected rice plants in Butte Co. The perfect stage of *R. oryzae-sativae* has never been described.

The perfect stage of the fungus occurs as a very thin, small, grey-white layer on the rice leaf sheath near the waterline. This layer is composed of a mass of basidia borne in cymose-like clusters from repent hyphae. The basidia are globose to pear-shaped, 15.5-32 x 11.5-16 um, and bear two long, stout sterigmata, 12.5-24 x 4-5 um, which produce near spherical basidiospores, 9-16 x 6.5-15 um. The basidial characteristics of the R. oryzae-sativae perfect stage place it in the genus Ceratobasidium. It is distinctly different from all previously described Ceratobasidium species, and it is therefore a new species.

We collected many samples of the R. oryzae-sativae perfect stage, but only two of the samples were fresh. The remainder of the samples were old and dried out and we were unable to rehydrate them for study. The fresh material we obtained was enough to work with to describe the perfect stage, but was not enough to allow us to collect single basidiospores to be used in studying the mating system of this fungus. We have attempted to produce the perfect stage of the fungus on rice in the greenhouse, but we have not been successful so far.

In the past three years, we have collected numerous isolates of R. oryzae-sativae and the isolates have exhibited considerable variation in cultural morphology and have shown some differences in virulence. The discovery of the sexual stage of the fungus may provide a causal explanation for the observed variability in R. oryzae-sativae.

Bordered Sheath Spot:

Bordered Sheath Spot of rice is caused by the fungus Rhizoctonia oryzae. This disease was found in California for the first time in Glenn Co. in 1983. The disease had previously only been reported to occur in Louisiana, Arkansas, and Texas. Also, the perfect stage of R. oryzae was found in Glenn Co. on infected rice plants. The perfect stage of R. oryzae has not been described.

The Disease:

The symptoms of Bordered Sheath Spot are very similar to those of Aggregate Sheath Spot, and the two diseases are not always easily separable in the field. Bordered Sheath Spot lesions differ from lesions of Aggregate Sheath Spot in that they tend to be longer and more irregular in outline, and the centers of the lesions are brown instead of tan or grey-green. Another distinguishing feature of Bordered Sheath Spot is the presence of bright orange, cylindrical sclerotia embedded in infected leaf sheaths near the base of the rice plant.

This summer Bordered Sheath Spot was found in several fields in Butte Co. and it is possible that this disease will soon be endemic in Northern California. From what we have observed in the field and greenhouse, Bordered Sheath Spot is a more aggressive disease than Aggregate Sheath Spot, but further evaluation of the disease is necessary to determine whether or not it will pose a problem in California. In the Southern U.S. the disease is not considered to be of major importance.

The Pathogen:

As mentioned above, the perfect stage of R. oryzae was found in Glenn Co. last summer. This summer we have been successful in inducing the fungus to produce the sexual stage on rice in the greenhouse. The perfect stage of R. oryzae occurs as a thin, orange-pink layer on the surface of rice leaf sheaths. The basidia are produced in candelabra-like groups or singly from repent hyphae. The basidia of R. oryzae are urnifrom in shape (cylindrical with a swollen base), 21.5-55.4 x 4.7-9.2 um. The basidia bear four stout, curved sterigmata, 6.1-14.8 x 1.5-3.4 um, which produce basidiospores that are broad ellipsoid in shape, 6.5-11.7 x 3.4-7.8 um.

At the present time, we are working on the taxonomic placement of the R. oryzae perfect stage. It is very similar to a genus called Laetisaria, however, it does differ in some ways from Laetisaria and these differences may be enough to warrant the creation of a new genus for the R. oryzae perfect stage.

We have collected numerous single basidiospore cultures from several isolates of R. oryzae (including 3 from Louisiana) which we fruited in the greenhouse. We are in the process of using these single basidiospore cultures to study the mating system of R. oryzae about which nothing is presently known. We also have found that several of the single basidiospore isolates inoculated on to rice in the greenhouse caused disease.

In the field it is unlikely that any disease resulting from basidiospore infection will be significant since the fungus was found fruiting at the end of the growing season. The basidiospores of R. oryzae may function in disseminating the fungus to new areas at the end of the growing season where it may produce inoculum that can overwinter and incite infections on rice the following growing season.

It is essential to understand the biology of these rice pathogens in attempting to develop control measures. Their taxonomy must be known as a prerequisite to selecting candidate fungicides for control studies since many new chemicals are specific to certain groups of fungi.

Objective 2: We continued to cooperate with Dr. J. Neil Rutger and his students in studies to evaluate sources of resistance to and inheritance of resistance to Aggregate Sheath Spot. Results from those studies will be included in Dr. Rutgers report. The results of field trials where the relative susceptibility of some of our most prevalently grown cultivars is on page 7. As seen there, California cultivars do vary in susceptibility to Aggregate Sheath Spot with the more recently released cultivars being the most susceptible.

Objective 3: Attempts to identify effective chemical control measures for Stem rot and Aggregate Sheath Spot were continued this year. The results of trials comparing rates and time of application of Tilt are summarized below. Rates tested this year were not effective in controlling stem rot but did give some significant differences in Aggregate Sheath Spot disease although yield was not increased.

We completed a 3 year residue study on Tilt in rice and also alternate crops. Chemical analysis was conducted by Ciba-Geigy on soil, water and plant samples. When results become available, we hope to be able to use application rates higher than those tested this year since our previous trials had indicated better disease control at higher rates of application.

Efficacy of Rates and Application Times of Tilt 3.6E for Control of Aggregate Sheath Spot and Stem Rot of Rice 1984

Treatments	Rate (grm ai/A) IL[1]	Boot	Aggregate Sheath Spot[3] Severity Trial 1[2]	Trial 2	Stem Rot Severity Trial 1	Trial 2	Yield[4] 14% Moisture Trial 1	Trial 2
1-Tilt 3.6E	200	--	13.9	15.0	1.21	1.12	30.3	30.5
2-Tilt 3.6E	--	200	14.4	16.8	1.12	1.19	30.8	31.2
3-Tilt 3.6E	75	125	15.4	17.6	1.20	1.16	32.2	28.9
4-Tilt 3.6E	125	75	12.3	12.7	1.19	1.14	30.0	33.8
5-Tilt 3.6E	75	75	15.0	13.5	1.11	1.11	31.8	32.0
6-Check	--	--	19.7	16.2	1.16	1.18	31.6	32.7
			LSD.4.8[5]	N.S.	N.S.	N.S.	N.S.	N.S.

[1]Internode elongation, Boot stage
[2]Mean of 4 replications per trial
[3]$\frac{\text{ht. of disease on \# infected tillers}}{100}$ = ASSS.
[4]Yield = lbs. rice at 14% form 140 ft^2.
[5]L.S.D. = least significant difference a .05. N.S. not significant

Objective 4: Interactions of cultivars with nitrogen level and stand density for effects on Aggregate Sheath Spot severity.

The relationship of increased disease severity with high and/or excess nitrogen fertilization has been known for Stem rot (*Sclerotium oryzae*) and sheath blight (*Rhizoctonia solani*) of rice for some time. The majority of the data available was obtained from trials comparing cultivars of standard (tall) height. At present, virtually all of the rice cultivars in California are classified as semi-dwarfs or short statured rice. These new short-statured varieties differ in their responses to nitrogen fertility i.e. most yield as well as the taller varieties at minimum nitrogen rates and yield considerably more at higher nitrogen rates.

The extensive cultivation of semi-dwarf cultivars has been paralleled by an increase in total nitrogen fertilization/acre and an increase in severity of Aggregate Sheath Spot disease (*R. oryzae sativae*). Since Aggregate Sheath Spot is similar in many ways to Sheath Blight, the effects of varying nitrogen levels of fertilization on this disease were also studied. The results of 1984 field trials to determine the interaction of cultivars, seeding rate (stand density) and Nitrogen Fertilization on severity of Aggregate Sheath Spot disease follow:

Nitrogen x Cultivar Trial

The purpose of this field trial was to access the effect of nitrogen on the development of Aggregate Sheath Spot. The design of the trial was a split plot with four blocks. Each block consisted of five rates of aqueous nitrogen (0, 50, 100, 150, and 200 lbs/acre) applied in strips. In each strip eight cultivars were planted: M-201, L-202, M-9, Cal Pearl, Cal Belle, S-201, Earlirose, and S-6. The trial was planted on May 10 and samples of 100 rice tillers were cut from each plot (total of 160 plots) on September 5 and rated for incidence of Aggregate Sheath Spot. The disease rating was done by measuring the length of infection on each disease tiller. The final disease rating for each plot was calculated as follows:

$$\frac{\text{sum of the infection lengths (cm) of diseased tillers}}{100}$$

Statistical analysis of the (data) show that the incidence of Aggregate Sheath Spot was not significantly effected by the different nitrogen treatments. However, with all cultivars the highest disease incidence occurred at the lowest nitrogen rate (0 lbs/acre) and there was a trend of decreasing disease incidence with increasing nitrogen rates up to 150 lbs/acre. At the highest nitrogen rate (200 lbs/acre) disease incidence increased with cultivars M-201, L-202, and M-9 to levels comparable to those at the 50 and 100 lbs/acre nitrogen rates. This trend was not seen with the other cultivars.

Though the rate of nitrogen did not significantly effect A.S.S. disease incidence, there were statistically significant differences in disease among cultivars. Cultivar M-201 had the highest disease incidence followed by L-202. S-201, Earlirose and S-6 had the least disease.

Effect of Nitrogen on Disease Incidence of Aggregate Sheath Spot

Cultivar	lbs/acre 0	50	100	150	200
M-201	30.0	27.9	23.5	15.7	27.3
L-202	26.5	23.2	19.0	20.3	24.3
M-9	20.0	15.8	18.4	15.2	18.4
Ca Pearl	16.7	14.4	15.1	14.0	12.1
Ca Belle	17.4	14.1	10.5	11.4	11.3
S-201	13.2	10.5	7.6	6.9	8.5
Earlirose	11.7	11.8	6.3	7.8	7.5
S-6	8.0	5.4	2.9	6.3	3.5

each value is a mean of 4 replications

Disease Incidence of Aggregate Sheath Spot on Eight Cultivars

Cultivar	mean disease index
M-201	24.9 a
L-202	22.6 b
M-9	17.6 c
Ca Pearl	15.2 d
Ca Belle	13.0 e
S-201	9.3 f
Earlirose	9.0 f
S-6	4.5 g

each value is an overall mean of the disease index at 5 nitrogen levels. Values followed by the same letter are not significantly different at P = 0.05.

Seeding Rate x Cultivar Trial

The purpose of this trial was to examine the effect of seeding rates on the incidence of Aggregate Sheath Spot. The field trial was set up in a completely randomized design with four cultivars (L-202, Cal Belle, Cal Pearl and M-201) each planted on May 15 and samples were taken from each plot on September 15 and rated for disease incidence as described before.

Statistical analysis of the data show that there was no significant differences in disease incidence among the three seeding rates. No trends were apparent in regard to disease incidence and seeding rate. There were, however, significant differences in disease incidence among cultivars with M-201 having significantly more disease than Cal Belle, Cal Pearl or L-202.

The data from this year's field trials support results obtained from field trials conducted in 1982 and 1983. Field trial data show that nitrogen levels and seeding rates do not significantly effect the incidence of Aggregate Sheath Spot. The data also show that there are distinct differences among commercial cultivars in vulnerability to the disease in the field.

Tall statured California rice cultivars are much less vulnerable to Aggregate Sheath Spot than the short statured cultivars. Originally, we thought that this may be due to the fact that the more compact stature of the semidwarf cultivars and the cultural practices employed to grow them (e.g. higher nitrogen rates, higher seeding rates) provide an environment more conducive to the development of Aggregate Sheath Spot. However, the field data does not support this theory and it is likely that differences in disease incidence of Aggregate Sheath Spot are due primarily to genetic differences among cultivars in vulnerability to the disease.

Effect of Seeding Rate on Disease Incidence of Aggregate Sheath Spot

	lbs/acre		
Cultivar	90	150	210
L-202	10.8	10.3	12.0
Ca Belle	10.9	12.4	12.3
Ca Pearl	11.9	12.8	10.5
M-201	17.7	13.9	13.1

each value is a mean of 4 replicaitons

Disease Incidence of Aggregate Sheath Spot on Four Cultivars

Cultivar	mean disease index
M-201	14.9 a
Ca Pearl	11.8 b
Ca Belle	11.7 b
L-202	11.0 b

each value is an overall mean of the disease index at 3 seeding rates. Values followed by the same letter are not significantly different at P = 0.05.

It is apparent that severity of Aggregate Sheath Spot is not as affected by these cultural factors as is severity of Stem rot disease. With stem rot, disease severity increases as nitrogen fertilization is increased on all cultivars we have tested. Disease severity continued to increase after maximum yield was obtained. In all cases, additional nitrogen fertilization above that required for maximum yields of the cultivar resulted in significant increases in disease severity and significant reductions in yield. Thus in the case of stem rot disease, excess nitrogen fertilization is as conducive to increased disease severity and yield loss on semi-dwarf cultivars as it is on tall cultivars. That this yield reduction is due to disease loss instead of lodging and delayed maturity due to excess nitrogen was established in trials where N levels varied and disease was controlled by fungicide applications.

The results indicate that management of N fertilization to asure obtaining maximum yield yet minimizing disease severity requires special attention. Our goal is to determine an optimal cultural system to maximize yields and at the same time provide adequate disease management practices.

Objective 5: Detection and Control of Kernel Smut of Rice.

Justification:

Kernel smut of rice has been detected in seed lots originating from several of the rice producing counties in California. Although there is the possibility that some of these seed lots were contaminated by harvest equipment or in handling rather than by infection in the field, it seems prudent to assume the disease is wide spread at this time. On the other hand, if a large portion of smut detected by recent CDFA tests is due to contamination during the handling process, it also seems prudent to carry out studies to attempt to determine the points of origin of the contamination and to determine actions that would minimize further spread of the pathogen. Paramount to the above, is the fact that there exists a considerable range of opinion both within the literature and among pathologists in other areas where the disease occurs endemically. This confusion applies to the biology of the causal organism, factors affecting disease occurrence, severity of losses caused and nature and efficacy of control attempts.

We have concentrated our research on kernel smut on the following areas. Many of our results thus far are preliminary but considerable progress is being made. Following is a summary of the rationale for study and results obtained to date.

a) Determine extent of infestation and feasibility of isolating sources of infestation to prevent further spread.

Although kernel smut is not considered to be seed borne (i.e. systemic infections do not occur from contaminated seed), contaminated seed is considered a primary means of distribution of the pathogen within the rice growing region. If the pathogen has already been introduced to a particular field, then the occurrence of smut on the present crop would be dependent on inoculum level, presence of a susceptible variety and favorable environmental conditions. To minimize the chance of further spread and infestation of the rice area we are conducting surveys of the extent of infestation as follows:

(i) Random fields were selected for survey by a predetermined path and direct observation made prior to harvest. This approach proved to be time consuming but was necessary to gain an estimate of the occurrence of kernel smut in individual fields. Based on the relative low incidence of kernel smut observed by this approach, we concluded that kernel smut occurred at a fairly low overall incidence this season.

(ii) To allow collection of data on a larger number of fields the following survey was also conducted. Rice dryers in all areas were contacted and asked to provide samples from lots as they were closed. This allowed us to obtain samples from a high precentage of the total rice fields grown this season. A method was developed for determining the presence of smut infested kernels in each sample. Since it is based on the actual presence of smutted kernels, this method excludes the possibility of smut detected being due to surface contamination of rice grains from other sources, i.e. equipment, other fields etc. Thus far we have processed over 1300 such samples. The level of smut detected in individul samples completed is very low, supporting observations of the field inspection study. On the other hand, of the samples processed, 9.6% contained some smutted kernels. After all samples are processed we will map their origin by lot number to determine the pattern of kernel smut distribution in the rice producing areas. In addition, the seed used to plant fields in which smut was detected can be identified and comparisons with the 1983 CDFA analysis of smut in seed lots will be made. This should provide information as to importance of infested seed in kernel smut occurrance in subsequent years.

b) <u>Elimination of Smut from Infested Seed.</u>

This phase of the project focuses on development of methods to eliminate the kernel smut organism from infested seed both as a surface contaminent and as smutted or partially smutted seed. We have initiated studies on the efficacy of various concentrations and treatment times of Sodium hypochlorite and Kocide for eliminating the smut organism from seed. Both of these treatments are or have been accepted methods of treating seed rice.

Several fungicidal treatments were tested for activity against seed borne teliospores of the kernel smut fungus. The effectiveness of each treatment was determined by assessing the viability of spores washed off the surface of treated seed. This was accomplished by stirring 20 grams of seed in 40 mls of water using a magnetic stir bar. The wash water was filtered through cheese cloth and centrifuged at 7000 rpm for five minutes. The supernatant was discarded; the pellet, which contained the spores, was resuspended in 5 mls of sterile water and centrifuged again. After pouring off the supernatant the pellet was resuspended in 2 mls of sterile water and transfered to a plate of water agar (80 ppm penicillin and 100 ppm streptomycin). The spores were allowed to incubate on these plates at room temperature with 12 hours of light per day. After four days plates were examined microscopically for the presence of germinating spores. The absence of germinating spores was regarded as evidence taht the seed treatment was effective. The results to date are summarized below:

Treatment	Rate	Kernel Smut Spore Germination (+/-)
Vitavax 200FF	3 oz./100wt.	-
Kocide SD	3 oz./100 wt.	-
Captan (39%)	3 oz./100 wt.	+
Difolatan (39%)	3 oz./100 wt.	-
XE779 (25%)	2.5 gm/100 wt.	-
NaOCl (1%)	24 hour soak	-

These preliminary results indicate that only captan was not effective in eliminating kernel smut spores from surface contaminated rice seed. These results are being retested for verification.

c) Study on the Disease Cycle and Biology of the Kernel Smut Organism.

As pointed out earlier, there exists considerable disagreement in the literature regarding several basic aspects of the kernel smut disease of rice. These include name and nature of the causal organisms, requirements for germination and subsequent infection by various spore stages, factors that affect disease occurrence and severity, site and persistence of inoculum and amount and importance of disease loss. Paramount of these are factors affecting and the nature of chlamydospore germination. Basic information regarding these aspects is badly needed in order to carry out reliable studies on detection of the organism in surveys and in attempts to eliminate it from infested seed. We are concentrating our efforts and experiments in this area first.

The first step in this investigation was to confirm the suscepted relationship between seed borne teliospres and the disease which had been observed in the field. This was done by isolating a partially smutted kernel from a seed lot of S201, and using it to prepare inoculum. The kernel was surface sterilized with 1% NaOCl and then broken up in a drop of sterile water. This suspension of teliospores was spread over the surface of water agar plates and allowed to incubate for seven days. By this time the plates were covered with growth of the smut fungus. The surface of the agar was rinsed with sterile water to obtain a suspension of primary and secondary sporidia which served as the source of inoculum.

Florets were inoculated by spraying exposed panicles with enough of the spore suspension to uniformly wet all florets. Pre-emergent panicles were inoculated by injecting 0.6-1.0 mls of the spore suspension into the boot. The spore concentration in the inoculum was 3.5-5.0x10^5 sporidia (I° and II°) per ml. Following inoculation plants were maintained at 21C and 100% RH for 48 hours. The following varieties were inoculated in this manner and found to be susceptible to kernel smut.

Calrose	M7	M401
Calrose 76	M9	L201
Cal oro	M101	L202
Calmochi 202	M201	S201
Cal Belle	M302	Earlirose

How long florets remain wet following inoculation may influence the infection process. Florets remained wet as long as plants were kept at 100% RH. Wetness periods as short as 10 hours (at 18C) were found to be adequate for infection to take place. Temperatures as low as 15C and as high as 23C were found to be conducive to infection. Interactions between temperature and the length of the wetness period have not yet been studied. It is probable that at higher temperatures a shorter wetness period is required.

d) Inoculation Methods - Relative Susceptibility of Cultivars

To develop a consistent and realistic method for screening rice varieties for susceptibility to kernel smut the influence of panicle age on susceptibility must be understood. This will make it possible to identify the period of maximum susceptibility. By inoculating panicles at different stages of development the following patterns have been identified. Individual florets cease to be susceptible after anthesis. Unopened (preanthesis) florets become less susceptible as the panicle ages. The period of maximum susceptibility is prior to emergence of the panicle from the boot. This is exemplified by the following data on the variety M-9.

PANICLE DEVELOPMENT	% KERNELS SMUTTED
In Boot 10 Days Prior to Emergence	86.9
In Boot 3 Days Prior to Emergence	34.5
Panicle Emerged, Pre Anthesis	16.2
Four Fls. Past Anthesis	11.8
50% of Fls. Past Anthesis	0

Preliminary results suggest that quantitative differences in susceptibility to kernel smut may exist among California rice varieties. For example, when inoculated under the same conditions M-9 shows a much higher level of infection than Calrose. This may reflect differences in susceptibility. But it is probably, at least in part, a reflection of the fact that the inoculum used was derived from a sorus on an M-9 rice plant. Additional evidence for the importance of the inoculum source comes from the observation that higher disease levels occur on Calrose 76 when inoculum is derived from an S201 sorus than when inoculum is derived from an M-9 sorus. This area requires closer scrutiny to determine the extent to which pathogenic races of the smut fungus interact differentially with California rice varieties.

e) Development of Methods to Control Kernel Smut.

Control methods for kernel smut are expected to hinge on results obtained under objectives A-D. Methods to eliminate the kernel smut organism from seed and reduce it's spread and possible seed treatment coupled with an increased understanding of the disease cycle and factors that favor smut development in the field should serve as a basis for developing a control program. Included in attempts to accomplish this objective will be further studies on relative susceptibilities of cultivars.

Several of the new systemic fungicides currently used for controlling smut diseases in other cereals may have application to the rice smut problem. Laboratory, greenhouse and field trials are being carried out to test the feasibility of their use both in eliminating infestation of seed and/or preventing smut infection in the field.

PUBLICATIONS OR REPORTS:

Gunnell, P. S. and R. K. Webster. 1984. Aggregate Sheath Spot of Rice in California. Plant Disease 68:529-531.

Webster, R. K., C. M. Wick and P. S. Gunnell. 1984. Effects of Nitrogen Fertilization on Severity of Stem Rot and Aggregate Sheath Spot of Rice. Proceedings to Meeting of the Rice Technical Working Group. Agricultural Information Department, Texas A&M University, College Station Texas.

Gunnell, P. S., R. K. Webster and C. M. Wick. 1984. Aggregate Sheath Spot of Rice in California. Proceedings to Meeting of the Rice Technical Working Group. Agricultural Information Department, Texas A&M University, College Station, Texas.

Gunnell, P. S. and R. K. Webster. 1984. The Teleomorph of Rhizoctonia oryzae. Phytopathology 74:857.

Webster, R. K. 1983. Report to the California Rice Research Board. Project RP-2. Cause and Control of Rice Diseases. 19-30 pp. in: Annual Report of Comprehensive Rice Research. 1983. University of California and U.S. Department of Agriculture.

CONCISE GENERAL SUMMARY OF CURRENT YEARS RESULTS:

Bordered Sheath Spot and Aggregate Sheath Spot of Rice comprise a disease complex frequently referred to in the past as sheath blight.

Aggregate Sheath Spot is caused by Rhizoctonia oryzae-sativae. The disease has increased in frequency and severity paralleling the use of short-statured rice cultivars. The perfect stage of the cuasal organism has been identified and its role in disease epidemiology is being investigated. Bordered Sheath Spot is caused by R. oryzae. This disease was first found in California in 1983.

Symptoms of the two diseases are quite similar and may be confused. Bordered Sheath Spot is a more agressive disease on our California cultivars than is Aggregate Sheath Spot. The causal organisms of the two diseases are distinctly different and also respond differently to control attempts.

Good sources of resistance to Aggregate Sheath Spot have been identified. Results thus far indicate they are heritable and of potential value in the breeding program.

Trials to determine chemical control for Stem Rot, Aggregate Sheath Spot and Bordered Sheath Spot were continued. Results for 1984 indicate higher levels of candidate chemicals tested will be required for adequate control. Residue data from soil, water, rice plants and alternate crops was obtained in attempts to facilitate registration.

Studies on effects of culture practices i.e. stand density and nitrogen fertilization indicate that Aggregate Sheath Spot and Stem Rot severity are effected differently. This finding indicates a necessity of careful management of stand density and nitrogen fertilization to assure obtaining maximum yields and yet minimizing disease severity. Our goal is to determine an optimal culture system to maximize yields and at the same time provide adequate disease management practices.

Studies on the distribution, biology and control rice kernel smut were initiated this year. Results thus far indicate that kernel smut is more prevelant than anticipated. The role of seed infestation in the epidemiology of kernel smut is still being determined. Seed treatments that will eliminate inoculum from seed have been identified. We have preliminary evidence that varieties differ in susceptibility. More study is needed on the biology of kernel smut, its impact on yield and potential control measures.