ANNUAL REPORT
COMPREHENSIVE RESEARCH ON RICE
January 1, 1990 - December 31, 1990

PROJECT TITLE: Cause and Control of Rice Diseases

PROJECT LEADER AND PRINCIPAL UC INVESTIGATORS:

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LEVEL OF 1989 FUNDING: $47,816

OBJECTIVES AND EXPERIMENTS CONDUCTED BY LOCATION TO ACCOMPLISH OBJECTIVES:

Our long term research objective is the development of a more thorough understanding of California rice diseases and methods to reduce their negative impact on California rice production. In view of the limited interest and availability of chemical control for rice diseases, we primarily research cultural and biological control methods. The applied portion of our research program is to improve existing methods and develop new ones that are better and more practical.

The major rice diseases in California continue to be stem rot and, occasionally, aggregate sheath spot. Severity of these diseases from year to year is closely associated with effective rice residue disposal in continuously cropped systems. Since burning the residue has become more restricted and may not be available in the future, many growers are experimenting with alternatives to burning. Although we have much information on the impact of rice diseases in continuously grown rice when the residue is not burned, much remains to be learned regarding long term effects and whether any biological manipulation might improve these systems for straw degradation and disease control. Consequently, we have continued to investigate the microbiology of the more common systems with regard to the stem rot disease.

One biological method that may improve non-burn residue management is directed application of straw decomposing fungi to enhance decay and promote destruction of overwintering pathogens. We have spent a great deal of effort the past year in isolating and testing naturally occurring fungi from overwintering rice straw and will continue this search during the next season. In addition to straw decomposers, we are attempting to isolate naturally occurring fungi from overwintering sclerotia of the stem rot fungus that may be mycoparasitic. Combined inoculations of straw

decomposing fungi and sclerotial parasites may improve the chances for success of our basic concept.

Efforts to find in-season biocontrol agents for stem rot continued with mixed success.

Also, greenhouse evaluation of California commercial rice cultivars for resistance to stem rot and other disease combinations were repeated.

Specific Objectives for 1990 were:

(1) Continue isolation, collection, and assay of naturally occurring fungi associated with decomposing rice residue in the field. Determine field potential of selected fungi to enhance decomposition of rice residue and overwintering inoculum of rice diseases, primarily stem rot.

(2) Continue evaluation of different rice culture systems in regard to residue decomposition and disease severity.

(3) Isolate and test in-season biocontrol agents for stem rot.

(4) Repeat evaluation of commercial cultivar resistance to stem rot and other disease combinations.

Field research in 1990 was conducted in grower's fields in Butte, Colusa and Sutter counties. Laboratory and greenhouse studies were conducted in University of California, Davis facilities.

SUMMARY OF 1989 RESEARCH (MAJOR ACCOMPLISHMENTS) BY OBJECTIVE:

Objective 1: We continued the isolation and collection of fungi from rice residue collected between December 1989 and March 20, 1990 from various fields in Yolo, Butte, and Sutter counties. Most of the residue was of commercial cultivar M202 and was collected at 30 day intervals.

The fungi isolated most frequently from our samples are listed in Table 1. In addition to fungi associated with decomposing straw, we isolated fungi associated with sclerotia of S. oryzae extracted from the straw samples (Table 2). Not unexpectedly, many of the fungi isolated from sclerotia are quite distinct from those associated with straw.

TABLE 1. Predominant Fungi Isolated From Rice Straw in 1990.

Code No.	Fungus
90-1	*Cladosporium cladosporioides*
90-2	Unknown grey slimy yeast
90-3	*Sporobolomyces* sp.
90-4	*Acremonium strictum*
90-6	*Epicoccum purpurescens*
90-8	*Alternaria alternata*
90-13A	*Humicola grisea*
90-14	*Mucor mucedo*? Type 1
90-16	*Fusarium moniliforme*
90-17	*Trichoderma harzianum*
90-18A,B	Binucleate *Rhizoctonia*
90-19	*Aspergillus terrestris*?
90-21	*Mucor mucedo*? Type 2
90-25	*Coniothyrium* sp.?
90-26	*Phoma eupyrena*
90 27A,B,C	*Waitea circinata*
90-31A	*Gelasinospora cerealis (seminuda)*
90-31B	*Gelasinospora retispora*
90-53	Sterile Fungus
90-54	*Mucor* sp.
90-55	*Penicillium* sp.
90-56	*Microdochium bolleyi*
90-57	*Rhizopus circinans*
90-58	*Ulocladium atrum*
90-59A,B	*Coprinus* sp.
90-64	*Botrytis cinerea*
90-69	Unknown Zygomycete
90-71A	*Fusarium reticulatum*
90-71B	*Fusarium avenaceum*
90-71C	*Fusarium culmorum*
90-71D	*Fusarium crookwellense*?
90-73	*Minimedusa* sp.
90-74	Unknown Zygomycete
90-75	Unknown Zygomycete

TABLE 2. Predominant Fungi Isolated From Sclerotia of *S. oryzae*.

Code No.	Fungus	Comment
90-A	*Phoma* sp.	
90-B	*Acremonium* sp.	
90-C1,2,3	Unknown Fungus	parasitic on *S. oryzae*
90-D	*Acremonium strictum*	same as 90-4
90-E	Sterile Fungus	
90-F	*Acremonium* sp.	common in non burn areas
90-G	*Acremonium* sp.	parasitic on *S. oryzae*?
90-H	*Microdochium bolleyi*	same as 90-56
90-I	*Epicoccum purpurascens*	same as 90-6
90-K	*Acremonium terricola*	
90-O	Sterile Fungus	
90-Q	*Cladosporium cladosporioides*	same as 90-1
90-R	*Alternaria alternata*	same as 90-8
90-V	Sterile Fungus	parasitic on *S. oryzae* ?
90-Z	*Chaetomium* sp.	rarely isolated

Fungi listed in Tables 1 and 2 were assayed in the lab for straw decomposing ability, ability to colonize and destroy *S. oryzae* sclerotia, and cellulase, chitinase, and xylanase activity (Tables 3 and 4). Results support the idea that the higher fungi (Ascomycetes and Basidiomycetes) appear to offer the most promise as straw decomposers (Table 3). As pointed out last year, many of these fungi are initially found at low populations in the straw early in the residue cycle but gradually increase in population as they displace the original straw colonists.

TABLE 3. Results of Lab Assays for Straw Decomposing and Enzyme Activity of Tested Fungi Isolated During 1990.

FUNGUS	DRY WEIGHT OF STRAW %LOSS	LAB ASSAYS FOR CELLULASE	CHITINASE	XYLANASE
90-31A	29.520	+++	-	+++
90-31B	29.134	+++	-	+++
90-18A+90-2+90-C2	27.086	+++	-	+++
90-18A	26.005	+++	-	+++
90-18A+90-2	25.872	+++	-	+++
90-18B	25.110	+++	-	+++
90-27B	24.634	+	-	-
90-27C	22.653	+	-	-
90-71C	20.596	+	-	++
90-K	19.937	-	++	++
90-18A+90-C2	18.643	+++	-	+++
90-27A	17.877	+	-	-
90-56	17.684	++	-	+++
90-71B	17.519	+	-	++
90-58	16.882	++	-	+++
90-6	16.259	++	-	++
90-26	15.786	++	-	+++
90-71A	14.784	++	-	++
90-53	14.530	+	-	-
T. harzianum (lab)	14.471	+++	++	+++
90-8	14.224	+++	-	+++
90-59A	12.571	+++	+	-
90-A	12.405	+	-	+++
90-1	12.044	+	-	+++
90-13A	11.962	++	+++	-
90-17	11.845	+++	++	+++
90-C2	11.518	++	-	+++
90-59B	10.701	++	-	++
90-C3	9.737	++	-	+++
90-C1	7.967	++	-	+++
90-V	7.016	++	-	++
90-64	6.557	+	-	+
90-F	6.404	+	-	-
90-55	5.958	+	+	+++
90-Z	5.752	+	+	-
90-25	2.853	+	-	-
90-2	1.422	-	-	-
90-21	1.350	-	+++	-
90-69	0.587	-	+++	-
90-14	-0.442	-	+++	-
90-54	-0.987	+	+++	-
90-19	-1.318	+	-	-
90-75	-2.762	-	+++	-

*[-= none, += slight, ++= moderate, +++= high activity]

TABLE 4. Results of Lab Assays for Degradation Ability of Various Fungi on Sclerotia of *S. oryzae*.

FUNGUS	PER CENT OF SCLEROTIA GERMINATED	COLONIZED
90-Z	14.03	67.60
18A+C2	14.34	91.26
90-C3	17.93	92.97
90-C2	18.30	77.59
90-59A	19.37	24.59
18A+C2	19.40	71.85
90-6	19.42	38.96
90-71C	21.04	59.56
90-C1	23.30	93.98
90-13A	23.97	55.98
90-26	25.20	45.62
90-71B	25.38	45.21
90-A	26.44	54.40
90-56	26.58	56.46
90-K	29.90	25.01
90-V	30.27	84.62
T. harzianum(lab)	30.53	48.17
90-58	35.98	47.98
90-71A	38.38	53.11
90-18B	41.79	34.49
90-17	44.44	17.33
90-53	46.16	1.93
90-55	48.43	12.67
90-18A	50.40	22.94
90-14	50.82	10.98
18A+2	51.59	16.29
90-1	53.16	15.17
90-31A	55.76	2.18
90-21	56.70	8.94
90-64	57.39	0.00
90-69	58.18	6.39
90-8	60.49	38.90
90-2	60.93	9.61
90-27A	61.88	0.00
90-59B	64.72	20.37
90-25	68.80	1.34
90-27B	69.59	6.94
90-75	70.79	8.67
90-31B	72.39	1.59
90-27C	73.75	8.40
UNTREATED	75.47	0.00
90-19	77.80	0.00
90-54	82.38	0.00

* Ranked in order of effectiveness.

Enzyme assays were used in the hope that they would represent an easier and faster means to screen our collection of fungi. However, it appears that while they indicate relative enzymatic activity they are not foolproof and would probably result in some promising fungi being overlooked. For example, a common fungus isolated from sclerotia is 90-C (Tables 5 and 6). It is mycoparasitic on S. oryzae in culture and is capable of colonizing and destroying sclerotia in the lab assay (Table 4). We have observed this fungus repeatedly parasitizing hyphae, conidia, and sclerotia of S. oryzae. However, it shows no chitinase activity in the enzyme assay, which is designed to indicate organisms capable of digesting fungal cell walls which are largely chitin. It is our opinion that the assays utilizing straw and sclerotia are more biologically relevant at this point and should continue to be used for screening potentially useful fungi, regardless of the time and labor disadvantage.

TABLE 5. Isolation Frequency of Fungi from Sclerotia of S. oryzae (Bagged Straw 1990).

	% ISOLATION FROM SCLEROTIA COLLECTED IN			
FUNGUS **	JAN	FEB	MAR	APR
90-A	7.27	1.14	12.50	11.52
90-B	9.45	3.79	13.95	.30
90-C	12.00	7.95	13.08	47.34
90-D	5.45	6.44	7.27	1.08
90-E	16.73	.76	0	0
90-F	6.18	15.53	3.49	4.82
90-G	12.36	7.58	11.63	9.65
90-H	5.09	11.36	4.07	6.40
90-I	7.27	14.77	7.85	3.25
90-K	5.82	4.17	2.03	1.48
90-O	1.45	3.41	1.45	.69
90-Q	2.18	6.44	10.17	.69
90-R	0	3.03	0	.30
90-V	0	1.14	11.05	12.20

TABLE 6. Overall Frequency of Isolation of Fungi from Sclerotia of S. oryzae. (Bags Containing Straw Placed in Various Systems and collected in March).

FUNGUS**	FREQ OF ISOLATION
90-A	6.53
90-B	1.04
90-C	17.06
90-D	.89
90-F	14.39
90-G	14.69
90-H	21.07
90-I	1.48
90-K	.45
90-O	2.08
90-Q	4.01
90-R	1.63
90-V	13.35

**Please refer to Table 2 for information regarding these fungi.

Lab assays are useful for screening large numbers of organisms, but they cannot substitute for some type of field test. It has been our observation that possessing the enzymatic ability to digest straw does not mean the fungus can colonize straw in the field especially considering the many competing organisms and often detrimental environmental conditions encountered. Therefore, we screened several potential decomposer fungi isolated during 1988-1989 in a field test this past winter.

Weighed bags of field collected straw were inoculated with infested seed of a test fungus and placed either on the soil surface or buried 5 - 10 cm deep in a Butte County field. Twenty bags were inoculated per fungal treatment and five bags were collected at monthly intervals for analysis. Four bags were gently washed to remove soil, dried, and weighed to determine weight loss. The bagged straw was naturally infected by S. oryzae, so the straw in the remaining bag was used for fungal isolations from both straw and sclerotia. Viability of the collected sclerotia was also recorded. Results of this experiment are shown in Tables 7 and 8.

TABLE 7. Results of 1990 Field Trial of Straw Decomposing Ability of Various Saprophytic Fungi.

** TRT	%DW LOSS FOR STRAW COLLECTED IN JAN	FEB	MAR	APR
1S	14.85	17.03	19.52	18.15
2S	15.21	16.72	22.63	22.02
3S	10.34	9.94	16.30	17.74
4S	11.39	13.09	17.13	16.08
5S	9.66	10.19	15.76	16.88
6S	11.34	12.36	17.66	19.25
7S	10.21	14.40	13.76	17.80
8S	9.13	17.05	17.19	17.73
9S	12.51	11.68	17.75	16.93
10S	13.42	14.23	15.36	14.20
11S	11.47	15.41	15.06	17.87
1B	14.01	18.50	27.78	28.66
2B	17.30	21.25	29.47	34.31
3B	15.38	15.51	16.99	16.65
4B	9.68	17.38	19.10	19.59
5B	15.95	15.22	18.14	17.99
6B	9.45	17.97	19.51	17.85
7B	14.21	20.48	22.09	22.88
8B	17.80	17.36	18.49	18.48
9B	12.51	19.56	20.04	18.80
10B	7.8	14.60	14.65	13.20
11B	13.2	18.78	21.03	20.88

**

TRT	PLACEMENT	FUNGUS	INOCULUM TYPE
1S	Soil Surface	90-18A	Infested Seed
2S	"	"	Ca-alginate pellets
3S	"	90-27A	Infested Seed
4S	"	90-19	"
5S	"	90-55	"
6S	"	90-8	"
7S	"	90-17	Ca-alginate pellets
8S	"	1+3+4+5+6	Infested Seed
9S	"	None	None
10S	"	None	None(double bagged)
11S	"	None	Ca-alginate pellets only

Trts 1B-11B are as above except inoculated straw in bags was buried 5 - 10cm under soil. Bags placed in the field December, 1989.

TABLE 8. Colonization of Inoculated Straw by Test Fungi During 1990 Field Trial.

** TRT	%COLONIZATION BY INOCULATED FUNGI JAN	FEB	MAR	APR
1S	50	58	100	100
2S	50	90	98	100
3S	0	0	8	0
4S	0	0	0	0
5S	17	17	25	0
6S	8	8	50	75
7S	0	7	36	48
8S	8	8	92	100
9S	0	0	0	8
10S	0	0	0	50
11S	0	0	0	0
1B	92	100	100	67
2B	100	100	100	83
3B	0	42	8	0
4B	0	0	0	0
5B	8	8	58	66
6B	83	66	67	50
7B	50	55	73	70
8B	8	67	58	0
9B	0	0	92	34
10B	0	0	0	0
11B	0	0	0	0

**See Table 7 for Treatment Explanation.

Only one fungus appeared to have enhanced decomposition, namely 90-18A (Binucleate Rhizoctonia). The increase in weight loss (~10-15%) was most pronounced in the buried bags which is not surprising considering the dry winter. A different type of inoculum employing this fungus in Calcium alginate pellets appeared to be superior to the infested seed we used as a standard method. In Table 8 it is also apparent that this fungus has the ability to colonize the straw early and completely. Trichoderma harzianum also colonized the straw but had little noticeable effect on decomposition. It is interesting that in this location, little difference was noted between surface applied bagged straw and buried straw except for the aforementioed 90-18A. It appears from these results that the concept of moving a late season decomposer earlier in the season may result in increasing final decomposition of the straw. Although inconclusive, it did not appear that viability of S. oryzae sclerotia was affected by any treatment (Data not shown). It would obviously be of interest to mix the best straw decomposer with the best sclerotial parasite to enhance both straw and sclerotia degradation. Due to small differences and

data inconsistency, it is important to repeat this trial this season.

(Objective 2)- We continued to monitor various systems of residue management employed by growers in Butte, Sutter, Colusa, and Yolo counties. Samples of weighed straw were placed on the soil surface or buried in these fields in December, 1989 and collected in late March, 1990.

Again, four bags from each placement were washed to remove soil, dried and weighed, while the remaining bag was used for fungal isolation and sclerotia viability determination. Straw weight loss results are shown in Table 9. As we would expect soil contact is essential for effective decomposition apparently even in the flooded field. During the time period sampled, little difference in final decomposition achieved was noted between systems. Whether this would hold true for the entire residue cycle is unknown, but would be unexpected. There was no indication of any dramatic decrease in sclerotial viability in any of the systems (Data not shown). Small sample size prevents any definitive conclusion about this item.

TABLE 9. Dry Weight Loss of Bagged Straw Placed in Various Systems (December 10, 1989 - March 20, 1990).

SYSTEM	%DW LOSS OF BAGGED STRAW SOIL SURFACE	BURIED
YOLO NOT BURNED (NB)	13.27	29.16
COLUSA BURNED	11.15	30.03
BUTTE NB FLOOD AND ROLLED	12.31	28.71
BUTTE BURNED	8.91	29.32
BUTTE NB ORGANIC	10.83	32.92
BUTTE NB ROLLED AND CHISEL	14.94	25.18
BUTTE NB (CHOPPED)	15.18	22.40
BUTTE BURNED	22.15	28.02
SUTTER NB ORGANIC	15.54	26.91
SUTTER NB INCORPORATED	16.76	24.64

Soil samples from prepared seedbeds in several management systems were taken in the spring and analyzed for sclerotial content, and later, disease levels (Table 10).

Although firm conclusions would be difficult to draw from one year's data, there are several interesting observations. For example, a high incidence of aggregate sheath spot (AgSS) often means lower than expected stem rot severity (Table 10 - Fields 28, 35, 40, 42, 22). The reverse may also exist (Fields 41, 27, 36, 26, 29). Fields 36, 26, and 29 had high disease levels and fairly low sclerotia populations. These fields contained L-202, a

cultivar repeatedly noted for its susceptibility in the field to stem rot, and had a very high stand density. High stand density is known to enhance the severity of stem rot. Field 42 had the highest sclerotia count but only a mild stem rot problem. This field contained S201, a cultivar with good field resistance to stem rot, and was managed well. In addition, the field had a high incidence of AgSS and Sclerotium hydrophilum (Data not shown), a fungus we have noted as a potential biocontrol agent of stem rot.

TABLE 10. Sclerotial Survival, Stem Rot Severity, and Aggregate Sheath Spot (AgSS) Incidence in Various Straw Management Systems.

SYSTEM AND FIELD NUMBER			VIABLE SCLEROTIA /GM SOIL	STEM ROT DI	% AgSS
BUTTE	NOT BURNED FLOODED	28	0.25	1.95	47.33
BUTTE	" " FALLOW	24	0.08	1.15	22.00
BUTTE	" " FLOODED	34	0.37	2.07	16.00
YOLO	CONVENTIONAL BURN	39	0.01	1.65	0.00
BUTTE	NB FLOODED	35	0.05	1.05	65.00
BUTTE	CONVENTIONAL BURN	41	0.12	2.36	4.00
BUTTE	NB FLOOD ROLL	40	0.79	2.44	42.00
BUTTE	BURNED FLOODED	33	0.05	2.90	13.00
BUTTE	NB FLOOD ROLL	37	0.45	2.90	13.17
BUTTE	NB ROLL CHISEL	43	0.24	2.33	5.83
BUTTE	NB FLOODED	42	1.50	1.75	44.67
GLENN	BURNED FLOODED	27	0.34	2.89	2.17
BUTTE	CONVENTIONAL BURN	25	0.00	1.02	3.00
BUTTE	CONVENTIONAL BURN	38	0.00	1.07	3.83
BUTTE	BURNED FLOODED	30	0.00	1.17	49.50
BUTTE	BURNED NOT FLOODED	31	0.46	1.98	3.00
BUTTE	BURNED FLOODED	23	0.66	1.86	12.33
BUTTE	BURNED FLOODED	32	0.51	2.52	6.67
BUTTE	NOT BURNED FLOODED	22	0.13	1.04	72.83
BUTTE	BURNED FLOODED	36	0.17	2.64	0.00
BUTTE	BURNED NOT FLOODED	26	0.17	2.61	3.00
BUTTE	BURNED NO TILL	29	0.13	2.67	3.00

** DI = See Krause and Webster, Phytopathology 63:518. Ratings are 1 = Healthy, 2 = Sheaths Infected, 3 = Outer Culm Infected, 4= Culm Penetrated, 5 = Culm Colonized by Fungus, 600 Tillers Rated per Field to Calculate DI.

(Objective 3)- We continued to evaluate various fungi as potential in season biocontrol agents of stem rot. These tests were conducted primarily in the greenhouse.

Results from an experiment involving Sclerotium hydrophilum

are shown in Table 11. As before, we found this organism can reduce stem rot severity when co-inoculated onto rice with the pathogen. It also appears that type of inoculum and perhaps rate may influence its effectiveness.

TABLE 11. Effect of Sclerotium hydrophilum on Severity of Stem Rot of Rice in Greenhouse Studies.

	SR DISEASE INDEX ON VARIETY		
TRT	S201	M202	L202
A	1.00	1.00	1.00
B	1.00	1.00	1.00
C	1.00	1.00	1.00
D	3.15	2.94	3.52
E	3.02	3.48	3.40
F	1.50	1.98	1.72
G	1.98	1.81	1.53
H	1.81	2.46	2.16
I	1.97	2.49	1.50

NOTE: A= NONE, B= S. HYDROPHILUM AT 20VS/PLT, C= S. HYDROPHILUM AT 100VS/PLT, D= S. ORYZAE AT 100VS/PLT, E= S. ORYZAE AT 100VS/PLT 2 WEEKS AFTER OTHER INOCULATIONS, F= B + D, G= C + D, H= B + E, I= C + E.

DI = See Table 10. VS/PLT = VIABLE SCLEROTIA PER PLANT.

S. hydrophilum has been reported in the past to be a minor pathogen of rice so we tested our isolates in a controlled experiment to determine whether it was pathogenic to rice (Table 12). This fungus caused no discernible symptoms or yield loss at any fertility or wounding level tested.

TABLE 12. Pathogenicity Test of Sclerotium hydrophilum on Rice.

	75#N/AC		150#N/AC		225#N/AC	
VAR	I	NI	I	NI	I	NI
S201	24.52	22.83	45.17	47.28	75.66	73.04
M202	26.68	23.58	55.19	53.69	81.80	80.69
L202	18.98	18.49	50.61	45.76	74.69	79.97

NOTE: DATA ARE GRAMS/POT DRY PANICLE WEIGHT.
I= INOCULATED NI= NOT INOCULATED
N= NITROGEN AS AMMONIUM SULFATE

	WOUNDED		NOT WOUNDED	
	I	NI	I	NI
M202	67.93	70.35	68.74	70.62

Other fungi isolated both in season and during the winter were also tested with no promising results (Table 13).

TABLE 13. Greenhouse Evaluation of Various Fungi as Potential In-Season Biocontrol Agents of Stem Rot of Rice.

TEST FUNGUS	DI	%RECOVERY *
UNTREATED CONTROL	1.00	--
S. ORYZAE (SO)	2.93	--
CA-ALGINATE PELLETS (CAFP) CONTROL	1.00	--
CAFP + SO	2.28	--
S. HYDROPHILUM (SH) + SO	1.36	100
SH (IN CAFP) + SO	2.03	76
90-18 + SO	2.61	0
90-27 + SO	3.28	0
90-17 + SO	2.80	83
90-13 + SO	3.00	11
90-2 + SO	3.01	26
90-3 + SO	3.20	100
90-4 + SO	3.11	100
90-5 + SO	2.97	100
90-6 + SO	2.75	63
90-1 + SO	2.82	88
90-8 + SO	2.99	41
90-7 + SO	3.10	62
90-19 + SO	3.17	0
90-55 + SO	2.89	14
90-56 + SO	2.76	23
90-14 + SO	2.78	0
90-16 + SO	2.94	34
90-31 + SO	3.01	0
TRICHODERMA HARZIANUM (commercial)	3.23	88
BACILLUS SUBTILIS (commercial)	2.79	0

*Recovery of test fungus from stems after rating.

*S. ORYZAE INOCULATED IN ALL TESTS AT 100 VIABLE SCLEROTIA PER PLANT. TEST FUNGI INOCULATED AT 10 PELLETS PER PLANT. S. ORYZAE INOCULATED 1 WEEK FOLLOWING TEST FUNGI.
T. HARZIANUM AND B. SUBTILIS APPLIED ALSO AS CONIDIA (10^{-6} ML) OR SPORE SUSPENSION (10^{-7} ML). RESULTS COMBINED. DI AS IN TABLE 10.

Since we had isolated a mycoparasitic Pythium from rice previously, and had several other mycoparasitic Pythiums available we screened them against S. oryzae in a seperate greenhouse test.

Although not effective at the inoculum levels tested, it appeared that some effect was attained in certain pots (Table 14).

TABLE 14. Evaluation of Mycoparasitic *Pythium* spp. as Potential In-season Biocontrol Agents of Stem Rot (Greenhouse).

	DI ON VARIETY		
FUNGUS	S201	M202	L202
P. periplocum	2.50	3.19	3.50
P. oligandrum	2.52	2.31	3.68
Pythium sp.	2.92	3.14	3.43
Combined *Pythiums*	2.19	2.81	3.00
S. oryzae alone	2.90	3.66	3.92
Ca-alginate Pellets	2.40	3.12	3.70
Untreated	1.00	1.00	1.00

DI = SEE TABLE 10.
S. ORYZAE INOCULATED AT 100 VIABLE SCLEROTIA PER PLANT ONE WEEK FOLLOWING *PYTHIUM* INOCULATION AT 10 FLOATING PELLETS PER PLANT.

Since lab and greenhouse tests of biocontrol agents can be misleading, we conducted one small field trial in Butte County employing three organisms (Table 15). While we had evidence that one of the agents was effective (*S. hydrophilum*) the other two were placed included as a test of our inoculation method. Unfortunately, stem rot disease pressure in the field test appeared more severe than even the greenhouse experiments. Since disease levels in the rings were higher than in the surrounding fields while sclerotial soil populations were the same, we feel other factors may have played a role in this test. For example, we observed high numbers of conidia of *S. oryzae* early in the rings. Normally, conidia are not a factor in disease severity in the field, but they may have been in the rings. Additionally, some of the rice was transplanted to ensure equal numbers of plants per ring and this injury may have predisposed the rice to stem rot. While some reduction in disease severity was noted for the *S. hydrophilum* treatments, it was not enough to prevent substantial yield reduction.

TABLE 15. Results of Field Test Employing Potential In-Season Biocontrol Agents Delivered by Floating Ca-Alginate Pellets.

TRT	STEM ROT DI	% AgSS
UNTREATED	3.90	15.2
CA-ALGINATE PELLETS ALONE	3.62	33.4
S. HYDROPHILUM (SCLEROTIA)	3.25	26.6
S. HYDROPHILUM (PELLETS)	3.15	19.8
P. PERIPLOCUM (PELLETS)	3.61	29.4
B. SUBTILIS (PELLETS)	3.66	25.2

*AgSS = Aggregate Sheath Spot. DI = See Table 10.

(Objective 4)- We repeated greenhouse experiments evaluating stem rot resistance in commercial California rice cultivars (Table 16) and the effect of multiple pathogen inoculation on rice. Although data have not been fully collected or analyzed, it appears that the trends noted last year are again evident.
In the multiple pathogen trial, stem rot severity was reduced when coinoculated with any combination of AgSS, bordered sheath spot, or S. hydrophilum.

TABLE 16. Resistance of Commercial Rice Cultivars to Stem Rot.

Cultivar	Comments on Resistance Greenhouse	Field
S-201	Moderate	Good
M-201	Moderate	Good
M-103	Moderate	Good
CM-101	Moderate-Weak	Some Problems
L-202	Moderate-Weak	Problems
M-202	Moderate-Weak	Problems
A-301	Moderate-Weak	Some Problems
M-401	Weak	Some Problems
S-101	Weak	Some Problems
M-203	Very Weak	Problems

PUBLICATIONS OR REPORTS:

Grigarick, A.A., R.K. Webster, R.P. Meyer, F.G. Zalom, and K.A. Smith. 1990. Effect of pesticide treatments on nontarget organisms in California rice paddies. I. Impact of Triphenyltin hydroxide. Hilgardia Vol. 58.

Webster, R.K. Report to the California Rice Research Board. Project RP-2. Cause and Control of Rice Diseases, pp. 15-25. In: Annual Report of Comprehensive Rice Research. 1989. University of California and U.S. Dept. of Agriculture.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS:

Results from a rice residue decompositon field trial showed that one fungus, a binucleate Rhizoctonia previously isolated from decomposing rice straw, was able to colonize inoculated straw and slightly increase final level of decomposition. No effect on viability of S. oryzae sclerotia was noted.

Fungi capable of parasitizing sclerotia of S. oryzae were isolated for the first time. One or more of these fungi should be investigated as coinoculants with potential straw decomposers for maximum benefit. Considering the number of different fungi isolated from both straw and sclerotia, it appears more work will be needed to select the most effective combination of useful organisms.

Studies of different residue management systems showed little difference in final decomposition levels of straw but did illustrate the importance of soil contact for effective degradation.

Samples of soil sclerotial populations and disease levels from different management systems revealed little new information. The data supported earlier observations that high levels of aggregate sheath spot correlate with reduced stem rot severity. In addition, the importance of cultivar selection, stand density, and nitrogen management in stem rot infested fields was repeatedly noted.

Sclerotium hydrophilum remains the only effective in-season biocontrol agent of stem rot in greenhouse tests. It was only slightly effective in a small field trial, probably due to unusually severe stem rot pressure within the trial rings. S. hydrophilum was nonpathogenic to rice in greenhouse trials.

Other fungi tested as potential biocontrol agents of stem rot, including several mycoparasitic Pythiums, did not appear promising.

S-201, M-201, and M-103 exhibited the most resistance to stem rot in the greenhouse and no problems were noted in field observations. On the other hand, M-202 and L-202, while showing moderate to weak resistance in the greenhouse were consistently noted as having stem rot problems in the field. Multiple pathogen combinations in the greenhouse result in reduced stem rot severity.