Chemical Control of Stem Rot of Rice in California

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ABSTRACT

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Control of stem rot disease of rice with triphenyltin hydroxide (TPTH) was demonstrated in 3 yr of field tests. A single application of TPTH at the rate of 1.12 kg/hectare (ha) at the midtillering stage resulted in significant reductions in disease severity which were accompanied by increases in yield ranging from 6-25%. Tests indicated that the fungicide reduced the number of early infections, delayed disease progress, and decreased final disease severity. The importance of an experimental design utilizing separate water systems for evaluating treatments for the control of stem rot of rice is discussed.

Additional key words: Sclerotium oryzae, Oryzae sativa.

Stem rot of rice, which is caused by the fungus *Sclerotium oryzae* Catt., is widespread in California rice-producing areas (4, 9) and has been reported from most rice-growing countries (7). Yield losses of up to 18% have been measured under field conditions in California (5, 10). Primary inoculum consists of sclerotia which float to the surface of the water when the fields are flooded in the spring and germinate to infect rice plants at the stem-water interface (3, 7). Currently the most effective control measure for the disease in California is burning of the rice stubble after harvest (11, 12). Burning destroys the straw that otherwise would be utilized by the fungus to produce sclerotia and kills sclerotia already produced resulting in lower inoculum levels for subsequent crops. However, burning contributes to air pollution in the Sacramento Valley and faces future restrictions, so an alternate control method is desired. Success in controlling stem rot hinges on prevention or reduction of early infections. Although a majority of tillers in a given field may become infected as the crop approaches maturity, the early infections result in more severe disease and greater subsequent yield losses than the late infections (5). Rice is most susceptible to infection between the tillering and internode elongation growth stages (5). The development of a control for stem rot with triphenyltin hydroxide (TPTH), reported herein, was based on the above factors. A preliminary report has been made on the efficacy of TPTH for stem rot control (2). The importance of water in the epidemiology of the disease is discussed in reference to previous reports on chemical control of stem rot (6, 8).

MATERIALS AND METHODS

Field experiments were conducted in 1974, 1975, and 1976 in Butte County, California, where stem rot of rice is endemic. Treatments were evaluated under conditions of natural infection. Disease severity in plots was determined by scoring a sample of tillers for disease on a scale of 1-5, wherein 1 = no symptoms, 2 = lesions only on the outer leaf sheaths, 3 = lesions extending through the sheaths to the culm, 4 = lesions penetrating the culm, and 5 = sclerotia and/or mycelium formed within the culm. A weighted disease index (DI) was calculated by multiplying the number of tillers in each category by their scores, combining the totals, and dividing by the total number of tillers (5). Plots were sampled by compositing tillers from a series of sites through the center of each plot. Yield data (seed weight at 14% moisture) were converted to a per hectare basis.

The fungicide DU-TER (47.5% Triphenyltin hydroxide), (TPTH), was provided by the Thompson-Hayward Chemical Company. Ground applications were made with a carbon-dioxide powered sprayer. Air applications were made by fixed-wing aircraft. TPTH was applied as a water suspension in a volume of 200 liters per hectare.

1974 Experiments.—Plots were located on the Lindberg Ranch in 1974 and consisted of eight basins, each 14 × 155 m, separated by dirt levees, and provided with individual water systems. This design precluded the exchange of inoculum or fungicides between basins. The cultivar Colusa was grown and commercial rice production practices were followed. The TPTH was applied as a ground spray at 1.12 kg/ha [active ingredient (a.i.)] to a 9 × 155 m area within four of the basins when the rice had reached the mid-to-late tillering (MLT) stage. Four basins served as nontreated controls. Disease ratings were made on three occasions during the season, the last when water was drained; at least 300 tillers were scored per basin each time. An area measuring 2.2 × 124 m was harvested from each basin to determine yield.

1975 Experiments.—In 1975, two experiments were conducted on the Rice Experiment Station at Biggs, California. In the first experiment six basins, each 6 × 31 m, were separated by dirt levees and provided with individual water systems. The cultivar CS-M3 was grown and TPTH was applied at the rate of 2.24 kg/ha (a.i.) to three of the basins at the midtillering (MT) stage. A disease rating was made prior to draining the field. Yield was measured by harvesting an area measuring 2.2 × 31 m from each basin.

In 1975, a second experiment was conducted to determine the effects of fungicide concentration and timing of application on disease. Forty basins, each 8 × 37 m, separated by aluminum levees and provided with individual water systems, were planted with the cultivar CS-M3. The TPTH was applied at the rates of 0.56, 1.12, and 2.25 kg/ha (a.i.) at either midtillering (MT), internode elongation (IE), panicle initiation (PI), MT and IE, or MT, IE, and PI (0.56 and 1.12 kg/ha rates only). Controls included nontreated basins and basins treated with benomyl (methyl 1-butylcarbamoyl)-2-benzimidazole-carbamate) at 1.12 kg/ha as a standard. Disease development was monitored during the season by determining the percentage of infected tillers in each basin each week for 10 consecutive weeks from late July to late September. The percentage of infected tillers was determined from a sample of at least 100 tillers from each basin.

A large-scale test of the commercial applicability of the fungicide was conducted on the La Malfa Ranch where TPTH was applied by aircraft to a 4-ha section of a 20-ha field of the cultivar Colusa. The application was made at MT at the rate of 1.12 kg/ha (a.i.). A disease rating was made prior to draining the field. Disease samples consisted of 10 subsamples of 100 tillers each from both treated and nontreated areas. Yields were compared on a per hectare basis.

Greenhouse studies on disease development also were conducted in 1975. Four cultivars, CS-M3, CS-M5,

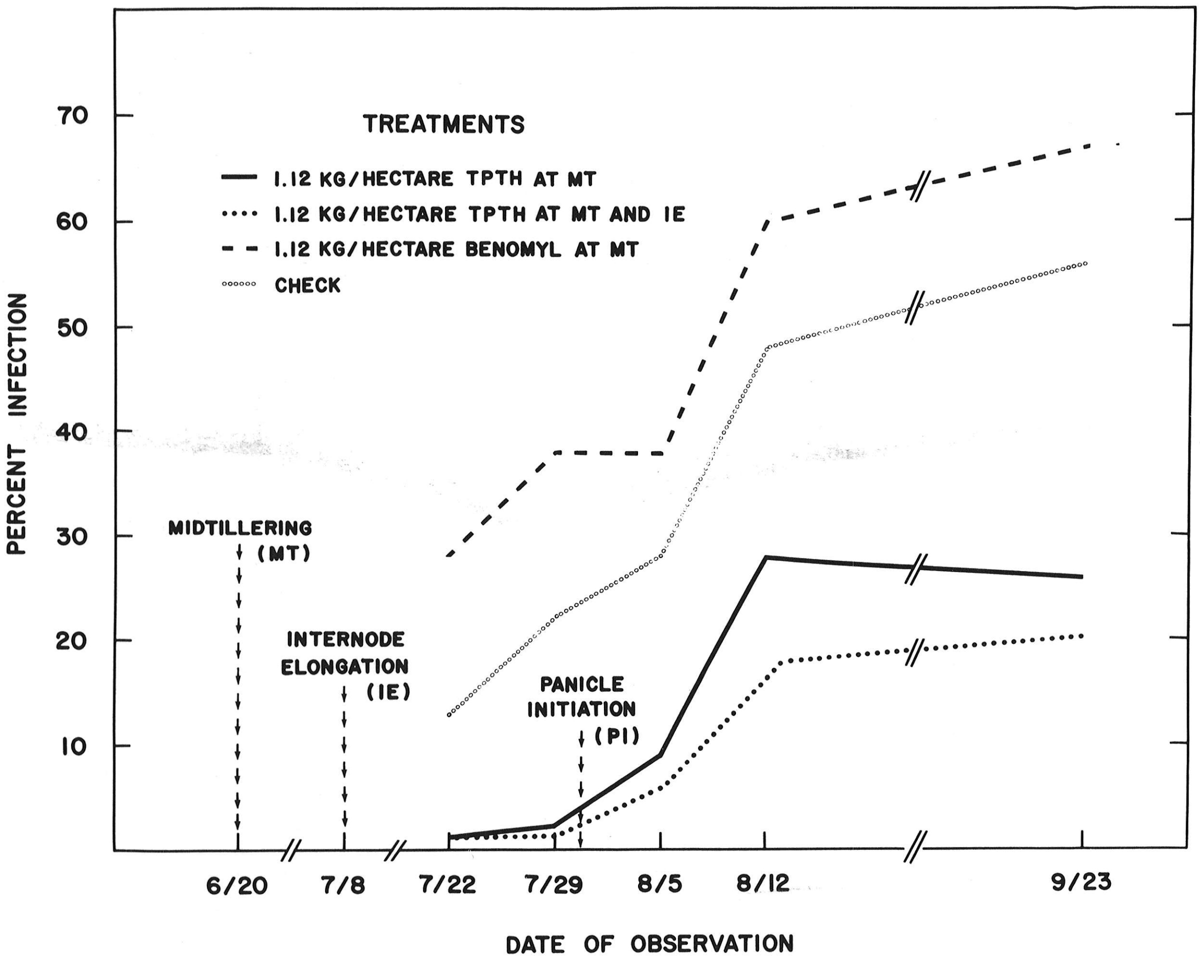

Fig. 1. Stem rot of rice disease increase in plots nontreated or treated either with triphenyltin hydroxide (TPTH) or benomyl in Butte County, California, 1975.

Calrose, and Colusa, were grown in Yolo clay loam in plastic buckets and treated with either TPTH or BRAVO 6F (54% chlorothalonil) at the rate of 1.12 kg a.i. per ha by atomizing a water suspension of the fungicide on the plants at the MLT stage. Plants were inoculated at the same time by adding 150 mg of sclerotia from two isolates of *S. oryzae* from Butte County to the water in each bucket. Nontreated controls either were inoculated or noninoculated. The appearance of lesions was noted over time.

Experiments in 1976.—The effectiveness of TPTH on a commercial scale was further tested in 1976. Five sites in Butte County were selected to receive an application of TPTH by fixed wing aircraft. Each site consisted of a treated and a nontreated area in the same field. Treated areas, each 2 ha in size, received an application of TPTH at the MT stage at the rate of 1.12 kg/ha (a.i.). Disease was rated twice during the season at each site, at midseason and when the fields were drained. At least 600 tillers were scored for disease from each treated and nontreated area each time. Yields were compared on a per hectare basis.

The feasibility of comparing fungicides for the control of stem rot by using small replicated plots without separate water systems, as is done for foliar diseases of rice (1, 6, 13) was tested in 1976. Five chemicals, TPTH, Bravo 6F, benomyl, Mertect 340-F [42.28% 2-(4-thiazolyl)-benzimidazole], and Daconil 2787 (75% chlorothalonil) were included in the experiment. Each chemical was applied at either MT, IE, or both stages. Two rates were used with each chemical, and only the lower rate was applied twice. Each chemical was represented by five treatments and each treatment was replicated six times in a randomized complete block design at two locations. Rates of active ingredients were as follows: TPTH, Daconil, and BRAVO 6F, 1.12 and 2.24 kg/ha; benomyl, 0.56 and 1.12 kg/ha; and Mertect 340-F, 0.58 and 1.17 liters/ha. Two nontreated controls also were included for a total of 27 treatments. Individual plots were 3.7 × 9.3 m. Disease severity was determined at midseason and when water was drained. Yield data were obtained from a 2.2-meter strip from each plot.

RESULTS

1974.—Disease was significantly reduced ($P = 0.01$) in basins on the Lindberg Ranch that received the TPTH compared with nontreated control basins. A reduction in the final average DI from 2.32 to 1.67 was accompanied by a nonsignificant increase in yield of 538 kg/ha.

1975.—Basins on the Rice Experiment Station treated with TPTH had significantly less disease ($P = 0.01$) than nontreated basins. Treated basins had an average DI of 1.28, compared to 2.03 for nontreated basins, a difference which was accompanied by a significant ($P = 0.05$) increase in yield equivalent to 1322 kg/ha, a 24% increase.

In the rate- and time-of-application experiments, all TPTH treatments had less disease than nontreated controls. Benomyl did not control stem rot. The 1.12 kg/ha rate of TPTH at MT and the 1.12 kg/ha rate at MT and IE were as good or better than any other combinations and rates used. Disease incidence peaked at about the 4th wk of observation (3 mo after planting) and leveled off thereafter (Fig. 1). Treatments in which the highest disease incidences occurred had the highest DIs at the end of the season. The rate of disease development in each treatment was similar, but the initial incidence of disease was considerably lower in the treated basins. The initial disease sampling revealed only 2% infection for both the 1.12 kg/ha rate at MT and the 1.12 kg/ha rate at MT and IE, whereas nontreated controls had 13% infection (means of four replications).

The application of TPTH by aircraft successfully reduced disease. The treated area had a DI of 1.59, compared with 2.14 for the nontreated area, and yielded 549 kg/ha more than the nontreated area, a 9% difference.

In the greenhouse experiment, inoculated plants in control and chlorothalonil treatments developed severe stem rot. Plants treated with TPTH did not develop any lesions until 6 wk after the control plants had begun to show symptoms, a time corresponding to when the water level in the flooded buckets was allowed to fluctuate, exposing unprotected portions of stems to sclerotial inoculum.

TABLE 1. Disease indices and yields of triphenyltin hydroxide (TPTH) treated and nontreated stem rot of rice plots in Butte County, California, 1976

			Disease index[a]		Yield	
Cultivar	Site	TPTH	mid-season	end of season	kg/ha	% treated over nontreated
CS-M5	1	Treated[b]	1.02	1.03	9038	9
		Nontreated	1.23	1.60	8235	
	2	Treated	1.03	1.03	8312	6
		Nontreated	1.30	1.75	7832	
CS-S6	3	Treated	1.08	1.13	9202	25
		Nontreated	1.79	2.11	6860	
	4	Treated	1.12	1.17	8705	24
		Nontreated	1.76	1.92	6651	

[a]Disease index: 1 = healthy, 5 = most severe; see text for details.
[b]Treated plots (2-hectare) received TPTH at rate of 1.12 kg/ha (a.i.) at the midtillering stage.

1976.—Disease was controlled and yield increases were attained in four of the five trials in which TPTH was applied by aircraft. In the one instance wherein disease was not controlled, the spray nozzles had become plugged, preventing the correct rate of TPTH from being delivered. At the four sites where the applications were effective, DI averaged 1.06 for the first rating (essentially no disease) and remained virtually unchanged for the second rating, averaging 1.09 (Table 1). Initial disease incidence was minimized, thus preventing later disease buildup. In contrast to treated areas, nontreated areas had an average DI of 1.52 for the first rating, which increased to 1.85 for the second rating. The four treated areas yielded an average of 8,814 kg/ha, compared with 7,394 kg/ha for the nontreated areas, a 16% difference.

In the small replicated plots in which treatments were not provided with separate water systems, the effectiveness of fungicides in stem-rot control could not be determined. There were no statistical differences in DIs or yields between treatments at either location.

DISCUSSION

In 3 yr of field tests, TPTH consistently controlled stem rot of rice in California. Reductions in disease severity were accompanied by increases in yield ranging from 6 to 25%. A yield response in this range makes TPTH application economically beneficial to the farmer. The fungicide reduced the number of early infections, delayed disease progress, and minimized final disease severity.

Disease control was achieved with a single application of TPTH, and yield increases were in addition to those achieved by open field burning since the fields involved had been burned the prior fall. In view of anticipated compulsory reductions in open field burning to alleviate air pollution problems, TPTH could prove valuable in an integrated control program for stem rot. A disease-forecasting system is being worked out in which the inoculum level in a field at the time of planting could be used to predict the expected disease severity. Use of TPTH and burning could be based on expected disease levels. Use of TPTH is on the assumption that EPA requirements for registration are met. The necessary tolerance and residue data are currently being gathered.

Small replicated field plots without individual water systems were inadequate for testing fungicides for stem rot control. Other researchers using this type of experimental design also have had difficulty in demonstrating the field efficacy of fungicides for stem rot control (8). Water plays an important role in the epidemiology of stem rot by transporting the initial inoculum, the sclerotia, to the infection court, the rice stem. Since infections occur at the water level of the plant it is here that fungicides must provide protection. Free circulation of water between plots results in the movement of both inoculum and fungicides. The provision of separate water systems for treatments is therefore considered mandatory in experiments evaluating fungicides for the control of stem rot.

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