Comprehensive Research Program on Rice
1971-72 Rice Contract

PROJECT NUMBER AND TITLE: RM-3, Improvement of Stand Establishment Practices and Systems of Rice Culture.

PROJECT LEADER: D. S. Mikkelsen

PERSONNEL: D. S. Mikkelsen, D. E. Seaman, M. D. Miller and J. Hardy.

OBJECTIVES:

1. Determine how to manage rice seed germination and seedling growth to insure adequate plant populations under established and new cropping systems.

2. Evaluate stand establishment practices, including seedbed preparation seed performance, fertilizer use and water management as they influence seedling development, rice growth and yield.

3. Investigate the possibilities of establishing new systems of rice culture which have fewer management problems and provide for lower unit costs of production.

4. Examine the causes of stand failure and poor seedling growth as related to agronomic practices and environmental factors.

WORK IN PROGRESS:

1. To determine the influence of environmental factors such as temperature, light, water sediment load, oxygen supply and mineral nutrition on seedling establishment and growth.

2. To develop further information on the effects of seedbed and soil flooding on the micro-climate and micro-chemical effects in flooded soils and how these might be modified to enhance stand establishment.

3. To develop through improved seedbed conditions, or with chemical treatment of seed, greater seed germination percentages, seed survival and seedling growth.

4. Micronutrient deficiencies of zinc in seedling rice as a factor in poor stand establishment and reduced rice yields.

EXPERIMENTS COMPLETED:

1. Effect of water management on stand establishment, plant growth and the grain yielding capacity of California medium grain rice.

2. Interaction of nitrogen fertilizer effects on medium grain rice varieties under four different water management systems.

3. The effect of oxygen extenders on seed germination and seedling emergence in continuously flooded rice systems.

4. The effects of various chemicals on the rate of germination and seedling growth of rice. Oxygen extenders, such as calcium peroxide have been evaluated with various stickers and chemical modifiers.

WORK PLANNED:

1. Investigate alternative systems of rice culture, including dry seeding in which improved cultural and crop-protection practices are combined to elicit maximum performance of improved rice varieties.

2. Continue development of practective, nutritive, and oxygenated seed coatings, and other methods of improving stand establishment under different management and environmental conditions.

3. Continue studies of genotypic, cultural and environmental interactions affecting the responses of rice to herbicides and other chemicals.

MAJOR ACCOMPLISHMENTS:

The response of rice to four methods of rice culture, including one drill-flush, then continuous flood treatment, and three water-sown continuously flooded treatments with water depths of 2, 4 and 6 inches was examined during the 1972 crop season. Seed germination, seedling vigor, carbohydrate accumulation, plant height, tillering, yield components and yield measurements were made on all treatments.

Seed germination and seedling growth were superior in the drill-flush treatment during the first 21 days after planting. During this period the seedlings had a greater shoot and root dry matter yield than the continuously flooded treatments. Seed reserves in the drill treatment were consumed about 24 percent more rapidly than in the continuously flooded treatments. After the leaves of seedlings grown under continuous flood emerged, these plants overtook the drill sown plants in plant height and total dry matter production and by 6 weeks after planting were superior in every respect.

Within each continuously flooded treatment, growth differences as influenced by water depth was not significant, even though plants growing in 2 inches of water emerged first and the 6 inch depth, last. Water temperature maxima were highest in the 2 inch water depth ranging in value between 6 and 10° F. warmer than in the 6 inch water depth. Minimum temperatures were lowest also in the 2 inch water depth, but differences among water depths did not exceed 3 to 4° F of each other.

Tillering occurred earliest in the drill sown treatment, but by the 6th week after planting, no differences were found in tiller number, except in the 6 inch water depth where tillering was slightly arrested. From the 7th week, the growth of rice in the continuously flooded treatments were superior in total dry matter production, photosynthetic leaf area, internode length, showed earlier flowering and maturity. Drill seeded rice flowered approximately 16 days later than rice continuously flooded and maturity of the grain was similarly affected.

Yields of rice grain, reported on the basis of 14% moisture, showing the systems of rice management and interaction response to nitrogen fertilization are shown in Table 1.

Calcium peroxide (CaO_2) as an oxygen extender, to enhance the germination and seedling growth of rice under continuously flooded cultural conditions, was studies in field experiments during 1972. Seed treated with 25 percent CaO_2 (by weight) was observed to emerge through 2 inches of soil (drill sown) and 4 inches of continuous flood water. The 25% CaO_2 treatment was however statistically less effective than 50% of CaO_2 treatment in optimum stand establishment characteristics. Seed drilled with 50% CaO_2 emerged from soil and water and gave a 92% survival of viable seed.

Seed coating characteristics were studied and materials which would not provide close attachment of CaO_2 powder to the seed were identified. Polyvinyl acetate, in a 50/50 water dilution applied to dry seed before adding CaO_2, gave the best seed coating characteristics.

Experiments with treated seed have shown that CaO_2 is quite stable under ordinary storage conditions and may be safely applied to rice seed without injury for seed storage periods of 2- to 4 months. Although CaO_2 is a comparatively strong oxidizing agent, its decomposition loss was less than 1% active oxygen per month under normal seed storage conditions. Calcium peroxide has proven to be a good disinfectant for seedborne organisms and provides good protection to rice seed from the usual water mold organisms.

Several fungicides and insecticides, which have earlier been identified to possess seedling growth stimulatory properties, have been examined. Several analogs of 0,0,diethyl 0, 3, 5, 6, trichloro-2 pyridyl phosphorthioate and analogs of o- isopropoxyphenyl methylcarbamate were evaluated for seedling stimulatory properties. Growth responses of 23% increased seedling dry matter were observed with some treatments, but the effects have been irregular. Investigations are being continued to determine what factors associated with seed treatment and environmental conditions affect this response.

The effect of muddy flood water or sediment load on the germination and seedling growth of water-sown rice has been examined in greenhouse tank experiments. Clay suspensions, which reduced light transmission by 0, 12.5, 25 and 50%, were evaluated in respect to their effect on seedling photosynthesis and seedling growth. Contrary to expected results, the heavy silt load, reducing light transmission by 50%, increased the dry matter production of rice by 14% over the control, with 7 and 13% growth increases, occurring with 12.5 and 25% clay-light transmission loads. Water-borne sediments did not have an adverse effect on photosynthetic activity, of seedling rice, but did contribute to improved seedling anchorage which enhanced nutrient uptake and growth.

Zinc deficiency in seedling rice is the cause of serious stand establisment problems on some high pH sodic and calcareous soils. Soil applications of various zinc sources have successfully corrected the problem. The possibility of coating rice seed with zinc materials represents another acceptable means of supplying this essential nutrient element. Rice seed coated with zinc sulfate and zinc oxide, at rates to supply 2 to 4 pounds of zinc per hundred pounds of seed has corrected zinc deficiency. Seed treatment, with application ratios of 2 to 4 pounds of zinc as $ZnSO_4$ or Zn 0 per 100 pounds of seed were not phytotoxic to rice.

EVALUATION OF THE PROJECT:

Although continuous flooding is recognized as essential in producing the highest yields of rice, only a limited amount of research has been done on determining the benefits to be derived from flooding. Improved, more reliable, less costly systems of rice management need to be investigated and if practicable, developed for grower use. Water supplies are not likely to be as plentiful in the future as in the past and information is needed on methods of improving water use efficiency without sacrifice of grain yields.

During the past year considerable information and field experience has been obtained which will be useful in developing new systems of rice production. To date, a better understanding has been developed for the growth response patterns of rice grown under drill-flush-flood type of rice culture in contrast with the conventional water-sown-continuous flood procedure used in California.

It is anticipated that continuation of this research will develop additional valuable information on the physiology of seedling growth and stand establishment that will result in improved seedling survival and more vigorous early seedling growth.

PUBLICATIONS OR REPORTS:

1. Mikkelsen, D. S. Improvement of stand establishment in California rice. 1972. University of California Rice Research Symposium.

Table 1

Rice Systems x Nitrogen Experiment
Rice Yields (lbs/Acre at 14% moisture)

Treatments Management Systems	Nitrogen Treatments (lbs/Acre) N_{40}	N_{80}	N_{120}	Systems Average
(A) Drill-flood	5605	6689	7000	6432
(B) Continuous flood-1" deep	7524	8674	8795	8331
(C) Continuous flood-1" deep	7520	8357	9075	8317
(D) Continuous flood-1: deep	7321	8127	8310	7920
Nitrogen Fertilization Average	6993	7962	8295	

C.V. for Main plots= 2.8% C.V. for Sub plots= 7.6%

Differences between management systems (Yield-lbs/Acre

B	C	D	A	
8331	8317	7920	6432	1% level

Differences between nitrogen rates

N_{120}	N_{80}	N_{40}	
8295	7962	6993	1% level

Difference between nitrogen levels in same management system

AN_3	AN_2	AN_1	
7000	6689	5605	
BN_3	BN_2	BN_1	
8795	8673	7524	
CN_3	CN_2	CN_1	
9074	8357	7520	
DN_3	DN_2	DN_1	
8310	8127	7321	1% level