BREEDING NEW RICE VARIETIES FOR CALIFORNIA

Effects of planting dates, seeding methods, low water temperatures

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ONE OF THE important considerations in the development of any new rice variety is its optimum range of seeding dates. The response to seeding date of present commercial rice varieties in California is well known, but must be determined for new and introduced varieties. The commercial rice crop in California is sown directly into the water. In the past, however, the rice-breeding nurseries have been drilled rather than water-seeded. Recent studies have demonstrated that rice sown directly into the water produces higher yields than rice that is drilled.

Experiments were conducted in 1961 and 1962 to study the effect of date and method of seeding on the growth of rice varieties (table 1). Colusa, Calrose, and Caloro varieties produced the highest yield both years when water-seeded at the earlier dates. In 1961, they yielded more when drilled on the second date, whereas in 1962, there was a marked decrease in yield as the date of seeding was delayed.

In 1961, the varieties Gulfrose, C.I. 9425-2, and C.I. 9187 produced the highest yield when sown late for both methods of seeding, whereas in 1962, the reverse was true. In 1961, all varieties produced the highest yield when water-seeded on the earliest and the latest date except that Caloro produced a higher yield when drill-seeded on the latest date. In 1962, Colusa and Calrose produced the higher yield when water-seeded on both the earliest and the latest date, but the reverse was true for C.I. 9187 that year. That year Gulfrose produced a higher yield when water-seeded on the earliest date; but the yield was higher when drill-seeded on the latest date, and C.I. 9425-2 also produced a higher yield when drill-seeded on the latest date. For Caloro, there was little or no difference in yield between seeding methods on either date in 1962.

Studies conducted on methods of handling breeding material in water-seeded plots and rows indicate that if the seeds are properly soaked and drained, drifting within and between plots is minimal. Preliminary trials now are conducted using water-seeded plots. These trials give information on the ability of varieties and breeding lines to emerge through the water and an indication of the straw-strength and tillering characteristics.

TABLE 1. DAYS FROM SEEDING TO EMERGENCE, HEADING, AND MATURITY FOR SIX RICE VARIETIES DRILLED AND WATER-SEEDED. RICE EXPERIMENT STATION, BIGGS, CALIFORNIA

Variety	C.I. No.	Grain[2] type	Seeding date	Days from seeding to: Emergence W-S[3]	Emergence D-S[4]	Heading W-S	Heading D-S	Maturity W-S	Maturity D-S	Av. grain yield per acre: W-S pounds	Av. grain yield per acre: D-S pounds
1961 TESTS											
Colusa	1600	S	5/10	15	..	91	91	140	137	5300	4200
			5/22	13	..	79	82	126	134	5200	4300
Caloro	1561-1	S	5/10	14	..	110	112	156	154	4900	3300
			5/22	13	..	105	107	147	148	4100	4500
Calrose	8988	M	5/10	15	..	110	109	155	150	6000	4000
			5/22	15	..	103	105	148	150	5400	4400
Gulfrose	9416	M	5/10	16	..	97	98	128	131	4700	4000
			5/22	15	..	91	96	127	134	5100	4600
[1]	9425-2	L	5/10	16	..	84	89	115	120	4200	3500
			5/22	16	..	80	80	109	112	5000	4500
[1]	9187	L	5/10	17	..	99	106	146	146	4100	3100
			5/22	17	..	97	104	138	141	4600	3600
1962 TESTS											
Colusa	1600	S	5/4	14	14	99	102	138	140	6000	5900
			5/16	15	15	91	92	134	138	5000	5200
			5/28	12	14	84	86	130	136	4400	3700
Caloro	1561-1	S	5/4	15	13	107	110	153	154	5100	5200
			5/16	15	14	100	101	151	156	4600	5100
			5/28	12	14	95	96	148	152	3700	3700
Calrose	8988	M	5/4	16	14	106	110	150	149	6800	6100
			5/16	15	13	100	110	153	152	5000	5400
			5/28	14	14	92	94	145	151	4700	3700
Gulfrose	9416	M	5/4	19	16	103	109	135	145	5500	3900
			5/16	15	18	99	102	132	145	2900	3900
			5/28	13	15	94	92	141	146	2800	3600
[1]	9425-2	L	5/4	19	15	87	101	108	124	[5]	3300
			5/16	16	14	87	88	115	122	3900	4400
			5/28	11	14	80	82	116	126	2400	2700
[1]	9187	L	5/4	20	19	108	111	147	145	2900	4000
			5/16	14	16	105	107	150	152	2600	3400
			5/28	13	16	84	99	150	150	2400	3100

[1] Unnamed experimental variety.
[2] S = short-grain; M = medium-grain; L = long-grain.
[3] Water-seeded.
[4] Drill-seeded.
[5] Bird damage.

Low water temperatures

The detrimental effect of cold water on stands and yield of rice is well known. Yields are reduced on an average as much as 5%, but the loss is considerably more in some localities during certain years. Breeding cold-water tolerant varieties is one of the major objectives in the rice improvement program in California.

A suitable basis for comparison is needed for measuring the effect of cold water on the various stages of plant growth, in both field and controlled chamber breeding studies with cold-water tolerant varieties. Studies in California and in Japan show that low water temperatures, at emergence and during tillering, delay seedling emergence, flowering and ripening, and reduce both tillering and yield. Further work in cooperation with plant physiologists is needed to de-

TABLE 2. EFFECT OF WATER TEMPERATURE ON THE DEVELOPMENT OF RICE PLANTS, CALIFORNIA, 1961

Variety	Number of days from seeding to: Emergence Willows[1]	Emergence Biggs[2]	Heading Willows	Heading Biggs	Ripening Willows	Ripening Biggs
Colusa	25	20	119	93	150	135
Calrose	27	17	124	101	168	155
Cody	23	18	112	92	148	137
Arkrose	26	22	133	121	176	163
Precoce	22	18	105	81	143	120
Caloro	25	18	126	106	165	157
Calady 40	26	17	130	94	171	148

[1] Water temperature at Willows about 60°F.
[2] Water temperature at Biggs 70° to 75°F.

termine the effect of cold water on the growth and development of the rice plant. These studies will include research on the inheritance of reaction to cold water.

Studies were conducted in 1961, near Willows, Glenn County, in a field irrigated with water from the Sacramento River at about 60°F. The effects of the cold water on the time from seeding to seedling emergence, heading, and ripening were determined by comparison with the same varieties grown at the Rice Experiment Station, Biggs, with irrigation water from 70° to 75°F. The results for seven varieties are shown in table 2.

Twenty-five rice varieties and hybrid lines were evaluated in 1962 for reaction to low water temperature. These tests were conducted in replicated field trials near Willows and in water-bath experiments at Beltsville, Maryland. A summary of data for eight varieties is presented in table 3.

Sixty-six Caloro plants were harvested in 1962 from two fields on the Wilfred Carrier ranch near Glenn, Glenn County. These plants were growing in checks adjacent to the canal transporting cold water. This location has a consistent history of cold-water damage. The plants were selected from the top several checks adjacent to the intake. Seed from each plant was divided into two lots so that each selection could be grown in single drilled rows and in single water-seeded rows in 1963. Where there was enough seed for evaluating response to cold water in water bath experiments, samples were sent to Beltsville.

TABLE 3. REACTION OF RICE VARIETIES TO LOW WATER TEMPERATURES IN A FIELD EXPERIMENT NEAR WILLOWS, CALIFORNIA, AND IN LABORATORY EXPERIMENTS AT BELTSVILLE, MARYLAND, 1962

Variety	Field Trials					Water-bath studies Beltsville	
	Time from sowing to emergence	Emergence[1] index (E)	Emergence[1] index (V)	Plants[2] at maturity	Floret sterility	Length of longest leaf	Comparison with Caloro
	days			number	per cent	Cm	per cent
Caloro	26	3.0	2.5	36.2	85.8	6.88	100
Calif. 489A1-7	27	2.8	3.2	25.2	80.0	5.61	81.5
Colusa	28	3.0	3.0	36.8	29.1	6.81	98.9
C.I. 9425-2	32	1.2	1.5	5.5	100.0	4.09	59.4
Sel. 2400	32	1.2	1.5	9.5	68.6	5.31	77.1
P.I. 226162	25	3.2	3.5	37.0	89.4	5.96	86.6
P.I. 175020	26	2.8	2.8	24.2	32.1	7.94	115.4
C.I. 8851-1	29	2.2	2.8	15.5	33.0	5.41	58.6

[1] Emergence index. 1 = Very poor. (E) = Relative speed. 5 = Very good. (V) = General vigor, leaf position, and root development.
[2] 180 seed sown in 3-ft. × 3-ft. plots.

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Nitrogen Fertilization of RICE in California

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CALIFORNIA'S RICE CROP, produced on land continuously flooded during the growing season, usually requires nitrogen fertilization for optimum production. Average yields are increased about 40% by nitrogen applications, but in some instances exceed 150%. The Japonica varieties, Caloro, Colusa or "1600," and Calrose—grown almost exclusively in California—require annual fertilization and receive an average of 80 lbs actual nitrogen per acre. Nitrogen is sometimes not required on new land or where a good leguminous green manure crop is turned into the soil. Generally, nitrogen is the only plant nutrient needed, but in some areas phosphorus is also required for optimum production.

The efficiency of nitrogen utilization depends on the fertilizer source and time and method of fertilizer application. Varietal effects are also important since yield capability is dependent upon genetic and agronomic factors. Among the major California water-sown rice varieties, Colusa is most responsive to fertilization but it lacks straw strength and resistance to lodging in some years. Calrose and Caloro are less responsive to high fertility levels but produce higher yields under low fertility conditions and have better resistance to lodging.

Nitrogen fertilization increased grain yields of Colusa by increasing both the size and number of seeds per panicle. This is reflected in a decreased grain/straw ratio as nitrogen fertilization is increased within reasonable limits. Grain yields obtained with the varieties Caloro and Calrose are accompanied by increased straw production, including increased tiller numbers and more panicles per plant, but not necessarily larger panicles.

Most of the many fertilizer studies were conducted with the Caloro variety which occupies a major portion of the planted acreage of California. In typical California lowland rice soils, oxidative conditions exist after flooding in the surface 0.5 cm. At a depth of 5.0 cm, reducing conditions develop about five days after flooding has occurred. The inorganic nitrogen present in the oxidative layer is transformed into nitrates which move into the reducing layer, where most of it is lost later through denitrification.

Application methods

Field experiments designed to evaluate different methods of nitrogen application under the conditions described have been conducted over a period of four years. Typical clay rice soils with impeded drainage were used in the experiments.