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BURIED RED RICE SEED[1]

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RED rice is the most troublesome weed pest occurring in rice fields. Once harvested with the cultivated rice crop, it cannot be removed by any known machinery. The kernel is often slightly smaller than that of commercial rice varieties and the red seed coat from which it derives its name cannot be entirely removed in the milling process without materially reducing the yield of head rice. Streaks of the red bran which often are left on the milled kernels seriously injure the appearance of the milled rice and lower the grade.

A survey of seed rice used in the states of Louisiana, Texas, and Arkansas was made in the spring of 1929 by W. D. Smith, J. J. Deffes, and C. H. Bennett of the Rice Project, Grain Investigations, Grain Division, Bureau of Agricultural Economics, U. S. Dept. of Agriculture. They drew samples from 337 lots of rice seed actually being planted. Of these samples, 54% contained seeds of red rice, the average number per pound being 28. One sample showed 585 red rice per pound. Using 80 pounds per acre, over half of the rice growers were planting on an average about 2,300 red rice seeds per acre or 1 on every 18 square feet.

A similar survey was made in California by the Federal-State Seed Laboratory in the spring of 1932. Samples were obtained from the seed being used in planting approximately one-sixth of the state's rice acreage. Of the samples taken, 42% contained red rice seed ranging from 3 to 57 seeds per pound. The California Federal-State rice inspection service reported in 1932 that of 907,251 sacks of rough rice inspected, 2.9% graded No. 2, 1.9% graded No. 3, 3.2% graded No. 4, and 0.3% graded No. 5 because of red rice.

Red rice is known to volunteer in the rice fields of the South, but just how long the seeds are capable of remaining viable in the soil is not definitely known.

An experiment was planned by the U. S. Dept. of Agriculture to determine the length of time red rice seed will remain viable in the soil under different climatic conditions and was started in the fall of 1930.

PLAN OF EXPERIMENT

Five samples of red and two samples of cultivated white rice were buried on the rice experiment stations at Stuttgart, Ark., October 28, 1930, at Beaumont, Tex., October 31, 1930, and at Biggs, Calif., November 17, 1930. At each station, 12 pits were dug, 6 so located that they would be submerged as is practiced in growing a normal crop of rice, and 6 so located that they would receive natural rainfall only.

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The seed was buried as follows: 200 seeds were mixed with enough dry soil to fill a 4-inch flower pot about three-quarters full. The mixture of the seed and soil was then pressed firmly into the pots and the remaining space filled with dry soil and then covered with a porous clay saucer. The pot and saucer were then inverted and placed in the pit, which was dug deep enough to allow for a 4-inch soil cover. The soil was packed firmly about the pots. The porous nature of the pots allows free circulation of moisture through the soil in the pots. The object was to subject the seeds, as nearly as possible, to the conditions which would prevail if they were plowed under and to be able to reclaim them for periodic germination tests. Seven pots, each containing a different sample of seed, were placed in each pit. It was planned to take up the seven pots from one of the dry and one of the wet pits at each of the three stations and test the seeds for germination in 1931, 1932, 1933, 1935, 1937, and 1940.

At Biggs, envelopes containing seed from each lot were placed in quart glass easy-seal jars, sealed as in canning fruit, and buried bottom-side up in each pit of the dry plot. In the irrigated plot at Biggs there was buried in each pit an unmarked pot containing seeds of water plantain (*Alisma plantago*) and water grass (*Echinochloa crusgalli*). Both the water plantain and the water grass have produced some sprouts each year that they have been tested previous to 1937, but the percentage of growth has been low, perhaps due to unfavorable conditions for germination. Weed seeds are often difficult to germinate under laboratory conditions.

Sets from the irrigated and non-irrigated plots were taken up and tested for germination in the spring of 1931, 1932, 1933, 1935, and 1937.

RESULTS

Table 1 shows the germination results obtained from the seeds buried in actual contact with the soil at the three stations for each of the years in which they have been taken up and tested for germination.

From these results, it is evident that the southern red rices retain their vitality when buried in the soil much longer than does either the Italian or California red or the cultivated white rices. It also appears that the southern reds retain their viability longer under Texas and Arkansas conditions than under California conditions. Under Texas and Arkansas conditions, the seed buried in the irrigated plots retained its vitality longer than that in the unirrigated plots. In California, the results were practically the same for the irrigated and unirrigated plots except that the Italian purple-awned red survived much longer under dry conditions. The California white-awned red rice and the two samples of cultivated white rice gave little or no germination after the first year. The Italian purple-awned red rice from California showed more resistance and retained its viability longer in California than in either Texas or Arkansas.

Table 2 gives the germination of each lot of seed before it was buried, the germination of samples from the same lot kept in dry storage in the Seed Laboratory at Washington, D. C., and the germination of samples from the same lots after they had been buried in sealed containers protected from outside moisture but subjected to the same temperature conditions as the seed buried in the terra cotta

TABLE 1.—*Vitality of red rice seed after being buried in the ground for one, two, three, and five winters.**

Year	Beaumont, Tex.		Stuttgart, Ark.		Biggs, Cal.	
	Irrigated %	Non-irrigated %	Irrigated %	Non-irrigated %	Irrigated %	Non-irrigated %
			Italian Red Rice, Purple Awns			
1931	0.0	1.0	29.0	0.0	2.0	15.5†
1932	1.5	2.0	14.0	0.5	0.5	35.0
1933	0.5	0.0	1.5	1.5	0.5	16.5
1935	0.0	0.0	2.5	1.0	0.05	0.0
1937	0.0	0.0	0.0	0.5	0.0	0.0
			California Red Rice, White Awns			
1931	0.0	0.0	17.0	0.0	4.5	2.0
1932	0.0	0.0	4.5	2.0	1.0	0.0
1933	0.0	0.0	7.0	0.5	1.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	3.0	0.0	0.0	0.0
			Southern Blackhull Red Rice			
1931	80.0†	47.5†	87.0	36.0†	95.0	99.0
1932	88.5	82.0	80.0	50.5	82.0	66.0
1933	80.5	59.0	47.5	31.0	7.0	1.0
1935	59.5	2.0	27.0	27.5	3.0	0.0
1937	2.5	0.0	20.0	1.5	0.0	0.0
			Southern Red Rice			
1931	58.0†	67.5	75.0	18.0†	67.5	63.5
1932	64.5	17.0†	45.0	42.5	67.0	36.5
1933	50.5	25.0	56.5	35.0	19.0	3.0
1935	7.0	0.0	11.5	0.5	6.0	0.0
1937	0.0	0.0	4.5	1.5	0.0	0.0
			Southern Red Rice			
1931	54.5	70.5	67.5†	20.0†	67.5	58.0
1932	44.0	8.5†	79.5	51.5	65.0	18.0
1933	15.5	23.0	59.0	27.5	5.5	5.0
1935	0.0	0.0	12.0	7.0	6.0	0.0
1937	0.0	0.5	2.5	1.0	0.5	0.0
			Supreme Blue Rose Rice			
1931	2.0	0.0	23.5	0.0	0.5	6.0
1932	0.0	0.0	0.0	0.0	0.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	0.0	0.0	0.0	0.0
			Caloro Rice			
1931	1.0	0.5	18.0	0.0	9.0	8.5
1932	0.0	0.0	0.0	0.0	1.0	0.0
1933	0.0	0.0	0.0	0.0	0.0	0.0
1935	0.0	0.0	0.0	0.0	0.0	0.0
1937	0.0	0.0	0.0	0.0	0.0	0.0

*The germination tests of the seed buried at Biggs, Cal., were made at the California Cooperative Seed Testing Laboratory, Sacramento, Cal., and the tests of those buried at Beaumont, Tex., and Stuttgart, Ark., were made at the Division of Seed Investigations, Bureau of Plant Industry, U. S. Dept. of Agriculture, Washington, D. C.

†These apparent low percentages were due to germination having occurred before the seed reached Washington, D. C., and the percentage could not be determined. The percentages show only germination after receipt.

pots. No test was made of the laboratory stored seed after 1933. The seed buried in the glass jar at Biggs retained its vitality perfectly for 2 years and only the two samples of cultivated rice showed serious loss of germination the third year. The rubber seal on the

TABLE 2.—*Germination of original red rice seed and of seed in dry storage in the laboratory and in sealed containers buried in the field.*

Year tested	Germination		
	At time of storage, %	Laboratory storage at Washington, D. C., %	Sealed container, non-irrigated plot, Biggs, Calif., %
	Italian Red Rice, Purple Awns		
1930	97.0		
1931		98.50	97.00
1932		99.00	96.50
1933		90.00	95.50
	California Red Rice, White Awns		
1930	93.00		
1931		97.50	97.00
1932		92.00	97.50
1933		85.50	83.50
	Southern Red Rice, Blackhull		
1930	76.00*		
1931		97.00	92.00
1932		97.50	100.00
1933		93.00	85.00
	Southern Red Rice		
1930	82.00*		
1931		94.00	88.00
1932		88.00	90.00
1933		82.50	84.50
	Southern Red Rice		
1930	83.00*		
1931		90.50	86.00
1932		86.00	88.50
1933		85.00	88.50
	Supreme Blue Rose Rice		
1930	86.50		
1931		92.50	94.00
1932		83.50	85.00
1933		74.50	62.50
	Caloro Rice		
1930	93.50		
1931		94.00	94.00
1932		81.50	88.50
1933		45.00	10.50

*Apparently seed was dormant when original test was made.

glass jar failed before the seeds were taken up in 1935, admitting moisture and consequently spoiling the seed, making a germination test useless.

CONCLUSIONS

Under dry storage at soil temperature conditions existing in California, all of the red rices tested showed good vitality after three winters. The cultivated rices showed loss of vitality in the third year, especially the Caloro variety.

Cultivated white rice when buried in the soil at the depth of ordinary plowing loses its vitality during the first winter.

Italian and California red rices behave very similarly to cultivated rices although they are slightly more persistent.

In general, the seed remained alive longer in the irrigated than in the non-irrigated plots.

The Italian purple-awned red variety retains its vitality longer than the California white-awned, particularly under dry conditions.

The southern red rices show good vitality after 3 years in the soil and some germination after 7 years. They appear to persist longer under Texas and Arkansas conditions than under California conditions.

It is evident that clean culture during a short rotation will not rid the land of red rice.