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BULLETIN NO. 371 DECEMBER, 1927

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DIVISION OF CHEMISTRY

THE EFFECT OF SALT WATER ON RICE

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SYNOPSIS

Rice farmers sometimes have trouble with salt in the water used for irrigation. Varying conditions, such as character of soil, amount of water already on the land, stage of growth of the rice, and others, render it difficult to say how much salt in the water would be injurious. Advantage was taken of a dry season to study the amount of salt in water as related to the yields of the crops on which it was used. Data were also secured from some irrigation concerns. It is difficult to establish a limit to the amount of salt in the water to be used, but it is probably best to stop pumping when the water contains over 50 grains of salt to the gallon. However, water has been used containing 100 grains to the gallon with fair results, especially after August 1. A method for estimating salt in water is described.

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AGRICULTURAL & MECHANICAL
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BULLETIN NO. 371 DECEMBER, 1927

THE EFFECT OF SALT WATER ON RICE

G. S. FRAPS

The occurrence of salt in water used for irrigation is sometimes a difficulty in Texas. At some of the rice farms located near the gulf coast of Texas, the amount of water pumped is sometimes greater than the capacity of the stream and as a result salt water finds its way up the stream and is pumped upon the fields. This is more liable to occur in dry than in moist seasons. Also, at times, salt water from the oil fields has found its way into streams used for irrigation.

Salt water is known to have an injurious effect upon rice. The object of the work here reported is to ascertain, if possible, what amount of salt water is dangerous. It is a continuation of work published in Bulletin 122 (June, 1909).

PREVIOUS WORK

Texas Bulletin 122 contains reports of pot experiments, and reaches the following conclusions:

(1) Water containing 0.3 per cent salt or over (175 grains per gallon) is dangerous to rice. Water containing less may be dangerous.

(2) Water containing 0.5 per cent salt or over (292 grains per gallon) should not be used.

(3) Water may be tested by taste, by a urinometer, or by silver nitrate. A method is outlined. The silver nitrate method will probably be most satisfactory.

The Louisiana Experiment Station, in Bulletin 171 (1920), summarizes the results of some observations, pot tests and field tests, and comes to the following conclusions:

(1) More than 35 grains per gallon of salt should not be used in a flooding of from 4 to 8 inches if this amount of salt water is to remain on the field until the water evaporates or is diluted with fresh water.

(2) Flooding a second time with water containing more than 15 grains of salt per gallon is not advisable.

(3) It may or may not be harmful to use water containing 50 grains of salt on land which is wet at the time of the application of the salt water, if it is possible to remove all of the salt water and replace with fresh water within two weeks of the time that the salt water is applied.

DANGER DEPENDS ON CONDITIONS

The danger from salt water depends upon the degree of saltiness, the length of time it goes on the land, the stage of growth of the plant, the amount of rainfall, the permeability of the soils, and perhaps other conditions. The water pumped upon the fields is diluted by that already

present, so that water containing comparatively large quantities of salt may be pumped for a short time and do little damage except near the point of inflow. Water containing a small percentage of salt may cause injury when pumped for some time, on account of the accumulation of the salt.

RESULTS OF A POT EXPERIMENT

Another pot experiment, in addition to those reported in Bulletin 122, was conducted in 1918. The pots were partly damaged by mice; so the results are only given in a general way. One addition of 0.2 per cent salt water made two weeks after planting, killed the plants of Honduras and Blue Rose, but did not kill those of a special Japan variety of rice supposed to be resistant to salt water, although the yield of the latter was only about one-third of that in the pot which received no salt water. One addition sufficient to make the water in the pot contain 0.2 per cent of salt, 5 weeks after planting, killed the Honduras and Japan but gave a good yield of rice on the check with the special Japan, but 0.3 per cent salt solution covered a yield of about one-third the check. One addition to make the water contain 0.2 per cent salt, seven weeks after planting, injured the Honduras and Japan to some extent but did not kill them, while it apparently did not injure the special Japan rice.

The Honduras variety of rice seemed to be less resistant than the Japan, while the Special Japan seemed to be most resistant to salt water. One irrigation to make the salt content of all the water 0.2 per cent (117 grains per gallon) caused decided injury with the first two varieties.

FIELD STUDY IN JEFFERSON COUNTY

An unusually dry season and the presence of salt water in the irrigation canals gave opportunity in 1925 to study the relation between the water used and its effects on the rice. Samples of water were collected by Mr. R. H. Wyche, Superintendent, Texas Substation No. 4, near Beaumont, and Mr. J. C. Eisentraut, County Agent of Jefferson County, and were subjected to analysis in this laboratory. Mr. Wyche and Mr. Eisentraut also collected data on the rice fields at the end of the season.

The results of the analysis and the yields of rice are given in Table 1.

Discussion of Results

Apparently the irrigation water and the water in the fields may contain 50 grains of salt per gallon up to August 1, and yet profitable yields be produced. After August 1, the water may contain more than 50 grains per gallon and apparently not cause injury.

However, it is better to be conservative and to stop pumping when the water contains 40 to 50 grains per gallon, unless the crop is likely to suffer more from deficiency of water than from the salt in the water. Since salt water is heavier than fresh water, it is best to take the water from as near the surface of the stream as possible.

Table 1.—Salt in water (grains per gallon) and yields of rice, 1925.

	June 19	June 22	June 23	June 27	June 30	July 5	July 10	July 19	July 22	July 28	Aug. 6	Aug. 10	Yield Per Acre
Stream near pump, Field 1, 2, 3.	37	41	.....	51	32	48	52	50	52	114	144	206	
At pump, Fields 1, 2, 3.....	38	41	.....	54	35	46	47	50	52	123	143	212	
Field No. 1.....	45	39	.....	53	32	44	51	46	53	.....	.....	.....	1880 pounds
Field No. 2.....	46	.....	38	96	36	39	46	46	.....	114	123	175	1727 pounds
Field No. 3.....	36	35	.....	48	39	39	47	49	52	114	124	149	
Stream near pump, Fields 4, 5, 6	62	70	.....	54	83	.....	61	104	143	207	.....	.....	Not worth harvesting
Flow of pump, Fields 4, 5, 6....	44	71	.....	102	77	.....	.....	.....	144	209	.....	.....	Not worth harvesting
Field No. 4.....	96	59	.....	.....	81	.....	70	86	103	184	271	.....	
Field No. 5.....	.....	.....	.....	114	.....	.....	102	90	131	190	.....	.....	Not worth harvesting
Field No. 6.....	.....	143	.....	148	146	.....	.....	83	15	145	.....	.....	
Field No. 7.....	.....	.....	18	.....	.....	.....	.....	.....	27	.....	.....	.....	⅛ less
Bayou Field No. 7.....	.....	.....	22	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Field No. 8.....	.....	.....	52	.....	.....	.....	.....	.....	33	.....	.....	.....	⅛ less
Canal Field No. 8.....	.....	.....	17	.....	.....	.....	.....	.....	36	.....	.....	.....	
Canal Field No. 9.....	.....	.....	52	.....	.....	.....	.....	.....	138	.....	.....	.....	Entire loss
Field No. 9.....	.....	.....	52	.....	.....	.....	.....	.....	125	.....	.....	.....	
Long's gate, Field No. 9.....	.....	.....	.....	.....	36	24	.....	.....	4	.....	.....	.....	
Check Plot in fertilizer test, Substation No. 4, Field No. 10.....	.....	.....	.....	.....	.....	.....	17	.....	9	.....	.....	17	2441

OTHER OBSERVATIONS IN VARIOUS SECTIONS

The following are some additional observations. One rice man wrote some years ago as follows: "We have made a season here on salt water exclusively with over 12,000 acres. Our results are largely in line with yours as outlined briefly in Bulletin 122. One noticeable result has been the absence of pollen at the flowering stage, resulting in, of course, no fruit. Another peculiarity reported by farmers is a second crop of heads which fill and mature so that we will get probably over a half crop of Honduras.

"This would indicate a subsequent adjustment of the plant to the abnormal condition.

"It is very difficult for us to draw any reliable conclusion for the reason that with about 70 farmers as observers and no two working under exactly the same conditions we get all sorts of results reported. Our water has varied in quality almost hourly at times and after making allowance for temperature would contain from .05 per cent to .4 per cent with an average estimated .2 per cent salt.

"We carried our crops in the finest condition up to the fruiting period. The foliage of the plants gave promise of a full crop but the salt seemed to prevent the development of the pollen in very many cases, resulting in chaffy heads with no grain.

"Some plants show resistant characters, while others under the same conditions fail utterly. It would be a fine opportunity to develop a salt-resistant strain if anybody had any use for that sort of rice.

"I am inclined to think that one irrigation of .05 per cent water would be beneficial but wouldn't want any more of a good thing of that kind."

Another writes as follows: "The water now in the stream contains about 70 grains (.12 per cent) per gallon and the farmers are afraid to use it on their young rice. The upper portions of the streams show less salt water, running from 25 to 30 grains (.0510 per cent) per gallon and where it shows no larger percentage than this the planters are all using the water for irrigation with very good results. However, as you know, the effects of the salt on the rice do not make their appearance until about the time the rice is heading out. In other words a little salt in the water seems to make the straw grow fine, but the heads are blighted."

ANALYSIS OF WATER PUMPED ON RICE COMPARED WITH YIELD

Tables 2 and 3 show the estimation of salt in water made by one of the irrigation companies in the State. The average yield of rice on the fields watered by this company in 1917 was 11.1 sacks; in 1918, 7.5 sacks; in 1919, 6.4 sacks; and in 1920, 4.8 sacks. Although there was more salt in the water in 1918, and a lower yield of rice, yet the yield was better than in 1919 and 1920 when there was no trouble from salt water.

Table 2.—Salt in water pumped (grains per gallon). Average yield per acre 11.16 sacks.

Date	Grains	Date	Grains	Date	Grains
May 12	50	July 13	30	Aug. 15	30
May 14	110	July 15	30	Aug. 16	32
May 15	95	July 17	35	Aug. 17	43
May 16	45	July 18	40	Aug. 18	50
May 17	75	July 19	44	Aug. 19	62
May 19	85	July 20	36	Aug. 20	74
May 20	100	July 22	35	Aug. 21	86
May 21	75	July 23	38	Aug. 22	90
May 22	60	July 24	70	Aug. 24	90
May 23	45	July 25	45	Aug. 25	82
May 24	38	July 26	38	Aug. 26	96
May 25	22½	July 27	28	Aug. 27	85
May 26	15	July 28	25	Aug. 28	65
May 27	12½	July 31	27	Aug. 30	62
May 28	12½	Aug. 1	27	Aug. 31	54
May 29	12½	Aug. 4	25	Sept. 1	52
May 31	10	Aug. 5	25	Sept. 2	52
June 1	10	Aug. 6	20	Sept. 3	54
June 2	6	Aug. 9	22	Sept. 4	60
June 4	7½	Aug. 10	22	Sept. 5	60
July 2	17½	Aug. 11	14	Sept. 6	67
July 3	22	Aug. 12	13	Sept. 7	64
July 4	30	Aug. 14	20	Sept. 8	56

Table 3.—Salt in water pumped, 1918 (grains per gallon). Average yield per acre 7.53 sacks.

Date	Grains	Date	Grains	Date	Grains
May 20	13	July 28	120	Aug. 12	185
July 11	20	July 29	115	Aug. 13	175
July 12	30	July 30	125	Aug. 14	155
July 13	40	July 31	135	Aug. 15	105
July 14	50	Aug. 2	130	Aug. 16	105
July 16	75	Aug. 3	155	Aug. 20	100
July 17	87	Aug. 4	165	Aug. 21	145
July 18	100	Aug. 5	175	Aug. 22	150
July 18	115	Aug. 6	205	Aug. 23	145
July 21	110	Aug. 7	225	Aug. 24	105
July 24	125	Aug. 8	215	Aug. 25	95
July 25	125	Aug. 9	225	Aug. 27	95
July 26	130	Aug. 10	225	Sept. 1	70
July 27	115	Aug. 11	200		

The irrigation company made the following remarks on this point: "The yield of rice has been much greater during the dry years, even though the water contains considerable salt at times; this is particularly true where the dry weather occurs during the planting season so the farmers can get their lands in a state of thorough cultivation. In other words, during wet winters and springs, the ground seems to be more or less soggy and sour and the rice does not grow and produce as well as when we have dry winters and springs. This is proven not only in Texas, but in California as well.

"The years 1918, 1920, 1921 and 1922 were years when there was either an excess of moisture during the winters and springs or a wet fall, which accounts for the low yields during those years. Therefore, without knowing the conditions in each instance, it is hard to arrive at the damage that the rice people sustain on account of the salt content of the water.

"We have several farms covering large acreages that were an absolute failure on account of the use of salt water in 1925. On other farms where the yield of rice has been reduced fully 50 per cent, the salt content was excessive during the irrigation period, and in still other instances, the application of salt water (containing as much as 150 grains of salt) placed on young rice, and later irrigated throughout the year with fresh water, resulted in not more than 50 per cent of a normal crop, and in adjoining fields where nearly as much salt was used on a different variety of rice, the yield was better than normal."

METHOD FOR THE APPROXIMATE ESTIMATION OF SALT IN WATER

A method for the estimation of salt in water is described below and should give satisfactory results. The work could be checked by a chemical laboratory, by testing a sample of water by this method, and sending a portion of the same sample to a laboratory for testing. A glass-stoppered burette is recommended for measuring the silver nitrate.

Solutions. Tenth normal silver nitrate or a solution of 8.50 grams fused silver nitrate in 500 cc. distilled water. This solution must be protected from the light.

Potassium chromate. One gram in 100 cc. distilled water.

Apparatus. A 100 cc. graduated cylinder, and a 12 oz. bottle. More accurate results are secured with a burette.

Method. Rinse the bottle and cylinder with distilled water or good cistern water. Measure 90 cc. of the water to be tested into the bottle. Add a few drops of the potassium chromate solution, so that the water is colored slightly yellow. Put 40 cc. silver nitrate in the cylinder and add it slowly to the water in the bottle until the color changes to a brick red. Multiply the number of cubic centimeters of silver nitrate used by 3. The result is the grains of salt to the gallon.

SUMMARY AND CONCLUSIONS

(1) Salt sometimes occurs in irrigation water used for rice, at times causes injury.

(2) The damage caused by salt water depends on several conditions, such as the amount of salt in the water, the length of time it is allowed to flow on the land, the amount of rainfall, the variety of rice grown and other conditions.

(3) A study was made of the salt content and yield of rice during an unusually dry season. Data were also secured from some of the irrigation concerns.

(4) It is difficult to establish a limit to the amount of salt in the water to be used, but it is probably safer to be conservative and stop pumping when the water contains 40 to 50 grains of salt to the gallon. However, data are given which show that water containing much more than this has been used with fair yields, especially after August 1.

(5) A method for estimating salt in water is described.