
STUDIES ON A LABORATORY METHOD OF TESTING SALINITY RESISTANCE IN RICE VARIETIES

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INTRODUCTION

BREEDING of salt resistant varieties of rice is an important problem in Ceylon. Before the initiation of a breeding program, however, it is necessary to have some measure of the resistance of the varieties to be improved.

The term 'salt resistant' can be expected to include two aspects, the physiological resistance of the plant against salt and the overall tolerance of the plant as shown by its performance under field conditions. For the purpose of breeding a salt resistant variety, both these aspects should be taken into consideration, and it would be very useful if resistance could be determined in the laboratory. This series of experiments was directed towards this purpose.

MATERIAL AND METHODS

In these experiments two groups of varieties were used :

- (1) Varieties classified as 'salt resistant', but whose degree of resistance is unknown. These varieties are referred to as 'resistant varieties' in this paper.
- (2) Varieties which have not been previously classified, and whose resistance to saline conditions was either in doubt or unknown. These varieties have been referred to as 'non-resistant' for the purposes of this paper.

Varieties belonging to both groups were grown in pots under normal conditions, without special fertilizer or manure. At the end of 40 days the plants were transferred into conical flasks with their roots

immersed in water for 48 hours. Thereafter the water was replaced with saline solutions, the salt used being unrefined common salt (NaCl).

The plants were left with their roots immersed in saline solution for a definite number of days after which the evaluation of resistance was made by grouping the plants according to the damage caused. The damage was first observed in the rolling up of the leaf tips, followed by rolling up of the entire leafblade, yellowing, and wilting of the entire plant. On observations made the degree of damage was rated between 0 (least damaged) and 5 (most damaged).

EXPERIMENTAL RESULTS

Experiment 1

Four concentrations of saline solution were used, viz. 0 per cent, 5 per cent, 10 per cent and 20 per cent. It was observed that all concentrations between 5 per cent and 20 per cent were too high to discriminate between the resistant and non-resistant varieties.

Experiment 2

Seedlings were treated with 0, 1, 2, and 4 per cent saline. Plants placed in 4 per cent and 2 per cent were too severely damaged for discrimination. Seedlings in 1 per cent solution showed less severe damage, which varied in the range of material tested.

Experiment 3

Seedlings were treated with 0 per cent, 0.5 per cent, 1 per cent, and 1.5 per cent saline and the evaluation of damage caused was made 2 days and 7 days after treatment.

The analysis of data obtained in this experiment is as follows :—

(1) Table 1 presents the correlation coefficients between the records of the 1st evaluation on the third day and that of the second evaluation on the eighth day.

TABLE 1.—Correlation Co-efficient between the 1st and the 2nd Evaluation

<i>Degrees of Freedom</i>			<i>Percentage salt in solutions</i>		
			<i>0.5%</i>	<i>1%</i>	<i>1.5%</i>
<i>r</i>	..	26	..	..	..
			0.6390**	0.7131**	0.5581**

**Significant at 1 per cent level.

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From Table 1 it is clear that the correlation between the 1st and 2nd evaluation was closest with the 1 per cent solution of salt.

(2) Each set of records was tested in order to determine the relationship to the previous classification of the salt resistant varieties used. The result is presented in Tables 2 and 3. Where very low frequencies were involved, Yates' correction was applied.

TABLE 2.—Contingency Table (1% salt solution)

		<i>First evaluation</i>				<i>Second evaluation</i>					
		<i>Damage</i>		<i>Total</i>			<i>Damage</i>		<i>Total</i>		
		<i>0-3</i>	<i>4-5</i>				<i>0-2</i>	<i>3-5</i>			
'Resistant'	..	10	..	2	12	..	10	..	2	..	12
'Non-resistant'	..	4	..	12	16	..	2	..	14	..	16
Total	..	14	..	14	28	..	12	..	16	..	28
X ²	..					7.1458					11.3006

TABLE 3.—Application of the Chi-Square test to the results of Experiment 3 in relation to the previous classification of resistance

		Salt solution		
		0.5%	1.0 %	1.5%
1st Evaluation	X ²	.. 1.8046	.. 7.1458	.. 1.6072
	Probability	.. 10-0.20	.. < 0.01	.. 0.20-0.50
2nd Evaluation	X ²	.. 2.0255	.. 11.3000	.. 5.0286
	Probability	.. 0.10-0.20	.. < 0.01	.. 0.02-0.05

According to Table 2 the most reliable evaluation of resistance was obtained using 1 per cent salt solution. Higher values of Chi-Square obtained from the 2nd evaluation, suggest that eighth day evaluation is superior to third day evaluation. Generally the 'salt-resistant' group showed less severe damage than the non-resistant group.

Statistical Analysis of Full Data

Data obtained in the second and third experiments included the treatments 0.5 per cent, 1 per cent, 1.5 per cent, 2 per cent, and 4 per cent. Separate analyses of variance were made of the data obtained from these treatments and of the data obtained using the treatments 1 per cent and 1.5 per cent in Experiments 2 and 3.

From these analyses repeatability of the records was estimated by the method of intraclass correlation and Chi-Square analysis on the relationship between the degree of damage and the 'salt-resistance'. The results are presented in Table 4.

TABLE 4.—Analysis of variance of full data, estimation of repeatability, and independency test (with previous classification of salt-resistance)

	Full data including salt solutions of concentrations			
	0.5%–4%		1%–1.5%	
Number of Experiments involved	..	6	..	3

Analysis of variance

Source		D. F.	M. S.	D. F.	M. S.
Blocks	..	5	..	2	..
Varieties	..	27	5.4189**	27	3.9660**
Res. vs. N. R.	..	1	70.5009**	1	56.1944**
Wn. resistant	..	11	2.0745*	11	1.3005
Wn. N. R.	..	15	3.5326**	15	2.4389**
Error	..	135	0.8845	54	0.8700

*, ** exceed 5 per cent and 1 per cent points respectively.

Estimated components of variance and repeatability values

Error variance	..	(SE ²)	0.8845	..	0.8700
Variance due to varietal difference	..	(SV ²)	0.7687	..	1.0320
Repeatability	..	(R)	0.4607	..	0.5426

Chi-Square Analysis

2	..	5.53	..	9.72
Probability	..	0.01–0.02	..	<0.01

It was observed that—

- (1) Varietal differences in response were distinct.
- (2) The salt-resistant variety group differed significantly from the non-resistant group.
- (3) Differences between varieties within the resistant variety group were not always significant.

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- (4) Differences between varieties within the 'non-resistant' group were highly significant.
- (5) Repeatability values indicate that evaluation after treatment with a 1 or 1.5 per cent. salt solution is more accurate than evaluation made in 4 per cent. (high concentration) or 0.5 per cent (lower concentration).
- (6) Degree of damage observed in 1-1.5 per cent solution showed better agreement with the previous classification than that observed in 4, 2, or 0.5 per cent, solutions.

The evaluation of the 28 varieties used, on damage caused by saline solutions (1 per cent and 1.5 per cent.) on the basis of these experiments is shown in Table 5.

TABLE 5.—Classification of Varieties used according to experimental data

		Degree of damage				
		1	2	3	4	5
'Resistant'	.. Hom 504	.. Bile Kagga	.. Uvar Karuppan			
	Gido 142	.. Kallurundai	..			
	Giongian	.. Perum Karuppan				
	Gitrang 131	Uvar Vellai				
	Temlop					
	Tamgiam					
	Kagga					
'Non-resistant'	..	.. MYAC 104	.. M. S. 3081	.. H-4	.. M-3	
		H-106	.. H 501	.. H-5	.. H-102	
		NYAC 12	.. Sulai 27614	.. H-105		
		M-104	.. Perillanel	.. M-302		
			26014	.. M-201		
				Sulai 301		

CONCLUSION

In this series of experiments our primary aim was to suggest a method of evaluating the saline resistance of rice varieties in the laboratory.

Both varieties of known resistance, and unknown resistance were used.

From the results of experiments we concluded that there is a correlation between degree of damage in 1 per cent. salt solution and saline resistance of varieties.

Evaluation made on the eighth day after commencement of the experiment is more reliable than that made on the third day.

Varietal differences caused by immersion of the root system in solutions of salt was very apparent, 'salt-resistant' varieties showing a higher degree of tolerance than those in the 'non-resistant' group.

The classification of 'salt-resistant' varieties on the basis of these experiments agreed with their previous classification.