Breeding for Saline-resistant Varieties of Rice

I. Variability for Salt Tolerance among Some Rice Varieties

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Synopsis. Rice Varieties : Bluebonnet, IR 8, Jhona 349 and Magnolia responded quite differently to salinization. Each character showed a differential reaction to salinity. Three types of sterility *i.e.* cluster, delayed, and random caused by salinization could be classified. Regarding panicle weight and seed setting percentage, which are important from the agronomic standpoint, Jhona 349 was relatively the most resistant, while Magnolia the least.

Introduction

Soil salinity is one of the foremost problems of crop production in arid zones, especially where an artificial irrigation system is developed. In these areas, low rainfall and high rates of evaporation result in the excessive accumulation of soluble salts in the rhizosphere and under these extreme conditions plant growth is totally checked. Although vast efforts are being vested in the reclamation of saline soils, little attempt has been made to breed salt-tolerant varieties of agricultural crops (EPSTEIN and JEFFERIES, 1964). Breeding for saline-resistant varieties is important not only for increasing yields but also for conquering saline soils. This is especially true for reclaimed areas where chances of a salt-resistant variety are much more likely. It has already been reported by many workers that there are marked differences in relative salt tolerance among genera, species and varieties of agricultural crops (HAYWARD and WADLEIGH 1949; BERNSTEIN and HAYWARD 1958; DEWEY 1960 and YOSHIDA 1967). To make use of this genetic divergence in a breeding program it is necessary to screen out better types under local conditions as environmental factors have a profound effect on the reaction of plants to salinity. The aim of the present study was to find genetic variation for salt tolerance among some rice varieties so that it can be utilized for further breeding programs.

Materials and Methods

A water culture experiment was designed

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in greenhouse during summer 1970 to determine the varietal difference for salt tolerance among four rice varieties. The general experimental procedure for this water culture experiment was similar to that practiced at IRRI (YOSHIDA 1970). The varieties tested were: Bluebonnet and Magnolia (U.S.A.); IR 8 (Philippines) and Jhona 349 (Pakistan). The selection of these varieties was based on their differential response to salinity. IR 8 and Jhona 349 are known to have considerable tolerance (YOSHIDA 1967), while preliminary studies on salt tolerance at our laboratory showed that Bluebonnet and Magnolia are very sensitive to salinity. In addition to control, the salinity levels were: 1,000, 2,000, 3,000, 4,000 and 5,000 ppm. The mean electrical conductivity values were: 0.4, 2.3, 4.1, 5.7, 7.5 and 9.0 mmh per cm at 25°C respectively. The different degrees of salinization were obtained by adding equal parts by weight of sodium chloride and calcium chloride to the base nutrient solution. The base nutrient solution contained ammonium sulfate, magnesium sulfate, calcium nitrate, potassium phosphate, potassium sulfate and iron citrate in concentration of 71.0, 61.2, 58.4, 24.5, 12.2 and 10.8 mg per litre respectively. The pH of the solution was kept at 6. Nursery was raised in sand and transplanted (three plants per pot) after five weeks of planting. For nursery a half dose of the above mentioned nutrient solution was applied. Salinization was commenced after two weeks of transplanting and continued till harvest. No attempt was made to introduce salinity gradually in a stepwise manner. Culture solution was changed

Table 1. Effects of salinization on the vegetative growth of four rice varieties

	Salt concentration (ppm)					
	Control	1,000	2,000	3,000	4,000	5,000
Plant height (cm)						
Bluebonnet	140.2±8.14	137.5±6.98	135.9±7.91	121.1±10.87**	103.6±9.29**	97.8±11.06**
IR 8	67.0±4.71	67.3±3.87	66.6±3.32	68.1±3.86	64.4±3.68	56.7±3.93**
Jhona 349	129.3±9.82	130.9±9.66	130.4±6.33	120.6±5.67	99.5±9.10**	72.9±5.20**
Magnolia	140.9±6.10	140.7±5.90	139.5±4.73	134.0±10.39	119.7±12.54**	104.2±9.51**
Number of mature tillers per plant						
Bluebonnet	7.5±1.16	7.8±1.65	6.8±1.19	7.3±1.28	5.9±1.44**	4.4±1.72**
IR 8	10.0±1.33	10.5±0.79	9.8±1.98	11.3±2.64	12.3±1.15	10.3±2.22
Jhona 349	10.3±1.42	10.1±1.31	10.4±1.62	11.0±2.62	10.9±2.71	9.6±3.26
Magnolia	7.6±0.66	7.8±1.13	8.1±1.24	8.3±1.66	7.3±1.61	6.1±1.72*
Straw weight per plant (g)						
Bluebonnet	36.4±5.98	36.2±8.27	35.8±6.96	33.9±6.53	37.5±6.91	30.9±10.32
IR 8	16.0±3.97	14.7±2.98	14.2±4.65	16.6±2.73	16.0±2.84	13.9±3.74
Jhona 349	38.0±5.52	33.5±4.93*	32.4±5.37*	32.5±6.65*	32.5±6.68	26.9±4.81**
Magnolia	34.0±5.71	39.2±6.54	41.2±6.70	47.4±11.6	49.4±12.01	41.5±10.51
Dry weight of roots per plant (g)						
Bluebonnet	4.4±1.15	4.4±1.41	4.5±1.27	3.8±0.68	4.9±0.94	3.2±1.14*
IR 8	1.4±0.35	1.5±0.31	1.5±0.45	2.3±0.48	2.1±0.42	1.6±0.42
Jhona 349	5.5±1.08	5.0±0.88	4.8±0.70	5.3±1.04	4.4±0.76**	2.8±0.83**
Magnolia	3.5±0.75	4.5±1.32	5.1±0.88	5.8±1.44	4.0±1.07	2.9±0.85
Root length (cm)						
Bluebonnet	44.9±3.98	41.8±2.25*	38.9±1.79**	35.9±1.18**	33.4±0.98**	27.2±1.13**
IR 8	27.4±5.69	29.4±2.72	29.6±2.96	33.4±2.57	26.3±3.28	22.1±2.04**
Jhona 349	43.8±2.89	41.5±1.84*	38.3±1.23**	37.9±2.72**	37.1±1.69**	26.4±3.32**
Magnolia	33.2±1.21	34.3±1.33	34.8±1.72	32.2±1.46	29.0±1.15**	23.9±2.43**
Number of days from seeding to heading						
Bluebonnet	105	110	117	117	119	128
IR 8	102	102	102	102	102	102
Jhona 349	106	106	108	108	110	121
Magnolia	95	95	98	102	103	109

* Difference significant from that of control at 5 per cent level.

** Difference significant from that of control at 1 per cent level.

once a week during early growth stages and twice a week thereafter. Water level and pH were adjusted on alternate days. pH was adjusted either by 1N-H₂SO₄ or 1N-KOH. The experiment was carried out in four replicates. During the course of the experiment (July~November), the mean maximum temperature was 29.8°C and the mean minimum 16.5°C. At the end of the experiment data were recorded for plant growth including yield

and its components. Root length was measured on the longest root. For dry matters plants were dried under greenhouse conditions. Pollen fertility was examined by potassium iodide method.

Terminology

It is already known that salinity causes sterility in rice plant (IWAKI 1956; KADDAH and FAKHRY 1961), but little attention has been

Table 2. Effects of salinization on the reproductive growth of four rice varieties

Salt concentration (ppm)						
	Control	1,000	2,000	3,000	4,000	5,000
Panicle weight (g)						
Bluebonnet	5.2±0.40	4.9±0.75	3.4±0.67**	2.0±1.03**	0.6±0.46**	0.5±0.3**
IR 8	1.6±0.39	1.4±0.33	1.2±0.32*	1.1±0.30**	0.7±0.24**	0.4±0.22**
Jhona 349	2.7±0.34	2.7±0.41	2.7±0.29	2.3±0.30**	1.4±0.30**	0.8±0.17**
Magnolia	4.5±0.31	4.5±0.41	4.0±0.47**	2.7±1.20**	0.8±0.64**	0.4±0.28**
Number of primary branches per panicle						
Bluebonnet	19.2±1.33	20.3±1.55	19.1±1.83	14.8±3.32**	12.3±2.41**	10.5±2.15**
IR 8	9.7±1.43	9.1±0.79	9.0±1.12	9.7±1.07	8.8±1.03	8.8±1.21
Jhona 349	8.9±0.79	8.9±0.66	9.7±0.77	9.2±1.03	7.6±1.13**	7.0±1.21**
Magnolia	11.4±0.79	12.2±0.83	13.0±0.95	13.6±0.66	11.8±0.83	10.5±1.00*
Panicle length (cm)						
Bluebonnet	30.8±1.75	30.6±1.46	28.1±1.44**	26.7±2.13**	23.4±3.29**	21.3±2.22**
IR 8	20.5±1.45	21.2±1.55	20.5±1.83	22.4±1.94	22.8±1.99	21.5±1.19
Jhona 349	23.1±1.97	23.0±1.46	22.0±1.07	20.8±1.83**	19.7±1.69**	17.1±1.37**
Magnolia	34.2±1.63	33.6±1.53	31.3±2.08**	30.6±2.36**	25.7±3.35**	25.1±2.55**
Number of spikelets per panicle						
Bluebonnet	253.8±22.54	268.9±35.65	219.7±34.94*	153.7±51.02**	104.2±28.76**	86.4±26.62**
IR 8	70.8±14.49	73.7±7.99	72.6±9.67	74.9±13.75	71.9±11.49	58.7±11.89*
Jhona 349	121.2±10.70	120.4±15.1	130.3±13.38	122.5±14.31	94.0±12.18**	68.6±10.83**
Magnolia	188.8±12.67	194.4±12.50	188.9±11.17	188.8±24.12	152.9±21.58**	110.8±14.75**
Grain yield per plant (g)						
Bluebonnet	26.9	22.9 (85.1)§	15.8 (58.7)	13.4 (49.8)	3.7 (13.8)	2.9 (10.8)
IR 8	9.5	8.2 (86.3)	6.4 (67.4)	6.9 (72.6)	3.8 (40.8)	1.5 (15.8)
Jhona 349	18.6	18.9 (101.6)	18.9 (101.6)	18.4 (98.9)	12.8 (68.8)	5.1 (27.4)
Magnolia	21.1	21.8 (103.3)	21.4 (101.4)	18.5 (87.7)	4.2 (19.9)	2.0 (9.5)

* Difference significant from that of control at 5 per cent level.

** Difference significant from that of control at 1 per cent level.

§ Figures in parentheses denote percentage of control.

paid to classify it. We could recognize three types of sterility and for the convenience of further description of the experiment those are defined as follows:

Cluster type. The panicle is affected by salinity before emergence probably in the very early development stages. Anther and stigma are defective, some stigma not bifurcated but three branched. Spikelets color white. Pollen quite sterile. These abnormal spikelets mostly appear in a cluster on the upper half of the panicle.

Delayed type. On the emergence, panicle

looks quite normal. Spikelets are normal in shape and color. The green color of the panicle gradually changes to whitish from tip to the base. Pollen fertility of some florets is below 50%, while some are quite fertile. Spikelets are devoid of or with little endosperm. This type of sterility is also caused by physiological disorder and some diseases (GRIST 1955). It is generally known as straight-head.

Random type. Mostly single spikelet is affected. These abnormal spikelets are scattered randomly on the panicle. Other characteristics are the same as for cluster type.

Results

Vegetative growth

Plant Height. Table 1 clearly shows the effect of various salt treatments on the vegetative growth of four rice varieties. The plant height was decreased significantly at 4,000 ppm in three varieties: Bluebonnet, Jhona 349 and Magnolia, while at the same concentration IR 8 did not show any significant difference from the control. The marked depression in plant height occurred at 5,000 ppm in all four varieties. Varieties behaved differently in regard to salt concentrations.

Number of mature tillers per plant. Number of mature tillers per plant were reduced significantly at 4,000 and 5,000 ppm in Bluebonnet. IR 8 and Jhona 349 were less affected by salt treatments and even produced more tillers than control at 3,000 and 4,000 ppm. The effect was recognized at 5,000 ppm in Magnolia.

Straw weight per plant. The different degrees of salinization did not affect the straw weight significantly in three varieties: Bluebonnet, IR 8 and Magnolia, whereas the adverse effect was much more pronounced in Jhona 349. Magnolia produced more dry matter at each salinity level than the control.

Dry weight of roots per plant. IR 8 and Magnolia were less affected by salt treatments. Dry weight of roots was higher at each salinity level than the control in IR 8, while it increased up to 4,000 ppm in Magnolia. The effect was significant at 5,000 ppm in Bluebonnet, whereas the accumulation of dry matter in the roots decreased significantly at 4,000 and 5,000 ppm in Jhona 349.

Root length. Salt concentrations apparently inhibited the elongation of the root in two varieties: Bluebonnet and Jhona 349. IR 8 was affected at the highest salinity level. The effect was significant at 4,000 and 5,000 ppm in the case of Magnolia.

Number of days from seeding to heading. With the exception of IR 8, salt treatments delayed the emergence of inflorescence in the other three varieties: Bluebonnet, Jhona 349 and Magnolia.

Reproductive growth

Panicle weight. It is evident from Table 2 that salinization also affects the reproduction

stages in rice. Panicle weight was adversely affected by different degrees of salinization. The low salinity level, *i. e.* 2,000 ppm, significantly reduced the panicle weight of three varieties: Bluebonnet, IR 8 and Magnolia. The differences of means were significant at 3,000 ppm in all the four varieties. The effect was much sharper at 4,000 and 5,000 ppm. At 4,000 ppm salinity level, the panicle weight for Bluebonnet, IR 8, Jhona 349 and Magnolia was: 11.5, 43.7, 51.9 and 17.8 per cent of the control respectively. The varietal differences were quite obvious. The tolerance of the varieties to salt concentrations in a descending order was: Jhona 349, IR 8, Magnolia and Bluebonnet.

Number of primary branches per panicle. All four varieties responded differently to various salt treatments. Number of primary branches per panicle were reduced significantly at 3,000 ppm in Bluebonnet and at 4,000 ppm in the case of Jhona 349. IR 8 did not show any significant difference from the control up to 5,000 ppm, whereas the effect was significant in Magnolia at the highest salinity level.

Panicle length. Low salinity, *i. e.* 2,000 ppm, decreased the panicle length significantly in Bluebonnet and Magnolia. Jhona 349 was affected significantly at 3,000 ppm. The effect was non significant in the case of IR 8.

Number of spikelets per panicle. Salt treatments caused reduction in the number of spikelets per panicle. Bluebonnet was the most severely affected, while IR 8 the least. Jhona 349 and Magnolia were unaffected up to 3,000 ppm but there was a significant reduction at 4,000 ppm in both varieties.

Grain yield per plant. Higher degrees of salinization caused a sharp and marked decrease in the yield of all four varieties. At 4,000 ppm salt concentration, Jhona 349 yielded 68.8 per cent of the control, whereas Bluebonnet and Magnolia produced only 13.8 and 19.9 per cent respectively. Jhona 349 was superior to other varieties tested.

Seed setting percentage. Seed setting percentage decreased with increasing salt concentration in all the four varieties. With the exception of Jhona 349, 50% reduction in seed setting occurred at 4,000 ppm in the other varieties. Regarding seed setting percentage

Table 3. Various types of sterility and seed setting percentage at different degrees of salinization

	Salt concentration (ppm)					
	Con- trol	1, 000	2, 000	3, 000	4, 000	5, 000
Seed setting (%)						
Bluebonnet	89.6	78.6	63.4	59.0	25.0	24.3
IR 8	87.5	78.3	75.1	74.0	45.5	39.5
Jhona 349	89.2	93.0	90.0	86.4	75.3	74.2
Magnolia	89.2	83.3	79.9	53.3	18.0	14.7
Cluster type spikelets (%)						
Bluebonnet	0.0	0.7	2.1	19.4	41.4	38.6
IR 8	0.0	0.7	0.1	1.0	7.2	12.8
Jhona 349	0.0	0.0	0.5	2.3	9.9	3.9
Magnolia	0.0	0.3	0.9	8.9	35.5	46.9
Delayed type spikelets (%)						
Bluebonnet	0.0	20.3	33.4	18.4	30.4	34.5
IR 8	0.0	21.0	24.0	24.7	47.0	47.6
Jhona 349	0.0	6.8	9.3	11.0	14.4	21.0
Magnolia	0.0	16.3	19.1	36.6	44.4	37.5
Random type spikelets (%)						
Bluebonnet	0.0	0.4	1.1	3.2	3.2	2.6
IR 8	0.0	0.0	0.8	0.3	0.3	0.1
Jhona 349	0.0	0.2	0.2	0.3	0.4	0.9
Magnolia	0.0	0.1	0.1	1.2	2.1	0.9

Jhona 349 was highly resistant (74.2%), while Magnolia (14.7%) and Bluebonnet (24.3%) were sensitive (Table 3).

Types of sterility. Cluster, delayed, and random types of sterility were caused by salt treatments (Table 3). In general, delayed type spikelets were remarkably abundant than cluster types spikelets at each salinity level. These types of sterility did not appear in the four varieties at control.

Pollen fertility. Pollen grains taken from normal spikelets at each salinity level were quite normal, whereas on all cluster and random types spikelets were quite sterile. On the other hand, some anthers of the delayed type spikelets were low in pollen fertility.

Seed color and size. Seeds produced at higher salt concentrations were darker and smaller in size than the seeds produced at the control. The effect was much more pronounced in Magnolia than in other varieties.

Discussion

The higher the salt content of the soil, the more retarded are the growth and development of the plants. This, in general, is the concept of the effect of salinity on growth and development of plants. Rice, on the otherhand, at critical salinity levels, may develop normal straw yield but produce little or no grain (KAPP 1947).

From data presented in Table 1~3, it is apparent that vegetative growth was less affected by salinization than reproductive growth. Three varieties: Bluebonnet, IR 8 and Magnolia did not show any significant difference in straw weight from the control, while their panicle weights were reduced significantly even at a low salinity level, *i. e.* 2,000 ppm. Similar results in relation to vegetative and reproductive growth have been reported by other workers (FRAPS 1927; IWAKI 1956, HAYWARD and BERNSTEIN 1958; PEARSON 1959; KADDAH and FAKHRY 1961 and YOSHIDA 1967).

In vegetative growth, salinity had little effect on the production of tillers and straw weight as compared to other vegetative characters. Some varieties even produced more tillers than the control at various salt concentrations. Similarly, straw weights of Bluebonnet and IR 8 were higher than the control at 4,000 and 3,000 ppm respectively. Magnolia developed more dry matter than the control at each salinity level. This shows that the tolerance of rice to salinity increases during growth period. It is now generally accepted that rice is least tolerant to salinity during early growth stages, and its tolerance increases during later stages of growth (FRAPS 1927; PEARSON 1959; KADDAH and FAKHRY 1961). DEL VALLE and BABE (1947) also reported that rice increased in its tolerance when 30, 60 and 90 days old plants were compared. Although the roots were in immediate contact with saline solution, the salinity effects were more on the elongation of roots than the production of dry matter in roots. Suppression of the elongation of roots, recognized in this study, may be attributed to the reduction in mitotic activity by salinity. Reduction in mitotic activity by salinity in the roots of maize and

barley has been reported by AVILOVA and MATUHIN (1967). The varietal differences in this respect were obvious. In Bluebonnet and Jhona 349, the root length was significantly reduced even at a low salinity level, *i. e.* 1,000 ppm, while the effect was recognized in IR 8 at the highest salinity level. The number of days from seeding to inflorescence emergence, with the exception of IR 8, increased progressively with an increase in salinity. Similar results were reported by IWAKI (1956) and SHIMOYAMA and OGO (1956) in rice.

In reproductive growth, salinization reduced the panicle weight, number of primary branches per panicle, panicle length, number of spikelets per panicle and seed setting percentage, thereby reducing the grain yield. Panicle weight was much more seriously affected than the other characters. No close relation could be observed among the yield components. For example, in IR 8, the number of primary branches per panicle, panicle length, number of spikelets per panicle and panicle weight at the highest salt concentration were: 90.7, 104.9, 82.9 and 25.0 per cent of the control, while its seed setting percentage was 39.5. Similarly, in Jhona 349 the seed setting percentage at the highest salinity level was 74.2, while its panicle weight was only 29.6 per cent of the control. In regard to panicle weight and seed setting percentage, Jhona 349 was relatively the most resistant to salinity, while Magnolia the least. Seed setting percentage had close relationship with the frequencies of three types of sterility caused by salinity. In general, delayed type spikelets were more than cluster type spikelets at each salinity level. This indicates that the effect of salinity is different according to the development stages of inflorescence and it may be very important to determine which stage is most sensitive. MATSUO (1953), OTA *et al.* (1955), IWAKI (1956), BERNSTEIN and HAYWARD (1958), PEARSON and AYERS (1960) and YOSHIDA (1967) support the view that rice is very sensitive to salinity during flowering, while other investigators, DEL VALLE and BABE (1947), TING and FANG (1957) and AKIHAMA (1960), believe that salinization during flowering has a much less effect in rice plant. KADDAH and FAKHRY (1961) reported that the development of straight-head

panicle was the accumulative effect of salinity on panicle formation when salinity was applied at the early stages of growth, rather than to increased sensitivity to salt at and after the booting stage. They also reported that the development of straight-head increased with the decrease of tolerance of rice variety to salt. It seems that delayed type sterility is probably the result of physiological disorder after the emergence of panicle. Cluster type sterility may be due to the toxic effects of salinity during very early panicle formation. Therefore experiments are needed to elucidate the mechanism for these sterile types.

Salt treatments did not affect the pollen viability in any of the four varieties except in the cases of cluster and random types. OTA *et al.* (1956) reported a decrease in germination percentage of pollen with increase in salinity. At higher salt concentrations, the seed produced was darker in color and smaller in size than the seed produced at control. This indicates that salinity also affects grain maturation. According to IWAKI (1956), the effect of salt is harmful during the first three weeks after the heading period. OTA *et al.* (1955) reported that grain size was decreased with the increasing salinity.

On the basis of results reported in Tables 1~3, it can be concluded that at the same salt concentration and for the same character all varieties reacted quite differently. This shows that the varieties of different genetical constitution show a differential reaction to salinization. No close relation was observed among the various characters studied. The results are in good agreement with PEARSON (1959) who reported that the effect of salinity on growth was found to vary among the various criteria measured. Jhona 349 was highly resistant for number of mature tillers per plant, panicle weight and seed setting percentage and sensitive for straw weight, dry weight of roots and root length. On the other hand, Magnolia showed resistance in straw weight, dry weight of roots, root length and number of primary branches per panicle and was highly sensitive regarding panicle weight and seed setting percentage. So if these characters can be combined together successfully by hybridization, there is a possibility of evol-

ing a new salt-resistant variety of rice.

Summary

Four rice varieties: Bluebonnet, IR 8, Jhona 349 and Magnolia were evaluated for salt tolerance by using water culture techniques in the greenhouse in summer 1970. The relative tolerance of these varieties to salinity varied greatly. Salinization inflicted much more harmful effects on reproductive growth as compared to vegetative development. Each character was found to be independent in its reaction to salinity. Jhona 349 was relatively resistant for number of mature tillers per plant, panicle weight and seed setting percentage, and sensitive for straw weight, dry weight of roots, root length and number of primary branches per panicle. On the other hand, Magnolia showed resistance in straw weight, dry weight of roots, root length and number of primary branches per panicle, and was highly sensitive for panicle weight and seed setting percentage. So, it seems to be possible that such variations in salt tolerance can be utilized by breeders in breeding salt-tolerant varieties.

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耐塩性イネ品種の育種

I. イネ数品種間にみられる耐塩性に関する変異性

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栽培稲4品種 Bluebonnet, IR 8, Jhona 349 および Magnolia の耐塩性を 1970 年の夏、ガラス室内で水耕培養法によつて検定した。

塩の濃度は塩化ナトリウムと塩化カルシウムを等量宛、基本培養液(硫酸アンモニウム 71.0 mg, 硫酸マグネシウム 61.2 mg, 硝酸カルシウム 58.4 mg, 燐酸カリウム 24.5 mg, 硫酸カリウム 12.2 mg, クエン酸鉄 10.8 mg/l) に添加することによつて、1,000; 2,000; 3,000; 4,000 および 5,000 ppm とした。塩処理は材料の移植 2 週間後から開始し、収穫まで継続した。培養液の pH は 6 とした。

供試各品種の塩に対する相対的な耐性には大きな差異

が認められた。

一般的傾向として、塩処理は栄養生長に対するよりは生殖生長に対してより大きな害を与えることが認められた。また、塩処理に対して各調査形質は互いに独立した反応を示すことが明らかにされた。

Jhona 349 は個体当りの有効分げつ数、穂重および着粒歩合については耐性を示したが、わら重、根重、根長、一穂当りの第1次枝梗数については感受性を示した。他方、Magnolia は塩処理に対して、これとは対照的な反応を示した。このように品種間、形質間に耐塩性に関して差異が認められるので、これらの変異性は耐塩性新品種育成に役立つであろう。