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SALT-TOLERANT PLANTS OBTAINED WITHIN A RICE CULTIVAR[1]

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Rice genotypes resistant to NaCl could be valuable for soils affected by high salinity. In recent years, we have initiated a program to enhance the salt tolerance level in rice, using cellular selection techniques. During preliminary experiments to determine the NaCl sensitivity of a popular local cultivar Tainung 67 (T67) as future possible parent material, we found that different seed lots of the variety responded differentially in artificially induced salt stresses, and seeds from the same lot also showed variable responses even under well-controlled conditions (Fig. 1). Since T67 has never been subjected to selection for salt tolerance during and after its breeding processes (Huang, 1979), it is highly possible that the cultivar per se contains large genetic variability with respect to NaCl sensitivity, and single plant selections may lead to the identification and isolation of line(s) tolerant of NaCl. This note reports the improvements made after one cycle of such selection.

About 1,000 foundation seeds of the cultivar, obtained from Taichung District Agriculture Improvement Station, Taichung, were germinated and raised directly with nutrient solution on stainless steel mesh suspended over plastic pots. Conditions in the growing chamber were at 27°C with 16 h photoperiod of 20,000 luxes. When seedlings were about 15 cm tall (3-4 leafed stage), they were subjected to 1% salt stress for two weeks at the above-mentioned conditions. Outstanding survivals, on the basis of vigor, greenness of leaves and relative seedling height, were then saved, allowed to recover for 7-10 days and transplanted in the field for seed increase.

To evaluate the relative NaCl tolerance of the selected plants, aseptic methods

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were used. Selfed seeds from individual selected lines were dehusked, sterilized with 2.5% sodium hypochlorite solution for 8 min and soaked in sterile water for 24 h. They were then subjected to another cycle of sterilization and rinses in water, and placed in a 3×16 cm test tube containing 15 ml of 1.25% (w/v) NaCl-salinized medium. The detailed components of the basal medium are listed in Table 1. Each culture tube contained 10 seeds and at least 11–13 uncontaminated cultures were successfully established for each strain. Culture conditions were at 26°C with 16 h photoperiod of 6000 luxes. After 24 days in culture on the stressed medium, the total biomass produced in each culture tube was removed, weighed and its mean seedling height determined. Survival rate was also scored for each line tested. Standard analysis of variance was then conducted and Duncan's Multiple Range Test used to test the significance of difference among the means.

Results of the evaluation are given in Table 2. Compared to the original parent population T67, all the selections showed a postive progress in terms of mean seedling height, increasing from 34% to 95% of control. Four selections viz. SS-1, SS-2, SS-3 and SS-5 were also accompanied by an simultaneous increase in the production of biomass. Furthermore, the number of seeds and/or seedlings not succumbing under the specified stress conditions was also improved in each selection (Table 3). For example, the survival rates of SS-1, SS-2, SS-3 and SS-5 were respectively 89.1%, 90.9%, 84.6% and 87.3%, while in control it was only 68.2%. All these data suggest that selection, over one generation, for salt tolerance at the 3–4 leafed seedling stage is effective not only in enhancing the tolerance of progeny seedlings, but also the tolerance at germination and subsequent development of the

Table 1. *Composition of the basal medium for germination and seedling growth**

Stock	Constituents	mg/l
A	KNO_3	910
	NH_4NO_3	240
B	$CaCl_2 \cdot H_2O$	88.4
C	KH_2PO_4	54.4
D	$MgSO_4 \cdot 7H_2O$	74.0
E	Na_2EDTA	37.3
	$FeSO_4 \cdot 7H_2O$	27.8
F	B_5 Micro elements (Gamborg, 1975)	1 ml/l
G	Sucrose	10,000
H	Bacto-agar (Difco)	9,000
pH before autoclaving=5.8		

* NaCl at 1.25% (w/v) is incorporated.

Table 2. *Mean seedling height and biomass production of selected lines*

Line	Height (cm)*	% control	CV (%)	Biomass (mg)*	% control	CV (%)
T67	2.8±1.1 a**	100	37	734±125 a	100	17.0
SS-1	5.3±1.5 e	184.9	28	919±201 b	125	21.9
SS-2	5.5±0.5 e	195.1	8.8	954±90 b	130	9.5
SS-3	5.1±1.1 e	178.5	21.7	913±162 b	124.4	17.8
SS-4	4.0±1.3 bc	139.4	31.5	770±151 a	104.9	19.6
SS-5	5.0±0.8 e	175.4	16.7	937±139 b	127.7	14.8
SS-6	3.8±0.9 bc	134.5	22.9	786±112 a	107.1	14.3
SS-7	4.0±0.8 cd	139.4	20.4	753±134 a	102.6	17.9

* Values are means of 11 cultures with each culture containing 10 seeds aseptically grown for 24 days at 1.25% NaCl-salinized medium.

** Different alphabets represent significance at 5% as tested by Duncan's Multiple Range Test.

Table 3. *Survival rates of selected lines**

Line	T67	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	SS-7
%	68.2	89.1	90.9	84.6	75.5	87.3	80.9	76.4

* Based on an accumulated total of 110 seeds per line after being aspetically germinated and grown for 24 days at 1.25% NaCl-salinized medium.

emerging seedlings, at least up to the period tested (24 days). To be successfully used as a commercial variety, any selected line should also possess an appreciable degree of tolerance beyond the seedling stage. Therefore, it would be of great interest to ascertain how the tolerant selections perform throughout their life cycles under saline conditions.

Of the selected lines that showed both an increase in mean seedling height and biomass production, SS-2 appeared to be the most promising (Fig. 2). It responded very uniformly to the imposed stress of 1.25% NaCl, as evidenced by its smallest CV's in both parameters (Table 2). This indicate that the line is relatively homozygous, or is approaching homozygosity, at least with respect to the character of salt tolerance at the young seedling stage. This line, together with another selected senstive line CK-5 which is characterized by little or no growth at 1.25% NaCl (results no shown), will be used in our *in vitro* attempts to further enhance their respective NaCl tolerance.

Pure line or mass selection has been very effective in isolating or developing desirable lines from land races or traditional varieties. It is relatively easy, and demands little time and resources compared to other breeding methods (Allard,

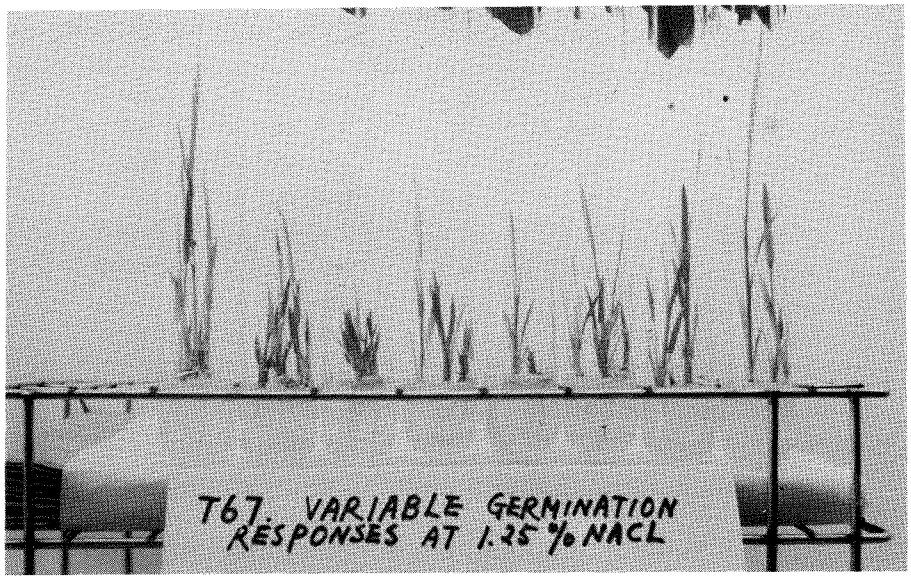

Fig. 1. Variable germination responses of parent population Tainung 67 at 1.25% NaCl.

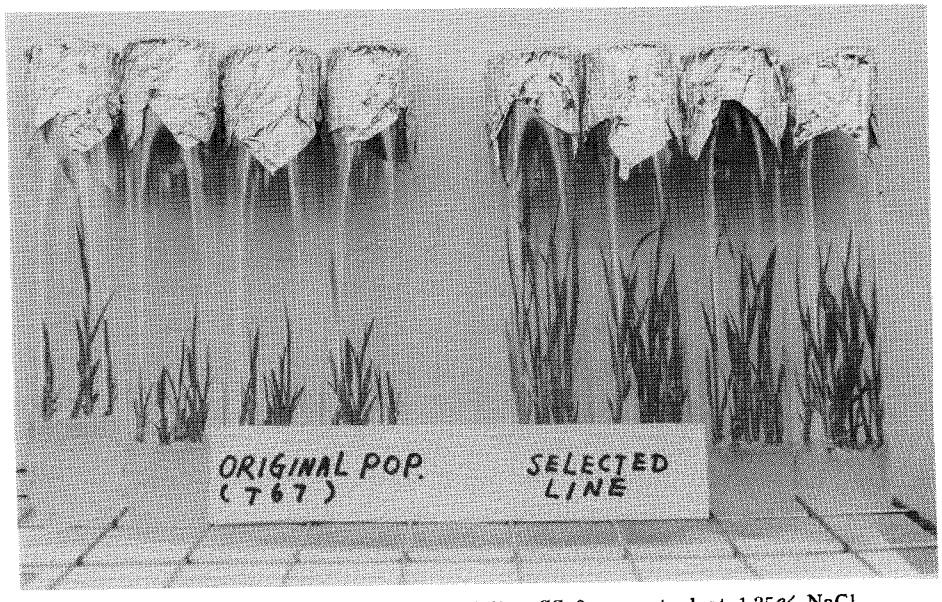

Fig. 2. The performance of a selected line SS-2 vs control at 1.25% NaCl.

1960). Our study has shown that it is worthwhile to first explore the possible existence of useful variant(s), before attempting other costly, time-consuming approaches for increasing salt tolerance in an otherwise agronomically desirable variety. Promising results were also obtained in alfalfa by Carlson *et al.* (1983). After one cycle of selecting putative tolerant plants and allowing them to intercross among themselves, the authors were able to enhance the germination of a cultivar by 3.75 times at 1.75% NaCl.

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水稻品種內之耐鹽系統

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粳稻臺農67號對氯化鈉 (NaCl) 之反應，品種內有若干程度之差異，這現象表示，該品種之耐鹽特性仍然具有變異，所以選擇該品種之耐鹽植株，極可能提高該品種之耐鹽能力。本研究由該品種之原種中選擇可能具有耐鹽能力之植株七株，嗣後繁殖成七系統，經檢驗結果，所選之系統在含1.25%氯化鈉培養劑中，無菌狀態發芽存活率均較對照系高，秧苗高度增加 34-95%；其中四系統之鮮物重較對照系統增加 24-30%。