

SALT TOLERANCE OF RICE (*Oryza sativa* L.) VARIETIES FROM MYANMAR

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ABSTRACT

Response to salinity of six rice varieties from Myanmar at germination and young seedling stages was studied using four salinity levels (0, 2, 4 and 8 dSm⁻¹ NaCl). Results showed that all varieties were significantly different based on germination, young seedling shoot and root dry weights in response to salinity. Among the rice varieties the most salt tolerant variety was Shwethweyin (a local variety) while the most sensitive variety was Hmawbi 2 (a high yield variety). It is suggested that further studies should be done for the whole growing cycle at field condition under wet and dry season.

INTRODUCTION

Rice (*Oryza sativa*) is the main staple food in Myanmar. The area planted with rice in 2000-01 was 6.5 million hectares of total arable land area (9.55 million hectares) with the average yield of 3.2 metric tons per hectare. The area sown to monsoon rice and summer rice constituted 4.85 and 1.08 million hectares, respectively. Most of the rice growing areas are located in delta region (Ayeyawady division, Bago division, Yangon division, Mon state) and coastal region (Rakhine state, Taninthari division). The climatic condition of these areas is tropical wet due to monsoon from the Bay of Bengal. The major extension of rice cultivation took place mostly on that areas because their hydromorphic nature was exclusively suited for rice. The dependable monsoonal rains of that area, its warm and humid environment offered an ideal environment for rice production. Most rice is grown where the soil is submerged during part or all of the growing cycle so that the major limiting factor in rice growing is water (IRRI, 1976).

One of the main rice production constraints is intrusion of sea water, especially in delta area. Marine salinity is confined to coastal region because of tidal regime. Often the mean tide level as well as the spring tide levels fluctuate seasonally. In delta area there are twice daily inundations of tidal flats that are normally occupied by mangroves. In most coastal and delta regions in Myanmar, spring tides are highest in summer season leading to strong seasonal salinization. The rice growing areas in these regions are not completely protected against periodic salt water intrusion even in rainy season.

According to the classification of crop tolerance to salinity, the rice crop is within the sensitive division from 0 dSm⁻¹ to 8 dSm⁻¹ (Maas, 1986). There are two essential parameters sufficient for expressing salt tolerance. Threshold means the maximum allowable salinity without yield reduction and slope means the percent of yield reduction per unit increasing in salinity beyond the threshold. The threshold and slope of rice (*Oryza sativa*) are 3.0 dSm⁻¹ and 12 % per dSm⁻¹ of saturated soil extract (EC_e), respectively (Maas and Hoffman, 1977). Relative salt tolerance of rice at 50 % yield and at 50 % emergence are 3.6 dSm⁻¹ and 18 dSm⁻¹ of EC_e, respectively (Wahhab, 1961).

When sufficient fresh water is available during the monsoon season, the salts are dissolved and diluted in the surface soil layers and washed out from plant's shallow root zone (Pearson and Ayres,

1960). Summer rice is cultivated using the irrigation water from the rivers and streams during the summer season. In delta region sea water penetrates deeper in rivers and streams entering the sea so that the problem of salinity of irrigation water occurs. The quality of irrigation water provided by rivers and streams is also variable and salt contents tend to be higher in summer season. Protection against these types of unpredictable salinity can be achieved by growing salt tolerant varieties (Moormann and Breeman, 1978), especially for summer rice. Therefore the objective of this study was to find out the salt tolerance of six paddy rice varieties from Myanmar.

MATERIALS AND METHODS

Seeds of six different rice varieties were obtained from Central Agricultural Research Farm, Hmawbi in Myanmar. The rice varieties used in the studies were Shwewatun (HYV), Manawthukha (HYV), Hmawbi-2 (HYV), Inmayebaw (Local), Yezin-3 (HYV), Shwethweyin (Local). The characteristics of the six rice varieties are shown in Table 1. All varieties are improved and are under production by farmers.

Table 1: Characteristics of six rice varieties from Myanmar

Sr. No	Name of rice varieties	Grain type	Days to maturity	Plant height (cm)	Effective tillers/ plant	Length of panicle (cm)	Grains per panicle	1000 Grains weight (gm)	Quality of rice	Yield (tons/ ha)
1	Shwewatun (HYV)	Ematha	140-145	137- 152	8-10	26,4	160	27,42	Clear	4-5
2	Manawthukha (HYV)	Latwezin	135-140	91- 107	8-10	23,8	178	18,00	Clear	4-5
3	Hmawbi 2 (HYV)	Ematha	140-145	107-122	8-10	26,1	133	28,18	Clear	4-5
4	Inmayebaw (Local)	Ematha	170-175	152 -178	6-8	27,1	146	28,90	Clear	3,75-4
5	Yezin 3 (HYV)	Ematha	120-125	75-90	15-18	---	159	24,00	Clear	5-6
6	Shwethweyin (Local)	Meedon	140-145	150-170	5-8	---	140	27,5	Not clear	3,5-4

Germination Experiment

The experiments were carried out to assess total germination percentage and seedling growth in response to salt levels. Uniform 20 seeds of each variety were placed on filter paper lined glass petri dishes. NaCl treatments of 0, 1.227 g l⁻¹, 2.629 g l⁻¹ and 5.550 g l⁻¹ were dissolved in distilled water corresponding to 0 (control), 2, 4 and 8 dSm⁻¹. 10 ml of appropriate solution was applied to each petri dish. The germination was conducted in a laboratory, the room temperature was 25 ±1 °C with 12 h daylight. The petri dishes were arranged in a completely randomized block design with four replications.

The number of germinated seeds was counted after 5 days. A seed was considered to have germinated when both plumule and radicle had emerged ≥0.5 cm. Seedling shoot dry weight and root dry weight were taken after 12 days. Total germination was expressed as a percentage of that in the control treatment for each variety.

RESULTS AND DISCUSSION

Germination

The germination of rice seeds was significantly ($p \leq 0.05$) influenced by salt levels, varietal differences and the interaction of both. Our data show that the percentage emergence of all varieties was reduced by increasing salt levels. The highest mean germination percentage was recorded for variety 6 (Shwethweyin) and the lowest for variety 3 (Hmawbi 2). Seeds for the latter practically failed to germinate at the 8 dSm^{-1} salt level. The germination of variety 4 (Inmayebaw) was nearly the same as that of variety 2 (Manawthukha) at the 4 dSm^{-1} level. Variety 2 (Manawthukha) and variety 5 (Yezin 3) were similar in their germination at the 8 dSm^{-1} level. The germination of variety 4 (Inmayebaw) between 0 dSm^{-1} and 2 dSm^{-1} was not different. Figure 1 shows the mean germination of the six rice varieties at four salt levels.

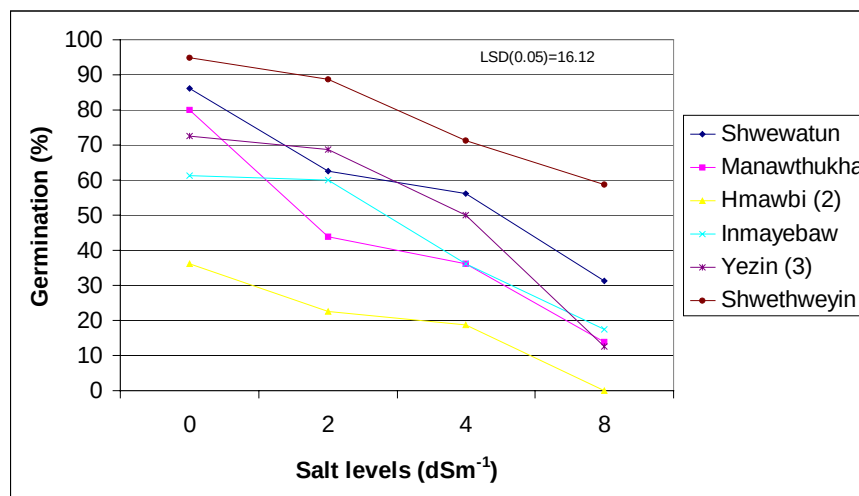


Fig. 1: Mean germination of six rice varieties at four salt levels

Shoot dry weight

Rice seedling shoot dry weight was significantly ($p \leq 0.05$) influenced by salt levels, varietal differences and the interaction of both. The data show that rice seedling shoot dry weight of all varieties was reduced by increasing salt levels. In general variety 6 (Shwethweyin) had the highest mean seedling shoot dry weight while the variety 3 (Hmawbi 2) had the lowest. Although the seedling shoot dry weights of variety 4 (Inmayebaw) and variety 6 (Shwethweyin) at the 2 dSm^{-1} salt level were higher than at the 0 dSm^{-1} (control), the differences of seedling shoot dry weight of these varieties between 2 dSm^{-1} and 0 dSm^{-1} were not statistically significant. The seedling shoot dry weight of variety 3 (Hmawbi 2) at 0 dSm^{-1} was nearly the same as at 2 dSm^{-1} . The rice seedling shoot dry weights among the variety 2 (Manawthukha), variety 4 (Inmayebaw), and variety 5 (Yezin 3) at 8 dSm^{-1} were at the same level. Figure 2 shows the mean shoot dry weight of the six rice varieties at four salt levels.

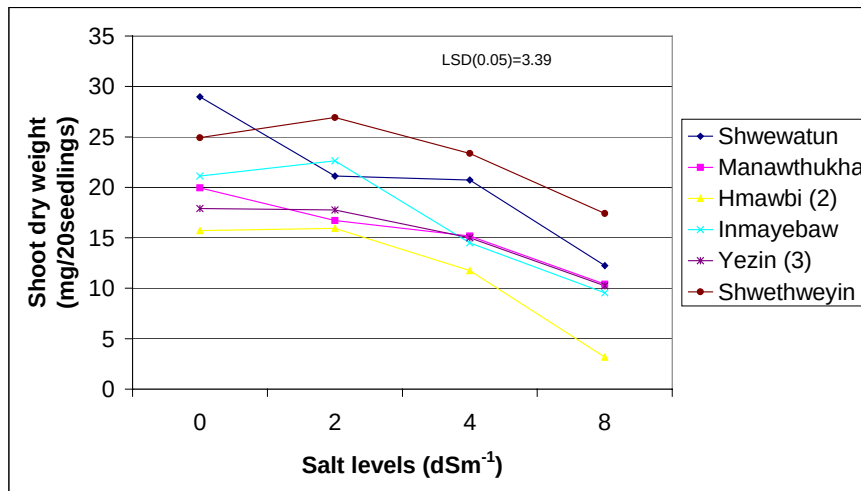


Fig. 2: Mean shoot dry weight of six rice varieties at four salt levels

Root dry weight

Rice seedling root dry weight was significantly ($p \leq 0.05$) affected by salt levels, varietal differences and the interaction of both. Our results show that generally rice seedling root dry weight was reduced by increasing salt levels. The highest mean seedling root dry weight was recorded for variety 6 (Shwethweyin) and the lowest for variety 2 (Manawthukha). The seedling root dry weight of variety 4 (Inmayebaw) at 2 dSm⁻¹ was higher than at 0 dSm⁻¹. The differences of seedling root dry weights among variety 5 (Yezin 3), variety 4 (Inmayebaw), variety 2 (Manawthukha) and variety 3 (Hmawbi 2) were not statistically significant. The seedling root dry weight of variety 2 (Manawthukha) at 8 dSm⁻¹ level was the same as that of variety 3 (Hmawbi 2). Figure 3 shows the mean root dry weight of the six rice varieties at four salt levels.

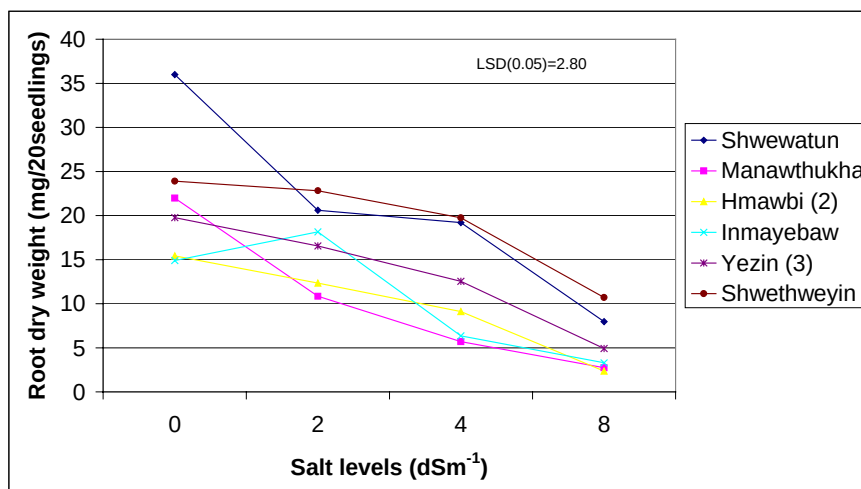


Fig. 3: Mean root dry weight of six rice varieties at four salt levels

CONCLUSION

Rice varietal differences in response to salinity were found out in this study. Increasing salt level had detrimental effects on germination percentage and relative seedling shoot and root dry weight of different rice varieties. It was observed that rice seedling shoot and root dry weights of some varieties were higher at 2 dSm⁻¹ than at 0 dSm⁻¹. One possible reason may be growth stimulation as a result of the replacement of K by Na (Marschner, 1995). Varieties differ considerably in susceptibility to salinity (Castro and Sabado, 1977). So, due to the results of this experiment, the rank of the tested six different rice varieties in response to salinity on germination percentage, seedling shoot and root dry weight was: Shwethweyin (Local) > Shwewatun (HYV) > Yezin 3 (HYV) > Inmayebaw (Local) > Manawthukha (HYV) > Hmawbi 2 (HYV).

Tolerance at emergence is based on survival, whereas tolerance after emergence is based on decrease in growth or yield (Maas, 1986). Plants initially adjust to saline conditions by decreasing tissue water content through osmotic adjustment (Marschner, 1995). Although differences in salt tolerance are not common among cultivars, significant differences have been observed for rice, barely, wheat and soybean. It is not always clear, however, whether varietal differences reflect differences in salt tolerance or differences in adaptation to climatic or nutritional conditions under which the tests were conducted (Maas, 1986).

Soil solution high in NaCl with electrical conductivity values of 6-10 dSm⁻¹ are associated with 50 % decrease in yield (Pearson, Ayres and Eberhard, 1966). At a given salinity level rice plants are more salt sensitive at higher light intensity and lower relative humidity, and can withstand a certain level of salinity better during the wet season than during the dry season (Moormann and Breeman, 1978). Salt tolerance of rice varies throughout its growing cycle. The rice plant is tolerant during germination but seedlings are sensitive until the age of at least 4 weeks. Damage to the rice plant during transplanting increases its sensitivity to salinity. An increase in salt tolerance occurs during tillering, but the plant again becomes sensitive during flowering. Sensitivity again diminishes during the maturation period (Pearson and Ayres, 1960). In this study the experiment is only conducted to germination and young seedling stage. Therefore the experiment for the whole growing cycle at field conditions should be carried out under wet season and dry season.

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