Effect of Salinity on the Germination of *Sonneratia apetala* Buch.-Ham.

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Abstract

The effect of salinity on the germination of *Sonneratia apetala* Buch.-Ham. was studied. The best germination success was observed in the 0-5 ppt salinity range with the highest value (98.67%) at the 0 ppt (fresh water) level. Germination success decreased significantly with the increasing level of salinity. Increasing salinity also remarkably delayed the germination. Satisfactory germination success was observed when salt treated seeds were sown in fresh water condition. This indicates that salt has only a reversible inhibitory effect on germination. The rate of recovery from the inhibitory effect of salt was not found to be sensitive to the level of salinity, and did not exhibit any definite relationship with the length of exposure of seed to the saline condition.

সারসংক্ষেপ

কেওড়া বীজের অঙ্কুরোদগমের উপর লবণাক্ততার প্রভাব পরীক্ষা করা হয়। পরীক্ষায় দেখা যায় যে ০-৫ পি পি টি মাত্রার লবণাক্ততা কেওড়া বীজের অঙ্কুরোদগমের জন্য সর্বাপেক্ষা উপযোগী এবং ০ পি পি টি মাত্রায় (লবণমুক্ত পরিবেশে) অঙ্কুরোদগম সর্বাধিক (৯৮.৬৭%)। লবণাক্ততা বাড়ার সাথে সাথে অঙ্কুরোদগমের হার উল্লেখযোগ্যভাবে কমে যায় এবং অঙ্কুরোদগম বিলম্বিত হয়। লবণাক্ত মাধ্যমে বীজ রাখার পর লবণমুক্ত পরিবেশে বপন করলে বীজ পুনরায় অঙ্কুরোদগম ক্ষমতা ফিরে পায়। অঙ্কুরোদগম ক্ষমতার এ পূনরুদ্ধার, প্রয়োগকৃত লবণাক্ততার মাত্রার উপর নির্ভরশীল নয়। অঙ্কুরোদগমের হার ও লবণাক্ততা প্রয়োগের স্থিতি কালের মধ্যে সুনির্দিষ্ট কোন সম্পর্ক পরিলক্ষিত হয় না।

Key words : Germination, inhibitory effect, NaCl, salinity effect

Introduction

Sonneratia apetala Buch.-Ham., locally known as keora, is a pioneer tree species in mangrove succession of the Sundarbans (Das and Siddiqi 1985). The species is of considerable ecological and economic importance. It represents about 4.5% of the merchantable growing stock in the Sundarbans natural mangrove forest (Chaffey *et al.* 1985) and 95% of the mangrove plantations in Bangladesh (Siddiqi and Shahjalal 1997). Traditionally, this species is used as fuelwood, in furniture making and boat building by poor people (Lakshmanan *et al.* 1984, Das and Siddiqi 1985). However, it can be an important raw material for pulp and pulp product industries (Khan 1982, Chakrabarti 1987, Khan and Shafi 1992). With active afforestation programme, *S. apetala* might become the single most important mangrove species in the country (Hoque 1996), and thus bears significance in forestry practices in Bangladesh.

Mangroves are facultative halophytes, but higher concentration of salt adversely affects almost all their physiological processes (Waisel 1972, Chapman 1976, Ball and Pidsely 1995). Salinity tolerance of mangroves varies greatly (Waisel 1972, Naskar and Bakshi 1987, Chaudhuri and Choudhury 1994), which determines the distribution, growth, and dominance of species in mangrove forest (Waisel 1972, Chapman 1976, Das and Siddiqi 1985, Portillo and Ezcurra 1989, Siddiqi *et al.* 1989, Lin and Sternberg 1993, Ball and Pidsley 1995).

Information regarding the impact of salinity on *Sonneratia* is scanty. Thus, this study was undertaken to observe the effect of salinity on the germination, and also the way salt affects the germination of *S. apetala* seeds.

Materials and methods

Mature fruits of *S. apetala* were collected during August, 1997 from Dhangmari area of the Sundarbans, which is a fresh water zone having salinity <2000 µmhos/cm in the top 10 cm soil (Chaffey *et al.* 1985). Seeds were separated from the fruit by conventional method (Siddiqi *et al.* 1993). Since sodium chloride (NaCl) constitutes the highest proportion of salt in the sea and is the dominant factor in halophytism (Waisel 1972), in this study only NaCl was used to observe the effect of salinity. Sand was used as substrate for better permeability and homogenous salinity distribution in the media. In each petridish 50 fresh seeds were sown in sterilized sand. Salt solutions of 0, 5, 10, 15, 20 and 25 ppt concentrations, measured by hand held salinity refractometer, were poured into petridishes. However, when a salt solution is kept open, water evaporates leaving behind the salt and thus, volume of the solution decreases and salinity increases. If the volume of the solution is maintained constant by adding fresh water continuously/frequently the salinity could be maintained at a uniform level. Therefore, the level of solution surface in petridishes was marked by a fine-tipped permanent marker. This level of solution in each petridish was checked and maintained by adding fresh water (0 ppt) at half an hour interval. Ball and Pidsley (1995) followed a similar method except that they added tap water once in a day to correct the level of water. The petridishes were kept closed from dusk to dawn. Completely randomized design was used for this experiment.

Fresh seeds of *S. apetala* were also kept in salt solutions of 15, 20 and 25 ppt concentration in air-tight containers. In each petridish containing sterilized sand and fresh water, 30 of such salt treated seeds were sown at 24 hours interval for 15 days. The sand in petridishes was maintained wet by adding fresh water. Factorial design was used in this experiment.

The experiment was laid out with three replications. Data were recorded every morning for statistical analysis.

Results and discussion

A significant impact of salinity on the germination success of *S. apetala* seeds was observed ($F = 15.51$; 5, 12 df; $P < 0.05$). The best germination success was observed in the 0-5 ppt salinity range with the highest value (98.67%) at 0 ppt. Increasing level of salinity exhibited a strong negative correlation with the rate of germination (Fig. 1; $r = -0.98$, $P < 0.05$). These findings reveal that *S. apetala* is a facultative halophyte.

The effect of salinity on the germination of *S. apetala* has been reported by Siddiqi *et al.* (1989) and Li-Yun *et al.* (1997). Both reported a negative correlation between germination success and the level of salinity. Siddiqi *et al.* (1989) obtained the highest germination success in 5 ppt salinity with an insignificant variation within a salinity range of 0-20 ppt. Li-Yun *et al.* (1997) observed best

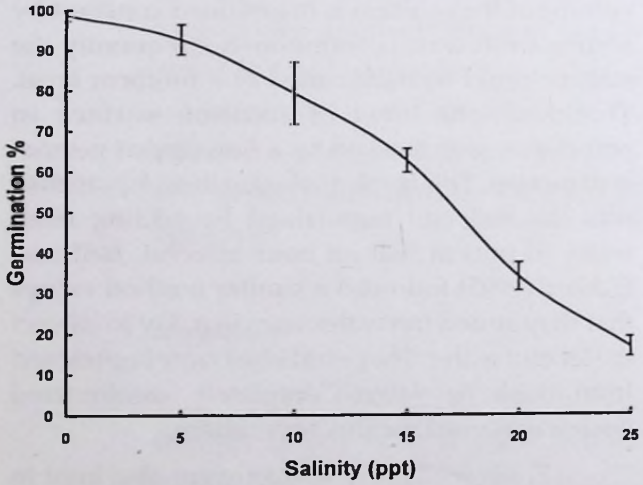

Figure 1. Relationship between germination percentage of *Sonneratia apetala* seeds and salinity of the substrate.

condition for germination in the salinity range of 2.5-5 ppt. Basu (1965) observed 86% germination success of *S. apetala* in fresh water condition at Calcutta Botanical Garden. Observations of Siddiqi *et al.* (1989) and Li-Yun *et al.* (1997) contradict with the present findings in that in slightly saline conditions they observed enhanced germination. This implies that *S. apetala* is an obligate halophyte. Such variations are possible when seeds are collected from different site conditions (Waisel 1972). *S. apetala* might also have several eco-types in the Sundarbans. Differences in the salt treatment processes may also contribute to such variation.

Increasing salinity remarkably delayed the germination of *S. apetala* seeds (Fig. 2). At 0 ppt germination started 48 hours after sowing, more

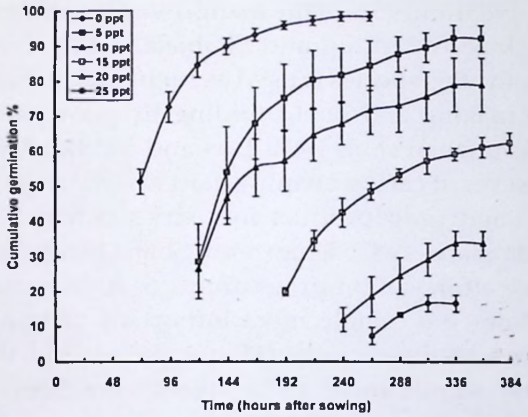

Figure 2. Progress of germination of *Sonneratia apetala* seeds with time in different salinity conditions.

than 50% germination was obtained within 72 hours and it was complete within 240 hours, whereas at 15 ppt germination started after 192 hours, it was about 50% after 288 hours and completed within 384 hours. This observation is similar to that of Siddiqi *et al.* (1989) and Waisel (1972). Melana *et al.* (1980) maintained that quick germination is very important where there is a risk of seed damage as in open sowing. This also applies to mangrove ecosystems where seeds are often liable to be washed away by tidal current and in areas of higher sedimentation where they are likely to be buried in mud.

It was observed that *S. apetala* seeds, kept in salt solutions up to 15 days, germinated when placed in fresh water condition. This implies that salt had only an inhibitory effect on germination of the species. With the same duration of seed treatment, germination percentage did not vary

Table 1. Germination success (%) of *Sonneratia apetala* seeds treated in different concentrations of salt solutions for different length of time.

Treatment time (Hours)	Germination success (%) of seeds treated in different concentrations of salt solutions					
	15 ppt		20 ppt		25 ppt	
	Mean value	± S. E.	Mean value	± S. E.	Mean value	± S. E.
24	87.78	4.01	61.11	2.94	71.11	1.11
48	75.56	4.01	51.11	1.11	63.33	1.92
72	50.00	1.92	44.44	1.11	62.22	1.11
96	46.67	1.92	37.78	2.22	36.67	1.92
120	31.11	2.94	26.67	1.92	28.89	2.94
144	23.33	3.85	21.11	2.94	17.78	2.22
168	20.00	5.09	18.89	2.94	16.67	1.92
192	36.67	1.92	37.78	2.94	31.11	2.94
216	35.56	2.94	32.22	4.01	33.33	5.09
240	48.89	1.11	56.67	1.92	46.67	3.85
264	61.11	9.69	51.11	2.22	62.2	11.3
288	28.89	2.22	27.78	4.01	31.11	4.44
312	33.33	7.70	28.89	2.22	28.89	2.22
336	40.00	3.85	33.33	3.85	33.33	3.85
360	35.56	2.22	28.89	2.22	31.11	4.44

significantly with the concentrations of the solutions (Fig. 3, Table 1; $F = 1.646$; 2, 4 df; $P < 0.05$).

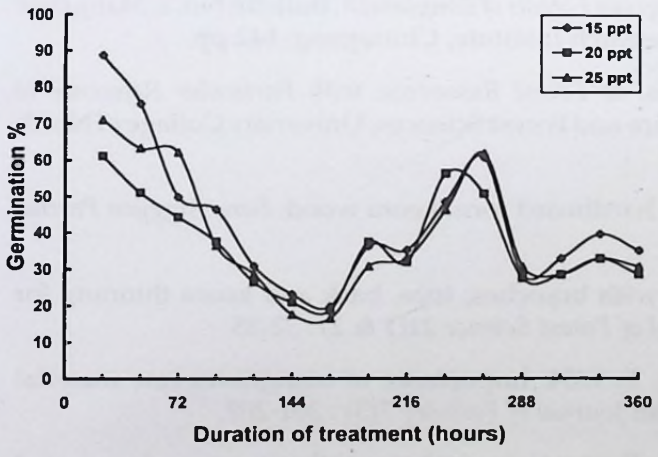

Figure 3. Germination percentage of *Sonneratia apetala* seeds treated in the solutions of different concentration of salt for different length of time in fresh water condition.

But at the same salinity level it varied significantly with the length of treatment period ($F = 73.92$; 14, 84 df; $P < 0.05$). From this, it might be inferred that salt treated seeds when exposed to fresh water condition recover from the inhibitory effect of salt, and this rate of recovery does not depend on the level of salinity to which they were exposed earlier. This information is important for academic interest.

The relationship between germination percentage and the duration of salt treatment was somewhat irregular. As a whole there was no correlation between germination percentage and the length of treatment period (at 15 ppt $r = -0.489$; 20 ppt $r = -0.359$; and 25 ppt $r = -0.439$; $n = 45$, $P < 0.05$). However, it was strongly negative up to 168 hours of treatment at all salinity levels (at 15 ppt $r = -0.972$; 20 ppt $r = -0.99$; and 25 ppt $r = -0.971$; $n = 21$, $P < 0.05$), and afterwards the germination perentage was elevated. This irregularity could not be explained but apparently due to long

exposure to saline conditions seeds developed some tolerance to salt.

Conclusion

Germination success was negatively correlated with the level of salinity for *Sonneratia apetala*. The salt had only an inhibitory effect on germination, which was recoverable in fresh water environment. The rate of this recovery was not sensitive to the level of salinity to which they were exposed and did not exhibit any definite relationship with the length of exposure of seed to the saline condition.

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