J. Tree Sci. 6(2) : 79-83 (1987)

Seed Germination and Initial Seedling Growth of *Schima khasiana* in Response to pH, Water Stress and Imbibition

A.N. Verma and P. Tandon

ABSTRACT

Slightly acidic to neutral pH (6.4-7.2) solutions enhanced seed germination and seedling growth in *Schima khasiana*, an economically important tree species of North-East India threatened in its natural sub-tropical, evergreen, montane forests. Osmotic potentials above -0.10 M Pa created by both polyethylene glycol and sucrose significantly inhibited the seed germination (P=0.05) and decreased seedling growth. Sucrose (-0.01 M Pa osmoticum) enhanced the yield of shoot. However, the radicle and shoot elongations were reduced. The soaking of seeds at 15°C for 6 hr resulted in maximum germination and early seedling growth.

Key words : *Schima khasiana*, osmotic potential, pH, polyethylene glycol, sucrose

INTRODUCTION

The substrate pH, moisture and temperature are imoportant soil factors which affect the resumption of embryonic growth during germination and also the juvenile stage in early seedling establishment (Kramer and Kozlowski 1979; Therios 1982; Everitt 1983; Verma and Tandon 1984). Plants can tolerate a pH range of 4.0-8.0 (Arnon and Johson 1942). However, the change from normal pH value may result in the decrease of forest productivety or alter the regeneration patterns (Raynal *et al.* 1982). During osmotic priming, the seeds imbible sufficient water to initiate the germination process, but radicle emergence is prevented by osmotic potential of the solution (Everitt 1983). *Schima khasiana* Dyer is an econocially important tree species of subtropic humid, evergreen, montane forests and is becoming threatened in its natural habitat of North-East India. The present study was undertaken to examine the effects of pH, water strees and imbibition on seed germination and subsequent seedling growth in relation to the adaptability of this species.

MATERIAL AND METHODS

Fruits of *Schima khasiana* Dyer were collected from Upper Shillong, Meghalaya, India (Lat. 25°34'N and Long. 91°56'E, Alt. 1800 m) during February-March 1983 and seeds extracted by air drying the fruits. Seeds were surface sterilized with 0.1% mercuric chloride for 5 min before use.

Twenty seeds were placed equidistant in covered petridishes (9 cm diam) containing sterilized filter paper ropriate experimental moistened with either sterilized distilled water or appropriate experimental solutions. The treatment solutions were drained off from the petridishes and replaced with 2 ml fresh solutions at 2-day intervals to avoid the effect of seed leachates. Each treatment consisted of four replicates and experiments were performed twice. The seeds were germinated at 20±1□c in the dark. The pH of distilled water in increaments of 0.4 units over the range of

Department of Botany, School of Life Sciences, North-Eastern Hill University, Shillong 793 014, India

4.8 to 8.0 was adjusted (Everitt 1983) with either HCl or NaoH solution. Water stress from 0 to 0.50 M Pa was obtained in solutions using either polyethylene glycol 6000 (PEG-Michel and Kaufmann 1973) or sucrose (Farmer and Bonner 1967) as osmotica. The seeds were also soaked in distilled water at various temperatures (5, 15, 25, 35⁰C) for 24 hr and also at a constant temperature of 15⁰C for varying durations (0-24 hr) in the dark.

Germination was recorded from the 6th to 20th day at 2-day intervals. A seed was considered germinated when the radicle protruded about 1 mm beyond the seed coat. The percentage germination (on viable seeds) after angular transformation, rate of germination (% seed per day) and days to peak value were calculated (Campbell and Sorensen 1979). Root and shoot elongations and their dry weight were recorded on the 20th day of germination. The data were analysed for statistical significance.

RESULTS

Seed germination

The earliest and maximum germination of S. *Khasiana* seeds occurred in slightly acidic to neutral pH (6.4-7.2) treatment. However, the pH below and above these were inhibitory (Table 1). While the total germination was significantly inhibi-ted (P=0.05) above -0.10 M Pa water stress, early germination was recorded at the lower osmotic potential of -0.01 M Pa and -0.05 M Pa (Table 2). Seeds imbibed in distilled water at various temperatures did not show any significant increase in seed germination (Fig 1). The earliest and highest germination of about 48% (P-0.05) was recorded in seeds imbibed for 6 hr at 15°C (Fig 1). However, the higher temperatures were inhibitory.

Seedling growth

Maximum radicle and shoot elongations and dry weight were recorded in the mildly acidic to neutral pH 6.4-7.2 (Fig 2). With increase in osmotic stress created with PEG, shoot and radicle growth were reduced as compared to control. In case of sucrose appli-cation, an increase in the shoot dry weight was recorded at-0.01 M Pa. However, radicle and shoot elonga-tions as well as radicle dry weight were reduced slightly (Fig 3). Growth of roots

Table 1. Effect of pH on seed germination in *Sachima khasiana*

Germination measurements	Treatment (pH)									LSD (P=0.05)
	4.8	5.2	5.6	6.0	6.4	6.8	7.2	7.6	8.0	
Germination (%)	26.90 ±4.60	26.90 ±1.80	31.20 ±1.80	31.20 ±4.60	36.30 ±4.60	37.20 ±3.00	37.20 ±4.60	24.80 ±1.80	20.60 ±1.80	9.40
Rate (% seed day^{-1})	10.20 ±3.70	16.40 ±3.05	18.50 ±3.10	21.60 ±7.10	42.30 ±10.30	57.10 ±17.30	56.70 ±16.80	11.00 ±6.50	9.30 0.70	29.70
Days to peak value	6.10	5.00	4.70	3.00	1.80	1.20	1.20	3.60	3.60	

± represent means S.E.

Table 2. Effect of water stress on seed germination in *Sachima khasiana*

Water potential (-M Pa)	Germination (%)		Rate (% seed.day^{-1})		Days to peak value	
	PEG	Sucrose	PEG	Sucrose	PEG	Sucrose
0	40.0±3.00	40.0±3.00	32.8± 8.0	32.8±8.8	2.20	2.20
0.01	42.0±4.50	36.0±4.60	39.6±10.5	43.3±5.9	1.80	2.00
0.05	40.0±4.00	30.0±3.10	39.1±10.1	41.6±6.8	2.00	2.00
0.10	40.0±5.00	30.0±5.00	39.9± 5.6	26.6±6.8	2.20	2.70
0.25	28.0±3.70	20.0±3.00	29.5± 1.4	18.3±6.5	3.30	3.40
0.50	16.0±4.90	4.0±0.90	9.3± 3.7	10.5±4.4	3.60	5.40
LSD (P=0.05)	12.7	13.3	18.8	13.0		

±represent mean S.E.

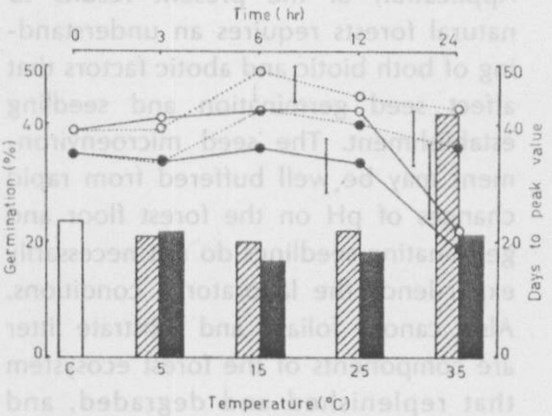

Fig. 1 Effect of soaking of *S. khasiana* seeds in water at different temperatures (continuous line and hatched bars) and periods (dotted line and closed bars) on total germination (open circle), rate (closed circle) and days to peak value (histogram), C-control (dry seeds), vertical bars (LSD, p=0.05)

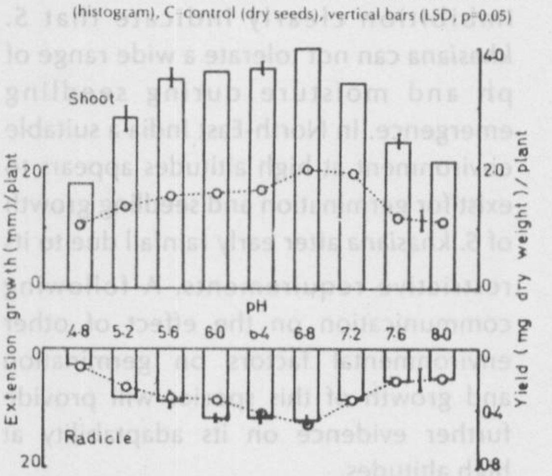

Fig. 2 Response of pH on seeding elongation (dotted line with circle) and yield (histogram) of *S. khasiana*, vertical bars (LSD, p=0.05 on line drawings and S.E. on histograms)

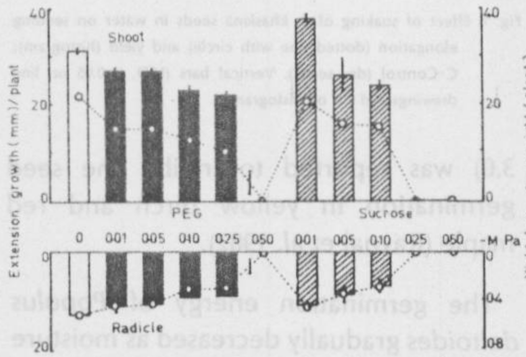

Fig. 3 Response of water stress on seedling elongation (dotted line with circle) and yield (histogram) of *S. khasiana*, vertical bars (LSD, p=0.05 on line drawings and S.E. on histograms)

and shoots were completely inhibited at higher osmotic stress. A 6 hr imbibition at 15°C was found optimum for seedling growth (Fig 4).

DISCUSSION

Germinating seeds are very sensitive to H^+ ion concentration of the medium. During the present investigation, in mildly acidic to neutral pH (6.4-7.2) solutions maximum germination and seedling growth of radicle and shoot were recorded, whereas higher alkaline or acidic pH solutions were toxic which is similar to finding on *Achillea millefolium* (Stjepanovic and Corovic 1963). Among deciduous species, substrate acidity (pH

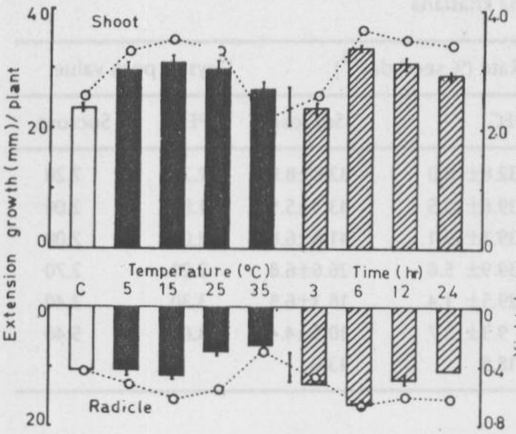

Fig. 4 Effect of soaking of *S. khasiana* seeds in water on seeding elongation (dotted line with circle) and yield (histogram); C=Control (dry seeds). Vertical bars (LSD, p=0.05 on line drawings and S.E. on histogram)

3.0) was reported to inhibit the seed germination in yellow birch and red maple (Raynal *et al.* 1982).

The germination energy of *Populus deltoides* gradually decreased as moisture stress increased and deterioration in the seedling growth was also recorded (Farmer and Bonner 1967). The present findings revealed that germination and seedling growth were extremely poor beyond -0.10 M Pa of water potential. Inhibition of germination at higher osmotic potential may possibly be related to the moisture deficit in the seeds below the threshold essential for germination (Everitt 1983). The prevention of seed germination by an osmoticum in calabrese and tomato seeds was reported on account of reduced water supply and appreci-able respiration during seeds germination (Hegarthy 1977). During the present study, water stress of -0.01 M Pa using sucrose resulted in increased shoot dry weight. The sucrose acts as respiratory substrate and is readily absorbed by cells resulting in higher metabolic activity of germinating seeds. Dry non-dormant seeds must imbibe a certain amount of water for resumption of physiological processes (Kramer and Kozlowski 1979) and in this study, soaking of *S. khasiana* seeds at 15^{0}C for 6 hr resulted in maximum germination and early seedling growth.

Application of the present results to natural forests requires an understand-ing of both biotic and abotic factors that affect seed germination and seedling establishment. The seed microenviron-ment may be well buffered from rapid changes of pH on the forest floor and germinating seedlings do not necessarily exper-ience the laboratory conditions. Also, canopy foliage and substrate litter are components of the forest ecosystem that replenished and degraded, and exhibit a remarable ability to neutralise acidified precipitation during early rainfall. The data of pH, water stress and imbibition clearly indicate that *S. khasiana* can not tolerate a wide range of ph and moisture during seedling emergence. In North-East India a suitable environment at high altitudes appears to exist for germination and seedling growth of *S. khasiana* after early rainfall due to its restrictive requirements. A following communication on the effect of other environmental factors on germination and growth of this species will provide further evidence on its adaptability at high altitudes.

ACKNOWLEDGEMENTS

Financial assistance from Indian National Science Academy and Council of Scientific and Industrial Research, New Delhi, is gratefully acknowledged. This study was supported by a research grant to P.T. from Indian National Science Academy, New Delhi.

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