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# Seedling emergence and development of *Pinus kesiya* Royle ex Gord. and *Schima khasiana* Dyer

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**Abstract.** Early emergence was recorded in *Schima khasiana* as compared to *Pinus kesiya*. However, initial seedling growth was higher in the latter. Better yield was recorded during monsoon in both the species. While in *Pinus kesiya* shoot length increased up to the month of July and August, in *Schima khasiana* it continued up to September. The peak period for relative growth rate was recorded from August–September in *Pinus kesiya* and September–October in *Schima khasiana*. It was concluded that the conditions prevalent at the study site during August (temperature 23·5/17·5°C) and September (temperature 22·5/14°C) under high humidity (80–90%) and moderate rainfall (400 mm) may be appropriate for growth of transplants of *Pinus kesiya* and *Schima khasiana* respectively, under controlled conditions.

**Keywords.** *Pinus kesiya*; *Schima khasiana*; seedlings; relative growth rate.

## 1. Introduction

Seed germination and seedling growth of plants depend on interaction between their hereditary potentialities and the environmental conditions (Kramer and Kozlowski 1979; Kozlowski 1983; Minore 1986). Natural regeneration of many tree species is hindered by lack of suitable climatic conditions for seed germination and subsequent seedling establishment. Light, temperature and humidity are so interdependent that a change in one alters the others. The study of weather effects on emergence and seedling growth is important as it may provide an opportunity to produce large number of uniform transplants in controlled environment in a limited time (Kozlowski 1983).

*Pinus kesiya* Royle ex Gord. and *Schima khasiana* Dyer are two economically important early successional tree species which are predominant at high altitude in sub-tropics of north-east India. The emergence and seedling growth in relation to climatic factors during early phase of seedling establishment in both the species is poorly understood. Therefore, the present study was conducted to evaluate the influence of weather conditions during seedling development.

## 2. Materials and methods

Seedling emergence and their growth pattern in *P. kesiya* and *S. khasiana* were studied in relation to some climatic factors like temperature, humidity and rainfall at the University Campus, Shillong (latitude 25° 35′ N and longitude 91° 56′ E, altitude 1,500 m) during the year 1983–1984. The temperature, rainfall and humidity data

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were collected from the nearest meteorological centre in Shillong. The climate is divided by seasonal differences into (i) monsoonic season, with higher temperature, humidity and rainfall extending from May–October, (ii) dry and humid winter season from November–February followed by (iii) warm, dry summer of March and April (figure 1).

Seeds of *P. kesiya* were collected from the University campus, Shillong (altitude 1,500 m) and those of *S. khasiana* from upper Shillong (altitude 1,800 m), Meghalaya, during the months of February–March 1983. The seeds of both the species were collected from many trees and then bulked separately. Fifty seeds of both the species were sown at about 1 cm soil depth in each plastic pots (30 cm diam) in open field conditions during April 1983. The duration of seedling emergence was recorded. Ten seedlings were maintained in each pot and 20 seedlings of each species in 4 groups of 5 were excavated every month. The root was washed thoroughly and length of root and shoot was measured. Seedlings were separated into root, shoot, needle/leaf and oven dried at 60 ± 5°C for 48 h. The increases in seasonal dry weight, length and relative growth rate (RGR) on dry weight basis of seedling and seedling parts were calculated and standard deviation computed.

## 3. Results

Seedlings emerged in *P. kesiya* and *S. khasiana* between 20–40 and 12–25 days, respectively, after sowing under open field conditions (table 1). The root and shoot elongations were more pronounced in *P. kesiya* as compared to *S. khasiana* at the time of seedling emergence. However, a reverse picture was obtained after a year of growth. On the other hand, root growth was significantly higher in *P. kesiya* after a year of growth. During the study of seasonal variation of climate, a better dry weight production of seedling and its parts in both the species (except for root) was observed in monsoon (table 2). The root dry weight was maximum during summer. As given in figure 2, *P. kesiya* seedlings showed maximum shoot elongation during July and August (mean temperature 23·5/17·5°C and RH 85–90%; average rainfall 400–

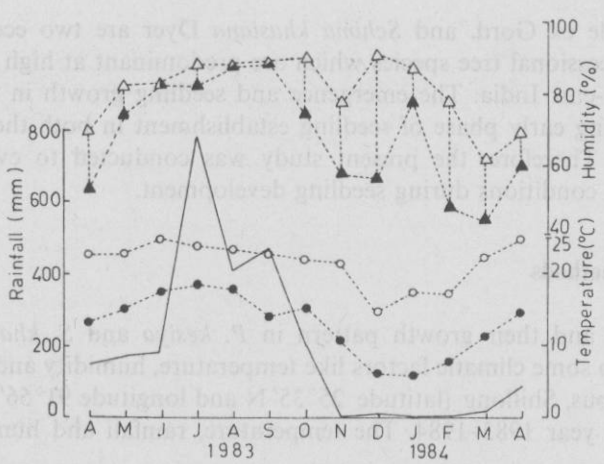


**Figure 1.** Climatic data of the study site (Shillong). Maximum temperature (○), minimum temperature (●), rainfall (———) and relative humidity (△, morning, ▲, evening).

**Table 1.** Emergence and growth of seedlings of *P. kesiya* and *S. khasiana* in field conditions.

| | Growth (cm or cm²)/seedling part | | | | | |
|---|---|---|---|---|---|---|
| | After emergence | | | After one year | | |
| Species | Root | Shoot | Needle/leaf | Root | Shoot | Needle/leaf |
| *P. kesiya*† | 3·00 ± 0·10 | 4·35 ± 0·20 | 2·45 ± 2·02 | 32·80 ± 0·10 | 11·50 ± 0·10 | 3·60 ± 0·25 |
| *S. khasiana**†† | 2·10 ± 0·10 | 3·00 ± 0·05 | 0·70 ± 0·02 | 19·80 ± 0·01 | 15·50 ± 1·90 | 9·10 ± 1·55 |

Emergence period: days of initiation of germination, †20, ††12; days of final germination, †40, ††25.
*Leaf (cm²)
± SD

**Table 2.** Seasonal variations in yield of *P. kesiya* and *S. khasiana* seedlings during the course of one year.

| | Yield (dry wt in mg/seedling part) | | |
|---|---|---|---|
| | Seasons | | |
| Seedling part | Monsoon | Winter | Summer |
| *P. kesiya* | | | |
| Seedling | 371·50 ± 25·70 | 5·10 ± 0·50 | 103·40 ± 24·00 |
| Shoot | 317·90 ± 26·30 | – | 26·60 ± 3·80 |
| Root | 53·60 ± 0·60 | 37·60 ± 7·20 | 76·80 ± 4·90 |
| Needle | 1·60 ± 0·10 | – | 1·35 ± 1·20 |
| *S. khasiana* | | | |
| Seedling | 560·00 ± 16·40 | – | 503·00 ± 28·50 |
| Shoot | 465·60 ± 25·20 | – | 284·00 ± 12·60 |
| Root | 94·20 ± 11·60 | 102·80 ± 9·25 | 219·00 ± 21·00 |
| Leaf | 42·50 ± 0·70 | – | 13·10 ± 1·50 |

± SD
–, No increase in growth.

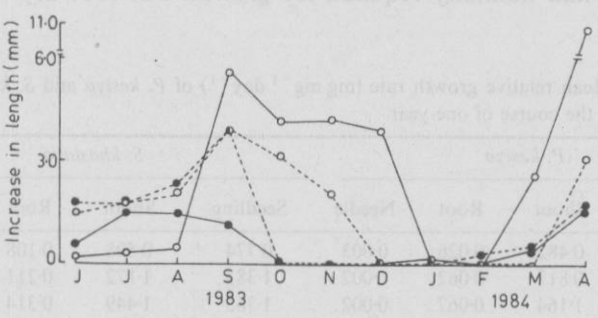


**Figure 2.** Increase in root (○) and shoot (●) elongations during the first year development of *S. khasiana* (– – –) and *P. kesiya* (——) seedlings.

800 mm, figure 1) which was almost negligible during winter (mean temperature 17·5/7·5°C and RH 60–85%; no rainfall). The maximum increase in root elongation in this species was recorded during September (mean temperature 22·5/14°C and RH 85–90%, average rainfall 450 mm) and was completely inhibited during

January–February (mean temperature 17·5/7·5°C and RH 65–80%; no rainfall). The maximum increase in shoot elongation of *S. khasiana* was recorded during September and thereafter it was markedly inhibited at the beginning of winter (figure 2). The recurrence of its growth was observed at the onset of summer. The root growth was also maximum in September and subsequently it declined gradually. It was inhibited completely from December–March and thereafter it resumed the growth. The peak periods of RGR in *P. kesiya* and *S. khasiana* seedlings were found in August–September (mean temperature 22·5/15°C and RH 80–90%; average rainfall 400–500 mm) and September–October (mean temperature 22·5/15°C and RH 80–90%; average rainfall 200–450 mm), respectively (table 3). The negative RGR were obtained in shoot of both the species during October–December (mean temperature 15/10°C and RH 60–85; rainfall 0–200 mm), in *P. kesiya* needles during October–February and *S. khasiana* leaf during October–January. The seedlings also showed negative RGR from October–December and November–December in *P. kesiya* and *S. khasiana*, respectively.

## 4. Discussion

The early seedling emergence in *S. khasiana* was recorded as compared to *P. kesiya*. The probable cause of early germination in the former is due to high permeability of the seed coat (Mayer and Poljakoff-Mayber 1982). Seed size (Silvertown 1981) and seed mass (Thomas 1966) have important ecological consequences in seedling vigour. During the present study of seedling emergence, the higher seed mass in *P. kesiya* when compared to that in *S. khasiana* may bear a direct correlation with seedling elongation. However, a reverse picture obtained for the two species after a year is due to difference in their genetic make up. Similar conclusions have been drawn with regard to seed weight and dry weight of one year old seedlings of 6 tree species grown in Mediterranean forest of western Australia (Abbott 1984). The maximum dry weight production of seedling and its above parts in both *P. kesiya* and *S. khasiana* during monsoon was directly related to optimum conditions of temperature, rainfall and humidity required for growth. But root dry weight was

**Table 3.** Mean relative growth rate (mg mg$^{-1}$ day$^{-1}$) of *P. kesiya* and *S. khasiana* seedlings during the course of one year.

| | *P. kesiya* | | | | *S. khasiana* | | | |
|---|---|---|---|---|---|---|---|---|
| Months | Seedling | Shoot | Root | Needle | Seedling | Shoot | Root | Leaf |
| M–J | 0·508 | 0·482 | 0·026 | 0·003 | 0·774 | 0·598 | 0·108 | 0·092 |
| J–J | 0·879 | 0·817 | 0·062 | 0·002 | 1·383 | 1·172 | 0·211 | 0·120 |
| J–A | 1·231 | 1·164 | 0·067 | 0·002 | 1·763 | 1·449 | 0·314 | 0·175 |
| A–S | 8·500 | 7·155 | 1·345 | 0·021 | 3·463 | 3·097 | 0·516 | 0·280 |
| S–O | 0·584 | 0·387 | 0·197 | 0·000 | 10·735 | 8·812 | 1·923 | 0·790 |
| O–N | −0·367 | −0·549 | 0·082 | −0·007 | 0·155 | −1·168 | 1·323 | −0·005 |
| N–D | −0·141 | −0·151 | 0·010 | −0·001 | −1·130 | −2·226 | 1·095 | −0·021 |
| D–J | 1·908 | 1·081 | 0·829 | −0·002 | 0·436 | 0·353 | 0·084 | −0·059 |
| J–F | 0·544 | 0·254 | 0·290 | −0·014 | 1·134 | 0·541 | 0·593 | 0·053 |
| F–M | 0·605 | 0·376 | 0·230 | 0·007 | 3·005 | 2·512 | 1·493 | 0·080 |
| M–A | 2·768 | 0·504 | 2·265 | 0·073 | 7·744 | 3·996 | 3·729 | 0·426 |

maximum during summer on account of higher development of roots needed for increased absorption (Mason *et al* 1970). Hence, it could be concluded that exponential growth of plants is time dependent and environmentally controlled (Ågren 1985).

The shoot elongation of *P. kesiya* and *S. khasiana* were maximum during July–August (temperature 23·5/17·5°C and RH 85–90%; rainfall 400–800 mm) and September (temperature 22·5/14°C and RH 85–90%; rainfall 450 mm), respectively. Both root and shoot were highly sensitive to low temperature (corresponding to 17·5/7·5°C of day and night) of winter. Besides, RGR revealed that August–September and September–October were optimum periods for the seedling growth in *P. kesiya* and *S. khasiana*, respectively. The negative RGR of the seedling and its above parts in both the species was due to needle and leaf fall during winter. The comparative study of increase in length and RGR of various parts exhibited that prevailing conditions in August (temperature 23·5/17·5°C, RH 85–90%; rainfall 400 mm) and September (temperature 22·5/14°C; RH 85–90; rainfall 450 mm) may be optimum for production of nursery transplants of *P. kesiya* and *S. khasiana*, respectively. The occurrence in field conditions of alternating temperatures of 23·5/17·5°C for *P. kesiya* and 22·5/14°C for *S. khasiana* resulted in higher growth under high humidity (Approx. 80–90%) and moderate rainfall (Approx. 400 mm) exhibiting the thermoperiodic behaviour of growth in both the species.

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