Short communication

Transplantation age of *Angelica glauca* Edgew. and *Heracleum candicans* Wall. seedlings: two threatened high value Himalayan medicinal herbs

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Abstract

A study was conducted on two high value threatened medicinal and aromatic herbs of Himalayan region, *viz*., *Angelica glauca* Edgew. and *Heracleum candicans* Wall. to determine the optimal age of seedlings for field transplantation along an altitudinal gradient. Thirty, 60, 90, and 120 days old seedlings were transplanted at Shat and Silha sites in Parbati Valley, Kullu district, Himachal Pradesh, India (1800 and 2200 m altitude respectively). Results showed that 90 and 120 days old seedlings of both species had significantly (p<0.005) higher survival compared to younger seedlings. Furthermore, survival in both the species was significantly (p<0.05) higher at Silha (high altitude) and mortality especially for *A. glauca* was very high at Shat (low altitude), implying a narrow range of adaptability for this species. Transplanting 90 to 120 days old seedlings above 2200 m altitude is recommended to achieve optimum survival rates.

Keywords: Altitudinal gradient, Conservation, Medicinal plants, Seedling age.

Angelica glauca Edgew., locally known as *chora* and *Heracleum candicans* Wall. (*patrala*) of the family Apiaceae are two medicinally important Himalayan herbs. Over-harvesting, however, has threatened their natural populations. Consequently, *A. glauca* in Northwest Himalayas has been described as critically endangered and *H. candicans* as an endangered species (IUCN, 1993). Domestication of these species in the managed ecosystems is recommended for meeting the rising demand from pharmaceutical industries. Erratic seed germination and slow growth rates, which result in heterogeneous stand growth (Butola, 2009), however, are major constraints. Transplanting seedlings is recommended in such circumstances, the success of which, however, may be dependent on the micro-environmental factors. Moreover, high altitude medicinal plants are habitat-specific and generally have narrow ecological amplitudes (Butola and Malik, 2009). Seedling age is a major determinant of transplantation success; however, the optimal age of transplantation has not been standardized for these species. Keeping these in view, an experiment was conducted to determine the optimal age of *A. glauca* and *H. candicans* seedlings for field transplantation in two distinct altitudinal zones of northwestern Himalayas.

The study was carried out in Shat and Silha located at 1800 and 2200 m altitude in Parbati Valley, Kullu district (Fig. 1), Himachal Pradesh, India (31°25' to 32°35' N and 76°9' to 77°9' E) from 2 March 2005 to 6 October 2005. During the study period, the average monthly temperatures at Silha ranged from 1.2 to 16°C and relative humidity from 22.2 to 82.16%. The average temperature at Shat ranged from 5 to 35°C and relative humidity from 35.5 to 90%. The area experienced 11.2±7.0 mm rainfall in November and 194.4±14 mm in July. The physico-chemical properties of the cultivation sites are given in Table 1.

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Table 1. Soil physico-chemical properties along an altitudinal gradient in Parbati Valley, Kullu district, Himachal Pradesh, India.

Parameter	Study locations	
	Shat	Silha
Altitude (m)	1800	2200
Moisture (%)	20.49 (6.85)	24.33 (4.05)
Bulk density ($mg \cdot cm^{-3}$)	0.71 (0.05)	0.94 (0.06)
Water holding capacity (%)	57.0 (6.24)	64.67(3.06)
pH	7.15 (0.16)	7.21 (0.22)
Electrical conductivity ($\mu S \cdot cm^{-1}$)	129.1 (41.96)	113.3 (31.57)
Total dissolved solids (ppm)	64.64 (21.0)	56.81 (15.8)
C (%)	1.87 (0.71)	1.61 (0.96)
N (%)	0.226 (0.104)	0.268 (0.085)
C:N ratio	12.51 (7.51)	6.43 (4.33)

Values in parentheses are standard deviations; source: Butola (2009).

Experimental plots, 0.02 ha in extent and 15–20° slope were selected at both locations. After ploughing and digging upto 20 cm depth, the clay lumps were crushed and stones removed. Along the slope, the plots were divided into 1 x 3 m vertical beds (15 cm high), separated by 40 cm wide gullies. Farmyard manure at the rate of 2 $kg \cdot m^{-2}$ (6 kg/bed, ~ 20 $tonne \cdot ha^{-1}$) was applied. Seedlings of *A. glauca* and *H. candicans* (30, 60, 90 and 120 days-old) obtained from a local nursery (1200 m altitude) were transplanted. Twenty seven seedlings from each age group and species (in triplicate) were used. The beds were arranged in a randomized block design maintaining three beds for each age group. Proper tilling, watering and weeding were done from time-to-time and small drains made on the beds to prevent water logging. Seedling survival was monitored for 60 days (15 days interval) and survival (%) was calculated (Number of seedlings survived/Number of seedlings planted in the bed x 100). Two-way ANOVA and Fisher's least significant differences ($p<0.05$) were used for mean separation (Snedecor and Cochran, 1967).

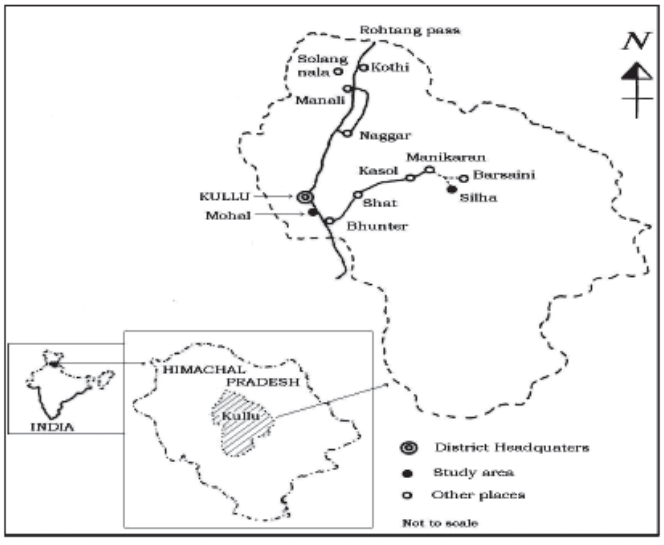

Figure 1. Map of study area (Shat and Silha, Parbati Valley, Kullu district, Himachal Pradesh, India located at 1800 and 2200 m respectively).

At Silha, 90 day old seedlings of *A. glauca* (73%; Fig. 2) and 120 day old *H. candicans* seedlings (51.11%; Fig. 3) had significantly ($p<0.05$) higher survival rates than 30 and 60 days old seedlings. Older seedlings in general showed better survival presumably because of their ability to cope with environmental stresses. Acclimatization along an altitudinal gradient is also dependent on morpho-physiological and biochemical adaptability (Rajasekaran et al., 1998). In the present study, seedlings of all age groups in both species showed

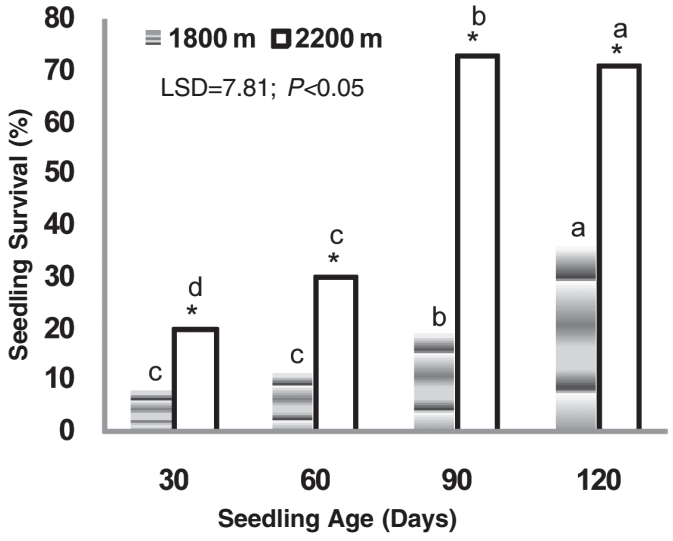

Figure 2. Seedling survival of *Angelica glauca* as influenced by seedling age and an altitudinal gradient (two sites Shat and Silha, Parbati Valley, Kullu district, Himachal Pradesh, India located at 1800 and 2200 m respectively). * Altitude effect was significant; Means marked by different letters are statistically significant.

significantly (p<0.05) higher survival at Silha (2200 m) compared to Shat located at 1800 m altitude (Figs 2 and 3). In particular, mortality of *A. glauca* seedlings was very high at the low altitude, indicating its narrow range of adaptability. This is consistent with the observations of Butola and Malik (2009). They reported significantly better survival and growth of plants of *A. glauca* and *H. candicans* at 2200 m, compared to 1800, 1600, and 1170 m, implying the possibilities for cultivating these species at altitudes >2000 m. The present study also recommends transplanting 90 to 120 days old seedlings at or above 2200 m altitude to achieve optimum survival rates, which may aid the cultivation and thus, conservation of *A. glauca* and *H. candicans* in the Himalayas.

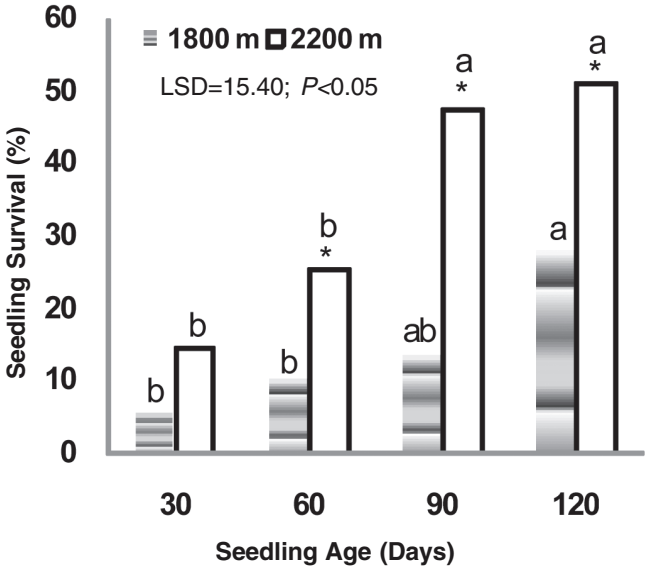

Figure 3. Seedling survival of *Heracleum candicans* as influenced by seedling age and an altitudinal gradient (two sites Shat and Silha, Parbati Valley, Kullu district, Himachal Pradesh, India located at 1800 and 2200 m respectively). * Altitude effect was significant; Means marked by different letters are statistically significant.

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References

Butola, J.S. 2009. Propagation and field trials using conventional methods, of some threatened medicinal plant species of Himachal Pradesh. PhD Thesis submitted to Forest Research Institute University, Dehradun, India (unpub.).

Butola, J.S. and Malik, A.R. 2009. Survival and phenophases of some Himalayan medicinal plants cultivated at different altitudes: a case study of district Kullu, Himachal Pradesh, India. Int. J. For. Usu. Manage. (in press).

IUCN, 1993. Draft IUCN Red List Categories, Gland Switzerland.

Rajasekaran, C., Kuniyal, C.P., Prasad, P. and Bhadula, S.K. 1998. Growth and ammonium assimilation in *Selinum vaginatum* Clarke and *Glycine max* L., seedlings grown at different altitudes of Garhwal Himalaya. Indian Physiol. Mol. Biol. Plants, 4: 33–37.

Snedecor, G.W. and Cochran, W.G. 1967. *Statistical Methods*. Oxford and IBH Publishing, New Delhi, India, 593p.