Cultivation of Himalayan aconites under polyhouse conditions

According to Lambert *et al.*[1], India is one of the few countries that is capable of producing most of the important plants used both in modern and traditional systems of medicine due to the availability of wide variations in climate, soil, altitude, and latitude. However, a majority of the plants used by the drug industries, especially from high altitudes are harvested from the wild. This has led to the depletion of resources and extinction of some of the species. Collection from the wild also has problems like possibility of adulteration, incorrect identification and non-availability of material throughout the year. Aconites, belonging to family Rananculaceae, are among those species that are facing serious threats of extinction in the Himalayan region because the tubers of these species are collected extensively from nature and are used for extraction of alkaloids. Based on an estimate by the Ministry of Health, Jain[2] stated that the demand to supply ratio of *Aconitum heterophyllum* (an alpine to sub-alpine species) was 10 : 1 in 1986. In spite of a ban on its collection, about 10,720 kg fresh tubers of *A. heterophyllum* were collected from the wild in Sikkim alone during 1990–1992 (ref. 3). On an average, each plant of this species produces only 0.8 g dry weight of tubers[4]. The average density of these plants in nature is not more than 1.2 to 1.6 plants/m^2 area. This means that about 53 lakh plants were up-rooted in two years from Sikkim alone. The supply/demand ratio is so low in some of the high altitude plants that now pharmaceutical industries are willing to pursue cultivation of many of the important species provided economically viable methods are available for cultivation and multiplication of such species. It is being realized that for conserving such plants, cultivation is the only effective method. It will not only ensure continuity of supply but also provide a source of income. To relieve pressure on wild sources there is a need to study cultivation requirements and multiply seed sources. The results reported in this note are the outcome of an attempt in this direction.

Fifty fresh root tubers of *A. balfourii* and *A. heterophyllum* were planted at 1 ft distance in open fields and in the polyhouse in October 1997 at Tungnath (13,000 ft a.s.l.). These were harvested in September 1998. The size of the plants was gigantic under polyhouse conditions (Figure 1). All morphological characters and also fresh and dry weight of tubers from five plants was recorded. Dry samples of the tubers were used for chemical analysis. It was observed that under polyhouse conditions plants yield 11 and 8 times higher tuber yield in *A. heterophyllum* and *A. balfourii*, respectively when compared to that in nature (Table 1). The height as well as the number of leaves per plant were also higher under polyhouse conditions. One of the contributing factors for this overall increase in growth could be 5 to 6°C higher temperature under polyhouse. However, details of the mechanism are under investigation. The number of tubers produced by the plants is under genetic control[5] but in our study, we found five tubers per plant in *A. balfourii*. This shows that even this character can be manipulated under suitable environmental conditions.

Roots from both the conditions were collected and dried in the sun. These were powdered and extracted at 60°C with 70% ethanol. The extracts were evaporated in vacuum. The residues were shaken with hexane and the hexane extract was evaporated to get the residue. This was suspended in $CHCl_3$ and extracted several times with 2% H_2SO_4. The neutral fraction was collected in $CHCl_3$ layer. The acidic fraction was basified with pH 5 Na_2CO_3 and again extracted with $CHCl_3$ to get the crude alkaloidal fraction. This fraction was dried under reduced pressure and weighed for total alkaloids.

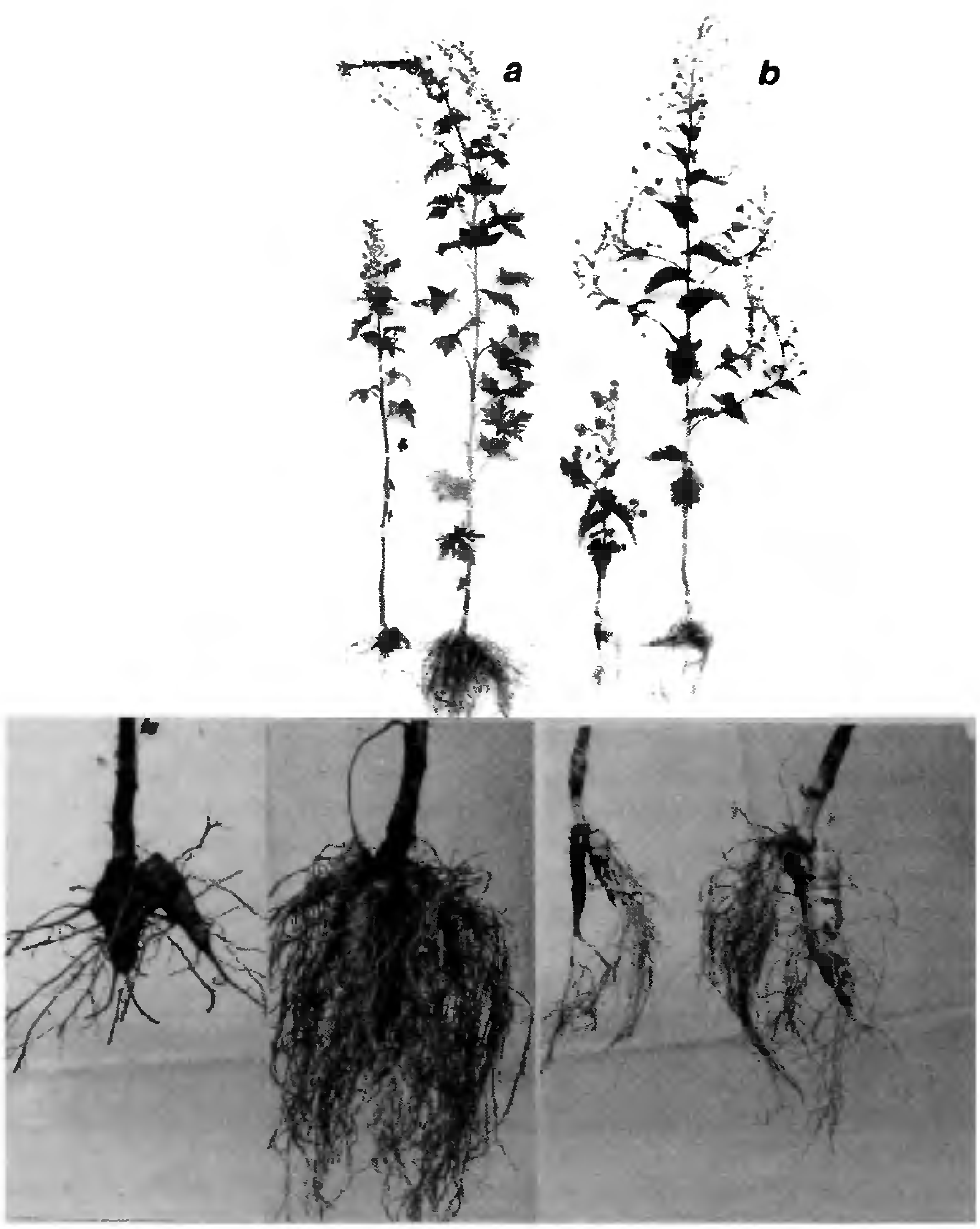

Figure 1. (Top) Nursery (left) and polyhouse (right) grown plants of *A. balfourii* (*a*) and *A. heterophyllum* (*b*). (Bottom) Root tubers under the respective conditions.

Table 1. Growth performance of two aconite species under two environmental conditions in alpine environments

Species	Parameters	Growth environment	
		Nature	Polyhouse
Aconitum heterophyllum	Plant height (cm)	40.80 ± 5.45	123.40 ± 21.77
	No. of leaves per plant	13.80 ± 2.17	19.60 ± 3.51
	No. of flowers per plant	17.00 ± 4.00	45.20 ± 17.05
	No. of new tubers per plant	1	1
	Av. length of tubers per plant	4.5	13.0
	Dry wt of tubers (g) per plant	1.10	12.10
	Per cent alkaloids (g per 100 g dry wt)	1.82	2.23
Aconitum balfourii	Plant height (cm)	120.20 ± 5.12	203.20 ± 32.03
	No. of leaves per plant	49.00 ± 3.39	58.80 ± 16.53
	No. of flowers per plant	64.00 ± 6.04	61.00 ± 28.33
	No. of new tubers per plant	1	5
	Av. length of tubers per plant	7.00	1.20
	Dry wt of tubers (g) per plant	8.76	69.00
	Per cent alkaloids (g per 100 g dry wt)	1.72	1.99

The alkaloidal fraction (0.01 mg) was dissolved in HPCL mobile phase (hexane : chloroform : methanol; 70 : 20 : 10) and filtered through 0.45 millipore filter. Normal phase silica-18 column (4.5 × 250 mm) with the same mobile phase at a flow rate of 1 ml/min was used to work out the retention behaviour of aconitine and atisine by injecting 20 μl samples. The standard alkaloids were detected λ_{max} 240 nm. Contents were calculated by the standard peak-area method. It can be seen that the quantity of aconitine as well as atisine was higher in plants grown under polyhouse conditions.

These results clearly indicate that the present market demand can be met by cultivating these species in polyhouses. The cost of cultivation would be around Rs 292,000 per acre and the production would be 8 to 11-fold higher than under open field conditions where the cost of cultivation would be about Rs 41,800 per acre. Keeping in view the present market rates, the net profit in polyhouse cultivation would be Rs 195,000 per acre and Rs 348,000 per acre in *A. balfourii* and *A. heterophyllum*, respectively. Whereas the cultivation in open fields would give a net profit of only Rs 20,300 and Rs 17,000 per acre in these plants. Cultivation following such methods will reduce the extraction of these plants from nature leading to their conservation in nature. Such a method of cultivation could be followed even in temperate conditions.

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M. C. NAUTIYAL
A. N. PUROHIT*

High Altitude Plant Physiology Research Centre,
H.N.B. Garhwal University,
Srinagar Garhwal 246 174, India
**For correspondence.*
(e-mail: happrc@nde.vsnl.net.in)

Antagonistic potential of N_2-fixing *Acetobacter diazotrophicus* against *Colletotrichum falcatum* Went., a causal organism of red-rot of sugarcane

Use of biological control agents present in nature has been widely studied for new eco-friendly approaches to control pests and pathogens. Application of beneficial bacteria as agents for biological control of plant diseases in agriculture is an emerging potential alternative to chemical fungicides. Some bacteria like *Enterobacter cloacae* protect the economically important plants against Pythium pre-emergence damping off caused by binding of *P. ultimum* to fungal hyphae[1].

Bacillus thuringiensis is reported to control many insects by producing different chemical compounds[2]. *Pseudomonas putida* reduced sheath blight incidence by 18% in comparison with infected control[3]. Evidences for mechanisms of biological control of pathogens can be exemplified by many factors that include competition, production of antibiotics, siderophores, etc. Endophytic pseudomonads surviving in different host plants hold the potential for the suppression of rice diseases[4,5].

Sugarcane crop is prone to diseases when climatic shifts are rapid. The oldest