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Original article

Integrated approaches for identification of promising populations of *Valeriana jatamansi* in West Himalaya

Arun Kumar Jugran, Indra Dutt Bhatt*, Ranbeer Singh Rawal

G.B. Pant Institute of Himalayan Environment and Development, Kosi-Katarmal, Almora, Uttarakhand, India

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A B S T R A C T

Biodiversity conservation and management is a global issue of concern for biologists keeping in view the rapid rate of degradation. The present study focuses on *Valeriana jatamansi*, a medicinally important herb used in traditional and modern medicines. The raw material of the species is collected from the wild, which puts pressure on its natural habitat; hence, data on diversity attributes including morphological, phytochemical, antioxidant activity, and genetic diversity of *V. jatamansi* are analyzed to identify promising sources and to develop conservation and management strategies for target species. Neighbor joining cluster and principal component analysis was used to identify elites based on all these attributes. Based on neighbor joining cluster and principal component analysis two populations, Dunagiri and Tharali, were identified as elites and promising sources for raw material collection and conservation purposes. However, individually, each attribute prioritizes different populations. The approach of the present study can be further utilized for developing conservation planning and management of different medicinal plants of the region. This will also promote the interest of researchers in future studies and will aid in collecting plant material from a choice of population.

Introduction

Setting priorities for conservation and utilization of threatened plants is a major concern of researchers. The conservation efforts often require balance between human needs and available resources, which may at times create a direct conflict with conservation (Vucetich et al 2013). This conflict has become more severe in cases of plant species of commercial importance. In this context, prioritization of the populations/individual is considered one of the best options for future conservation and utilization of a species (Allendorf et al 2010). In cases of medicinal plants, investigations on habitat protection, possibility of dispersal, and evolution via gene flow with naturally selected surrounding populations is considered the best method for preserving vulnerable populations at particular habitats/ecosystems where selection holds special importance. Conserving the habitat of a species is considered to conserve all the morphological, genetic, and phytochemical attributes; thus, ensuring the long-term conservation of the species. Studies recommend conservation of biological diversity at three levels: genes, species, and ecosystem (McNeely et al 1990) and all have their own significance. For instance, conserving biological diversity at ecosystem level is best because the losses of habitat and ecological processes have immediate impacts on species survival. However, it is not possible to conserve all habitats and ecosystems. Therefore, prioritization of representative habitats/populations is an alternative to conserve maximum diversity in an ecosystem, which will ultimately conserve the diversity of a species. Moreover, conservation at species level is an alternative method to conserve the population of choice, which has some direct ecological and economic significance. This is rather easy as it involves less complexity than the ecosystem level. It is more important in the Himalayan perspective where variation in environmental conditions is prevalent. Conservation of a species based on a combination of personal experience, ecological understanding, and political expediency are being used for setting priorities; however, these are not applicable for all species. In addition, conclusions drawn on the basis of a few selected attributes do not provide full mechanistic insights of a species for conservation and management. Therefore, analysis and assemblage of multiple attributes in respect to different dimensions is a prerequisite for the conservation planning of a species (Oliver et al 2004). The present study focuses on

* Corresponding author. Tel.: +91 5962 241041; fax: +91 5962 241014.
E-mail addresses: idbhatt@gbpihed.nic.in, id_bhatt@yahoo.com (I.D. Bhatt).
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Table 1. Site characteristics and accession number of selected populations of *Valeriana jatamansi.*

S. no.	Population	Altitude (m asl)	Latitude (N°)	Longitude (E°)	Habitat	Accession number
1	Daulaghat (DAG)	1215	29° 46′ 00″	80° 18′ 00″	Grassy	113261
2	Katarmal (KAT)	1250	29° 38′ 25″	79° 37′ 20″	Oak	BSD-112793
3	Tharali (THA)	1330	30° 04′ 06″	79° 30′ 08″	Oak	113206
4	Dolti (DOL)	1626	30° 02′ 56″	79° 29′ 50″	Oak	GBPI-3201-2
5	Berinag (BER)	1672	29° 43′17″	80° 02′ 14″	Pine	113257
6	Majkhali (MAJ)	1702	29° 40′ 20″	79° 31′ 47″	Pine	113209
7	Talwari (TAL)	1785	30° 01′ 46″	79° 30′ 59″	Oak	113205
8	Khirshu (KHR)	1810	29° 51′ 17″	79° 35′ 46″	Oak	113212
9	Didihat (DID)	1850	29° 46′16″	80° 17′ 59″	Oak	113253
10	Pithoragarh (PIT)	1872	29° 36′ 14″	80° 11′ 40″	Pine	113214
11	Sitlakhet (SIT)	1900	29° 35′40″	79° 32′ 42″	Pine	GBPI-3201-1
12	Gwaldam (GWL)	1923	30° 00′ 24″	79° 33′ 30″	Oak	113213
13	Kausani (KAU)	1925	29° 47′ 51″	79° 26′ 12″	Grassy	113210
14	Ukhimath (UKH)	1985	30° 31′ 00″	80° 05′ 00″	Pine	113258
15	Camel back (CMB)	2000	30° 27′ 43″	78° 04′ 26″	Grassy	113200
16	Jaberkhet (JAB)	2080	30° 27′ 18″	78° 06′ 50″	Grassy	113260
17	Joshimath (JHM)	2100	29°47′ 37″	79° 27′ 38″	Mixed	113211
18	Dunagiri (DNG)	2125	29° 47′ 37″	79 27′ 40″	Grassy	113254
19	Buranskhanda (BRK)	2150	30° 27′ 22″	78° 05′ 59″	Oak	113207
20	Nainital (NNT)	2176	29° 23′ 34″	79° 27′ 45″	Mix	113208
21	Makku band (MKB)	2240	30° 34′ 0.0″	79° 13′ 00″	Grassy	113262
22	Munsyari (MUN)	2240	30° 03′ 39″	80° 14′ 36″	Mixed	113202
23	Malyadaur (MLD)	2350	30° 08′ 16″	79° 57′ 56″	Mix	113255
24	Dwali (DWL)	2730	30° 10′ 38″	79° 59′ 46″	Mix	113204
25	Surkanda (SRK)	2775	30° 24′ 21″	78° 17′ 21″	Mixed	113259

asl, above sea level; S., species.

Valeriana jatamansi Jones (common name "Tagar" or "Indian valerian"; family Valerianaceae), one of the most important medicinal plants of the Himalayan region. This species remains a subject of interest due to its uses in traditional and modern medicine, variability in morphology, reproductive behavior, essential oil content, and antioxidant properties. The species is dioecious, perennial, polygamous, or occasionally polygamo monocious (Prakash 1999) and grows wild in the temperate Himalayan region between 1000 m above sea level (asl) and 3000 m asl. The species is used in the treatment of various ailments and comprises over 150 chemical compounds (Jugran 2013). *V. jatamansi* is used as a substitute of *Valeriana officinalis*, a member of same family of European origin (Singh et al 2010). Although the species is widely distributed, at a regional scale the species is vulnerable due to overexploitation and habitat destruction (CAMP 2003; Jugran et al 2013a; Jugran et al 2013b). Therefore, there is an urgent need to investigate the species at different dimensions for setting priorities for conservation and utilization. The present study is an attempt to: (1) assess the relationship among morphological, phytochemical, and genetic attributes in different populations; and (2) develop an approach for prioritizing the promising populations based on these attributes. The result of the present study will thus be helpful in developing suitable strategies for conservation and management of *V. jatamansi*.

Materials and methods

V. jatamansi (family Valerinaceae) was collected from 25 different populations of Uttarakhand within an altitudinal range from 1000 m asl to 3000 m asl (Table 1; Figure 1). Different morphological and genetic attributes were analyzed across populations of *V. jatamansi* (Jugran et al 2013b; Jugran et al 2015). A total of 125 plants (5 plants/population) from 25 distant populations of *V. jatamansi* were subjected to detailed morphological analysis and various morphological attributes like leaf number, leaf area, plant height, above ground fresh weight (AGFW), below ground fresh weight (BGFW), above ground dry weight (AGDW), below ground dry weight (BGDW), rhizome length (RL), and rhizome diameter (RD) were evaluated. Similarly, DNA was isolated from 151 genotypes belonging to 25 distant populations of *V. jatamansi* and polymerase chain reaction amplification was performed using 20 different inter simple sequence repeat primers. For phytochemical analysis plant material was collected from all 25 populations, washed thoroughly with tap water followed by washing with distilled water, and divided into two portions namely, aerial and root portion. Phytochemical (valerenic acid, total phenolics, flavonoids, and tannins) and antioxidant activity of all populations were investigated across the populations (Jugran 2013). Data drawn from different attributes (morphological, phytochemical, and genetic) were used for detailed analysis and prioritization of populations.

Identification of promising sources/populations with higher morphological, phytochemical, and genetic attributes was performed using different sets of statistical procedures. Neighbor joining cluster analysis was performed using Paleontological Statistics Software Package for Education and Data Analysis packages, USA (Hammer et al 2001) for clustering of *V. jatamansi* populations based on all studied attributes. Neighbor joining clustering is considered an alternative method for hierarchical clustering analysis (Saitou and Nei 1987) for small data sets (Jianfu et al 2011). The data were further subjected for principal component analysis (PCA) to identify the major population groups with higher ranking of each attributes using SPSS version 16 (SPSS Inc. 1989–1996, Chicago, IL, USA).

Results

Data pertaining to different morphological (leaf number, leaf area, plant height, AGFW, BGFW, AGDW, BGDW, RL, and RD), phytochemical (total phenolics, flavonoids, tannins, valerenic acid, and antioxidant activity), and molecular attributes (Nei's genetic diversity and %polymorphism) recorded among targeted populations revealed wide variations among the populations (Jugran et al 2013a; Jugran et al 2015). Different populations behave differently for each attribute. For example, in the morphological