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Full Length Research Paper

Analysis of variabilities in populations of *Nardostachys jatamansi* DC. in Garhwal Himalaya, India

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***Nardostachys jatamansi* DC. is an endangered medicinal and aromatic plant species. Considering the status and importance, there is an urgent need of its conservation, cultivation and crop improvement. Variability studies may serve as an important tool for effective conservation and crop improvement program. Therefore, germplasm was collected from different natural population and transplanted in Tungnath. Different morphometric traits along with essential oil content (%) were used for variability analysis. Cluster 3 (accession NJ5 and NJ6) showed best performance among most of the studied characters. Therefore, germplasm should be collected from Tungnath and the Valley of flowers population for large scale cultivation.**

Key words: Cluster composition, D^2 statistics, endangered, environmental regime, variabilities.

INTRODUCTION

Nardostachys jatamansi DC. is a small, perennial, dwarf, hairy, rhizomatous, herbaceous, endangered and most primitive species within family Valerianaceae (Tribe-Patrinaeae). The species has very long history of use as medicine in Ayurveda, Homeopathy, ethno medicine and Indian System of Medicine (ISM) to modern medicine industry which is distributed in the Himalayas from Pakistan, India (Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim) to Nepal, Tibet and China between 3300 to 5000 m asl. It has been reported that the species has become critically endangered depending on habitats (Nayar and Sastry, 1988; Airi et al., 2000; Nautiyal et al., 2003), due to over-exploitation of rhizomes for medicinal use, habitat degradation and other biotic interferences. Hence emphasis was given on its conservation and multiplication by earlier workers (Airi et al., 2000; Chauhan and Nautiyal, 2005; Ghimiri et al., 2005; Ghimire et al., 2008; Chauhan et al., 2008).

Effective conservation, management and recovery of rare and endangered species can be deliberated through variability analysis. A single plant species generally consist of genetically differentiated populations that are outcomes of the interactions among natural selection, gene flow and genetic drift (Suichi, 2003). Variations in phenotypic attributes become important to the biologist solely because they indicate the presence or absence of physiological attributes that are of ecological significance (Daubenmire, 1967). Natural selection plays important role in structuring the observed patterns of variation than other factors (Ian et al., 2009). Cluster analysis can be used as useful tools for screening of such populations (Karami et al., 2009).

According to published literature an adequate information are available on distribution pattern of *N. Jatamansi* (Airi et al., 2000; Nautiyal et al., 2003; Ghimire et al., 2008), medicinal properties (Anonymous, 1966; Ved and Goraya, 2008), chemical composition (Mahalwal and Ali, 2002) and biological activities (Takaya et al., 2000), but there is a complete lacking on the nature of variabilities. In view of aforementioned, present paper reveals variabilities analysis and selection studies on *N. jatamansi*. Such studies will be helpful for effective conservation management and genetic improvement of *N. jatamansi*.

MATERIALS AND METHODS

Sampling and experimental design

Garhwal Himalaya (between 29°31'9" to 31°26'5" N Latitude and

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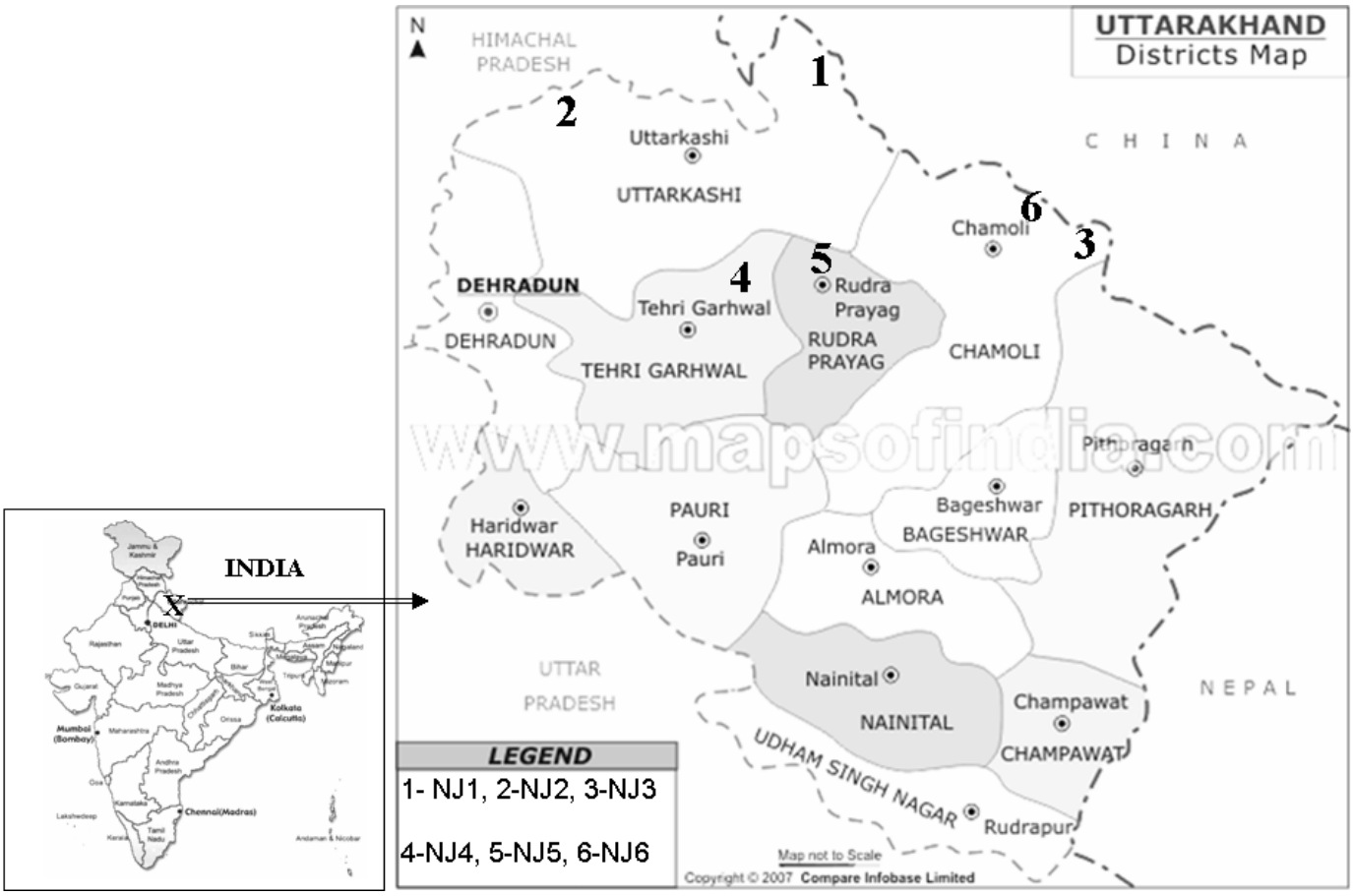

Figure 1. Location map showing natural populations of *N. jatamansi* used for germplasm collection.

77°33'5" to 80°6' E Longitude Figure 1) known for occurrence of *N. jatamansi* was surveyed and germplasm (rhizomes) were collected from different sites (Table 1). To evaluate variability, twenty accessions were collected from each population and transplanted vegetatively under *ex situ* condition (near close proximity to natural habitat) in Tungnath (3600 m asl, between 30° 14' N Latitude and 79°13' E Longitude Uttarakhand, India). Morphological data of 20 accessions were pooled and shown as a single accession for different collection sites. Triplicate replication method was used and normal cultural practices that is, weeding, irrigation, etc. were performed whenever it was felt necessary.

Data collection

Data were recorded on fourth year of plantation on 10 competitive plants in each plot (three replicate) for morphometric traits (for example, plant height, number of leaves, number of branches (ramet)/plant, number of flower per ramet, number of seeds per ramet, root length (cm), root diameter (cm) above ground biomass, belowground biomass) and essential oil content (%).

Analysis

The data were subjected to the analysis of variance (ANOVA) and significant variations were taken for multivariate analysis of D^2 statistics (Mahalanribis, 1936; Rao, 1952). The analysis was done using indostat statistical package and the cluster formation was confirmed by Tocher method (Rao, 1952). The relative contributions of each character towards genetic divergence were also worked out. Finally selection of better accession was made on the basis of growth performance and essential oil content.

RESULTS

The mean growth performance (in similar environmental regime) of different quantitative characters in Tungnath (3600 msl) is presented in Table 2. Seven characters out of ten, showing significant difference were used for present analysis. ANOVA test revealed significant variability among the studied accession. The variability range was between 20 to 28 cm in plant height, 29 to 38 in flower per ramet, 25 to 34 in seed per ramet and 2 to 3 g/plant in underground biomass. Essential oil content also varied between 0.83 to 1.22% on dry weight basis (Table 2). Accession NJ5 showed best performance in most of the quantitative characters that is, number of leaves, number of flowers, number of seeds, above ground biomass, below ground biomass and essential oil content. Accession NJ6 also showed good performance in term of plant height, above ground biomass, below

Table 1. Details of the original population selected for germplasm collection of *N. jatamansi.*

Accession No.	Original location	Altitude	Latitude	Longitude
NJ1	Dayara	3400	30°50' N	78°33' E
NJ2	Hari Ki Dun	3500	31°06' N	78°18' E
NJ3	Kunwari Pass	3500	-	-
NJ4	Panwali Kantha	3300	30°37' N	78°55'E
NJ5	Tungnath	3600	30°14' N	79°62' E
NJ6	The valley of flowers	3500	30°10' N	79°70' E

- Data not available.

Table 2. Mean growth performance in different accession of *N. jatamansi* (3600 m).

Accession No.	Plant height (cm)	Leaf nos.	Flowers/ ramet	Seed/ ramet	Aerial biomass (g/plant)	Underground biomass (g/plant)	Essential oil content (%)
NJ1	20.95	12.03	29.71	26.40	2.13	2.53	0.83
NJ2	20.29	13.13	31.67	25.6	1.33	2.60	0.93
NJ3	24.27	12.48	31.67	26.3	2.0	3.0	0.90
NJ4	25.08	12.40	37.0	31.17	1.4	2.47	1.03
NJ5	26.59	13.17	38.94	34.40	2.07	3.23	1.22
NJ6	28.96	12.40	32.40	28.47	2.03	3.13	1.15
Mean	24.36	12.60	33.56	28.72	1.83	2.83	1.01
SD	3.31	0.45	3.58	3.44	0.33	0.36	0.15
Range	20.29-28.96	12.03-13.17	29.71-38.94	25.60-34.40	1.33-2.13	2.47-3.23	0.83-1.15
CD 5%	5.58	1.72	4.05	4.83	0.87	0.92	0.21

ground biomass and essential oil content, whereas, four other accessions (that is, NJ1, NJ2, NJ3 and NJ4) performed poorly in most of the quantitative characters.

These variations among individuals are based on environmental and genetic effect as suggested by Toucher method (Rao, 1952). In view of considerable amount of variability among accessions, D^2 values were compared for all possible pairs of accession/populations. Based on D^2 values these accessions could be grouped into three clusters (Figure 2). The higher contribution of characters regarding variability was underground biomass (60.0%), aboveground biomass (26.67%) and flowers per ramet (13.33%), whereas other quantitative characters showed little share. Mean growth performance of these three clusters is presented in Table 3. Cluster three contain both the important accession NJ5 and NJ6 (that is, Tungnath and The Valley of flowers population) performed better among all the studied accession. The average intra-cluster distance ranged from 0.0 to 4.72 whereas the inter-cluster distance ranged from 3.84 to 12.24 (Table 4).

DISCUSSION

Cluster pattern reveals that accession originating from different populations may be closer or distant from one another that is, does not show direct effect of latitude or distance on clustering. The

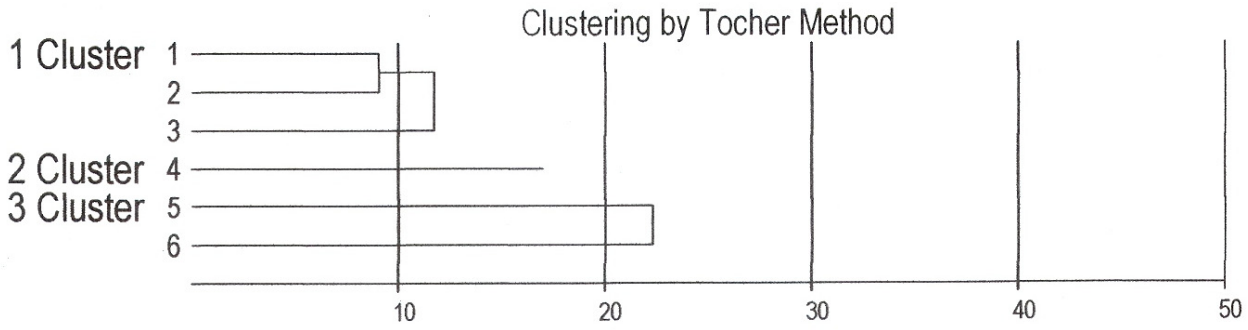

Figure 2. Distance among different accession of *N. jatamansi* by Clustering method.

Table 3. Cluster mean for six accession of *N. jatamansi.*

Cluster No.	No. of accession	Plant height (cm)	Number of leaves	Flowers/ ramet	Seed/ ramet	Aerial biomass (g/plant)	Underground biomass (g/plant)	Essential oil content (%)
1	3	21.84	12.55	31.01	26.43	1.82	2.71	0.89
2	1	25.08	12.40	37.0	31.17	1.40	2.47	1.03
3	2	27.66	12.78	35.67	31.43	2.05	3.18	1.18

Table 4. Intra and Inter cluster divergence (D^2) among three cluster of *N. jatamansi.*

Cluster	1	2	3
1	3.84	6.16	12.24
2	-	0.00	7.68
3	-	-	4.72

pattern of distribution of these entries in various cluster shows considerable amount of genetic divergence among these accession for phenotypic and essential oil characters. Inter-cluster distances was maximum in cluster 1 and cluster 3 suggesting that the accession included here are more diverse. Thus, the accession NJ1, NJ2, NJ3 and NJ4 may be useful in varietal improvement program. It may be concluded that these populations developed independently after distribution of species from originating center. Such differential grouping indicates the factors other than geographical distributions are responsible for genetic divergence. *Hippophae rhamnoides* has been categorized in nine subspecies on the basis of such morphological variability (Cao, 1999). Same type of relation were also reported earlier for *Hypericum* spp. (Radusiene and Bagdonaite, 2002), *Withania somnifera* (Kumar et al., 2007), *Pistacia* sp. (Karimi et al., 2009). Tendency to form such types of clustering irrespective of geographical boundaries showed that the regional isolation was not the only factor contributing to diversity in natural populations. The clustering pattern was also confirmed by the canonical root analysis, showed distant relationship among selected

accession. On the basis of quantitative traits, data generated in this study, it is suggested that number of leaves, flowers and seed are closely related to plant biomass and essential oil content. Heterogeneity observed in these accessions is probably attributed to the genotypic variability within and between the individual groups. Variabilities existing in this study open a new area for conservation and genetic improvement in *N. jatamansi*. On the basis of such multifaceted information on specific species, future conservation strategies can be initiated (Airi et al., 2000).

Conclusions

It can be concluded that heterogenecity observed among studied accessions is probably due to the genotypic variability. The germplasm collection should be made from cluster 3 (that is, Tungnath and The Valley of flowers population) for large scale cultivation. Other accession used in this study may be utilized for hybridization experiments for development of improved varieties. Further investigation on the volatile composition of different germplasm source growing under identical environmental regime is recommended.

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