



Plant Diversity Status in the Alpine Pasture of Shikari Devi, District Mandi, Himachal Pradesh

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Abstract: Assessment of seasonal variation in the plant diversity of Shikari Devi alpine pasture provide basis for devising suitable strategies for management and conservation of the plant resources. The present study was conducted to understand the plant diversity of Shikari Devi alpine pasture, District Mandi, Himachal Pradesh during the year 2017 between 3100-3350 m elevation ranges. The study was carried out on seasonal basis. The study was carried out in summer season in May and winter season in November. A total of 62 plant species belonging to 30 families and 47 genera were recorded in summer season and a total of 18 plant species belonging to 9 families and 16 genera were recorded in winter season from the study area. Dominant families were Rosaceae, Asteraceae, Polygonaceae, Boraginaceae, Lamiaceae and Poaceae. Out of the 62 plant species recorded from the study area, 52 were medicinal plant species and four species viz., *Bergenia stracheyi*, *Fritillaria roylei*, *Polygonatum verticillatum* and *Roscoea alpina* were fall in the category of threatened plants.

Key words: Alpine, Dominant family, Growth form, Threatened plant.

Himalayas are known to be one of the most diverse vegetation centre of the world. The intrinsic diversity and fragility of Himalayan ecosystem has brought this mountain as being the most significant in the world. The alpine region of Western Himalaya is well known for its floral diversity and fascinating phytogeography. The Western Himalayan alpine are among the most diverse ecological locations having diverse vegetation and provide a wide range of ecosystem services. Himachal Pradesh, a north Indian state, is located in western part of the Himalayan range. North-west Himalayas are the important floristic region in India. The important alpine regions in Himachal Pradesh are the Dhauladhar and Pir Panjal ranges (Santvan, 1993). The pastures in the alpine zone occupy about 1.52% of the total land area in the country and are chiefly concentrated in the Himalayan states of Arunachal Pradesh, Sikkim, Uttarakhand, Himachal Pradesh and Union Territory of Jammu and Kashmir (Verma and Chauhan, 2022). The Himalayan land in India is enclosed by alpine pastures usually found at an altitude above 2400 m and where climate is not congenial for growth of trees. Shikari Devi alpine pasture situated in the Shikari Devi wildlife sanctuary which is situated in Mandi district of Himachal Pradesh. Shikari Devi wildlife

sanctuary was notified in 1962 and re-notified in 1974. Altitude of this wildlife sanctuary varies from 1800 m to 3350 m above msl whereas the climate ranges from temperate to alpine and covers an area of about 3,065 ha. The sanctuary represents the flora of temperate to alpine climate. The region is surrounded by River Beas and Tirthan khad from north, Sunder Nagar tehsil from south, Banjar region of Kullu district from East and on the west by Balh Valley of Sunder Nagar tehsil. Due to heavy snowfall in winters, the place experiences extreme cold climatic conditions (Verma and Kapoor, 2019; Thakur *et al.*, 2020; Devi and Gupta, 2022). In Himachal Pradesh alpine pastures cover around 18.1% of the total geographical area of the state. These alpine pastures are locally known as Dhar in Himachal Pradesh. The flora of alpine region represents the total quantity of different types of plants. The floristic study involves periodic observations of the flora of a community for the whole year. Floristic study is a suitable measure to assess the species diversity in the various communities. Hence floristic study is the one of the major anatomical characters of the community. The alpine pastures are supposed to be the only true grasslands in India and where the grazing intensity is very high. Uncontrolled and unregulated grazing results in a loss of productivity and pasture degradation. A large number of pastures lands have been converted or are in the process of conversion to degraded lands due to lack of proper management practices. The present study was carried out to know the status of plant diversity of alpine pasture, which may provide key devising strategies and action plan for the management of biodiversity rich alpine pastures through generating baseline data for future changes in the pasture.

Materials and Methods

The study was conducted in alpine pasture of Shikari Devi, District Mandi, Himachal Pradesh during the year 2017. The study site lies at 31°28'45.50"N to 31°28'49.36"N latitude and 77°09'32.54" E to 77°10'02.18" E longitude and 3100-3350 m elevation range. An intensive survey was conducted to assess the seasonal fluctuation in the plant diversity and various growth form of Shikari Devi alpine pasture. The studies of plant diversity in this alpine pasture were done on seasonal basis. The study was carried out in summer season in May and

winter season in November. The different plant categories viz; grasses, sedges, leguminous and non-leguminous forbs were recognized and then species were assigned to various growth forms i.e. tall forbs (>30 cm height), short forbs (<30 cm height) and cushion & spreading forbs following Santvan (1993). Plant samples collected were identified at Botanical Survey of India, Dehradun, Himalyan Forest Research Institute, Shimla and Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan.

Results

During the summer season at Shikari Devi alpine pasture, total number of herb species was 62 belonging to 30 families and 47 genera. Out of which 2 species were grasses, 1 sedges, 2 leguminous and 57 species were non-leguminous forbs. The species present in the alpine pasture were analyzed for four different plant categories viz; grasses, sedges, leguminous and non-leguminous forbs. Tall forbs contributed 24.19% in the present alpine pasture flora. This category comprised of fifteen species of non-leguminous forbs. Short forbs contributed 61.29% to the present alpine pasture flora and comprised of thirty-five species of non-leguminous forbs, one species of sedges and two species of grasses. Grasses comprised in this category were *Poa alpina* and *Poa annua*. Cushion and spreading forbs comprised of herbaceous or rosette forming prostrate flora of the alpine pasture. It contributed 14.52% to the total alpine pasture flora. The species comprised of seven species of non-leguminous forbs and two species of leguminous forbs. The two species included in the leguminous forbs category were *Parochetus communis* and *Trifolium repens* (Table 1).

While in winter season, total number of herb species was 18 belonging to 9 families and 16 genera. Out of which 2 species were grasses, 1 sedges, 1 leguminous and 14 species were non-leguminous forbs. The species present in the alpine pasture were analyzed for four different plant categories viz., grasses, sedges, leguminous and non-leguminous forbs. Tall forbs contributed 22.22% in the present alpine pasture flora. This category comprised of four species of non-leguminous forbs. Short forbs contributed 61.11% to the present alpine pasture flora and comprised of eight species of non-leguminous forbs, one species of sedges

Table 1. Presence and absence of the species recorded at the Shikari Devi alpine pasture during the study period in Summer Season, 2017 and Winter Season, 2017

S. No.	Species	2017		Growth Form
		SS, 2017	WS, 2017	
	Grasses:			
1	<i>Eragrostis nigra</i> Nees ex Steud.	-	+	SF
2	<i>Poa alpina</i> L.	+	+	SF
3	<i>Poa annua</i> L.	+	-	SF
	Sedges:			
1	<i>Carex nivalis</i> Boott	-	+	SF
2	<i>Carex nubigena</i> D.Don ex Tilloch & Taylor	+	-	SF
	Leguminous Forb:			
1	<i>Parochetus communis</i> D.Don	+	-	CS
2	<i>Trifolium repens</i> L.	+	+	CS
	Non-Leguminous Forb:			
1	<i>Adiantum edgeworthii</i> Hook.	+	-	SF
2	<i>Ainsliaea latifolia</i> (D.Don) Sch.Bip.	+	-	SF
3	<i>Allium humile</i> Kunth	+	-	SF
4	<i>Anaphalis triplinervis</i> (Sims) Sims ex C.B.Clarke	+	+	SF
5	<i>Anemone obtusiloba</i> D.Don	+	-	SF
6	<i>Arisaema jacquemontii</i> Blume	+	-	SF
7	<i>Arisaema propinquum</i> Schott	+	-	TF
8	<i>Bergenia stracheyi</i> (Hook.f. & Thomson) Engl.	+	-	SF
9	<i>Cirsium falconeri</i> (Hook.f.) Petr.	+	+	TF
10	<i>Cirsium wallichii</i> DC	+	+	SF
11	<i>Corydalis govaniana</i> Wall	+	-	SF
12	<i>Cynoglossum microglochin</i> Benth.	+	-	TF
13	<i>Cynoglossum wallichii</i> G.Don	+	-	TF
14	<i>Cynoglossum zeylanicum</i> (Vahl) Brand	+	-	TF
15	<i>Elsholtzia strobilifera</i> (Benth.) Benth.	-	+	SF
16	<i>Euphorbia wallichii</i> Hook.f.	+	-	SF
17	<i>Fragaria vesca</i> L.	+	+	CS
18	<i>Fritillaria roylei</i> Hook.	+	-	SF
19	<i>Galium aparine</i> L.	+	-	CS
20	<i>Geranium wallichianum</i> D.Don ex Sweet	+	-	SF
21	<i>Geum elatum</i> Wall. ex G.Don	+	+	CS
22	<i>Gypsophila cerastoides</i> D.Don	+	-	SF
23	<i>Malva neglecta</i> Wallr.	+	+	SF
24	<i>Mazus surculosus</i> D. Don	+	-	CS
25	<i>Mentha longifolia</i> (L.) L.	+	-	SF
26	<i>Microula sikkimensis</i> (C.B. Clarke) Hemsl.	+	-	SF
27	<i>Origanum vulgare</i> L.	+	-	SF
28	<i>Parnassia nubicola</i> Wall. ex Royle	+	-	SF
29	<i>Pedicularis gracilis</i> Wall. ex Benth.	+	-	SF
30	<i>Persicaria amplexicaulis</i> (D.Don) Ronse Decr.	+	-	TF
31	<i>Persicaria wallichii</i> Greuter & Burdet	+	-	SF
32	<i>Phlomis bracteosa</i> Royle ex Benth.	-	+	SF
33	<i>Plantago depressa</i> Willd.	+	-	SF
34	<i>Polygonatum verticillatum</i> (L.) All.	+	-	SF
35	<i>Polygonum aviculare</i> L.	+	-	SF
36	<i>Potentilla argyrophylla</i> Wall. ex Lehm.	+	+	TF
37	<i>Potentilla atrosanguinea</i> G.Lodd. ex D.Don	+	-	TF
38	<i>Potentilla leschenaultiana</i> Ser.	+	-	SF

Table 1. Contd...

S. No.	Species	2017		Growth Form
		SS, 2017	WS, 2017	
39	<i>Potentilla lineata</i> Trevir.	+	-	SF
40	<i>Potentilla nepalensis</i> Hook.	+	-	TF
41	<i>Potentilla polyphylla</i> Wall. ex Lehm.	+	-	SF
42	<i>Primula denticulata</i> Sm.	+	-	SF
43	<i>Prunella vulgaris</i> L.	+	-	SF
44	<i>Ranunculus hirtellus</i> Royle	+	-	SF
45	<i>Rhodiola wallichiana</i> (Hook.) S.H. Fu	+	-	CS
46	<i>Roscoea alpina</i> Royle	+	-	SF
47	<i>Rosularia rosulata</i> (Edgew.) H. Ohba	+	-	CS
48	<i>Rumex acetosa</i> L.	+	-	TF
49	<i>Rumex nepalensis</i> Spreng.	+	+	TF
50	<i>Senecio laetus</i> Edgew.	+	-	TF
51	<i>Sibbaldia cuneata</i> Schouw ex Kunze	+	+	SF
52	<i>Tanacetum dolichophyllum</i> (Kitam.) Kitam.	+	-	SF
53	<i>Taraxacum officinale</i> (L.) Weber ex F.H.Wigg.	+	+	SF
54	<i>Thalictrum foliolosum</i> DC.	+	-	TF
55	<i>Thymus linearis</i> Benth.	+	+	SF
56	<i>Verbascum thapsus</i> L.	+	+	TF
57	<i>Veronica capitata</i> Royle ex Benth.	+	-	SF
58	<i>Veronica persica</i> Poir.	+	-	SF
59	<i>Viola biflora</i> L.	+	-	SF

Note: + = Presence, - Absence, TF = Tall Forbs, SF= Short Forbs, CS=Cushion and Spreading Forbs, SS= Summer Season, WS=Winter Season

and two species of grasses. Grasses comprised in this category were *Eragrostis nigra* and *Poa alpina*. Cushion and spreading forbs comprised of herbaceous or rosette forming prostrate flora of the alpine pasture. It contributed 16.67% to the total alpine pasture flora. The species comprised of two species of non-leguminous forbs and one species of leguminous forbs. The one species included in the leguminous forbs category were *Trifolium repens* (Table 1).

Medicinal and Threatened Plants

The important plants of medicinal value found in alpine pasture of Shikari Devi were compiled following Chopra *et al.*, 1956; Kirtikar and Basu, 1987; Kala, 2002; Kala, 2006; Samant *et al.*, 2007; Singh *et al.*, 2009; Devi *et al.*, 2013; Kumar and Sharma, 2013; Kumari *et al.*, 2018; Devi *et al.*, 2019; Kumar and Verma, 2019a; Kumar and Verma, 2019b and Verma and Chauhan, 2022. These include; *Ainsliaea latifolia*, *Allium humile*, *Anaphalis triplinervis*, *Anemone obtusiloba*, *Arisaema jacquemontii*, *Arisaema propinquum*, *Bergenia stracheyi*, *Carex nivalis*, *Cirsium falconeri*, *Cirsium wallichii*, *Corydalis govaniana*, *Cynoglossum wallichii*, *Cynoglossum*

zeylanicum, *Elsholtzia strobilifera*, *Euphorbia wallichii*, *Fragaria vesca*, *Fritillaria roylei*, *Galium aparine*, *Geranium wallichianum*, *Geum elatum*, *Gypsophila cerastoides*, *Malva neglecta*, *Mazus surculosus*, *Mentha longifolia*, *Origanum vulgare*, *Parnassia nubicola*, *Parochetus communis*, *Persicaria amplexicaulis*, *Phlomis bracteosa*, *Plantago depressa*, *Polygonatum verticillatum*, *Polygonum aviculare*, *Potentilla argyrophylla*, *Potentilla atosanguinea*, *Primula denticulata*, *Prunella vulgaris*, *Ranunculus hirtellus*, *Rhodiola wallichiana*, *Roscoea alpina*, *Rosularia rosulata*, *Rumex acetosa*, *Rumex nepalensis*, *Senecio laetus*, *Sibbaldia cuneata*, *Tanacetum dolichophyllum*, *Taraxacum officinale*, *Thalictrum foliolosum*, *Thymus linearis*, *Trifolium repens*, *Verbascum thapsus*, *Veronica persica*, *Viola biflora*. Out of the total plant species recorded from the alpine pasture, four species i.e. *Bergenia stracheyi*, *Fritillaria roylei*, *Polygonatum verticillatum* and *Roscoea alpina* fall in the category of threatened species (Goraya *et al.*, 2013).

Discussion

Floristic compositions are the key distinguishing features of a community. The

appropriate measure to assess the species diversity in the various communities is the floristic composition. It is an important component of the community that determines the functioning of an ecosystem and can vary from place to place according to habitat heterogeneity of the area itself.

In the present study a distinct changes in plant diversity of Shikari Devi alpine pasture site were recorded in different seasons. In Shikari Devi alpine pasture, the maximum numbers of species recorded were 62 in summer season and 18 were in winter season during the study period respectively. This was due to the availability of water in summer season due to snow melts which support the growth of the plant and favorable climatic condition. However in this alpine region the melting of the snow provided a major trigger for the germination of dormant buds and seeds. Germination started from summer season onwards. However, drastic reduction in number of species in winter season may be due to environmental severeness and completion of life cycle of most of plant species. Similar findings were observed by Dhaulakhandi *et al.* (2010a) and Prakash and Paliwal (2012). In these alpine pastures, the annuals and perennials grow; develop flower and fruits by September/October, thereafter the senescence of aerial parts start, which holds true to the present study sites also. This also accounted for the low number of species in winter season. Various worker such as Dhaulakhandi *et al.* (2010b) reported 36 species in July and 41 species in August at Tapovan and 33 species in July and 35 in August at Nandanvan sites at Gangotri in Garhwal Himalaya at an elevation of 4300 m and 4400 m, Verma and Kapoor (2014) reported 102 plant species in alpine area of Rani Kanda in Rakchham Chitkul wild life sanctuary in district Kinnaur, Himachal Pradesh along an altitudinal gradient with elevations varying from 3700 m to 4700 m, Arya and Samant (2018) reported 226 plant species in the Milam alpine meadows, located in the Pithoragarh district of Uttarakhand, a part of NDBR at a elevation between 3470m to 4160 m, Verma and Chauhan, 2022 reported 82 plant species in alpine pasture of Mural Danda of district Shimla, Himachal Pradesh at an elevation between 3245 m to 3750 m, Bisht *et al.* (2022) also reported taxa in two Indian Himalayan National Parks along

elevation transects, i.e., the Valley of Flowers National Park (3200 m to 6700 m) and the Great Himalayan National Park (1500 m to 6000 m), India and Sekar *et al.* (2023) reported 212 plant species along altitude gradient of 3200 m to 4800 m covering high-altitude alpine regions of west Himalaya, India.

The quantitative differences in the different types of pasture supporting different types of species due to climatic variations, genetic alterations, latitudinal differences, the completion of life cycle and biotic interference. The annuals form a main component in all the alpine and sub-alpine environments, as it was difficult for most species to complete the entire life cycle in a single cold growing season Santvan (1993) and Singh and Sundriyal (2005). Mortality in annuals plants is due to their short life period, poor establishment and lack of competitive power. All these factors directly affect the seasonality of species distribution. In the present study, tall forbs varied from 22.22% to 24.19%, short forbs varied from 61.11% to 61.29% and cushion spreading forbs varied from 14.52% to 16.67% were observed during the year in different season. Similar findings were reported by different workers while conducted the study in alpine pasture such as Ram *et al.* (1988) observed 17% were tall forbs, 36% short forbs and 27% cushion and spreading forbs, Santvan (1993) for the alpine pasture near Rahla, reported 22.5% tall forbs, 45.0% short forbs and 32.5% cushion and spreading forbs, Pandey *et al.* (1999) observed the tall forbs contribute 27.4%, short forbs 39.2%, cushion and spreading forbs 25.2%, grasses and sedges 5.9%, Verma *et al.* (2008) reported 29.33% tall forbs, 54.66% short forbs and 16% cushion and spreading forbs whereas Verma and Chauhan (2022) reported 41.46% tall forbs, 52.44% short forbs and 6.10% cushion and spreading forbs. The short forbs usually have hairy leaves which protect them against frost condition.

The dominant families recorded at Shikari Devi alpine pastures were Rosaceae, Asteraceae, Polygonaceae, Boraginaceae, Lamiaceae and Poaceae during the year in different season. The dominance of these families in the alpine pasture was due to their phytogeographic origin and specific niches adapted for the alpine climates. Similar findings were reported by several workers while conducted study in alpine pastures and other high altitude forest

ecosystems such as Gaur *et al.* (2005); Singh and Sundriyal, (2005); Chawla *et al.* (2008); Dad and Khan (2010); Kaur *et al.* (2010); Sharma *et al.* (2014); Verma and Kapoor (2014); Rawat *et al.* (2016); Kumar and Verma (2019a); Kumar and Verma (2019b) and Verma and Chauhan (2022).

Hence, it was observed that the occurrence of non-leguminous forbs is more than the grasses, sedges and leguminous forbs in both season may be due to heavy grazing pressure. The dominant non leguminous forbs plant species i.e. *Anaphalis triplinervis*, *Anemone obtusiloba*, *Cirsium falconeri*, *Cirsium wallichii*, *Cynoglossum wallichii*, *Cynoglossum zeylanicum*, *Geum elatum*, *Gypsophila cerastoides*, *Malva neglecta*, *Persicaria amplexicaulis*, *Potentilla argyrophylla*, *Potentilla atrosanguinea*, *Ranunculus hirtellus*, *Rhodiola wallichiana*, *Rumex acetosa*, *Rumex nepalensis*, *Senecio laetus*, *Tanacetum dolichophyllum*, *Verbascum thapsus* etc. are not preferred by the animal to eat. Similar results were reported by Santvan (1993); Verma *et al.* (2008); Verma and Chauhan (2022). The overgrazing does not only alter their botanical compositions but also result in to the degradation of pasture. If suitable steps are not taken in times, there must be further decline in the floristic composition and potential of the pasture. It is recommended to suitably manage the precious and diverse flora of Shikari Devi alpine pasture by regulating the intensity of grazing pressure and controlling habitat degradation.

Conclusion

Present paper documented the plant diversity of Shikari Devi alpine pasture and helped to explore the flora of the pasture. The study had documented the highest number of plant species was recording during summer season and least in winter season with the dominance of family Rosaceae, Asteraceae, Polygonaceae, Boraginaceae, Lamiaceae and Poaceae. In the present study the occurrence of non-leguminous forbs is more than the grasses, sedges and leguminous forbs in both seasons may be due to heavy grazing pressure. The major threats to plant diversity, in the Shikari Devi alpine pasture are expansion of overgrazing, uncontrolled and unscientific extraction of important medicinal plant species from their habitats, unregulated tourism and construction of roads. To minimize the impacts on the floristic diversity, there is an

urgent need for the conservation of pasture important habitats by implementing scientific conservation measures such as create awareness about the usefulness of the flora, promote community based conservation, *in situ* and *ex situ* conservation, cultivation of important medicinal plants, restoration of degraded pasture, controlled and rotational grazing, herb collectors should be educated with the sustainable harvest of these species so that there is a continuous regeneration of flora.

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Authorship contribution

A. Kumar: Investigation, data collection, analysis, interpretation of result, writing original draft review and editing. H. Chauhan: Review and editing.

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