

Research Article

Documentation of Wild Ornamental Plants (WOPs) of District Rudraprayag of Uttarakhand (Western Himalaya) India

Ankit Singh¹, Vandana Shukla¹, Zubair A. Malik^{2,3,*} and M.C. Nautiyal¹

¹High Altitude Plant Physiology Research Centre (HAPPRC), Post Box: 14 H.N.B. Garhwal University, Srinagar Garhwal - 246174, Uttarakhand, India

²Department of Botany and Microbiology, HNB Garhwal University, Srinagar Garhwal Uttarakhand -246174, India

³Presently at Department of Biology, Govt. HSS Hardturoo Anantnag (J&K)- 192201, India

(Received: September 24, 2022 ; Revised: June 01, 2023; Accepted: September 01, 2023)

ABSTRACT

The present study was carried out to document the wild ornamental plants (WOPs) of District Rudraprayag of Uttarakhand, India. The WOPs were documented from three different altitudinal zones viz., sub-tropical zone (500-1500 m asl), temperate zone (1600-2600 m asl) and sub-alpine/alpine zones (2700-4000 m asl). Data was collected via key informants and random sampling with interview of 156 informants. A total of 208 species of WOPs (belonging to 142 genera and 51 families) were reported from the study area. The number of WOPs increased with increasing altitude. The highest WOPs (118 species) were reported from upper altitude, followed by middle (64 species) and lower altitude (26 species). Orchidaceae was the highest WOPs family (32 species) followed by Asteraceae and Ranunculaceae (17 species each). Herbaceous life form was dominant in the entire altitudinal range and most of the WOPs had medicinal utility also. Due to the continuous extraction and over exploitation, some of the reported WOPs (especially those having medicinal importance) have declined in their natural habitats. Domestication and cultivation of WOPs is one of the viable options to meet the growing demands from the industries and to reduce the extraction pressures in the natural habitats of WOPs.

Key words: floral diversity, Himalaya, ornamental plant, Rudraprayag, wild

INTRODUCTION

India is rich in floral diversity, with more than 17,000 angiosperm species, 64 gymnosperms, 1,200 pteridophytes, 2,850 bryophytes, and 2,021 lichens (Joshi & Pant, 2012). The Himalaya, designated as one of the global biodiversity hotspot, has high species diversity favoured by ecological, phytogeographical and evolutionary factors (Samant *et al.*, 2003). The Himalayan region occupies only 15% of the country's geographical area, it accounts for about 30% of the endemic species found in the Indian subcontinent (Kumar *et al.*, 2011a). Biodiversity in wild and domesticated plants forms the basis for medicine, food, oil, and fibre for many communities living in or adjacent to this region (Semwal, 2007). The wild vegetation of Garhwal Himalaya is blessed with high ecosystem diversity including a large number of curious, botanically interesting, economically important, rare, endangered, threatened (RET) plant communities across the altitudinal gradient and topography (Rai *et al.*, 2012) and the alpine meadows, in particular, harbor a great variety of flowers.

Wild ornamental flowers may be defined as those which occur naturally in the field and have highly ornamental features (Reddy *et al.*, 2012) or the plants which are grown for display purposes and usually for the purpose of beautification because of their fascinating foliage, flowers and their pleasant smell rather than functional ones (Swarup, 1998). While some plants are both ornamental and functional, people usually use the term "ornamental plants" to refer to plants which have no

value beyond being attractive, although many people feel that this is value enough (Kensa, 2014). The ornamental horticulture is the main pathway for the introduction of native plants in to the country (Harris, 1992). A variety of wild plants are highly useful to the local people, while the others are of significant commercial importance and in horticulture used ornamental plants should be understood as an expression of human desire (Babu *et al.*, 2017). Wild ornamental species are also a great source of medicine and aroma (Asati & Yadav, 2004) i.e. *Dactylorhiza hatagirea* (D. Don) Soó, *Meconopsis aculeata* Royle, *Nardostachys jatamansi* (D. Don) DC., *Saussurea obvallata* (DC.) Edgew., etc. Most of the ornamental flowers of present day come from the wild progenitors; a few of which still exist in natural habitat and most of them are hard to find (WGBH Educational Foundation, 2001, Thomas *et al.* 2011) due to rapid environmental changes and anthropogenic activity (Drummond and Strimmer, 2001). Nature has given a wealth of wild flower and ornamental plants, unfortunately many of them have been destroyed to such an extent that several have become extinct and survival of many is endangered by over exploitation by human beings (Arora, 1993). The Rudraprayag District of Uttarakhand has a good diversity of wild ornamental plants (WOPs) and presently there is not a single study that has focused on the documentation of these plants of Rudraprayag. Keeping in view the aforementioned facts and in order to fill the research gap, the present study was carried out to explore and document the wild ornamental plants of this region of Western Himalaya.

*Corresponding Author's E-mail: malikzubair081@gmail.com

MATERIALS AND METHODS

Study area

Present study was carried out in Rudraprayag district of Uttarakhand, India that lies between 30°19'00"N-30°49'N and 78°49'E-79°21'13" E (Figure 1). Total area of the district is about 1984 square kilometer and total population is about 242,285 (Census of India, 2011; www.censusindia.gov.in/2011census/dchb/0503_PART_B_DCHB_RUDRAPRAYAG.pdf). The area possesses wide range of topography (high alpine meadows to lowland hills) and climate and the altitude range is between 500-5000 m asl. The average annual rainfall is about 2000-2600 mm. Agriculture is major occupation in the region followed by cattle, goat and sheep farming. Wheat, rice, barnyard millet, foxtail millet, finger millet, soybean, amaranth, are traditional crops in the region. Nowadays, younger population migrates towards the cities for education and job.

Data collection

For the documentation of wild ornamental plants (WOPs), an extensive survey was carried out in the study area (Rudraprayag) during 2017-2019. The survey included field survey as well as individual personal meetings and group discussions. Detailed structured and semi-structured questionnaires were designed for household survey. A total of 52 villages of Rudraprayag (located between 600 to 2400 m asl) were surveyed during the study. The study area was divided into three altitudinal zones viz., lower altitude zone, 500-1500 (sub-tropical zone), 1600-2600 (temperate zone) and 2700-4000m (sub-alpine and alpine zones). Data was collected via key informants and random sampling with interview of 156 informants (Table 1).

Table 1. Demographic features of informants

Demographic feature	Categories	No of person	Percentage
Informants	Male	91	58.33
	Female	65	41.66
Age	15-30	14	8.97
	30-45	47	30.13
	45-60	59	37.82
	More than 60	36	23.08
Education	Illiterate	42	26.92
	Primary	79	50.64
	Matric	23	14.74
	Intermediate	12	7.69
Total		156	

Extensive and intensive field visits were made to collect the information about WOPs including their life form, habitat and availability. People's perceptions regarding the utility and usefulness of these plants were also recorded.

Interview with local people and key informants along with the forest inventory approach were used to collect information related to WOPs. Forest inventory were made with villagers in alpine meadows (i.e. Panwali Kantha, Tungnath, Madhyamaheshwar, Kedarnath, Rudranath) and lower hills including collection of plants, photographs, and asked the preference or rank of WOPs to the informants. WOPs were ranked differently (i.e. 1: best, 2: better, 3: good, 4: average) based on the beauty of flowers by showing the photograph of listed plants to local people.

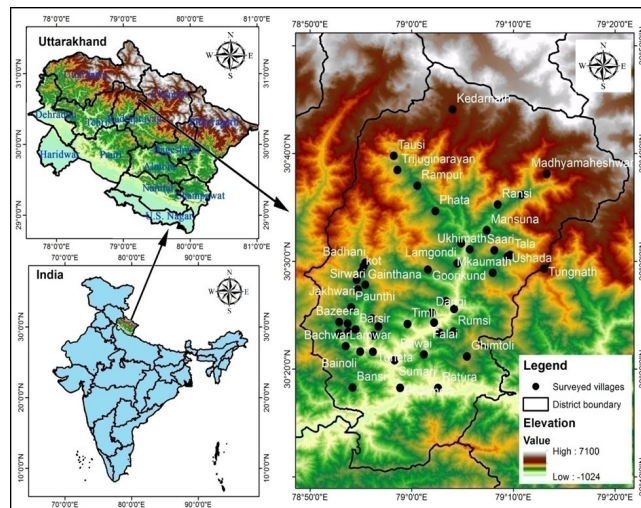


Figure 1. Rudraprayag district of Uttarakhand, India

The collected plant specimens were identified with the help of local and regional floras (Gaur, 1999; Naithani, 1985; Rai et al., 2012) and further recently accepted names were applied after consulting different reliable websites (viz., <http://www.plantsoftheworldonline.org>, <https://www.ipni.org>, <https://www.tropicos.org>).

RESULTS

A total 208 species of WOPs, belonging to 142 genera and 51 families were reported from Rudraprayag district of Uttarakhand India. The highest WOPs (118 species) were reported from sub-alpine and alpine zones (2700-4000 m altitudinal zone) followed by 64 species from temperate zone (1600-2600m altitudinal zone) and least (26 species) from sub-tropical (500-1500 altitudinal) zone.

WOPs of sub-tropical (500-1500m altitudinal) Zone

Out of the total 26 species of WOPs reported from sub-tropical zone of Rudraprayag, 58% represented herbaceous life form followed by trees (23%), shrubs (15%) and climbers (4%) (Figure 2 and Table 2).

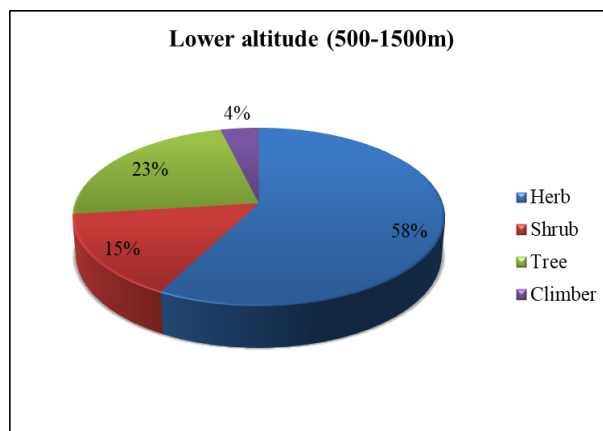


Figure 2. Distribution of WOPs (life form wise) in sub-tropical zone of Rudraprayag district.

Most of the WOPs were white colored (6 species, 23%) followed by Red colored (4 species, 15%), while Purple, Greenish white and White-Yellow were least attractive WOPs in this altitudinal zone (1 species each, 4%) (Figure 3). *Curcuma aromatica* Salisb. (Figure 4K),

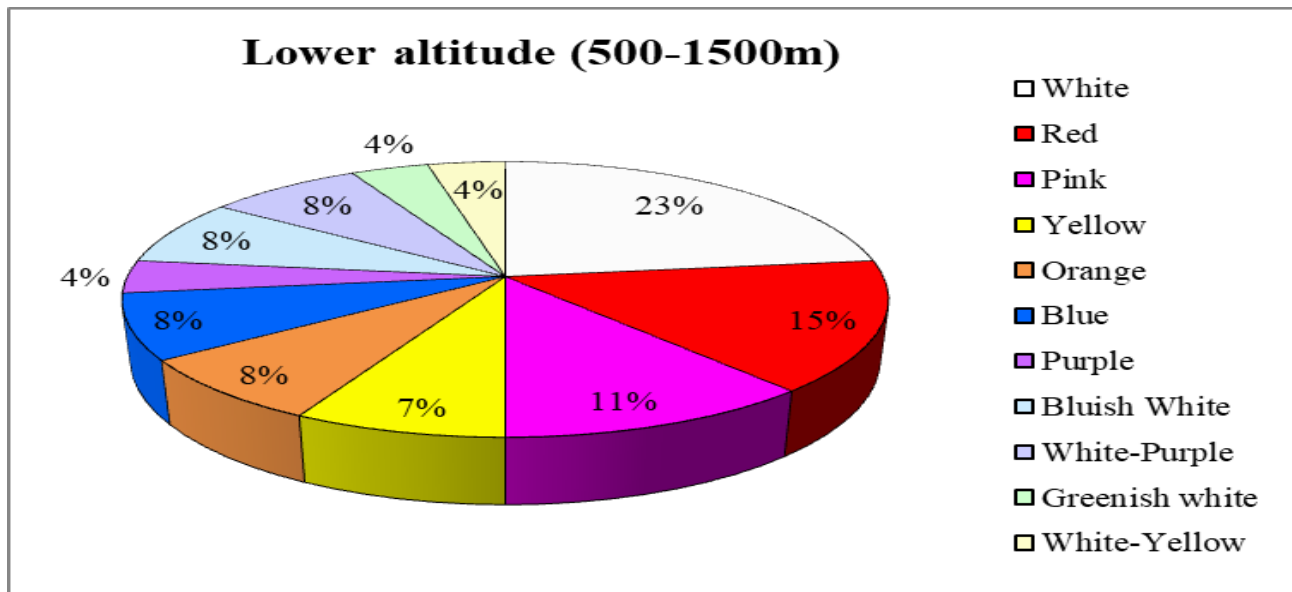


Figure 3. Color wise distribution of WOPs in lower altitudinal zone of Rudraprayag district

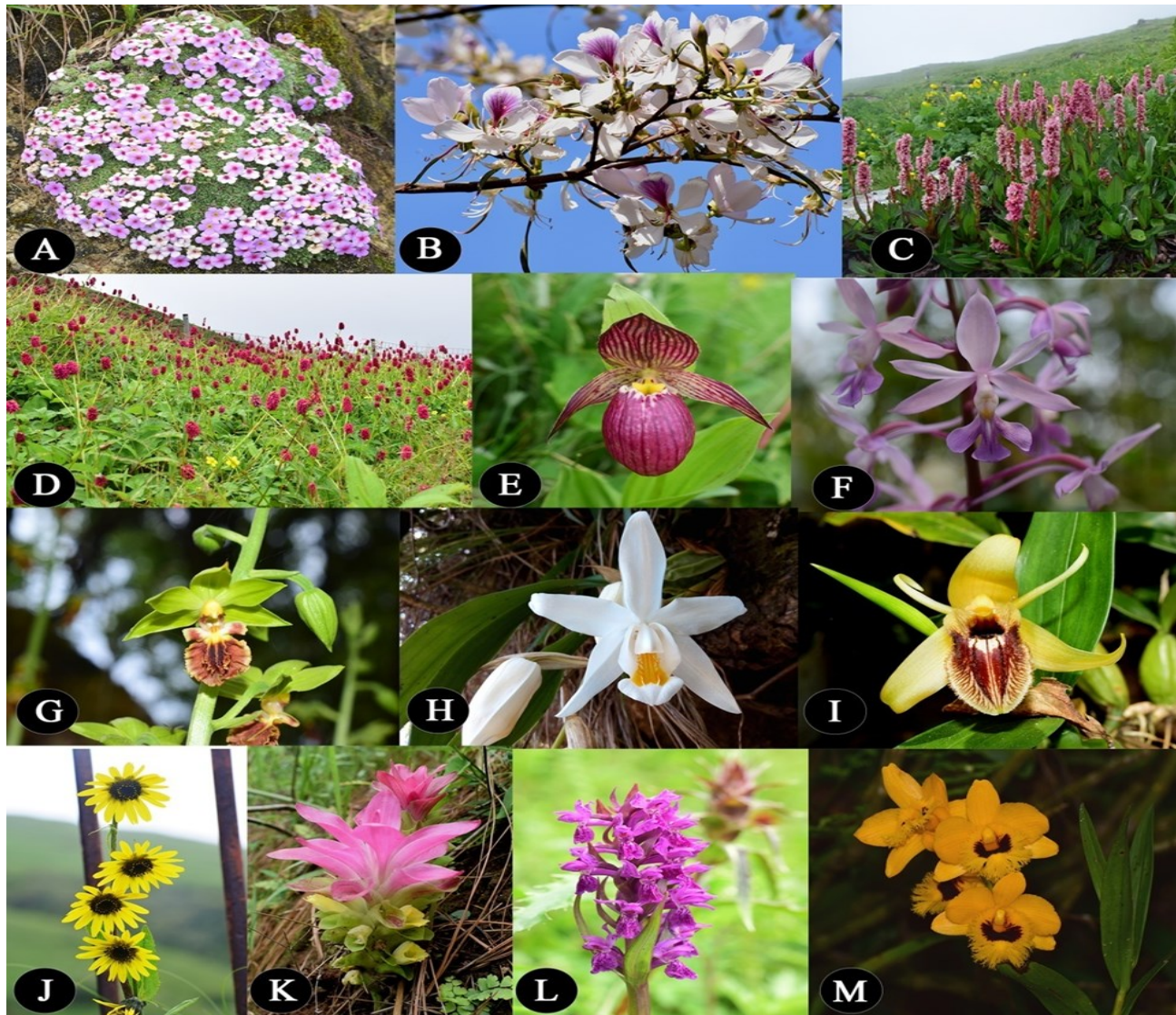


Figure 4. Wild Ornamental Plants (WOPs) of District Rudraprayag of Uttarakhand (Western Himalaya) India (A) *Androsace globifera* Duby (B) *Bauhinia variegata* L. (C) *Bistorta affinis* (D. Don) Greene (D) *Bistorta macrophylla* (D. Don) Soják (E) *Cypripedium himalaicum* Rolfe (F) *Calanthe plantaginea* Lindl. (G) *Calanthe tricarinata* Lindl. (H) *Coelogyne cristata* Lindl. (I) *Coelogyne ovalis* Lindl. (J) *Cremanthodium arnicoides* (DC. ex Royle) R.D. Good (K) *Curcuma aromatica* Salisb. (L) *Dactylorhiza hatagirea* (D. Don) Soó (M) *Dendrobium fimbriatum* Hook.



Figure 5. Wild Ornamental Plants (WOPs) of District Rudraprayag of Uttarakhand (Western Himalaya) India (A) *Notholirion thomsonianum* (Royle) Stapf (B) *Osbeckia stellata* Buch.-Ham. ex Ker Gawl. (C) *Potentilla atosanguinea* G.Lodd. ex D.Don (D) *Potentilla microphylla* D.Don (E) *Primula denticulata* Sm. (F) *Prunus cerasoides* Buch.-Ham. ex D.Don (G) *Reinwardtia indica* Dumort. (H) *Rhododendron lepidotum* Wall. ex G. Don (I) *Rhododendron arboreum* Sm. (J) *Rosa macrophylla* Lindl. (K) *Saussurea obvallata* (DC.) Edgew. (L) *Senecio chrysanthemoides* DC.

Eulophia herbacea Lindl., *Gloriosa superba* L., *Hedychium coccineum* Buch.-Ham. ex Sm., *Notholirion thomsonianum* (Royle) Stapf (Figure 5A), and *Pecteilis susannae* (L.) Raf. were ranked 1st WOPs in this altitudinal zone (Table 2).

WOPs of Temperate (1600-2600m Altitudinal) Zone

Out of the total 64 WOPs reported from temperate (middle altitudinal) zone of district Rudraprayag, majority (81%) belonged to herbaceous life form followed by shrubs (10%), trees (6%) and climbers (3%) (Figure 6

and Table 3). *Androsace sarmentosa* Wall., *Begonia picta* Sm, *Calanthe plantaginea* Lindl. (Figure 4F), *Calanthe tricarinata* Lindl. (Figure 4G), *Coelogyne cristata* Lindl. (Figure 4H), *Coelogyne ovalis* Lindl. (Figure 4I), *Coelogyne stricta* (D.Don) Schltr., *Dendrobium amoenum* Wall. ex Lindl, *Dendrobium fimbriatum* Hook. (Figure 4M), *Habenaria ensifolia* Lindl. (Figure 7H), *Habenaria intermedia* D.Don (Figure 7E), *Ipomoea purpurea* (L.) Roth (Figure 7G), *Reinwardtia indica* Dumort. (Figure 5G), *Rhododendron arboreum* Sm. (Figure 5I), *Rhynchosyilis retusa* (L.) Blume,

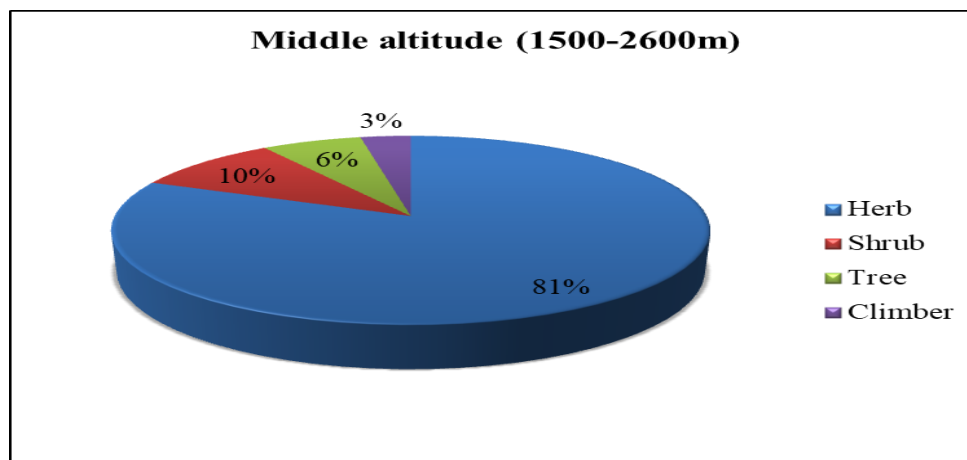


Figure 6. Life form distribution of WOPs in middle altitudinal zone of Rudraprayag district.



Figure 7. Wild Ornamental Plants (WOPs) of District Rudraprayag of Uttarakhand (Western Himalaya) India (A) *Erigeron karvinskianus* DC. (B) *Erythrina suberosa* Roxb. (C) *Geranium collinum* Stephan ex Willd (D) *Geum elatum* Wall (E) *Habenaria intermedia* D. Don (F) *Inula grandiflora* Gray (G) *Ipomoea purpurea* (L.) Roth (H) *Habenaria ensifolia* Lindl. (I) *Lagotis cashmeriana* (Royle ex Benth.) Rupr. (J) *Meconopsis aculeata* Royle (K) *Morina longifolia* Wall. ex DC.

Thunia alba (Lindl.) Rchb.f. and *Zingiber roseum* (Roxb.) Roscoe were 1st ranked WOPs in this altitudinal zone.

Majority of the WOPs (21 species, 33%) of this zone had white colored flowers similar to those of lower altitudinal zone. The next dominant color was Pink (12 species, 19%) followed by yellow and others (Figure 8).

WOPs of Sub-alpine and Alpine (2700-4000 m) Altitudinal Zones

Majority (87%) of the 118 WOPs reported this zone of district Rudraprayag were herbaceous followed by shrubs (8%), climbers (3%) and trees (2%) (Table 4 and figure 9). The species *Androsace globifera* Duby

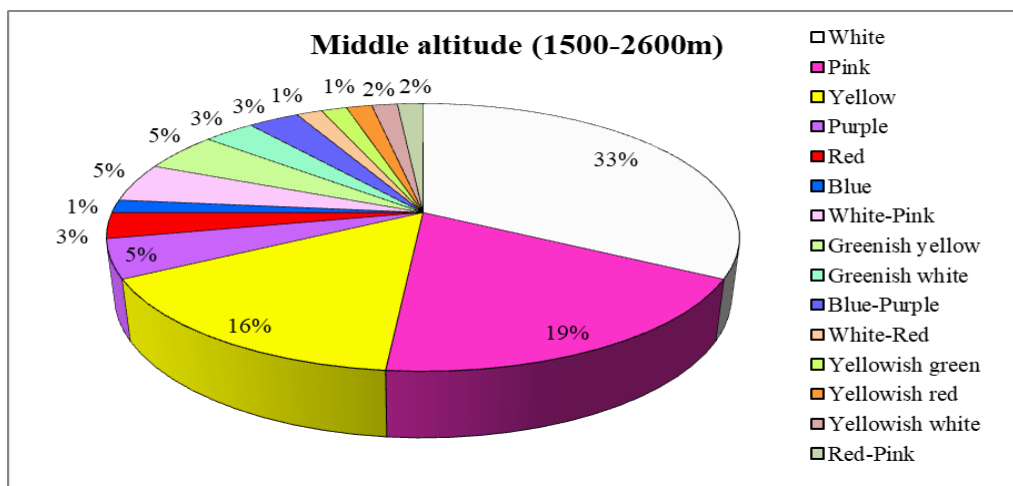


Figure 8. Color wise distribution of WOPs in middle altitude zone of Rudraprayag district

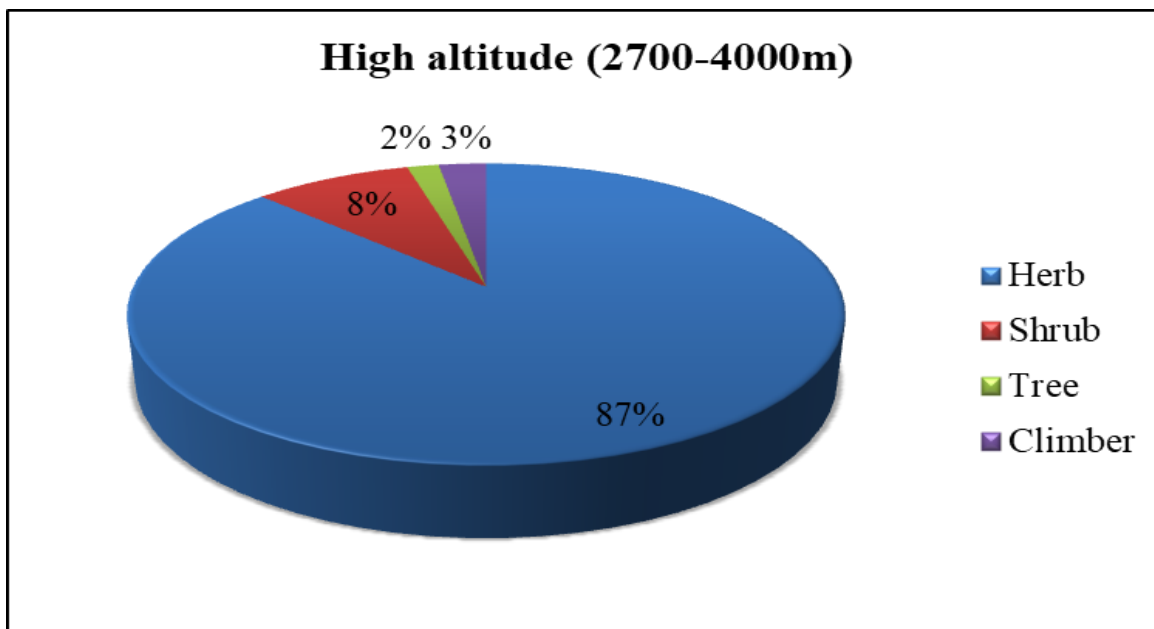


Figure 9. Life form distribution of WOPs in high altitudinal zone of Rudraprayag district.

(Figure 4A), *Androsace lanuginosa* Wall., *Bistorta af-finis* (D.Don) Greene (Figure 4C), *Bistorta macrophylla* (D.Don) Soják (Figure 4D), *Cremanthodium arnicoides* (DC. ex Royle) R.D.Good (Figure 4J), *Cypripedium cordigerum* D.Don, *Cypripedium himalaicum* Rolfe (Figure 4E), *Inula grandiflora* Gray (Figure 7F), *Mec-nopsis aculeata* Royle (Figure 7J), *Potentilla atosan-guinea* G.Lodd. ex D.Don (Figure 5C), *Primula denticu-lata* Sm. (Figure 5E), *Rosa macrophylla* Lindl. (Figure 5J), *Saussurea gossypiphora* D.Don, *Saussurea obvalla-ta* (DC.) Edgew. (Figure 5K) and *Saussurea simpsoni-ana* (Fielding & Gardner) Lipsch. were 1st ranked WOPs in this altitudinal zone.

Yellow color flowers were dominant WOPs in this altitudinal zone (28 species, 24%) followed by

White color (24 species, 20%) and Green, Greenish-yellow, Chocolate Brown-Green, Blue-Purple, Yellow-ish-Green and Pinkish-Red color were least dominant (1 species each, 1%) (Figure 10).

Ethnomedicinal importance of the reported WOPs

Some of the WOPs reported in the present study also have ethnomedicinal importance in different parts of Western Himalaya. As for example, *Barleria cristata* L. is used to treat cut and wounds, *Bergenia ciliata* (Haw.) Sternb and *Bergenia stracheyi* (Hook.f. & Thomson) Engl. used as to cure kidney stone, *Justicia adhatoda* L. and *Woodfordia fruticosa* (L.) Kurz are used to treat cough, *Paeonia emodi* Royle used to treat stomach ache and fever, *Aconitum balfourii* Stapf used to treat gout

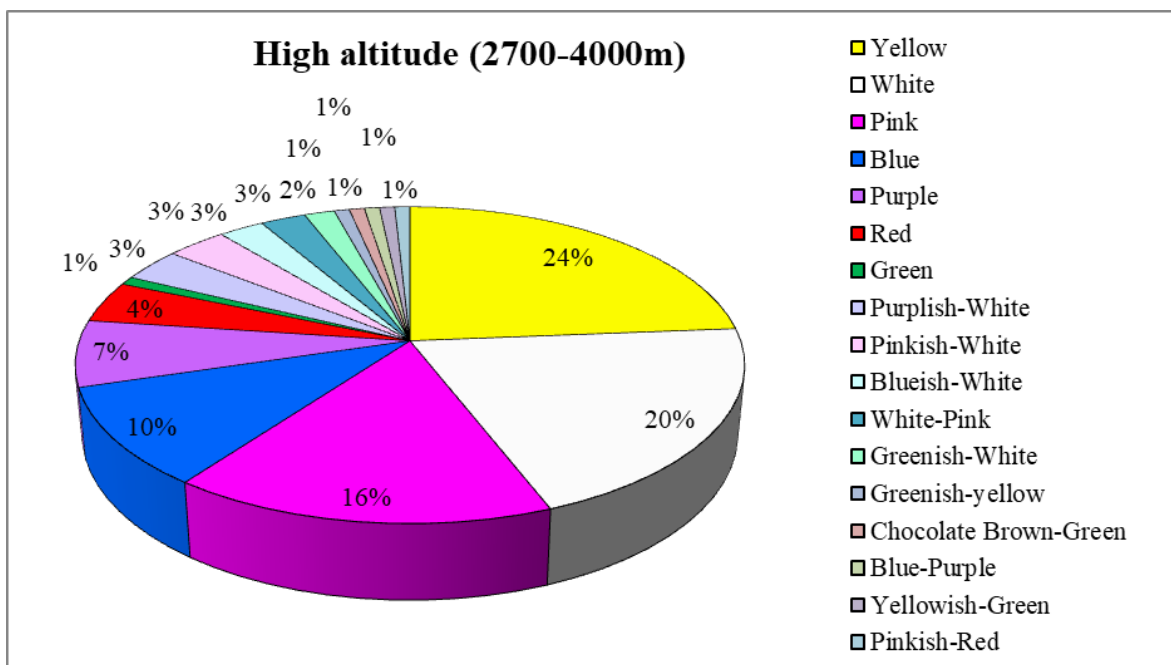


Figure 10. Color wise distribution of WOPs in sub-alpine and alpine zones of Rudraprayag district

and poisonous bite, *Dactylorhiza hatagirea* (D. Don) Soó is used as tonic, coolant, to cure cut and wounds, *Meconopsis aculeata* Royle and *Taraxacum officinale* Wigg. are used to treat cut and wounds. Some of the WOPs (*Nardostachys jatamansi* (D. Don) DC., *Valeriana jatamansi* Jones, *Saussurea gossypiphora* D. Don, *Saussurea obvallata* (DC.) Edgew., *Saussurea simpsoniana* (Fielding & Gardner) Lipsch., *Selinum wallichianum* (DC.) Raizada & H.O. Saxena, *Tanacetum dolichophyllum* (Kitam.) Kitam. and *Reinwardtia indica* Dumort frequently used as incense and religious uses.

Conservation status: Threatened WOPs

Majority of the WOPs have also medicinal importance, the main reason for their extraction from wild. Due to the continuous extraction and over exploitation, some of the reported WOPs are facing population decline and need to be conserved on priority. For this reason, these WOPs are already kept under various threat categories like threatened, endangered, critically endangered etc. For example, *Aconitum balfourii* Stapf., *Aconitum ferox* Wall. ex Ser, *Aconitum violaceum* Jacquem. ex Stapf, *Arnebia benthamii* (Wall. ex G. Don) I.M. Johnst.,

Table 2. Details of WOPs reported from Sub-tropical (500-1500 m asl) Zone of Rudraprayag.

Plant species	Family	Local name	Life form	Flower color	Local uses	Flowering -Fruiting	Rank
<i>Abrus precatorius</i> L.	Fabaceae	Ratti	Climber	Bluish White		Oct-Dec	3
<i>Asparagus adscendens</i> Roxb.	Asparagaceae	Jhirnu	Shrub	White	As tonic	Aug-Nov	4
<i>Barleria cristata</i> L.	Acanthaceae	Kulkarkatya	Herb	Blue-White	Cut wounds	Sep-Dec	3
<i>Bauhinia purpurea</i> L.	Fabaceae	Gwiral	Tree	Pink	-	Sep-Nov	2
<i>Bauhinia variegata</i> L.	Fabaceae	Gwiral	Tree	White	-	Feb-Jul	2
<i>Bombax ceiba</i> L.	Malvaceae	Semal	Tree	Red	Fever	Jan-May	2
<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	Dhak	Tree	Orange	-	Mar-May	2
<i>Callicarpa macrophylla</i> Vahl	Lamiaceae	Daiya	Shrub	Purple	-	Jul-Oct	4
<i>Coleus barbatus</i> (Andrews) Benth. ex G. Don	Lamiaceae	Pattarchur	Herb	Blue	-	Aug-Oct	4
<i>Curcuma aromatica</i> Salisb.	Zingiberaceae	Ban haldu	Herb	Pink	Cut wounds	Jun-Oct	1
<i>Datura metel</i> L.	Solanaceae	Dhatura	Herb	White-Purple	-	Jul-Dec	3
<i>Datura stramonium</i> L.	Solanaceae	Dhatura	Herb	White	-	May-Sep	3
<i>Delphinium denudatum</i> Wall. ex Hook.f. & Thomson	Ranunculaceae	-	Herb	Blue	-	Apr-Jul	2
<i>Desmodium oojainense</i> (Roxb.) H. Ohashi	Fabaceae	Sandan	Tree	Pink	-	Jan-Apr	2
<i>Erythrina suberosa</i> Roxb.	Fabaceae	-	Tree	Orange	-	Mar-June	2
<i>Eulophia herbacea</i> Lindl.	Orchidaceae	-	Herb	Greenish White	-	Jun-Sep	1
<i>Gloriosa superba</i> L.	Colchicaceae	Kalihari	Herb	Red	-	Aug-Nov	1
<i>Habenaria pectinata</i> D. Don	Orchidaceae	-	Herb	White	-	Jul-Oct	2
<i>Hedychium coccineum</i> Buch.-Ham. ex Sm.	Zingiberaceae	Ban haldu	Herb	Red	-	Jun-Aug	1
<i>Hedychium ellipticum</i> Buch.-Ham. ex Sm.	Zingiberaceae	Ban Haldu	Herb	White-yellow	Cut wounds	Jul-Oct	2
<i>Justicia adhatoda</i> L.	Acanthaceae	Basya	Shrub	White	Cough	Dec-Jun	3
<i>Lindenbergia grandiflora</i> (Buch.-Ham. ex D. Don) Benth.	Plantaginaceae	-	Herb	Yellow	-	Oct-Dec	3
<i>Notholirion thomsonianum</i> (Royle) Stapf	Liliaceae	-	Herb	White-purple	-	Mar-May	1
<i>Pecteilis susannae</i> (L.) Raf.	Orchidaceae	-	Herb	White	-	Jul-Sep	1
<i>Verbascum thapsus</i> L.	Scrophulariaceae	Ekalveer	Herb	Yellow	Religious	Apl-Nov	2
<i>Woodfordia fruticosa</i> (L.) Kurz*	Lythraceae	Dhau	Shrub	Red	Cough	Jan-Jun	2

Table 3. Detailsof WOPs reported from temperate (1600-2600 m asl) Zone of Rudraprayag

Plant species	Family	Local name	Life form	Flower color	Local uses	Flower-ing-Fruiting	Rank
<i>Aesculus indica</i> (Wall. ex Cambess.) Hook.	Sapindaceae	Pangar	Tree	White-red	-	May-Aug	2
<i>Androsace sarmentosa</i> Wall.	Primulaceae	-	Herb	Pink	-	Jun-Aug	1
<i>Asparagus filicinus</i> Buch.-Ham. ex D.Don	Asparagaceae	Jhirna	Herb	White	As tonic	Jun-Sep	2
<i>Begonia dioica</i> Buch.-Ham. ex D.Don	Begoniaceae	-	Herb	White-Pink	-	Jul-Oct	2
<i>Begonia picta</i> Sm.	Begoniaceae	-	Herb	Pink	-	Jul-Oct	1
<i>Bergenia ciliata</i> (Haw.) Sternb	Saxifragaceae	Silphori	Herb	White	Stone	Feb-Apr	2
<i>Calanthe plantaginea</i> Lindl.	Orchidaceae	-	Herb	Pink	-	Mar-Jun	1
<i>Calanthe tricarinata</i> Lindl.	Orchidaceae	-	Herb	Greenish yellow	-	Jun-Sep	1
<i>Cardiocrinum giganteum</i> (Wall.) Makino	Liliaceae	-	Herb	White	-	Jul-Sep	2
<i>Cautleya spicata</i> (Sm.) Baker	Zingiberaceae	Ban elaichi	Herb	Yellow	-	Jul-Oct	2
<i>Cephalanthera longifolia</i> (L.) Fritsch.	Orchidaceae	-	Herb	White	-	May-Sep	2
<i>Ceropegia longifolia</i> Wall.	Apocynaceae	-	Climber	Greenish white	-	Aug-Oct	2
<i>Coelogyne cristata</i> Lindl.	Orchidaceae	-	Herb	White	-	Mar-Jun	1
<i>Coelogyne ovalis</i> Lindl.	Orchidaceae	-	Herb	Yellow	-	Aug-Sep	1
<i>Coelogyne stricta</i> (D.Don) Schltr.	Orchidaceae	-	Herb	White	-	Aug-Oct	1
<i>Crepidium acuminatum</i> (D.Don) Szlach.	Orchidaceae	-	Herb	Greenish yellow	-	Jul-Oct	3
<i>Dendrobium amoenum</i> Wall. ex Lindl	Orchidaceae	-	Herb	White-pink	-	May-Jul	1
<i>Dendrobium bicameratum</i> Lindl.	Orchidaceae	-	Herb	Yellow	-	Aug-Nov	2
<i>Dendrobium fimbriatum</i> Hook.	Orchidaceae	-	Herb	Yellow	-	Sep-Oct	1
<i>Desmodium elegans</i> DC.	Fabaceae	-	Shrub	Pink	-	Apr-Oct	3
<i>Dipsacus inermis</i> Wall.*	Caprifoliaceae	-	Herb	White	-	Jul-Oct	4
<i>Duhaldea cappa</i> (Buch.-Ham. ex D.Don) Pruski & Anderb.	Asteraceae	-	Shrub	Yellow	-	Aug-Feb	3
<i>Epipactis helleborine</i> (L.) Crantz	Orchidaceae	-	Herb	Greenish white	-	Jul-Oct	2
<i>Erigeron annuus</i> (L.) Pers.	Asteraceae	-	Herb	White	-	Jun-Nov	2
<i>Erigeron karvinskianus</i> DC.	Asteraceae	Phulyar	Herb	White-Pink	-	Jan-Dec	2
<i>Gerbera gossypina</i> (Royle) Beauverd	Asteraceae	-	Herb	White	-	Mar-Aug	3
<i>Habenaria ensifolia</i> Lindl.	Orchidaceae	-	Herb	Greenish yellow	-	Jul-Aug	1
<i>Habenaria intermedia</i> D.Don	Orchidaceae	-	Herb	White	-	Jul-Sep	1
<i>Hedychium spicatum</i> Sm.	Zingiberaceae	Syodu	Herb	White	-	Jun-Nov	2
<i>Henckelia bifolia</i> (D.Don) A.Dietr.	Gesneriaceae	-	Herb	Blue-purple	-	Jul-Oct	2
<i>Henckelia pumila</i> (D.Don) A.Dietr.	Gesneriaceae	-	Herb	White	-	Jul-Oct	2

<i>Hypericum uralum</i> Buch.-Ham. ex D. Don	Hypericaceae	-	Shrub	Yellow	-	Mar-Sep	3
<i>Indigofera heterantha</i> Wall. ex Brandis	Fabaceae	Sakina	Shrub	Pink	-	May-Jun	3
<i>Ipomoea purpurea</i> (L.) Roth	Convolvulaceae	-	Climber	Blue-purple	-	Feb-Oct	1
<i>Lamium album</i> L.	Lamiaceae	-	Herb	White	-	May-Sep	3
<i>Nicandra physalodes</i> (L.) Gaertn.	Solanaceae	-	Herb	Blue	-	Jul-Nov	3
<i>Ophiopogon intermedius</i> D. Don	Asparagaceae	-	Herb	White	-	Jun-Sep	4
<i>Osbeckia stellata</i> Buch.-Ham. ex Ker Gawl.	Melastomataceae	-	Shrub	Pink	-	Aug-Oct	2
<i>Oxalis latifolia</i> Kunth*	Oxalidaceae	-	Herb	Pink	-	Jun-Sep	3
<i>Paeonia emodi</i> Royle	Paeoniaceae	Chandra/Dhendra	Herb	White	Stomachache, Fever	Mar-Aug	2
<i>Pholidota articulata</i> Lindl.	Orchidaceae	-	Herb	White	-	Apr-May	2
<i>Pinalia leucantha</i> Kuntze	Orchidaceae	-	Herb	White	-	Jun	4
<i>Pinalia spicata</i> (D. Don) S.C. Chen & J.J. Wood	Orchidaceae	-	Herb	Yellowish white	-	Aug-Oct	2
<i>Potentilla fulgens</i> Wall. ex Sims ●	Rosaceae	Bajradanti	Herb	Yellow	Cleansing of teeth	Jul-Sep	2
<i>Prunus cerasoides</i> Buch.-Ham. ex D. Don	Rosaceae	Panya	Tree	Pink	-	Oct-Mar	3
<i>Pyrus pashia</i> Buch.-Ham. ex D. Don	Rosaceae	Melu	Tree	White	-	Feb-Dec	4
<i>Reinwardtia indica</i> Dumort.*	Linaceae	Phyunli	Herb	Yellow	Religious	Dec-May	1
<i>Rhododendron arboreum</i> Sm. ●	Ericaceae	Burans	Tree	Red-Pink	-	Apr-Nov	1
<i>Rhynchostylis retusa</i> (L.) Blume	Orchidaceae	-	Herb	Pink	-	Apr-Sep	1
<i>Rosa moschata</i> Herrm.	Rosaceae	Kunja	Shrub	White	-	Jun-Nov	2
<i>Roscoea purpurea</i> Sm.	Zingiberaceae	-	Herb	Purple	-	Jul-Oct	2
<i>Rumex hastatus</i> D. Don*	Polygonaceae	Amedu	Herb	Red	-	Feb-Oct	4
<i>Salvia cana</i> Wall. ex Benth.	Lamiaceae	-	Herb	Purple	-	Jun-Sep	2
<i>Satyrium nepalense</i> D. Don ●	Orchidaceae	-	Herb	Pink	-	Jul-Oct	3
<i>Sauromatum diversifolium</i> (Wall. ex Schott) Cusimano & Hett.	Araceae	-	Herb	Red	-	Apr-Jul	3
<i>Scutellaria scandens</i> D. Don	Lamiaceae	Kapphu	Herb	Yellowish red	-	Mar-May	4
<i>Silene conoidea</i> L.	Caryophyllaceae	-	Herb	Pink	-	Feb-May	2
<i>Spiranthes sinensis</i> (Pers.) Ames	Orchidaceae	-	Herb	Bluish-White	-	May-Jul	3
<i>Taraxacum officinale</i> Wigg. ●	Asteraceae	Karatu	Herb	Yellow	Cut and wounds	Feb-Oct	3
<i>Thunia alba</i> (Lindl.) Rehb.f.	Orchidaceae	-	Herb	White	-	Mar-May	1
<i>Valeriana jatamansi</i> Jones #	Caprifoliaceae	Sumaya	Herb	White	As incense	Feb-Jun	3
<i>Vanda cristata</i> Wall. ex Lindl.	Orchidaceae	-	Herb	Yellowish green	-	May-Jul	2
<i>Viola pilosa</i> Blume	Violaceae	Banasa	Herb	Purple	-	Mar-Jul	4
<i>Zingiber roseum</i> (Roxb.) Roscoe	Zingiberaceae	Ban Haldu	Herb	Yellow	-	Aug-Oct	1

*Found in lower and middle altitude ● Found in middle and high altitude, # Vulnerable

Table 4. Details of WOPs reported from Sub-alpine and Alpine (2700-4000 m asl) Zones of Rudraprayag

Plant species	Family	Local name	Habit	Flower color	Local uses	Flowering-Fruiting	Rank
<i>Aconitum balfourii</i> Stapf ▲	Ranunculaceae	Bikh	Herb	Blue	Gout, poisonous bite	Aug-Nov	3
<i>Aconitum ferox</i> Wall. ex Ser	Ranunculaceae	-	Herb	Blue	Gout, poisonous bite	Sep-Oct	3
<i>Aconitum violaceum</i> Jacquem. ex Stapf ▲	Ranunculaceae	Dudiya atis	Herb	Blue	Fever, as coolant	Sep-Oct	3
<i>Allium humile</i> Kunth	Amaryllidaceae	Jambu Pharan	Herb	White	As a spices	Aug-Oct	2
<i>Allium wallichii</i> Kunth	Amaryllidaceae	Lainka	Herb	Pink	As spices	Jul-Oct	2
<i>Anaphalis nepalensis</i> (Spreng.) Hand.-Mazz.	Asteraceae	Bugla	Herb	White	Religious	Jul-Nov	3
<i>Androsace globifera</i> Duby	Primulaceae	-	Herb	Pink	-	June-Sep	1
<i>Androsace lanuginosa</i> Wall.	Primulaceae	-	Herb	White	-	May-Sep	1
<i>Anemone obtusiloba</i> D.Don	Ranunculaceae	Kakhrya	Herb	Blueish-White	-	May-Aug	3
<i>Anemone polyanthes</i> D.Don	Ranunculaceae	Kakhrya	Herb	White	-	May-Jul	3
<i>Anemone rivularis</i> Buch.-Ham. ex DC.	Ranunculaceae	Kakhrya	Herb	White	-	Jun-Oct	2
<i>Anemone vitifolia</i> Buch.-Ham. ex DC.	Ranunculaceae	Mudila	Herb	White	-	Jun-Oct	3
<i>Aquilegia nivalis</i> (Baker) Falc. ex B.D.Jacks.	Ranunculaceae	-	Herb	Blue	-	Jun-Oct	2
<i>Aquilegia pubiflora</i> Wall. ex Royle	Ranunculaceae	-	Herb	Purple	-	Jun-Sep	2
<i>Arenaria bryophylla</i> Fernald	Caryophyllaceae	-	Herb	White	-	Jul-Aug	3
<i>Arisaema jacquemontii</i> Blume	Araceae	Naagphani	Herb	Green	-	May-Sep	4
<i>Arisaema propinquum</i> Schott	Araceae	Baagh mungri	Herb	Chocolate Brown-Green	-	Jun-Jul	3
<i>Arnebia benthamii</i> (Wall. ex G.Don) I.M.Johnst. ▲	Boraginaceae	Balchadi	Herb	Purplish-White	Hair tonic	May-Aug	3
<i>Aster thomsonii</i> C.B.Clarke	Asteraceae	-	Herb	Purplish-White	-	Aug-Oct	2
<i>Bergenia stracheyi</i> (Hook.f. & Thomson) Engl.	Saxifragaceae	Pashanbhed	Herb	White-Pink	Stone	Jun-Sep	3
<i>Bistorta affinis</i> (D.Don) Greene	Polygonaceae	Kukhdi	Herb	Pink	-	Jul-Oct	1
<i>Bistorta macrophylla</i> (D.Don) Soják	Polygonaceae	Kukhdi	Herb	Pink	-	Jul-Oct	1
<i>Bistorta vacciniifolia</i> (Wall. ex Meisn.) Greene	Polygonaceae	Enuri	Herb	Pink	-	Jul-Oct	3
<i>Caltha palustris</i> L.	Ranunculaceae	-	Herb	Yellow	-	Jun-Sep	2
<i>Cassiope fastigiata</i> (Wall.) D.Don	Ericaceae	-	Shrub	White	-	Jun-Aug	2
<i>Clematis barbellata</i> Edgew.	Ranunculaceae	-	Climber	Purple	-	May-Sep	3
<i>Clematis montana</i> Buch.-Ham. ex DC.	Ranunculaceae	Koniya	Climber	White	-	May-Aug	3
<i>Codonopsis rotundifolia</i> Benth.	Campanulaceae	-	Climber	Greenish-White	-	Jul-Oct	3
<i>Corydalis cashmeriana</i> Royle	Papaveraceae	-	Herb	Blue	-	May-Aug	3

<i>Corydalis cornuta</i> Royle	Papaveraceae	Balsam jadd	Herb	Yellow	-	Jul-Oct	4
<i>Corydalis govaniana</i> Wall.	Papaveraceae	-	Herb	Yellow	-	Jul-Sep	2
<i>Cremanthodium arnicoides</i> (DC. ex Royle) R.D.Good	Asteraceae	Jarhil	Herb	Yellow	-	Jul-Sep	1
<i>Cyananthus integer</i> Wall. ex Benth.	Campanulaceae	-	Herb	Blue	-		3
<i>Cyananthus lobatus</i> Wall. ex Benth.	Campanulaceae	-	Herb	Blue	-	Jul-Sep	3
<i>Cypripedium cordigerum</i> D.Don	Orchidaceae	-	Herb	White	-	May-Oct	1
<i>Cypripedium himalaicum</i> Rolfe	Orchidaceae	-	Herb	Pink	-	June-Sep	1
<i>Dactylorhiza hatagirea</i> (D.Don) Soó ▼	Orchidaceae	Hathajari	Herb	Pink	As tonic, Coolant, cut wounds	Jun-Sep	2
<i>Dasiphora arbuscula</i> (D.Don) Soják	Rosaceae	-	Shrub	Yellow	-	Jun-Oct	3
<i>Delphinium vestitum</i> Wall ex Royle	Ranunculaceae	-	Herb	Purple	-	Jun-Jul	3
<i>Doronicum kamaonense</i> (DC.) Alv.Fern.	Asteraceae	-	Herb	Yellow	-	May-Sep	2
<i>Fragaria nubicola</i> (Lindl. ex Hook.f.) Lacaita	Rosaceae	Gandhkaphal	Herb	White	-	May-Jul	3
<i>Fritillaria cirrhosa</i> D.Don #	Liliaceae	-	Herb	Greenish-yellow	-	Jun-Sep	3
<i>Gentiana stipitata</i> Edgew.	Gentianaceae	-	Herb	White	-		3
<i>Geranium collinum</i> Stephan ex Willd	Geraniaceae	-	Herb	Pink	-	Jul-Aug	3
<i>Geranium wallichianum</i> D.Don ex Sweet	Geraniaceae	-	Herb	Pink	-	Jul-Oct	2
<i>Geum elatum</i> Wall	Rosaceae	Mooli	Herb	Yellow	-	Jun-Oct	2
<i>Goodyera repens</i> (L.) R.Br.	Orchidaceae	-	Herb	White	-	Aug-Oct	3
<i>Gymnadenia orchidis</i> Lindl.	Orchidaceae	-	Herb	Pink	-	Jun-Sep	2
<i>Hypericum choisianum</i> Wall. ex N.Robson	Hypericaceae	-	Shrub	Yellow	-	Mar-Sep	3
<i>Impatiens sulcata</i> Wall.	Balsaminaceae	-	Herb	Pink	-	Jul-Oct	2
<i>Inula grandiflora</i> Gray	Asteraceae	Jhuri	Herb	Yellow	-	Jul-Sep	1
<i>Iris kemaonensis</i> Wall. ex D.Don	Iridaceae	-	Herb	Blue-Purple	-	Mar-Sep	2
<i>Jasminum humile</i> L.	Oleaceae	Surmadii	Shrub	Yellow	-	Apr-Oct	4
<i>Kashmiria himalaica</i> (Hook. f.) D.Y. Hong	Plantaginaceae	-	Herb	Purple	-		3
<i>Koenigia polystachya</i> (Wall. ex Meisn.) T.M.Schust. & Reveal	Polygonaceae	Bhontu	Herb	White	-	Aug-Oct	3
<i>Lagotis cashmeriana</i> (Royle ex Benth.) Rupr.	Plantaginaceae	-	Herb	Blue	-	Jun-Aug	2
<i>Leontopodium himalayanum</i> DC.	Asteraceae	-	Herb	White	-	Jul-Oct	3
<i>Ligularia amplexicaulis</i> DC.	Asteraceae	Kalak	Herb	Yellow	-	Apr-Sep	3
<i>Lilium nanum</i> Klotzsch	Liliaceae	-	Herb	Purplish-White	-	Jun-Oct	2
<i>Lloydia longiscapa</i> Hook.	Liliaceae	-	Herb	White	-	Jun-Aug	3
<i>Lomatogonium carinthiacum</i> (Wulfen) A.Braun	Gentianaceae	-	Herb	Blue-White	-	Sep-Oct	4
<i>Maharanga emodi</i> (Wall.) A. DC.	Boraginaceae	Sankhuli/Ratanjoot	Herb	Pinkish-White	-	Aug-Sep	3

<i>Maianthemum purpureum</i> (Wall.) LaFrankie	Asparagaceae	-	Herb	White	-	May-Sep	4
▲ <i>Meconopsis aculeata</i> Royle	Papaveraceae	Kaliyari	Herb	Blue	Cut wounds	Jul-Oct	1
<i>Meconopsis paniculata</i> (D. Don) Prain	Papaveraceae	-	Herb	Yellow	-	Jul-Oct	2
<i>Morina longifolia</i> Wall. ex DC.	Caprifoliaceae	-	Herb	Pinkish-White	-	Jul-Oct	2
▼ <i>Nardostachys jatamansi</i> (D. Don) DC.	Caprifoliaceae	Jatamansi	Herb	White	As incense	Jul-Oct	3
<i>Nomocharis oxypetala</i> (D. Don) E.H. Wilson	Liliaceae	-	Herb	Yellow	-	Jun-Aug	2
<i>Oreorchis foliosa</i> var. <i>indica</i> (Lindl.) N. Pearce & P.J. Cribb	Orchidaceae	-	Herb	Pinkish-White	-	May-Jul	2
<i>Oxygraphis polypetala</i> (Raf.) Hook. f. & Thomson	Ranunculaceae	-	Herb	Yellow	-	May-Aug	2
<i>Oxyria digyna</i> (L.) Hill.	Polygonaceae	Kailashi Al-mora	Herb	Red	-	Jun-Oct	2
<i>Parnassia nubicola</i> Wall. ex Royle	Celastraceae	Fhutkya	Herb	White	-	Jul-Oct	3
<i>Pedicularis gracilis</i> Wall. ex Benth.	Orobanchaceae	-	Herb	Pink	-	Sep-Nov	3
<i>Pedicularis hoffmeisteri</i> Klotzsch	Orobanchaceae	-	Herb	Yellow	-	Aug-Oct	2
<i>Pedicularis pectinata</i> var. <i>rosea</i> P. Agnihotri & T. Husain	Orobanchaceae	-	Herb	Pink	-	Aug-Oct	2
<i>Pedicularis pectinata</i> Wall. ex Benn	Orobanchaceae	-	Herb	Pink	-	Aug-Oct	2
<i>Pedicularis punctata</i> Decne.	Orobanchaceae	-	Herb	Pink	-	Aug-Oct	2
<i>Phlomis bracteosa</i> (Royle ex Benth.) Kamelin & Makhm.	Lamiaceae	Bhanjadiya	Herb	Purple	-	Aug-Oct	2
<i>Piptanthus nepalensis</i> (Hook.) D. Don	Fabaceae	-	Shrub	Yellow	-	May-Sep	3
<i>Pleione hookeriana</i> (Lindl.) Rollisson	Orchidaceae	-	Herb	White-Pink	-	May-Aug	2
▲ <i>Podophyllum hexandrum</i> Royle	Berberidaceae	Ban Kakri	Herb	White-Pink	-	Apr-Sep	2
<i>Persicaria amplexicaulis</i> (D. Don) Ronse Decr.	Polygonaceae	Dhonpelu	Herb	Red	-	Jun-Oct	3
<i>Ponerorchis chusua</i> (D. Don) Soó	Orchidaceae	-	Herb	Pink	-	Jul-Sep	2
<i>Potentilla argrophylla</i> Wall. ex Lehm.	Rosaceae	-	Herb	Yellow	-	Jul-Sep	2
<i>Potentilla atrosanguinea</i> G. Lodd. ex D. Don	Rosaceae	-	Herb	Red	-	Jul-Sep	1
<i>Potentilla eriocarpa</i> Wall. ex Lehm.	Rosaceae	-	Herb	Yellow	-	Jul-Sep	2
<i>Potentilla microphylla</i> D. Don	Rosaceae	-	Herb	Yellow	-	Jul-Sep	2
<i>Potentilla nepalensis</i> Hook. F.	Rosaceae	-	Herb	Pinkish-Red	-	Jun-Sep	3
<i>Primula denticulata</i> Sm	Primulaceae	Jal kutra	Herb	Purple	-	May-Jul	1
<i>Primula edgeworthii</i> Pax	Primulaceae	-	Herb	Purple	-	Jul-Oct	2
<i>Primula macrophylla</i> D. Don	Primulaceae	Jai-Vijay	Herb	Purple	-	Jul-Sep	2
<i>Primula reidii</i> Duthie	Primulaceae	Haishaderi	Herb	White	-	Jul-Sep	3
<i>Primula stuartii</i> Wall.	Primulaceae	Jai-Vijay	Herb	Yellow	-	Jul-Oct	2
<i>Ranunculus hirtellus</i> Royle	Ranunculaceae	-	Herb	Yellow	-	Jul-Sep	3
<i>Rhododendron anthopogon</i> D. Don	Ericaceae	-	Herb	Yellow	-	Apr-Oct	4
<i>Rhododendron barbatum</i> Wall. ex G. Don	Ericaceae	Chimal	Tree	Red	-	May-Oct	2
<i>Rhododendron campanulatum</i> D. Don	Ericaceae	Semru	Shrub	Purple-White	-	May-Oct	3

<i>Rhododendron lepidotum</i> Wall. ex G. Don	Ericaceae	-	Shrub	Pink	-	Apr-Oct	2
<i>Rhododendron rawatii</i> I.D.Rai & B.S.Adhikari	Ericaceae	-	Shrub	Pink	-	Apr-Oct	2
<i>Rosa macrophylla</i> Lindl.	Rosaceae	Dan kunja	Shrub	Pink	-	Jul-Nov	1
<i>Rosa sericea</i> Wall. ex Lindl	Rosaceae	-	Shrub	White	-	May-Sep	4
<i>Roscoea alpina</i> Royle	Zingiberaceae	Jilsuwa	Herb	Blue	-	Jul-Sep	3
<i>Salvia hians</i> Royle ex Benth.	Lamiaceae	-	Herb	Blue	-	May-Sep	3
<i>Salvia nubicola</i> Wall. ex Sweet	Lamiaceae	-	Herb	Yellow	-	Jun-Aug	4
<i>Saussurea gossypiphora</i> D.Don	Asteraceae	Hyunkaunl	Herb	White	Religious	Jul-Oct	1
<i>Saussurea obvallata</i> (DC.) Edgew. ▲	Asteraceae	Barmikaunl	Herb	Greenish white	Religious	Jul-Sep	1
<i>Saussurea simpsoniana</i> (Fielding & Gardner) Lipsch.	Asteraceae	Phen kaunl	Herb	Bluish-White	Religious	Jul-Aug	1
<i>Saxifraga parnassifolia</i> D. Don	Saxifragaceae	-	Herb	Yellow	-	Jul-Oct	4
<i>Selinum wallichianum</i> (DC.) Raizada & H.O. Saxena	Apiaceae	Chippi	Herb	White	As incense	Jul-Sep	3
<i>Senecio chrysanthemoides</i> DC.	Asteraceae	-	Herb	Yellow	-	Jun-Nov	2
<i>Silene edgeworthii</i> Bocquet	Caryophyllaceae	-	Herb	White	-	Aug-Oct	4
<i>Strobilanthes atropurpureus</i> Nees	Acanthaceae	-	Herb	Blue	-	Mar-Aug	4
<i>Swertia speciosa</i> Wall.	Gentianaceae	-	Herb	Yellowish-Green	-	Jul-Nov	3
<i>Tanacetum dolichophyllum</i> (Kitam.) Kitam.	Asteraceae	Guggal	Herb	Yellow	As incense	Jul-Sep	2
<i>Thermopsis barbata</i> Benth	Fabaceae	-	Herb	Red	-	May-Sep	2
<i>Trollius acaulis</i> Lindl	Ranunculaceae	-	Herb	Yellow	-	Apr-Oct	3
<i>Viburnum grandiflorum</i> Wall. ex DC.	Adoxaceae	Ghinaroo	Tree	Pinkish-White	-	Apr-Oct	3
<i>Viola biflora</i> L.	Violaceae	Dundi Birali	Herb	Yellow	-	Jun-Sep	3

▲ – Endangered ▼ - Critically endangered

Dactylorhiza hatagirea (D.Don) Soó, *Meconopsis aculeata* Royle, *Nardostachys jatamansi* (D.Don) DC. *Sinopodophyllum hexandrum* (Royle) T.S.Ying and *Saussurea obvallata* (DC.) Edgew. are critically endangered plant species of Himalayan region.

DISCUSSION

The present study was carried out to explore and document the wild ornamental plants of Rudraprayag district. Ornamental plants play a significant role in human health, wasteland development, landscaping of outdoor and indoor spaces to establish eco-friendly habitats (Babu *et al.*, 2017). It was found that this district of Uttarakhand (Rudraprayag) has a varied climate due to varied topography ranging from lowland/sub-tropical to upper alpine zones. Due to this reason, Rudraprayag possesses a rich diversity of WOPs and a total of 208 species of WOPs, belonging to 142 genera and 51 families were reported. The present study revealed that the alpine meadows (*Bugyals*) are the main repository of WOPs and famous among the inhabitants due to huge diversity of flowers and mat forming herbs and people travel 20-30 Kms from village to alpine region to view the beauty of alpine meadows and flowers.

Herbaceous life form was dominant in the entire altitudinal range (sub-tropical to alpine) and the same thing was reported by Reddy *et al.*, 2012 and Babu *et al.*, 2017 from different parts of India. Herbaceous plants are always much diverse than other life forms. The herbaceous layer is significant to the structure and function of forest ecosystems. Although, it represents less than 1% of the biomass of the forests, yet can contain 90% or more of the plant species of the forest and contribute up to 20% of the foliar litter to the forest floor—litter that is generally of higher nutrient content than that of trees (Gilliam, 2007). Moreover, the herbaceous communities are resilient to disturbances. Because species diversity is highest in the herb layer among all forest strata, forest biodiversity is largely a function of the herb-layer community. It has been found that the individual herb species are more highly aggregated than their woody neighbors, resulting in higher overall beta-diversity, which our results suggest is due to stronger habitat associations and dispersal limitation (Murphy *et al.*, 2016).

Some of the WOPs reported in the present study also have ethnomedicinal importance and are frequently used as first aid to cure many diseases like

cough, stomach ache, fever, cuts/wounds etc. Similar uses have been reported in various previous study (Kumar *et al.*, 2011b; Semwal *et al.*, 2010; Rathore *et al.*, 2015; Malik *et al.*, 2015; Singh *et al.*, 2017a, Singh *et al.*, 2017b, Singh *et al.*, 2019). As far as their conservation status is concerned, many WOPs are threatened, endangered, or critically endangered. High grazing pressure, over exploitation, habitat loss, and lack of awareness are the main factors that are held responsible for the population decline of these species from their natural habitats (Malik *et al.*, 2015; Singh *et al.*, 2019).

Ornamental plants with different colored flowers were reported but four colors including White, Red, Pink and Yellow were reported to be more attractive, dominant and most common in the whole altitudinal range of Uttarakhand. Similar results were reported by Babu *et al.*, 2017 from Eastern Ghats of India. Lázaro *et al.* (2008) also reported that flowers of white and yellow appearance to a human observer are represented by a more diverse range of plant species when considering the total number of plant species in an environment. Similar results were recently reported from Taiwan by Tai *et al.*, (2020) who reported that the most common floral colour in human vision was white (45%), followed by yellow (18%), pink (13%) and others. Their analysis of reflectance spectra showed that almost all white flowers are UV-absorbed white. Floral colors result from the selective absorption and reflection of ambient light in the tissues of flower petals. Ultraviolet reflections from some flowers impart colors that cannot be appreciated directly by human beings, and white flowers, which appear so abundant to humans, are almost all UV absorbing (Kevan *et al.*, 1996; Körner, 1999).

Landscape gardening and bio-aesthetic planning is a recent trend to establish eco-friendly human habitats (Reddy *et al.*, 2012). Exploration/documentation, collection and conservation of wild ornamental species can prove one of the alternate methods to maintain and conserve the diversity of the species especially the endemic, rare and endangered species with ornamental value. The present study also revealed that many WOPs have also the medicinal significance and hence the use of WOPs for decoration and medicine is widespread and increasing day by day. The whole Indian Himalayan Region supports a large number of such species but the continuous extraction and over exploitation of these WOPs can result in their population decline (Gosh *et al.*, 2017). Conservation, propagation and utilization of WOPs could be a major thrust area of research activity throughout this region. There is a need for the wide recognition of the contributions that WOPs make to the global economy and human welfare. Since most of the WOPs in the study area are extracted from the wild, it may lead to loss of genetic diversity and rapid depletion of a number of such species from their natural habitats (Singh, 2002). Domestication and cultivation of WOPs is one of the viable options to meet the growing demands from the industries and to reduce the extraction pressures in the natural habitats of WOPs. However, it is important to mention here that some WOPs such as orchids, pose challenges in cultivation through seeds due to the necessity of mycorrhizal associates for natural seed germination (Rasmussen *et al.*, 2015; Ticktin *et al.*, 2023).

CONCLUSION

The present study documented the wild ornamental plants of Rudraprayag district of Uttarakhand (Western Himalaya). The ornamental potentiality of plants is due to their attractive habit and good looking flowers. Rudraprayag has a rich diversity of WOPs and many such species have medicinal importance also. Due to such properties (*i.e.* ornamental and medicinal), many WOPs are over exploited and extracted in an unsustainable manner. Hence, the present study also emphasizes the need for their conservation for the existence of current and future generations. High grazing pressure, over exploitation, habitat loss, and lack of awareness are the established factors that are responsible for the population decline of these species from their natural habitats. Domestication and cultivation of such WOPs can help in reducing the extraction pressures in their natural habitats.

REFERENCES

- Aasati, B. S. and Yadav, D. S. 2004. Diversity of horticultural crops in North Eastern region. ENVIS Bulletin: Himalaya Ecology 12 (1).
- Arora, J. S. 1993. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.
- Babu, S. M. V., Rajagopal, R. S. and Madhusudana, R. A. 2017. Exploration of Wild ornamental flowering plants in Palakonda Hills of Eastern Ghats, India. Asian Journal of Conservation Biology 6 (1): 21-30.
- Drummond, A. and Strimmer, K. 2001. Frequently asked questions about evolution. Evolution Library 1367-4803.
- Gaur, R. D. 1999. Flora of the District Garhwal, North West Himalaya. Transmedia.
- Ghosh, S., Ganga, M., Priyanka, R. R., Manimaran, P. 2017. Endangered ornamental plant species in India and strategy for their conservation a review. Chemical Science Review Letters, 6(23), 1457-1464.
- Gilliam, F. S. 2007. The ecological significance of the herbaceous layer in temperate forest ecosystems. BioScience, 57(10): 845-858.
- Harris, R. W. 1992. Arboriculture. Integrated management of landscape trees, shrubs and vines. 2nd Edition. Regents, Prentice Hall, New Jersey, U.S.A.
- Joshi, B. and Pant, S. C. 2012. Ethnobotanical study of some common plants used among the tribal communities of Kashipur, Uttarakhand. Indian Journal of Natural Products and Resources 3(2):262-266.
- Kensa, V. M., Ancelsowmiya, S., Jijomickle, J., Meera, S., Sindhu, J., Sumathi, M. S. and Radhika, R. 2014. Exploration of ornamental floras in the campus of Bishop's house, Nagercoil, Kanyakumari District, India. International Journal of Current Microbiology and Applied Sciences (10): 441-448.
- Kevan, P., Giurfa, M., Chittka, L. 1996. Why are there so many and so few white flowers? Trends in Plant Science, 1(8): 252.

- Körner C (1999) Alpine plant life: Functional plant ecology of high mountain ecosystems. Springer Verlag, Berlin.
- Kumar, G. P., Kumar, R., Chaurasia, O. P. and Singh, S. B. 2011a. Current status and potential prospects of medicinal plant sector in trans-Himalayan Ladakh. *Journal of Medicinal Plants Research* 5 (14): 2929-2940.
- Kumar, M., Bussmann, R. W., Mukesh, J. and Kumar, P. 2011b. Ethnomedicinal uses of plants close to rural habitation in Garhwal Himalaya, India. *Journal of Medicinal Plant Research* 5(11):2252–2260.
- Lázaro, A., Hegland, S. J., and Totland, Ø. 2008. The relationships between floral traits and specificity of pollination systems in three Scandinavian plant communities. *Oecologia*, 157: 249–257.
- Malik, Z. A., Bhat, J. A., Ballabha, R., Bussmann, R. W. and Bhatt, A. B. 2015. Ethnomedicinal plants traditionally used in health care practices by inhabitants of Western Himalaya. *Journal of Ethnopharmacology* 172: 133-144.
- Naithani, B. D. 1984-1985. Flora of Chamoli. Botanical Survey of India. Howrah.
- Rai, I. D., Adhikari, B. S. and Gopal, G. S. 2012. Floral diversity along sub alpine and alpine ecosystem in Tungnath area of Kedarnath Wildlife Sanctuary, Uttarakhand. *Indian Forester* 138(10): 927-940.
- Rathore, S., Tiwari, J. K. and Malik, Z. A. 2015. Ethnomedicinal survey of herbaceous flora traditionally used in health care practices by inhabitants of Dhundsir gad watershed of Garhwal Himalaya, India. *Global Journal of Research on Medicinal Plants & Indigenous Medicine* 4(4): 65.
- Reddy, R. S., Reddy, A. M. and Yasodamma, N. 2012. Exploration of wild ornamental flora of YSR District Andhra Pradesh, India. *Indian Journal of Fundamental and Applied Life Sciences* 2(1): 192-199.
- Samant, S. S., Dhar, U. and Palni, L. M. S. 2003. Medicinal plants of Indian Himalayas: Diversity, distribution, potential values. *Gyanodya Prakashan, Nainital* pp:12-14.
- Semwal, D. P., Pardha, S. P., Kala, C. P. and Sajwan, B. S. 2010. Medicinal plants used by local Vaidyas in Ukhimath block, Uttarakhand. *Indian Journal of Traditional Knowledge* 9(3):480–485.
- Semwal, D. P., Saradhi, P. P., Nautiyal, B. P. and Bhatt, A. B. 2007. Current status, distribution and conservation of rare and endangered medicinal plants of Kedarnath Wildlife Sanctuary, Central Himalayas, India. *Current science* 92(12): 1733-1738.
- Singh, S., Bhat, J. A., Malik, Z. A., Youssouf, M., Bussmann, R. W. and Kunwar, R. M. 2019. Sacred groves in Western Himalaya, India: community-managed nature refuges for conservation of biodiversity and culture. *Ethnobotany Research and Applications* 18: 1-21.
- Singh, S., Youssouf, M., Malik, Z. A. and Bussmann, R. W. 2017b. Sacred groves: myths, beliefs, and biodiversity conservation—a case study from Western Himalaya, India. *International Journal of Ecology*. <https://doi.org/10.1155/2017/3828609>
- Swarup, V. 1998. Ornamental horticulture. Macmillan Indian Limited, New Delhi.
- Singh, A., Hart, R., Chandra, S., Nautiyal, M.C., Sayok, A.K. 2019. Traditional Herbal Knowledge among the Inhabitants: A Case Study in Urgan Valley of Chamoli Garhwal, Uttarakhand, India, Evidence-Based Complementary and Alternative Medicine (2019) 1-21. <https://doi.org/10.1155/2019/5656925>
- Tai, K. C., Shrestha, M., Dyer, A. G., Yang, E. C., & Wang, C. N. (2020). Floral colour diversity: how are signals shaped by elevational gradient on the tropical-subtropical mountainous island of Taiwan? *Frontiers in plant science* 11: 2037.
- Ticktin, T., Charitonidou, M., Douglas, J., Halley, J. M., Hernández-Apolinar, M., Liu, H., ... & Phelps, J. (2023). Wild orchids: A framework for identifying and improving sustainable harvest. *Biological Conservation* 277: 109816
- Thomas, B., Rajendran, A., Aravindhan, V., and Mahajan, M. 2011. Wild ornamental chasmophytic plants for rockery. *Global Journal of Modern Biology and Technology* 1(3): 20–21.
- Rasmussen, H. N., Dixon, K. W., Jersáková, J., & Těšitelová, T. (2015). Germination and seedling establishment in orchids: a complex of requirements. *Annals of Botany*, 116(3): 391-402.
- WGBH Educational Foundation. 2001. Roundtable: Mass Extinction", Evolution: a journey into where we're from and where we're going. <https://www.pbs.org/wgbh/evolution/extinction/massext/index.html>

