International Journal of Environment and Climate Change

Volume 14, Issue 12, Page 713-727, 2024; Article no.IJECC.129056
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Floristic Diversity and Seasonal Variation of Herbaceous Species in *Taxus contorta* Griff. Bearing Stands of Kashmir Himalayas

Tanveer Ahmad Rather [a++*], A.H. Mughal [b#], S.A. Gangoo [a†], K.N. Qaisar [c‡], J.A.Mugloo [d^] and S.N. Geelani [e^]

[a] Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Ganderbal-191201, India.
[b] Directorate of Research, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar-190025, India.
[c] Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar-190025, India.
[d] KVK-Malangpora, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar-190025, India.
[e] Division of SBS, Faculty of Forestry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar-190025, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors TAR and AHM designed the study, performed the statistical analysis and prepared the manuscript. Authors AHM, SAG, KNQ and JAM managed the analyses of the study and revived the final manuscript. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijecc/2024/v14i124657

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/129056

[++] *Research Scholar;*
[#] *Associate Director Research;*
[†] *Dean;*
[‡] *Controller of Examination;*
[^] *Head;*
**Corresponding author: E-mail: tanveerr817@gmail.com;*

Cite as: *Rather, Tanveer Ahmad, A.H. Mughal, S.A. Gangoo, K.N. Qaisar, J.A. Mugloo, and S.N. Geelani. 2024. "Floristic Diversity and Seasonal Variation of Herbaceous Species in Taxus Contorta Griff. Bearing Stands of Kashmir Himalayas". International Journal of Environment and Climate Change 14 (12):713-27. https://doi.org/10.9734/ijecc/2024/v14i124657.*

Original Research Article

Received: 27/10/2024
Accepted: 30/12/2024
Published: 30/12/2024

ABSTRACT

The study was conducted in the Kashmir himalayan region during the year 2022 to assess the plant diversity, the species associated with *Taxus contorta*, aspect and seasonal variation of herbaceous species in *Taxus* bearing sites of the Kashmir Himalayas. A total of 9 sites were selected across the Kashmir Himalayas Viz., S1-Pahalgam (Northwest), S2-Vastoorwan (Southeast), S3-Daksum (Northeast), S4-Naranag (Northeast), S5-Ganidobh (Southwest), S6-Gund (Northeast), S7-Tangmarg (Northwest), S8-Lolab (Southeast) and S9-Gulmarg (Northwest). The purposive sampling method was employed and three quadrants of size 1m×1m were laid at each site. A total of 57 herbs species belonging to 23 families were reported with Poaceae, Asteraceae and Lamiaceae, being dominant families recorded 12, 07 and 05 herb species respectively from study sites. Herb density peaked in summer at Ganidobh (S5) on the southwest aspect and was lowest in autumn at Daksum (S3) on the northeast aspect. The herbaceous density followed the trend in decending order Ganidobh > Lolab > Vastoorwan > Tangmarg > Gulmarg > Pahalgam > Gund > Naranag > Daksum. *Phytolacca acinosa* showed the highest IVI in spring season at S3 (23.34) and S2 (22.13) and the lowest IVI values were recorded for *Polygonum heterophyllum* (3.39) at S6 and *Viola odorata* at S9 (3.08). During the summer season, *Phytolacca acinosa* maintained dominance with an IVI of 27.52 at S3, while *Plantago lanceolata* (20.63) at S3, *Cannabis sativa* had notable values at S6 (19.58) and S4 (19.13). The lowest values were observed for *Thymus linearis* (3.57) at S9 and *Myosotis arvensis* (3.20) at S2. Similarly, in the autumn season**,** *Phytolacca acinosa* again recorded the highest IVI (28.34) at S3. The lowest IVI values included *Daucus carota* (2.21) at S2 and *Festuca rubra* (2.94) at S6. The IVI of herb species depends upon the density, basal area and frequency at the site. *Phytolacca acinosa* emerged as the dominant species exhibited the highest Importance Value Index (IVI) during spring (23.34), summer (27.52) and autumn (28.34) at Daksum (S3). *Cannabis sativa* dominated at Gund across all seasons, while *Plantago lanceolata* dominated at Gulmarg.

Keywords: Diversity; herbs; spring; dominance; density; IVI; kashmir Himalaya.

1. INTRODUCTION

The Kashmir Himalaya, situated in the northwestern part of the Himalayan region, is renowned for its diverse landscapes, encompassing forests, meadows and glaciers (Dar & Khuroo, 2020; Khuroo, 2015). Due to its wide range of habitats, the region is considered one of the most ecologically complex and biologically rich areas within the Himalayan Biodiversity Hotspot (Dar & Parthasarathy, 2022; Haq et al., 2020). Its topographical diversity and broad altitude range contribute significantly to its vast floristic diversity (Mir et al*.,* 2020). Although the region accounts for only 0.4% of India's land area, it hosts 12% of the nation's angiosperm species, emphasizing its remarkable biodiversity (Dar & Khuroo, 2013). However, like other Himalayan regions, Kashmir's biodiversity is under significant threat from multiple factors. Over recent decades, several plant species have become endangered due to habitat destruction, fragmentation, deforestation, overgrazing, invasive species, overexploitation, changes in land use, increased tourism, road construction and political instability (Dar, 2008; Khuroo et al*.,* 2018; Tali et al., 2019; Hamid et al*.,* 2020; Mir et al*.,* 2020). Hence various national and international campaigns have been launched to combat the global biodiversity crisis (Kullberg & Moilanen, 2014). Recognizing the importance of biodiversity, the Convention on Biological Diversity (CBD) established a goal in 2010 to conserve 17% of terrestrial areas under Protected Area (PA) Networks by 2020 (Saura et al*.,* 2019).

Several plant species in the Kashmir Himalaya are vital for the Indian pharmaceutical industry (Bhardwaj, 2023). However, their populations are declining due to unsustainable harvesting. Among these is the Western Himalayan yew (*Taxus contorta*), an endangered species with medicinal significance. Previously classified as

Taxus baccata and later as *Taxus wallichiana*, this species is known locally as "Poshtul" in Kashmiri and "Birmi" in Dogri (Kandari et al. 2012, Lanker et al. 2010). It grows naturally in shady, sheltered locations at altitudes ranging from 1,700 to 3,300 masl. The associated species of *Taxus contorta* are *Quercus semecarpifolia* (Kharshu) and *Abies pindrow* (Silver Fir), *Picea smithiana* (Spruce), *Cedrus deodara* (Deodar), and *Quercus dilatata* (Moru Oak). In the eastern Himalayas, it often grows alongside *Abies pindrow* and *Rhododendron* species. *Taxus contorta* is dioecious and evergreen tree species, it can regenerate through seeds, however its regeneration is hindered by slow germination, rapid loss of seed viability and low survival rates (Pande et al., 2002; Rajewski et al., 2000).

Efforts to conserve this species are essential for preserving its ecological and medicinal value. Therefore, to address gaps in understanding the ecological associates of *T. contorta* and habitat suitability (Chauhan et al., 2022). The present study was undertaken to assess the floristic diversity and seasonal variations of herbaceous species in the forests of Kashmir.

Seasonal dynamics and spatial variations significantly influence herb diversity in forest ecosystems. In spring, abundant light and minimal canopy closure allow abiotic factors, such as topography and soil nutrients, to shape herb diversity. In summer and autumn, reduced light due to canopy closure shifts the primary influence to biotic factors, particularly overstory trees. The structural complexity of the canopy becomes a more significant driver than overstory composition. Herb diversity is linked to microsite conditions, with soil nutrients being most important in spring, while light availability limits diversity in summer and autumn. Seasonal transitions show marked changes from spring to summer, with reduced light and herb turnover, but greater stability from summer to autumn. Our findings highlight the importance of considering seasonal and spatial factors in forest management to support herb diversity under changing environmental conditions.

2. METHODOLOGY

2.1 Study Area

Kashmir valley is located in the north-western extremity of India, between 34º 16'.67" North latitude and 74º75'.00" East longitude. The valley is located in the northern most latitude of the country holds almost central position in the continent of Asia. Average altitude of Kashmir valley (valley zone) ranges between 1, 500 to 2, 300 m above sea level. Total geographical area of the Jammu and Kashmir is 2,22,236 km2 out of which 78,114 km2 (35.15%) area lies under the occupation of Pakistan and 42,735 km2 (19.23%) under the occupation of China (including the area handed over by Pakistan to China). Therefore, the Union territory of J&K is left with an area of 101,387 km2 (45.62%). The present study on “Floristic diversity and seasonal variation of herbaceous species in *Taxus contorta* stands of Kashmir Himalayas” was carried out across the Kashmir valley. The 3 sites were selected for study from each 3 regions.

2.2 Sampling Procedure and Vegetational Analysis

Purposive sampling was employed to collect the floristic data. The total of 9 locations were selected for the study across the Kashmir valley. Phytosociological attributes of herbages were carried out in three seasons: spring, summer and autumn and 3 quadrants of size 1×1 were laid at each site. The plant samples collected were collected brought to the laboratory, washed properly with fresh running water and segregated

Table 1. Study site characteristics

Region	Sites		Aspect	Altitude (m)
South Kashmir	Pahalgam	S1	Northwest	2741
	Vastoorwan	S2	Southeast	1872
	Daksum	S3	Northeast	2992
Central Kashmir	Naranag	S4	Northeast	2624
	Ganidobh	S5	Souhwest	2128
	Gund	S6	Northeast	1774
North Kashmir	Tangmarg	S7	Northwest	2173
	Lolab	S8	Southeast	1851
	Gulmarg	S9	Northwest	2652

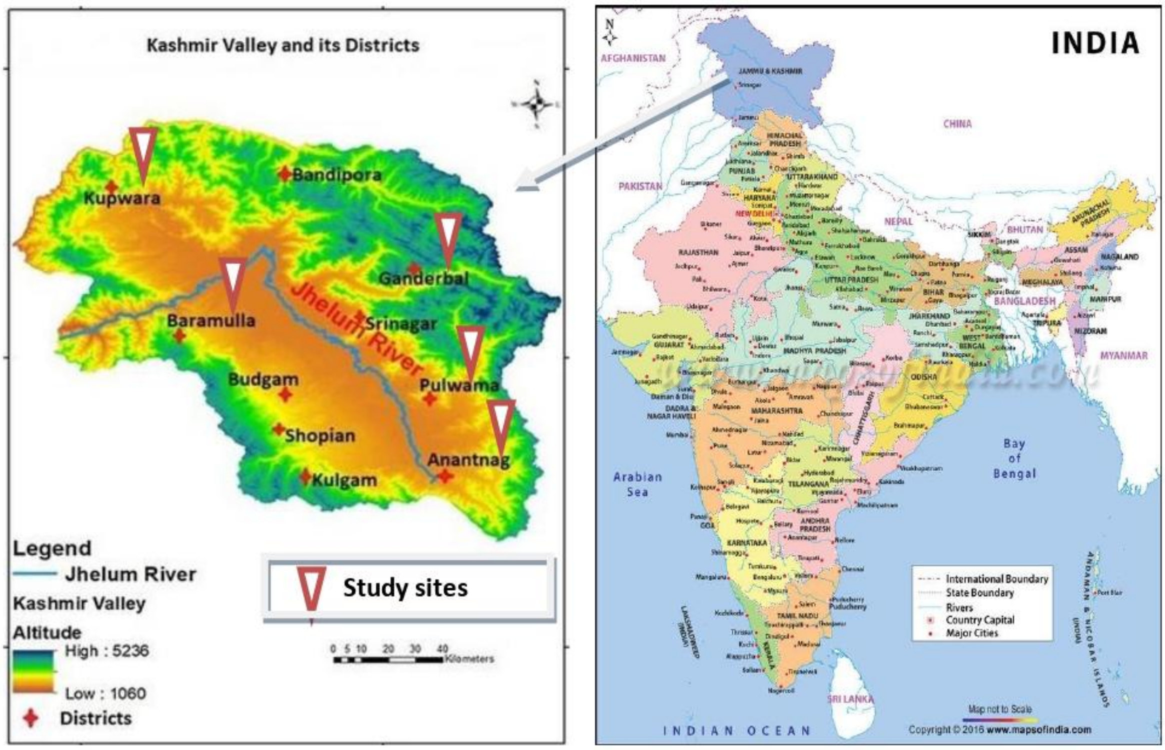

Plate 1. Map of the study area

species-wise. The collected specimens during growing season from study site and identified from Division of Environmental science, SKUAST-Kashmir and centre for Biodiversity and Taxonomy, Department of Botany, University of Kashmir. The individuals of each species from different quadrates were counted separately and their basal area was calculated following (Phillips, 1959). The following formula was used to determine the phytosociology:

i. **Floristic composition:** Presence or absence of species recorded during the spring, summer and autumn season.

ii. **Density:** Density was recorded as the number of tillers per unit area following (Misra, 1968).

$$\frac{Total\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrates}{Total\ number\ of\ quadrates\ studied}$$

iii. **Frequency (%):** Frequency (%) =

$$\frac{Number\ of\ quadrats\ in\ which\ the\ species\ occured}{Total\ number\ of\ quadrates\ studied} \times 100$$

iv. **Basal area (Misra, 1968):** Basal area = $\frac{\pi d^2}{4}$, where d = Diameter of tillers.

v. **Importance value index (IVI):** This index was used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance or basal area were summed up together and this value was designated as the Importance Value Index or IVI of the species (Misra, 1968).

vi. **Important value index** = Relative Density (RD) + Relative Frequency (RF) + Relative basal area (RBA)

3. RESULTS AND DISCUSSION

The present study recorded 57 herb species in the *T. contorta* Forest stands in Kashmir Valley. The highest herb species were reported from the Ganidobh site (39), Lolab (36) and Vastoorwan (35) at the southwest and southeast aspect and lowest at Daksum (23), Naranag (26) and Gund (27) along northeast aspect. The Importance Value Index (IVI) was recorded for herbaceous species at different sites in each spring, summer and autumn season. The highest IVI was reported for *Phytolacca acinosa* in spring (23.34), summer (27.52) and autumn (28.34) season at

S3-Daksum site respectively (Tables 2-4). The density of herbs was /recorded highest in summer season at the southwest aspect of Ganidobh site, followed by Southeast aspects of Vastoorwan and Lolab, then northwest of Pahalgam, Tangmarg and Gumarg. The lowest density was recorded in autumn season at the Northeast aspect of Daksum site (Fig. 1).

The study reported that the *Phytolacca acinosa* showed the highest IVI (28.34) at S3 in autumn season followed by summer season (27.52) and spring season (23.34) at the S3 (Daksum site) and *Thymus linearis* recorded the lowest IVI (2.80) at S5 and (2.72) at S9*.* The Importance Value Index (IVI) varied significantly across seasons, with *Phytolacca acinosa* consistently emerging as the most dominant species, reflecting its ecological adaptability and competitive strength.

In the spring season, *Phytolacca acinosa* recorded the highest IVI at S3 (23.34) and S2 (22.13), underscoring its prominent role in the floristic composition at these sites. Conversely, *Thymus linearis* had the lowest IVI at S5 (2.80), indicating its less dominance in spring season at the study sites (Table 2).

During the summer season, *Phytolacca acinosa* maintained its dominance, exhibited the highest IVI of 27.52 at S3 followed by 20.96 at S2 and 19.71 at S1. Meanwhile, *Thymus linearis* showed the lowest IVI at S4 (2.90), suggesting limited ecological presence during summer (Table 3).

In the autumn season**,** *Phytolacca acinosa* had the highest IVI, particularly at S3 (28.34), followed by S1 (20.92) and S4 (18.67). In contrast, the lowest IVI values were reported for *Daucus carota* (2.21), *Festuca arundinacea* (3.14), and *Poa annua* (3.20) at S2, indicating these species reduced ecological roles in autumn season (Table 4).

Overall, these findings highlightned *Phytolacca acinosa* as a consistently dominant species across all seasons, particularly at site S3 and S2 in spring, S3, S2 and S1 in summer and S3, S1 and S4 in autumn. Similarly, the other species like *Thymus linearis* and *Daucus carota* exhibited lower ecological significance. The variation in IVI underscores the influence of environmental factors and site-specific conditions on species dominance and distribution.

The maximum occurrence of species during spring and summer season at both sites could be due to availability of moisture provided mostly by rains and through other environmental factors. The presence of a wide range of species from different families underscores the ecological richness and complexity of this region. Our findings also highlight the richness and composition of plant species across different families and demonstrated that *Phytolacca acinosa* was the most dominant species across all seasons, with the highest IVI (28.34) recorded at S3 in autumn. Its consistent dominance reflected strong ecological adaptability and

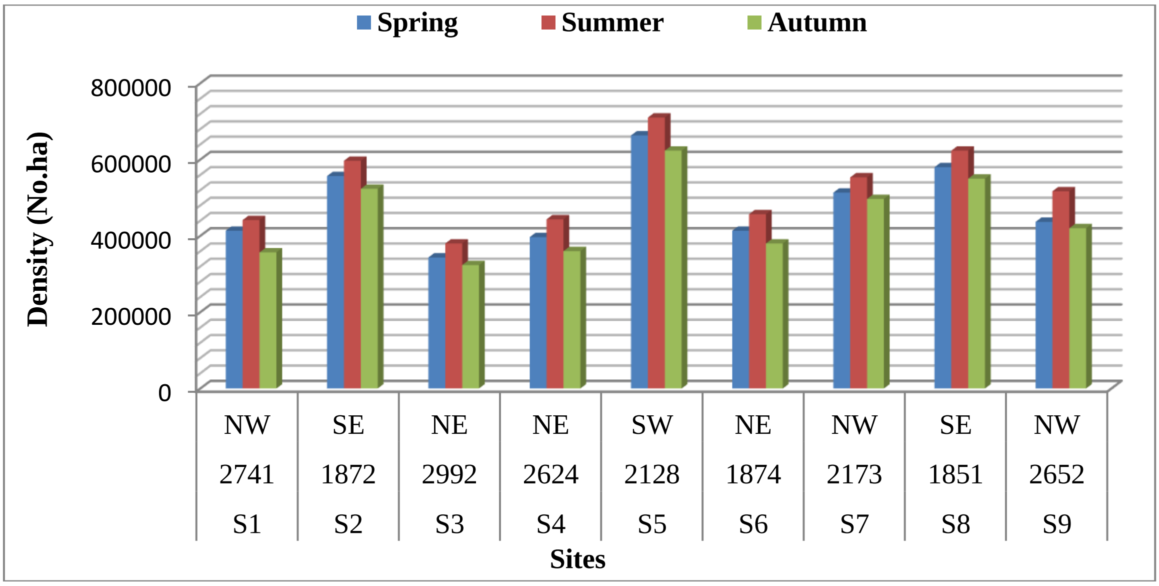

Fig. 1. Density (number/ha) of herb species at different sites in spring, summer and autumn season

Table 2. Importance value index of herbs in spring season at the different sites of kashmir himalayas

S. No.	Name of the species	Spring season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
1.	*Achillea millefolium*	12.13	-	-	-	6.93	10.9	7.93	9.67	10.76
2.	*Agrimonia eupatoria*	-	9.54	-	-	10.07	-	-	-	-
3.	*A. caudatus*	13.02	8.27	-	-	7.98	10.7	4.57	8.45	10.61
4.	*A. viridis*	-	9.42	-	-	11.21	14.37	-	10.61	-
5.	*Arctium lappa*	-	-	8.23	4.67	7.04	13.56	3.65	-	6.99
6.	*Arnebia hispidissima*	-	7.70	-	-	-	6.03	10.47	11.02	-
7.	*Artemisia absinthium*	10.03	-	12.89	10.02	9.90	-	6.53	10.87	15.08
8.	*Asplenium* spp.	-	-	13.25	13.45	-	9.45	7.93	-	7.58
9.	*Bothriochloa ischaemum*	-	6.58	-	-	5.33	-	7.92	5.47	6.66
10.	*Cannabis sativa*	-	13.87	19.05	15.71	11.45	20.3	-	-	-
11.	*Capsella bursa pastoris* M.	-	8.90	-	-	8.58	14.97	-	-	9.17
12.	*Centaurea iberica*	-	-	-	9.24	5.35	11.88	-	5.11	13.3
13.	*Chenopodium album* L.	-	-	-	-	-	-	-	-	-
14.	*Cichorium intybus*	9.60	-	-	-	5.43	-	3.54	6.29	8.17
15.	*Conyza canadensis*	-	-	20.71	-	10.92	12.09	-	-	-
16.	*Cymbopogan nardus*	13.74	7.56	17.45	-	-	-	6.73	6.91	6.53
17.	*Cynodon dactylon* L.	9.87	11.61	13.51	12.12	10.32	13.98	12.64	11.40	15.84
18.	*Daucus carota* L.	5.20	7.94	-	16.91	-	-	13.21	12.96	13.48
19.	*F. arundinacea*	-	2.98	-	6.92	-	-	-	-	-
20.	*F. rubra* L.	-	4.02	-	-	-	4.10	9.12	6.09	7.69
21.	*F. nubicula*	7.59	5.41	10.05	10.38	7.56	-	-	5.56	-
22.	*F. vesca*	-	6.75	-	14.6	4.69	8.33	10.31	9.79	-
23.	*Lespedeza* spp.	9.34	-	10.36	10.76	-	-	-	-	12.01
24.	*Lolium perenne*	12.47	10.32	-	12.81	8.29	-	11.91	9.79	10.19
25.	*Malva neglecta*	-	7.77	-	15.4	8.18	13.11	-	5.41	12.45
26.	*Marrubium vulgare*	18.64	-	13.55	12.29	7.14	11.31	10.93	-	7.80
27.	*Matricaria chamomilla*	-	11.94	-	-	-	-	8.78	7.73	10.22
28.	*Medicago minima* L.	15.01	12.39	-	-	9.90	-	13.04	9.29	12.02
29.	*Mentha longifolia* Huds.	10.68	9.04	9.88	-	7.35	-	-	11.18	-
30.	*M. spicata* L.	-	-	-	-	6.39	-	-	-	-
31.	*Myosotis arvensis* (L.)	-	-	-	-	-	-	-	-	-

S. No.	Name of the species	Spring season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
32.	*Nepata cataria L.*	9.49	-	-	-	5.60	-	-	8.04	-
33.	*Oxalis acetosella*	-	10.49	17.39	14.18	5.85	8.88	-	10.78	-
34.	*Oxalis corniculata* L.	6.60	9.43	14.9	14.33	5.30	7.08	12.20	10.26	-
35.	*Phytolacca acinosa*	20.12	22.13	23.34	17.04	9.62	-	14.70	-	-
36.	*Plantago lanceolata* L.	13.40	-	21.54	3.79	11.36	15.20	13.75	-	19.84
37.	*Plantago major* L.	-	13.39	12.89	8.44	7.97	-	9.14	9.29	-
38.	*P. annua*	14.93	7.19	3.35	-	-	-	11.91	9.72	-
39.	*P. bulbosa*	-	3.18	-	-	-	-	-	-	-
40.	*P. pretense*	-	6.40	8.34	-	5.18	-	9.12	7.00	-
41.	*Polygonum heterophyllum*	-	-	-	-	-	3.39	-	-	-
42.	*Prunella vulgaris*	-	3.97	-	13.05	-	-	-	6.34	-
43.	*Ranunculus hirtellus*	-	-	-	-	5.27	-	-	7.13	-
44.	*Rumex nepalensis*	-	6.40	13.55	10.68	9.31	-	-	9.80	-
45.	*Salvia moorcroftiana*	-	8.44	-	12.09	11.32	-	-	10.31	-
46.	*Scandix pectenveneris*	-	10.28	9.24	-	-	17.03	14.65	-	14.95
47.	*Setaria viridis* L.	-	9.87	-	-	-	-	-	-	-
48.	*Solanum nigrum*	-	12.39	11.41	12.1	10.04	-	-	-	-
49.	*Sorghum helpense*	12.90	-	-	-	6.20	8.58	11.78	7.29	6.81
50.	*Stipa sibirica*	10.22	-	15.09	-	5.97	17.21	7.93	-	10.63
51.	*Taraxicum officinale*	-	-	-	16.73	9.90	15.5	3.91	6.95	15.08
52.	*Thymus linearis* Benth.	-	-	-	-	2.80	-	-	-	-
53.	*T. pratense*	15.22	-	-	-	7.03	12.92	12.40	11.90	13.03
54.	*T. repens*	9.86	-	-	12.31	5.38	8.58	11.57	-	10.92
55.	*Urtica dioica*	19.03	-	-	-	5.88	-	7.89	5.73	9.12
56.	*Verbascum thapsus*	7.95	11.76	-	-	-	10.48	9.85	11.66	-
57.	*Viola odorata*	-	2.65	-	-	-	-	-	4.28	3.08

NW-North West, NE-North East, SE-South East, SW-South West, S1-Pahalgam, S2-Vastoorwan, S3- Daksum, S4-Naranag, S5-Ganidobh, S6-Gund, S7-Tangmarg, S8-Lolab, S9-Gulmarg, (-) Absence, (+) Presence

Table 3. Importance value index of herbs in summer season at the different sites of kashmir Himalayas

S. No.	Name of the species	Summer season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
1.	*Achillea millefolium*	12.02	-	-	-	9.34	13.29	8.59	9.94	11.86
2.	*Agrimonia eupatoria*	-	10.97	-	-	10.31	-	-	-	-
3.	*A. caudatus*	13.16	11.46	-	-	10.81	13.01	7.85	8.61	12.18
4.	*A. viridis*	8.33	9.99	-	-	10.96	15.08	-	13.18	-
5.	*Arctium lappa*	-	-	6.93	7.21	8.53	13.03	5.79	-	6.22
6.	*Arnebia hispidissima*	-	9.18	-	-	-	5.86	7.17	12.35	-
7.	*Artemisia absinthium*	8.77	-	16.97	12.09	9.95	-	7.23	10.70	12.79
8.	*Asplenium* spp.	-	-	13.82	12.19	-	8.69	7.23	-	5.15
9.	*Bothriochloa ischaemum*	-	7.44	-	-	5.07	-	7.81	5.15	6.96
10.	*Cannabis sativa*	-	15.32	18.72	19.13	11.39	19.58	-	-	-
11.	*Capsella bursa pastoris* M.	-	9.18	-	-	8.33	15.48	-	-	9.42
12.	*Centaurea iberica*	-	-	-	10.31	6.18	12.76	-	4.93	14.67
13.	*Chenopodium album* L.	7.42	6.79	12.74	-	-	12.33	7.44	8.12	7.73
14.	*Cichorium intybus*	11.61	-	-	-	5.22	-	3.41	6.12	7.32
15.	*Conyza canadensis*	-	-	18.56	-	9.93	10.83	-	-	-
16.	*Cymbopogan nardus*	11.95	6.96	16.77	-	-	-	6.48	6.74	5.88
17.	*Cynodon dactylon* L.	10.15	10.99	11.89	12.62	9.77	12.35	10.92	10.59	13.58
18.	*Daucus carota* L.	4.68	7.35	-	14.56	-	-	11.61	10.28	11.01
19.	*F. arundinacea*	-	2.82	-	7.55	-	-	-	-	-
20.	*F. rubra* L.	-	3.65	-	-	-	3.76	8.24	5.45	6.46
21.	*F. nubicula*	3.62	6.02	9.79	9.96	7.06	-	-	6.12	-
22.	*F. vesca*	-	6.21	-	13.95	4.38	4.71	10.06	9.03	-
23.	*Lespedeza* spp.	8.75	-	10.28	9.01	-	-	-	-	9.96
24.	*Lolium perenne*	10.89	9.09	-	12.17	7.50	-	10.51	8.69	8.49
25.	*Malva neglecta*	-	7.7	-	16.61	8.30	13.08	-	5.43	11.64
26.	*Marrubium vulgare*	16.75	-	13.69	12.19	7.32	11.34	10.99	-	7.29
27.	*Matricaria chamomilla*	-	11.13	-	-	-	-	8.13	7.27	8.74
28.	*Medicago minima* L.	13.13	10.97	-	-	9.09	-	11.96	8.63	10.26
29.	*Mentha longifolia* Huds.	9.20	8.09	8.97	-	6.72	-	-	10.22	-
30.	*M. spicata* L.	-	-	-	-	5.64	-	-	-	-
31.	*Myosotis arvensis* (L.)	-	-	-	-	-	-	3.20	-	5.78

S. No.	Name of the species	Summer season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
32.	*Nepata cataria L.*	9.59	-	-	-	4.99	-	-	7.09	-
33.	*Oxalis acetosella*	-	9.39	14.42	12.62	5.37	7.57	-	9.80	-
34.	*Oxalis corniculata* L.	7.40	8.93	12.34	14.41	4.92	6.75	10.51	9.43	-
35.	*Phytolacca acinosa*	19.71	20.96	27.52	15.68	9.27	-	13.83	-	-
36.	*Plantago lanceolata* L.	13.99	-	20.63	9	12.16	11.95	13.16	-	17.49
37.	*Plantago major* L.	-	12.11	11.93	9.13	7.42	-	7.23	8.71	-
38.	*P. annua*	13.58	6.61	5.70	-	-	-	11.06	9.11	-
39.	*P. bulbosa*	-	2.91	-	-	-	-	-	-	-
40.	*P. pretense*	-	5.68	7.40	-	5.31	-	8.15	6.17	-
41.	*Polygonum heterophyllum*	-	-	-	-	-	4.41	-	-	-
42.	*Prunella vulgaris*	-	3.47	-	11.13	-	-	-	5.66	-
43.	*Ranunculus hirtellus*	-	-	-	-	4.89	-	-	6.55	-
44.	*Rumex nepalensis*	-	7.95	12.33	9.38	9.43	-	-	8.94	-
45.	*Salvia moorcroftiana*	-	7.27	-	10.07	9.70	-	-	8.79	-
46.	*Scandix pectenveneris*	-	8.73	5.78	-	-	14.53	12.34	-	13.21
47.	*Setaria viridis* L.	-	9.01	-	-	-	-	-	-	-
48.	*Solanum nigrum*	-	10.97	8.56	10.49	9.09	-	-	-	-
49.	*Sorghum helpense*	12.07	-	-	-	5.82	9.14	12.56	6.81	9.42
50.	*Stipa sibirica*	10.62	-	14.28	-	5.73	16.26	7.51	-	12.09
51.	*Taraxicum officinale*	13.99	-	-	14.4	9.57	13.79	3.45	8.33	12.26
52.	*Thymus linearis* Benth.	-	-	-	2.90	3.56	-	-	-	3.57
53.	*T. pratense*	14.37	-	-	-	7.51	13.07	11.75	12.29	11.48
54.	*T. repens*	12.07	-	-	11.24	6.88	9.23	10.99	-	10.63
55.	*Urtica dioica*	15.85	-	-	-	6.6	-	7.18	7.82	11.07
56.	*Verbascum thapsus*	6.33	11.27	-	-	-	8.14	9.43	11.36	-
57.	*Viola odorata*	-	3.42	-	-	-	-	6.20	5.57	5.28

NW-North West, NE-North East, SE-South East, SW-South West, S1-Pahalgam, S2-Vastoorwan, S3- Daksum, S4-Naranag, S5-Ganidobh, S6-Gund, S7-Tangmarg, S8-Lolab, S9-Gulmarg, (-) Absence, (+) Presence

Table 4. Importance Value Index of herbs in autumn season at the different sites of Kashmir Himalayas

S. No.	Name of the species	Autumn season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
1.	*Achillea millefolium*	12.07	7.57	-	-	7.28	11.57	6.63	7.33	9.30
2.	*Agrimonia eupatoria*	-	9.65	-	-	10.12	-	-	-	-
3.	*A. caudatus*	11.07	9.02	-	-	9.55	12.63	5.28	9.60	9.99
4.	*A. viridis*	6.43	-	-	-	10.44	17.40	-	11.25	-
5.	*Arctium lappa*	-	8.34	5.51	5.13	7.70	12.06	3.81	-	7.48
6.	*Arnebia hispidissima*	-	-	-	-	-	4.83	9.08	11.56	-
7.	*Artemisia absinthium*	8.45	-	11.42	10.52	9.12	-	5.14	10.72	13.25
8.	*Asplenium* spp.	-	6.00	13.46	10.58	-	9.74	7.84	-	6.15
9.	*Bothriochloa ischaemum*	-	17.1	-	-	4.91	-	8.33	5.67	6.05
10.	*Cannabis sativa*	-	9.11	14.98	18.02	11.15	19.98	-	-	-
11.	*Capsella bursa pastoris* M.	-	-	-	-	9.24	14.79	-	-	8.23
12.	*Centaurea iberica*	-	4.55	-	9.95	5.69	10.89	-	5.51	11.9
13.	*Chenopodium album* L.	6.46	-	7.22	-	-	9.86	9.94	7.39	9.44
14.	*Cichorium intybus*	11.12	-	-	-	5.78	-	3.69	6.78	8.64
15.	*Conyza canadensis*	-	7.71	16.61	-	9.94	12.30	-	-	-
16.	*Cymbopogan nardus*	12.29	10.37	17.22	-	-	-	6.99	7.47	5.53
17.	*Cynodon dactylon* L.	10.19	7.05	13.11	11.99	9.34	12.55	11.82	10.86	11.41
18.	*Daucus carota* L.	3.52	2.21	-	13.1	-	-	12.62	11.41	11.26
19.	*F. arundinacea*	-	3.14	-	5.72	-	-	-	-	-
20.	*F. rubra* L.	-	4.58	-	-	-	2.94	8.82	6.02	7.77
21.	*F. nubicula*	8.03	5.8	9.15	10.06	5.78	-	-	5.69	-
22.	*F. vesca*	-	-	-	13.15	3.92	7.7	10.87	8.94	-
23.	*Lespedeza* spp.	7.36	8.31	9.97	9.13	-	-	-	-	10.46
24.	*Lolium perenne*	9.9	8.55	-	12.89	7.56	-	11.36	8.75	7.3
25.	*Malva neglecta*	-	-	-	17.79	8.2	13.08	-	6.00	12.19
26.	*Marrubium vulgare*	17.65	12.34	15.28	14.41	8.17	11.03	11.93	-	8.61
27.	*Matricaria chamomilla*	-	12.16	-	-	-	-	8.85	8.08	8.51
28.	*Medicago minima* L.	13.53	8.99	-	-	9.12	-	13.00	9.54	12.07
29.	*Mentha longifolia* Huds.	10.75	-	9.99	-	7.49	-	-	10.06	-
30.	*M. spicata* L.	-	-	-	-	6.25	-	-	-	-
31.	*Myosotis arvensis* (L.)	-	-	-	-	-	-	5.81	-	2.72

S. No.	Name of the species	Autumn season								
		S1	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**
32.	*Nepata cataria L.*	9.22	10.37	-	-	5.52	-	-	7.88	-
33.	*Oxalis acetosella*	-	9.84	16.09	11.99	5.95	8.39	-	9.96	-
34.	*Oxalis corniculata* L.	7.39	-	13.65	13.97	5.43	7.40	11.37	8.51	-
35.	*Phytolacca acinosa*	20.92	21.56	28.34	18.67	10.41	-	15.14	-	-
36.	*Plantago lanceolata* L.	14.05	13.46	23.44	6.45	12.31	13.64	14.37	-	18.90
37.	*Plantago major* L.	-	7.31	13.47	8.87	8.2	-	7.84	9.63	-
38.	*P. annua*	13.05	3.20	4.90	-	-	-	10.96	9.17	-
39.	*P. bulbosa*	-	6.25	-	-	-	-	-	-	-
40.	*P. pretense*	-	-	8.13	-	5.13	-	7.74	6.83	-
41.	*Polygonum heterophyllum*	-	3.84	-	-	-	3.33	-	-	-
42.	*Prunella vulgaris*	-	-	-	9.26	-	-	-	4.98	-
43.	*Ranunculus hirtellus*	-	7.60	-	-	5.40	-	-	7.26	-
44.	*Rumex nepalensis*	-	8.05	13.93	10.98	9.45	-	-	9.89	-
45.	*Salvia moorcroftiana*	-	9.71	-	11.81	10.81	-	-	9.81	-
46.	*Scandix pectenveneris*	-	8.95	10.71	-	-	16.39	11.83	-	15.71
47.	*Setaria viridis* L.	-	12.16	-	-	-	-	-	-	-
48.	*Solanum nigrum*	-	-	9.50	12.35	10.11	-	-	-	-
49.	*Sorghum helpense*	13.94	-	-	-	6.46	8.91	10.64	7.56	9.57
50.	*Stipa sibirica*	10.65	-	13.89	-	6.36	16.81	8.15	-	12.65
51.	*Taraxicum officinale*	16.34	-	-	16.89	9.72	12.56	3.73	6.88	13.08
52.	*Thymus linearis* Benth.	-	-	-	3.3	2.84	-	-	-	2.81
53.	*T. pratense*	13.79	-	-	-	7.45	13.29	10.52	10.69	13.57
54.	*T. repens*	10.89	-	-	13.02	5.65	8.99	9.60	-	11.15
55.	*Urtica dioica*	16.37	12.6	-	-	6.05	-	7.79	5.92	11.18
56.	*Verbascum thapsus*	4.56	2.55	-	-	-	6.93	5.87	12.72	-
57.	*Viola odorata*	-	-	-	-	-	-	2.65	3.70	3.07

NW-North West, NE-North East, SE-South East, SW-South West, S1-Pahalgam, S2-Vastoorwan, S3- Daksum, S4-Naranag, S5-Ganidobh, S6-Gund, S7-Tangmarg, S8-Lolab, S9-Gulmarg, (-) Absence, (+) Presence

competitive strength under varying environmental conditions. Conversely, species such as *Thymus linearis*, *Daucus carota, Festuca arundinacea* and *Poa annua* exhibited low IVI values, indicating reduced ecological presence. For example, *Thymus linearis* recorded the lowest IVI (2.80) at S5 in spring, likely due to resource limitations and competitive displacement. Seasonal variations in IVI highlighted the impact of climatic factors, such as temperature and moisture, on species dominance. *Phytolacca acinosa* thrived during spring and summer, with optimal conditions enhancing its performance. Site-specific factors also played a significant role, as S3 consistently provided the best conditions for its growth. These findings emphasized the importance of environmental and competitive factors in shaping plant community structure and inform biodiversity conservation strategies. Opportunistic species, which are highly light-dependent, quickly occupy gaps in vegetation. Their establishment is facilitated by increased light, water availability and accelerated organic matter decomposition, all of which provide essential resources for herbaceous species to thrive.

Key physiographic features such as slope, aspect, parent material and soil properties are crucial in defining vegetation patterns across different landscapes (Barnes et al*.,* 1997). Each species has specific resource needs or tolerances, enabling some to outcompete others in certain environments (Glatzel, 2009). Evidence suggests that understorey vegetation tends to proliferate during the early stages of succession when open conditions favor species invasion (Gairola et al*.,* 2008). In forest ecosystems, resource distribution is often spatially heterogeneous, creating multiple niches even within small areas due to significant variations in resource availability (Balandier et al*.,* 2006). Seasonal resource fluctuations further contribute to competitive dynamics, where no single species can dominate consistently under changing conditions (Lambers et al*.,* 1998; Grime, 2001). The high species density observed during spring and summer is likely linked to increased moisture availability from rainfall and other environmental factors. Similar patterns have been documented in previous studies (Hussain et al*.,* 2019; Sharma & Upadhyay 2002; Baba et al*.,* 2017). Additionally, Alhassan et al*.,* (2006) identified climatic variables as significant contributors to variations in species diversity and abundance.

The reduction in understorey vegetation can be attributed to differences in overstorey tree species and their densities, which alter microclimatic conditions (Anderson et al*.,* 1968; Alaback and Herman, 1988; Thomas et al*.,* 1999). Furthermore, changes in environmental factors such as altitude, aspect and litter accumulation on the soil surface regulated by the balance between litter production and decomposition affect microhabitats (Berg and Staaf, 1981; Staelens et al*.,* 2003). Studies by Tasveer, (2022), Rizvi, (2021) and Hussain et al*.,* (2019) also report similar patterns of herbaceous vegetation in Special Forest Division Tangmarg Dar, (2007), Hao et al., (2015).

4. CONCLUSION

The present study conducted in the Kashmir valley at 4 different aspects (Northwest, Northeast, Southeast and Southwest aspect) reveals diverse floristic composition and seasonal variation with 57 reported herbs from 23 familes across the study sites. The density of herbs was recorded highest in summer season of Ganidobh (S5) site at southwest aspect and lowest in autumn season at Northeast aspect of Daksum (S3) site and followed the trend in decending order Ganidobh > Lolab > Vastoorwan > Tangmarg > Gulmarg > Pahalgam > Gund > Naranag > Daksum. The highest Importance Value Index (IVI) for *Phytolacca acinosa* occurs at S3 in each spring, summer and autumn season. The highest Importance Value Index (IVI) was recorded for *Phytolacca acinosa* during the spring, summer and autumn season at the Pahalgam, Vastoorwan, Daksum and Tangmarg site. At the Naranag site, *Phytolacca acinosa* exhibited highest IVI in the spring and autumn seasons. *Cannabis sativa* was recorded with highest IVI across all the three season spring, summer and autumn at the Gund site, in the summer season at Naranag and in the spring season at Ganidobh site. Similarly at Lolab site, *Daucus carota* had highest IVI in spring season, *Amaranthus viridis* in summer and *Verbascum thapsus* in autumn season. *Plantago lanceolata* was reported with the highest IVI during the spring, summer and autumn seasons at Gulmarg and also achieved the highest IVI at Ganidobh in summer and autumn seasons.

SUPPLEMENATRY MATERIALS

Supplementary materials available in this link:https://journalijecc.com/index.php/IJECC/libraryFiles/downloadPublic/23

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have not been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENT

The authors are grateful to the Faculty of Forestry SKUAST-K especially Head division of SAF (Prof. G.M. Bhat) and my dear friends Dr. Mudasir Rashid Bhat & Dr. Arsheed Ah. Mir

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Alaback, P. B., & Hermann, F. R. (1988). Long term response of understorey vegetation to stand density in *Picea* and *Tsuga* forest. *Canadian Journal of Forest Research, 18*, 1522–1530.

Alhassan, A. B., Chiroma, A. M., & Kundiri, A. M. (2006). Properties and classification of soils of Kajimaram Oasis of Northeast Nigeria. *International Journal of Agriculture and Biology, 8*, 256–261.

Anderson, R. C., Louks, O. L., & Swain, A. M. (1968). Herbaceous response to canopy cover, light intensity and throughfall precipitation in coniferous forests. *Ecology, 50*, 255–263.

Baba, A. A., Geelani, S. N., Saleem, I., & Husain, M. (2017). Phytosociological status of the selected sites (Protected site) for assessing the effect of grazing in Kashmir Valley, India. *Journal of Pharmacognosy and Photochemistry, 6*(4), 388–393.

Balandier, P., Collet, C., Miller, J. H., Reynolds, P. E., & Zedaker, S. M. (2006). Designing forest vegetation management strategies based on the mechanisms and dynamics of crop tree competition by neighbouring vegetation. *Forestry, 79*(1), 3–27.

Barnes, B. V., Zak, D. R., Denton, S. R., & Spurr, S. H. (1997). *Forest Ecology* (4th ed.). John Wiley and Sons, Inc.

Berg, B., & Staaf, H. (1981). Chemical composition of main plant litter components at Invejarsheden - Data from the decomposition studies. *Swedish Central Forest Project International Research Report, 104*(7), 3–4.

Bhardwaj, V. (2023). *Taxus wallichiana* Zucc. (Himalayan yew): A medicinal plant exhibiting antibacterial properties. *Advances in Experimental Medicine and Biology, 1370*, 145–153. https://doi.org/10.1007/5584_2023_772

Chauhan, S., Ghoshal, S., Kanwal, K. S., Sharma, V., & Ravikanth, G. (2022). Ecological niche modelling for predicting the habitat suitability of endangered tree species *Taxus contorta* Griff. in Himachal Pradesh (Western Himalayas, India). *Tropical Ecology, 63*(2), 300–313.

Dar, A. A., & Parthasarathy, N. (2022). Tree species composition, stand structure and distribution patterns across three Kashmir Himalayan forests, India. *Écoscience, 29*(4), 1–14. https://doi.org/10.1080/11956860.2022.2048534

Dar, A. R. (2008). Narrow endemic angiosperms of the Kashmir Himalaya: Threat assessment and conservation. In M. Z. Chisti & F. Ahmad (Eds.), *Science for Better Tomorrow* (pp. 31–39).

Dar, G. H. (2007). Medicinal flora of the Kashmir Himalaya: A taxonomic overview. *The Journal of Himalayan Ecology and Sustainable Development, 2*, 13–20.

Dar, G. H., & Khuroo, A. A. (2013). Floristic diversity in the Kashmir Himalaya: Progress, problems and prospects. *Sains Malay, 42*(10), 1377–1386.

Dar, G. H., & Khuroo, A. A. (2020). An introduction to biodiversity of the Himalaya: Jammu and Kashmir state. In G. H. Dar & A. A. Khuroo (Eds.), *Biodiversity of the Himalaya*.

Gairola, S., Rawal, R. S., & Todaria, N. P. (2008). Forest vegetation patterns along an altitudinal gradient in the sub-alpine zone of west Himalaya, India. *African Journal of Plant Science, 2*(6), 42–48.

Glatzel, G. (2009). Mountain forests in a changing world: An epilogue. *Mountain Research and Development, 29*, 188–190.

Grime, J. P. (2001). *Plant Strategies, Vegetation Processes, and Ecosystem Properties* (2nd ed.). John Wiley & Sons.

Hamid, M., Khuroo, A. A., Malik, A. H., Ahmad, R., & Singh, C. P. (2020). Assessment of alpine summit flora in Kashmir Himalaya and its implications for long-term monitoring of climate change impacts.

Journal of Mountain Science, 17(8), 1974–1988. https://doi.org/10.1007/s11629-019-5924-7

Hao, D. C., Gu, X. J., & Xiao, P. G. (2015). *Taxus* medicinal resources: A comprehensive study. In D. C. Hao, X. J. Gu, & P. G. Xiao (Eds.), *Medicinal Plants* (pp. 97–136). Woodhead Publishing. https://doi.org/10.1016/B978-0-08-100085-4.000037

Haq, S. M., Calixto, E. S., & Kumar, M. (2020). Assessing biodiversity and productivity over a small-scale gradient in the protected forests of Indian western Himalayas. *Journal of Sustainable Forestry, 40*(7), 1–20. https://doi.org/10.1080/10549811.2020.1803918

Hussain, M., Geelani, S. N., Mughal, A. H., Wani, A. A., & Bhat, G. M. (2019). Floristic composition of alpine grassland in Gulmarg Kashmir. *Range Management and Agroforestry, 40*(2), 188–195.

Kandari, L., Phondani, P., Payal, K., Rao, K., & Maikhuri, R. (2012). Ethnobotanical study towards conservation of medicinal and aromatic plants in upper catchments of Dhauli Ganga in the central Himalaya. *Journal of Mountain Science, 9*, 286–296.

Khuroo, A. A. (2015). Himadri site in Kashmir Himalaya. *ENVIS Newsletter on Himalayan Ecology, 12*(2), 4.

Khuroo, A. A., Shapoo, G. A., Rasheed, S., Kaloo, Z. A., & Rafiq, S. (2018). *Goodyera fusca* (Orchidaceae): A new record for Kashmir Himalaya, India. *Lankesteriana, 18*(2), 151–154. https://doi.org/10.15517/lank.v18i2.34219

Kullberg, P., & Moilanen, A. (2014). How do recent spatial biodiversity analyses support the convention on biological diversity in the expansion of the global conservation area network? *Natureza & Conservação, 12*(1), 3–10. https://doi.org/10.4322/natcon.2014.002

Lambers, H., Chapin III, F. S., & Pons, T. L. (1998). *Plant Physiological Ecology*. Springer Verlag.

Lanker, U., Malik, A. R., Gupta, N. K., & Butola, J. S. (2010). Natural regeneration status of the endangered medicinal plant, *Taxus baccata* Hook. F. syn. *T. wallichiana*, in northwest Himalaya. *International Journal of Biodiversity Science and Ecosystem Service Management, 6*, 20–27.

Mir, A. H., Tyub, S., & Kamili, A. N. (2020). Ecology, distribution mapping and conservation implications of four critically endangered endemic plants of Kashmir Himalaya. *Saudi Journal of Biological Sciences, 27*(9), 2380–2389. https://doi.org/10.1016/j.sjbs.2020.05.006

Misra, R. (1968). *Ecology Work Book*. Oxford and IBH Publishing Company.

Pande, P. K., Negi, J. D. S., & Sharma, S. C. (2002). Plant species diversity, composition, gradient analysis, and regeneration behavior of some tree species in a moist temperate western-Himalayan forest ecosystem. *Indian Forester, 128*(8), 869–886.

Phillips, E. A. (1959). *Methods of Vegetation Study*. Henry Holt & Co. Inc.

Rajewski, M. S., Lange, D., & Hattemer, H. H. (2000). Problems of reproduction in the genetic conservation of rare tree species: The example of common yew (*Taxus baccata* L.). *Forest Snow Landscape Research*, 251–266.

Rizvi, Z. S. (2021). Edapho-ecological characteristics and natural regeneration status of Silver fir (*Abies pindrow*) in special forest division Tangmarg. (Master's thesis). Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir.

Saura, S., Bertzky, B., Bastin, L., Battistella, L., Mandrici, A., & Dubois, G. (2019). Global trends in protected area connectivity from 2010 to 2018. *Biological Conservation, 238*, 108183. https://doi.org/10.1016/j.biocon.2019.07.028

Sharma, K. P., & Upadhyaya, B. P. (2002). Phytosociology, primary production and nutrient retention in herbaceous vegetation of the forestry arboretum on the Aravalli hills at Jaipur. *Tropical Ecology*, 325–335.

Staelens, J., Nachtergale, L., Luyssaert, S., & Lust, N. (2003). A model of wind-influenced leaf litterfall in a mixed hardwood forest. *Canadian Journal of Forest Research, 33*(2), 201–209.

Tali, B. A., Khuroo, A. A., Nawchoo, I. A., & Ganie, A. H. (2019). Prioritizing conservation of medicinal flora in the Himalayan biodiversity hotspot: An integrated ecological and socioeconomic approach. *Environmental Conservation,* *46*(2), 147–154. https://doi.org/10.1017/S0376892918000425

Tasveer, S. (2022). Regeneration status of different conifers in Gulmarg Forest Range of Kashmir Himalayas. (Master's thesis). Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir.

Thomas, S. C., Halpren, C. B., Falk, D. A., & Austin, K. A. (1999). Plant diversity in managed forests: Understorey response to thinning and fertilization. *Applied Ecology, 9*, 864–879.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/129056