

Floristic diversity and seasonal variation of herbaceous species in *Taxus contorta* Griff. bearing stands of Kashmir Himalayas

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 herb 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 descending 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 34° 16'.67" North latitude and 74°75'.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.

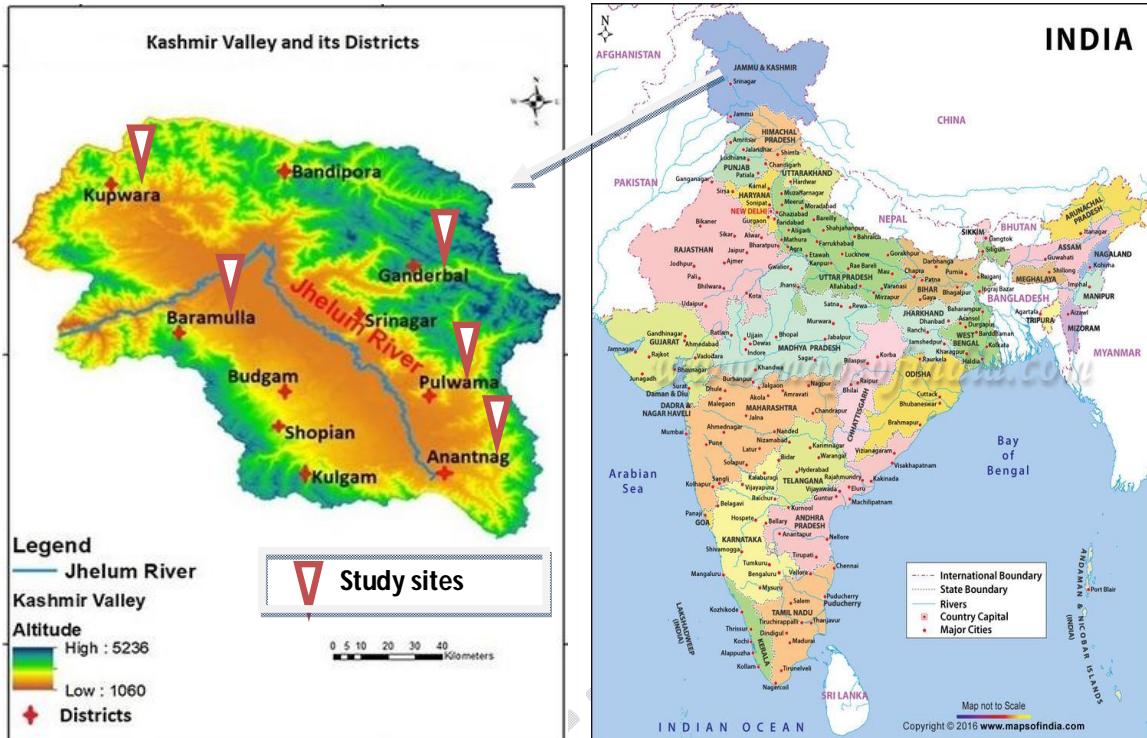


Plate 1. Map of the study area

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

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 herbage 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 brought to the laboratory, washed properly with fresh running water and segregated 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).

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

iii. Frequency (%)

$$\text{Frequency (\%)} = \frac{\text{Number of quadrats in which the species occurred}}{\text{Total number of quadrates studied}} \times 100$$

iv. Basal area (Misra, 1968)

$$\text{Basal area} = \frac{\pi d^2}{4}, \text{ where } d = \text{Diameter of tillers}$$

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)

Important Value Index = Relative Density (RD) + Relative Frequency (RF) + Relative basal area (RBA)

3. RESULTS & 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 for reported for *Phytolacca acinosa* in spring (23.34), summer (27.52) and autumn (28.34) season at S3-Daksum site respectively (Table 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).

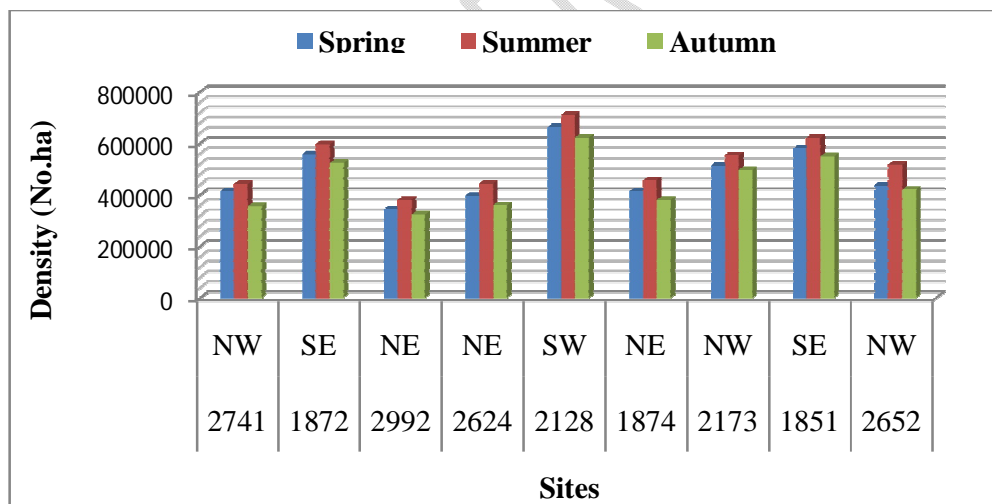


Fig. 1: Density (number/ha) of herb species at different sites in spring, summer and autumn season

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 highlighted *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.

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.	<i>Achillea millefolium</i>	12.13	-	-	-	6.93	10.9	7.93	9.67	10.76
2.	<i>Agrimonia eupatoria</i>	-	9.54	-	-	10.07	-	-	-	-
3.	<i>A. caudatus</i>	13.02	8.27	-	-	7.98	10.7	4.57	8.45	10.61
4.	<i>A. viridis</i>	-	9.42	-	-	11.21	14.37	-	10.61	-
5.	<i>Arctium lappa</i>	-	-	8.23	4.67	7.04	13.56	3.65	-	6.99
6.	<i>Arnebia hispidissima</i>	-	7.70	-	-	-	6.03	10.47	11.02	-
7.	<i>Artemisia absinthium</i>	10.03	-	12.89	10.02	9.90	-	6.53	10.87	15.08
8.	<i>Asplenium spp.</i>	-	-	13.25	13.45	-	9.45	7.93	-	7.58
9.	<i>Bothriochloa ischaemum</i>	-	6.58	-	-	5.33	-	7.92	5.47	6.66
10.	<i>Cannabis sativa</i>	-	13.87	19.05	15.71	11.45	20.3	-	-	-
11.	<i>Capsella bursa pastoris</i> M.	-	8.90	-	-	8.58	14.97	-	-	9.17
12.	<i>Centaurea iberica</i>	-	-	-	9.24	5.35	11.88	-	5.11	13.3
13.	<i>Chenopodium album</i> L.	-	-	-	-	-	-	-	-	-
14.	<i>Cichorium intybus</i>	9.60	-	-	-	5.43	-	3.54	6.29	8.17
15.	<i>Conyza canadensis</i>	-	-	20.71	-	10.92	12.09	-	-	-
16.	<i>Cymbopogon nardus</i>	13.74	7.56	17.45	-	-	-	6.73	6.91	6.53
17.	<i>Cynodon dactylon</i> L.	9.87	11.61	13.51	12.12	10.32	13.98	12.64	11.40	15.84
18.	<i>Daucus carota</i> L.	5.20	7.94	-	16.91	-	-	13.21	12.96	13.48
19.	<i>F. arundinacea</i>	-	2.98	-	6.92	-	-	-	-	-
20.	<i>F. rubra</i> L.	-	4.02	-	-	-	4.10	9.12	6.09	7.69
21.	<i>F. nubicula</i>	7.59	5.41	10.05	10.38	7.56	-	-	5.56	-
22.	<i>F. vesca</i>	-	6.75	-	14.6	4.69	8.33	10.31	9.79	-
23.	<i>Lespedeza spp.</i>	9.34	-	10.36	10.76	-	-	-	-	12.01
24.	<i>Lolium perenne</i>	12.47	10.32	-	12.81	8.29	-	11.91	9.79	10.19
25.	<i>Malva neglecta</i>	-	7.77	-	15.4	8.18	13.11	-	5.41	12.45
26.	<i>Marrubium vulgare</i>	18.64	-	13.55	12.29	7.14	11.31	10.93	-	7.80
27.	<i>Matricaria chamomilla</i>	-	11.94	-	-	-	-	8.78	7.73	10.22
28.	<i>Medicago minima</i> L.	15.01	12.39	-	-	9.90	-	13.04	9.29	12.02
29.	<i>Mentha longifolia</i> Huds.	10.68	9.04	9.88	-	7.35	-	-	11.18	-
30.	<i>M. spicata</i> L.	-	-	-	-	6.39	-	-	-	-
31.	<i>Myosotis arvensis</i> (L.)	-	-	-	-	-	-	-	-	-
32.	<i>Nepata cataria</i> L.	9.49	-	-	-	5.60	-	-	8.04	-
33.	<i>Oxalis acetosella</i>	-	10.49	17.39	14.18	5.85	8.88	-	10.78	-
34.	<i>Oxalis corniculata</i> L.	6.60	9.43	14.9	14.33	5.30	7.08	12.20	10.26	-
35.	<i>Phytolacca acinosa</i>	20.12	22.13	23.34	17.04	9.62	-	14.70	-	-
36.	<i>Plantago lanceolata</i> L.	13.40	-	21.54	3.79	11.36	15.20	13.75	-	19.84
37.	<i>Plantago major</i> L.	-	13.39	12.89	8.44	7.97	-	9.14	9.29	-
38.	<i>P. annua</i>	14.93	7.19	3.35	-	-	-	11.91	9.72	-
39.	<i>P. bulbosa</i>	-	3.18	-	-	-	-	-	-	-
40.	<i>P. pretense</i>	-	6.40	8.34	-	5.18	-	9.12	7.00	-
41.	<i>Polygonum heterophyllum</i>	-	-	-	-	-	3.39	-	-	-
42.	<i>Prunella vulgaris</i>	-	3.97	-	13.05	-	-	-	6.34	-
43.	<i>Ranunculus hirtellus</i>	-	-	-	-	5.27	-	-	7.13	-
44.	<i>Rumex nepalensis</i>	-	6.40	13.55	10.68	9.31	-	-	9.80	-

45.	<i>Salvia moorcroftiana</i>	-	8.44	-	12.09	11.32	-	-	10.31	-
46.	<i>Scandix pectenvenensis</i>	-	10.28	9.24	-	-	17.03	14.65	-	14.95
47.	<i>Setaria viridis</i> L.	-	9.87	-	-	-	-	-	-	-
48.	<i>Solanum nigrum</i>	-	12.39	11.41	12.1	10.04	-	-	-	-
49.	<i>Sorghum helpense</i>	12.90	-	-	-	6.20	8.58	11.78	7.29	6.81
50.	<i>Stipa sibirica</i>	10.22	-	15.09	-	5.97	17.21	7.93	-	10.63
51.	<i>Taraxicum officinale</i>	-	-	-	16.73	9.90	15.5	3.91	6.95	15.08
52.	<i>Thymus linearis</i> Benth.	-	-	-	-	2.80	-	-	-	-
53.	<i>T. pratense</i>	15.22	-	-	-	7.03	12.92	12.40	11.90	13.03
54.	<i>T. repens</i>	9.86	-	-	12.31	5.38	8.58	11.57	-	10.92
55.	<i>Urtica dioica</i>	19.03	-	-	-	5.88	-	7.89	5.73	9.12
56.	<i>Verbasicum thapus</i>	7.95	11.76	-	-	-	10.48	9.85	11.66	-
57.	<i>Viola odorata</i>	-	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.	<i>Achillea millefolium</i>	12.02	-	-	-	9.34	13.29	8.59	9.94	11.86
2.	<i>Agrimonia eupatoria</i>	-	10.97	-	-	10.31	-	-	-	-
3.	<i>A. caudatus</i>	13.16	11.46	-	-	10.81	13.01	7.85	8.61	12.18
4.	<i>A. viridis</i>	8.33	9.99	-	-	10.96	15.08	-	13.18	-
5.	<i>Arctium lappa</i>	-	-	6.93	7.21	8.53	13.03	5.79	-	6.22
6.	<i>Arnebia hispidissima</i>	-	9.18	-	-	-	5.86	7.17	12.35	-
7.	<i>Artemisia absinthium</i>	8.77	-	16.97	12.09	9.95	-	7.23	10.70	12.79
8.	<i>Asplenium</i> spp.	-	-	13.82	12.19	-	8.69	7.23	-	5.15
9.	<i>Bothriochloa ischaemum</i>	-	7.44	-	-	5.07	-	7.81	5.15	6.96
10.	<i>Cannabis sativa</i>	-	15.32	18.72	19.13	11.39	19.58	-	-	-
11.	<i>Capsella bursa pastoris</i> M.	-	9.18	-	-	8.33	15.48	-	-	9.42
12.	<i>Centaurea iberica</i>	-	-	-	10.31	6.18	12.76	-	4.93	14.67
13.	<i>Chenopodium album</i> L.	7.42	6.79	12.74	-	-	12.33	7.44	8.12	7.73
14.	<i>Cichorium intybus</i>	11.61	-	-	-	5.22	-	3.41	6.12	7.32
15.	<i>Conyza canadensis</i>	-	-	18.56	-	9.93	10.83	-	-	-
16.	<i>Cymbopogan nardus</i>	11.95	6.96	16.77	-	-	-	6.48	6.74	5.88
17.	<i>Cynodon dactylon</i> L.	10.15	10.99	11.89	12.62	9.77	12.35	10.92	10.59	13.58
18.	<i>Daucus carota</i> L.	4.68	7.35	-	14.56	-	-	11.61	10.28	11.01
19.	<i>F. arundinacea</i>	-	2.82	-	7.55	-	-	-	-	-
20.	<i>F. rubra</i> L.	-	3.65	-	-	-	3.76	8.24	5.45	6.46
21.	<i>F. nubicula</i>	3.62	6.02	9.79	9.96	7.06	-	-	6.12	-
22.	<i>F. vesca</i>	-	6.21	-	13.95	4.38	4.71	10.06	9.03	-
23.	<i>Lespedeza</i> spp.	8.75	-	10.28	9.01	-	-	-	-	9.96
24.	<i>Lolium perenne</i>	10.89	9.09	-	12.17	7.50	-	10.51	8.69	8.49
25.	<i>Malva neglecta</i>	-	7.7	-	16.61	8.30	13.08	-	5.43	11.64
26.	<i>Marrubium vulgare</i>	16.75	-	13.69	12.19	7.32	11.34	10.99	-	7.29

27.	<i>Matricaria chamomilla</i>	-	11.13	-	-	-	-	8.13	7.27	8.74
28.	<i>Medicago minima</i> L.	13.13	10.97	-	-	9.09	-	11.96	8.63	10.26
29.	<i>Mentha longifolia</i> Huds.	9.20	8.09	8.97	-	6.72	-	-	10.22	-
30.	<i>M. spicata</i> L.	-	-	-	-	5.64	-	-	-	-
31.	<i>Myosotis arvensis</i> (L.)	-	-	-	-	-	-	3.20	-	5.78
32.	<i>Nepeta cataria</i> L.	9.59	-	-	-	4.99	-	-	7.09	-
33.	<i>Oxalis acetosella</i>	-	9.39	14.42	12.62	5.37	7.57	-	9.80	-
34.	<i>Oxalis corniculata</i> L.	7.40	8.93	12.34	14.41	4.92	6.75	10.51	9.43	-
35.	<i>Phytolacca acinosa</i>	19.71	20.96	27.52	15.68	9.27	-	13.83	-	-
36.	<i>Plantago lanceolata</i> L.	13.99	-	20.63	9	12.16	11.95	13.16	-	17.49
37.	<i>Plantago major</i> L.	-	12.11	11.93	9.13	7.42	-	7.23	8.71	-
38.	<i>P. annua</i>	13.58	6.61	5.70	-	-	-	11.06	9.11	-
39.	<i>P. bulbosa</i>	-	2.91	-	-	-	-	-	-	-
40.	<i>P. pretense</i>	-	5.68	7.40	-	5.31	-	8.15	6.17	-
41.	<i>Polygonum heterophyllum</i>	-	-	-	-	-	4.41	-	-	-
42.	<i>Prunella vulgaris</i>	-	3.47	-	11.13	-	-	-	5.66	-
43.	<i>Ranunculus hirtellus</i>	-	-	-	-	4.89	-	-	6.55	-
44.	<i>Rumex nepalensis</i>	-	7.95	12.33	9.38	9.43	-	-	8.94	-
45.	<i>Salvia moorcroftiana</i>	-	7.27	-	10.07	9.70	-	-	8.79	-
46.	<i>Scandix pectenvenersis</i>	-	8.73	5.78	-	-	14.53	12.34	-	13.21
47.	<i>Setaria viridis</i> L.	-	9.01	-	-	-	-	-	-	-
48.	<i>Solanum nigrum</i>	-	10.97	8.56	10.49	9.09	-	-	-	-
49.	<i>Sorghum helpense</i>	12.07	-	-	-	5.82	9.14	12.56	6.81	9.42
50.	<i>Stipa sibirica</i>	10.62	-	14.28	-	5.73	16.26	7.51	-	12.09
51.	<i>Taraxicum officinale</i>	13.99	-	-	14.4	9.57	13.79	3.45	8.33	12.26
52.	<i>Thymus linearis</i> Benth.	-	-	-	2.90	3.56	-	-	-	3.57
53.	<i>T. pratense</i>	14.37	-	-	-	7.51	13.07	11.75	12.29	11.48
54.	<i>T. repens</i>	12.07	-	-	11.24	6.88	9.23	10.99	-	10.63
55.	<i>Urtica dioica</i>	15.85	-	-	-	6.6	-	7.18	7.82	11.07
56.	<i>Verbascum thapus</i>	6.33	11.27	-	-	-	8.14	9.43	11.36	-
57.	<i>Viola odorata</i>	-	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.	<i>Achillea millefolium</i>	12.07	7.57	-	-	7.28	11.57	6.63	7.33	9.30
2.	<i>Agrimonia eupatoria</i>	-	9.65	-	-	10.12	-	-	-	-
3.	<i>A. caudatus</i>	11.07	9.02	-	-	9.55	12.63	5.28	9.60	9.99
4.	<i>A. viridis</i>	6.43	-	-	-	10.44	17.40	-	11.25	-
5.	<i>Arctium lappa</i>	-	8.34	5.51	5.13	7.70	12.06	3.81	-	7.48
6.	<i>Arnebia hispidissima</i>	-	-	-	-	-	4.83	9.08	11.56	-
7.	<i>Artemisia absinthium</i>	8.45	-	11.42	10.52	9.12	-	5.14	10.72	13.25

8.	<i>Asplenium</i> spp.	-	6.00	13.46	10.58	-	9.74	7.84	-	6.15
9.	<i>Bothriochloa ischaemum</i>	-	17.1	-	-	4.91	-	8.33	5.67	6.05
10.	<i>Cannabis sativa</i>	-	9.11	14.98	18.02	11.15	19.98	-	-	-
11.	<i>Capsella bursa pastoris</i> M.	-	-	-	-	9.24	14.79	-	-	8.23
12.	<i>Centaurea iberica</i>	-	4.55	-	9.95	5.69	10.89	-	5.51	11.9
13.	<i>Chenopodium album</i> L.	6.46	-	7.22	-	-	9.86	9.94	7.39	9.44
14.	<i>Cichorium intybus</i>	11.12	-	-	-	5.78	-	3.69	6.78	8.64
15.	<i>Conyza canadensis</i>	-	7.71	16.61	-	9.94	12.30	-	-	-
16.	<i>Cymbopogon nardus</i>	12.29	10.37	17.22	-	-	-	6.99	7.47	5.53
17.	<i>Cynodon dactylon</i> L.	10.19	7.05	13.11	11.99	9.34	12.55	11.82	10.86	11.41
18.	<i>Daucus carota</i> L.	3.52	2.21	-	13.1	-	-	12.62	11.41	11.26
19.	<i>F. arundinacea</i>	-	3.14	-	5.72	-	-	-	-	-
20.	<i>F. rubra</i> L.	-	4.58	-	-	-	2.94	8.82	6.02	7.77
21.	<i>F. nubicula</i>	8.03	5.8	9.15	10.06	5.78	-	-	5.69	-
22.	<i>F. vesca</i>	-	-	-	13.15	3.92	7.7	10.87	8.94	-
23.	<i>Lespedeza</i> spp.	7.36	8.31	9.97	9.13	-	-	-	-	10.46
24.	<i>Lolium perenne</i>	9.9	8.55	-	12.89	7.56	-	11.36	8.75	7.3
25.	<i>Malva neglecta</i>	-	-	-	17.79	8.2	13.08	-	6.00	12.19
26.	<i>Marrubium vulgare</i>	17.65	12.34	15.28	14.41	8.17	11.03	11.93	-	8.61
27.	<i>Matricaria chamomilla</i>	-	12.16	-	-	-	-	8.85	8.08	8.51
28.	<i>Medicago minima</i> L.	13.53	8.99	-	-	9.12	-	13.00	9.54	12.07
29.	<i>Mentha longifolia</i> Huds.	10.75	-	9.99	-	7.49	-	-	10.06	-
30.	<i>M. spicata</i> L.	-	-	-	-	6.25	-	-	-	-
31.	<i>Myosotis arvensis</i> (L.)	-	-	-	-	-	-	5.81	-	2.72
32.	<i>Nepeta cataria</i> L.	9.22	10.37	-	-	5.52	-	-	7.88	-
33.	<i>Oxalis acetosella</i>	-	9.84	16.09	11.99	5.95	8.39	-	9.96	-
34.	<i>Oxalis corniculata</i> L.	7.39	-	13.65	13.97	5.43	7.40	11.37	8.51	-
35.	<i>Phytolacca acinosa</i>	20.92	21.56	28.34	18.67	10.41	-	15.14	-	-
36.	<i>Plantago lanceolata</i> L.	14.05	13.46	23.44	6.45	12.31	13.64	14.37	-	18.90
37.	<i>Plantago major</i> L.	-	7.31	13.47	8.87	8.2	-	7.84	9.63	-
38.	<i>P. annua</i>	13.05	3.20	4.90	-	-	-	10.96	9.17	-
39.	<i>P. bulbosa</i>	-	6.25	-	-	-	-	-	-	-
40.	<i>P. pretense</i>	-	-	8.13	-	5.13	-	7.74	6.83	-
41.	<i>Polygonum heterophyllum</i>	-	3.84	-	-	-	3.33	-	-	-
42.	<i>Prunella vulgaris</i>	-	-	-	9.26	-	-	-	4.98	-
43.	<i>Ranunculus hirtellus</i>	-	7.60	-	-	5.40	-	-	7.26	-
44.	<i>Rumex nepalensis</i>	-	8.05	13.93	10.98	9.45	-	-	9.89	-
45.	<i>Salvia moorcroftiana</i>	-	9.71	-	11.81	10.81	-	-	9.81	-
46.	<i>Scandix pectenvenensis</i>	-	8.95	10.71	-	-	16.39	11.83	-	15.71
47.	<i>Setaria viridis</i> L.	-	12.16	-	-	-	-	-	-	-
48.	<i>Solanum nigrum</i>	-	-	9.50	12.35	10.11	-	-	-	-
49.	<i>Sorghum helpense</i>	13.94	-	-	-	6.46	8.91	10.64	7.56	9.57
50.	<i>Stipa sibirica</i>	10.65	-	13.89	-	6.36	16.81	8.15	-	12.65
51.	<i>Taraxicum officinale</i>	16.34	-	-	16.89	9.72	12.56	3.73	6.88	13.08
52.	<i>Thymus linearis</i> Benth.	-	-	-	3.3	2.84	-	-	-	2.81
53.	<i>T. pratense</i>	13.79	-	-	-	7.45	13.29	10.52	10.69	13.57
54.	<i>T. repens</i>	10.89	-	-	13.02	5.65	8.99	9.60	-	11.15
55.	<i>Urtica dioica</i>	16.37	12.6	-	-	6.05	-	7.79	5.92	11.18
56.	<i>Verbascum thapus</i>	4.56	2.55	-	-	-	6.93	5.87	12.72	-
57.	<i>Viola odorata</i>	-	-	-	-	-	-	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

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 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 (Goirala *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), Rizwi (2021) and Hussain *et al.*, (2019) also report similar patterns of herbaceous vegetation in Special Forest Division Tangmarg.

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 families 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 descending 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.

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.

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