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

Floristic Diversity and Seasonal Variation of Herbaceous Species in Taxus contorta Griff. Forests of the Kashmir Himalaya

Comment [N1]: Author citation is required for Botanical name; *Taxus contorta* Griff.

ABASTRACT

The present study was carried out during the 2022-2023 to assess the floristic diversity and seasonal variation of herbaceous species dominance in *Taxus contorta*griff. stands of Kashmir Himalayas. A total of 9 sites were selected across the Kashmir himalayan region 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 ~~done~~employed ~~by purposive sampling~~ with and three quadrants of size 1m×1m were laid and a total of 57 herbs species belonging to 23 families were reported from each study sites .The highest total density (71000 N/ha) of herbs was reported in summer season at Ganidobh site followed by density at Lolab (623333 N/ha) and Vastoorwan (596667 N/ha). Lowest density was recorded at Daksum site in autumn season (323333N/ha). The study revealed the seasonal variation in the Importance Value Index (IVI) of herbaceous species across study sites. In the spring season**,***Phytolacca acinosa* showed the highest IVI at S3 (23.34) and S2 (22.13), followed by *Plantago lanceolata* (21.54) and *Conyza canadensis* (20.71) at S3. 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 *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, while *Plantago lanceolata* (23.44) and *Oxalis corniculata* (21.56) were prominent. 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.

Comment [N2]: Please Rewrite abstract

Keywords: Diversity, Herbs, Spring, Dominance, Density, IVI, Kashmir

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 ~~variety~~ (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, ~~V~~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. (Citation is required) 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 (citation required). It grows naturally in shady, sheltered locations at altitudes ranging from 1,700 to 3,300 masl. ~~.~~ ~~T~~the associated species of *T. contorta*are *Quercus semecarpifolia* (Kharshu) and *Abies pindrow* (Silver Fir), *Picea smithiana* (Spruce), *Cedrus deodara* (Deodar), and *Quercus dilatata* (Moru Oak). In the eastern Himalaya~~s~~, it often grows alongside *Abies pindrow* and *Rhododendron* species.It is ~~This~~ dioecious and ~~,~~ evergreen tree species. *Taxus contorta* 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* , the present study was undertaken to assess the floristic diversity and seasonal variations of herbaceous species in the forests of Kashmir.

~~The Kashmir Valley's geography is further enriched by the Jhelum River, which, along with its tributaries, is a major source of irrigation. The Valley's diverse habitats include rivers, lakes, springs, marshes, cultivated fields, orchards, graveyards, forests, alpine meadows and glaciers. Its temperate climate is characterized by four distinct seasons: wet, cold winters (December-February), mild springs (March-May), warm summers (June-August) and cool autumns (September-November).To address gaps in understanding, the present study was undertaken to assess the floristic diversity and seasonal variations of herbaceous species in the forests of Kashmir.~~

~~1. MATERIALS AND METHODS~~ METHODOLOGY

2.1 Study area

Kashmir valley is located in the north-western extremity of India, between Lat. 33° North ~~latitude~~ and Long. 75° East ~~longitude~~. The valley is located in the northern most latitude of the country and 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. The geographical expanse of Kashmir is 15, 948.00 sq km. The present ~~A~~ study on"Floristic diversity and seasonal variation of herbaceous species in *Taxus contorta* stands of Kashmir Himalayas" was carried out across the all the Kashmir valley. The 3 sites were selected for study from each 3 regions.

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Comment [N4]: Please provide study map of the 3 region selected for floristics study.

Table 1: Study site characteristics

Region	Sites		Aspect	Altitude(m)
South Kashmir	Pahalgam	S1	Northwest	2741
	Vastoorwan	S2	Southeas	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

Comment [N5]: Study map is required

1.2. Study Sampling ~~procedure~~ and Vegetational analysis

~~Sampling was done by p~~Purposive sampling methods was employed to collect the floristic data. ~~at T~~the total of 9 locations across the Kashmir valley was selected for the study~~.~~ Phytosociological attributes of herbages were carried out in three season; spring, summer and autumn. ~~season from~~ In each site, 3 quadrates with quadrant ~~of~~ size 1×1 m waslayedin each sampling plot. The plant samples were collected and ~~were be~~ brought to the laboratory, washed properly with fresh running water and segregated species-wise. Species identification and species count ?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: ~~various observations recorded as:~~

Comment [N6]: Explain how species are identified ? Give references used for species identification

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).

Comment [N7]: Provide formula here for density

iii. Frequency (%)

Frequency (%) = $\frac{Numberofquadratsinw\ \ ic\ \ t\ \ especiesoccured}{Totalnumberofquadratesstudied} \times 100$

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)

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

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2. RESULTS & DISCUSSION

The present study recorded ~~was conducted in *Taxus* dominated stands across the Kashmir Valley during the year 2022-2023. During the study~~ 57 herb species in the T. contorta Forest in Kashmir Valley. ~~were reported among them t~~The highest ~~maximum~~ herb species were reported from the Ganidobh site (39), Lolab (36) and Vastoorwan (35) at the southwest and southeast aspect. The Importance Value Index (IVI) of herbs at different sites is presented for spring season in (Table 2), for summer season (Table 3) and autumn season (Table 4). ~~and~~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).

Comment [N8]: Have to at least explain which herb species is most dominant in respective sites in spring, summer and autumn to know the most important herb associates of T. contorta

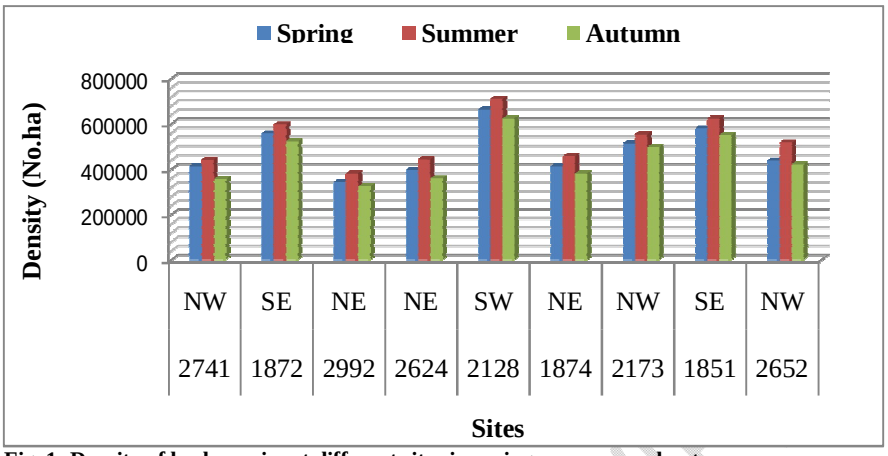

Fig. 1: Density of herb species at different sites in spring, summer and autumn season

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 ~~vegetation structure~~ at these sites. Conversely, *Thymus linearis* had the lowest IVI at S5 (2.80), indicating less dominance ~~its minimal influenc~~e during this period (Table 2).

During the summer season, *Phytolacca acinosa* maintained its dominance, achieving 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*has ~~again recorded~~ 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 (Table 4).

Overall, these findings highlight *Phytolacca acinosa* as a consistently dominant species across all seasons, particularly at site S3, while 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.

Comment [N9]: If you could explain site wise, which species is dominant with Highest IVI in different season and the less dominant one

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 NW (2771 m)	**S2** SE (1872 m)	**S3** NE (2992 m)	**S4** NE (2624 m)	**S5** SW (2128 m)	**S6** NE (1774 m)	**S7** NW (2173 m)	**S8** SE (1851 m)	**S9** NW (2652
1.	*Achillea millefolium*	12.13	-	-	-	6.93	10.9	7.93	9.67	1
2.	*Agrimonia eupatoria*	-	9.54	-	-	10.07	-	-	-	-
3.	*Amaranthus caudatus*	13.02	8.27	-	-	7.98	10.7	4.57	8.45	10.61
4.	*Amaranthus 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 species*	-	-	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*	-	8.90	-	-	8.58	14.97	-	-	9.17
12.	*Centaurea iberica*	-	-	-	9.24	5.35	11.88	-	5.11	13.3
13.	*Chenopodium album*	-	-	-	-	-	-	-	-	-
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*	9.87	11.61	13.51	12.12	10.32	13.98	12.64	11.40	15.84
18.	*Daucus carota*	5.20	7.94	-	16.91	-	-	13.21	12.96	13.48
19.	*Festuca arundinacea*	-	2.98	-	6.92	-	-	-	-	-
20.	*Festuca rubra L.*	-	4.02	-	-	-	4.10	9.12	6.09	7.69
21.	*Fragaria nubicula*	7.59	5.41	10.05	10.38	7.56	-	-	5.56	-
22.	*Frageria vesca*	-	6.75	-	14.6	4.69	8.33	10.31	9.79	-
23.	*Lespedeza species*	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*	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.	*Mentha spicata L.*	-	-	-	-	6.39	-	-	-	-
31.	*Myosotis arvensis (L.)*	-	-	-	-	-	-	-	-	-
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	-

Comment [N10]: No need to give altitude here in table since, it is reflected earlier in table 1.

34.	*Oxalis corniculata*	6.60	9.43	14.9	14.33	5.30	7.08	12.20	10.26	-
35.	*Phytolacca acinosa*	20.12	22.14	23.34	17.04	9.62	-	14.70	-	-
36.	*Plantago lanceolata*	13.40	-	21.54	3.79	11.36	15.20	13.75	-	19.84
37.	*Plantago major*	-	13.39	12.89	8.44	7.97	-	9.14	9.29	-
38.	*Poa annua*	14.93	7.19	3.35	-	-	-	11.91	9.72	-
39.	*Poa bulbosa*	-	3.18	-	-	-	-	-	-	-
40.	*Poa 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*	-	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.	*Trifolium pratense*	15.22	-	-	-	7.03	12.92	12.40	11.90	13.03
54.	*Trifolium 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.	*Verbasicum thapus*	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 NW (2771 m)	**S2** SE (1872 m)	**S3** NE (2992 m)	**S4** NE (2624 m)	**S5** SW (2128 m)	**S6** NE (1774 m)	**S7** NW (2173 m)	**S8** SE (1851 m)	**S9** NW (2652 m)
1.	*Achillea millefolium*	12.02	-	-	-	9.34	13.29	8.59	9.94	11.86
2.	*Agrimonia eupatoria*	-	10.97	-	-	10.31	-	-	-	-
3.	*Amaranthus caudatus*	13.16	11.46	-	-	10.81	13.01	7.85	8.61	12.18
4.	*Amaranthus 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 species*	-	-	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*	-	9.18	-	-	8.33	15.48	-	-	9.42
12.	*Centaurea iberica*	-	-	-	10.31	6.18	12.76	-	4.93	14.67
13.	*Chenopodium album*	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*	10.15	10.99	11.89	12.62	9.77	12.35	10.92	10.59	13.58
18.	*Daucus carota*	4.68	7.35	-	14.56	-	-	11.61	10.28	11.01
19.	*Festuca arundinacea*	-	2.82	-	7.55	-	-	-	-	-
20.	*Festuca rubra L.*	-	3.65	-	-	-	3.76	8.24	5.45	6.46
21.	*Fragaria nubicula*	3.62	6.02	9.79	9.96	7.06	-	-	6.12	-
22.	*Frageria vesca*	-	6.21	-	13.95	4.38	4.71	10.06	9.03	-
23.	*Lespedeza species*	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*	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.	*Mentha spicata L.*	-	-	-	-	5.64	-	-	-	-
31.	*Myosotis arvensis (L.)*	-	-	-	-	-	-	3.20	-	5.78
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*	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*	13.99	-	20.63	9	12.16	11.95	13.16	-	17.49
37.	*Plantago major*	-	12.11	11.93	9.13	7.42	-	7.23	8.71	-
38.	*Poa annua*	13.58	6.61	5.70	-	-	-	11.06	9.11	-
39.	*Poa bulbosa*	-	2.91	-	-	-	-	-	-	-
40.	*Poa 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*	-	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.	*Trifolium pratense*	14.37	-	-	-	7.51	13.07	11.75	12.29	11.48
54.	*Trifolium 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.	*Verbasicum thapus*	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 NW (2771 m)	**S2** SE (1872 m)	**S3** NE (2992 m)	**S4** NE (2624 m)	**S5** SW (2128 m)	**S6** NE (1774 m)	**S7** NW (2173 m)	**S8** SE (1851 m)	**S9** NW (2652 m)
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.	*Amaranthus caudatus*	11.07	9.02	-	-	9.55	12.63	5.28	9.60	9.99
4.	*Amaranthus 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 species*	-	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*	-	-	-	-	9.24	14.79	-	-	8.23
12.	*Centaurea iberica*	-	4.55	-	9.95	5.69	10.89	-	5.51	11.9
13.	*Chenopodium album*	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*	10.19	7.05	13.11	11.99	9.34	12.55	11.82	10.86	11.41
18.	*Daucus carota*	3.52	2.21	-	13.1	-	-	12.62	11.41	11.26
19.	*Festuca arundinacea*	-	3.14	-	5.72	-	-	-	-	-
20.	*Festuca rubra L.*	-	4.58	-	-	-	2.94	8.82	6.02	7.77
21.	*Fragaria nubicula*	8.03	5.8	9.15	10.06	5.78	-	-	5.69	-
22.	*Frageria vesca*	-	-	-	13.15	3.92	7.7	10.87	8.94	-
23.	*Lespedeza species*	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*	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.	*Mentha spicata L.*	-	-	-	-	6.25	-	-	-	-
31.	*Myosotis arvensis (L.)*	-	-	-	-	-	-	5.81	-	2.72

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*	7.39	21.56	13.65	13.97	5.43	7.40	11.37	8.51	-
35.	*Phytolacca acinosa*	20.92	-	28.34	18.67	10.41	-	15.14	-	-
36.	*Plantago lanceolata*	14.05	13.46	23.44	6.45	12.31	13.64	14.37	-	18.90
37.	*Plantago major*	-	7.31	13.47	8.87	8.2	-	7.84	9.63	-
38.	*Poa annua*	13.05	3.20	4.90	-	-	-	10.96	9.17	-
39.	*Poa bulbosa*	-	6.25	-	-	-	-	-	-	-
40.	*Poa 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*	-	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.	*Trifolium pratense*	13.79	-	-	-	7.45	13.29	10.52	10.69	13.57
54.	*Trifolium 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.	*Verbasicum thapus*	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

The distribution of plant populations in a given area is shaped by an interplay of biological and physical factors. 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). 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. As gaps expand, additional resources become accessible, further supporting the growth of these plants.

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 and 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, highlighting consistent findings across different regions.

Comment [N11]: Your discussion is more or less literature review, therefore please kindly discuss your findings, results with other literatures available.

3. 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 ~~of~~ 57 ~~reported~~ herb~~s~~ species across the study sites. The density of herbs was recorded highest in summer season at ~~of~~Ganidobh (S5) site at southwest aspect and lowest in autumn season at Northeast aspect of Daksum (S3) site. The highest Importance Value Index (IVI) in spring season for *Phytolacca acinosa* occurs at S3 and S2with values of 23.34 and 22.13 respectively and lowest by *Thymus linearis* (2.80) at S5. In summer season,the highest IVI for *Phytolacca acinosa* is recorded at S3 (NE) with 27.52

followed by S2 (20.96) and S1 (19.71) and *Thymus linearis* lowest IVI (2.90) at S4.The highest IVI in autumn season at study sites for *Phytolacca acinosa* with value (28.34) at S3 followed by S1 (20.92) and S4 with IVI (18.67) and the lowest was reported for *Daucus carota, Festuca arundinacea*and *Poa annua*at S2 with respective IVI values (2.21, 3.14 and 3.20).

Comment [N12]: If you could rewrite conclusion, since you are just repeating results.

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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