



Endemic Species of Poaceae from Western Himalaya: Diversity and Distribution

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Abstract

Present work deals with the distribution and diversity of endemic species of Poaceae in Western Himalaya. Out of 333 endemic taxa of Poaceae in India, 13 taxa are confined to Western Himalaya. A brief taxonomic description and type locality have been provided along with their altitudinal distribution.

Key words: Poaceae, Endemism, Western Himalaya, India.

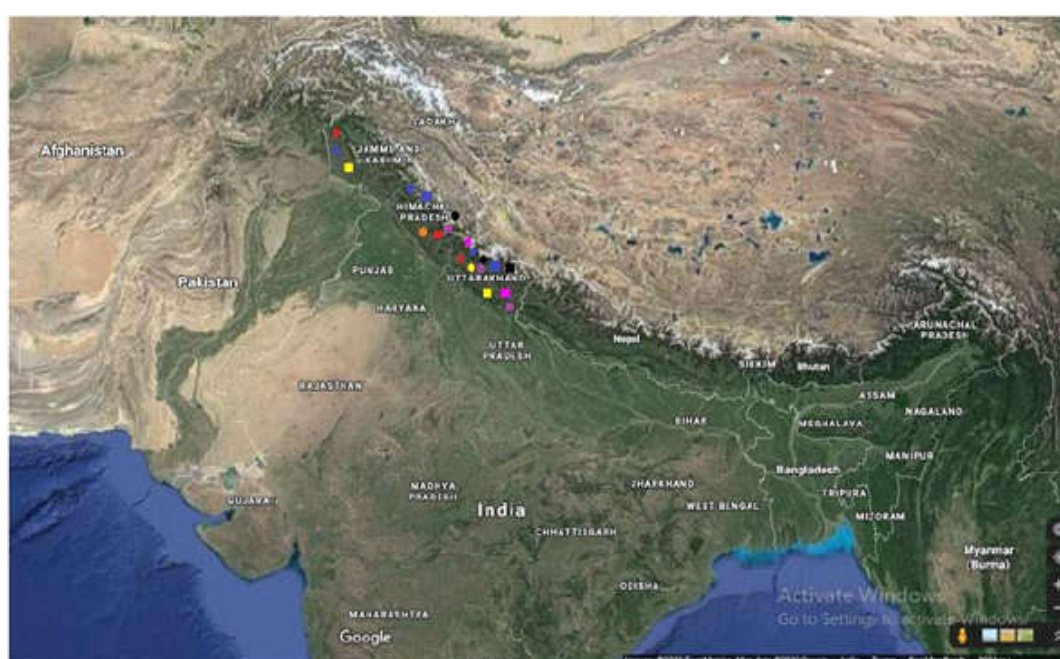
INTRODUCTION

The term endemism is applied to those taxa that are confined to a particular geographical area and nowhere else; definitions are customized to specific needs (Heywood 1995). In recent times taxonomic units that are found exclusively in a specified geographical area i.e. peninsular regions, oceanic islands, distinct phytogeographical area or mountain peaks and isolated through ecological or temporal barriers and could be threatened due to restricted distribution are called endemic taxa. Endemic taxa are restricted to a confined region and remain separated from a widely distributed species or cosmopolitan species (Mitra & Mukherjee 2007).

India is one of the 17 megabiodiverse countries with rich biodiversity due to its prevailing climatic, edaphic, topographic and geological stability for many years. The varied physiographic and climatic conditions have resulted in a long term stable habitat that permitted the survival of remaining tertiary flora to survive and facilitated the continuation of species diversification for the evolution of new species, thereby leading to a greater number of endemic plants. The degree of endemism for an area is often cited as a measure of the uniqueness of the flora and consequently is important for prioritizing sites for conservation (Myers *et al.* 2000).

The members of Poaceae Barnhart are commonly known as grasses. It is nested in the order Poales along with 13 other families and is the 5th largest plant family in the world. However, it stands first in its economic and ecological importance (Hodkinson 2018). Although family shows cosmopolitan distribution inhabiting in all continents, including Antarctica (Convey 2001) but some species are confined to a particular area. In India, Poaceae comprises of about 1300 species belonging to 268 genera (Karthikeyan *et al.* 1989). Amongst the total angiospermic flora of India, Poaceae has the largest number of endemic taxa, contributing around 7.75% of the angiosperm taxa (Singh *et al.* 2018). Chatterjee (1939) pioneered the studies on endemic plants of India. He reported 6580 endemic dicots to this region, representing 61.5% of Indian flora. Of these, 3169 species were endemic to Himalayan region and 2045 species were endemic to Peninsular India. Many naturalists and botanists have also surveyed the endemic plant taxa in India (Nayar 1996; Karthikeyan 2000; Ahmedullah 2000; Mitra & Mukherjee 2007; Irwin & Narasimhan 2011). Dhar *et al.* (2012) reported 153 endemic taxa to Kashmir Himalaya including

six endemic taxa of Poaceae. Recently, Singh *et al.* (2015) enumerated only 86 genera including 335 taxa as strict endemics to India, of which, 15 taxa are reported from Western Himalaya. During our revisionary studies on Poaceae from Western Himalaya, we came across with three additional endemic taxa viz. *Agropyron thomsonii* Hook.f., *Festuca lucida* Stapf, and *Poa garhwalensis* D.C. Nautiyal & R.D. Gaur that were not earlier reported earlier by Singh *et al.* (2015). Phytogeographically, Western Himalaya refers to the westernmost section of the Great Himalayas, which stretch across northeastern Afghanistan through India to central Nepal (Tripathi *et al.* 2019). In India, Western Himalaya stretches between 28° 45' – 36° 20' N and 73° 26' – 80° 24' E covering an area of ca. 331,402 km² and passes through three states viz., Jammu & Kashmir, Himachal Pradesh and Uttarakhand (Jalal & Jayanthi 2015) (Figure 1). The Western Himalaya comprises of about 10 % of the country's total geographical area (Jalal & Jayanthi 2015). Due to habitat diversity along with rich biodiversity, Western Himalaya has always been a fascinating site for the taxonomists for observation of biodiversity. Based on extensive literature survey, nomenclatural changes and extended distributional range, the present paper attempts an updated analysis of taxa of Poaceae that are endemic exclusively to the Western Himalayan region.



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|----------------------------------|-------------------------------------|
| ● <i>Agropyron thomsonii</i> | ■ <i>Muhlenbergia rakhchamensis</i> |
| ● <i>Dendrocalamus somdevae</i> | ■ <i>Poa garhwalensis</i> |
| ● <i>Eulalia madkotiensis</i> | ■ <i>Poa rhadina</i> |
| ● <i>Festuca lucida</i> | ■ <i>Pseudodanthonia himalaica</i> |
| ● <i>Festuca nandadevica</i> | ■ <i>Sehima notatum</i> |
| ● <i>Festuca sanjappae</i> | ■ <i>Koeleria micans</i> |
| ● <i>Helictotrichon uniyalii</i> | |

Figure 1. Map of Western Himalaya having endemic species in its three states viz., Jammu and Kashmir, Himachal Pradesh, and Uttarakhand.

TAXONOMIC TREATMENTS

Agropyron Gaertn.

Agropyron thomsonii Hook.f., Fl. Brit. India (J.D. Hooker). 7: 370. 1896.

Type: Western Himalaya, alt. 3000 – 3700 m from Kunawur and Piti; *Jacquemont s.n.*, *Thomson s.n.* Garhwal; R. *Strachey & J.E. Winterbottom s.n.*, *Duthie s.n.*

Perennial herbs. Culms 60 – 90 cm tall, slender. Leaf-blade flat, upper surface glabrous, lower more or less hairy. Racemes 7.6 – 15.2 cm long. Spikelets 0.6 – 1.5 cm long, awnless, 5 – 7-flowered, scaberulous, ovoid, erect; lower glumes and upper glume ovate to oblong, hyaline, 5 – 7-nerved, apex acute or acuminate sometimes upper glume apex toothed and mucronate; lemma ovate to lanceolate, 5-nerved, villous; palea keels ciliate. Stamens 3.

Dendrocalamus Nees

Dendrocalamus somdevae H.B. Naithani, Indian For. 119(6): 504 – 506. 1993.

Type: Uttarakhand, Dehra Dun, Haridwar Road between Jogiwala and Majri (Mokhampur), 11 March 1991, *Somadeva* 10985 (Holotype: DD).

Perennial herbs, pachymorphic, short rhizomes. Culms woody upto 20 m tall. Culm sheath 35–45 cm × 18 – 20 cm, imperfect blade ovate to lanceolate upto 30 cm long; ligule entire or dentate, sometimes fimbriate. Leaf-blade lanceolate, 37.5 cm × 3.75 cm, acuminate, scabrous and twisted, margins finely serrate, base rounded with short thick petiole; leaf-sheath keeled, outer surface hairy, inner surface glabrous; ligule obliquely truncate. Panicles bearing half-verticillate semi-globular heads of purple spikelets. Spikelets 0.8 – 1.5 cm × 0.3 – 0.5 cm, 2 – 3-flowered; lemma outer surface glabrous, inner surface hairy, margins ciliate; palea two-keeled, ciliate. Stamens 6; caryopsis stony with short beak at apex.

Eulalia Kunth

Eulalia madkotiensis Kandwal, B.K. Gupta & S.K. Srivast., Kew Bull. 62: 519. 2007.

Type: India, Uttarakhand, Pithoragarh Distt, Madkot, towards Jauljibi, 2 Aug. 2004, *Manish K. Kandwal*, 3363 (Holotype: BSD).

Perennial herbs. Culms terete up to 50 cm high. Leaf-blade 25 – 50 × 0.2 cm, hairy, filiform; leaf-sheath pubescent; ligule membranous. Racemes digitate upto 9 cm long. Spikelets elliptic, paired, similar, sessile and pedicelled; lower glume 2-nerved, 1.6 mm long pilose hairs, awns 2, subequal; upper glume compressed, awned. Lower floret empty; lemma oblanceolate, c. 3 mm long, acute; palea absent. Upper floret hermaphrodite; lemma c. 3 mm long, hyaline, awned; palea ovate upto 2 mm long. Lodicules 2, cuneate, truncate. Stamens 3, c. 2 mm long.

Festuca L.

Festuca lucida Stapf, Fl. Brit. Ind. 7: 355. 1896.

Type: Uttarakhand, Jaunsar, Deodar forest below Karambar Peak, 2700 m, 03 May 1894, *Duthie* 14481 (Lectotype: K, K000032138!, designated by Kar 2017: 69).

Perennial herbs. Culms erect, 0.6 – 1 m tall, glabrous. Leaf-blade 15 – 30 cm × 1.2 – 1.8 cm, flat, scaberulous, glabrous, acuminate; ligule membranous, 5 – 9 mm long, lacerate; leaf-sheath glabrous, 20 – 24 cm long. Panicles lax, 15 – 20 cm × 0.7 – 0.9 cm. Spikelets single, laterally compressed, 8 – 15 mm × 2.1 – 2.6 mm, acute; lower glume 1-nerved, 3 – 5 mm × 1.3 – 1.8 mm, ovate to lanceolate, glabrous, acute; upper glume 3-nerved, 4 – 6 mm × 2 – 2.1 mm, ovate to lanceolate, glabrous, apex acute; lemma 5-nerved, 6 – 9.1 mm × 2 – 3 mm, oblong

to lanceolate, awnless; palea 2-keeled, oblong to lanceolate, 6 – 7 mm × 1 – 1.2 mm, hyaline, apex acute and bi-fid. Lodicules 2, membranous, 1 – 1.1 mm × 0.2 – 0.4 mm. Stamens 3, 7 – 4 mm × 0.2 – 0.4 mm.

Festuca nandadevica Hajra, Indian J. Forest. 6(1): 79 – 80. 1983.

Type: Uttarakhand, Chamoli distt, Deodi-Ramani, Nanda Devi National Park, Hab. In *Rhododendron-Betula* Forest 25.08.1981, *Hajra* 73285A (Holotype: CAL, CAL0000002492!).

Perennial herbs. Culms erect, glabrous upto 30 – 70 cm tall. Leaf-blade linear to lanceolate, 3 – 18 mm × 1.5 – 3 mm, pubescent; ligule membranous, eciliate, 1 – 2 mm long, auricles minute, erect; leaf-sheath 10 – 14 cm, glabrous. Panicles nodding, 25 – 30 cm × 1 – 3 cm. Spikelets solitary, pedicelate, laterally compressed, 8 – 12 × 1.5 – 1.8 mm; glumes dissimilar; lower glume 1-nerved, lanceolate, 3 – 4 × 0.8 – 1.6 mm, acuminate; upper glume 1-nerved, lanceolate, 3 – 4 × 0.5 – 0.8 mm; lemma 5-nerved, 7 – 8 × 0.8 – 1 mm, ovate to lanceolate, awned; palea 2-keeled, 7 – 8 × 0.8 – 1 mm, apex bifid. Lodicules 2, membranous, 1.1 – 1.3 × 0.2 – 0.4 mm. Stamens 3, 1.5 – 2 × 0.2 – 0.5 mm.

Festuca sanjappae Chandra Sek. & S.K. Srivast., J. Jap. Bot. 80: 72. 2005.

Type: Himachal Pradesh, Pin Valley National Park, Chhohem, 4000 – 4100 m.; *K. Chandra Sekar* 103271 (Holotype: CAL).

Perennial herbs. Culms terete, 35 – 43 × 1 – 2.5 mm, hairy. Leaf-blade, flat, 7-nerved, sparsely hairy, 6 – 10.2 × 3 – 4 mm; ligule membranous, 1 – 1.4 mm long. Panicles elliptic to oblanceolate 6.5 – 14 × 5 – 2.5 cm. Spikelets 4 – 5 flowered, ovate-lanceolate or elliptic ovate, 4 – 5 × 1.8 – 2.2 mm; lower glume 1-nerved, 3.7 – 4 × 0.8 – 0.9 mm; upper glume 3-nerved, 4 – 4.5 × 0.9 – 1 mm; lemma ovate or elliptic-lanceolate, slightly bifid at tip, 3.9 – 4.2 × 0.9 – 1.1 mm, awned; awn 1.4 – 1.6 cm long; palea 2-keeled, lanceolate, 3.2 – 3.8 × 0.5 – 0.8 mm. Lodicules 2, elliptic to obovate 0.2 – 0.35 × 0.1 – 0.2 mm. Stamens 3, 0.2 – 0.6 mm long.

***Helictotrichon* Besser**

Helictotrichon uniyalii Kandwal & B.K. Gupta, Nordic J. Bot. 28: 47 – 48. 2010.

Type: Uttarakhand, Distt Bageshwar, near Dhakuri, 20 Sep 2003, *Manish K. Kandwal* 1186 (Holotype: BSD).

Perennial herbs. Culms, erect, upto 40 – 60 cm tall. Leaf-blade 15 – 23 × 0.2 cm, conduplicate; ligule membranous upto 1.2 mm long. Panicles 7.5 – 16 × 1 – 2 cm, erect, branches ascending. Spikelets 2 – 3-flowered, laterally compressed, 5.5 – 7.5 mm long; lower 2 fertile flowers, bisexual, upper floret rudimentary; lower glume 1-nerved, linear-lanceolate, upto 6.6 mm long; upper glume 3-nerved lanceolate, 6.0 – 7.0 mm long; lemma 5-nerved lanceolate, 5.5 – 7.0 mm long, apex bifid, awned; awn scabrid with twisted column; palea linear, 2-keeled, keels scabrous, 5.0 – 5.5 mm long. Lodicules 2. Stamens 3, upto 2 mm long.

***Koeleria* Pers.**

Koeleria micans (Hook.f.) Barberá, Quintanar, Soreng, & P.M. Peterson, Phytoneuron 46:1 – 13. 2019. *Avena micans* Hook.f., Fl. Brit. India 7: 279. 1896.

Type: Uttarakhand, Garhwal division, Tehri Garhwal, 30°30' N 78°30' E, *J.F. Duthie* 46 (Lectotype: K, K000032268!, designated by Barberá *et al.* 2019: 5).

Perennial herbs. Culms 40 – 50 cm high, tufted. Leaf sheath glabrous; ligule membranous, lacerate; leaf blade 15 – 30 cm long, flat, glabrous or scaberulous, apex finely acuminate. Panicles 7 – 10 cm long, erect or inclined. Spikelets laterally compressed, 6 – 7 mm long; lower glume lanceolate, 1-nerved; upper glume 1-nerved, lanceolate to oblong; lemma 5-nerved, apex acuminate and bifid, awned; awn straight or recurved; palea 2-keeled, keels minutely scabrid. Lodicule 2. Stamens 3, linear.

***Muhlenbergia* Schreb.**

Muhlenbergia rakhchamensis Arum., G.V.S. Murthy & V.J. Nair, Indian J. Forest. 36(1): 51 – 54. 2013.

Type: Himachal Pradesh, Kinnaur distt, Baspa Valley, Rakhcham, 2950 m, 13.8.1973, *K.P. Janardhanan*, 52661 (Holotype: CAL).

Tufted annual herbs. Culms erect, 25 – 35 cm tall. Leaf-blade flat, linear to lanceolate, 0.5 – 1.7 × 0.2 – 0.4 cm; leaf sheath 0.6 – 4.1 cm long, glabrous; ligule membranous, 0.3 – 0.5 mm long, apex lacerate or fimbriate. Panicles 1.5 – 4 × 0.3 – 0.5 cm, scabrous. Spikelets solitary, 2 – 3 × 0.5 – 1 mm, flowers 2. Lower floret hermaphrodite. Upper floret hermaphrodite sometimes male or sterile. Lower glume 1-nerved, glabrous, lanceolate, 1.9 – 2.3 × 0.5 mm, acute or aristate; upper glume 1-nerved, elliptic to lanceolate, 2 – 2.3 × 0.6 mm, apex mucicous or acute. Florets oblong to lanceolate, 2 – 2.8 × 0.5 – 0.8 mm; lemma 3 or 5-nerved, lanceolate, 2 – 2.5 × 0.3 – 0.8 mm, awned; awn scaberulous, 2 – 7 mm long; palea 2-keeled, elliptic to lanceolate, 2 – 2.5 × 0.3 – 0.6 mm, acute or acuminate. Lodicules 2 upto 0.3 mm long. Stamens 3 upto 1 mm long.

***Poa* L.**

Poa garhwalensis D.C. Nautiyal & R.D. Gaur, J. Bombay Nat. Hist. Soc. 96: 285 – 287. 1999.

Type: Uttarakhand, Chamoli distt., Leptal, 4000 m, 4 Aug. 1996, *D.C. Nautiyal* 13501A (Holotype: GUH).

Perennial herbs. Culms erect, 45–60 cm tall, glabrous. Leaf-blade 4 – 10 × 0.2 – 0.3 cm, linear, acute; leaf-sheath keeled, 10 – 20 cm long; ligule 1.6 – 3.5 mm long, ovate. Panicles lax, 3.5 – 10 × 3 – 4 cm, scabrid. Spikelets 4 – 12 mm long, elliptic; lower glume, nerves 3, 3 – 3.2 mm long, oblong, smooth, apex acute; upper glume 3-nerved, 3.0 – 4.0 mm long, oblong, glabrous; lemma 5-nerved, 4 – 4.8 mm long, scabrid; palea 2.8 – 4.5 mm long, oblong to elliptic. Stamens 3, 2 – 2.5 mm long.

Poa rhadina Bor, Kew Bull. 3(1): 138 – 144. 1948.

Type: Uttarakhand, Tehri-Garwahal, Jaulea bah, Srikanta, 3700 - 4000 m., 7 Aug 1883, *J. F. Duthie* 265 (Holotype: K).

Annual herbs. Culms erect, 6 – 16 cm tall. Leaf blade linear, scabrous, 3 – 5.5 × 0.1 cm, acuminate. Leaf sheath glabrous; ligule eciliate, 2 – 3 mm long. Panicles elliptic to oblong, 2.5 – 6.5 × 1.5 – 3 cm, branches scabrid and spreading. Spikelets wedge-shaped, 2.5 – 3 mm long, florets 2 – 3 (– 4); lower glume oblong, 3-nerved, 2.5 – 2.7 mm long, acuminate; upper glume oblong, 3-nerved, 2.7 – 3 mm long, acute; lemmas 5-nerved, 2 – 2.5 mm long, apex obtuse; palea oblong to elliptic, 1.7 mm long, keels scabrid. Stamens 0.5 – 0.6 mm long.

***Pseudodanthonia* Bor & C.E. Hubb.**

Pseudodanthonia himalaica (Hook.f.) Bor & C.E. Hubb., Kew Bull. 12(3): 425 – 427. 1957 publ. 1958. *Danthonia himalaica* Hook.f., Fl. Brit. India 7: 281. 1896.

Type: Uttarakhand, Tehri Garhwal, Jaunsar, rocks on east side of Lakandi Peak, 2500 – 2800 m, 19 Apr. 1894, *J. F. Duthie* 14467 (Holotype: K).

Perennial herbs. Culms upto 45 cm tall. Leaf blade involute, 15 “ 30 cm × 1.5 “ 2.0 mm. Panicles contracted, lanceolate, 2.0 “ 9.0 cm × 0.5 “ 1.0 mm. Spikelets solitary; cuneate, laterally compressed, 1.2 “ 2.5 cm long. Fertile spikelets pedicelate, pedicels ciliate; glumes similar; lemma 7 – 9-nerved, lanceolate, 10 – 14 mm long, apex bifid, awned; palea winged, 2-keeled. Lodicules 2. Stamens 3.

***Sehima* Forssk.**

Sehima notata (Hack.) A. Camus., Bull. Mus. Hist. Nat. 27: 372 – 373. 1921. *Ischaemum notatum* Hackel, Mono. Phanero. 6: 246 – 247. 1889.

Type: Uttarakhand, Almoradistt, Dunagiri mountain, 1800 – 2100 m, 28 September 1885, J.F. Duthie 5057 (Lectotype: K, K000245768!, designated by Tiwari *et al.* 2018: 95).

Perennial herbs. Culms 50 – 120 cm tall. Leaf-sheaths glabrous or hispid. Ligule ciliate; leaf-blades flat, hairy, 10 – 40 × 0.3 – 0.6 cm, acuminate. Racemes 9 – 15 cm long. Spikelets appressed, paired, sessile and pedicelate; lower glume 8-nerved, lanceolate, apex awned, bifid, dentate; upper glume lanceolate, 7-nerved, apex acute, awned, awn 10 – 11 mm long; lemma lanceolate, 3-nerved, 40 – 45 mm long, apex bifid, awned; palea hyaline. Stamens 3, 4 – 5 mm long.

RESULT AND DISCUSSION

The present study revealed that a total of 13 species nested within 10 genera of Poaceae are endemic to Western Himalayan region including *Agropyron thomsonii*, *Dendrocalamus somdevae*, *Eulalia madkotiensis*, *Festuca lucida*, *F. nandadevica*, *F. sanjappae*, *Helictotrichon uniyalii*, *Koeleria micans*, *Muhlenbergia rakbhamensis*, *Poa garhwalensis*, *P. rhadina*, *Pseudodanthonia himalaica* and *Sehima notatum* (Table 1). Occurrence of taxa ranges between the elevations of ca. 1000 – 5180 m. *Sehima notatum* is known to possess a wide distributional range along the altitudinal gradient. Distribution

Table 1. Distribution of endemic taxa of Poaceae in Western Himalaya with its altitudinal range [Abbreviations used: J&K = Jammu and Kashmir; HP = Himachal Pradesh; UK = Uttarakhand].

Sr. No.	Name of Taxa	Altitude (m)	States
1.	<i>Agropyron thomsonii</i>	3048 – 3657	J&K, UK
2.	<i>Dendrocalamus somdevae</i>	1000	UK
3.	<i>Eulaliamadkotiensis</i>	1500	UK
4.	<i>Festuca lucida</i>	2133 – 5180	J&K, HP, UK
5.	<i>Festuca nandadevica</i>	3500 – 3550	HP, UK
6.	<i>Festuca sanjappae</i>	4000 – 4100	HP
7.	<i>Helictotrichonuniyalii</i>	1004	UK
8.	<i>Koeleria micans</i>	3000 – 4100	HP & UK
9.	<i>Muhlenbergia rakbhamensis</i>	2950	HP
10.	<i>Poa garhwalensis</i>	4000	J&K, UK
11.	<i>Poa rhadina</i>	3500 – 5000	UK
12.	<i>Pseudodanthonia himalaica</i>	2100 – 2150	HP, UK
13.	<i>Sehima notatum</i>	1600 – 4000	UK

of the taxa reveals that out of 13 taxa endemic to Western Himalaya, 41% taxa are found exclusively in Uttarakhand and 16% in Himachal Pradesh (Figure 2). Assessment of the state wise distribution of endemic taxa revealed that about 80 % of total endemic grasses from Western Himalaya have been recorded from tropical to alpine region of Uttarakhand. Therefore,

Degree of Endemism in different states of Western Himalaya

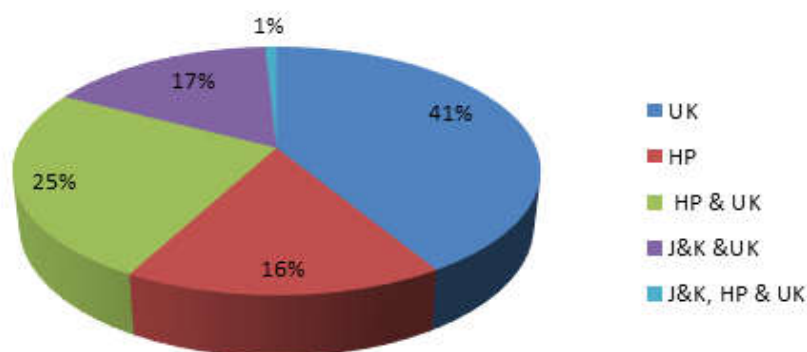


Figure 2. Degree of Endemism in different states of Western Himalaya.

Uttarakhand provides optimum conditions for the vegetation of grasses. Restriction of these 13 endemic taxa to Western Himalaya may be attributed due to their habitat specificity. Due to restricted geographical distribution, habitat specificity, endemic taxa are more vulnerable to natural and anthropogenic threats and, therefore, hold a high risk of extinction. Endemic plants are of substantial phytogeographic value. Being the basic component of any flora, they determine the degree of uniqueness of that region. Therefore, endemic species should be closely monitored and managed, and assessment of their conservation also be considered a global priority.

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