Journal of
Plant Development Sciences
Meerut, India

RESEARCH ARTICLE

STUDIES ON FLORAL BIOLOGY AND INTER-POPULATION PHENOLOGICAL VARIABILITY IN THREATENED *ALLIUM STRACHEYI* BAKER FROM WESTERN HIMALAYA

Pooja Devi, Hrishi Manchanda and Geeta Sharma*

Department of Botany, University of Jammu, Jammu
Email: geetaji@yahoo.com

Received-02.03.2026, Revised-13.03.2026, Accepted-29.03.2026

Abstract: *Allium stracheyi* Baker, an important species used for seasoning dishes, is endemic to Himalaya. The identified germplasm of this species from Pir-Panjal comprised fifteen populations growing between 2224–3080 masl. The plants of this bear tunicated bulbs, flat leaves and a single long scape bearing umbel inflorescence having trimerous flowers. In just opened flowers, anthers appear at two levels with respect to stigma, with maximum flowers having 3 long and 3 short filaments and minor ones having long and short filaments in proportion of 4:2, 2:4, 1:3median:2. Another interesting condition revealed by this species is distylous, with some flowers having long style and others having short style at the same stage of development. The studied plants differ slightly in flower colour, with more plants of higher reaches bearing inflorescences having light-pink flowers, with plants of lower altitudes bearing outnumbering inflorescence with pale-yellow flowers. The studied *A. stracheyi* plants of varying altitudes also show variation in the duration of different phenological events. The plants of higher reaches (2600-3100 m) emerge in April ending and depict vegetative growth till July, flower from 1st to 3rd week of August, develop fruits from mid-August to mid-September, show senescence in October and dormancy till April. In the plants of lower altitudes (2300-2500 m), these events get delayed by nearly two weeks. Higher variability existing in phenological behaviour and floral traits in *A. stracheyi* seems to be the outcome of heterogeneity prevalent with regard to altitude, topography and associated climatic conditions.

Keywords: *Allium stracheyi*, Pir-Panjal, Heterogeneity, Phenological behaviour

INTRODUCTION

Allium stracheyi Baker (Amaryllidaceae), the species having distinct aroma due to its sulphur-rich compounds, is endemic to Himalaya (Dhar and Kachroo, 1983; Pandey *et al.*, 2008, 2021). Known to inhabit high altitudinal regions (2000-4000 masl) of India, Bhutan, Burma, Nepal and Pakistan (Nasir, 1975; Hooker, 1978; Shah, 2014; Tiwari *et al.*, 2014), in our country it has been reported from few pockets of Jammu and Kashmir (Gohil and Koul, 1973), West Bengal (Sharma and Aiyangar, 1961; Sen, 1974) and nearly 28 sites of Uttarakhand and Himachal Pradesh (Verma *et al.*, 2008; Pandey *et al.*, 2021; Semwal *et al.*, 2021; Kumar *et al.*, 2024).

A. stracheyi has high culinary value, with its fresh and blanched leaves along with inflorescences being used as spice (Tiwari *et al.*, 2014). These are rich in proteins, carbohydrates, phosphorous, vitamins C and E, and contain anti-inflammatory and analgesic components (Ranjan *et al.*, 2010; Maikhuri *et al.*, 2017). The indigenous people use leaf decoctions as stimulant, appetizer, carminative, expectorant and to cure digestive problems (Tiwari *et al.*, 2014; Kumar *et al.*, 2015; Agnihotri *et al.*, 2020; Chandrasekaran *et al.*, 2020). Going by these benefits, this species has high market value in India as dried *A. stracheyi* leaves from Uttarakhand are available on online platform for 245 INR/20g. This species, however, has been mentioned as vulnerable in the Red Data Book (Ved *et al.*, 2003).

While locating germplasm of this species from Pir-Panjal, we came across fifteen populations growing between 2224–3080 masl which were prolific flower producers. Literature survey (Nasir, 1975; Hooker, 1978; Pandey *et al.*, 2021) depicted this species bearing rosy-pink to pale-yellow flowers. Previously our group found such variation in flower colour in *Allium roylei* (Sharma and Gohil, 2002) as its wild plants of higher reaches (1400 masl) bear light-pink flowers and those translocated to plains (351 masl) form dirty-white flowers, with Kohli (2013) reporting inflorescences with/without bulbils. This interesting observation instigated us to study floral biology of *A. stracheyi*, detect floral variability, if present and find any association between variable forms and elevation.

*Corresponding Author

Recording timing of onset and duration of various phenological events of populations inhabiting different geographical locations is an important aspect that can aid in identifying the elevation-wise specific period during which plants produce more herbage and flowers, the products of economic use (Mir *et al.*, 2020). Therefore, studies on this aspect were also conducted.

MATERIALS AND METHODS

Distribution

The 15 populations of *A. stracheyi* located in 2021 from varying elevations (2224-3080m) of Pir-Panjal range of Jammu Himalayas belonged to Padri (3080m, 32.917°N, 75.810°E), Kondlu (2804m, 32.900°N, 75.818°E), Ganja-goth (2670m, 32.895°N, 75.810°E), Dalan (2494m, 32.932°N, 75.810°E), Khani-top (2427m, 32.938°N, 75.773°E), Thanala (2277m, 32.932°N, 75.785°E), Tiba (2781m, 33.005°N, 75.770°E), Dari (2764m, 33.006°N, 75.775°E), Dhaeri (2420m, 33.001°N, 75.776°E), Kansar (2496m, 32.965°N, 76.764°E), Sharakhi (2390m, 32.944°N, 75.788°E), Bharai (2233m, 32.997°N, 76.005°E), Ligri (2785m, 33.301°N, 76.161°E), Kedna-nallah (2396m, 33.203°N, 75.538°E) and Shiryari-top (2224m, 33.068°N, 76.009°E). For these sites, approximate area of occurrence of this species was determined alongwith number of plants growing there.

Floral biology and diversity analysis:

The plants of representative population were analysed for onset and sequence of different floral events such as sequence of emergence of floral buds, onset and duration of flower opening and fruit development and maturation followed by seed dispersal. During this analysis, tagged populations were also screened for floral variability.

Phenological studies

Various phenological events such as plant emergence, vegetative growth, flowering, fruit development and senescence have been recorded by visual inspection by frequently visiting the study sites during four seasons namely, winter (December-February), spring (March-May), summer (June-August) and autumn (September-November).

RESULTS AND DISCUSSION

Distribution detail

Presently, 15 populations from high temperate and subalpine areas of Pir-Panjal falling in Doda and Kishtwar districts were identified (Table 1). While from Doda, 13 populations were located, with six each from Padri valley and Bhaderwah forest block and one from Bhalessa. In Kishtwar district, one population each was spotted from Padder valley and Kuchal Chattroo belt. At these sites, *A. stracheyi* plants largely inhabited crevices of rocks in open meadows (Fig. 1A), sloppy grasslands (Fig. 1B) and those near streams and beneath pine trees.

Since at the studied sites Keer plants showed patchy distribution, we estimated the area within which present plants were found, though in patches in 2021. This data along with approximate number of plants seen there were counted and enlisted in Table 1.

Table 1. Habitat details and number of plants inhabiting study sites of *Allium stracheyi*

District	Locations	Population (Identity)	Alt. (masl)	Habitat	Occurrence area (km^2)	Approx. no. of plants	Inflores-cences scanned for flower colour
Doda	Padri valley and adjacent sites	Padri (Pdr)	3080	Rocky areas of meadows	1	80	35
		Kondlu (Kdl)	2804	Rocky areas of meadows	0.5	56	38
		Ganja-goth (Ggt)	2670	Undergrowth in Pine forests	0.5	15	15
		Dalan (Dln)	2494	Sloppy grasslands	0.5	5	5
		Khani-top (Ktp)	2427	Undergrowth in Pine forests	1-2	57	41
		Thanala(Thn)	2277	Open sloppy grasslands	0.5	52	34
	Villages falling in forest block	Tiba (Tib)	2781	Rockyareasof open grasslands	0.5	10	10
		Dari (Dar)	2764	Undergrowth in Pine forests	0.5	30	24
		Dhaeri (Dhr)	2420	Undergrowth in Pine forests	0.5	18	18

	of Bhaderwah	Kansar (Kns)	2496	Rocky crevices of grassland	1-2	68	37
		Sharakhi (Sha)	2390	Rocky crevices of grasslands	1-2	45	36
		Bharai (Bhr)	2233	Rocky crevices of sloppy open grasslands	0.5	69	33
	Bhalessa valley	Shiryari-top (Sht)	2224	Open sloppy grasslands	1-2	57	30
Kishtwar	Paddar Valley	Ligri (Lgr)	2785	Rocks aside stream	0.5	60	48
	Kuchal-Chatroo belt	Kedna-nallah (Kdn)	2396	Rocks in grassland near stream	0.5-1	60	49

As evident from table 1, the patches of *A. stracheyi* plants in Khani-top, Kansar, Sharakhi, Shiryari-top covered nearly 1 to 2 km^2 area whereas the remaining populations were found spread between 0.5 to 0.9 km^2. At most of these locations, nearly 45 to 80 individuals were spotted whereas at Tiba, Dari and Dhaeri, 10-18 plants and at Dalan only 5 plants were seen. It is pertinent to mention here that at Dalan and Tiba, not a single plant could be seen during subsequent visits.

Floral biology

The studied perennial plants of *A. stracheyi* above ground bear flat glaborous leaves (Fig. 1C) and underground differentiate tunicated bulbs having a distinct rhizome (Fig. 1D). With the onset of flowering season, a single long scape emerges which supports young inflorescences. After some time, spathe of young inflorescence ruptures followed by exposure of floral buds. Then the flowers start opening sequentially in morning and evening hours. Expansion of flower is followed by unfolding of one tepal and marginal opening of bud. Nearly after 2 hours, one stamen emanates (Fig 1E) followed by other two (Fig. 1F). After some time, floral bud is fully expanded and all the six stamens are visible. Subsequentially, filaments start elongating, first three in a sequence in a short period of time. In just open flowers, anthers appear at different levels with respect to stigma (Table 2). In a sample of 20 flowers, those with 3 long+3 short filaments (Fig. 1G) were preponderant followed by the flowers having 4 long+2 short (Fig. 1H), 2 long+4 short (Fig. 1I) and 1 long+3 medium+2 short filaments (Fig. 1J).

Table 2. Different patterns of appearance of anthers with respect to stigma in *A. stracheyi*

Stage	Appearance of anthers with respect to stigma			
Long+Short filaments	3Long+3Short	4Long+2Short	2Long+4Short	1Long+3Medium+2Short
Percentage of flowers	70	15	10	5
Flower no./ Total	14/20	3/20	2/20	1/20
Fig.	1G	1H	1I	1J

At these stages, style is short nearly at the level of anthers of short filaments. As soon as, filaments attain maximum length, three were seen dehisced and three undehisced (Fig. 1K), followed by dehiscence of the remaining three. The flowers having six long stamens showed distylous condition (Figs. 1L, M). That is flowers having short (4mm) and long styles (8mm) were found at the same stage of development.

Allium roylei is another species whose trimerous flowers bear three long and three short stamens (Kohli, 2013) though it depicts tristylous condition. The complete opening of flower takes about 20-24 hrs and its longevity remains for 4-5 days. Nearly after 7 days, tepals wither and ovaries start swelling. Within next 10 days, fruit get matured followed by seed dispersal.

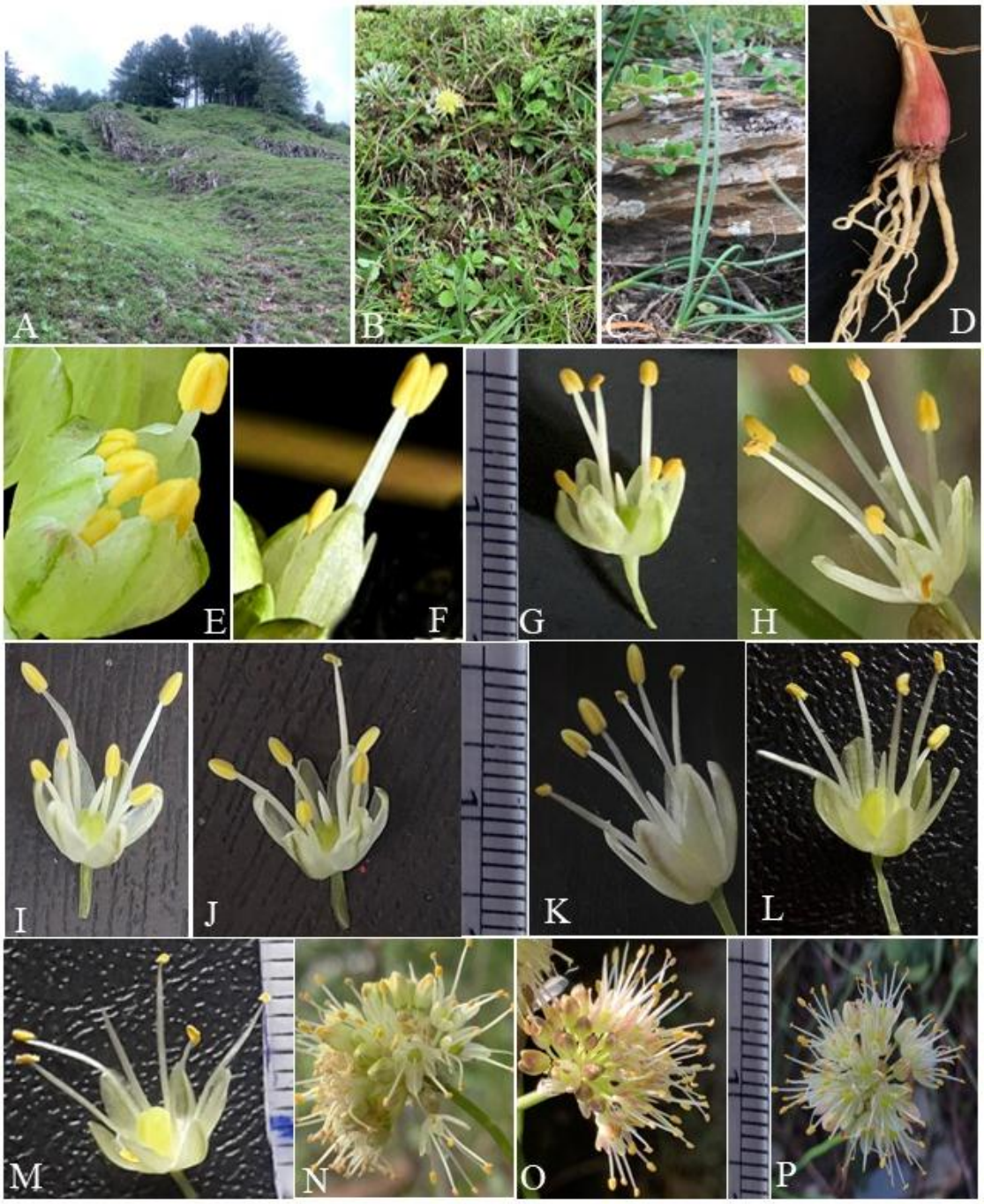

Figure 1. Plants of *A. stracheyi* growing in (A) open meadows; (B) sloppy grasslands; (C) leaves; (D) bulb; (E-F) buds showing flower opening sequence; Flowers with variable stamens length (G) 3 long plus 3 short; (H) 4 long and 2 small; (I) 2 long and 4 small and (J) 1long plus 3 intermediate and 2 short; (L) 6 long filaments bearing 3 dehisced and 3 undehisced anthers; (L) flowers with long and (M) short style. Inflorescences bearing (N) pale-yellow; (O) light pink and (P) pale-yellow plus light pink flowers

Floral variability

Current studies revealed that the flower colour of *A. stracheyi* plants slightly vary at different elevations (Fig. 2). While flowers of 5 populations (Dha, Dln, Kns, Thn and Bhr) of lower elevations (2200-2400 m) are pale-yellow barring Shiryar-top having more pink flowers, those of remaining populations growing at (Pdr, Kdl, Lgr, Sha, Tib, Kdn, Ggt, Dar, Ktp) higher altitudes (2400-3000 m) contain more plants with light pink-flowers except Ganja-goth (Figs. 1N-P).

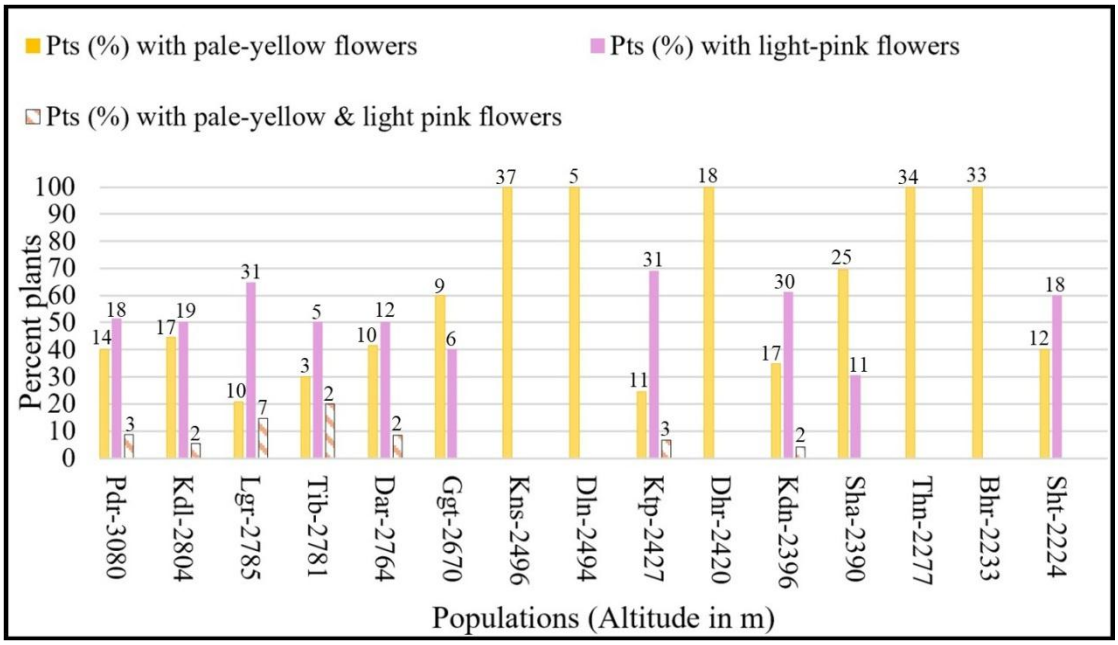

Figure 2. Graph showing plants (%) with pale-yellow, light pink and both pale-yellow and light-pink flowers

Earlier, Nasir (1975) and Pandey *et al.,* (2021) documented pink to pale-yellow flowers of *A. stracheyi*, but without mentioning occurrence of specific flower type at distinct elevation range. We (Sharma and Gohil, 2002) also found in *Allium roylei*, plants bearing light-pink flowers at higher elevations (1800m) and dirty-white in plains (351m). Higher variability witnessed in floral traits in *A. stracheyi* seems to be the outcome of heterogeneity with regards to altitude, topography, temperature, relative humidity, ecology and soil conditions.

Phenological characteristics

Recording of phenological events such as initiation and duration of flowering, fruiting and senescence in medicinal herbs which are valued primarily for foliage, provides an idea about suitability of specific season for its harvesting (Mir *et al.,* 2020, Lalmuanpuii *et al.,* 2020). Duration of different biological events and timing of onset varied in plants of high temperate and sub-alpine zones (Fig. 3). The perennial plants of higher reaches (2600-3100 m) show vegetative growth from April ending to July. They flower from 1st to 3rd week of August, develop fruits from mid-August to mid-September. show senescence in October and dormancy till April, followed by emergence of juvenile plants in April. In the plants of lower altitudes (2300-2500 m), these events get delayed by nearly two weeks. Occurrence of *Allium* plants at different habitats of varying elevations with some differences in the duration of phenological events is indicative of their high adaptability to varying climatic conditions (Duchoslav, 2009).

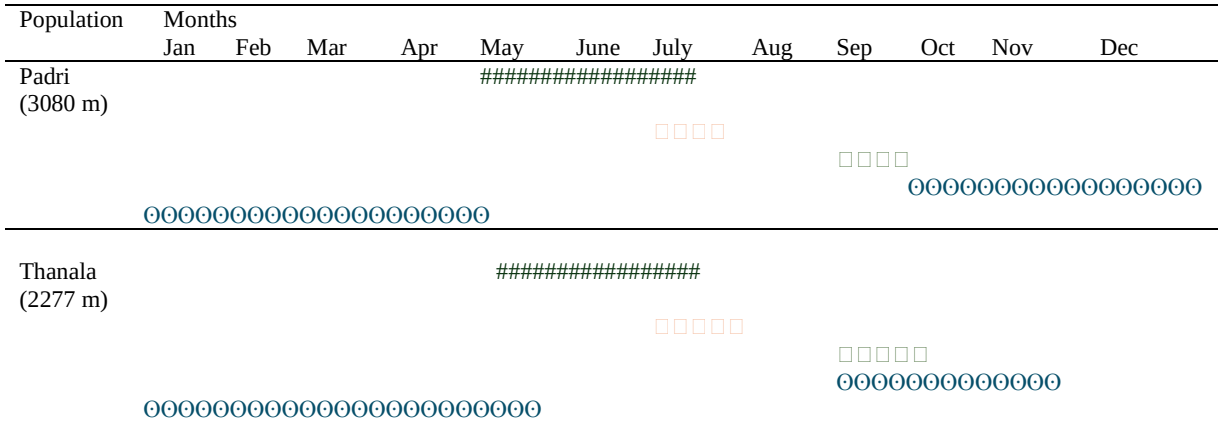

Figure 3. Phenological events of emergence and vegetative growth (###), flowering (□□□□), fruiting (□□□□) and senescence (ΘΘΘ) in *A. stracheyi* plants found at 2277 and 3080 m

As such, current studies are indicative of significant effect of altitude and associated climatic conditions on floral traits and phenological behaviour of *A. stracheyi*.

ACKNOWLEDGEMENTS

Pooja Devi is thankful to CSIR-UGC New Delhi for providing Junior and Senior Research Fellowship with file no. 09/0100(12836)/2021/EMR-I. Hrishi Manchanda acknowledges the financial assistance provided by University of Jammu in the form of University Research Scholarship (URS). Senior author is thankful to RUSA 2.0 (2025) for providing financial assistance for the research project "Assessment ------ grape species" vide no. RA/25/4714-20 dated 9th December, 2025. Thanks are also due to Special Assistance Programme-Departmental Research Support II (SAP-DRS II), RUSA and Promotion of University Research for providing financial assistance to Department.

REFERENCES

Agnihotri, V., Anjum, S. and Rana, S. (2020). Nutraceutical potential of North‑West Himalayan spices *Allium stracheyi* and *Angelica glauca* and their comparison with commonly used spices. *J. Food Meas.Charact.*,**14**: 1708–1719.
Google Scholar

Chandrasekaran, R., Thiagarajan, K., Mukherjee, A., Alphonse, M., Nachiappan, K., Parthibanraja, A., Chauhan, K., Kandari, L., S., Rawat, L.S. and Maikhuri, R.K. (2020). Large scale cultivation and commercialization opportunities and constraints of *Allium stracheyi* Baker–An endangered medicinal plant of Western Himalaya, India. *Ecol. Environ. Conserv.*,**26**: 26–32.
Google Scholar

Dhar, U. and Kachroo, P. (1983). Alpine flora of Kashmir Himalaya. *Scientific Publishers*, p. 171.
Google Scholar

Duchoslav, M. (2009). Effects of contrasting habitats on the phenology, seasonal growth, and dry-mass allocation pattern of two bulbous geophytes (Alliaceae) with partly different geographic ranges. *Pol. J. of Ecol.*,**57**(1): 15-32.
Google Scholar

Gohil, R.N. and Koul, A.K. (1973). Some adaptive genetic-evolutionary processes accompanying polyploidy in the Indian *Alliums.Bot. Not.*,**126**(4): 426–32.
Google Scholar

Hooker, J.D. (1978). Flora of British India. *Bishen Singh Mahendra Pal Singh, Dehradun*, Vol **VI**. p. 340.
Google Scholar

Kohli, B. (2014). Studies on chromosomal repatterning in *Allium roylei* Stearn. Ph. D. Thesis, University of Jammu, Jammu, Jammu and Kashmir, India.
Google Scholar

Kumar, A., Jugran, A., K., Joshi, K., Bhatt, I.D. and Bargali, S.S. (2024). Deciphering the morphological, phytochemical, genetic diversity and niche distribution of *Allium stracheyi* Baker (Amaryllidaceae): An economically important culinary herb of Western Himalaya India. *S. Afr. J. Bot.*,171: 1–14.
Google Scholar

Kumar, A., Mitra, M., Adhikari, B.S. and Rawat, G.S. (2015). Depleting indigenous knowledge of medicinal plants in cold-arid region of Nanda Devi Biosphere Reserve, Western Himalaya. *Med. Aromat Plants*,**4**(195): 2167–2178.
Google Scholar

Lalmuanpuii, R., Zothanpuia, Z.B. and Lalbiaknunga, J. (2020). Phenological observations of selected wild edible vegetables from tropical and subtropical forest of Mizoram, Northeast India. *Vegetos*,**33**: 409–419.
Google Scholar

Maikhuri, R., K., Negi, V., S., Rawat, L.S. and Pharswan, D.S. (2017). Bioprospecting of medicinal plants in Nanda Devi Biosphere Reserve: linking conservation with livelihood. *Curr. Sci.*,**113**: 571–577.
Google Scholar

Mir, A., H., Tayub, S. and Kamili, A.N. (2020). Ecology, distribution mapping and conservation implications of four critically endangered endemic plants of Kashmir Himalaya. *Saudi. J. Biol. Sci.*,**27**: 2380–2389.
Google Scholar

Nasir, E. (1975). Flora of West Pakistan. Alliaceae. *Stewart Herbarium, Gordon College, Rawalpindi*,**83**.
Google Scholar

Pandey, A., Malav, P., K., Rai, M.K. and Ahlawat, S.P. (2021). 'Neodomesticates' of the Himalayan *Allium* spices (*Allium* species) in Uttarakhand, India and studies on eco-geography and morphology. *Genet. Resour. Crop Evol.*,**68**(5): 2167–2179.
Google Scholar

Pandey, A., Pandey, R., Negi, K.S. and Radhamani, J. (2008). Realizing value of genetic resources of *Allium* in India. *Genet. Resour. Crop Evol.*,**55**(7): 985–994.
Google Scholar

Ranjan, S., Jadon, V., S., Sharma, N., Singh, K., Parcha, V., Gupta, S. and Bhatt, J.P. (2010). Anti-inflammatory and analgesic potential of leaf extract of *Allium stracheyi. J. Appl.Sci. Res.*,**6**(2): 139–143.
Google Scholar

Semwal, D., P., Pandey, A. and Ahlawat, S.P. (2021). Genetic resources of genus *Allium* in India: collection status, distribution and diversity mapping using GIS tools. *Indian J. Plant Genet. Resour.*,**34**(2): 206–215.
Google Scholar

Sen, S. (1974). Nature and behaviour of B chromosomes in *Allium stracheyi* Baker and *Urginea indica* Kunth. *Cytologia*,**39**(2): 245–251.
Google Scholar

Shah, N.C. (2014). Status of cultivated and wild *Allium* species in India: A review. *The Scitech Journal*,**1**: 28-36.

Google Scholar

Sharma, A.K. and Aiyangar, H.R. (1961). Occurrence of B-chromosomes in diploid *Allium stracheyi* Baker and their elimination in polyploids. *Chromosoma*,**12**(1): 310–317.

Google Scholar

Sharma, G. and Gohil, R.N. (2002). Addition to the germplasm *Allium roylei* Stearn. *Indian J. Plant Genet. Resour.*,**15**(3): 288–289.

Google Scholar

Tiwari, U., Adams, S., J., Begum, N., S., Krishnamurthy, K., V., Ravikumar, K. and Padma, V. (2014). Pharmacognostic studies on two Himalayan species of traditional medicinal value: *Allium wallichii* and *Allium stracheyi*. *Not. Sci. Biol.*,**6**(2): 149–154.

Google Scholar

Ved, D., K., Kinhal, G., A., Ravikumar, K., Prabhakaran, V., Ghate, U., Vijayshankar, R. and Indresha, J.H. (2003). Conservation was assessment and management prioritization for the medicinal plants of Jammu and Kashmir, Himachal Pradesh and Uttaranchal. *Regional workshop, Shimla*. *Himachal Pradesh, India*.

Google Scholar

Verma, V., D, Pradheep, K., Khar, A., Negi, K.S. and Rana, J.C. (2008). Collection and characterization of *Allium* species from Himachal Pradesh. *Indian J. Plant Genet. Resour.*,**21**(3): 225–228.

Google Scholar