Pak. J. Bot., 50(3): 1093-1112, 2018.

CLIMATIC AND FLOWERING PHENOLOGICAL RELATIONSHIPS OF WESTERN HIMALAYAN FLORA OF MUZAFFARABAD DISTRICT, AZAD JAMMU AND KASHMIR, PAKISTAN

ARSHAD MAHMOOD KHAN[1], RAHMATULLAH QURESHI[1,*], MUHAMMAD ARSHAD[1] AND S. N. MIRZA[2]

[1]*Department of Botany, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Pakistan*
[2]*Department of Forestry and Range Management, Pir Mehr Ali Shah Arid Agriculture University Rawalpindi, Pakistan*
[*]*Corresponding author's email: rahmatullahq@uaar.edu.pk*

Abstract

Anthropogenic climate change is influencing many aspects of biodiversity hotspot of the western Himalaya. Muzaffarabad district as part of western Himalayan is a strongly seasonal area, thus studies on interrelationship of timing of phenological periodic events and climatic seasonality is of obvious significance. A first ever detailedeco-taxonomical field survey of the whole district was conducted to explore floral diversity, plant habit associated with microhabitats. Timing of flowering response of species within the different months was also recorded during two consective years (2014-16) and flowering phonological data was stored as binary data matrix. The influence of studied climatic variables on the flowering phenological response was tested through canonical correspondence analysis (CCA). A total of 748 vascular plants (740 species, 3 sub-species, 5 varieties) belonged to 490 genera and 120 plant families were recorded including 77 species as new to the study area. The leading plant family was Compositae (69 spp., 9.22%), followed by Poaceae (57 spp., 7.62%), Leguminosae (54 spp., 7.22%), Lamiaceae (42 spp., 5.61%) and Rosaceae (29 spp., 3.88%); while the leading genus was *Euphorbia* (10 spp.), followed by *Cyperus*, *Ficus*, *Geranium* and *Prunus* (7spp. each). With respect to life forms, perennial herbs were the most dominant (297 spp., 39.71%), followed by annual herbs (188 spp., 25.13%). With reference to diversity of microhabitats, coniferous forest was leading in terms of floristic diversity having 243 species (32.10% of total flora), followed by drier slopes, home gardens (158 spp., 20.87% each), arable land (143 spp., 18.89%) and waste places (122 spp., 16.12%).The majority of plant species found in flowering stage during July and August months (473 spp., 62.48% and 458 spp., 60.5% respectively),while the least ones during January (51 spp., 6.73%) and December (55 spp., 7.26%). Results of CCA showed that total variations in the response data were 1.742 and 71.8% were explained by the explanatory variables. Based on conditional (net) term effects, mean monthly minimum temperature was detected as the most important and significant [pseudo-F 4.3; p(adj) 0.005] towards explaining the variations in the flowering response data. It was followed by wind speed [pseudo-F 2.9; p(adj) 0.0225] and relative humidity [pseudo-F 2; p(adj) 0.04625] variable. Intrestingly, July and August months not only receive maximum rainfall but also majority of species flowered in these months, but CCA results confirmed that rainfall is not important predictor with respect to species flowering response event in the area. It was concluded that the flora of the study area was more influenced by the climatic factors like temperature, wind speed and relative humidity. This Himalayan region is fragile and rapid temperature rise could lead to catastrophies like wiping out of endemic and endangered species, earlier snowmelts and resultant ealier blooming causing invasive species spread, upwards timber-line shift and rapid changes in vegetation composition. This baseline study information could be used to deal these issues and need to have effective regional collaboration of scientific community and policy makers is recommended.

Key words: Phytodiversity, Phenology, Climate change, CCA, Muzaffarabad AJ&K, Western Himalaya.

Introduction

Phenology can be described as the study of periodic timing of various life events in organisms, their causes as function of seasonal and climatic variations (Lieth, 1974). Phenology word is derived from Greek word "phainomai" meaning to appear or come into view (Vashistha *et al.*, 2009). Plant phenological variations in response to climate are the most responsive and easily observable factors (Badeck *et al.*, 2004). The interrelationship of phenological events and climate can reveal the potential impacts of upcoming climate changes (Yadav & Yadav, 2008). These events are related to periodic edaphic and weather changes (Rathcke & Lacey, 1985; Schwartz, 2003). Phenological studies prove useful to evaluate the pattern of climate and reproductive cyclic changes of the plant species.

Initiation of flowering event is of prime significance for reproductive success of plant species. This event varied from species-species due to difference in requirement of inductive photo-thermoperiod (Vashistha *et al.*, 2009). The time to flower is a pivotal event for plant species because its further linked with some important events like pollination chances, arrival of insects as pollinator (themselves seasonal), timing of seed ripening and dispersal, andfruit set (Santandreu & Lloret, 1999). This event also influence insects and other animals for which pollen, nectar and seeds are important resources (Visser & Holleman, 2001). Similarly earlier flowering is also related to earlier activity in other processes like leaf expansion, root growth and nutrient uptake etc. All these process and activities are important for niche differentiation among coexisting species (Veresoglou & Fitter, 1984; McKane *et al.*, 1990). These changes in flowering dates will alter competitive interactions amongst the species and therefore could disrupt ecosystem structure. Holway and Ward (1965) reported that different phenological events at high altitude areas are mainly controlled by temperature variations. Similarly the influence of tempaerature and moisture on these events has been studied by various workers (Walter, 1973; Dewald & Steiner, 1986). Temperature is an important factor for many plant developmental processes (viz. temperature dependent chemical reaction rates, enzyme kinetics, denaturation of enzymes, formation of ice crystals, membranes fludity etc.) whereas higher temperatures usually hasten such process and lead to

earlier switching to the next ontogenetic stage (Badeck *et al.,* 2004). Increase in regional and global temperatures are well documented (IPCC, 2001), thus providing sufficient reasons to expect changes in plant phenological events. Photoperiod length and moisture are another important factors that could alter the timing of responses in plants whereas according to Sparks *et al.,* (1997) evidence for impacts of precipitation on plant responces are scarce. Phenomenological and phenological responses of the plants species are actually the product of their genotypic-environment interactions (Vashistha *et al.,* 2009) but according to Huntley (1991), evidence gathered from past literature indicate that species are more likely to respond by migration rather than by adapting genetically.

Himalayas are source of eight largest river in Asia known as‘‘water tower of Asia’’.The rate of temperature rise in the Himalayan region is greater than the global average. Thus Himalayas are rightly considered as one of the most vulnerable regions in the world (Shrestha *et al.,* 2012). The rapid climatic changes are significantly disrupting Himalayan biome in term of losses/alteration to biodiversity, shifts in geographical ranges of species, species extinction, vegetation composition, water resources and glacier melting, agriculture, socioe-conomic and cultural changes in associated ethnic communities (Chaudhary *et al.,* 2011). Ram *et al.,* (1988) reported that central Himalayan plant species are changing their strategies including quick completion of growth cycle to assure species survival due to unfavorable environmental changes.

The preparation and communication of plant species lists containing information about species microhabitat, habit and flowering phenology are important for effective species conservation and management plans. These findings serve as easy tools for floristic workers, taxonomists and vegetation scientists since these contain much important preliminary information (Raimondo *et al.,* 2010). Kirschbaum *et al.,* (1996) reported that as compared to crop phenology, the forest species phenolgy were discussed least due to scarcity of published results. Thus, inclusion of species phenological responses and their microhabitats in floristic lists are not only important to predict climate pattern but also enables latter workers to collect their required material from wild for detailed studies (Lechowicz, 2001; Malik, 2005; Gairola *et al.,* 2010; Raimondo *et al.,* 2010). Simultaneously, Khan *et al.,* (2016) suggested that while preparing such manuscripts, the use of updated nomenclature, position or rank and placement of various taxa in hierarchies according to latest information avoid confusions and simultaneously enhance the reliability and reproducibility of such communication.

Many floristic checklists from Pakistan (Qureshi *et al.,* 2011a; 2011b; 2014; Ilyas *et al*., 2013; Shaheen *et al*., 2014) and one from study area (Dar *et al*., 2012) has been published but role and contribution of climate towards the plant responses particularly flowering response is missing. Currently, single floristic checklist from Machiara National Park, Muzaffarabad ((Dar *et al*., 2012) has been published that covers only 8% land area of the Muzaffarabad district (Dar *et al*., 2014). Neither detailed floristic list nor interrelationship of timimg of flowering event by the local flora and climatic variables like temerature, rainfall, atmospheric humidity and wind speed through multivariate tools was documented. Thus, this first ever study from this western Himalayan region is planned to answer the following questions. 1. What about the overall diversity of vascular flora and which microhabitats are more diverse? 2. When majority of plant species give flowering response around the year during different seasons and what are the number of their possible groups? 3. Flowering response is related to which climatic variable the most and what is the order of importance of climatic variables in this regard? This study will serve as the first ever baseline study in the region which could be further used to explore and predict various climate impacts and patterns.

Materials and Methods

The study area: Muzaffarabad district is the capital of Azad Jammu and Kashmir, Pakistan that lies in the western Himalayan range between latitude 34º03'-34º35'N and longitude 73º23'-73º45'E, and comprised of land area of 1642Km^2. The elevation ranges from 582 m a.s.l. in the southern part (viz. Kohala locality) to 3819 m a.s.l. (viz. Makra mountain summit) and 4473 m a.s.l. (viz. Neela Ganja mountain summit) in the northern part of the study area (Fig. 1). It is bounded by the district Hattian Bala on the east, district Neelum on the northeast, Hazara division, KPK on the north and northwest, district Bagh on the south, and Murree hills, Punjab on the southwest. The topography is marked by mountains that stretches from subtropical valleys to typical scenic Himalayan alpine zones. The area is bestowed with natural beauty, having thick forests, fast flowing rivers and winding streams. Main rivers are the Jhelum and the Neelum. The climate is sub-tropical highland type. The mean minimum and maximum extreme temperatures were recorded as -2.6 to 45.2°Ċ in the month of January and June respectively. The average mean annual rainfall varies between 1000-1300 mm, of which approximately 680 mm fall during four months (i.e. May to August). The wind blows from west to east during the day time, while at night it blows from south east to north. The wind velocity is higher during afternoon as compared to early morning. The snow line in winter remains around 1200 m a.s.l. while in summer, it rises to 3300 m a.s.l. (Qasim *et al.*, 2010a; 2010b; Anon., 2015).

Plants collection and identification: The detailed floristic surveys were conducted during each month from August 2014 to July 2016. The voucher specimens were collected, pressed, dried and mounted on standard sized herbarium sheets. The same were identified by using available taxonomic literature and online floral databases (Stewart, 1972; Ali & Qaiser, 1995-2009; EFLORAS, 2012a, 2012b, 2014; TROPICOS, 2012). After identification, all the familial and species binomials were copied from theplantlist.org (TPL, 2013) to attain global homogeneity (Khan *et al.*, 2016). The same were deposited in the Department of Botany, Pir Mehr Ali Shah, Arid Agriculture University Rawalpindi, Pakistan for future reference and record. Plant species were also categorized on the basis of their growth habit and 16 microhabitats like Arable land, Cliff, Dry slope, Exposed (alpine) slope, Forest, Grassland, Grave yard, Home garden, Marsh, Moist & Shady, Rock crevice, Roadside, Sandy stream/riverside, Scrubland, Waste place and Water course.

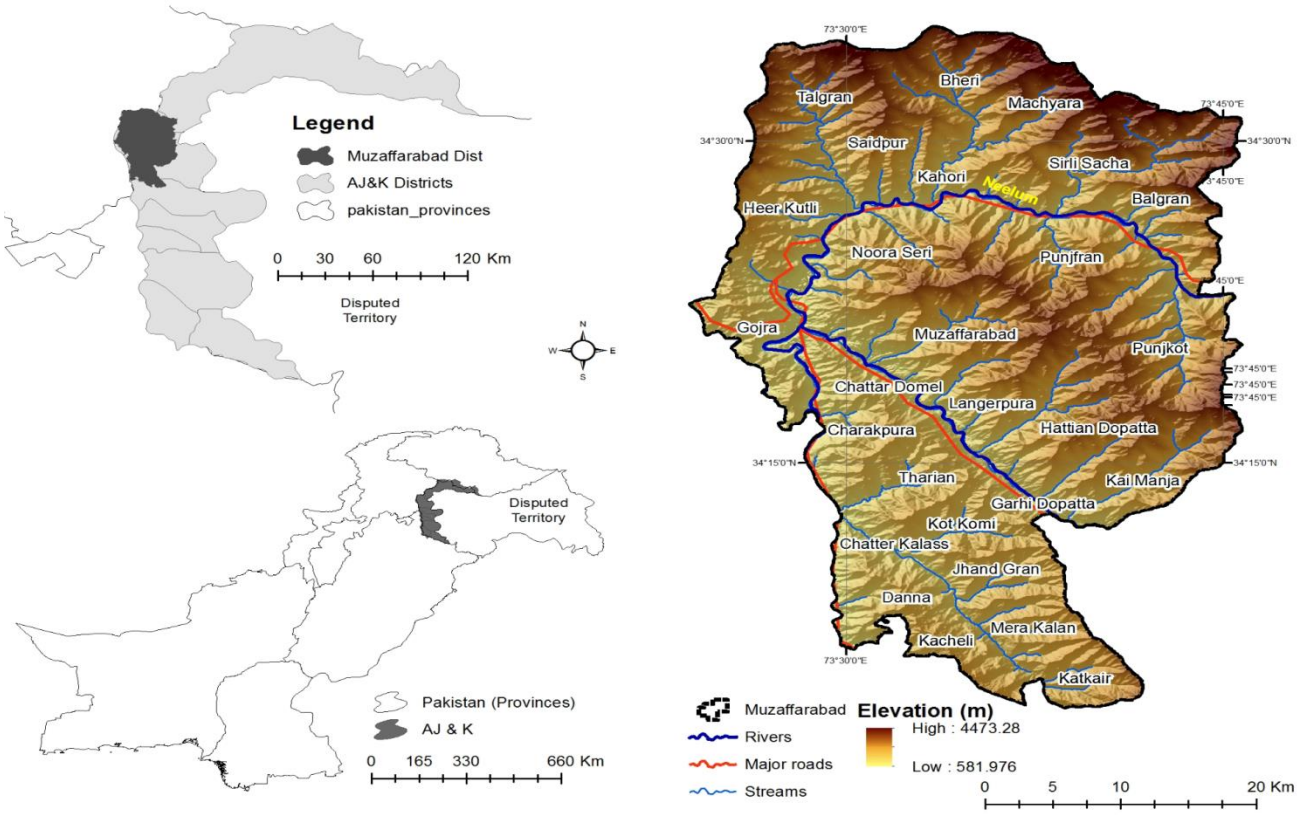

Fig. 1. Location map of Muzaffarabad district, Azad Jammu and Kashmir, Pakistan.

Flowering phenology and statistical analyses: Complete duration of flowering response of all 748 vascular plant species within different months around the year was recorded during 2014-15 and again confirmed during 2015-16. For this, flowering event in case of angiosperms, strobili development in gymnosperms and sporogenesis (sori development) event in pteridophytes were considered. Finally, binary data matrix (1=flowering, 0=vegetative/absent) of species during the different months was stored as excel spreadsheet. For example, *Barleria cristata* was found in flowering stage during 4 months, from November to February in the study area, thus value of 1 was allotted to these months for this species and value of zero to all other 8 months. Monthly mean climatic data (minimum temperature, maximum temperature, rainfall, wind speed, relative humidity) of the study area was collected from National Agromet Centre, Pakistan Meteorological Department, H-8/2 Islamabad, Pakistan. From the binary data matrix, number of plant species found in flowering during each month was also calculated like Khan *et al.,* (2015) and named as species flowering response or SFR variable (a response variable) It was correlated with climatic data variables through Pearson correlation. By using library "pvclust" in R statistical package (R-Core-Team, 2015), clustering dendrogram of SFR and climatic variables was also developed by using correlation as distance matrix and ward as linkage method. Similarly cluster analysis of binary data matrix was done by using PC-ORD 5 (McCune & Mefford, 2006) with "Euclidean distance" and "Ward linkage" to seek pattern of months grouping based on similarities of species flowering response. To seek the contribution of climatic variables towards explaining variations in the binary response data, canonical correspondance analysis was performed by using Canoco 5 (Ter Braak & Smilauer, 2012) software.

Result and Discussion

A total of 748 vascular plant taxa (740 species, 3 sub-species, 5 varieties) belonging to 490 genera and 120 plant families were recorded from the Muzaffarabad district, AJ&K, Pakistan. The proportion of pteridophytes and their allies was, 29 species (3.88%) belonging to 15 genera (3.06%) and 10 plant families (8.33%). Similarly gymnosperms were represented by 12 species (1.60%), 11 genera (2.24%) and 6 plant families (5%) whereas angiosperms contribution was 707 plant taxa (94.51%) with 464 genera (94.69%) and 104 plant families (86.67%). Within angiosperms, the major contributors were dicots with 592 plant taxa (79.14%) that belongs to 384 genera (78.37%) and 87 families (72.5%) whereas monocots were comprised of 115 species (15.37%) belonging to 80 genera (16.32%) and 17 plant families (14.17%). The categorization of all 748 vascular plant taxa on the basis of their habit depicted the dominance of the perennial herbs (297, 39.71%) followed by annual herbs (188, 25.13%), deciduous trees (66, 8.82%), deciduous shrubs (54, 7.22%), evergreen trees (49, 6.55%), evergreen shrubs (39, 5.21%), perennial climbers (27, 3.61%), annual climbers and biennial herbs (14, 1.87% each) (Table 1).

Table 1. Summary of floral composition of major phyto-taxa and species growth habit in the study area.

Taxa	Families (%)	Genera (%)	Species/taxa (%)
Pteridophytes	10 (8.33%)	15 (3.06%)	29 (3.88%)
Gymnosperms	6 (5%)	11 (2.24%)	12 (1.60%)
Monocots	17 (14.17%)	80 (16.32%)	115 (15.37%)
Dicots	87 (72.5%)	384 (78.37%)	592 (79.14%)
Total	120	490	748
Habit		**Species/taxa**	**%age**
Annual climbers		14	1.87
Annual herbs		188	25.13
Biennial herbs		14	1.87
Deciduous shrubs		54	7.22
Deciduous trees		66	8.82
Evergreen shrubs		39	5.21
Evergreen trees		49	6.55
Perennial climbers		27	3.61
Perennial herbs		297	39.71

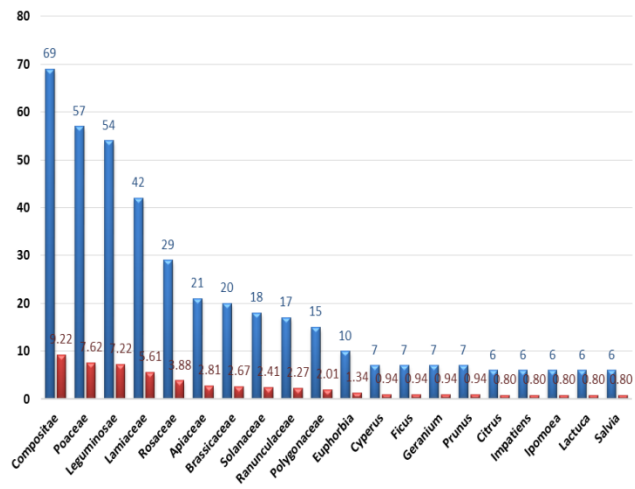

Fig. 2. Leading 10 families and genera in the study area.

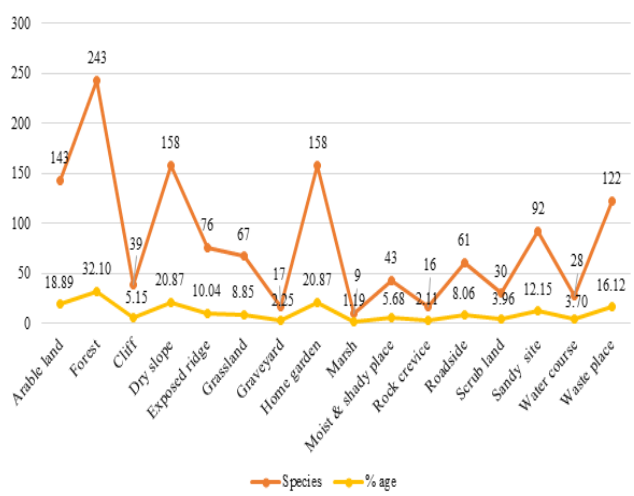

Fig. 3. Distribution of plant species into various microhabitats in the study area.

The leading plant family with maximum number of species in the study area was Compositae (69 species/taxa, 9.22%), followed by Poaceae (57 spp., 7.62%), Leguminosae (54 spp./taxa, 7.22%), Lamiaceae (42 spp., 5.61%), Rosaceae (29 spp., 3.88%), Apiaceae (21 spp., 2.81%), Brassicaceae (20 spp./taxa, 2.67%), Solanaceae (18 spp., 2.41%), Ranunculaceae (17 spp., 2.27%) and Polygonaceae (15 spp., 2.01%). Similarly the leading genus was *Euphorbia* (10 spp., 1.34%), followed by*C yp erus, Ficus, Geranium* and *Prunus* (7 spp., 0.94% each), *Citrus, Impatiens, I pomoea, Lactuca* and *Salvia* (6 spp., 0.80% each) as shown in Fig. 2.

Plant species micro-habitats: Native peoples of the study area were found interacting more with 176 plant species/taxa (23.53%). These includes crops, fruits, vegetables and ornamental species and grown at agricultural fields, home gardens, public park s and roadside plantations for fulfilling food, aesthetic and ecological purposes like wind breaker and soil binders etc. Similarly, 572 plant species/taxa (76.47%) were recorded aswild species at variety of micro- habitats in the study area.

The categorization of 748 plant species into variety of microhabitats in the Muzaffarabad district showed that conifer forest was the most diverse (243 spp., 32.10%), followed by drier slopes and home gardens (158 spp., 20.87% each), arable land including weeds (143 spp., 18.89%), and waste places (122 spp., 16.12%), and thus supporting majority of plant species in the study area. Similarly least species richness was observed within graveyards (17 spp., 2.25%), rock crevices (16 spp., 2.11%) and marshy area (9 spp., 1.19%) microhabitats (Fig. 3).

New record to study area: This study not only enhances the plant species count (748 phyto-taxa) as compared to Dar *et al.,* (2012) from the area but also includes 77 new records because it was the first ever detailed botanical exploration that encompssed the whole Muzaffarabad district.These plant species were reported either from adjacent or other areas of Pakistan but not from Muzaffarabad district. For confirmation, we compared our species records with the previous published literature such as Khan *et al.,* (2016), Stewart (1972) and Flora of Pakistan at TROPICOS (2012).To the best of our knowledge, 73 plant species are recorded as new record for the Muzaffarabad district. Of them, 4 pteridophytes, 10 monocotyledonous and 63 dicotyledonous species are determined (Table 2). These in orderly mamner include *Athyrium filix-femina*, *Dryopteris filix-mas*, *Polystichum yunnanense*, *Cheilanthes farinosa*, *Arisaema utile*, *Agave vivipara*, *Juncus inflexus*, *Bothriochloa ischaemum*, *Capillipedium parviflorum*, *Cenchrus setiger*, *Echinochloa colona*, *Piptatherum aequiglume*, *Piptatherum munroi*, *Saccharum arundinaceum*, *Hygrophila auriculata*, *Amaranthus graecizans* subsp. *silvestris*, *Aegopodium alpestre*, *Conium maculatum*, *Eryngium caeruleum*, *Pentatropis capensis*, *Vincetoxicum sakesarense*, *Incarvillea emodi*, *Alliaria petiolata*, *Erysimum melicentae*, *Nasturtium microphyllum*, *Rorippa palustris*, *Thlaspi arvense*, *Turritis glabra*, *Cerastium glomeratum*, *Silene coronaria*, *Euonymus hamiltonianus*, *Cleome viscosa, Ageratum conyzoides*, *Anaphalis busua*, *Arctium lappa*, *Carpesium cernuum*, *Echinops niveus*, *Galinsoga parviflora*, *Lactuca dolichophylla*, *Lactuca serriola*, *Matricaria chamomilla*, *Pseudognaphalium affine*, *Senecio nudicaulis*, *Tridax procumbens*, *Cuscuta chinensis*, *Sedum hispanicum*, *Euphorbia cornigera*, *Euphorbia heterophylla*, *Euphorbia hispida*, *Triadica sebifera*, *Geranium pusillum*, *Geranium rectum*, *Clerodendrum chinense*, *Elsholtzia stachyodes*,

Leonurus cardiaca, *Leucas lanata*, *Salvia aegyptiaca*, *Scutellaria grossa*, *Caesalpinia decapetala*, *Crotalaria albida*, *Rhynchosia himalensis*, *Lavatera cachemiriana*, *Ficus sarmentosa* var. *nipponica*, *Persicaria maculosa*, *Androsace sempervivoides*, *Androsace umbellata*, *Aquilegia fragrans*, *Prunus cerasoides*, *Galium asperuloides*, *Mazus pumilus*, *Daphne mucronata*, *Glandularia aristigera* and *Ampelopsis vitifolia.*

Flowering phenology response and its relationship with the climatic data: The results of timing of vascular plant species flowering response during the different months revealed that majority of species responded in the month of July (473 spp., 62.48%) followed by August (458 spp., 60.5%) and June (411 spp., 54.29). Similar results were also reported by Vashistha *et al.*, (2009), in which they found that majority of plant species showed flowering response during July and August months in the north western Himalaya. Similarly, least flowering response was observed during December (55 spp., 7.26%) and January (51 spp., 6.73%); (Fig. 4).Thus, maximum number of plant species blossom during rainy/monsoon season in the study area.

This number of plant species found in flowering during each month or SFR variable (n = 12 = months in a year) was correlated with mean monthly values of five climatic variables of the study area. It showed that minimum temperature was significantly positively (r = 0.949, p-value <0.01) related with the species flowering response followed by maximum temperature (r = 0.913, p-value <0.01) and wind speed (r = 0.693, p-value <0.05). Moderate positive correlation (r = 0.558, p-value 0.06) was observed for mean monthly rainfall (mm) data and very weak negative correlation (r = -0.085, p-value0.792) with the relative humidity values of the study area (Table 3). For pictorial view of these correlation results, hierarchical clustering dendrogram was developed. In this dendrogram, the values given in red and green above each cluster represents approximately unbiased (AU %) p-values and bootstrapped probability (BP %) values respectively. Similarly values below the cluster represents the order of clustering (Fig. 5).

Classification of months: Binary data matrix was used for clustering of months into groups based on similarity of species sexual reproduction event response in the area. It showed that there were three important groups. Group 1 was comprised of 5 months (October to February) with least flowering response of species and lower mean temperature. Similarly, Group 2 was comprised of 4 months (March to June), and showed intermediate values for both flowering response and air temperature. Group 3 included 3 months (July to September), and showed maximum values for both species flowering response and rainfall varaiable (Fig. 6).

Canonical correspondence analysis (CCA): Constrained unimodal ordination (CCA) was performed to seek the contribution of five explanatory variables (climatic variables) towards explaining the variations in the species flowering response data (binary data matrix). Both simple and conditional (net) term effects were tested. Total variations in the response data were 1.742. About, 71.8% variations were explained by explanatory variables whereas adjusted explained variations were 48.3%. Based on simple term effects, mean monthly minimum temperature was detected as most important and significant [pseudo-F 4.3; p(adj) 0.0025] towards explaining the variations in the flowering response data in the study area. It was followed by maximum temperature [pseudo-F 4; p(adj) 0.0025],relative humidity [pseudo-F 2.1; p(adj) 0.05] whereas wind speed [pseudo-F 1.9; p(adj) 0.06125] and rainfall [pseudo-F 0.9; p(adj) 0.474] variables were detected as non-significant. All the p-values were corrected by false discovery rate and adjusted. We know that these climatic variables are also intercorrelated thus to seek the unique contribution (not contributed by the previously entered variable) of each of five climatic variable, conditional (net) term effects were tested. This revealed that wind speed [pseudo-F 2.9; p(adj) 0.0225] variable was the second most important and significant factor followed by relative humidity [pseudo-F 2; p(adj) 0.04625] variable whereas rainfall [pseudo-F 0.8; p(adj) 0.622] variable again proved least important. The entrance of these five climatic variables through forward selection method again detected the same order of importance as conditional term effect results but suggested that first three variables are sufficient enough to retain the CCA modal as constrained. July and August months receive maximum rainfall as well as SFR score, but CCA results confirmed that rainfall is not important predictor with respect to species flowering response in the area. CCA numerical and graphical results are presented in Table 3 and Fig. 7 respectively.

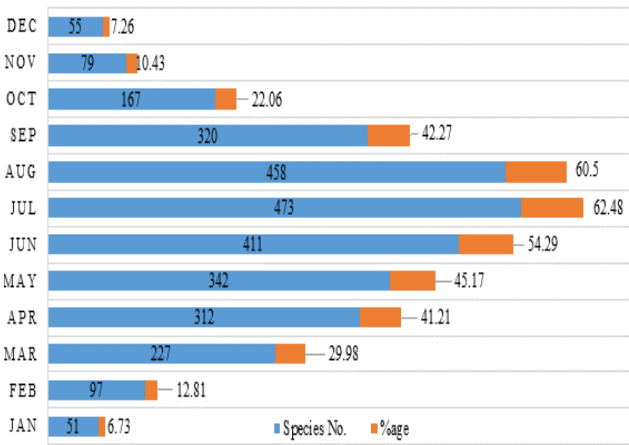

Fig. 4. Timing of flowering response of vascular flora of western Himalayan forest, Muzaffarabad, Azad Jammu and Kashmir, Pakisan.

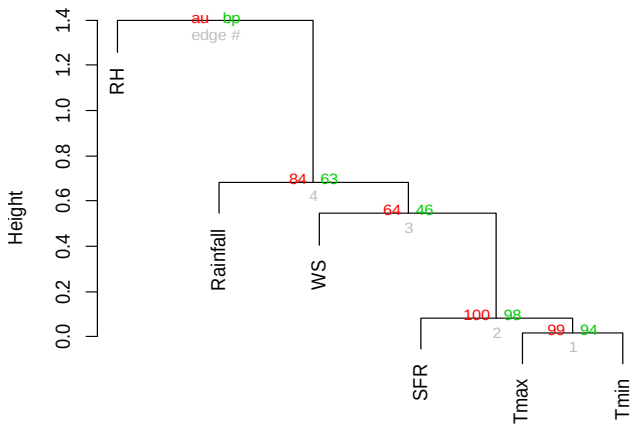

Fig. 5. Cluster dendrogram with AU/BP% values showing correlation of climatic and species floweringresponse (SFR) variablesfrom the forest of the western Himalaya.

Table 2. Detailed floristic results of Muzaffarabad district, Azad Jammu and Kashmir, Pakistan.

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
Pteridophytes and their related species						
1. Aspleniaceae	1	*Asplenium adiantum-nigrum* L.	AMK/3861	PH	R, F	Jun-Aug
	2	*Asplenium dalhousiae* Hook.	AMK/3620	PH	F, R	Jul-Sep
	3	*Asplenium trichomanes* L.	AMK/3963	PH	F, R	May-Aug
2. Athyriaceae	4	*Athyrium filix-femina* (L.) Roth	AMK/3636	PH	F, MS	Jul-Aug
	5	*Athyrium microphyllum* Alston	AMK/4284	PH	F, MS	Jul-Aug
3. Blechnaceae	6	*Woodwardia unigemmata* (Makino) Nakai	AMK/3757	PH	F	Jul-Sep
4. Cystopteridaceae	7	*Cystopteris fragilis* (L.) Bernh.	AMK/4351	PH	F, MS	Jul-Sep
5. Dennstaedtiaceae	8	*Pteridium aquilinum* (L.) Kuhn	AMK/3813	PH	F, MS	Jul-Sep
6. Dryopteridaceae	9	*Cyrtomium falcatum* (L. f.) C. Presl	AMK/4021	PH	F, S, WC	Jul-Sep
	10	*Dryopteris filix-mas* (L.) Schott	AMK/4346	PH	F, MS	Jul-Sep
	11	*Dryopteris juxtaposita* Christ	AMK/3881	PH	F, S	Jun-Aug
	12	*Dryopteris ramosa* (C. Hope) C. Chr.	AMK/3950	PH	F, MS	Jun-Sep
	13	*Dryopteris stewartii* Fraser-Jenk.	AMK/3962	PH	F, MS	May-Sep
	14	*Polystichum discretum* (D. Don) J. Sm.	AMK/4052	PH	F, MS	Jul-Sep
	15	*Polystichum piceopaleaceum* Tagawa	AMK/4282	PH	F, MS	Jun-Aug
	16	*Polystichum squarrosum* (D. Don) Fée	AMK/4038	PH	F, MS	Jul-Sep
	17	*Polystichum yunnanense* Christ	AMK/4164	PH	F, MS	Jun-Aug
7. Equisetaceae	18	*Equisetum arvense* L.	AMK/3928	PH	F, MS, S	May-Aug
	19	*Equisetum ramosissimum* Desf.	AMK/3638	PH	F, S	Mar-Aug
8. Pteridaceae	20	*Adiantum capillus-veneris* L.	AMK/3986	PH	C, MS	Jun-Aug
	21	*Adiantum incisum* Forssk.	AMK/4222	PH	C, R, MS	Jun-Oct
	22	*Adiantum venustum* D. Don	AMK/3696	PH	E, F, R	Jun-Aug
	23	*Cheilanthes farinosa* (Forssk.) Kaulf.	AMK/4207	PH	F, MS	Jun-Aug
	24	*Onychium contiguum* C.Hope	AMK/4077	PH	F, MS	Jun-Sep
	25	*Onychium japonicum* (Thunb.) Kunze	AMK/3792	PH	F, MS	Jun-Sep
	26	*Pteris cretica* L.	AMK/4093	PH	MS	Jun-Sep
	27	*Pteris vittata* L.	AMK/4130	PH	MS	Jun-Aug
9. Selaginellaceae	28	*Selaginella sanguinolenta* (L.) Spring	AMK/3987	PH	MS, E	Jun-Sep
10. Thelypteridaceae	29	*Christella dentata* (Forssk.) Brownsey & Jermy	AMK/3981	PH	F, MS	Jun-Sep
Gymnosperms						
11. Araucariaceae	30	**Araucaria columnaris* (G. Forst.) Hook.	AMK/3785	ET	H, RS	Feb-Jun
12. Cupressaceae	31	**Cupressus sempervirens* L.	AMK/3871	ET	H, RS	Jan-Mar
	32	*Juniperus communis* L.	AMK/3613	ES	E	Apr-May
	33	**Platycladus orientalis* (L.) Franco	AMK/3944	ET	H, RS	Feb-Apr
13. Cycadaceae	34	**Cycas revoluta* Thunb.	AMK/3601	ET	H, RS	May-Jul
14. Pinaceae	35	*Abies pindrow* (Royle ex D.Don) Royle	AMK/3789	ET	F	Apr-May
	36	**Cedrus deodara* (Roxb. ex D.Don) G.Don	AMK/3697	ET	F, H	Aug-Oct
	37	*Picea smithiana* (Wall.) Boiss.	AMK/4173	ET	F	Apr-May
	38	*Pinus roxburghii* Sarg.	AMK/3690	ET	F	Feb-Apr
	39	*Pinus wallichiana* A.B.Jacks.	AMK/3738	ET	F	Apr-Jun
15. Taxaceae	40	*Taxus wallichiana* Zucc.	AMK/4014	ET	F	Sep-Apr
16. Zamiaceae	41	**Zamia furfuracea* L.f. ex Aiton	AMK/3840	ES	H	Feb-May
Angiosperms (Monocots)						
17. Amaryllidaceae	42	**Allium cepa* L.	AMK/4176	BH	A, H	Apr-Jun
	43	*Allium griffithianum* Boiss.	AMK/4133	BH	SL	Mar-Apr
	44	*Allium humile* Kunth	AMK/3754	BH	E	Jun-Jul
	45	*Allium jacquemontii* Kunth	AMK/4262	AH	D	Mar-Apr
	46	**Allium sativum* L.	AMK/3716	AH	A, H	Mar-Jun
	47	**Hippeastrum puniceum* (Lam.) Voss	AMK/3845	PH	H	Mar-Oct
18. Araceae	48	*Arisaema flavum* (Forssk.) Schott	AMK/4202	PH	E, F	Jun-Jul
	49	*Arisaema jacquemontii* Blume	AMK/4189	PH	F	Jun-Jul
	50	*Arisaema tortuosum* (Wall.) Schott	AMK/4006	PH	F	Jun-Jul
	51	*Arisaema utile* Hook.f. ex Schott	AMK/4036	PH	F, MS	Jun-Aug
	52	**Caladium bicolor* (Aiton) Vent.	AMK/4302	PH	H	Jul-Sep
	53	**Colocasia esculenta* (L.) Schott	AMK/4060	PH	H	Feb-Apr
	54	**Monstera deliciosa* Liebm.	AMK/4291	PH	H	May-Aug
	55	*Sauromatum venosum* (Dryand. ex Aiton) Kunth	AMK/4293	PH	F	Apr-May
19. Arecaceae	56	**Archontophoenix cunninghamiana* (H.Wendl.) H.Wendl. & Drude	AMK/4117	ET	H	Feb-Oct
	57	**Bismarckia nobilis* Hildebr. & H.Wendl.	AMK/4101	ET	H	Jun-Sep
	58	**Livistona chinensis* (Jacq.) R.Br. ex Mart.	AMK/3879	ET	H	Feb-Mar
	59	**Nannorrhops ritchieana* (Griff.) Aitch.	AMK/3787	ET	H	Jul-Nov
	60	*Phoenix sylvestris* (L.) Roxb.	AMK/3647	ET	S, SL	Mar-Apr

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
20. Asparagaceae	61	*Agave cantala* (Haw.) Roxb. ex Salm-Dyck	AMK/4318	PH	RS, W	Jun-Aug
	62	*Agave vivipara* L.	AMK/4246	PH	RS, W	Jun-Aug
	63	*Asparagus adscendens* Roxb.	AMK/3948	PH	D	Oct-Nov
	64	*Asparagus filicinus* Buch.-Ham. ex D.Don	AMK/4226	PH	F	May-Jul
	65	*Asparagus racemosus ld.*	AMK/4320	PH	F	Oct-Dec
	66	**Chlorophytum comosum* (Thunb.) Jacques	AMK/3811	PH	H	Jun-Aug
	67	**Cordyline fruticosa* (L.) A.Chev.	AMK/3618	ES	H	Nov-Mar
	68	**Dracaena reflexa* Lam.	AMK/4048	ES	H	Mar-Jul
	69	**Yucca aloifolia* L.	AMK/4027	ES	H	Jun-Jul
21. Cannaceae	70	**Canna indica* L.	AMK/3686	PH	H	Mar-Sep
22. Colchicaceae	71	*Colchicum luteum* Baker	AMK/3706	PH	F	Feb-May
23. Commelinaceae	72	**Commelina benghalensis* L.	AMK/4308	PH	H	Mar-Oct
	73	**Tradescantia pallida* (Rose) D.R.Hunt	AMK/4196	PH	H	Mar-Sep
	74	**Tradescantia zebrina* Bosse	AMK/3759	PH	A, W	Jul-Sep
24. Cyperaceae	75	*Cyperus difformis* L.	AMK/3775	AH	S, W	Jul-Oct
	76	*Cyperus iria* L.	AMK/3895	AH	S, W, M	May-Oct
	77	*Cyperus niveus* Retz.	AMK/3932	PH	D	Apr-Jun
	78	*Cyperus rotundus* L.	AMK/3670	PH	W	Apr-Oct
	79	*Cyperus serotinus* Rottb.	AMK/4102	PH	WC	Jul-Sep
	80	*Cyperus squarrosus* L.	AMK/3999	AH	A, S	Aug-Oct
	81	*Cyperus stoloniferus* Retz.	AMK/3971	PH	A, S	Jul-Nov
	82	*Eriophorum comosum* (Wall.) Nees	AMK/4170	PH	D, R	Jul-Sep
	83	*Fimbristylis dichotoma* (L.) Vahl	AMK/4065	PH	S	Aug-Oct
	84	*Scirpoides holoschoenus* (L.) Soják	AMK/3749	PH	WC	Apr-Jun
25. Iridaceae	85	**Gladiolus grandiflorus* Andrews	AMK/3644	PH	H	Jan-Dec
	86	*Iris hookeriana* Foster	AMK/3617	PH	E	Jun-Jul
26. Juncaceae	87	*Juncus articulatus* L.	AMK/4303	PH	M, S	May-Sep
	88	*Juncus bufonius* L.	AMK/3866	AH	S, WC	May-Jul
	89	*Juncus inflexus* L.	AMK/4252	PH	M, S	Jun-Jul
27. Liliaceae	90	*Gagea lutea* (L.) Ker Gawl.	AMK/4200	PH	F	Apr-Jun
	91	*Tulipa clusiana* DC.	AMK/3954	PH	D, R	Mar-May
28. Melanthiaceae	92	*Trillium govanianum* Wall. ex D.Don	AMK/3965	PH	E, F	Apr-Aug
29. Musaceae	93	**Musa paradisiaca* L.	AMK/3815	PH	H	Mar-Aug
30. Orchidaceae	94	*Dactylorhiza hatagirea* (D.Don) Soó	AMK/4272	PH	G, F	Jun-Jul
	95	*Epipactis helleborine* (L.) Crantz	AMK/3835	PH	F	Jun-Aug
	96	*Herminium monorchis* (L.) R.Br.	AMK/3911	PH	F, MS	Jun-Aug
31. Poaceae	97	*Agrostis canina* L.	AMK/4156	PH	D, G	Jul-Aug
	98	*Agrostis stolonifera* L.	AMK/3773	PH	E, F, G,	Jul-Aug
	99	*Andropogon gerardii* Vitman	AMK/3847	PH	D	Jul-Aug
	100	*Apluda mutica* L.	AMK/4188	PH	A, G	Aug-Sep
	101	*Aristida adscensionis* L.	AMK/3893	AH	D, G	Mar-Dec
	102	*Arundo donax* L.	AMK/3810	PH	W, WC	Jun-Nov
	103	*Avena fatua* L.	AMK/3862	AH	A, G	May-Aug
	104	*Avena sativa* L.	AMK/4090	AH	A, G	May-Aug
	105	**Bambusa bambos* (L.) Voss	AMK/3953	PH	A	May-Aug
	106	*Bothriochloa ischaemum* (L.) Keng	AMK/4348	PH	F, D	May-Oct
	107	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb.	AMK/4193	AH	A	Jun-Oct
	108	*Brachypodium sylvaticum* (Huds.) P.Beauv.	AMK/4105	PH	G	Jun-Sep
	109	*Bromus japonicus* Thunb.	AMK/4313	AH	F	Jun-Aug
	110	*Bromus pectinatus* Thunb.	AMK/4104	AH	F	Apr-Aug
	111	*Capillipedium parviflorum* (R.Br.) Stapf	AMK/4349	PH	D, F, G	May-Sep
	112	*Cenchrus biflorus* Roxb.	AMK/3968	AH	G	Feb-Oct
	113	*Cenchrus ciliaris* L.	AMK/4191	PH	D, G	Feb-Mar
	114	*Cenchrus pennisetiformis* Steud.	AMK/4127	AH	G, SL	Feb-Oct
	115	*Cenchrus setiger* Vahl	AMK/4250	PH	G, SL	Aug-Feb
	116	*Cymbopogon distans* (Nees ex Steud.) W.Watson	AMK/4338	PH	D, G	Aug-Oct
	117	*Cymbopogon jwarancusa* (Jones) Schult.	AMK/3786	PH	D	Mar-Sep
	118	*Cymbopogon martini* (Roxb.) W.Watson	AMK/4148	PH	D, F	Sep-Nov
	119	*Cynodon dactylon* (L.) Pers.	AMK/3734	PH	G, S, W	Jan-Dec
	120	*Dactylis glomerata* L.	AMK/3641	PH	F, E	Jul-Aug
	121	*Dactyloctenium aegyptium* (L.) Willd.	AMK/4079	AH	W	Jul-Oct
	122	**Dendrocalamus strictus* (Roxb.) Nees	AMK/4260	PH	A	Nov-Apr
	123	*Desmostachya bipinnata* (L.) Stapf.	AMK/3858	PH	D	Jul-Oct
	124	*Dichanthium annulatum* (Forsk.) Stapf.	AMK/3984	PH	D, G	Mar-Nov

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	125	*Digitaria ciliaris* (Retz.) Koeler	AMK/4266	AH	S	Jul-Oct
	126	*Digitaria violascens* Link	AMK/3921	AH	S	Jul-Aug
	127	*Echinochloa colona* (L.) Link	AMK/3649	AH	A	May-Sep
	128	*Echinochloa crus-galli* (L.) P.Beauv.	AMK/4269	AH	A	Jun-Oct
	129	*Eleusine indica* (L.) Gaertn.	AMK/4155	AH	W	Jun-Aug
	130	*Elymus repens* (L.) Gould	AMK/3894	PH	G, F	Jun-Aug
	131	*Heteropogon contortus* (L.) P.Beauv. ex Roem. & Schult.	AMK/3793	PH	D, E, F, G	Jun-Oct
	132	*Imperata cylindrica* (L.) Raeusch.	AMK/4244	PH	W	Apr-Jun
	133	*Oplismenus compositus* (L.) P. Beauv.	AMK/3761	PH	F	Aug-Sep
	134	**Oryza sativa* L.	AMK/3869	AH	A	Mar-Sep
	135	*Pennisetum orientale* Rich.	AMK/3743	PH	D	Apr-Oct
	136	*Phalaris minor* Retz.	AMK/3769	AH	A	Mar-May
	137	*Phleum alpinum* L.	AMK/4225	PH	E	Jun-Oct
	138	*Phragmites karka* (Retz.) Trin. ex Steud.	AMK/3890	PH	RS, W	Apr-Nov
	139	*Piptatherum aequiglume* (Duthie ex Hook.f.) Roshev.	AMK/4344	PH	F	Jun-Aug
	140	*Piptatherum munroi* (Stapf ex Hook.f.) Mez	AMK/4125	PH	RS, W	Jul-Aug
	141	*Poa alpina* L.	AMK/3830	PH	E	Jun-Sep
	142	*Poa annua* L.	AMK/4267	AH	GY, W	Apr-Sep
	143	*Polypogon monspeliensis* (L.) Desf.	AMK/3978	AH	W	Mar-Jul
	144	*Saccharum arundinaceum* Retz.	AMK/4235	PH	S, W	Jul-Oct
	145	*Saccharum bengalense* Retz.	AMK/4195	PH	S, W	Oct-Jan
	146	**Saccharum officinarum* L.	AMK/3854	PH	H	Dec-May
	147	*Saccharum spontaneum* L.	AMK/3864	PH	S, W	Jul-Sep
	148	*Setaria pumila* (Poir.) Roem. & Schult.	AMK/4142	AH	A, G	Jun-Oct
	149	*Setaria viridis* (L.) P.Beauv.	AMK/4167	AH	A, G	Jun-Sep
	150	*Sorghum halepense* (L.) Pers.	AMK/4165	PH	A, G	May-Sep
	151	*Themeda anathera* (Nees ex Steud.) Hack.	AMK/4131	PH	D, G	Jun-Oct
	152	**Triticum aestivum* L.	AMK/3627	AH	A	Dec-Apr
	153	**Zea mays* L.	AMK/3674	AH	A	Jul-Sep
32. Xanthorrhoeaceae	154	**Aloe vera* (L.) Burm.f.	AMK/3661	PH	H	Jan-Apr
33. Zingiberaceae	155	**Curcuma longa* L.	AMK/3705	PH	H	Jul-Aug
	156	**Zingiber officinale* Roscoe	AMK/3994	PH	H	Sep-Oct
Angiosperms (Dicots)						
34. Acanthaceae	157	*Barleria cristata* L.	AMK/4296	DS	D	Nov-Feb
	158	*Dicliptera bupleuroides* Nees	AMK/4128	PH	GY, RS, W	Jun-Oct
	159	*Dicliptera chinensis* (L.) Juss.	AMK/3828	AH	RS, W	Aug-Nov
	160	*Hygrophila auriculata* (Schumach.) Heine	AMK/3645	PH	F, MS, WC	Aug-Mar
	161	*Justicia adhatoda* L.	AMK/3715	ES	D, SL	Jul-Oct
	162	*Strobilanthes urticifolia* Wall. ex Kuntze	AMK/4240	DS	F	Jun-Oct
35. Adoxaceae	163	**Sambucus nigra* L.	AMK/4288	DT	H	May-Jun
	164	*Sambucus wightiana* Wall. ex Wight & Arn.	AMK/3731	PH	E	Jun-Aug
	165	*Viburnum grandiflorum* Wall. ex DC.	AMK/3878	DS	F	Mar-Jun
36. Aizoaceae	166	**Stigmatocarpum criniflorum* (L. f.) L. Bolus	AMK/4227	AH	H	Jun-Sep
	167	*Trianthema portulacastrum* L.	AMK/3742	AH	A	May-Oct
37. Amaranthaceae	168	*Achyranthes aspera* L.	AMK/3675	PH	GY, S, W	Jul-Oct
	169	*Achyranthes bidentata* Blume	AMK/3772	AH	F, RS	Jun-Sep
	170	*Aerva javanica* (Burm.f.) Juss. ex Schult.	AMK/3849	PH	D, G	Aug-Oct
	171	*Alternanthera pungens* Kunth	AMK/4129	PH	W	Aug-Oct
	172	*Amaranthus graecizans* subsp. *silvestris* (Vill.) Brenan	AMK/4219	AH	A	Jun-Sep
	173	*Amaranthus hybridus* L.	AMK/4185	AH	A	Jul-Oct
	174	*Amaranthus spinosus* L.	AMK/3762	AH	A	May-Sep
	175	*Amaranthus viridis* L.	AMK/3740	AH	A, W	Mar-Oct
	176	**Celosia argentea* L.	AMK/3943	AH	H	Jul-Aug
	177	*Chenopodium album* L.	AMK/4294	AH	D, S, GY	Jun-Oct
	178	*Digera muricata* (L.) Mart.	AMK/4135	AH	A	Jul-Sep
	179	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	AMK/3795	AH	W, S	Apr-Oct
	180	**Spinacia oleracea* L.	AMK/4312	AH	A	Apr-Jun
38. Anacardiaceae	181	*Cotinus coggygria* Scop.	AMK/3889	DS	D	Apr-May
	182	**Lannea coromandelica* (Houtt.) Merr.	AMK/3717	DT	H	Mar-Apr
	183	**Mangifera indica* L.	AMK/3688	ET	H	Mar-Apr
	184	*Rhus punjabensis* J. L. Stewart ex Brandis	AMK/3934	DT	F	May-Jun
	185	**Schinus molle* L.	AMK/4300	ET	H	Feb-Mar
	186	*Toxicodendron vernicifluum* (Stokes) F.A. Barkley	AMK/4248	DT	F	May-Jun

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
39. Apiaceae	187	*Aegopodium alpestre* Ledeb.	AMK/4342	PH	D, F	Jun-Aug
	188	**Anethum graveolens* L.	AMK/3736	AH	H	May-Aug
	189	*Angelica cyclocarpa* (C.Norman) M.Hiroe	AMK/4031	PH	E, F	Jul-Sep
	190	*Angelica glauca* Edgew.	AMK/4228	PH	F	Jun-Aug
	191	*Bupleurum falcatum* L.	AMK/4044	PH	D	Jun-Oct
	192	*Bupleurum longicaule* Wall. ex DC.	AMK/3947	PH	E, F	Jul-Sep
	193	*Bupleurum rotundifolium* L.	AMK/3875	AH	E, F	Jul-Sep
	194	**Carum carvi* L.	AMK/4254	BH	H	May-Jul
	195	*Chaerophyllum villosum* Wall. ex DC.	AMK/4121	AH	F, G, RS	Jul-Aug
	196	*Conium maculatum* L.	AMK/4056	AH	F, WC	Jun-Aug
	197	**Coriandrum sativum* L.	AMK/3995	AH	A, H	Feb-Jun
	198	**Cuminum cyminum* L.	AMK/3969	AH	H	Feb-Apr
	199	**Daucus carota* L.	AMK/3726	BH	A, H	Mar-Jun
	200	*Eryngium caeruleum* M.Bieb.	AMK/4040	PH	S	May-Jul
	201	**Foeniculum vulgare* Mill.	AMK/4297	PH	A, H	May-Jun
	202	*Heracleum candicans* Wall. ex DC.	AMK/4054	PH	D, F	May-Jul
	203	*Pimpinella diversifolia* DC.	AMK/3855	PH	F, E	May-Sep
	204	*Scaligeria indica* H.Wolff	AMK/3949	PH	F	Jun-Aug
	205	*Scandix pecten-veneris* L.	AMK/4334	AH	A, W	Mar-May
	206	*Torilis leptophylla* (L.) Rchb.f.	AMK/3637	AH	W	Feb-May
	207	**Trachyspermum ammi* (L.) Sprague	AMK/3782	AH	H	May-Aug
40. Apocynaceae	208	**Alstonia scholaris* (L.) R. Br.	AMK/4205	ET	H	Dec-May
	209	*Calotropis procera* (Aiton) Dryand.	AMK/4001	ES	D, SL	Jan-Dec
	210	*Carissa spinarum* L.	AMK/4330	DS	D, SL	Apr-Jun
	211	**Cascabela thevetia* (L.) Lippold	AMK/4184	ET	H	Jan-Dec
	212	**Catharanthus roseus* (L.) G.Don	AMK/3842	ES	H	Jan-Dec
	213	*Nerium oleander* L.	AMK/3684	ES	D, S	Apr-Sep
	214	*Pentatropis capensis* (L. f.) Bullock	AMK/3929	PC	F	Sep-Nov
	215	*Periploca aphylla* Decne.	AMK/3908	ES	D	Mar-May
	216	**Plumeria rubra* L.	AMK/4175	DT	H	May-Sep
	217	**Vinca major* L.	AMK/4325	PH	H	Dec-Mar
	218	*Vincetoxicum hirundinaria* Medik.	AMK/3631	DS	D	May-Jul
	219	*Vincetoxicum sakesarense* Ali & Khatoon	AMK/3741	DS	E, F	Jul-Sep
41. Araliaceae	220	*Hedera nepalensis* K.Koch	AMK/4329	PC	F	Oct-Apr
42. Balsaminaceae	221	*Impatiens bicolor* Royle	AMK/4315	AH	MS	Jul-Aug
	222	*Impatiens brachycentra* Kar. & Kir.	AMK/4086	AH	F	Jul-Aug
	223	*Impatiens edgeworthii* Hook.f.	AMK/3701	AH	F	Jul-Sep
	224	*Impatiens glandulifera* Royle	AMK/3767	AH	RS, WC	Jul-Aug
	225	*Impatiens scabrida* DC.	AMK/4159	AH	F	Jul-Aug
	226	*Impatiens sulcata* Wall.	AMK/4122	AH	F	Jul-Aug
43. Berberidaceae	227	*Berberis vulgaris* L.	AMK/4332	DS	D, F	Apr-Jun
	228	*Berberis lycium* Royle	AMK/3966	DS	F, G	May-Jul
	229	*Sinopodophyllum hexandrum* (Royle) T.S.Ying	AMK/3974	PH	F	Apr-May
44. Betulaceae	230	*Alnus nitida* (Spach) Endl.	AMK/3885	DT	RS, WC	Aug-Oct
	231	*Betula utilis* D.Don	AMK/3605	DT	E, F	May-Jun
45. Bignoniaceae	232	**Campsis radicans* (L.) Seem.	AMK/3914	PC	H	May-Jul
	233	**Dolichandra unguis-cati* (L.) L.G.Lohmann	AMK/4347	PC	H	Apr-Aug
	234	*Incarvillea emodi* (Royle ex Lindl.) Chatterjee	AMK/4327	PH	D, RS	Mar-Apr
	235	**Jacaranda mimosifolia* D.Don	AMK/3832	DT	H	Apr-May
	236	**Tecoma stans* (L.) Juss. ex Kunth	AMK/3615	ES	H	Jan-Dec
46. Boraginaceae	237	*Buglossoides arvensis* (L.) I.M.Johnst.	AMK/4070	AH	A	Mar-Apr
	238	*Cynoglossum lanceolatum* Forssk.	AMK/3816	AH	W, S	Jun-Aug
	239	*Cynoglossum wallichii* G.Don	AMK/4136	AH	F	Jun-Sep
	240	*Cynoglossum wallichii* var. *glochidiatum* (Wall. ex Benth.) Kazmi	AMK/3912	AH	F	Jun-Sep
	241	*Onosma hispida* var. *kashmirica* (I.M. Johnst.) I.M. Johnst.	AMK/3724	PH	D, F	May-Jul
	242	*Onosma thomsonii* Clarke	AMK/3960	PH	D, F	Apr-May
	243	*Trichodesma indicum* (L.) Lehm.	AMK/3655	PH	D	Aug-Oct
47. Brassicaceae	244	*Alliaria petiolata* (M.Bieb.) Cavara & Grande	AMK/4124	AH	GY, W	Mar-Jun
	245	**Brassica oleracea* L.	AMK/3693	PH	A, H	Mar-Jun
	246	**Brassica oleracea var. botrytis* L.	AMK/3913	AH	A, H	Jun-Sep
	247	**Brassica oleracea* var. *capitata* L.	AMK/3952	PH	A, H	Jun-Sep
	248	**Brassica rapa* subsp. *campestris* (L.) A.R.Clapham	AMK/3732	AH	A, H	Feb-Apr

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	249	**Brassica rapa* subsp. *rapa* L.	AMK/3801	AH	A, H	Jun-Sep
	250	*Capsella bursa-pastoris* (L.) Medik.	AMK/3927	AH	A, S, W	May-Jul
	251	*Cardamine impatiens* L.	AMK/4258	AH	W, WC	May-Jul
	252	**Eruca vesicaria* (L.) Cav.	AMK/4149	AH	A	Feb-Apr
	253	*Erysimum melicentae* Dunn	AMK/4057	PH	F, RS	Jun-Aug
	254	*Lepidium didymum* L.	AMK/3642	AH	W	Mar-Jun
	255	*Lepidium pinnatifidum* Ledeb.	AMK/4190	AH	G, W	Apr-Jun
	256	*Lepidium sativum* L.	AMK/4281	AH	A, E	Apr-Jun
	257	*Nasturtium microphyllum* (Boenn. ex Rchb.) Rchb.	AMK/4290	PH	M, WC	Apr-Jul
	258	*Nasturtium officinale* R.Br.	AMK/4158	PH	M, WC	Apr-Jul
	259	**Raphanus raphanistrum* subsp. *sativus* (L.) Domin	AMK/4299	BH	A	Mar-May
	260	*Rorippa palustris* (L.) Besser	AMK/3939	AH	F	May-Jul
	261	*Sisymbrium irio* L.	AMK/4069	AH	W	Mar-May
	262	*Thlaspi arvense* L.	AMK/3846	AH	D, S	Apr-Jul
	263	*Turritis glabra* L.	AMK/4081	BH	D	Jun-Aug
48. Buxaceae	264	*Sarcococca pruniformis* Lindl.	AMK/3677	ES	F	Sep-Mar
49. Cactaceae	265	*Opuntia dillenii* (Ker Gawl.) Haw.	AMK/3695	ES	D, W	May-Nov
50. Campanulaceae	266	*Campanula pallida* Wall.	AMK/4286	AH	F	Jul-Oct
	267	*Codonopsis clematidea* (Schrenk) C.B.Clarke	AMK/3823	PH	F	Jun-Aug
51. Cannabaceae	268	*Cannabis sativa* L.	AMK/4251	AH	GY, RS, W	Jul-Sep
	269	*Celtis australis* subsp. *caucasica* (Willd.) C.C.Towns.	AMK/4336	DT	SL	Mar-May
52. Caprifoliaceae	270	*Dipsacus inermis* Wall.	AMK/3991	PH	E, F	Aug-Sep
	271	*Morina coulteriana* Royle	AMK/4216	PH	E, F	Jun-Jul
	272	*Valeriana jatamansi* Jones	AMK/3924	PH	F	Mar-May
53. Caricaceae	273	**Carica papaya* L.	AMK/4259	DT	H	Jan-Dec
54. Caryophyllaceae	274	*Arenaria serpyllifolia* L.	AMK/4206	AH	E	Jul-Sep
	275	*Cerastium cerastoides* (L.) Britton	AMK/4212	PH	F	Jul-Aug
	276	*Cerastium fontanum* Baumg.	AMK/4340	PH	A, F	Apr-Jun
	277	*Cerastium glomeratum* Thuill.	AMK/4199	AH	A, F	Apr-Jul
	278	*Gypsophila cerastoides* D.Don	AMK/3917	PH	E, F	Apr-Jul
	279	*Silene coronaria* (Desr.) Clairv. ex Rchb.	AMK/4074	PH	D, F	Jul-Sep
	280	*Silene indica* var. *cashmeriana* (Royle) Y.J. Nasir	AMK/3868	PH	E	Jun-Jul
	281	*Spergula arvensis* L.	AMK/4099	AH	S	Mar-Apr
	282	*Stellaria media* (L.) Vill.	AMK/4064	PH	A, RS	Apr-Aug
55. Celastraceae	283	*Euonymus hamiltonianus* Wall.	AMK/3808	DT	F	Apr-Jun
	284	*Gymnosporia royleana* Wall. ex M.A.Lawson	AMK/4298	DS	D, SL	Sep-Jan
	285	*Parnassia nubicola* Wall. ex Royle	AMK/4075	PH	F, MS	Aug-Sep
56. Cleomaceae	286	*Cleome viscosa* L.	AMK/4350	AH	D, G	Jun-Aug
57. Combretaceae	287	**Combretum indicum* (L.) DeFilipps	AMK/3692	PC	H	Mar-Sep
	288	**Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.	AMK/3900	DT	H	Apr-May
	289	**Terminalia bellirica* (Gaertn.) Roxb.	AMK/3915	DT	H, SL	Mar-Apr
	290	**Terminalia chebula* Retz.	AMK/3629	DT	H	Apr-Jun
58. Compositae	291	*Achillea millefolium* L.	AMK/3733	PH	E	Jul-Sep
	292	*Ageratum conyzoides* (L.) L.	AMK/4323	AH	D, W	Jan-Dec
	293	*Ainsliaea aptera* DC.	AMK/4322	PH	F	Jun-Aug
	294	*Anaphalis busua* (Buch.-Ham.) DC.	AMK/4357	BH	F	Aug-Oct
	295	*Anaphalis margaritacea* (L.) Benth. & Hook.f.	AMK/4137	PH	E, F, G	Jul-Sep
	296	*Anaphalis nepalensis* (Spreng.) Hand.-Mazz.	AMK/3628	PH	E	Jun-Sep
	297	*Anaphalis triplinervis* (Sims) Sims ex C.B.Clarke	AMK/3722	PH	E, F, G	Jul-Oct
	298	*Arctium lappa* L.	AMK/4024	BH	A, RS	Jun-Sep
	299	*Artemisia roxburghiana* Wall. ex Besser	AMK/4287	PH	F, G, RS, W	Aug-Oct
	300	*Artemisia scoparia* Waldst. and Kit.	AMK/3820	AH	D, S, W	Jul-Sep
	301	*Aster albescens* (DC.) Wall. ex Hand.-Mazz.	AMK/3898	DS	F, S, W	Jun-Sep
	302	*Aster himalaicus* C.B.Clarke	AMK/3860	PH	E, F	Jul-Aug
	303	*Bidens pilosa* L.	AMK/4055	AH	GY, RS, W	Jul-Sep
	304	*Calendula arvensis* M.Bieb.	AMK/4020	AH	A, W	May-Sep
	305	*Carpesium cernuum* L.	AMK/4261	PH	D, F	Jun-Sep
	306	*Carthamus oxyacantha* M.Bieb.	AMK/3799	AH	A	Mar-Jun
	307	*Centaurea iberica* Trevir. ex Spreng.	AMK/3936	AH	S	Jun-Aug
	308	**Chamaemelum nobile* (L.) All.	AMK/3836	PH	H	Jun-Jul
	309	**Chrysanthemum indicum* L.	AMK/3988	PH	H	Aug-Nov
	310	*Cichorium intybus* L.	AMK/4119	PH	A, D	Apr-Jul
	311	*Cirsium arvense* (Linn.) Scop.	AMK/3942	PH	W	Aug-Oct

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	312	*Cirsium falconeri* (Hook.f.) Petr.	AMK/3852	PH	E, F	Jun-Oct
	313	*Echinops niveus* Wall. ex Wall.	AMK/4153	PH	E, F	Jun-Aug
	314	*Eclipta prostrata* (L.) L.	AMK/3653	AH	M	Jun-Sep
	315	*Erigeron annuus* (L.) Pers.	AMK/4341	AH	G, W	Jun-Sep
	316	*Erigeron bonariensis* L.	AMK/3902	AH	A, W	Jun-Nov
	317	*Erigeron canadensis* L.	AMK/3829	AH	A, GY, RS, W	Jul-Sep
	318	*Erigeron multiradiatus* (Lindl. ex DC.) Benth. & Hook.f.	AMK/4243	PH	E, F	May-Sep
	319	*Galinsoga parviflora* Cav.	AMK/4108	AH	W	Jul-Oct
	320	**Gazania rigens* (L.) Gaertn.	AMK/3964	AH	H	Jun-Oct
	321	*Gerbera gossypina* (Royle) Beauverd	AMK/4047	PH	D	May-Jul
	322	**Helianthus annuus* L.	AMK/4192	AH	A, H, RS	Feb-May
	323	*Himalaiella heteromalla* (D. Don) Raab-Straube	AMK/3824	AH	W	Jun-Aug
	324	*Inula orientalis* Lam.	AMK/3750	PH	F, WC	Jun-Aug
	325	*Inula royleana* DC.	AMK/3993	PH	E	Aug-Oct
	326	*Jurinea dolomiaea* Boiss.	AMK/4295	PH	E	Aug-Sep
	327	*Lactuca dissecta* D.Don	AMK/3982	AH	D, W	Jun-Jul
	328	*Lactuca dolichophylla* Kitam.	AMK/4179	AH	RS, W	Aug-Sep
	329	**Lactuca sativa* L.	AMK/4042	AH	H	Feb-Sep
	330	*Lactuca serriola* L.	AMK/3821	AH	RS, W, WC	Jun-Aug
	331	*Launaea procumbens* (Roxb.) Ram. and Rajagopal	AMK/3822	PH	D, W	Jun-Oct
	332	*Launaea secunda* (C.B.Clarke) Hook.f.	AMK/3763	PH	C, D	May-Oct
	333	*Leontopodium himalayanum* DC.	AMK/4316	PH	F	Jul-Oct
	334	*Leontopodium nivale* subsp. *alpinum* (Cass.) Greuter	AMK/3606	PH	E, F	Jul-Oct
	335	*Matricaria chamomilla* L.	AMK/4314	AH	A, F	Apr-Aug
	336	*Melanoseris brunoniana* (Wall. ex DC.) N.Kilian & Ze H.Wang	AMK/3850	PH	MS	Jul-Aug
	337	*Myriactis nepalensis* Less.	AMK/3774	PH	F	Apr-Nov
	338	*Parthenium hysterophorus* L.	AMK/3831	AH	RS, W	Apr-Oct
	339	*Phagnalon niveum* Edgew.	AMK/4080	PH	C, D, R	May-Aug
	340	*Pseudognaphalium affine* (D.Don) Anderb.	AMK/4145	BH	G, W	Jun-Aug
	341	*Saussurea costus* (Falc.) Lipsch.	AMK/3776	PH	E	Jul-Sep
	342	*Senecio chrysanthemoides* DC.	AMK/3709	PH	E	Jun-Sep
	343	*Senecio graciliflorus* (Wall.) DC.	AMK/4152	PH	E	May-Oct
	344	*Senecio nudicaulis* Buch.-Ham. ex D.Don	AMK/4306	PH	F	Mar-Apr
	345	*Sigesbeckia orientalis* L.	AMK/4004	AH	MS	Apr-Sep
	346	*Silybum marianum* (L.) Gaertn.	AMK/4289	AH	RS, W	Feb-Apr
	347	*Solidago virga-aurea* L.	AMK/4139	PH	F, WC	Jul-Sep
	348	*Sonchus arvensis* L.	AMK/4217	AH	F, W	Feb-May
	349	*Sonchus asper* (L.) Hill	AMK/4034	AH	A, F, RS, W	May-Oct
	350	*Sonchus oleraceus* (L.) L.	AMK/4204	AH	A, F, RS, W	Mar-Dec
	351	**Tagetes erecta* L.	AMK/3806	AH	H	Aug-Nov
	352	*Tagetes minuta* L.	AMK/3918	AH	RS, W	Jun-Sep
	353	*T. sp.*	AMK/4278	PH	E, W	Mar-Sep
	354	*Tragopogon dubius* Scop.	AMK/4068	BH	C, MS	Apr-Jun
	355	*Tridax procumbens* (L.) L.	AMK/4116	AH	D, RS, W	Nov-Mar
	356	*Tussilago farfara* L.	AMK/4089	PH	C, F, W	Mar-May
	357	*Xanthium strumarium* L.	AMK/3723	AH	W	Aug-Oct
	358	*Youngia japonica* (L.) DC.	AMK/4046	AH	F, G, W	Feb-Dec
	359	**Zinnia elegans* L.	AMK/3883	AH	H	Feb-May
59. Convolvulaceae	360	*Convolvulus arvensis* L.	AMK/3972	AC	A, RS	Jan-Dec
	361	*Cuscuta chinensis* Lam.	AMK/4311	PC	F, SL	Jul-Sep
	362	*Cuscuta reflexa* Roxb.	AMK/3685	PC	F, SL	Jul-Sep
	363	**Ipomoea cairica* (L.) Sweet	AMK/4160	PC	H	Jul-Oct
	364	*Ipomoea carnea* Jacq.	AMK/3979	DS	D, SL, RS	Jul-Nov
	365	*Ipomoea eriocarpa* R. Br.	AMK/4280	AC	A, RS	Aug-Oct
	366	*Ipomoea nil* (L.) Roth	AMK/4109	AC	A, RS	Jul-Oct
	367	*Ipomoea pes-tigridis* L.	AMK/4096	AC	A, RS	Aug-Oct
	368	*Ipomoea purpurea* (L.) Roth	AMK/3970	AC	A, RS	Jul-Sep
60. Coriariaceae	369	*Coriaria nepalensis* Wall.	AMK/4237	ES	F	Mar-Apr
61. Crassulaceae	370	**Bryophyllum pinnatum* (Lam.) Oken.	AMK/3614	PH	H	Feb-May
	371	*Rosularia adenotricha* (Wall. ex Edgew.) C.-A. Jansson	AMK/3956	PH	R	May-Jul
	372	*Sedum ewersii* Ledeb.	AMK/3976	PH	R	Jun-Sep
	373	*Sedum hispanicum* L.	AMK/4210	PH	R	Mar-Jun

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
62. Cucurbitaceae	374	**Citrullus lanatus* (Thunb.) Matsum. & Nakai	AMK/3611	AH	A	Feb-May
	375	**Cucumis melo* L.	AMK/4324	AH	A	Apr-Jul
	376	**Cucumis sativus* L.	AMK/3727	AH	A	Jan-Dec
	377	**Cucurbita maxima* Duchesne	AMK/3643	AC	A, H	Jun-Oct
	378	**Cucurbita moschata* Duchesne	AMK/3771	AC	A, H	May-Oct
	379	**Cucurbita pepo* L.	AMK/3630	AC	A, H	Jun-Sep
	380	**Lagenaria siceraria* (Molina) Standl.	AMK/3625	AC	A, H	Mar-May
	381	**Luffa acutangula* (L.) Roxb.	AMK/3891	AC	A, H	May-Oct
	382	**Luffa cylindrica* (L.) M. Roem.	AMK/3721	AC	A, H	Apr-Oct
	383	**Momordica charantia* L.	AMK/3707	AC	A, H	Apr-Jul
	384	**Praecitrullus fistulosus* (Stocks) Pangalo	AMK/4229	AH	A, H	Mar-Sep
	385	*Solena heterophylla* Lour.	AMK/4140	PC	F, G, RS	May-Aug
63. Ebenaceae	386	**Diospyros kaki* L.f.	AMK/3781	DT	A	May-Aug
	387	**Diospyros lotus* L.	AMK/3788	DT	F	May-Jun
64. Elaeagnaceae	388	*Elaeagnus angustifolia* L.	AMK/4358	DS	D, F	May-Jul
65. Euphorbiaceae	389	*Croton bonplandianus* Baill.	AMK/3880	PH	G, F	Apr-Jul
	390	*Euphorbia cashmeriana* Royle	AMK/4073	PH	F	May-Sep
	391	*Euphorbia cornigera* Boiss.	AMK/4337	PH	F, G	Apr-Sep
	392	*Euphorbia helioscopia* L.	AMK/4082	AH	A, W	Jan-Jul
	393	*Euphorbia heterophylla* L.	AMK/4025	AH	F, S	Jan-Dec
	394	*Euphorbia hirta* L.	AMK/3711	AH	D, W	Jul-Dec
	395	*Euphorbia hispida* Boiss.	AMK/4285	AH	D, W	Jun-Nov
	396	**Euphorbia milii* var. *splendens* (Bojer ex Hook.) Ursch & Leandri	AMK/3951	ES	H	Feb-Nov
	397	*Euphorbia prostrata* Ait.	AMK/4234	AH	A, D, W	Jan-Dec
	398	**Euphorbia royleana* Boiss.	AMK/3973	DS	H	May-Aug
	399	*Euphorbia wallichii* Hook.f.	AMK/3728	PH	E, F	May-Aug
	400	*Mallotus philippensis* (Lam.) Müll.Arg.	AMK/3660	ET	D, G, SL	Feb-Apr
	401	*Ricinus communis* L.	AMK/3678	ES	D, GY	Feb-Oct
	402	*Triadica sebifera* (L.) Small	AMK/4221	DT	S	May-Oct
66. Fagaceae	403	*Quercus baloot* Griff.	AMK/4061	ET	D, SL	Apr-May
	404	*Quercus floribunda* Lindl. ex A.Camus	AMK/3946	ET	F	Apr-May
	405	*Quercus glauca* Thunb.	AMK/4178	ET	F	Mar-Apr
	406	*Quercus oblongata* D.Don	AMK/3730	ET	F	Apr-May
67. Gentianaceae	407	*Gentiana argentea* (Royle ex D.Don) Royle ex D.Don	AMK/3916	AH	E, G	Apr-Jun
	408	*Gentiana kurroo* Royle	AMK/4063	PH	F	Sep-Nov
	409	*Swertia chirayita* (Roxb.) Buch.-Ham. ex C.B.Clarke	AMK/4058	AH	F, WC	Jul-Oct
	410	*Swertia ciliata* (D. Don ex G. Don) B.L. Burtt	AMK/4238	AH	F	Jun-Nov
	411	*Swertia cordata* (Wall. ex G. Don) C.B. Clarke	AMK/3874	AH	E, F, G	Aug-Oct
	412	*Swertia paniculata* Wall.	AMK/3909	AH	F	Jul-Nov
	413	*Swertia petiolata* D. Don	AMK/4182	PH	F	Jul-Nov
	414	*Swertia speciosa* Wall.	AMK/3747	PH	F	Jun-Nov
68. Geraniaceae	415	*Erodium cicutarium* (L.) L'Hér.	AMK/4100	AH	S	Mar-Apr
	416	*Geranium himalayense* Klotzsch	AMK/3639	PH	E	Jul-Aug
	417	*Geranium mascatense* Boiss.	AMK/3607	AH	G, W	Mar-Apr
	418	*Geranium nepalense* Sweet	AMK/3770	AH	F	Apr-Sep
	419	*Geranium pusillum* L.	AMK/4353	AH	D, G, W	Apr-May
	420	*Geranium rectum* Trautv.	AMK/4059	PH	F	Jul-Sep
	421	*Geranium rotundifolium* L.	AMK/4328	AH	W	Mar-May
	422	*Geranium wallichianum* D.Don ex Sweet	AMK/3764	PH	E, F	Jul-Sep
	423	**Pelargonium zonale* (L.) L'Hér. ex Aiton	AMK/4239	PH	GY, H	Apr-May
69. Hamamelidaceae	424	*Parrotiopsis jacquemontiana* (Decne.) Rehder	AMK/4037	DS	F	Mar-May
70. Hypericaceae	425	*Hypericum oblongifolium* Choisy	AMK/3681	DS	D, F	Mar-Aug
	426	*Hypericum perforatum* L.	AMK/3669	PH	D, G	Jun-Sep
71. Juglandaceae	427	**Juglans regia* L.	AMK/3713	DT	A	Feb-Apr
72. Lamiaceae	428	*Ajuga integrifolia* Buch.-Ham.	AMK/3739	PH	D	Mar-Dec
	429	*Anisomeles indica* (L.) Kuntze	AMK/3856	PH	S	Apr-Sep
	430	*Callicarpa macrophylla* Vahl	AMK/4162	ES	D, RS, W	Apr-Dec
	431	*Clerodendrum chinense* (Osbeck) Mabb.	AMK/3626	DS	RS, WC	Jun-Aug
	432	*Clinopodium umbrosum* (M.Bieb.) Kuntze	AMK/4062	PH	D, W	May-Jul
	433	*Clinopodium vulgare* L.	AMK/4305	PH	D, W	Mar-Jul
	434	*Colebrookea oppositifolia* Sm.	AMK/3753	ES	D	Jan-Apr
	435	*Elsholtzia ciliata* (Thunb.) Hyl.	AMK/3945	AH	D, F	Aug-Sep
	436	*Elsholtzia fruticosa* (D.Don) Rehder	AMK/4018	DS	D	Aug-Oct

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	437	*Elsholtzia stachyodes* (Link) Raizada & H.O.Saxena	AMK/4345	PH	SL, W	Jul-Oct
	438	*Isodon rugosus* (Wall. ex Benth.) Codd	AMK/3702	DS	D	Mar-Oct
	439	*Lamium album* L.	AMK/3983	PH	F	Jun-Sep
	440	*Leonurus cardiaca* L.	AMK/4354	AH	D, SL	Jul-Sep
	441	*Leucas cephalotes* (Roth) Spreng.	AMK/4010	AH	F	Jul-Oct
	442	*Leucas lanata* Benth.	AMK/4333	PH	F	Aug-Sep
	443	**Mentha arvensis* L.	AMK/3812	PH	H	Jul-Sep
	444	*Mentha longifolia* (L.) L.	AMK/3737	PH	F, W	May-Oct
	445	*Mentha royleana* Wall. ex Benth.	AMK/4035	PH	F	Jul-Oct
	446	**Mentha spicata* L.	AMK/3957	PH	H	Jul-Sep
	447	*Micromeria biflora* (Buch.-Ham. ex D.Don) Benth.	AMK/4026	PH	D	Mar-Nov
	448	*Nepeta govaniana* (Wall. ex Benth.) Benth.	AMK/4141	PH	F	Jul-Sep
	449	*Nepeta laevigata* (D.Don) Hand.-Mazz.	AMK/4091	PH	F	Jun-Aug
	450	*Nepeta podostachys* Benth.	AMK/4051	PH	F	Jul-Sep
	451	**Ocimum basilicum* L.	AMK/3665	AH	H	Mar-Oct
	452	*Origanum vulgare* L.	AMK/4276	PH	D	Jun-Oct
	453	*Phlomoides bracteosa* (Royle ex Benth.) Kamelin & Makhm.	AMK/3748	PH	D, F	Jul-Sep
	454	*Phlomoides spectabilis* (Falc. ex Benth.) Kamelin & Makhm.	AMK/4012	PH	E, F	Jul-Sep
	455	**Plectranthus scutellarioides* (L.) R.Br.	AMK/3807	PH	H	Apr-Sep
	456	*Prunella vulgaris* L.	AMK/3658	PH	MS	Jun-Aug
	457	*Pseudocaryopteris bicolor* (Roxb. ex Hardw.) P.D. Cantino	AMK/4180	DS	D, SL	Feb-May
	458	*Rydingia limbata* (Benth.) Scheen and Albert	AMK/3744	DS	D	Apr-May
	459	*Salvia aegyptiaca* L.	AMK/3938	PH	D	Mar-May
	460	**Salvia coccinea* Buc'hoz ex Etl.	AMK/3933	AH	H, W	May-Aug
	461	*Salvia hians* Royle ex Benth.	AMK/4208	PH	E	Jun-Sep
	462	*Salvia moorcroftiana* Wall. ex Benth.	AMK/3766	PH	D, RS, W	Apr-Jun
	463	*Salvia plebeia* R.Br.	AMK/4211	AH	S, W	Mar-Jun
	464	*Salvia virgata* Jacq.	AMK/4118	PH	F, W	Jun-Sep
	465	*Scutellaria grossa* Wall.	AMK/4268	PH	F, G	Jul-Sep
	466	*Scutellaria linearis* Benth.	AMK/3798	PH	D, G	May-Jul
	467	*Stachys floccosa* Benth.	AMK/3834	PH	D	Jun-Sep
	468	*Thymus linearis* Benth.	AMK/4279	PH	D, E	Jun-Sep
	469	*Vitex negundo* L.	AMK/4022	DS	W, WC	Jan-Dec
73. Leguminosae	470	*Acacia farnesiana* (L.) Willd.	AMK/3756	DS	RS, W	Nov-Mar
	471	*Acacia modesta* Wall.	AMK/3853	DT	D, SL	Mar-May
	472	*Acacia nilotica* (L.) Delile	AMK/3833	DT	D, SL	Mar-Aug
	473	**Albizia julibrissin* Durazz.	AMK/3819	DT	H	Jun-Jul
	474	**Albizia lebbeck* (L.) Benth.	AMK/4157	DT	H	Apr-May
	475	**Albizia odoratissima* (L.f.) Benth.	AMK/4231	ET	A	Apr-Jun
	476	**Albizia procera* (Roxb.) Benth.	AMK/4232	DT	RS	Jun-Aug
	477	**Arachis hypogaea* L.	AMK/3719	AH	A	Jun-Aug
	478	*Argyrolobium roseum* (Cambess.) Jaub. & Spach	AMK/3608	PH	D, G	Apr-Sep
	479	*Astragalus grahamianus* Benth.	AMK/3612	DS	D, F	Apr-Aug
	480	*Astragalus leucocephalus* Bunge	AMK/3752	PH	D	Mar-Jun
	481	*Astragalus rhizanthus* subsp. *candolleanus* (Benth.) Podlech	AMK/3616	DS	C, E	Jun-Aug
	482	**Bauhinia variegata* L.	AMK/3640	DT	H, RS	Feb-Apr
	483	**Butea monosperma* (Lam.) Taub.	AMK/4033	DT	H, RS	Mar-Apr
	484	*Caesalpinia decapetala* (Roth) Alston	AMK/3837	DS	RS, W	Mar-Apr
	485	**Cassia fistula* L.	AMK/3718	DT	H, RS	Mar-Jun
	486	*Crotalaria albida* Roth	AMK/4301	PH	D, F	Jun-Aug
	487	*Crotalaria medicaginea* Lam.	AMK/4201	PH	D	May-Aug
	488	*Crotalaria medicaginea* var. *luxurians* (Benth.) Baker	AMK/3746	PH	D	May-Aug
	489	*Dalbergia sissoo* DC.	AMK/3841	DT	A, SL	Mar-May
	490	*Desmodium elegans* DC.	AMK/4132	DS	D, F	Jun-Sep
	491	*Dumasia villosa* DC.	AMK/4126	PC	G, F	Aug-Nov
	492	*Indigofera heterantha* Brandis	AMK/3680	DS	F	May-Jul
	493	*Indigofera linifolia* (L.f.) Retz.	AMK/3602	AH	D	Jul-Oct
	494	**Lablab purpureus* subsp. *bengalensis* (Jacq.) Verdc.	AMK/4245	PC	A, H	Jul-Sep
	495	*Lathyrus aphaca* L.	AMK/4292	AC	A	Feb-Apr
	496	*Lespedeza juncea* (L.f.) Pers.	AMK/4087	PH	D	Jul-Sep
	497	*Lespedeza juncea* var. *sericea* (Thunb.) Lace & Hauech	AMK/3800	PH	D	Jul-Oct
	498	*Leucaena leucocephala* (Lam.) de Wit	AMK/4174	ES	G, SL	Jun-Nov
	499	*Lotus corniculatus* L.	AMK/3877	PH	D, E, F	Apr-Aug

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	500	*Medicago laciniata* (L.) Mill.	AMK/3619	AH	A, G, W	Mar-Apr
	501	*Medicago lupulina* L.	AMK/4019	AH	S, W	Mar-May
	502	*Medicago polymorpha* L.	AMK/3872	AH	A, G, W	Mar-May
	503	*Medicago sativa* L.	AMK/4213	PH	A, G, W	May-Sep
	504	*Melilotus indicus* (L.) All.	AMK/4114	AH	A, G, W	Mar-Aug
	505	*Melilotus officinalis* (L.) Pall.	AMK/3777	AH	A, G	Mar-Aug
	506	*Melilotus officinalis* subsp. *alba* (Medik.) H.Ohashi & Tateishi	AMK/4224	AH	A, F	Mar-Sep
	507	**Parkinsonia aculeata* L.	AMK/4143	DS	H, RS	Mar-May
	508	**Phaseolus lunatus* L.	AMK/3958	PC	A	Mar-Jul
	509	**Pisum sativum* L.	AMK/3940	AH	A, H	Dec-Mar
	510	**Pongamia pinnata* (L.) Pierre	AMK/4270	ET	H, RS	Apr-May
	511	*Prosopis juliflora* (Sw.) DC.	AMK/4264	DS	SL, W	Mar-Jun
	512	*Rhynchosia himalensis* Baker	AMK/3989	PC	RS, W	Jul-Aug
	513	*Rhynchosia minima* (L.) DC.	AMK/4007	PC	G, W	Feb-Apr
	514	*Rhynchosia pseudo-cajan* Cambess.	AMK/3888	DS	G, W	May-Jun
	515	*Robinia pseudoacacia* L.	AMK/4154	DT	A, D, SL	Mar-Apr
	516	*Senna occidentalis* (L.) Link	AMK/3648	ES	RS, W	Aug-Mar
	517	**Tamarindus indica* L.	AMK/3975	ET	H	Mar-Jun
	518	*Trifolium dubium* Sibth.	AMK/3920	AH	G, F	Aug-Oct
	519	*Trifolium pratense* L.	AMK/3825	PH	A	May-Sep
	520	*Trifolium repens* L.	AMK/3622	PH	E, G, MS	Apr-Jul
	521	*Trifolium resupinatum* L.	AMK/4111	AH	A	Mar-Aug
	522	**Trigonella foenum-graecum* L.	AMK/4147	AH	A	Apr-May
	523	*Vicia sativa* L.	AMK/4097	AH	A, W	Jul-Aug
74. Linaceae	524	*Reinwardtia indica* Dumort.	AMK/4072	DS	F	Feb-May
75. Lythraceae	525	**Lagerstroemia indica* L.	AMK/3826	DS	H	Mar-Aug
	526	**Lawsonia inermis* L.	AMK/3699	ES	H	Oct-Nov
	527	*Punica granatum* L.	AMK/4043	DT	D	Apr-Jun
	528	*Woodfordia fruticosa* (L.) Kurz	AMK/3896	DS	D, G	Mar-Apr
76. Magnoliaceae	529	**Magnolia grandiflora* L.	AMK/4015	ET	H	Apr-May
77. Malvaceae	530	**Abelmoschus esculentus* (L.) Moench	AMK/4161	AH	A	Apr-Sep
	531	**Alcea rosea* L.	AMK/4247	AH	GY, H	Feb-Aug
	532	**Bombax ceiba* L.	AMK/4076	DT	H	Dec-Mar
	533	**Brachychiton populneus* (Schott & Endl.) R.Br.	AMK/3844	ET	H	Mar-May
	534	**Hibiscus rosa-sinensis* L.	AMK/4151	ES	H	Jan-Dec
	535	**Hibiscus syriacus* L.	AMK/3923	DS	H	Jul-Oct
	536	*Lavatera cachemiriana* Cambess.	AMK/4273	PH	E, F	Jun-Aug
	537	*Malva neglecta* Wallr.	AMK/4123	AH	A, W	Mar-Aug
	538	*Malva parviflora* L.	AMK/4009	AH	A	Apr-Sep
	539	*Malvastrum coromandelianum* (L.) Garcke	AMK/3666	AH	D, GY, W	Jun-Sep
	540	**Pterospermum acerifolium (L.) ld.*	AMK/3676	ET	H	Dec-Jul
	541	*Sida cordata* (Burm.f.) Borss.Waalk.	AMK/3961	PH	D, G	Feb-Apr
78. Martyniaceae	542	*Martynia annua* L.	AMK/4194	AH	G, W	Aug-Nov
79. Meliaceae	543	**Azadirachta indica* A.Juss.	AMK/3712	ET	H	Apr-May
	544	*Cedrela serrata* Royle	AMK/4092	DT	F	May-Jun
	545	*Melia azedarach* L.	AMK/3691	DT	A, D, H	Mar-Apr
	546	*Toona ciliata* M. Roem.	AMK/3758	DT	F	Mar-Apr
80. Menispermaceae	547	*Cissampelos pareira* L.	AMK/3654	PC	D	Mar-Oct
	548	**Tinospora sinensis* (Lour.) Merr.	AMK/3997	PC	H	Mar-Jun
81. Moraceae	549	*Broussonetia papyrifera* (L.) L'Her. ex Vent.	AMK/4120	DT	A	Mar-Aug
	550	*Ficus auriculata* Lour.	AMK/3765	ET	D, SL	Aug-Nov
	551	*Ficus benghalensis* L.	AMK/3657	ET	D	Apr-Jul
	552	**Ficus carica* L.	AMK/4274	DT	A, H	Apr-Dec
	553	**Ficus elastica* Roxb. ex Hornem.	AMK/3935	ET	H	Mar-Apr
	554	*Ficus palmata* Forssk.	AMK/4257	DT	D, W	May-Sep
	555	**Ficus religiosa* L.	AMK/3708	ET	H	Mar-Aug
	556	*Ficus sarmentosa* var. *nipponica* (Franch. & Sav.) Corner	AMK/3817	PC	F, MS	May-Sep
	557	*Morus alba* L.	AMK/3783	DT	A	Mar-May
	558	*Morus nigra* L.	AMK/3857	DT	A, D, H	Mar-May
82. Myrtaceae	559	**Callistemon citrinus* (Curtis) Skeels	AMK/3873	ET	H	Feb-Apr
	560	**Callistemon salignus* (Sm.) Colv. ex Sweet	AMK/3768	ET	H	Jun-Sep
	561	*Corymbia citriodora* (Hook.) K.D.Hill & L.A.S.Johnson	AMK/4008	ET	A, D, RS	Jun-Nov
	562	*Eucalyptus camaldulensis* Dehnh.	AMK/4041	ET	A, D, RS	May-Jan

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	563	*Eucalyptus globulus* Labill.	AMK/4112	ET	A, D, RS	Dec-May
	564	*Eucalyptus tereticornis* Sm.	AMK/4277	ET	A, D, RS	Jun-Aug
	565	**Myrtus communis* L.	AMK/4088	ES	H	Jul-Aug
	566	**Psidium guajava* L.	AMK/3603	DT	H	Jun-Sep
	567	**Syzygium cumini* (L.) Skeels	AMK/3992	DT	H	Apr-May
83. Nyctaginaceae	568	*Boerhavia diffusa* L.	AMK/4187	PH	D, S	Jul-Sep
	569	*Boerhavia procumbens* Banks ex Roxb.	AMK/3632	PH	D, SL	Aug-Sep
	570	**Bougainvillea glabra* Choisy	AMK/4078	PC	H	Dec-Mar
	571	**Mirabilis jalapa* L.	AMK/3698	PH	GY, H	Aug-Oct
84. Oleaceae	572	*Jasminum grandiflorum* L.	AMK/3922	DS	F, MS	Jun-Sep
	573	*Jasminum humile* L.	AMK/3651	DS	D, SL	Mar-Jun
	574	**Jasminum mesnyi* Hance	AMK/3797	DS	H	Feb-Mar
	575	*Jasminum officinale* L.	AMK/4011	DS	D, F	May-Jul
	576	**Jasminum sambac* (L.) Aiton	AMK/4241	DS	H	May-Sep
	577	**Ligustrum lucidum* W.T. Aiton	AMK/4150	ES	H, RS	May-Jun
	578	*Olea europaea* subsp. *cuspidata* (Wall. & G.Don) Cif.	AMK/4016	ET	D, SL	Apr-May
85. Onagraceae	579	*Circaea alpina* L.	AMK/3985	PH	F, E, M	Jun-Aug
	580	*Epilobium hirsutum* L.	AMK/3802	PH	E, F	Jun-Aug
	581	*Epilobium laxum* Royle	AMK/4067	PH	F, E	Jun-Sep
	582	*Oenothera rosea* L'Hér. ex Aiton	AMK/3624	PH	S, W	May-Nov
86. Oxalidaceae	583	*Oxalis acetosella* L.	AMK/4115	PH	F, MS	Apr-Jun
	584	*Oxalis corniculata* L.	AMK/3667	AH	MS, W	Feb-Oct
87. Paeoniaceae	585	*Paeonia emodi* Royle	AMK/3899	PH	F, MS	May-Jul
88. Papaveraceae	586	*Fumaria indica* (Hausskn.) Pugsley	AMK/4233	AH	A, W	Mar-Jun
	587	*Fumaria parviflora* Lam.	AMK/3790	AH	A, W	Mar-Jun
89. Pedaliaceae	588	**Sesamum indicum* L.	AMK/3990	AH	A	Jun-Sep
90. Phyllanthaceae	589	**Bischofia javanica* Blume	AMK/3635	ET	H	Apr-May
	590	*Leptopus cordifolius* Decne.	AMK/4066	DS	F	Jul-Oct
	591	**Phyllanthus emblica* L.	AMK/4215	DT	H	Mar-May
	592	*Phyllanthus niruri* L.	AMK/4053	AH	W	Aug-Sep
91. Phytolaccaceae	593	*Phytolacca latbenia* (Moq.) H. Walter	AMK/4168	PH	F	Jun-Aug
92. Plantaginaceae	594	**Antirrhinum majus* L.	AMK/3633	AH	H	Mar-Sep
	595	*Nanorrhinum ramosissimum* (Wall.) Betsche subsp. *pakistanicum* G.R.Sarwar	AMK/4146	PH	F	Feb-Apr
	596	*Plantago lanceolata* L.	AMK/4309	PH	A, W	Jul-Sep
	597	*Plantago major* L.	AMK/3687	PH	F	Aug-Sep
	598	*Veronica anagallis-aquatica* L.	AMK/3886	PH	M	Apr-Sep
	599	*Veronica laxa* Benth.	AMK/3610	PH	E	Jul-Sep
	600	*Veronica persica* Poir.	AMK/3901	AH	A, W	Mar-May
	601	*Veronica polita* Fr.	AMK/3745	AH	A, W	Feb-May
	602	*Wulfeniopsis amherstiana* (Benth.) D.Y. Hong	AMK/3623	PH	F, R	May-Aug
93. Platanaceae	603	**Platanus orientalis* L.	AMK/3967	DT	H, WC	Apr-May
94. Plumbaginaceae	604	*Plumbago zeylanica* L.	AMK/3818	ES	D, G	Jul-Sep
95. Polygalaceae	605	*Polygala abyssinica* R.Br. ex Fresen.	AMK/3919	PH	E, D, R	Mar-Sep
96. Polygonaceae	606	*Bistorta affinis* (D.Don) Greene	AMK/3848	PH	E	Jun-Sep
	607	*Bistorta vivipora* (L.) S.F. Gray	AMK/4355	PH	C, R	Jul-Sep
	608	*Oxyria digyna* (L.) Hill	AMK/3905	PH	E	Mar-Aug
	609	*Persicaria alpina* (All.) H.Gross	AMK/4265	PH	E	Jun-Jul
	610	*Persicaria amplexicaulis* (D.Don) Ronse Decr.	AMK/3673	PH	E, F	Jun-Sep
	611	*Persicaria maculosa* Gray	AMK/3794	AH	M	Jun-Oct
	612	*Persicaria nepalensis* (Meisn.) Miyabe	AMK/4095	AH	F, WC	Jun-Sep
	613	*Polygonum aviculare* L.	AMK/3604	AH	G, W	Mar-Sep
	614	*Polygonum patulum* M.Bieb.	AMK/4039	AH	R	Mar-Jun
	615	*Polygonum plebeium* R.Br.	AMK/4013	AH	S	May-Aug
	616	*Rheum australe* D. Don	AMK/3668	PH	E	Jun-Aug
	617	*Rheum webbianum* Royle	AMK/4255	PH	E	Jun-Sep
	618	*Rumex dentatus* L.	AMK/4002	AH	A, W	May-Jun
	619	*Rumex hastatus* D. Don	AMK/4198	PH	D	Jun-Oct
	620	*Rumex nepalensis* Spreng.	AMK/3672	PH	F	Jun-Sep
97. Portulacaceae	621	*Portulaca oleracea* L.	AMK/3791	AH	A, MS	Jan-Dec
98. Primulaceae	622	*Anagallis arvensis* L.	AMK/3735	AH	A, D, W	Feb-Mar
	623	*Androsace rotundifolia* Hardw.	AMK/4197	PH	D	Apr-Aug
	624	*Androsace sempervivoides* Jacq. ex Duby	AMK/4271	PH	F	Jun-Aug
	625	*Androsace umbellata* (Lour.) Merr.	AMK/4310	AH	F	Mar-Apr

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	626	*Myrsine africana* L.	AMK/4171	ES	D, SL	Mar-May
	627	*Primula denticulata* Sm.	AMK/4045	PH	E, G	Mar-Apr
99. Proteaceae	628	**Grevillea robusta* A.Cunn. ex R.Br.	AMK/3760	ET	H	Mar-Apr
100. Putranjivaceae	629	**Putranjiva roxburghii* Wall.	AMK/4049	DT	H	Mar-May
101. Ranunculaceae	630	*Aconitum chasmanthum* Stapf ex Holmes	AMK/3652	PH	E, F	Jul-Aug
	631	*Aconitum heterophyllum* Wall. ex Royle	AMK/4030	BH	E	Jul-Aug
	632	*Actaea spicata* var. *acuminata* (Wall. ex Royle) H.Hara	AMK/3867	PH	E, F	Jul-Aug
	633	*Anemone vitifolia* Buch.-Ham. ex DC.	AMK/3959	PH	D, F	Mar-Sep
	634	*Aquilegia fragrans* Benth.	AMK/4242	PH	E	Jul-Aug
	635	*Aquilegia pubiflora* Wall. ex Royle	AMK/3931	PH	F	May-Aug
	636	*Caltha palustris* var. *alba* (Cambess.) Hook.f. & Thomson	AMK/4134	PH	F, WC	Apr-Jun
	637	*Clematis gouriana* Roxb. ex DC.	AMK/3937	PC	A, D	Aug-Sep
	638	*Clematis grata* Wall.	AMK/3662	PC	A, D	Aug-Sep
	639	**Consolida ajacis* (L.) Schur	AMK/3925	AH	H	Mar-Apr
	640	*Delphinium denudatum* Wall. ex Hook.f. & Thomson	AMK/3859	PH	F	May-Aug
	641	*Ranunculus arvensis* L.	AMK/3656	AH	A, W	Mar-Apr
	642	*Ranunculus laetus* Wall. ex Hook. f. & J.W. Thomson	AMK/3839	PH	E, F	Jun-Aug
	643	*Ranunculus muricatus* L.	AMK/3725	AH	A, W, WC	Mar-Apr
	644	*Ranunculus repens* L.	AMK/4085	PH	E, F	Apr-Aug
	645	*Ranunculus sceleratus* L.	AMK/4113	AH	WC	Mar-Apr
	646	*Thalictrum foliolosum* DC.	AMK/3907	PC	F	Jul-Aug
102. Rhamnaceae	647	*Rhamnus triquetra* (Wall.) Brandis	AMK/3851	DT	D, F	Jul-Aug
	648	*Rhamnus virgata* Roxb.	AMK/3827	DT	D, F	Apr-Jun
	649	*Ziziphus jujuba* Mill.	AMK/3778	DT	A, D	Mar-Apr
	650	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	AMK/4106	DS	D	Mar-Jun
103. Rosaceae	651	*Agrimonia pilosa* Ledeb.	AMK/4256	PH	E, F	May-Sep
	652	*Contoneaster affinis Lind L.*	AMK/3977	DS	F	Mar-May
	653	*Cotoneaster microphyllus* Wall. ex Lindl.	AMK/3910	ES	D, E	May-Jun
	654	*Cotoneaster nummularius* Fisch. & C.A.Mey.	AMK/3779	DS	D, F	Mar-Apr
	655	*Crataegus songarica* K. Koch	AMK/4098	DT	D, F	Apr-May
	656	*Duchesnea indica* (Andrews) Focke	AMK/3714	PH	MS, WC	Jun-Aug
	657	**Eriobotrya japonica* (Thunb.) Lindl.	AMK/4249	ET	A, H	Dec-Feb
	658	*Fragaria nubicola* (Lindl. ex Hook.f.) Lindl.ex Lacaita	AMK/4023	PH	F	May-Aug
	659	*Geum urbanum* L.	AMK/4209	PH	F	May-Aug
	660	**Malus domestica* Borkh.	AMK/3755	DT	A, H	Apr-May
	661	**Malus pumila* Mill.	AMK/4321	DT	A, H	Apr-May
	662	*Potentilla nepalensis* Hook.	AMK/4003	PH	F	Jul-Aug
	663	**Prunus amygdalus* Batsch	AMK/4339	DT	A, H	Mar-Apr
	664	**Prunus armeniaca* L.	AMK/3703	DT	A, H	Feb-Apr
	665	**Prunus cerasifera* Ehrh.	AMK/3751	DT	A, H	Feb-Apr
	666	*Prunus cerasoides* Buch.-Ham. ex D.Don	AMK/4253	DT	F	Oct-Nov
	667	*Prunus cornuta* (Wall. ex Royle) Steud.	AMK/4186	DT	F	Apr-Jun
	668	**Prunus domestica* L.	AMK/3838	DT	A, H	Feb-Apr
	669	**Prunus persica* (L.) Batsch	AMK/3930	DT	A, H	Mar-Apr
	670	**Pyrus communis* L.	AMK/3904	DT	A, H	Mar-Apr
	671	*Pyrus pashia* Buch.-Ham. ex D.Don	AMK/4181	DT	D	Mar-Apr
	672	*Rosa brunonii* Lindl.	AMK/3887	PC	F	May-Jun
	673	**Rosa chinensis* Jacq.	AMK/4166	ES	H	Jul-Aug
	674	*Rosa macrophylla* Lindl.	AMK/3955	DS	F	Jun-Jul
	675	*Rubus ellipticus* Sm.	AMK/3804	DS	D, F	Mar-Apr
	676	*Rubus niveus* Thunb.	AMK/3809	DS	D	May-Jul
	677	*Sibbaldia procumbens* L.	AMK/3865	PH	E, G	Jul-Aug
	678	*Sorbaria tomentosa* (Lindl.) Rehder	AMK/3659	DS	F	Jul-Aug
	679	*Spiraea canescens* D.Don	AMK/3941	DS	D, F	Jul-Aug
104. Rubiaceae	680	*Galium aparine* L.	AMK/4223	AC	W	Mar-Jul
	681	*Galium asperifolium* Wall.	AMK/4236	PH	F, W	Jun-Sep
	682	*Galium asperuloides* Edgew.	AMK/4352	AH	F	Apr-Aug
	683	*Galium boreale* L.	AMK/4084	PH	D, F, W	Jun-Sep
	684	*Galium elegans* Wall. ex Roxb.	AMK/3784	PH	A, W	Jul-Oct
	685	*Himalrandia tetrasperma* (Wall. ex Roxb.) T.Yamaz.	AMK/4163	DS	F	May-Jun
	686	*Rubia cordifolia* L.	AMK/4028	PC	D, F	Jun-Nov
105. Rutaceae	687	**Citrus aurantiifolia* (Christm.) Swingle	AMK/3664	ES	H	Dec-Feb
	688	**Citrus limon* (L.) Osbeck	AMK/3682	ES	H	Aug-Nov

Table 2. (Cont'd.).

Family	#	Species name	V/No	Habit	Micro-habitat	Phenology
	689	**Citrus maxima* (Burm.) Merr.	AMK/3903	ET	H	Mar-Apr
	690	**Citrus medica* L.	AMK/4083	ET	H	Apr-May
	691	**Citrus reticulata* Blanco	AMK/3694	ET	H	Feb-Apr
	692	**Citrus sinensis* (L.) Osbeck	AMK/4000	ET	A, H	Mar-May
	693	**Murraya koenigii* (L.) Spreng.	AMK/3814	ES	H	Apr-Jun
	694	*Skimmia laureola* Franch.	AMK/3720	ES	F	Apr-Jun
	695	*Zanthoxylum armatum* DC.	AMK/4144	DS	D	Mar-Apr
106. Salicaceae	696	*Populus alba* L.	AMK/4172	DT	A, RS	May-Jul
	697	*Populus ciliata* Wall. ex Royle	AMK/4335	DT	A, RS, WC	Mar-Apr
	698	*Salix alba* L.	AMK/4218	DT	F	Apr-May
	699	*Salix tetrasperma* Roxb.	AMK/4017	DT	A, S, WC	Oct-Mar
107. Santalaceae	700	*Viscum album* L.	AMK/3803	PC	D, F	Mar-May
108. Sapindaceae	701	*Aesculus indica* (Wall. ex Cambess.) Hook.	AMK/3892	DS	F	Apr-May
	702	*Dodonaea viscosa* (L.) Jacq.	AMK/3704	ES	D	Jan-Mar
	703	**Sapindus mukorossi* Gaertn.	AMK/4220	DT	A, H, RS	May-Jun
109. Saxifragaceae	704	*Bergenia ciliata* (Haw.) Sternb.	AMK/3689	PH	C, R	Mar-May
110. Scrophulariaceae	705	*Buddleja asiatica* Lour.	AMK/4326	ES	D, F	Feb-Apr
	706	*Buddleja crispa* Benth.	AMK/4275	DS	D	Apr-May
	707	*Mazus pumilus* (Burm.f.) van Steenis	AMK/4230	AH	F, S	Apr-Oct
	708	*Verbascum thapsus* L.	AMK/3683	BH	D, S	Jun-Aug
111. Simaroubaceae	709	*Ailanthus altissima* (Mill.) Swingle	AMK/3906	DT	A, D	Apr-May
112. Solanaceae	710	*Atropa acuminata* Royle ex Lindl.	AMK/3884	PH	F	Jun-Jul
	711	**Capsicum annuum* L.	AMK/4071	AH	A, H	Apr-May
	712	**Cestrum nocturnum* L.	AMK/3998	DS	H	Jun-Sep
	713	*Datura innoxia* Mill.	AMK/4183	PH	A, D, RS, W	May-Oct
	714	*Datura stramonium* L.	AMK/3700	AH	E, F, W	Jun-Aug
	715	*Hyoscyamus niger* L.	AMK/3926	BH	F	Jun-Aug
	716	**Lycopersicon esculentum* Mill.	AMK/3663	AH	A, H	Jun-Oct
	717	**Nicotiana tabacum* L.	AMK/3882	AH	A	Jun-Aug
	718	**Petunia axillaris* (Lam.) Britton, Sterns & Poggenb.	AMK/4304	AH	H	Mar-Apr
	719	**Petunia hybrida* Vilm.	AMK/4307	AH	H, RS	Mar-Apr
	720	*Physalis minima* L.	AMK/3780	AH	A, S	Jul-Sep
	721	*Solanum americanum* Mill.	AMK/3729	AH	A, GY, S, W	Jan-Dec
	722	*Solanum dulcamara* L.	AMK/4331	PC	F	Jul-Aug
	723	**Solanum melongena* L.	AMK/4094	AH	A	Jun-Sep
	724	*Solanum pseudocapsicum* L.	AMK/4214	PH	D	May-Aug
	725	*Solanum surattense* Burm. f.	AMK/3843	PH	S, W	Jan-Dec
	726	**Solanum tuberosum* L.	AMK/4110	PH	A	May-Aug
	727	*Withania somnifera* (L.) Dunal	AMK/3805	PH	D	Jan-Dec
113. Thymelaeaceae	728	*Daphne mucronata* Royle	AMK/3796	ES	D	Apr-Jun
114. Tropaeolaceae	729	**Tropaeolum majus* L.	AMK/4029	AH	H	Jun-Oct
115. Ulmaceae	730	*Ulmus wallichiana* Planch.	AMK/4177	DT	F	Mar-Apr
116. Urticaceae	731	*Debregeasia saeneb* (Forssk.) Hepper & J.R.I.Wood	AMK/3650	ES	WC	Mar-Jun
	732	*Girardinia palmata* (Forssk.) Gaudich.	AMK/3634	PH	F, MS	Jul-Aug
	733	*Pilea umbrosa* Blume	AMK/4138	PH	F, MS	Jul-Aug
	734	*Urtica dioica* L.	AMK/3621	PH	S, W	May-Sep
117. Verbenaceae	735	**Citharexylum spinosum* L.	AMK/4005	DT	H	Aug-Nov
	736	**Duranta erecta* L.	AMK/3980	ES	H	Jan-Dec
	737	*Glandularia aristigera* (S.Moore) Tronc.	AMK/4343	PH	D, GY, W	Mar-May
	738	*Lantana camara* L.	AMK/3897	ES	D, GY, W	Jan-Dec
	739	*Lantana indica* Roxb.	AMK/4203	ES	D, GY, W	Jul-Sep
	740	*Phyla nodiflora* (L.) Greene	AMK/4107	PH	S, W	Jan-Dec
	741	*Verbena officinalis* L.	AMK/3870	PH	S, W	Jul-Oct
118. Violaceae	742	*Viola biflora* L.	AMK/4317	PH	C, E, F	May-Aug
	743	*Viola canescens* Wall.	AMK/4283	PH	D, F, SL	Mar-May
	744	**Viola odorata* L.	AMK/3710	PH	H, F	Apr-May
	745	*Viola pilosa* Blume	AMK/3679	PH	D, F	Apr-Aug
119. Vitaceae	746	*Ampelopsis vitifolia* (Boiss.) Planch.	AMK/4032	PC	D, S	May-Jul
	747	**Vitis vinifera* L.	AMK/4319	PC	A, H	May-Jul
120. Zygophyllaceae	748	*Tribulus terrestris* L.	AMK/4103	AH	D, S, W	Jan-Dec

(**Legends:** *= Agricultural/Ornamental species; AC= Annual climber; AH= Annual herb; BH= Biennial herb; DS= Deciduous shrub; DT= Deciduous tree; ES= Evergreen shrub; ET=Evergreen tree; PC= Perennial climber; PH= Perennial herb; A= Arable land; C= Cliff; D= Dry slope; E= Exposed (alpine) slope; F= Forest; G= Grassland; GY= Grave yard; H= Home garden; M= Marsh; MS= Moist & shady; R= Rock crevice; RS= Roadside; S= Sandy stream/riverside; SL= Scrubland; W= Waste place; WC= Water course)

Table 3. Pearson correlation and contribution ofclimatic variables towards flowering phenologicalresponse at the western Himalayan forest of Muzaffarabad.

	SFR	Rainfall	Tmax	Tmin	RH	WS
Rainfall	0.558 0.06	1				
Tmax	0.913** 0.000	0.298 0.346	1			
Tmin	0.949** 0.000	0.425 0.169	0.983** 0.000	1		
RH	-0.085 0.792	0.26 0.414	-0.195 0.544	-0.046 0.888	1	
WS	.693* 0.012	0.45 0.142	0.497 0.1	0.502 0.096	-0.413 0.182	1
Canonical correspondence analysis (simple term effects)						
Variable			**Explains %**	**Pseudo-F**	**p-value**	**p(adj)**
Tmin			29.8	4.3	0.001	0.0025
Tmax			28.6	4	0.001	0.0025
RH			17.6	2.1	0.03	0.05
WS			16.2	1.9	0.049	0.06125
Rainfall			8.1	0.9	0.474	0.474
Canonical correspondence analysis (conditional or net term effects)						
Variable			**Explains %**	**Pseudo-F**	**p-value**	**p(adj)**
Tmin			29.8	4.3	0.001	0.005
WS			17.1	2.9	0.009	0.0225
RH			10.5	2	0.037	0.04625
Tmax			10.7	2.4	0.023	0.03833
Rainfall			3.6	0.8	0.622	0.622

Legends: ** Correlation is significant at the 0.01 level (2-tailed) and * Correlation is significant at the 0.05 level (2-tailed). SFR; Species flowering response, Rainfall; Mean monthly rainfall (mm), Tmax; mean monthly max. Temperature (°C), Tmin; mean monthly min. temperature (°C), RH; Mean monthly relative humidity (%), WS; Mean monthly wind speed (km/hrs.)

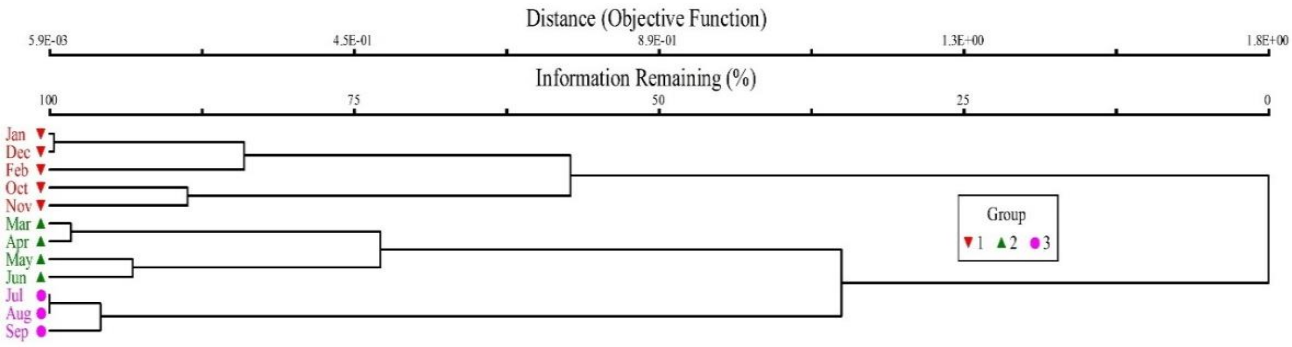

Fig. 6. Dendrogram with monthly grouping relationship based on flowering phenological response.

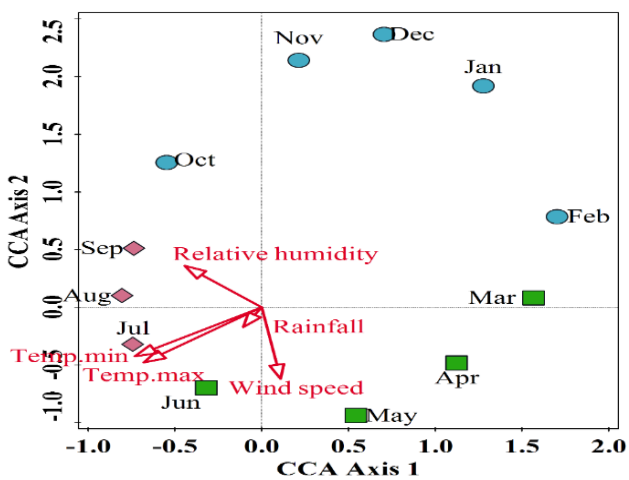

Fig. 7. CCA biplot showing contribution and relationships of climatic variables with the different months (samples) groups based on species flowering response in the western Himalayan forest.

The Himalayas are facing the most far reaching global climate changes outside of the poles. There is predicted temperature increase of 5 to 6°C, rainfall increase of 20 to 30% and rapid melting of permanent snows and glaciers. Himalayan plants respond to these environmental and climate change variables including altitude, precipitation and biogeography, thus these changes threatens rare, endemic and useful Himalayan biodiversity (Salick *et al*., 2014).

The single published floristic checklist (Dar *et al*., 2012) from Machiara National Park (MNP), Muzaffarabad reported 409 plant species belonging to 225 genera and 103 families. This firstevr study covered the whole district, thus comprised of 748 phyto-taxa including 77 plant species as new record from the study area. With respect to number of plant species found in flowering stage during different months, our results matched with Vashistha *et al.,* (2009), who reported that majority of plant species show flowering response during July and August months in the north

western Himalaya (Tungnath), India. Similarly many workers (Holway & Ward, 1965; Walter, 1973; Dewald & Steiner, 1986; Badeck *et al.*, 2004) recognised the importance of temperature towards the plants phenological responses especially in high altitude areas. This study confirm the same and further revealed that minimum temperature is more important than the maximum temperature in the area. Heydel *et al.,* (2015) reported the synchronization of seed release timing and high long distance dispersal by wind amongst the tree species with winged seed.We also found wind speed as second most important factor which might involvled as one of synchronized pollinating agent with species flowering response and helping in long distance pollen spread for anemophilous species in the area. The results of grouping of months based on similarities of their flowering phenological response of vascular plant species considerably resemble with the related study conducted at Kotli district, Azad Jammu and Kashmir (Khan *et al*., 2015), where they also detected three major groups of months. We observed that three months viz. July, August and September are favored by majority of plant species, thus depicting collection of set of climatic variables with optimum values. It is also widely reported that flowering phenology is more correlated and influenced by 1-2 months before temperatures (Yadav & Yadav, 2008; Tooke & Battey, 2010), thus we can say that May and June as preceeding month's temperatures were actually providing the required thero-periodic stimulus in this regard.

Conclusions and Recommendations

Plant phenological events as response factors to climatic variations are well proven today. Based on results, it is concluded that western Himalayan (Muzaffarabad district) forests are endowed with rich biodiversity and support about 13% (area spp./Pakistan spp. or 748/5783*100) of flora of Pakistan instead of only 0.21% (land area in mill. hec. of Muzaffarabad/Pakistan area or 0.16/79.61*100) proportinate land area, calculated as conveyed by Ilyas *et al.,* (2013). This first of its kind, this study concluded that climatic variables like minimum temperature, wind speedand relative humidity are significantly explaining variations in the species flowering response data form the study area.Thus, further quantification of the patterns of these responses as consequences of climatic change by using long time series of satellite-derived measuresare required to be documented immidiately in the study area to save this identified biological hotspot. This Himalayan region is fragile and rapid temperature rise could be lead to catastrophies like wiping out of endemic and endangered species (especially of mountains summits), earlier snow melts and resultant ealier blooming causing invasive species spread, upwards timber-line shift and rapid changes in vegetation composition. This baseline study information could be used to delt these issues and need of effective regional collaboration of scientific community and policy makers is recommended. Future detailed studies related to ecological, morphological, reproductive, palynological, pharmacological and physiological aspects of new record species would be fruitful and productive. This will help in their sustainable use, management and conservation related activities in the the study area. The timing of species flowering response recorded in this study conducted at western Himalayan (Muzaffarabad district) forest can be used as baseline study and comparison with past herbarium records and satellite-derived climatic measures will represent another productive prospect to unflod impacts of climatic variations on species phenological responses. Similarly local people perceptions about the climate changes and resultant impacts on phenological responses of wild as well as crop species can also be documented. Overall, study area is rich in biodiversity and this hotspot need immidiate attention to minimize the risk of reduction of valuable species distributional ranges, migration and resultant species extinction due to ever increasing stress caused by adverse climate changes.

Acknowledgements

The authors are extremely grateful to local community who helped through sharing their information about the locations of unique microhabitats supporting rare plant species and Director General, National Agromet Centre, Pakistan Meteorological Department, H-8/2 Islamabad, Pakistan for provision of local climatic data. This research work is part of PhD thesis of the principal author.

References

Ali, S.I. and M. Qaiser. 1995–2009. *Flora of West Pakistan*, Department of Botany, University of Karachi, Karachi, Pakistan.

Anonoymous. 2015. AJK at Glance; A report by Planning & Development Department Muzaffarabad, Azad Jammu & Kashmir, Pakistan. Website: http://pndajk.gov.pk/ (accessed: 4/10/2016).

Badeck, F.W., A. Bondeau, K. Böttcher, D. Doktor, W. Lucht, J. Schaber and S. Sitch. 2004. Responses of spring phenology to climate change. *New Phytologist*, 162(2): 295-309.

Chaudhary, P., S. Rai, S. Wangdi, A. Mao, N. Rehman, S. Chettri and K.S. Bawa. 2011. Consistency of local perceptions of climate change in the Kangchenjunga Himalaya landscape. *Curr. Sci.*, 101(4): 504-513.

Dar, M.E.U.I., R. Cochard, R. P. Shrestha and S. Ahmad. 2012. Floristic composition of Machiara National Park, district Muzaffarabad Azad Kashmir, Pakistan. *Int. J. Biosciences*, 2: 28-45.

Dar, M.E.U.I., S. Ahmad, T. Habib, H. Shaheen and M. A. Hussain. 2014. Spatiotemporal analysis of vegetation change in Himalayan foothills, a case from Machiara National Park, Azad Jammu and Kashmir, Pakistan. *J. Food Agric. Environ*., 12: 922-925.

Dewald, L.E. and K.C. Steiner. 1986. Phenology, height increment and cold tolerance of Alnus glutinosa population in a common environment. *Silvae Genetica*, 35: 205-211.

EFLORAS. 2012a. Flora of Pakistan @ efloras.org. Website: http://www.efloras.org/flora_page.aspx?flora_id=5 (accessed 13/3/2017).

EFLORAS. 2012b. Flora of China @ efloras.org. Website: http://www.efloras.org/flora_page.aspx?flora_id=2 (accessed 12/12/2016).

EFLORAS. 2014. Flora of India. Website: http://efloraindia.nic.in /efloraindia/homePage.action (accessed 12/1/2017).

Gairola, S., C.M. Sharma, C.S. Rana, S.K. Ghildiyal and S. Suyal. 2010. Phytodiversity (Angiosperms and Gymnosperms) in Mandal-Choptaforest of Garhwal Himalaya, Uttarakhand, India. *Nature and Science*, 8(1): 1-17.

Heydel, F., S. Cunze, M. Bernhardt-Römermann and O. Tackenberg. 2015. Seasonal synchronization of seed

release phenology promotes long-distance seed dispersal by wind for tree species with medium wind dispersal potential. *J. Veg. Sci.*, 26: 1090-1101.

Holway, J.G. and R.T. Ward. 1965. Phenology of alpine plants in northern Colorado. *Ecology*, 46(1-2): 73-83.

Huntley, B. 1991. How plants respond to climate change: migration rates, individualism and the consequences for plant communities. *Ann. Botany*, 67(1): 15-22.

Ilyas, M., R. Qureshi, M. Arshad and S.N. Mirza. 2013. A Preliminary checklist of the vascular flora of Kabal Valley, Swat, Pakistan. *Pak. J. Bot.*, 45(2): 605-615.

IPCC. 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the International Panel on Climate Change. Cambridge, UK: Cambridge University Press.

Khan, A.M., R. Qureshi, M.F. Qaseem, M. Munir, M. Ilyas and Z. Saqib. 2015. Floristic checklist of district Kotli, Azad Jammu & Kashmir. *Pak. J. Bot.*, 47(5): 1957-1968.

Khan, A.M., R. Qureshi, M.F. Qaseem, W. Ahmad, Z. Saqib and T. Habib. 2016. Status of Basic Taxonomic Skills in Botanical Articles Related to Azad Jammu and Kashmir, Pakistan: A Review. *J. Bioreso. Manag.*, 3(3): 22-54.

Kirschbaum, M.U.F., A. Fischlin, M.G.R. Cannell, R.V.O. Cruz and W.P. Cramer. 1996. Climate change impacts on forests. In: (Eds.): Watson, R.T., M.C. Zinyowera and R.H. Moss. Climate Change 1995. Impacts, Adaptation and Mitigation of Climate Change: Scientific–Technical Analyses.Contribution of WGII to the Second Assessment Report of the IPCC. Cambridge, UK: Cambridge University Press, pp. 95-129.

Lechowicz, M.J. 2001. *Phenology-Encyclopedia of Global Environmental Change.* Volume 2. The Earth System: biological and ecological dimensions of global environmental change. Wiley, London.

Lieth, H. 1974. Phenology and seasonality modelling. Springer, Berlin Germany.

Malik, Z.H. 2005. Comparative study on the vegetation of Ganga chotti and Bedori hills District Bagh, Azad Jammu and Kashmir with special reference to Range conditions. Ph.D. Thesis, Department of Botany, University of Peshawar, Pakistan.

McCune, B. and M.J. Mefford. 2006. PC-ORD: Multivariate analysis of ecological data. MJM Software Design, Gleneden Beach, Oregon, USA. pp. 1-237.

McKane, R.B., D.F. Grigal and M.P. Russelle. 1990. Spatiotemporal differences in 15N uptake and the organization of an old‐field plant community. *Ecology*, 71(3): 1126-1132.

Qasim, M., H.M. Tayyab and E. Ahmad. 2010a. Use of salvage wood for reconstruction in earthquake affected sites of Muzaffarabad, Azad Jammu & Kashmir. *World Appl. Sci. J.*, 8: 914-916.

Qasim, M., Z. Kiyani and E. Ahmad. 2010b. Role of different vegetation types in reducing the earthquake damages in Muzaffarabad District. *World Appl. Sci. J.*, 8: 1163-1167.

Qureshi, R., G.R. Bhatti and G. Shabbir. 2011a. Floristic inventory of Pir Mehr Ali Shah Arid Agriculture University Research Farm at Koont and its surrounding areas. *Pak. J. Bot.*, 43(3): 1679-1684.

Qureshi, R., H. Shaheen, M. Ilyas, W. Ahmed and M. Munir. 2014. Phytodiversity and plant life of Khanpur dam, Khyber Pakhtunkhwa, Pakistan. *Pak. J. Bot.*, 46(3): 841-849.

Qureshi, R., W.A. Khan, G.R. Bhatti, B. Khan, S. Iqbal, M.S. Ahmad and M. Abid. 2011b. First report on the biodiversity of Khunjerab National Park, Pakistan *Pak. J. Bot.*, 43(2): 849-861.

Raimondo, F.M., G. Domina and V. Spadaro. 2010. Checklist of the vascular flora of Sicily. *Quad. Bot. Amb. Appl.*, 21: 189-252.

Ram, J., S.P. Singh and J.S. Singh. 1988. Community level phenology of grassland above treeline in central Himalaya, India. *Arctic and Alpine Research*, 20(3): 325-332.

Rathcke, B. and E.P. Lacey. 1985. Phenological patterns of terrestrial plants. *Ann. Rev. Ecol. Syst.*, 16: 179-214.

R-Core-Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL: http://www.R-project.org/.

Salick, J., S.K. Ghimire, Z. Fang, S. Dema and K.M. Konchar. 2014. Himalayan alpine vegetation, climate change and mitigation. *J. Ethnobiol.*, 34: 276-293.

Santandreu, M. and F. Lloret. 1999. Effect of flowering phenology and habitat on pollen limitation in Erica multiflora. *Canadian J. Bot.*, 77(5): 734-743.

Schwartz, M.D. 2003. Phenology: an integrative environmental science. Dordrecht. The Netherlands: Kluwer Academic Publishers, pp. 592.

Shaheen, H., R. Qureshi, A. Akram, M. Gulfraz and D. Potter. 2014. A preliminary floristic checklist of Thal Desert Punjab, Pakistan. *Pak. J. Bot.*, 46(1): 13-18.

Shrestha, U.B., S. Gautam and K.S. Bawa. 2012. Widespread climate change in the Himalayas and associated changes in local ecosystems. *Plos One*, 7(5): e36741.

Sparks, T.H., P.D. Carey and J. Combes. 1997. First leafing dates of trees in Surrey between 1947 and 1996. *London Naturalist*, 76: 15-20.

Stewart, R.R. 1972. An Annotated Catalogue of the Vascular Plants of West Pakistan and Kashmir. Fakhri Printing Press, Karachi.

Ter Braak, C.J.F. and P. Smilauer. 2012. Canoco 5. Windows release (5.00). [Software for canonical community ordination]. Microcomputer Power, Ithaca, NY, USA.

Tooke, F. and N.H. Battey. 2010. Temperate flowering phenology. *J. Exp. Bot.*, 61: 2853-2862.

TPL. 2013. onward (continuouslyupdated). The Plant List. Version1.1. Website:http://www.theplantlist.org/ (accessed 6/12/20116)

TROPICOS. 2012. onward. Flora of Pakistan. Website: http://www.tropicos.org/NameSearch.aspx?projectid=32 (accessed 2/12/2016)

Vashistha, R.K., N. Rawat, A.K. Chaturvedi, B.P. Nautiyal, P. Prasad and M.C. Nautiyal. 2009. An exploration on the phenology of different growth forms of an alpine expanse of North-West Himalaya, India. *New York Sci. J.*, 2(6): 29-41.

Veresoglou, D.S. and A.H. Fitter. 1984. Spatial and temporal patterns of growth and nutrient uptake of five co- existing grasses. *J. Ecol.*, 72(1): 259-272.

Visser, M.E. and L.J.M. Holleman. 2001. Warmer springs disrupt the synchrony of oak and winter moth phenology. *Proc. R. Soc. Lond., Ser. B.: Biol. Sci.*, pp. 268-289.

Walter, H. 1973. Vegetation of the Earth in Relation to Climate and the Eco-physiological Conditions. English Universities Press.

Yadav, R.K. and A.S. Yadav. 2008. Phenology of selected woody species in a tropical dry deciduous forest in Rajasthan, India. *Trop. Ecol.*, 49: 25-34.

(Received for publication 15 June 2017)