IMPACT OF CLIMATIC VARIATIONS ON THE FLOWERING PHENOLOGY OF PLANT SPECIES IN JHELUM DISTRICT, PUNJAB, PAKISTAN

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Abstract. District Jhelum is located in the extremely diverse province of Punjab, Pakistan, and flowering event in plants is always influenced by the environment. This study was conducted during 2018 to 2020 to investigate the climatic effects on flowering cycle of plants. The main focus of the study was to find out the particular association between flowering phenology of plants and climatic variables. Month-wise phenological response of plants was recorded during frequent field visits at multiple representative microhabitats. The response data is saved as binary data matrix, and mean monthly climatic data is obtained through remote sensing, and analysed by using multivariate analyses like canonical correspondence analysis, hierarchical classification and pseudo-canonical correlation. CCA and Hierarchical classification were applied to assess the importance climatic variations towards the flowering phenological response and potential groups respectively. A total of 404 plant species of 223 genera belonging to 75 plant families were examined. Majority of plant species were found in flowering during the month of March (174 spp.) followed by April (159 spp.) and August (158 spp.), similarly, Summer was the leading season (208 spp.) followed by Monsoon (203 spp.), Spring (181 spp.) and Autumn (157 spp.). CCA results depicted that total variations in the flowering phenology response data were 3.45084, and about 45.6% were explained by the explanatory climatic variables. Wind speed, mean monthly maximum temperature and soil moisture were detected as most influential drivers of flowering phenology in the study area. The current study will be useful for researchers as a major source of knowledge for the conservation of valuable species. Such type of attempts will be supportive to explore the phenological response of plants in various habitats such as forest, hilly, riverine, desert and range lands flora in their future projects.
Keywords: *phenological response, hierarchical classification, canonical correspondence analysis*

Introduction

The word "phenology" stands for the life history of plants (Vashistha et al., 2009). To record phenological response at local and regional scale some modeling tools and remote sensing play significant role (Neil and Wu, 2006). Phenology of plants is recorded through observation during ecological explorations to estimate month wise or season wise data including the last stage of appearance (Meier et al., 2007; Menzel et al., 2006). During documentation of ground truth data, various climatic variables were recorded for comparative data analysis (Badeck et al., 2004). In an ecosystem clear effects of climatic variables on phenological response were determined (Kolb et al., 2007). Climatic and phenological relations were documented by many research studies (Petry et al., 2016). Phenology and climatic conditions are linked to multiple scales (Bertin, 2008), environmental variables can affect the functional aspects of plants in any ecosystem (Parmesan, 2006; Calinger et al., 2013) resulting in close relationships among plant pollinators and plant species (Forrest, 2015; Kharouba and Vellend, 2015), and also among migratory birds and plants (Both et al., 2006). In life of plants, some unpredicted

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circumstances can affect the flowering event such as extreme temperature, day length and humidity, and studies documenting the influence of current climate on phenological events become extremely important because researchers already predicted a remarkable potential change in future climate. The presence or absence of biotic factors such as, grazers and insect pollinators and abiotic factors such as temperature, day length, and rainfall which influence the pattern of phenology (Thomson, 2010).

Various research studies resulted that temperature had significant effect on Phenology of plant species. But it was noted that temperature and phenological effect was not uniform in the World. The reason depicted that there was fluctuation in temperatures from different regions. Each species showed particular effect of temperature on phenology. So, the effect of temperature varied from species to species. In different regions of the World, with altitudinal variations, temperature played a basic role in different phenological response (Luo et al., 2007) (Holway and Ward, 1965; Shen et al., 2015; Luo et al., 2007) (Mooney and Billings, 1960). At different stages of phenology, the plants showed variable response at various temperature (Vashistha et al., 2009). International Panel on Climate Change, stated that a global rise of 0.74 °C in surface temperature results in environmental changes including less snow cover, rise in glacier melting, rise in sea level and variations in environmental temperature, rainfall and wind speed (Change, 2007).

In various regions of the World, climatic variations affected phenological responses greatly. The major climatic factors which influence the phenological pattern among various species are temperature, soil moisture, precipitation and rainfall (Chambers et al., 2013; Liu et al., 2016a, b; Inouye, 2008; Wolkovich and Cleland, 2011; Sun et al., 2015; Shen et al., 2016; Buyantuyev and Wu, 2012; Piao et al., 2019; Ma et al., 2013; Yu et al., 2003; Zhang et al., 2018; Visser et al., 2010; Richardson et al., 2013; Badeck et al., 2004; Zalamea and González, 2008). Globally, various seasons also play an important role in the phenology of plant species (Piao et al., 2019; Wolkovich and Cleland, 2011; Mittermeier et al., 2019; Gordo and Sanz, 2005; Morisette et al., 2009; Chambers et al., 2013; Yang et al., 2017).

Many studies resulted that temperature directly had direct influence on the phenological response among various plants species (Piao et al., 2019; Cleland et al., 2007; Cornelius et al., 2013; Prevéy et al., 2017; Crabbe et al., 2016; Shen et al., 2011; Keenan et al., 2020). Whereas, seasonal environmental variations showed a clear association to flowering period of plants. While phonological period, during life cycle of plants, represent prominent association with temperature. Moreover, in some cases, humidity, soil moisture, soil composition and soil texture influence the plant phenology (Cleverly et al., 2016; Francioli et al., 2018; Nandintsetseg and Shinoda, 2011; Peña-Barragán et al., 2011; Bodin and Morlat, 2006). Soil showed a major effect on the life cycle of plants. Many studies from different regions of the World, revealed the influence of soil factors on phenological pattern of plant species (Pausas and Austin, 2001; Okusanya et al., 2016; Anderson et al., 2012; Tadey, 2020; Tooke and Battey, 2010; Staehlin and Fant, 2015; Hulme, 2011; Cleland, 2007; Godoy et al., 2009; Neil et al., 2010; Lesica and Kittelson, 2010; Khanduri et al., 2008; Chen et al., 2020; Wolkovich and Cleland, 2014; McEwan et al., 2011; Matthews and Mazer, 2016).

The effect of climate and phenological response among large number of plants species was investigated in different geographical regions (Menzel et al., 2006; Parmesan, 2006; Parmesan and Yohe, 2003). Phenological response during spring season were recorded from many decades (Chambers et al., 2013; Schwartz et al., 2013; Ge et al., 2015), while phenological stages were not reported exactly (Menzel et al., 2006; Gill et al., 2015). From terrestrial ecosystems, flowering patterns of plant which played a significant role as

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biological factor are influenced by climate variations (Rosenzweig et al., 2007; Khan et al., 2018; Wang et al., 2018). It is resulted that species with progress in phenology with the rise in temperature will have better chances of survival. Such types of species represented maximum number of flowers, biomass production and vegetation cover. On the other hand, species which do not respond to climate variation faced hazard with short growth period as compared to active competitors (Cleland et al., 2012). As, such types of plant species not responding to temperature changes are facing a rapid decline in their abundance during the previous 150 years (Willis et al., 2008). Many ecologists reported the impact of topography, anthropogenic and climatic changes and possible causes upon various plant species (Khan et al., 2019a, b).

Ecologists should focus on durable and long lasting programming of existing natural resources to assess biodiversity of rich flora from unexplored regions by using multivariate analyses as comprising ordination techniques and hierarchical classification (Khan et al., 2019a, b). Moreover, the district Jhelum, Punjab, Pakistan was still unexplored, mainly relating to plant species indicating phenology and its patterns. As a result, the first ever comprehensive research was conducted to explore the unexplained aims which were

a. to explore the flowering response of angiosperms during the year in different seasons and monthly base
b. to discover the effect of climatic factors on phenological response of the plant species.

The current attempt will convey effective ecological knowledge to the researchers, range land managers, foresters, botanists and ecologists in future studies but also provide many valuable plant species grouping with the phonological response.

Materials and methods

Study area

District Jhelum from Pakistan is located towards North of the river Jhelum and bounded by district Rawalpindi in the North, Sargodha and Gujrat districts lies in the South, Azad Kashmir is situated East, and district Chakwal is located West (Mushtaq et al., 2011; Shah et al., 2013; Majeed et al., 2021). Total population of the district Jhelum is 1.223 million, 71% population lives in rural areas while the remaining 29% population lives in urban area (Altaf et al., 2018). The climatic condition showed that the district is semi-arid, warm subtropical region and is categorized by warm summer and severe winters. Jhelum is a semi-mountainous range, mean annual rainfall is 880 mm per annum while annually temperature in average is 23.6 °C. Jhelum river is compromise up to 247, 102 acres of main land of plains on the other hand 41,207 acres is covered by hills (*Figs. 1* and *2*). The second largest salt mine of the world (Khewra) is in Jhelum which covers an area of 2268 acres (Shah et al., 2013; Hamidov et al., 2016). People of district Jhelum have their diverse mode of life span, culture, traditions, beliefs and have been using indigenous plants for various purposes (Iqbal et al., 2011). The ethnic groups of the area showed a strong linkage with wild plants of cultural and medicinal significance (Majeed et al., 2020).

Floristic and phenological data collection

The research area was floristically explored 2018-2020 (3 years) to record plant species. The main focus was to record the phenological response to climatic changes with reference

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to season and monthly basis. The collected specimens of plant species were tagged with voucher number, pressed, fully dried and finally mounted on the International standard sized sheets of herbarium, following the identification by applying Flora of Pakistan (URL: http://www.efloras.org/) and cross matched with floristic literature (Qureshi et al., 2011; Ali and Nasir, 1989; Ali and Qaiser, 1995). Afterward the initial possible identification of specimens, presently established binomials of each plant species and the family names were copied from the plant list ver. 1.1 (URL: http://www.theplantlist.org/) (TPL, 2013), as proposed by (Khan et al., 2016), to evade any taxonomic mistakes and misperception linked to ordering and placement. Further information comprising local names (Cain and Castro, 1960), were also documented. Frequent field visits were conducted to note phenology and to collect the plant samples from study sites. To record phenological responses of plant species, 171 altitudinal transects (Grids 5×5 km^2) containing 513 samples and 1539 sub-plots were studied by applying stratified random vegetation sampling method. Sub-plots (quadrates) size was 10×10 m for tree layer, 5×5 m for shrub layer and 1×1 m for herbaceous layer (herbs and grasses). The completely prepared voucher specimens were placed in the herbarium of the Department of Botany, University of Gujrat, Punjab, Pakistan for future reference and record. Phenological response of each reported plant species was found out by using the given equation:

$$SFR\ (\%) = \frac{Species\ recored\ during\ floweing\ in\ a\ month}{Total\ plant\ species\ docomented\ in\ study\ area} \times 100$$

where: SFR is monthly-based species flowering phenological response. Likewise, the monthly-based response is used to determine the seasonal based flowering response for each plant species, and this classification include winter season (November to February), spring (March to April), summer (May to August), monsoon (July to September), and autumn season (September to October). While family importance value (FIV) was calculated with given equation:

$$FIV\ (\%) = \frac{Species\ belong\ to\ plant\ family}{total\ plant\ species\ reported\ in\ study\ area} \times 100$$

Climate data collection

In the study area, the climate conditions vary both in temporal and spatial scales. The climate data including environmental precipitation, maximum and minimum temperature, humidity, soil moisture, wind speed, and downward short and long wave radiations (2010-2019 = 10 years) of the study area (Jhelum) was developed from the United States National Centers for Environmental Prediction (US-NCEP), Climate Forecast System Reanalysis (CFSR) by applying climate engine, (https://app.climateengine.org/). The temperature data source was CFSv2 19200 m (1/5-deg) daily reanalysis dataset (NOAA) (*Table 2*).

Statistical analyses

The reported data of phenological response was put in Microsoft excel spreadsheet (plant species vs month-seasons), binary data matrix. Phenology of plant species was recorded monthly. Climatic and phenological data was calculated and linked to remote sensing data created with R statistical package (Ilyas et al., 2013), to produce pairwise correlation, distribution and scatterplots (Khan et al., 2015, 2018). Hierarchical clustering tree for months and seasons (Distance; Correlation, Linkage; Ward) was established and the

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package was named as “pvclust” with R statistical package (Team, 2014). CCA was applied by using Canoco software (Ter Braak and Šmilauer, 2012), to find out the impact of climatic factors to show variations in the data for binary response (Khan et al., 2018).

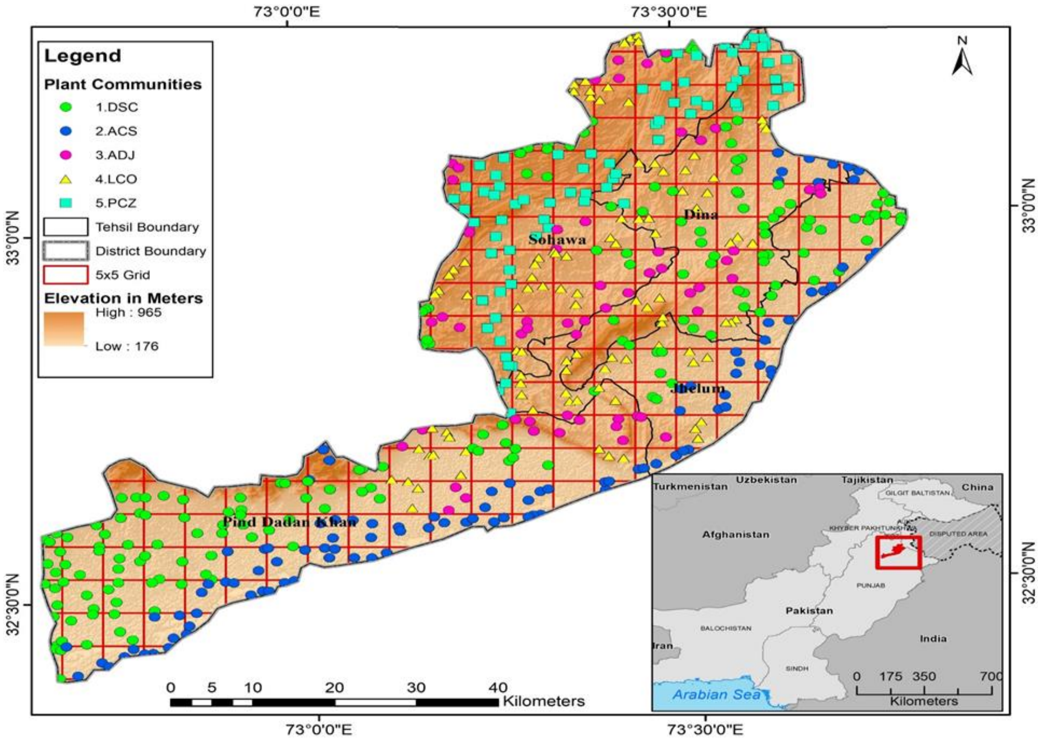

Figure 1. *Map of the study area representing the points of quadrates at different elevations in the district of Jhelum*

Figure. 2. *Landscape representing richness of flora of the study area (a) forest (b) first author identifying plant species (c) view of salt range (d) view of hilly vegetation*

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Results

The record of phenology period of each plant species is a fundamental and important element of such explorations. Reproductive phenological response is permanently interrelated to unique set of climatic variables of any area, thus, assessment of essential climatic factors are needed to lean any potential future climate variation influences.

Floristic classification

A total of 404 plant species were explored including vascular plants belonging to Angiosperms (402 species (99.5%)), Gymnosperms (1 species (0.45%)) and non-vascular Pteridophytes (1 species (1.33%)) including 223 genera and 75 families. Angiosperms were further classified as dicot including 328 species (81.19%), 177 (79.37%) genera and 63 families (84%) while monocot comprised of 74 species (18.32%), 44 (19.73%) genera and 10 families (13.33%) (*Table 1*). The leading plant family was Poaceae (59 spp., 14.6%), followed by Leguminosae (57 spp., 14.11%), Amaranthaceae (27 spp., 6.68%) and Solanaceae (19 spp., 4.7%) (*Fig. 3*), while the leading genus was *Euphorbia* (10 spp., 2.48%), followed by *Brassica* (7 spp., 1.783%), *Heliotropium*, *Acacia*, *Solanum* (6 spp., 1.49% each.) (*Fig. 4*).

Table 1. *Summary of floristic composition in Jhelum district, Punjab, Pakistan*

Phyto-Taxa	Families	Genera	Species
Pteridophytes	1 (1.33%)	1 (0.45%)	1 (0.25%)
Gymnosperms	1 (1.33%)	1 (0.45%)	1 (0.25%)
Angiosperms	73 (97.33%)	221 (99.1%)	402 (99.5%)
Monocots	10 (13.33%)	44 (19.73%)	74 (18.32%)
Dicots	63 (84%)	177 (79.37%)	328 (81.19%)
Total	75 (100%)	223 (100%)	404 (100%)

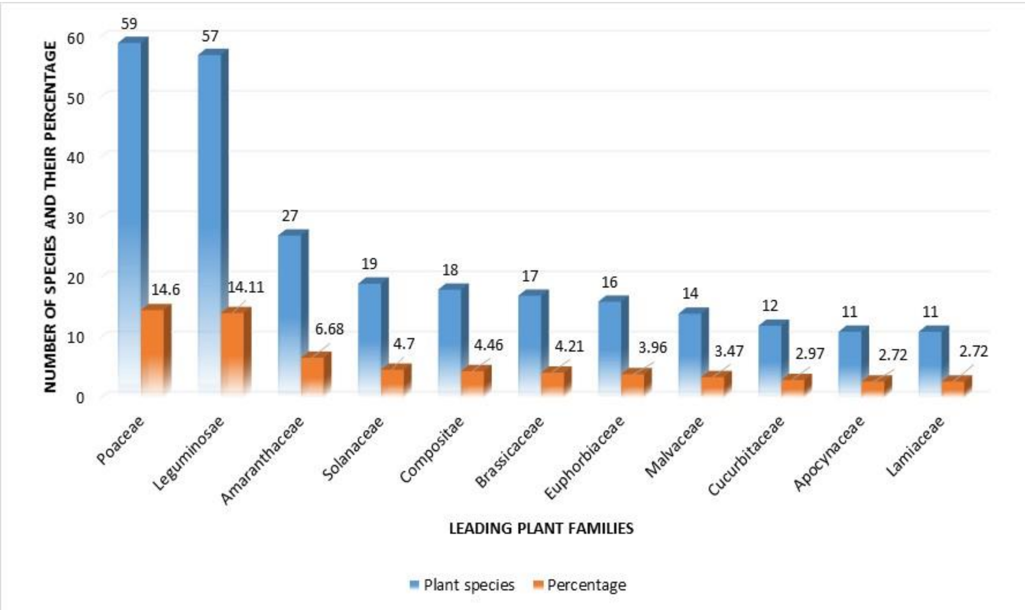

Figure 3. *Graph depicting the leading plant families in the study area*

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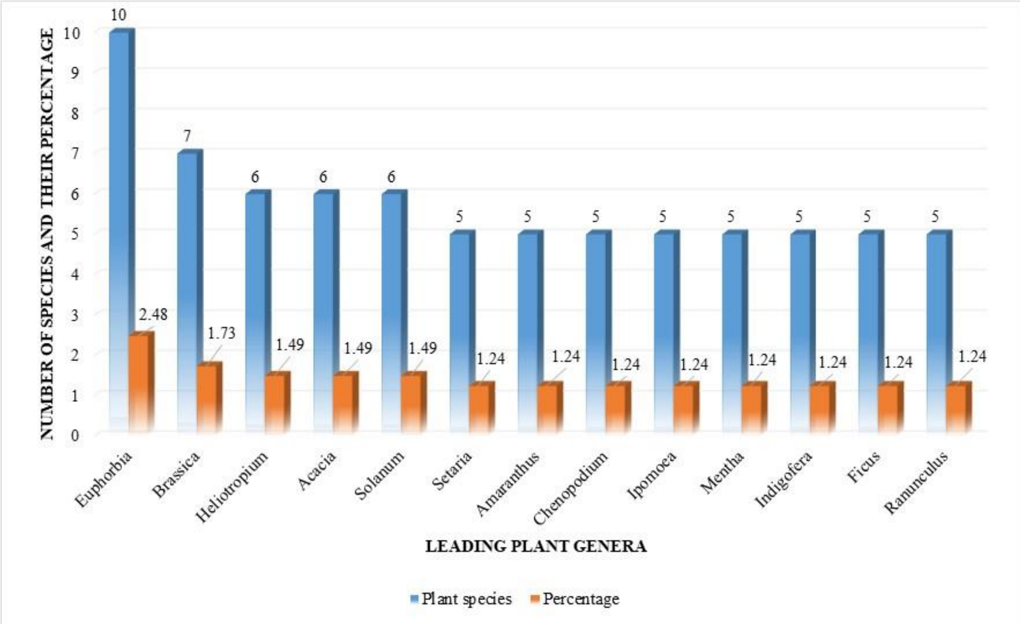

Figure 4. *Graph depicting the leading plant genera in the study area*

With respect to the diverse microhabitats, grassland showed the maximum number of 283 species (70.05% of overall flora), followed by 281 road side species (69.55%), 228 forest species (55.44%) and 223 arable land species (55.2%), rest of micro-habitat resulted waste places with 216 species (53.47%), hilly slope with 209 species (51.73%), shady places with 184 species (45.54%), graveyard with 174 species (43.07), wet land with 129 (31.93%), dry land with 122 species (30.2%), scrubland and home garden, both with 110 species (27.23%), sandy places with 92 species (22.77%) and mountain summits with 34 species (8.2%). An overall habit-wise arrangement of the documented plant species showed four groups. Maximum number of herbs involved 246 species (60.89%), followed by grasses with 59 species (14.6%), shrubs with 50 species (12.38%) and trees with 49 species (12.13%) (*Fig. 5*).

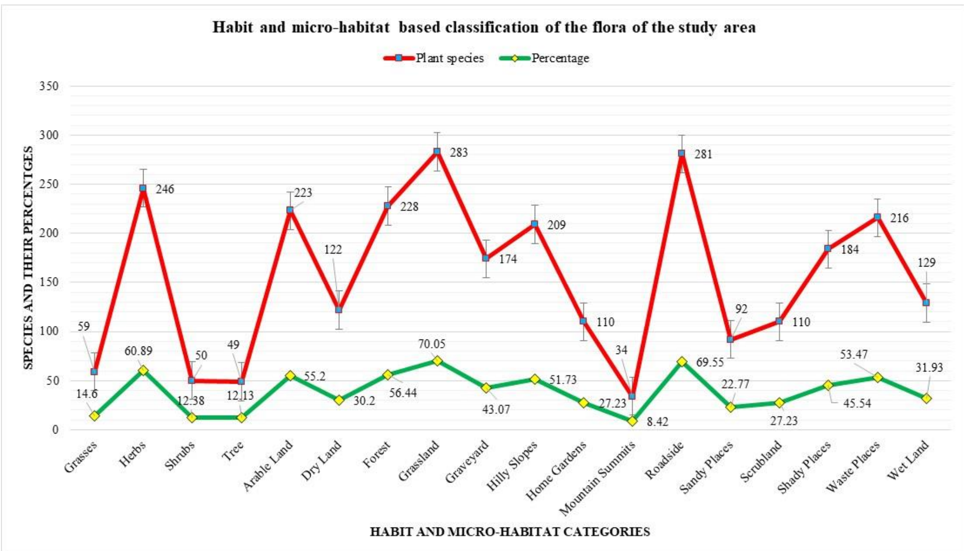

Figure 5. *A graph depicting the results of grouping of vascular plant species into different habitat and micro-habitat categories*

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Flowering phenology and classification

The reproductive phenological response recorded and showed that maximum flowering stage of plant species was during months of March, April and August (174 spp., 43.07%, 159 spp., 39.36% and 158 spp., 39.11%). The minimum phonological response was noted in the month of January and December (5 spp., 1.24%) and November (7 ssp., 1.73%) (*Fig. 6*).

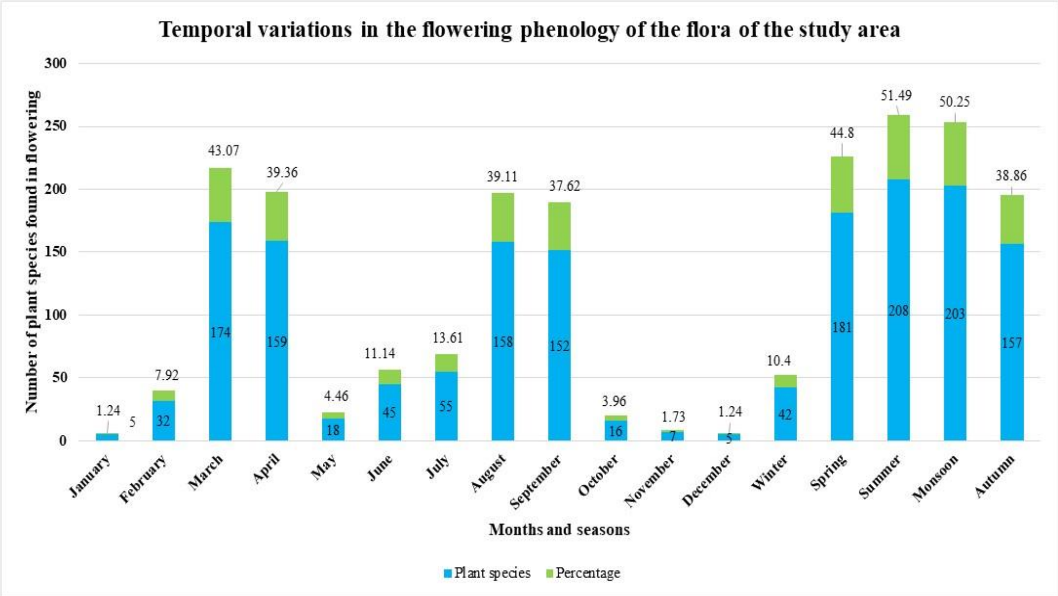

Figure 6. *Graphical representation of temporal variations in the flowering phenology of the vascular plant species*

The reproductive phenology response resulted that the majority of the plant species go through their reproductive phase during March, April, August and September months in a year, while, November to January is not a favored time to arrive into effective reproductive phonological phase due to ecological fluctuations. As far as the beginning time for species phenological response is depicted, most of the plant species started the flowering period in the months of February (32 spp., 7.92%), May (18 spp., 4.45%), June (45 spp., 11.14%) and July (55 spp., 13.61%). While, decline in flowering response with reduced number of plant species occurred in the month of October in 16 spp., 3.96%) (*Fig. 7*).

Leading reproductive phenological response results were shown in the summer by 208 species (51.49%) followed by Monsoon with 203 species (50.25%), during Spring with 181 species (44.8%) and Autumn with 157 species (38.86%). The least phenological response was recorded during Winter in 42 species (10.4%) (*Fig. 8*).

Ordination analysis

With reference to ordination analysis, detrended correspondence analysis (DCA), a unimodal unconstrained model (where as climatic factors were applied for supplementary variables) was designated to pursue the gradient length in the binary compositional phenological response data. The results of presented analysis represented that the gradient length in the response data was above 3 SD (standard deviation of species turnover) for

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the first two DCA axes. Moreover, the response data was binary (1/0), by concluding data on the basis of the given two observations, a constrained uni-modal ordination model such as CCA was used to find out the type variables in the phenological response data described by the recorded predictions, and sort of importance order.

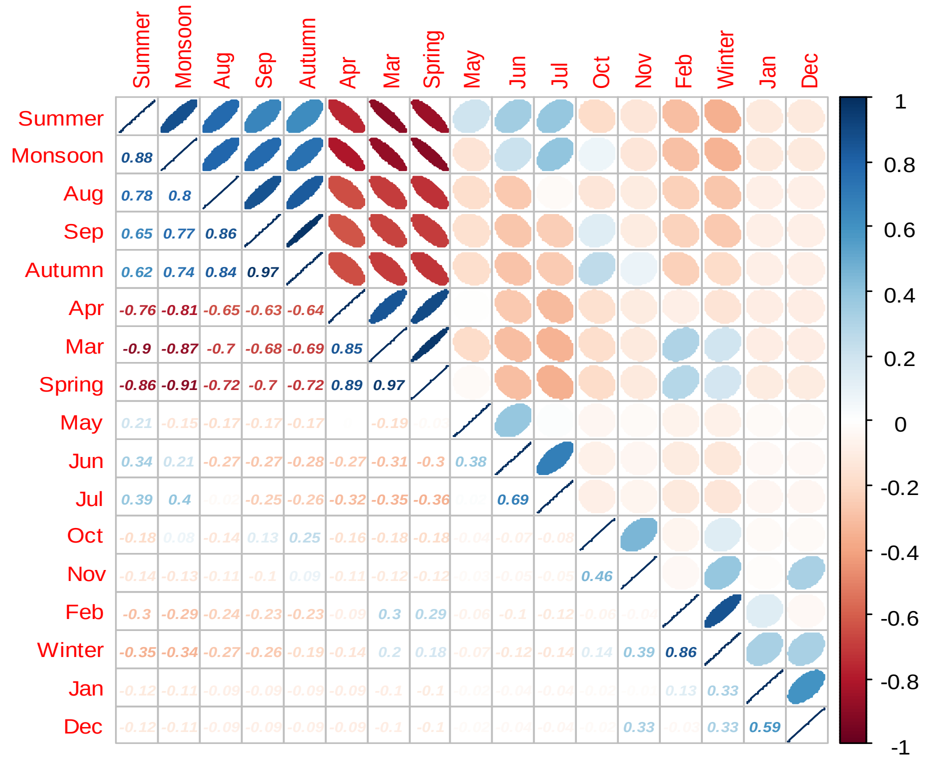

***Figure 7.** Correlation plot of months and seasons based on their flowering phenology response*

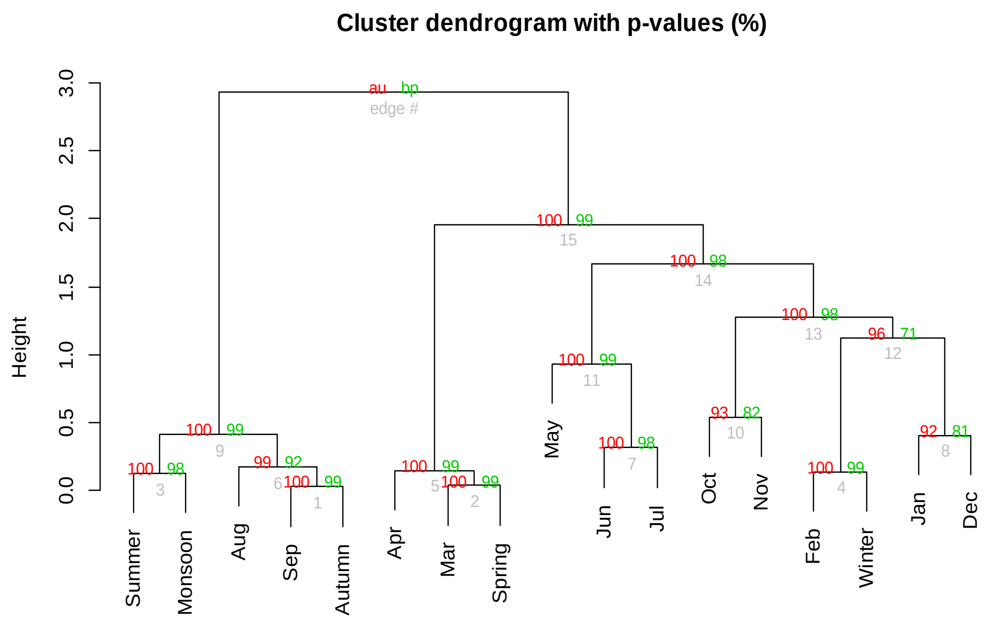

***Figure 8.** Hierarchical clustering tree of Months and seasons (Distance: Correlation, Linkage: Ward) with AU/BP% values based on their flowering phenology response*

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The results of Pearson's correlation and its significance showed that overall plant species found in flowering phenological phase in different months is strongly correlated (r > 0.8) with mean monthly values of five different climatic variables. These include mean soil moisture (r = 0.65), followed by precipitation variable that was found moderately positively correlated (r = 0.62), mean specific humidity (r = 0.60), long wave radiations (r = 0.52), shortwave radiations (r = 0.49), mean minimum temperature (r = 0.46), mean maximum temperature (r = 0.40), and similarly, a strong negative correlation was observed with wind speed (r = 0.36) in the study area (*Figs. 9* and *10*).

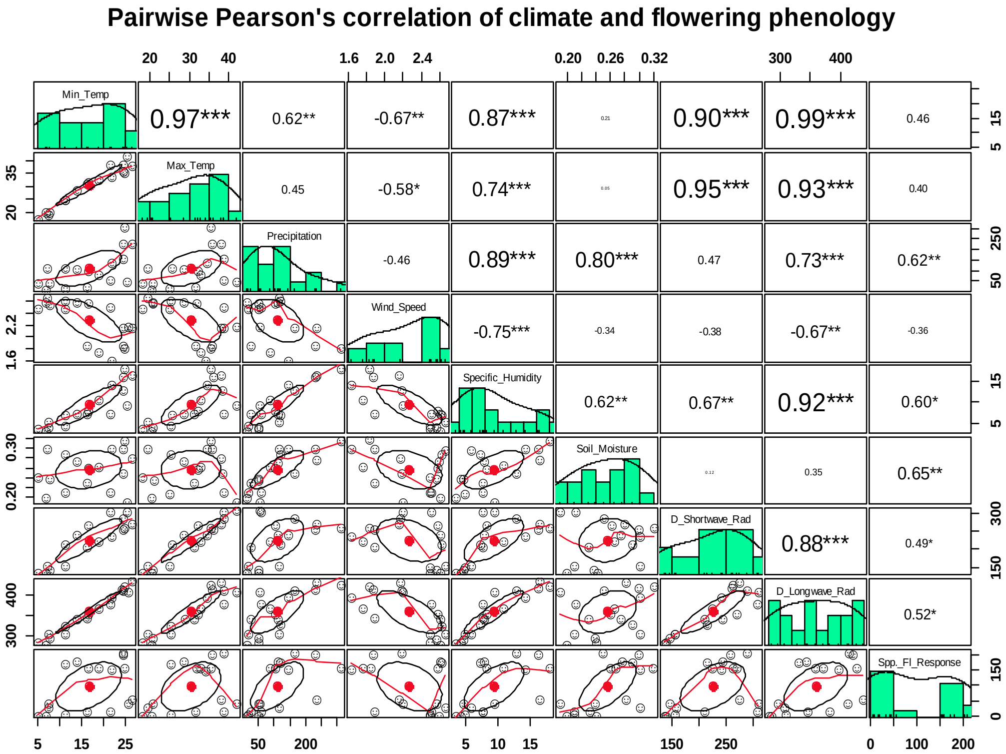

Figure 9. *Graph representing correlation significance. (The distribution of each variable is shown on the diagonal. On the bottom of the diagonal the bivariate scatter plots with a fitted line, and ellipses are presented, while on the top of the diagonal the value of the correlation plus the significance level as stars. Each significance level is linked to a symbol: p-values (0, 0.001, 0.01, 0.05, 0.1, 1) < = > symbols ("***", "**", "*", ".", " ")*

The results showed the interlink age of response (months and seasons) and descriptive (climatic) data. Multi-nonlinearity among climatic variations were determined on the observations within variables of inflation factor (VIFs) assessment of every climatic factors, and a threshold value of < 5 is designated to eliminate the extremely collinear descriptive variations. The ultimate CCA model was included of four types of predictions such as minimum temperature, wind speed, and soil moisture (25 cm below the soil surface) (*Fig. 11*). A total Variations of 3.45084 was noted in the reproductive phenology response data, about 58.85% variations were described by the descriptive variables, and the modified explained variations were 84.68%. The first two CCA axes cumulatively explained about 45.6% variations (*Table 2*). A significantly higher pseudo-canonical correlation (r > 0.8) value was recorded for the first three CCA axes which show that the

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nominated predictions were significant factors, and there is no single significant climatic gradient relatively all the four were significant in one way or another (*Table 3*).

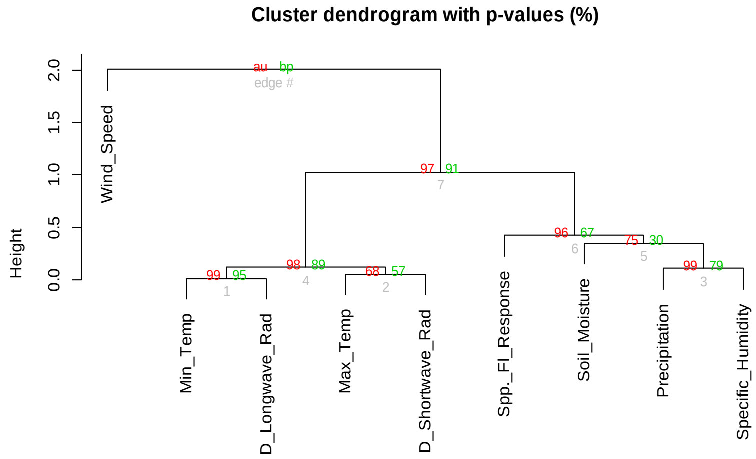

Figure 10. *Hierarchical clustering tree of climate and species flowering response variables (Distance: Correlation, Linkage: Ward) with AU/BP% values (n = 17)*

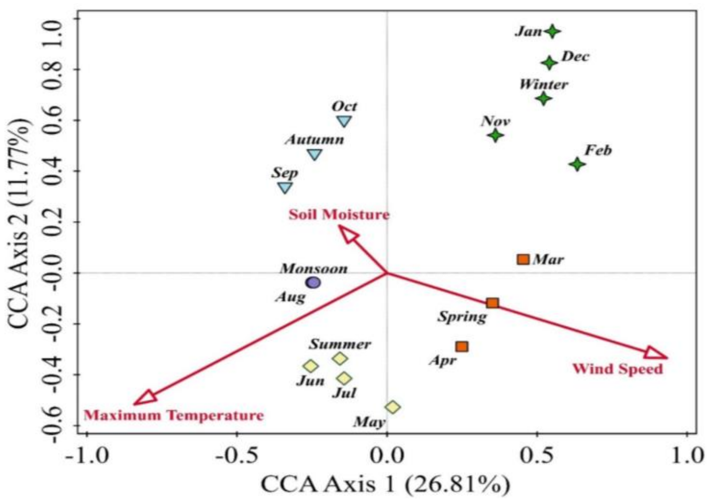

Figure 11. *Canonical correspondence analysis biplot depicting the interrelationships of climate and flowering phenological samples (months and seasons) in the study area*

Table 2. *CCA summary table*

Statistic	Axis 1	Axis 2
Eigenvalues	0.9252	0.406
Explained variation (cumulative)	26.81	38.58
Pseudo-canonical correlation	0.9797	0.8384
Explained fitted variation (cumulative)	58.85	84.68
Total variations	3.45084	
Sum of canonical eigenvalues	1.57358304	
Explained variation %	45.6	
Unexplained variation %	54.4	

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Table 3. *Canonical correspondence analysis numerical results showing the order of importance of studied climatic variables (p-values were corrected by using False Discovery Rate method)*

1. Simple term effects:				
Variable	**Explains %**	**pseudo-F**	**P**	**P(adj)**
Wind speed (M/Sec)	24.7	4.9	0.002	0.0032
Min. temperature °C	24.3	4.8	0.002	0.0032
Downward long wave radiation (W/M^2)	23.4	4.6	0.002	0.0032
Max. temperature °C	22.3	4.3	0.002	0.0032
Specific humidity (g/kg)	21.2	4	0.002	0.0032
Downward shortwave radiation (W/M^2)	15.7	2.8	0.004	0.00533
Precipitation (mm)	10.2	1.7	0.056	0.064
Soil moisture (5 cm; in fraction)	7.6	1.2	0.234	0.234
2. Conditional term effects:				
Wind speed (M/Sec)	24.7	4.9	0.002	0.003
Max. temperature °C	13.3	3	0.002	0.003
Soil moisture (5 cm; in fraction)	7.5	1.8	0.045	0.05

Discussion

Floristic classification and its importance

The study area District Jhelum, Punjab, Pakistan contains hills, Jhelum river flows through it, mostly forest cover, scrub lands, range lands and little part of salt range. The area is unique due to versatile geography, variable ecology and rich soil composition. It was observed that the district contains maximum vegetation cover, species richness and floristic diversity. The conducted study aimed to document the floristic composition of the study area along with diverse features counting flowering phenology and reproductive phenological response of the vascular and non-vascular plant species with respect to basic climatic variables.

In the study area, a total of 401 vascular and 1 non-vascular plant species were recorded. The obtained results of family importance value showed that the leading plant family was Poaceae with 59 species followed by Leguminosae (57 spp.), Amaranthaceae (27 spp.) and Solanaceae (19 sp.) while the leading genus was *Euphorbia* (10 spp.,) followed by *Brassica* (7 spp.), and *Heliotropium*, *Acacia*, and *Solanum* (6 spp. each). The conducted study was similar to the floristic composition of Muzaffarabad district, Azad Jammu and Kashmir, Pakistan published by Khan et al., 2015, who explored that the leading plant family was Compositae (69 spp.), followed by Poaceae (57 spp.), Leguminosae (54 spp.), Lamiaceae (42 spp.) and Rosaceae (29 spp.); whereas the prominent genus was Euphorbia (10 spp.), followed by Cyperus, Ficus, Geranium and Prunus (7 spp. each). Identical discoveries with floristic composition of Qalagai hills, Kabal valley Swat directed by Ilyas et al., 2013, the Poaceae (22 spp.) was the leading plant family followed by Compositae (16 spp.) and Lamiaceae (14 spp.). In the parallel style Shaheen et al., 2015 quantified 65 plant species of 26 families from western Himalayan subtropical forest stands of Kashmir in which Poaceae (8 spp.) was the prominent family followed by Compositae (6 spp.) and Lamiaceae (2 spp.) was typically equivalent to the presented discoveries. Comparable outcomes from Shahbaz Garhi, district Mardan, Pakistan by Khan et al., 2014, showed Poaceae (15 pp.) as the prominent

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family followed by Compositae (14 spp.). The identical survey was documented from district Bagh of Azad Jammu and Kasmir by Tanvir et al., 2014 and reported Poaceae (42 spp.) as the leading plant family followed by Compositae (11 spp.). Khan et al., 2015 recorded Poaceae (54 spp.) as the leading family followed by Compositae (33 app.) and Lamiaceae (23 spp.), and closely match with this study. Khan et al., 2017 described same findings that Poaceae was the prominent family comprised of 20 species followed by Lamiaceae (16 spp.) and Compositae (14 spp.), from Swat Ranizai, district Malakand, Khyber Pakhtunkhwa, Pakistan. Poaceae and Compositae are leading due to widespread ecological amplitude with diverse habitats (Ibrahim et al., 2019).

Traditional uses of 149 species belonging to 60 genera and 16 tribes of 5 sub families of Poaceae were recorded by Majeed et al., 2020, from Punjab Province, Pakistan. Hussain, 2009 documented 120 plant species belonging to 46 families, and detected Poaceae as the leading family with 14 plant species also match with this study. Similar results were presented by Shaheen et al., 2014, from Santh Saroola Kotli Sattian, Rawalpindi, Pakistan, who recorded 106 species, Poaceae family was dominant with 21 spp., followed by Asteraceae (19 spp.), Fabaceae (15 spp.), Euphorbiaceae, Lamiaceae (7 spp., each). Umair et al., 2019 recorded similar results, as 129 plant species belonging to 59 families were examined and Poaceae with 13 plants species was the leading family, from Chenab riverine area, Punjab province Pakistan. Amjad et al., 2016 presented similar results from Nikyal valley, Azad Jammu and Kashmir, Pakistan, who recorded 110 species belonging to 51 families and 98 genera. Poaceae (18 spp.) was the leading family followed by Asteraceae (10 spp.), Lamiaceae (8 spp.) and Fabaceae (7 spp.). Zahoor et al., 2017 investigated 96 plants belonging to 34 families from district Sheikhupura, province Punjab, Pakistan and Poaceae was the dominant family with 16 spp. followed by Fabaceae 15 spp. results were similar to the present study. Plant species of the Poaceae family are not only used as fodder and forage but also contribute substantially to the treatment of various health disorders, particularly in livestock (Majeed et al., 2020).

Climatic determinants of flowering phenology

The flowering response results indicated that majority of plant species flowered during the months of March (43.07%), followed by April (39.36%) and August (39.11%). The minimum phenological response was noted in the month of January (1.24%), December (1.24%) and November (1.73%).

The timing of flowering response as presented above was found highly correlated with the climatic variations (like temperature and monsoon rainfall) of the study area. A constrained unimodal ordination such as CCA was applied to check three predictors including minimum temperature, humidity, and soil moisture (25 cm below the soil surface).

According to the results of conditional (unique) term effect testing, mean maximum temperature was shown as a significant factor of the phenological response followed by soil moisture and wind speed. The majority of plant species are found in flowering stage during July and August months in the Western Himalayan regions of India and Pakistan (Vashistha et al., 2009; Khan et al., 2018), and strikingly match with our findings.

Likewise, the importance of temperature to the plants phenological responses, our results are similar as stated in several explorations (Badeck et al., 2004; Ahas and Aasa, 2006; Estrella and Menzel, 2006; Peñuelas et al., 2009) mostly in higher altitudinal areas of the World.

Minimum temperature was recorded as significant as maximum temperature in the research area similar to Khan et al., 2018. Furthermore, rainfall was discovered as another main element of the phenological response (Pearson, 2019), the similar influence of rainfall on both spring and fall flowering events was reported from Southeastern United State of America. Our results match with Heydel et al., 2015; and Khan et al., 2018, that is maximum flowering species were recorded during four months (March, April, august, September) due to favorable climatic conditions. Whereas minimum flowering species were documented during three months (January, November and December) due to severe climatic conditions. Many explorations showed that in hilly areas, maximum flowering species were noted due to optimum climatic variables to support the phenomenon (Yadav and Yadav, 2008; Tooke, 2010). So it was assessed that months of May, June and July are appropriate regarding day length and temperature. The highest phenological response of plant species during months of March, April, August and September which can also be linked with maximum rainfall in these months (Summer and monsoon seasons) resulting in higher soil moisture. While, rare plant species were also found in flowering stage in November to January (in winters) due to severity in environmental conditions during mentioned months. Climatic variations might be harmful in general but mainly useful to rare and widespread plant species of this versatile, unique but delicate ecosystem of Jhelum district, Punjab, Pakistan.

Conclusions and recommendations

The research area district Jhelum resulted higher degree of plant species richness features of mostly diverse and rich flora in Punjab, Pakistan. The leading plant family was Poaceae followed by Leguminosae, Amaranthaceae, Solanaceae while the leading genus was *Euphorbia* followed by *Brassica*, *Heliotropium*, *Acacia*, *Solanum*, which proposed that the research area is under heavy anthropogenic pressure and harbors unique climatic environments. As concerned with the reproductive phenological response of the plant species, minimum temperature, wind speed, precipitation and specific humidity are the significant climatic determinants. The study resulted that the temperature is the leading effective feature observing the phenology of the plant species. It was estimated that increase or decrease in temperature showed specific association with pattern of phenology. Response of phenology also showed month and season wise correlation. Suddenly increase in temperature might be dangerous mainly to threatened and widespread flora of the area. The study area needs active supervision and protection strategies done with the participation of the indigenous population. The floristic study and phenology of plant species was explored for the first time. Consequently, the current research serves valuable information in future botanical investigation, and for plant reserve managing and preservation effort in the area. Future research studies should be linked to measurement of continuing climate variations. Under changing climatic conditions, the spread of invasive alien plant species is needed to be controlled to save the ecological niche of indigenous wild flora in the area.

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Conflict of interests. The authors declare that they have no conflict of interests.

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APPENDIX

Table A1. *Temporal (2010-2019) variations in the climatic data (Mean ± SD (Min-Max)) of district Jhelum, Punjab, Pakistan*

Months	Min Temp	Max Temp	Precipitation	Wind speed	Specific humidity	Soil moisture	D-Shortwave-Rad	D-Longwave-Rad
January (2010-2019)	5.24±0.81 (3.98-6.53)	18±1.75 (15.81-21.37)	47.74±54.85 (0.4-178.23)	2.49±0.17 (2.29-2.74)	4.07±0.91 (2.59-5.59)	0.24±0.04 (0.17-0.28)	137.35±17.72 (102.79-156.34)	285.19±10.4 (273.15-305.42)
February (2010-2019)	7.32±1.15 (5.24-8.64)	19.3±2.44 (16.42-23.18)	113.9±72.6 (9.08-239.44)	2.66±0.18 (2.44-2.94)	5.83±0.81 (4.75-6.81)	0.3±0.04 (0.24-0.35)	156.06±20.95 (125.65-195.67)	306.07±8.92 (292.52-317.13)
March (2010-2019)	11.36±1.31 (9.96-13.92)	25.3±2.86 (21.53-30.59)	117.59±98.66 (12.1-283.46)	2.62±0.16 (2.39-2.87)	7.2±1.13 (4.92-8.39)	0.29±0.06 (0.2-0.37)	215.35±19.93 (176.04-238.07)	328.84±7.66 (316.34-342.61)
April (2010-2019)	16.49±1.03 (15.04-18.46)	31.99±2.7 (28.93-37.35)	104.04±55.51 (19.16-177.93)	2.58±0.31 (2.34-3.25)	8.21±1.2 (6.72-10.46)	0.26±0.05 (0.16-0.33)	268.88±16.83 (228.62-288.59)	357.86±5.73 (351.28-365.76)
May (2010-2019)	21.48±0.87 (20.15-22.7)	38.79±1.74 (35.16-40.95)	56.02±40.76 (5.83-133.89)	2.51±0.26 (2.14-2.99)	7.59±1.13 (5.96-9.72)	0.21±0.04 (0.16-0.27)	307.76±10.62 (287.96-318.56)	381.49±7.98 (371.25-393.43)
June (2010-2019)	25.49±0.89 (24.24-27.23)	42.06±1.44 (39.4-44.29)	51.78±49.11 (3.66-155.66)	2.19±0.12 (2.05-2.38)	9.38±2.08 (5.88-12.33)	0.19±0.03 (0.15-0.23)	308.9±10.75 (290.16-325.21)	411.44±9.36 (395.77-427.8)
July (2010-2019)	26.53±0.73 (25.73-27.7)	38.17±2.01 (35.78-41.92)	233.75±131.86 (66.36-483.97)	2.16±0.19 (1.9-2.45)	16.48±1.63 (14.26-19.35)	0.28±0.04 (0.23-0.34)	273.07±10.52 (254.7-296.1)	436.86±3.65 (430.46-444.15)
August (2010-2019)	24.82±0.59 (23.95-25.84)	35.46±2.3 (31.81-39.51)	310.41±198 (57.49-741.27)	1.83±0.17 (1.67-2.15)	18.04±1.76 (14.5-19.96)	0.32±0.05 (0.23-0.39)	261.09±13.48 (229.54-281.76)	427.21±4.01 (420.36-434.18)
September (2010-2019)	21.76±0.75 (20.76-23.29)	34.28±2.27 (31.27-37.65)	144.67±128.34 (35.44-413.59)	1.63±0.16 (1.37-1.84)	14.17±2.32 (9.66-16.62)	0.3±0.06 (0.22-0.36)	240.94±12.69 (214.93-256.23)	397.08±8.21 (384.37-411.53)
October (2010-2019)	16.28±0.67 (15.41-17.55)	31.32±2.14 (28.54-34.8)	26.71±22.77 (0.03-58.86)	1.88±0.15 (1.66-2.07)	7.58±1.98 (4.76-11)	0.23±0.06 (0.15-0.3)	208.42±6.36 (199.84-217.49)	345.61±6.99 (336.76-358.26)
November (2010-2019)	11.26±0.52 (10.46-12)	25.01±2.14 (20.85-28.08)	17.43±25.19 (0.05-82.33)	2.49±0.21 (2.18-2.86)	4.68±1.08 (3.06-6.75)	0.21±0.06 (0.15-0.31)	154.49±13.02 (122.82-167.86)	307.63±7.75 (296.51-323.29)
December (2010-2019)	6.79±0.99 (5.65-8.63)	20.34±2.06 (16.7-24.55)	13.85±16.82 (0.01-48.49)	2.6±0.24 (2.28-2.93)	3.4±0.89 (2.08-4.89)	0.2±0.05 (0.14-0.31)	135.96±6.53 (121.15-144.45)	280.97±6.64 (268.85-290.74)

Source: The climate data about precipitation, maximum and minimum temperature, specific humidity, soil moisture, wind speed, and downward short and longwave radiations (2010-2019 = 10 years) of the study area (Jhelum) was acquired from United States National Centers for Environmental Prediction (US-NCEP) Climate Forecast System Reanalysis (CFSR) by using climate engine (https://app.climateengine.org/). The data source was CFSv2 19200 m (1/5-deg) daily reanalysis dataset (NOAA)

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Table A2. *Detailed attributes of the floristic elements of Jhelum district, Punjab, Pakistan*

Family	No.	Species	V/No.	Local name	Habit*	Micro-habitats**	Phenology
		Pteridophytes and their related species					
1. Pteridaceae	1	*Adiantum capillus-veneris* L.	621/MM//2020	Sarhaj	H	WL	August-September
		Gymnosperms					
2. Ephedraceae	2	*Ephedra ciliata* Fisch. & C.A.Mey.	880/MM//2020	Phog	S	DL,FO,GR,HS,RS,SP,SL,WP	March-April
		Angiosperms (Monocots)					
3. Araceae	3	*Colocasia esculenta* (L.) Schott	897/MM//2020	Arvi	H	AL,HG	June-July
	4	*Pistia stratiotes* L.	515/MM//2020	Water Cabbage	H	WL	March-April
4. Arecaceae	5	*Phoenix dactylifera* L.	501/MM//2020	Khajoor	T	AL,DL,GL,RS	February-March
5. Asparagaceae	6	*Agave americana* L.	675/MM//2020	Desi kwargandal	S	AL,DL,FO,GL,GR,RS,SP,WP	August-September
6. Cannaceae	7	*Canna indica* L.	867/MM//2020	Ratta phool	H	HG	March-April
7. Commelinaceae	8	*Commelina benghalensis* L.	795/MM//2020	Kani	H	FO,GL,HS,RS,SL,SH,WP,WL	March-April
8. Cyperaceae	9	*Cyperus difformis* L.	776/MM//2020	Chota dheela	H	AL,FO,GL,GR,HS,RS,SL,SH,WP,WL	August-September
	10	*Cyperus iria* L.	573/MM//2020	Murak ghaa	H	AL,FO,GL,GR,HS,RS,SP,SL,SH,WP,WL	August-September
	11	*Cyperus niveus* Retz.	815/MM//2020	Chita dheela	H	AL,FO,GL,GR,HS,RS,SL,SH,WP,WL	August-September
	12	*Cyperus rotundus* L.	663/MM//2020	Murak	H	AL,FO,GL,HS,RS,SL,SH,WP,WL	August-September
9. Juncaceae	13	*Juncus articulatus* L.	546/MM//2020	Dheela	H	FO,GL,HS,WP,WL	August-September
10. Poaceae	14	*Apluda mutica* L.	668/MM//2020	Tachuli	G	AL,DL,FO,GL,GR,RS,SP,WP	August-September
	15	*Aristida abnormis* Chiov.	810/MM//2020	Bara Lumb	G	DL,GL,SP,SH,WP	August-September
	16	*Aristida adscensionis* L.	608/MM//2020	Chitta Lumb	G	DL,GL,SP,SH,WP	August-September
	17	*Aristida mutabilis* Trin. & Rupr.	562/MM//2020	Lumb	G	DL,GL,GR,SP,SH,WP	August-September
	18	*Arundo donax* L.	875/MM//2020	Naru ghaa	G	GL,RS,WP	August-September
	19	*Avena fatua* L.	653/MM//2020	Jai	G	AL,DL,GL,RS,SP,WP	March-April
	20	*Bothriochloa bladhii* (Retz.) S.T.Blake	696/MM//2020	Palwan ghaa	G	AL,GL,HS,RS,SH,WP,WL	August-September
	21	*Brachiaria deflexa* (Schumach.) C.E.Hubb. ex Robyns	632/MM//2020	Moti ghaa	G	AL,GL,HG,RS,SH,WP,WL	August-September
	22	*Brachiaria distachya* (L.) Stapf	622/MM//2020	Seer ghaa	G	AL,GL,HS,RS,SH,WP,WL	August-September
	23	*Brachiaria ramosa* (L.) Stapf	820/MM//2020	Chota kmadi	G	AL,FO,GL,GR,HS,RS,SH,WP,WL	August-September
	24	*Brachiaria reptans* (L.) C.A.Gardner & C.E.Hubb.	654/MM//2020	Para ghaa	G	AL,FO,GL,GR,RS,SH,WP,WL	August-September
	25	*Cenchrus biflorus* Roxb.	692/MM//2020	Chita Dhaman	G	AL,DL,FO,GL,GR,RS,SP,WP	August-September
	26	*Cenchrus ciliaris* L.	734/MM//2020	Kala Dhaman	G	DL,FO,GL,RS,SP,WP	August-September
	27	*Cenchrus pennisetiformis* Steud.	870/MM//2020	Kali Dhamani	G	DL,FO,GL,GR,RS,SP	August-September

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	28	*Cenchrus setiger* Vahl	704/MM//2020	Kala Dhamani	G	DL,FO,GL,RS,SP,WP	August-September
	29	*Chrysopogon serrulatus* Trin.	586/MM//2020	Jangli jai	G	DL,FO,GL,RS,SP,WP	August-September
	30	*Chrysopogon aucheri* (Boiss.) Stapf	528/MM//2020	Chitta Dhaman	G	DL,FO,GL,HS,RS,SP,WP	August-September
	31	*Cymbopogon jwarancusa* (Jones) Schult.	839/MM//2020	Lamb ghaa	G	DL,GR,RS,SP,WP	August-September
	32	*Cynodon dactylon* (L.) Pers.	660/MM//2020	Khabbal ghaa	G	AL,DL,FO,GL,GR,HS,HG,MS,RS,SP,SL,SH,WP, WL	August-September
	33	*Dactyloctenium aegyptium* (L.) Willd.	559/MM//2020	Khar Madana	G	AL,DL,GL,GR,RS,SP,SL,SH,WP,WL	August-September
	34	*Desmostachya bipinnata* (L.) Stapf	735/MM//2020	Khusa Dab	G	DL,GL,GR,SP,WP	August-September
	35	*Dichanthium annulatum* (Forssk.) Stapf	845/MM//2020	Murgha ghaa	G	AL,FO,GL,GR,HS,HG,RS,SL,SH,WP,WL	August-September
	36	*Digitaria nodosa* Parl.	661/MM//2020	Chota ghaa	G	AL,FO,GL,HS,HG,RS,SH,WP,WL	August-September
	37	*Digitaria sanguinalis* (L.) Scop.	538/MM//2020	Toota ghaa	G	AL,FO,GL,RS,SL,SH,WP,WL	August-September
	38	*Echinochloa colona* (L.) Link	614/MM//2020	Jungli chawly	G	AL,FO,GL,HS,HG,RS,SL,SH,WP,WL	August-September
	39	*Echinochloa crus-galli* (L.) P.Beauv.	731/MM//2020	Sanwari	G	AL,FO,GL,GR,HS,HG,RS,SL,SH,WP,WL	August-September
	40	*Echinochloa stagnina* (Retz.) P.Beauv.	671/MM//2020	Chawly ghaa	G	FO,GL,HS,RS,SH,WP,WL	August-September
	41	*Eleusine indica* (L.) Gaertn.	822/MM//2020	Nika mdhana	G	AL,FO,GL,HS,RS,SH,WP,WL	August-September
	42	*Eragrostis cilianensis* (All.) Janch.	889/MM//2020	Chitti pholi ghaa	G	FO,GL,HS,RS,SL,SH,WP,WL	August-September
	43	*Eragrostis ciliaris* (L.) R.Br.	789/MM//2020	Makni ghaa	G	AL,FO,GL,HS,SL,SH,WP,WL	August-September
	44	*Hordeum vulgare* L.	858/MM//2020	Jao	G	AL,DL,RS	February-March
	45	*Imperata cylindrica* (L.) Raeusch.	775/MM//2020	Baggi sari	G	WL	August-September
	46	*Ochthochloa compressa* (Forssk.) Hilu	529/MM//2020	Tara ghaa	G	DL,HS,RS,SP	August-September
	47	*Oryza sativa* L.	804/MM//2020	Monji, Chawal	G	AL,WL	September-October
	48	*Panicum antidotale* Retz.	508/MM//2020	Bara chawala	G	HS,RS,WL	August-September
	49	*Panicum maximum* Jacq.	524/MM//2020	Bansi ghaa	G	GL,RS,SL,WP,WL	August-September
	50	*Panicum repens* L.	771/MM//2020	Moti khabal	G	AL,GL,GR,HS,RS,WP,WL	August-September
	51	*Panicum turgidum* Forssk.	807/MM//2020	Garam	G	DL,GL	August-September
	52	*Pennisetum divisum* (Forssk. ex J.F.Gmel.) Henrard	637/MM//2020	Desi Garam	G	DL,GL	August-September
	53	*Pennisetum orientale* Rich.	541/MM//2020	Chita ghaa	G	AL,GL,HS,RS,WL	August-September
	54	*Pennisetum glaucum* (L.) R.Br.	852/MM//2020	Bajra	G	AL,DL	June-July
	55	*Phalaris minor* Retz.	784/MM//2020	Dumbi sitti	G	AL,GL,RS,WP,WL	March-April
	56	*Phragmites karka* (Retz.) Trin. ex Steud.	540/MM//2020	Narru	G	RS,WL	August-September
	57	*Poa annua* L.	652/MM//2020	Jangli Jai	G	AL,HS,RS,WP,WL	March-April
	58	*Poa pratensis* L.	557/MM//2020	Sanwak	G	AL,GL,HS,WP,WL	August-September
	59	*Polypogon fugax* Nees ex Steud.	895/MM//2020	Daddi ghaa	G	AL,GL,GR,HS,RS,SH,WP,WL	August-September

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	60	*Saccharum bengalense* Retz.	582/MM//2020	Kana, Sarkanda	G	FO,GL,GR,HS,RS,SP,SL,WP,WL	August-September
	61	*Saccharum spontaneum* L.	626/MM//2020	Kana	G	DL,FO,GL,GR,HS,RS,SP,SL,WP,WL	August-September
	62	*Saccharum officinarum* L.	558/MM//2020	Ganna phool	G	AL,WL	October-November
	63	*Setaria intermedia* Roem. & Schult.	710/MM//2020	Choti Chawly	G	AL,HS,RS,SH,WP,WL	August-September
	64	*Setaria italica* (L.) P.Beauv.	824/MM//2020	Kangni ghaa	G	AL,GL,GR,WP,WL	August-September
	65	*Setaria pumila* (Poir.) Roem. & Schult.	651/MM//2020	Ban kangni	G	AL,FO,GL,RS,WL	August-September
	66	*Setaria verticillata* (L.) P.Beauv.	898/MM//2020	Bajra ghaa	G	AL,DL,GL,GR,RS,SH,WP,WL	August-September
	67	*Setaria viridis* (L.) P.Beauv.	854/MM//2020	Lumba Kangni ghaa	G	AL,DL,GL,GR,RS,WP,WL	August-September
	68	*Sorghum bicolor* (L.) Moench	601/MM//2020	Jowar, milo	G	AL,GL,RS,WP,WL	June-July
	69	*Sorghum halepense* (L.) Pers.	548/MM//2020	Kmadi ghaa, Baru	G	AL,GL,HS,RS,WL	August-September
	70	*Stipagrostis plumosa* Munro ex T.Anderson	657/MM//2020	Bhalu ghaa	G	AL,GL,HS,WP,WL	August-September
	71	*Triticum aestivum* L.	876/MM//2020	Kanak, Gandum	G	AL,HS,SP	February-March
	72	*Zea mays* L.	803/MM//2020	Makai	G	AL,GL,HS,RS,WL	June-July
11. Typhaceae	73	*Typha domingensis* Pers.	506/MM//2020	Konder	H	WL	October-November
	74	*Typha elephantina* Roxb.	884/MM//2020	Kondar	H	WL	August-September
12. Xanthorrhoeaceae	75	*Aloe vera* (L.) Burm.f.	894/MM//2020	Kawar gandal	H	AL,DL,FO,GR,HG	August-September
	76	*Asphodelus tenuifolius* Cav.	585/MM//2020	Piazi	H	AL,FO,GL,GR,HS,RS,SP,SL,SH,WP,WL	February-March
Angiosperms (Dicots)							
13. Acanthaceae	77	*Dicliptera bupleuroides* Nees	881/MM//2020	Rewari	H	AL,DL,FO,GL,GR,RS,SH,WP	March-April
	78	*Dicliptera verticillata* (Forssk.) C.Chr.	590/MM//2020	Jamni booti	H	DL,FO,GR,HS,RS,SP,SL,SH,WP	February-April
	79	*Justicia adhatoda* L.	574/MM//2020	Baikr	S	DL,FO,GL,GR,HS,MS,RS,SL	February-March
14. Aizoaceae	80	*Trianthema portulacastrum* L.	525/MM//2020	Jangli Sanwak	H	AL,DL,FO,GL,HS,RS,SH,WP,WL	June-July
	81	*Trianthema triquetra* Rottler & Willd.	570/MM//2020	Choti alwati	H	DL,FO,GL,GR,HS,MS,SP,SL,WP	June-July
	82	*Zaleya pentandra* (L.) C.Jeffrey	715/MM//2020	Ratti Hazar dani	H	AL,FO,GL,GR,RS,SL,SH,WL	August-September
15. Amaranthaceae	83	*Achyranthes aspera* L.	802/MM//2020	Puth kanda	H	AL,DL,FO,GL,GR,RS,WP,WL	August-September
	84	*Achyranthes bidentata* Blume	512/MM//2020	Puth kanda	H	AL,DL,FO,GL,GR,RS	August-September
	85	*Aerva javanica* (Burm.f.) Juss. ex Schult.	544/MM//2020	Niki boi	H	DL,FO,GR,HS,SP,SL,WP	February-April
	86	*Aerva lanata* (L.) Juss.	688/MM//2020	Boi	H	DL,FO,GR,HS,SP,SL,WP	May-July
	87	*Alternanthera paronychioides* A.St.-Hil.	724/MM//2020	Chitti pholi	H	DL,FO,GR,HS,MS,SP	August-September
	88	*Alternanthera pungens* Kunth	706/MM//2020	Khaki, Bhakrra	H	FO,GL,HS,RS,SL,SH,WP	March-April
	89	*Alternanthera sessilis* (L.) R.Br. ex DC.	509/MM//2020	Poni booti	H	FO,GL,HS,SL,SH,WP,WL	September-October
	90	*Amaranthus deflexus* L.	542/MM//2020	Jangli Tandla	H	AL,FO,GL,HS,SH,WP	August-September

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	91	*Amaranthus graecizans* L.	634/MM//2020	Pohli	H	FO,GL,HS,RS,SL,SH,WP	August-September
	92	*Amaranthus retroflexus* L.	673/MM//2020	Aam bathoo	H	FO,GL,GR,HS,RS,SL,SH,WP	March-April
	93	*Amaranthus spinosus* L.	787/MM//2020	Konjel	H	FO,GL,HS,RS,SH,WP,WL	March-April
	94	*Amaranthus viridis* L.	878/MM//2020	Tandla	H	AL,GL,HS,RS,SL,SH,WP	August-September
	95	*Atriplex aucheri* Moq.	678/MM//2020	Loni jhari	S	DL,FO,GL,GR,HS,SL,SH,WP	July-August
	96	*Atriplex dimorphostegia* Kar. & Kir.	736/MM//2020	Loni booti	H	FO,GL,HS,RS,WP,WL	August-September
	97	*Atriplex griffithii* Moq.	551/MM//2020	Lani jhari	S	DL,FO,GL,GR,HS,RS,SP,SL,SH	May-July
	98	*Bassia hyssopifolia* (Pall.) Kuntze	825/MM//2020	Chotti lani, Retli booti	H	DL,FO,GL,GR,HS,RS,SH,WP	March-April
	99	*Beta vulgaris* L.	744/MM//2020	Chukandar	H	AL,GL,HG,RS	March-April
	100	*Chenopodium album* L.	748/MM//2020	Bathoo	H	AL,FO,GL,GR,HS,RS,SL,SH,WP	March-April
	101	*Chenopodium ficifolium* Sm.	552/MM//2020	Jangli Bathoo	H	DL,FO,GL,GR,HS,RS,SH	March-April
	102	*Chenopodium murale* L.	805/MM//2020	Karwa bathoo	H	FO,GL,GR,HS,RS,SL	March-April
	103	*Chenopodium glaucum* L.	887/MM//2020	Ratta Bathoo	H	FO,GL,GR,HS,RS,SH,WP	March-April
	104	*Chenopodium vulvaria* L.	611/MM//2020	Chitta bathoo	H	AL,DL,RS	March-April
	105	*Digera muricata* (L.) Mart.	694/MM//2020	Tandla saag	H	FO,GL,GR,HS,RS,SH,WP,WL	August-September
	106	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	856/MM//2020	Desi Bathoo	H	AL,DL,FO,GL,GR,HS,RS,SL,SH,WP	August-September
	107	*Spinacia oleracea* L.	823/MM//2020	Pallak	H	AL,GL,HG	March-April
	108	*Suaeda acuminata* (C.A.Mey.) Moq.	583/MM//2020	Smandri booti	H	DL,FO,GL,GR,HS,RS,SP,SH	August-September
	109	*Suaeda vermiculata* Forssk. ex J.F.Gmel.	799/MM//2020	Lani booti	S	FO,GL,GR,HS,RS,SL,SH,WP	March-April
16. Amaryllidaceae	110	*Allium cepa* L.	602/MM//2020	Ganda	H	RS	March-April
	111	*Allium sativum* L.	684/MM//2020	Thoom	H	AL,GL,HG	March-April
17. Anacardiaceae	112	*Mangifera indica* L.	580/MM//2020	Aam	T	AL,GL,HG,RS	May-June
18. Annonaceae	113	*Polyalthia longifolia* (Sonn.) Thwaites	677/MM//2020	Ulta ashoq	T	HG,RS	April-June
19. Apiaceae	114	*Centella asiatica* (L.) Urb.	893/MM//2020	Chattri	H	DL,GL,GR,HS,SH,WP	June-August
	115	*Coriandrum sativum* L.	513/MM//2020	Dhaniya	H	AL,GL,HG,RS	March-April
	116	*Daucus carota* L.	843/MM//2020	Gajjar	H	AL,GL,HG	March-April
	117	*Foeniculum vulgare* Mill.	517/MM//2020	Sounf	H	AL,GL,HG	March-April
20. Apocynaceae	118	*Blyttia spiralis* (Forssk.) D.V.Field & J.R.I.Wood	598/MM//2020	Wal-tara	H	FO,HS,SH,WP	March-April
	119	*Calotropis procera* (Aiton) Dryand.	640/MM//2020	Ak	S	DL,FO,GR,HS,RS,SP,WP	March-April
	120	*Calotropis gigantea* (L.) Dryand.	565/MM//2020	Bara ak	S	DL,FO,GR,HS,RS,SP,SH,WP	March-April
	121	*Cascabela thevetia* (L.) Lippold	793/MM//2020	Peeli kanier	T	AL,GL,HG,RS	March-April
	122	*Leptadenia pyrotechnica* (Forssk.) Decne.	883/MM//2020	Khip	S	DL,FO,GR,HS,RS,SP,WP	September-October

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	123	*Nerium oleander* L.	658/MM//2020	Kanair	S	HG,RS	July-August
	124	*Pentatropis capensis* (L. f.) Bullock	853/MM//2020	Tara lee	H	FO,GL,GR,HS,RS,SL,SH,WP	March-April
	125	*Pergularia daemia* (Forssk.) Chiov.	774/MM//2020	Sapni vail	H	FO,GR,HS,RS,SH,WP	February-April
	126	*Pergularia tomentosa* L.	606/MM//2020	Jangli Sapni vail	H	FO,HS,RS,SH,WP,WL	February-April
	127	*Rhazya stricta* Decne.	672/MM//2020	Wlayti Ak	S	DL,FO,GL,GR,HS,RS,SP,SL,SH,WP	August-September
	128	*Tylophora hirsuta* Wight	563/MM//2020	Panjni jhari	S	AL,GL,HG,RS	May-July
21. Berberidaceae	129	*Berberis lycium* Royle.	840/MM//2020	Sumbulu	T	AL,GL,RS	March-April
22. Bignoniaceae	130	*Tecoma stans* (L.) Juss. ex Kunth	806/MM//2020	Peeli jhari	S	HG,RS	August-September
23. Boraginaceae	131	*Cordia myxa* L.	535/MM//2020	Lasura	T	AL,GL,HG,RS	March-April
	132	*Cordia dichotoma* G.Forst.	518/MM//2020	Lasuree	T	AL,GL,HG,RS	March-April
	133	*Heliotropium aucheri* DC.	871/MM//2020	Tara booti	H	DL,FO,GL,GR,HS,RS,SP,SL	March-April
	134	*Heliotropium crispum* Desf.	682/MM//2020	Chitti choli	H	DL,FO,GR,HS,RS,SP,SL,SH,WP	August-September
	135	*Heliotropium curassavicum* L.	507/MM//2020	Lani pata	H	DL,FO,GR,HS,RS,SP,SL,SH,WP	March-April
	136	*Heliotropium europaeum* L.	616/MM//2020	Uth chaaro, Hathi sundi	H	DL,FO,GL,GR,HS,RS,SP,SL,SH,WP	August-September
	137	*Heliotropium strigosum* Willd.	756/MM//2020	Chita koka	H	DL,FO,GR,RS,SP,SL,SH,WP	March-April
	138	*Heliotropium supinum* L.	533/MM//2020	Choti boi	H	DL,FO,GR,HS,RS,SP,SL,WP	March-April
24. Brassicaceae	139	*Brassica nigra* (L.) K.Koch	792/MM//2020	Kala saroon, Kala rayea	H	AL,GL	March-April
	140	*Brassica oleracea* L.	770/MM//2020	Band ghobi	H	AL,GL,HG	February-March
	141	*Brassica deflexa* Boiss.	782/MM//2020	Peela saroon	H	AL,DL,FO,GL,GR,HS,HG,MS,RS,SP,SL,SH,WP, WL	March-April
	142	*Brassica juncea* (L.) Czern.	674/MM//2020	Peela raya	H	AL,GL	March-April
	143	*Brassica napus* L.	629/MM//2020	Shaljam	H	AL,GL,HG	February-March
	144	*Brassica rapa* L.	619/MM//2020	Peeli rayi	H	AL,GL	February-March
	145	*Brassica tournefortii* Gouan	828/MM//2020	Sirmi	H	AL,GL	February-March
	146	*Capsella bursa-pastoris* (L.) Medik.	760/MM//2020	Mirch booti	H	FO,GL,GR,HS,MS,RS,SH,WP,WL	August-September
	147	*Eruca vesicaria* (L.) Cav.	751/MM//2020	Tara Meera, Osoon rayea	H	AL,FO,GL,GR,HS,MS,RS,SL,SH,WP,WL	March-April
	148	*Lepidium apetalum* Willd.	505/MM//2020	Jangli Khoob kalan	H	FO,GL,HS,MS,SH,WP,WL	July-August
	149	*Lepidium didymum* L.	703/MM//2020	Chattri booti	H	AL,FO,GL,GR,HS,MS,SL,SH,WP,WL	March-April
	150	*Lepidium aucheri* Boiss.	873/MM//2020	Choti Lani	H	FO,GL,GR,HS,MS,RS,SL,SH,WP,WL	April-May
	151	*Lepidium sativum* L.	813/MM//2020	Bag bhari	H	HG,RS,SH	March-April
	152	*Malcolmia africana* (L.) R.Br.	780/MM//2020	Chiti phuli	H	DL,FO,GL,GR,MS,RS,SH,WP,WL	March-April
	153	*Raphanus raphanistrum* L.	664/MM//2020	Mongrae	H	AL,GL,HG	February-April

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	154	*Sisymbrium irio* L.	750/MM//2020	Peeli Saroon	H	AL,GL,HS,RS,SH,WP	March-April
	155	*Sisymbrium orientale* L.	826/MM//2020	Jangli Saroon	H	AL,GL,HS,RS,SH,WP	March-April
25. Cactaceae	156	*Opuntia dillenii* (Ker Gawl.) Haw.	699/MM//2020	Chitter thore	H	DL,HS,SP,SL,SH,WP	March-April
26. Cannabaceae	157	*Cannabis sativa* L.	669/MM//2020	Bhang	H	AL,GL,GR,RS,SH,WP,WL	March-April
27. Capparaceae	158	*Capparis decidua* (Forssk.) Edgew.	532/MM//2020	Karir	S	DL,FO,GR,HS,SP	August-September
28. Caricaceae	159	*Carica papaya* L.	904/MM//2020	Papeeta	S	AL,GL,HG	March-April
29. Caryophyllaceae	160	*Stellaria media* (L.) Vill.	796/MM//2020	Chitti booti	H	AL,FO,GL,HS,MS,RS,SL,SH,WP	March-April
	161	*Stellaria persica* Boiss.	511/MM//2020	Sitara booti	H	AL,FO,GL,HS,RS,SL,SH,WP	July-August
	162	*Stellaria decumbens* Edgew.	587/MM//2020	Chitti cona	H	FO	July-August
	163	*Stellaria monosperma* Buch.-Ham. ex D. Don	716/MM//2020	Ghal booti	H	FO,GL,GR,RS,SL,SH,WP,WL	July-August
30. Cleomaceae	164	*Cleome viscosa* L.	578/MM//2020	Zard booti	H	FO,GL,GR,RS,SH,WP,WL	March-April
31. Compositae	165	*Carthamus oxyacantha* M.Bieb.	863/MM//2020	Pholi, Kandiyari	H	DL,FO,GL,GR,HS,RS,SP,SL,WP	August-September
	166	*Cirsium arvense* (L.) Scop.	761/MM//2020	Kandiyari	H	DL,FO,GL,GR,HS,SP,SH,WP	March-April
	167	*Cirsium falconeri* (Hook.f.) Petr.	720/MM//2020	Jhalar Kandiyari	H	DL,FO,GR,HS,RS,SP,SH,WP	September-October
	168	*Echinops echinatus* Roxb.	566/MM//2020	Ont-ktara	H	DL,FO,GL,GR,HS,RS,SP,SL,SH	March-April
	169	*Eclipta prostrata* (L.) L.	847/MM//2020	Bhangra	H	AL,FO,GL,GR,RS,SH,WP,WL	March-April
	170	*Erigeron aegyptiacus* L.	757/MM//2020	Jangli Genda Phool	H	AL,FO,GL,GR,RS,SP,SH	September-October
	171	*Erigeron bonariensis* L.	872/MM//2020	Dodi booti	H	DL,FO,GR,HS,RS,SH,WL	March-April
	172	*Erigeron canadensis* L.	605/MM//2020	Konjel pholi	H	DL,FO,GL,GR,RS,SH,WL	October-November
	173	*Lactuca serriola* L.	609/MM//2020	Bhatal	H	AL,FO,GL,GR,HS,RS,SH,WP,WL	March-April
	174	*Launaea nudicaulis* (L.) Hook.f.	861/MM//2020	Dodak, Dudhkal	H	AL,FO,GL,GR,RS,SH	March-April
	175	*Launaea procumbens* (Roxb.) Ramayya & Rajagopal	821/MM//2020	Dodak, Bhathala	H	AL,FO,GL,GR,RS,SH,WP,WL	March-April
	176	*Parthenium hysterophorus* L.	670/MM//2020	Koka booti	H	AL,DL,FO,GL,GR,RS,SH,WP,WL	March-April
	177	*Silybum marianum* (L.) Gaertn.	553/MM//2020	Ount Katara	H	DL,GL,GR,RS,SL,SH,WP	March-April
	178	*Sonchus arvensis* L.	623/MM//2020	Peeli Bhattal	H	AL,GL,GR,HS,RS,SL,SH,WP	March-April
	179	*Sonchus asper* (L.) Hill	666/MM//2020	Bhattal	H	DL,FO,GL,HS,RS,SL,SH	March-April
	180	*Sonchus oleraceus* (L.) L.	713/MM//2020	Peeli dodhak	H	AL,FO,GR,RS,SH	March-April
	181	*Tagetes erecta* L.	830/MM//2020	Peela Genda	H	HG,RS,SH	July-September
	182	*Xanthium strumarium* L.	764/MM//2020	Puth kanda	H	AL,DL,FO,GL,GR,HS,RS,SH,WP,WL	March-April
32. Convolvulaceae	183	*Convolvulus arvensis* L.	728/MM//2020	Lelli	H	AL,FO,GL,GR,RS,SH,WL	March-April
	184	*Convolvulus prostratus* Forssk.	785/MM//2020	Lehi, Vanvaihre	H	AL,FO,GL,GR,RS,SH,WL	February-April
	185	*Convolvulus lineatus* L.	888/MM//2020	Waja vail	H	AL,FO,GL,GR,RS,SP,SH,WL	March-April

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	186	*Cuscuta reflexa* Roxb.	811/MM//2020	Ashk bail , Ambar bail	H	AL,DL,FO,GR,HS,RS,SL,SH,WP,WL	December-January
	187	*Ipomoea alba* L.	534/MM//2020	Sawer pholi	H	AL,GL,HG,RS,SH,WL	March-April
	188	*Ipomoea carnea* Jacq.	729/MM//2020	Gull e abbasi	S	AL,RS,WL	August-September
	189	*Ipomoea pes-tigridis* L.	903/MM//2020	Chitti chatri	H	AL,DL,GL,GR,HS,RS,SH,WP,WL	August-September
	190	*Ipomoea aquatica* Forssk.	896/MM//2020	Jungli vail	H	AL,FO,GL,GR,RS,SH,WL	February-April
	191	*Ipomoea cairica* (L.) Sweet	604/MM//2020	Jungli lehli	H	AL,FO,GL,GR,HS,RS,SL,SH,WP,WL	July-August
33. Cucurbitaceae	192	*Benincasa hispida* (Thunb.) Cogn.	730/MM//2020	Bari Khakhri	H	AL,GL,HG	June-July
	193	*Citrullus colocynthis* (L.) Schrad.	638/MM//2020	Tumma	H	AL,DL,FO,GL,GR,HS,RS,SP,SL,SH,WP	May-June
	194	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	755/MM//2020	Dwana, Turbooz	H	AL,GL,HG	July-August
	195	*Cucumis sativus* L.	635/MM//2020	Khera	H	AL,GL,HG	June-July
	196	*Cucumis melo* L.	527/MM//2020	Khakhri	H	AL,GL,HG	June-July
	197	*Cucurbita moschata* Duchesne	718/MM//2020	Paitha	H	AL,GL,HG	June-July
	198	*Cucurbita maxima* Duchesne	702/MM//2020	Ghea	H	AL,GL,HG	June-July
	199	*Cucurbita pepo* L.	709/MM//2020	Kaddu	H	AL,GL,HG	June-July
	200	*Luffa acutangula* (L.) Roxb.	624/MM//2020	Kali Toori	H	AL,GL,HG	June-July
	201	*Luffa cylindrica* (L.) M.Roem.	522/MM//2020	Ghea toori	H	AL,GL,HG	June-July
	202	*Momordica balsamina* L.	712/MM//2020	Jangli kraila	H	AL,GL,HG	May-June
	203	*Praecitrullus fistulosus* (Stocks) Pangalo	809/MM//2020	Tinda	H	AL,GL,HG	June-July
34. Euphorbiaceae	204	*Chrozophora* tinctoria (L.) A.Juss.	850/MM//2020	Chitti Boi	H	DL,FO,GR,HS,RS,SP,SL,WP	May-June
	205	*Chrozophora oblongifolia* (Delile) A.Juss. ex Spreng.	781/MM//2020	Khuri	H	DL,FO,GR,HS,SP,WP	August-September
	206	*Chrozophora plicata* (Vahl) A.Juss. ex Spreng.	656/MM//2020	Chitri booti	H	DL,FO,GR,HS,RS,SP,WP	August-September
	207	*Chrozophora sabulosa* Kar. & Kir.	687/MM//2020	Giri booti	H	DL,FO,GL,GR,HS,RS,SP,WP	August-September
	208	*Croton bonplandianus* Baill.	762/MM//2020	Kala bhangra	H	FO,GL,GR,HS,RS,SH,WP,WL	March-April
	209	*Euphorbia cyathophora* Murray	848/MM//2020	Pathar chat	S	HG,RS,SH	March-April
	210	*Euphorbia helioscopia* L.	892/MM//2020	Choti chattri	H	AL,FO,GL,GR,RS,SH,WP,WL	March-April
	211	*Euphorbia hirta* L.	801/MM//2020	Lal dhudi	H	AL,FO,GL,GR,HS,HG,MS,RS,SL,SH,WP,WL	March-April
	212	*Euphorbia indica* Lam.	837/MM//2020	Dudhi kalan	H	AL,FO,GL,GR,HS,RS,WP,WL	March-April
	213	*Euphorbia prostrata* Aiton	648/MM//2020	Choti it-sit	H	AL,DL,GL,GR,HS,HG,RS,SH,WP	June-July
	214	*Euphorbia thymifolia* L.	819/MM//2020	It-sit	H	AL,DL,FO,GL,GR,HS,HG,RS,SH,WP	June-July
	215	*Euphorbia densa* Schrenk	584/MM//2020	Dhodak	H	AL,DL,FO,GL,GR,RS,SH,WP,WL	June-July
	216	*Euphorbia granulata* Forssk.	874/MM//2020	Ltari booti	H	DL,FO,GR,HS,MS,SP,SL,WP	August-September
	217	*Euphorbia prolifera Buch.*-Ham. ex D.Don	561/MM//2020	Pholi booti	H	DL,FO,GL,GR,HS,MS,RS,SP,SL	April-May

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	218	*Euphorbia serpens* Kunth	779/MM//2020	Boni booti	H	DL,FO,GL,GR,HS,MS,RS,SP,SL,SH	August-September
	219	*Ricinus communis* L.	689/MM//2020	Hernoli	S	AL,DL,FO,GL,GR,HS,RS,SP,SL,WP	August-September
35. Fagaceae	220	*Quercus incana* Bartram	617/MM//2020	Shah baloot	T	AL,FO,GL,HG,RS	August-September
36. Geraniaceae	221	*Geranium rotundifolium* L.	722/MM//2020	Bouni booti	H	AL,FO,GL,GR,RS,SH,WP,WL	March-April
	222	*Geranium lambertii* Sweet	545/MM//2020	Tara booti	H	FO,GL,RS,SH,WP,WL	March-April
	223	*Geranium pratense* L.	707/MM//2020	Asmani pholi	H	AL,FO,GR,HS,RS,SH,WP	March-April
	224	*Geranium pusillum* L.	862/MM//2020	Gana booti	H	FO,GL,GR,HS,RS,SL,SH,WP	August-September
37. Gisekiaceae	225	*Gisekia pharnaceoides* L.	644/MM//2020	Balu ka sag	H	AL,FO,GL,GR,RS,SP,SH,WP	July-August
38. Lamiaceae	226	*Anisomeles indica* (L.) Kuntze	794/MM//2020	Jamni booti	H	FO,HS,RS,SH,WP	March-April
	227	*Mentha longifolia* (L.) L.	698/MM//2020	Jangli poodina	H	FO,GL,HS,SL,SH,WL	May-June
	228	*Mentha arvensis* L.	693/MM//2020	Poodina	H	AL,GL,HG	March-April
	229	*Mentha pulegium* L.	659/MM//2020	Jamni poodina	H	AL,FO,GL,HS,RS,SL,SH,WL	March-April
	230	*Mentha royleana* Wall. ex Benth.	631/MM//2020	Chitta poodina	H	AL,FO,GL,HS,RS,SL,SH,WL	March-April
	231	*Mentha spicata* L.	503/MM//2020	Podina	H	FO,GL,HS,SH,WL	March-April
	232	*Ocimum americanum* L.	890/MM//2020	Danadar booti	H	FO,GR,HS,RS,SL,SH,WP	August-September
	233	*Ocimum basilicum* L.	737/MM//2020	Niazbo	S	HG,SH	August-September
	234	*Salvia aegyptiaca* L.	705/MM//2020	Ksaroo	H	FO,HS,RS,SP,SL,SH,WP	August-September
	235	*Salvia moorcroftiana* Wall. ex Benth.	530/MM//2020	Lapra	H	FO,HS,SL,SH,WP	May-June
	236	*Salvia nubicola* Wall. ex Sweet	841/MM//2020	Hernar	H	FO,HS,RS,SH,WP,WL	August-September
39. Leguminosae	237	*Acacia farnesiana* (L.) Willd.	851/MM//2020	Kabli kikar	T	DL,FO,HS,RS,WP	August-September
	238	*Acacia nilotica* (L.) Delile	783/MM//2020	Kikar	T	DL,FO,HS,RS,SP,WP	August-September
	239	*Acacia catechu* (L.f.) Willd.	514/MM//2020	Wada kiker	T	DL,FO,HS,RS,WP	July-August
	240	*Acacia modesta* Wall.	827/MM//2020	Pholai kiker	T	DL,FO,HS,RS,SP,WP	March-April
	241	*Acacia senegal* (L.) Willd.	618/MM//2020	Wlayti kikeri	T	FO,GL,HG,RS,WP	August-September
	242	*Acacia torta* (Roxb.) Craib	831/MM//2020	Jungli kiker	S	DL,FO,GL,HS,RS	August-September
	243	*Albizia procera* (Roxb.) Benth.	630/MM//2020	Chita Sharin	T	AL,DL,GL,HG,RS,SP	August-September
	244	*Albizia lebbeck* (L.) Benth.	597/MM//2020	Shareen	T	AL,FO,GL,GR,HG,RS,WP	August-September
	245	*Alhagi maurorum* Medik.	610/MM//2020	Kandera	S	DL,FO,GR,HS,SP	July-August
	246	*Arachis hypogaea* L.	877/MM//2020	Moong phali	H	AL,DL,GL,SP	August-September
	247	*Astragalus psilocentros* Fisch.	882/MM//2020	Jangli jantri	H	HS	August-September
	248	*Bauhinia variegata* L.	685/MM//2020	Kachnar	T	AL,GL,HG,RS	March-April
	249	*Butea monosperma* (Lam.) Taub.	772/MM//2020	Wlayti sumbal	T	RS	March-April

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	250	*Cassia fistula* L.	846/MM//2020	Girdi nalli, Amaltas	T	AL,GL,HG,RS	March-April
	251	*Cicer arietinum* L.	577/MM//2020	Choly, chany	H	AL,DL,SP	February-March
	252	*Dalbergia sissoo* DC.	695/MM//2020	Tahli	T	AL,DL,FO,GL,GR,HS,RS,SP,SH,WP,WL	April-May
	253	*Indigofera linifolia* (L.f.) Retz.	714/MM//2020	Lal dani	H	DL,FO,GR,HS,RS,SP,SL,SH,WP	March-April
	254	*Indigofera arabica* Jaub. & Spach	646/MM//2020	Gulabi pholi	H	DL,FO,GR,HS,RS,SP,SL,WP	March-April
	255	*Indigofera sessiliflora* DC.	759/MM//2020	Shareni booti	H	DL,FO,GR,HS,RS,SL,WP	March-April
	256	*Indigofera tinctoria* L.	849/MM//2020	Neeli jhari	S	DL,FO,GR,HS,RS,SL,WP	November-December
	257	*Indigofera trita* L.f.	680/MM//2020	Lal pholi	H	AL,FO,GL,RS,SH,WP,WL	February-March
	258	*Lathyrus aphaca* L.	844/MM//2020	Jangli mattar	H	AL,FO,GL,RS,SH,WP,WL	September-October
	259	*Lathyrus sativus* L.	572/MM//2020	Jangli mattri	H	AL,FO,GL,HS,RS,WP,WL	March-April
	260	*Lathyrus pratensis* L.	818/MM//2020	Peeli vail	H	AL,FO,GL,HS,RS,WP,WL	March-April
	261	*Lens culinaris* Medik.	516/MM//2020	Dal masoor	H	AL,GL,HG	February-March
	262	*Leucaena leucocephala* (Lam.) de Wit	550/MM//2020	Desi shareen	T	AL,GL,GR,HS,HG,RS,WP	March-April
	263	*Medicago sativa* L.	662/MM//2020	Lucen, Losan	H	AL,GL	June-July
	264	*Melilotus indicus* (L.) All.	754/MM//2020	Senji	H	AL,GL,GR,RS,SH,WP,WL	March-April
	265	*Melilotus officinalis* (L.) Pall.	600/MM//2020	Chitti Sinje	H	AL,GL,GR,RS,SH,WP,WL	March-April
	266	*Melilotus messanensis* (L.) All.	790/MM//2020	Patrro	H	AL,GL,RS,WP,WL	March-April
	267	*Parkinsonia aculeata* L.	667/MM//2020	Angrezi kikar	T	DL,FO,GR,HS,RS,SP,WP	August-September
	268	*Pisum sativum* L.	711/MM//2020	Mattar	H	AL,GL	September-October
	269	*Pongamia pinnata* (L.) Pierre	592/MM//2020	Sukh chain	T	AL,GL,HG,RS	August-September
	270	*Prosopis cineraria* (L.) Druce	745/MM//2020	Jand	T	DL,FO,GR,HS,RS,SP,SL,WP	August-September
	271	*Prosopis glandulosa* Torr.	886/MM//2020	Wlayti kikar	T	AL,DL,FO,GR,HS,RS,SP,SL	August-September
	272	*Prosopis juliflora* (Sw.) DC.	547/MM//2020	Phari kikar	T	AL,FO,GR,HS,RS,WP	August-September
	273	*Rhynchosia capitata* (Roth) DC	686/MM//2020	Rawan	H	AL,GL,HG	March-April
	274	*Rhynchosia minima* (L.) DC.	855/MM//2020	Jangli Rawan	H	AL,FO,HS,HG,RS,WP,WL	March-April
	275	*Senna occidentalis* (L.) Link	576/MM//2020	Jangli arwan	H	AL,FO,HS,HG,RS,WP,WL	March-April
	276	*Senna tora* (L.) Roxb.	766/MM//2020	Jantar	H	AL,GL	March-April
	277	*Sesbania sesban* (L.) Merr.	581/MM//2020	Wlayti shareen	T	FO,HS,HG,RS,WP	August-September
	278	*Sesbania concolor* J.B.Gillett	620/MM//2020	Jungli shareen	S	FO,HS,HG,RS	August-September
	279	Sesbania *grandiflora* (L.) Pers.	607/MM//2020	Majandri	T	FO,HS,HG,RS	November-December
	280	*Tamarindus indica* L.	798/MM//2020	Imli	T	AL,GL,HG,RS	December-January
	281	*Trifolium resupinatum* L.	788/MM//2020	Barsan	H	AL,GL	March-April

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	282	*Trifolium alexandrinum* L.	717/MM//2020	Chita Shatala	H	AL,GL	March-April
	283	*Trifolium pratense* L.	556/MM//2020	Gulabi Shatala	H	AL,GL	March-April
	284	*Trifolium repens* L.	579/MM//2020	Shatala	H	AL,GL	February-March
	285	*Trigonella anguina* Delile	568/MM//2020	Jangli meethre	H	AL,DL,FO,GL,GR,HS,RS,SH,WP,WL	March-April
	286	*Trigonella corniculata* Sibth. & Sm.	615/MM//2020	Meethre	H	AL,HG	March-April
	287	*Trigonella foenum-graecum* L.	901/MM//2020	Methra	H	AL,HG	March-April
	288	*Vicia sativa* L.	767/MM//2020	Jangli Rewari	H	AL,FO,GL,HS,SL,SH,WP,WL	March-April
	289	*Vicia bakeri* Ali	549/MM//2020	Daturi	H	AL,FO,GL,HS,RS,SH,WP,WL	August-September
	290	*Vicia faba* L.	725/MM//2020	Lobia	H	AL,GL,HG	December-January
	291	*Vigna mungo* (L.) Hepper	777/MM//2020	Mung dal	H	AL,GL,HG	February-March
	292	*Vigna trilobata* (L.) Verdc.	832/MM//2020	Rawan dal	H	AL,GL,HG	February-March
	293	*Vigna unguiculata* (L.) Walp.	560/MM//2020	Lobia	H	AL,HG	February-March
40. Linaceae	294	*Linum usitatissimum* L.	857/MM//2020	Alsi	H	AL,HG	June-July
41. Lythraceae	295	*Ammannia baccifera* L.	613/MM//2020	Ratta krond	H	AL,DL,FO,GL,HS,RS,SL,WP,WL	August-September
	296	*Ammannia auriculata* Willd.	536/MM//2020	Kandi booti	H	AL,DL,FO,GL,GR,HS,RS,SL,SH,WP	August-September
	297	*Ammannia verticillata* (Ard.) Lam.	902/MM//2020	Nevi kandi	H	AL,DL,FO,GL,GR,HS,RS,WP	August-September
	298	*Lawsonia inermis* L.	833/MM//2020	Mehndi	S	AL,GL,HG	March-April
42. Malvaceae	299	*Abelmoschus esculentus* L. Moench	567/MM//2020	Bhindi	H	AL,HG	June-July
	300	*Abutilon indicum* (L.) Sweet	588/MM//2020	Peela crown	H	FO,GR,HS,RS,SL,SH,WP	March-April
	301	*Abutilon theophrasti* Medik.	543/MM//2020	Janlgi Peela crown	H	FO,GR,HS,RS,SL,WP	March-April
	302	*Abutilon grandifolium* (Willd.) Sweet	765/MM//2020	Gidar booti	S	FO,GR,HS,RS,SL,WP	July-August
	303	*Abutilon hirtum* (Lam.) Sweet	800/MM//2020	Peeli booti	H	FO,RS,SL,WP	March-April
	304	*Bombax ceiba* L.	786/MM//2020	Simbal	T	AL,GL,GR,RS	February-March
	305	*Corchorus depressus* (L.) Stocks	591/MM//2020	Bahu-phali	H	DL,GR,HS,MS,SP,SL	March-April
	306	*Grewia asiatica* L.	721/MM//2020	Falsa	S	AL,GL,HG,RS	February-March
	307	*Malva neglecta* Wallr.	665/MM//2020	Sitara Sunchal	H	AL,DL,FO,GL,GR,RS,SH,WP,WL	March-April
	308	*Malva parviflora* L.	510/MM//2020	Sunchal	H	AL,DL,FO,GL,GR,RS,SH,WP,WL	March-April
	309	*Malva sylvestris* L.	564/MM//2020	Jamni phool	H	HG,RS,SH	April-May
	310	*Malva verticillata* L.	885/MM//2020	Kandi Sunchal	H	AL,GL,GR,RS,SH,WP,WL	March-April
	311	*Malvastrum coromandelianum* (L.) Garcke	642/MM//2020	Khati booti, Peeli booti	H	DL,FO,GL,GR,HS,MS,RS,SL,SH,WP	October-November
	312	*Sida spinosa* L.	719/MM//2020	Jungle maithi	H	FO,GL,GR,HS,MS,RS,SH,WP	March-April
43. Martyniaceae	313	*Martynia annua* L.	575/MM//2020	Gulabi kona	H	FO,GL,GR,HS,MS,RS,SL,SH,WP,WL	March-April

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44. Meliaceae	314	*Azadirachta indica* A.Juss.	633/MM//2020	Neem	T	AL,GL,HG,RS	July-August
	315	*Melia azedarach* L.	864/MM//2020	Dharaik	T	AL,GL,HG,RS	August-September
45. Menispermaceae	316	*Tinospora sinensis* (Lour.) Merr.	639/MM//2020	Glow	S	AL,GL,HG	April-May
46. Moraceae	317	*Broussonetia papyrifera* (L.) L'Hér. ex Vent.	817/MM//2020	Gul toot	T	HG,RS	March-April
	318	*Ficus benghalensis* L.	593/MM//2020	Desi bohar	T	AL,GL,HG,RS	March-April
	319	*Ficus carica* L.	749/MM//2020	Anjeer	T	AL,GL,HG,RS	May-June
	320	*Ficus religiosa* L.	791/MM//2020	Peepal	T	AL,GL,HG,RS	August-September
	321	*Ficus palmata* Forssk.	879/MM//2020	Desi Anjeer	T	AL,GL,HG,RS	May-June
	322	*Ficus sarmentosa* Buch.-Ham. ex Sm.	521/MM//2020	Wlayti bohar	T	AL,GL,RS	August-September
	323	*Morus alba* L.	866/MM//2020	Safaid toot	T	AL,GL,HG,RS	March-April
	324	*Morus nigra* L.	625/MM//2020	Kala toot	T	AL,GL,HG,RS	March-April
47. Moringaceae	325	*Moringa oleifera* Lam.	700/MM//2020	Sohanjana	T	AL,GL,HG,RS	February-March
48. Musaceae	326	*Musa × paradisiaca* L.	645/MM//2020	Keela	H	AL,GL,HG,WL	March-April
49. Myrtaceae	327	*Callistemon lanceolatus* (Sm.) Sweet	643/MM//2020	Bottle bursh	T	HG,RS	March-April
	328	*Eucalyptus globulus* Labill.	554/MM//2020	Saifeda	T	AL,GL,GR,RS,WL	August-September
	329	*Psidium guajava* L.	859/MM//2020	Amrood	S	AL,GL,HG	January-February
	330	*Syzygium cumini* (L.) Skeels	808/MM//2020	Kala jaman	T	AL,HG,RS	August-September
50. Nitrariaceae	331	*Peganum harmala* L.	701/MM//2020	Harmal booti	H	DL,FO,GR,HS,MS,RS,SP	March-April
51. Nyctaginaceae	332	*Boerhavia diffusa* L.	504/MM//2020	Nevi booti	H	AL,FO,GL,HS,RS,SL,SH,WP	July-August
	333	*Boerhavia procumbens* Banks ex Roxb.	649/MM//2020	Itsit	H	FO,GL,HS,RS,WP	June-July
	334	*Boerhavia repens* L.	816/MM//2020	Looni booti	H	AL,FO,GL,GR,HS,RS,SH,WP	August-September
	335	*Bougainvillea glabra* Choisy	520/MM//2020	Rangli bail	S	HG,RS	August-September
	336	*Bougainvillea spectabilis* Willd.	723/MM//2020	Bugal bail	S	HG,RS	August-September
	337	*Mirabilis jalapa* L.	526/MM//2020	Gul-e-Asar	H	HG,RS	August-September
52. Oleaceae	338	*Jasminum grandiflorum* L.	594/MM//2020	Chambeli	S	AL,HG	July-September
	339	*Jasminum sambac* (L.) Aiton	641/MM//2020	Motiya	S	AL,HG	July-September
	340	*Olea ferruginea* Wall. ex Aitch.	746/MM//2020	Kao	S	AL	August-September
53. Oxalidaceae	341	*Oxalis corniculata* L.	732/MM//2020	Peeli booti, Choti lonak	H	AL,FO,GL,GR,HS,RS,SH,WP,WL	February-March
54. Papaveraceae	342	*Fumaria indica* (Hausskn.) Pugsley	537/MM//2020	Papra	H	AL,GL,HS,RS,SH,WP	March-April
	343	*Fumaria vaillantii* Loisel.	899/MM//2020	Shatra papra	H	AL,GL,HS,RS,SH,WP	March-April
55. Pedaliaceae	344	*Sesamum indicum* L.	835/MM//2020	Till	H	AL	March-April
56. Phrymaceae	345	*Mazus pumilus* (Burm.f.) Steenis	691/MM//2020	Chita phol	H	FO,GR,HS,RS,SH,WL	March-April

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57. Plantaginaceae	346	*Veronica anagallis-aquatica* L.	834/MM//2020	Hazar booti	H	AL,FO,GL,HS,RS,SH,WP	March-April
58. Polygonaceae	347	*Persicaria glabra* (Willd.) M.Gómez	523/MM//2020	Hazar dani	H	AL,FO,GL,HS,RS,SP,SH,WP	September-October
	348	*Polygonum plebeium* R.Br.	531/MM//2020	Droonk, Gorakh pan	H	AL,FO,GL,GR,HS,MS,RS,SL,SH,WP,WL	March-April
	349	*Rumex crispus* L.	650/MM//2020	Lonak	H	AL,FO,GL,HS,RS,SL,SH,WP,WL	March-April
	350	*Rumex dentatus* L.	812/MM//2020	Khatkal	H	AL,FO,GL,HS,RS,SL,SH,WP,WL	March-April
	351	*Rumex patientia* L.	860/MM//2020	Khatkal	H	AL,FO,GL,GR,HS,MS,RS,SH,WP,WL	March-April
59. Portulacaceae	352	*Portulaca grandiflora* Hook.	763/MM//2020	Kulfa	H	DL,FO,GL,GR,HS,RS,SP,SL	August-September
	353	*Portulaca oleracea* L.	865/MM//2020	Kulfa lonak	H	FO,GL,HS,RS,SH,WP,WL	August-September
	354	*Portulaca pilosa* L.	829/MM//2020	Lorni booti	H	FO,GL,HS,MS,RS,SH	August-September
	355	*Portulaca quadrifida* L.	753/MM//2020	Lornak booti	H	FO,GL,GR,HS,MS,RS,SL,SH,WP	August-September
60. Primulaceae	356	*Anagallis arvensis* L.	900/MM//2020	Neeli booti, Billi booti.	H	AL,FO,GL,GR,HS,MS,RS,SH,WP	March-April
61. Ranunculaceae	357	*Nigella sativa* L.	740/MM//2020	Kalwanji	H	AL,HG	March-April
	358	*Ranunculus muricatus* L.	773/MM//2020	Chambel booti	H	FO,GL,SH,WP	March-April
	359	*Ranunculus sceleratus* L.	571/MM//2020	Jal Dhania	H	FO,GL,GR,HS,RS,SL,SH	February-March
	360	*Ranunculus arvensis* L.	739/MM//2020	Peela phola	H	DL,GL,HS,SP,SH,WP	March-April
	361	*Ranunculus natans* C.A.Mey.	697/MM//2020	Peela tara	H	FO,GL,GR,HS,SP,SH	August-September
	362	*Ranunculus repens* L.	738/MM//2020	Peela Gullab	H	GL,GR,HS,RS,SH,WP	June-July
62. Rhamnaceae	363	*Ziziphus jujuba* Mill.	726/MM//2020	Bairi	T	DL,FO,GL,GR,HS,HG,RS,SP	August-September
	364	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	612/MM//2020	Jangli bairi	T	FO,GL,HS,RS,SP	August-September
63. Rosaceae	365	*Rosa indica* L.	814/MM//2020	Gulaab	S	HG,RS	March-April
64. Rubiaceae	366	*Galium aparine* L.	589/MM//2020	Wanwair booti	H	AL,FO,GL,GR,HS,RS,SL,SH,WP	June-July
65. Rutaceae	367	*Citrus limon* (L.) Osbeck	869/MM//2020	Nimboo	S	AL,HG	March-April
	368	*Citrus reticulata* Blanco	836/MM//2020	Kino malta	S	AL,HG	September-October
	369	*Citrus sinensis* (L.) Osbeck	743/MM//2020	Musmi malta	S	AL,HG	September-October
66. Salicaceae	370	*Populus alba* L.	778/MM//2020	Sufaid Poplar	T	AL,HG	February-March
	371	*Salix alba* L.	599/MM//2020	Desi bohoer	T	AL,GL,GR,HG,RS	February-April
67. Salvadoraceae	372	*Salvadora oleoides* Decne.	690/MM//2020	Jall, Van	T	DL,FO,GR,HS,SP,WP	August-September
	373	*Salvadora persica* L.	747/MM//2020	Pelo	S	DL,GR,RS,SP,SL,WP	August-September
68. Sapindaceae	374	*Dodonaea viscosa* (L.) Jacq.	768/MM//2020	Sanatha	S	FO,GR,HS,MS,RS,SL,SH,WP	March-April
69. Scrophulariaceae	375	*Verbascum thapsus* L.	891/MM//2020	Gidhar tambaku	H	FO,GR,HS,SP,SH	March-April
70. Solanaceae	376	*Capsicum annuum* L.	742/MM//2020	Shimla mirch	H	AL,GL,HG	June-July
	377	*Cestrum nocturnum* L.	838/MM//2020	Rat ki rani	S	HG,RS	March-April

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	378	*Datura innoxia* Mill.	519/MM//2020	Siah dhatoora	S	FO,GL,GR,HS,MS,RS,SH,WP	August-September
	379	*Datura metel* L.	628/MM//2020	Datura	S	FO,GL,GR,HS,MS,RS,SP,SL,SH,WP,WL	June-July
	380	*Datura stramonium* L.	627/MM//2020	Jangli dhatoora	S	FO,GL,GR,HS,MS,RS,SP,SL,SH,WP,WL	June-July
	381	*Hyoscyamus niger* L.	683/MM//2020	Khoob kalan	H	GL,HS,RS,SH,WP	March-April
	382	*Nicotiana tabacum* L.	679/MM//2020	Tambaku	H	AL,GL,HG	July-September
	383	*Physalis alkekengi* L.	769/MM//2020	Lal cherry	H	FO,GL,HS,SH	June-July
	384	*Physalis minima* L.	733/MM//2020	Jangli rasbari	H	FO,GL,HS,SL,SH	August-October
	385	*Physalis divaricata* D. Don	569/MM//2020	Jungli berry	H	FO,GL,HS,SL,SH,WP	August-September
	386	*Physalis peruviana* L.	502/MM//2020	Jungli berry	H	FO,GL,GR,HS,SL,SH	August-September
	387	*Solanum americanum* Mill.	636/MM//2020	Kainch Mainch, Makao	H	AL,FO,GL,GR,HS,RS,SH,WP	June-July
	388	*Solanum incanum* L.	727/MM//2020	Jangli baingan, Mahokari	S	FO,GL,HS,SH,WP	June-July
	389	*Solanum melongena* L.	681/MM//2020	Baingan	H	AL,HG	June-July
	390	*Solanum nigrum* L.	603/MM//2020	Kanch Manch, Makao	H	AL,DL,FO,GL,GR,HS,RS,SP,SL,SH,WP,WL	March-April
	391	*Solanum surattense* Burm. f.	758/MM//2020	Choti Kandiari	H	DL,FO,GR,HS,MS,RS,SP,SL	October-November
	392	*Solanum tuberosum* L.	596/MM//2020	Allo	H	AL,HG	January-February
	393	*Withania somnifera* (L.) Dunal	555/MM//2020	Aksn, Jangli panair, Akeri	H	DL,FO,GL,GR,HS,RS,SP,SL,SH,WP	March-April
	394	*Withania coagulans* (Stocks) Dunal	741/MM//2020	Jangly chana	S	DL,FO,GL,SP,SH	March-April
71. Tamaricaceae	395	*Tamarix aphylla* (L.) H.Karst.	868/MM//2020	Khagal	T	DL,FO,GL,RS,WP	March-April
	396	*Tamarix dioica* Roxb. ex Roth	676/MM//2020	Khagal, Rukh	S	DL,FO,GL,GR,RS,SP,SL,WP	August-September
72. Verbenaceae	397	*Lantana camara* L.	708/MM//2020	Rangli jhari	S	FO,GL,HS,RS	August-September
	398	*Lantana indica* Roxb.	797/MM//2020	Chitti rangli	S	FO,GL,HS,RS	August-September
	399	*Phyla nodiflora* (L.) Greene	595/MM//2020	Bukand booti	H	FO,GL,MS,SH,WP,WL	August-September
	400	*Verbena officinalis* L.	752/MM//2020	Chandni, Sindhi podina	H	FO,GL,HS,MS,SL,SH,WL	August-September
73. Violaceae	401	*Viola pilosa* Blume	647/MM//2020	Lillio	H	FO,GL,HS,SH,WL	April-May
74. Vitaceae	402	*Vitis vinifera* Linn.	655/MM//2020	Angoor	S	AL,HG	June-July
75. Zygophyllaceae	403	*Fagonia indica* Burm.f.	842/MM//2020	Jawanh booti	S	DL,FO,GR,HS,RS,SP,SL	July-August
	404	*Tribulus terrestris* L.	539/MM//2020	Bhakhra	H	DL,FO,GL,GR,HS,MS,RS,SP,SL,SH,WP	August-September

*; H: Herbs; S: Shrubs; T: Tree; G: Grass; **; AL: Arable Land; DL: Dry Land; FO: Forest; GL: Grassland; GR: Graveyard; HS: Hilly Slopes; HG: Home Gardens; MS: Mountain Summits; RS: Roadside; SP: Sandy Places; SL: Scrubland; SH: Shady Places; WP: Waste Places; WL: Wet Land

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