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"Study of Phenology of Woody Flora of Gulmarg and Its Neighbourhood" for Landscape Use

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Authors' contributions

This work was carried out in collaboration among all authors. Author ABN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors Nelofer and RAL managed the analyses of the study and managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation entitled "Study of phenology of ornamental flora of Gulmarg and its neighbourhood for landscape use" conducted during the years 2008-2010 in Gulmarg area of Kashmir valley. For this purpose four representative zones including zone A. ferozpur (1880 m.asl) and Tangmarg (2153 m.asl), zone B. Drang. (2218 m.asl) zone C. Doobi ghat (2218 m.asl), Gulmarg (2688 m.asl) and Baba reshi (2703 m.asl) and zone D. khelanmarg (3041 m.asl) were selected and recorded observations on flower emergence by making exploratory trips to these sites. Phonological spectrum of the flora of deciduous trees and shrubs, broad leaf evergreen trees and shrubs, deciduous woody vines, ground covers and evergreen ground cover shrubs revealed maximum availability of flowers during spring followed by summer and autumn.

Keywords: Phenology; woody flora; ground covers.

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1. INTRODUCTION

Landscaping today is more important than ever before. As the highways, parks and banks of lakes/river became more crowded, beautiful places and quiet retreats where we can relax and enjoy nature became more essential. The planting of landscape plants is an easy and effective way to increase the beauty of tourist sites [1]. The knowledge of performance of woody plant species would be of immense importance to the landscapist and architect in developing landscape designs and judicious selection of species [2].

Trees and shrubs are often the most dominant plants in landscapes but ground covers and vines play an important role too. The low spreading form of ground covers can connect and unify major planting areas and even serves as a focal point when the plants are flowering [3].

Since there is an increasing trend and awareness of planned landscaping in the public and in view of its value in preserving the environment, there is an urgent need to identify the potential germplasm/ appropriate planting material for specific sites/ locations. In this direction little work has been done under Kashmir condition so for especially the hilly regions of Gulmarg. Gulmarg is one of the rich turfs situated to the west of Srinagar at a distance of about 51 km. It extends between 74–$^{o\theta}$ 28$^{/-}$to 74–$^{o\theta}$ 31–$^{/}$ East longitude at an altitude of about 2676 m.asl. Gulmarg's legendary beauty, prime location and proximity to Srinagar naturally make it one of Asia's premier hill resorts. Originally called 'Gaurimarg' by shepherds, Gulmarg was discovered in the 16th century by Sultan Yusuf, who was inspired by the sight of its grassy slopes emblazoned with wild flowers. It was also a favourite resort of the Mughal Emperor Jahangir, who changed the name to Gulmarg (Meadow of Flowers) rightly attributed to the profusion of flowers he collected at the place. The region being completely mountains the topography of the area is most uneven. Various topographic factors like altitude, steepness of the slope, exposure of slopes to light and winds and direction of mountain chains affects the vegetation at all levels. This beauty is further boasted by the rich flora which is present in the region. Gulmarg is considered one of the famous health resorts of Kashmir which receives national and international tourists in lacks throughout the year. During winter Gulmarg is also known for skiing in which both national and international players participate every year. Therefore taking the importance of the region the Gulmarg and its neighborhood has been selected to study the phenology of woody ornamental flora for landscape use.

2. MATERIALS AND METHODS

The present investigations entitled "Study of phenology of ornamental flora of Gulmarg and its neighborhood for landscape use" were conducted during the year 2008, 2009 and 2010 in Gulmarg and its neighborhood areas of the Kashmir valley. Gulmarg is one of the rich turfs situated to the west of Srinagar at a distance of about 51 km. It extends between 74° 28$^{/}$to 74° 31$^{/}$ East longitude at an altitude of about 2676 m.asl. .Gulmarg's legendary beauty, prime location and proximity to Srinagar naturally make it one of Asia's premier hill resorts.

Studies on flowering phenology were conducted during three consecutive years (2007-08 through 2008-09). However data of two years are only presented (2008-09 as 1st-year and 2009-10 as 2nd- year). The year 2007-08 was utilized for preliminary survey and assessment in the natural habitats. In the present studies, survey and identification of native and introduced woody perennial species of ornamental values were made and observations on flower emergence, end of blooming and total duration were recorded from five representative specimen of each species wherever available by making exploratory trips fort nightly to four representative zones of Gulmarg and its neighborhood.

3. RESULTS

3.1 Deciduous Trees

From the perusal of data presented in Table 1, it is quite evident that none of the tree species showed any flower emergence in January and February during both years. In March during 1st-year flower emergence of only one tree species namely *Corylus colurna* was recorded in 3rd week of March.Similar results were recorded in second year. In both the years *Corylus colurna* remained presentable for maximum of 10 days.

In April, during 1st year flower emergence of 10 tree species were recorded. Out of which 5 species, belonging to genus Populus and Salix produced inconspicuous flowers. Flower emergence of remaining five species namely *Celtis australis, Morus alba, Parrotiopsis*

jacquemontiana, Platanus orientalis and *Quercus robur* were recorded in 4th week of April. Similar results were obtained during 2nd year also.

During 1st year, *Parrotiopsis jacquemontiana* remained presentable for 18 days followed by *Quercus robur* (16 days) and minimum in *Morus alba* (10 days). During 2nd year *Parrotiopsis jacquemontiana* remained presentable for 19 days followed by *Quercus robur* (18 days) and minimum in *Platanus orientalis* (07 days). On an average *Parrotiopsis jacquemontiana* remained presentable for maximum duration of 18.5 days followed by *Quercus robur* (17 days) and *Platanus orientalis* remained for minimum duration of 08.5 days followed by *Morus alba* (09 days).

In May, during 1st year flower emergence of 5 tree species were recorded. Out of which one species belonging to genus*betula* produced inconspicuous flowers. Flower emergence of *Acer caecium* and *Crataegus songarica* were observed in 3rd week of May and those of *Aesculus indica* and*Robina pseudoacacia* in 4th week of May. Similar results were observed during 2nd year.

During 1st year, *Aesculus indica* remained presentable for 23 days, followed by *Crataegus songarica* (22 days) and minimum in *Acer caecium* (10 days). During 2nd year *Aesculus indica* remained presentable for 24 days, followed by *Crataegus songarica* (22 days) and minimum in *Acer caecium* (08 days). On an average, *Aesculus indica* remained in bloom for longest period (23.5 days) followed by *Crataegus songarica* (22 days) and minimum in*Acer caecium* (09 days).

In June, during 1st year flower emergence of 3 tree species namely *Ailanthus altissima, Euonymous hamiltonianus* and *Prunus cornuta* were recorded in the 3rd week of June. Similar results were obseved during 2nd year.

During 1st year, *Ailanthus altissima* and *Euonymous hamiltonianus* remained presentable for maximum duration of 16 days and minimum in *Prunus cornuta* (15), during 2nd year *Ailanthus altissima* remained presentable for 18 days followed by *Prunus cornuta* (17 days) and minimum duration was observed in *Euonymous hamiltonianus* (15days). On an average maximum blooming duration (17 days) was noticed in *Ailanthus altissima* and minimum (15.5) in *Euonymous hamiltonianus.*

3.2 Broad Leaf Evergreen Trees

Flowering periodicity of broad leaf evergreen trees recorded during 2008-09 (1st year) and 2009-10 (2nd year) is presented in Table 1. From the perusal of data, it is quite evident that none of the tree species showed any flower emergence in January, February, March and April during both the years. Flower emergence of *Prunus lusitanica* was recorded in 4th week of May. Similar results were recorded in 2nd year.

During 1st year *Prunus lusitanica* remained presentable for 17 days and in 2nd year it remained presentable for 19 days. On an average *Prunus lusitanica* remained in bloom for maximum duration of 18 days.

3.3 Deciduous Shrubs

Flowering periodicity of deciduous shrubs recorded during two years of study is presented in Table 1. From the perusal of data, it is quite evident that none of the tree species showed any flower emergence in January, February, and March during both the years. In April, during 1st year flower emergence was recorded in 6 species. Out of which flower emergence of *Prunus prostrate* was recorded during 3rd week of April and flower emergence of 5 species namely *Cotoneaster baccillaris, Jasminum humile, Parrotiopsis jacquemontiana, Rosa foetida and Viburnum grandiflorum* were recorded during 4th week of April. Similar results were observed in during 2nd year.

In 1st year, *Jasminum humile* remained presentable for maximum duration of 62 days, followed by *Parrotiopsis jacquemontiana* and *Viburnum grandiflorum* (18 days) and minimum presentable duration was observed in *Prunus prostrate* (13 days). In 2nd year *Jasminum humile* remained presentable for maximum duration of 60 days, followed by *Parrotiopsis jacquemontiana, Cotoneaster baccillaris* and *Viburnum grandiflorum* (18 days) and minimum presentable duration was observed in *Prunus prostrate* (14 days). On an average maximum blooming duration (61 days) was noticed in *Jasminum humile* and minimum (13.5 days) in *Prunus prostrate.*

In May, during 1st year flower emergence of 6 species was recorded. Out of which flower emergence of 3 species were noticed during 3rd week of May and that of three species in 4th week of May. Similar results were recorded during 2nd year.

Table 1. Phenology of ornamental flora

S. no.	Name of the species	Flowering period				Durtion (days)		
		2008		2009				
		From	To	From	To	2008	2009	Av.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Deciduous trees							
	March							
1.	*Corylus colurna*	16-05-08	25-05-08	17-04-09	26-05-09	10	10	10
	April							
1.	*Celtis australis.*	28-04-08	08-05-08	26-04-009	05-05-09	11	10	10.5
2.	*Morus alba*	24-04-08	03-05-08	26-04-09	03-05-09	10	08	09
3.	*Parrotiopsis jacquemontiana*	24-04-08	11-05-08	25-04-09	13-05-09	18	19	18.5
4.	*Platanus orientalis*	25-04-08	04-05-08	25-04-09	01-05-09	10	07	08.5
5.	*Quercus robur*	25-04-08	10-05-08	24-04-09	11-05-09	16	18	17
	May							
1.	*Acer caecium*	16-05-08	25-05-08	15-05-09	22-05-09	10	08	09
2.	*Aesculus indica.*	24-05-08	15-06-08	24-05-09	16-06-09	23	24	23.5
3.	*Crataegus songarica*	18-05-08	08-06-08	16-05-09	06-06-09	22	22	22
4.	*Robina pseudo acacia*	28-05-08	17-06-08	27-05-09	18-06-09	21	23	22
	June							
1.	*Ailanthus altissima*	20-06-08	05-07-08	22-06-09	09-07-09	16	18	17
2.	*Euonymous hamiltonianus.*	15-06-08	30-06-08	15-06-09	29-06-09	16	15	15.5
3.	*Prunus cornuta*	20-06-08	04-07-08	21-06-09	04-07-09	15	17	16
2	**Broad leaf evergreen trees**							
	May							
1.	*Prunus lusitanica*	25-05-08	10-06-08	24-05-09	11-06-09	17	19	18
3	**Deciduous shrubs**							
	April							
1.	*Cotoneaster baccillaris*	25-04-08	10-05-08	24-04-09	11-05-09	16	18	17
2.	*Jasminum humile*	25-04-08	27-06-08	25-04-09	25-06-09	62	60	61
3.	*Parrotiopsis jacquemontiana*	28-04-08	15-05-08	26-04-09	12-05-09	18	18	18
4.	*Prunus prostrate*	20-04-08	02-05-08	21-04-09	04-05-09	13	14	13.5
5.	*Rosa foetida.*	25-04-08	08-05-08	22-04-09	06-05-09	16	17	16.5
6.	*Viburnum grandiflorum*	25-04-08	12-05-08	24-04-09	11-05-09	18	18	18
	May							
1.	*Berberis thunbergii* var. atropurpurea	22-05-08	04-06-08	22-05-09	01-06-09	13	10	11.5
2.	*Berberis vulgaris*	19-05-08	03-06-08	20-05-09	01-06-09	17	15	16
3.	*Cotoneaster microphyllus*	18-05-08	03-05-08	20-05-09	04-06-09	17	16	16.5
4.	*Cotoneaster numularia*	16-05-08	02-06-08	15-05-09	30-06-09	18	15	16.5
5.	*Lonicera quinquelocularis*	28-05-08	25-06-08	25-05-09	20-06-09	29	27	28
6.	*Ribes orientale*	20-05-08	05-06-08	20-05-09	07-06-09	17	19	18
	June							
1	*Euonymous hamiltonianus*	15-06-08	30-06-08	16-06-09	29-06-09	16	14	15
2.	*Indigofera heterantha*	21-06-08	16-07-08	22-06-09	17-07-09	25	25	25

Deciduous trees								
S. no.	Name of the species	Flowering period				Durtion (days)		
		2008		2009				
		From	To	From	To	2008	2009	Av.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
3.	*Rabdosia rugosa*	10-06-08	10-07-08	15-06-09	17-07-09	31	33	32
4.	*Rosa macrophylla*	23-06-08	09-07-08	25-06-09	12-07-09	17	18	17.5
5.	*Rosa webbiana*	28-06-08	12-07-08	27-06-09	11-07-09	15	15	15
6.	*Rubus fruticosus* var. discolor	22-06-08	05-07-08	25-06-09	10-07-09	14	16	15
7.	*Sorbaria tomentosa*	13-06-08	05-07-08	12-06-09	04-07-09	23	23	23
4.	**Broad leaf evergreen shrubs**							
	April							
1.	*Skimmia laureola*	18-04-08	5-05-08	20-04-09	07-05-09	19	19	19
5.	**Deciduous woody vines**							
	May							
1.	*Rosa multiflora*	23-05-08	03-06-08	22-05-09	02-06-09	12	12	12
	June							
1.	*Jasminum officinale*	15-06-08	05-07-08	14-06-09	03-07-09	21	20	20.5
6.	**Ground covers (deciduous shrubs)**							
	April							
1.	*Prunus prostrate*	20-04-08	02-05-08	20-04-09	04-05-09	13	15	14
2.	*Rosa foetida*	25-04-08	08-05-08	24-04-09	07-05-09	14	14	14
3.	*Viburnum grandiflorum*	25-04-08	12-05-08	27-04-09	15-05-09	18	19	18.5
	May							
1.	*Astragalus grahamianus*	25-05-08	25-06-08	23-05-09	22-06-09	31	30	30.5
2.	*Berberis thunbergii* var. atropurpurea	22-05-08	04-06-08	22-05-09	01-06-09	13	10	11.5
3.	*Cotoneaster microphyllus*	24-05-08	07-06-08	25-05-09	08-06-09	15	15	15
7.	**Ground cover (evergreen shrubs)**							
	April							
1.	*Skimmia laureola*	18-04-08	5-05-08	20-04-09	08-05-09	19	19	19

Note: The exact date of flowering of various woody species was not recorded as the flowers were not significant from aesthetic point of view. However, the month of bloom has been recorded for the following species.
Deciduous tree viz. species like Populus alba, Populus ciliate, Populus deltoids, Salix alba and Salix babylonica flowered during April-May and Betula utilis flowered during May-June.
Broad leaf evergreen tree Quercus baloot flowered during April -May
Narrow leaf evergreen trees viz. species like Abies pindrow, Abies spectabilis and Juniperus indica flowered during May-June, Picea smithiana, Pinus wallichiana and Taxus baccata flowered during April-May, Juniperus recurva flowered during June-Julywhile as Cedrus deodara flowered during September-October.
Narrow leaf evergreen Shrubs viz. species Juniperus indica flowered during May-June and Juniperus recurva flowered during June-July.
Ground covers including shrubs and vines viz. Hedera nepalensis flowered during October-November and Humulus lupulus flowered during September

In 1st year, *Lonicera quinquelocularis* remained presentable for maximum duration of 29 days, followed by *Cotoneaster numularia* (18 days) and minimum in *Berberis thunbergii* (13 days). In 2ndyear, *Lonicera quinquelocularis* remained presentable for maximum duration of 27 days, followed by *Ribes orientale* (19 days) and minimum in *Berberis thunbergii* (10 days). On an average *Lonicera quinquelocularis* remained in bloom for maximum duration of 28 days whereas, *Berberis thunbergii* remained presentable for minimum duration (11.5 days).

In June, 1st year flower emergence of 7 species was recorded. Out of which flower emergence of two species were recorded in 2nd week, two species in 3rd week and three species in 4th week of May. In 2nd year flower emergence of one

species *Sorbaria tomentosa* were recorded in 1st week, two species in 3rd week and four species i 4th week of May (Table 1).

In 1st year, *Rabdosia rugosa* remained presentable for maximum duration of 31 days, followed by *Indigofera heterantha* (25 days) and minimum in *Rubus fruticosus* var. discolor (14 days). In 2nd year, *Rabdosia rugosa* remained presentable for maximum duration of 33 days, followed by *Indigofera heterantha* (25 days) and minimum in *Euonymous hamiltonianus* (14 days). On an average *Rabdosia rugosa* remained in bloom for maximum duration of 32 days whereas, *Euonymous hamiltonianus, Rosa webbiana and Rubus fruticosus* var. discolour remained presentable for minimum duration (15 days) respectively.

3.4 Broad Leaf Evergreen Shrubs

Data of flowering periodicity of broad leaf evergreen shrubs recorded during two years of study is presented in Table 1. From the perusal of data, it is quite evident that none of the shrub species showed any flower emergence in January, February and March during both the years. In April flower emergence of *Skimmia laureola* was recorded in 3rd week of April. Similar results were recorded in 2nd year.In both the years, *Skimmia laureola* remained presentable for 19 days.

3.5 Deciduous Woody Vines

Flowering periodicity of deciduous woody vines recorded during 2008-09 (1st year) and 2009-10 (2nd year) is presented in Table 1. From the perusal of data, it is quite evident that none of the deciduous woody vines showed any flower emergence in January, February, March and April during both the years. During 1st year flower emergence of *Rosa multiflora*was recorded in 4th week of May. Similar results were recorded in 2nd year. .In both the years, *Rosa multiflora* remained presentable for 12 days.

In June, during 1st year flower emergence of *Jasminum officinale*was recorded in 3rdweek of June. In 2nd year, flower emergence of *Jasminum officinale*was recorded in 2nd week of June. *Jasminum officinale* remained presentable for maximum duration of 21 days during 1st year. In 2nd year, *Jasminum officinale* remained presentable for maximum duration of 20 days. On an average *Jasminum officinale* remained in bloom for maximum duration of 20.5 days.

3.6 Ground Covers (Deciduous Shrubs)

The phenology of different types of shrubs used as ground covers has been described in Table 1. From the perusal of data, it is quite evident that none of the shrubs showed any flower emergence in January, February and March during both the years. In April, during 1st year flower emergence was recorded in 3 species. Out of which flower emergence of *Prunus prostrate* was recorded during 3rd week of April and flower emergence of 2 species namely *Rosa foetida and Viburnum grandiflorum* were recorded during 4th week of April. Similar results were observed in during 2nd year.

In 1st year, *Viburnum grandiflorum* remained presentable for maximum duration of 18 days and minimum presentable duration was observed in *Prunus prostrate* (13 days). In 2nd year *Viburnum grandiflorum* remained presentable for maximum duration of 19 days, and minimum presentable duration was observed in *Rosa foetida* (14 days). On an average maximum blooming duration (18.5 days) was noticed in *Viburnum grandiflorum* and minimum (14 days) in *Prunus prostrate* and *Rosa foetida* respectively.

In May, during 1st year flower emergence of 3 species namely *Astragalus grahamianus, Berberis thunbergii* var. Atropurpurea and *Cotoneaster microphyllus* was recorded and flower emergence of all the 3 species were noticed during 4th week of May. Similar results were recorded during 2nd year.

In 1st year, *Astragalus grahamianus* remained presentable for maximum duration of 31 days and minimum in *Berberis thunbergii* var. Atropurpurea (13 days). In 2nd year, *Astragalus grahamianus* remained presentable for maximum duration of 30 days and minimum in *Berberis thunbergii*var. Atropurpurea (10 days). On an average *Astragalus grahamianus* remained in bloom for maximum duration of 30.5 days whereas, *Berberis thunbergii* remained presentable for minimum duration (11.5 days).

3.7 Ground Covers (Evergreen Shrubs)

The phenology of different types of shrubs used as ground covers has been described in Table 1. From the perusal of data, it is quite evident that none of the shrubs showed any flower emergence in January, February and March during both the years. In April flower emergence

of *Skimmia laureola* was recorded in 3rd week of April. Similar results were recorded in 2nd year.In both the years, *Skimmia laureola* remained presentable for 19 days.

4. DISCUSSION

Out of nineteen deciduous species, phenology was recorded in 13 species having conspicuous flowers. During both the years, none of the tree species under discussion bloomed in month of January and February (Table 1). Only one species *Corylus colurna* bloomed in the month of March and remained presentable for 10 days. During the month of April 26.3 percent of the species bloomed. Species like *Parrotiopsis jacquemontiana* remained presentable for 18.5 days. Further perusal of (Table 1) revealed that 21 per cent species bloomed in May and 15.7 per cent in June. The most magnificent specimen bloomed in June was *Prunus cornuta.* None of the deciduous tree species were in bloom from July to December at the sites under study. Out of two broad leaf evergreen species phenology was recorded in only one species having conspicuous flowers. *Prunus lusitanica* bloomed in the month of May and remained presentable for eighteen days.

Studies on phenology of deciduous shrubs revealed that none of the species bloomed in the month January, February, March, July, August, September, October, November and December (Table 1) during both the years. Out of the nineteen species under discussion, 31.5 per cent bloomed in the month of April. The finest flowering specimen like *Jasminum humile* was presentable for 61 days. About 31.5 per cent species bloomed in the month of May; 36.8 per cent in June and the most magnificent specimen was *Rosa macrophylla.* Similar study was also conducted by several authors [4,5].

Among the two broad leaf evergreen shrubs only one species has conspicuous flowers. *Skimmia laureola* bloomed in the month of April and remained presentable for 19 days. Out of three deciduous woody vines phenology of 2 deciduous vine species was recorded having conspicuous flowers. *Rosa multiflora* bloomed in the month of May and remained presentable for 12 days where as *Jasminum officinale* bloomed in the month of June and remained presentable for 20 days.

5. CONCLUSION

The studies on phenology of flowering revealed that large number of ornamentals flowered in the month of April (61.78%) followed by June (57.80%); May (45.34%); March (41.24%); July (34.34%); February (20.09%); August (16.67%); January (7.21%); September (6.90%), October (2%).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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