Environment and Ecology 37 (3) : 649—663, July—September 2019
Website: environmentandecology.com ISSN 0970-0420

# Floristic Conservation and Phenological Study on Some Valuable Medicinal Plant Species in Sadhuragiri Hills, Southern Western Ghats of Tamil Nadu, India

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Received 3 January 2019; Accepted 8 February 2019, Published on 28 February 2019

**Abstract** The document of various periodic behaviors of medicinal plant species or the phenology has great importance because it not only provides knowledge about the plant growth pattern but also provides the inferences on the effect of environment and selective pressure on flowering and fruiting behavior. In this document an attempt has been made to record such data regarding periods of medicinal plants leaf fall, leaf flushing, flowering, fruiting and all. Of the 165 taxa valuable medicinal plants occurring in the southern most hills (Sadhuragiri) of the Southern Western Ghats, Moist deciduous forest (34.5%), Semi evergreen forest (26.06%), Tropical thorn forest (18.18%), Low evergreen forest (16.36%) and Grass land (1.21%) vegetation types. In the study the leaf fall peak period was found in last part of March-July, leaf flushing peak period in the month of march where as flowering and fruiting activity peak period was found during the month of March—April and July–August respectively. So, this type of study will be helpful to give inferences in future whether the of climate change are giving pressure on the periodic behavior of medicinal plant species. Changed phenological behavior of plant species indicates the losing of plant diversity of the study region. Existing information on medicinal plants indicates habitat loss and has heightened they require for more proactive protection strategies. The need for adequate phenological information ahead of *ex-situ* conservation program is desirable. Low stocking density observed across the range and land use types is implicated for holistic conservation strategies and sustainability.

**Keywords** Phenology, Leaf fall, Leaf flush, Flowering, Fruiting.

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## Introduction

India is one of the mega biodiversity regions over the world. It also includes much plant diversity in different ecological areas followed by their environmental condition as well as adaptability of the plants in changeable climatic conditions. Plants are registered as efficient capability to regenerates as well as adjust in their variable localities. Plants diversity also supports the wealth of other species diversity in particular ecological areas and is remarkable for their major participation on environmental cleanup and supporting components for the presence and growth

of variable life forms. Plants are marked for their multifold utility in environment. On the basis of their importance for human beings are categorized as for food, fodder, fuel plants. Some plants also showing their efficiency to treat certain disorders these are referred as Medicinal and Aromatic plants (Patel 2014). India has well-off and diverse inheritance of biodiversity covering 10 bio-geographical zones. The Indian subcontinent is blessed with a wide variety of aromatic and medicinal plants. India natures enormous plant diversity and as many as 140 genera out of 5285 angiosperm species are endemic to the country (Botanical Survey of India 2001).

In nature it is often seen that each species has a specific period, month, season in a year during which its seeds germinate, seedlings grow or show maximum vegeative growth, leaves fall (if it is deciduous), flushing of new leaves, flowering and then fruiting. The study of all these periodic behavior of a species is called its phenology. In the life cycle of a plant each and every stage is greatly influenced by a number of environmental factors. The different stages of the plant species remain completely embedded in an environmental complex. It is very interesting to note that being fixed at a particular place, the requirement of germination, growth, flowering, fruiting, leaf fall of the species are met with at the same place but of course in different times of the year. There is a synchronization of phenological behavior of the species and the various factors of the surroundings that plants are spoken of biological clocks. This is mostly regulated by external signals from the environment. But the interactions of each and every species are different at different stages of their life cycle. Thus plant phenological study has great significance because it not only provides knowledge about the plant growth pattern but it also provides the idea on the effect of environment and selective pressure on flowering and fruiting behavior (Zhang et al. 2006).

Plants respond biologically to various parameters in the holocoenotic environment besides this, many extrinsic factors, e. g. the time of phenophase and seed dispersal are very important in distribution, survival and success in the establishment of a species in the community. Considering these facts, it is known that phenological studies are important for the conservation of genetic resources and forest management as well as for a better understanding of ecological capabilities of plant species and community-level interactions. Another important attribute which decides the establishment of a species is population size. This is redulated by an array of environmental factors. In this study we have observed the times of phenophase and determined the influence of environmental variables on the population density of uncommon medicinal plants (Sundriyal et al. 1987, Duraisamy and Palsumy 2010).

Majority of them are reported to have medicinal properties. With increasing interest in herbal medicines worldwide, conservation of medicinal plants has assumed considerable importance. Conservation efforts including inventorying and documentation of the available medicinal plant diversity is the need of the hour. The study of phenology of medicinal plants in intact tropical ecosystems is also important if we are to learn more about the dynamics of medicinal plant species evolving in particular ecosystems, as well as how they may be excluded or successful in adjacent ecosystems; it is necessary to study first how species operate within the context of their respective environments. The study of gender distribution is useful in assessing the breeding systems in any ecosystem. There are many works concerning the breeding systems of tropical and sub-tropical forests of other regions of the world (Bawa 1974, Bullock 1985, Croat 1979, Flores and Schemske 1984, Freeman et al. 1980, Sivaraj and Krishnamurthy 1989, Sivaraj 1991).

Flowering and fruiting behaviors which are typical medicinal plants, sound decisions in sustainable *in-situ* and *ex-situ* conservation and management program for indigenous medicinal plants will require detailed knowledge of not only their taxonomy, natural regeneration pattern but also their current population pattern and their reproductive biology over the years, it is evident that substantial medicinal plants collections come from the wild without corresponding efforts at enrichment plantings or deliberate efforts to protect the remaining the germplasm because most collectors believe that there will always be enough in their natural habitat. However recent field observations indicate depletion in their gene pool (Oni

2001, 2004 and 2010). The most useful and main source of botanical information of a particular area is its floristic checklists. Floristic composition is a good floristic marker, because any kind of changing floristic compositions in different endogenous milieu show the existence of different ecological factors; leads to inter and intra-specific diversity (Safidkon et al. 2003). Floristic study of any given area helps to evaluate the plant wealth and its potential values. The local plants identification and introduction of an area is very important to introduce the specific species of local area and their occurrence, growing seasons, finding new species and also the effect of climatic conditions like over-grazing, drought and temperature on vegetation (Ali 2008, Ahmad et al. 2008).

Conservation of medicinal plants in natural ecosystem has assumed considerable importance. Conservation efforts including investorying and documentation of the available medicinal plant diversity is the need of the hour. The learn of phenology of medicinal plants in intact tropical ecosystems is also important if we are to learn more about the dynamics of medicinal plant species evolving in particular ecosystems, as well as how they may be excluded or successful in adjacent ecosystems; it is necessary to study first how species operate within the context of their respective environments. The life history of plant species involves seed germination, vegetative growth, flowering, fruit formation, seed maturation, leaf fall, seed dispersal and death. Environmental factors influence the phonological events can be recorded diagrammatically month wise and season wise and provide valuable information (Barman et al. 2014).

Estimate that nearly 90% medicinal plants in use are collected the wild, in which 70% collection involves destructive harvesting. Habitat degradation due to prevailing biotic and non-biotic factors has caused to loss of various leaves of diversity and increasing risk of extinction to many high value species (Nayar and Sastry 1987, 1988 and 1990). Which need to understood to ascertain appropriate production site for any plant. Among important parameters, study of phenological behavior of any wild plants species, which is being targeted for cultivation is a pre-requisite exercise, it is helpful in developing and standardizing agrotechniques for targeted plant species. Identification of phenological stages in incredibly critical (Sanz–Cortes et al. 2002). Phenology on the other hand is the study of growth buds, leaf flushing anthesis, fruiting and leaf fall in relation to season or years with climatic factors. It is the relationship of plant growth stage and calanterdate. The calanter is based on the solar year. The information of phenology shows relationship of plant growth to seasonal changes and changes in leath of day light or photoperiod to program their growth stage and biological activities appropriated with the seasonal condition (Manske 2006).

The flowering and fruiting colud be correlated with climatic conditions for off spring's survival (Van Sachaik et al. 1993). The fruiting occurred at beings of rainy season which helps survival of seeds to the exposure to predators and provides maximum time to seedlings for development of root system. It is now widely accepted that different biological interactions and phylogeneitic relationships help in shaping the phenological patterns (Hamann 2004). Flowering time has been used as reproductive characters in taxonomic keys and in classification (Devis and Heywood 1973). Therefore plant phenology permits a calander to construct the growth activity of plants especially the period of new leaf bud, appearance of mature leaves, flowers, bud, appearance of mature leaves, flowers, bud initiation, formation of mature flowers, young fruits formation and seeds maturity. Hence, it is very important to know about the exact timing of various phonological events for a particular tree or shrub species to raise the nursery in time and for the need of animal and human being for various purpose (Das and Pandey 2007, Sundriyal et al. 1987).

The life history of plant species involves seed germination, vegetation, growth flowering, fruit formation, seed maturation, leaf fall, seed dispersal and death. A study of the date and time of occurrence of these events is called phenology. Environment factors influence the phenological events can be recorded diagrammatically monthwise and season wise and provide valuable information such as diagram is called a phenogram. Study of phenology is important from the point of view of the conservation of tree genetics resources and forestry management as well as better understanding of the ecological adoptions. The study

of plant phenological provides knowledge about the pattern of plant growth and development as well as the effect of environment and selective pressures on flowering and fruiting behavior (Zhang et al. 2005). Review of literature indicates that our understanding on phenological behavior of medicinal plants under cultivation is very poor (Butola and Badola 2007, Sefidkon et al. 2003, Butola 2009, Vashistha et al. 2006). Considering the significance of phenological studies of plant species of a locality the present work was undertaken over a period 3 years (2015—2017). This was carried out to understand the response of some medicinal plant species to climatic factors and the periodicity of seasons of the Sadhuragiri hills.

## Material and Methods

### Study area

Sadhuagiri hills are situated in Southern Western Ghats comes under The Srivilliputhur Grizzled Squirrel Wildling sanctuary Srivilliputhur Taluk, Virudhunagar and Theni district. The elevation of Sadhuragiri is 1900 meters (3,937.0 ft.) msl in Western Ghats of South India. It lies between 9°.42′ – 9°.44′′ West latitude and between 77°.37–77°.41′′ East longitude. Sadhuragiri is in an area with a Tropical evergreen forest, Semi evergreen forest and Mixed deciduous forest climate. The only tribal community residing in this region is Hindu Paliyar Tribes (Fig. 1).

### Methods

The flowering fruiting periods and gender distribution and breeding systems of 165 medicinal plants occurring in the vegetation were recorded during the year monthly field trips to the Sadhuragiri hills, Western Ghats. They were examined in relation to fruit type (fleshy or dry) and vegetation type (scrub, deciduous, semi-evergreen) and habit form (Arborescent and Herbaceous). Arborescent taxa included shrubs, woody climbers, lianas and trees, while herbaceous taxa comprised herbs, slender twiners, climbers, epiphytes and parasites. Nomenclature for designating various categories of gender distribution has been followed from Richards (1986). For purposes of correlative analyses polygamodioecious species were considered Dioecious, similarly Polygamomonoecious and Gynomonoecious species were considered Monoecious. For purpose of computation the taxa that flowered and fruited throughout the year were listed as flowering and fruiting in all months. In addition, data obtained from the following sources were used : Herbarium specimens available at the Botanical Survey of India (BSI) and Rapinat Herbarium (RHT). Published floras (Jain 1963, Gamble 1935, Matthew 1991, Nair 1983, Henry 1987. Field books available at the Botanical Survey of India, Coimbatore, with phenological notes on 90 days, distributed all through the year. Field books available at the Rapinat Herbarium, Triuchirappalli, with phenological notes on 40 days, for collection made in this area during the years 2015—2017.

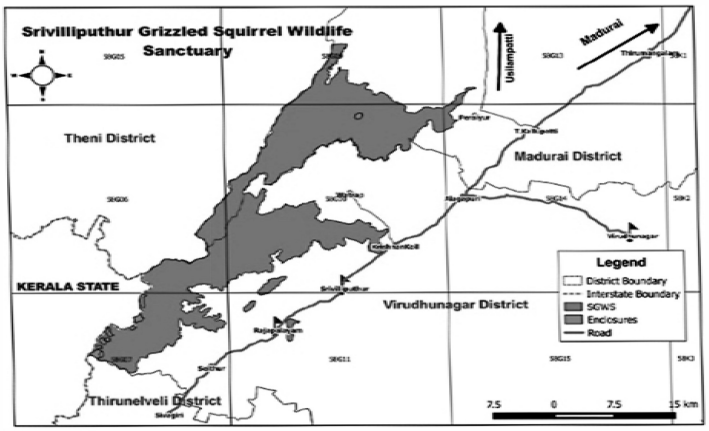


**Fig. 1.** The map over view of study region.

**Table 1.** List out the phenological study on the some medicinal plant species in Sadhuragiri hills. ALT and Vegetation type : Tropical thorn forest (300–500 m), Moist deciduous forest 500–700, Low evergreen forest (>800 m), Semievergreen forest >900, Grass land <1000, Growth form : Herbaceous–H, Arborscent–A breeding technology : Hermaphrodite –H, Monoecious–M, Dioecious–D, Polygamodioecious–Pd, Polygamomonoecious–Pm, Gynomonoecious–Gm, Fruit Type : DD–Dry dehiscent, DI–Dry indehiscent, F-Fleshy, F (l) – Fleshy (with one seeded), F (A) –Fleshy (with appendages).

| Sl. No. | Name of the plant species | Family | AI (m) | VT | GF | BT | Flowering period |
|---|---|---|---|---|---|---|---|
| 1. | *Abrus precatorius* L. | Fabaceae | 500 | TTE | H | H | Jan-Feb |
| 2. | *Abutilon indicum* (L.) Sweet | Malvaceae | 500 | TTE | A | H | Jan-Apr |
| 3. | *Abutilon polyandrum* (Roxb.) Wight & Arn. | Malvaceae | 700 | MDE | A | H | Jan-Apr |
| 4. | *Acacia nilotica* (L.) Willd. Ex Del. Subsp. Indica. | Mimosaceae | 500 | TTE | A | H | Aug-Nov |
| 5. | *Acacia planifrons* Wight & Arn. | Mimosaceae | 700 | MDF | H | H | Aug-Nov |
| 6. | *Acacia auriculiformis* Benth. | Mimosaceae | 700 | MDF | A | H | Aug-Nov |
| 7. | *Acalypha ciliata* Forrsk | Euphorbiaceae | 800 | LEF | H | M | Jan-Dec |
| 8. | *Acalypha indica* L. | Euphorbiaceae | 900 | SEF | H | M | Jan-Dec |
| 9. | *Acalypha racemosa* Wall. ex.Baill. | Euphorbiaceae | 800 | LEF | H | M | Jan-Dec |
| 10. | *Achyrannthes aspera* L. | Amaranthaceae | 500 | TTF | H | H | Jan-Dec |
| 11. | *Achyranthes bidentata* Blume | Amaranthaceae | 700 | MDF | H | H | Jan-Dec |
| 12. | *Adhatoda zeylanica* Medik. | Acanthaceae | 600 | MDF | H | H | Feb-Mar |
| 13. | *Aegle marmelos* (L.) Correa ex. Schultz | Rutaceae | 700 | MDF | A | H | Mar-May |
| 14. | *Aerva lanata* (L.) Juss.ex Schult. | Amaranthaceae | 600 | MDF | H | H | Jan-Mar |
| 15. | *Agave americana* L. | Agavaceae | 500 | TTF | A | H | Apr-May |
| 16. | *Ageratum conyzoides* L. | Asteraceae | 700 | MDF | H | H | Jan-Apr |
| 17. | *Alangium salviifolium* (L.f.) Wangerin | Alangiaceae | 800 | LEF | H | H | Feb-Apr |
| 18. | *Albizia lebbek* (L.) Benth | Mimosaceae | 600 | MDF | A | H | Feb-Apr |
| 19. | *Alstonia scholaris* (L.) R. Br. | Apocynaceae | 800 | LEF | A | H | Nov-Dec |
| 20. | *Alternanthera sessilis* (L.) R.Br. ex DC. | Amaranthaceae | 500 | TTF | H | H | Jan-Dec |
| 21. | *Alysicarpus vaginalis* (L.) DC. | Fabaceae | 500 | TTF | H | H | Jan-Dec |
| 22. | *Amaranthus spinosus* L. | Amaranthaceae | 600 | MDF | H | M | Jan-Dec |
| 23. | *Amaranthus viridis* L. | Amaranthaceae | 600 | MDF | H | M | Jan-Dec |
| 24. | *Anacardium occidentale* L. | Anacardiaceae | 500 | TTF | A | D | Feb-Mar |
| 25. | *Andrographis paniculata* (Burm.f.) Wall.ex.Nees | Acanthaceae | 700 | MDF | H | H | May-Jul |
| 26. | *Anisomeles malabarica* R.Br.ex.Sims. | Lamiaceae | 500 | TTF | H | H | Jan-Dec |
| 27. | *Annona reticulata* L. | Annonaceae | 800 | LEF | A | D | Dec-Mar |
| 28. | *Annona squamosa* L. | Annonaceae | 700 | MDF | A | D | Mar-May |
| 29. | *Apama siliquosa* Lam. | Aristolochiaceae | 800 | LEF | A | H | Mar-May |
| 30. | *Aristolochia bracteolata* Lam. | Aristolochiaceae | 500 | TTF | H | H | Feb-Apr |
| 31. | *Aristolochia indica* L. | Aristolochiaceae | 700 | MDF | H | H | Feb-Apr |
| 32. | *Asparagus racemosus* Willd. | Liliaceae | 700 | MDF | H | H | Oct-Nov |
| 33. | *Atalantia monophylla* (L.) Corr. Serr. | Rutaceae | 800 | LEF | A | H | Jan-Apr |
| 34. | *Averrhoa carambola* L. | Oxalidaceae | 900 | SEF | A | H | Feb-Mar |
| 35. | *Bacopa monneria* L.Wettst. | Scrophulariaceae | 800 | LEF | H | H | Jun-Sep |
| 36. | *Barleria buxifolia* L. | Acanthaceae | 500 | TTF | H | H | Jan-Mar |
| 37. | *Bauhinia racemosa* LAM. | Caesalpiniaceae | 800 | LEF | A | H | Jan-Mar |
| 38. | *Benkara malabarica* (LAM.) | Rubiaceae | 600 | MDF | A | H | Jan-Mar |
| 39. | *Biophytum sensitivum* (L.) DC. | Oxalidaceae | 1000 | GL | H | H | Sep-Oct |
| 40. | *Blepharis boerhaviifolia* Pers. | Acanthaceae | 700 | MDF | H | H | Jan-Feb |
| 41. | *Boerhaavia diffusa* L. | Nyctaginaceae | 500 | TTF | H | H | Oct-Nov |
| 42. | *Bombax pentandrum* JACQ. | Bombacaceae | 600 | MDF | A | H | Jan-Mar |
| 43. | *Boswellia glabra* Roxb. | Burseraceae | 700 | MDF | A | H | Jan-Apr |
| 44. | *Butea monosperma* (Lam.) Taub. | Fabaceae | 900 | SEF | A | H | Mar-Apr |
| 45. | *Calophyllum inophyllum* L. | Clusiaceae | 900 | SEF | A | H | Mar-Apr |
| 46. | *Calotropis gigantea* (L.) R.Br. | Asclepiadaceae | 500 | TTF | H | H | Feb-May |
| 47. | *Cannabis sativa* L. | Cannabinaceae | 700 | MDF | H | H | Jan-Mar |
| 48. | *Canthium coromandelicum* (N. Burm.) | Rubiaceae | 600 | MDF | A | H | Sep-Nov |
| 49. | *Canthium parviflorum* Lam. | Rubiaceae | 800 | LEF | H | H | Sep-Nov |
| 50. | *Capparis sepiaria* L. | Capparaceae | 700 | MDF | H | H | Mar-Apr |
| 51. | *Capparis zeylancia* L. | Capparaceae | 600 | MDF | H | H | Mar-Apr |

**Table 1.** Continued.

| Sl. No. | Name of the plant species | Family | AI (m) | VT | GT | BT | Flowering period |
|---|---|---|---|---|---|---|---|
| 52. | *Caralluma attemata* Wight | Asclepiadaceae | 800 | LEF | H | H | Apr-May |
| 53. | *Caralluma umbellata* Haw. | Asclepiadaceae | 700 | MDF | H | H | Apr-May |
| 54. | *Cardiospermum helicacabum* L. | Sapindaceae | 500 | TTF | H | H | Jan-Feb |
| 55. | *Careya arborea* Roxb. | Lecythidaceae | 800 | LEF | A | H | Mar-Apr |
| 56. | *Carissa carandas* L. | Apocynaceae | 500 | TTF | A | H | Feb-May |
| 57. | *Carissa spinarum* L. | Apocynaceae | 600 | MDF | A | H | Feb-May |
| 58. | *Caryota urens* L. | Palmaceae | 900 | SEF | A | H | Jan-Apr |
| 59. | *Cassia auriculata* L. | Caesalpiniaceae | 500 | TTF | A | H | Jan-Mar |
| 60. | *Cassia fistula* L. | Caesalpiniaceae | 700 | MDF | A | H | Jan-Mar |
| 61. | *Cassia tora* L. | Caesalpiniaceae | 700 | LEF | H | H | Jan-Mar |
| 62. | *Catharanthus roseus* (L.) G.Don | Apocynaceae | 600 | MDF | H | H | Jan-Dec |
| 63. | *Celastrus paniculatus* Willd. | Celastraceae | 800 | LEF | H | PM | Jan-Mar |
| 64. | *Centella asiatica* (L.) urban | Umbelliferae | 600 | MDF | H | H | Jan-Dec |
| 65. | *Ceropegia candelabrum* L. Subsp. | Asclepiadaceae | 900 | SEF | H | H | Apr-May |
| 66. | *Ceropegia juncea* Roxb. | Asclepiadaceae | 1000 | GL | H | H | Apr-May |
| 67. | *Chenopodium ambrosioides* L. | Chenopodiaceae | 900 | SEF | H | H | Jan-Dec |
| 68. | *Cissus quadragularis* L. | Vitaceae | 500 | TTF | H | H | Feb-Mar |
| 69. | *Clitoria ternatea* L. | Fabaceae | 500 | TTF | H | H | Jan-Dec |
| 70. | *Coccinia grandis* (L.) Voigt. | Cucurbitaceae | 500 | TTF | H | H | Jan-Dec |
| 71. | *Cocculus laurifolius* DC. | Menispermaceae | 700 | MDF | H | D | Feb-Mar |
| 72. | *Cyanthillium albicans* (DC.) H. Rob. | Asteraceae | 700 | MDF | H | H | Feb-May |
| 73. | *Cynodon dactylon* (L.) Pers. | Poaceae | 700 | MDF | H | H | Jan-Dec |
| 74. | *Dalbergia latifolia* Roxb. | Fabaceae | 800 | LEF | A | H | Jul-Aug |
| 75. | *Datura metel* L. | Solanaceae | 700 | MDF | H | H | Jan-Dec |
| 76. | *Decalapis hamiltonii* Wight & Arn. | Asclepiadaceae | 900 | SEF | A | H | Feb-Mar |
| 77. | *Desmodium triflorum* (L.) DC. | Fabaceae | 800 | LEF | H | H | Jan-Feb |
| 78. | *Dillenia indica* L. | Dilleniaceae | 900 | SEF | A | H | Mar-Apr |
| 79. | *Dioscorea pentaphylla* L. | Dioscoreaceae | 800 | LEF | H | M | Feb-Mar |
| 80. | *Diospyros ebenum* J.Koenig ex.Retz. | Ebenaceae | 800 | LEF | A | M | Mar-Apr |
| 81. | *Diospyros melanoxylon* Roxb. | Ebenaceae | 800 | LEF | H | M | Mar-Apr |
| 82. | *Diospyros montana* Roxb. | Ebenaceae | 800 | LEF | A | M | Mar-Apr |
| 83. | *Diospyros paniculata* Dalz | Ebenaceae | 700 | MDF | A | M | Mar-Apr |
| 84. | *Eclipta alba* (L.) Massk. | Asteraceae | 600 | MDF | H | GM | Jan-Feb |
| 85. | *Elaeocarpus recurvatus* Corner | Elaeocarpaceae | 900 | SEF | A | H | Apr-May |
| 86. | *Elaeocarpus tuberculats* Roxb. | Elaeocarpaceae | 800 | LEF | H | H | Apr-May |
| 87. | *Emblica officinalis* Gaertner | Euphorbiaceae | 900 | SEF | A | H | Mar-Apr |
| 88. | *Erythrina indica* L. | Fabaceae | 800 | LEF | A | H | Jan-Mar |
| 89. | *Euphorbia hirta* L. | Euphorbiaceae | 500 | TTF | H | M | Jan-Dec |
| 90. | *Evolvulus alsinoides* (L.) L. | Convolvulaceae | 600 | MDF | H | H | Jan-Dec |
| 91. | *Feronia elephantum* Corr.serr. | Rutaceae | 800 | LEF | A | H | Jan-Mar |
| 92. | *Ficus bendhalensis* L. | Moraceae | 700 | MDF | A | PM | Apr-May |
| 93. | *Givotia moluccana* (L.) Sreem. | Euphorbiaceae | 700 | MDF | A | H | Jan-Mar |
| 94. | *Gloriosa superba* L. | Liliaceae | 800 | LEF | H | H | Jan-Feb |
| 95. | *Gmelina arborrea* Roxb. | Verbenaceae | 600 | MDF | A | H | Jan-Mar |
| 96. | *Gmelina asiatica* L. | Verbenaceae | 800 | LEF | H | H | Jan-Feb |
| 97. | *Grewia flavescens* Juss | Tiliaceae | 700 | LEF | A | H | Mar-Apr |
| 98. | *Grewia hirsuta* vahl | Tiliaceae | 600 | MDF | A | H | Mar-Apr |
| 99. | *Grewia orientalis* L. | Tiliaceae | 800 | LEF | A | H | Mar-Apr |
| 100. | *Grewia tiliifolia* Vahl | Tiliaceae | 700 | LEF | A | H | Mar-Apr |
| 101. | *Gymnema sylvestre* (Retz.) R.Br. ex Schult | Asclepiadaceae | 700 | MDF | H | H | Jan-Mar |
| 102. | *Helicteres isora* L. | Sterculiaceae | 800 | LEF | A | H | Sep-Dec |
| 103. | *Hemidesmus indicus* (L.) R. Br. | Asclepiadaceae | 800 | LEF | H | H | Jan-Mar |
| 104. | *Hibiscus vitifolius* L. | Malvaceae | 500 | TTF | H | H | Jan-Feb |
| 105. | *Hibiscus canescens* B. Heyne ex Wall. | Malvaceae | 600 | MDF | H | H | Jan-Feb |
| 106. | *Hibiscus ovalifolius* (Forssk.) Vahl | Malvaceae | 600 | MDF | H | H | Jan-Feb |

**Table 1.** Continued.

| Sl. No. | Name of the plant species | Family | AI (m) | VT | GT | BT | Flowering period |
|---|---|---|---|---|---|---|---|
| 107. | *Hibiscus planifolius* Sweet | Malvaceae | 800 | LEF | H | H | Jan-Feb |
| 108. | *Hybanthus enneasper mus* (L.) F. Muell. | Violaceae | 700 | MDF | H | H | Mar-Apr |
| 109. | *Hydnocarpus macrocapra* (Bedd.)Warp | Flacourtiaceae | 800 | LEF | A | H | Feb-Apr |
| 110. | *Hyptis suaveolens* (L.) Poit | Lamiaceae | 500 | TTF | H | H | Jan-Feb |
| 111. | *Ichnocarpus frutescens* (L.)W.T.Aiton | Apocynaceae | 700 | MDF | H | H | Jan-Mar |
| 112. | *Jatropha curcas* L. | Euphorbiaceae | 800 | LEF | A | M | Jan-Mar |
| 113. | *Justicia gendarussa* Burm.f. | Acanthaceae | 500 | TTF | H | H | Jan-Mar |
| 114. | *Leonotis nepetiifolia* (L.) R. Br. | Lamiaceae | 900 | SEF | H | H | Jan-Feb |
| 115. | *Leucas lanceifolia* Desf. | Lamiaceae | 900 | SEF | H | H | Jan-Feb |
| 116. | *Leucas biflora* (Vahl) Sm. | Lamiaceae | 900 | SEF | H | H | Jan-Feb |
| 117. | *Lindernia parviflora* (Roxb.) Haines | Scrophulariaceae | 600 | MDF | H | H | Jan-Feb |
| 118. | *Mallotus philippensis* Muell. Arg. | Euphorbiaceae | 900 | SEF | A | D | Jan-Dec |
| 119. | *Melia azedarach* L. | Meliaceae | 700 | MDF | A | H | Mar-Apr |
| 120. | *Michelia champaca* L. | Magnoliaceae | 800 | LEF | A | H | Mar-Apr |
| 121. | *Miliusa eriocarpa* Dunn | Annonaceae | 900 | SEF | A | H | Jan-Mar |
| 122. | *Mimosa pudica* L. | Mimosaceae | 800 | LEF | H | PM | Jan-Feb |
| 123. | *Mucuna prurita* Hook. | Fabaceae | 900 | SEF | H | H | Mar-Apr |
| 124. | *Murraya koenigii* (L.) Spreng. | Rutaceae | 700 | MDF | A | H | Jan-Mar |
| 125. | *Murraya paniculata* (L.) Jack | Rutaceae | 800 | LEF | A | H | Jan-Mar |
| 126. | *Ocimum canum* Sims. | Lamiaceae | 500 | TTF | H | H | Feb-Mar |
| 127. | *Oldenlandia corymbose* L. | Rubiaceae | 500 | TTF | H | H | Feb-Mar |
| 128. | *Orthosiphon thymiflorus* (Roth) Sleesen | Lamiaceae | 900 | SEF | H | H | Jan-Mar |
| 129. | *Oxalis corniculata* L. | Oxalidaceae | 900 | SEF | H | H | Jan-Mar |
| 130. | *Passiflora foetida* L. | Passifloraceae | 700 | MDF | H | H | Mar-Apr |
| 131. | *Pavetta indica* L. | Rubiaceae | 600 | MDF | A | H | Jan-Feb |
| 132. | *Phyllanthus virgatus* G. Forst. | Euphorbiaceae | 800 | LEF | H | M | Jan-Feb |
| 133. | *Pithecolobium dulce* (Roxb.) Benth | Mimosaceae | 800 | LEF | A | PM | Jan-Feb |
| 134. | *Plectranthus coleoides* Benth. | Lamiaceae | 700 | MDF | H | H | Mar-Apr |
| 135. | *Plumbago zeylanica* L. | Plumbaginaceae | 800 | LEF | H | H | Feb-Mar |
| 136. | *Polygala arvensis* Willd. | Polygalaceae | 800 | LEF | H | H | Jan-Feb |
| 137. | *Portulaca oleracea* L. | Portulacaceae | 500 | TTF | H | H | Feb-Mar |
| 138. | *Premna tomentosa* Willd. | Verbenaceae | 900 | SEF | A | H | Feb-Mar |
| 139. | *Psilanthus wightianus* (Wall.ex Wight & Arn.) J. F. Leroy | Rubiaceae | 700 | MDF | H | H | Feb-Mar |
| 140. | *Pterocarpus marsupium* Roxb. | Fabaceae | 900 | SEF | A | H | Sep-Oct |
| 141. | *Ricinus communis* L. | Euphobiaceae | 500 | TTF | A | H | Jan-Feb |
| 142. | *Rubia cordifolia* L. | Rubiaceae | 600 | LEF | H | H | Mar-Apr |
| 143. | *Smilax wightii* A. DC. | Smilacaceae | 800 | LEF | H | H | Mar-Apr |
| 144. | *Solanum nigrum* L. | Solanaceae | 500 | TTF | H | H | Feb-Mar |
| 145. | *Solanum pubescens* Ruiz & Pav. | Solanaceae | 600 | MDF | H | H | Feb-Mar |
| 146. | *Syzygium cuminii* (L.) Skeels. | Myrtaceae | 800 | LEF | A | H | Jun-Jul |
| 147. | *Tephrosia purpurea* (L.) Pers. | Fabaceae | 500 | TTF | H | H | Jan-Feb |
| 148. | *Terminalia bellirica* (Gaertn. ) Roxb. | Combretaceae | 900 | SEF | A | PM | Mar-May |
| 149. | *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn. | Combretaceae | 900 | SEF | A | PM | Mar-Apr |
| 150 | *Terminalia chebula* Retz. | Combretaceae | 900 | SEF | A | PM | Mar-Apr |
| 151 | *Tinospora cordifolia* (Thunb.) Miers. | Menispermaceae | 600 | MDF | H | D | Jan-Feb |
| 152. | *Trema orientalis* (L.) Blume | Ulmaceae | 900 | SEF | A | D | Mar-Apr |
| 153. | *Tribulus terrestris* L. | Zygophyllaceae | 500 | TTF | H | H | Jan-Feb |
| 154. | *Trichodesma zeeylanicum* (Burm.f.) | Boraginaceae | 700 | MDF | H | H | Jan-Feb |
| 155. | *Vanda tessellata* (Roxb.) Don. | Orchidaceae | 700 | MDF | H | H | Jan-Feb |
| 156. | *Ventilago maderasptana* Gaertner | Rhamnaceae | 500 | TTF | H | H | Feb-Mar |
| 157. | *Viscum angulatum* B. Heyne ex DC. | Viscaceae | 800 | LEF | H | H | Jan-Feb |
| 158. | *Vitex negundo* L. | Verbenaceae | 500 | TTF | A | H | Feb-Mar |
| 159. | *Walsure trifoliolata* (A. Juss.) Harms | Meliaceae | 900 | SEF | A | H | Jan-Feb |
| 160. | *Waltheria indica* L. | Sterculiaceae | 900 | SEF | A | H | Feb-Mar |

**Table 1.** Continued.

| Sl. No. | Name of the plant species | Family | AI (m) | VT | GT | Bt | Flowering period |
|---|---|---|---|---|---|---|---|
| 161. | *Withania somniferum* (L.) Dunal | Solanaceae | 700 | MDF | H | H | Jan-Feb |
| 162 | *Wrightia tinctoria* (Roxb.) R. Br. | Apocynaceae | 800 | LEF | A | H | Mar-Apr |
| 163. | *Xanthium indicum* KOEN. | Asteraceae | 700 | MDF | H | M | Jan-Feb |
| 164. | *Ziziphus oenoplia* (L.) Miller | Rhamnaceae | 500 | TTF | A | H | Feb-Mar |
| 165. | *Zizyphus nummularia* (Burm. F.) Wights | Rhamnaceae | 700 | MDF | A | H | Feb-Mar |

**Table 1.** Continued.

| Sl. No. | Fruiting period | FT | Leaf fall period | Leaf flush period | Conservat - tive part | Reproductive cost Seed setting | Seed germinative |
|---|---|---|---|---|---|---|---|
| 1. | Mar-Apr | DD | May-Jun | Oct-Nov | Seed | Minimum | Poor |
| 2. | Mar-May | DD | Jun-Aug | Oct-Dec | Seed | Maximum | Very good |
| 3. | Mar-May | DD | Jun-Aug | Oct-Dec | Seed | Maximum | Very good |
| 4. | Sep-Nov | DD | Mar-May | Jan-Dec | Seed | Minimum | Good |
| 5. | Sep-Nov | DD | Apr-Jun | Jan-Dec | Seed | Minimum | Good |
| 6. | Sep-Nov | DD | Mar-May | Jan-Dec | Seed | Minimum | Good |
| 7. | Jan-Dec | D | Jan-Dec | Jan-Dec | Seed | Few | Good |
| 8. | Jan-Dec | D | Jan-Dec | Jan-Dec | Seed | Few | Good |
| 9. | Jan-Dec | D | Jan-Dec | Jan-Dec | Seed | Few | Good |
| 10. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 11. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Minimum | Very good |
| 12. | Apr-May | D | Jun-Aug | Aug-Sep | Seed | Few | Good |
| 13. | May-Jun | F (A) | Dec-Jan | Dec-Jan | Seed | Minimum | Poor |
| 14. | Jan-Apr | DD | Dec-Jan | Dec-Jan | Rhizome | Maximum | Good |
| 15. | May-Jun | DD | | | Stem/Seed | Few | Good |
| 16. | Jan-May | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 17. | Mar-Jun | F (I) | Dec-Jan | Mar-Apr | Seed | Average | Very good |
| 18. | Mar-Jun | DD | Dec-Jan | Feb-Apr | Seed | Minimum | Good |
| 19. | Jan-Mar | DD | Feb-Apr | May-Jul | Stem | Minimum | Good |
| 20. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 21. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Minimum | Good |
| 22. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 23. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 24. | Apr-May | FI | Sep-Oct | Nov-Dec | Seed | Minimum | Good |
| 25. | Aug-Sep | DD | Jan-Feb | Mar-Apr | Seed | Average | Good |
| 26. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed | Maximum | Good |
| 27. | Jan-May | DD | Mar-Jun | Nov-Dec | Seed | minimum | Good |
| 28. | Aug-Nov | F (A) | Jan-Feb | Mar-Apr | Seed | Minimum | Good |
| 29. | Aug-Nov | F (A) | Jan-Feb | Mar-Apr | Seed | Average | Poor |
| 30. | Mar-May | DI | Jan-Feb | Apr-May | Seed | Minimum | Poor |
| 31. | Mar-May | DI | Jan-Feb | Apr- May | Seed | Minimum | Poor |
| 32. | Sep-Jan | DD | Jun-Aug | Jun-Oct | Tuber | Few | Very good |
| 33. | Feb-May | DI | Jan-May | Apr-May | Seed | Minimum | Good |
| 34. | Mar-Apr | DI | Feb-Mar | Mar-Apr | Seed | Minimum | Good |
| 35. | Oct-Dec | DD | Jun-Jul | Aug-Sep | seed | Minimum | Good |
| 36. | Feb-May | DI | Sep-Jan | May-jun | Seed | Minimum | Good |
| 37. | Feb-Jun | F (I) | Sep-Jan | May-Jun | Seed | Minimum | Good |
| 38. | Feb-Jun | DI | Sep-Jan | May-Jun | Seed | Maximum | Good |
| 39. | Nov-Dec | DD | Jun-Jul | Aug-Sep | Seed | Few | Poor |
| 40. | Feb-Mar | DD | Sep-Oct | Nov-Dec | Seed | Minimum | Good |
| 41. | Jan-Apr | DI | Aug-Sep | Oct-Dec | Seed | Minimum | Good |
| 42. | Mar-Jun | DI | Sep-Oct | Nov-Dec | Seed | Minimum | Good |
| 43. | Mar-Jul | F (I) | Aug-Sep | Oct-Jan | Seed | Few | Very poor |

**Table 1.** Continued.

| Sl. No. | Fruiting period | FT | Leaf fall period | Leaf flush period | Conservative part | Reproductive cost | |
|---|---|---|---|---|---|---|---|
| | | | | | | Seed setting | Seed germinative |
| 44. | Apr-Jun | F (I) | Jan-Feb | Feb-Mar | Seed | Minimum | Poor |
| 45. | May-Apr | DD | Jan-Dec | Jan-Dec | Seed | Minimum | Good |
| 46. | May-Aug | DD | Nov-Dec | Jan-Feb | Seed | Minimum | Good |
| 47. | May-Jul | DI | Oct-Nov | Nov-Jan | Seed | Few | Poor |
| 48. | Jan-Apr | F (I) | Apr-Jun | Apr-Jun | Seed | Few | Good |
| 49. | Jan-Apr | F (I) | Dec-Mar | Apr-Jun | Seed | Minimum | Good |
| 50. | Apr-Jul | F (A) | Jan-Mar | Mar-Aug | Seed | Minimum | Good |
| 51. | Apr-Jul | F (A) | Jan-Mar | Mar-Aug | Seed | Few | Poor |
| 52. | May-Jun | DD | Jan-Mar | Feb-May | Bulb | Few | Very poor |
| 53. | May-Aug | DD | Jan-Mar | Feb-May | Bulb | Few | Very poor |
| 54. | Mar-Apr | DI | Jul-Aug | Aug-Sep | Seed | Minimum | Good |
| 55. | Apr-Jun | F | Jan-Feb | Mar-Apr | Seed | Few | Poor |
| 56. | Mar-Jun | F | Jan-Mar | Mar-May | Seed | Minimum | Good |
| 57. | Mar-Jun | F | Jan-Mar | Mar-May | Seed | Few | Poor |
| 58. | Feb-Jun | F (I) | Apr-May | Jul-Sep | Seed | Few | Poor |
| 59. | Feb-May | DI | Oct-Nov | Nov-Dec | Seed | Maximum | Good |
| 60. | Feb-May | DI | Oct-Nov | Nov-Dec | Seed | Minimum | Good |
| 61. | Feb-May | DI | Oct-Nov | Nov-Dec | Seed | Minimum | Good |
| 62. | Jan-Dec | DD | Jan-Dec | Jan-Dec | Seed | Maximum | Very good |
| 63. | Mar-May | F (A) | Sep-Oct | Oct-Nov | Seed | Minimum | Good |
| 64. | Jan-Dec | DI | | | Seed | Maximum | Very good |
| 65. | Jun-Aug | DD | Sep-Oct | Jan-Feb | Tuber | Few | Very poor |
| 66. | Jun-Aug | DD | Sep-Oct | Jan-Feb | Tuber | Few | Very poor |
| 67. | Jan-Dec | DI | Sep-Oct | Jan-Feb | Seed | Average | Good |
| 68. | Apr-May | F | Sep-Nov | Jun-Jul | Stem | Minimum | Good |
| 69. | Jan-Dec | DI | Sep-Oct | Jan-Feb | Seed | Minimum | Good |
| 70. | Jan-Dec | F (A) | Sep-Oct | Jan-Feb | Seed | Maximum | Good |
| 71. | Apr-May | F | Sep-Nov | Jun-Jul | Seed | Maximum | Good |
| 72. | Mar-Jun | F (I) | Jan-Mar | Mar-may | Seed | Minimum | Good |
| 73. | Jan-Dec | DI | May-Jul | Jun-Sep | Seed/Rhizome | Maximum | Very good |
| 74. | Aug-Oct | DD | May-jul | Jun-Sep | Seed | Few | Poor |
| 75. | Jan-Dec | DD | May-Jul | Jun-Sep | Seed | Minimum | Good |
| 76. | Apr-May | DD | Mar-apr | Apr-Jun | Seed | Few | Poor |
| 77. | Feb-Apr | DD | Nov-Dec | Apr-May | Seed | Minimum | Good |
| 78. | Apr-Jun | DI | Jan-Mar | May-Jun | Seed/Stem | Minimum | Poor |
| 79. | Mar-May | DD | Jan-Feb | Mar-May | Bulb | Few | Poor |
| 80. | Apr-Jun | F | Jan-Mar | Feb-Apr | Seed | Few | Poor |
| 81. | Apr-Jun | F | Jan-Mar | Feb-Apr | Seed | Few | Poor |
| 82. | Apr-Jun | F | Jan-Mar | Feb-Apr | Seed | Few | Very poor |
| 83. | Apr-Jun | F | Jan-Mar | Feb-Apr | Seed | Few | Poor |
| 84. | Mar-Apr | DI | Oct-Nov | Nov-Dec | Seed | Maximum | Very good |
| 85. | May-Jul | F (I) | Jan-Mar | Feb-Apr | Seed | Few | Nil |
| 86. | May-Jul | F (I) | Jan-Mar | Feb-Apr | Seed | Few | Nil |
| 87. | Apr-Jun | F (I) | Jan-Feb | Feb-Mar | Seed | Minimum | Good |
| 88. | Mar-Apr | DD | Aug-Sep | Nov-Dec | Seed/Stem | Average | Good |
| 89. | Jan-Dec | F (A) | Jan-Dec | Jan-Dec | Seed | Minimum | Very good |
| 90. | Jan-Dec | DD | Jan-Dec | Jan-Dec | Seed | Minimum | Very Good |
| 91. | Apr-May | F | Nov-Dec | Feb-Mar | Seed | Minimum | Good |
| 92. | May-Jul | DI | Jan-Mar | Mar-Apr | Stem/Seed | Maximum | Very poor |
| 93. | May-Jul | DI | Oct-Dec | Mar-Apr | Seed/Stem | Minimum | Poor |
| 94. | Mar-Apr | DD | Sep-Oct | Nov-Dec | Seed | Minimum | Good |
| 95. | Mar-Apr | DD | Sep-Oct | Nov-Dec | Seed | Minimum | Good |
| 96. | Mar-Apr | DD | Apr-May | Jun-Jul | Seed | Minimum | Good |
| 97. | May-Jun | F (I) | Jul-Aug | Sep-Oct | Seed | Minimum | Poor |
| 98. | May-Jun | F (I) | Jul-Aug | Sep-Oct | Seed | Minimum | Poor |

**Table 1.** Continued.

| Sl. No. | Fruiting period | FT | Leaf fall period | Leaf flush period | Conservative part | Reproductive cost | |
|---|---|---|---|---|---|---|---|
| | | | | | | Seed setting | Seed germinative |
| 99. | May-Jun | F (I) | Jul-Aug | Sep-Oct | Seed | Minimum | Poor |
| 100. | May-Jun | F (I) | Jul-Aug | Sep-Oct | Seed | Minimum | Poor |
| 101. | Mar-Apr | DD | Sep-Oct | Nov-Dec | Seed | Few | Poor |
| 102. | Dec-Mar | DD | Jan-Apr | Jun-Aug | Seed | Few | Nil |
| 103. | Mar-Apr | DD | Sep-Oct | Nov-Dec | Root/Stem | Few | Very poor |
| 104. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Seed | Minimum | Good |
| 105. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Seed | Minimum | Good |
| 106. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Seed | Minimum | Good |
| 107. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Seed | Minimum | Good |
| 108. | Apr-May | DI | Aug-Sep | Oct-Nov | Seed | Few | Poor |
| 109. | Apr-May | F (I) | Jun-Jul | Aug-Sep | Seed | Few | Poor |
| 110. | Mar-Apr | DD | May-Jun | Jun-Aug | Seed | Maximum | Very good |
| 111. | Mar-Apr | DD | Jun-Jul | Aug-Sep | Seed | Few | Very poor |
| 112. | Mar-Apr | DI | Jun-Jul | Aug-Sep | Seed/Stem | Minimum | Very good |
| 113. | Mar-Apr | DI | Jun-Jul | Aug-Sep | Seed | Minimum | Good |
| 114. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Seed | Minimum | Poor |
| 115. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 116. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 117. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 118. | Jan-Dec | DI | Jan-Dec | Jan-Dec | Seed/Stem | Minimum | Good |
| 119. | Apr-May | F (I) | Jun-Jul | Aug-Sep | Seed/Stem | Maximum | Very good |
| 120. | Apr-May | DD | Jun-Jul | Aug-Sep | Seed/Stem | Few | Poor |
| 121. | Mar-May | F (I) | May-Aug | Aug-Oct | Seed | Few | Poor |
| 122. | Feb-Apr | DD | May-Aug | Aug-Oct | Seed | Maximum | Very good |
| 123. | Apr-May | DI | Jun-Jul | Aug-Sep | Seed | Few | Good |
| 124. | Mar-Apr | F (I) | Jun-Jul | Aug-Sep | Seed | Minimum | Good |
| 125. | Mar-Apr | F (I) | Jun-Jul | Aug-Sep | Seed | Minimum | Good |
| 126. | Mar-Apr | DI | Jul-Sep | Aug-Nov | Seed | Maximum | Very good |
| 127. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Very good |
| 128. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Very good |
| 129. | Mar-Apr | F (A) | May-Aug | Aug-Oct | Seed | Minimum | Good |
| 130. | Apr-May | F (A) | Jun-Jul | Aug-Sep | Seed | Minimum | Good |
| 131. | Mar-Apr | F (I) | Jul-Sep | Aug-Nov | Seed | Maximum | Good |
| 132. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 133. | Mar-Apr | F (I) | Jul-Sep | Aug-Nov | Seed | Maximum | Good |
| 134. | Apr-May | DD | Jun-Jul | Aug-Sep | Seed | Minimum | Good |
| 135. | Mar-Apr | DI | Jul-Sep | Oct-Nov | Seed | Average | Poor |
| 136. | Mar-Apr | DI | Jun-Aug | Oct-Dec | Seed | Few | Good |
| 137. | Mar-May | DD | May-Jun | Jul-Aug | Seed/Stem | Minimum | Good |
| 138. | Mar-May | DD | May-Jun | Jul-Aug | Seed | Minimum | Poor |
| 139. | Mar-Apr | F (A) | Jul-Sep | Aug-Nov | Seed | Minimum | Poor |
| 140. | Oct-Nov | F | Jan-Feb | Mar-Apr | Seed | Minimum | Poor |
| 141. | Mar-Apr | DI | Jun-Aug | Oct-Dec | Seed | Maximum | Very good |
| 142. | Mar-May | DD | May-Jun | Jul-Aug | Seed | Minimum | Good |
| 143. | Apr-Jun | DI | Aug-Sep | Oct-Nov | Seed | Minimum | Poor |
| 144. | Mar-Apr | F | Jul-Sep | Aug-Nov | Seed | Maximum | Very good |
| 145. | Mar-Apr | F | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 146. | Jul-Aug | F | Mar-Apr | Apr-May | Seed | Minimum | Good |
| 147. | Mar-Apr | DI | Jun-Aug | Oct-Dec | Seed | Maximum | Very good |
| 148. | Apr-May | DD | Jun-Jul | Aug-Sep | Seed | Minimum | Poor |
| 149. | Apr-May | DD | Jun-Jul | Aug-Sep | Seed | Minimum | Poor |
| 150. | Apr-May | F (I) | Jun-Jul | Aug-Sep | Seed | Few | Very good |
| 151. | Mar-Apr | F (A) | Jul-Sep | Aug-Nov | Seed | Average | Poor |
| 152. | Apr-May | F (I) | Jun-Jul | Aug-Sep | Seed | Few | Poor |
| 153. | Mar-May | D | Aug-Nov | Jul-Sep | Seed | Maximum | Very good |

**Table 1.** Continued.

| Sl. No. | Fruiting period | FT | Leaf fall period | Leaf flush period | Conservative part | Reproductive cost | |
|---|---|---|---|---|---|---|---|
| | | | | | | Seed setting | Seed germinative |
| 154. | Mar-Apr | F (I) | Jun-Aug | Oct-Dec | Seed | Minimum | Very good |
| 155. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Bud | Few | Poor |
| 156. | Mar-Apr | F (I) | Jul-Sep | Aug-Nov | Seed | Minimum | Poor |
| 157. | Mar-Apr | DD | Jun-Aug | Oct-Dec | Stem | Few | Poor |
| 158. | Mar-Apr | DD | Jul-Sep | Aug-Nov | Seed/Stem | Minimum | Good |
| 159. | Mar-Apr | DI | Jun-Aug | Oct-Dec | Seed | Minimum | Good |
| 160. | Apr-May | DD | Jul-Sep | Aug-Nov | Seed | Few | Poor |
| 161. | Mar-Apr | F | Jul-Aug | Aug-Sep | Seed | Minimum | Good |
| 162. | Apr-May | DI | Jun-Jul | Jul-Aug | Seed/Stem | Minimum | Good |
| 163. | Mar-Apr | DI | Jun-Aug | Oct-Dec | Seed | Average | Poor |
| 164. | Apr-May | F (I) | Jul-Sep | Aug-Nov | Seed | Minimum | Good |
| 165. | Apr-May | F (I) | Jul-Sep | Aug-Nov | Seed | Minimum | Good |

## Results and Discussion

The study of floristic ecology and phenology of medicinal plants in intact tropical ecosystems is important to understand the dynamics of medicinal plant species evolving in particular ecosystems. The Southern most hill of the Western Ghats, Sadhuragiri comprises 165 taxa in distribution as Moist deciduous forest (34.5%), Semi evergreen forest (26.06%), Tropical thorn forest (18.18%), Low evergreen forest (16.36%) and Grass land (1.21%) vegetation types. Among the gender distribution, hermaphrodite category dominated (82%) in the medicinal flora followed by monoecy (8.4%) and dioecy (4.2%) (Table 1 and Fig.2).

Popular medicinal arborescent taxa was found to flower during the months of March and April (dry period) and only a few are in bloom during August and December, while herbaceous taxa flowered during December-February. Majority of tree taxa were found in fruit during the dry season (April-May) with a peak during April while the herbaceous medicinal plants fruited during March-June (Fig. 3). The nature of fruits types recorded was Dry dehiscent (66 sps), Dry indehiscent (43 sps), Fleshy (with one seeded) (29 sps), Fleshy (15 sps), Fleshy (with appendages) (12 sps). Higher temperature conditions were observed to be conducive to flowering and fruiting among the arborescent taxa, whereas cooler conditions were favorable for herbaceous taxa. In Sadhuragiri hills, the fruiting phenology pattern closely follows that of the flowering.

The majority of tree taxa fruits for the period of the dry season with a peak during April-May while the peak fruiting period recorded for herbaceous taxa was during January-February. The time interval between flowering and fruiting was normally 30—55

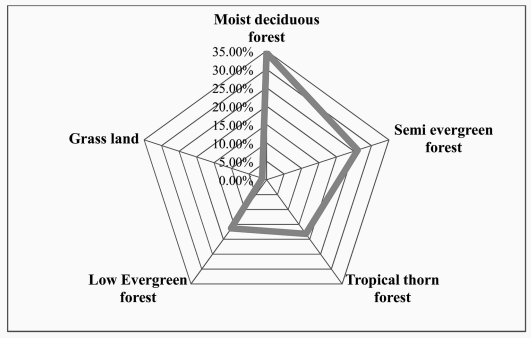


**Fig. 2.** Distribution of phenology study some medicinal plants accumulated different forest types.

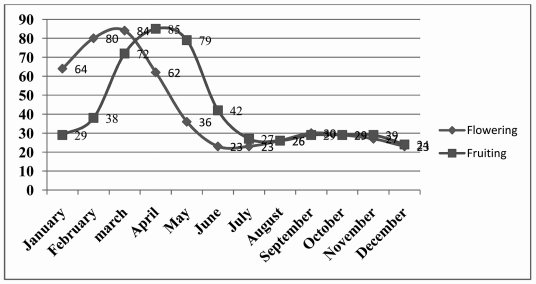


**Fig. 3.** Flowering and Fruiting pattern in some medicinal plants of Sadhuragiri hills.

days. Three species viz., *Buddleja asiatica* (Buddlejaceae), *Cissus quadrangularis* (Vitaceae) and *Ricinus communis* (Euphorbiaceae) were observed to flower and fruit throughout the year while 5 species namely *Mallotus phillipensis* (Euphorbiaceae), *Michelia champaca* (Magnoliaceae), *Tithonia diversifolia* (Asteraceae), *Trema orientalis* (Ulmaceae) and *Solanum indicum* (Solanaceae) flowered and fruited in 2 spells (Sivaraj et al. 2014). The pattern of leaf fall and leaf flush recorded in the study region highest leaf fall occurred in March-July while the least was observed during June-October. The maximum leaf flush was seen in July-August while the least was recorded in November-January (Fig.4).

Phenology is the art of observing life cycle or activities of plants in their temporal occurrence throughout the growing season. Phenological and phenomenological variations of the plants are the product of interaction between genotype and environment. However, these modifications in plants may be reversible when plants are grown under diverse climatic conditions (Bhatt and Purohit 1984). The data analysis it was found that leaf fall initiation was a periodic activity for most of the species. In popular of the species leaf fall starts in the month of November and December with a peak in the last part of January (30%) to first part of February (50 %). Later than shedding of older leaves new leaf initiation starts in the species, the time period of this activity seen to be different in different species. But it can be said that new leaf formation started in majority of species in the month of February (25%) continued up to May

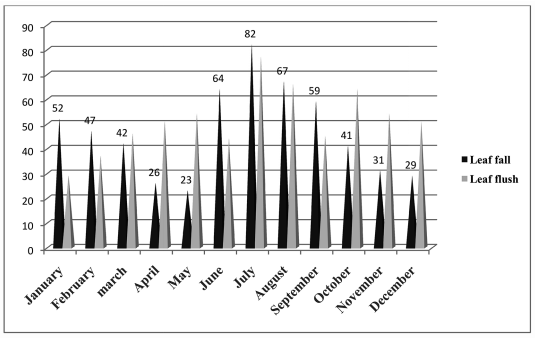


**Fig. 4.** Leaf all and leaf flush in some medicinal plants of Sadhuragiri hills.

(30%) with a peak in the month of March (50%) that is before the outset of monsoon. Among 40 species, 75% showed brief leaf flushing activity whereas only about 25% exhibited extended leaf activation (Barman et al. 2014).

In the majority cases leaf flushing was seasonal and occurred simply once in year. Under this category, leaf flushing occurred in the majority of the species towards the end of the dry season. Nine species alone, namely *Garuga pinnata* (Burseraceae), *Pterocarpus marsupium* (Papilionaceae), *Cinnamomum camphorum* (Lauraceae), *Strychnos nux-vomica* (Loganiaceae), *Feronia elephantum* (Rutaceae), *Homonoia riparia* (Euphorbiaceae), *Atalantia monophylla* (Rutaceae), *Citrus medica* (Rutaceae) and *Aglaia roxburghiana* (Meliaceae) produced new leaves during the cooler months of December and January. The growth of new leaves, when it was irregular occurred at periodic or intermittent intervals. In *Cinnamomum camphora* (Lauraceae) *Boswellia glabra* (Burseraceae) and *Pterocarpus marsupium* (Papilionaceae) leaf flushing occurred many times a year and was not predictable. Late dry season leaf flushing was observed in the deciduous trees of Sri Lanka, Southern Nigeria, Belgian Congo (Wright 1905, Coster 1923) while flushing in cooler months was recorded in Mexico and Osa peninsula of South East Costa Rica (Bullock and Solis-Magallanes 1990, Boinski and Fowler 1989). The actual factors responsible for this leaf flushing behavior are not yet obviously understood. Moisture stress has been considered as an important factor in leaf fall, since the phenomenon is generally observed during dry months (Njoku 1963, Hopkins 1970, Frankie et al. 1974). Wet season defoliation in trees is most likely due to unusual sensitivity of plants to low light intensities and high humidity that accompany beginning rainy season (Koriba 1958, Alvim 1964, Addicott and Lyon 1973).

Leaf fall may be total or partial depending on the taxa. In some actually deciduous taxa, all or most of the elderly leaves got abscised at a considerable time before the production of new ones so that the tree was bare for a period of weeks or a few months (*Terminalia* spp.). These taxa belong to the holo deciduous category recognized by Koriba (1958). In others such as *Sterculia urens* and *Ficus benghalen-*

*sis* and *Pongamia pinnata* leaf fall and leaf flushing processes overlap slightly in the similar tree. In certain others, only a portion of the tree was shed when some branches possessed intact leaves. This category called semi-deciduos by Koriba (1958) was also recorded in a few taxa. In mainly evergreens, old leaves abscised over a period of time throughout the year as and when they elderly, thus retaining a steady population of functional leaves all the time, but even in these cases there was often a period when leaf fall was substantial. All these categories of leaf fall patterns are very well predictable in the flora of several countries (Beard 1964, Boinski and Fowler 1989, Addicot 1978).

Flowering continued in different species throughout the year. However, peak period of flowering can be distinguished for most of the species in the month of March-April where plants like *Cassia alata, Saraca indica, Murraya koenigii, Alstonia scholaris, Cassia fistula, Azadirachta indica, Spondias pinnata* all these exhibited flower beginning in response to increasing distance end to end photoperiod. There is wide flutuation in the phenology of a species from region to region due to changes in the climatic situation. Leaf fall : The average time of commencement and completion of leaf fall has been noted that this phenomenon starts from January and continues up to February. Maximum leaf fall occurred in January–February while the least was observed during September to December. Flowering : The observations about the time of beginning and completion of flowering of different species of medicinal plants are tabulated. The highest number of medicinal tree taxa was found to flower during the months of March and April and only a few were in bloom during the period October-December. The peak flowering period of tree taxa coincided with the hot and dry season March-April.

In present study seeds are shed down in cold season typically in December and develop in next spring season. In majority of plants the leaf falling period is cool season i.e. January and February, leaf flushing usually occurred in warm period i.e. in March and April, in rainy season i.e. in August flowering was at its peak and usually in September and October fruit maturation takes place. In small, in our learning area plants grow and goes up to flowering and fruiting stage in humid and wet season and shed seeds which gain cold treatment in winter season and then once again grows up in favorable season.

## Conclusion

The phenology study documentation on the circumstance of the flora of this vulnerable region we can know what actually occurrence to the biodiversity in the finest or accurate level. Floristic phenology works on micro level should not be continued to explore level or scientific population but we should make it open to the community about the position, circumstances of nature forest vegetation and awful effect of defeat of biodiversity and each and every one. Each step should be taken to keep the medicinal or other medicinal plant diversity of the region to region which is already in a critical level that can be necessary by observing the present percentage of forest, inclusion of species in (RET) Red Data Book or changed phenological behavior of the medicinal plant species. Understanding on floristic, phenology and reproduction systems for any forest ecosystem constituting medicinal plants taxa is very supportive in deciding strategies for responsible management of plant genetic resources including conservation activities. Periodicity of medicinal plants flowering and fruiting in tropical environments has received little attention untill recently. The records so composed would be helpful for planning proper PGR management strategies in the Western Ghats region to maintain development without destruction.

## Acknowledgement

The authors would like to thank the Paliyar Tribes in Sadhuragiri hills and local people for their valuable indigenous knowledge transfer. We are also thankful to the Tamil Nadu Forest Department for their co-operation during the field work.

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