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RESEARCH ARTICLE

PHENOLOGICAL BEHAVIOUR OF FIVE DOMINANT TREE SPECIES IN A MIXED DRY DECIDUOUS FOREST OF ORCHHA, TIKAMGARH (MADHYA PRADESH)

Piyush Paul

Department of Botany, Institute of Basic Science, Bundelkhand University, Jhansi-284 128, Uttar Pradesh, India

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ABSTRACT

Phenological behaviour of five dominant tree species has been studied in a mixed dry deciduous forest of Orchha, Tikamgarh (M.P.). All five tree species bear new foliage in dry months from March to June. The leaf fall was seasonal and various studied tree species shed their leaves at different intervals during study period. The leaf fall period covered the month from last week of September to end of March. The leaf retention period, in present study, exhibited that A. *pendula, C. fistula and T. grandis* retained fully mature green leaf for three months and three weeks and *B. monosperma* retained fully mature green leaf for longest period while *L. coromendelica* retained fully mature green leaf for shortest period. The leafless period of trees illustrated that *L. coromendelica* stayed leafless longest period. The flowering was found seasonal and various studied tree species had flower at different intervals during study period and fruit fall occurred from December to first week of July in different tree species

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INTRODUCTION

PHENOLOGY is the study of relationship between climatic factors and periodic phenomena in organisms. Pattern of phenological events are variously used for characterization of vegetation type (Opler *et al*., 1980; Shim well 1972). The study of plant phenology provides knowledge about the pattern of plant growth and development as well as the effects of environment (Zhang *et al*. 2006). PHENOLOGY is an important function of forest ecosystem that relates the growth habit of a species with the physical environment. The periodic development in plants at a place is largely determined by their changing environment. Phenology embraces all the studies of the relationships between environmental factors and periodic developmental phenomenon in plant. Each stage in periodic phenomenon is termed as phenophase and the sequence of different phenophases in a year is called phenodynamic analysis. It is a quantitative measurement of life cycle or specific phenophase. The main phenophases in plants are *viz*., seed germination, bud bursting, leaf development, flowering time, fruit and seed dispersal, senescence and litter fall (Leith, 1970). PHENOLOGICAL analysis of trees provides a potential tool to address critical questions related to modelling and monitoring of climate change (Schwartz, 1999).

Corresponding author: **Piyush Paul**
Department of Botany, Institute of Basic Science, Bundelkhand University, Jhansi-284 128, Uttar Pradesh, India

Climate change will affect many aspects of the biology of tropical trees, and its effect on plant phenology would be of immense significance (Corlett and Lafrankie, 1998). In recent years, therefore, the focus of phenological studies has shifted to questions of how phenology will be affected by global climate change and what consequences any climatic change may have for species distribution and ecosystem function. The control of phenology in tropical trees is not well understood (Borchert *et al*., 2002). Much of the available phenological information on tropical trees is inadequate, partly because of lack of standardized terminology, and also because most studies have been for a short term and have focused on community level patterns only (Newstrom *et al*., 1994). The present study was undertaken with a view to study phenology of five dominant tree species A. *pendula, B. monosperma, C. fistula, L. coramandelica and T. grandis* occurring in a mixed dry deciduous forest of Orchha, Tikamgarh (M.P.).

MATERIAL AND METHODS

Study site and Climate

The study was conducted at Orchha forest during July 2016 to June 2017. This forest is located nearly 18 km. from Jhansi, U.P. (25°27' N latitude 78°35' E longitude) on Jhansi-Tikamgarh road in Orchha range of Tikamgarh district, M.P. (24°26' and 25°40'N latitude and 78°26' and 79°26' E longitude).

The climate of this forest is semi-arid and has a distinct seasonality. On the basis of distribution of rainfall and variation in temperature, the climate of Tikamgarh can be said to be typically monsoonic and can be divided into three distinct season *viz*., warm-wet rainy (mid - June to September); cool-dry winter (November to February) and hot–dry summer (April to June). March and October represent the transitional months between seasons, the major part of both being closer to the season following them.

Methods of studying phenology: Two phonological study plots (> two ha each) were established in Orchha forest. Five individuals (> 30cm GBH and > 6m height) of dominant tree species *A. pendula, B. monosperma, C. fistula, L. coramandelica and T. grandis* were marked. Weekly observations were taken on leaf and reproductive phenology. The observations on phenological events were summarized on monthly basis. A species was considered to be passing through peak of a particular phenophase if three of five marked individuals were found in that particular phenophase. Finally, information about all the tree species was tabulated and the species of similar characteristics were categorized together into suitable co-related group of identical phonological behaviour.

RESULTS

Results on phonological behavior of selected dominant tree species are presented in figure 1 and 2.

Phenology of *Anogeissus pendula*

Leaf phenology: The leaf flush in *A. pendula* began in the last week of March and leaves became fully develop by the end of June. Young leaves were small sized, pinkish-yellow and had silky hairs on both surface. At maturity leaves changed their colour to green and hairs were also gradually reduced. All the trees retained green leaves till the last week of October and in the beginning of November leaves began change their colour to dull-radish. All leaves turned into dry and dull-radish before falling. The leaf fall started in winter season in last week of November and trees became leafless in first week of March. The tree of *A. pendula* remained leafless in first and second week of March for very short period.

Reproductive phenology: The flowering of *A. pendula* started in the last week of July and completed by the third week of September. The fruiting and fruit retained period was from last week of September to third week of December. The fruit fall of this species was occurred from last week of December to third week of February.

Phenology of *Butea monosperma*:

Leaf phenology: The initiation of new leaves in *B. monosperma* began in the first week of April and leaves became fully matured by the end of June. Young leaves were small sized, light green in color and had hairs. At maturity leaves changed their color to dark green and hairs were also gradually reduced. The mature leaf retained period of *B. monosperma* was from first week July to end of January. The leaf fall started in first week of February and completed by end of March.

Reproductive phenology: The flowering of *B. monosperma* began in the second week of February and completed by first week of April. The fruiting and fruit retained period was from second week of April to third week of May. The fruit fall of this species was occurred from last week of May to last week of June.

Phenology of *Cassia fistula*:

Leaf phenology: The initiation of new leaves in *C. fistula* started in the last week of April and leaves became fully matured by the end of June. Young leaves were small sized and light green in color. At maturity leaves changed their color to dark green. The mature leaf retained period of *C. fistula* was from first week July to third week of November. The leaf fall started in last week of November and tree became leafless in third week of March. The trees of *C. fistula* remained leafless for one month from last week of March to third week of April.

Reproductive phenology: The flowering of *C. fistula* initiated in the third week of May and completed in last week of July. The fruiting and fruit retained period was from first week of August to second week of January. The fruit fall of this species was occurred from third week of January to second week of Aril.

Phenology of *Lannea coromendelica*

Leaf phenology: The leaf flush in *L. coromendelica* began in the last week of April and leaves became fully matured by the end of June. Young leaves were small sized, light green in color. At maturity leaves changed their color to green. The mature leaf retained period of *L. coromendelica* was from first week July to third week of Septemder. The leaf fall started in last week of September and tree became leafless in last week of December. The leafless remained leafless from first week of January to third week of April.

Reproductive phenology: The flowering in *L. coromendelica* started in the last week of January and completed by the last week of March. The fruiting and fruit retained was from first week of April to last week of May. The fruit fall of this species was occurred from first week of June to first week of July.

Phenology of *Tectona grandis*

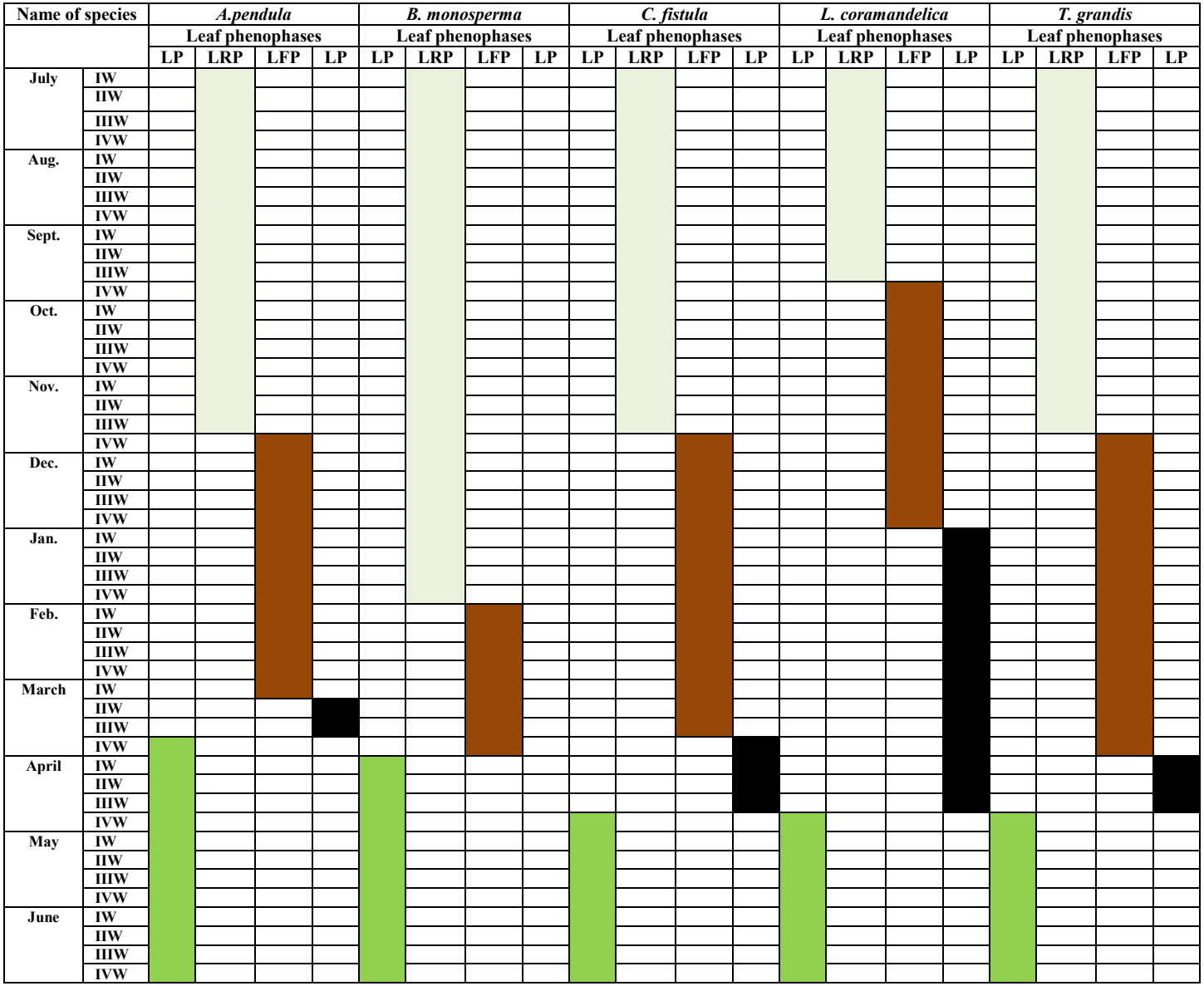
Leaf phenology: The initiation of new leaves in *T. grandis* began in the last week of April and leaves became fully matured by the end of June. Young leaves were small sized and light green in color. At maturity leaves changed their color to dark green. The mature leaf retained period of *T. grandis* was from first week July to third week of November. The leaf fall started in last week of November and completed by the last of March. The trees of *T. grandis* stayed leafless for three weeks in the month of April.

Reproductive phenology: The flowering in *T. grandis* initiated in the second week of July and completed by the last week of September. The fruiting and fruit retained period was from first week of October to last week of November. The fruit fall of this species was occurred from first week of December to last week of March.

DISCUSSION

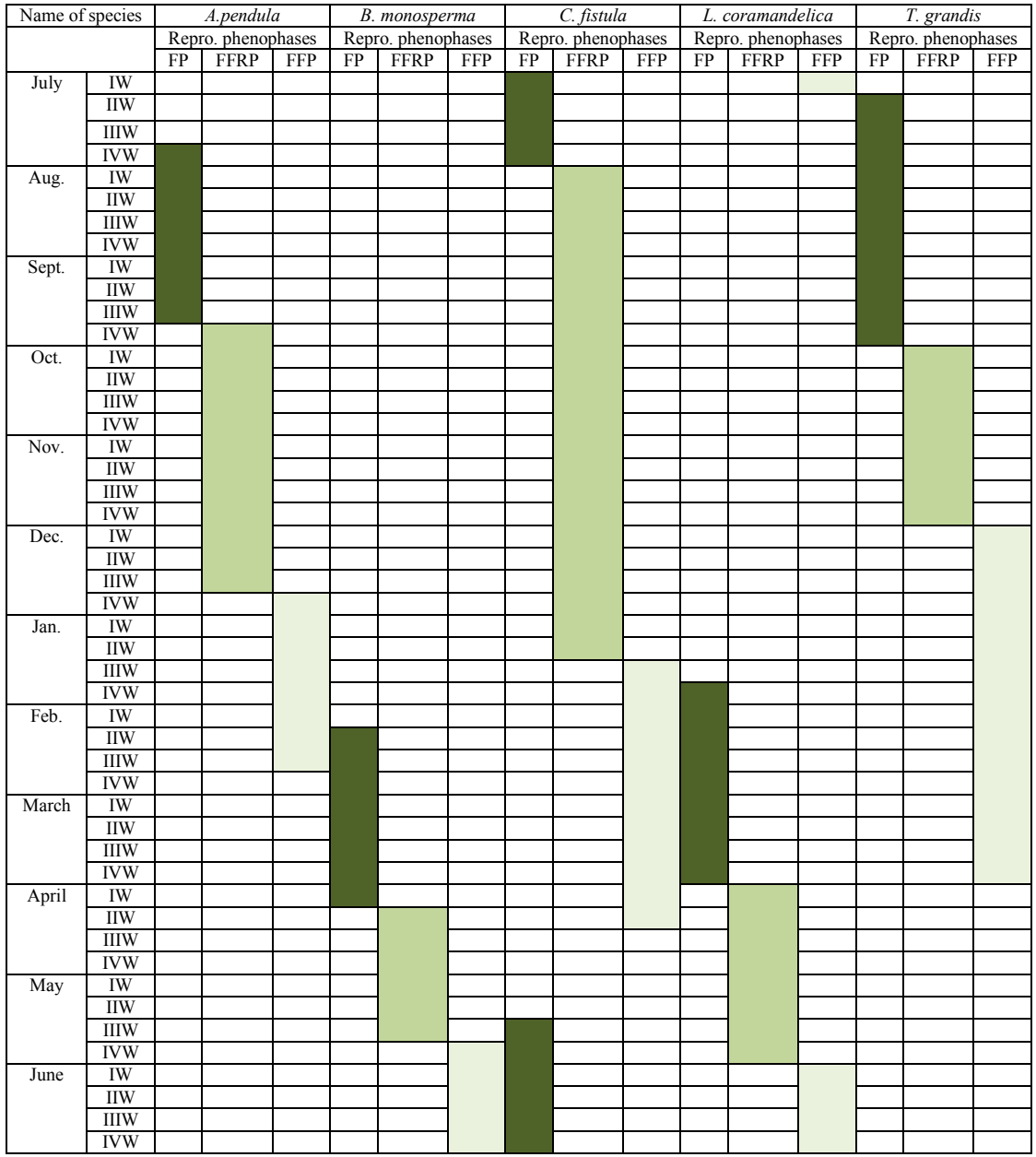
The five selected dominant tree species A. *pendula, B. monosperma, C. fistula, L. coramandelica and T. grandis* occurring in mixed dry deciduous forest of Orchha, Tikamgarh exhibited diversity in leaf and reproductive phenology. However, as per climate of the study site, peaks for all phenophases were distinguished due to defined seasons.

Figure 1. Leaf phenological behaviour and events of studied five important tree species at a mixed dry deciduous forest of Orchha, Tikamgarh, M.P



(LP: Leafing period; LRP: Leaf retained period; LFP: Leaf fall period; LLP: Leafless period; IW: First week; IIW: Second week; IIIW: Third week; IVW; Fourth week)

Figure 2. Reproductive phenological behaviour and events of studied five important tree species at a mixed dry deciduous forest of Orchha, Tikamgarh, M.P.



(FP: Flowing period; FFRP: Fruiting and fruit retained period; FFP: Fruit fall period; IW: First week; IIW: Second week; IIIW: Third week; IVW; Fourth week)

In present study all five tree species bear new foliage in dry months. This period covered the months from March to June. Three tree species *C.fistula, L.coromendelica* and *T. grandis* exhibited same pattern of leafing and putted on new foliage during late summer month *i.e.* last week of April to end of June. However, *A. pendula* and *B.monosperma* began leafing in early summer and completed by the end of June. The leafing in dry season may be attributed to hot months of the year before rains. Leaf-production towards the end of the dry season and before rains has also been observed in tree species by several workers (Frankie *et al.* 1974; Kikim and Yadava 2001; Shukla and Ramakrishnan 1982; Singh and Kushwaha 2005a and b; Singh and Singh 1992; Sundriyal 1990). This may be attributed to the triggering effect of the rising temperature (Walter 1968) and increase in length of photoperiods (Lawton and Akpan 1968; Njoku 1964). The role of photoperiod has been confirmed by Rivera *et al.* (2002) who reported that spring flushing in tropical semi-deciduous trees is induced by an increase in photoperiod of 30 minutes or less. They further suggested that production of new foliage shortly before the rainy season is likely to optimize synthetic gain in tropical forests with relatively short growing season. Borchert and Rivera (2001) also suggested that in dry summer season, the vegetative buds of spring flushing stem succulent species are in a state of endo-induced dormancy induced and terminated by declining and increasing photoperiod, respectively.

In present study leaf fall was seasonal and various studied tree species shed their leaves at different intervals during study period. The leaf fall period covered the month from last week of September to end of March. Out five tree species *L.coromendelica* was early winter defoliating species, in which leaf fall began in the last week of September and completed by the end of December whereas *B.monosperma* shed their leaves in spring season and continued at the commencement of summer *i.e.* leaf fall started in first week of February and completed by the end of March. The rest of tree species namely *A. pendula C.fistula and T. grandis* were found to be mid-winter defoliating and shed their 90 percent leaves. The patterns of leaf fall, in selected five dominant tree species A. *pendula, B. monosperma, C. fistula, L. coramandelica and T. grandis* occurring in a mixed dry deciduous forest of Orchha, Tikamgarh, is similar to the pattern observed in dry deciduous forest of Sagar (M.P.) by Bhatnagar (1968), Joseph (1977) and Tripathi (1987). Reich and Borchert (1982) suggested that the leaf-fall during the dry season was directly influenced by the decline in soil moisture and increasing water stress conditions. The results are also in conformity with Singh and Singh (1992) who reported that initiation of leaf fall coincides with the onset of the post-monsoon low temperature dry period and can be a mechanism maintaining turgidity of shoots.

The leaf retention period, in present study, exhibited that three species namely *A. pendula, C.fistula and T. grandis* retained fully mature green leaf for three months and three weeks *i.e.* from first week of July to third week of November. Out of all tree species *B. monosperma* retained fully mature green leaf for longest period from first week of July to last week of January however *L. coromendelica* retained fully mature green leaf for shortest period only for two months and three weeks *i.e.* from first week of July to third week of September. The leafless period of trees illustrated that *L. coromendelica* stayed leafless from first week of January to third week of Aril for longest period while left over tree remained leafless for one month or less than month. In present study patterns of leaf retention and leaf less period is also similar to the pattern observed in dry deciduous forest of Sagar (M.P.) by Bhatnagar (1968), Joseph (1977) and Tripathi (1987). In present study flowering was found seasonal and various studied tree species had flower at different intervals during study period. Out five tree species *A. pendula* and *T. grandis* was rainy flowering whereas *L. coromendelica* and *B. monosperma was* late winter flowering species. Only *C. fistula* had flowers from summer to rainy months. The fruiting and fruit retained period of trees illustrated that fruiting and fruit retained period of *C. fistula* was longest followed by *A. pendula, L. coromendelica* , *T. grandis* and *B. monosperma*. In present study fruit fall occurred from December to first week of July in different tree species (fig.2). In present study patterns of fruiting, fruit fall and fruit retained period is also similar to the pattern observed in dry deciduous forest of Orchha, Madhya Pradesh by Verma *et al.,* (2007), Joseph (1977) and Tripathi (1987).

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