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Phenology of Some Dominant Tree Species of Ajmer Region, Rajasthan, India

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Abstract

Effect of seasonality in regulating the phonological events such as leaf fall, flushing, flowering and fruiting of dominant tree species of Ajmer region which is a zone of confluence between north-west dry and south-east comparatively humid region was studied. The region is dominated by deciduous tree species such as *Albizzia lebbeck*, *Butea monosperma*, *Dalbergia sissoo*, *Acacia Senegal*, Delonix *regia*. Phenological events are regulated by ecoclimatic parameters like temperature, moisture and humidity of the region. Observations reveal that for each of the phonological event, a single peak was evident which occurred one after other. Observations indicate that in trees like *Bauhinia racemosa*, *Butea monosperma*, *Aegle marmelose* peak period to shed leaves is late winter (Feb-March). Bud initiation started in February and completed in April. In 85% species, blooming was recorded in April-May. Peak period of each activity was simultaneous in tree species. However, deciduous tree species have shown early leaf fall, flowering and fruiting than evergreen tree species. Thus, vegetative and reproductive growth of trees is more periodic rather than continuous because of extremes of seasonal periodicity. Most of the tree species of Ajmer region show leaf fall and flushing in the same period. So to some extent, phonological behaviour of trees of Ajmer region is different than that of same tree species present in extreme dry as well as in wet regions. The study reveals that transitional zone such as Ajmer region, beside floristic content, differ in plant phonological cycles.

Keywords: Climate Change, Phenophase, Phenology, Tropical, Seasonality, Deciduous.

Introduction

Plants perform various vegetative and reproductive functions throughout the year in order to persist in their habitat. The study of these events including their timing and how the environment influences the timing of these events is known as phenology. Phenology is the study of the trees or recurring natural phenomenon. The word 'Phenology' is derived from Greek word- 'Phaino' means to appear, comes into view and indicate that phenology has been principally concerned with the dates of first occurrence of natural events in their annual cycle. Phenology is defined as a branch of science dealing with the relation between climate and periodic biological phenomena. Pattern of phonological events are variously used for characterization of vegetation type (Shemwell 1972; Opler et al. 1980). India with a wide range of variation in climate, altitude and physiography exhibit enormous variations in the life cycle of plants of different regions. Precise phenological information with respect to flowering and fruiting evaluated against leafing and leafless period is scarce in tropical deciduous forests in India which account for about 46% of the forested land in the country (Singh and Singh 1988).

Phenology of trees is a major determinant of forest dynamics especially in the seasonal zone. Phenological events show a keen relationship with climatic factors and periodic phenomenon in different seasons. Various phenological events of plants are helpful in understanding of ecosystem functioning and their impact on ecology of herbivores. Different phenological conditions such as leaf shedding and flushing affect both climate and soil below the canopies. Similarly, flowering and fruiting affect the mean of dispersal, germination and establishment of seeds and subsequently the regenerative capacity of tree species. Phenology is the study of growth of buds, leaf flushing, leaf fall, anthesis and fruiting in relation to seasonality (Okullo et al. 2004).

Phenology of tree in any ecosystem and community strongly determine the flowering period which is indirectly dependent on the environmental variations (Rivera et al. 2002; Hawann 2004; Zhang et al. 2006). The dependence of plants on the climate for the succession of different life phases increases the significance of phenological studies in its connection with climate change and global climate monitoring. The phenological studies are instrumental in assessing the response of plants and plant communities against climatic disturbances. The effect of climatic change may be assessed by correlating seasonal climatic condition and different phenophases of the plants (Kushwaha and Singh 2008).

The study of phenology provides information and knowledge about the pattern of plant growth and the development as well as effect of environment and selective pressure on flowering and fruiting behaviour (Zhang et al. 2006). The knowledge of phenological events such as leafing, flowering and fruiting period may help to layout management practice.

Aim of the Study

In the present investigation, different phenological observation on leaf fall, flushing, flowering and fruiting were made for some dominant tree species of Ajmer region and monthly observation were recorded throughout the study period. The main aim of this quantitative phenological study was to assess the different phenological events in selected species of tropical deciduous forest to utilise them to understand the impact of climate changes on the plant species. Since such type of studies has not been carried out properly from the study area, hence the data provided here may be utilized for further climate change assessment.

Review of Literature

Wright (1905) for the first time emphasized the significance of major phenological events to understand the development of trees. Koriba (1958) stated that in trees, vegetative and reproductive growth phases are periodic rather than continuous. Phenological observations on various trees of India were made by Champion and Seth (1968). Ambasht (1976) mentioned that biotic and abiotic aspects of environment are measured at different stages of growth intervals. A study of the complex relationship between plant structure, vegetative development and incidence of flowering of selected tropical trees has been studied by Borchert (1983). There have been some detailed studies on phenology of plants in different forest ecosystems in India (Prasad and Hegde 1986 and Shukla and Ramakrishan 1982). Aspects that have been addressed in this respect are the incidence of rhythmic cycles (Mikich and Selva 2001), the influence of climatic triggers and day length as proximate factors (Borchert et al. 2005). These being ultimate factors that regulate plant life and plant animal interaction.

Numata et al. (2003) showed that the flower production of tropical canopy trees was triggered by prolonged drought, high solar radiation and abnormally low temperature. The floral phenology and sex expression helps to understand the adaptive significance of sexual systems. Pereira et al. (2007) concluded that measured rainfall and soil water storage did not reflect the actual water status of trees. Phenology and growth adjustments of oil Palm (*Elaeis guineensis*) to photoperiod and climatic variablility were studied by Logros et al. (2009). Phenology of trees in strongly driven by environmental factors such as temperature (Morin et al. 2010). The leaf phenology in trees of tropical region, vegetative as well reproductive phenology of trees occurs synchronously at the end of dry season. Polansky and Boesch (2013) studied the long term changes in fruit phenology in West African tropical rain forest and observed that decrease in rainfall have a negative impact on fruit phenology. Okusanya et al. (2016) studied the variation in flowering phenology of *Cassia fritula* and they observed that commencement of flowering was correlated with rainfall and temperature while the end was correlated the amount of rainfall and number of rainy days. Bajpai et al. (2017) observed the periodicity of different phenophases in some trees of Himalayan Terai of India.

Site of Study and Methodology

Ajmer is situatied in the central Aravalli region which assumes to be ecologically significant as it shares the flora of both North-wetern arid and South-east humid region. Ajmer city is located at the foot of Taragarh hill with its highest peak (873 m). For the south-west of Taragarh hill a prominent part of Aravalli range, the Nagpahar is situated at a distance of about 10 km from Ajmer. The Aravalli ranges in the south-west of Ajmer cross the state and finally merge into the Vidhyan system near Mount Abu. The study site is located in central Aravalli region at a distance of 12 km. North- West to Ajmer ($26^0$25' and $26^0$29' N latitude $74^0$37' and $74^0$72' E longitude). The site comprises stabilised sand dunes where tree plantations were made by the forest department.

The general vegetation of Ajmer is xerophytic type (Sharma, 1958) because of variable topographic features and stress condition of both drought and temperature. Climatic data of Ajmer show that annual rainfall was 1641.2 mm out of which 784.4 was recorded for the month of September. Mean monthly temperature was maximum in June (31.7^0C) and minimum in month of January (15.9^0C). Humidity was maximum (80%) in month of July and minimum (27%) in month of April. For detailed phenological observation a list of tree species of different sites in and around Ajmer was prepared. The phenological observations such as leaf fall, flowering, fruiting etc. of various trees were made as described by Sundriyal (1990).

Result and Discussion

The vegetative and reproductive growth of trees is more periodic rather than continuous. The study of the timing of seasonal biological activities of plants is very important to know about plant survival and its reproductive success. Truly, constant environmental conditions do not exist anywhere in the earth. The intensity and duration of development events are markedly affected by change in internal functional correlations as well as on prevailing

environmental conditions. Variations in phenological changes observed in the present study, strictly illustrate that changes in tree development are strongly associated with seasonal climate. The seasonal changes and phenological events like leaf fall, flowering and fruiting takes place simultaneously for each tree species (Table 1). Increased drought conditions enhance the leaf fall and synchronization of tree development. Borchert (2004); Rivera et al. (2002) observed that bud break and leafing are determined mainly by seasonal variation in tree water status, day length and shedding of old leaves. In the deep rooted trees leaf flush initiate just after the winter and continue upto 3-4 months because at slower rate and conserve them till the end of winter (Kushwaha and Singh 2008).

Generally, tree species of Ajmer region showed only one single peak of leaf fall. Many deciduous trees shed their leaves during winter and spring season, while evergreen species start leaf drop at the end of spring season. Reports on maximum leaf fall during the driest period of the year are frequent (Shukla and Ramakrishan 1982). Trees of Ajmer region show leaf replacement strategy in March-April to minimize stress by leaf fall and maximum photosynthetic activity. Because of extremes of climatic fluctuations, most of the trees of Ajmer region show leaf fall and flushing in the same period. A number of workers have reported similar trends of flushing and production in dry conditions (Frankie et al. 1974; Shukla and Ramakrishan 1982; Sundriyal 1990 and Borchert et al. 2005). The reason behind this emergence and maturation of the leaves in the dry season could be increased day length, rise of temperature and change in photoperiod which favour to maximize the photosynthesis and vegetative growth. Similar observation has also been reported by Sukwong et al. (1975) in dry Dipterocarp forest and Mishra et al. (2006) in moist deciduous forest.

In many tree species, to switch from vegetative growth to flower production requires a signal in which drought or shortage of soil moisture is involved (Borchert 1983; Reich and Borchert 1982). Tree species of Ajmer showed blooming once a year, but the period of flowering is variable among different tree species. The peak period of flowering was April-May in trees such as *Azadirachta indica*, *Bauhinia racemose*, *Cassia fistula*, *Pongamia glabra*, *Albizzia lebbeck* etc. Similar observations have also been reported by Mishra et al. (2006) and Bhat (1992) from tree species of tropical moist deciduous forests of India. Maximum flowering before rainy season has been reported for many trees (Medway 1972). Observations recorded during the present investigation suggest that the extreme variability in moisture, temperature and photoperiod directs the flowering of many trees. Role of moisture, temperature and photoperiods on flowering has been well documented by Opler et al 1980. In most of the tree species, peak fruiting was observed in July-October, after which it was declined. It was noticed that fruit maturation and fruit fall coincides with commencement of rainy season. The period of seed maturation and dispersal for different trees varied from April to October. Similar results were also reported by Sundriyal (1990), Bhat (1992) and Mishra et al. (2006).

Thus flowering as well as seed dispersal both dependent on dry weather are well positioned in the less humid period of the year. The initiation of fruiting in dry season and maturation in late dry season, just before the rains provide opportunity for optimum seed germination and seedling establishment on moist soil. Phenological data collected during the present investigation revealed that Ajmer region is dominated by deciduous tree species. Phenological events of various tree species are generally initiated by temperature, moisture and humid condition of the area. Observation revealed that for each of the phenological event, a single peak was evident which occurred one after the other.

Conclusion

To summarise, it can be concluded that phenological activity of the investigated trees generally follows an annual oscillation with relatively less or more humid. Hence, the current investigation of periodicities in weather and tree phenology is indispensable for producing sufficient plant material in tree nurseries for reforestation purpose. Reforestation of abandoned agricultural areas with indigenous trees could help to rehabilitate biodiversity.

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Table 1: Phenology of Tree flora of Ajmer region

No.	Tree species	Description	Leaf-fall	Flushing	Flowering	Fruiting
1	*Acacia leucophloea*	Medium sized deciduous tree with whitish bark and dark foliage	Jan- Mar	Mar- Aug	Sept- Nov	Nov- Mar
2	*A. nilotica*	Moderate sized, evergreen tree and long spine	Throughout year	Throughout year	May- Oct	Dec- Apr
3	*A. senegal*	Small prickly tree with pale bark	Feb- Mar	Apr- Jul	Jul- Jan	Jul- Jan
4	*A.tortillis*	Medium sized deciduous tree	Jan- Mar	Mar- May	July- Sep	Sep – Dec
5	*Aegle marmelos*	Medium sized deciduous tree with 3 foliate leaves	Jan- Feb	Feb- Mar	Apr- Jun	Apr- Jun
6	*Albizia lebbeck*	Large deciduous tree with long flat pod	Feb- Mar	Feb- Mar	Jun- Aug	Aug – Nov
7	*Anogeissus pendula*	Moderate sized, leaves become copper-tinged in winter	Jan- Mar	Jul- Sep	Sep- Oct	Oct- Nov
8	*Azadirachta indica*	Large shady tree, yellow fruit in bunches	Throughout year	Throughout year	Mar- May	Mar- May
9	*Bauhinia racemosa*	Medium tree with lobed leaves	Feb- Mar	Feb- Mar	May- Jun	Aug- Nov
10	*Butea monosperma*	Medium tree with ash-coloured branches	Jan- Feb	Feb- Mar	Feb- Apr	Apr- Jun
11	*Cassia fistula*	Medium sized tree, flower hanging in branches	Throughout year	Throughout year	Nov- Jun	Nov- Jun
12	*Dalbergia sissoo*	Medium sized tree with spreading branches	Jan- Feb	Jan- Feb	Feb- May	Feb- May
13	*Eucalyptus camaldulensis*	Large evergreen tree	Throughout year	Throughout year	Jan- Mar	Jun- Oct
14	*Maytenus emarginata*	Small compact spiny tree, young branches purple, flower on the spine	Throughout year	Throughout year	Sep- Dec	Dec- Apr
15	*Pithecellobium dulce*	Medium sized tree with flat coiled pod	Jan- Feb	Feb- Mar	Jan- Mar	Mar-May
16	*Pongamia glabra*	Medium size deciduous tree	Jan- Feb	Feb- Mar	Mar- Jun	Mar- Jun
17	*Prosopis cineraria*	Small much branched tree with scattered prickles, pods very long	Jan- Feb	Feb- Mar	Dec- Apr	Mar- Jun
18	*Salvodora oleoides*	Much branched evergreen small tree	Throughout year	Throughout year	Mar- Apr	May- Jun
19	*Salvodora persica*	Much branched small tree with spreading branches	Throughout year	Throughout year	Mar- Apr	May- Jun
20	*Tamarindus indica*	Very large tree with small leaves and brown pods	Jan- Feb	Feb- Mar	Feb- Mar	May- Jun
21	*Zizyphus mauritiana*	Small evergreen much branched tree	Throughout year	Throughout year	Sep- Oct	Dec- Jan