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LEAFING, FLOWERING AND FRUITING OF *AZADIRACHTA INDICA* (NEEM) IN INDIA

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KISHAN KUMAR, V. S. & ARRAWATIA, M. L. 1999. Leafing, flowering and fruiting of *Azadirachta indica* (neem) in India. Some basic phenological observations on neem were carried out at different locations situated in six different agro-ecological zones (ER2, ER4, ER8, ER9, ER10 and ER15) of India. The neem tree is generally in heavy leafing during May–November. Leaf shedding in general starts from November and the trees are back in full leafing by April. There is an appreciable drop in percentage of trees flowering immediately after May. The flowering peak is April for arid locations (ER2) and the semi-arid regions (ER4 and ER8) have a broad peak spread between March and May. Among the sub-humids, ER10 has a single flowering peak in March whereas ER9 and ER15 have broad peaks spreading between April and May. Some restricted flowering during August and November is indicated at some locations both in the semi-arid and sub-humid regions. As far as fruiting is concerned, neem trees in the arid and semi-arid areas start fruiting in May and June whereas in the sub-humid regions it varies between April and July. In ER15 there is an overlapping of flowering and fruiting patterns. Mature fruit availability time in the arid region is in June whereas in the semi-arid region it is in June and July extending up to August–September in ER8. In the sub-humid region June–July is also the best time for seed collection. Secondary flowering found in some regions is followed by fruiting and a few of the fruits mature subsequently. This provides an additional seed collection time in these regions.

Key words: Neem - phenology - leafing - flowering - fruiting - seed collection - India

KISHAN KUMAR, V. S. & ARRAWATIA, M. L. 1999. Pendaunan, pembungaan dan pembuahan *Azadirachta indica* (neem) di India. Beberapa cerapan fenologi asas bagi neem dijalankan di lokasi yang berbeza di enam zon ekologi-tani yang berbeza (ER2, ER4, ER8, ER9, ER10 dan ER15) di India. Pokok neem pada amnya berdaun lebat pada bulan Mei-November. Peluruhan daun kebiasaannya bermula pada bulan November dan pokok mula mengalami pendaunan penuh pada bulan April. Selepas bulan Mei, terdapat penurunan dalam peratus pembungaan pokok. Kemuncak musim berbunga ialah pada bulan April bagi lokasi gersang (ER2) dan kawasan separa-gersang (ER4 dan ER8) mempunyai masa kemuncak yang panjang antara April dan Mei. Di kawasan sublembap, ER10 mengalami kemuncak pembungaan hanya pada bulan Mac manakala ER9 dan ER15 mengalami kemuncak pembungaan yang lebih panjang antara bulan April dan Mei. Beberapa pembungaan yang terbatas pada bulan Ogos dan November terdapat di beberapa lokasi di kedua-dua kawasan. Mengenai pembuahan, pokok neem di kawasan gersang dan semi-gersang memulakan pembuahan pada bulan Mei dan Jun manakala di kawasan sublembap ia berubah-ubah antara bulan April dan Julai. Dalam ER15 terdapat pola bertindih bagi pembungaan dan pembuahan. Buah matang di kawasan gersang ialah pada bulan Jun manakala di kawasan separa gersang ia matang pada bulan Jun dan Julai sehinggalah ke bulan Ogos dan September dalam ER8. Di kawasan sublembap juga, masa yang paling sesuai untuk pengutipan biji benih ialah pada bulan Jun-Julai. Pembungaan sekunder yang didapati di beberapa kawasan diikuti oleh pembuahan dan sesetengahnya matang selepas itu. Ini memberikan pertambahan masa bagi pengutipan biji benih di kawasan ini.

Introduction

Azadirachta indica A. Juss. of family Meliaceae, widely known as neem, has a variety of uses ranging from medicinal applications to use as fodder. The ability of this plant to grow in hardy conditions makes it a preferred species for the arid regions. Although its value as a utility tree has already been established, detailed studies on its morphological and phenological aspects are found wanting in India. The processes of flowering and fruiting, which are generally connected with each other, are important from the point of view of silviculture. Often one finds that an abundant flowering is not followed by an equally abundant fruiting. And due to its important role in regeneration, fruiting of any tree species deserves special attention. Though abundant fruiting is a prerequisite, it cannot always ensure vigorous regeneration. The time of flowering (and subsequent fruiting) may vary in a given region. The leaves of neem tree are acknowledged fodder for goat and camel and also are well known for their pesticidal properties. Apart from these, the spermicidal, antifertility and anti-implantation properties of neem leaves have attracted the attention of researchers in the recent past (Shaikh *et al.* 1993). Hence a clear understanding of the availability of neem leaves and leaf shedding period of the tree is also of much importance. It is in these contexts that a pilot study on the phenological aspects of neem was initiated in April 1993. This paper discusses some of the important observations which came out of the study.

Locations and methods

Studies on the phenology of neem were taken up to understand its leafing, flowering and fruiting behaviour throughout the year at twelve different locations in India which are situated in six different agro-ecological zones as classified by the National Bureau of Soil and Land-use Planning. The twelve different locations and the six agro-ecological zones in which they are situated are tabulated below.

Region	Location	State	Agro-ecological zone
Hot arid	Jaisalmer	Rajasthan	ER2
	Jodhpur		
Hot semi-arid	Ahmedabad	Gujarat	ER4
	Allahabad	Uttar Pradesh (UP)	
	Jaipur	Rajasthan	
	New Delhi	Delhi	
	Bangalore	Karnataka	ER8
	Coimbatore	Tamil Nadu (TN)	
Hot sub-humid	Pinjore	Haryana	ER9
	Jabalpur	Madhya Pradesh (MP)	ER10
	Jorhat	Assam	ER15
	Midnapore	West Bengal (WB)	

Note:

ER2: Western plains and Kucchh Peninsula with desert and saline soils
ER4: Northern plains and central highlands with alluvium derived soils
ER8: Eastern Ghats (Tamil Nadu uplands) and Deccan Plateau with red loamy soils
ER9: Northern plains with alluvium-derived soils
ER10: Central highlands (Malwa and Bundelkhand) with medium and deep black soils
ER15: Assam and Bengal plains with alluvium derived soils

At each location, ten trees were marked for monthly observations. The study was initiated in April 1993 and data up to December 1994 were analysed to generate information regarding flowering and fruiting times, maximum leafing period, seed availability time, etc. As neem is seldom leafless in India, the data on leafing were collected based on whether or not a tree is in heavy leafing. A tree with more than two-third portion of its crown covered with leaves was considered to be in heavy leafing. As far as flowering and fruiting are concerned, a tree which bears at least a few flowers/fruits was considered to be in flowering/fruiting. The percentages of the total number of trees bearing flowers, bearing young and mature fruits and found in heavy leafing were then calculated for each agro-ecological region.

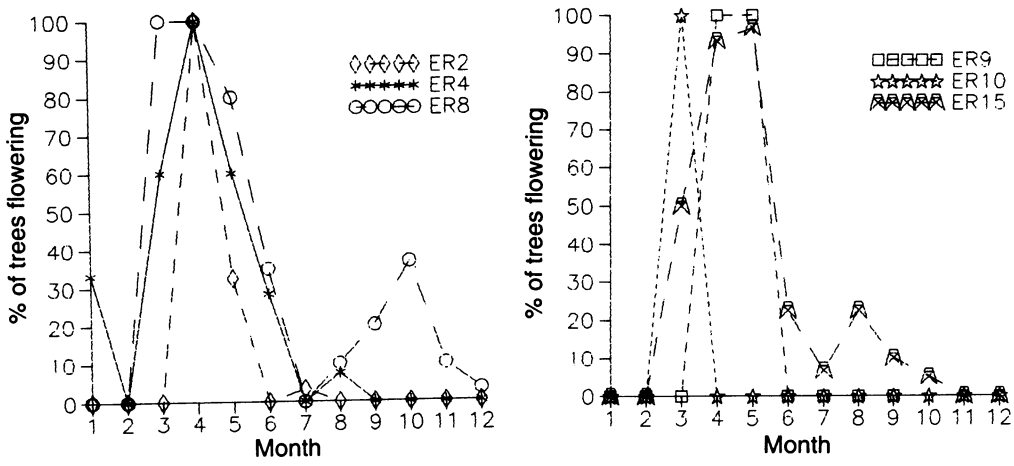
Results and discussion

Leafing

Most of the trees are in heavy leafing during May–November. The notable exception is in the case of the northern plains represented by ER4 and ER9 where heavy leafing is observed in most of the trees even up to January. Otherwise it can be assumed that leaf shedding in general starts from November and the trees are back in full leafing by April. Only in very dry areas the tree is found leafless for a short period during February–March (Dwivedi 1993). Neem is already reported to be in full foliage when most other trees are leafless (Troup 1981).

Flowering

From the point of view of natural pollination, flowering season is very important. Figures 1(a) and 1(b) show the distribution of flowering intensity (percentage of trees which bear at least a few flowers) for the calendar year. At almost all the locations there is an appreciable drop in the percentage of trees flowering immediately after May. This is preceded by peak flowering in March–April–May. Only in the arid locations (Jodhpur and Jaisalmer in Rajasthan) is there a sharp drop in percentage of trees flowering after April itself. In this agro-ecological region (ER2), less than 35% of the trees are flowering in May whereas, in all other regions 60% or more of the trees are flowering in this month. But the situation changes considerably in June. While 80 to 100% of the trees are flowering in May in most of the locations, only a few of them (less than 35%) bear flowers in June except in ER2 and ER9 where there are no flowering trees in this month.



(a) Hot arid and semi-arid regions (b) Hot sub-humid region

Figure 1. Flowering of neem

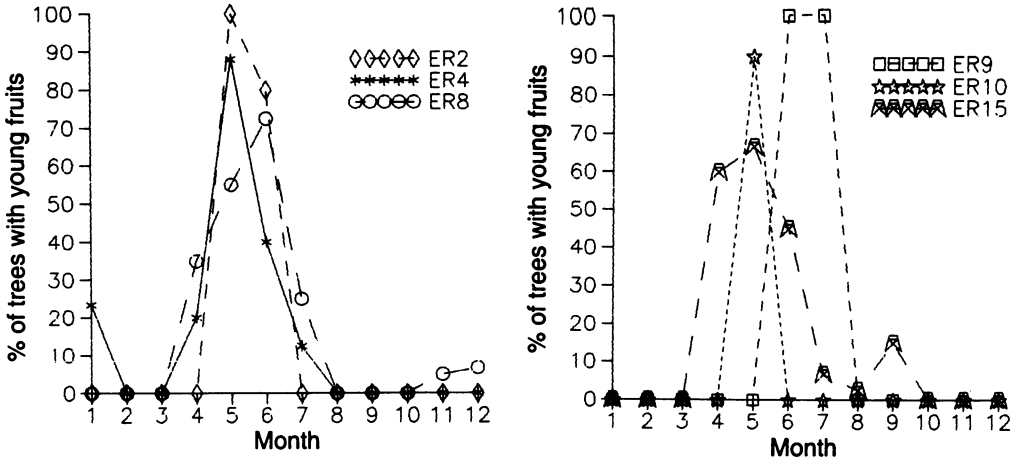
Some restricted flowering is indicated during July–October in the sub-humid locations in Assam and Bengal (ER15). In August, nearly 23% of the trees are flowering here. At the semi-arid locations of Eastern Ghats and Deccan Plateau (ER8) also there is some restricted flowering during August–December. The secondary peak in this case is in October with about 4% of the trees being found flowering. In the semi-arid regions of northern India represented by ER4, some restricted flowering is indicated in January and August with about 34% and less than 10% of trees being flowering respectively.

These observations are largely in agreement with other reports. In a study in Tamil Nadu the primary and secondary flowering seasons were reported as April and September respectively (Shanti *et al.* 1996). Mahadevan (1991) has reported the two flowering periods to be March to mid-May and mid-August to September based on his observations in Tamil Nadu and Andhra Pradesh. In Malaysia, these seasons were reported to be February–April and July–September respectively (Loke *et al.* 1992).

Fruiting

The beginning of fruiting was studied by observing young fruits. It is observed that generally May–June is the season when fruiting starts in neem. However, there are different peak patterns for fruiting in different regions [Figures 2(a) and 2(b)]. In the arid locations (ER2) more than 80% of the trees have young fruits on them in May and June and there is no observation of young fruits for the other periods of the year. In the semi-arid parts of northern India (ER4), the peak is distinct in May (more than 85%) with June showing only 40% of the trees bearing young

fruits. The flowering pattern for this agro-ecological zone is a wider one ranging from March to May showing more than 60% of the trees to be flowering and peaking in April. But the fruiting peak is sharper with a distinct peak in May indicating that the fruiting pattern is quite different from that of flowering for this zone. The restricted flowering in January is accompanied by some fruiting too. In the semi-arid parts of southern India (ER8), more trees start to fruit in June and the restricted flowering found in October is accompanied by some fruiting in November–December.



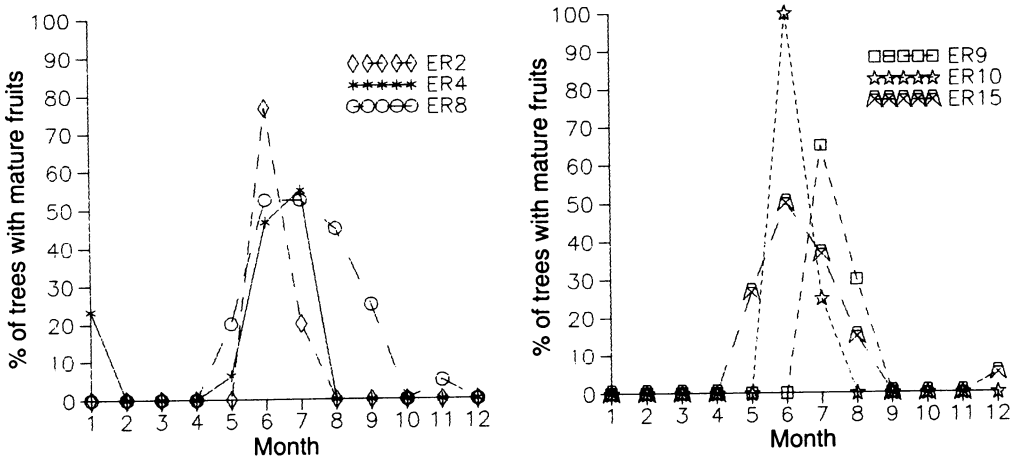
(a) Hot arid and semi-arid regions (b) Hot sub-humid region

Figure 2. Young fruits of neem

Among the sub-humid parts, the central highlands (ER10) have only a single peak in May which follows its corresponding flowering peak in March. There is no record of young fruits during the rest of the year in this zone whereas in ER9 (northern parts) the only fruiting peak is found in June–July following the flowering peak of April–May. In the Assam and Bengal plains (ER15), there is a broad peak between April and June with 45–65% of the trees showing young fruits which closely follows its corresponding flowering peak of March–May. This is followed by a few trees (less than 20%) showing some young fruits in September following the secondary flowering peak of August. One can see that the flowering and fruiting peaks of ER15 somewhat overlap. Such an overlap of flowering and fruiting in young trees of neem was reported in a provenance trial also (Gupta *et al.* 1995).

Seed collection

This case was studied by taking stock of the intensity of mature fruits. It is reported that the optimum period for seed collection is when the colour of the drupe turns from full green to yellow-green (Lauridsen & Souvannavong 1993). Yellow-brown, wrinkled or already fallen drupes should be avoided as their viability declines rapidly in storage (Suri & Mehrotra 1994). Figures 3(a) and 3(b) give the times of occurrence of mature fruits in the different agro-ecological zones. In the arid region (ER2), maximum ripened fruits occur in the month of June. In the semi-arid regions, it is in June and July. But a notable exception is in the case of semi-arid regions of southern India (ER8) where about 45 and 25% of the trees still have mature fruits in August and September respectively. In Tamil Nadu fruits from the primary flowering have been reported to be ready for harvest in July–August and those from the secondary flowering in December (Shanti *et al.* 1996). The respective seasons were reported by Mahadevan (1991) to be June and October from his studies in Andhra Pradesh and Tamil Nadu.



(a) Hot arid and semi-arid regions (b) Hot sub-humid region

Figure 3. Mature fruits of neem

In the sub-humid regions also the analysis shows diversity in peaks of ripened fruits. In ER9 the peak is in July whereas ER10 and ER15 show the peaks in June. But about 40 and 25% of trees in ER15 and ER10 respectively have mature fruits in July too. In Malaysia, ripened fruits from the two flowerings were reported to be available in June–August and October–December (Loke *et al.* 1992). A study on the characteristics of seeds of neem collected from the two seasons (primary and secondary) indicated that those collected in the secondary season have higher seed weight, larger size and lower moisture content (Mishra & Tomar 1995).

The various phenological observations, viz. leafing, flowering, occurrence of young and mature fruits, etc., from this study are summarised in Table 1.

Table 1. Peak months in which various phenological characteristics take place in neem in India

	Arid	Semi-arid		Sub-humid		
	ER2	ER4	ER8	ER9	ER10	ER15
Heavy leafing	May–Nov.	Apr.–Jan.	Apr.–Dec.	June–Feb.	Apr.–Dec.	June–Oct.
Flowering	April	Mar.–May	Mar.–May	Apr.–May	March	Apr.–May
Young fruits	May–June	May	May–June	June–July	May	Apr.–June
Mature fruits	June	June–July	June–Sept.	July	June	June

Conclusion

Flowering and fruiting characteristics of neem generally show up during March and August. The fruiting pattern closely follows the flowering pattern in the various agro-ecological zones studied except in the case of the semi-arid parts of northern India falling in ER4. Moreover, some of the agro-ecological regions show restricted flowering and fruiting. The seed collection period is the month of June for most of the regions except for ER4, ER8 and ER9 where the best seed collection periods are June–July, June–September and July respectively.

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