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LEAFING, FLOWERING AND FRUITING OF *Sterculia setigera* IN METEMA, NORTH WESTERN ETHIOPIA

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ABSTRACT : Episodic in leaf, flower and fruit patterns of *Sterculia setigera* were examined in Metema woreda of north Gondar zone of the Amhara region, Northwest Ethiopia. Monitoring was conducted for the period of 24 months starting from September, 2011 to September, 2013. For the purpose, we selected 16 individual trees (Dbh ≥ 10 cm) of *S.setigera* trees at 100 m apart. The trees were measured for dbh, marked and mapped using a GPS and monitoring was conducted in every week. The results of monitoring revealed that pattern of leafing and leaf loss, flowering and fruiting are unimodal in lined with the nature of the rainfall pattern of the study area. Leafing was started at the end of dry season when the rain season begins (Mid May) and the trees were in full leaf (Peak leaf flushing) in June and continued peak in leafing during July. Shedding of leaves starts on October but was higher (peak) in December coinciding with the beginning of dry season. Uniformity was observed in blooming among trees and flowering was concentrated in April and ends at the beginning of mid-May. Early fruiting was observed during October. However, mass fruiting was observed during November and ends in in late December up to early January. Therefore, we concluded that seed harvesting of *S.setigera* is better to conduct in mid-November to beginning of December in the study area.

Keywords : *Sterculia setigera, leafing, flowering seeding, periodicity*

An important feature of Ethiopia's dry forests is their richness in valuable tree species that provide gum acacia (gum arabic and gum talha), frankincense, myrrh and gum karaya. These products contribute significantly to rural livelihoods, the national economy and ecosystem stability (Azene *et al.,* 2; EFAP, 4; Abeje, 1; Wubalem *et al.,* 19; Mulugeta and Demel, 12). They contribute to local livelihoods in terms of both cash income, gained by selling products to buyers, and of subsistence local use (FAO, 6; Gemedo *et al.,* 7; Abeje, 1; Wubalem *et al.,* 19; Mulugeta and Demel, 12). However, despite the enormous socio-economic and ecological contribution from the proper management and utilization of gum and resin resources of the country, the resource is reported to be in a big threat due to several interrelated factors through which its degradation is framed (Abeje, 1; Wubalem *et al.,* 19; Mulugeta and Demel, 11) for the reason that they are among the least managed and protected ecosystems (Mulugeta and Demel, 12).

To develop viable conservation strategy for dryland species of the country, formal studies of the reproductive processes and phenological patterns are vital. In view of the fact that the dry land species are valued by local communities both for subsistence uses and for sale, knowledge of their phenology is necessary not only for managing the stands, but also to facilitate the regeneration needed to restore the stands since phenological studies provide information on functional rhythms of plants and plant communities, where the timing of various phenological events may reflect biotic and/or abiotic environmental conditions. Thus the main objective of this study was to investigate phenological events in *S.setigera* in relation to locality at the individual levels in the study area. The leafing, flowering and fruiting patterns over a period of 24 months are reported below.

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MATERIALS AND METHODS

Description of the study species

S.setigera is an indigenous deciduous tree common to central and Southern Africa occurring in most types of woodlands and in hot dry areas on rockyhills of woodlands. In Ethiopia, it grows in dry to moist Bereha and Kolla agro-climatic zones with the altitudinal range 0-1,400 m. The tree could reach to the height of 5-12m but may reach to 25 m. The gum from *S.setigera* used as additive to medicines. The wood could be used for fuelwood and fencing, pulp, paper and cheap furniture and the erect branches spreading to a rounded crown. The tree can be propagated by both seed and cuttings.

Study area description

The study was conducted in Metema Woreda of north Gondar zone of the Amhara region. The study

area is located at 36017' – 36048' East Latitude and 12039' – 12045' North longitudinal ranges. It lies within an altitudinal range of 550 – 1608 m above sea level (m a.s.l). The annual mean maximum and minimum temperature is 35.6 ºC and 19.1 ºC, respectively and the annual rainfall ranges between 664.7–1131.5 mm, with a mean annual rainfall of *ca.* 954.6 mm. Metema has a unimodal rainfall. The rainy months extend from June to the end of September. However, most of the rainfall is received during the months of July and August (Abeje, 1: Sisay, 15; MDOA, 10).

According to the conservation strategy for Ethiopia (EPA, 5; NCSS, 13), the vegetation zone of Metema district is categorized under the Combretum–Terminalia or Broad-Leaved Deciduous Woodland, and is an extension of the Sudano-Sahelian zones (Abeje, 1; Ogbazghi, 4; Kuchar, 9; Tamire, 16). Although the woodlands are very extensive, almost all of them have been burnt every year, and grazed by domestic animals owned by both the local people and highlanders.

September, 2013. For the purpose of monitoring we used 16 trees of *S.setigera* with dbh ≥ 10 cm and 100m apart from each other. Each individual tree was measured for dbh, tagged and mapped using a GPS. Then monitoring was done in every week from the second week of September, 2011. Leafing, flowering and fruiting were visually estimated, separately monitored and a sequence of phases (Table 1) was distinguished in each. A separate phenological record was maintained for each of the marked trees for the study. Leaf loss/shedding, leafflush, flowering and fruiting times are estimated as theinterval between the first and last dates on which respective activities were observed on each individual.

At each monitoring year, peak flowering and fruiting refer to the months in which the number of individuals observed in that phenophase reached a maximum. The leaf fall period was taken as the time from first recording of leaf discoloration to the last time when newly fallen leaves were noted dropped. The flowering period was recorded as from flower bud

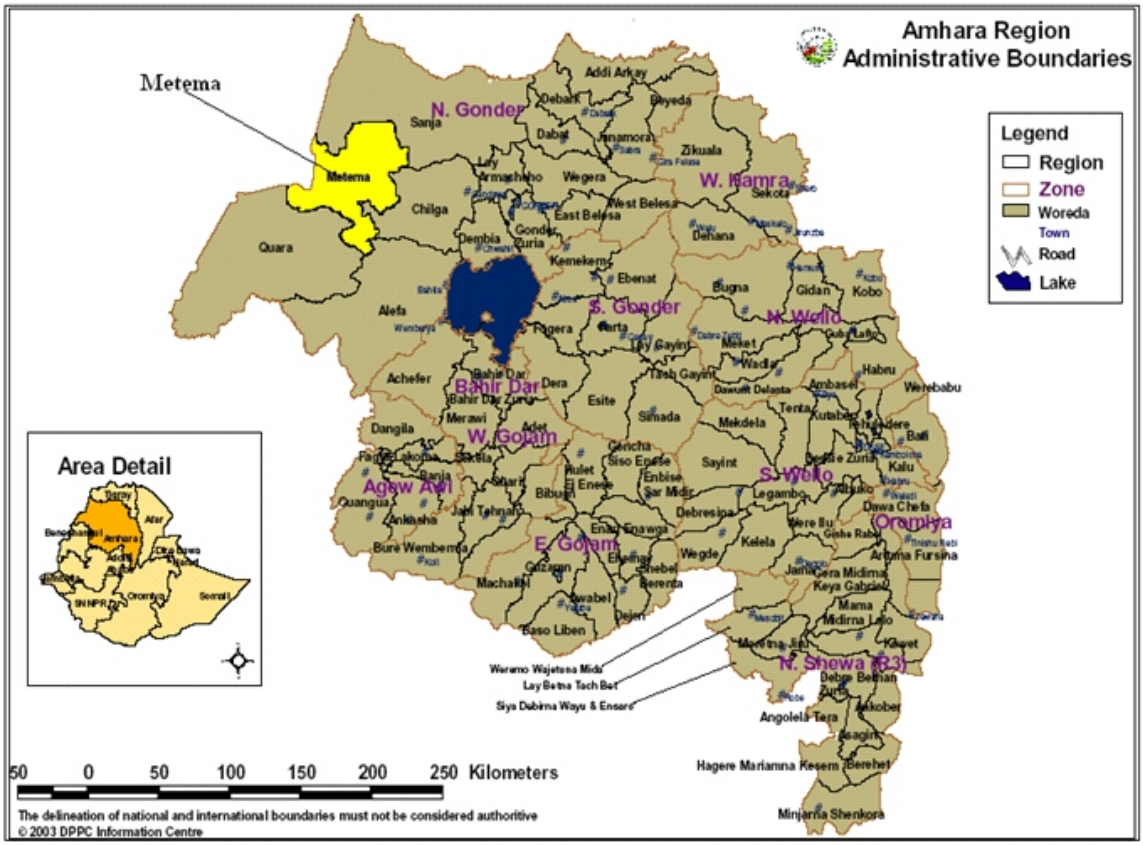

Fig. 1 : Map of Ethiopia showing location of the study areas.

Data collection

Leaf, flower and fruit periodicity of the species *S.setigera* were recorded from September, 2011 to initiation up to fertilization. The fruiting period was taken as from fruit initiation to the last recording of presence of mature fruits.

Data analysis

The phenology of *S.setigera* was summarized byrecording the phenophases of each marked trees and presented the result in combined. An excel sheet used for data analysis.

RESULTS AND DISCUSSION

Phenophases in *S. setigera*

The monitoring revealed that pattern of leafing and leaf loss, flowering and fruiting are unimodal in lined with the nature of the rainfall pattern of the study area. The species *S.setigera* has shown six phenophases for its leaf, flower and fruits periodicity in the study area.The detected phenophases of *S.setigera* tree is presented below in Table 1.

Table 1: Phenological phases of individual trees of *S. setigera* in Metema.

No	Phenophases		
	Leafing	**Flowering**	**Fruiting**
1	Swelling leaf buds	No inflorescence buds	No fruit
2	Leaf buds breaking	Opening flowers buds	Early fruits
3	Leaf flushing	Mass flowering	Green fruits
4	New leaf developed	Peak flowering	Fully developed fruits
5	Matured leaf covered	Withered flowers	Peak fruit maturation
6	Leaf shading	Dried and withered of flowers	Fruit dissemination

Leafing and leaf shading episodic

Leafing was one of the most phenological events of the species *S.setigera* in the study area. It starts at the end of dry season when the rain season begins in each year. During monitoring, leaf flushing in S.setigera was observed in mid-May (Fig. 2). All marked individual treesin both monitoring years were peakin leaf flushingduring the months of Junsince the month correspond to the beginning of the rainy season and no difference was observed in the pattern of leaf flushing among individual of *S.setigera* trees in both years.

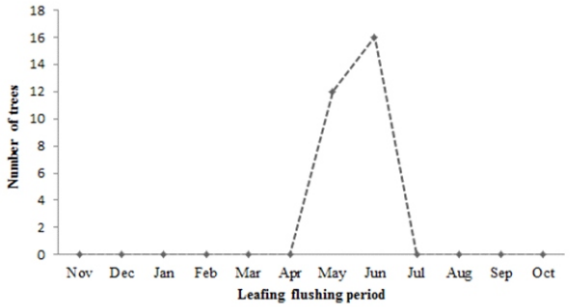

Fig. 2 : Leaf flushing period of *S.setigera* in the study area

On the other hand, the leaf maturation was started in June and got peak in July (Fig. 3). During these time the whole trees were with full of matured leaf. Similarly the loss of leaves starts on October but was higher (peak) in December coinciding with the beginning of dry season (Fig. 4). Like leaf flushing, individual treesdid not show difference in leaf maturation pattern. However few individuals were observed early to starts hedding in the two monitoring years in the study area. During monitoring it was observed that *S.setigera* was early to shade the leaf among the associated species in the study area.

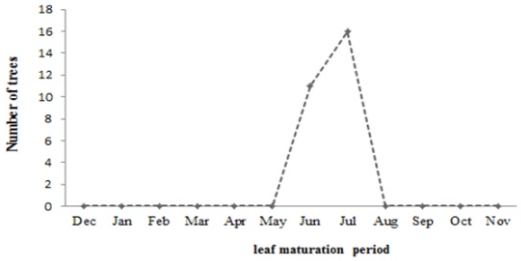

Fig.3 : Leaf maturation period of *S.setigera* in the study area.

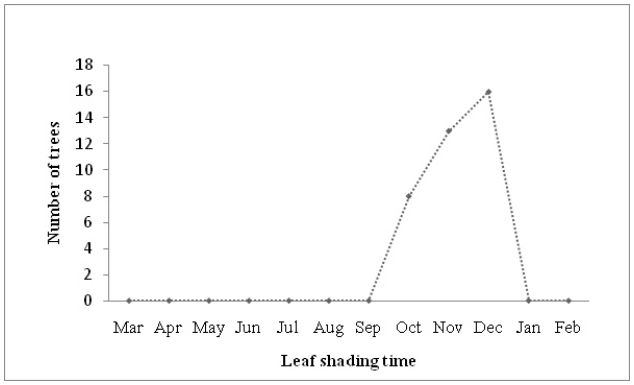

Fig. 4 : Leaf shading period of *S.setigera* in the study area

Flowering periodicity

In flowering, uniformity was observed on the patterns between the sampled *S.setigera* trees. During

monitoring, the whole trees were bloomed in the same months except few (2) trees shown early flowering. Bud opening in both monitoring yearstarted in early March. However flowering was peak in April and shading occurs in the mid may (Fig. 5).

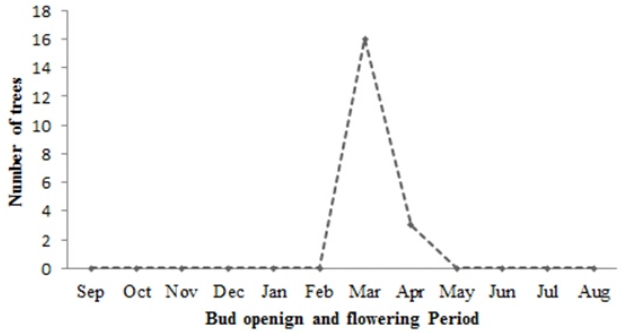

Fig 5 : Bud opening and flowering of *S.setigera* in the study area

Flowering was lasted for four months and generally began in late March and continued into mid-May although in a few individuals it extended into early June (Fig. 6). However, peak flowering was in April (Fig. 6).

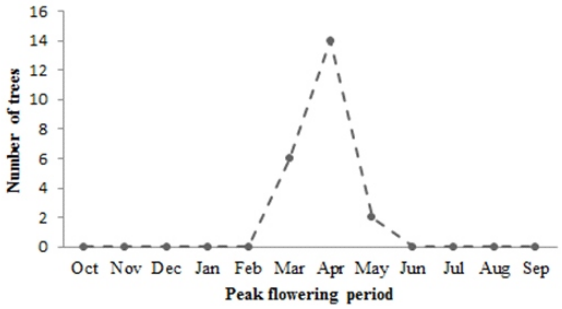

Fig. 6 : Peak flowering of *S.setigera* in the study area

Flower drying and withering in S.setigera was occurred in mid-May (Fig 7). At the moment the whole trees was observed shading the flower specially late May.

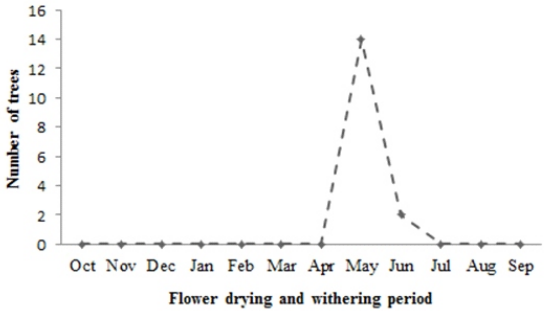

Fig. 7 : Dried and withered flowers of *S. setigera* in the study area

Fruiting and fruit dissemination episodic

Fruiting and fruit dissemination monitoring of *S.setigera* trees showed variation in fruit setting among the experimental trees in the study area. Early fruiting was observed on some of the trees and it occurred in October (Fig. 8).

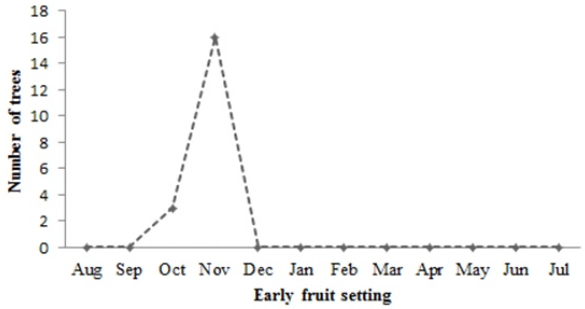

Fig. 8 : Early fruit setting of *S.setigera* in the study area.

However, mass fruiting starts in November and lasted up to two months (Fig. 9). The highest fruit was observed during November and ends in December (Fig. 9). During these times all of the trees were with matured fruits.

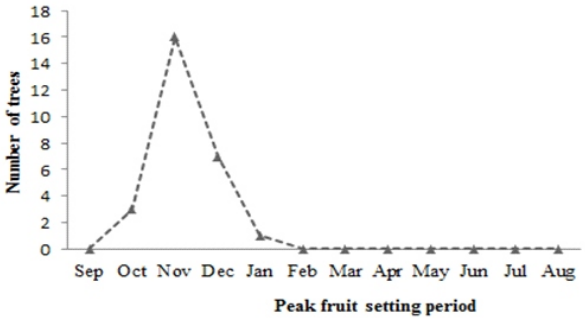

Fig. 9 : Peak fruit setting period of *S.setigera* in the study area

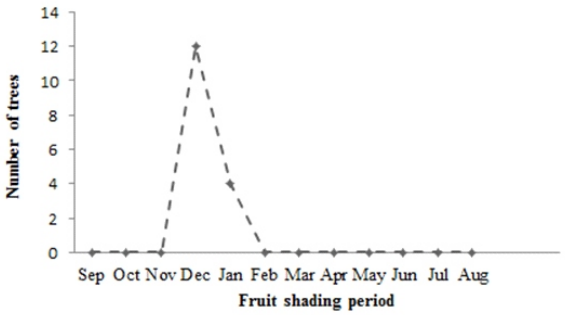

Fig. 10 : Fruit shading time of *S. setigera* in the study area.

Fruit shading in the trees of *S. setigera* was observed peak in late December and early January (Fig. 10).

In this study, it has been shown that *S.setigera* developed full leaf coverage during the rainy season which is correlated with high water availability (Table 4). Such leaf development is more closely connected to changing conditions in water availability (Borchert, 3; Van Schaik, 17). Similarly the species shade its leaves in the dry seasons when the moisture is low (Fig. 4). This might be the species strategy to reduce evapo-transpiration since at this time there is high rate of evaporation in the study area.

A trigger of flowering in *S.setigera* tends to be concentrated in the months a climatic factor ensures change in moisture stress (Fig. 6). This might be due to the fact that flowering in the dry season is for avoiding competition for physiologically active sites within the individual and to the availability of pollinators (Janzen, 8). Immediately after dried and withered flower, the tree of *S.setigera* starts giving fruits (early fruit). However mass fruiting in *S.setigera* starts in November and lasted up to two months(Fig. 9). During these months, the trees of S.setigera are with ripe fruits and seeds are ready for collection so that intensive seed collection could be takes place at these seasons for development purpose.

CONCLUSION

The present study revealed that phenological events have many practical implications in assisting to predicting of the flowering, fruiting andseed maturation of the study species. Leaf production in *S.setigera* takes place during the onset of rain season while leaf shedding occurs in the dry season. Similarly flowering of *S.setigera* coincide with the dry seasons of the study area indicating flowering in *S.setigera* is a dry season event although variation was observed in some study trees.

From early fruit setting up to fruit dissemination, *S.setigera* requires up to threemonths. However, the seed shading/dispersal will takes place immediately after peak fruiting in late December.Therefore, early seed collectionbefore dispersal is advisable for the species *S.setigera* to maintain in the seed storage.

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