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PHENOLOGY OF LEAF, FLOWER AND FRUITS OF *Boswellia neglecta* AND *Commiphora myrrha* IN BORENA ZONE, SOUTH EASTERN ETHIOPIA

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ABSTRACT : Leafing, flowering and fruiting phenology patterns of *C.myrrha* and *B.neglecta* were examined in Borena Zone of Oromiya region, South Eastern Ethiopia, for the period of 24 months starting from September, 2011 to September, 2013. We selected 16 individual trees (Dbh ≥ 10 cm) of both species at 100m apart and monitored in every week for phenologies.The result revealed that pattern of leafing and leaf loss, flowering and fruiting are bimodal following the rainfall pattern of the study area. Leaf flushing starts in the month of September and March when wet season begin for both species. And flushing reached peak and trees covered with leaf in the months of October to November and April to May in the first and second seasons, respectively. Leaf shedding starts in mid-December and mid-June. Flowering is concentrated in December and June and usually ends (Dried and withered) at the mid of January and July. Early fruiting observed in October for *C. myrrha* and in Novemberfor *B.neglecta* in the first season and in July for both species in the second season. However, fruit maturation was in November and July for *C.myrrha* and January and July for *B.neglecta*. According to the local people and monitoring of the trees, seed harvesting is possible before end of January for *C.myrrha* and mid-February for *B.neglecta* since fruiting of both species in the second season is not certain.

Keywords : *Commiphora myrrha, Boswellia neglecta, leafing, flowering, seeding, phenology.*

In Ethiopia, the Vast areas of land (cal. 51%) are arid to semiarid (NCSS, 12; Tamerie, 13) with marginal or no agricultural potentials. Nevertheless, many of the indigenous trees and shrubs in these vast arid and semi-arid lowlands hold known for the production of economically valuable products, principally *oleo* gum resins such as gum acacia (gum arabic and gum talha), frankincense, myrrh, and gum karaya (Dejene, 4; EFAP, 5; Kuchar, 9; FAO, 6) and they play a significant role in the livelihood of many people in the dryland regions of Ethiopia. Moreover, the direct national economic contribution of the dryland vegetation in terms of generating foreign currency far outweighs that of the forest resources in the humid and sub humid parts of Ethiopia combined (Mulugeta and Demel, 10).

However, despite the enormous socio-economic and ecological contribution from the proper management and utilization, the dry land resource in Ethiopia is reported to be in a big threat due to several interrelated factors through which its degradation is framed (Abeje, 1; Wubalem *et al.,* 16; Mulugeta and Demel, 11) for the reason that they are among the least managed and protected ecosystems. Increasing human pressure in recent years in the drylands and on dry forests is initiating the rapid advance of desertification (Mulugeta and Demel, 11).

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In view of the fact that the dry land species are valued by local communities both for subsistence uses and for sale. Knowledge of the species patterns in phenophase isessential for understanding the functioning of the species in the ecosystem and scientific management of the resources. This type of study will help to understand various phenophases in the global climatic change scenario at local level. Moreover, developing viable local conservation strategies for the species depend on the ability to realize the vegetative and reproductive potential of the species which overlay on the knowledge of the species phenology.Thus the main objective of this study was to investigate phenological events in *C. myrrha* and *B.negelectain* relation to locality at the individual levels in the study area.

MATERIALS AND METHODS

Description of the species

C.myrrha and *B. neglecta* are indigenous tree species that can grow in Acacia-Commiphora woodland and bush land on sandy to loamy soil overlying limestone or granite, rocky lava hills; 250-1,300m (Dejene, 4; Vollesen, 15; Azene *et al.,* 2). Gum production from the species is carried out by collecting exudates from trees in natural stands by random picking from naturally and/or accidentally exuding trees by peasants and pastoralists.

Description of the study area

Borana Zone lies at the most southern and south eastern edges of the Oromia National Regional State, southern Ethiopia, between 360 42' 38"' to 390 45' 15"' E and 30 31' 31"' to 60 35' 37"' N (Fig. 1). Most of the area falls under the dry climatic regime with marginal or no agricultural potential. The mean annual rainfall ranges between 400 and 600 mm (Gemedo *et al.,* 7). The rainfall distribution is bimodal with a short rainy season occurring between April and May and a major dry season occurring between December and February (Gemedo *et al.* 7). The small monthly rainfall is associated with a high evapo-transpiration rate, which makes the rainfall unable to sustain good livestock and agricultural production. The human population of Borana is estimated at about 400,000 (Gemedo *et al.,* 7). The people of the study area are called Borana, the eldest branch of the Oromo ethnic group in Ethiopia, and derive their subsistence from livestock husbandry and small-scale traditional farming practices. Most communities are dependent on the collection of various non-timber forest products to generate income (Dejene, 4; Gemedo *et al.,* 7).

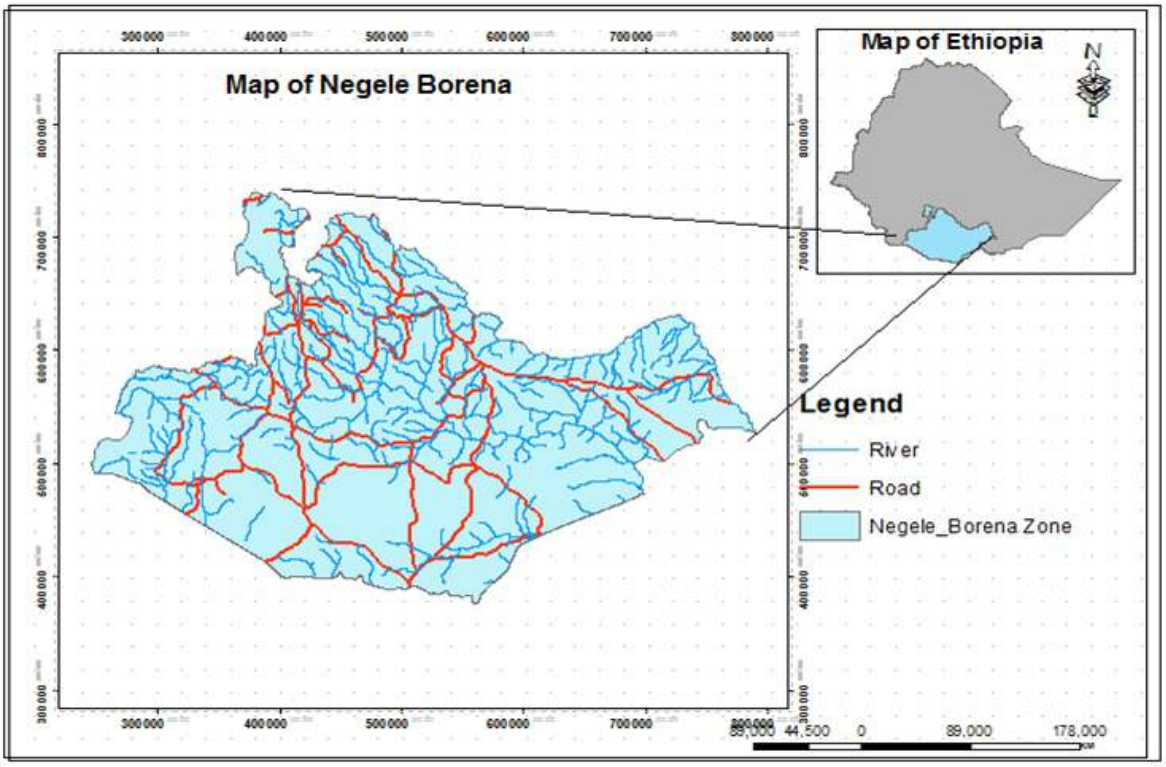

Fig.1 : Map of Ethiopia showing location of the study areas.

Data collection

Leafing, flowering and fruiting phenologies were recorded from September, 2011 to September, 2013. 16 trees of *C. myrrha* and *B. neglecta* with dbh =10 cm and 100m apart from each other were identified for monitoring. 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 the interval between the first and last dates on which respectiveactivities 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 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 *C.myrrha* 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 of the studied species

In each observation time, phenophases of the studied species were recorded through careful observation of the canopy. The phenology of the studied individual trees exhibited those six prominent phenophases (Table 1). These phenophases followed the bimodal pattern of the rain fall the study area.

Table 1 : Phenophases observed in the species studied.

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

Leaf phenology

Leafing was the most synchronized phenological event of the studied species. Leafing starts at the end of dry season when the rain seasons begin in each year. During monitoring, leaf flushing in *C.myrrha* was started in end of September in the first season and mid-February in the second season (Fig. 2). On the other hand leaf flushing in *B.neglecta* starts in end of August and March in the first and second season, respectively (Fig. 2). All marked individual trees in both monitoring years were peak in leafing during the months of October and early March for both studied species since these months correspond to the beginning of the rainy season.In both years the pattern of leaf flushing did not show differences among individual trees.

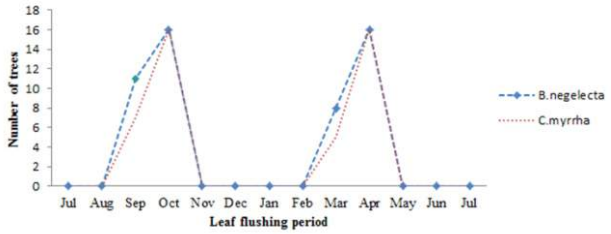

Fig 2 : Leaf flushing period of the studied species in the study area.

On the other hand, the leaf maturation was peak in November and May for *C.myrrha* and in October and April for *B. neglecta* (Fig. 3). During these time the whole trees were with full of matured leaf.

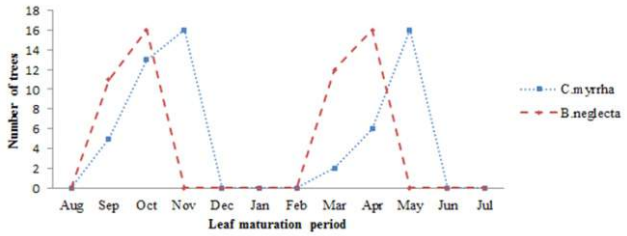

Fig. 3 : Leaf maturation period of the studied species in the study area

Similarly the loss of leaves starts on December and Jun but was higher (peak) in January and July for both species coincidingwith the dry season (Fig. 4). However the species *B. neglecta* is early to start shading leaves in the second season (Fig. 4). Like leaf flushing, individual treesdid not show difference in leaf maturation and shedding patterns between years in the study area.

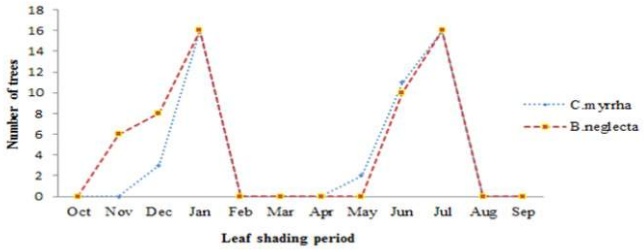

Fig 4 : Leaf shading periodof the studied species in the study area.

Flowering phenology

In flower manifestation, uniformity was not observed on the patterns between the two species. C.myrrha is the first to open buds for flowering. Bud opening and flowering in both monitoring year started in October and April and was peak in November and May (Fig 5). On the other hand bud opening and flowering in B.neglecta started in November and May but reached peak in mid-December and Jun (Fig. 5).

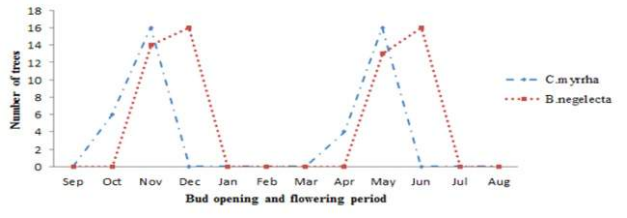

Fig. 5 : Bud opening and flowering of the studied species in the study area.

For both study species, flowering was lasted for four to five months and generally began in early November and continued into late February in the first season and in late April continued into late June, although in a few individuals it extended into early July (Fig. 6). However, peak flowering was from December and June (Fig. 6) for both species.

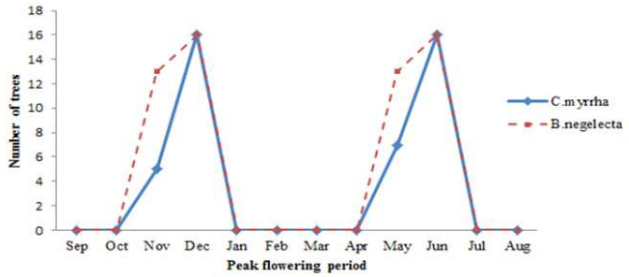

Fig. 6 : Peak flowering of the studied species in the study area.

Flower dried and withered in both species was observed in January and June for *B. neglecta* and January and July for *C. myrrha* then it started to shade and continued into late February and early August (Fig. 7). During this time the observed trees were transferred in to fruiting.

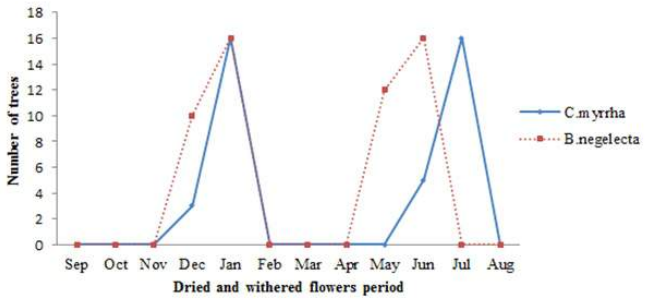

Fig. 7 : Dried and withered flowers of the studied species in the study area.

Fruiting phenology

Monitoring of the study speciesshowed variation during onsetof fruit and fruit dissemination. However, fruit maturation reachedpeak on the same time. Early fruiting was observed for some trees and early maturation was in October and Jun for *C.myrrha* and November and June for *B.neglecta* for the first and second fruiting season (Fig. 8).

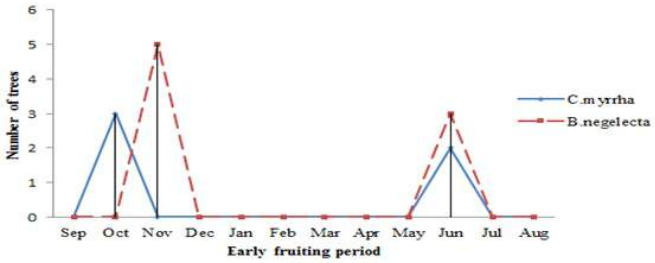

Fig. 8 : Early fruit setting of the studied species in the study area.

Generally fruiting starts in October and June and lasted up to two months in both fruiting season for *C. myrrha* and December and June for *B.neglecta* in the first and second fruiting season (Fig 9). However, fruiting phase were noted to be shorter than this for some of the trees. The highest fruit was observed during November and July (Fig. 9) for *C. myrrha* and January and July for *B. neglecta* for the first and second season. During these times all of the trees were observed with matured fruits. However, trees exhibited lower number of fruits in the first season and high number of fruits in the following season, and vice versa.

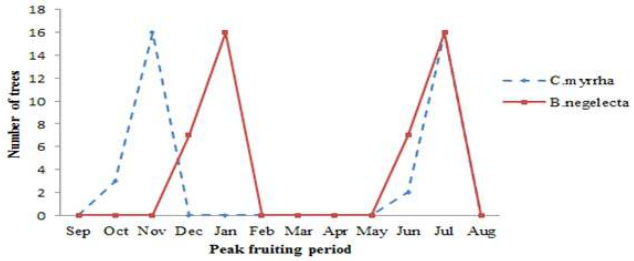

Fig. 9 : Peak fruit setting period of the studied species in the study area.

Fruit shading in the trees of *C. myrrha* was observed peak in January and Aug (Fig 10). Whereas in February and August for *B. neglecta* (Fig. 10).

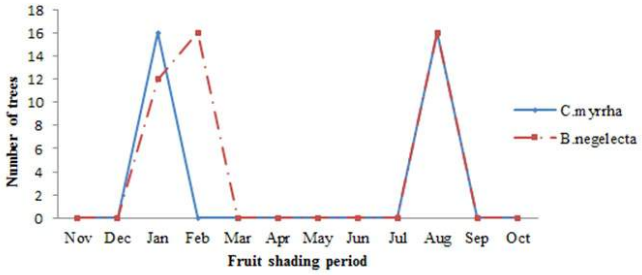

Fig. 10 : Fruit shading time of the studied species in the study area.

In tropical dry forests, environmental changes control the tree phenology. Trees periodicity is most likely observed when the first rain set after a period of severe droughtor the cessation of rains. In this study, it has been shown that the study tree speciesdeveloped full leaf coverage during the rainy season which is correlated with high water availability (Fig. 3). Such leaf development is more closely connected to changing conditions in water availability than to flowering or fruit production (Borchert, 3). Similarly the species shade its leaves in the dry seasons when the moisture is limited (Fig. 4). This might be the species strategy to reduce evapotranspiration since at this time there is high rate of evaporation in the study area.

Triggers of flowering in in the study tree species tend to be concentrated in the months when leaf sheddingstarts and a climatic factor ensures change in moisture stress (Fig. 6). Janzen (8) attributed flowering in the dry season to the necessity for avoiding competition for physiologically active sites within the individual and to the availability of pollinators. The short flowering period (~41 days) may be a result of responseto competition for promoting pollen exchange among the mass flowering individuals since excessiveresources at these periods are thought to attract many types of pollinators (Van Schaik, 14).

The fruit phenology of the study tree species start (early fruit) instantly after dried and withered occurred in flower. However mass fruiting was in mid-October and June and lasted up to two months in both fruiting season (Fig. 9). The duration of fruit maturation was short but with bimodal pattern. By November and July *C. myrrha* tree hold with ripe fruits while *B. neglecta* in January and June and are ready for collection so that intensive seed collection of the study species could be takes place at these seasons. However, fruit production in July is not certain since in both monitoring year, we observed that seeds were terminated.

Conclusion

Observations on phenology of a tree is basic information that since phenological events have manypractical implications in assisting to predicting of flowering, fruiting andseed maturation of individual trees and can also relateto a tree's ability to capture environmental resources successfully. The present study revealed leaf production in the study species takes place during the onset of rain season while leaf shedding occurs in thedry season. Similarly flowerings coincide with the dry seasons of the study area indicating flowering for the study species is a dryseason event although variation to some extent between the study tree species existed. From early fruit setting up to fruit dissemination, the study species requiredup to six months. However, the seed shading/dispersal will takes place immediately after peak fruiting. Given thefact that the studied species seeds are Orthodox, early seed collection before dispersal is advisable through maintaining the seed in the storage.

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