Asian Journal of Biology

13(2):1-6, 2021; Article no.AJOB.75151
ISSN: 2456-7124

Phenological Study of *Elaeis guineensis* (Jacq.) Growing in Ihiala, Anambra State, South-East Nigeria

Ochia, M. Angela[1*], Ekwealor, U. Kenneth[1], Njom S. Victor[2], Mbaukwu A. Onyinye[1] and Iroka, F. Chisom[1]

[1]Department of Botany, Nnamdi Azikiwe University, P.M.B. 5025, Awka, Nigeria.
[2]Department of Applied Biology and Biotechnology, Enugu State University of Science and Technology, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJOB/2021/v13i230180
Editor(s):
(1) Dr. P. Dhasarathan, Anna University, India.
Reviewers:
(1) José Alberto Iannacone Oliver, Universidad Nacional Federico Villarreal, Peru.
(2) Víctor Libardo Hurtado Nery, University of Los Llanos, Colombia.
Complete Peer review History: https://www.sdiarticle4.com/review-history/75151

Original Research Article

Received 06 August 2021
Accepted 12 October 2021
Published 18 October 2021

ABSTRACT

The aim of the study was to provide a phenological data and baseline information on the phenology of *Elaeis guineensis* Jacq. The study was conducted with exotic species at Ihiala, South-East, Nigeria, a tropical climate. The initiation and completion of different phenophases of the tree, such as budding, leafing, flowering, fruiting and ripening were recorded at two weeks interval. The combination of the principal growth stages and the secondary growth stages produced 2-digit codes, were used to delineate the time-dependent phenophases. The results revealed that *E. guineensis* showed a cyclical and seasonal appearance of the phenophases observed in the course of the year. Bud formation and leaf development phenophases were very gradual and steady across the months observed. Peak flowering time of August through November and peak ripening time of April was recorded in this study. Also, the study revealed that difference existed in the extent of phenophases of the observed species. The study also showed that *E. guineensis* belong to the family (Arecaceae) had different time frames for the phenophases. It is concluded that the phenological records obtained from the study can be very useful in planning and management of orchards, and can provide reference records in tracing changes in the phenology of *E. guineensis* in the future.

Keywords: Climate variability; Elaeis guineensis; palm tree; phenology; plant responses.

1. INTRODUCTION

Plants tend to possess definite recurring growth and developmental phases in any given environment over time. They perform various vegetative and reproductive functions throughout the year in order to persist in their habitats. The entire developmental cycles of plants occur as rhythmic events. This phenomenon is termed phenology [1,2].

Phenology has been defined as the study of cyclical biological events. In plants, this can include flowering, leaf unfolding (or bud burst), seed set and dispersal, and leaf fall in relation to climatic conditions [1]. Plant phenology has been proposed as an indicator of climatic difference and global change by the European Environmental Agency and the intergovernmental panel on climate change [2].

Plant phenology, the timing of plants life cycle transitional events, plays an important role in tracking climate change, diagnosing agricultural management practices and investigating ecosystem processes [3,4,5]. Since 1990, Phenology has been one of the most active disciplines to evaluate the effects of climate change on ecosystems [5]. Shifts in plant phenology have been one of the most widely reported responses of organisms to current climate change [5,6].

The responses of plant phenology to changes in climate are complex and vary substantially across species, locations and seasons [5]. Depending on these factors, plant phenology may respond to changes in temperature, precipitation, snow melt or day length and plants may respond to cues differently in different seasons [7]. But there is a dearth of experimental information on the phenology of Tropical plants, compared with temperate and boreal regions [8].

There are still gaps in knowledge on baseline information and phenological data on tropical fruit trees. This has made it almost impossible for researchers to say in clear terms the fruit trees that have remained resilient or otherwise in the last few decades.

Determination of the sequence in the seasonal appearance of phenophases in *Elaeis guineensis* (Jacq.) commonly called oil palm tree found in Ihiala, Anambra State, Nigeria, a tropical climate is the specific aim of the study. The main objective of the study was to provide phenological data for *E. guineensis* and provide baseline information on the phenology of this fruit tree.

2. MATERIALS AND METHODS

2.1 Study Area Characteristics

The study will be carried out in Ihiala, Nigeria. Ihiala is in a tropical region with dry deciduous vegetation and experienced two seasons- raining season (March-October) with temperature ranging from 22.9^{0}C to about 30.2^{0}C and dry season November- February) where temperature can reach 33.9^{0}C. Ihiala is a semi-urban area with enough fruit trees and is located in the south-eastern Nigeria between latitude 6^{0}10'0''N and longitude 6^{0}46'0'E. The average daily minimum and maximum temperatures of Ihiala is 23^{0}C and 33^{0}C respectively. With mean annual rainfall of 1886.88mm (Enugu weather station, 2017).

2.2 Data Collection

The BBCH (Biologische Bundesantalt and Chemische industries) scale method of Meier et al. [9] in which the principal growth phases of the trees under study were arranged chronologically according to their appearance in the course of the year or all phases from one plant were grouped in one line, following their natural developments was used.

The entire developmental cycles of the selected fruit trees were subdivided into ten (10) clearly recognizable and distinguishable long-lasting phenological phases, that is, the principal growth phases, thus; germination. Sprouting/bud development; leaf development; formation of side shoots/tillering; stem elongation/shoot development; development of harvestable vegetative plant parts or vegetatively propagated organs; inflorescence emergence; flowering, development of fruit; ripening or maturity of fruit and seed; senescence. Ordinal numbers 0 to 9 was used to describe the principal growth stages in ascending order.

However, not all the principal growth stages were observed, as attention was on leaf development, flowering, development of fruit, fruit ripening.

Table 1. The following are the principal growth stages

S/N	Stages	Description
1.	0	Germination/bud development
2.	1	Leaf development
3.	2	Formation of side shoots
4.	3	Stem elongation
5.	4	Development of harvestable vegetative plant parts
6.	5	Inflorescent emergency
7.	6	Flowering
8.	7	Development of fruit
9.	8	Ripening or maturity of fruit and seed
10.	9	Senescence, beginning of dormancy

BBCH Scale Meier et al. [9]

Since the principal growth stages cannot be sufficiently used to define exactly the stages in the developmental cycles before senescence, the secondary growth stages were introduced. They are the intermediate values between 0 and 9. These values, however, were expressed as percentage values in this study.

The principal growth stages and the secondary growth stages resulted in 2 digit codes, BBCHXY, which defined the phenophases over time. The first ordinal number X denotes the principal growth stage while the second ordinal number Y denotes the percentage of the development in the secondary stages. For example, the phonological leaf fall or leaf fall phenophase was defined with BBCH95.

That is 9 is the principal growth stage for senescence secondary growth stage 5 in this case stands for 50% of the leaves have fallen. Also, code BBCH10 depicts the beginning of leaf development.

The observer made use of visual observation in observing opening of flower buds and petals, colour changes and changes in size and number in the principal growth stages for the phenophases.

The researcher ensured uniform conditions by observing the trees at 1.00pm. This was to ensure optimum sensitivity for colours for the eyes. Also, at this time, the sun is high and behind the observer. The frequency of observation was two weeks interval starting from the month of September, 2018 to August, 2019.

3. RESULTS

Table 2 presents the percentage occurance of the phenophases of *Elaeis guineensis.*

Bud formation and leaf development phenophases were observed to be very gradual and steady across the months with no peak or reduced developmental period. The flowering phenophases was most obvious between 1st week of August (BBCH61) through 4th week of November (BBCH68). Though flowering was scanty and inconsistent across other months observed.

Fruiting Phenophase started 3rd and 4th September (BBCH72) through end of April (BBCH79). Fruit ripening started 3rd and 4th week of November (BBCH82) through 4th week of April, (BBCH88). Ripening was also scanty and inconsistent across other months observed.

4. DISCUSSION

The phenological studies of *E. guineensis* found at Ihiala, Anambra State, South-East, Nigeria, a tropical climate, revealed high phenological diversity for the principal growth stages (Budding, Leafing, Flowering, fruiting and ripening in the tree observed from August, 2018 to July, 2019).

The study revealed that the studied fruit tree showed cyclical and seasonal appearances of the phenophases observed in the course of the year. This supports Sigh and Kushwaha [10] assertion that plant vegetative and reproductive growth and development shows rhythmic appearances over time.

Bud formation and leaf development phenophases were very gradual and steady across the months and seasons observed. Fruit development occurred more at the onset of dry season through the onset of the rainy season (October through April). Ripening occurred more during dry season/ onset of rainy season (November through April).

Table 2. Phenophases of Elaeis guineensis

Time Period	Months observed																							
	August		September		October		November		December		January		February		March		April		May		June		July	
Principal growth stage	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks	1-2wks	3-4wks
Bud formation	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leaf development	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Flowering	BBCH61	BBCH62	BBCH63	BBCH64	–	BBCH66	–	BBCH68	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fruit development	–	–	–	BBCH72	–	BBCH73	–	–	BBCH74	–	–	BBCH76	–	–	BBCH78	–	–	BBCH79	–	–	–	–	–	–
Ripening	–	–	–	–	–	–	–	BBCH81	–	BBCH82	–	–	BBCH84	–	BBCH85	–	BBCH86	BBCH88	–	–	–	–	–	–
Senescence																								

Note: the dash (-) represents gradual development of the phenophase

Although there were little or no earlier information on the phenology of *E. guineensis* in this region (South-East, Nigeria), Legros et al [11] Indonesia recorded a peak flowering time of August through October and peak ripening time of march as against August through November (Flowering) and peak ripening time of April recorded in this report.

This suggests that phenology of *E. guineensis* may have lagged by 2-4 weeks in both flowering and ripening. Shifts in plant phenology have been one of the most widely reported responses of organisms to current climate change [6]. Global climate change may force variation in timing, duration and synchronization of phenological events in tropical forest [12].

There was a gradual and steady bud and leaf development across the months observed. Also, flowering and fruiting persisted throughout the seasons and months observed as reported by earlier researchers. It seems not to be affected by the changing environment. This seems to coincide with the reports of Dransfield [13] that changes in phenological patterns are species specific.

5. CONCLUSION

This study has revealed baseline information on the phenology of *Elaeis guineensis*. It will be of help in knowing the timing of different phenophases in *E. guineensis* and this could be of interest to the people of this region (or where similar climatic conditions prevail, who wish to plan their orchards and also some Agro allied industries whose major raw materials is palm oil or kernel. This study has provided important insights into the biology of *E. guineensis* and revealed its phenological pattern.

This study has equally revealed a change in peak fruiting and ripening time of *E. guineensis*. This study would also be of great help for comparison over long duration of time, for example, to see if there is any change in the phenological patterns of the same plant species in the next 10 or more years. Studies like this would equally reveal the fruit tree species that are more resilient or more resistant to effects of climate change. This would help in mitigating the adverse effects of our changing climate. Such comparative study could not be possible at this time since sufficient relevant literatures are not available for the region.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Davi H, Gillmann M, Ibanez T and Cailleret M. Diversity of leaf unfolding dynamics among tree species; New Insights from a study along an altitudinal gradient: Agricultural and Forest Meteorology. 2011;151(12):1504-1513.
2. IPCC. Climate change 2007, impacts, adaptation and vulnerability. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; 2007.
3. Chuine I, Yiou P, Viovy N, Seguin B, Daux V, Le Ladurie E. Back to the middle ages? Grape harvest dates and temperature variations in France since 1370. Nature. 2004;432:289-290.
4. Gao M, Wang X, Meng F, Liu D, Li X, Zang Y, and Piao S. Three-dimensional change in temperature sensitivity of northern vegetation phenology. Global change Biology. 2020;26(9): 5169-5201.
5. Piao S, Liu P, Chen A and Wan AJ. Plant phenology and global climate change; Current progresses and challenges. Global change Biology. 2019;25(6):3120-3124.
6. Ibanez T, Primack R, Miller-Rushing A and Ellwood ER. Forecasting phenology under global warming. Philosophical Transactions of the Royal society B Biological Sciences. 2010;365(1555):3247-3260.
7. Flynn DFB and Wolkovich EM. Temp and Photoperiod drive spring phenology across all species in a temperate forest community. New phytologist. 2018;219(4):1353-1362.
8. Bradley NL, Leopold AC and Ross J. Phenological changes reflect climate change in Wisconsin proceedings of the

National Academy of Sciences. 2011; 96(17):9701-9704.
9. Meier N, Bachmann L, Buhtz E, Hach H, Klose R, Marlander B, Weber E. Phanologische enttwicklungsstadien der beta ruben (*Beta vulgaris* L.) coddierung und bschreibung nach der erweiterten BBCH-ska la mit Abbildungen, Nachrichtenbl. Deut. Pflanzenschutzd. 1993;45:37-41.
10. Singh KP and Kushwaha CP. Diversity of flowering and fruiting phenology of trees in a tropical deciduous forest in India. Annals of Botany. 2006;97(2):265-276.
11. Bhriguvanshi SR. Impact of climate change on mango and tropical fruits. In: Singh, H.P Singh, J.P, Lal, S.S, Westrille Publishing House, New Delhi, India. 2010; 224.
12. Reich PB. Phenology of tropical forests-patterns, causes and consequences. Canadian Journal of Botany. 1995;73:164-174.
13. Gorisamo A, Clen Jing M, Chapyang W. Citizen science: Linking the recent rapid advances of plant flowering in canada with climate variability". Scientific Reports. 2013;3(1):2239.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle4.com/review-history/75151