Direct Research Journal of Agriculture and Food Science
Vol. 11(10), Pp. 302-309, October 2023
ISSN: 2354-4147
DOI: https://doi.org/10.26765/DRJAFS62811374
Article Number: DRJAFS62811374

https://journals.directresearchpublisher.org/index.php/drjafs

Original Research

Variations in African Pear (*Dacryodes Edulis (G. DON) H.J. LAM*) Flowering Phenology in Mangrove Zone of Nigeria

Njoku, T.C.

Department of Crop Science & Biotechnology, Imo State University, P. M. B 2000, Owerri, Imo State, Nigeria.
Author E-mail: tcnjoku2011@yahoo.com

Received 9 September 2023; Accepted 5 October 2023; Published 11 October 2023

ABSTRACT: Field phenology study was conducted in three locations in each of two states (Rivers and Delta State), in Mangrove zone of Nigeria where the trees exist during 2013 to 2015 to determine the flowering phenology of African pear (Dacyrodes edulis (G.Don) H. J. Lam)). Various cutigens of the species were used. 60 trees with180 flowered branches were sampled. Data collected include time for flowering, days of inflorescence flower bud formation to anthesis, days from anthesis to fruit formation, inflorescence length, number of flower in an inflorescence and number of inflorescence in a panicle. Data collected were subjected to analyses. Standard errors and percentages were calculated where appropriate. The obtained result showed that time of flowering varied. Strong positive relationship exist between inflorescence length and flower per inflorescence. No ssignificant ($P<0.05$) difference were observed in mean flower per inflorescence and mean inflorescence per panicle in Rivers and Delta States for the three years. Approximately one quarter of the trees flowered by December in Delta State for the three years, while flowering started by January in Rivers State for the three years. Peak flowering was January in both States. The variations that exist in African pear flowering time are more of genetic and less environmental.Therefore the survey study suggested that variations of genetic and horticultural interest exists in African pear (D. edulis) floweringand that the initiation of a planned phrenological program for selection and improvement of African pear for optimal fruit yield is necessary.

Keywords: African pear, mangrove, phenology, variation, fruit yield

Citation: Njoku, T.C.(2023). Variations in African Pear (*Dacryodes Edulis (G. DON) H.J. LAM*) Flowering Phenology in Mangrove Zone of Nigeria. Direct Res. J. Agric. Food Sci. Vol. 11(10), Pp. 302-309. https://doi.org/10.26765/DRJAFS62811374. This article is published under the terms of the Creative Commons Attribution License 4.0.

INTRODUCTION

Phenology is concerned with timing of developmental processes that is the start, the duration and the end rather than with the rate of development. Phenology is important for optimal crop yield in an environment. It can be used to specify the most appropriate rate and time of specific developmental processes (Hatfield and Prueger, 2015). In pointing out the importance of timing Chapman *et al. (*1999) observed that cloudy conditions depress the productivity of several tropical crops. Therefore, during sunny years, flowering is increased. Phenological events in plant may be affected by various factors that could be classified as proximate causes such as, short term environmental events and ultimate causes which may include evolutionary forces. Environmental clues such as changes in water level stored by plants, seasonal variations in rain fall, Changes in temperature, photo periods, Irradiance and sporadic climatic events are proximate causes triggering phenological events in temperate and tropical plants. Phenological patterns are linked to many processes governing forest functions and structures including population biology of pollinators, dispersers, seed predators and herbivores, inter-specific competition among trees and processes of primary production (Chapman *et al.,* 1999*).* One of the most

familiar of natural phenomena is the circle of events associated with the passage of the seasons. In the tropical regions, seasons are often marked by differences in rainfall associated with life history events occurring in response to water availability (Fenner and Thompson, 2006). He further stated that in plants, bud-bust, leaf expansion, abscission, flowering and fertilization all take place in due season. In African pear these events such as bud-bust, pollen shading, fertilization and fruit swelling all took place immediately after flowering, but there is no record as regards to the timing and duration of these events. Therefore, this study evaluates the phenology of flowering in African pear in two states of Mangrove zone of Nigeria where the trees exist.

MATERIALS AND METHODS

Experimental location and conditions

The field work was carried out for three years in Rivers and Delta States which is in the Mangrove zone of Nigeria. Extensive field trips were made in these two States where the species naturally occurs. Rivers and Delta States are located between Latitude $04^{0}46^{1}$ N and $06^{0}11^{1}$ N and longitude $07^{0}0^{1}$ E and $06^{0}43^{1}$ E and at Altitude 200 - 247 m above sea level. These areas have two main features; warm wet season (mid-march to October) and a hot dry season (November to mid-March). Annual precipitation of 2,000 – 4,000 mm falls during the wet season.Relative humidity is near saturation point (82 %) and often with minimum and maximum temperature ranges of 21^{0}C to 31^{0}C respectively (https://www.worlddata.info/climatecomparison.php?r1=ng-south-south&r2=nigeria). African pear (*D. edulis*) trees growing in different places were used. These include the ones found growing in the farms, forests, homesteads etc. At Delta and Rivers States, the following activities were carried out during the survey study: photographs, line drawings, measurements and morphological observations. Also data were collected on the time of flowering, number of flower per inflorescence, inflorescence per panicle and number of fruits in an inflorescence. Random measurements on floral characters were made from ten growing trees and replicated three times for each attribute in each tree sampled. During the flowering time, observations were made on 180 different trees for the three years in the two States and six locations. The field survey was monitored twice a day for floral data collections for the period of the study. Floral parameters collected are as follows: time of flower formation, flower bud to anthesis, anthesis to fruit formation, inflorescence length, inflorescence per panicle, number of fruit per inflorescence. Materials used during the field survey include: measuring tape for linear measurement, telescope, microscope, pencil, biro and exercise book. Data collected were analyzed using Analysis of Variance as in Statgraphics centurion XVI (16.0) software package. Significant means were separated using Duncan's new multiple range test (DNMRT). Descriptive statistics, correlation coefficients and coefficients of variation (CV) were also used (Gupta, 2011).

RESULTS AND DISCUSSION

Results obtained from the analysis of variation showed that differences exist in the time of flowering of African pear (Table 1 and Figure 1). Differences and similarities were seen in African pear flowering within and between the six locations covered in Rivers and Delta States. At Delta State, flowering started from December to February for the three years, while at River state flowering started by January to February except 2013 where flowering commenced towards the end of December. The month of January was the optimum flowering time at Delta State with the mean tree flowering values of 3.5, 4.0 and 3.5 for 2013, 2014 and 2015, respectively. At Rivers state, January was also the peak of flowering with the mean tree flowering values of 4.5, 4.0 and 4.0 for 2013,2014 and 2015, respectively. Also in March and April 2014 double flowering was observed in some trees at the two locations (Figure 1). Environmental factors might be the reason for the variation in flowering time of the trees within and between the locations surveyedsuch as peak of irradiance (Corlett, 2014; Chapman *et al.,* 1999) and cumulative heat sum (Jia *et al.,* 2011; Cober *et al.,* 2014). Flowering in African pear is seasonal and concentrates in the transition from the late dry to the early wet season and its timing and duration may be largely determined by seasonal changes in resource availability. Abiotic factors such as high temperature and low rainfall plays a major role in flowering time and duration of African pear. The first rain that ushered in the harmattan was a strong force that influenced the staggered flowering in African pear tree. Therefore, the effect of the warm harmattan dry season temperatures is suppressed, until a quota of cold temperature is accuminated releasing the plant from rainy season dormancy. In the two locations, peak of flowering occurred during the month of January. However, few other trees flowered during the months of December, February and March which were also within the period of dry season and this naturally occur from year to year which showed that apart from climatic factors, genetic plays a role in time of flowering.

Similarly statistical results of mean days of inflorescence flower bud formation to anthesis in RiversState and DeltaState lasted for two to five days (2-5). Mean days from inflorescence flower bud to anthesis

Table 1a: Location effect on mean (ẋ) inflorescence length of *D. edulis* in Rivers State 2013 – 2015.

Year	RL_1		RL_2		RL_3		RGẋ(cm)
	ẋ (cm)	CV(%)	ẋ (cm)	CV(%)	ẋ (cm)	CV(%)	
2013	21.41[a]	3.37	15.94[ab]	7.59	11.07[b]	10.61	16.14
2014	21.29 [a]	3.25	20.78 [a]	3.13	16.27 [a]	6.14	19.45
2015	21.24 [a]	2.82	13.77 [a]	9.26	13.85 [a]	8.68	16.29
Total	63.94	9.44	50.49	19.98	41.19	25.43	51.88
Mean	21.31	3.15	16.83	6.66	13.73	8.47	17.29

Means on the same row with different letters are significantly different at ($p < 0.05$).**ẋ** = Mean values, CV = Coefficient of variation, % = Percentage, RL_1 = Rivers location 1(Etche), RL_2 = Rivers location 2(Elele), RL_3 = Rivers location 3(Obiebe).

Table 1b: Location effect on mean (ẋ) inflorescence length of *D. edulis* in Delta State 2013 - 2015.

Year	DL_1		DL_2		DL_3		DGẋ
	ẋ (cm)	CV (%)	ẋ (cm)	CV (%)	ẋ (cm	CV(%)	(cm)
2013	23.60 [a]	2.75	26.12 [a]	1.24	22.25 [a]	5.11	23.99
2014	24.41 [a]	1.71	27.75 [a]	1.29	22.32 [a]	4.46	24.83
2015	24.20 [a]	3.27	16.75 [a]	7.07	18.54 [a]	6.17	19.83
Total	72.21	7.73	70.62	9.60	63.11	15.74	68.65
Mean	24.07	2.58	23.54	3.20	21.04	5.25	22.88

Means on the same row with different letters are significantly different at ($p < 0.05$).**ẋ** = Mean values, CV = Coefficient of variation, % = Percentage., DL_1 = Delta location 1 (Anwai), DL_2 = Delta location 2 (Ugbolu), DL_3 = Delta location 3 (Ogwashiukwu).

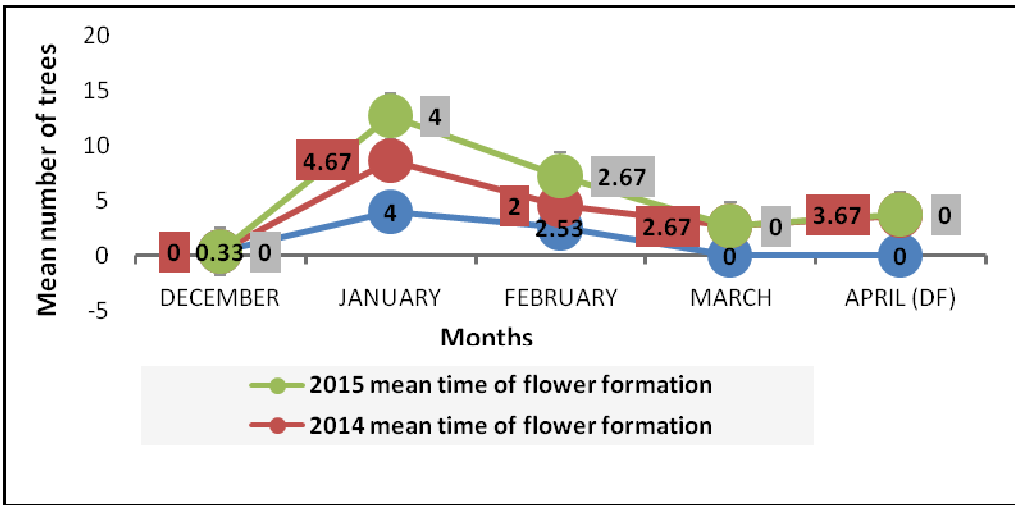

Figure 1a: Mean time of flower formation in Rivers State from 2013 -2015.

in River State ranged from 0.40 to 3.50 days in 2013, while 2014 and 2015, the values ranged from 0.40 to 4.50 and 1.50 to 3.00 days respectively. At Delta State, mean number of trees that took 2 to 5 days from inflorescence flower bud to anthesis ranged from 0.50 to 3.50 in 2013,0.50 to 3.50 in 2014 and 0.50 to 3.50 in 2015 respectively.This may be as a result of variations in duration and time of flower formation and variations in temperature. Mean days of flower formation to anthesis in the two locations for the three years varied. The peak anthesis was within three (3) to four (4) days. This may be as a result of the climatic factors, particularly temperature prevailing at that point in time and also genetic variations between the trees. More-so, all flower

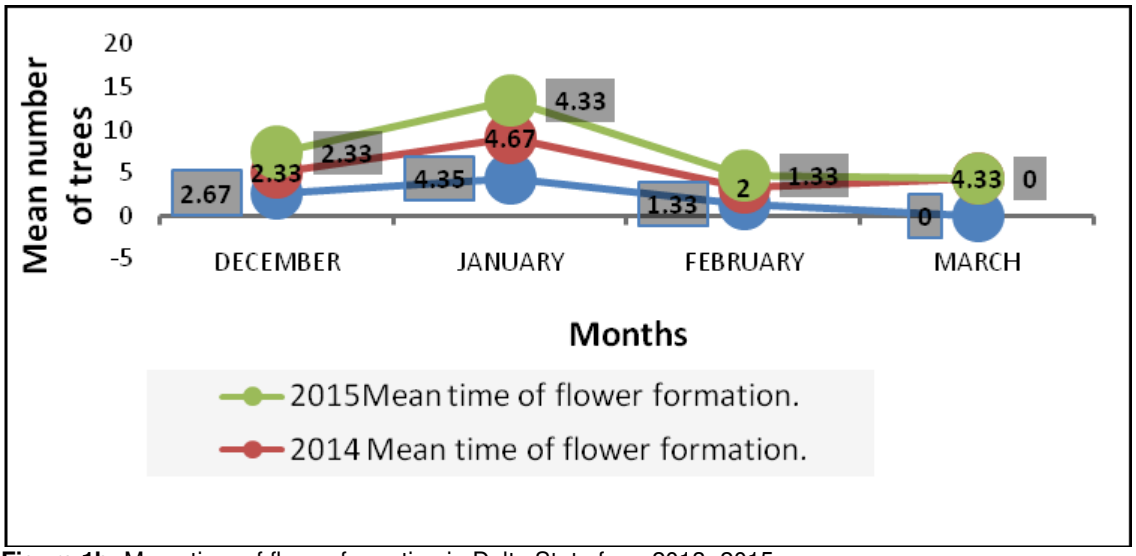

Figure 1b: Mean time of flower formation in Delta State from 2013 -2015.

bud did not reach anthesis at the same time. Some fall off before anthesis as a result of pest and disease attack, some due to unfavourable climatic condition (Figure 2). The duration from anthesis to fruit formation ranged from 26 to 40 days for the three year and for the two States. Rivers State in 2013, majority of the trees mean of 3.00 reached fruit formation from anthesis at 36 to 40 days. However, in 2014, a high mean 4.50 number of trees reached fruit formation from anthesis between 36 and 40 days duration. Delta state had similar values. Mean number of trees that reached fruit formation from anthesis within 36 to 40days for the three years were 4.30, 5.00 and 4.50, respectively (Figure 3).

Inflorescence length

Similarities were observed in the mean inflorescence length obtained from different location in Rivers state and Delta State. The mean inflorescence length in 2013 for Rivers State ranged from 11.07 cm to 21.41 cm. In 2014 and 2015, inflorescence length was statistically ($p< 0.05$) the same (Table 1a). The means and coefficients of variation for the three years of study in the three locations were statistically the same in Delta State. Differences were observed in the mean values for the three years but they are not significantly ($P< 0.05$) different (Table 1b). Therefore, similarities and variations observed is more of genetics than environmental factors.

Inflorescence per panicle (I/P)

The mean numbers of inflorescence per panicle of African pear trees in Rivers and Delta States for 2013 to 2015 were shown on (Tables 2a and b). Analyzed results showed significant differences between the locations and the years of study. Location and year had effect on mean inflorescence number per panicle with means ranged from 1.94 - 6.59 and 4.64 - 6.49, and grand mean of 3.65 and 5.69 for 2013 and 2014 respectively (Table 2a). In 2013, the mean values recorded at Delta State were 4.19, 4.82 and 3.35 for Anwai, Ugbolu and Ogwashiukwu respectively (Table 2b). Differences were observed in these means, but they were not significantly different. 2014 recorded the following mean values: 5.56, 5.95 and 4.65 for Anwai, Ugbolu and Ogwashiukwu respectively. Significant ($P < 0.05$) differences were observed between Ugbolu and Ogwashiukwu, while mean number of inflorescence per panicle were not significantly ($P < 0.05$) different between Ugbolu and Anwai and Ogwashiukwu and Anwai respectively (Table 2b). This means that the variations observed were both genetic and environmental.

Flower per inflorescence (F/I)

The highest mean number of flowers per inflorescence for 2013, 2014 and 2015 were 45.69, 57.68 and 42.71, respectively (Table 3). The mean number of flowers per inflorescence in 2013 was statistically ($P < 0.05$) not the same at Rivers State. Mean number of flowers per inflorescence of African pear in Delta State is shown on (Table 3b). In 2013, the mean number of flower per inflorescence ranged from 44.30 to 88.87. In 2014, it ranged from 39.94 to 50.20, while in 2015, flower per inflorescence ranged from 29.28 to 46.24 respectively (Table 3b). No significant ($P < 0.05$) differences were observed between the years of study and the locations. This may mean that flower per inflorescence is a genetic

Table 2a: Location effect on mean (ẋ) number of inflorescence per panicle of *D. edulis* in Rivers State 2013 – 2015.

Year	RL_1		RL_2		RL_3		RGẋ (cm)
	ẋ (cm)	CV (%)	ẋ (cm)	CV (%)	ẋ (cm)	CV(%)	
2013	6.59[a]	3.53	2.42[b]	6.96	1.94[b]	10.56	3.65
2014	5.94[ab]	1.98	6.49[a]	1.17	4.64[b]	5.82	5.69
2015	3.76[a]	0.68	2.58[a]	9.06	3.31[a]	9.71	3.22
Total	16.29	6.18	11.49	17.19	9.89	26.10	12.56
Mean	5.43	2.06	3.83	5.73	3.30	8.70	4.19

Means on the same row with different letters are significantly different at ($p < 0.05$).ẋ = Mean values, CV = Coefficient of variation, % = Percentage., RL_1 = Rivers location 1(Etche), RL_2 = Rivers location 2(Elele), RL_3 = Rivers location 3(Obiebe).

Table 2b: Location effect on mean (ẋ) number of inflorescence per panicle of *D. edulis* in Delta State2013 - 2015.

Year	DL_1		DL_2		DL_3		DGẋ (cm)
	ẋ (cm)	CV (%)	ẋ (cm)	CV (%)	ẋ (cm	CV(%)	
2013	4.19[a]	3.07	4.82[a]	1.49	3.35[a]	5.04	4.12
2014	5.56[ab]	1.04	5.95[a]	1.22	4.65[b]	3.83	5.39
2015	4.03[a]	2.01	2.64[b]	6.18	2.95[ab]	4.12	3.21
Total	13.78	6.12	13.41	8.89	10.95	13.00	12.72
Mean	4.59	2.04	4.47	2.96	3.65	4.33	4.24

Means on the same row with different letters are significantly different at ($p < 0.05$).ẋ = Mean values, CV = Coefficient of variation, % = Percentage., DL_1 = Delta location 1(Anwai), DL_2 = Delta location 2(Ugbolu), DL_3 = Delta location 3 (Ogwashiukwu).

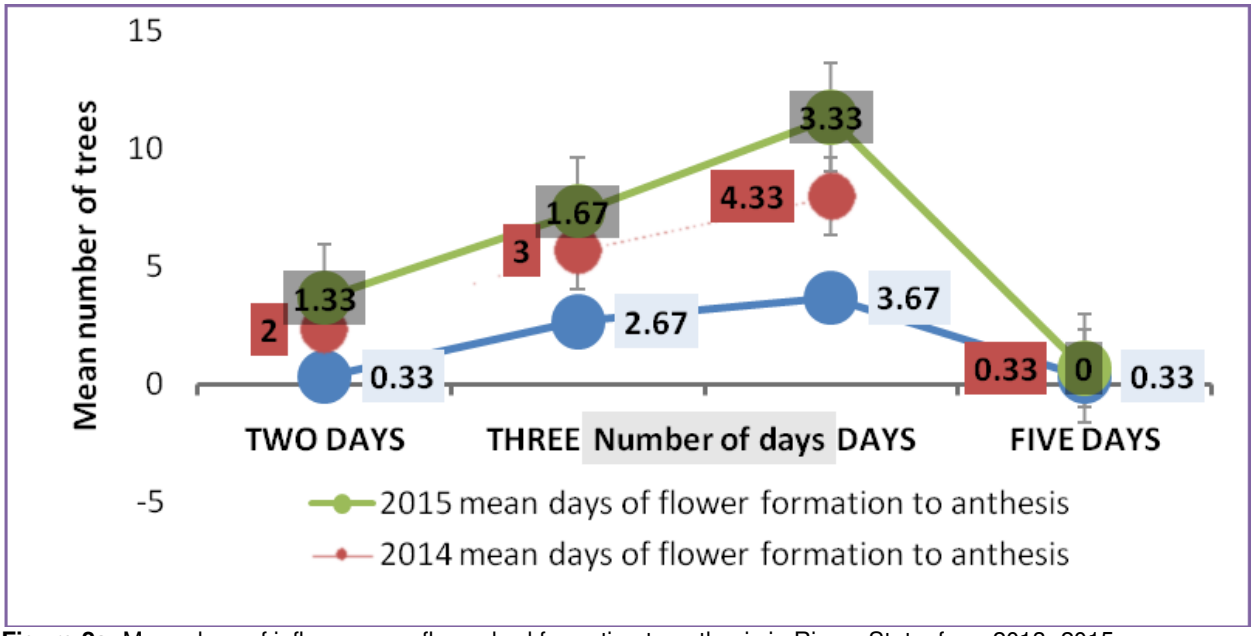

Figure 2a: Mean days of inflorescence flower bud formation to anthesis in Rivers State from 2013 -2015

factor rather than environmental. The results obtained from the survey study carried out at Rivers and Delta States showed some variations and similarities among the parameters measured. Variations noticed is an indication that the differences is less environmental and more of genetic. It is for this reason that some of these trees though, were found growing together in the same environmental condition and area, however, their time of flowering varied. There were also variations in size of inflorescence. Some were short while others were long

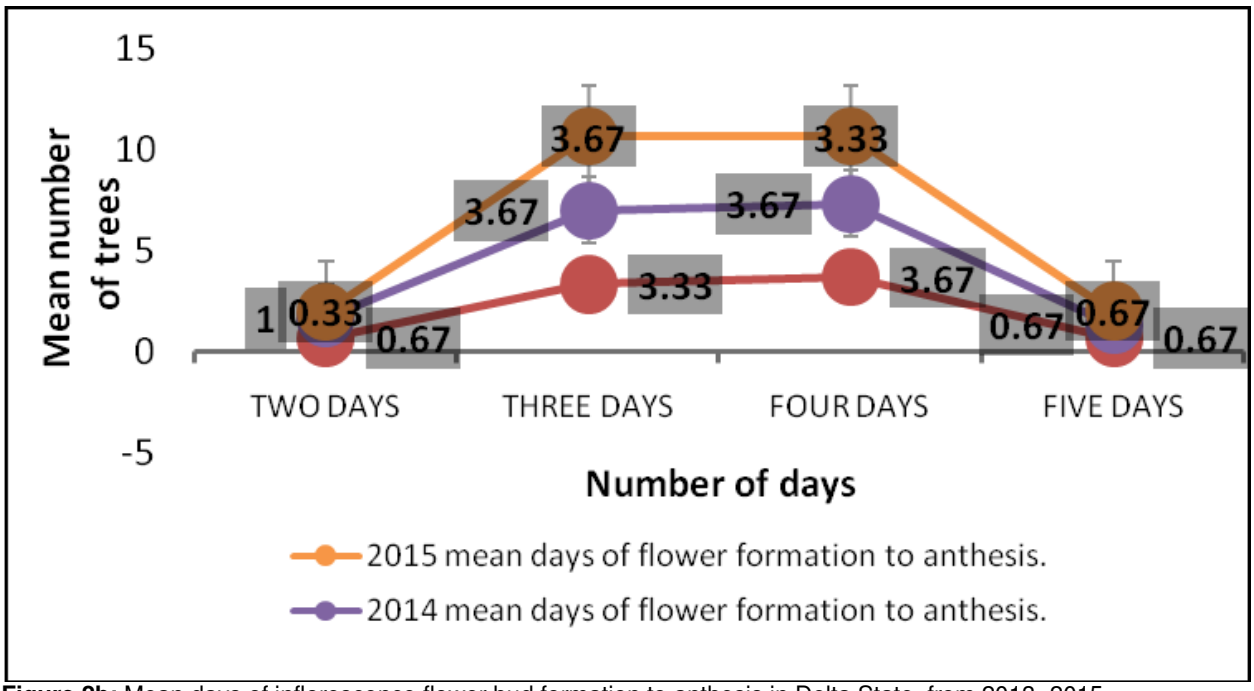

Figure 2b: Mean days of inflorescence flower bud formation to anthesis in Delta State from 2013 -2015.

Table 3a: Location effect on mean number of flower per inflorescence of *D. edulis* in Rivers State 2013 – 2015.

Year	RL_1		RL_2		RL_3		RGẋ (cm)
	ẋ (cm)	CV (%)	ẋ (cm)	CV(%)	ẋ (cm)	CV(%)	
2013	45.69[a]	7.34	37.14[ab]	9.48	17.81[b]	11.12	33.55
2014	46.98[a]	7.52	57.68[a]	5.78	37.14[a]	9.19	47.26
2015	42.71[a]	7.66	32.58[a]	11.71	29.45[a]	12.22	34.91
Total	135.38	22.52	127.40	26.97	84.40	32.53	115.72
Mean	45.13	7.51	42.47	8.99	28.13	10.84	38.57

The same row with different letters are significantly different at ($p < 0.05$). **ẋ** =Mean values, CV = Coefficient of variation, % = Percentage, RL_1 = Rivers location 1(Etche), RL_2 = Rivers location 2 (Elele), RL_3 = Rivers location 3 (Obiebe).

Table 3b: Location effect on mean number of flower per inflorescence of *D. edulis* in Delta State 2013 - 2015.

Year	DL_1		DL_2		DL_3		DGẋ
	ẋ (cm)	CV (%)	ẋ (cm)	(cm)	ẋ (cm	CV (%)	
2013	44.30[a]	3.57	88.87[a]	11.37	48.37[a]	7.76	60.51
2014	39.94[a]	4.73	47.09[a]	3.75	50.20[a]	6.29	45.74
2015	46.24[a]	5.83	29.28[a]	7.12	43.95[a]	6.64	39.83
Total	130.48	14.13	165.24	22.24	142.52	20.69	146.08
Mean	43.49	4.71	55.08	7.41	47.51	6.90	48.70

Means on the same row with different letters are significantly different at ($p < 0.05$).**ẋ** = Mean values, CV = Coefficient of variation, % = Percentage, DL_1 = Delta location 1(Anwai), DL_2 = Delta location 2 (Ugbolu), DL_3 = Delta location 3 (Ogwashiukwu).

and may attain a mean of 23 – 45cm, while others may not. The length of the inflorescence was genetically motivated and this may also be responsible for the numbers of flowers seen in the inflorescence. The number of panicle or inflorescence differed at times between locations and year and this may have been

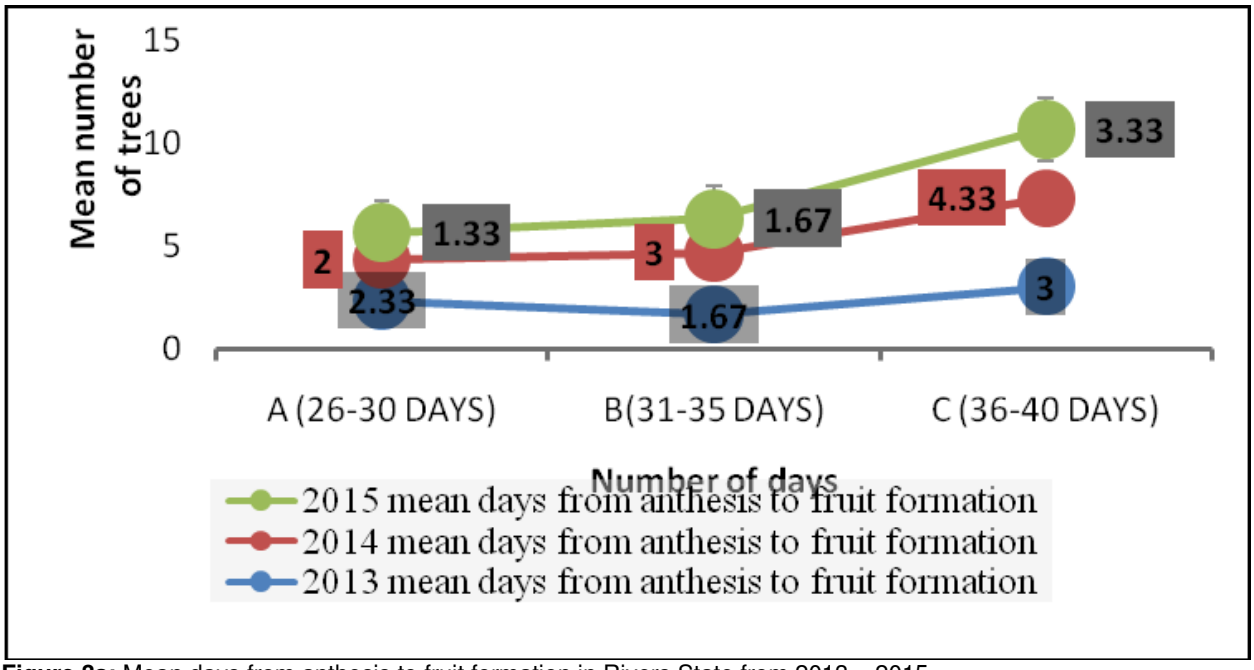

Figure 3a: Mean days from anthesis to fruit formation in Rivers State from 2013 – 2015.

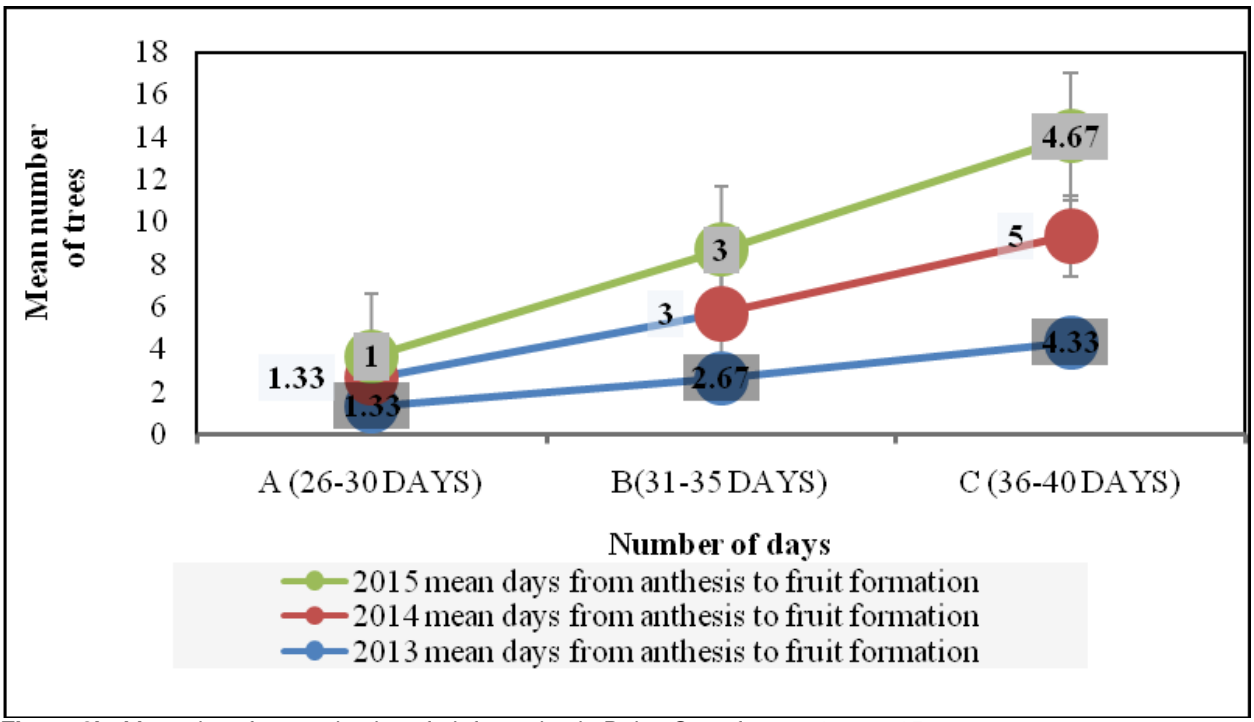

Figure 3b: Mean days from anthesis to fruit formation in Delta State from 2013 – 2015.

motivated by environmental factor. The intensity of flowering is ascertained by number of panicle per branch.

Conclusion

Phenology is the study of developmental timing in relation to the calendar. African pear *(Dacryodes edulis (G. Don) H. J. Lam*) flowers during the dry season, starting from December to March with Peak flowering by January at Rivers and Delta States in mangrove zone of Nigeria. Duration of inflorescence bud formation to anthesis during the period of the survey was 2-5 days. Anthesis to fruit formation duration was 26 to 40 days. For optimal flower and fruit yield and improvement and development

of African pear, flowering phenology is a necessity. In African pear *(D. edulis*) floweringthere exists much variation of genetic and horticultural attributes to guarantee the commencement of a planned program on phenology for selection and improvement of this tropical fruit tree species. However, further studies are required in the areas of tree to tree variations in terms of taste, colour, and size etc. by breeders for further improvement of the cutigens.

REFERENCES

Chapman, C. A., Wragham, R. W., Chapman, L. J., Kennard, D. K. and Zanne, A. E. (1999). Fruit and flower phenology at two sites in Kibale National Park, Uganda. *Journal of Tropical Ecology*15: 189-211.

Cober, E. R., Curtis, D. F., Stewart, D. W. and Morrison, M. J. (2014). Qualifying the effects of photoperiods, temperature and daily irradiance on flowering time of Soya bean Isolines. *Plants 201,3,476-47*

Corlett, R. (2014).The Ecology of Tropical East Asia. 2nd Edition, Oxford University Press Publishers. Page 53.

Fenner, M. and Thompson, K. (2006). The ecology of seeds. *Annals of Botany*, *Volume 97*, *Issue 1, 1 January 2006, Pages 151–152.*

Gupta, S.C (2011). Fundamentals of statistics 6threvised and enlarged edition.:: Himalaya Publishing House, PVT, Limited,, Mumbai, India

Hatfield, J. L. and Prueger, J. H. (2015). Temperature extremes: effect of plant growth and development. *Weather and Planet Extremes. 10 (A.)12, 2015, pages 4-10*

https://www.worlddata.info/climate-comparison.php?r1=ng-south-south&r2=nigeria

Jia, P., Bayaerta, T., Xiangqian, L. and Du, G. (2011). Relationship between flowering phenology and functional traits in Eastern Tibet Alpine Meadows. *An Interdisciplinary Journal 43, 4.2011.*