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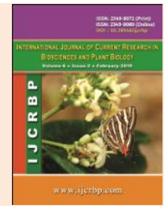

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Determinism of shade off in tropical species of the Sudano - Sahelian zone of Cameroon

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ABSTRACT

Phenological studies were undertaken on ten indigenous species of socio - economic importance of the Sudano-Sahelian zone of Cameroon. The selected species were *Adansonia digitata* L., *Balanites aegptiaca* (L.) Del., *Detarium microcarpum* Guill. & Perr., *Diospyros mespiliformis* Hochst. ex A. Rich., *Haematostaphis barteri* Hook. f., *Hexalobus monopetalus* (A. Rich.) Engl. & Diels, *Parkia biglobosa* (Jacq.) R. Br. ex G. Don*,* *Sclerocarya birrea* (A. Rich.) Hochst., *Tamarindus indica* L. and *Vitex doniana* Sweet. The studies which involve monitoring of the selected species were carried out from 2015 to 2017 along isoyets in the Sudano-Sahelian zone of Cameroon. The main objective of the study was to assess the phenological behaviour of the selected species in their natural habitat, with a view to determining their response to climate change in terms of shading off. If we understand sufficiently about it, and have at least a basic understanding of phenological characteritics, morphological and physiological adaptative behaviour when exposed to environmental change, we will be able to propose appropriate management techniques to optimize the product we required. The results reveal significant differences between species (0.0000 < 0.001), years (0.01 < 0.05) and isoyets (0.01 < 0.05) concerning mean period of defoliation. For the range of defoliation, significant differences exit equally between species (0.0000<0.001), years (0.0002<0.001) and isoyets (0.0002<0.001). Two categories of species are distinguished : deciduous and evergreen. The range of defoliation among species is equally significanly different (0.0000 < 0.001). Clamatic data in relation with phenological manifestations show that even if it is possible to find mean patterns, individual factors remain very important for more refined predictions, before more quantitative explorations, which must be foreseen, are done. These informations are important in the elaboration of efficient domestication strategies

Introduction

In the Sudano-Sahelian zone of Cameroon, socio-economic local plant species occupy an important place in the rural communities and in the food security of the housholds (Tchiégang-Megueni et al., 2001; Gautier et al., 2002; Eyog et al., 2006; Mapongmetsem et al., 2012). Unfortunatelly, in locality of high population growth where agriculture and breeding remain the main socio-economic activity, they assist to overexploitation of natural resources resulting to the reduction of vegetal cover of the environment (Gormo, 2013). Therefore the problematique of sustainable management of soils in a bit to occur to food needs of the population as well as maintening long terms productivity remain up to date (Traoré, 2000; Mapongmetsem et al., 2010). This alarmant situation leaded to search efficient strategies against this calamity. These strategics options have consisted to redymise and modernise agroforestry systems and reafforest denuded zones (Mapongmetsem et al., 1999; Lebel et al., 2002; Traoré, 2000). Despite these different humen and financial efforts, problems still persit (Baumer, 1987). Gentic resources management and conservation must pass trough a reintrocuction of suitable species to different production ecosystems among which agroforestry systems in view to durably participate to socio-economically development of the local comunities (Diallo et al., 2015; Mapongmetsem et al., 2010). The first step of the domestication process of these plant species of great importance is to master mecanism of defoliation and to know the exact period of litterfall in the zone. Very few studies were devoted to plant phenology and few species were studied in the tropics. To the best of our knowleges, little attention has been focused on this aspect except the works of Mapongmetsem (2005) and Mapongmetsem et al.(1998). The assessment of plant phenology permits to know the auto-ecology of a species in order to select the suitable genotype for the futur reafforestation in different contexts for those of origin (Abdallah et al., 1999). The master of the auto-ecology of plant species constitutes an essential step in the process of the rational management of ecosystems, and particularly the explotation of local plant species. Defoliation of plant trees covers a capital importance in the restitution of part of phytomasse in terms of litters which increases the rate of organic matter in the soil. Litter decomposition releases in the soil biogenic compounds which are useful to plants (Puig & Delobelle, 1988; Mapongmetsem, 2005; Diallo et al., 2016).

The main objective of the work is to evaluate defoliation modalities in order to determine mean periods and ranges of leave shade off. Two hypothesis were formulated : a) the development sequence of this phenophasis could vary from one species to another as well as from individual to another; and from year to another; b) it could also vary according pedoclimatic conditions of the site.

Materials and methods

Study site

The work was carried out in the Sudano-sahelian zone of Cameroon, grouping nothern and Far north regions. In the south of the Benue Divion (from April to October), the rainy season duration is 7 months but in the Chari, it lasts 3 months (from June to August) (M'biandoun et al., 2003). Based on the distribution of precipitations in the zone, five isoyets (lines along which the rainfall is constant) selected were : 1= 600-700; 2 = 700-800; 3 = 800-900; 4 = 900-1000; 5 = 1000-1100 mm (Fig.1). Each isoyet is represented by three phenological stations. Waza, Bogo and Maga belong to 600-700mm; Maroua, Salak and Moutourwa to 700-800mm; Kaélé, Touloum and Dziguilao to 800-900mm; Bidzar, Guider and Louggéré to 900-1000 mm and Dourbeye, Mayo-oulo and Peské-bori to 1000-1100mm. Phenological stations are equidistant among themselves for about 10 km. Previous studies in the area demonstrated that the following species (*Adansonia digitata, Balanites aegptiaca*, *Detarium microcarpum*, *Diospyros mespiliformis*, *Haematostaphis barteri*, *Hexalobus monopetalus*, *Parkia biglobosa, Sclerocarya birrea*, *Tamarindus indica* and *Vitex doniana*) are among those of a great socio-economic importance for the local population (Mapongmetsem et al., 2012). They provide numerous products and services to farmers (medicaments, foods, fodders, fuelwoods, shade, construction materials, etc.). They represent important source of income for the local comunities (Fawa et al., 2015; Mapongmetsem et al., 2008; Mapongmetsem et al., 2012; Mapongmetsem et al., 2015). Despite their socio - economic importance, they are still in wild live and subjected to zoo-anthropic presures. All the ten plant species were present in each station. Each plant species was represented by 10 adult trees in perfect sanity status and each labelled.

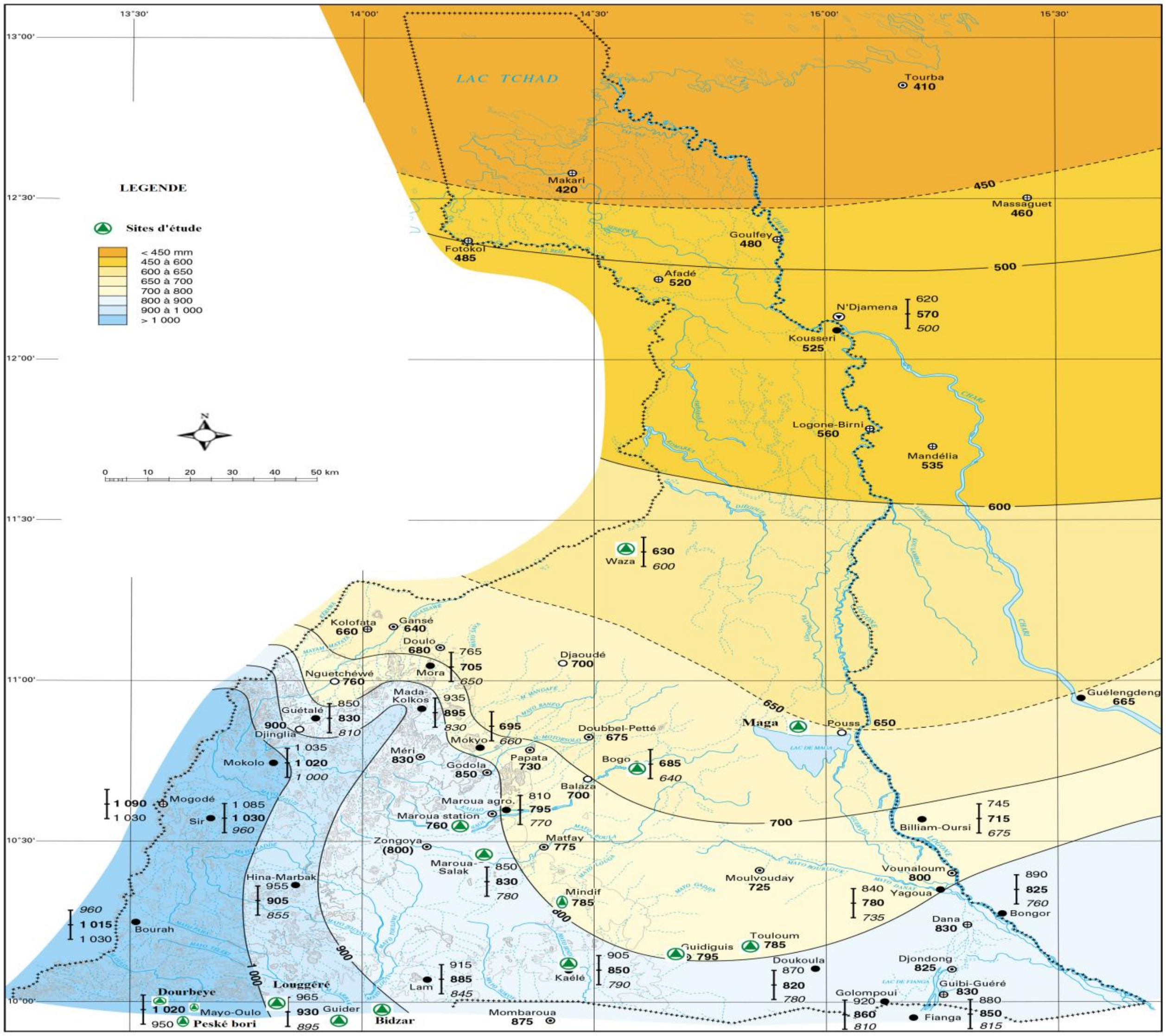


Fig. 1: Localisation of study sites. Source : IRD (2000) DB= Dourbeye, MO = Mayo-oulo, PB = Peské-bori, LG = Louggéré, GD = Guider, MT = Moutourwa.

Methodology

Phenological observations were undertaken in each station on the aforementioned species from January 2015 to December 2017 in a monthly basis. The phenological calender was coded as it follows: January = 1, February = 2, March = 3,…. November = 11 and December = 12 (Mapongmetsem, 1994; Mapongmetsem et al., 1998). Characterisation of the defoliation was based on the methodology of Kouyaté (2005) and Mapongmetsem (1994). The experimental design was a split-split-plot with three replications. The treatments was represented by plant species, the sub-treatment was isoyet whereas the sub-sub-treatment was the year. Phenological station corresponded to repetitions. The experimental unit was made up of 10 trees. Thus the total number of trees managed was 10 x 10 x 5 x 3 = 5300 individuals. Data collected were subjected to analysis of variance. Comparison of the significant mean was done through Duncan Multiple Range Test (DMRT) whereas their separation used LSD at 5%. The statistical programme used was Statgraphics plus.

Results and discussion

The In the Sudano-sahalian zone of Cameroon, the phenological behaviour of the selected species exhibits rougthly intraspecific and interspecific variations among them.

Intraspecific variations

The yellowing of leaves and litter fall in *Adansonia digitata* started at the end of October and the apogee is achieved in January. The tree is deciduous. The period of naked branches stays between 3 to four months. In some individuals, leaves shade off lasts a month. According years, individuals present disparities among themselves going from partial to total defoliation. In humid lowlands of Cameroon, such pattern was reported in forest species (Mapongmetsem et al., 1998). The authors reported that each tree has its internal watch. It is not scare to see that in the same station, two individuals near by near present the same type of comportment confirming the conclusion of the authors. This result agrees the fact that each individual tree is a specific case. The maximum of trees which shaded their leaves was in February (89.28%) (2015), January 2016 (65%) and February 2017 (87.85%).

Concerning isoyet, the analogous pattern was observed. The peak of of trees defoliated was registered in the isoyet 3 (86.67%) whereas 83.33%; 83.33 and 78.33% were noted respectively in isoyet 4, 5, 2 and 1. Similar results was reported in northern Senegal (Poupon, 1980).
Balanites aegyptiaca is an evergreen species. In this species, old leaves fall without special rythm, then are simultaneously replaced with new one. Of cause the species keeps its leaves all over the year but nevertheless during dry season ligthening foliaceous is observed. Individual variations of partial defoliation are noted.

Yellowing and leaves shade off in *Detarium microcarpum* start in December and end in March. There is absence of homogeneity in defoliation among individuals. Some individuals are deciduous stage in February while other in March. In other trees, there is partial defoliation which goes along with refoliation. The most important percentage of trees defoliated were registered in March (73.33%) in the isohyet 2; 66.66% in isohyet 3; 64.44% in isohyet 4; 61.11% in 5. Similar results were reported in Mali (Kouyaté, 2005). According to the author, *Detarium microcarpum* drops its leaves during the dry season in Mali. Grouzis & Sicot (1980) argue that simultaneous diminution of air relative humidity and soil hydric reserve can justify leaves shade off in sahelian zone of Africa. Others think that phenology of tropical trees varies according to environmental seasonality conditions, essentially precipitations (Reich et Borchert, 1984; Newberry et al., 2006). Devineau (1999) classes *Detarium microcarpum* among species with little phenological plasticity. It presents adapatative advantages due to reccurent pertubations such as bush fires (Bastide et Ouédraogo, 2009).

Concerning the years, interannual disparities have been registered. Maximum defoliation (80.90 % of trees defoliated) was observed in 2015 et 2016. However, in the year 2017, the percentage of trees defoliated was generaly very low (37.27%).

Diospyros mespiliformis like *Balanites aegyptiaca* keeps its leaves all over the year. It is reported as evergreen one (Mahamane et al., 2007). Old leaves drop from January to May followed immediatelly by flushing and flowering. There is lack of rythmicity in defoliation phenophasis in this species. This defoliation takes place in cold dry season.

Partial defoliation is noted in *Haematostaphis barteri* between Novembre and April for 98% of leaves dropped. Total defoliation has not been observed. Leaves become yellow and turned to reddish and drop from the tree without a synchronous rythm. Individual variations suggested that trees resistance to drough keep their leaves for a long time. Analogous results have been reported in the Guinean Savannah Higlands of Cameroon in *Ximenia americana* (Mapongmetsem, 2005). The zenith of defoliation was observed in January (100% of trees was defoliated). The same behaviour was registered all over the three years.

Concerning isohyet, the rate of defoliated trees oscillate between 15.55% in February and 92,22% in March in isoyet 2. It varies from 18.88% to 97.77% in isohyet 3; from 13.33% to 88.88% in isohyet 4; from 13.33% to 86.66% in isohyet 5.

Interannual variation has been registered too. Maximum tree defoliation is situated in March 2016 (99.16%); 2017 (87.5%) and 2015 (86.66%).
In *Parkia biglobosa* two phenomenons were observed : lightening foliaceaous and partial defoliation. Its last were observed from November to February. Partial defoliation is gradual and occurs in cold dry season indicating that relative humidity influences leaves drop. Sanogo (1997) showed in Mali that some savannah species among which *Diospyros mespiliformis, Prosopis africana* and *Tamarindus indica* do not drop their leaves after rainy season. This result suggests that those species develop physiological adapdatives mecanisms which support abcission conditions in cold dry season (Kouyaté, 2005).

Defoliation in *Sclerocarya birrea* occurs between October and March. This result corroborates that of Zida (2009) in Burkina Faso. It is frequent to observe two individuals in the spot showing a defoliated tree near by another cover with leaves. This pattern confirms the existing of endogenous factor (internal watch among trees of the same species). Genetic factors can explain the individual behaviour in a species. In some individuals, defoliation starts in old branches whereas in others, it beguins from the sommit to the bottom of branches and in others, it is at random or scattered in the canopy of the tree. Young branches loss their leaves in the last position compare to old one. Defoliation is total in some trees while partial in others despite the fact that the species is deciduous.There is asynchronous defoliation in *Sclerocarya birrea*. The same trend is observed in *Ceiba pentandra*, *Erythrophleum suaveolens* and *E. africanum*. Defoliation in those species varies from tree to another and from branch to another in the same tree (Childes, 1988; Richer, 2008; Kouadio, 2009; Mapongmetsem et al., 1998).

The most important pics of defoliation were registered in February 2015 (84.66 %) and 2016 (74 %). For isoyet, important variations were registered among them. The most important pic was observed in isoyet 3(92.22%).

The total leaves dropped in *Tamarindus indica* trees beguins from March to April while the renewal of leaves is in the same period. There is no temporal separation beween defoliation an flushing in the species. These results are analogous with thoses of Bourou (2012) who noticed that defoliation last 2.5 months in Niokhoul (Senegal). Defoliation in the species is partial and asynchronous among individuals, even in the same tree. Partial one can ocur till 50% during dry season (El-Siddig et al., 2006). These authors qualify the species as semi-evergreen one. However, Bourou (2012) reported the registration of *Tamarindus indica* individuals presenting a total defoliation with a short deciduous period. The author explains this phenological behaviour by the response of the species to hydric stress. The fact that plants maintain the hydric potential low participate to strategies to avoid deshydratation (Logan et al., 2011). It is a main physiological mecanism in *T. indica* to be adapted to hydric stress.

Defoliation in *Vitex doniana* oscillates between Novembre and February. Individuals in different biological stages were registered and very offen in the same individual. Neverthess, total defoliation was not observed. There is lack of synchronism in defoliation in *Vitex doniana*. It is a caducifoliaceous species (Mapongmetsem, 2005). According to isoyet, major variations were observed. In isoyet 2, the rate of trees defoliated varies from 6.66% in March to 86.66% in November. It oscillates between 21.11% and 72.22% in isohyet 3; 10% to 65.55% in 4, 21.11% and 60% in 5. Interannual variations were registered with a pic of 75.83 % in Juin 2015. This variation is manifested by the existance of individuals at different biological stages and often in the same tree in the same period. Going in the same way, Fétéké et al.(2016) argue that defoliation in *Entandrophragma cylindricum* varies from tree to another in Central Africa.

Interspecific variations

The determinism of defoliation among the plant species can be characterized by the mean period and duration.

Defoliation mean period

It stands out from table 1 that the mean period of defoliation varies from 2.54± 0,26 in *D. microcarpum* to 10.22± 0,84 in *V. doniana*. This indicates that the maximum of trees in *D. microcarpum* shade off their leaves in March whereas those of *V. doniana* did it in November. The analysis of variance shows a significant difference among the species (0.0000 < 0.001). The Duncan Multiple Range Test gathers plant species in four groups according to their mean period of defoliation : species that shade off their leaves early in Martch (*D. microcarpum*); plant species which drop theirs at the beguining of April (*S. birrea, Hexalobus monopetelatus);* plant species which drop their leaves in mid April (*Adansonia digitata*, *Haematostaphis barteri*) and plant species which loss their leaves late in November (*V. doniana*). The defoliation spectrum is characterised by species that loss leaves early in mid March and those which shade off theirs late in mi-November. Between these extrems, exist intermediary species. Similar pattern has been described in humid lowlands of Cameroon (Mapongmetsem, 1994). In this work *Balanites aegyptiaca*, *Diospyros mespiliformis* and *Tamarindus indica* did not shade off their leaves consequently, they are evergreen. The behaviour of *P. biglobosa* is contradictory to that which was exhibited in the Guinean Savannah Highlands of Cameroon. In the Guinean savannah highlands, *P. biglobosa* showed total defoliation conducted by a long deciduous period (Mapongmetsem, 2005). This contradictory behaviour among these agro-ecological zones demonstrates that many factors controle the phenodynamism of each species; by this way, confirming our hypothesis concerning pedoclimatic conditions of the site.

According to isohyets, the average period of defoliation varies from 2.37 ± 1.91 in isoyet 1 to 2.88 ± 3.08 in isohyet 5. The analysis of variance indicates a significant difference among the mean periods of defoliation (0.01< 0.05). This result suggested that the mean period of defoliation is influenced by precipitations. The classification based on Duncan Multiple Range Test show 2 groups. The first group is composed of the following isohyets : 3 (800 – 900 mm), 4 (900 – 1000 mm), 5 (1000 – 1100 mm). The second is made of isoyet 2 (700-800mm) and 1(600-700mm). This result suggests that defoliation is early in isoyet where precipitation is abondant whereas late for those where rainfall is low. In each group of isohyets the mean date of defoliation is homogeneous.

For the effect of year, the mean period of defoliation ranges from 2.57 in 2015 to 2.82 in 2016. This result indicates that the average period of defoliation varies from year to year. The analysis of variance shows a significant difference between years (0.01< 0.05), confirming that plant species do not drop leaves at the same time during year. In the present study, the pic of defoliation in 2015 was in mid March whereas in 2016, it was at the end of March. According to the Duncan Multiple Range Test, two categories of years were distinguished : the first group is constituted by 2015 (2.57) and 2017 (2.70) during which the defoliation date was identical; the second by 2016 (2.82). The mean period of defoliation was earlier (mid March) in 2015 and 2017 whereas in 2016, it was late (end of March).

Defoliation mean range

Concerning the average duration of defoliation, it appears that, it oscillates from 1.34 ± 0.33 in *Vitex doniana* and 4.66 ± 0.26 months in *Haematostaphis barteri* (Table 1). There is a significant difference between species (0.000 < 0.001). It indicates that the duration of defoliation differs between species. This result militates in favor of the existance of endogenous factors which govern defoliation in tropics. A fine analysis with Duncan Multiple Range Test classifies plant following their mean defoliation duration in 5 groups. The extreme are made up of species like *Haematostaphis barteri* (4.66 ± 0.26) which spread its defoliation for more than 4 months, then species with massive defoliation (1.5month) such as *Detarium microcarpum* (1.28 ± 1.54) and *Vitex doniana* (1.34 ± 0.33) (Table 1). Between the two extrems, exist intermediaries species such as *A. digita*, *H. monopetalus* and *S. birrea*.

During dry season, species like *Balanites aegyptiaca*, *Diospyros mespiliformis*, *Parkia biglobosa* and *Tamarindus indica* drop their leaves wihout showing a deciduous period. Their exhibit sempervirent characteristics in the sudano - sahelian zone of Cameroon. They loss their leaves while at the same time, they recover them. There is lack of synchronous rythm in dropping leaves. Keeping leaves during dry season is an important behaviour that the leaves protect soil against heavy weather.

According to isohyets, the mean defoliation period oscillates between 2.37 ± 1.91 in Isoyet 600-

700mm to 2.88 ± 3.08 in Isoyet 1000-1100mm. Two categories of isoyets were distinguished among which early (Mid-March) and late (end March) defoliation. Defoliation is early in low precipitation isoyet. For the mean defoliation duration varies from 1.40 ± 1.59 in isohyet 700-800mm to 1.55 ± 1.62 month in 800-900mm (Table 2). Despite the slight variation observed among isohyets, there is a significant difference between them in terms of defoliation range (0.0002<0.001). The lack of of great difference between isohyets confirms the fact that endogenous manifestations are the main factors which controle defoliation.

Table 1. Mean defoliation variation period and range of species.

Species	Mean period of defoliation (months)	Mean range of defoliation (months)
Vitex doniana	10.22 ± 0.84a	1.34 ± 0.33e
Adansonia digitata	4.26 ± 1.25b	3.2 ± 1.16b
Haematostaphis barteri	4.02 ± 0.34b	4.66 ± 0.26a
Hexalobus monopetalus	3.14 ± 0.18c	1.8 ± 0.33d
Sclerocarya birrea	2.96 ± 1.23c	2.37 ± 0.87c
Detarium microcarpum	2,54 ± 0,26d	1,28 ± 1,54e
Average	**4.52**±0.82	**1.48**±0.90

Means followed with the same letter are statistically identical (P < 0.05).

Table 2. Mean defoliation variation period and range of isohyets.

Isohyet (mm)	Mean date of defoliation (months)	Mean Range of defoliation (months)
1000 - 1100	2.88 ± 1.08a	1.41 ± 1.28ab
900 - 1000	2.82 ± 2.27a	1.53 ± 1.22ab
800 - 900	2.81 ± 1.90a	1.55 ± 1.12a
700 – 800	2.61 ± 2.05b	1.40 ± 1.29b
600 – 700	2.37 ± 1.91b	1.52 ± 1.16ab
Average	**2.69**±2.00	**1.48**±1.21

Concerning the years, defoliation was spread in 2015 (1.65month) whereas in 2016 (1.38 month) and 2017 (1.42 mois), it was massive. There is a significant difference between years. Duration of defoliation in 2015 was different from what happen in 2016 and 2017 meaning that the range of defoliation was similar between the last two years. However there was a significant difference among years (0.0000 < 0.001). In other ecologies, some trees conserve their phenological rythm during years. Parfait illustrations are given by *Vitex doniana* and *Sclerocarya birrea* which drop their leaves always earlier in Guinean Savannah Highlands (Mapongmetsem, 2005).

Significant interactions were noticed between species – isohyet (0.000<0.001); species – year (0.000<0.001); isohyet - year (0.000<0.001) and species -isohyet-year (0.0000<0.001). For the species-isoyet interaction, the mean period of defoliation starts from March (2.51 ± 0.28) in *D. macrocarpum* along the isohyet 800 - 900mm to November (10.60 ± 0.65) in *V. doniana* along the isoyet 600 - 700 mm (Fig.2a). The various species exhibit different attitudes according the rainfall. Hence, *D. microcarpum* shade off its leaves earlier in the zone while *V.doniana* does it late. Among the these extremes, exist intermediary species composed of *A. digitata*, *Haematostaphis barteri*, *Hexalobus monopetelatus* and *Sclerocarya birrea*. Concerning the species - year interaction, the mean time of defoliation varies from March 2017 (2.58 ± 0,22) in *D. microcarpum* to November 2016 (10.70 ± 0.55) in *V. doniana* (Fig.2b). *V.doniana* is a species with extended defoliation.

The isohyet –year interaction was equally significant (0.000<0.001). The mean period of defoliation fluctuate from April (4.20 ± 2.74) in the isohyet 3 in 2017 to June 2016 (5.30 ± 2.33) in the isohyet 3 (Fig.3). In the year 2016, defoliation was generally extended along the isoyet 3 and 4 in the area.

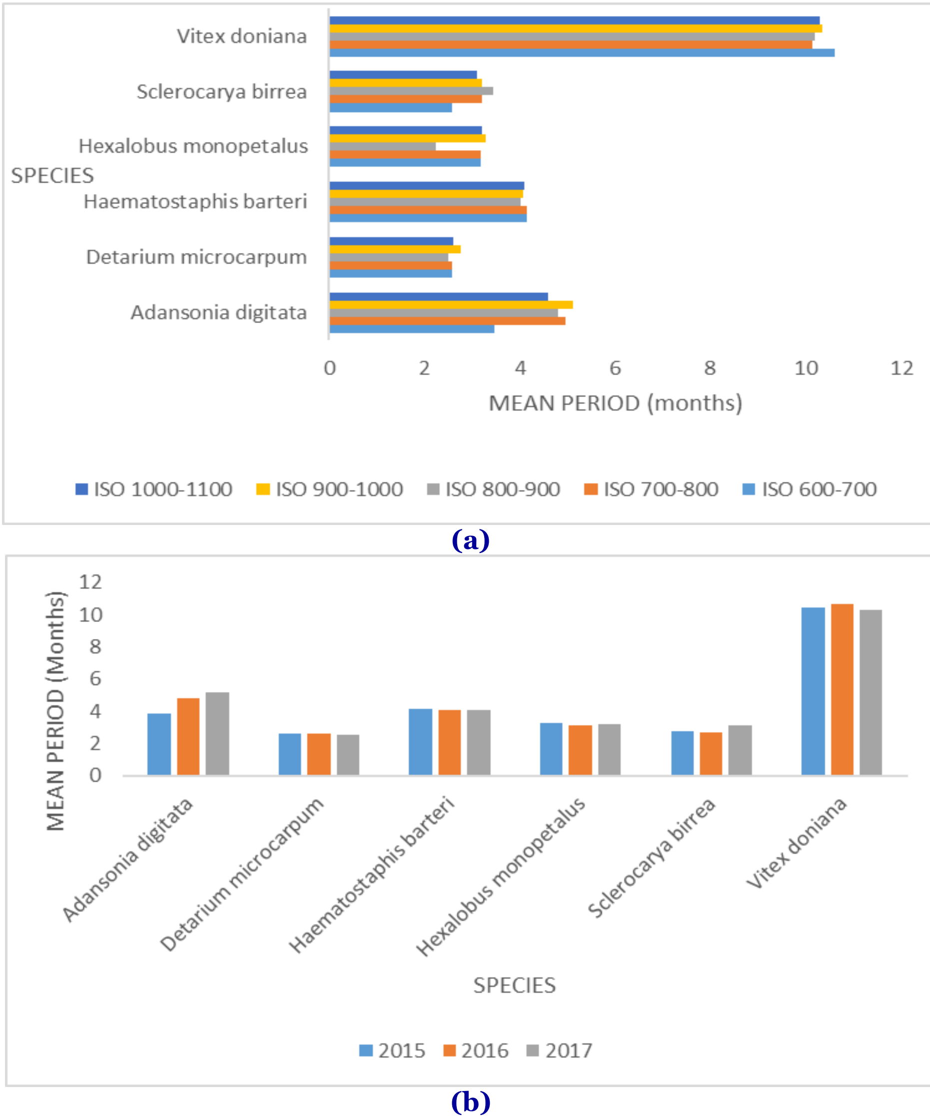


Fig. 2: Interaction species – isoyet and species-year on mean period of defoliation.

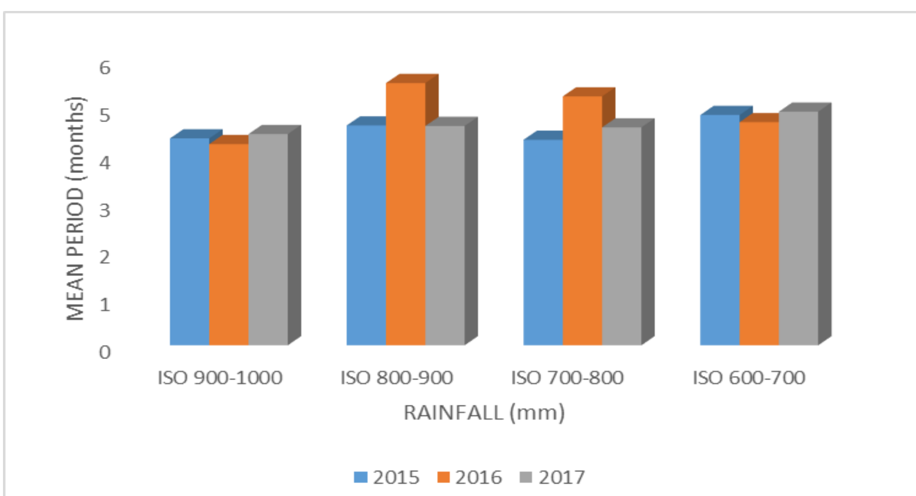
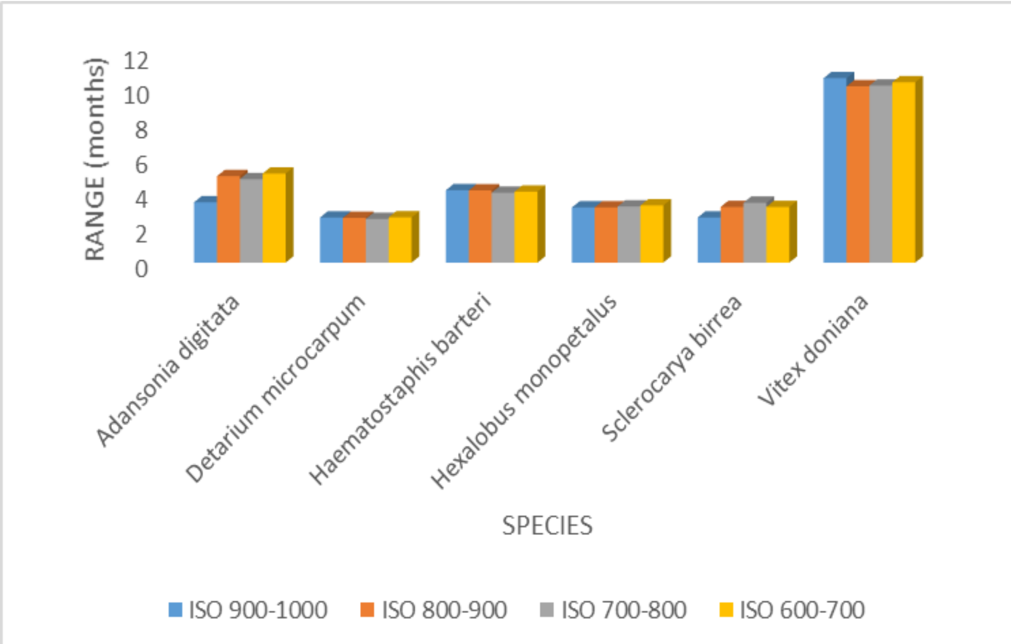


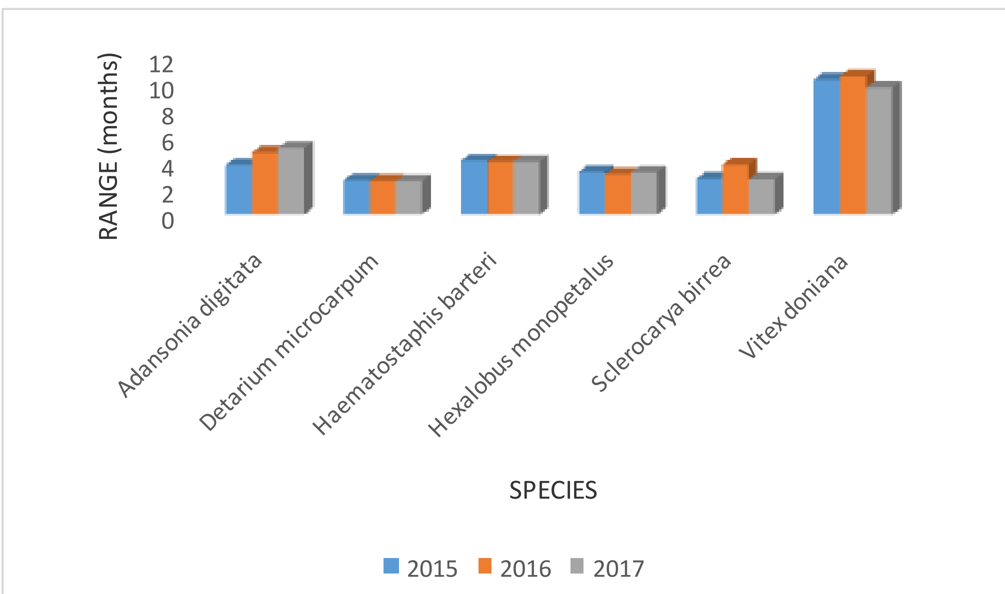
Fig. 3: Interaction isohyet-year on the mean period of defoliation.

The duration of defoliation in species oscillates from 2.51 ± 0.28 in *D. macrocarpum* and 10.60 ± 0.65 months in *Vitex doniana* independently to isoyet (Fig. 4a). The duration of 11 months in *V. doniana* confirms the character of extended defoliation above mentionned in the species.

For the species by year interaction, the range of defoliation varies from 2.58 ± 0.22 in *D. microcarpum* in 2017 to 10.70 ± 0.55 months in *V. doniana* in 2016 (Fig. 4b). *D. microcarpum* is a species of short defoliation in the contrary of *V. doniana*.



(a)



(b)

Fig. 4: Interaction species-isoyet and species-year on range of defoliation.

The examination of the isohyet by year show that the duration of defoliation of the species was exceptional during the year 2016 among the isohyets 3 (5.30 ± 2.33 months) and 4 (5.22 ± 2.46 months). The results are depicted in Fig. 5.

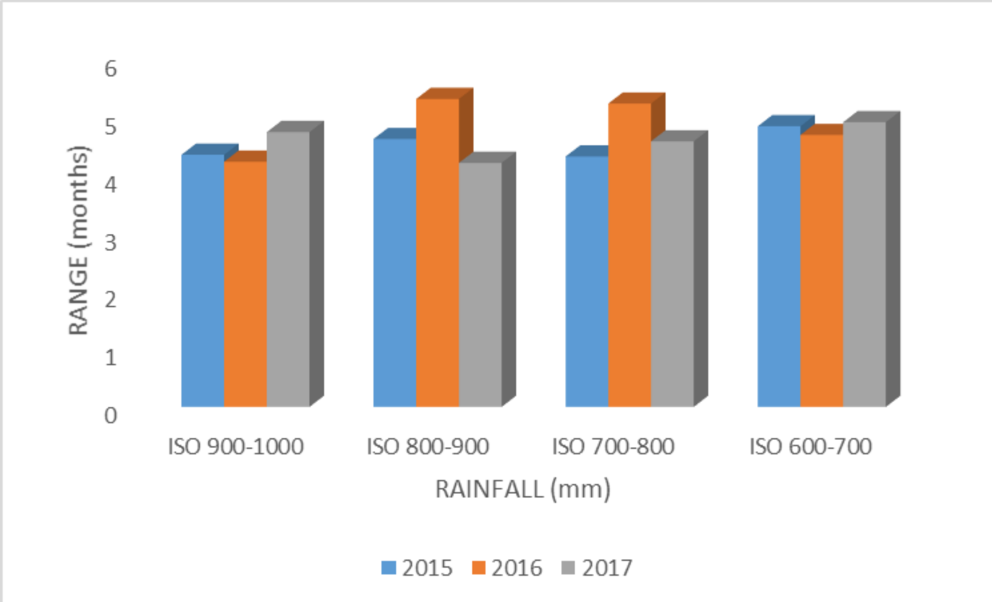


Fig. 5 : Interaction isoyet-year on range of defoliation of species.

In the majority of species, defoliation take place in the dry season. The trifactorial interaction species-year-isohyet was significant (0.0000 < 0.001) suggesting that the behaviour of the various species varies according the years and isohyet as well as the specific characters of each species. Mapongmetsem et al.(1998) report analogous behaviours in forest zone of Cameroon.

Considering the relation between defoliation and environmental, different behaviours can be reported. Leaf fall in *A. digitata*, is slow and inversely correlated to precipitations ($r = - 0.25$; $P < 0.001$). This findings indicate that in this species, 25 % of trees shade off their leaves durting rainy season while 75% drop theirs in dry season. For temperature, a low negative correlation was equally observed ($r = - 0.13$; $P < 0.05$).

Defoliation in *D. microcarpum* took place in absence of precipitations. 15% of trees are conversly linked to increase precipitations ($r = - 0.15$; $P < 0.05$) and positive correlated to temperature ($r = 0.31$; $P < 0.001$). Leaf fall in *S. birrea* is negatively correlated to precipitations ($r = - 0.21$; $P < 0.001$). Few are trees (21%) which lose theirs in dry season. Relation between defoliation and temperature is weak and positive ($r = 0.11$; $P < 0.001$).

Out of the above relations reported, no correlation between defoliation and climatic parameters has been noticed during this work in other species.

Conclusion

The study has demonstred that defoliation in tropical plant species is complexe and governed by both environmental and endogenous factors. Among the plant species studied, three are evergreen (*Balanites aegyptiaca*, *Diospyros mespiliformis* and *Tamarindus indica*) while six others present total defoliation. All the epecies have an optimum of leaf fall between January and December. Yellowing of leaves appear to be precursor sign of leaf fall. Mean period and range of spread of this phenophasis varies accoding species and pedoclimatic conditions of the station.

To the functional individualism of trees from a species is added that of branches of the same trees. Predicting analysis show that defoliation is a dynamic phenomenon and atypic. Its determinism undergoes exogenous and endogenous influences.The effect of exogenous and endogenous factors vary in fonction species and pedoclimatic conditions of sites. Data presented in the present work were lacking and bring a new or complementary lighting on phenology and defoliation of some tropical trees but their interpretation show that, if it is possible to find average behaviours, individuals factors remain important for precise predictions.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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