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# FRUIT PRODUCTION OF RICINODENDRON HEUDELOTII (BAILL.) (NDJANSANG): INFLUENCE OF NEAREST NEIGHBOUR'S DENDROMETRIC DESCRIPTORS IN FOREST AND AGROFORESTRY SYSTEMS

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# Abstract

**Description of the subject**. *Ricinodendron heudelotii* (Baill.) is a fruit species who's economic and ecological interests have been proven today and which has been the subject of several research projects. However, little is known about its productive potential and the influence of certain competitive factors on the fruit production of this species.

**Objectives**. The present study aims to evaluate the influence of dendrometric descriptors of *R*. *heudelotii* close neighbours on their fruit production potential in forest and agroforestry systems.

**Methods**. Data were collected from adult individuals of  $DBH \ge 20$  cm in selected 15 m radius circular plots each centered on a *R. heudelotii* individual. To evaluate the fruit production, a periodic collection and counting of the fruits fallen under the tree was done on a periodic basis of 10 days during three (03) consecutive years (August, September and October). The variation of fruit production according to dendrometric parameters was assessed through correlations determined by one and multi-factor analyses of variance.

**Results**. The results obtained show that the height of individuals (individuals and close neighbours) has a greater influence on fruit production than the other dendrometric descriptors. Thus, from the allometric combinations by simple and multiple linear regressions, the variability of the fruiting potential of *R. heudelotii* was established. Three combinations were thus retained from the low values of the Aïkkake information criterion. These three combinations could therefore be used to predict the fruit yields of *R. heudelotii* from the dendrometric descriptors.

**Conclusion**. The present study evaluated the fruiting potential of *R. heudelotii* and also assessed its variability according to dendrometric descriptors in two land use types. It established that the height of individuals (subjects and close neighbors) has a greater influence on fruit production compared to other dendrometric descriptors.

Keywords: Ricinodendron heudelotii, Ndjansang, production, fruit, agroforestry

Production fruitière du *Ricinodendron heudelotii* (Baill.) (Ndjansang) : influence des descripteurs dendrométriques des plus proches voisins dans les systèmes forestier et agroforestier

**Description du sujet**. *Ricinodendron heudelotii* (Baill.) est une espèce fruitière dont l'intérêt économique et écologique avérés ont motivé plusieurs travaux de recherche. Toutefois, son potentiel productif reste peu connu ainsi que l'influence de certains éléments de compétition sur la production fruitière de cette espèce.

**Objectif**. La présente étude vise à évaluer l'influence des descripteurs dendrométriques des individus proches voisins de *R. heudelotii* sur la production fruitière en milieu forêt et agro-forestiers.

**Méthodes**. Les données été collectées sur des individus adultes de DHP  $\ge 20$  cm dans des placettes circulaires de 15 m de rayon et centrées chacune sur un individu de *R. heudelotii* sujet. Pour évaluer la production fruitière, un ramassage périodique et comptage des fruits tombés sous l'arbre a été fait après 15 jours durant trois (03) années (Août, Septembre et Octobre). La variation de la production fruitière en fonction des paramètres dendrométriques a été appréciée à travers des corrélations déterminées par analyses de variance (ANOVA) à un et plusieurs facteurs.

**Résultats**. Les résultats montrent que la hauteur des individus (sujets et proches voisins) a une plus grande influence sur la production fruitière par rapport aux autres descripteurs dendrométriques. Ainsi, à partir des combinaisons allométriques, la variabilité du potentiel fruitier du *R. heudelotii* a été établie

à partir des faibles valeurs du critère d'information d'Aïkkake. Ces trois combinaisons pourront donc permettre la prédiction du rendement du *R. heudelotii* à partir des descripteurs dendrométriques.

**Conclusion**. La présente étude a permis d'évaluer le potentiel fruitier du *R. heudelotii* et aussi d'apprécier sa variabilité en fonction des descripteurs dendrométriques dans deux types d'utilisation des terres. Elle a établi que la hauteur des individus (sujets et proches voisins) a une plus grande influence sur la production fruitière par rapport aux autres descripteurs dendrométriques.

Mots clés. Ricinodendron heudelotii, Ndjansang, production, fruits, prédiction

#### **1. Introduction**

*Ricinodendron heudelotii* (Baill.), commonly known as Ndjansang, is a fruit-bearing species, widespread in the humid tropical forest zones of Central and West Africa (Clark and Sunderland, 2004; Fotso and *al.*, 2004; Gusua Caspa and al., 2018; Boko-Haya and *al.*, 2021). In Cameroon, this species is observed in the Guinean savannahs and in forest areas (Laird and Betaford, 1997; Anjah and Oyun, 2009). It is a fast-growing heliophilous species that can reach 50 m in height and 2.7 m in diameter (Taylor, 1960; Lemmens et *al.*, 2008; Orwa et *al.*, 2009; Gusua Caspa et *al.*, 2014).

The proven economic interest of *R. heudelotii* has motivated several research studies in various fields. In terms of socioeconomic areas, many studies carried out on *R. heudelotii* fruit production have focused on marketing, the market and distribution (Perez and Ndoye, 1999; Tabuna, 2000; Ngono and Ndoye, 2004; Kouamé N'Dri et *al.*, 2012). This research has shown that the marketing of this production generates sales of over  $\in$  500,000 per year (Awono et *al.*, 2002; Ndoye and Chupezi Tieguhong, 2004). Consequently, *R. heudelotii* has a high market value in local, regional and international markets. According to Nkwatoh and *al.*, 2011, the quantities of *R. heudelotii* kernels between 2003- 2010, was about 71585.4 tones contributing a total of about USD \$. 708771.33 to the local and national economies of Cameroon.

Ecologically, studies have focused on the contribution of *R. Heudelotii* to interactions within its environment. Some authors report that it increases the organic materials content of the soil and provides litter rich in mobile and immobile mineral elements for the plants of the lower stratum (Oyefesobi, 1983, Mapongmetsem et *al.*, 1998; Djeukap Fovo, 2013). Thanks to its roots, it promotes better erosion control and avoids competition with adjacent plants located in the upper layer (Latham,

1999; Djeukap Fovo, 2013). Also, these roots allow the species to achieve other forms of association such as symbioses with arbuscular endomycorrhizal fungi (Högberg, 1982).

However, it is important to note that, despite this abundant literature, little is known about the productive potential of this species and the influence of certain competitive factors on its fruit production. However, knowledge of its production potential and the parameters of its variability make it possible to estimate its contribution to the economy of farming households and to boost programs for the development and domestication of the species. A previous study was carried out with the objective of determining the peak fruiting time and biometric characteristics of *R. heudelotii* var. africanum in the main agro-ecological zones of Cameroon where this species is found (Mbarga Bindzi et *al.*, 2017). This study therefore follows and aims to evaluate the influence of dendrometric descriptors of individuals of close neighbours of *R. heudelotii* on their fruit production in a context of interspecific competition.

# 2. Material and methods

#### 2.1. Study area

This study was conducted in locality of Ndji, a village located about 12 km from the town of Batchenga in Cameroon center region with an estimated population of 1613 (Figure 1). This locality is directly impacted by the Nachtigal hydroelectric dam construction project. The study site has a relatively flat and varied relief, with plains, hills and valleys, and slopes of between 0 and 10%, indicating a low sensitivity to erosion. The average altitude is 600 m. This locality is watered by the Sanaga River, which has a permanent flow, with small seasonal rivers, notably Awo'o and Mbo'o. Two types of soil can be distinguished: ferralitic soils and hydro morphic soils. According to the work of Bocquier et al (1984) and Muller (1987), these soils are predominantly red in the ecological context of transition zones between forest and savannah. Data collected at the Ministry of Transport over the three years of study (2017 to 2019) show that the annual average rainfall and temperature were  $1264.98\pm156.59$ mm and  $25.1\pm0.83^{\circ}$ C respectively, with an average annual amplitude of  $2.5^{\circ}$ C.

This locality is part of an ecotone (forest-savannah) in the agro-ecological zone of dense rainforest with bimodal rainfall, which is subdivided into Guinean-Sudanese peri-forest savannahs and

Guinean-Congolese semi-caducified forests. There are Guinean-Sudanese peri-forest savannas, semicaducified forest recruits, domesticated forests in the Obala subdivision, *Raphia mombuttorum* raffia and degraded facies of semi-deciduous and evergreen forests.



# 2.2. Survey design and data collection

Data were collected in selected 15 m radius circular plots each centered on one subject *R*. *heudelotii* individual (Fonton and Sagbo, 2004; Dan Guimbo et *al.*, 2012; Mbonayem and Bobo, 2017). These data were taken from all adult individuals of DBH  $\geq$  20 cm in each plot (Kumba et *al.*, 2013). Indeed, all individuals (including subject *R. heudelotii*) were numbered, grouped into diameter classes and georeferenced. Thus, the circular plots were placed in the two land use types, 17 circular plots in agro-forestry area and 13 circular plots in forest area.

# 2.3. Floristic and dendrometric characteristics

For each tree several dendrometric characteristics were measured using the DBH-meter at 1.30 m above the ground and 0.30 m above the buttresses for individuals that have them. The diameter is obtained by first measuring the circumference of each tree with a tape measure and dividing it by  $\pi$ 

(Nshimba, 2008). Tree heights were obtained by indirect measurements using a Suunto clinometer. In addition to these two dendrometric characteristics, the distance between the subject individual and those of close neighbours was also measured.

#### **2.4. Fruit production per tree**

To assess the fruit production of *Ricinodendron heudelotii* (Baill.), a periodic collection and counting of the fallen fruits under the tree was conducted on a periodic basis of 10 days during three (03) consecutive years during august, september and october (Kouyaté et *al.*, 2016). For this purpose, the ground under the subject-tree was previously cleared of dead leaves, branches and vegetation to facilitate the location and collection of the fruits and to have as few impurities as possible. Thus, the fruits that fell to the ground under each seedling were classified in three categories : intact fruits, fruits that had been partially consumed and/or mineralized. They were placed in a labelled container indicating the date, the place of harvest and the tree number. This information was then recorded in a register made for this purpose.

#### 2.5. Data processing

# **2.5.1.** Analysis of production variations

Total fruit production was estimated by summing the total production of each producing tree PT in each land use type.  $PT = \sum P_i$ , where  $P_i$  the amount of fruit is harvested from tree i. The variation of fruit production as a function of dendrometric parameters were evaluated by simple multivariate statistical analyses using XLSTAT 2.0 software. Correlations through regressions of production with dendrometric characteristics were determined by multi-factor analyses of variance (ANOVA). An analysis of the differences between these variables with a 95% confidence interval was performed to check the heterogeneity of the variances. In case of a significant test (P<0.05), the difference in variables is established by Turkey's HSD Test.

## 2.5.2. Analysis of potential production predictors

Predictors of fruit production potential were determined using the least squares method of simple and multiple regression analyses. The simple and multiple regressions with each of the determined explanatory variables (dendrometric parameters) were carried out by iterations in order to

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minimize the residual standard deviation between the observed and estimated production values. The level of significance was assessed by the p-value and specified by the coefficients of determination ( $R^2$ ). The variables present in the first two combinations that provided the lowest AIC were retained as potentially usable in predictive models of fruit production of *Ricinodendron heudelotii* (Baill.). These variables were used to build multiple allometric models between fruit production and dendrometric parameters (number of competitors, diameter at base, height of the competitor tree, height of the subject tree, distance between nearest neighbours...).

# 3. Results

#### 3.1. Floristic and structural characteristics of forest types

Overall, data were collected in 30 transects, 13 of which were in forests area and 17 in agroforests area. The cocoa agroforests had 88 individuals belonging to 37 species with an average of  $4.18\pm2.63$  potential competitors per transect. The diameter of individuals varied from 0.18 m to 2.70 m with an average diameter of  $0.78\pm0.37$  m. The height of the individuals varied from 8 m to 40 m with an average of  $29.13\pm4.80$  m. The average density of individuals was  $73.23\pm37.17$  trees/ha, varying from 28.29 to 155.61 trees/ha. The basal area varied from 8.24 to 44.29 ft<sup>2</sup> with an average of  $20.01\pm10.81$  ft<sup>2</sup>.

Types of forestry	Parameters	NnT	HmC (m)	HmS (m)	Distj (m)	DmC (m)	DmS (m)	<b>Densities</b> (trees/ha)	Basal area (ft <sup>2</sup> )
Agroforest	minimum	0	15.36	17	5	0.87	1.02	28.29	8.24
	Maximum	7	30.22	40	11.02	2,68	2,06	155.61	44.29
	Mean	4.18±2.63	$24.63 \pm 4.14$	$29.13 \pm 4.80$	$8.86 \pm 1.59$	$1.49 \pm 0.50$	$1.49\pm0.34$	73.23±37.17	20.01±10.81
Forest	minimum	1	13.17	16	3.8	1.05	0.53	70.74	6.21
	Maximum	5	38.33	40	8.76	2.08	1.69	282.94	23.98
	Mean	8.31±4.23	$27.91 \pm 8.04$	$34.23 \pm 8.19$	$5.37 \pm 1.50$	$1.48\pm0.33$	$1.09\pm0.39$	131.68±59.85	$10.80 \pm 5.73$

Table I. Distribution of dendrometric parameters of seed trees in land use types

NnT: Total number of competitors of greater height than the subject individual; HmC: Average height of competitors; HmS: Average height of subject; Distj: Average distance between competitor and subject; DmC: Average diameter of competitors; DmS: Average diameter of subject

In the forests, 121 individuals were recorded and grouped into 17 species with an average number of competitors of  $8.31\pm4.23$  individuals. The average diameter of the individuals is  $1.48\pm0.46$  m with values ranging from 0.38 to 3.94 m. The heights of the individuals vary from 8 to 40 m, with an average height of  $34.23\pm8.19$  m. Densities obtained in the forest surveys range from 70.74 to

282.94 trees/ha with an average value of  $131.68\pm59.85$  trees/ha. As for the land area, it varies from 6.21 to 23.98 m<sup>2</sup> with an average of  $10.80\pm5.73$  m<sup>2</sup>.

It is observed that overall the total number of competitors with heights greater than that of the subject individual (NnT) is greater in the forest environment than in the agro-forest. In the same way, densities are also more important with however relatively weak distances between the potential competitors and the individuals-subjects in forest than in agro-forestry environment. The forest environment presents individuals (potential competitors and individuals-subjects) of greater height compared to the agro-forestry environment. However, these individuals are smaller in diameter in the forest than in the agroforestry environment, hence the average values of land area obtained in the previous table (Table I). These results imply that competition is more important in forest environments than in agroforestry environments.

# 3.3. Fruit production of Ricinodendron heudelotii (Baill.)

The cumulative production of the two types of land use of these plants during the three years is 750.93 kg, which is an average of  $25.03\pm22$  kg per year. This cumulative production does not fluctuate from one year to another, which justifies the values of the coefficient of determination  $R^2 = 0.60\%$  and the p-value = 0.84>0.05 (Turkey's HSD test) obtained. Indeed, the cumulative production in 2017 is estimated at 260.90 kg with an average per plant of  $8.70\pm7.60$  kg; that of 2018 is 249.03 kg and in 2019, a production of 241 kg was obtained with respective averages per plant of  $8.30\pm7.35$  kg and  $8.03\pm7.41$  kg. The production per plant varies between 0.46 kg and 24.25 kg in the same year in 2019, with a strong dispersion of values above the average.

The total cumulative production of the three years of observation varies according to the type of land use. It is higher in agro-forests with a cumulative sum of 535.68 kg than in forests where this sum is 215.25 kg. The average production is significantly different (p-value = 0.0001 < 0.05; Turkey's HSD test) from one land use type to another. It varies between 1.67 and 67.18 kg in agro-forests and 4.61 to 53.34 kg in forests.

The distribution of production by land use type is shown in Table II. It can be seen from this table that total production is significantly (p-value < 0.05). However, it does not vary between years (p-value > 0.05).

types						
Types of forestry	Parameters	PT (Kg)	2017	2018	2019	Variability per forest type
Cocoa	Average Sum (Kg)	535.68	184.54	173.85	177.29	$R^2 = 1.28\%$
Agroforest		$3.50 \pm 2.73a$	$3.62 \pm 2.80$ ag	$3.41 \pm 2.60$ ag	$3.48 \pm 2.84$ ag	0.925 > 0.05
Forests	Average Sum (Kg)	215.25	76.36	75.18	63.71	$R^2 = 1.10\%$
	(8)	$1.84 \pm 1.83 b$	$1.96 \pm 1.93$ bg	1.93 ±2.07bg	$1.63 \pm 1.46$ bg	0.691 > 0.05
Variability per year	Proportion of variability $(R^2)$	10.39%	9.22%	7.80%	12.40%	
	p-value	0.0001 < 0.05	0.002 < 0.05	0.004 < 0.05	0.0004 < 0.05	

Table II. Annual average production per tree of *Ricinodendron heudelotii* (Baill.) by type of land use types

NB: This table should be read in columns (a, b) and rows (g). TP: Total production. The difference of letters reflects the significant difference between the values they precede.

Total production in agroforests is higher and significantly different from that in forests (p-value = 0.0001 < 0.05; Tukey's HSD test). This significant difference is noticeable throughout the three years of observation. Overall, the largest harvest was achieved in 2017 with average yields per plant of  $3.62\pm2.80$  kg and  $1.96\pm1.93$  kg in agroforests and forests respectively.

Overall, 30 individuals-subjects identified in agroforest area and forest area produced an average of  $250.31\pm22$  kg per year. This average, which varies significantly from one month to the next, is fairly stable over the years of observation. Also, the total production is more important in the agro-forest area than in the forest, i.e. in conditions where the individuals-subjects are exposed to a weak competition according to the results listed in Table I.

# 3.4. Competitors' characteristics and variation in fruit production

In agroforestry surveys, multiple linear regressions by combination of four (4) variables were performed in order to assess the association of parameters that could vary and depend on total fruit production. From these combinations, the following equations are provided for the prediction of potential production in cocoa agroforests.

N°	Var 1	Var 2	Var 3	Var 4	AIC	$\mathbf{R}^2$	p-value	<b>Regression equations</b>
1	PT	HS	NnT	Distj	74.41	89.06%	0.0001<0.05	PT = 115.40-4.02*HMC+2.52*Distj-3.58*NnT
2	PT	HmC	NnT	Distj	64.42	93.93%	0.0001<0.05	PT = -35.86+1.29*HS+5.40*Distj-9.10*NnT
3	PT	DS	NnT	Distj	76.42	87.69%	0.0001<0.05	PT = -3.47+4.98*DS+5.34*Distj-12.25*NnT
4	PT	DmC	NnT	Distj	76.29	87.79%	0.0001<0.05	PT = 6.78-13.70*NnT+5.27*Distj+3.67*DmC
5	PT	St	NnT	Densité	80.06	84.75%	0.0001<0.05	PT = 74.15-13.45*NnT-3.30E-02*d-0.67*St
6	PT	DmC	DS	NnT	87.43	80.88%	0.0001<0.05	PT = 21.93-15.14*NnT+8.48*DmC+11.12*DS
7	PT	DmC	DS	Distj	99.57	51.96%	0.0054<0.05	PT = -86.60+7.59*Distj-10.35*DmC+27.10*DS
8	PT	HmC	HS	Distj	65.46	93.54%	0.0001<0.05	PT = 209.52-6.47*HMC-0.93*HS+0.95*Distj
9	PT	HmC	HS	NnT	64.40	93.93%	0.0001 < 0.05	PT = 245.70-6.50*HMC-1.65*HS-2.94*NnT
		<b>X</b> 7 <b>X</b> 7	• 1 1 • •		T C	a		

Table VII. A four-variable multiple regressions relevant to fruit production of *R. heudelotii* (Baill.) in agroforests

Var: Variable; AIC: Aikaka Information Criterion

This table shows that fruit production in *R. heudelotii* fluctuate significantly with all variables used in this analysis (p-value < 0.05). However, combinations 2, 8 and 9 have lower values of the Aikake information criterion (64.42, 65.46 and 64.40 respectively). These criterion determine the best equations for production prediction. They are therefore the most relevant combinations. They are even more relevant when they combine distance and number of competitors. And although presenting significant variability, combinations that combine the diameters of both subject and competitor trees have high values of the Aikake criterion and are therefore less relevant than those that combine heights (subject and competitor trees).

 Table VIII. A four-variable multiple regressions relevant to fruit production of *Ricinodendron heudelotii* (Baill.) in forests

N°	Var 1	Var 2	Var 3	Var 4	AIC	$\mathbb{R}^2$	p-value	<b>Regression equations</b>
1	РТ	HS	NnT	Distj	57.62	72.64%	0.002<0.05	PT = 46.33-9.24*NnT+4.33*Distj-0.70*HS
2	PT	HmC	NnT	Distj	47.67	87.27%	0.0001 < 0.05	PT = 45.52+2.46*NnT+2.54*Distj-1.80*HmC
3	PT	DS	NnT	Distj	60.00	67.15%	0.004 < 0.05	PT = 7.66 + 1.08 * DS + 4.55 * Distj - 5.43 * NnT
4	РТ	DmC	NnT	Distj	60.01	67.14%	0.004<0.05	PT = 9.88-5.26*NnT+4.71*Distj-1.38*DmC
5	PT	St	NnT	Densité	62.70	59.58%	0.010<0.05	PT = 43.44  2.64 E - 02 * d - 8.89 * NnT + 0.369 * St
6	PT	DmC	DS	NnT	62.59	59.93%	0.010<0.05	PT = 42.20-8.12*NnT-7.25*DmC+7.20*DS
7	PT	DmC	DS	Distj	63.53	56.91%	0.014<0.05	PT = -18.65+7.62*Distj-6.86*DmC+2.98*DS
8	РТ	HmC	HS	Distj	36.01	94.81%	0.0001 < 0.05	PT = 87.33+2.20*Distj-0.74*HS-2.05*HmC
9	РТ	HmC	HS	NnT	38.93	93.50%	0.0001<0.05	PT = 113.69-2.68*NnT-0.89*HS-2.09*HmC

Var: Variable; AIC: Aikake information criterion; d: Average density

The four-variable multiple regression in the forest surveys, thus three explanatory variables,

highlights three combinations as the most relevant due to the low values of the Aikake information

criterion. These are combinations 8 (AIC = 36.01), 9 (38.93) and 2 (47.67). These have the most accurate and significant proportions of variability, reinforced by Tukey's USD tests. The equation lines associated with these combinations are those that could best predict potential fruit production in a lightly anthropized forest.

Finally, three combinations that best predict fruit production of *R. heudelotii* each have three variables with low AIC values in both land use types with high correlations. And each of the combinations has an associated fit line with established equations.

Table IX. Regression of the most relevant combinations for the prediction of fruit production in the two land use types

N°		AIC	$\mathbf{R}^2$	p-value	<b>Regression equations</b>
1		47.67	87.27%	0.0001<0.05	PT = 45.52+2.46*NnT+2.54*Distj-1.80*HmC
2	Forest	36.01	94.81%	0.0001 < 0.05	PT = 87.33+2.20*Distj-0.74*HS-2.05*HmC
3		38.93	93.50%	0.0001 < 0.05	PT = 113.69-2.68*NnT-0.89*HS-2.09*HmC
1		64.42	93.93%	0.0001 < 0.05	PT = -35.86+1.29*HS+5.40*Distj-9.10*NnT
2	Agroforest	65.46	93.54%	0.0001 < 0.05	PT = 209.52-6.47*HmC-0.93*HS+0.95*Distj
3		64.40	93.93%	0.0001 < 0.05	PT = 245.70-6.50*HmC-1.65*HS-2.94*NnT

Overall, the correlations become more refined and accurate as the number of variables regressed increases with respect to the Aikake information criterion (AIC). Thus, in both types of land use, these combinations are most relevant when they involve, on the one hand, the number of competitors of greater height than the subject individuals and, on the other hand, the height of the subject individual and the average height of the competitors and the distance between the competitors and the subject individuals. This means that height is the main dendrometric descriptor that is most relevant for predicting fruit production in a nearest neighbour's competition context.

# 4. Discussion

# Variation of total production according to dendrometric parameters

The aim of this work is to propose simple allometric equations for predicting the fruit production of *Ricinodendron heudelotii* (Baill.) based on the dendrometric characteristics of the subject individuals and their close neighbours. To achieve this, the dendrometric characteristics relating to height (competitors and subjects), diameter (competitors and subjects), density, basal area, number of competitors taller than the subject individual and distance between the competitor and the subject individual were tested using simple and multiple regressions.

The results obtained show a large and significant difference in production in the agroforest versus forest surveys. A similar result allowed Lamien et al (2004) to find high proportions of productivity of trees in agroforestry parks compared to trees in natural formations.

The analysis of the variations in total cumulative fruit production as a function of some dendrometric parameters showed that the diameter (of the tree and its close neighbours) does not have a significant influence on it. This is not the case for height (subject and potential competitors) which significantly influences total fruit production (p-value < 0.05). The significant influence of height certainly justifies the severity of horizontal competition obtained in this study in both agroforests and forests. Indeed, taller neighboring trees can shade and prevent light capture by others. As *R. heudelotii* is a heliophilic species, competition for light would therefore affect its productivity (Djeugap Fovo et *al.*, 2013). A similar observation will make Tabarant (2007) say that, the role of light is very important, as variations in its spectrum influence the growth, reproduction and production of the forest.

Fruit production varies significantly with both density and the number of competitors taller than the subject tree. Agroforests have low densities but high total cumulative fruit production compared to forest surveys. Indeed, at low densities as observed in agroforests, tree-tree competition is not a limiting factor (Scholes and Archer, 1997), as it might be in forests where densities are high.

The results obtained showed that fruit production is not optimal when the distance between the competitor and the subject-tree is reduced. Thus, a tall competitor would have a negative influence on the fruit production of the subject-tree if the distance between the two individuals is small. This observation could be explained by the fact that the influence of a neighboring-tree on the competence of a target tree is a direct function of the neighbour's height and an inverse function of the neighbour's distance (Uriarte et *al.* 2004).

#### Linear allometric equations and prediction of fruit production

Thus, combinations of individual subject and competitor heights, as well as the number of competitors taller than the subject, individually predict fruit production better. These have lower AIC values. Combinations with density and distance of competitors from the subject tree could also be considered as a predictor variable although AIC values are high in agro-forests. In forest surveys, the

combinations all have low AIC values, justifying the influence of each physical descriptor used. Indeed, Burnham and Anderson (2002), Mbow et *al.* (2013), Sileshi (2014) and Laminou Manzo et *al.* (2015), have shown that the Akaike information criterion (AIC) is a decisive validation element of a prediction model, as well as the different statistical tests and the standard residual error.

Indeed, the fact that low AIC values influenced the choice of these equations corroborates the result obtained by Mbonayem Liboum and Bobo (2017) when studying the growth of Moabi. These authors showed that the combinations that provided the lowest AIC values were retained as potentially usable in predictive models of Moabi growth.

# 5. Conclusion

The present study allowed the evaluation of the fruiting potential of *Ricinodendron heudelotii* (Baill.) and also to assesses its variability according to dendrometric descriptors in two types of land use. The results obtained show that the height of individuals (subjects and close neighbours) has a greater influence on fruit production than the other dendrometric descriptors. Thus, from the allometric combinations by simple and multiple linear regressions, the variability of fruit potential of *Ricinodendron heudelotii* (Baill.) for the explanatory variables chosen in this study. Three combinations were selected from the low values of the Aikkake information criterion (AIC). These three combinations can be used to predict fruit yields of *Ricinodendron Heudelotii* (Baill.) from the dendrometric descriptors. They can also be used by decision-makers for domestication projects of this species. Thus, this study could be extended to other environmental parameters such as soil, climate, etc. for a fruit potential that contributes to food security and poverty reduction.

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