

Pedoclimatic parameters influence on the structural parameters and survival of *Acacia auriculiformis* plants in Kétou and Toui-Kilibo classified forests in Benin

Conrentin S. Gnahoui

gnahouisenou@gmail.com

University of Parakou, Faculty of Agronomy

Towanou Houetchegnon

University of Parakou, Faculty of Agronomy

Bienvenu HOUEHANOU

University of Parakou, Faculty of Agronomy

Bienvenue N. Kuiga Sourou

University of Parakou, Faculty of Agronomy

Adigla Appolinaire Wédjangnon

University of Parakou, Faculty of Agronomy

Justin Dossou

University of Parakou, Faculty of Agronomy

Christine Ouinsavi

University of Parakou, Faculty of Agronomy

Research Article

Keywords: Precipitation, Temperature, Soil pH, Interaction, Growth, Survival, *Acacia auriculiformis*

Posted Date: March 5th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-8734321/v1>

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Additional Declarations: No competing interests reported.

Abstract

Understanding the mechanisms that influence the dynamics of plant species has become a major issue in conservation ecology, especially with the impact of climate change and ecosystem degradation due to strong anthropization. Thus, this research evaluates the effects of pedoclimatic parameters on structural parameters of young *Acacia auriculiformis* plants in the Toui-Kilibo and Kétou classified forests in Benin, West Africa. In this study, we sampled permanent plots monitored over 3 years, where we measured the basal diameter, total height, number of main branches and plant mortality rate. We built a structural equation model to test the direct and indirect effects of pedoclimatic parameters on the growth and survival parameters of *Acacia auriculiformis*. As predicted, the results demonstrate a positive effect of rainfall on growth, but with variable responses depending on the sites. Contrary to our predictions, temperature has a positive effect on growth in Kétou, but a negative effect on seedling diameter and survival in Toui-Kilibo. Finally, soil pH is identified as a limiting factor in the growth and survival of young *Acacia auriculiformis* plants. Overall, the results highlight the importance of considering the complex interaction between climate and soil in predicting species dynamics.

1 Introduction

Land degradation and forest cover loss in tropical regions constitute a major environmental crisis, demanding intensive and immediate reforestation strategies (Ripple et al. 2017). This degradation is exacerbated by rapidly increasing anthropogenic pressure, particularly in West Africa, where demographic growth exerts an exponential demand on forest resources (Herrmann et al. 2020; Kouassi et al. 2021; Dimobe et al. 2015). In this context, it should also be noted that the demand for fuelwood in urban and rural areas is rising, thus requiring the urgent development of a plantation policy based on fast-growing exotic species to mitigate the supply deficit in cities such as Cotonou, Lomé, or Accra (Padonou et al. 2023).

In this tense socio-ecological environment, monospecific plantations of fast-growing, difficult condition tolerant species have become essential tools for rehabilitating depleted soils and rapidly producing wood (Aweto 2001; Lemenih 2006). *Acacia auriculiformis*, an exotic species native to Australia, is particularly favored in reforestation programs across West Africa, notably in Benin. Its widespread use in ecosystem restoration by several programs (PANA-énergie, COFORMO, PFCB, etc.) is explained by its intrinsic ability to fix atmospheric nitrogen, thereby contributing to the improvement of degraded soil fertility, and by its remarkable capacity to grow rapidly in environments subject to hydric or edaphic stress (Sikuzani et al. 2023; Devi et al. 2023). In Benin, this species is the subject of large-scale plantations and covers a wide geographical spectrum, extending from the South (Guinean zone) up to the latitude of Toui-Kilibo (Sudano-Guinean zone), making it a key species for the national strategy to combat desertification and produce biomass. *Acacia auriculiformis* is a fast-growing species that adapts to a wide variety of soils and is widespread in tropical and subtropical areas. It has some salinity tolerance and pH values ranging from 3.0 to 9.5 (Gnahoua and Louppe 2003). *Acacia auriculiformis* is a

large tree that can reach 30 m in height under good conditions, with a straight bole approximately 60 cm in diameter.

Despite the proven potential of these fast-growing species in terms of biomass production and initial restoration of forest cover, the silvicultural success and long-term sustainability of the plantations are highly dependent on local pedoclimatic conditions (Schuler et al. 2025; Hung et al. 2016). Understanding how local environmental factors interact is essential, as the phenotypic plasticity of young seedlings is constantly challenged by a heterogeneous environment. Variations in the rainfall regime (Brienen et Zuidema 2005), temperature (Hatfield et Prueger 2015), and soil pH (Bourg and Riano 2025; Huong et al. 2015) directly influence the regulation of physiological processes in young plants. These complex interactions are the ultimate determinants of their growth rate and, critically, their survival rate during the crucial early establishment years.

Rainfall is one of the most important abiotic factors, acting as a major limiting factor for plant physiological processes and ecological adaptability, particularly in the Sudano-Guinean regions characterized by a marked dry season (Grogan et Schulze 2012; Seghieri et al. 2012). It shapes not only phenology and productivity but also species distribution (Boland et al. 1990; Kriticos et al. 2003). Water availability is a stimulating factor that increases plant growth and survival by supporting photosynthesis. Furthermore, plants draw all the nutrients they need from their environment, and rainfall plays a fundamental role in this regard, acting as a vector and a leaching agent (Huntley 2023). Indeed, rainfall contributes to mobilizing and releasing nutrients and materials into the soil that plants need to survive and thrive (Zhao and Riaz 2024; Gavrilescu 2021). This positively affects the growth parameters of plant species by improving nutrient uptake by the roots (Van Breemen 1993), and consequently leads to a significant reduction in mortality, particularly during post-transplantation stress phases (Morison and Morecroft 2006). Temperature plays an equally important role in regulating key physiological processes, influencing respiration, transpiration, and the development of plant species (Bahuguna and Jagadish 2015). Excessive temperatures can cause thermal stress, leading to reduced growth and increased vulnerability of young seedlings (Dusenge et al. 2019; Feller and Vaseva 2014).

Considered the master variable of the soil, pH influences the majority of biogeochemical processes that indirectly or directly affect the growth of plant species (Neina 2019). pH variation has a significant impact on nutrient availability and uptake, soil structure, and the symbiotic microbial activity crucial for a nitrogen-fixing species like *Acacia* (Barrow and Hartemink 2023). For example, acidic soil (low pH), common in tropical zones, significantly reduces plant growth (Lammel et al. 2018). An excessively acidic environment thus contributes to the increase in plant mortality rates, seriously hindering reforestation objectives (Nabara et al. 2024).

To optimize yield, establishment, and durability of *Acacia auriculiformis* plantations and to inform silvicultural management decisions (site selection, irrigation methods, amendments), it is essential to understand not only the isolated effects of these factors, but especially how these environmental factors

interact to modulate the species' performance across the Beninese bioclimatic gradient. The approach must go beyond simple correlation to identify complex causal pathways.

Therefore, we used Structural Equation Modeling (SEM) to dissect the direct and indirect relationships between pedoclimatic factors (rainfall, temperature, pH) and structural parameters (basal diameter, height, survival, etc.). Based on general ecological knowledge and field observations, we hypothesized the following: Increased rainfall would promote plant growth and, consequently, reduce their mortality rate. Extreme temperatures and high soil acidity (low pH) would lead to reduced growth and an increased mortality rate of young plants. SEM analyses were used to test this complex network of hypotheses and precisely identify the site-specific responses in the two study sites, thereby providing a solid scientific basis for the management of *Acacia auriculiformis* plantations in the context of climate change in West Africa.

2 Materials and Methods

2.1 Study area

We tested our hypotheses using *Acacia auriculiformis* plantations in the Kétou and Toui-Kilibo classified forests in Benin, West Africa. In the Kétou classified forest, the plantations are located in the Guinean-Congolese zone (6°10'-7°30'N), characterized by a subequatorial climate with annual rainfall between 1100 and 1300 mm (Adomou 2005). In the Toui-Kilibo classified forest, the plantations located in the Sudano-Guinean zone (7°30'-9°30'N), also called the "transition zone", receives annual rainfall ranging from 900 to 1200 mm (Adomou 2005). In October 2022, permanent sub-plots were established on four 25-ha plots in each of the two classified forests. These sub-plots, each 100 m², are at least 100 meters apart. The plantations are the same age (installed in October 2022), and the plots that compose them all have an area of 25 hectares. The *A. auriculiformis* seedlings came from the nurseries set up for the PFCB and are on average 35 cm tall. The soils of the plots studied are hydromorphic leached tropical ferruginous soils and leached tropical ferruginous soils with concretions in the Toui-Kilibo classified forest, then leached concretionary tropical ferruginous soils and leached hydromorphic tropical ferruginous soils with concretions in the Kétou classified forest (PFCB 2023).

The selection of Kétou (Guinean zone) and Toui-Kilibo (Sudano-Guinean transition zone) sites represents the largest climatic gradient available in Benin for established *Acacia auriculiformis* plantations. Although a third site in the Sudanian zone would have been ideal for complete statistical generalization, this approach was not feasible due to a major operational constraint: the absence of large-scale *Acacia auriculiformis* plantations suitable for our monitoring protocol within this third climatic zone of Benin. Therefore, the study is structured as a maximal comparative case analysis between these two principal climatic zones.

2.2 Growth parameters

In each classified forest, 4 plots of 25 hectares were selected, for a total of 8 plots. On each plot, 10 permanent sub-plots were installed, for a total of 80 sub-plots. Two plots per forest had a density of 1111 plants/ha (3m x 3m) and two others had a density of 2500 plants/ha (2m x 2m). On each sub-plot, on each collection date, we counted the number of live and dead *Acacia auriculiformis* plants in order to calculate the mortality rate per sub-plot and by age, measured the diameter at the collar of each living individual using vernier calipers, measured the total height of each living individual using graduated boards and then counted all the main branches of each living plant identified per sub-plot. The first collections took place in November 2022, with two repeats in November 2023 and November 2024, representing three consecutive years of collection from the same individuals. Soil pH is specifically determined for PFCB for *Acacia auriculiformis* plantations establishment in 2023 by the Support Laboratory for the Improvement of Soil Health, Water Quality, and Environmental Protection.

For climate data, the GPS coordinates of each plot were recorded. These were used to estimate the average annual rainfall and average annual temperature for each plot. Climate data for 2022, 2023, and 2024 (rainfall HP and average temperature TM) were extracted via the NASA platform (GMAO - Global Modeling and Assimilation Office Research Site) from a grid covering the relevant classified forests. A random number generation algorithm was used to select 80 points on this grid based on the data resolution. A geostatistical approach was then used to model the extracted data at a scale of 100 m², corresponding to the minimum distance between plots.

2.3 Data analysis

A structural equation model (SEM) was developed in R (Grace 2006) to test the direct and indirect effects of mean rainfall, mean temperature, soil pH, plantations age, and density of *Acacia auriculiformis* individuals on three structural parameters (root collar diameter, total height, and number of main branches) as well as on the mortality rate of these young *Acacia auriculiformis* populations. SEM is a powerful statistical tool for modeling complex ecological systems. It allows the construction of a single causal network between multiple predictor and response variables (Grace 2006), identifying their direct and indirect effects (Fan et al. 2016). The piecewise SEM package (Lefcheck 2016) was used, including generalized linear mixed-effects models to predict dependent variables based on plantation age, mean rainfall, mean temperature, soil pH, and individual density, with plot as a random effect.

The models were fitted with Poisson errors using the glmer function of the lme4 package, as the count data did not exhibit overdispersion. To facilitate model convergence and interpretation, all variables were standardized (mean subtraction and division by the standard deviation).

3 Results

3.1 The effect of rainfall on the growth parameters of *Acacia auriculiformis* seedlings

The results showed that rainfall significantly affected the growth parameters of *Acacia auriculiformis* seedlings. In Kétou, rainfall positively affected basal diameter ($\beta = 0.012 \pm 3e-04$; $p < 0.001$, Fig. 2.1c), plant height ($\beta = 0.007 \pm 7e-04$; $p < 0.001$, Fig. 2.1g), and branch number ($\beta = 0.011 \pm 8e-04$; $p < 0.001$, Fig. 2.1h), while significantly reducing the mortality rate ($\beta = -0.012 \pm 0.002$; $p < 0.001$, Fig. 2.1e). In Toui-Kilibo, its positive effect is also observed on the basal diameter ($\beta = 0.012 \pm 8e-04$; $p < 0.001$, Fig. 3.1b) and on the number of branches ($\beta = 0.009 \pm 0.001$; $p < 0.001$, Fig. 3.1i).

3.2 The effect of temperature on the growth parameters of *Acacia auriculiformis* seedlings

The results showed that temperature significantly influences the growth parameters of *Acacia auriculiformis* seedlings. In Kétou, temperature significantly affected branch number (0.669 ± 0.042 ; $p < 0.001$, Fig. 2.1) and moderately affected basal diameter (0.063 ± 0.029 ; $p = 0.03$, Fig. 2.1). Although it had no effect on plant height (0.073 ± 0.046 ; $p = 0.12$, Fig. 2.1), temperature negatively but significantly influenced mortality (-0.994 ± 0.103 ; $p < 0.001$, Fig. 2) of *Acacia auriculiformis* seedlings. In contrast, at Toui-Kilibo, temperature had a significant negative effect on basal diameter ($\beta = -0.723 \pm 0.035$; $p < 0.001$, Fig. 3.1c), plant height ($\beta = -0.092 \pm 0.016$; $p < 0.001$, Fig. 3.1h), and branch number ($\beta = -0.404 \pm 0.083$; $p < 0.001$, Fig. 3.1j).

3.3 The influence of soil pH on the growth parameters of *Acacia auriculiformis* seedling

The results showed that soil pH leads to changes in growth parameters, with divergent effects between the two locations. At Kétou, soil pH positively and significantly influenced basal diameter growth ($\beta = 0.418 \pm 0.098$; $p < 0.001$, Fig. 2.1a). Conversely, at Toui-Kilibo, it negatively affected basal diameter ($\beta = -0.331 \pm 0.07$; $p < 0.001$, Fig. 3.1a), but positively promoted plant height ($\beta = 0.247 \pm 0.041$; $p < 0.001$, Fig. 3.1f).

3.4 The effect of planting age on planting growth and survival

Planting age is a determining factor in growth and survival at both sites. In Kétou, age positively influences basal diameter ($\beta = 0.25 \pm 0.011$; $p < 0.001$, Fig. 2.1b) and plant height ($\beta = 0.383 \pm 0.021$; $p < 0.001$, Fig. 2.1f) while drastically reducing mortality rates ($\beta = -5.667 \pm 0.093$; $p < 0.001$, Fig. 2.1d). In Toui-Kilibo, age also favors plant height ($\beta = 0.219 \pm 0.009$; $p < 0.001$, Fig. 3.1g) and reduces mortality rates ($\beta = -0.697 \pm 0.074$; $p < 0.001$, Fig. 3.1d).

3.5 The influence of plant density on mortality

The results show that higher plant density significantly increases the mortality rate ($\beta = 0.07 \pm 0.025$; $p < 0.01$, Fig. 3.1e).

4 Discussion

The results of this study clearly highlight the effect of rainfall, soil pH, temperature, planting density and plantation age on the growth and survival of *Acacia auriculiformis*. While the limitation to two sites dictates caution regarding the generalization of our findings across the whole of West Africa, it does not undermine the validity of the ecological mechanisms identified. On the contrary, the comparative use of Kétou (Guinean zone, more humid) and Toui-Kilibo (Sudano-Guinean zone, drier) allowed us to employ Structural Equation Modeling (SEM) to dissect how ecological mechanisms fundamentally shift between a wetter and a drier regime. The resulting data provide immediate and practical value by establishing silvicultural management recommendations adapted to the two principal climatic zones where restoration efforts are currently focused in Benin. These observations generally refer to the study of functional traits studied by (Diaz et al. 2004) which postulates that the performance of an organism is determined by its morphological, physiological and phenological characteristics in interaction with the environment.

The results show that in Kétou, growth in basal diameter is significantly influenced by rainfall, a moderately basic pH and the age of plantations. This finding is consistent with the law of the limiting factor, which stipulates that the scarcest resource limits the growth of organisms. Here, water and nutrient accessibility, favored by abundant rainfall and near-neutral pH, removes limiting constraints, as observed in other tropical legumes (Hossain et al. 1997; Tonini et al. 2018); Tonini et al. 2018). This suggests that more established plantations in areas with high rainfall and favorable pH develop a larger basal diameter due to better nutritional conditions and water availability, facilitating root and woody growth. In parallel, the negative effect of rainfall and age on mortality rate indicates an increase in resilience over time, which is aligned with the environmental stress theory, according to which plants subjected to moderate but sustained resource conditions develop efficient acquisition strategies and greater morphological robustness. This principle is also supported by the ecological succession theory (Connell and Slatyer 1977), which posits that older plantations are more resilient due to structural stability and increased resource use efficiency. These results suggest that more favorable environmental conditions, including high rainfall, moderately basic pH, and older plantations, contribute to increased growth and better survival of *Acacia auriculiformis* seedlings. At Toui-Kilibo, on the other hand, the results reveal the restrictive influence of high temperature and more acidic pH on diameter and height growth. These observations can be interpreted in light of the thermal tolerance theory (Callaghan et al. 2004; Christiansen 1978), which predicts a drop in plant physiological performance beyond specific thermal thresholds, affecting photosynthesis, respiration, and growth. The negative effects of temperature on plant morphology (height, number of branches) also support energetic cost of stress models (Valladares et al. 2007), according to which tolerance to abiotic stresses requires resource reallocations, to the detriment of vegetative growth. These results suggest that, in more thermally constrained environments, radial growth is limited by heat stress and unfavorable edaphic conditions, although water remains a determining factor. The negative effect of density on survival at Toui-Kilibo reflects classic asymmetric competition processes (Weiner 1990), where dominant individuals monopolize resources at the expense of smaller ones, leading to increased mortality. This phenomenon is particularly marked under harsh environmental conditions, reinforcing competitive selection dynamics within stands (Pretzsch 2009).

These results obtained in Toui-Kilibo indicate that abiotic constraints, in particular high temperature and pH variations, slow the growth of young *Acacia auriculiformis* plants, although the beneficial effect of rainfall and the age of the plantations remains perceptible.

Rainfall also has a positive effect on the number of branches in both sites, illustrating the importance of water in adjusting architectural plasticity. This link can be linked to the theory of optimal resource allocation (Bloom et al. 1985), according to which plants modulate their morphological growth according to available resources to maximize their reproductive output or photosynthetic efficiency. Plantation age appears to be a transversal and constant determinant of ecological performance. This result is consistent with the observations of (Poorter et al. 2016) on structural resilience linked to accumulated biomass and reinforces the relevance of considering time as a structuring ecological variable (Chazdon 2014). Root development, leaf cover thickness, as well as the richness of soil microorganisms increase with age, reinforcing positive feedbacks between plants and the environment. Finally, the inter-site comparison highlights the importance of the rainfall gradient and environmental constraints in structuring the growth of young *Acacia auriculiformis* plants. In Kétou, more abundant water conditions and relatively more favorable soils favor structural development and survival, while in Toui-Kilibo, thermal stress and competition negatively influence several growth traits. The beneficial effect of plantation age is, however, observed at both sites, suggesting a significant contribution of stand maturity to resilience.

5 Conclusion

This study shows that environmental variables significantly affect the growth parameters of *Acacia auriculiformis* in both plantations. We found that rainfall increases the basal diameter of *Acacia auriculiformis* seedlings in both plantations. These results highlight the importance of rainfall in the growth and maintenance of plant species. Furthermore, although temperature variation negatively affects the mortality rate in both plantations, it leads to a reduction in the size, basal diameter and number of branches of seedlings at the Toui-Kilibo site. This suggests that increased temperature can negatively affect the growth parameters of plant species. Furthermore, we found that the basal diameter of young plants at the Toui-Kilibo site is negatively affected by soil pH, which increases the mortality rate of *Acacia auriculiformis* seedlings at the site. This could be explained by soil acidity (Hue 2022).

Declarations

Acknowledgments

We are grateful to Ozias N. K. Orou Yawa, Cesar V. D. S. Meviekpon, for field assistance and Hermann Bassoki for assistance with data analysis.

Authors contribution

TH, BH and TH conceived the ideas for this study and designed the methodology. CSG and BH collected the data and conducted the statistical analysis with assistance from TH and CO. CSG drafted the first version of the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

Funding

We did not receive any funding for this study.

Clinical Trial Number

Not applicable.

Data availability

Data and R script used for the statistical analyses will be publicly published in an open-access data repository.

Ethics approval and consent to participate: Not applicable.

Consent for publication: Not applicable.

Competing interests: The authors declare that they have no competing interests.

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Tables

Table 1: Results of analyses of the effects of environmental variables on the growth parameters of young *Acacia auriculiformis* plants, Toui-Kilibo site

Site: Toui-Kilibo					
Response	Predictor	Estimate	SE	DF	P
basal diameter	phsol	-0.3317	0,070 7	39,166 3	<0,000 1
	age	-0.0837	0,024 8	1214,915 8	0,000 8
	rain	0.0123	0.0008	1200.0895	<0.0001
	temp	-0.7232	0.0358	1174.6082	<0.0001
	density	0.0934	0.0056	1205.9676	<0.0001
death	phsol	2.4366	0.2026	1221.0000	<0.0001
	rain	0.0126	0.0039	1221.0000	0.0013
	age	-0.6974	0.0749	1221.0000	<0.0001
	temp	-0.4129	0.1963	1221.0000	0.0354
	density	0.0707	0.0250	1221.0000	0.0047
	dia_col	-4.9363	0.1682	1221.0000	<0.0001
	height	1.2330	0.2023	1221.0000	<0.0001
height	phsol	0.2474	0.0413	38.5374	<0.0001
	age	0.2190	0.0099	1204.6844	<0.0001
	rain	-0.0031	0.0004	1212.6381	<0.0001
	temp	-0.0926	0.0166	1213.3077	<0.0001
	dia_col	0.7629	0.0114	1202.4648	<0.0001
	density	0.0448	0.0025	1212.6043	<0.0001
ramification	phsol	-0.0415	0.1352	1221.0000	0.7586
	age	-0.0855	0.0598	1221.0000	0.1529
	rain	0.0099	0.0017	1221.0000	<0.0001
	temp	-0.4943	0.0834	1221.0000	<0.0001
	dia_col	-0.3071	0.1306	1221.0000	0.0187
	height	1.1154	0.1561	1221.0000	<0.0001
	density	0.1505	0.0148	1221.0000	<0.0001

Table 2: Results of the analyses of the effects of environmental variables on the growth parameters of young *Acacia auriculiformis* seedlings, Ketou site. Growth parameters (dia_col = Diameter at the collar, death = Mortality, height = Height, ram = Branching); Predictor (phsol = Soil pH, age = Age of the plantation, temp = Temperature, rain = Precipitation, density = Density of young *Acacia auriculiformis* seedlings, height = Height, dia_col = Diameter at the collar, ram = Branching); SE = Standard Error; DF = Degree of Freedom; P = p_value.

Site: Ketou					
Parameters	Predictor	Estimate	SE	DF	P
dia_col	phsol	0,418 0	0,098 8	38,080 6	0,000 1
	age	0,250 7	0,011 4	1215,590 6	<0,000 1
	temp	0.0634	0.0295	1208.2762	0.0317
	rain	0.0120	0.0003	1200.1359	<0.0001
	density	0.0007	0.0039	37.3788	0.8577
death	phsol	-7.3495	0.3129	1232.0000	<0.0001
	ram	-0.0742	0,004 1	1232,000 0	<0,000 1
	age	-5.6671	0,093 8	1232,000 0	<0,000 1
	temp	0.9941	0.1031	1232.0000	<0.0001
	density	-0.1360	0.0118	1232.0000	<0.0001
	rain	-0.0124	0.0021	1232.0000	<0.0001
	height	-0.4823	0.0626	1232.0000	<0.0001
	dia_col	9.1269	0.1893	1232.0000	<0.0001
height	phsol	-0.2433	0.1285	38.6837	0.0658
	density	-0.0035	0.0050	36.3209	0.4939
	age	0.3835	0.0212	1222.8140	<0.0001
	rain	0.0072	0.0007	1220.6100	<0.0001
	dia_col	-0.0109	0.0446	1215.8503	0.8076
	temp	0.0729	0.0464	1214.3485	0.1164
ram	age	-0.2458	0.0232	1232.0000	<0.0001
	rain	0.0111	0.0008	1232.0000	<0.0001
	temp	0.6690	0.0423	1232.0000	<0.0001

density	0.0052	0.0039	1232.0000	0.1885
dia_col	1,331 5	0,048 8	1232,000 0	<0,000 1
height	0.4499	0.0348	1232.0000	<0.0001

Figures

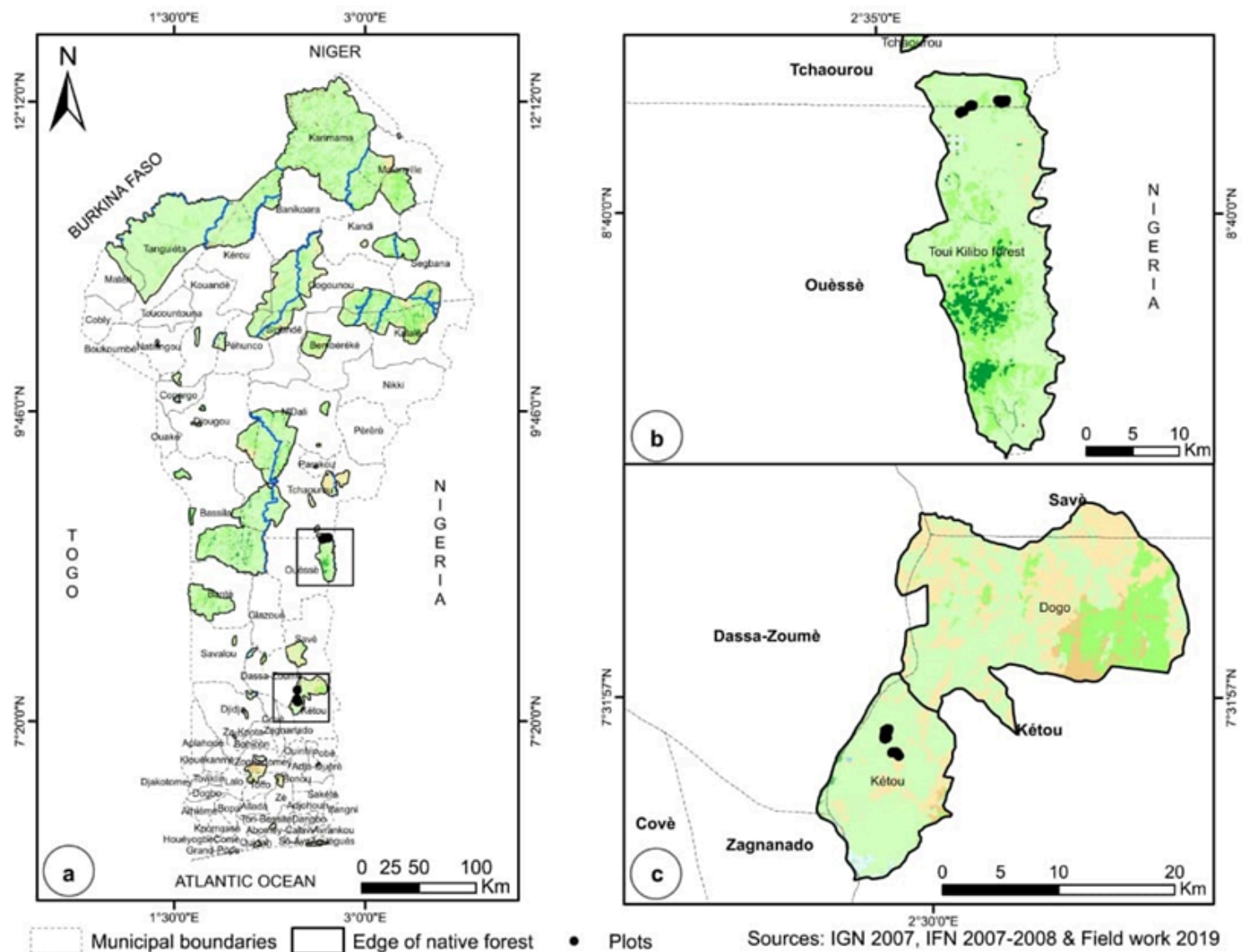


Figure 1

(a) The map showing the geographical location of the study areas, the first map (b) shows the geographical location of the *Acacia auriculiformis* plantation of Toui-Kilibo and the second map (c) shows the geographical location of the *Acacia auriculiformis* plantation of Kétou.

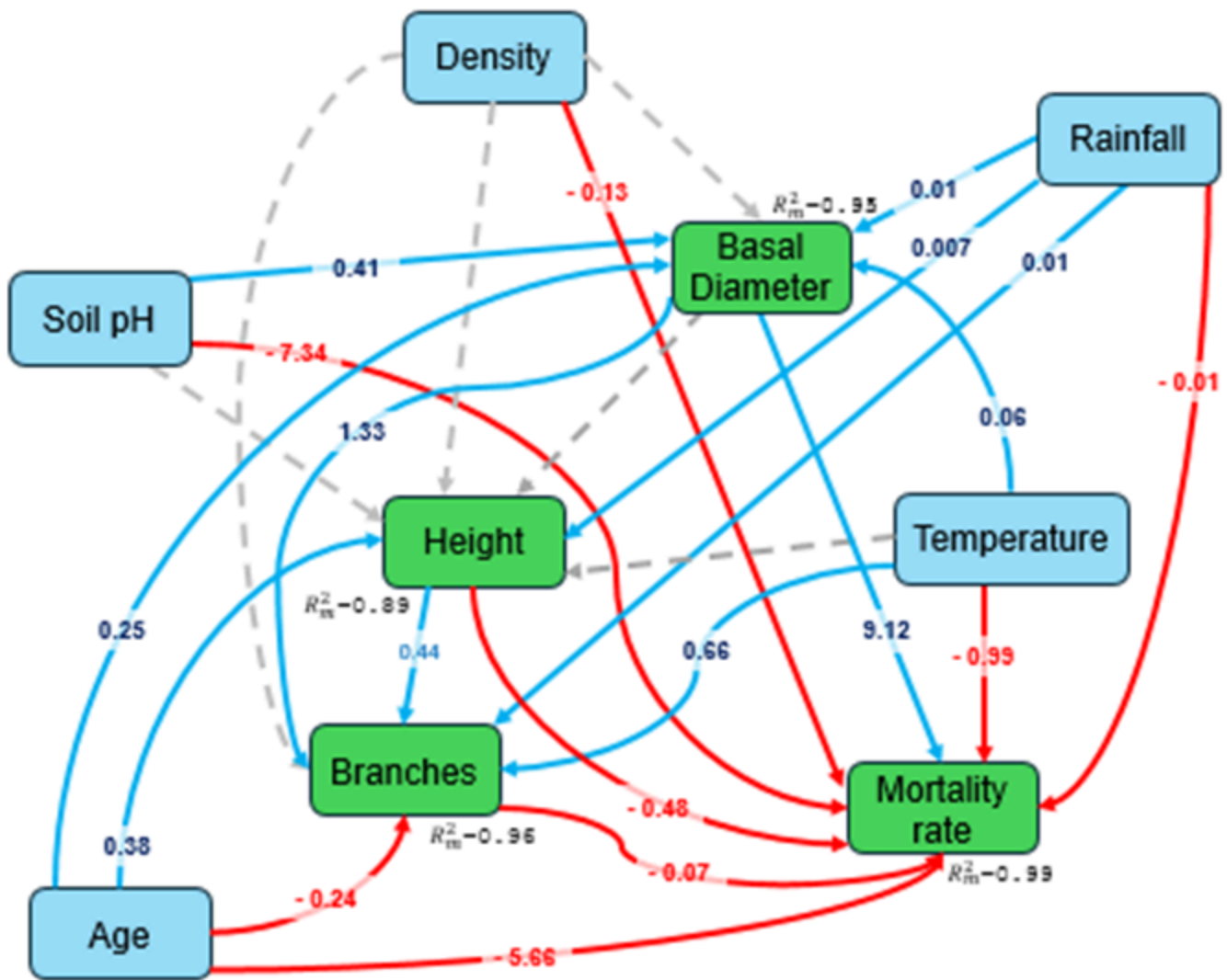


Figure 2

Structural Equation Model (SEM) showing the effect of environmental variables on the growth parameters of *Acacia auriculiformis* Fisher's C = 3,336, p-value = 0.189: Kétou site.

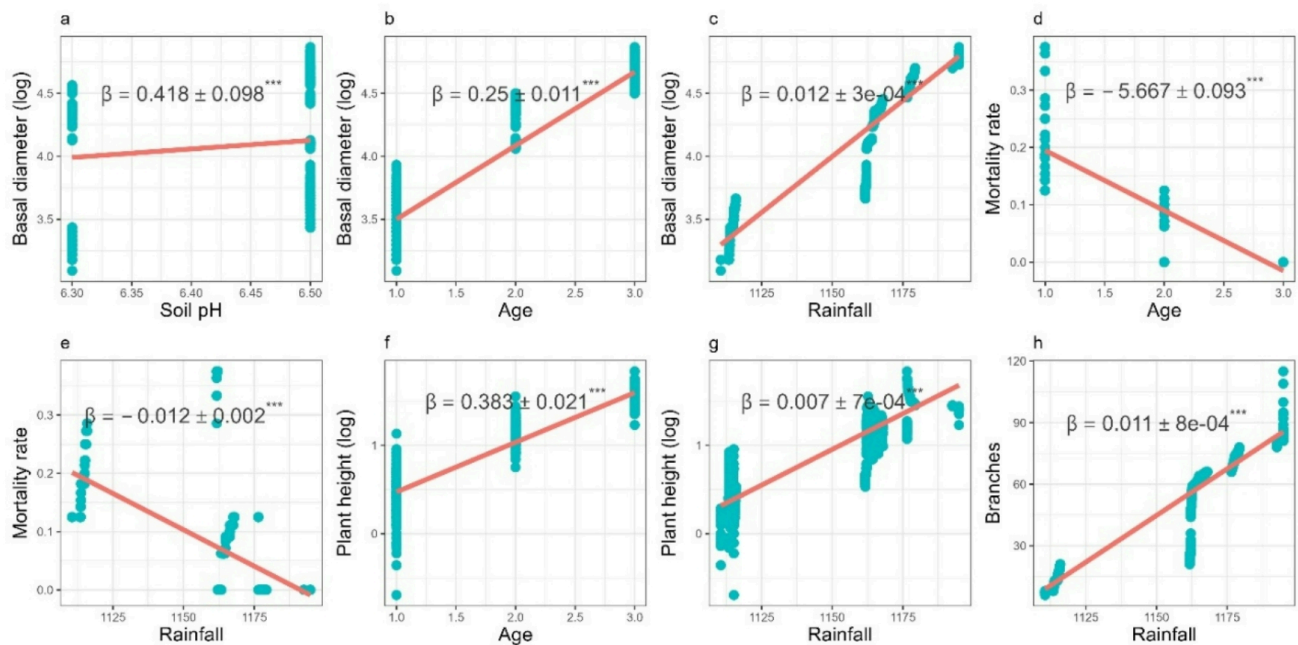


Figure 3

Figure 2.1: Regression showing the effect of environmental variables on the growth parameters of *Acacia auriculiformis* seedlings at Kétou. (a) Effect of soil pH on basal diameter, (b) Effect of planting age on basal diameter of seedlings, (c) c, (d) Effect of planting age on seedling mortality, (e) Effect of rainfall on seedling mortality, (f) Effect of planting age on seedling size, (g) Effect of rainfall on seedling size and (h) Effect of rainfall on branch number of *Acacia auriculiformis* seedlings at the Kétou site.

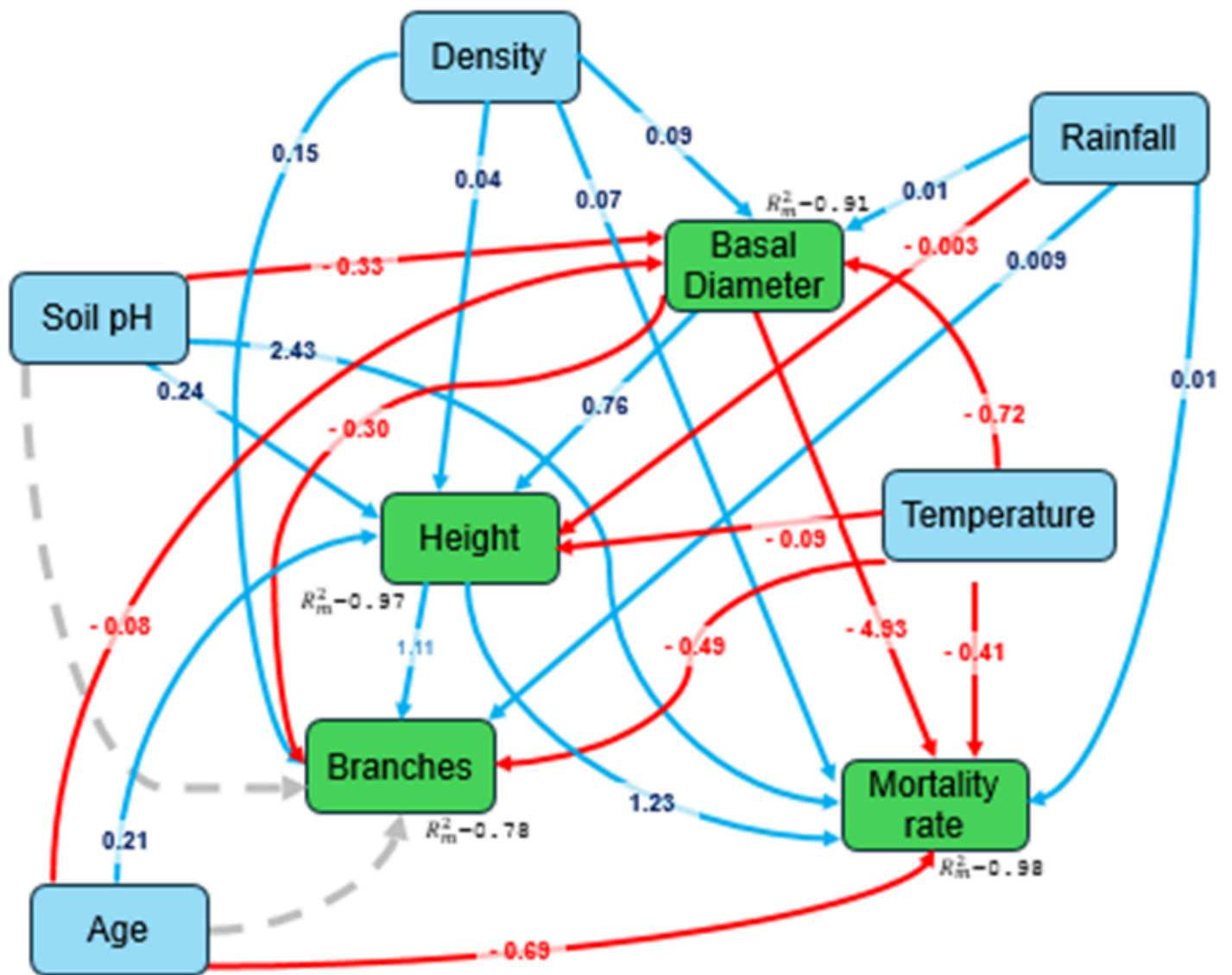


Figure 4

Figure 3: Structural Equation Model (SEM) showing the effect of environmental variables on the growth parameters of *Acacia auriculiformis* Fisher's C = 1733, pvalue = 0.42: Toui-Kilibo site.

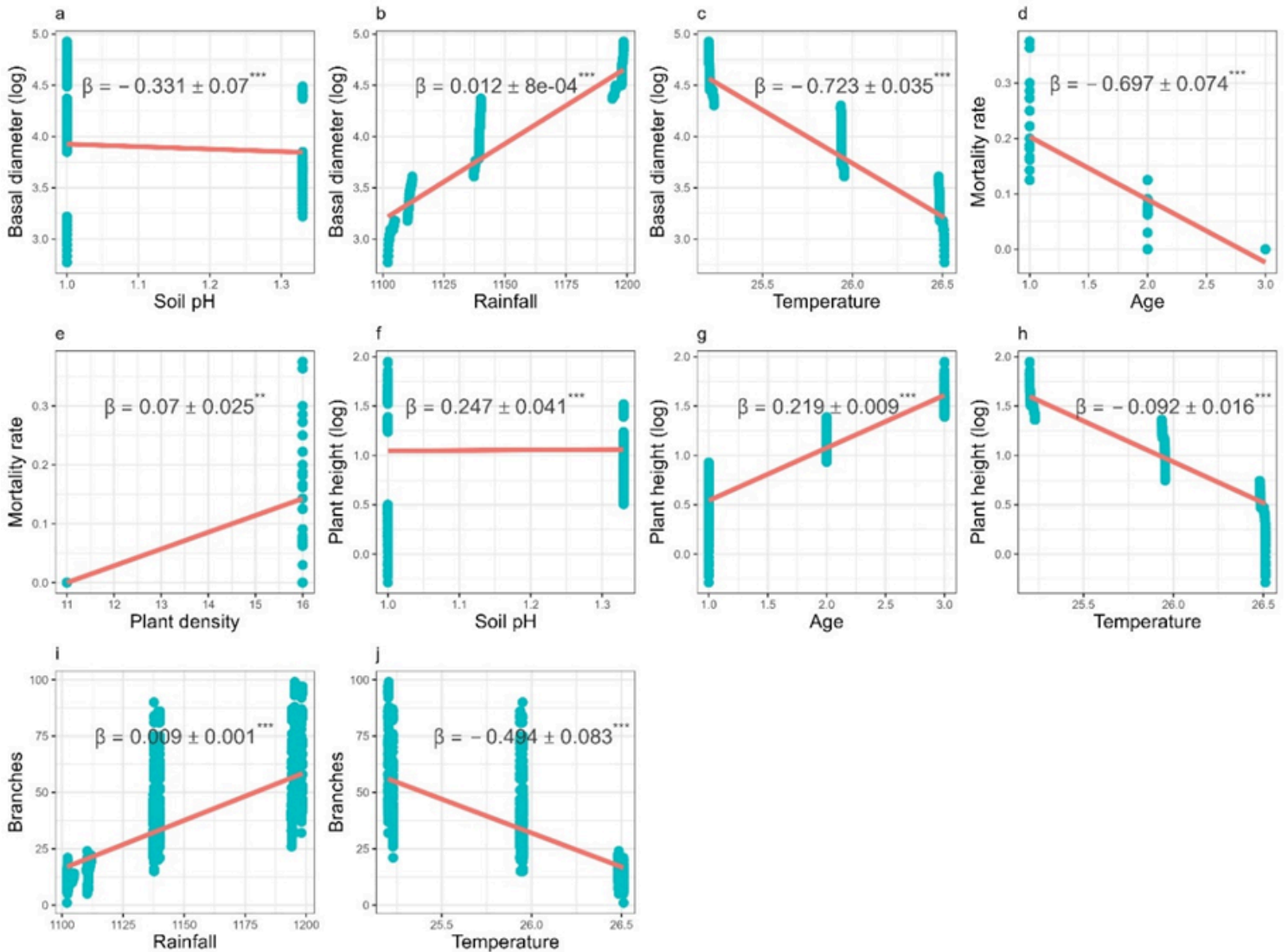


Figure 5

Figure 3.1: Regression showing the effect of environmental variables on the growth parameters of *Acacia auriculiformis* seedlings at Toui-Kilibo. (a) Effect of soil pH on basal diameter, (b) Effect of rainfall on the basal diameter of seedlings, (c) Effect of temperature on the basal diameter of seedlings, (d) Effect of planting age on seedling mortality, (e) Effect of density on seedling mortality (f) Effect of soil pH on seedling size, (g) Effect of planting age on seedling size, (h) Effect of temperature on seedling size, (i) Effect of rainfall on the number of branches of seedlings, and (j) Effect of temperature on the number of branches of *Acacia auriculiformis* seedlings at the Toui-Kilibo site.