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Evaluation of the Productivity of Intercropping Plantain Cultivar (PITA 3) Fertilized with Two Types of Manure, under Coconut Tree Based (*Cocos nucifera* L.), on the Tertiary Sands of Côte d'Ivoire

Pierre-Marie Janvier Coffi[1,2*], Joséphine Tamia Ama[1], Thierry Tacra Lekadou[2], Siaka Traore[2], Charly Fernand Agoh[2], Didier Martial Saraka Yao[3]

[1]Geosciences and Environment Laboratory, Environmental Sciences and Management Training and Research Unit (UFR), Nangui Abrogoua University (UNA), Abidjan, Côte d'Ivoire
[2]Centre National de Recherche Agronomique, Station de Recherche Marc DELORME, Abidjan, Côte d'Ivoire
[3]Department of Biochemistry-Genetics, UFR of Biological Sciences, Péléforo Gon Coulibaly University, Korhogo, Côte d'Ivoire

Email: *janvier77@yahoo.fr, tamjoseab@gmail.com, thierry_lekadou@hotmail.fr, traoresk8@gmail.com, charlenand@gmail.com, didierys@yahoo.fr

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Abstract

Pressure on land tenure is having a negative impact on the coconut sector, reducing farmers' incomes. Intercropping cultivars plantain under coconut based has been considered as a solution to this problem. The aim of this work is to diversify the sources of income for coconut growers. The plantain variety PITA 3, popularised by the CNRA, was grown in coconut inter-rows (PB113$^+$), with two types of manure (chemical, organic). Six (06) treatments D1, D2, D3, D4, D5 and D6 were studied. In the tenth month after planting, treatment D3, which included banana plants fertilised with 9 kg of manure/plant, got the best agromorphological performance: height (264.08 cm), neck circumference (57.68 cm) and 12 leaves. In terms of production parameters, D3 banana plants had a shorter production cycle (347 days) and the highest diet mass (9.3 kg). However, the plants that received no fertiliser (D6) showed stunted growth and were unable to produce brunch. The fertilization of plantain with 10 t/ha of laying hen droppings permitted good development and production of plantains on tertiary sands.

Keywords

Intercropping, Coconut, Plantain PITA 3, Manure, Tertiary Sands

1. Introduction

Côte d'Ivoire is the leading coconut plantation in Africa [1], with several industrial plantations and numerous small private farms, mainly located on the tertiary to quaternary sands along the coast, on which more than 20,000 families depend [2]. Coconut plays a key role in people's lives in terms of social and economic uses [3].

However, the majority of this coconut field is planted with the local variety, Grand Ouest Africain (GOA), which has a low yield and low density (143 trees/ha) [4]. In addition to the biotic difficulties (pests, diseases), this coconut plantation is under ever-increasing land pressure, which is considerably reducing the area available for cultivation. This situation is leading to a drop in yields and, consequently, in people's incomes [3]. To remedy the situation, research is proposing to renew the coconut plantations with improved, resistant varieties at high planting densities, and to grow alternative crops such as plantain in the coconut inter-rows.

Indeed, sold on the market, plantain contributes to the GDP of countries in Central and West Africa, helps to diversify people's incomes and thus helps to reduce poverty [5]. Plantain is one of the main sources of carbohydrates [6] and feeds many people around the world, particularly in tropical countries [7]. In Côte d'Ivoire, plantain is the third most important food crop, after yam and cassava, with average annual production estimated at around 1.7 million tonnes [8]. However, plantain is one of the staple foods of the Ivorian population [9], and despite its socio-economic importance, large-scale plantain cultivation is confined to the East, Centre-West and West zones, where soil conditions are favourable [10]. As a result, this commodity is often irregular on local markets.

In the coastal zone, plantain cultivation techniques remain rudimentary, using very few inputs. In addition, farmers who grow plantain mainly use the Corne 1 variety, which has limited intrinsic capacity [11]. This variety has poor resistance to disease and is mainly grown in areas where there is a lot of humidity at all times, such as low-lying areas, rubbish dumps and around houses [11].

It is therefore necessary to test other, better-performing varieties in order to meet the ever-increasing market demand for plantain. The aim of this study is therefore to find an ideal technical itinerary for growing and intercropping the high-yielding PITA 3 plantain, popularised by the CNRA under coconut base, on the tertiary sands of Côte d'Ivoire.

2. Study Site

The study was carried out at the Marc DELORME research station, on the coast in south-eastern Côte d'Ivoire. The station is located on littoral, in Abidjan district southern Côte d'Ivoire, between 3˚82' - 3˚87' West longitude and 5˚26' - 5˚29' North latitude (**Figure 1**).

The soil pH is acid, around 5, in depths 0 - 20 and 20 - 40 cm. it is consists

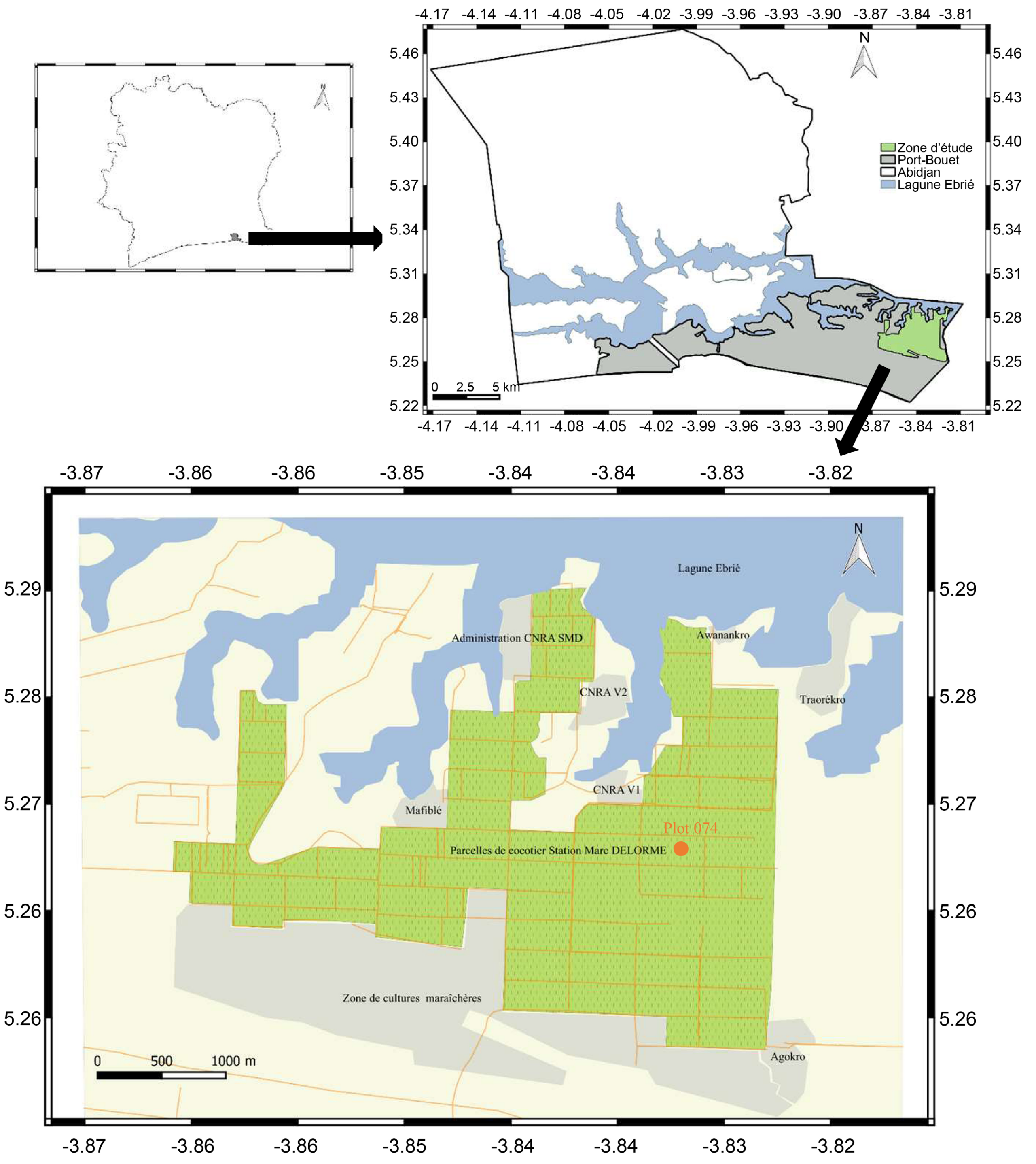

Figure 1. Location of the Marc DELORME station and the experimental plot.

mainly of fine sand (over 80%) with very little silt and clay (less than 10% each).

The soil composition in chemical of elements and exchangeable bases at the beginning of the trial, analysed at the Laboratory of the National Soil Bureau of Burkina Faso (BUNASOLS), are shown in **Table 1**.

The climate is characterized by four seasons: two dry seasons and two rainy

Table 1. Composition of chemical elements and exchangeable bases in the plot.

Minerals	O.M. (%)	C (%)	N (%)	C/N	P ass (ppm)	K disp (ppm)
0 - 20 cm	2.09	1.21	0.12	10.22	51.09	43.71
20 - 40 cm	0.91	0.53	0.06	8.39	28.52	16.61
Cation and CEC	**Ca^{2+} (meq/100 g)**	**Mg^{2+} (meq/100 g)**	**K^{+} (meq/100 g)**	**Na^{+} (meq/100 g)**	**S (meq/100 g)**	**CEC (meq/100 g)**
0 - 20 cm	0.59	0.24	0.14	0.02	0.99	7.06
20 - 40 cm	0.54	0.19	0.07	0.05	0.85	6.78

1 ppm = 1 mg/kg, O.M.: Organic matter, CEC: Exchangeable bases.

seasons. For the dry seasons, the longest covers the months of December to March and the shortest goes from August to September. For the rainy seasons, the longest covers April to July and the shortest goes from October to November. Over the decade from 2012 to 2021, average monthly rainfall ranged from 33.4 mm (January) to 464.1 mm (June) and temperatures from 25.3˚C (September) to 28.3˚C (April) (Figure 2). The sunshine was around 2000 hours a year^{-1} and relative humidity fluctuated between 80% and 90%.

3. Material and Methods

3.1. Plant Material

Plantains suckers, PITA 3 variety, averaging 60 cm in height and with a production potential of 30 t/ha (Figure 3(a)), were selected for the trial. They were planted between rows of PB113^{+} (NRC × GRL^{+}), eighteen months old, with an average of 4 living leaves (Figure 3(b)). PB 113^{+} is a high-yield hybrid (4 to 6 t/ha/year), produced by the National Center of Agricultural Research (CNRA, Côte d'Ivoire), characterised by its early production (3 to 4 years).

3.2. Fertilisers

Two types of fertilisations (chemical and organic) were used in this study. Chemical fertilisation was carried out using urea and potassium chloride. Organic fertilisation was carried out using laying hen droppings, composted during 6 months. Dolomite was applied to all plantain's suckers at planting.

3.3. Methods

3.3.1. Fertilisation and Maintenance

Chemical fertilisation with urea was carried out according to the dose recommended by Kouamé *et al.* (2014), for plantain. Thus, on the basis of 380 g of urea provided per plantain banana tree to constitute treatment D4, the equivalent in hen droppings, 6 kg, was spread around the banana trees in D1. Based on these two types of fertilization (chemical and organic), three (03) other fertilization were applied to the banana plants: half the reference dose of droppings (1/2 × 6 kg of droppings) for the banana plants in D2; three halves (3/2) the reference

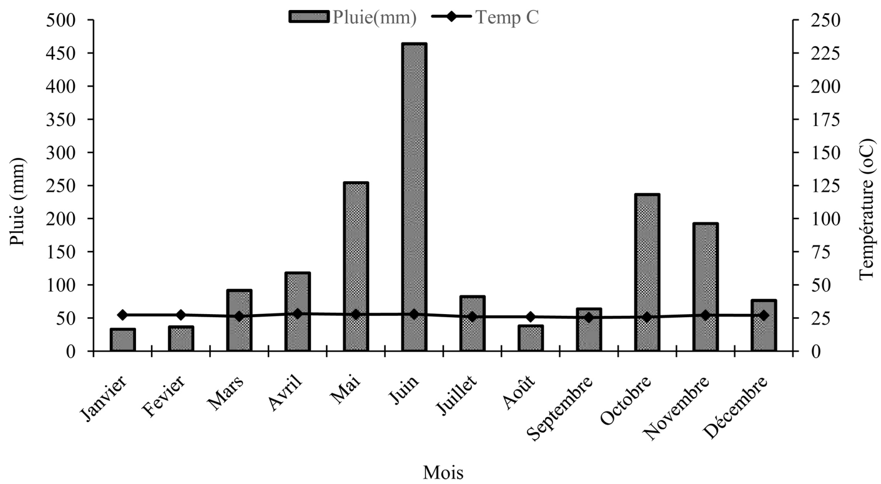

Figure 2. Umbrothermal diagram for the Marc DELORME station (By data of Marc DELORME weather station from 2012 to 2021).

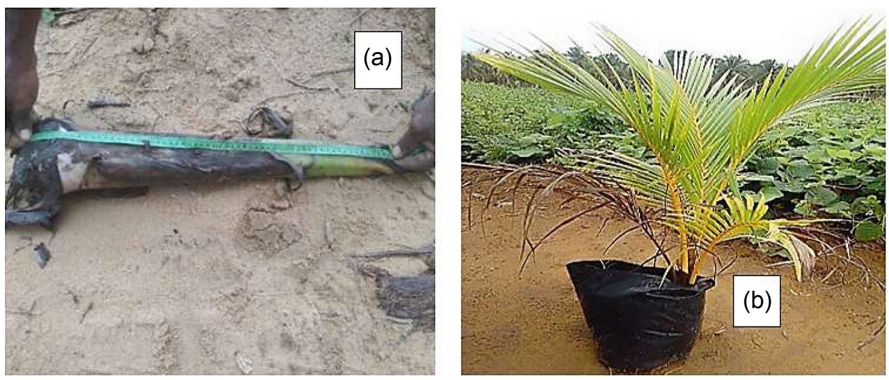

Figure 3. Plant material used for the study; (a): Plantain sucker of 60 cm, PITA 3 variety; (b): Young coconut seedling in nursery.

dose applied to the banana plants in D3; and another fertilisation applied to the plantains in D5, based on half the reference doses of urea and laying hen droppings.

A total of six treatments were carried out:

T0: Pure Coconut trees (main crop);

D1: Coconut and plantain trees fertilized with 06 kg of manure;

D2: Coconut and plantain trees fertilised with 03 kg of manure;

D3: Coconut and plantain trees fertilised with 09 kg of manure;

D4: Coconut and plantain trees fertilised with the reference chemical fertiliser, 380 g of urea and 400 g of potassium chloride;

D5: Coconut and plantain trees fertilized with urea and chicken droppings (190 g urea + 3 kg chicken droppings);

D6: Coconut with banana without manure.

Weeding was carried out along the banana rows on a monthly basis, to reduce the effect of competition with weeds. Regular leaf-stripping was also carried out on the plantain trees to reduce the risk of leaf diseases, that could lead to the death of the plant. The suckers were planted at the beginning of the short rainy season, in early October 2019. During dry periods, the banana plants were irrigated with 15 litres of water/day/plant.

3.3.2. Experimental Design

A Fisher system containing 03 blocks and 07 completely randomised treatments was set up on plot 074 covering an area of 1.4 ha.

A total of 21 sub-plots were set up (**Figure 4**). Each sub-plot consisted of ten (10) plantain trees and four (4) useful coconut trees (**Figure 5**). The configuration of plantain in the field (**Figure 6**), was 2 m between two plants and 2 m between plantains rows (2 × 2 m), which represented a density of 1110 plants/ha. The density of coconut plantation was 160 plants/ha, that means a configuration of 7.35 m × 8.5 m (**Figure 7**).

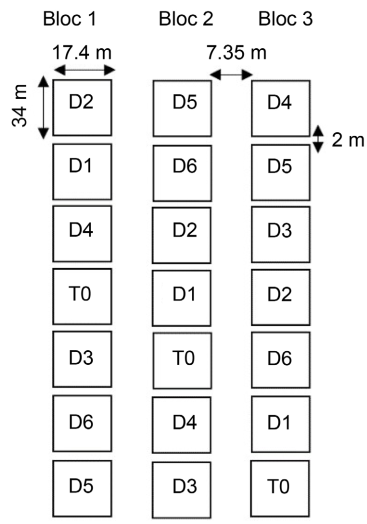

Figure 4. Fisher system containing tree blocks with all treatments randomised.

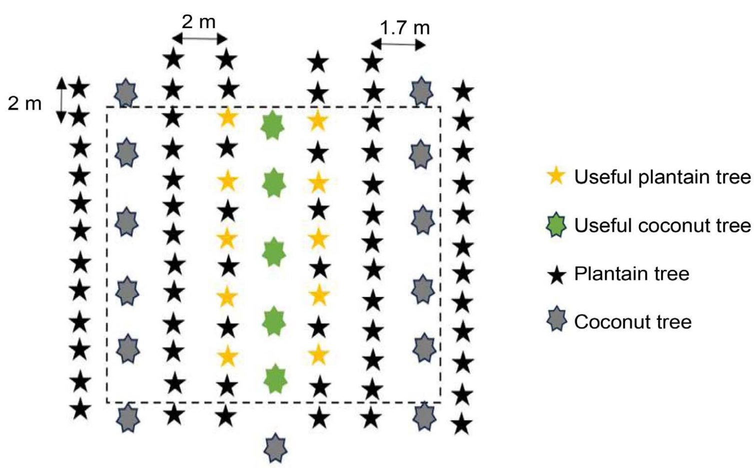

Figure 5. Treatment of the experimental set-up showing useful bananas and coconut trees.

Figure 6. Spacing configuration inintercropping plantain cultivar (PITA 3) under coconut tree based; (a): Observed distance between plantain rows and plants in a coconut row; (b): Observed distance between coconut and plantain rows.

Figure 7. Spacing between coconut palms on the same rows and between rows.

3.3.3. Variables Measured

Observations were made on plantain trees in treatments D1, D2, D3, D4, D5 and D6. Measurements of the banana plants were taken from the third month after planting to the tenth month after planting (**Table 2**). The vegetative growth parameters determined at monthly intervals were the height to the last V formed by leaves of the plant, the circumference at 10 cm from the ground of pseudo-stem and the number of functional leaves. From flowering onwards, the time intervals Planting-Flowering, Planting-Cutting and Flowering-Cutting were monitored. At harvest, the masses of the bunches obtained were compared (**Table 3**).

3.3.4. Statistical Analysis of Data

Statistical analyses were carried out using IBM software, Statistical Package of Social Sciences (SPSS), Version 16.0 (IBM Corp. Armonk, New York, USA). The agromorphological data of the banana plants were subjected to an analysis of variance (ANOVA). Significant differences between the agromorphological parameters measured were identified using the Student-Newman-Keuls multiple comparison of means test with a threshold of 5% ($\alpha = 0.05$). The Microsoft Office 2013 Excel spreadsheet was used to produce curves and histograms to monitor changes in the variables studied.

Table 2. Definition of measurement periods for growth parameters.

Measurement period	Definition
TIME 1	Third month after planting plantain suckers
TIME 2	Fourth month after planting plantain suckers
TIME 2	Fifth month after planting plantain suckers
TIME 4	Six months after planting plantain suckers
TIME 5	Seventh month after planting plantain suckers
TIME 6	Eighth month after planting plantain suckers
TIME 7	Ninth month after planting plantain suckers
TIME 8	Tenth month after planting plantain suckers

Table 3. Parameters measured on banana plants.

Parameters	Variable measured	Unit	Method
Vegetative growth parameters	Height to the last V formed by leaves	cm	Measured with a tape measure
	Circumference 10 cm above ground		
	Number of living leaves		List
Production parameters	Flowering planting interval (FPI)	Days	List
	Interval Planting Regime cut (IPC)		
	Flowering interval Diet cut (IFC)		
	Average weight of plans	kg	Weighing on the scales

4. Results

4.1. Agromorphological Characteristics

- **Height**

The Newman Keul statistical test at the 5% threshold (Table 4), shows significant differences between plantain heights after TIME 1, which is 3 months after the planting suckers ($F = 0.25$; $P = 0.94$).

The average height of the plantains varied between 82 and 222.18 cm from TIME 1 to TIME 8. The greatest performance at TIME 8 was that of D3 plantains (264.08 cm), followed by D1 plantains (239.53 cm) (Figure 8). The lowest height of plantains was obtained in D4, where values rose from 81.73 (TIME 1) to 193.76 cm (TIME 8). The growth of D6 banana plants stopped at the eighth month (TIME 6) and the value reached at this stage was 90.19 cm (Figure 8).

- **Circumference**

Table 4. Indicative values for the Newman Keul test for comparing heights.

Modalities	ddl	Medium squares	F	P Value
TIME 1	5	5.02	0.25	0.94
TIME 2	5	2293.84	48.30	<0.001
TIME 3	5	8338.89	243.48	<0.001
TIME 4	5	15870.16	388.76	<0.001
TIME 5	5	27297.52	561.62	<0.001
TIME 6	5	42942.39	578.49	<0.001
TIME 7	5	205454.28	3006.17	<0.001
TIME 8	5	267207.76	5919.48	<0.001

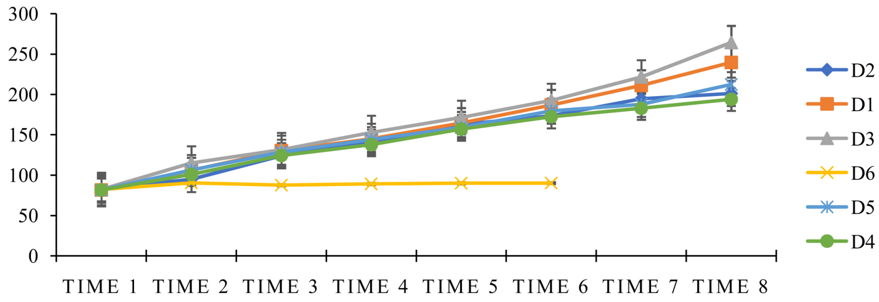

Figure 8. Changes in plant height as a function of time.

The Newman Keul statistical test at the 5% threshold indicates significant differences between neck circumferences after TIME 1, which means 3 months after the shoots were planted (F = 1.57; P = 0.17) (Table 5).

The circumferences of the plantains varied between 20.46 and 47.33 cm. The tenth month (TIME 8) was marked by strong growth in circumference for D3 banana plants (57.68 cm). At this stage, the smallest circumference (41.38 cm) was that of T4 plantains. The growth in circumference of T6 plantains stopped in the eighth month after the suckers were planted. At this stage, the circumference was 25.11 cm (Figure 9).

- **Number of functional leaves**

Table 6, shows significant differences in the number of functional plantain leaves after TIME 1, which is 3 months after transplanting (F = 0.48; P = 0.79). The number of functional plantain leaves increased from 5.1 to 9.15 on average during the observations, except for the leaves at D6. The maximum number of leaves obtained at TIME 8 was 12 for D3 plantain followed by D1 (10.03 leaves) and D5 (9.29 leaves). D4 and D2 plantains had the fewest functional leaves (7.43 and 6.97 respectively) at the tenth month. For D6, a drop in the number of functional leaves was observed from TIME 1 (5.07 leaves) to TIME 6 (2.63 leaves) (Figure 10).

Table 5. Indicative values of the Newman Keul test for comparing neck circumferences.

Measurement period	ddl	Medium squares	F	P Value
TIME 1	5	2.22	1.57	0.17
TIME 2	5	94.79	19.56	<0.001
TIME 3	5	415.16	38.31	<0.001
TIME 4	5	719.19	53.10	<0.001
TIME 5	5	1189.80	67.45	<0.001
TIME 6	5	2270.63	138.47	<0.001
TIME 7	5	11011.06	923.24	<0.001
TIME 8	5	12271.59	953.38	<0.001

Table 6. Indicative values of the Newman Keul test for the comparison of functional plantain leaves.

Measurement period	ddl	Medium squares	F	P Value
TIME 1	5	0.166	0.48	0.79
TIME 2	5	35.04	76.70	<0.001
TIME 3	5	112.573	184.23	<0.001
TIME 4	5	163.14	245.26	<0.001
TIME 5	5	204.29	375.99	<0.001
TIME 6	5	250.44	576.13	<0.001
TIME 7	5	393.05	309.65	<0.001
TIME 8	5	519.52	1086.22	<0.001

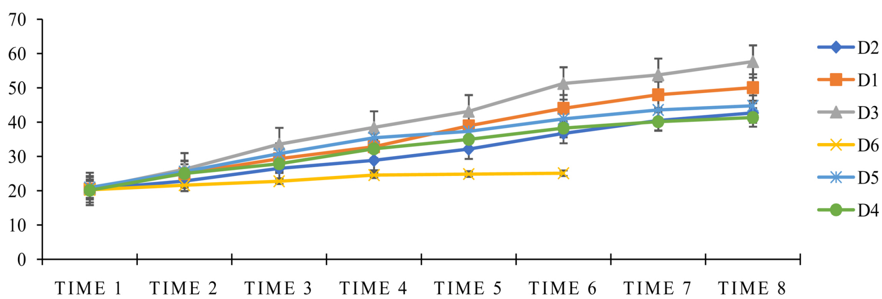

Figure 9. Changes in neck circumference of plants as a function of time.

4.2. Production Parameters

Planting-Flowering, Planting-Cutting and Flowering-Cutting Intervals

The interval of time Planting-Flowering (IPF), varied from 264 to 282 days, with significant differences depending on treatments (F = 24.52; P < 0.001). Of all the Planting-Flowering intervals (IPF) obtained, the shortest was for D3 plants (264 days), followed immediately by D1 plantain (279 days) and those of D5 (281

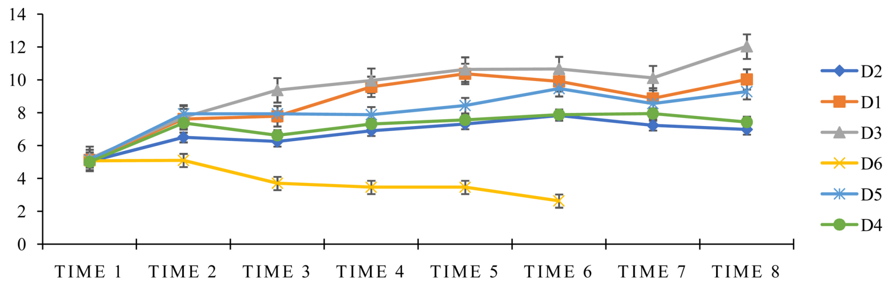

Figure 10. Changes in the number of leaves on plants as a function of time.

days). The highest number of days was obtained by plants in the reference chemical treatment (D4), with a value of 287 days (**Table 7**).

Planting-Cutting intervals (IPC) were statistically differentiated by treatment ($F = 29$; $P < 0.001$). The lowest number of days was for D3 plants fertilised with 9 kg of chicken droppings/plantain (347 days), followed by D1 plants fertilised with 6 kg of chicken droppings/plantain (364 days). D4 plantains had the longest planting-cutting interval at 373 days (**Table 7**).

Concerning Flowering-Cutting interval (IFC), no significant difference was observed in this parameter. The different treatments showed statistically identical values of between 83 and 86 days (**Table 7**).

4.3. Brunch Mass

The different treatments applied to the plantain had a significant effect on bunch weight ($F = 186.13$ and $P < 0.001$). At the end of the cycle, plantain of D6 (Control with no manure applied) did not produce any bunches. Those in D3 had the highest bunch mass (9.3 kg), followed by the plantains in D1 with 8.36 kg. Brunches from (D4) had the lowest mass at 5.1 kg (**Figure 11**).

5. Discussion

Fertilised PITA 3 plantains showed better agromorphological performance than unfertilised ones (D6). This lack of improvement in the performance of unfertilised plants indicates the positive effect of fertilisers on plantain [12], and the usefulness of fertilisers in sandy soil cultivation [13]. The number of leaves, height and circumference of D3 plants (9 kg of chicken droppings per banana plant) were highest at the tenth month with values of 12 cm; 264.08 cm and 57.68 cm respectively. These performances were immediately followed by those of the D1 banana plants (6 kg of droppings per plant). Chicken droppings are therefore an essential mineral reserve for plantain growth and ripening. According to [14], the application of hen droppings provides additional quantities of nitrogen, phosphorus, potassium and magnesium to the pool of mineral elements in the soil, thereby increasing the nutrient content [15]. The plants would integrate the mineral elements supplied, in particular nitrogen, into their metabolism more efficiently and more slowly. For D3 plantains, the quantity of nitrogen required for development would be better conserved, unlike that available

Table 7. Duration of parameters determining plantain production.

Treatments	IPF (Day)	IPC (Day)	IFC (Day)
D1 (droppings 6 kg)	278.5 ± 5.1 b	363.7 ± 5.4 c	85.2 ± 1.5
D2 (droppings 3 kg)	284.3 ± 7.8 bc	370.3 ±7.7 ab	86.0 ± 5.50
D3 (droppings 9 kg)	264.2 ±7.4 c	347.2 ±7.2 d	83.0 ±1.4
D4 (TCHref)	287.9 ± 2.9 a	373.5 ± 5.32 a	85.6 ± 3.8
D5 (TCH + droppings)	281.1 ± 4.5 b	365.7 ± 2.23 bc	84.6 ± 2.88
F	24.52	29	1.74
P	<0.001	<0.001	0.157

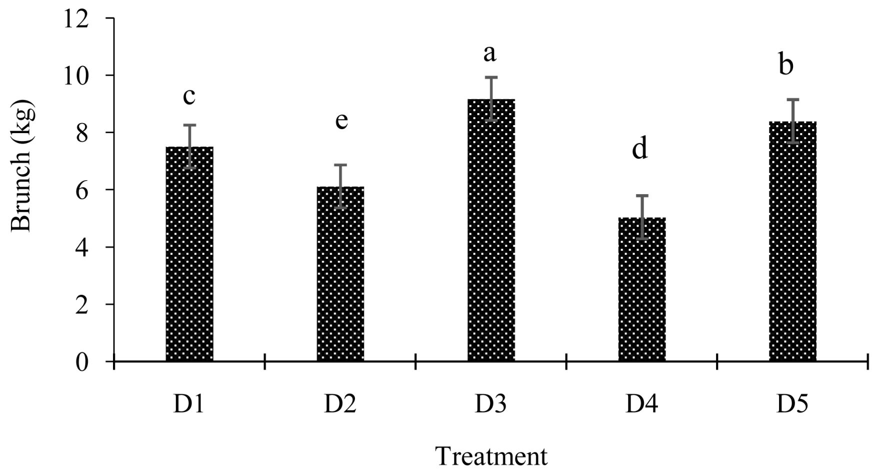

Figure 11. Weight of plantain bunches according to treatments. The letters (a, b, c, d, e) show the significant differences according to the Student-Newman-Keuls test ($\alpha = 0.05$).

for D1, D2, D5 and D4 plantains. This is despite the high infiltration capacity of sandy soils. According to [16], organic matter contributes to the fixation of mineral elements and limits soil leaching. In this sense, leaching and the low nitrogen content of the soil, as indicated by [17], would be overcome.

For the reference chemical treatment (D4), the height, circumference and number of living leaves at the tenth month of cultivation were statistically lower than for the plants in D1, D5 and particularly D3. The weakness of these parameters could be linked to three factors:

- firstly, the low presence of litter or organic matter [18]. The low natural content of organic matter and clay in the first 20 to 30 centimetres of sandy soils reduces the formation of colloidal matter and clay-humus complex. As a result, cation exchange is reduced, leading to low soil fertility (Koull and Halilat, 2016) [16];
- then to the rapid lateral and deep infiltration of rainwater and irrigation water, which leaches out the mineral elements. According to [17], farmers cultivating sandy soils in Côte d'Ivoire use organic matter as a fertiliser and soil improver to counter the leaching phenomenon;

- lastly, the high heat stored by sandy soils during the day (rapid heating), which would cause mineral fertilisers to react more quickly, particularly urea, which is highly susceptible to evaporation under the effect of heat. This rapid warming of the soil [17] would also reduce the humidity around the plantain. This reduction in humidity would be more pronounced for unfertilised plants and those that have received chemical fertiliser. This would be a major limitation to root development.

Irrigation was therefore very important in maintaining humidity around the plantain. It was an essential condition for their development. The addition of organic fertiliser also improved soil structure and reduced water infiltration deep into the soil. The combination of organic matter and water promotes good humidity, adequate biological activity and better availability of mineral elements [19], for the plantains needs. This result corroborates those of [20], during his work on tomatoes in tertiary sandy soils. According to this author, this condition is essential for good vegetative growth and higher yields. However, the absence of fertiliser in D6 plants resulted in stunted growth and death.

The plantains in treatment D3 got interval Planting-Flowering (IPF) and Planting-Cutting (IPC) of 264 and 347 days respectively. These plantains flowered and were harvested 14 and 16 days before those of D1. This difference in cycle would be due to the cumulative effect of the height, circumference and number of leaves of the banana plants [12], which were greater for the plantain of D3 than for the others. The plantain in D3, reached the flowering and fruiting stage more quickly. In the case of D4 plantain, the high leaching capacity of tertiary sandy soils led to a reduction in the mineral elements required by the plantain, which would have delayed its production cycle. The average weight of plantains bunches receiving fertiliser varied from 5.05 kg to 9.32 kg. Unfertilized plantain did not produce any bunch. In fact, the ability of plantains to produce bunches is strongly linked to the treatment applied and to good vegetative development (Géraldine, 2012) [21]. This would explain the good performance observed in D3, D1 and D5 banana plants, both in terms of parameters relating to vegetative growth (height, girth, number of living leaves) and those relating to production (short cycle, greater mass of bunches).

6. Conclusion

The study was carried out in order to highlight the effects of two types of fertilization on plantain associated with coconut. It was found that plantain of the PITA 3 variety fertilised with hen droppings performed better agromorphologically than those fertilised with chemical fertiliser and those not fertilised. Banana plants of D3 (9 kg of droppings), D1 (6 kg of droppings), D2 (3 kg of droppings) and D5 (mixture of droppings and chemical fertiliser) all achieved production. However, D3 gave the best values in terms of agromorphological parameters (height, circumference, number of leaves and production). In addition, a shorter production cycle was observed in these banana plants (D3) compared with the other treatments (D1, D2, D4 and D5).

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Konan, B. (2011) Comparative Study of the Physico-Chemical Characteristics of the Kernel, Water and Haustorium of the Nuts of 3 Coconut Cultivars (*Cocos nucifera* L.) as a Function of Germination Time. Ph.D. Thesis, University of Abobo-Adjamé, Abidjan, 189 p.

[2] Assa, R., Konan, K., Nemlin, J., Prades, A., Agbo, N. and Sié, R. (2006) Diagnostic de la Cocoteraie Paysanne du Littoral Ivoirien. *Sciences et Nature. Série A*, *Biosciences Agronomie Environnement Biotechnologie*, **3**, 113-120.

[3] N'guessan, T.S., Kouamé, D.K., Ibo, G.J. and Taky, H.A.D. (2019) Jaunissement Mortel du Cocotier et Mutations Sociales à Grand-Lahou, Côte d'Ivoire. *European Scientific Journal*, **15**, 130-142. https://doi.org/10.19044/esj.2019.v15n25p130

[4] Zakra, A.N. (1997) Contribution à l'étude de la restauration et du maintien de la fertilité des sables quaternaires du littoral ivoirien: cas de l'utilisation d'arbres fixateurs biologiques d'azote comme plantes associatives avec les cocotiers. Ph.D. Thesis, University of Abidjan Cocody, Abidjan, 152 p.

[5] Folefack, P.D. and Nsangou Njankouo, A. (2021) Local Food Trade in the Streets of Douala: The Case of Braised Ripe Plantain Sold by Women. *International Journal of Biological and Chemical*, **16**, 753-771. https://doi.org/10.4314/ijbcs.v16i2.20

[6] Traoré, S., Kobenan, K., Kouassi, K.S. and Gnonhouri G. (2009) Systèmes de culture du bananier plantain et méthodes de lutte contre les parasites et ravageurs en milieu paysan en Côte d'Ivoire. *Journal of Applied Biosciences*, **19**, 1094-1101.

[7] Lassois, L., Busogoro, J.P. and Jijakli, H., (2009) La banane: de son origine à sa commercialisation. *Geography Biotechnologie*, *Agronomie*, *Société et Environnement*, **13**, 575-586.

[8] Atsin, O.G., N'Guetta, A., N'Da, V., Traoré, S., Aby, N. and Kobenan, K. (2019) Effet du compost à base de résidus de bananiers et cacao sur la croissance et le développement des vivo plants de trois variétés de bananier plantain. *Revue Ivoirienne des Sciences et Technologie*, **33**, 276-286.

[9] Kwa, M. and Temple, L. (2019) Le bananier plantain: Enjeux socio-économiques et techniques. Quæ CTA Presses agronomiques de Gembloux, 199 p. https://doi.org/10.35690/978-2-7592-2680-1

[10] Thiémélé, D. (2013) Systèmes de culture avec le plantain en Côte d'Ivoire. CNRA, Abidjan, 8 p.

[11] Coffi, J.P.-M., Lékadou, T.T., Ama, J.T., Traoré, S., Yao, D.M.S., Agoh, F.C., Koffi, Z.E.B., Djaha, E.K. and Hala, F.N. (2021) État des lieux des bananeraies (Musa sp) en zone de culture du cocotier, sur le littoral en Côte d'Ivoire: Cas de la station Marc DELORME et des villages aux alentours. *International Journal of Biological and Chemical Sciences*, **15**, 2438-2455. https://doi.org/10.4314/ijbcs.v15i6.16

[12] Kouamé, N., Dick, A.E., Assidjo, N.E. and Anno, A.P. (2014) Étude de la croissance du bananier plantain (Musa sp., AAB cultivar Corne 1) dans les régions de Yamoussoukro et Azaguié (Cote d'Ivoire). *Journal of Applied Biosciences*, **76**, 6411-6424.

https://doi.org/10.4314/jab.v76i1.8

[13] Boa, B.B. Ama, Y.T.J., Lékadou, T.T., Kouassi, Y.F. and N'Cho, O.C. (2022) Performances Agromorphologiques de fumures organiques sur deux variétés de tomates sur sols sableux du littoral ivoirien. *International Journal of Progressive Sciences and Technologies*, **33**, 136-149.

[14] Kouassi, Y.F., Gbogouri, G.A., N'guessan, K.A., Bilgo, A., Angui, K.T.P. and Ama, T.J. (2019) Effets de fertilisants organique et organominéral à base de déchets végétaux et animaux sur la croissance et le rendement du soja (*Glycine max* (L.) Merrill) en zone de savane de Côte d'Ivoire. *Agronomie Africaine*, **31**, 1-12.

[15] Mukendi, R.T., Mutamba, B.T., Kabongo, D.M., Longanza, L.B. and Munyuli, T.M. (2017) Amélioration du sol dégradé par l'apport d'engrais inorganique, organiques et évaluation de rendement du maïs (*Zea mays* L.) dans la province de Lomami, République Démocratique du Congo. *International Journal of Biological and Chemical Sciences*, **11**, 816-827. https://doi.org/10.4314/ijbcs.v11i2.23

[16] Koull, N. and Halilat, N.T. (2016) Effets de la matière organique sur les propriétés physiques et chimiques des sols sableux de la région d'Ouargla (Algérie). *La Revue des Sciences de Gestion Direction et Gestion*, **23**, 9-20.

[17] Lékadou, T.T., Coffi, P.M.J., Yao, S.D.M. and Ama, T.J. (2019) Vegetative Growth Response of Eggplant (*Solanum aethiopicum* L.) to Combined Effects of Fertilizer Types and Irrigation Regimes Applied on Littoral Tertiary Soil in Côte d'Ivoire. *International Journal of Plant & Soil Science*, **30**, 2320-7035.

[18] Tanoh, A.G. (2022) Apport des légumineuses (*Acacia mangium*, *Arachis hypogaea*) pour la restauration de la fertilité des sols sableux sous culture d'igname (*Dioscorea cayenesis-rotundata*) dans la région de Grand-Lahou (Sud-Ouest de la Côte D'Ivoire) Ph.D. Thesis, Université Felix Houhouet-Bouagny, Abidjan, 148p.

[19] Yoboué, A.N., N'goran, K.E., Ama, T.J., Kouassi, Y.F. and Yao, G.F. (2020) Effets du précédent cultural arachide (*Arachis hypogaea* L.) et de la charge en éléments grossiers du sol sur la production du coton (*Gossypium hirsutum* L.). *International Journal of Biological and Chemical Sciences*, **14**, 2120-2133. https://doi.org/10.4314/ijbcs.v14i6.15

[20] Ama, T.J., Boa, B.B.Y., Yéboua, F.K., Lékadou, T.T. and Djaha, K.E. (2022) Caractéristiques physico-chimiques de compostes à base de résidus végétaux et de déjection animales et leurs effets sur des paramètres de croissance et de rendement de la tomate sur sols sableux. *International Journals of Innovation and Scientific Research*, **62**, 61-65.

[21] Géraldine, L.M. (2012) Study of the Impact of Potassium Fertilization on the Physico-Chemical Characteristics of Dessert Bananas during Growth and at Maturity. End of Studies Internship Thesis, University of Lorraine, Nancy, 31 p.