Future of Food: Journal on Food, Agriculture and Society
14 (2) July 2026

Evaluation of Agronomic Parameters of Lettuce (*Lactuca Sativa* L.) Grown on Sandy Soil Amended with Cattle Dung Composts in Daloa (Central-West, Ivory)

Zoumana Konate[1], Toussegoué Anicet Gbeuli[2*], Souleymane Sanogo[3], Sidiky Bakayoko[4]

[1]Jean-Lorougnon Guédé University Daloa, Agroforestry Training and Research Unit, BP 150 Daloa, Ivory Coast.
Email: zoumko@yahoo.fr
[2]Jean-Lorougnon Guédé University Daloa, Agroforestry Training and Research Unit. National Center for Agronomic Research (CNRA), Divo Station, Cocoa Program, BP 808 Divo, Ivory Coast.
Email: tousgbeuli@gmail.com
[3]University Félix Houphouët-Boigny, UFR Biosciences, Plant Physiology Laboratory, 22 BP 582 Abidjan 22, Ivory Coast.
Email: sanogosousa@yahoo.fr
[4]Jean-Lorougnon Guédé University Daloa, Agroforestry Training and Research Unit, BP 150 Daloa, Ivory Coast.
Email: sidikybakayoko@yahoo.fr

*Correspondence: tousgbeuli@gmail.com

Data of the Article

First Received: 02 January 2026 | Last Revision Received: 02 June 2026
Accepted: 10 June 2026 | Published Online: 04 August 2026
DOI: https://doi.org/10.5281/zenodo.21284107

Keywords

Compost,
Cattle Dung,
Lettuce (*Lactuca Sativa* L.),
Sandy Soil,
Daloa.

This study was initiated with a view to improving soil fertility while reducing the quantities of cattle dung to be applied to the soil. To this end, different doses of composts derived from cattle dung composted for 28 days were applied as bottom dressing to a lettuce (*Lactuca Sativa* L.) crop in a Fisher block design. The trial lasted three months, with one replicate per month. Each treatment was repeated three times. Data on collar diameter, number of leaves and plant biomass of lettuce were collected on plots amended with compost at doses of 0, 10, 20, 30 and 40 t ha^{-1} and evaluated through the respective treatments T_0, T_{10}, T_{20}, T_{30}, T_{40}. The data collected were subjected to an analysis of variance using SAS 9.4 software, where the Newman and Keuls test at the 5% threshold was used to compare means. Treatment T20, at a dose of 20 t ha^{-1}, yielded statistically superior results for the agronomic parameters of lettuce. With a yield of 8,802.88 kg ha^{-1}, the 20 t ha^{-1} dose of cow manure compost produced statistically higher lettuce biomass than the other compost doses applied.

1. Introduction

Faced with strong pressure on arable land due to population growth and increasingly recurrent land tenure problems, agriculture has become increasingly intensive, leading to a decline in cultivated soil fertility and low crop productivity (Kasongo et al., 2013). The chemical fertilizers recommended to improve soil fertility and crop productivity are not always within the reach of small farmers, however, due to their high cost (Yannick et al., 2013). In addition to economic problems, overuse of chemical fertilizers pollutes groundwater, increases soil acidity, degrades soil physical status and reduces soil organic matter (Kyela, 2011). As a result, they compromise soil chemical fertility and product quality. Hence the need for organic fertilizers capable of improving soil fertility while maintaining its ecological balance. In addition, organic fertilizers enrich the soil in mineral elements and limit water consumption by plants (Petit & Jobin, 2005). Among these organic fertilizers, cattle dung is widely used in market gardening systems due to its availability and lower cost compared with chemical fertilizers. However, the direct use of dung without composting, as practised by most market gardeners, does not allow its chemical fertility potential to be truly expressed. What's more, dung used without composting requires large quantities for the cultivated areas (Govaerts et al., 2007). Moreover, the soils used for market gardening are mostly sandy, generally with low chemical fertility. In view of this situation, dung composting has been considered as a means of making compost nutrients available as the organic matter degrades, with a view to improving the fertilizing potential and chemical fertility of sandy soils. The aim of this study is to determine the doses of cattle dung composts that will improve the fertility of the composts produced and crop production

2. Location and Characteristics of the Study Area and Site

The trial was carried out on the experimental site of the Université Jean Lorougnon Guédé in the commune of Daloa, located between 6°54 north latitude and 6°26 longitude in the Haut-Sassandra region of central-western Côte d'Ivoire (Figure 1).

The region's climatic regime is characterized by two alternating dry and wet seasons, with average temperatures ranging from 24.65 to 27.75°C. The forest landscape in the study area varies progressively from semi-deciduous dense rainforest to cleared mesophilic forest (Brou, 2005). Soil studies carried out in the area reveal that the soils are generally ferralitic with moderate leaching. They are suitable for all types of crops (Konate et al., 2020). The region's dense hydrographic network is dominated by the Sassandra River and its many tributaries, which create large alluvial plains (Sangaré et al., 2009) ideal for off-season vegetable crops. The topography is relatively flat and varied, dominated by plateaus between 200 and 400 m in altitude. Agriculture is the main income-generating activity and occupies the majority of the population.

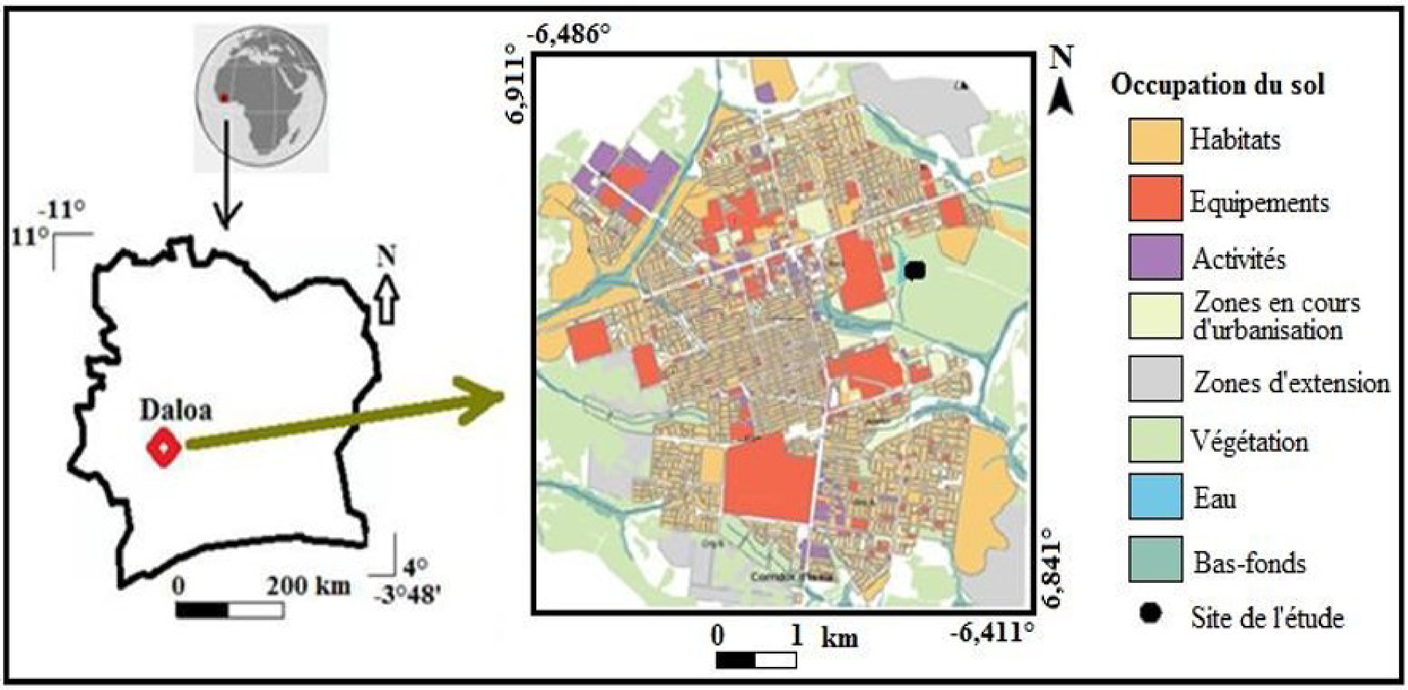

Figure 1: Location Map of the Study Area and Site (Konate et al., 2020).

3. Hardware

3.1. Fertilizing Equipment

The fertilizing material consisted of different doses of cattle dung compost. Cattle dung was used because most market gardeners in the town of Daloa use it as an organic soil fertilizer due to the high cost of chemical fertilizers.

3.2. Plant Material

The plant material used is lettuce seed (*Lactuca sativa L.*). Lettuce (Lactuca *sativa L.*) is used because it is a staple food in Daloa.

4. Method

4.1. Obtaining Cattle Dung Composts

Fresh cattle dung (Figure 2) was collected from a pasture and then composted using the windrow method for 28 days. The resulting compost (Figure 3) was dried and sieved to remove impurities before use.

ISSN-Internet 2197-411x OLCL 862804632

Figure 2: Fresh Cattle Dung.

Figure 3: Compost.

4.2. Planting and Nursery Maintenance

The nursery was set up by sowing lettuce seeds on a 2 m^2 (2m x 1m) bed. After sowing, the bed was covered with palm leaves and the plants watered regularly every day in the absence of rain. Two days before transplanting, the shade was completely removed and the 15-20 dayold seedlings were transplanted.

4.3. Experimental Design and Trial Set-up

The trial was conducted on sandy soil using a Fisher block design over an area of 110.5 m^2. Each block comprised 5 elementary plots, each representing a treatment (Figure 4), giving a total of 15 elementary plots for the trial. The compost was incorporated into the soil one week before transplanting. Treatments were repeated 3 times and randomly distributed within each block and the useful plot, consisting of 12 lettuce plants. Compost was applied uniformly across the plot as a single dose of basal fertilizer in 4 doses (10, 20, 30 and 40 t ha^{-1}), represented respectively by treatments T_{10}, T_{20}, T_{30} and T_{40}). To these treatments, a control treatment T0 (without dung addition) was added to form the following treatments:

o $\mathbf{T_0}$ (control): no compost added;
o $\mathbf{T_{10}}$: 10 t ha^{-1} of cattle dung compost; o $\mathbf{T_{20}}$: 20 t ha^{-1} of cattle dung compost; o $\mathbf{T_{30}}$: 30 t ha^{-1} of cattle dung compost; o $\mathbf{T_{40}}$: 40 t ha^{-1} of cattle dung compost (commonly used rate).

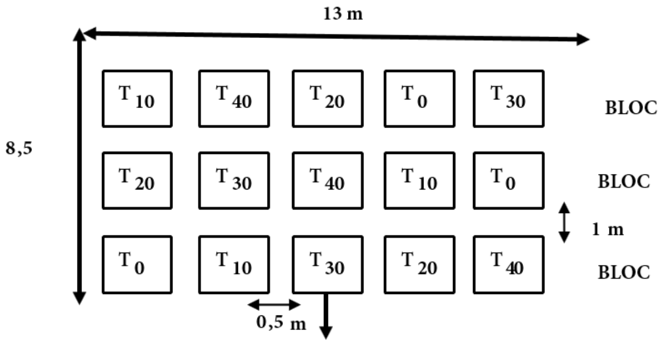

Figure 4: Schematic Diagram of the Experimental Set-up with Treatment Distribution.

4.4. Transplanting and Maintenance of Lettuce Plants

On each of the elementary plots, 7 lines of 10 lettuce plants aged 15 to 20 days were transplanted at a density of 20 cm x 20 cm. This gives 70 plants per elementary plot. Sanitary treatments based on *Azadirachta indica* (neem) extract were carried out on the plants against pests (aphids, caterpillars, flies) every week until the lettuce plants were harvested. The lettuce was harvested 21 days after transplanting.

4.5. Data Collection

4.5.1. Sampling of Dung Composts and Fresh Non-composted Dung

Sampling consisted of taking samples of dung compost and uncomposted dung a view to chemical analysis in the laboratory. To do this, samples from several locations on each substrate (compost, fresh dung) were mixed and stirred to form a composite sample for each substrate. These composite samples were dried, sieved and then placed in plastic bags before being sent to the laboratory for analysis.

4.5.2. Evaluation of Chemical Parameters of Compost and Fresh Non Composted Dung Samples

Analyses of compost samples and fresh non-composted dung were carried out at the soil and plant laboratory of the Institut National Polytechnique Houphouët-Boigny (INP-HB) in Yamoussoukro (Côte d'Ivoire) to assess their fertilizing values. They concerned :

- pH, determined by the electrometric method;
- Measurements of total nitrogen (N), organic carbon, phosphorus and exchangeable bases (K, Mg, Na and Ca) were carried out using Kjeldhal, Walkley and Black or cold sulfochromic etching[18], modified Olsen and atomic absorption spectrophotometry techniques respectively;
- The organic matter (OM) content was calculated by multiplying the carbon content by 1.72;
- The levels of iron, zinc and lead, two major trace metal elements (TMEs), were determined by atomic absorption spectrometry to assess the risk of soil pollution by these TMEs if the composts used were added to the soil.

4.5.3. Assessment of Agronomic Parameters for Lettuce

On all 15 elementary plots, measurements were taken in the center of the elementary plot, leaving the border plants to avoid border effects, on a total of 20 plants per treatment, with 5 plants per line along the diagonal. For each treatment, these measurements concerned:

- The average number of leaves per plant and the total number of leaves were determined by counting the 12 plants on the diagonals. These measurements began in the second week after transplanting and were repeated every week until the end of the lettuce cycle;
- The total fresh biomass (g), which refers to the mass of the entire lettuce plant, was determined after the lettuce plant was pulled up at harvest followed by washing of the plant to rid the roots of all soil mass, and then estimated in kg;
- The diameter at the collar was determined after pulling up the lettuce plant using a caliper.

4.6. Statistical Processing of Data

Data were analyzed using descriptive statistics and analysis of variance methods. The data collected were subjected to an analysis of variance (ANOVA) using SAS software version 9.4. Means were separated using the Newman and Keuls test at the 5% probability threshold.

5. Results

5.1. Chemical Properties of Compost

After chemical analysis, the results obtained show a significant increase in the fertilizing value of dung compost compared with non-composted dung (Table 1). Indeed, the pH value increased from 7.81 in non-composted dung to 9 in cattle dung compost. Organic carbon (C), total nitrogen (Nt) and organic matter (OM) contents increased from 3.64%, 0.35% and 6.26% respectively in the uncomposted dung to 6.12%, 0.64% and 10.53% in the 28-day compost. Cation exchange capacity (CEC) increased from 17.60 $cmol.kg^{-1}$ in uncomposted dung to 23.20 $cmol.kg^{-1}$ in cattle dung compost. On the other hand, trace metal element (TME) levels were lower in the 28-day compost than in the non-composted dung. In fact, average levels fell from 108.4 ppm and 88.5 ppm respectively for iron (Fe^{2+}) and zinc (Zn^{2+}) in non-composted dung to 91.1 ppm and 54.8 ppm in 28-day compost.

Table 1: Chemical and Organic Compositions of Cattle Dung Compost.

	Physico-chemical Properties								
	pH	Organic Matter			P.ass. (ppm)	Exchangeable Cations ($cmol.kg^{-1}$)		Trace Metal Elements (TME) (ppm)	
		C (%)	Nt (%) M.O(%)	C/Nt		CEC	Ca^{2+} Mg^{2+} K^{+} Na^{+}	Fe^{2+} Zn^{2+}	Pb^{2+}
Dung not composted	6.81	3.64	0.35 6.26	10	368	17.60	6.741 2.839 5.583 0.718	108.4 885	0.00
28-day compost	9.0	6.12	0.64 10.53	10	380	23.20	10.474 3.342 8.825 1.018	91.1 54.8	0.00

5.2. Effect of Compost Doses on Lettuce Agronomic Parameters

5.2.1. Collar Diameter

Analysis of variance showed a highly significant difference ($p< 0.0001$) between compost doses in terms of lettuce plant collar diameter values (Table 2). Indeed, the highest values were obtained with treatments T20 (9.35 mm), T30 (8.76 mm) and T40 (9.23 mm). On the other hand, lowest neck diameter values were observed with treatments T0 (6.5 mm) and T10 (7.44 mm).

5.2.2. Number of Leaves Per Plant

Cattle dung compost doses resulted in a highly significant difference ($p< 0.0001$) in the evolution of the average number of leaves per lettuce plant (Table

ISSN-Internet 2197-411x OLCL 862804632

2). Treatments T20 (7.15 leaves), T30 (6.87 leaves) and T40 (7.05 leaves). had the highest numbers of leaves. However, the lowest numbers of leaves were obtained by the control treatments T0 (5.27 leaves) and T10 (5.95 leaves).

5.2.3. Total Biomass of Leaves

The different doses of cattle dung compost produced a highly significant difference ($p< 0.0001$) in the evolution of total lettuce leaf biomass (Table 2). The highest total leaf biomass was recorded with treatment T20 for an average production of 8802.88 kg ha^{-1} and the lowest by control treatment T0, for an average production of 3593.33 kg ha^{-1}. Treatments T10, T30 and T40 obtained average intermediate yields of 5113.11 kg ha^{-1}, 7720.22 kg ha^{-1} and 7667.33 kg ha^{-1} respectively.

Table 2: Evolution of Plant Collar Diameter, Number of Leaves Per Plant and Total Leaf Biomass as a Function of Compost Doses.

Treatments	Agronomic Parameters		
	Collar Diameter (mm)	Number of Leaves	Total Leaf Biomass (kg ha^{-1})
T0	6.50 ± 0.20 c	5.27 ± 0.11 c	3593.33 ± 17.11 d
T10	7.44 ± 0.22 b	5.95 ± 0.17 b	5113.11 ± 26.44 c
T20	9.35 ± 0.21 a	7.15 ± 0.23 a	8802.88 ± 35.77 a
T30	8.76 ± 0.25 a	6.87 ± 0.23 a	7720.22 ± 35.77 b
T40	9.23 ± 0.21 a	7.05 ± 0.22 a	7667.33 ± 34.22 ab
CV	12.45	10.66	34.92
P	< 0.0001	< 0.0001	< 0.0001
Values followed by the same letter in the column are not statistically different at the 5% probability level.			

6. Discussion

The low values observed for the agronomic parameters of lettuce in the control treatment are due to the sandy soil texture (Zro et al., 2016), which promotes the leaching of almost all mineral elements and reduces its water retention capacity due to its high permeability and filtration properties. This is detrimental to the plant's development. Indeed, according to Bazongo et al. (2024), soils poor in mineral elements limit crop growth and yields.

The improvement in the agronomic parameters of lettuce on this sandy soil is linked to the application of manure, an important source of organic matter that improves soil fertility and lettuce productivity. These improvements can also be explained by the action of composting, which, through the mineralization of manure, makes its nutrients available to the lettuce plants (Alla et al., 2021). These nutrients help reduce soil acidity and are essential for plant development. The alkaline pH (pH = 9.1) observed in the compost promoted the formation of the clay-humus complex and improved the cation binding capacity of the sandy soil's adsorption complex. This creates better conditions for improving biological properties and promotes the availability of soil cations for plant nutrition (Normand et al., 2023).

According to Mounirou (2022), achieving an alkaline pH in compost is beneficial for improved nutrient absorption from the soil by roots. Indeed, this author explains that at a high pH, exchangeable bases (Ca^{2+}, Mg^{2+}, K^+, Na^+) bind to the soil's adsorption complex, thus reducing the number of adsorbed H^+ and Al^{3+} ions, which are responsible for soil acidity. This improved pH also breaks the bonds between phosphorus and iron and aluminum oxides, releasing phosphorus into the compost. Under the influence of organic matter, aluminum and iron oxides and hydroxides form complexes, releasing phosphate ions and increasing their concentration in the compost, hence the high phosphorus levels in compost.

The improvement in lettuce agronomic parameters is thought to be linked to soil enrichment with mineral elements due to the release of nutrients from cattle manure during the composting process (Cannavo et al., 2023). The work of Anguessin et al. (2021) showed that composting allows the release of cations from the composted substrate, acting as a soil amendment and nutrient source for plants.

The significant improvement in lettuce agronomic parameters observed with compost at a dose of 20 t ha^{-1} compared to other doses (10 t ha^{-1}, 30, and 40 t ha^{-1}) indicates that 20 t ha^{-1} appears sufficient not only to improve the physical and biological properties of the soils at the study site but also to provide lettuce plants with the essential nutrients for their growth. Conversely, the small improvements observed with the lower compost doses (10 t ha^{-1}) are due to the fact that the quantity of compost is insufficient to release enough nutrients and ensure optimal mineral nutrition and growth of the lettuce plants. Furthermore, the non-significant difference observed and the small variations in agronomic parameters between the higher doses (30 t ha^{-1} and 40 t ha^{-1}) are linked to a depressive effect of these doses, which constitutes a limiting factor for the growth and development of the lettuce plants. Indeed, according to Bressoud, Parès, & Lecompte (2003), fertilization must be measured and limited in order to avoid an excess of nutrients, which will ultimately be unusable by the plant.

In view of the results of the chemical analyses of the compost and the improvement of the agronomic parameters of the lettuce, it appears necessary to compost the manure and use it at a dose of 20 t ha^{-1} in order to improve the productivity of the lettuce on sandy soils.

8. Ethical and Scientific Standards and Conflicts of Interest

The authors declare that they have no ethical problems or conflicts of interest.

References

Alla, T. K., Bomisso, L. E., Tuo, S., & Dick, E. A. (2021). Effets de la fertilisation organique à base de pelure de banane plantain et de fiente de poulet sur les paramètres agronomiques et la rentabilité financière de l'aubergine N'drowa (Solanum aethiopicum L.) en Côte d'Ivoire. *Afrique Science, 18*(6), 25–38. Retrieved from https://www.afriquescience.net/admin/postpdfs/f445b636197b439d65d362f69680eb1e1727790766.pdf

Anguessin, B., Mapongmetsem, P. M., Ibrahima, A., & Fawa, G. (2021). Effet de la fertilisation organique à base de litière foliaire de Jatropha curcas L. et Jatropha gossypifolia L. sur la culture de tomate (Lycopersicon esculentum Mill.) à Guider (Nord/Cameroun). *International Journal of Biological and Chemical Sciences, 15*(2), 524–535. doi: https://doi.org/10.4314/ijbcs.v15i2.12

Bazongo, P., Traoré, K., Ouédraogo, P. B., & Traoré, O. (2024). Effets des fertilisants biologiques et de la fertilisation microdose sur la rentabilité économique de la culture du maïs (Zea mays L.) l'Ouest du Burkina Faso. *International Journal of Innovation and Applied Studies, 43*(4), 1097–1105. Retrieved from https://ijias.issr-journals.org/abstract.php?article=IJIAS-24-238-01

Bressoud, F., Parès, L., & Lecompte, F. (2003). Tomate d'abri froid. Fertilisation et restriction en azote: le standard actuel inadapté au sol. *Réussir Fruits et Légumes, 220*, 30–31. Retrieved from https://hal.inrae.fr/hal-02672574v1

Brou, Y. T. (2005). *Climat, mutations socio-économiques et paysages en Côte d'Ivoire*. Mémoire de Synthèse des Activités Scientifiques Présenté en vue de l'obtention de l'Habilitation à Diriger des Recherches, Université des Sciences et Techniques de Lille (France), Villeneuve-d'Ascq, 212 p.

Cannavo, P., Benbrahim, M., Valé, M., Bresch, S., Joussemet, M.-A., Yzebe, O., et al. (2023). Optimisation de la fertilisation azotée organique dans les supports de culture horticoles. *Innovations Agronomiques, 88*, 1–14. doi: https://doi.org/10.17180/ciag-2023-vol88-art01

Govaerts, B., Fuentes, M., Mezzalama, M., Nicol, J. M., Deckers, J., Etchevers, J. D., et al. (2007). Infiltration, soil moisture, root rot and nematode populations after 12 years of different tillage, residue and crop rotation managements. *Soil and Tillage Research, 94*(1), 209–219. doi: https://doi.org/10.1016/j.still.2006.07.013

Kasongo, L. M. E., Mwamba, M. T., Tshipoya, M. P., Mukalay, M. J., Useni, S. Y., Mazinga, K. M., et al. (2013). Réponse de la culture de soja (Glycine max L.(Merril) à l'apport des biomasses vertes de Tithonia diversifolia (Hemsley) A. Gray comme fumure organique sur un Ferralsol à Lubumbashi, RD Congo. *Journal of Applied Biosciences, 63*, 4727–4735. Retrieved from https://www.ajol.info/index.php/jab/article/download/87247/76977

Konate, Z., N'ganzoua, K. R., Sanogo, S., & Camara, M. (2020). Effet des durées de compostage de la fiente de poulet sur la fertilité physico-chimique des composts produits. *International Journal of Innovation and Applied Studies, 29*(4), 1233–1241. Retrieved from https://ijias.issr-journals.org/abstract.php?article=IJIAS-20-146-02

Kyela, C. M. (2011). *Utilisation des composts de biodéchets ménagers pour l'amélioration de la fertilité des sols acides de la province de Kinshasa (République Démocratique du Congo)* (PhD thèse, Universite de Liege (Belgium)). Retrieved from https://www.proquest.com/openview/0edf72cd2cf8053260a7164345828ed4

Mounirou, M. M. (2022). Effet comparé de la fertilisation à base de biochar, engrais organique et engrais chimique sur les éléments minéraux et la production de l'oignon (Allium cepa L.). *European Scientific Journal, ESJ, 18*(24), 47–67. doi: https://doi.org/10.19044/esj.2022.v18n24p47

Normand, L., Quimeby, C., Heuguet, B., Dorel, M., Dorey, E., & Grossard, F. (2023). *Rapport final d'exécution du projet SOLORGA» Fertilité des sols et fertilisation organique des cultures», PDR Guadeloupe*. Retrieved from https://publications.cirad.fr/une_notice.php?dk=612584

Petit, J., & Jobin, P. (2005). *La fertilisation organique des cultures: Les bases*. Fédération d'agriculture biologique du Québec. Retrieved from https://www.agrireseau.net/agriculturebiologique/documents/Brochure%20fertilisation15nov.pdf

Sangaré, A., Koffi, E., Akamou, F., & Fall, C. (2009). État des ressources phytogénétiques pour l›alimentation et l›agriculture. Ministry of Agriculture, Republic of Côte d'Ivoire.

Yannick, U. S., Minerve, C. K., John, T. K., Emmanuel, M. M., Prisca, K. K., François, N. N., et al. (2013). Utilisation des déchets humains recyclés pour l'augmentation de la production du maïs (Zea mays L.) sur un ferralsol du sud-est de la RD Congo. *Journal of Applied Biosciences, 66*, 5070–5081. Retrieved from https://m.elewa.org/JABS/2013/66/5.pdf

Zro, B. G. F., Guéi, A. M., Nangah, K. Y., Soro, D., & Bakayoko, S. (2016). Statistical approach to the analysis of the variability and fertility of vegetable soils of Daloa (Côte d'Ivoire). *African Journal of Soil Science, 4*(4), 328–338. Retrieved from https://www.internationalscholarsjournals.com/articles/statistical-approach-to-the-analysis-of-the-variability-and-fertility-of-vegetable-soils-of-daloa-cte-divoire.pdf

ISSN-Internet 2197-411x OLCL 862804632