**Int. j. adv. multidisc. res. stud.** 2023; 3(5):617-622

**Received:** 08-08-2023
**Accepted:** 18-09-2023

International Journal of Advanced Multidisciplinary Research and Studies

**ISSN: 2583-049X**

# Evaluation of the Growth and Yields of Peanut Variety Based with the Use of Organic Manure and Phosphate Fertilizers in the Degraded Soil of Sudano-Sahelean Area, Cameroon

**[1] Mana Gaston Guiwa, [2] David Amedep, [3] Bertrand Wang-Bara, [4] Hayatou Sadou, [5] Gilbert Rongoumi**

[1, 3, 4, 5] Polyvalente Station of Agricultural Research, Institute of Agricultural Research for Development (IRAD) Garoua, Cameroon

[2] Institute of Agricultural Research for Development (IRAD) of Ngaoundere, Regional Center of Wakwa, Cameroon

Corresponding Author: **Bertrand Wang-Bara**

**Abstract**

The Sudano-sahelean zone in Africa, with the demographic growth are marked by the intensification of monocultures and the lack of the rotation of cultures, causing the organic matter impoverishment in the soil. This study is focuses on the organic and phosphate fertilization in order to improve soil fertility of the peanut variety "ICGV-80003" and to enhance the yield in the Sudano-sahelean zone which the soil is highly degraded. This study was carried out at the site of Polyvalente Station of Agricultural Research of North-Cameroon. Treatments were: T0 = control; T1 = poultry manure; T2 = superphosphate (46 % P); T3 = poultry manure + superphosphate (46 % P). The experimental design was a completely randomized blocks with 3 repetitions. The parameters evaluated were: The germination rate, the height of plant, the vegetative ramification at 90 DAS and the weight of seeds plants. The results show that the germination rate was suitable with the use of superphosphate substrate and the association of poultry manure + superphosphate substrate for the peanut variety "ICGV-80003". The apply of fertilizers types such as the poultry manure, superphosphate and the combined effect of poultry manure + superphosphate were significant ($P \leq 0.05$) on the height of peanut variety "ICGV-80003" compared to the control plots. Although, the number of leaves emitted by this variety were significant ($P \leq 0.05$) with the use of all treatment compared to control plots. The number of vegetative ramifications per plants was more significant ($P \leq 0.05$) with the supply of poultry manure during the development. Concerning the weight of 100 seeds per plants, the poultry manure treatment was significantly ($P \leq 0.05$) suitable compared to control and others treatments.

**Keywords:** Peanut, Fertilizers Types, Variety, Yield, Sudano-Sahelean Zone

## 1. Introduction

*Arachis hypogea* (L.) is an annual plant of the family of Papilionaceae (Fabaceae). Also considered like leguminous plant, it is used as income of resources and food for a subsistence in many habits of populations (Betdogo *et al.*, 2015 [6]; Wang-Bara *et al.*, 2022). These leguminous is capable to fix atmospheric nitrogen (N2) of air by symbiosis association with bacteria (*Rhyzobium sp*.) and favor soil restauration (Akanza *et al.*, 2020; Hamidou *et al.*, 2018) [3, 13]. Soils quality and productivity of cultures are improved by the decomposition of residues of these cultures. In the same, these residues of cultures are rich in nutrient elements (Akanza *et al.*, 2020; Gbakatchetche *et al.*, 2010) [3, 10]. Their leaves considerably rich in phosphorous, are most consumed by animals in dry season (Betdogo *et al.*, 2015 [6]; Wang-Bara *et al.*, 2022). However, it is so true that plants use of Nitrogen, Phosphorous and Potassium in important quantities, but in the context of degraded soils subject to a frequently monoculture systems, soil reserves on nutrients element must be constantly adjusted in order to maintain a good production of cultures (Razafindramboa, 2015; Moughli, 2000) [22, 18].

In the majority of African countries, the decrease of agricultural production of cultures would come from law levels of use of fertilizers by the peasant (Pieri, 1988; Rahajaharitompo, 2004) [20, 21]. This suggests a mastery on management of phosphate fertilization of the middle of study, requirement of a certain knowledge of process of supplying nutrients element for plants (Rahajaharitompo, 2004) [21]. In fact, for obtaining a good yield of cultures, plant roots require a sufficient nutrients quality, need of water and loose soil structure (Razafindramboa, 2015) [22]. This requires amendments in certain elements such as

Nitrogen, Phosphorous or others minerals element, although they are on insufficient to reach optimum yields of plants (Razafindramboa, 2015; Zohra, 2008) [22, 32].

Phosphorous is one of the three major elements essential for feeding crops. It is also doing part of element which constitute of cells membrane like phospholipids (Rahajaharitompo, 2004) [21]. Phosphorous constitute around 0.2 % of dry mass of plants (Razafindramboa, 2015; Salisbury & Ross, 1992) [22, 23]. Its deficiency for cultures causes not only the decrease of seeds productivity (Rahajaharitompo, 2004) [21], but also the reduction of growth, the number of flowers which induces a delay of plant maturity and the decrease of the productivities of plants (Razafindramboa, 2015; Kedi *et al.*, 2011; Salisbury & Ross, 1992) [22, 14, 23]. Considering that, this element is very important to the need of cultures, the majority content provides to high proportion in phosphate fertilizers like superphosphate.

Besides these important nutrient elements for culture, we have poultry manure that play an important role in restauration of degraded soils and improves soil fertility (Wang-Bara *et al.*, 2022; Somda *et al.*, 2017 [24]). Soil nutrients element like N, P, K, S; Physical, chemical, biological properties are available in high quantities by the use of poultry manure (Lompo *et al.*, 2006 [15]; Wang-Bara *et al.*, 2022). Also, the poultry manure by their presence in the soil accelerate the decomposition process, enhance the growth of plant and increase the productivity of culture (Wang-Bara *et al.*, 2022; Dikinya and Mufwanzala, 2010 [8]; Widowati *et al.*, 2005 [31]). Hence the importance given to the amelioration of food leguminous product by the organic matter (poultry manure) and phosphate fertilizers. But, in the context of decrease of production on the degraded soils, the study focuses on improvement of growth and productivity of variety of Peanut (*Arachis hypogea* (L.)) by the use of poultry manure and phosphate fertilizers. The main objective of this study was to evaluate the effect of different substrates such as the poultry manure and phosphate fertilizers on the growth parameters and yields of Peanut in the Sudano-sahelean zone.

## 2. Materials and Methods

### 2.1 Description of the Site Zone

The study was realized on the site of Polyvalent Station of Agricultural Research of North of Cameroon. The area is covered by the Sudano-Sahelean climate type, characterized by 2 seasons: a rainy season from May to September period, with heavy rains from July to August, followed by a cold season (October to January) and a warm dry season (February to April). Temperatures range from 30°C to 40°C. The vegetation in the area is dominated by *Butyrospermum parkii*, *Tamarindus indica*, *Balanites aegyptiaca* and herbaceous. The main cultivated crops are Millet (*Pennisetum glaucum*), Sorghum (*Sorghum bicolor*), Maize (*Zea mays*), Peanut (*Arachis hypogea*), Fonio (*Digitaria sp*), Cowpea (*Vigna unguiculata*), Bambara groundnut (*Vigna subterranea*).

### 2.2 Vegetal Materials

For this experience, the seeds peanut of the variety "ICGV-80003" was collected from the Polyvalent Station of Agricultural Research of the North. This variety are considered like late with the cycle of development around 80 to 100 days (Fig 1).

**Fig 1:** Variety "ICGV-80003"

### 2.3 Fertilizers Used

The chemical fertilizers used are constituted of recommended superphosphate fertilizers (45 % P) of dose 100 kg and chicken manure in reason of 70 g per units of 9 $m^2$. The application dose of superphosphate fertilizers (46 % P) is 1.2 kg per unit on field for the peanut culture. The organic manure (chicken manure) is used in reason of 70 g per pockets for the density of 76 plants per unit. The quantities of 5 kg of chicken manure were applied per unit which receives this substrate.

### 2.4 Experimental Design

The experimental design was a block completely randomized with 3 repetitions and four treatments including control (T0), poultry manure (T1), superphosphate (46 % P) and poultry manure + superphosphate at 46 % P (T3). Every block is divided in sub-blocks arranged at the distance of 0.5 and each unit measure 3 m x 3 m= 9 $m^2$. Before sowing, soil was labor at 25 cm of depth. Sowing process was done two weeks after with 40 cm of distances between lines and 20 cm between pockets. The total number of plants per unit was 76. The seeds were sowed in the soil approximatively at 5 cm of depth and weeds were sprayed in every unit considered.

### 2.5 Treatments

The applied quantities of different substrates (poultry manure and mineral fertilizers) were measured with a scale and presented on the Table 1. Treatments are control without any substrate (T0), poultry manure (T1), superphosphate (T2) and the association of substrate (T3). Before sowing, 5 kg of organic manure (poultry manure) were applied on all units which receives poultry manure per pockets. However, phosphate fertilizers types (46 % P) were applied in reason 1.2 kg on units which receives phosphate fertilizers 2 weeks after sowing.

**Table 1:** Applied treatments and control

| Treatments | Doses |
|---|---|
| Control (T0) | 0 kg |
| Poultry manure (T1) | 5 kg |
| Superphosphate at 46 % P (T2) | 1.2 kg |
| Poultry manure+ Superphosphate at 46 % P (T3) | 5 kg+1.2kg |

### 2.6 Parameters Assessment

#### 2.6.1 Growth Parameters

The growing of plants such as the height of plants and the number of leaves were collected on 15 plants by counting

for each treatment at the interval of 10 days, on four sampling campaigns, 40th DAS, 50th DAS, and 60th DAS.

### 2.6.2 Ramification at 90 DAS
The vegetative recover of plant was evaluated at 90 DAS by counting number of ramifications on every plant reference of 15 plants for every treatment and control plots during the maturity of plants.

### 2.6.3 Yields of Plants
#### 2.6.3.1 Weight of Seeds
For each treatment and control, 100 seeds in total were weighed with an electronic scale (2000*0.1g), in order to determine if the effect of different substrate influence the yield of these varieties.

### 2.6.4 Statistical Analysis
Data of growing and yields were performed using ANOVA test with software R-cmd. Significances average separation were done with the test of Tukey at the probability of 5 %.

## 3. Results and Discussions
### 3.1 Height of Plants
The Fig 2 show the height of plants according to different treatment during the growth stages of plants. The average height of plants differs according to the different substrates (Fig 2). Compared to control treatment (T0), we obtained a significant difference (P≤0.05) by the use of poultry manure (T1) and the association of substrates (T3). The highest value of height was recorded by the amendment of both fertilizers (1.81 cm) and poultry manure (1.76 cm), followed by the superphosphate substrate with 1.67 cm.

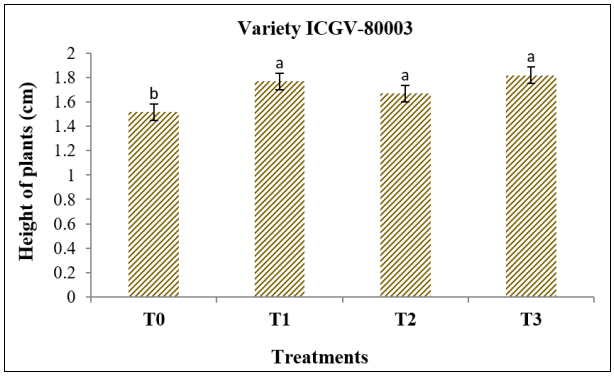


**Fig 2:** Height of plants during growing (P≤0.05; **T0** = control; **T1** = poultry manure; **T2** = superphosphate (46 % P); **T3** = poultry manure + superphosphate (46 % P)

### 3.2 Number of Leaves
The number of leaves per plants according to the different substrates is illustrated in the Fig 3 below. The leaves density differs according to the treatment used. Compared to the control plots (T0), a most significant difference (P≤0.05) was obtained with the supply of poultry manure and the association of substrates (T3), followed by the applied of superphosphate (T2). The highest value of average rate of leaves per plant was observed with the use of combined effect of substrates (52) and the poultry manure (52), followed by the superphosphate substrate (43).

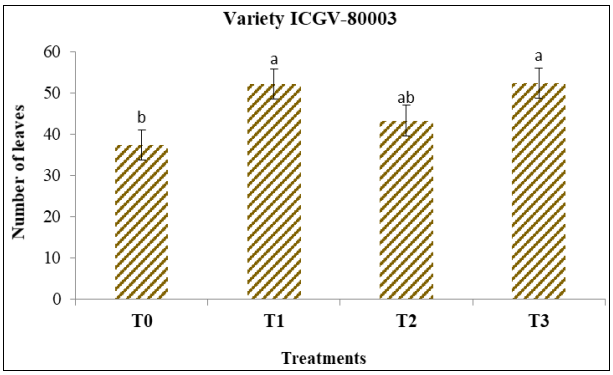


**Fig 3:** Number of leaves during the growth (P≤0.05; **T0** = control; **T1** = poultry manure; **T2** = superphosphate (46 % P); **T3** = poultry manure + superphosphate (46 % P)

### 3.3 Number of Ramification at 90 DAS
The results obtained after the supply of different substrates on the appearance of ramification of plants are presented in the Fig 4 below. These results show that the use of poultry manure (T1) favored a significant vegetative recover of plants, compared to others treatments (T2 and T3) and to the control plots (T0). We obtained a significant difference (P≤0.05) by the applied of poultry manure, compared to others fertilizers used with a vegetative recover of 12.

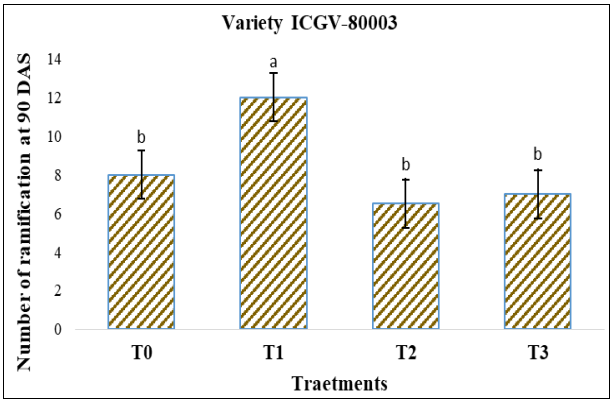


**Fig 4:** Number of leaves during the growth (P≤0.05; **T0** = control; **T1** = poultry manure; **T2** = superphosphate (46 % P); **T3** = poultry manure + superphosphate (46 % P)

### 3.4 Weight of 100 Seeds
The results of average rate of weight of 100 seeds by the use of three substrates are illustrated in the Fig 5. Comparatively to the control plots (T0), and among the different treatment, only the use of poultry manure (T1) was significant (P≤0.05) on the average weight of 100 seeds with the average rate of 30 gramme after harvest.

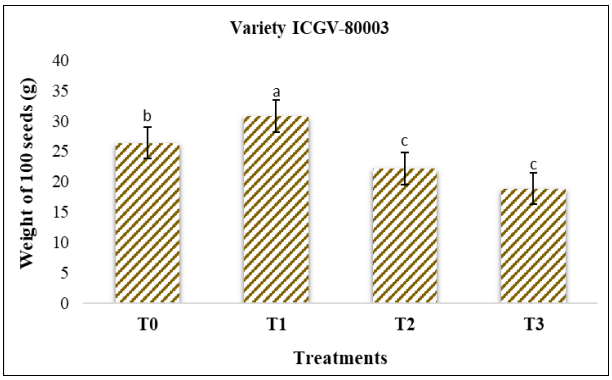


**Fig 5:** Number of leaves during the growth (P≤0.05; **T0** = control; **T1** = poultry manure; **T2** = superphosphate (46 % P); **T3** = poultry manure + superphosphate (46 % P)

## 4. Discussions

This study demonstrated the effect of poultry manure and superphosphate fertilizers to improve of the growth and yield of variety *Arachis hypogea* "ICGV-80003" on a degraded soil of Sudano-sahelean area. The growing of plants was improved with the use of different types of fertilizers. It is therefore appearing that the poultry manure, superphosphate and the association of poultry manure + superphosphate treatment has a significant influence on the height of plants of this variety. Our works corroborate with the works of Metouchi and Yahia (2020) [17], which demonstrated the beneficial effects of the organic matter on the vegetative growth of *Lactuca sativa* (L.). The same results were also found by Ahmed *et al.* (2023) [2], which shows the positive effect of phosphate fertilization on increasing of the height of *Zea mays* during their growing stages. The use of phosphate fertilizers in high proportion on the Maize culture significantly improve the height of plants compared to the non-amended plots (Nsiku *et al.*, 2019) [19].

The number of leaves emitted were most significant with the use of poultry manure, superphosphate and the association of poultry manure + superphosphate treatment compared to non-amended plots. In the most cultivated and degraded soils where the intensive activities of crops are frequent with or lack of crops rotations, the availability of nutrients element for plants is lowest and the productivity of cultures considerably decreases. The aim of phosphate fertilization is to supply the need of plants on phosphorous element according to the yield and the quality and so to complete soils incomes for a good production (UNIFA, 2005) [28]. Ours works corroborate with the results of Sossa (2012) [25], which found that the growth of *Vigna unguiculata* plant is most expressed on the vegetative stages and the plant has a good recover of plant during their vegetative development. The Cowpea plant has a good development with the use of organic manure like sources of incomes nutrients element (Metouchi and Yahia 2020) [17]. The use of organic manure associated to the chemical fertilizers improve the growth of plants (Wang-Bara *et al.*, 2022; Tchaniley *et al.*, 2020 [27]).

The vegetative recover of plants was most important with the supply of poultry manure compared to the non-amended plots. The use of this substrate favors a good growth and the vegetative recover of plants. According to the works of Metouchi and Yahia (2020) [17], the supply of organic matter favors a good vegetative recover of plant of *Phaseolus vulgaris* (L.). The same results were also found by Tchaniley *et al.* (2020) [27], which obtained a good stem diameter and vegetative recover of plants of *Lactuca sativa* (L.). The amendment with the organic manure in poor soils considerably maintain and restore the soils. The nutrients element (Phosphorous, Nitrogen) of soils are mostly available in high quantity for a good growth and vegetative recover of plants (Wang-Bara *et al.*, 2021).

The weight of 100 seeds was significantly increased on the poultry manure treatment compared to control plots. However, similar studies of Gomez *et al.* (2006) [12] and Mannix *et al.* (2001) [16] proved that the high quantities of poultry manure have a good effect on Peanut yield. According to these authors, the mineralization of organic manure and the activities of telluric microflora favors a good improvement of the productivity of plants. The applied of mineral fertilizers alone not maintain on a long term the productivity of soils due to washing of nutrients and the degradation of soils properties (Wang-Bara *et al.*, 2022). Soils amendments by the high quantities of phosphorous significantly increase the pods weight on the maturity (Hamidou *et al.*, 2018) [13]. According to Razafindramboa (2015) [22], the fertilization with phosphorous element improves the yields of *Phaseolus vulgaris* (L.). In leguminous plants, the need of phosphorous is important than the Nitrogen element and the variety of "ICGV" in general produces most of pods with the use of phosphate fertilizers (Hamidou *et al.*, 2018) [13]. In a deficiency of P and N elements of soil, the culture of Peanut is most beneficial for cereals (Hamidou *et al.*, 2018) [13]. The phosphorous element is important for the production of fruits, that mean the incorporation of poultry manure is more suitable in phosphorous which permit a good fructification and maturation of pods (FAO, 2004) [9].

## 5. Conclusion

The study on the evaluation of growth and yields of Peanut variety "ICGV-80003" based on the use of poultry manure and phosphate fertilizers permit to known that the growing of plants height was improved with the use of poultry manure, superphosphate and the association of poultry manure + superphosphate treatment, compared to control plots. Although, the number of leaves emitted were most significant (P≤0.05) with the use of all treatments compared to the non-amended plots. Referred to control plots, the ramification or vegetative recover of plants was more densified with the supply of poultry manure. The weight of 100 seeds was significant with the amendment of poultry manure substrates after harvest of cultures.

## 6. Acknowledgements

Authors are grateful Institute of Agricultural Research for Development (IRAD), Multipurpose Station of Agricultural Research of Garoua, Cameroon and Regional Center of Wakwa, Cameroon. Authors acknowledge also the staff of the University of Maroua and Ngaoundéré, Cameroon for their kind collaboration with researchers for the realization of this study.

## 7. References

1. Adjanohoun A, Baba-Moussa LS, Dagbénonbakin G, Saïdou A, Toukourou F. Utilisation des microorganismes du sol pour accroître la productivité agricole: Manuel de l'apprenant. CNS-Maïs/INRAB/SNRA. 76 p. Dépôt légal N° 9644 du 27 Septembre 2017, Bibliothèque Nationale (BN) du Bénin, 3ème trimestre, 2017. ISBN: 978-99919-819-1-8.

2. Ahmed H, Ramatou LA, Wang-Bara B, Kaouvon P, Amedep D. A Study of the Effect of Phosphorous Solubilization by Microorganisms on Growing Plants Maize (*Zea mays* (L.) in Adamawa, Cameroon. Journal of Experimental Agriculture International. 2023; 45(1):30-42. Article no. JEAI.84974
3. Akanza KP, N'Da HA, Gbakatchetche HC. Note Technique: Bien cultiver l'Arachide et le Maïs en rotation. Journal of Applied Biosciences. 2020; 146:15040-15045. ISSN: 1997-5902
4. Amadji GL, Aholoukpe HNS. Impact du niébé (Vigna unguiculata) et de la fumure minérale sur les propriétés chimiques de la terre de barre du Bénin. 2008; 15(3):147-160.
5. Balzergue C. Régulation de la symbiose endo-mycorhizienne par le phosphate. Doctorat de l'Université de Toulouse, France, 2012, 1-115.
6. Betdogo S, Sali B, Adamou I, Woin Noé. Évaluation agronomique de cinq cultivars d'arachide (Arachis hypogeae L.) introduits dans la région du Nord, Cameroun. Journal of Applied Biosciences. 2015; 89:8311-8319. ISSN: 1997-5902
7. Chabalier PF. Les phénomènes de dégradation des sols et de l'environnement: Facteurs physiques et humains. Mémoires de l'Académie Nationale des Arts, des Lettres et des Sciences. Actes du Colloque du Centenaire de l'Académie Malgache «Sol, Environnement et Développement », 2003, 99-108.
8. Dikinya O, Mufwanzala N. Chicken manure-enhanced soil fertility and productivity: Effects of application rates. Journal of Soil Science and Environmental Management. 2010; 1(3):46-54.
9. FAO. Glossaire de la gestion intégrée des éléments nutritifs. Rome, 2004.
10. Gbakatchetche H, Sanogo S, Camara M, Bouet A, Keli JZ. Effet du paillage par des résidus de pois d'Angole (*Cajanus cajan* (L.) sur le rendement du riz (Oryza sativa) pluvial en zone forestière de Côte d'Ivoire. Agronomie Africaine. 2010; 22(2):131-137. Doi: 10.4314/aga. v22i2.68361
11. Goalbaye T, Diallo MD, Mahamat-Saleh M, Madjimbe G, Guisse A. Effet du compost à base de Calotropis procera (Aiton) W. T. Aiton sur la productivité de l'arachide (Arachis hypogaea (L.) en zone marginale du Tchad. Journal of Applied Biosciences. 2016; 104:10034-10041. ISSN: 1997-5902
12. Gomez E, Ferreras L, Toresani S. Soils bacterial functional diversity as influenced by organic amendment application; Bioresource technology. 2006; 97:1484-1489.
13. Hamidou F., Harou A., Achirou B. F., Halilou O., Bakasso Y. Fixation de l'azote chez l'arachide et le niébé en conditions de sécheresse pour l'amélioration de la productivité au sahel. Tropicultura. 2018; 36(1):63-79.
14. Kedi ABB, Staunton S, Quiquampoix H. Fonctionnement des phosphatases dans les sols tropicaux: Influence de la composition organo-minérale sur l'expression de l'activité enzymatique. Mémoire Doctorat Ecosystèmes. Université de COCODY, Abidjan, 2011, 1-138.
15. Lompo DP. Gestion de la fertilité des sols dans les systèmes de culture de l'Ouest du Burkina Faso: Evaluation des effets Agronomiques et de rentabilité économique de trois formules de fumure. Mémoire de fin d'études IDR; Université Polytechnique de Bobo Dioulasso, 2006, 1-60.
16. Mannix SP, Shin H, Masaru S, Rumiko Y, Chie H, Koichiro I, *et al*. Denaturing gradient gel electrophoresis analysis of microbial community from field scale computer; Journal of Bioscience; Biorenginer. 2001; 91:159-165.
17. Metouchi I, Yahia L. Evaluation de l'effet d'engrais organique sur l'expression végétative du haricot: Cas de la biomasse du romarin et pin pignon; Mémoire de Master, 2020, 1-69.
18. Moughli L. Les engrais minéraux. Caractéristiques et utilisations. Institut Agronomique et Vétérinaire Hassan II. Transfert de technologie en agriculture. 2000; 72:1-4.
19. Nsiku DN, Mbeyame CA, Prosper Mudimbiyi P. Effets des doses croissantes d'azote et de phosphore sur deux variétés du maïs (*Zea mays* L. var Mudishi 1 et Pan 53) dans les conditions édapho-climatiques de Kinshasa; Revue Africaine d'Environnement et d'Agriculture. 2019; 2(1):52-59.
20. Pieri C. Industrie des engrais phosphatées et développement de la fertilisation en Afrique. L'Agronomie Tropicale. 1988; 43:261-277.
21. Rahajaharitompo RL. Gestion de la fertilité et de la fertilisation phosphatée des sols ferrallitiques des hautes terres de Madagascar. Thèse de Doctorat d'Etat ès Sciences Naturelles. Université d'Antananarivo, 2004, 1-202.
22. Razafindramboa S. Effets de différents niveaux de fertilisation phosphatée sur le fonctionnement microbien du sol de la région Vakinankaratra: Cas du haricot (*Phaseolus vulgaris* (L.). Mémoire en vue de l'obtention du Diplôme d'Etudes Approfondies en Sciences de la vie. Université d'Antananarivo, 2015, 1-49.
23. Salisbury FB, Ross CW. Plant physiology. Wadsworth Publishing, Belmont, C. A. 1992; 4:116-129.
24. Somda BB, Ouattara B, Serme I, Pouya MB, Lompo F, Taonda SJB, *et al*. Détermination des doses optimales de fumures organo-minérales en microdose dans la zone soudano-sahélienne du Burkina Faso. International Journal of Biological and Chemical Sciences. 2017; 11(2):670-683. ISSN: 1997-342X (Online).
25. Sossa EL. Arrière effet de la fertilisation et des résidus de récolte du niébé (*Vigna unguiculata* (L.) sur la production du riz de bas-fond dans un système de culture riz maraîchage. Mémoire Doctorat en Sciences Agronomiques, 2012, 1-51.
26. Subbarao GV, Ae N, Otani T. Genotypic variation in Iron and Aluminium- phosphate solubilizing activity of pigeon pea root exudates under P deficient conditions. Soil Science and Plant Nutrition. 1997; 43(2):295-305.
27. Tchaniley L, Ayisah KD, Dewa Kassa KA. Effet de la combinaison des fertilisants organiques et minéraux (NPK 15-15-15 et urée) sur le rendement de la laitue (*Lactuca sativa* (L.) dans le sud du Togo. Journal of Applied Biosciences. 2020; 151:15540-15549.
28. UNIFA, Edition. Principaux éléments fertilisants. Parlons fertilisations, 2005, 1-6.
29. Wang-Bara B, Ahmed H, Amedep D, Ramatou LA, Kaouvon P, Guidjinga Kanpetta NA. Effect of organic amendment (Biochar and Compost) on growth and

yields of two varieties of Rice (*Oryza sativa* (L.) in Ngaoundere, Cameroon. International Journal of Science Academic Research. 2022; 3(4):3661-3666.
30. Wang-Bara B, Danra DD, Ahmed H, Amedep D, Housseini DJ. Comparative effects of poultry manures and mycorrhiza on the growth parameters and yields of Peanut (*Arachis hypogea* (L.) in a Sudano-Sahelian area of Cameroun (Yagoua, Far-North region). International Journal of Research and Scientific Innovation (IJRSI). 2022; 9(3). ISSN: 2321-2705.
31. Widowati LR, Widati S, Jaenudin U, Hartatik W. Effect of Organic Fertilizer Compost Enriched with Mineral Materials and Biological Fertilizer on the properties of soil, Nutrient Uptake and Organic Vegetable Production. Research Project Report Agribusiness Development Program, Soil Research Institute, 2005.
32. Zohra SF. Les bactéries nodulant les Légumineuses (B.N.L): Caractérisation des bactéries associées aux nodules de la légumineuse Fourragère, *Hedysarum perrauderianum*. Thèse pour l'obtention de Magister en Génétique et Amélioration des plantes Algérie, Université de Mentouri de Constantine, 2008, 1-79.