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Efficient Evaluation of the Quality of Organic Fertilizers on Agronomical Characteristic and Grain Yields of Transplanted Plants of Rice Nerica L-56 (*Oryza sativa* (L.)) in Sudano-sahelian Zone, Cameroon

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Abstract— *In the context of rice yield improvement, a study was conducted at the site of Polyvalente Station of Agricultural Research for Development of North-Cameroon during the rainy season of 2023. The study focused on the response of the transplanted rice variety Nerica L-56 at the quality of two organic manures, one based on chicken manure and the other consisting of goat dropout. The aim of this study was to evaluate the effect of these two organic fertilizers on agronomical characteristic and grain yields of transplanted plants of variety rice Nerica L-56 in a most cultivated soils of the North, Cameroon. A randomized block design with 3 repetitions was used for the experiment. Treatments were:* ***T0*** *= control (0 kg);* ***T1*** *= poultry manure (10 kg);* ***T2*** *= goat dropout manure (10 kg). The parameters evaluated at the maturity of development were: the length of tillers, the number of tillers, the number of panicles per pockets, the number of seeds per panicles and the weight of 1000 seeds. The results showed that the length rice at the end of development not differed significantly ($p<0.05$) among the different substrates treatments. Compared to control, the number of tillers was significantly ($p<0.05$) increased with the applied of poultry manure and goat dropout treatments. The different substrates applied not significantly ($p<0.05$) influence the development of panicles at the maturity. The number of seeds per panicles at the maturity was significantly ($p<0.05$) enhanced by the use of goat dropout treatments. The weight of 1000 seeds for all substrates after harvest were significant highest ($p<0.05$) with the use of poultry manure compared to the non-amended plots. This study on the use of these organic fertilizers permits to identify mostly the poultry manure, as best organic matter that the nutrients elements are directly available for the suitable growth parameters of plant and yields, compared to the goat dropout which take more time during the mineralization process and availability of nutrients that plant are needed.*

Keywords— *Organic manures, Oryza sativa, Variety, Yields, Sudano-sahelian zone.*

I. INTRODUCTION

Rice (*Oryza sativa* (L.)) constitutes the basic food for more than half of the world population (Siri, 2015). The cultivation of rice is the one which is the subject of a great pedoclimatic plan (Fofiri, 2013). In Africa, rice is the third source of calories for the continent (Adrao, 2009). In the Western part, it is one of the main cereal foodstuffs. The average per capita consumption of rice increased from 13 kg in the 1960s to 18 kg in 2009 (Siri, 2015; IFDC, 2009). In Cameroon, its production is mainly based in the Far-North (Mayo-Danay 11.800 tons, Mayo-Sava 11.000 tons and Logon and Chari 9.700 tons). These three departments provide 80 % of the production of North Cameroon and more than 60 % in national plan (Fofiri, 2013). Rice cultivation employs some 145.000 farmers (mainly women and young people) who produce around 174.000 ton of cultivated paddy rice on 155.000 ha (MINADER, 2011). But according to compiled data in the reports of 2020 on external market of Cameroon, published by the National Institute of Statistics, rice imports in 2020 finally accumulated to 591.597 tons, for a value of 159.8 billion of FCFA. The massive imports of rice, which explode the country's trade balance deficit, often serve as a free pass for certain economic operations to redolently supply the neighboring countries (SNDSR, 2015). Despite the assets and immense natural potential to its production such as: availability of land, water resources, varied climate changes, locally produced varieties, its production remains below the demand of the rapidly growing population. Cameroon must therefore resort to massive imports in order to fill these production deficits.

Nowadays, the consumption of fertilizers in recent years is constantly increasing (Solidarité International, 2022). The high cost of the latter makes it the main factor in the operating account in intensive rice cultivation (Siri, 2015). In addition, current problems linked to poor soil management leading to a drop in the level of its fertility, the cost of production of irrigated rice requiring considerable investments for the development of production basins, the location of the three main production structures, both far from urban centers (Yaounde and Douala) and close to border markets (Nigeria,

Tchad, RCA), lack of seed multiplier, poor management of weeds and cultural practices leads to a drop in agricultural production. According to the work of Batiano et al. (2004), the reduction in the quantity of nitrogen in the soil associated with the drop in the level of organic matters and the invasion of cultivated land by weeds leads to reduction in crops yield. By the process of progressive land degradation which takes with it the nutrient contents, crop yields decrease negatively from one year to the other (Siri, 2015).

The biological fertilization of a soil results mainly from biological activity due to the presence of several groups of living beings: fauna, micro-organisms and roots (Siri, 2015). Organic residues left on the ground after harvests constitute temporary litter. It directly influences soil nutrition and the physico-chemical properties of soils (Siri, 2015). The great majority of chemical soil depletion comes from a considerable decline in organic matter in soils. Formulation tests on the quality and quantity of the manure should be initiated based on the expected results at the plot scale, in order to qualitatively and quantitatively recommend the type of manure best for rice production. However, the effective management of fertilization and the economic profitability of rice production would then depend on the control of efficient fertilization (Siri, 2015). Optimization of production through the adequate use of the quality of organic fertilizers is therefore essential in order to increase productivity. It is with this in mind that this study has the general objective of evaluating the quality of organic fertilizers on agronomical characteristic and grain yield of transplanted Rice variety L-56 (*Oryza sativa* (L.)) in Sudano-sahelian zone, Cameroon.

II. Materials and Methods

I.1 Study location

The study was carried out in July 2023 at the Multipurpose Agricultural Research Station for the Development of Garoua (SPRAD Garoua) more precisely at the stable of the station in the locality of Sanguere-Paul (Garoua III). It's a locality located about ten kilometers from the town of Garoua, region of North-Cameroon, department of Benoué, district of Garoua 3rd. Its geographical coordinates are 09°34'310'' North Latitude and 013°27'712'' East Longitude and covers an area of approximately 3000 ha. The climate is Sudano-Sahelian (Sadou *et al.,* 2023). It is an area between the Isohyets 700 m (Seignobos & Iyebi-mandjeck, 2000; Sadou *et al.,* 2023). Temperatures remain high with an average of 28°C and maximums reaching 40 à 45°C in March and April. The distribution of rain is as important as its abondance for crop production (Donfack *et al.,* 1997; Sadou *et al.,* 2023). It is therefore ecologically dry with a rainfall index which is between 800 and 900 mm of water per year. In general, we encounter two seasons of unequal duration and clearly defined: a long dry season from November to May and a short rainy season from June to September. The vegetation is dominated by tree savannahs, shrub savannahs and open forests. The soil of the station is sandy (Sadou *et al.,* 2023).

I.2 Vegetal Materials

The vegetal material for this study is constituted of one ameliorated vegetal species cultivated mostly in the locality of the study. It's the variety of Rice Nerica L-56 at long life cycle, developed and vulgarized by the Institute of Agricultural Research for Development (IRAD) of Garoua (Figure 1).

Figure 1: Ameliorated variety Rice Nerica L-56.

TABLE 1: The characteristic and provenance of the variety.

Denomination (synonyms)	**NERICA L-56**
Pedigree	WAS 191-8-3
Parent	IR64/TOG5681//4*IR64
Breeder	ADRAO
Cultural vocation	Low depths; irrigated
Cycle (days)	100-120 days
Seeds texture	Long
Potential yields (t/ha)	(05-06 ton/ha)
Others characteristics	Pretty good resistant to rice blast; Medium resistance to insects; Tolerant to dryness; Resistant to lodging; Good culinary quality and non-aromatic.

Sources: Africa Rice Center (Warda, 2008).

I.3 Nursery preparation

To better obtain the plants to be transplanted in just 10 to 12 days, a rectangular raised ridge board is made. It is 10 meters long and one meter wide. It is on this board that the nursery was defined and monitored for the good emergence and growth of the young plants to be transplanted into the experimental units.

I.4 Organic amendments

The manufacture of compost or the valorization of feces by the manufacture of livestock, poultry, goat and pig manures constitute entirely new practices for the restoration and fertilization of the soil (Ravelomanarivo *et al.,* 2015). The adoption of these new organic amendment practices is necessary for the possibilities of experimenting on the plot unit. To carry out our study, goat dropout and poultry manure were used for the good mineralization, assimilation and a significant supply of the quantity of nitrogen necessary for the plant. In addition, taking into account the fallowness of this soil estimated at two years without any cultural crops, the supply of organic fertilizers will improve the quantity of nutrients in this soil. The poultry manure was obtained in poultry farms located in the peri-urban area of Garoua I. as for goat dropout, it was produced in the Polyvalente Station of Agricultural Research for Development (PSARD-Garoua), more precisely at the stable of the said station.

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I.5 Experimental design

The experimental design is a block completely randomized with three treatments and 3 replications. Each units represent a treatment with a spacing of 0.5 m between the units. This experimental unit is represented on a form of scare of 7.5 m x 7.5 m with the formation of five lines on a reason of seven pockets per lines for the density 35 plants.

I.6 Treatments

The applied quantities of different organic substrates (chicken and goat dropout) were measured with a scale and presented on the Table 1. The treatments are the control without any substrate (T0), the poultry dropout (T1) and the goat dropout (T2). The organic fertilizer sources were applied two weeks before transplanting to allow for their mineralization. The quantity of 10 kg of organic matter (chicken and goat dropout) were applied on all experimental units which receives the chicken and the goat dropout (Table 2).

TABLE 2: Applied treatments and control.

Treatment code	Treatments	Quantities
T0	Control	0 kg/ha
T1	Chicken dropout	100000 kg/ha
T2	Goat dropout	100000 kg/ha

I.7 Preparation, sowing process and maintenance of plots on field

The plots were prepared by clearing and plowing the different experimental units. The sowing was carried out on July 2023 for all the plots on a reason of seven seeds per pockets at the depth of 2.5 cm. Two weeks after germination on field, weeding was done manually after every three weeks during the development of plant. The use of pesticides (Optimal and Cypercal) was applied at one month after sowing to fight against harmful insects that perforate the leaves.

I.8 Harvest process

The harvest of plants was done at the end of maturation of the majority of plots of each experimental unit. It is consisting to clear each unit using a sickle and disposing of it by treatment in order to avoid the effect of loss of seeds that are most dry during the harvest process.

I.9 Statistical analysis

Data of growing and yields were performed using ANOVA test with software GenStat Version 9.2. Significances average separation was done with the test of Tukey at the probability of 5 %.

III. RESULTS AND DISCUSSIONS

II.1 Length of tillers on maturity

The Figure 2 indicate the length of tillers arrived at the maturity of development of transplanted plants according to the different substrates applied. The length of plants not varied according to the different treatments (Figure 2). Compared to control plots (T0), not significant difference (P value=0.333) was observed for the supply of different substrates (T1 and T2). The average length of tillers for every substrate at the maturity of development is 1.12 m.

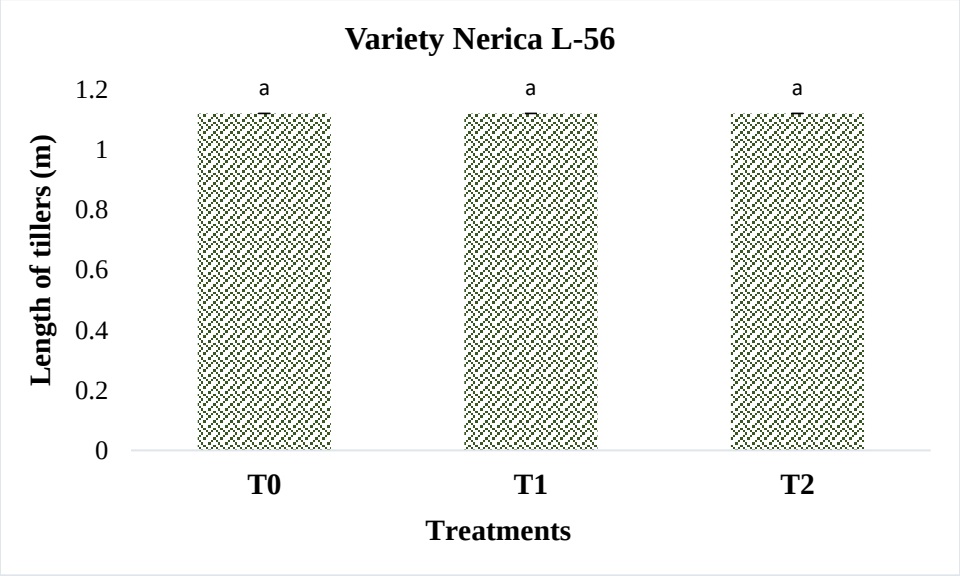

Figure 2: Length of panicles on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

II.2 Number of tillers on maturity

The Figure 3 illustrate the number of tillers at the maturity of development of plants according to different substrates applied. The number of tillers differs according to the different treatments used. Referred to control plots (T0), more significant difference (P value=0.102) is recorded for the supply of poultry manure substrate (T1) and the goat dropout substrate (T2) as organic fertilizers. The highest value of the average number of tillers of plants was observed on the supply of poultry manure, with the rate of 22, followed by the used goat dropout with the average rate of 20.

II.3 Number of panicles on maturity

The Figure 4 show the number of panicles arrived at the maturity of development of plants according to the different

substrates. The number of panicles differs according to the different treatments used. In comparison to control plots (T0), the supply of different substrate as fertilizers (T1 and T2) not significantly (P value=0.449) influenced on the appearance of panicles of plants during the development of plants at the maturity.

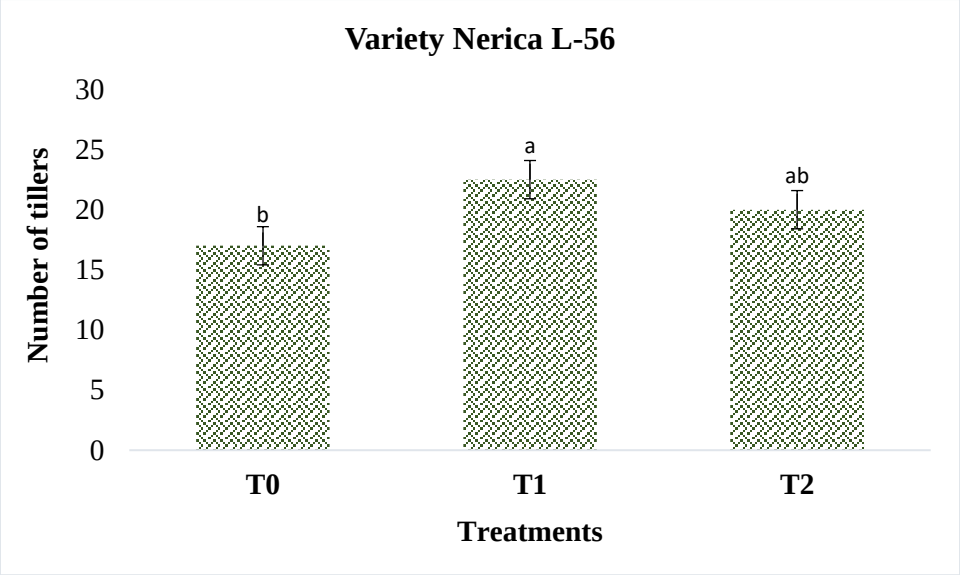

Figure 3: Number of tillers on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

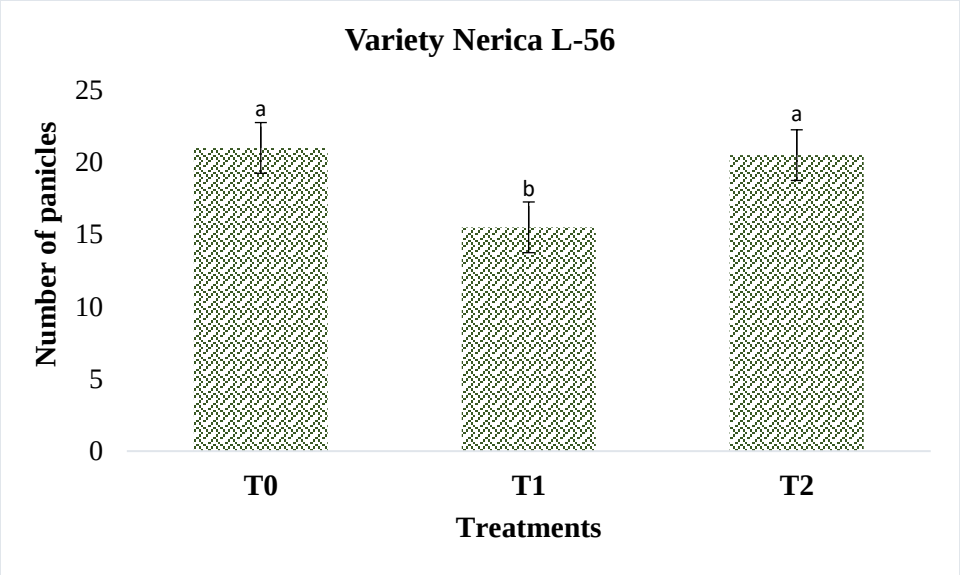

Figure 4: Number of panicles on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

II.4 Number of seeds per panicles on maturity

The Figure 5 show the number of grains per panicles at the maturity of development of plants according to the use of different treatments. The number of grains per panicles vary according to different treatments (Figure 5). Comparatively to control (T0) and supply of poultry manure (T1), the supply of goat dropout as organic fertilizers (T2) was significant (P value<.001) on the number of grains per panicles at the maturity of development of plants. The must highest value of the average number of grains per panicles was recorded by the supply of dropout (203).

II.5 Weight of 1000 seeds on maturity

The Figure 6 illustrate the weight of 1000 seeds at the maturity for the different treatment evaluated after harvest of plants. The weight of grains varies according the substrates applied. Comparatively to the control (T0), the supply of poultry manure as organic fertilizers was significant (P value<.001) on the weight of 1000 grains after harvest of plants. The must highest value of average weight of 1000 grains by substrates was recorded by the supply of poultry manure (29.83).

Discussions

This study demonstrates the effect of the quality of organic fertilizers on agronomical characteristic and grain yields of

transplanted plants of Rice L-56 on a degraded soil of Sudano-sahelian area. The growth and yields parameters of plants were improved by the use of poultry manure and goat dropout. The evaluation of the length of plants is one indicator of growth that is important to determine the responses of different substrates on maturity. The plants responses on length for the different substrates were suitable at the maturity of development. It is therefore appearing that the length of plants on the maturity is uniform and constant during the growth of plants due to the adaptability (roots systems) of every transplanted rice to the new environment. Results found by Diallo et al. (2010), showed that the use of organic fertilizers has a good improvement on the length of plants of rice Nerica 3 due to the Nitrogen nutrition which is well restored. Also, according to the works of Mamadou (2018), significant improvement of the height of plants rice was recorded at the maturity of development by the applied of compost and mineral fertilizers.

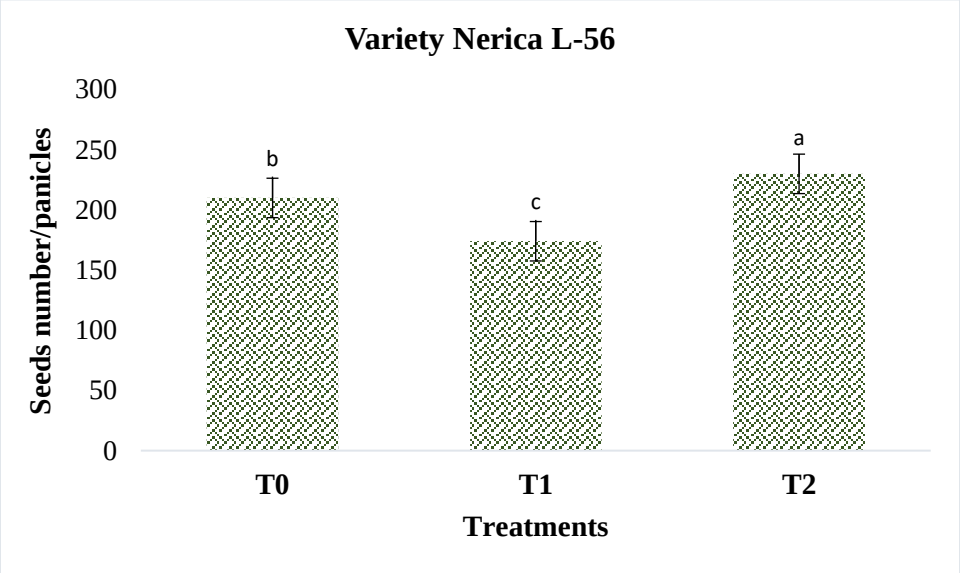

Figure 5: Number of panicles on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

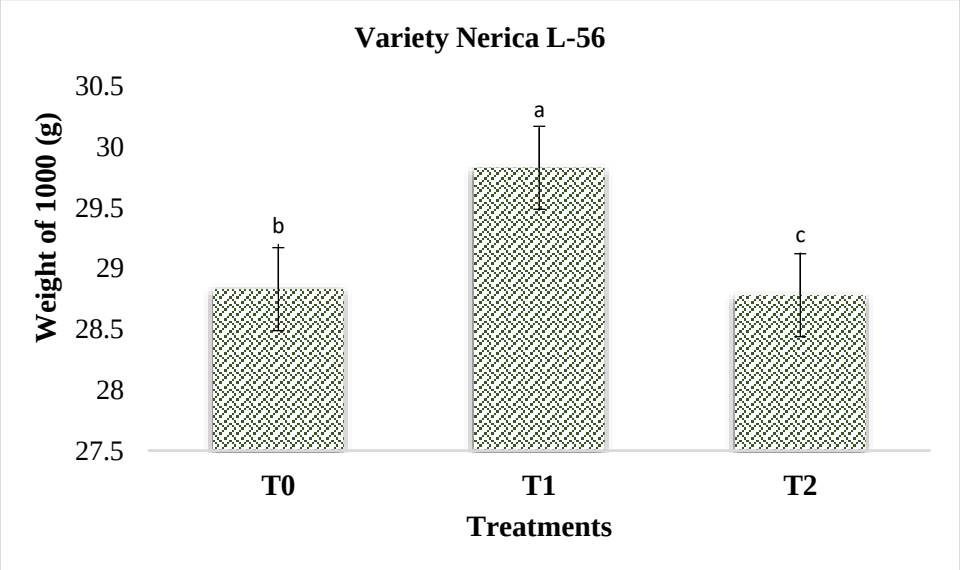

Figure 6: Weight of 1000 seeds on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

Counting of the number of tillers permit to appreciate globally the effect of different substrates on the capacity of rice to produce the tillers. The results showed that the organic fertilizers such as poultry manure and goat dropout substrates were significant on the number of tillers during development of plants. Ours works corroborate with the results of Diallo et al. (2010), which demonstrated that the number of tillers of the variety of rice Nerica 3 enhance by the benefit effect organic manure during the growth. The works of Konaté et al. (2022) showed a significant effect of the doses of poultry manure on the vegetative recover of *Lactuca sativa* plants during the development. Same results were also found by the works of Bahan et al. (2018) on the biofertilization of rainy rice variety, which showed a good response of the number of tillers by the

use of bio-stimulant compared to the control plots. We could suggest that the organic matter not only plays a role in the slow and regular release of mineral elements but also in water retention, soil consistence, which becomes loose and permeable to air and roots for uptake nutrients element for plants. The organic matter provided by the poultry manure improves the physical properties of the soil (Onana, 2006).

The results shows that the use of different substrates (poultry manure and goat dropout) not more influenced the appearance number of panicles of plants during the growth. Ours results not corroborate with the works of Bahan et al. (2018), which found that the number of panicles of rainy rice variety was improved by the use of biofertilization. Also, these authors shows that the number of panicles produces were significant with the applied of biofertilizers during the study. However, the works of Diallo et al. (2010) on the organic amendment of rice culture demonstrated a significant appearance of rice panicles at the end of development. According to Mamadou (2018), the use of only compost as organic manure could increase the number of panicles per m^2 compared to non-amended plots. we could suggest that by presence of the humus contained in organic manure, the biological activities of micro-organisms should favor the aeration of soil, enhances the availability of nutrients for the plant, improves soil fertility and favor a good development of plants.

The number of seeds per panicles at the maturity after harvesting was significant with the applied of goat dropout compared to non-amended plots. The goat dropout improves the average number of seeds per panicles contrary to the use of poultry manure. However, the works of Bahan et al. (2018) showed an enhancing of the number of seeds per panicles with the applied of bio-stimulant like fertilizers of rice culture. We could say that comparatively to poultry manure, goat dropout takes more time to mineralize totally in the soil and contain more or less of evolved nutrients elements. Also, during the decomposition and mineralization process of organic matter, the release of nutrients is beneficial to the soil of this study, which is poor in organic matter, nitrogen, phosphorous and exchangeable bases. Also, the works of Farhad et al. (2009) proved a significant effect of poultry manure on the number of grains per cob of the Maize culture by the applied of different levels of poultry manure. The high levels of poultry manure enhance the number of rows per cob, number of grains per row with the application of 12 t ha^{-1} of poultry manure (Farhad *et al.*, 2009).

The weight of 1000 seeds on the maturity of development after harvest was significantly increased on the poultry manure treatment compared to control plots and goat dropout treatment. According to the works of Sanon et al. (2021), the applied of organic amendment alone or associated to mineral fertilizers has a significant improvement of grain yields of rice compared to the vulgarized inorganic fertilizers. The poultry manure enhances the levels of organic manure in the soil and consequently increase the Nitrogen uptake in soil for the plants (Sanon *et al.*, 2021). The good mineralization of poultry manure favor also the availability of phosphorous elements which accelerate the maturation of fruit, legumes and cereals (Sanon *et al.*, 2021). The same results were also found by Farhad et al. (2009), which recorded a highest value of the weight of 1000 grain weight with the applied of different levels of poultry manure of Maize culture.

IV. Conclusion

Our study on the evaluation the quality of organic fertilizers on agronomical characteristic and grain yield of transplanted Rice variety L-56 (*Oryza sativa* (L.)) in Sudano-sahelian zone showed that the use of poultry manure and goat dropout fertilizers not more improves the length of rice compared to control plots. However, the number of tillers was significantly ($P \leq 0.05$) highest with the use of poultry manure and goat dropout treatments, compared to control treatments. Compared to non-amended plots, the number of panicles at the maturity not significantly ($p<0.05$) differs for all the substrates applied. The number of seeds per panicles at the maturity was most significantly ($p<0.05$) highest by the use of goat dropout treatments. The weight of 1000 seeds for all substrates after harvest were significantly ($p<0.05$) highest with the use of poultry manure compared to the non-amended plots. We can't suggest that the poultry manure could be consider as good organic matter that the nutrients elements are directly available for the suitable growth parameters of plant and yields, compared to the goat dropout which also suitable but take more time for the mineralization and availability of nutrients that plant are needed.

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References

1. Adrao (2009). Sélection variétale participative du riz : Manuel du technicien. Cotonou, Bénin : Centre du riz pour l'Afrique (ADRAO), 1-126 pp.
2. Africa Rice Center: Warda (2008). NERICA: the New Rice for Africa-a Compendium. EA Somado, RG Guei and SO Keya (eds.). Cotonou; Benin: Africa Rice Center (Warda). 1-210 pp.
3. Agbede T. M., Ojeniyi S. O & Adeyemo A. J. (2008). Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest, Nigeria. *Am.-Eurasian J. Sustainable Agric*., 2,1,72-77 pp.
4. Bahan F., Messoum G. F., Bouet A., Dekeister D., Barraud F., Keli Z. J., Adiko A & Ble F. (2018). Bio-fertilisation du riz : Efficacité d'un ingrédient actif naturel (Bio-stimulant) - un champignon mycorhizien sur le rendement du riz de plateau en côte d'ivoire. *Asian Journal of Science and Technology* ; Vol. 09, Issue, 01, pp.7358-7365.
5. Bationo A., Kimetu J., Ikera S., Kimani S., Mugenda D., Odendo M., Silver M., Swift M. J., Sanginga N. N. (2004). The Africa Network for soil biology and fertility: new challenge and opportunities. In Bationo (Ed): Managing of Nutrient Cycles to sustain soil fertility in Sub-Saharan Africa. *Academy of science publishers*, Nairobi, Kenya ;1-123 p.
6. Diallo D., Tamini Z., Barry B & Faya O. A. (2010). Effet de la fumure organique sur la croissance et le rendement du riz NERICA (WAB 450 IBP 28HB) à Faranah. *International Journal Biological and Chemical Sciences* ; 4(6) : pp.2017-2025.
7. Donfack P., Seiny B. L. & M'Biandou M. (1997). Les caractéristiques du milieu physique. In Seiny Boukar L, Pouain J-F. & Faure G. (eds)

Agricultures des savanes du Nord-Cameroun : vers un développement solidaire des savanes d'Afrique centrale. Actes de l'Atelier d'échange, 25-29 Novembre 1996, Garoua, Cameroun. Montpellier, France, CIRAD-CD, 1-528 p.
8. Farhad W., Saleem F. M., Cheema A. M & Hammad M. H. (2009). Effect of poultry manure levels on the productivity of spring maize (*Zea mays* (L.)). *The Journal of Animal & Plant Sciences*; 19(3): pp.122-125.
9. Fofiri Nzossie E. J. (2013). Les déterminants de l'offre alimentaire vivrière dans les villes du Nord-Cameroun. Ph/D de Géographie ; Université de Ngaoundéré (Cameroun). 1-410 p.
10. IFDC (2009). An uptake on the work and progress at IFDC. Vol 34, NO. 3 ; 1-12 p.
11. Konate Z., N'ganzoua R. K., Bi Zro G. F., Bakayoko S., Camara M. (2022). Effet de différentes doses de compost de fiente de poulet sur la fertilité des sols et les paramètres agronomiques de la Laitue (*Lactuca sativa* (L.)). *Agronomie Africaine*. 34 (1) : 117-131 pp.
12. Mamadou S. (2018). Effets de deux types de compost et de la fertilisation minérale azotée sur les propriétés du sol et le rendement du riz (*Oryza sativa* (L.)) de Nappe en station au CRA de Djibélor. Mémoire de Master, Université Assane Seck de Ziguinchor ; 1-34 p.
13. MINADER (2011). Rapport des Enquêtes sur les Statistiques Agricoles au Cameroun.
14. Onana Onana L. G. (2006). Pratiques de fertilisation et caractéristiques des sols en zone maraîchère périurbaine de Yaoundé : cas des basfonds de Nkolondom. Mémoire de fin d'étude, Université de Dschang ; 1-73 p.
15. Ravelomanarivo E., Du Portal D., Bourgois F. (2015). Valorisation d'essais comparatifs de fertilisation minérale et/ou organique pratiqués en milieu paysan dans le Sud-Est de Madagascar ; La fertilisation en riziculture irriguée. 1-10 p.
16. Sadou H., Rongoumi G., Ahmadou Y., Njoya O., Wang-Bara B., Saifoullah D. (2023). Etudes de la déhiscence des 07 variétés de Soja dans les conditions climatiques du Nord-Cameroun. *International Journal of Innovation Scientific Research and Review*; Vol. 05, Issue, 05, pp.4501-4505.
17. Sanon A., Gomgnimbou K. P. A., Coulibaly K., Nacro B. H. (2021). Effets de biodéchets et de fertilisants inorganiques sur la production du riz pluvial strict en zone Sud-Soudanienne du Burkina Faso. *Afrique Science ;* 18(1) : 230-241 pp.
18. Sanon A., Gomgnimbou K. P. A., Coulibaly K., Zongo K. F., Bambara A. C., Fofana S., Sanou W., Nacro B. H. (2021). Caractéristiques chimiques d'un Lixisol sous les effets synergiques de biodéchets et de fertilisants minéraux dans la zone Sud-Soudanienne du Burkina Faso. *International Journal of Development Research* ; Vol. 11, Issue, 07, pp. 48668-48673.
19. Seignobos C & Iyébi-Mandjeck O. (2000). Atlas de la Province Extrême-Nord Cameroun. IRD Editions 2017.
20. Siri A (2015). Optimisation de la fertilisation minérale et rentabilité économique de la production de riz irrigué dans la vallée du Sourou (Burkina Faso) ; Mémoire : Diplôme d'Etudes Approfondies en Gestion Intégrée des Ressources Naturelles, 1-44 pp.
21. Solidarités International (2022). Analyse de la crise alimentaire mondiale & ses liens avec la guerre en Ukraine. 1-9 p.
22. Stratégie Nationale de Développement de la Filière Semences de Riz : SNDSR (2015). 1-56 p.