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Agronomic evaluation of the variety of rice nerica L-56 (*Oryza sativa* (L.)) under the effect of organic fertilizers in the sudano-sahelian zone of Cameroon

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Abstract
To increase rice production in the Sudano-sahelian zone of Cameroon, a study was realized at the Multipurpose Agricultural Research Station for the Development of Garoua-Cameroon during the rainy season of 2023. This study focuses on the search of the best quality of two organic fertilizers based on the use of chicken manure and goat dropout on the growth and yields products of the variety of rice Nerica L-56 in a most cultivated soils of the North, Cameroon. The experimental design was a completely randomized blocks with 3 repetitions. The treatments were: T0 (control at 0 kg); T1 (poultry manure at 10 kg) and T2 (goat dropout manure at 10 kg). Evaluating parameters during the development were: the height of plants, 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 average plants size at the maturity of development was most significantly ($p<0.05$) for the poultry manure and goat dropout treatments, compared to non-amended plots. Referred to control, the number of tillers were most significantly ($p<0.05$) highest on goat dropout substrate and followed by poultry manure treatments. Compared to control plots, the different substrates applied not significantly ($p<0.05$) influence the number of panicles at the maturity. The number of seeds per panicles at the maturity was significantly ($p<0.05$) highest by the use of poultry manure treatments. The weight of 1000 seeds after harvest for all substrates applied were not significant ($p<0.05$) compared to the non-amended plots. This comparative 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 fertilizers, oryza sativa, variety, yields, sudano-sahelian zone

Introduction

Agriculture represents an essential part of the economy of all African countries. With an agricultural population estimated at 580 million of persons in 2020, Africa has immense potentials which allows it not only to feed itself, to fuel hunger and food insecurity but also to become a major player in international markets (NEPAD, 2013). Often described as the breadbaskets of Central Africa, Cameroon has considerable agricultural potential, both in the production of food and livestock crops and export crops (DSCE, 2009). Among the most cultivated species, cereals such as sorghum, millet, wheat, corn and rice are staple foods for the majority of the population in Cameroon.

Particularly for the rice (*Oryza sativa* (L.)), it is one of the most consumed cereals in the world (CTA, 2013). It constitutes the basic food of more than half of humanity (Siri, 2015) [27]. In 2018 rice production is estimated at 782 million ton, 90 % of which is produced in Asia, 5 % in America and only 4 % in Africa (FAO, 2020). Annual consumption per capita is 100 kg in Asia, 40 kg in Africa (CIRAD, 2010). More than 200 million hectares of arable land can be used for rice cultivation (Africa Rice, 2013). It only cultivates 9.7 million hectares for rice. Rice has become a very strategic and priority product for food security in Africa. Along with wheat, it constitutes the most consumed cereals in the world (Abiassi, 2006; FAOSTAT, 2020) [1]. In West Africa, rice is the most important source of food energy and 3rd for the entire African continent (Africa Rice, 2020).

Rice is a very important staple food in Cameroon's economy and food culture. However, rice production is struggling to meet growing market demand. Despite cumulative efforts, public companies have an annual production of barely 100.000 tons; national demand is estimated at 576.949 tons in 2022. According to figures just published by the ministry of agriculture (MINADER, 2009) [16], the country produced 140.170 tons of rice, or 23.4 % of its demand after a difference estimated at 436.779 tons. This situation creates a dependence on exports, which has a significant impact on economy and food security of the country. The cost of importing rice is high, which has an impact on the purchasing power of consumers. According to data on import in 2013, around 150 billion CFA francs were spent on rice imports in the household food budget compared to 112 billion CFA francs in 2001, an increase of around 4 % per year (SNDSR, 2015). In addition, the state of Cameroon promotes the importation of rice at more than 200 billion CFA francs from 2020 to today to meet national demand.

National production is estimated at 217.280 tons of national demand (final household consumption and stock variations) at 757.000 tons. Under the hypothesis that the consumption behaviors of Cameroonian households have not significantly changed between 2018 and 2019, it appears that the sharp increase in rice imports (in 2019) generate the gap between supply demand of approximately 332.300 tons. This gap could be explained by informal re-exports to neighboring

countries, and amount to approximately 87 billion CFA francs (MINADER, 2009) [16].

The country has a climate conductive to the cultivation of rice, arable and fertile land and large network of watercourses, it also has five rice fields established with the possibility of increasing production to meet local rice consumption needs. Despite this potential, Cameroon does not produce enough rice for national market, so the production deficit persists. Indeed, the Benoué Valley in Cameroon is one of the places where Nerica is cultivated. However, yields of this crop is often low due to lack of appropriate fertilizers and inefficient agricultural practices, insufficient and irregular rainfall, and pest attacks. This is why numerous research projects have been undertaken with the aim of improving production through better fertilization (Kambou *et al.*, 2008) [15]. An efficient improvement of rice production through the adequate use of the quality of organic fertilizers is important, in order to increase yields. It is with this in mind that this study has the general objective of evaluating the quality of organic fertilizers on the growth characteristic and grain yield of the variety of Rice L-56 (*Oryza sativa* (L.)) in Sudano-sahelian zone of Cameroon.

Materials and methods

Site 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 Sanguéré-Paul (Garoua 3rd). 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 13°27'712'' East Longitude and covers an area of approximately 3000 ha. The climate is Soudano-sahelian type (Sadou *et al.*, 2023) [24]. It is an area between the Isohyets 700 m (Seignobos & Iyebi-mandjeck, 2000; Sadou *et al.*, 2023) [24]. 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 abundance for crop production (Donfack *et al.*, 1997; Sadou *et al.*, 2023) [7, 24]. 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) [24].

Plant material

The plant 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).

Fig 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 tons/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)

Organic amendments

The manufacture of compost or the valorization of feces by the manufacture of livestock, poultry, goat and pig manure constitute entirely new practices for the restoration and fertilization of the soil (Ravelomanarivo *et al.*, 2015) [23]. 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 Multipurpose Agricultural Research Station for the Development of Garoua (SPRAD-Garoua), more precisely at the stable of the said station.

Experimental design

The experimental design is a block completely randomized with three treatments repeat three times. Each unit 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.

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 planting to allow for their good mineralization in soil. 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 1).

Table 1: Applied treatments and control

Treatment code	Treatments applied	Quantities applied
T0	Control	0 kg/ha
T1	Chicken dropout	100.000 kg/ha
T2	Goat dropout	100.000 kg/ha

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.

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 of clearing 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.

Data analysis

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

Results and discussions

Height of plants during the growth

The Figure 1 illustrate the height of plants according to the different treatments during the growing stages of plants. The height of plants increases during the growth and differs according to substrate applied (Figure **1**). Comparatively to control plots (T0), the height of plants is most significant (P value<.001) for the supply of poultry manure substrate (T1), followed by the goat dropout fertilization (T2). The must highest value of the height was recorded by the supply of poultry manure (1.29 m), followed by goat dropout fertilizer (1.11 m) during the development of plants.

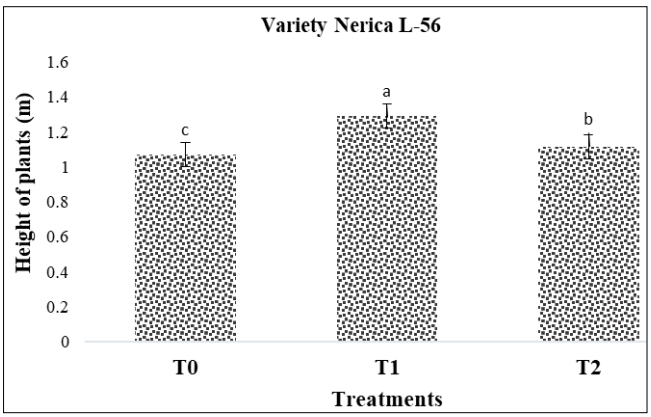

Fig 1: Height of plants during the development (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout).

Number of tillers on maturity of plants

The Figure 2 illustrate the number of tillers at the maturity of development of plants according to the different substrate applied. The number of tillers vary according to the substrate used. Referred to control plots (T0), a most significant difference (P value=0.442) is recorded for the supply of poultry manure substrate (T1) and the goat dropout (T2). The highest value of the average number of tillers of plants was observed with the supply of goat dropout (30), followed by the apply of poultry manure with average rate of 25.

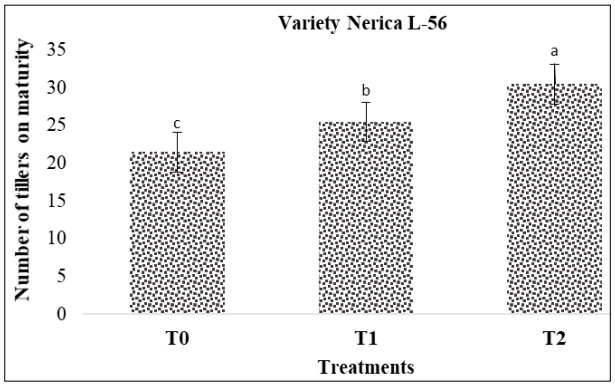

Fig 2: Number of tillers on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout)

Number of panicles per pockets at the maturity of plants

The Figure 3 show the number of panicles arrived at the maturity of development of plants according to the different substrate applied. The number of tillers differs according to the different treatments used. In comparison to control plots (T0), the supply of different substrates (T1 and T2) not significantly (P value=0.282) influenced the appearance of panicles of plants during the development of plants at the maturity.

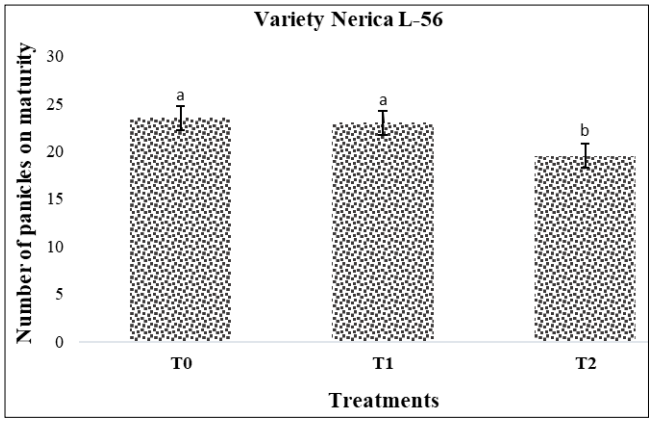

Fig 3: Number of panicles on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout)

Number of seeds per panicles on maturity of plants

The Figure 4 show the number of grains per panicles at the maturity of development of plants according to the different substrate applied. The number of grains per panicles varies according to the different treatments (Figure 4). Comparatively to control plots (T0), the supply of poultry manure as organic fertilizers (T1) was significant (P value=0.001) on the number of grains per panicles at the maturity of development of plants. The highest value of the average number of grains per panicles was recorded by the supply of poultry manure (262), followed by the control plots (T0) with the average rate of 208.

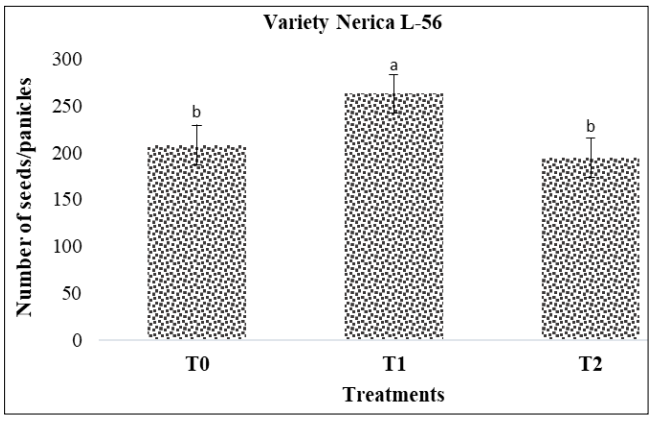

Fig 4: Number of seeds on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout)

Weight of 1000 seeds on maturity

The Figure 5 illustrate the weight of 1000 grains taken at the maturity of development of plants for the different substrates considered. The weight of grains varies according to the different substrate applied. Comparatively to non-amended plots (T0), the supply of all substrates (T1 and T2) not significantly (P value=0.048) influenced on the weight of 1000 grains after harvest of plants rice at the maturity. The highest value of the average weight of 1000 grains per substrates was recorded by the control plots (29.48).

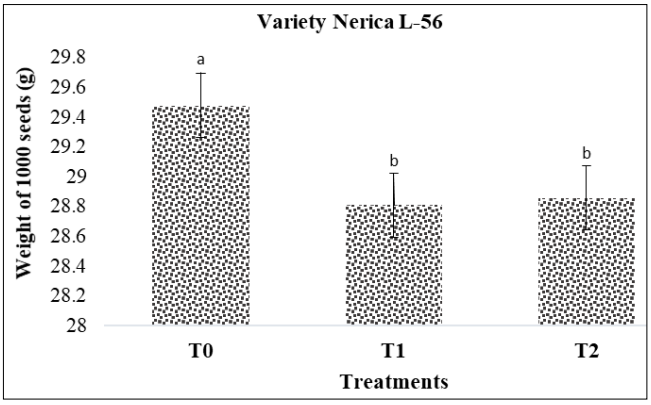

Fig 5: Weight of 1000 seeds on maturity of plants (P≤0.05; T0 = control; T1 = poultry manure; T2 = goat dropout)

Discussions

This study is focuses on the effect evaluation the quality of organic fertilizers on the growth characteristic and grain yield of the variety of Rice L-56 (*Oryza sativa* (L.)) in Sudano-sahelian zone. A significant increasing of height of plants were recorded by the supply of poultry manure and goat dropout during the growth of plants. The response of plants on growth at the maturity were improves with the applied of these two organic fertilizers. The founded works of Dzomeku *et al*. (2016) [9] on the effect of residual organic materials on the growth of maize showed a significant supply of organic residues of the rice culture on the height of plants, according to the different levels of organic manure applied. More the quantity is high, must we have an improvement of the height of plants at the maturity. In the same idea, a direct significant effect of different organic residual of poultry compost as biological fertilizers on the height of plants of maize was recorded at 6 weeks after planting (Otitoju *et al.*, 2016) [22]. The growth of maize plants was must improve by the supply of cockerel manures and broiler manures as organic fertilizers (Otitoju *et al.*, 2016) [22]. The supply of organic manure permits the restoration of nutrients elements, increase soils fertility and a good water efficiency (Gomgnimbou *et al.*, 2019; Kaho *et al.*, 2011) [12, 14].

The number of tillers of plants rice at the maturity differed significantly within the different substrates applied. The apply of goat dropout and poultry manure as organic fertilizers used on rice culture were improved considerably the number of tillers during the growth of plants. The works of Otitoju *et al*. (2016) [22] demonstrated a significant gradual increasing of the number of leaves of maize plants by the supply of a certain level of broiler manure. Also, works of Wang *et al*. (2020) [29] on the effect organic manure input in the improvement of soil water and nutrients use for sustainable maize (*Zea mays* (L.)) productivity on the Loess Plateau if China showed a significant effect of organic fertilizers of leaf area and above-ground biomass of maize plants à three different densities according to years. They demonstrated also that the association of chemical fertilizers with organic manures have great potential to improved leaf area of individual plant compared to that of

chemical fertilizer input alone (Wang *et al.,* 2020) [29]. Similar finding results of Ogendo *et al*. (2018) showed a good effect of the supply of compost like biological fertilizers on the appearance number of leaves of maize plants in one of two sites of agro-ecological zone of Kenya.

The number of panicles per pockets at the end of the maturity differed among the different substrates used. However, the poultry manure and goat dropout applied as organic fertilizers not influenced more the appearance of the number of panicles during heading process of rice plants. Our results not corroborate with the works of Isitekhale *et al*. (2013) [13], which showed that the poultry manure effect alone and their residual effect gave a significant highest number of fruits compared to control plots in one of experimental site. In retrospect, in another site the applied of poultry manure level combined with mineral fertilizers gave highest number of fruits compared to poultry manure alone (Isitekhale *et al.,* 2013) [13]. Same results were also recorded by Wang *et al*. (2020) [29] which found that organic manure input significant enhanced the maize cobs number per unit area compared to that of chemical fertilizer applied alone.

The number of seeds per panicles after harvesting process of plants rice differed significantly among the different treatments applied. The supply of poultry manures as organic fertilizers applied was enhanced the number of seeds per panicles. Finding works of Farhad *et al*. (2009), has proved a significant effect of poultry manure on the number of grains per rows of maize cob by the applied of different levels of poultry manure. In the same idea, this works was similar to the results found by the works of Wang *et al*. (2020) [29], showed a significant effect organic manure input on the grains number per cobs and grains number per unit area compared to that of chemical fertilizer applied alone. According to Nyembo *et al*. (2014) [19], poultry manure presents a high potential of the improve of the availability of soils nutrients element for a good production.

The weight of 1000 grains differed significantly among the different fertilizer treatments applied. The supply of two organic fertilizers (poultry manure and goat dropout) not more influenced the grain yields after weighting the seeds for all substrates used. This works not similar to the works of Dzomeku *et al*. (2016) [9], which found that the stover weight and cob weight of maize plants were significant improved with the applied of residual organic materials of rice culture as organic fertilizers used. The length of cobs after harvesting varies according to the levels of supply on quantity of residual organic materials of rice (Dzomeku *et al.,* 2016) [9]. Also, finding results of Yusuf *et al*. (2018) [30] demonstrated a non-significant effect of the combined of leaves of Moringa litters with the poultry manure on the grain yields of maize of plants. In retrospect, the works of Ndongo *et al*. (2022) [17], showed a significant effect of the use of poultry manure and compost fertilizers on improvement of grains yields of maize culture. Same works were also recorded by the results of Wang *et al*. (2020) [29], which found that organic manure input significant enhanced the kernel dry weight (1000 seeds) of maize compared to that of chemical fertilizer applied alone.

Conclusion

The study on the quality of organic fertilizers on the growth characteristic and grain yield of the variety of Rice L-56 (*Oryza sativa* (L.)) in Sudano-sahelian zone showed that the use of poultry manure and goat dropout as organic fertilizers significantly improves the height of plants rice compared to non-amended plots. However, the number of tillers were significant ($P \leq 0.05$) with the use of poultry manure and goat dropout treatments, compared to control plots. Referred to control plots, the different substrates applied not significantly ($p<0.05$) influence the number of panicles at the maturity of development. The number of seeds per panicles at the maturity were significantly ($p<0.05$) highest by the use of poultry manure treatments. The weight of 1000 seeds after harvest for all substrates applied were not significant ($p<0.05$) compared to the non-amended plots. We 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 take more time for the mineralization and availability of nutrients that plant are needed.

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