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Comparative test of chemical fertilizers associated to organic manure on growing parameters of the most cultivated cereals on degraded area of the Sudano-sahelean zone of Cameroon

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Abstract

Of our time, the intensification of cultures, the poor management of plant nutrition, the degradation of soil and the lack of crop rotation are principal factors responsible to the decrease of the productivities of cultures. The main objective of this study was to evaluate effects of fertilizers associated to the organic manure on the growing measure of cereals (Maize and Sorghum) in a degraded soil of North. This study was carried out at the site of the Polyvalente Station of Agricultural Research of the North-Cameroon. Treatments were: T0 (control); T1 (poultry manure); T2 (fertilizers 23-10-5+2Mgo +7.5S); T3 (poultry manure + fertilizers 23-10-5+2Mgo +7.5S). The experimental design was a completely randomized blocks with 3 repetitions. The parameters evaluated were: the germination rate, the height of plants and the diameters of plants of these two cereals. The results showed that the germination rate was suitable with the use of all treatments for the Maize variety CMS-8501 and favorable for the Zouaye variety with the use of poultry manure and the association of poultry manure + fertilizers. The apply of fertilizers types and the association of poultry manure + fertilizers were significant ($P \leq 0.05$) on the height of Maize variety CMS-8501, compared to the control plots. Concerning the Zouaye variety, the use of poultry manure, fertilizers types and both treatments were significant ($P \leq 0.05$) on the height of plants compared to control. Moreover, the number of leaves emitted by the Maize variety CMS-8501 was significant ($P \leq 0.05$) with the fertilizers and poultry manure + fertilizers treatments. But for the Zouaye variety, all treatments applied were enhance the number of leaves emitted. However, the diameter of plants for the Maize variety CMS-8501 significantly ($P \leq 0.05$) increased with the supply of fertilizers and both treatments compared to control plots. Concerning the Zouaye variety, all treatments applied significantly ($P \leq 0.05$) favor the diameter of plants compared to control plots.

Keywords: Fertilizers, cereals, poultry manure, degraded soils, sudano-sahelean zone

Introduction

Nowadays, very significant increase of crop vegetation is due to improve of soil fertility by the use of mineral fertilizers, irrigation and control with help of chemical pesticides, pests like weeds, insects, fungus, viral and bacterial pathogens (Adjanohoun *et al.*, 2017) [3]. In Africa, agriculture is one of the pillars of growth and the majority of cereals (Sorghum, Millet, Maize, and Rice) are cultivated in particular by small farmers (Harold & Tabo, 2015) [9]. In Cameroon, around 70 % of population is depend on agriculture and breeding for surviver, 90 % of rural households are engaged in an agricultural activity and a third of them benefit an income of cash crop (PAM, 2011) [12]. Which makes agricultural sector like a key for the growth and the reduction of poverty which may contributes to supply surrounding countries (PAM, 2011) [12].

Regarding yield gaps that are deep, poverty of soils and others constraints rending most difficult a sustainable agriculture (Harold & Tabo, 2015) [9]. Agriculture should be improved for feed its population, respond to the regional request considering the large availability of ground and satisfy the cereal and food deficit (PAM, 2011) [12]. However, these basic foods (cereals and foods cultures) in majority cultivated by smalls producer are confronted to the little of agricultural productivity due to the degradation of soils, persistent biotic and abiotic pressure and insufficient mechanization. Furthermore, in Africa yields of cereals are inferior to the half of worldwide average. Average consumption of fertilizers ($N + P_2O_5$) is 16.24 kg/ha (FAO, 2010), which represent $1/6^e$ of worldwide consumption of 98.20 kg/ha (Harold & Tabo, 2015) [9]. In this context agricultural transformation will be encouraged by the increasing of yield of small farmers in using adapted fertilizers and in improving new technologies like cultural technique, resistant variety to stress and high productivity. However, intensive agriculture is more criticized due to degradations caused to environment, particularly on soil namely excess of nitrate or pesticides, others intrants in high fossil energy consumption non-renewable (Adjanohoun *et al.*, 2017) [3]. Hence the importance of news strategies of agricultural development and environmental requiring to focalize not only to agricultural technology, but in particular to organic matter and mineral for degraded soil.

In the actual context where the productivity of cereals cultures (Maize and Sorghum) in the degraded area is improved by use of fertilizers, control by chemical pesticides, pests (weeds, insects, pathogens), it is important to adjust and ameliorate the productivity of these cultures of subsistence. Considering the actual food insecurity, constraints that encountered of cereals producers and the increase of price of agricultural fertilizers causing hunger. An awareness of producers for food security of cereals cultures and new methods of production (association of cultures, polyculture or rotation) are necessary for enhance

the cereals production in degraded middle. Moreover, for the good agricultural activity in the site, the use of nutritive elements is suitable (Useni *et al.*, 2013) [16], because the soils are the most unproductive due to the intensification of cultures, the lack of cultures rotation and the absence of crop practices management.

It is in this idea that a comparative test of fertilizers associated to organic manure on the growth parameters of cereals (Maize and Sorghum) was realized. The general objective of this study is to evaluate the effects of chemical fertilizers associated to the organic manure on the growth measure of cereals (Maize and Sorghum varieties) in the degraded soil of Sudano-sahelean zone, Cameroon.

Materials and methods

1. Description of the site zone

The study was realized on the site of Polyvalente Station of Agricultural Research of North of Cameroon. The area is covered by the Sudano-Sahelian 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. Vegetal materials

For the experience, ameliorated seeds of cereals such as one variety of Maize (CMS-8501) and Sorghum (Zouaye) were collected from the Institute of Agricultural Research for Development (IRAD) of Garoua. This varieties are considered like late with the cycle of development around 120 to 140 days for Maize and 90 to 120 days for Sorghum.

A (CMS-8501)

B (Zouaye)

3. Soil preparation

The soil preparation consists to doing plowing process and delimitation of experimental units. Soil labor was made at 25 cm of depth and also treatment of soil was done with herbicides for kill weeds in unit plots. The spreading of substrates (poultry manure + mineral fertilizers) was quantified and done two weeks before sowing of different cultures. After two weeks, the mineral fertilizers NPK 23-10-5+2Mgo +7.5S was applied for a good growing of plants in field.

4. Fertilizers used

The chemical fertilizers used are constituted of recommended mineral fertilizers NPK (23-10-5+2Mgo +7.5S) of the dose of 100 kg and urea (45 % N) for 1 ha and chicken manure on a reason of 70 g per units of 20 m^2. The application dose of fertilizers is 2.4 kg per unit on field for the cereals culture (Maize CMS-8501 and Zouaye). The organic manure as chicken manure is used on reason of 70 g per plants for the density of 174 plants per unit for the cereals. The quantities of 14 kg of chicken manure were applied per unit which receives this substrate.

5. Experimental design

The experimental design was a block completely randomized with 3 repetitions and fourth treatments including control (T0), chicken manure (T1), Fertilizers types 23-10-5+2Mgo +7.5S (T2) and chicken manure + fertilizers (T3). Every block is divided in sub-blocks arranged at the distance of 0.5 and each unit measure 4 m x 10 m =20 m^2 for the cereals culture. Before sowing, soil was labor at 25 cm of depth. Sowing process was done two weeks after with 80 cm of distances between lines and 25 cm between pockets. The total number of plants per unit was 174. Seeds were sowed in soil approximatively at 5 cm depth and weeds were sprayed in every unit considered. Spraying after sowed with pesticide was realized at thirteen weeks against attacks of plants by others insects.

6. Treatments

The applied quantities of different substrate (chicken manure and mineral fertilizers) were measured with a scale (Table 1). Treatments are control without any substrate (T0), poultry manure (T1), fertilizers 23-10-5+2Mgo +7.5S (T2) and the association of substrate (T3). Before sowing, 14 kg of organic manure (chicken manure) were applied on all experimental units which receives poultry manure. However, fertilizers types 23-10-5+2Mgo +7.5S+ urea (45 % N) were applied in reason 2.4 kg on units which receives mineral fertilizers 2 weeks after sowing.

Table 1: Applied treatments and control.

Treatment code	Treatments	Doses
T0	Control	0 kg
T1	Chicken manure	14 kg
T2	Fertilizers 23-10-5+2Mgo +7.5S	2.4 kg
T3	Chicken manure+ Fertilizers 23-10-5+2Mgo +7.5S	14 kg+2.4 kg

6. Parameters assessment

6.1. Germination rate of cereals

The germination rate was evaluated on the field. The numbers of germinated plants and not germinated plants were counted in order to determine the rate of plants, which are germinated per units for different treatment and control. Data were collected from 10^{th} days after sowing (DAS) on 15 plants takes like reference for measure.

$$Germination\ rate = \frac{\text{Number of seeds germinated poquets}}{\text{Number of seeds on the try}} \times 100$$

Total numbers of pocket = number of germinated pockets + number of empty pockets.

6.2. Height of cereals

The growing of plants determination consists to measure with decameter the height of 15 plants takes like reference at the interval of 10 days. Data were collected for every treatment and control on four sampling campaigns, 30th DAS, 40th DAS, 50th DAS, and 60th DAS.

6.3. Number of leaves of cereals
The number of leaves was counted on every plant reference of 15 plants. It is consisting to determine the number of leaves for each treatment considered at the interval 10 days on four sampling campaigns, 30th DAS, 40th DAS, 50th DAS, and 60th DAS.

6.4. Diameter of cereals
The diameter of plants was measure with caliper on every 15 plants reference for all treatments at the interval 10 days on four sampling campaigns, 30th DAS, 40th DAS, 50th DAS, and 60th DAS.

6.5 Statistical analysis
Data of growing and yields were performed using ANOVA test with software R-Cmdr. Significances average separation were done with the test of Tukey at the probability of 5 %.

Results
1. Germination rates of cereals
The germination rate of Maize variety (CMS-8501) in amended plots was higher compared to control plot (Figure 2a). Uses of poultry manure, fertilizers type 23-10-5+2Mgo +7.5S and poultry manure considerably favor germination of Maize plant. The difference on germination rate was noted with fertilizers, poultry manure + fertilizers and poultry manure compared to control plots ($P \leq 0.05$). They vary respectively of 95.45 % (fertilizers type 23-10-5+2Mgo +7.5S), 94.13 % (poultry manure + fertilizers) and 93.37 % (poultry manure). Concerning the Zouaye variety (Figure 2b), the difference was recorded on fertilizers + poultry manure treatment followed by poultry manure, compared to control plots. The germination rates vary respectively of 94.69 % (fertilizers + poultry manure), 94.5 % (poultry manure), compared to the control plots (93.63 %). However, use of fertilizers types 23-10-5+2Mgo +7.5S not improve germination rates of Zouaye variety (T2). Germination rates at 100 % was not observed due to the effect of degraded soil of north region and the soil is considerably poor in nutrients element for plants (Figure 2b).

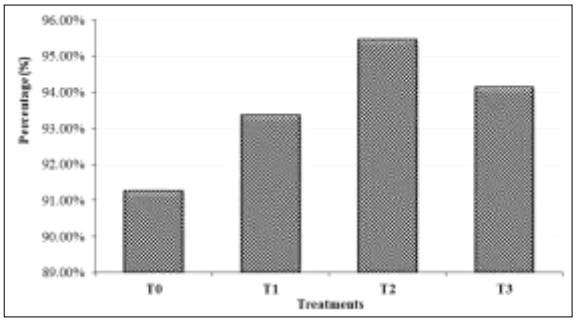

Fig 2a: Maize variety CMS-8501

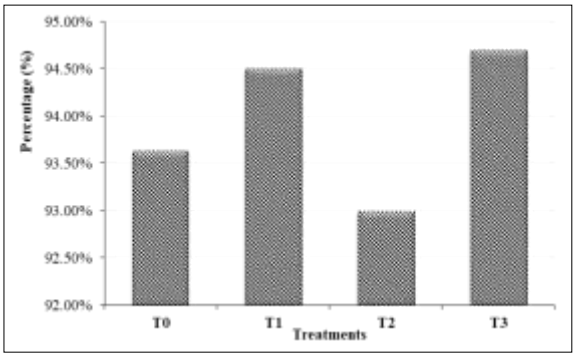

Fig 2b: Zouaye variety

(T0 = control; T1 = poultry manure; T2 = fertilizers 23-10-5+2Mgo +7.5S; T3 = poultry manure + fertilizers 23-10-5+2Mgo +7.5S).

III.2 Height and the number of leaves of cereals
The Figure 3a show the effect of different treatment on the height of plants for the Maize variety CMS-8501 at 30th, 40th, 50th and 60th DAS. The height of plants increased during the growing stages of Maize plants. Referred to control plots (T0), the growing of plants was significant ($P \leq 0.05$) from 30th DAS to 60th DAS by the use of poultry manure (T1), fertilizers (T2) and the association of substrate of poultry manure + fertilizers (T3) for the Maize variety CMS-8501 (Figure 3a). That suggest the effect of all treatments on growth of plants height. The same results were obtained also with the Zouaye variety of Sorghum (Figure 3b) and show that all the supply of treatments significantly ($P \leq 0.05$) enhance the growth of plants from 40th DAS to 60th DAS by the use of poultry manure (T1), fertilizers (T2) and the association of substrate poultry manure + fertilizers (T3).
The Figure 4a illustrate the effect of different treatments on the number of leaves for Maize variety CMS-8501 at 30th, 40th, 50th and 60th DAS. The number of leaves was enhanced during the growth of plants. In comparison to the control plots (T0), the number of leaves was significant ($P \leq 0.05$) at 40th DAS and 60th DAS with the applied of fertilizers types (T2) and the association of substrate poultry manure + fertilizers (T3). The rate number of leaves varies respectively of 8 to 9 (40th DAS) and 7 to 9 (60th DAS). In comparison among cereals, the applied of all substrates was significant on the average of number of leaves emitted from 40th DAS to 60th DAS for the Zouaye variety (Figure 4b).

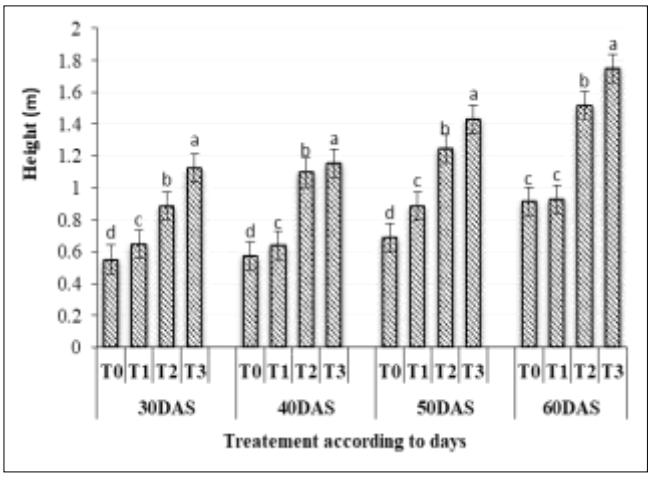

Fig 3a: Maize variety CMS-8501.

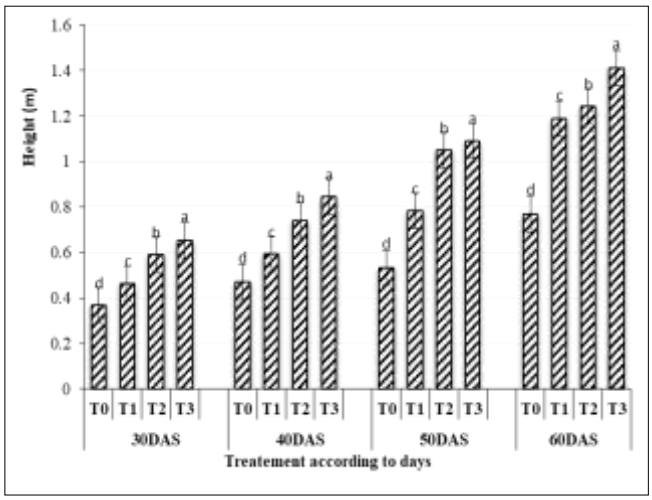

Fig 3b: Zouaye variety.

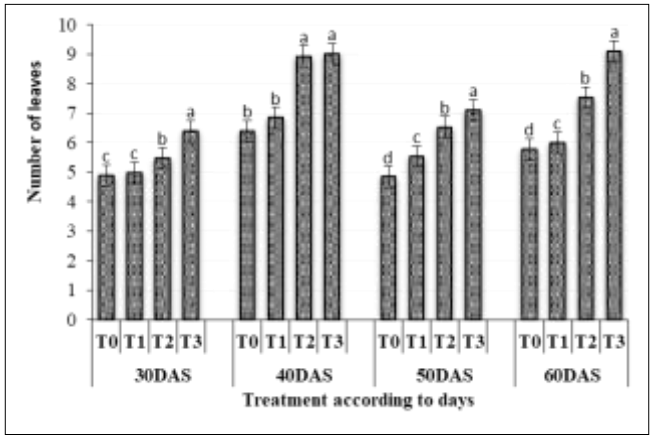

Fig 4a: Maize variety CMS-8501.

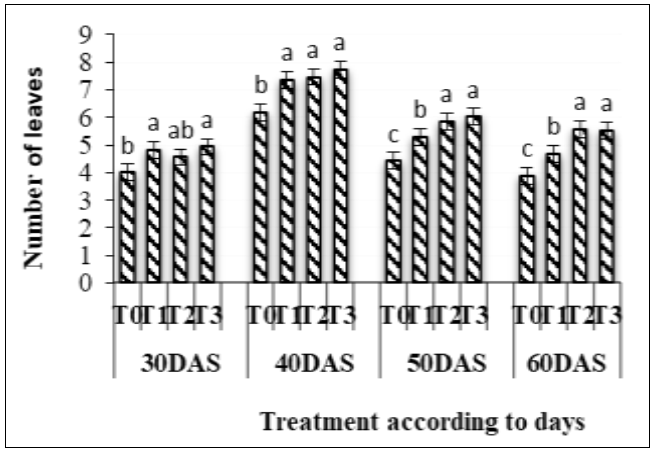

Fig 4b: Zouaye variety.

3. Diameters of cereals

The Figure 5a show the effect of different treatments on the diameters of plants for Maize variety CMS-8501 at 30th, 40th, 50th and 60th DAS. The diameters of plants were increased during the growth of Maize plants. In comparison to control plots (T0), the use of fertilizers types (T2) and the association of substrate of poultry manure + fertilizers (T3) significantly (P≤0.05) enhance the diameters of plants from 30th DAS to 60th DAS. For the Zouaye variety of Sorghum (Figure 5b), the use of substrates such as the poultry manure (T1), fertilizers (T2) and the association of substrate of poultry manure + fertilizers (T3) significantly (P≤0.05) enhance the diameter of plants from 30th DAS to 60th DAS.

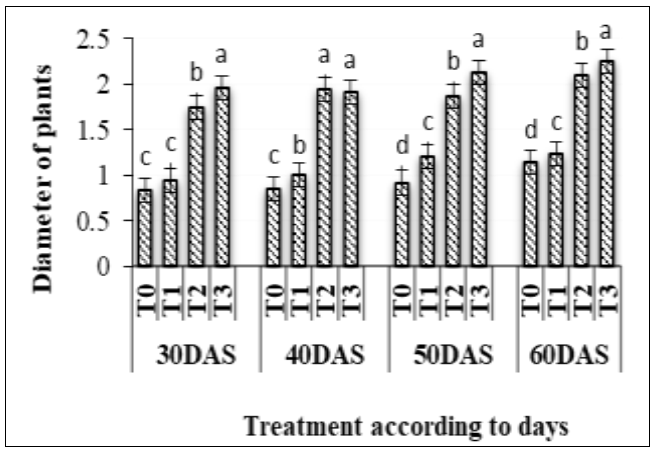

Fig 5a: Diameter of Maize variety CMS-8501.

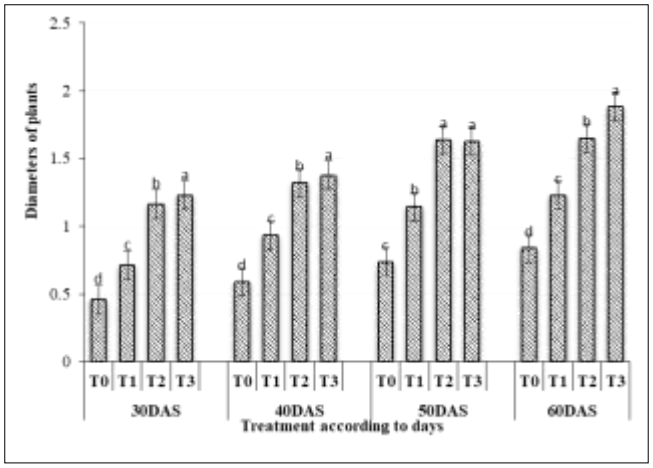

Fig 5b: Diameter of Zouaye variety.

(T0 = control; T1 = poultry manure; T2 = fertilizers 23-10-5+2Mgo +7.5S; T3 = poultry manure + fertilizers 23-10-5+2Mgo +7.5S).

Discussions

First step for this study began by the germination rate of cereals in the field and growth parameters. This study showed that the germination rate of Maize variety CMS-8501 was greater in amended plots compared to control. Concerning the Zouaye variety, germination rate was most suitable with substrate poultry manure and the association of fertilizers + poultry manure compared to the nonamended control plots. The works of Nyembo *et al.* (2012) [11] on the different doses of fertilizers on the Maize productivity enhance the germination rate of plants. Also, the works of Wang-Bara *et al.* (2022 and 2021) [17, 18] on the organic amendment of Maize and Sorghum plants ameliorate the germination rate of plants. These different responses may be due to the restoration of soil with fertilizers types (23-10-5+2Mgo +7.5S) and the organic manure, because this soil received not only many cultures, but may be the monoculture systems in this locality.

The applied of substrate such as fertilizers and association of substrate poultry manure + fertilizers enhance the height of Maize variety CMS-8501 compared to control plots. For the Zouaye variety, poultry manure, fertilizers and association of substrate poultry manure + fertilizers were suitable to the height of plants compared to control plots. Our works corroborate with the works of Nyembo *et al.* (2012) [11], which founded that the use of inorganic fertilizers doses on the productivity of two varieties of Maize were increased considerably the growth such as: germination rate height of plants on male flowering, height at corn insertion and pour resistance. Same results were also proved by Mariama *et al.* (2016) [10], which found a significant growth on height of plants at 5 varieties of Maize by the use of some doses of mineral fertilizers. According to the works of Tchuenteu (2017) [14], the organic matter applied in the degraded soil restore well the nutrients elements of this soil. This positive effect of substrate its due to restoration of soil with substrate given to the degradation of soil on the field. According to the works of Nyembo *et al.* (2012) [11], the crops intensification leads to the decrease of the level of soil fertility. In this idea, we have the reduction of the organic matter (N element) in the soil and appearance of weeds (Nyembo *et al.*, 2012; Batiano *et al.*, 2004) [11]. In the same idea the results of the works of Abdourahmane *et al.* (2020) on the Sorghum plants and Wang-Bara *et al.* (2022 and 2021) [17, 18] on Maize and Sorghum plants, proved the benefit effects of organic manure on growth parameters of Maize plants. Contrary, the works of Abdou *et al.* (2019) [1] had not affect on growth with organic fertilizers on the Millet culture (Sanio), but the mineral fertilizers affected the growth of Millet.

The use of different substrate as fertilizers and association of substrate poultry manure + fertilizers improve leaves of plant of

the variety Maize CMS-8501 compared to non-amended plots. Concerning Zouaye variety of Sorghum, the appearance of leaves was noted with poultry manure, fertilizers and association of substrate poultry manure + fertilizers. One of the benefit aspects of the use of fertilizers it these improves the biomass for the previous cultures (Nyembo *et al.,* 2012; Batiano *et al.,* 2006) [11, 6]. The works of Siene *et al*. (2019) [13] on the effects of two different types of mineral and organic fertilizers on morphological characteristics and yield of a variety of Millet showed that the density of leaves emitted is correlated to two types of fertilizers. As for, the mineral fertilizers are good indicator of leaves formation of Millet culture during the vegetative stages (Siene *et al.,* 2019) [13]. That suggest the organic and mineral fertilizers have good effect on the growth and vegetative recover of plants. The degraded soil of this locality could be a one factors of the decrease of crops production.

The use of fertilizers and associated of substrate poultry manure + fertilizers improve the diameter of Maize CMS-8501 compared to non-amended plots. For the variety of Zouaye the use of substrates such as poultry manure, fertilizers and association of substrate poultry manure + fertilizers improve the diameter of plants compared to amended plots. The growth of plants in term of thickness depends mostly by the use of substrate. In this case, the applied of fertilizers types (23-10-5+2Mgo +7.5S) specially for cereals and the association of organic manure + fertilizers types (23-10-5+2Mgo +7.5S) in the degraded soil of the North could justify the restoration of this soil in nutrients element (N, P) benefits to the growth of plants. Also, by the presence of organic manure associated to fertilizers types (23-10-5+2Mgo +7.5S) could accelerate the activities of soil micro-organism and favor the release of nutrients element that plant needed. Similarly, the works of Wang-Bara *et al*. (2021) [18] and Tshibingu *et al*. (2017) [15] respectively on Sorghum and Maize showed that the diameters of plants were significant on fertilizers plots compared to non-amended plots. According to Carpenter-Boggs *et al*. (2000) [8], micro-organism activities by the supply of organic manure enhance the restoration of soil.

Conclusion

The results of this study on essay of mineral and organic fertilization on the growth parameters of two types of cereals (Maize and Sorghum) in the degraded soil of the Sudano-sahelean zone showed that, the use of fertilizers types and the association of poultry manure + fertilizers are beneficial on the height of plants for the Maize variety CMS-8501. However, for the Zouaye variety the use of all different substrates ameliorates the height of plants during their growth. The number of leaves of the Maize variety CMS-8501 enhance with the use of fertilizers types and the combined effect of poultry manure + fertilizers, compared to the Zouaye variety that all the different substrate are suitable on the leaves emitted. The diameter of plants of the Maize variety CMS-8501 increase with the use of fertilizers and the association of poultry manure + fertilizers, compared to the Zouaye variety that the different treatment used ameliorate the growth in stem thickness of plants.

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