# Comparative effects of poultry manures and mycorrhiza on growth parameters and yields of Peanut (*Arachis hypogea* (L.)) in a Sudano-Sahelian area of Cameroun (Yagoua, Far-North region)

Wang-Bara Bertrand[1], Danra Djackba Dieudonné[2], Ahmed Hamana[3], David Amedep[4], Housseini Djida Jacques[5]

[1]*Polyvalente Station of Agricultural Research, Institute of Agricultural Research for Development (IRAD) B.P: 415 Garoua, Cameroon.*

*University of Dschang, Faculty of Agronomy and Agricultural Sciences, B.P: 222, Dschang (Cameroon).*

[2]*Department of Biological Sciences, Faculty of Sciences, University of Maroua, Cameroon*

[3]*Department of Biological Sciences, University of Ngaoundéré, Cameroon*

[4]*Department of Biological Sciences, Faculty of Sciences, University of Ngaoundéré, Cameroon*

[5]*Institute of Agricultural Research for Development (IRAD), Multipurpose Station of Agricultural Research of Garoua, Cameroon*

***Abstract:*** **The use of poultry manure as organic amendment and mycorrhiza inoculation to increase plants productivities is increasing. This study was carried out at the SVRA of Yagoua, Far-North of Cameroon. The main objective was to examine the efficiency of mycorrhiza and poultry manure on peanut plant growth and yield. Treatments were: mycorrhiza (20g) and poultry manure (50g) and a control without any substrate. The experimental design was a completely randomized blocks with 3 repetitions. The evaluated parameters were: the germination rate, the plants growth parameters and yield.**

**Findings in general revealed that, the application of mycorrhiza and poultry manure affected almost all variables observed on growth and yield of peanut. The germination rate was important in amended plots compared to the nonamended control plots. Plants were higher in amended plots compared to control. Moreover, all the amendments increased the numbers of leaves, pods and ramification per plants. Statistical analysis showed that all treatments significantly affected leaves, pods and ramification number per plants at some stage of the peanut plants development ($P<0.05$). However, only treatments with mycorrhiza significantly increased seeds weight ($p<0.05$).**

***Key words*****: Mycorrhiza, organic fertilizers, Yield, Peanut, poultry manure.**

## I. INTRODUCTION

Peanuts (*Arachis hypogea* (L.)) are leguminous plants, of the family of Papilionaceae (Fabaceae) used generally as income of resources and food for subsistence (Schilling, 1996, Betdogo *et al.,* 2015). In Africa, peanuts are the first leguminous plants in term of production and human consumption. Leaves rich in phosphorous are highly used for animal feeding and are considered as green manure (Debbabie and Shafchak, 2008). Peanut pulp are applied as organic amendment on salty soil, to improve fertility by increasing carbon, nitrogen, phosphorous contents of soil (Maodo, 2018). Optimal valorization of this agricultural sub-product may present a benefit in stock farming (Bougoum, 2000). In a rotation crop system, peanut plants are considered as important source of nitrogen incomes for cereals cultures like Millet, Sorghum and Maize (Karimata, 2001).

In Cameroon, peanut is produced in all regions, but the yields remains low (Rapport projet C2D, 2013; Mandimba *et al.,* 1996). The excellent cropping area of peanut in Cameroon is the Soudano-Sahelean zone (Betdogo *et al.,* 2015). However this cultivation is now threatened due to climate change, drastic soil degradation, insect's attacks and rain reduction (Granier *et al.,* 2000; Kasongo *et al.,* 2013). Moreover, the poor knowledge of soils qualities, and the intensives uses of chemical fertilizers is destabilizing this cultivation. In degraded area like the Sudano-Sahelean zone of Cameroon and specially the Sahelean area of Yagoua, mycorrhiza and organic manures maybe useful to improve soil health and soil fertility.

Mycorrhizas are beneficial associations between soils fungi and plants roots. Appear as an alternative to improve soil nutrients availability for plants growth without impacting the environment and human's health. Leguminous plants roots are easily colonized by fungi and the effect of mycorrhiza on leguminous crops is potentially most important than the other groups of plants (Razakatiana, 2019). Moreover, studies showed that mycorrhiza inoculation in poor soils is vital for leguminous plants (Roger *et al.* 2001, Cavagnaro and Martin, 2010, Lü *et al.* 2018, Huang *et al.* 2020). Mycorrhiza inoculation may improve plants growth and productivity by increasing total root length and volume thus, the soil nutrients uptake by plants roots (Wu and He 2010, Cameron *et al.,* 2013, Yang *et al.,* 2015, Heinonsalo *et al.,* 2016, Shao *et al.,* 2018, Li *et al.,* 2019, Huang *et al.,* 2020).

Organic manures like poultry manure also play important role on maintaining soils fertility. Their are availability on the soil increase nutrients element like N, P, K, S. Physical, chemical, biological properties of soils and productivities of plants are also improved (Agbede *et al.*, 2008, Lompo *et al.*, 2009, Somda *et al.*, 2017). Some studies revealed that application of poultry manure could enhance soil fertility and improves plants growth and productivity (Dikinya and Mufwanzala, 2010, Yerima *et al.*, 2014). In soil, the decomposition process of poultry manure is faster than the other organic manure and may release higher quantities of plants nutrients in soil, good for plants growth and productivity (Widowati *et al.*, 2005, Dikinya and Mufwanzala, 2010, Yerima *et al.*, 2014, Martin *et al.*, 2014, Adekiya *et al.*, 2016, Fatin *et al.*, 2019).

Thus, the main objective of this research is to evaluate the effects of mycorrhiza and poultry manure amendments on Peanut plants growth and productivity in a degraded and dry area characterized by a very short rainy season (three month), the Sahel zone of Cameroon.

## II- MATERIALS AND METHODS

### *II.1. the study site*

The study was conducted at the Valorization Station of Agricultural Research (PSAR) of Yagoua, Mayo-Danay in the Far North region of Cameroon (10°19'45.4" North and 15°15'35.7" East. Altitude of the area is 255 m).

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 15°C to 35°C The Vegetation in the area is dominated by *Acacia seyal*, *Butyrospermum parkii*, *Faiderbia albida*, *Anogeissus leocarpus*, *Balanites aegyptiaca*, *Tamarindus indica* and herbaceous like *Andropogon spp*, *Loutedia togoensis*, *Schoenefel diagracilis* (GIZ, 2017; MINTP, 2017).

The main cultivated crops are Millet (*Pennisetum glaucum*), Sorghum (*Sorghum bicolor*), Maize (*Zea mays*), Peanut (*Arachis hypogea*), Fonio (*Digitaria sp*), Cowpea (*Vigna unguiculata*) and vegetable crops like Carrot (*Daucus carota*), Watermelon (*Citrullus lanatus*), Tomato (*Lycopersicum esculentum*), Onion (*Allium cepa*), Gombo (*Albelmoschus esculentus*), Lettuce (*Lactuca sativa*), Black nightshade (*Solanum scabrum*) (GIZ, 2017).

### *II.2 Peanut seeds*

For the present study, Peanut (variety JL 24) seeds were collected from Institute of Agricultural Research for Development (IRAD) of Yagoua. This variety is considered like late with the cycle of development around 80 to 100 days.

### *II. 3 Mycorrhiza and chicken manures*

The selected fungi material for this investigation is a mixture of 04 stumps, *Rhizophagus irregularis* (50 %), *Scuttellospora gregaria* (10 %), *Gigaspora margarita* (20 %), *Glomus hoi* (20 %), provided by the GIC AGRIBIO CAM. it is adapted for local sols and is generally in many leguminous ant cereals cropping system in Yagoua. Poultry manure was collected from local farmers.

### *II. 4 Experimental design*

A block completely randomized with 3 replications was used with mycorrhiza inoculation and chicken manure. Each block is divided in sub-blocks arranged at distance of 1m and each unit is 2.4 m × 2.5 m = 6 $m^2$ (**Figure 1**). Before sowing, soil was hand mixed at 25 cm of depth. Sowing process was done two weeks after with 40 cm distances between lines and 25 cm between pockets. The total number of plants per unit was 60. Seeds were sowed in soil approx. at 5 cm depth. Weeding has been made every two weeks during the rainy season.

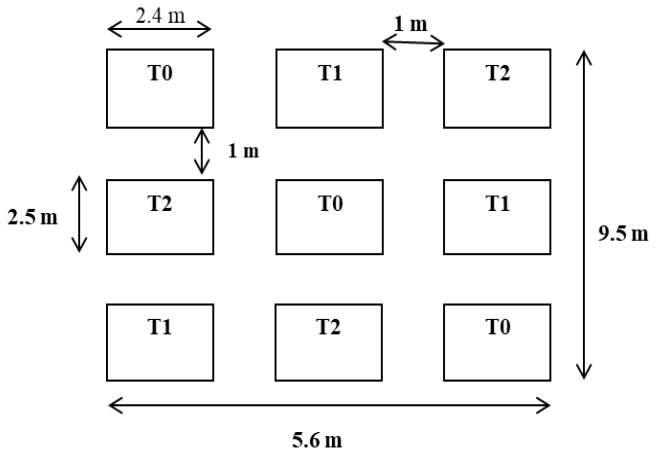


Figure 1: Experimental design (a block completely randomized with 3 replications, each block is divided in sub-blocks arranged at distance of 1m and each unit is 2.4 m × 2.5 m = 6 $m^2$)

### *II.5 Treatments*

The applied quantities of different substrate were measured with an electronic scale (2000*0.1g). Different treatments are indicated in **Table 1**. Treatments are mycorrhiza (T1) and poultry manure (T2) and control without any substrate (T0).

Table 1: Applied treatments and control.

| Treatments | Doses |
|---|---|
| Control (**T0**) | 0g |
| Mycorrhiza (**T1**) | 20g |
| poultry manure (**T2**) | 50g |

The inoculation processes was done as describe by GIC AGRO-BIOCAM, which consist to coating each seeds with mycorrhiza one hour before sowing. Before sowing, seeds were mixed at 20 g of mycorrhiza with water. Poultry

manure treatments (T2) was applied 2 weeks after sowing at the quantities of 50 g per seeds holes.

a) Water dilution with myco manures.

b) Seeds drying after coating

c) Coating of myco+chicken manures.

**Picture 1:** Coating peanut seeds with mycorrhiza and applications of mycorrhiza + organic manures on field**.**

*II. 6 Parameters assessment*

*Germination rate*

Germinated seeds and not germinated seeds were counted in order to evaluate the germination rate for the different treatments and control. Data were collected from 5$^{th}$ day after sowing (DAS) to the 10$^{th}$ day after sowing (DAS).

$$\textbf{Germination rate} = \frac{\textbf{Number of seeds germinated}}{\textbf{number of seed on the try}} \times \textbf{100}$$

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

*Growth parameters*

Data on plants height, number of leaves and number of ramification were collected on five plants for each treatment and control, on four sampling campaigns, 20$^{e}$ DAS, 30$^{e}$ DAS, 40$^{e}$ DAS, and 50$^{e}$ DAS at 10 days interval.

*Varietal precocity*

To evaluate the varietal precocity, parameters were collected on five plants for each treatment starting from the first flowering of the plants (DAS) until the 50 % of plants flowering.

*Plants Yields*

The yield of plants was evaluated at the end of the cropping season (84 DAS). The number of pods per plant for each treatments and control was evaluated on five plants. For each treatment and control, 100 seeds in total were weighed with an electronic scale (2000*0.1g).

*II.7 Statistical analysis*

Data analyses were performed using R-cmdr in R software. Significances were tested with ANOVA and subsequent Tukey test for pairs ($p<0.05$).

## III. RESULT AND DISCUSSION

*3.1 Germination rates*

The germination rate of the peanut seeds in the amended plots was higher compared to the nonamended control plots (**Figure 2**). The significantly highest germination rate was recorded on chicken manures treatment followed by the mycorrhiza treatment respectively ($P \leq 0.05$). Germination rate at 100 % was not observed, this can be due to the rustic effect of the natural environment of the investigated area.

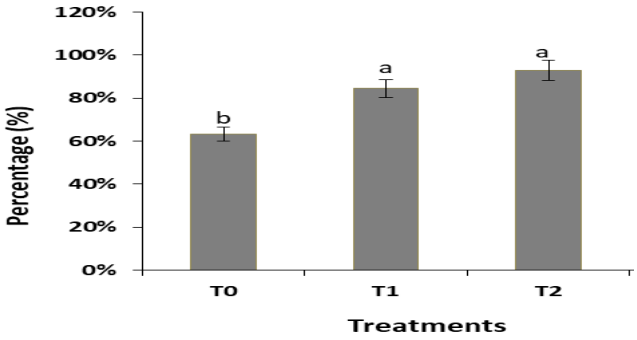

**Figure 2:** Effects of different types of fertilization on the germination rates. Histograms with the same letter are not significantly different ($P \leq 0.05$; **T0** = control; **T1** = mycorrhiza; **T2** = poultry manures).

### *3.2 Growth of plants*

#### *3.2.1 Effect of treatments on plants height*

All treatments applied positively affected peanut plants growth (**Figure 3**). All over the sampling period, peanut plants were higher in amended plots with mycorrhiza and poultry manures compared to nonamended control plots (**Figure 3**). However, the significantly highest plants were recorded in poultry manures treatment ($p<0.05$).

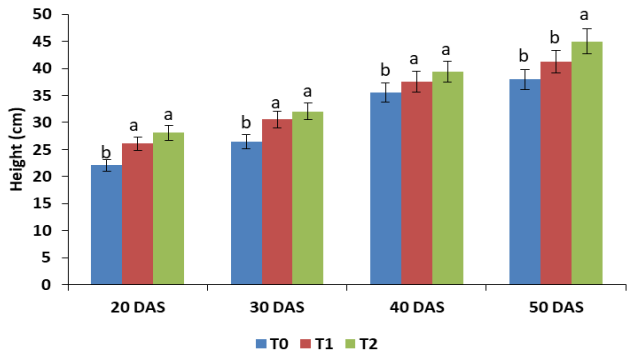


Figure 3: Effect of treatments on plants height. Treatments with the same letter (a or b) are not significantly different at the level of probability considered ($P \leq 0.05$). T0 = control; T1 = mycorrhiza; T2 = poultry manures.

#### *3.2.2 Effect of treatments on the number of leaves*

Leaves number per plant in the beginning of the vegetative stage at $20^e$ DAS and $30^e$ DAS was higher in amended plots compared to the nonamended control plots (**Figure 4**). At this stage, the significant highest leaves numbers ($p<0.05$) were recorded in poultry manures followed by mycorrhiza treatment. At $40^e$ and $50^e$ DAS leaves number in poultry manures treatment dropped down compared to control plots and mycorrhiza treatments (**Figure 4**). Same result was observed at $40^e$ DAS in mycorrhiza treatment where leaves number per plant was lower compared to control. For the whole sampling period, mycorrhiza inoculation positively affected the number of leaves per plant better than the poultry manure treatment.

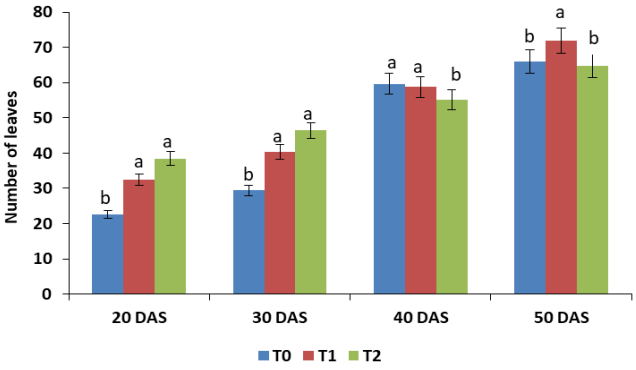


Figure 4: Effect of treatments on leaves number per plants. Treatments with same letter (a or b) are not significantly different at the level of probability considered ($P \leq 0.05$). T0 = control; T1 = mycorrhiza; T2 = poultry manures.

#### *3.2.3 Effect of the treatments on the ramification*

The effects of the different treatments on the ramification of peanut plants are showing on **Figure 5**. Compared to the nonamended control plots, mycorrhiza and poultry manure treatments increased the ramification number on peanut plants. Poultry manures compared to mycorrhiza and control plots, in most instances significantly increased the ramification of plants ($p<0.05$). At the earlier stage of plants growth ($20^e$ and $30^e$ DAS), poultry manures treatment significantly increased the ramification number on plants ($p<0.05$). At $40^e$ and $50^e$ DAS, the number of ramification par plant was again slightly higher in amended plots compared to control plots excepted at $50^e$ DAS where it was lower in mycorrhiza treatment. The application of poultry manure as treatment increased the ramification number on peanut plants over the sampling period better than mycorrhiza inoculation.

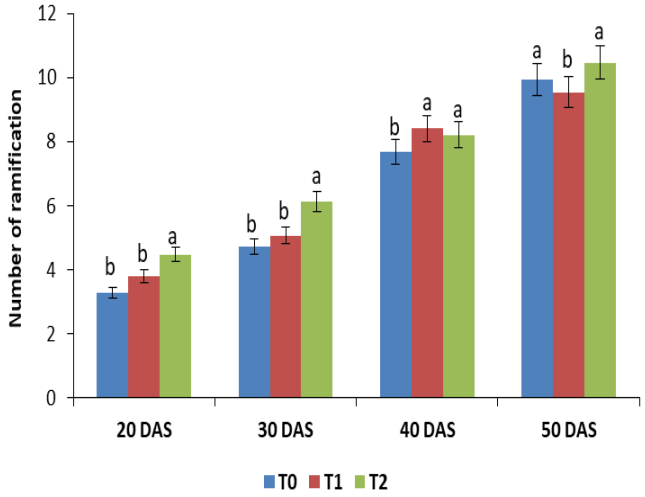


Figure 5: Effect of the different treatments on plants ramification. Treatments same letter (a or b) are not significantly different at the level of probability considered ($P \leq 0.05$). T0 = control; T1 = mycorrhiza; T2 = poultry manures.

### *3.3 Phenological stages*

#### *3.3.1 Effect of treatments on plants flowering*

Peanut plants in amended plots flowered earlier than in the nonamended control plots. Compared to control plots and even mycorrhiza treatment, poultry manure treatment reduced the flowering time of peanut plants as the first flower was observed on peanut plants from poultry manure treatment earlier at 23 DAS (**Figure 6a**). In mycorrhiza treatments, first flower appeared at 25 DAS. While, in the nonamended control plots, flowering started a bit later at 27 DAS (**Figure 6a**). Same results were recorded at 50 % of flowering stage (**Figure 6b**). Plants in poultry manure treatment reached 50 % of flowering earlier at 26 DAS compared to mycorrhiza treatment as well as the nonamended control plots in which

peanut plants reached 50 % of flowering at 28 and 31 DAS respectively (**Figure 6b**).

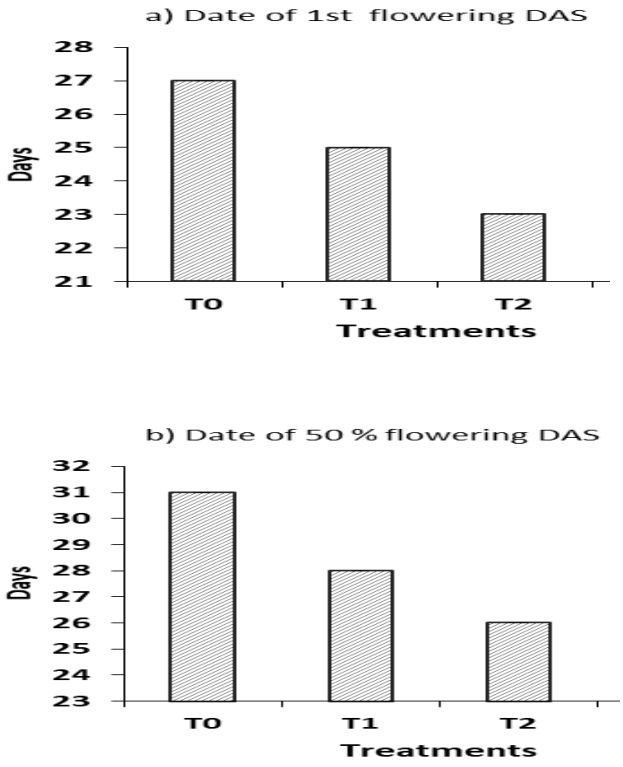


Figure 6: Effect of different amendments on the peanut plants flowering (T0 = control; T1 = mycorrhiza; T2 = poultry manures).

*3.4. Yield parameters*

*3.4.1. Effect of treatments on number of pods per plants.*

Mycorrhiza inoculation as well as poultry manure application considerably increased the number of pods per plants (**Figure 7**). ANOVA revealed that, the number of pods per plant was significantly higher in amended plots compared to the nonamended control plots ($p<0.05$). The highest number of pods per plant was recorded in plots amended with poultry manure followed by mycorrhiza treatment. The lowest number of pods per plant was obtained in control plots ($p<0.05$).

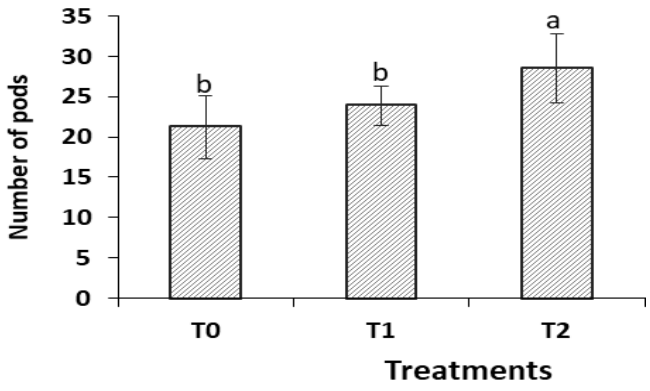


Figure 7: Effect of different types of fertilization on flowering of plants at 50 % (T0 = control; T1 = mycorrhiza; T2 = chicken manures).

*3.5 Seed Weight*

Seed weight was positively affected only by mycorrhiza inoculation (**Figure 8**). Compared to the nonamended control plots and the poultry manure treatment, significant highest seeds weight was recorded in mycorrhiza treatment ($p<0.05$). Although non significant, seeds weight in poultry manure treatment was surprisingly lower compared to the nonamended control plots.

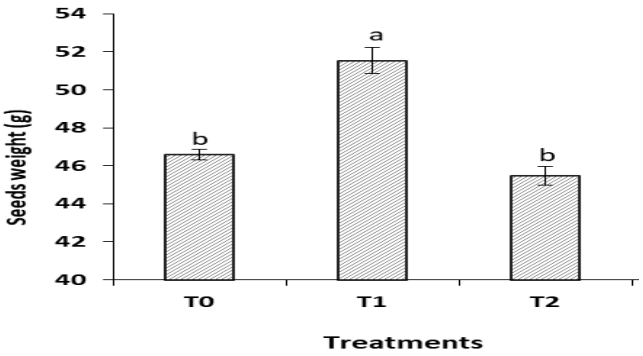


Figure 8: Effect of different types of fertilization on the weight of seeds (T0 = control; T1 = mycorrhiza; T2 = poultry manures).

## IV. DISCUSSIONS

First evaluation in field began by the germination rate of peanut seeds and then some growth parameters of the plants and also the productivity. This study showed that the germination rate was greater in amended plots compared to the nonamended control plots. Between the applied treatments, the highest germination rate was observed in poultry manure treatment.

The applied treatments: mycorrhiza and poultry manure increased more or less the peanut plant height compared to the nonamended control plots. This may be due to the positive effect of the poultry manure and mycorrhiza on the physical and chemical properties of soil. Similarly results of Azangue et al. (2019) and Agbede et al. (2008) showed also a positive effect of poultry manure on plant height. Poultry

manure remain rich in nutrient elements (Yerima *et al.*, 2014; Tchuenteu, 2017; Kobierski *et al.*, 2017), hence the degradation of soil. Poultry manure applied in soil may have released good quantities of nutrient elements and that is why, peanut plants grew faster in poultry manure treatment compared to those in mycorrhiza inoculation treatment. This result prove also that mycorrhiza inoculation may stimulate plants growth height and this was proved earlier Haro et al. (2012) and Doley and Jite (2012) studies.

Leaves number per peanut plants compared to control plots was significantly higher respectively in poultry manure and mycorrhiza treatment only at the beginning of the vegetative stage at $20^e$ and $30^e$ DAS. While, at $40^e$ and $50^e$ DAS, the counted leaves number per plants in poultry manure treatment dropped down. The same phenomenon was also observed in mycorrhiza treatment but only at $40^e$ DAS. Although Lü et al. (2018), reported occasional no positive or depressed effect of mycorrhiza on plants development, similar investigation on poultry manure and mycorrhiza by Agbede et al. (2008), Yerima et al. (2014), Azangue et al. (2019) and Haro et al. (2012) and Doley and Jite (2012) revealed opposite results.

Compared to the nonamended control plots, both mycorrhiza inoculation and poultry manure application increased the ramification number on peanut plants. In most instances poultry manures compared to mycorrhiza and control plots, significantly increased the ramification of plants ($p<0.05$). For the whole sampling period poultry manure treatment increased the ramification number on peanut plants better than mycorrhiza inoculation. These findings show that poultry manure amendment my increase plants biomass, as indicated in previous investigation by Perkasa et al. (2016), Biratu et al. (2018) and Li et al. (2019) respectively, but poultry manure better than mycorrhiza inoculation.

Mycorrhiza inoculation and poultry manure application both positively affected the peanut plants flowering compared to the nonamended control plots. Peanut plants in mycorrhiza and poultry manure treatment flowered and reached the 50 % of flowering earlier than in control plots. However, peanut plants in poultry manure treatment flowered and reached the 50 % of flowering earlier than in mycorrhiza inoculation treatment. Poultry manure amendment boosted all most all the plants growth parameters since the earlier stage of the plants development and consequently the earlier flowering of plants. These results are similar to those of Ndubuaku et al. (2015) and Fatin et al. (2019).

The number of pods per plants was comparatively higher in mycorrhiza and poultry manure than in the nonamended plots. The significant highest pods number per plant was recorded in poultry manure treatment. Results of Aipa and Michael (2018) prove also positive effect of poultry manure application on peanut yield.

Seed weight was significantly increased in mycorrhiza treatment compared to poultry manure treatment and control plots. The significant lowest seed weight recorded in poultry manure treatment compared to the control and mycorrhiza treatment was not expected. However, similar studies by Balkcom et al. (2003) and Lin et al. (2010) with high quantities of poultry manure revealed positive effect of poultry manure on peanut yield. This may be due to the low quantity of the applied poultry manure (50g). This finding may suggest that soil amendment with low quantity of poultry manure may not be long lasting in soil like mycorrhiza. Moreover, study by Li et al. (2019) showed that mycorrhiza inoculation in soil had long lasting effect on peanut plants growth and development under continuous cropping systems.

## V. CONCLUSION

Results of this investigation showed that, mycorrhiza inoculation [(*Rhizophagus irregularis* (50 %), *Scuttellospora gregaria* (10 %), *Gigaspora margarita* (20 %), *Glomus hoi* (20 %)] and poultry manure amendment may be beneficial for peanut plants growth parameters in a sahel area characterized by low organic matter. The expected high yield following soil amendment with poultry manure was not recorded. This was probably due to the low quantity of the applied organic manure. Thus, more researches are needed to check which quantities are more suitable for peanut plants yield in such degraded soil. However, the inoculation of peanut (variety JL24) with a mixture of *Rhizophagus irregularis*, *Scuttellospora gregaria*, *Gigaspora margarita* and *Glomus hoi* has to be considered particularly in degraded soils like in the Sahel zone of Cameroon.

## RÉFÉRENCE:


[1] Adekiya A. O. & Agbede T. M. (2016). Effect of methods and time of poultry manure application on soil and leaf nutrient concentrations,growth and fruit yield of Tomato (*Lycopersicon esculentum* Mill). *Journal of Saudi Society of Agricultural Sciences*, 1-6.

[2] 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. *American-Eurasian Journal of Sustainable Agriculture*, 2(1): 72-77pp.

[3] Aipa J and Michael P. S. (2018). Poultry manure application and fallow improves peanut production in a sandy soil under continuous cultivation. *International Journal of Environmental & Agriculture Research* (IJOEAR) ISSN: 2454-1850.Vol-4, Issue-2, February, 2018. 68-75pp.

[4] Azangue G. J., Nguetsop V. F., Tendonkeng F., Wauffo F. D., Pamo T. E. (2019). Effets des différents niveaux de fertilisation aux fientes de poules sur la croissance et la production de biomasse de *Brachiaria ruziziensis* (Poaceae) en fonction des stades phénologiques à l'Ouest-Cameroun. *International Journal of Biological and Chemical Sciences.* 13 (3): 1762-1774. ISSN 1997-342X (Online).

[5] Balkcom, K. S., Adams J. F and Hartzog D. L. (2003). Peanut Yield Response to Poultry Litter and Municipal Sludge Application. Communications in soil science and plant analysis .Vol. 34, Nos. 5 & 6, pp. 801-814.

[6] Béreau M., Louisanna E., Grandcourt A., Garbaye J. (2003). Symbiose mycorhizenne et nutrition minérale. (cité 11 Novembre 2016).

[7] Betdogo S., Sali B., Adamou I., Woin Noé. (2015). Évaluation agronomique de cinq cultivars d'arachide (*Arachis hypogeae* L.) introduits dans la région du Nord Cameroun. *Journal of Applied Biosciences* 89:8311-8319pp. ISSN 1997-5902.

[8] Biratu G. K., Elias E., Ntawuruhunga P and and Nhamo N. (2018). Effect of Chicken Manure Application on Cassava Biomass and Root Yields in Two Agro-Ecologies of Zambia. *Agriculture*, 8, 45.1-15pp.

[9] Bougoum A. (2000). Contribution des issues de céréales et des fourrages dans l'alimentation des animaux des élevages périurbains. Université polytechnique de Bobo-dioulasso (upb). Mémoire de fin d'études, 1-92pp, 21p.

[10] Cameron D. D., Neal A. L., Van Wees S. C., Ton J. (2013). Mycorrhiza-induced resistance: More than the sum of its parts? *Trends in Plant Science*, 18, 539-545pp.

[11] Cavagnaro T. R and Martin A. W. (2010). The role of mycorrhizas in plant nutrition: field and mutant based approaches. 19th World Congress of Soil Science, Soil Solutions for a Changing World. 148-151

[12] Debbabie A. H., Shafchak S. D. (2008). Production des produits du champ. éditions Dar el fekre El Arabie, Egypt. 594 p.

[13] Dikinya, O. & Mufwanzala, N. (2010). Chicken manure-enhanced soil fertility and productivity: Effects of application rates. *Journal of Soil Science and Environmental Management.* 1(3), 46-54.

[14] Doley K., Jite P. K. (2012). Response of Groundnut ('JL-24') Cultivar to Mycorrhiza Inoculation and Phosphorous Application. *Notulae Scientia Biologicae*. 4(3):118-125.

[15] Fatin M. A., Nur S. T., Rozilawati S., Che N. A. C. A. (2019). Effects of Different Chicken Manure Rates of on Early Growth of Fig tree *(Ficus Carica)*. *Environmental Contaminants Reviews*, 2(1): 19-22.

[16] Grenier C. H., Inze D., and Tardieu F. (2000). Spatial distribution cell division rate can be deduced from that of P34 kinas activity in maize leaves grown in contrasting conditions of temperature and water status. *Plant Physiology*, 124, pp. 1393-1402.

[17] Haro H., Sanon B. K. B., Diop I., Kane A., Dianda M., Houngnandan P., Neyra M., Traore A. (2012). Réponse à l'inoculation mycorhizienne de quatre variétés de niébé (*Vigna unguiculata* (L.) Walp.) cultivées au Burkina Faso et au Sénégal. *International Journal of Biological and Chemical Sciences*. 6(5): 2097-2112.

[18] Heinonsalo J., Buée M., Vaario L. M. (2016): Root-endophytic fungi cause morphological and functional differences in Scots pine roots in contrast to ectomycorrhizal fungi. *Botany*, 95: 203-210pp.

[19] Hiep N. H., Diep C. N., Herridge D. F. (2002). Nitrogen fixation of soybean and groundnut in the Mekouy Delta, Veietnam. In: Inoculants and nitrogen fixation of legumes in Vietnam. Ed. Herridge. 10-18pp.

[20] Huang G.-M., Zou Y.-N., Wu Q.-S., Xu Y.-J., Kuča K. (2020): Mycorrhizal roles in plant growth, gas exchange, root morphology, and nutrient uptake of walnuts. *Plant, Soil and Environment*, 66: 295-302.

[21] Hubert P. (2000). (ING. D'Agronomie) : Fiche technique d'agriculture spéciale.

[22] Iyeri-Manjeck O., Seignobos C. (2000). Production arachidière in Atlas de la Province de l'Extrême Nord Cameroun Planche 16. IRD (Edit) 1-16pp.

[23] Jacques Petit et Pierre Jobin. (2005). La fertilisation organique des cultures. Les bases. La Fédération d'Agriculture Biologique du Québec (FABQ). P. 26

[24] Karimata S. (2001). Guide technique de l'agriculture.1-67pp.

[25] Kasongo L. M. E., Mwamba M. T., Tshipoya M. P., Mukalay M. J., Useni S. Y., Mazinga K. M., Nyembo K. L. (2013). Réponse de la culture de Soja (*Glycine max* (L). (Merril) à l'apport des biomasses vertes de *Tithonia diversifolia* (Hemsley) A. Gray comme fumure organique sur un Ferralsol à Lubumbashi, R. D. Congo. *Journal of Applied Biosciences* 63: 4727-4735

[26] Kobierski M., Bartkowiak A., Lemanowicz J., Piekarczyk M. (2017). Impact of poultry manure fertilization on chemical and biochemical properties of soils. *Plant Soil Environment*, 63: 558-563.

[27] Li C., Feng G., Jia-lei Z., Sha Y., Jing-jing M.,Yun G., Quan W., Xin-guo L., Shu-bo W. (2019). Arbuscular mycorrhizal fungi combined with exogenous calcium improves the growth of peanut (*Arachis hypogaea* (L.)) seedlings under continuous cropping. *Journal of Integrative Agriculture*. 18(2): 407-416pp.

[28] Li C.C., Zhou J., Wang X. R., Liao H. (2019). A purple acid phosphatase, GmPAP33, participates in arbuscule degeneration during Arbuscular Mycorrhizal Symbiosis in Soybean. *Plant, Cell and Environment*, 42: 2015-2027.

[29] Lin X. J., Wang F., Cai H. S., Lin R. B., He C. M., Li Q. H and Li Y. (2010). Effects of different organic fertilizers on soil microbial biomass and peanut yield. 19th World Congress of Soil Science, Soil Solutions for a Changing World.72-75

[30] Lü L. H., Zou Y. N and Wu Q. S. (2018). Relationship Between Arbuscular Mycorrhizas and Plant Growth: Improvement or Depression? Springer International Publishing AG, part of Springer Nature. B. Giri et al. (eds.), Root Biology, *Soil Biology*. 52, 451-464.

[31] Magrin G. (2003). Un vivrier marchand sous-régional : l'arachide in Atlas Agriculture et développement rural des savanes d'Afrique centrale CIRAD/PRASAC 63-64pp.

[32] Mahanta D., Rai R. K., Mishra S. D., Raja A., Purakayastha T. J., Varghese E. (2014). Influence of phosphorus and bio-fertilizers on soybean phosphorus fertilization, and intraspecific density. Mycorrhiza, 15: 203-221pp. Doi:10.1007/s00572-004-0324-3.

[33] Mandimba G. R. and Y. M. Djondo. (1996). Nodulation and yield of *Arachis hypogea* (L.) as affected by soil managenment in Congo. *Biological Agricultural and Horticulture* 12(4) :339-351pp.

[34] Maodo M. C. (2018). Synthèse de travaux de recherches sur des méthodes de fertilisation organique pour améliorer la productivité agricole au Sénégal. 1-28pp.

[35] Martin R. C. & MacRae R. (Eds.). (2014). Managing energy, nutrients, and pests in organic field crops. Boca Raton: CRC Press.

[36] MINTP-Projet (2017). Lake Chad Basin Regional Integrative Road Network Project - Construction of a Bridge Over River Logone Between Yagoua In Cameroon And Bongor In Chad. 1-34.

[37] Ndubuaku U. M., Ede A. E., Kayode Paul Baiyeri K. P and Ezeaku P. I. (2015). Application of poultry manure and the effect on growth and performance of potted Moringa (*Moringa oleifera* (L.)) plants raised for Urban dwellers' use. *African Journal of Agricultural Research*. Vol. 10(36), pp. 3575-3581.

[38] Ogou A., Tchabi A., Tounou A. K., Agboka K., Sokame B. M. (2018). Effet de quatre souches de Champignons Mychoriziens Arbusculaires sur *Meloidogyne spp*., principal nématode parasitaire du soja (*Glycine max* (L.)) au Togo. *Journal of Applied Biosciences*, 127: 12758-12769, ISSN : 1997-5902.

[39] Okoli P. S. O. & Nweke I. A. (2015). Effect of different rates of poultry manure on growth and yield of Amaranthus (*Amaranthus cruentus*). IOSR *Journal of Agriculture and Veterinary Science*, 8(2), 73-76.

[40] Perkasa A. Y., Gunawan E., Dewi S. A., Zulfa U. (2016). The testing of chicken manure fertilizer doses to plant physiology components and bioactive compound of dewa leaf. *Procedia Environmental Sciences*, 33 54-62

[41] Rapport Projet C2D/Programme d'Appui à la Recherche Agronomique. (2013). Contribution de la recherche à l'amélioration de la production et la consommation des légumineuses alimentaires au Cameroun. 57pp.

[42] Seignobos C., Yébi-Mandjek O. I. (2020). Atlas de la province Extrême-Nord Cameroun. Nouvelle édition. Marseille : IRD Éditions, 2005 (généré le 12 mai 2020). 91-93pp.

[43] Shao Y. D., Zhang D. J., Hu X. C., Wu Q. S., Jiang C. J., Xia T. J., Gao X. B., Kuča K. (2018). Mycorrhiza-induced changes in root growth and nutrient absorption of tea plants. *Plant, Soil and Environment*, 64: 283-289pp.

[44] Smith S. E and Read D. J. (2008). Mycorrhizal symbiosis. Third Edition, London, UK, Academic press; 787pp.

[45] Somda B. B., Ouattara B., Serme I., Pouya M. B., Lompo F., Taonda S. J. B., Sedogo P. M. (2017). 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*. 11(2): 670-683 ISSN 1997-342X (Online).

[46] Tchaniley L., Ayisah K. D., Dewa K. K. A. (2020). 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*. 151: 15540-15549pp.

[47] Tchuenteu K. I. (2017). Effets des doses de fientes de poule et d'acide gibbérellique sur les paramètres de croissance et de rendement de *Solanum scabrum* sur un nitisol des Hauts plateaux de l'Ouest Cameroun. Mémoire de fin d'études d'Ingénieur Agronome, FASA. 64pp.

[48] Touil W. (2017). Effets comparés des champignons mycorhiziens arbusculaires et des Rhizobia isolés d'un sol algérien avec ceux du commerce, sur le rendement de l'arachide *Arachis hypogaea* (L.).1-169pp. Thèse de doctorat de l'Université de badji mokhtar-annaba. Discipline ou spécialité : Biosciences Végétales.

[49] Widowati L. R., Widati S., Jaenudin U., Hartatik W. (2005). 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*.

[50] Wu Y. N., He X. H. (2010). Contributions of arbuscular mycorrhizal fungi to growth, photosynthesis, root morphology and ionic balance of citrus seedlings under salt stress. *Acta Physiologiae Plantarum*, 32, 297-304pp.

[51] Yang S., Wang F., Guo F., Meng J. J., Li X. G., Wan S. B. (2015). Calcium contributes to photo-protection and repair of photosystem II in peanut leaves during heat and high irradiance. *Journal of Integrative Plant Biology*, 57, 486-495pp.

[52] Yerima B. P. K., Tiamgne A. Y., E Van Ranst. (2014). Réponse de deux variétés de tournesol (*Helianthus sp*.) à la fertilisation à base de fiente de poule sur un Hapli-Humic Ferrasol du Yongka Western Highlands Research Garden Park (YWHRGP) Nkwen-Bamenda, Cameroun, Afrique centrale. *Tropicultura*, 32(4): 168-176pp.

[53] Zougari-Elwedi B., Sanaa M., Labidi S., Lounès-Haj A. (2012). Evaluation de l'impact de la mycorhization arbusculaire sur la nutrition minérale des plantules de palmier dattier (*Phoenix dactylifera* L. Var Deglet Nour) ; 19 :193-202pp.

.