Fertilization test based on chicken manure and mycorrhiza on the growth parameters of Maize (*Zea mays* (L.)) in Yagoua, Far North-Cameroon

Ahmed Hamana[2], Bertrand Wang-Bara[1], David Amedep[2], Philémon Kaouvon[1], Sounou Paul Alioum[1]

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

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

***Abstract*: Soils amendment by using organic manure and bio-fertilizers is a complementary to improve chemical fertilizer efficiency. This study was conducted in Yagoua, Far North region with objective to evaluate the responses of chicken manure and mycorrhiza application on growing of plants Maize. The soils were amended with 20 g of mycorrhiza, 50 g of chicken manure and 20+50g of effect combined mycorrhiza+chicken manure in comparison to the check (0g). The experimental design was the randomized block with 3 replications. Parameters evaluated are: germination rate, plants growth parameters and precocity.**

The results showed that uses of different levels of fertilization on germination rates were significant (P<0.05) for all the levels of fertilizers compared to the control (87.5 %). It's varying from 97.5 % for the chicken manure, followed by the effect of combined treatments (96.67 %) and bio-fertilizers with 94.17 %. Height of plants during vegetative (30^{th} to 50^{th} DAS) were most significant (P<0.05) by the use of organic manure as fertilization. Mycorrhiza and chicken manure as treatment was influenced the phenological stages of plants especially first flowering of plants days after sowing. Flowering of plants at 50 % was most favorable for the treatments based on the uses chicken manure and the combined effect of treatments (mycorrhiza+chicken manure).

***Keys words*: Maize, Fertilizers, Phenological stages, Chicken manure, Far North Cameroon**

I. INTRODUCTION

In sahelean zone where the periods of rainy seasons are little, pluvial cultures which is most used during rainy seasons are Millet, Sorghum and Maize. They constitute an important culture of the zone (Karimata, 2001). Increases of populations due to the demographic growth, natural disasters, the dryness, increases of the price of fertilizers, food poverty on this last year remains the major causes of actual problems of this region (Ziegler, 2012). Cameroon like others Africans countries depends on the supply of Cereals resources among them Maize, that is one of important food products of populations (IRAD, 2008). Maize is a first cultivated cereal and consumed in terms of quantity and surfaces before the Rice, Wheat and Sorghum. Two Cameroonians on three consumes Maize, around twelve billions of persons (FAO 2017). In these conditions it is necessary to preserve food culture with the context of increasing populations these last years followed by Maize (*Zea mays* (L.)).

Maize (*Z. mays* (L.)) is one of the major cereal of the family of Poaceae. It is an annual cultivated plant in many agro ecological zones, alone or with the associations with others plants (Leguminous). In several countries Maize is a base of food products of many populations (Maybelline and Maïga, 2012). The plant can measure most of 2m of height. With annual production means around 817 billion of ton in 2009 is a cereal which is most cultivated before Wheat (681 billion of ton) and Rice with 678 billion (Maybelline and Maïga, 2012). On feeding humans, seeds of maize are used in many forms (cooked or toasted). We can also transform Maize to obtain a various product like flour. It is also used on feeding animal (poultry, pig, cattle) in form of seeds or fodder. It is also used as raw material in some industries (food), traditional alcohol. The stem of plants serves on making enclosure. According to the agro-ecological zone and the variety used, yield can change. Generally, in Sudano Sahelean zone, yield varies around 04 to 05 t/ha (Menyonga *et al.*, 1994).

Despite to his importance on food sector of Cameroon, Maize culture encounter problems these last years due to food security causes by the increasing of populations consumers, decreases of soils fertility causes by the intensives monoculture, climate change, water stress and inundation in rainy season on Sahelean zone (Bring, 2005; ECAM3, 2007). Actually in Sahelean area, the monoculture systems are predominant which consequently induces poverty of soils. In fact, several strategies are known to increase yield of plants by the uses of chemical fertilizers types, pesticides and news varieties (Dalgaard *et al.*, 2003). These methods are known like dangerous for human's health and environments (Bowers *et al.*, 2001).

Mycorrhiza is a symbiosis association between fungi and plants roots within the soil. It is appearing as an alternative to improve soils availability on nutrients elements for plants growth without impacting the environment and human's health. 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). Arbuscular

Mycorrhizal Fungi (AMF) positively improve plant biomass with increasing total chlorophyll (Li *et al.*, 2019; Yang *et al.*, 2015), alleviating abiotic and biotic stresses by increasing scavenging capacity for Reactive Oxygen Species (ROS) (Wu and He 2010) and improving plant resistance against pathogens by enhancing defensive capacity (Cameron *et al.*, 2013). Also previous studies showed that AMF affect the root morphology and photosynthetic rate of host plants, help their hosts absorb nutrients from the soil, especially immobile elements such as phosphorus (P) (Li *et al.*, 2019), improve total root length and volume, while decrease root hair length and number (Huang *et al.*, 2020; Shao *et al.*, 2018; Heinonsalo *et al.*, 2016).

In this context, the present research consists to use the beneficial effect of symbiotic micro-organisms (mycorrhiza) with organic manures (chicken manure) on improvement of growing stages of plants during the phenology of the variety CMS 8501 of Maize on field. General objective of this study was to compare the effect of fertilizers types based on applications of chicken manures and mycorrhiza on vegetative parameters of the variety CMS 8501 of Maize (*Zea mays* (L.)) in rural zone.

II- MATERIALS AND METHODS

I.1. Study Site

The study was conducted at the Valorization Station of Agricultural Research (VSAR) 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: The wet season spans the 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. Rain becomes scanty in volume and abundance as one goes further north. Two air masses predominantly influence the area, namely the harmattan and monsoon winds, in the dry season and wet seasons respectively. Low precipitations ranges between 600 mm and 1200 mm/year (MINTP, 2017).

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). 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. Vegetal Materials

For this purpose, the variety of Maize used is CMS 8501 which provides from Institute of Agricultural Research for Development (IRAD). This variety has a cycle of development which varying from 110 to 120 days.

Figure 1: Variety of Maize CMS 8501 provide to IRAD of North (Garoua).

III. BIOLOGICAL MATERIAL

III.1 Mycorrhiza

Bio-fertilizing Myco providing from GIC AGRIBIO CAM had used like biological. It is adapted to local sols for nursery culture (legumes, fruit and horticultural plants) and field culture like leguminous, cereals and fruit. This bio-fertilizer is characterized by 4 strains of AMF such as, *Rhizophagus irregularis* (50 %), *Scuttellospora gregaria* (10 %), *Gigaspora margarita* (20 %), *Glomus hoi* (20 %).

Figure 2: Mycorrhiza containing 4 strains of AMF (WANG-BARA Bertrand, 2018).

IV. METHODS

IV.1 Experimental design

The study was realized on a surface of 181. 65 m^2. Experimental design of this study was a randomized block with 3 repetitions (**Figure 1**). The factor is represented by the bio-fertilizers and chicken manure treatments with 4 levels (T0 = control, T1 = mycorrhiza, T2 = chicken manure and T3 = chicken manure + mycorrhiza) with a total of 12 treatments within 3 blocks. Experimental unit are constituted of 2.5 m × 3.2 m = 8 m^2. Even block is divided in plots and they are equal according to a distance of 1m. Experience had started by manual clearing of weeds. A labor of 25 cm of depth have made in order to mix the soil and remove some grass and arboreous. Sowing has been made two weeks after labor. The distance within space line is 80 cm and 25 cm from pockets. The total densities of plants per unit are 40, such as 10 per lines and 4 lines for each unit. Seeds were sowing on soil at 3

to 5 cm of depth. Weeding has been made every two weeks during the period of culture.

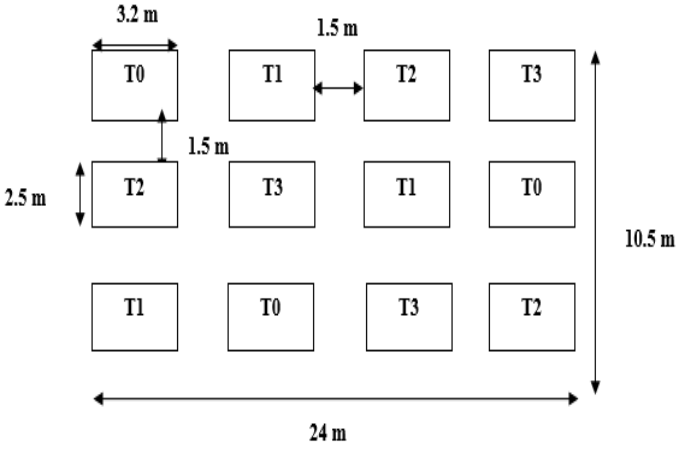

Figure 3: Experimental design (a block completely randomized with 3 replications)

IV.2 Inoculation And Organic Manure Procedure

Treatment were measured with an electronic balance (2000*0.1g). The doses are defined as follow: 20 g for the treatment of mycorrhiza (T1; T3), 50 g for the treatments of chicken manure (T2; T3). The inoculation processes used is a method describe by GIC AGRO-BIOCAM, which consist to coat each seed before to receive mycorrhiza treatments during one hour. Seeds were mixed at 20 g of mycorrhiza with water then sowing after. Organic manure treatments (T2; T3) was been applied 2 weeks after sowing at the quantities of 50 g per pockets. Levels of treatments was being fixed as follow: T0 = control; T1 = 20 g of mycorrhiza; T2 = 50 g of chicken manure; T3 = 20 g of mycorrhiza + 50 g of chicken manure.

Figure 4: Coating process of seeds and mycorrhiza applied on field.

IV. 3 Assessment Parameters

IV.3.1 Germination Parameters

Data collected have been made from 5th DAS to 10th DAS. They consist for each unit per treatment to count the numbers of germinated plants and those who not germinated in order to evaluate the germination rate of different treatments according to following formula:

$$Germination\ rate = \frac{\text{Number of germinated pockets}}{\text{Total number of pockets}} \times 100$$

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

IV.3.2 Growth Parameters

Data of growth were being collected. They consist to collect data in 3 repetitions on an interval of time of 10 days during phenological growth stages plants at 30th, 40th, 50th DAS. Five plants for each treatment was been taken like a reference for collecting data of growth parameter such as height of plants and diameter stem girth.

IV.3.3 Varietal Precocity

Precocity parameter was evaluated on five plants taken as a reference for collecting data of each treatments. The effects of different levels of treatments (fertilizers) were been observed on the day of 1st flowering plants (DAS) and 50 % of flowering plants (DAS).

IV.3.4 Statistical Analysis

Data collected for each parameter was been recorded on a table of Excel de Microsoft. 2017. These data was transferred from the software of R-commander for analysis of variance (ANOVA) and the means were separated with the test of Tukey for the comparison of average at 5 % of probability.

V. RESULTS AND DISCUSSIONS

V.1 Germination Rates

Germination rate of maize plants in the amended plots was higher compared to non-amended plots (**Figure 5**). The significant difference on germination rate was recorded on chicken manure treatment followed by mycorrhiza + chicken manure, mycorrhiza respectively compared to non-amended plots (P≤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.

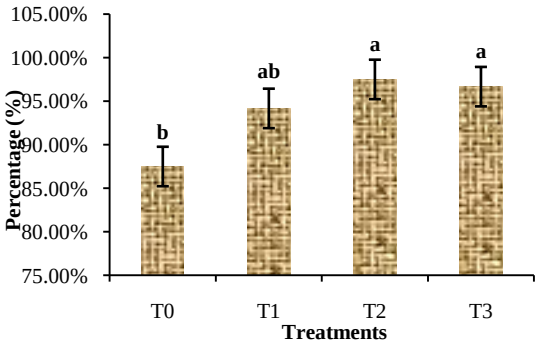

Figure 5: Effects of different types of fertilization on germination rates. Germination rate with the same letter are not significantly different (P≤0.05; T0 = control; T1 = mycorrhiza; T2 = chicken manure; T3 = mycorrhiza + chicken manure).

V.2 Growth Of Plants

Heights of plants per treatments were showed on the **Table 1.** Compared to non-amended plots, chicken manure treatments and mycorrhiza + chicken manure treatments increased the height of plants of Maize. Significant difference was recorded by the applied of organic manure treatments compared to control (P≤0.05) on all the period of days after sowing (DAS).

Table 1: Effect of different types of fertilization on height of plants Maize.

Treatments	Height of plants (m)		
	30th DAS	40th DAS	50th DAS
T0	0.77 ± 0.13b	0.92 ± 0.19b	1.31 ± 0.31b
T1	0.77 ± 0.16b	0.91 ± 0.19b	1.31 ± 0.25b
T2	0.9 ± 0.03a	1.33 ± 0.21a	1.66 ± 0.28a
T3	0.83 ± 0.10ab	0.99 ± 0.17b	1.42 ± 0.18ab

NB: Values of the column for a variable followed by the same letter are not significantly different at the level of probability considered (P≤0.05). **T0** = control; **T1** = mycorrhiza; **T2** = chicken manure; **T3** = mycorrhiza + chicken manure.

a) Maize plants treated

b) Maize plants without treatment.

Figure 6: Comparison effects of plants treated and without treatments

V.3 Phenological Stages Of Plants

V.3.1 Effect Of Treatments On First Flowering Of Plants

Maize plants in amended plots flowered earlier than non-amended control plots. Compared to control plots and even mycorrhiza treatment, chicken manure treatment reduced the flowering time of maize plants. First flower was observed on maize plants from poultry manure treatment earlier at 42 DAS (**Figure 7**). In mycorrhiza treatments, first flowers appeared at 44 DAS. While, in the non-amended control plots, flowering started a bit later at 46 DAS (**Figure 7**). No difference was recorded between mycorrhiza + chicken manure compared to non-amended plots.

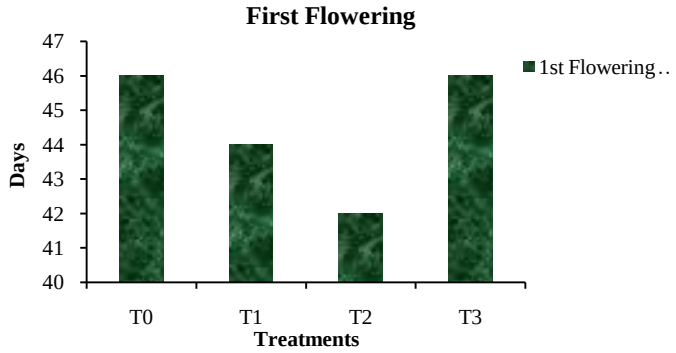

Figure 7: Effect of different amendments on the maize plants flowering (T0= control; T1= mycorrhiza; T2= poultry manures; T3= mycorrhiza + chicken manure.)

V.3.2 Effect Of Treatments On 50 % Flowering Of Plants

Referred to non-amended plots, maize plants treated with poultry manure and mycorrhiza + chicken reached 50 % of flowering earlier respectively at 50 DAS compared to mycorrhiza treatment in which maize plants reached 50 % of flowering at 53 DAS respectively (**Figure 8**). Soils quality and chicken manure mixtures can, therefore, constitute a suitable medium for growing maize plants. The flowering process was faster compare to control plots. This could be due to competitive effects of vegetative growth which could delayed the onset of reproductive growth such as flowering in the poultry manure and mycorrhiza media.

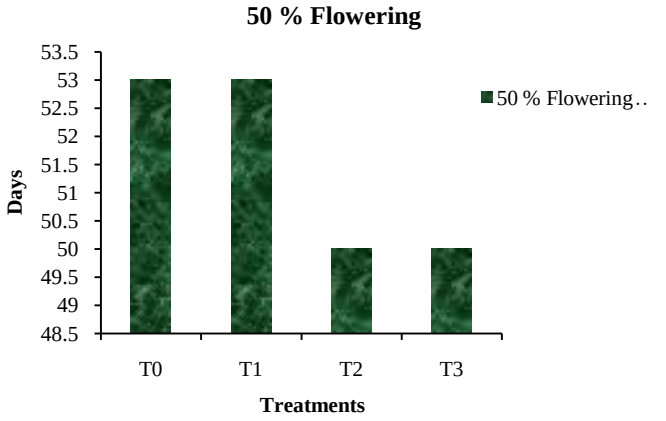

Figure 7: Effect of different amendments on the maize plants flowering (T0= control; T1= mycorrhiza; T2= chicken manures; T3= mycorrhiza + chicken manure).

VI. DISCUSSIONS

Objective of this study was to evaluate the effect poultry manure and mycorrhiza like treatment on growth parameters of maize in Far North region. Germination rate of plants maize was evaluated firstly, growth parameters of plants and phenology stages.

Results showed that germination rate of plants were higher in amended plots compared to non-amended control plots. Among fertilizers types used, the highest germination rate was recorded on organic manure followed by mycorrhiza + chicken manure treatment. Works of Wang-Bara et al. (2021) proved the positive effect of chicken manure and mycorrhiza on the germination rate of plants of Sorghum (Poaceae). Also according to Abdourahmane et al. (2020), fertilization effects based on chicken manure and mycorrhiza can improve the vigour of plants during germination compared to the check.

Heights of plants were higher during the period of growing. The applied treatments: mycorrhiza, poultry manure and the combined effect of both treatments increased more or less the maize plant height compared to the non-amended control plots. This may be due to the good effect of poultry manure and mycorrhiza to the demand of plant. Poultry manure effect on Moringa showed a significant difference in the plant height and stem girth all through the growth period (Ndubuaku *et al.*, 2015). Similar AMF effect increase plant growth, nutrient acquisition or absorption of K, Fe, Zn, Cu, and Mo from the soil to the fungal partner (Lü *et al.*, 2018). In semi-arid tropical area, works showed that mycorrhiza symbiosis effect play an important role on growing of plants (Wang-Bara *et al.*, 2021; Estaùn *et al.*, 1997). Ours works corroborate with the works of Wang-Bara et al. (2021) showing the positive effect of chicken manure and mycorrhiza treatments on height of plants during the vegetative period of plants of Sorghum (Poaceae)

Flowering process were positively affected by some treatments applied compared to non-amended plots. Maize plants in mycorrhiza and poultry manure treatment flowered and reached the 1st flowering earlier than in both treatment and control plots. However, maize plants in poultry manure and both treatment flowered and reached the 50 % of flowering earlier than in mycorrhiza inoculation treatment and control plots. Flowering stages of plants Moringa with the applications of poultry manure were faster compared to control plots (Ndubuaku *et al.*, 2015). Same results were also proved by Fatin et al. (2019). Also works Wang-Bara et al. (2021) on phenological stages of plants by the uses of organic manure and mycorrhiza showed earlier appearance of flowering process of plants of Sorghum during their vegetative development. According to works of Abdourahmane et al. (2020) phosphorous provides in organic manures stimulate flowering, precocity of flowering and harvest.

VII. CONCLUSION

Results of this study showed that the inoculation [(*Rhizophagus irregularis* (50 %), *Scuttellospora gregaria* (10 %), *Gigaspora margarita* (20 %), *Glomus hoi* (20 %)] and poultry manure amendment has good effect on germination rate of Maize CMS 8501 mainly with organic manure and both treatment. Organic manure and mycorrhiza + chicken manure positively increase the height of plants Maize. First flowering was earlier on amended plots (mycorrhiza and chicken manure) compared to control plots. However, the flowering stages at 50 % was earlier with the uses of organic manure and both treatment. These induce the significant effect of treatments on phenological stages of plants.

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