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Effect of biological fertilizers on the production of tomato (*Solanum Lycopersicum* L.) in the district of Ngaoundere I (Adamawa, Cameroon)

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Abstract
Tomato remains the most profitable vegetable crop in the country and is the most consumed and cultivated in Cameroon. However, the production of crop tomatoes is not enough due to soil degradation. To change this situation, the study of the effect of biological fertilizers on tomato (*Solanum Lycopersicum* L.) production in the district of Ngaoundere I (Adamawa, Cameroon) was done. The experimental set-up was a complete randomized block with 6 treatments: Chicken Droppings (Cd), mycorrhizae (M), Vivianite Rock Phosphate (VRP), combinations of 2 fertilizers (M + VRP, M + Cd, and VRP + Cd), the positive control (C+) which receive NPK 20-10-10 and the negative control (C-) which receive nothing repeated 3 times. These biological fertilizers used in this study improved the yield production of *Lycopersicon esculentum* by 70%, 60%, and 54% for Cd + M, Cd + VRP, and M + VRP treatments respectively compared to the negative control (C-).

Keywords: Adamawa, chicken droppings, *Lycopersicon esculentum*, mycorrhiza, soil, vivianite rock Phosphate

Introduction
The world's population in general and that of Africa, in particular, has experienced considerable demographic growth in recent years (Fresco, 2003) [16]. Cameroon has not been left behind, as from 1960 to 2022, its population has grown rapidly. The Cameroonian population has increased almost 4-fold since its independence in 1960 with an annual growth rate of 2.5% (Piebiep, 2008) [34]. At this rate, Cameroon's population will double in about 27 years, around 2037 (MINEPAT, 2010) [27]. This growth has generated an increase in demand for food resources that can only be met by intensifying agricultural activity (Kasongo *et al.*, 2008) [20]. To meet this demand for food, Cameroun will have to increase its agricultural production by 4% per year (Griffon *et al.*, 1993) [17]. This requires an increase in food production and a frantic search for strategies that can contribute to increasing crop yields (Kimuni *et al.*, 2014) [21]. Loss of soil fertility is a fundamental problem that limits plant productivity in the Adamawa region where soils are subject to leaching by rainfall, flooding, and intensive agriculture. This soil leaching accentuates nutrient deficiencies, especially in nitrogen and phosphorus (Anonymous, 2008) [5].
Tomatoes remain the most profitable vegetable crop in the country as the evaluation of gross margins per crop shows that tomatoes accounted for about CFAF 5.5 billion, followed by onions with CFAF 4.5 billion (Mahrh, 2011) [25]. Because of the vitamins and minerals that they provide to the body, they occupy an essential place in the diet (Christel *et al.*, 2008) [8]. The tomato is the most consumed vegetable and the most cultivated of all vegetable crops in Cameroon. National production was around 5,000 tons per year between 1990 and 2000 (Dossou and Soulé, 2006) [11]. This is not enough to cover the needs of the population, which is estimated at 100 000 tons of tomatoes per year (Christel *et al.*, 2008) [8]. To meet the population's demand, it will be necessary to increase national production by a factor of 20 in 2035.
Therefore, the use of chemical fertilizers, due to their immediate beneficial action on the productivity of food crops provides an immediate solution to this problem of mineral deficit and

declining fertility, but their high cost and unavailability make them almost inaccessible to small farmers (Useni *et al.,* 2013) [37]. In addition, its exclusive use leads to an increase in acidity, a degradation of the physical status, and a decrease in soil organic matter (Mulaji, 2011) [29]. Thus, the great challenge of the 21st century is to provide for the food needs of a growing population by adopting agricultural methods that are both ecological and profitable (FAO, 2003) [13].

Scientific research recommends adapting strategies based on the use of biological fertilizers such as compost, chicken droppings, cow dung, rabbit dung, mycorrhizal fungi, and phosphorus-solubilizing microorganisms are also part of this list (Bationo *et al.,* 2004; FAO, 2005; Ngakou *et al.,* 2008; Megueni *et al.,* 2011; Amardip & Ghosh., 2012; Maimouna *et al.,* 2020) [6, 15, 31, 26, 4, 24]. To this end, the use of organic fertilizers rich in mineral elements is important for production in quantity and quality (FAO, 2004) [14]. In the Adamawa region, several organic fertilizers can be used to amend the soil and improve agricultural production. In the Adamawa region, several organic fertilizers can be used to amend soils and improve agricultural production. Mycorrhizae, chicken droppings, and Vivianite Rock Phosphate are among these fertilizers, which are rich in nitrogen, phosphate, potassium, and even trace elements and are easily accessible to farmers and less expensive. The general objective of this work is to evaluate the growth and production parameters of *Lycopersicon esculentum* by the use of organic fertilizers. Specifically, the study aims to evaluate the effect of these fertilizers on the growth, on production, and yield of tomatoes.

Materials and Methods

The study site: A field experiment was conducted during the 2020 cropping season. The work was carried out in the locality of Ngaoundere I, VINA Department, in the Adamawa Region of Cameroon. The study was conducted in the city of Ngaoundere. The geographical coordinates are 07°19'56.97"N latitude, 13°35'09.99"E longitude, and 987 m altitude. Regarding the chemical composition of the soil site is: Humidity (14.36 ± 0.28%), it pH is moderately acidic (6.23 ± 0.07) and the conductivity is good (53.70 ± 0.61 µs/cm), as well as the cation exchange capacity (CEC) (15.46± 1.16 meq/100 g). But this soil has low assimilable phosphorus (P: 1.26 ± 0.01%), and low Mg (0.34 ± 0.02%), Ca (0.25 ± 0.03%), K (0.8± 0.05%), and Fe^{2+} (1.96 ± 0.02%). The Organic matter is 15.80±0.51%, the Nitrogen concentration is 4.01±0.04% and C/N is 2.07±0.02.

Material

Plant material

The plant material on which the experiment is based consists of pre-germinated seeds and young tomato seedlings from the nursery (*Lycopersicum esculentum*) belonging to the Solanaceae family (Fig. 1). The variety of this tomato is locally called "blindé"; with a cycle of about 3.5 to 4 months. It is the most cultivated variety in the locality.

Fig 1: Tomato seed

Biological material

Mycorrhizal inoculum

The mycorrhizal inoculum (Fig. 2) used for this work comes from the microbiology laboratory of Nkolbissong (University of Yaoundé I). The inoculum consisted of sand, root fragments with spores of fungi of the genus *Glomus hoï, Glomus intraradices; Gigaspora margarita, Scutellospora dipurpurescens* with a concentration of 20 spores/g of the substrate.

Fig 2: Inoculum of mycorrhizae

Rock vivianite Phosphate

The rock vivianite Phosphate used for this work comes from Hangloa, a locality located 23 km from the University of Ngaoundere. The rocks collected were transformed into Powder when using local equipment (Fig. 3).

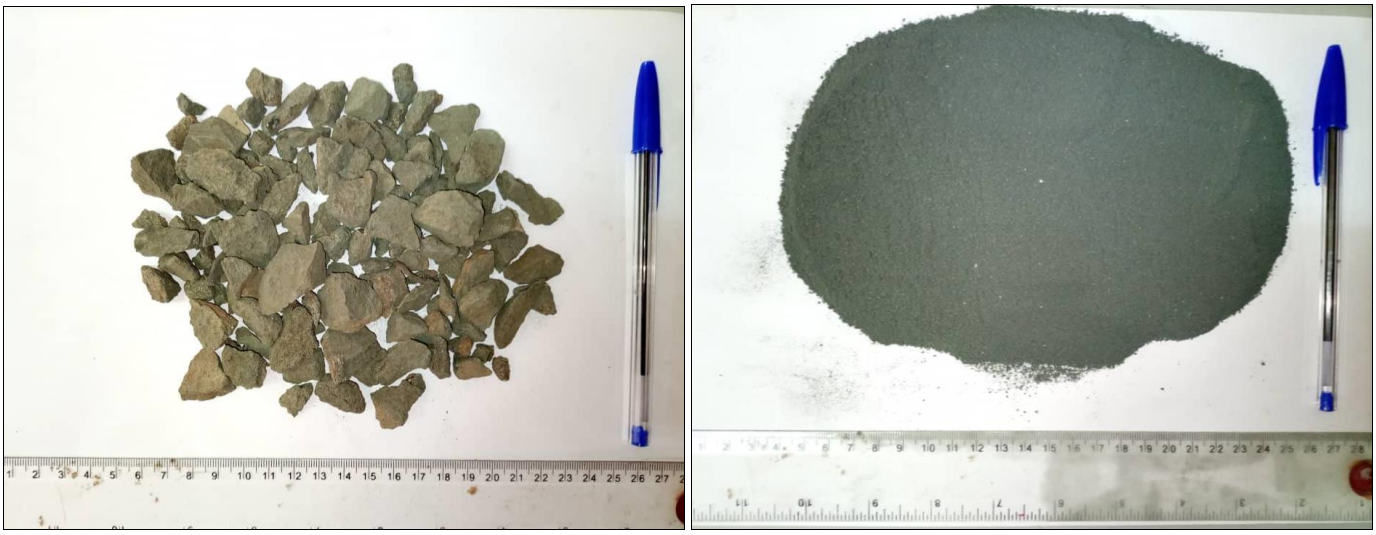


Fig 3: Vivianite rock phosphate and vivianite powder

Chicken droppings

The chicken droppings used in this work were purchased from a farmer. They are droppings of the subspecies *Gallus domesticus* (Fig. 4). The chemical composition of chicken droppings is the dry matter (DM) content is 80.57±1.82, the organic matter (OM) content is 33.26±2.24%, the water content (W) isn23.98±2.57%, and the total mineral content (TM) is 74.99±2.33%. The pH of chicken droppings is 6.81±0.42. The chicken droppings have significant contents of major nutrients namely nitrogen (N), phosphorus (N), and potassium (K) with 15.70 ± 0.90 g/kg, 492.27 ± 9.48 mg/kg, and 19.85 ± 0.64 mg/kg respectively.

Fig 4: Dried chicken dropping

Chemical fertilizers

The fertilizer used as a chemical fertilizer in this work is NPK 20-10-10, a granular fertilizer available and sold on the local market. It is a fertilizer that contains 20% nitrogen (N), 10% phosphorus, and 10% potassium (K).

Methods

Preparation of the experimental site and experimental setup

After cleaning the field, the experimental soil was sampled at a depth of 0 to 25 cm. Soil samples were taken from the perimeters and diagonals of the plot to obtain a representative mixture. One kilogram (1 kg) of the composite sample was then sent to the Chemical Engineering Laboratory of the National School of Agro-Industrial Sciences of the University of Ngaoundere for chemical analysis. As for fertilizers, 1 kg of chicken droppings were sent to the same laboratory.

After soil sampling, the experimental units were a complete randomized block with 6 treatments: Chicken Droppings (Cd), mycorrhizae (M), Vivianite Rock Phosphate (VRP), combinations of 2 fertilizers (M + VRP, M + Cd, and VRP + Cd), the negative control (C-), and the positive control (C+) which receive NPK 20-10-10 repeated 3 times. The experimental site is a plot of 22 m in length and 11 m in width or an area of 242 m^2. The plot is divided into 3 blocks. Each block consists of 8 experimental units of the same area: 4.255 m^2 (2.30 m x 1.85 m). Each experimental unit received 12 plants that were subjected to the same treatment. The spacing between the blocks is 2 m and between the subplots is 1 m.

The quantities of the various fertilizers (chicken droppings, mycorrhiza, vivianite rock powder, chemical fertilizer (NPK 20-10-10)) were weighed using a sensitive electronic balance in quantities of 500 g, 20 g, 50 g and 20 g respectively. Ploughing

was carried out 3 weeks after fertilization for the first time and then 2 weeks after the first ploughing.

Data collection and statistical analysis

During plant emergence, the average plant height over time, number of leaves, leaf area, and flowering dates were evaluated. Field survival rate (%) was evaluated on ten days after transplanting. It was calculated by the following formula. Field survival rate = Number of survival plants total plants x 100. Plant height (cm) was recorded in centimeters by measuring the height of sample plants from the ground level to the main apex with a meter. Stem diameter (cm) was measured as the diameter of the plant just above the graft union. At maturity, the yield is calculated by the formula: average weight of grain (AWg/grams) multiplied by the average number of grains per plant (ANg) and the number of plants per hectare (NP/ha): Fresh yield = (AWg) x (ANg) x (NP/ha) / 1000000. NP/ha=(X*Y) /10000.

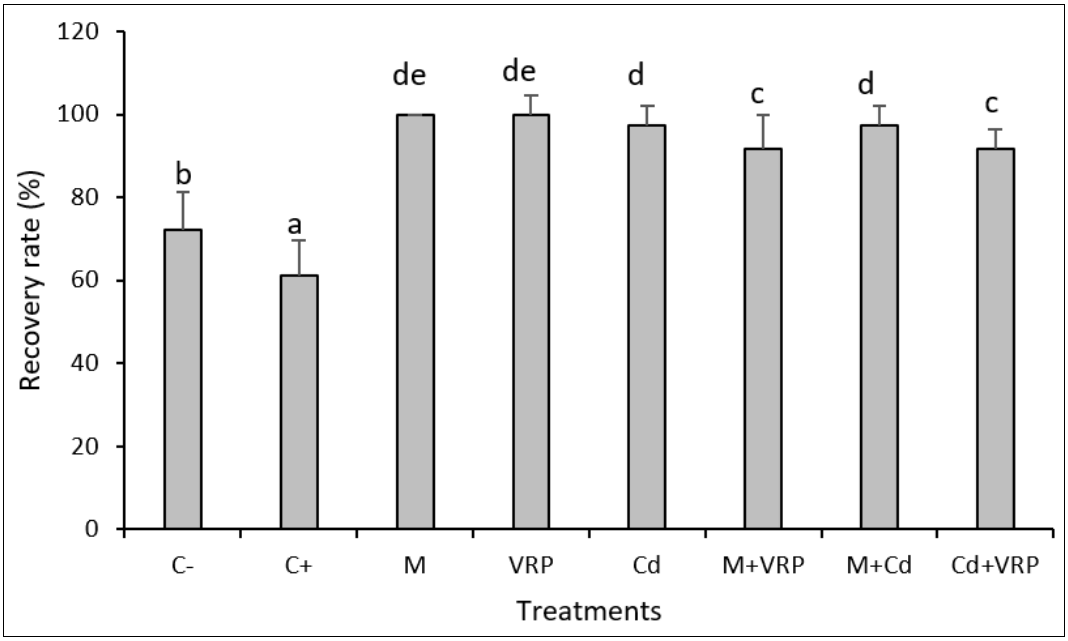
Statistical analyses are performed using the software "Stratigraphic Plus version 5.0", which performs the analysis of variance (ANOVA), to determine the interactions between treatments. Duncan's test is used to judge the difference between the means of the treatments.

Results

Effects of fertilizers on tomato growth parameters

Percentage of tomato plant recovery

Figure 5 summarizes the percentage recovery of cuttings according to the different treatments. The analysis of variance performed reveals a very high significant difference ($P < 0.001$). The results showed that for the fertilized plots, the seedlings gave a good rate of emergence except for the plots having received treatment with the chemical fertilizer (NPK 20-10-10). However, the percentage of seedling recovery on the plots fertilized with mycorrhiza (100 ± 0.0%), Vivianite Rock Phosphate (100 ± 4.95%), chicken droppings (97.22 ± 4.81%), Vivianite Rock Phosphate + mycorrhiza treatments (91.66 ± 8.33%), chicken droppings + Vivianite Rock Phosphate (91.66 ± 4.81%) and chicken droppings + mycorrhiza (97.22 ± 5.0%) were the highest compared to the negative control (C-) and positive control (C+) plots which had low recovery rate with 61.11 ± 8.5% and 72.22 ± 9.1% respectively.

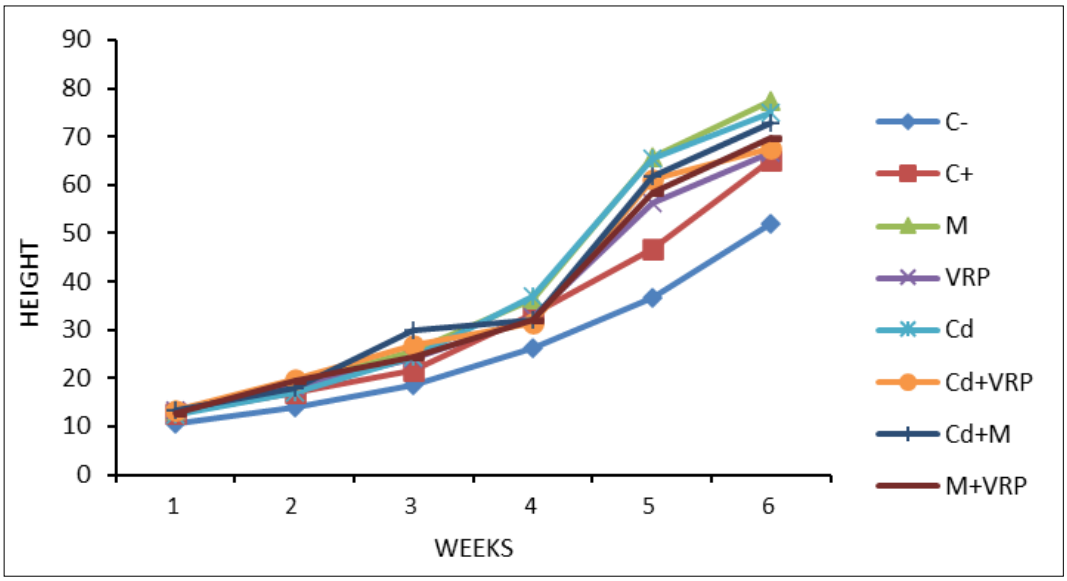


Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Fig. 5: Effect of treatments on plant recovery rate

Effects of fertilizers on plant length

Figure 6 shows the effect of treatments on tomato plant height growth as a function of time. It shows that the change in plant height is continuous for all treatments throughout the trial. Comparing the means of tomato plant height, the analysis of variance (ANOVA) reveals that there is a significant difference ($P<0.05$) between treatments throughout the trial. One week after transplanting, the analysis of variance revealed a significant difference ($P<0.05$) between the amended plots and the control treatment. In the second week, the treatments were as follows: M > Cd > Cd + M >M + VRP > Cd + VRP> VRP > C+> C-. The plant height of the M treatment (77.46 ± 1.25f cm) was significantly higher than that of Chicken Droppings (74.86 ±3.10e cm), Chicken Droppings + Mycorrhiza (72.69 ± 2.5de cm), Mycorrhiza + Vivianite Rock Phosphate combination (69.73 ± 1.20d cm), Chicken Droppings + Vivianite Rock Phosphate (67.52 ± 3.50bc cm), Vivianite Rock Phosphate (66.66 ± 1.45b cm), C+ (65.06 ± 5.12b cm) and that of the negative control (52.06 ± 6.20a cm). Similarly, at week eight, the length of the plants treated with mycorrhizae, chicken droppings, Vivianite Rock Phosphate, chicken droppings, and mycorrhizae combination, is significantly higher ($P <0.05$) than that of the negative control plants (52.06 ± 6.20a cm). Indeed, the high plant length in the treatments M, Cd, Cd + M, VRP + M could be explained by the high nitrogen (N) and phosphorus (P) content in these fertilizers.

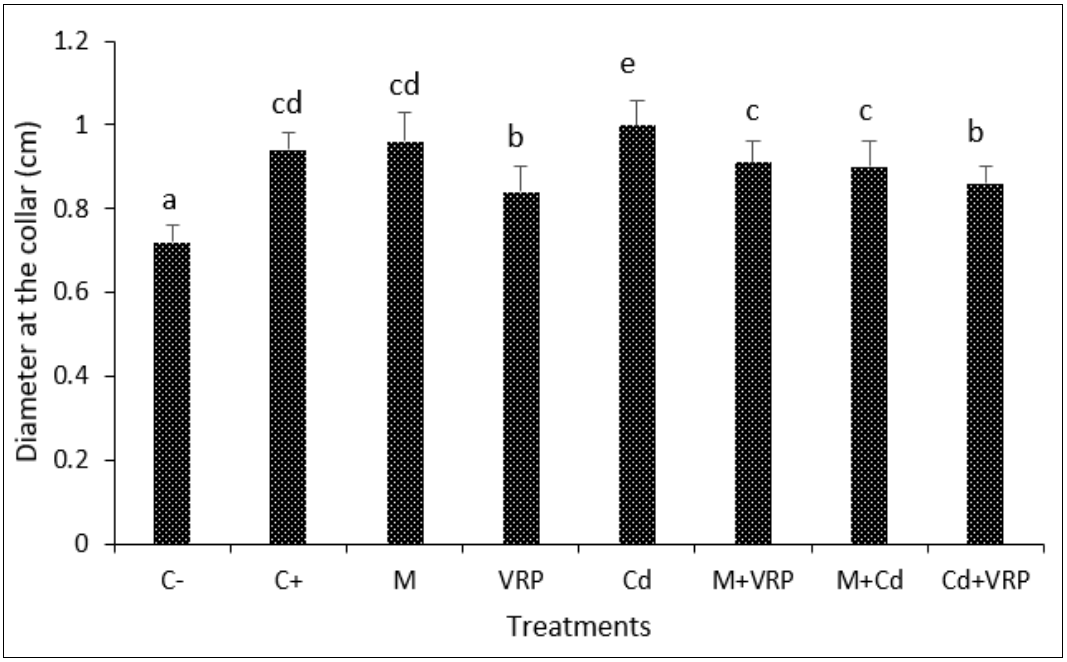


Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Fig 6: Evolution of height growth of tomato plants

Effect of different treatments on the collar diameter

Figure 7 shows the collar diameter of tomato plants at six (6) weeks after transplanting (AR) in our study area. The analysis of variance shows that the different treatments have a significant influence ($p<0.05$) on the lateral growth of tomato plants. The plants on the plots treated with chicken droppings (Cd) had the highest diameter (1.00 ± 0.06e cm) and the smallest diameter came from the negative control plot (C-: 0.72 ± 0.04a cm). The other treatments, M, C+, M + VRP, Cd + M, Cd + VRP and VRP, had values of 0.96 ± 0.07cd cm, 0.94 ± 0.04cd cm, 0.91 ± 0.05c cm, 0.90 ± 0.06c cm, 0.86 ± 0.04b cm and 0.84 ± 0.06b cm respectively.



Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Fig 7: Diameter at the collar at 6 weeks after transplanting

Effects of fertilizers on the variation of production and yield components

Flowering dates of tomato plants: Table 1 shows the effect of treatments on the flowering of tomato plants. It appears from this table that apart from the plants of treatment C+, M, VRP, and M+VRP which started their flowering early respectively at 47th, 46th, 46th, and 46th day after planting and reached 50 and 100% of flowering respectively at 51st and 59th, 50th, 56th, 50th and 57th, 51st and 57th, the plants of treatments Cd, Cd + VRP, Cd + M, and C- started to flower insignificantly at 48th, 48th, 48th and 53rd DAP respectively. The achievement of 50 and 100% flowering in these treatments is effective respectively at the 51st and 58th DAP for the plants of the C treatment, at the 53rd and 57th DAP for Cd + VRP, at the 53rd and 57th DAP for Cd + M,

and finally at the 57th and 63rd DAP for C- which is the latest.

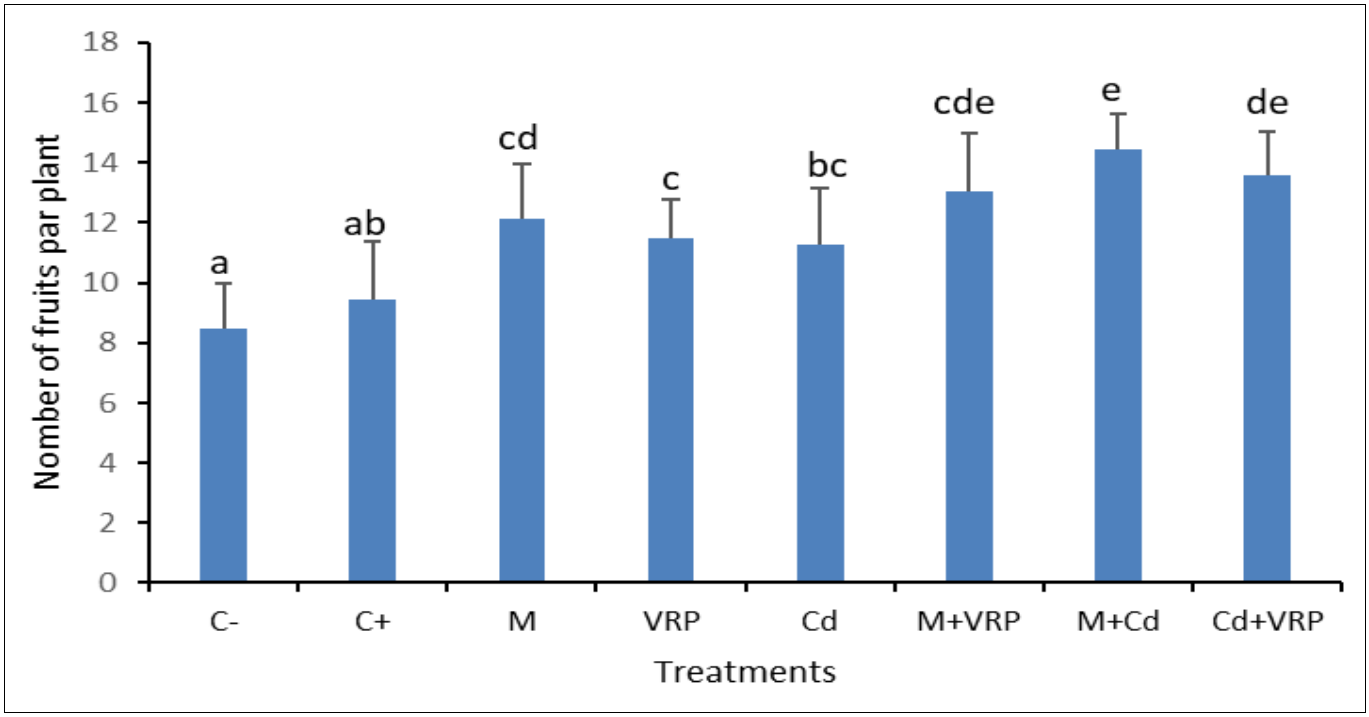
Table 1: Date of first flowering, 50% flowering and 100% flowering

Traitements	First flowering	50% flowering	100% flowering
C-	53	57	63
C+	47	51	59
M	46	50	56
VRP	46	50	57
Cd	48	51	58
M + VRP	46	51	57
VRP + Cd	48	53	57
M + Cd	48	53	57

Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Dopings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Number of fruits per plant

The effect of treatments on the average number of fruits per tomato plant at the end of the experiment is presented in Fig. 8. The ANOVA thus applied to the values obtained reveals that there is a significant difference ($p< 0.05$) between the average number of fruits per plant and treatments. The analysis made shows that there is a highly significant difference ($p< 0.01$) between the Cd + M, Cd + VRP and M + VRP treatments (14.46 ± 1.16e, 13.6 ± 1.41de, 13.06 ± 1.94cde) respectively and the negative control (C-: 8.46 ± 1.52a) and positive control (C+: 9.46 ± 1.94ab) treatments. The M, VRP, and Cd treatments show intermediate values with respective values of: 12.13 ± 1.85cd, 11.46 ± 1.32c, and 11.26 ± 1.90bc.

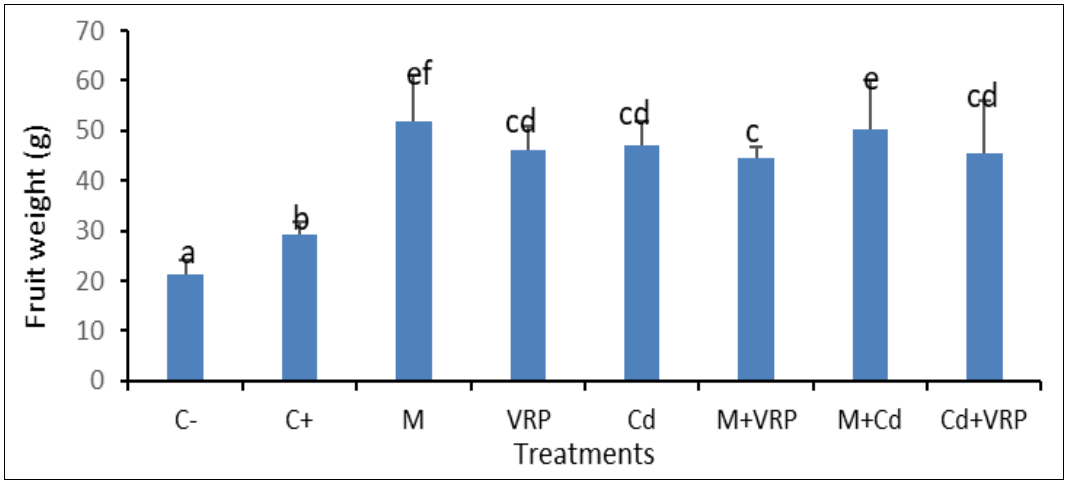


Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Fig 8: Effect of fertilizers on the number of fruits per plant

The average weight of tubers

Figure 9 shows the effect of treatments on tomato fruit weight. The average fruit weight in grams per fruit (g/f) per treatment was 52.0±9.07ef, 50.33±9.71e, 46.93±5.03cd, 46.06±4.84cd, 45.6±10.54cd, 44,46±2,45, 29.33±2.46b, 21.4±2.82a for treatments M, Cd+M, Cd, VRP, Cd+VRP, M+VRP, C+, and C- respectively. These results indicate that the fertilizers used have a significant effect ($p < 0.05$) on the average weight of tomato fruits. The M and Cd+M treatments with respective mean weights of 52.0 ± 9.07ef, and 50.33 ± 9.71e had the highest values while the negative control treatment C- (21.4 ± 2.82a) had the lowest mean weight.



Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Fig 9: Effect of fertilizers on average fruit weight per plant

Tomato fresh fruit yield per hectare

Table 2 shows the effect of the different treatments on the production yield of the number of fruits per hectare (ha) of each treatment. The ANOVA applied to the values obtained reveals that there is a significant difference ($p< 0.05$) between the means of the treatments. Thus, the production is significantly ($p< 0.05$) better for the treatments Cd + M (169996.08±17323c NF/ha), Cd + VRP (159811.98±18653.95c NF/ha) and M + VRP (153544.84±17639.37c NF/ha). The percentage gain was 70%, 60%, and 54% for Cd + M, Cd + VRP, and M + VRP treatments respectively compared to the C- treatment which had a value of 99490.79±38783.84a fruits/ha. The combinations of treatments positively induced a very good fruit yield of tomatoes.

Table 2: Average yield of fruit per ha in tomato plants

Trématent	Fruit Numbers per hectare	Yield production
C-	99490.79±38783.84^{a}	/
C+	111241.67±21324.96^{ab}	/
M	142577.35±17639.37^{bc}	43%
VRP	134743.43±16673^{c}	35%
Cd	132393.26±22582.90^{abc}	33%
M+VRP	153544.84±17639.37^{c}	54%
M + Cd	169996.08±17323^{c}	70%
VRP + Cd	159811.98±18653.95^{c}	60%

Legend: C-: negative control; C+: positive control; M: Mycorrhiza; VRP: Vivianite Rock Phosphate; Cd: Chicken Droppings; M + VRP: Mycorrhiza + Vivianite Rock Phosphate; M + Cd: Mycorrhiza + Chicken Droppings; VRP + Cd: Vivianite Rock Phosphate + Chicken Droppings.

Discussion

The low soil pH could decrease soil microbial activity and promote soil toxicity by increasing the solubility of certain elements such as aluminum (Segalen, 1973) [35]. These results are consistent with the work of Djao (2022) [10] and Mounkene (2020) [28] which low concentration of P (1.26 ± 0.01%) in the experimental site is believed to be because it is sequestered by aluminum and iron. The results of the analyses showed that the droppings can straighten the cation balance and the C/N ratio of the study soil. This adjustment is possible because the manure will provide sufficient amounts of N, P, K, Ca, Mg, and OM (Agbede *et al.,* 2008) [2]. Organic Matter (OM) provided by manure improves the physical properties of the soil. A study showed that the bulk density and temperature of the soil undergo a reduction with the provision of OM (Agbede *et al.,* 2008) [2] while the total porosity, moisture, and water holding capacity are improved. The latter reduces the daily soil temperature, thus reducing water loss (Akanni, 2005) [3].

The increased emergence rate observed in mycorrhizal plants could be due to the bioregulatory effect of mycorrhizal fungi and their spores. Indeed, these fungi would have optimized the growth conditions of the plants in the soil by promoting the bioavailability of water, increasing the soil moisture and the availability of soil nutrients, and regulating its temperature. These results thus mirror those obtained by Abakar (2015) [1], and Koulagna (2015) [22] who showed that inoculation of cotton grains would lead to an increase in emergence rate by a value of 97% compared to the control. Indeed, chicken droppings contain phosphorus, which would have influenced the installation and the start of this plant at emergence. Bennai and Benabbas (2007) [7], showed that phosphorus acts on root development by activating histogenesis. The growth parameters of tomatoes were positively affected by the use of fertilizers. Indeed, the increase in tomato growth would be due to the nitrogen, phosphorus, and minor mineral elements contained in these fertilizers. These results obtained could be explained by the fact that the incorporation of chicken droppings, known for their richness in major nutrients, in the different cell structures (nitrogen base, structural proteins, enzymatic proteins) is necessary for the establishment of membranes according to the results of Dauda *et al.* (2009) [9] and Kra (2002) [23]. Indeed, studies conducted by some authors have shown that local resources such as organic waste, applied to poor and acidic tropical soils can provide nutrients necessary for the feeding and growth of plants (Mulaji, 2011) [29]. These results are thus consistent with those of Ndiaye *et al.* (2007) [30] on *Acacia Senegal* and *Sterculiasetigera*; Haro *et al.* (2012) [19] on cowpea; Abakar (2015) [1] and Koulagna (2015) [22] on cotton. Flowering is very early in plants treated with RA, M, T+, and TM+Pr combinations compared to the negative control. This leads us to believe that the nutrients provided by the Vivianite Rock Phosphate and their influence on soil properties resulted in faster growth and development of tomato plants. Therefore, the application of RA allows tomato plants to complete their development cycle quickly. These results corroborate those obtained by Douzene (2012) [12] on bell pepper, Abakar (2015) [1], and Koulagna (2015) [22] on cotton. The higher number of fruits observed on plants amended with

the combination of chicken droppings and mycorrhiza, chicken droppings, and Vivianite Rock Phosphate could be explained by the fact that these fertilizers would have progressively released the necessary nutrients at the origin of root multiplication of tomato plants. Fruit number is an indicator of fruit yield. Similar results have been obtained by several researchers such as Nwaga (2000 and 2008) [32, 33] on tomatoes, Douzeune (2012) [12], Hamza (2014) [18], Abakar (2015) [1], and Koulagna (2015) [22] on cotton. The combinations of treatments positively induced a very good fruit yield of tomatoes. These results corroborate those of Hamza (2014) [18] who obtained again in watermelon fruit yield per hectare of 32.54%. This also reflects the results obtained by Tcheunteu (2009) [36] on *Ricinus communis* and by Douzeune, (2012) [12] on bell pepper.

Conclusion

The overall objective was to contribute to the improvement of tomato (*Lycopersicon esculentum*) productivity through the use of fertilizers in Ngaoundere in the Adamawa region (Cameroon). The application of chicken manure, mycorrhiza, and Vivianite Rock Phosphate significantly and positively ($p< 0.05$) improved tomato growth and production compared to the negative control. The combination of chicken droppings + mycorrhiza (Cd + M), the combination of chicken droppings + Vivianite Rock Phosphate (Cd + VRP), and the combination of mycorrhiza + Vivianite Rock Phosphate (M+VRP) were found to be more effective for the cultivation of this plant compared to the chemical fertilizer and the control treatment concerning the growth and production parameters. In perspective, it would be desirable: to test the effectiveness of these fertilizers on other varieties of tomato and to determine the contribution of these fertilizers to the content of vitamin A, and vitamin C on the antioxidant activity, the content of fibers, and carbohydrates.

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