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The Compost-Vivianite Powder-Liquid Manure Combination: a Better Fertiliser for Excellent Tomato Profitability

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This study aims to improve tomato growth under the High Guinean Savannah Climate of Adamawa-Cameroon through agroecology fertilisation. Field experimentations were carried out during both 2023 and 2024 cropping years. A randomised complete block experimental design with 8 treatments (unfertilised plot (T0), chemical fertiliser (T1), compost derived poultry litter (T2), *Pennisetum purpureum* manure (T3), vivianite powder (T4), compost derived poultry litter + *P. purpureum* manure (T5), compost derived poultry litter + vivianite powder (T6), and compost derived poultry litter + vivianite powder + *P. purpureum* manure (T7)) with 3 replications was used. Physico-chemical properties of growth substrates (growing soil, composts and *P. purpureum* manure), tomato growth and production parameters were assessed. Results showed that the soil of Bini-Dang is acidic and poor in nutrient elements necessary for improving tomato production. Studied agronomic parameters varied significantly ($p < 0.05$) according to fertiliser and experimentation year. T7 fertiliser increased significantly ($p < 0.05$) tomato fruit yield compared to other treatments. This increase was at 110.90% and 55.40% in the 2023 cropping year, and at 94.48% and 56.66% in the 2024 cropping year, compared to unfertilised soil and chemical fertiliser, respectively. The economic rentability of T7 fertiliser is excellent, while that of chemical fertiliser is profitable. The following combination, compost + *P. purpureum* manure + vivianite powder for tomato growth, is a good alternative to chemical fertiliser for growing this vegetable.

Key words: Bini-Dang, *Solanum lycopersicum* L., compost, vivianite powder, *Pennisetum purpureum* manure, productivity

Solanum lycopersicum L. (tomato) is a vegetable plant belonging to the Solanaceae family. The tomato is the second most consumed vegetable in the world and the first in Cameroon (FAO 2018). It is an important source of minerals, vitamins, essential amino acids, sugars, and dietary fibre (Wang *et al*. 2022). Tomatoes grow best on soils rich in N, P, K, and Mg (Abdel-Mawgoud 2007).

Ngaoundere's swamp soils are acidic and poor in the mineral elements essential for tomato growth and development (Maimouna *et al*. 2023). In this regard, Tomato growers generally use chemical fertilisers to improve soil fertility. These chemical fertilisers have an immediate and spectacular benefit on tomato yields (Tsala *et al*. 2024). However, these chemical fertilisers are not always within the reach of average farmers due to their high cost, and failure to control their use leads to environmental risks (Hamadou *et al*. 2022; Tambeayuk *et al*. 2025). Indeed, chemical fertilisers pollute groundwater and cause soil salinisation (Batamoussi *et al*. 2016). In addition, the excessive use of chemical fertilisers contributes to climate change by releasing greenhouse gases into the atmosphere, such as NO_2,

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which is a more potent greenhouse gas than CO_2 (Fisher 2018). In this respect, the adoption of sustainable fertilisation methods that respect ecological functionalities is a necessity.

Recent work on tomatoes aims to improve growth and fruit yield without using chemical fertilisers. In this respect, Anguessin *et al.* (2021) studied the effect of organic fertilisation based on *Jatropha curcas* L. and *J. gossypifolia* L. foliar litter on tomato growth in Guider-Cameroon, and found that these organic fertilisers increased tomato fruit yield. In addition, Maimouna *et al.* (2023) found that biological fertilisers improved tomato production under the High Guinean Savannah climate of Cameroon. Similarly, our previous studies (Maboulé *et al.* 2021) on various sources of compost on tomato productivity in the Bini-Dang locality (Ngaoundere, Cameroon) revealed that compost derived from poultry litter improves the yield of this fruiting vegetable.

To the best of our knowledge, no study has been carried out on tomato fertilisation using a mixture of compost, rock powder and liquid manure. This lack of data seems to be a handicap for the valorisation of local material in agroecology. Indeed, the Adamawa Cameroon region abounds in animal dung, rock deposits and plants with fertilising potential (Kamdem *et al*. 2020). Tomato growth using compost derived from animal waste, vivianite powder and *Pennisetum purpureum* manure would improve the growth potential of this fruiting vegetable. Compost improves soil quality, reduces losses due to plant pests, and enhances plant growth and production yields. Compost maintains soil fertility and, therefore, the sustainability of agricultural production systems. It is rich in various mineral elements that are essential for good plant growth (Bachirou *et al*. 2022). Compost improves the soil's physical characteristics and biodiversity (Getinet 2016). In addition, the Adamawa region of Cameroon abounds in geominerals such as vivianite, that the beneficial effect on agricultural production has been demonstrated (Yaya *et al*. 2015; Tchuenteu *et al*. 2020). Vivianite is an iron phosphate oxide with the formula $Fe_2(PO4)^2 8H_2O$ (Yaya *et al.* 2015). Phosphorus is an essential element determining plants' growth and development (Jiang *et al*. 2019). *Pennisetum* sp. has an important role in restoring soil fertility through biological reactivation and protects crops against pests (Euzanyr *et al.* 2024).

This study aims to improve tomato yield without using chemical fertilisers. Specifically, it aims to: (1) study the effect of combining various natural fertilisers (compost, vivianite powder and *P. purpureum manure*) on tomato growth parameters; (2) determine which treatment induces the best fruit yield (3) estimate the economic value of fertilisers. The importance of this work lies in the fact that the natural fertiliser formulation that would best improve tomato fruit yield will be popularised in agroecology.

MATERIAL AND METHODS

Study Area

The study was conducted during two cropping years (2023 and 2024) in the experimental field of the Faculty of Science of the University of Ngaoundere (Cameroon), located on its main campus. The following are the geographical parameters of the field: 7°24'61'' North latitude, 13°34'24'' East longitude, and 1155.80 m altitude. The area belongs to the agro-ecological zone II of Cameroon and is characterised by a High Guinean Savannah with a six-month rainy season (May to October) and a six-month dry season (November to April). The meteorological data (temperature and precipitation) for both cropping years were provided by the Adamawa Regional (Cameroon) Meteorological Service. Precipitation is higher in 2023 than in 2024, with an average of 197.11 mm per month and an annual total of 2,365.30 mm in 2023, compared with 116.97 mm per month and an annual total of 1,403.70 mm in 2024. May and June are the wettest months in 2023, with 0.30 mm and 493.10 mm of precipitation, respectively. In 2024, May and September are the wettest months, with 240.30 mm and 332.20 mm of precipitation, respectively. Average temperatures are higher in 2024 than in 2023, with an average of 24.25°C in 2024, 22.10°C in 2023. March and April are the hottest months in 2024, with average temperatures of 29°C and 28°C, respectively. In 2023, March and May are the hottest months, with mean temperatures of 24.20°C and 23.60°C, respectively. The vegetation of the study area is an herbaceous savannah dominated by *Thitonia diversifolia*, *Pennisetum purpureum*, *Bidens Pilosa, Mimosa* sp., *Sida rhombifolia*, *Ageratum conyzoides*, and *Borrelia* *latifolia*. Shrubs on the study site are scattered and between 0.50 m and 1.50 m tall.

Tomato Seeds

Seeds of the Rio Grande tomato variety were used. This tomato variety is used widely by farmers in Bini-Dang because of its high fruit yield and disease resistance (Tsala *et al.* 2024), as well as its adaptability to the rainy season and its short development cycle. Using the variety that has a short development cycle is advantageous for the peasants as it can favour multiple cropping per year if there is a possibility for off-season crops (Tchuenteu *et al*. 2018).

Fertilisers

Four different types of fertilisers were used (Figure 1): NPK chemical fertiliser (3a), compost (3b), vivianite powder (3c) and *Pennisetum purpureum* manure (3d). The various treatments in the trial are formulated using the four fertilisers listed above.

Compost-derived poultry litter was used. Poultry litter from henhouses located near the campus of the University of Ngaoundere was collected. The heap composting method, according to Tchuenteu *et al*. (2018), was used. The composting process lasted 3 months.

Vivianite rock was collected in the Hangloa village located between 7°20' and 7°30' North latitude and 13°20' and 13°25' East longitude. Chemical composition of vivianite powder is the following: Fe_2O_3 (68.72%), P_2O_5 (9.17%), Al_2O_3 (7.72%), and SiO_2 (9.67%) (Yaya *et al*. 2015). Thus, the total phosphorus content was estimated at 671.50 mg/kg while the assimilated phosphorus content was 81.13 mg/kg. Phosphate contained in this geological material can be solubilised.

P. purpureum grows wild in the High Guinean Savannahs of Cameroon. *P*. *purpureum* manure is produced according to Chukwuka (2014) method. This method involves fermenting *P. purpureum*. The main nutrients of used chemical fertilisers are N, P and K. They are referred to as NPK (20-10-10) chemical fertiliser, meaning that it contains 20% N, 10% P_2O_5 and 10% K_2O.

Physicochemical Analysis of Soil and Composts

Soil samples were collected from the study site using a fifteen-point randomisation system (1 kg per point). All these samples were mixed to form a composite sample representative of the study site (15 kg of soil). Soil samples were taken at 30 cm.

The physico-chemical analyses of soil and produced compost were carried out in the Laboratory of Research Unit in Soil Analysis and Environmental Chemistry at the University of Dschang (Cameroon), using suitable methods.

Assessment of the Responses of Tomato to Compost, Vivianite Powder and Pennisetum purpureum Manure

Nursery management

After collecting the black earth substrate, a sterilisation of this substrate was done in order to destroy the microorganisms capable of eating away the seeds of the tomato. The sterilisation consisted of heating water to a high temperature (over 100°C) and then pouring it onto the substrate. Once the substrate had cooled, the seeds were scattered and covered with a thin layer of soil to facilitate germination. The start of germination took place at 6 days after sowing.

Experimental Design, Transplantation and Crop Management

The field work was carried out during the both years 2023 and 2024 following an experimental design in completely randomised blocks with 8 treatments (unfertilised plot (negative control) (T0), NPK (20-10-10) chemical fertiliser (positive control (T1), compost derived poultry litter (T2), *Pennisetum purpureum* manure (T3), vivianite powder (T4), compost derived poultry litter + *P. purpureum* manure (T5), compost derived poultry litter + vivianite powder (T6), and compost derived poultry litter + vivianite powder + *P. purpureum* manure (T7)) repeated 3 times. 1 kg of compost, 20 g of vivianite powder and 0.15 L of *P. purpureum* manure were applied per plant. One-month-old tomato seedlings, with 3 cm height, 5 leaves, and no branching are used for transplantation. Each experimental unit consists of 15 plants spaced 50 cm apart and arranged in the same row. A total of 360 plants was maintained by manual weeding once every 2 weeks during the trial, to prevent weeds from competing with tomato plants for sunlight and hydromineral nutrition.

Data Collection, Sampling and Statistical Analysis

During the vegetative phase, 30 plants were ran-

1a: NPK (20-10-10) chemical fertiliser

1b: Compost

1c: Vivianite powder

1d: *Pennisetum purpureum* manure

Figure 1. Fertilisers: NPK (20-10-10) chemical fertilisers (1a), compost-derived poultry litter (1b), vivianite powder (1c) and *Pennisetum Purpureum manure* (1d).

domly selected; plant height, number of leaves per plant and diameter of stem at collar were evaluated at a regular interval time of 14 days starting from the 14th day after transplantation (DAT) to 70th DAT. At maturity, yield parameters such as number of fruits per plant, fruit weight and estimated fruit yield [t/ha] were assessed. Stem diameter at collar was measured using a 0.01 mm precision calliper.

The economic analysis of treatments was used to estimate the economic value of fertilisers used in this experiment. The RVC compares the profitability of new treatments with the reference treatment that farmers are familiar with. It is therefore the ratio between the yield increase of the new treatment and the fertiliser cost of the same treatment.

RVC = value of yield increase/fertiliser cost; if RVC > 1, fertiliser is profitable; if RVC ≥ 3, profitability is excellent (Useni *et al*. 2014). For the profit calculation, the following expenses were retained: purchase of mineral fertilisers, transport and incorporation into the soil. The cost of chemical fertilisers is that observed on the local market ($43.28/50 kg of NPK) and the cost of labour for spreading mineral fertilisers has been estimated at $10/50 kg. The average price of 1 kg of tomato is around $0.57 in Ngaoundere markets.

All the data were statistically analysed using the Statgraphics Plus Program version 5.0. The significance of differences was determined using Duncan test.

RESULTS

Physicochemical Properties of Growth Substrates

Table 1 illustrates the physico-chemical properties of the growth substrates (soil from the Bini-Dang locality (Adamawa, Cameroon), compost derived from poultry litter and *Pennisetum purpureum* manure). The soil of the study site is acidic (4.80) with a sandy-loam texture, while the pH of the compost (7.80) and *P. purpureum* manure (6.93) are neutral. Overall, the produced compost and liquid manure for this study are rich in various mineral elements compared to the soil of Bini-Dang. The P, Ca, Mg, K, and Na contents of compost are higher, but the nitrogen content of liquid manure is higher than that of compost. The P, Ca, Mg, K, and Na contents of the produced compost are 24.44, 6.72, 95.00, 15.75, and 18.00 times higher than those of the Bini-Dang soil, respectively. The N content of *P. purpureum* manure is 20.81 times higher than that of the soil of the study site.

Responses of Tomato to Compost, Vivianite Powder and Pennisetum Purpureum Manure

Analysis of variance (ANOVA) revealed a highly significant difference ($p < 0.001$) between treatments on all studied growth parameters (plant height, stem diameter at collar and number of leaves/plant), and yield parameters (number of fruits/plants, fruit weight and yield in t/ha) for each experimentation year.

T a b l e 1

Physicochemical properties of growth substrates

Parameters	Soil	Compost	*Pennisetum purpureum* manure
Ar [%]	25.00	–	–
Li [%]	35.00	–	–
Sa [%]	40.00	–	–
CO [%]	0.57	–	–
MO [%]	0.98	–	–
pH	4.80	7.80	6.93
N [%]	0.11	0.12	2.29
P [mg/100g DM]	35.80	875.00	6.85
Ca [mg/100g DM]	67.00	450.00	2.70
Mg [mg/100g DM]	3.00	285.00	2.05
K [mg/100g MS]	29.00	457.00	8.05

Note: Ar – clay; Li – silt; Sa – sand; DM – dry matter.

Plant Height and Diameter of the Stem at the Collar

The height growth curve of tomato plants as a function of time has the appearance of a sigmoidal curve for both cropping years 2023 and 2024 for each treatment (Figure 2). These growth curves show a slow growth phase from 14 to 28 DAT, then an exponential growth phase between 28 and 56 DAT, and finally a stationary phase beyond 56 DAT. Height growth of tomato plants was higher on plants fertilised with compost derived from poultry litter (T2) in both 2023 and 2024 experimentation years.

In 2023, the tallest tomato was T2 plants (65.20 ± 9.14 cm), while the shortest (40.26 ± 11.38 cm) was unfertilised plants. T2 fertiliser improved the plants' height by 61.94% and 21.21% compared to unfertilised plants and chemical fertiliser.

Regarding the 2024 cropping year, T2 fertiliser exhibited the highest plant height (58.53 ± 6.90 cm), and the shortest plant height (46.83 ± 8.22 cm) was from T3 fertiliser. T2 fertiliser increased the plant's height by 19.06% and 22.29% compared to T0 and T1, respectively. The height of unfertilised plants in 2024 is higher than that of the same plants in 2023. Unfertilised plants in 2024 are 1.16 times taller than those in 2023.

In the 2023 cropping year, at 56 DAT, the greatest diameter of stem at collar (1.86 ± 0.36 cm) was recorded on T6 plants, while T4 plants exhibited the lowest value (0.93 ± 0.21 cm) of this parameter (Figure 3a). The stem diameter of T6 plants is 1.45 and 1.75 times wider than that of chemical fertiliser and unfertilised plants, respectively.

Concerning the second cropping year 2024, T7 plants exhibited the widest diameter of stem (2.29 ± 0.34 cm) while the smallest diameter was recorded on T3 plants (1.67 ± 0.29 cm) (Figure 3b). The diameter of stems of T7 plants is 1.17 and 1.28 times wider than that of T1 and T0 plants, respectively. The diameter of the stem of unfertilised plants in 2024 is 1.23 times greater than that of the same plants in 2023. Tomato plant diameter is a key indicator of plant vigour and health, resistance to harsh weather conditions and tomato productivity.

Foliar Production

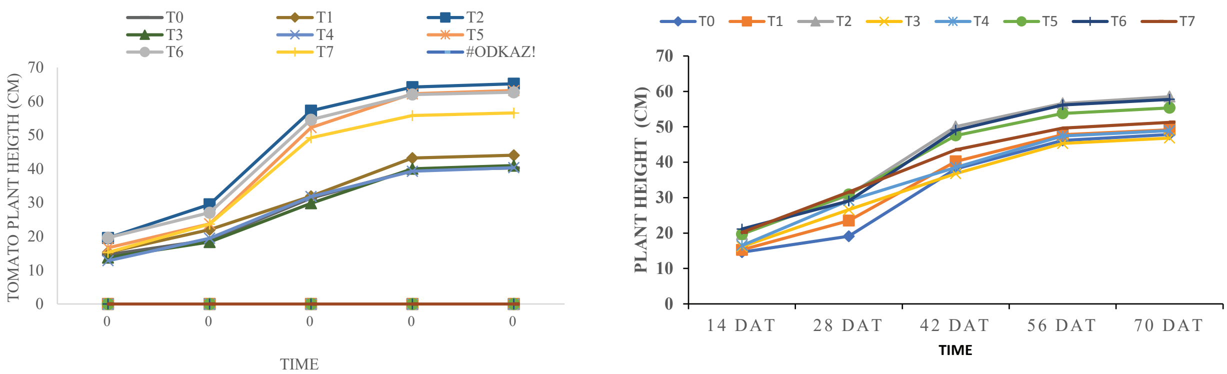
In 2023, at 56 DAT, foliar production varies from 27.43 ± 14.15 leaves per plant for T3 fertiliser to 55.40 ± 14.43 leaves per plant for T5 fertiliser. The foliar production of the T5 plant was 1.76 and 1.93 times greater compared to that of treated chemical fertiliser plants and unfertilised plants, respectively (Figure 4a).

Concerning the second cropping year 2024, the greatest foliar production (76.96 ± 15.33 leaves per plant) was recorded on T6 plants, while the lowest leaf production was from T4 plants (44.43 ± 17.97 leaves per plant) (Figure 4b). T6 plants produce 1.48 times and 1.44 times more leaves than T1 and T0 plants respectively. Unfertilised plants in 2024 produce 1.74 times more leaves than the same plants in 2023.

Fruit yield is significantly correlated with fruit weight. This correlation suggested that the important parameters like foliar production, fruit number showed a positive relation with fruit weight. On the other hand, a positive relation with these characters indicates that tall plants produce more fruits. These characters are important yield attributes to be reckoned in the fruit yield improvement through fertilisation. Thus, suggesting that T5 and T6 plants would produce more fruits than other plants, but this needs to be investigated. The Figure 5 shows the foliar production of treated T6 plants, unfertilised plants and treated chemical fertiliser plants.

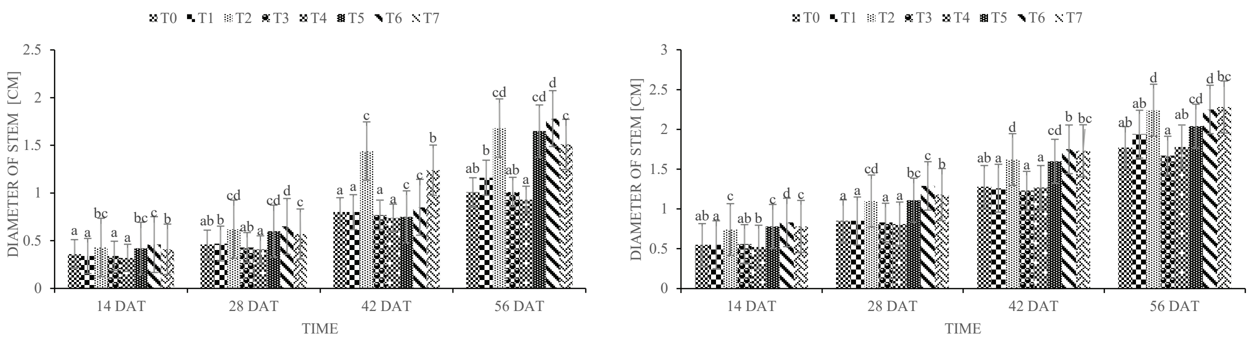
Number of Fruits per Plant

In the first cropping year 2023, the highest number of fruits per plant was recorded on plants grown on treated soil treated with T5 and T6 fertilisers. However, the lowest fruit production per plant was recorded on T4 plants. (Table 2). T5 and T6 fertilisers increased the number of fruits per plant by



2a: Plant´s height from 2023 2b: Plant´s height from 2024

Figure 2. Evolution of tomato plants height depending on fertiliser in 2023 (2a) and 2024 (2b).
Note: DAT – day after transplantation; T0 – unfertilised plot; T1 – chemical fertiliser; T2 – compost derived poultry litter; T3 – *Pennisetum purpureum* manure; T4 – vivianite powder; T5 – compost derived poultry litter + *P. purpureum* manure; T6 – compost derived poultry litter + vivianite powder; T7 – compost derived poultry litter + vivianite powder + *P. purpureum* manure.



3a: Diameter of stem from 2023 3b: Diameter of stem from 2024

Figure 3. Evolution of the diameter of the stem depending on the fertiliser in 2023 (3a) and 2024 (3b).
Note: DAT; T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2. Values of band for the same date affected by the same letter are not significantly different.

198.83% and 354.06% compared to chemical fertiliser and unfertilised plants.

Regarding the second cropping year 2024, T6 plants produced the highest number of fruits per plant, while plants grown on unfertilised soil produced fewer fruits than all the other treatments (Table 3). T6 fertiliser increased the number of fruits per plant by 227.01% and 270.27% compared to chemical fertiliser and unfertilised plants. Unfertilised plants in 2024 produce 1.24 times more fruit than the same plant in 2023.

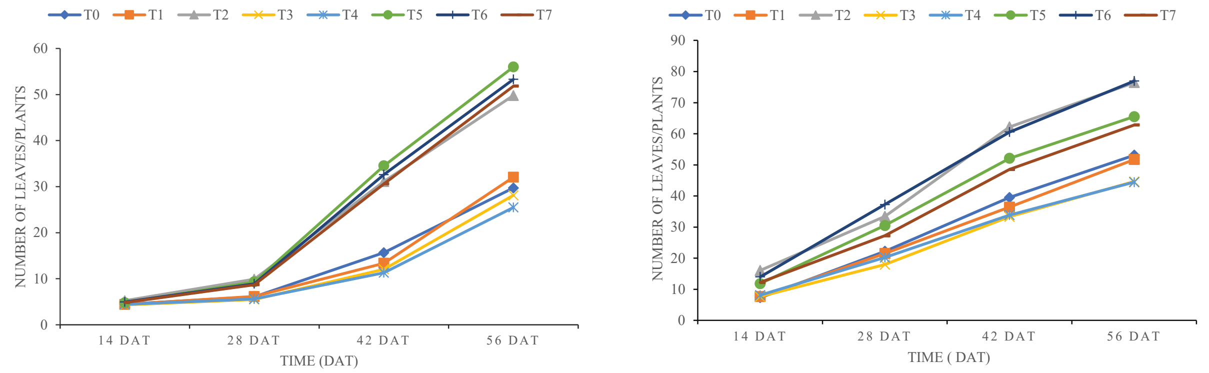
Fruits Weight

The highest fruit weight in 2023 was recorded on T7 plants, while the lowest value of this parameter was from T0 plants (Table 4). The weight of T7 fruits was 1.55 times and 2.10 times greater than T1 and T0 fruits respectively.

Regarding the 2024 second cropping year, the fruits of plants grown on unfertilised soil were lighter than those of all other treatments, while the highest fruit weight was recorded on T7 plants (Table 4). T7 tomato fruits weighed 1.56 and 2.07 times more than T1 and T0, respectively. Fruits from crop year 2023 weighed 1.01 times more than those from crop year 2024.

Tomato Fruits Yield

Regarding the 2023 first cropping year, tomato fruit yield varied from 6.61 t/ha for T0 plots to 13.94 t/ha for T7 plots. T7 fertiliser increased tomato fruit yield by 55.40% and 110.89% compared to T1 (8.97 t/ha) and T0 (6.61 t/ha), respectively. In the 2024 cropping year, T7 plants exhibited the highest fruit yield (13.05 t/ha), while the lowest fruit yield (6.71 t/ha) was recorded on T0 plants. T7 fertiliser increased tomato fruit yield by 56.66% and 94.48% compared to T1 and T0 treatments. The fruits yield of T7 plants in 2023 was 1.06 times greater than in 2024 (Figure 6).



4a: Foliar production from 2023 4b: Foliar production from 2024

Figure 4. Evolution of tomato foliar production depending on fertiliser in 2023 (4a) and 2024 (4b).
Note: DAT; T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2.

Figure 5. Leaf production of T6, T0 and T1 plants.
Note: T0; T1; T6 – see Figure 2.

Economic Values of Fertilisers

The ratio between the yield increase of a fertiliser and fertiliser cost (RCV) varied according to fertilisation and the year of experimentation (Table 5). The RCV varied from 1.66 for chemical fertiliser (T1) in 2024 to 3.08 for T7 fertiliser (1 kg + 20 g de vivianite + 0.25 l de purin de *Pennisetum purpureum*). In both studies, year 2023 and 2024, the RCV of chemical fertiliser is greater than 1 and less than 3, thus suggesting that this fertiliser is economically profitable. Regarding T7 fertiliser, the RCV is higher than 3, thus suggesting that the rentability of T7 fertiliser is excellent. Furthermore, in both study years, the RCV of T7 fertiliser is higher than that of chemical fertiliser. This result suggests that the profitability of T7 fertiliser is better than that of chemical fertiliser.

T a b l e 2

Number of fruits per plant depending on fertiliser in the cropping year 2023

Treatments	Number of fruits/plants in 2023		
	42 DAT	56 DAT	70 DAT
T0	0.53 ± 1.35^{a}	2.26 ± 3.46^{a}	5.66 ± 4.61^{ab}
T1	1.16 ± 0.37^{a}	1.40 ± 2.52^{a}	8.60 ± 5.51^{b}
T2	4.40 ± 3.10^{b}	12.96 ± 5.82^{b}	20.96 ± 6.66^{c}
T3	0.06 ± 0.36^{a}	1.03 ± 2.05^{a}	4.60 ± 3.80^{a}
T4	0.23 ± 0.81^{a}	1.40 ± 1.58^{a}	4.50 ± 2.75^{a}
T5	3.50 ± 3.77^{b}	15.03 ± 7.85^{bc}	25.70 ± 6.94^{d}
T6	4.30 ± 1.87^{b}	17.23 ± 6.01^{c}	25.70 ± 7.89^{d}
T7	3.23 ± 5.27^{b}	13.03 ± 9.42^{b}	20.70 ± 11.32^{c}

Note: DAT; T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2. Values of column affected by the same letters are not significantly. different.

T a b l e 3

Number of fruits per plant depending on fertiliser in cropping year 2024

Treatments	Number of fruits/plants in 2024		
	42 DAT	56 DAT	70 DAT
T0	3.76 ± 3.14^{bc}	11.90 ± 6.55^{b}	7.03 ± 3.48^{a}
T1	2.06 ± 2.22^{ab}	10.13 ± 8.86^{ab}	7.96 ± 4.48^{a}
T2	7.30 ± 4.69^{de}	29.36 ± 12.82^{e}	16.36 ± 6.67^{c}
T3	1.66 ± 1.68^{a}	9.50 ± 9.95^{ab}	8.20 ± 5.09^{a}
T4	1.36 ± 1.65^{a}	6.76 ± 6.49^{a}	7.50 ± 4.10^{a}
T5	6.86 ± 4.47^{d}	14.53 ± 7.19^{bc}	24.30 ± 8.95^{d}
T6	8.93 ± 3.88^{e}	14.70 ± 6.58^{bc}	26.03 ± 10.19^{de}
T7	4.96 ± 4.16^{c}	18.13 ± 10.79^{c}	13.00 ± 5.41^{b}

Note: DAT; T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2. Values of column affected by the same letters are not significantly different.

Table 4

Weight of fruits according to fertiliser and harvested year

Treatments	Fruits weight /plant	
	Crop year 2023	Crop year 2024
T0	46.55±6.42[a]	46.87±6.34[a]
T1	63.23±4.28[b]	62.24±4.89[b]
T2	80.32±12.19[d]	79.42±13.28[d]
T3	61.19±8.25[b]	59.58±8.37[b]
T4	77.47±19.06[d]	76.35±19.21[d]
T5	71.04±6.57[c]	70.03±7.16[c]
T6	75.68±12.52[cd]	74.57±12.80[cd]
T7	98.20±17.22[e]	97.15±17.40[e]

Note: T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2. Values of columns affected by the same letters are not significantly different.

DISCUSSION

The results obtained on growth substrates in this study showed that the soil of Bini-Dang is acidic. Acid soils limit the absorption of mineral elements such as phosphorus, potassium and magnesium. The pH of produced compost (7.80) corroborates the work of Djongmo *et al.* (2024), who showed that the pH of walled compost ranges normally between 7.33 and 7.83. This proves that adding compost to an acid soil would improve soil pH, which is in line with the work of Useni *et al*. (2014), who indicate that increasing pH by adding composts is a good option for restoring soil fertility. Mineral elements (nitrogen, phosphorus, potassium, calcium, and magnesium) contained in *Pennisetum purpureum* manure and compost can provide the mineral elements that tomato plants need for better growth and development (plant height, foliar production, and fruit production), thereby increasing soil fertility (Mohammadi *et al*. 2011).

Plant height is one of the morphological parameters that can predict tomato weight yield. Plant height is considered a good indicator of photosynthetic intensity (Tchuenteu *et al*. 2020) and transpiration area, which are closely correlated with leaf production (Vertessy *et al*. 1995), leading to better energy production for fruit filling and an increase in overall yield (Menzel 2005). The increase in the number of tomato leaves suggests an increase in photosynthetic activity (Tchuenteu *et al*. 2018), and consequently, an increase in tomato fruit yield. Furthermore, Haydar *et al*. (2007) studied the interrelationship among different traits on tomato and found that fruit weight showed significant positive correlations with the number of leaves and total number of fruits at maturity. Results recorded on fruit production partially corroborate the work of Maimouna *et al*. (2023), who reported that the number of fruits per plant of tomato varies from 8.46±1.52 to

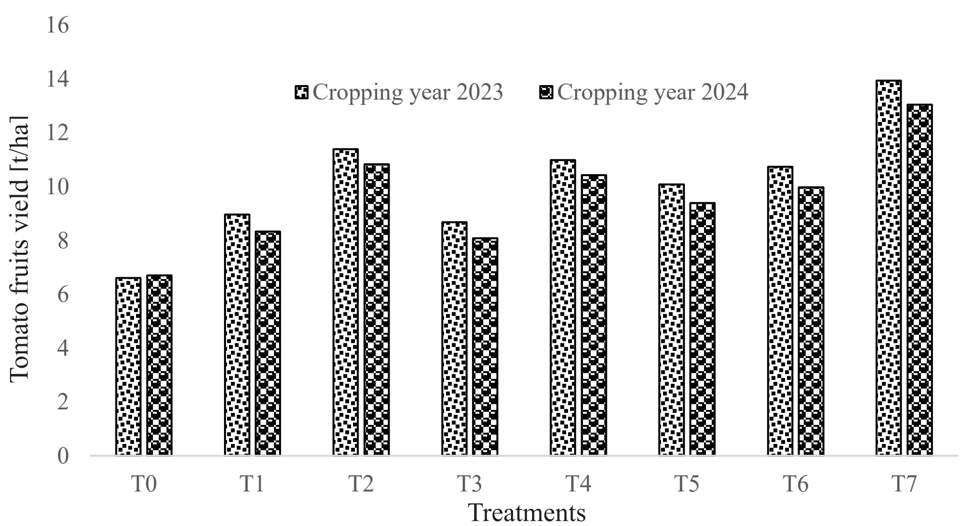


Figure 6. Tomato fruits yield [t/ha].
Note: T0; T1; T2; T3; T4; T5; T6; T7 – see Figure 2.

Table 5

Profitability of fertilisers used according to the year of experimentation

Fertilisers	Total fertilisers cost ($/ha)	Tomato fruits yield [kg/ha]		Yield increase [kg/ha]		Value of yield increase [$/ha]		RVC	
		2023	2024	2023	2024	2023	2024	2023	2024
T0	0	6,611.53	6,710.91	–	–	–	–	–	–
T1	852.44	8,976.75	8,339.30	2,365.22	1,628.39	2,057.74	1,416.70	2.41	1.66
T7	1352.75	13,931.43	13,055.54	7,319.90	6,344.63	4,172.34	3,616.43	3.08	2.67

Note: T0; T1; T7 – see Figure 2.

14.46 ± 1.16 depending on fertiliser. Data obtained in the present study on tomato fruit weight corroborate the work of Takamitsu *et al*. (2020), who reported that tomato fruits yields range between 97.15 g and 98.20 g according to fertilisation.

In the present work, tomato fruit yield varies from 6.61 t/ha to 13.94 t/ha. This result partially corroborates the work of Maboulé *et al.* (2025), who found that the fruit yield of Tomato Rio Grande variety is 12.80 t/ha. Furthermore, Dürdane *et al.* (2011) found that fertilised tomato plants using chemical fertiliser exhibited a fruit yield at 122.92 t/ha. The tomato fruits are the second most consumed vegetable in the world and the first in Cameroon (FAO 2018). It is an important source of minerals, vitamins, essential amino acids, sugars and dietary fibre (Wang *et al*. 2022). T7 fertiliser was found as the better fertiliser to improve tomato fruits.

Natural fertilisers used in this work had positive effects on growing parameters, and consequently on tomato fruits yield. Several possible explanations would justify these results. Indeed, produced composts have an alkaline pH (7.80), which would improve that of soil from the study site (Ognalaga & Itsoma 2014). Furthermore, compost macronutrient content and organic matter content are far higher than those of soil from Bini-Dang. An important soil organic matter content promotes phosphorus uptake (Gichangi & Mnkeni 2009), which presents a key role in photosynthesis (Chapman & Edmeades 1999). The applying of organic matter to study soil stimulates the microorganisms' activities, leading to greater availability of soil nutrients to plants (Khosro *et al.* 2011).

The addition of produced compost, *Pennisetum purpureum* manure, and rock powders therefore has the positive effect of promoting good plant nutrition by releasing nutrient elements into the soil solution, thus promoting increased growth parameters compared to plants that received no fertiliser (Toundou *et al*. 2014).

However, the optimum was reached with the treatment based on the mixture of compost-derived poultry litter + vivianite powder + *P. purpureum* manure. (T7). These results may be justified by the ionic balance of mineral elements in the fertilised soil with this treatment. Indeed, there is a necessary ionic balance that the crops need to absorb nutrients for better growth. Although produced compost and *P. purpureum* manure are rich in various mineral elements. Vivianite is an iron phosphate oxide with the formula $Fe_2(PO4)^2 8H_2O$ (Yaya *et al.* 2015). The combination of compost with *P. purpureum* manure and vivianite powder gives balanced ionic content that improves plant growth. A high cation content, for example, can inhibit ammonium and potassium uptake (Coleto *et al.* 2023), which can slow crop growth. This would be the case for fertilised plots with composts derived from poultry litter, *P. purpureum* manure and vivianite powder, which contain high levels of mineral elements (Table 1).

The difference in tomato production parameters recorded between the two cropping years 2023 and 2024 would be explained by differences in meteorological conditions. The low photosynthesis activity leads crop growth due to water stress (Zhang *et al.* 2011; Chao *et al*. 2022). Increased rainfall intensity affects crop yield through waterlogging or leaching of soil nutrients. Waterlogging compacts the soil, deprives roots of oxygen and contributes to salinisation. This in turn reduces the effective photosynthetic surface area of the leaves, the length and diameter of the ear, and consequently disrupts the accumulation of dry matter, leading to lower growth (Chao *et al*. 2022). In addition, optimum temperatures for better tomato development range between 15 and 25°C (Adams *et al*. 2001).

In this experiment, the chemical fertiliser is profitable. This result corroborates data reported by Useni *et al*. (2014), who studied the influence of seedling date and inorganic fertilisation in Lubumbashi on maize seed yield and found that the RCV of the combination NPK chemical fertiliser and urea range between 1.47 and 2.42 according to level and the year of experimentation.

Producing and using of T7 fertiliser for tomato growth under High Guinean Savannah of Cameroon, contribute not only to improve tomato fruits yield, but also to improve local material in agriculture, and to protect environment. However nutritional value of fruits from T7 fertiliser is necessary.

CONCLUSIONS

The agronomic efficacy of poultry litter compost, vivianite powder and *Pennisetum purpureum* manure on tomato cultivation revealed that the combination of compost + *P. purpureum* manure + vivianite powder improved tomato growth and yield compared with the positive and negative controls. However, the non-combined application of these different fertilisers (compost, vivianite powder, *P. purpureum*) all had a beneficial effect on growth and yield. T7 fertiliser increased tomato fruit yield at 110.9% and 55.40% in 2023, the first cropping year, and at 94.48% and 56.66% in 2024, the second cropping year, compared to unfertilised plants and chemical fertiliser, respectively. The profitability of T7 fertiliser is excellent, while that of chemical fertiliser is profitable. The combination (compost + *P. purpureum* manure + vivianite powder) could therefore be an alternative to chemical fertilisers, harmful to human health and the consumer and can be recommended as a fertiliser in tomato cultivation if large, healthy fruits are to be obtained.

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