# Enriched compost with vivianite or basaltic pyroclastite powder: Better fertilizer to improve Artemisia growth under High Guinean Savannah climate of Cameroon

**Abstract**

This study aims to improve the productivity of *Artemisia annua* L. based on natural fertilizer in Adamawa-Cameroon. Field experimentations were carried out during two cropping years (2023 and 2024). A randomized complete block experimental design with 12 treatments (unfertilized plots (C-), chemical fertilizer (C+), cow dung manure-based compost (CCD), poultry litter-based compost (CPL), vivianite (V), pyroclastite (P), cow dung manure-based compost + vivianite (CCDV), cow dung manure-based compost + pyroclastite (CCDP), poultry litter based-compost + vivianite powder (CPLV), poultry litter-based compost + pyroclastites (CPLP), cow dung manure-based compost + vivianite powder + pyroclastite (CCDVP)) and 03 replications were used. Physico-chemical characteristics of growth substrates (soil and composts), and growth parameters were evaluated. Results show that the soil of Bini-Dang is acidic and poor in mineral elements necessary for Artemisia better growth. Artemisia growth varies significantly (p<0.05) depending on fertilization and experimentation year. Overall, unfertilized plants exhibited significantly (p<0.05) the smallest growth parameters. CCDV fertilizer increased fresh biomass at 528.33% compared to C- and at 258.23% compared to C+ respectively in 2023 first cropping year. However, CPLV fertilizer increased fresh biomass at 431.65% compared to C- and at 414.33% compared to C+ in 2024 second cropping year. The supply of the following combination, 1 Kg compost derived cow dung manure + 10 g pyroclastite powder, or 1 Kg compost derived poultry litter + 10 g vivianite powder was found to be very promising in improving the sustainable Artemisia production.

**Key words:** *Artemisia annua* L., compost, vivianite, basaltic pyroclastites, growth

**Introduction**

*Artemisia annua* L. is a medicinal plant belonging to Asteraceae family. It is an aromatic herb widely distributed in cool temperate and subtropical regions of the world. It is cultivated over large areas in many countries such as China, Kenya, the United Republic of Tanzania and Vietnam (Smitha *et al*., 2014). This plant has been used in traditional Chinese medicine for more than 2000 years (Diemer *et al*.,2003). Artemisia is used to treat several ailments such as jaundice, fever caused by tuberculosis, colds, diarrhea, poor blood circulation, excessive bleeding during menstruation. Also, recent studies confirmed its potential in the management of COVID-19 (Haq *et al*., 2020; Dong *et al*., 2020). Artemisia has been more popularized by the World Health Organization (WHO) for malaria treatment, due to its high artemisinin content (WHO, 2020). Artemisia consumption in herbal teas or capsules is more effective for malaria treatment, compared with pharmaceutical drugs containing artemisinin. This offers hope for impoverished populations to access a curative antimalarial treatment that is both effective and economical (Zime-Diawara *et al*., 2015).

As artemisinin production is insufficient to meet the ever-increasing global demand and its marketing at a high price by China, production channels were set up in the early 2000s, first in Vietnam, then in East Africa (Blanc *et al*., 2008). Recent work on Artemisia aims to improve the sustainable production of the plant. Thus, Mounkaila *et al*. (2015) studied the influence of organic manures on the germination and growth of *A. annua* in Niamey, Niger, and Abdou Salam (2021) studied the effect of cow dung and mycorrhizae on the growth of *A. annua* in Nkolbisson (Yaounde Cameroon). These authors recorded that these natural fertilizers are beneficial for the growth and production of *A. annua*. To the limit of our knowledge, no study has been carried out on the cultivation of this medicinal plant based on natural fertilizers such as compost, vivianite and basaltite pyroclastites in the High Guinean Savannah area of ​​Adamawa Cameroon. This lack of data seems to be a handicap for the valorization of local material for sustainable production of Artemisia. Indeed, it has been reported by several researchers (Tchuenteu *et al*., 2020; Kamdem *et al*., 2020) that compost plays a major role in maintaining soil fertility and consequently, in the sustainability of agricultural production, this organic amendment is rich in mineral elements necessary for plant growth. They improve the physical characteristics of the soil as well as its biological composition. In addition, the Adamawa region of Cameroon is full of geo-minerals such as vivianite and pyroclastites whose beneficial effect on agricultural production has been demonstrated. Vivianite is an iron oxide and phosphate with the formula Fe2++(PO4)28H2O (Yaya *et al*., 2015). Phosphorus is one of the essential macronutrients for plant growth and development (Vassilev and Vassileva, 2003). It is involved in photosynthesis as an energy fixer and transporter, its deficiency causes major abiotic stress that limits plant growth and crop productivity on many soils around the world. Pyroclastites are rich in exchangeable bases (Ca2+, Mg2+, Na+ and K+) capable of enriching the soil with mineral elements (Nkouatio *et al*., 2008).

This study aims to improve the productivity of Artemisia based on natural fertilizers under High Guinean Savannah climate of Adamawa-Cameroon. Specifically, it involves to: (1) evaluate various growth substrates (soil and compost) for the growth of *A.* *annua*, (2) evaluate the impact of the combination of compost and vivianite powders on the growth and production parameters of *A. annua*. The interest of this work is based on the fact that the most appropriate natural fertilizer for the growth of Artemisia will be popularized.

**Materials and methods**

**Study area**

The study was conducted during two cropping seasons (2023 and 2024) in the experimental field of Faculty of Science of the University of Ngaoundere (Cameroon) located on its main campus. The area belongs to the agro-ecological zone II of Cameroon and is characterized by a High Guinean Savannah with six months rainy season (May to October) and six months dry season (November to April).

The meteorological data (precipitation and temperature) for the 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 2365.30 mm in 2023, compared with 116.97 mm per month and an annual total of 1403.70 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 versus 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 area is an herbaceous savannah dominated by *Pennisetum purpureum, Imperata cylindrica*, *Piliostigma thonningii* and *Annona senegalensis*. The followings are the geographical parameters of the field: 7°24’61’’ North latitude, 13°34’24’’ East longitude, and 1155.80 m altitude.

*Artemisia annua* **seeds**

The seeds of *Artemisia annua* used for this work are provided by the Laboratory of Biodiversity and Sustainable Development of the University of Ngaoundere Cameroon. These seeds are brown oblong and very small (less than 1 mm) (Figure 1). The number of seeds per gram ranges between 10000 and 14000 (Sanner, 2008; Ellman, 2010).



**Figure 1:** Seeds of *Artemisia annua*

**Fertilizers: composts, rock powder and chemical fertilizers**

The fertilizers used in the trials include 02 types of compost (composts derived poultry litter and cow dung manure), 02 types of rock powders (vivianite and pyroclastite basaltic powders), and a chemical fertilizer (figure 2).

Dung manure from *Boss* spp. was collected on the school farm of the Faculty of Veterinary Medicine in the campus of the University of Ngaoundere. While litter from *Gallus domesticus* subspecies comes from a local livestock farm in Bini-Dang. The heap composting method according to Tchuenteu *et al*. (2018) was used. The composting process lasted 06 months.

Vivianite was collected in the Hangloa locality located between 7o20' and 7o30' North latitude and 13o20' and 13o25' East longitude. The chemical analyses of the powder derived from vivianite were conducted earlier by Yaya *et al*. (2015) and gives the following composition: Fe2O3 (68.72%), P2O5 (9.17%), Al2O3 (7.72%), and SiO2 (9.67%). Thus, the total phosphorus content was estimated at about 671.50 mg/kg while the assimilated phosphorus content was around 81.13 mg/kg. Phosphate contained in this mineral can be solubilized. Pyroclastites were collected around Lake Tyson (Adamawa, Cameroon). Their geochemical composition is similar to that of the Tombel graben, rich in total agronomic bases: CaO > 8%, MgO > 6%, K2O > 1% (Nkouathio, 2008). These rocks were ground to powder using a hammer, then sieved (2 mm mesh) before being used.

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| **2a)** Compost | **2b)** Vivianite powder | **2c)** basaltic pyroclastite powder | **2d)** chemical fertilizer |
| **Figure 2:** Different Fertilizers | | | |

**Methodology**

**Physicochemical analyses of compost and soil from the study site**

Soil samples were collected from the study site using a five-point randomization system (1 Kg per point); in the center and four corners of the experimental field. All these samples were mixed to form a composite sample representative of the study site (5 Kg of soil) (Hamza, 2014). The physico-chemical analyses of the soil and composts were carried out at the Laboratory of Research Unit in Soil Analysis and Environmental Chemistry at the University of Dschang Cameroon, using standard methods. The pH and conductivity are determined respectively using a pH meter and conductivity meter. Total nitrogen is determined after mineralization of samples according to Kjeldahl method (AFNOR, 1984) and measured using the calorimetric technique of Devani *et al*. (1989). Phosphorus is measured by absorption spectrophotometry. The analysis of these mineral elements is carried out with an absorption spectrophotometer. The method used is that described by Rodier (1978).

**Evaluation of the responses of Artemisia to rock powders and composts**

**Nursery management**

After putting the substrate which is made up of black soil in the bags, a sterilization of this substrate was done in order to destroy the microorganisms capable of eating away at the tiny seeds of *Artemisia annua*. The sterilization consisted of heating water to a high temperature (over 100°C) and then it was poured onto the substrate. Once the substrate had cooled, the seeds were scattered and covered with a thin layer of soil to facilitate germination (MDA, 2020). The start of germination took place at 05 days after sowing.

**Experimental design, transplantation and crop management**

The field work was carried out during the 2023 and 2024 growing seasons following an experimental design in completely randomized blocks with 12 treatments (unfertilized plots (C-), chemical fertilizer (C+), 1 kg compost derived cow dung manure (CCD), 1 kg compost derived poultry litter (CPL), 10 g vivianite powder (V), 10 g basaltic pyroclastite powder (P), 1 kg compost derived cow dung manure + 10 g vivianite powder (CCDV), 1 kg compost derived cow dung manure + 10 g basaltic pyroclastite powder (CCDP), 1 kg compost derived poultry litter + 10 g vivianite powder (CPLV), 1 kg compost derived poultry litter + 10 g basaltic pyroclastites (CPLP), 1kg compost derived cow dung manure + 10g vivianite powder + 10g basaltic pyroclastite powder (CCDVP), 1Kg compost derived poultry litter + 10g vivianite powder + 10g basaltic pyroclastite powder (CPLVP)) repeated 03 times.

Artemisia seedlings with 12 cm height, 06 leaves, 0.10 cm diameter of stem at collar, and no branching are used for transplantation (Ellman, 2010). Space between two consecutive holes on an elementary plot is 0.50 m. The seedlings were pulled out manually with great caution and then placed in the hole up to the collar without twisting the roots. To promote contact of roots and soil, earthing was carried out. The natural fertilizers were applied at transplantation time. The chemical fertilizer was applied 3 weeks after transplantation. Regarding crop management, manual weeding is carried out regularly in order to prevent weeds from competing with crops (Artemisia) and competing for hydromineral nutrition and light.

S**tudied parameters, sampling and statistical analysis**

During the vegetative phase, plant height and the number of leaves per plant were measured and counted, respectively, at regular time intervals of 14 days starting from the 14th day after transplantation. At maturity, fresh biomass yield and dry aerial biomass yield of Artemisia are evaluated. 21 plants are sampled. All the data were statistically analyzed using the Stagraphic plus Program version 5.0. The significance of differences was determined using Duncan test. Correlation tests between the different parameters are performed.

Results and discussion

Physicochemical properties of growth substrates

The texture of growing soil is richer in sand (41%) than in silt (30%) and clay (29%). The soil of study site is acidic while pH of composts derived *Boss* spp. dung and poultry litter are 6.60 and 7.40 respectively. The soil of the study site is poor in organic matter (table 1). Organic matter contents of composts derived *Boss* spp. dung and poultry litter are 18.07 times and 16.87 times richer than that of growing soil respectively. The nitrogen contents of compost derived *Boss* spp. dung and poultry litter are 5.50 times and 14.44 times higher compared to nitrogen content of the soil from Bini-Dang locality respectively.

The studies of several authors (Sougnez, 2017; Yamus *et al*., 2019) revealed that nitrogen fertilization has a beneficial significant effect on Artemisia plants height, biomass root length, and stimulates flowering. Artemisia needs a high level of organic matter for better growth. According to WHO (2006), *Artemisia annua* grows normally on neutral pH soils. The soil of Bini-Dang locality is acidic and low in nitrogen, suggesting that this soil is not suited to optimal Artemisia production, which is demanding in organic matter, nitrogen, and in neutral pH. Composts produced derived *Boss* spp. dung and poultry litter are rich in organic matter and nitrogen. These organic amendments would correct the acidity of the growing soil as well as the soil deficiencies in organic matter and mineral elements, which would improve the growth potential of Artemisia. It would therefore be necessary to study the influence of the produced composts in this study on Artemisia growth.

Table 1: Physicochemical properties of growing and composts

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| --- | --- | --- | --- |
| **Parameters** | **Growing soil** | **CCD** | **CPL** |
| Clay(%) | 29 | / | / |
| Silt(%) | 30 | / | / |
| Sand(%) | 41 | / | / |
| pH Water | 6.10 | 6.60 | 7.40 |
| CO% | 1.93 | 30 | 28 |
| MO% | 3.32 | 60 | 56 |
| N (%) | 0.09 | 0.50 | 1.30 |
| C/N | 21.40 | 60 | 21.54 |
| Ca (mg/100 g DM) | 119.60 | 63.52 | 119.52 |
| Mg (mg/100 g DM) | 18.24 | 10.01 | 18.51 |
| K (mg/100 g DM) | 1.56 | 1.50 | 2.06 |
| Na (mg/100g DM) | 1.15 | 0.003 | 0.002 |
| Fe (mg/100 g DM) | 5.33 | 5.91 | 2.68 |
| P (mg/100 g DM) | 1.12 | 0.40 | 0.43 |

DM: dry matter; CCD: compost derived from cow dung manure; CPL: compost derived from poultry litter; pH: hydrogen potential; CO: organic carbon; MO: organic matter; N: nitrogen, P: phosphorus, K: potassium, C/N: carbon nitrogen ratio, Ca: calcium, Mg: magnesium, Na: sodium, Fe: iron; CEC: Cation Exchange Capacity; SBE: Sum of Exchangeable Bases.

**Responses of Artemisia to rock powders and composts**

The analysis of variance revealed that there is a significant difference (p<0.05) between treatments (unfertilized plots (C-), chemical fertilizer (C+), cow dung manure-based compost (CCD), poultry litter-based compost (CPL), vivianite (V), pyroclastite (P), cow dung manure-based compost + vivianite (CCDV), cow dung manure-based compost + pyroclastite (CCDP), poultry litter based-compost + vivianite powder (CPLV), poultry litter-based compost + pyroclastites (CPLP), cow dung manure-based compost + vivianite powder + pyroclastite (CCDVP)) on studied growth parameters (plants height, number of leaves per plant, fresh and dry biomass). Overall, unfertilized plants of Artemisia exhibited significantly (p<0.05) the smallest values ​​of studied growth parameters.

**Plants height of** *Artemisia annua*

During the first year cropping season 2023, plants height of Artemisiaranged from 47.75 ± 4.61 cm for C- plants to 87.28 ± 10.77 cm for amended CPLV plants (figure 3a). CPLV fertilizer increased plant height at 86.85% compared to C-, and at 62.51% compared to C+ chemical fertilizer.

Regarding the second cropping year 2024, Artemisia plants height ranged from 54.13 ± 7.86 cm for P fertilizer to 110.85 ± 8.28 cm for CCDP fertilizer (figure 3b). CCDP fertilizer increased plant height by 93.22% compared to C-, and at 65.35% compared to chemical fertilizer C+. Unfertilized plants from 2024 are taller than those from 2023, the height of unfertilized plants in the first cropping season 2024 is 1.13 time greater than that of 2024 cropping year. Figure 3 illustrates a view of Artemisia plants 2 months after transplanting.

The results obtained on Artemisia plants height do not corroborate the data found in literature. Indeed, Yeboah *et al*. (2011) studied the application of organic and inorganic fertilizers on the growth of *A. annua* in a humid tropical environment in Ghana and reported that fertilized organic manure plants of Artemisia was the tallest (156.60 cm). In addition, Houehoumé *et al*. (2014) revealed that the average height of amended cow dung manure plants of Artemisia in Benin was 33.80 ± 0.60 cm. Plant height is one of the morphological parameters that can predict biomass yield of Artemisia. According to Tchuenteu *et al*. (2020), it is considered a good indicator of photosynthetic capacity which are closely correlated with the number of leaves and biomass. Hence the need to determine the foliar production.

**3a:** Cropping year 2023

**3b:** Cropping year 2024

Figure 3: Plant height of Artemisia depending on fertilization in 2023 (3a) and 2024 (3b)

unfertilized plots (C-), chemical fertilizer (C+), 1 kg of compost derived cow dung manure (CCD), 1 kg of compost

derived poultry litter (CPL), 10 g of vivianite powder (V), 10 g of basaltic pyroclastite powder (P), 1 kg of compost derived cow dung manure + 10 g of vivianite powder (CCDV), 1 kg of compost derived cow dung manure + 10 g of basaltic pyroclastite powder (CCDP), 1 kg of compost derived poultry manure + 10 g of vivianite powder (CPLV), 1 kg of compost derived poultry litter + 10 g of basaltic pyroclastite powder (CPLP), 1 kg of compost derived cow dung manure + 10 g of vivianite powder + 10 g of pyroclastite powder basaltic (CCDVP), 1Kg of compost derived poultry litter + 10g of vivianite powder + 10g of basaltic pyroclastic powder (CPLVP). Values of bands affected by the same letter are not significantly different.

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| 4a) Treated plants with compost derived cow dung manure + pyroclastite powder | 4b) Unfertilized plants | 4c)Treated plants with chemical fertilizer |
| **Figure 4:** Artemisia plants at 2 months post-transplant | | |

**Number of leaves per plant**

At maturity (10 weeks after transplantation) during 2023 first cropping year, CPLV treated plants exhibited the most important foliar production (1784.94 ± 296.08 leaves/plant) while the lowest leaf production (440.70 ± 43.25 leaves/plant) was recorded on unfertilized plants (figure 5a). CPLV fertilizer increased foliar production at 305.02% and 65.47% to C- and C+ treatments respectively.

Regarding the second cropping year 2024, leaf production varied from 119.52 ± 28.76 leaves/plant for P plants and 2035.71 ± 1046.57 leaves/plant for CCDP treated plants (figure 5b). CCDP fertilizer increased leaf production at 775.16% compared to C- and by 372.64% compared to C+. Unfertilized plants of the first cropping year 2023 exhibited the most important leaf production compared to that of 2024 cropping year, the leaf production of unfertilized plants in the first cropping year 2023 is 1.02 time greater than that of 2024 cropping year.

Results obtained in the present work on leaf production are significantly higher than those found in literature. Indeed, Mounkaila *et al*. (2015) found that the number of leaves per plant of organic manure treated plants of Artemisia is 33.90. In addition, Kihindo *et al*. (2023) revealed that treated plants of Artemisia using effective microorganisms exhibited 110 leaves/plant.

Leaves are the organs responsible for photosynthesis. High Artemisia foliar production suggests high photosynthetic activity and, consequently, high biomass yield. Furthermore, the most interesting part of Artemisia annua is the leaf. This is where artemisinin is found in large quantities (Blanc *et al*., 2008). Artemisinin is the bioactive molecule of this medicinal plant.

5a: Cropping year 2023

5b: Cropping year 2024

Figure 5: Foliar production according to fertilization in 2023 (5a) and 2024 (5b)

unfertilized plots (C-), chemical fertilizer (C+), 1 kg of compost derived cow dung manure (CCD), 1 kg of compost derived poultry litter (CPL), 10 g of vivianite powder (V), 10 g of basaltic pyroclastite powder (P), 1 kg of compost derived cow dung manure + 10 g of vivianite powder (CCDV), 1 kg of compost derived cow dung manure + 10 g of basaltic pyroclastite powder (CCDP), 1 kg of compost derived poultry manure + 10 g of vivianite powder (CPLV), 1 kg of compost derived poultry litter + 10 g of basaltic pyroclastite powder (CPLP), 1 kg of compost derived cow dung manure + 10 g of vivianite powder + 10 g of pyroclastite powder basaltic (CCDVP), 1Kg of compost derived poultry litter + 10g of vivianite powder + 10g of basaltic pyroclastic powder (CPLVP).

**Production parameters**

Studied production parameters include fresh aerial biomass and dry aerial biomass. Regarding the first year cropping 2023, treated CCD plants (255.55 ± 88.99 g/plant) and treated CCDV plants (200±68.32/plant) had the highest fresh aerial biomass and unfertilized plants exhibited the lowest value of this parameter (31.83 ± 11.94 g/plant) (table 2). CCDV fertilizer increased fresh biomass at 528.33% compared to C- and at 258.33% compared to C+ respectively.

Concerning the second cropping season 2024, the highest fresh aerial biomass (212.66 ± 79.75 g/plant) was recorded on treated CPLV plants and the lowest value of this parameter (14.33 ± 10.21 g/plant) was from treated P plants. CPLV fertilizer increased fresh biomass at 431.65% compared to C- and at 414.33% compared to C+ (table 2). Fresh biomass of unfertilized plants of Artemisia in the second cropping year 2024 was higher than that of 2023 first cropping year. Fresh biomass of unfertilized plants growing in 2024 was 1.26 time greater that those growing in 2023.

The results obtained in this study are different from those of Abdou Salam (2021) who studied the fertilization of Artemisia in Nkolbisson (Yaoundé Cameroon) and found that fertilized plants using the combination cow dung manure and mycorrhizae had 961.41 ± 0.12 g/plant of biomass. It was found in this work that enriched compost with vivianite or basaltic pyroclastite powders better improves Artemisia growth. However, several authors (Megueni *et al*., 2017; Tchuenteu *et al*., 2018; Kamdem *et al*., 2025) found that plants chemical properties vary according to fertilizer. In this context, artemisinin contents of Artemisia from fertilizers used in this study needs to be assessed.

Table 2: Fresh and dry biomass (g/plant)

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| --- | --- | --- | --- | --- |
| Fertilizers | Cropping year 2023 | | Cropping year 2024 | |
| **FAB (g/plant)** | **DAB (g/plant)** | **FAB (g/plant)** | **DAB(g/plant)** |
| C- | 31.83±11.94ab | 12.66±3.38a | 40±27.85ab | 20.25±16.70ab |
| C+ | 55.83±21.51a | 15.66±5.96a | 41.33±29.68abc | 12.33±9.45a |
| V | 117.88±84.90de | 21.33±11.72ab | 32.33±11.59ab | 10±2.64a |
| P | 108.55±29.82bcd | 23.66±7.44ab | 14.33±10.21a | 5.67±2.88a |
| CCD | 255.55±88.99de | 45.4±18.00bc | 185.33±89.36def | 53.67±15.50de |
| CPL | 204.54±82.02ef | 39±14.66a | 192±52.04def | 48±1.76cde |
| CCDV | 200±68.32cde | 35.88±12.23ab | 109.67±24.54bcd | 41.33±20.55bcd |
| CCDP | 98.77±21.48de | 33±18.63bc | 178±82.16def | 43±17.08cde |
| CPLV | 123±83.27ab | 33.66±13.06bc | 212.67±79.75f | 53±21.70de |
| CPLP | 68.9±47.36cd | 22.66±14.53ab | 201.67±7.50ef | 64.33±2.30e |
| CCDVP | 45±18.00cd | 28.66±15.09bc | 89.67±40.01abc | 27.67±13.57abc |
| CPLVP | 106.33±80.05ef | 40.66±19.05ab | 121.67±61.98cde | 28±10.53abc |
| Probability | 0.000 | 0.0001 | 0.000 | 0.0001 |

unfertilized plots (C-), chemical fertilizer (C+), 1 kg of compost derived cow dung manure (CCD), 1 kg of compost derived poultry litter (CPL), 10 g of vivianite powder (V), 10 g of basaltic pyroclastite powder (P), 1 kg of compost derived cow dung manure + 10 g of vivianite powder (CCDV), 1 kg of compost derived cow dung manure + 10 g of basaltic pyroclastite powder (CCDP), 1 kg of compost derived poultry manure + 10 g of vivianite powder (CPLV), 1 kg of compost derived poultry litter + 10 g of basaltic pyroclastite powder (CPLP), 1 kg of compost derived cow dung manure + 10 g of vivianite powder + 10 g of pyroclastite powder basaltic (CCDVP), 1Kg of compost derived poultry litter + 10g of vivianite powder + 10g of basaltic pyroclastic powder (CPLVP).FAB = Fresh aerial biomass and DAB = Dry aerial biomass. Values of bands affected by the same letter are not significantly different.

**Correlation between studied parameters**

The correlation coefficient (r) measures the strength of the relationship between the different parameters. The closer this coefficient is to -1 or +1, the stronger the association; if r = 0, there is no relationship; if r < 0.5 the relationship is said to be weak; if r ≥ 0.5 there is a strong relationship (PEARSON Karl (1857-1936)). It emerges from this correlation test that all the parameters evaluated are positively linked two by two without exception (r > 0.5). However, the correlation between plant height × fresh biomass, plant height × dry biomass and fresh biomass × dry biomass are very strong respectively r = 0.74, r = 0.77 and r = 0.89. The higher the plant height, the greater the fresh and dry aerial biomasses. On the other hand, the correlation is weak between plant height × number of leaves (r = 0.40), number of leaves × fresh biomass (r = 0.27) and number of leaves × dry biomass (r = 0.36). The highest correlation coefficient is that of the fresh biomass × dry biomass link (r = 0.89) (table 3). The link between these two variables is very strong. Indeed, these two parameters are identical; just a simple drying to go from fresh biomass to dry biomass.

Our results are similar to those of Yeboah *et al*. (2011) in Ghana who obtained positive and significant correlation coefficients between plant height × aerial biomass (r = 0.66).

Table 3: Correlation between studied parameters

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | H | NL | FAB | DAB |
| H | 1 |  |  |  |
| NL | 0,400 | 1 |  |  |
| FAB | 0,747 | 0,273 | 1 |  |
| DAB | 0,774 | 0,362 | 0,899 | 1 |

H: plant height; NL: foliar production; BMF: fresh aerial biomass; BMD: dry aerial biomass

It was reported in the present work that fertilization showed higher responses for all variables when compared with any fertilization. This confirms the low nutrient availability in the used growing soil, being necessary the using of fertilizer, mineral or organic, for the Artemisia growth.

Furthermore, several studies (Megueni *et al*., 2017, Tchuenteu *et al*., 2018, Tchuenteu *et al*., 2020) reported that organic fertilizer as compost improves plants growth. Indeed, it plays a major role in maintaining soil fertility and thus the sustainability of agricultural production. Compost is rich in various mineral elements needed for plant productivity. The beneficial effect of compost on Artemisia growth would be related to the combined effect of improved nutrients mineralization and soil properties. In addition, studies revealed that local resources such as compost, applied to acidic and poor tropical soils can provide nutrients needed for plant growth. Produced compost derived poultry litter is rich in mineral elements needed for plant growth. It improves soil physical characteristics (Tchuenteu *et al*., 2020) as well as its biological composition. In addition, Vilmar *et* *al*. (2012) revealed that poultry litter provides nitrogen favoring the accumulation of chlorophyll. Indeed, photosynthesis phenomenon requires chlorophyll, and therefore a higher chlorophyll content suggests the intensification of photosynthesis activities with consequence the increase of plant productivity. Also, this would justify the beneficial effects of compost on Artemisia growth recorded in this study.

Chemical analysis of vivianite powder used were done by Yaya *et al*. (2015) and gives the following composition: Fe2O3 (68.72%), P2O5 (9.17%), Al2O3 (7.72%) and SiO2 (9.67%), Total phosphorus (671.50 mg/kg) and assimilated phosphorus (81.13 mg/kg). the mineral elements contained in this rock powder would have improved the crop soil fertility and thus the Artemisia productivity.

It was observed in the current work that the combination, compost derived cow dung with pyroclastite basaltic powder, or compost derived poultry litter with vivianite powder better encreases the Artemisia growth than compost without any combination. Adding vivianite powder (rich in phosphorus) or basaltic pyroclastites (rich in potassium) to the compost would increase the compost's phosphorus or potassium content, which would explain the beneficial effect of compost enriched with vivianite powder or potassium on Artemisia's growth potential.

By producing enriched compost with vivianite powder or pyroclastite basaltic power for Artemisia growth we contribute no only to improve the growth of this medicinal plant, but also to valorize our local resources for agroecology. However, the study of influence of fertilizers used in this study on artemisinin content of Artemisia need to be investigated.

**CONCLUSION**

Soil of Bini Dang locality (Adamawa Cameroon) is acidic and poor in the mineral elements essential (N) for better Artemisia growth. Artemisia growth (plant height, foliar production, plant biomass) varies significantly (p<0.05) depending on fertilization and experimentation year. Overall, unfertilized plants exhibited significantly (p<0.05) the smallest values of studied growth parameters. CCDV fertilizer increased fresh biomass at 528.33% compared to C- and at 258.23% compared to C+ respectively in 2023 first cropping year. However, CPLV fertilizer increased biomass at 431.65% compared to C- and at 414.33% compared to C+. By producing compost derived poultry litter or cow dung enriched with vivianite powder or pyroclastite basaltic powder for Artemisia growth, we will not only contribute to improving the growing parameters of this medicinal plant, but also valorize the local resources in agroecology. However, the effects of natural fertilizers used in this work on artemisinin biosynthesis of Artemisia need to be investigated.

**Disclaimer (Artificial intelligence)**

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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