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Research Paper

Evaluation of the effect of Nofosuo compost on the growth of tomato (*Solanum lycopersicum* L.) and its effect on soil fertility

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Abstract. Tomato is a valuable crop production in Burkina Faso and the yield is lost due to decline of soil fertility. This study aimed to evaluate the agro-economic profitability of *Nofosuo* compost on tomato production and its effects on soil fertility.The study was conducted at Koubri, which is located in the Central region of Burkina Faso. It consisted of seven treatments which were arranged according to the randomized Fisher block design with three replicates.The experiment was conducted under rainfed, bio and mineral fertilizers conditions. The selected tomato variety was F1 *Mongal* (*Lycopersicon esculentum*). The applied treatments were: i) T0 (control), ii) T1 (single *Nofosuo* compost (NC)), iii) T2 (NC + organic fertilizer (OF)), iv) T3 (NC + mineral fertilizer (MF)), v) T4 (NC + OF + MF), vi) T5 (single OF), vii) T6 (single MF). These treatments performance were measured on tomato growth parameters, on yield and yield components, on the economic profitability and on soil fertility. The results revealed that plant height and diameter, the number of ramification, fruits length and width and fresh fruit yield were much improved under Nofosuo compost combined with OF (T2), organic fertilizer alone (T5) and MF (T6). This study underscored therefore the outperformance of these treatments regardless of the others applied (T0, T1, T3 and T4). The three treatments contributed to improve tomato yields up 61.5, 64 and 62% respectively and were found most profitable than *Nofosuo* compost in single-use. Moreover, T2 and T5 increased more soil chemical properties.

Keywords: Koubri, Nofosuo compost, soil fertility, tomato yield.

INTRODUCTION

Tomato is one of the most valuable vegetable crops in human nutrition. Fresh, or non-processed, it can be considered as one of the three most important vegetables in the world due to its nutritional, economic and social relevance in several countries (Causse *et al*., 2003; Bilalis *et al.*, 2018). It can be consumed either fresh or processed. More than 80% of grown tomatoes worldwide are processing in the products such as tomato juice, paste, puree, catsup, sauce, and salsa (Viskelis *et al*., 2015).

Epidemiological studies have also proven the importance of tomato fruit. It is rich in phytochemicals and vitamins and can reduce various infections as it contains high amounts of antioxidants such as carotenoids, polyphenols, ascorbic acid and many others (Perveen *et al.*, 2015) such as lycopene. Indeed, lycopene is the most abundant carotene in tomatoes. It contains up to 90% of the total carotenoids present in tomatoes and protects against chronic diseases, including cancers of the mouth, pharynx, esophagus, stomach of the intestines, as well as cardiovascular diseases (Perveen *et al*., 2015; Bilalis *et al*., 2018).

Globally, the annual production of fresh tomatoes is about 180 million tons (FAO, 2020). It is grown in more than 170 countries, onthe six continents (FAOSTAT, 2017). In terms of area, it is ranked 3rd after potato and sweet potato (FAO, 2010).The major tomato-producing countries are China, USA, Italy, Turkey, India and Egypt (WPTC, 2020). The total area devoted to this crop was about 4.6 million hectares with a production of about 150.5 million tons or 32.8 tons/ha (APEDA, 2011).

In Africa, tomato is mainly considered as a cash crop (Fufa *et al.*, 2011). It is produced on 660,215 ha with a production of 14,918,554 tons (FAO, 2009). It is largely produced in North Africa (Egypt, Morocco, and Algeria), and to a lesser extent in Southern and Central Africa (FAO, 2009). Average yields ranged from 6 t/ha in Central Africa to 34 t/ha in Southern Africa (FAO, 2009).

In Burkina Faso, market gardening is a major component in agriculture.Tomato ranges 2ndafter onion (MASA, 2014). Its production has increased from 1,000 t in 2000 to 12,635 t in 2017 due to the increase in cultivated areas which went from 1000 ha in 2000 to 1254 ha in 2017, with an average yield of 10 t/ha (FAO, 2020). This cropis produced throughout the country, mainly in the Centre-North (82,463.9 t), Hauts-Bassins (43904.5 t), Centre-West (31250 t), North (26300 t) and Centre-East (20329.8 t). The lowest production is recorded in the Cascades and Centre-South regions. At the country level, the total production is 15,7086 tons, representing 21% of total vegetable production (RGA, 2006-2010) and estimated to be 17.5 billion CFAand 21% of market gardeners turnover (MAAH, 2011).

That way, tomato contributes to the improvement of living and nutrition conditions of the population (MASA, 2013). For 1 ha of tomato produced in developing and developed countries, farmer makes a profit of 500,000 CFA and more than 1,000,000 CFA annually respectively (MAAH, 2011).However, nowadays, market gardeners are facing many constraints that considerably limit their production. Most soils are poor and soil nutrient balances are often negative due to low fertilizer inputs (Bationo *et al*., 2006). To improve soil fertility and crop yields, chemical fertilizers are frequently used in high doses, whichleads to environmental health issues, soil texture and physico chemical properties alteration. Another consequence is the increase in production costs (Shimbo *et al*., 2001).To mitigate these impacts, researchersare currently promoting organic fertilizers including composts, farmyard manures, green manures and biofertilizers such as *Nofosuo* compost made in Ghana from cocoa waste and pods, Potash, Biochar, Azadirachtin, processed manure and legume pods. These fertilizers are sought to improve soil physical, chemical and biological properties leading to better crop growth and yields (Singh *et al.*, 2020). The study aimed to evaluate the agro-economic profitability of these biofertilizers on tomato production and their effects on soil fertility. Specifically, it evaluated the effect of Nofosuo compost on (1) tomato growth parameters, (2) yield and yield components, (3) soil physico chemical properties, and (4) economic profitability.

MATERIALS AND METHODS

Description of the study site

This study was conducted in Koubri, an area (12°11'39.96'' N and 1°24'56.568'' W) in the Central region of Burkina Faso, at 25 km from Ouagadougou (Figure 1). This area is located in an agro-climatic zone with annual rainfall between 700 and 900 mm. The hydromorphic soils are dominant in this areaand are in continuous degradation. Water and wind erosion carry away the fertilizing elements of the soil, leaving other soils improper for crops growth. Mechanical techniques such as stone bands methods are used to reduce this degradation.

Experimental design and applied treatments

The experiment used a completely randomized Fischer Bloc design with 7 treatments in 3 replications. The applied treatments were : T0 (control), (ii)T1 (500 kg/ha of Nofosuo compost), (iii)T2 (500 kg/ha of Nofosuo compost + 30 t/ha of organic fertilizer), iv) T3 (500 kg/ha of Nofosuo compost + 0.35 t/ha NPK + 0.11 t/ha urea (46%)), v) T4 (500 kg/ha of *Nofosuo* compost + 30 t/ha of organic fertilizer + 0.35 t/ha NPK + 0.11 t/ha urea (46%)), vi) T5 (30 t/ha of organic fertilizer), vii) T6 (0.35 t/ha NPK + 0.11 t/ha urea (46%)).

Husbandry practices and data collection

A nursery was set up and 15 g of tomato seed were sown in four boxes containing mixed soil with organic matter and a biofertilizer (*Solsain)*. The nursery was then covered with straw and watered regularly. After seven days, almost all the plants grew and 35days after, they were brought to the site to be planted. The planting was done on plots of 4 m² (2 m×2 m) with a spacing of 0.5 m between plots. There were 3 lines and the planting density was 0.8 m between lines and 0.4 m between planting hills. 5 plants were chosen within a plot for measurements.

The experimental area was prepared and fertilize done month before planting. Basal applications of Nofosuo compost (500 kg/ha) and organic fertilizer (30 t/ha) were applied to plots to be fertilized with these organic resources. Mineral fertilizers, urea (0.11 t/ha) and NPK

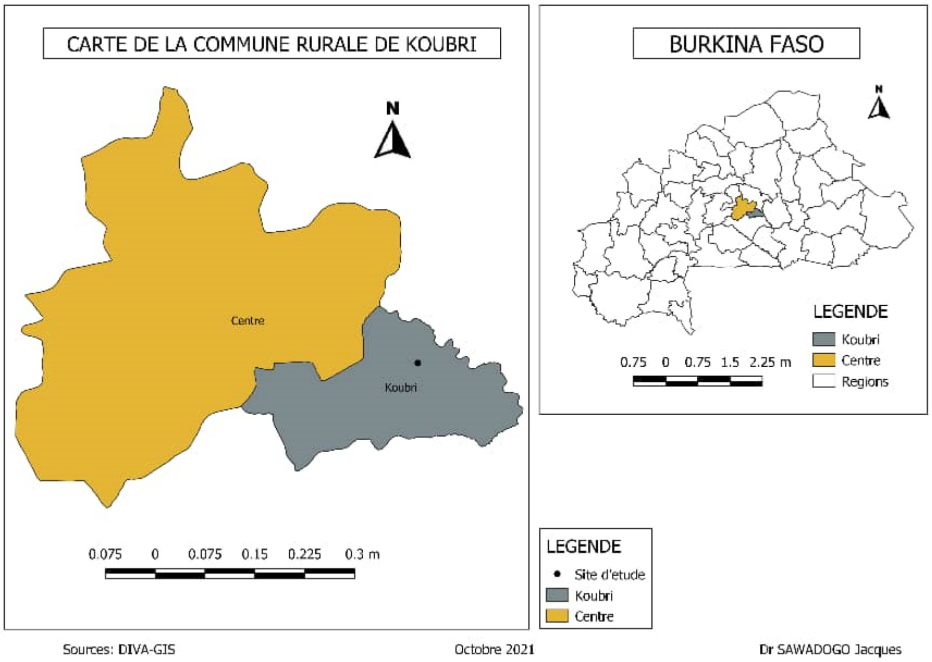

Figure 1. Study site location. Source: DIVA GIS (October 2021).

(0.35 t/ha) were applied in one and two fractions respectively.

Weeding was carried out manually two weeks after planting.

The biopesticides *Piol* and the *Biopoder* were used for plants protections.

Field data collection consisted of the following operations:

Growth parameters

- Plant height and diameter were measured with a measuring tape and a caliper respectively, at the 25th, 40th, 55th and 70th DAP;
- Number of ramifications assessed at the 25th, 40th, 55th and 70th DAP;

Yield and yield components

- Yield components studied in this experiment were based on the length and width of tomato fruit done longitudinally and transversally at the harvest day.
- Fruit yield was estimated in kilogram per hectare. The assessment was first done per foot and then extrapolated to the hectare using the following formula:

$$Rdt(kg/ha) = \frac{Rdt(\frac{g}{pied})x31250}{1000} \quad (1)$$

With 31250 = number of foot/ha and $\frac{1}{1000}$ is the conversion factor in kg.

Economic profitability

It was evaluated using two different methods such as:

- The value-to-cost ratio (VCR),to identify the best treatment that can be readily adopted by producers.

$$VCR = \frac{X - Y}{Z} \quad (2)$$

where X is the net profit, Y is the control net profit and Z is the total variable cost.

- The return on investment (ROI), to see whether the profits obtained after the sale of the tomato have made it possible to offset the expenses made during the production.

$$ROI(\%) = \frac{X - Z}{Z} \times 100 \quad (3)$$

where X is the net profit and Z is the total variable cost.

Delville (1996)and Sawadogo *et al.* (2021) concluded a treatment economically profitable if VCR> 2 and ROI> 100%.

Soil sampling and laboratory analysis

Two (02) composite soil samples were taken before sowing at depth of 0 to 20 cm. After harvest, soil samples were again taken from all treatment plots and at the same depth. The samples were air-dried and ground to pass through a 2 mm and 0.5 mm sieve. The samples were

Table 1. chemical properties of *Nofosuo* compost.

pH_{H2O}	OM	Nt	Pt	Kt	C/N	Mn	Cu	Zn	B	S	Ca	Mg	Humidity
	%					mg/kg							%
7.24	73.92	2.73	2.95	1.49	16	189	126	208	228	684	12.36	6.42	6.78

Legend: *OM: organic matter; Nt: total nitrogen; Pt: total phosphorus; Kt: total potassium; C/N: carbon to nitrogen ratio; Mn: Manganese; Cu: Copper; Zn: Zinc; B: Boron; S: Sulfur; Ca: Calcium; Mg: Magnesium; pH: hydrogen potential.*

Table 2. Plant height as affected by Nofosuo compost.

Treatments	H25	H40	H55	H70
T0	13.62 ± 1.13^{b}	41.95 ± 0.2^{a}	59.25 ± 0.6^{b}	74.4 ± 5.13^{b}
T1	22.13 ± 0.42^{ab}	40.55 ± 1.93^{a}	58.24 ± 1.23^{b}	81.85 ± 0.72^{ab}
T2	27.41 ± 1.2^{a}	60.7 ± 0.4^{a}	70.12 ± 1.02^{ab}	84.7 ± 3.40^{ab}
T3	18.07 ± 2.04^{ab}	39.05 ± 2.56^{a}	60.59 ± 1.79^{ab}	77.5 ± 3.63^{ab}
T4	19.28 ± 5.37^{ab}	46.8 ± 9.81^{a}	69.55 ± 7.24^{ab}	87.35 ± 4.64^{ab}
T5	24.2 ± 1.85^{ab}	52.15 ± 0.95^{a}	73.95 ± 0.2^{ab}	95.1 ± 0.86^{a}
T6	23.66 ± 2.84^{ab}	48.8 ± 5.88^{a}	77.25 ± 6.55^{a}	86.95 ± 6.26^{ab}
Ddl		6		
Probability < 5%	0.039	0.050	0.015	0.047
Significance	S	NS	S	S

Legend: *T0: control ; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer ; T5: organic fertilizer ; T6: mineral fertilizer; NS: no significant; Ddl: degree of liberty; Pr: probability; means with the same letter in the same column are not significantly different at the probability level of 0.05. H25 : height at 25 DAP; H40 : height at 40 DAP; H55: height at 55 DAP; H70: height at 70 DAP.*

analyzed at the INERA Farakoba soil, water and plant analysis laboratory for physicochemical properties, pH, N, P, K, C, Ca, Mg, and CEC. These analyses were done using standard analytical procedures. Soil organic C was determined using the Walkley and Black method. The pH was measured with a pHmeter (WTW InoLab, Weilheim, Germany). P and N were determined in the digest with a SKALAR automatic colorimeter (Skalar SANplus Segmented flow analyser, Model 4000- 02, Breda, Holland). Soil available phosphorus was determined by the Bray-1 method. CEC and exchangeable bases (Ca, Mg) were determined using the silver thiourea method.

Statistical analysis

To compare variables among treatments, the data were subjected to analysis of variance (ANOVA) using GenStat Release 12.1 software. The means were separated by the Newman-Keuls test at 0.05 of probability level.

RESULTS

Chemical analysis of *Nofosuo* compost

Prior tothe experiment, a sample of *Nofosuo* compost was analyzed and this analysis showed a neutral pH bio-fertilizer with high levels of organic matter, total N, P, K, and a high level of exchangeable bases with a high C/N (16) ratio (Table 1).

Effect of *Nofosuo* compost on tomato plant growth

Data collected on plant height, diameter and number of ramifications were subjected to statistical analysis. The analysis of variance showed a more or less significant effects of the applied treatments on these growth parameters. The results are presented in Table 2 and Figures 2 and 3.

Regardless of plant height, Table 2 revealed that apart from 40 days after planting (DAP) where no significant difference (p = 0.05) was seen among treatments applied, at 25, 55 and 70 DAP, a significant difference (p< 0.05) was noted among these treatments. The results indicated that at 25 DAP, the control plot T0 and the T2 treatment (*Nofosuo* compost + organic manure) induced the lowest and highest plants growth respectively. At 55 and 70 DAP, the highest height was obtained in T6 (mineral fertilizer) and T5 (organic fertilizer) treatments respectively. This study underscored that during plant growth, *Nofosuo* compost combined with mineral fertilizer

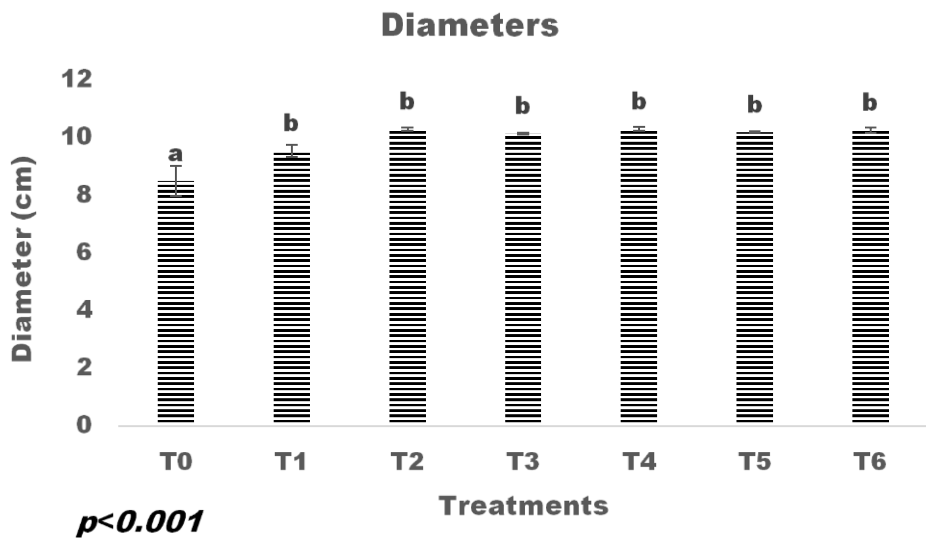

Figure 2. Plant diameter as affected by Nofosuo compost at 70 DAP. *Legend: T0: control; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; graphs with the same letter are not significantly different at the probability level of 0.05.*

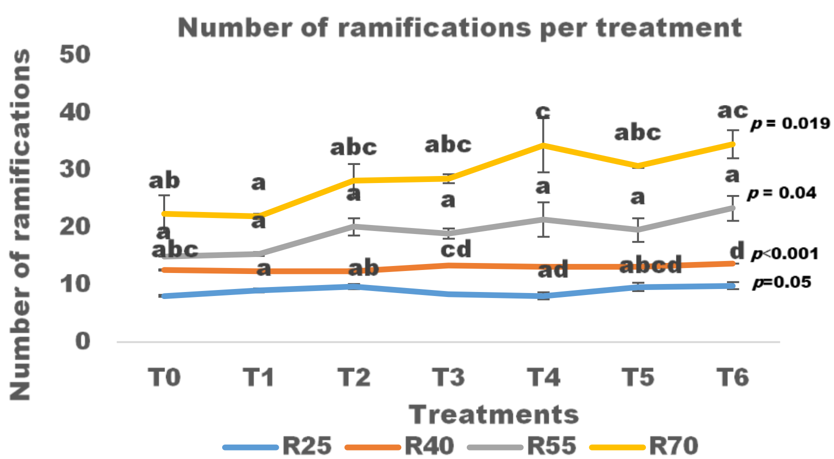

Figure 3. Number of ramification as affected by Nofosuo compost. *Legend: T0: control; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; graphs with the same letter are not significantly different at the probability level of 0.05.*

(T3) resulted in the lowest value. Moreover, compared to *Nofosuo* compost in single-use, its combination with mineral fertilizer was unfavorable to plant growth. This observation is also made with the combination of *Nofosuo* compost with organic and mineral fertilizers (T4). Indeed, *Nofosuo* compost combined with organic fertilizer contributed to improving plant growth more than when it was combined with mineral fertilizer.

Regarding plant diameter measured at 70 DAP, the analysis of variance showed a highly significant difference ($p<0.001$) between plant diameter in the control plot and those of the other treatments. Similar to plant height, Figure 2 highlighted that plots with *Nofosuo* compost in a single use (T1) and *Nofosuo* compost combined with mineral fertilizer (T3) had the lowest diameters, indicating a deficiency of nutrients in these plots compared to the other plots.

For the number of ramifications, excepted at 25 DAP where no significant effect was noted, from 40 to 70 DAP, significant differences were observed ($p<0.05$). Figure 3 presented low numbers of ramification in the control plot and high numbers in plots with *Nofosuo* compost

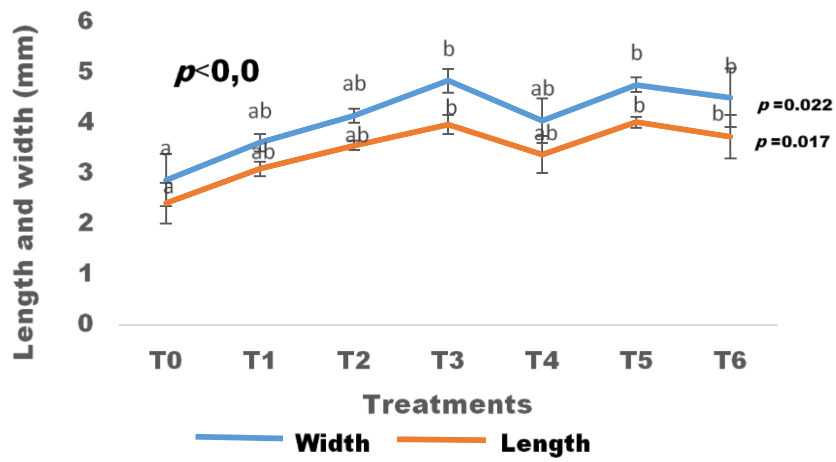

Figure 4. Tomato fruit lengthand width as affected by Nofosuo compost. ***Legend****: T0: control; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; graphs with the same letter are not significantly different at the probability level of 0.05.*

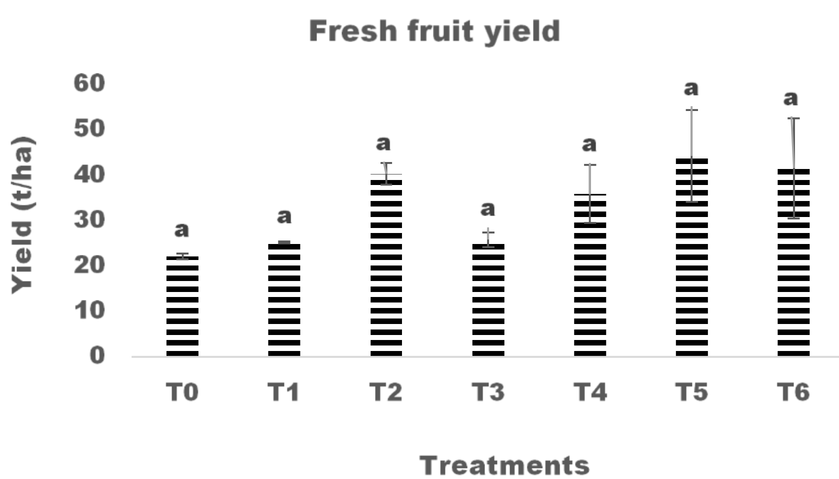

Figure 5. Tomato fresh fruit yield as affected by compost. *Legend: T0: control ; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; graphs with the same letter are not significantly different at the probability level of 0.05.*

combined with organic and mineral fertilizers (T4) and exclusive mineral fertilizer (T6). These treatments contributed to increasing the number of ramifications by 60% compared to the control (T0) and *Nofosuo* compost in single-use (T1).

Effect of *Nofosuo* compost in yield and yield components of tomato

Yield components estimated in this experiment were tomato fruit length and width. The yield was that of tomato fresh fruit. The analysis of variance showed significant effects in yield components and no significant effect was noted in fresh fruit yield (Figure 4).

Concerning yield components, the longest and widest fruits were harvested in plots with *Nofosuo* compost combined with mineral fertilizer (T3) and organic manure alone (T5). Contrary to plant height and diameter, *Nofosuo* compost combined with mineral fertilizer had a significant positive influence on tomato fruit growth.

With regards to fresh fruit yield, Figure 5 showed the lowest yields in the control plot (T0) (22.15 t/ha) followed by T1 (*Nofosuo* compost in single use) (25.21 t/ha) and T3 (*Nofosuo* compost + mineral fertilizer) (25.82 t/ha). The highest yields were noted in plots where *Nofosuo*

Table 3. Economic profitability of applied treatments.

Treatments	Total variable costs (FCFA/ha)	Yield (kg/ha)	Gross income (FCFA/ha)	Gross profit (FCFA/ha)	Net profit (FCFA/ha)	VCR	ROI
T0	1,241,539	22,150	10,667,440	12,092,762	9,959,274	0.00	702.17
T1	1,455,242	25,210	12,141,136	13,721,179	11,2929,51.8	0.92	676.02
T2	1,786,220	40,280	19,398,848	22,462,340	18,582,570.4	4.08	940.33
T3	1,636,572	25,820	12,434,912	13,907,068	11,420,085.6	-4.38	597.81
T4	2,039,976	35,900	17,289,440	19,571,824	16,113,936	2.30	689.91
T5	1,696,947	44,310	21,339,696	24,977,674	20,709,734.8	2.71	1,120.41
T6	1,752,458	41,540	20,056,64	23,254,622	22,853,489.2	1.22	1,204.08

***Legend**: T0: control; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer, VCR: valur to cost ratio; ROI: return on investment.*

compost was combined with the organic and mineral fertilizers (T4) (35.9 t/ha) followed by T2 (*Nofosuo* compost + organic fertilizer) (40.28 t/ha), T6 (exclusive mineral fertilizer) (41.54 t/ha) and T5 (44.31 t/ha).

Compared to *Nofosuo* compost in single use (T1), the organic (T5) and mineral (T6) fertilizers in single use contributed to improving tomato yield by 64 and 62% respectively. Comparing the yields from the combination of *Nofosuo* compost with mineral fertilizer (T3) and *Nofosuo* compost combined with organicfertilizer (T2), the results of the present study realized that the combination of *Nofosuo* compost with organic fertilizer improved better tomato yields (66%). Moreover, comparing yields from *Nofosuo* compost combined with mineral fertilizer (T3) and *Nofosuo* compost combined with organo-mineral fertilizers (T4), tomato fresh fruit yield was much improved (58%).

Effect of *Nofosuo* compost on economic profitability

Table 3 revealed that all the VCR and the ROI are positive and are >2 (for the VCR) and >100% (for the ROI). The results of the study realized that treatments that had high tomato fresh fruit yield had the highest production and the best VCR and ROI ratios. These treatments (T2: VCR=11.69 and ROI=2497; T6: VCR=12.50 and ROI=2577 and T5: VCR =17.13 and ROI=3325) were, therefore, more agro-economical benefit than the others.

Effect of *Nofosuo* compost on soil fertility

The laboratory analysis performed on soil samples taken before the experiment revealed an acid soil, poor in carbon and major elements (Table 4) as well as in CEC and exchangeable bases (Table 5). Table 4 showed that treatments had a high significant (p =0.009) effect on soil pH which became more acid than the initial soil sample especially in the control plot and plots with Nofosuo compost in single use (T1) and its combination with mineral fertilizer (T3). However, this acidity was improved in soil from plots with organic fertilizer (T5) and its combination with Nofosuo compost (T2). Compared to the initial soil sample, soil C was improved under organic fertilizer (T5) and its combination with Nofosuo compost (T2) and Nofosuo compost combined with mineral fertilizer (T3) and more under exclusive use of mineral fertilizer (T6). Considering total N and K, they were improved under mineral fertilizer (T6) and its combination with Nofosuo compost (T3). As for total and available P content, it decreased under all applied treatments. But this decrease was less in T2, T3, T4 and T6 treatments. The same observation was done for available K content. These treatments leading to soil nutrients (C, N, P, K, available P and K) improvement had a C/N ratio between 12.2 and 12.7 > to that of the T0 (C/N=10.5) and < to that of the *Nofosuo* compost in single use T1 (C/N=13.7). This C/N ratio between 12.2 and 12.7 could be the most suitable (compared to 10.5 and 13.7) for soil organic matter mineralization.

Regardless of soil exchangeable bases and CEC, no significant effect was noted. However, Na^+, Mg^{2+} and CEC contents were improved compared to the initial soil sample. As for K^+ content, it was improved under *Nofosuo* compost combined with organic fertilizer (T2) and exclusive mineral fertilizer (T6). Ca^{2+} content was improved under the combination of Nofosuo with mineral fertilizer (T3), organic (T5) and mineral (T6) fertilizers in single use. Soil saturation rate (SEB/CEC) provided by the clay and organic matter in the soil, ranged from 67 to 77%.The lowest saturation rate (67%) and the highest rate (77%) were induced by treatments T4 (*Nofosuo*+organic and mineral fertilizers) and T3 (*Nofosuo*+mineral fertilizer) respectively.

DISCUSSION

Nofosuo compost, made by Farmer Hope Company (2017) in Ghana, contains a significant amount of organic matter (4.80%), nitrogen (4.08%), phosphorus (3.81%), potassium (3.04%) and a high amount of exchangeable

Table 4. Soil major nutrients as affected by Nofosuo compost.

Treatments	pH	Ct	N t	C/N	P_t	K_t	P_{avail}	K_{avail}
		%			mg/kg			
T0'	6.3	0.46	0.04	11.5	118	933.1	9.19	92.74
T0	5.94	0.42	0.04	10.5	80.1	913.3	3.04	67.09
T1	6.09	0.41	0.03	13.7	98.6	837.5	4.23	81.56
T2	6.22	0.51	0.04	12.7	117.2	796	8.67	107.2
T3	6.11	0.49	0.04	12.2	114.2	934	7.51	113.13
T4	6.19	0.44	0.04	11	75.6	913.4	7.54	92.74
T5	6.29	0.49	0.04	12.2	105.6	923.7	3.4	89.45
T6	6.27	0.62	0.05	12.4	113.7	886.5	8.6	104.58
ddl	6							
P < 0.05	0.009	0.53	0.52	0.66	0.34	0.29	0.025	0.3
Significance	HS	NS	NS	NS	NS	NS	S	NS

***Legend**: T0: control ; T1: Nofosuo compost ; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer ; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; NS: no significant; S: significant ; HS : high significant; C_t: total carbon; N_t: total nitrogen; P_t: total phosphorus; P_{avail}: phosphorus available; K_t: total potassium; K_{avail}: potassium available; C/N: carbon to nitrogen ratio; pH: hydrogen potential.*

Table 5. Soil exchangeable bases and CEC as affected by Nofosuo compost.

Treatments	Na^+	K^+	Ca^{2+}	Mg^{2+}	CEC	SEB	SR
	Cmolc/kg					%	
T0'	0.03	0.23	3.11	0.65	5.39	4.04	75.17
T0	0.04	0.17	2.94	0.77	5.55	3.92	71.4
T1	0.04	0.2	2.91	0.83	5.76	4	69.36
T2	0.04	0.32	2.98	0.75	5.66	4.1	72.51
T3	0.04	0.23	3.38	0.72	5.68	4.39	77.24
T4	0.04	0.23	2.94	0.72	5.89	3.94	67.02
T5	0.03	0.22	3.24	0.92	6.22	4.44	71.41
T6	0.04	0.26	3.21	0.92	5.81	4.45	76.47
ddl	6						
P< 0.05	0.78	0.087	0.61	84	0.39	0.37	0.09
Significance	NS	NS	NS	NS	NS	NS	NS

Legend: T0: control; T1: Nofosuo compost; T2: Nofosuo compost+organic fertilizer; T3: Nofosuo compost+mineral fertilizer; T4: Nofosuo compost+organic fertilizer+mineral fertilizer; T5: organic fertilizer; T6: mineral fertilizer; NS: no significant ; SEB : sum of exchangeable bases; SR: saturation rate; Mg^{2+}: Magnesium ion; Ca^{2+}: calcium ion; Na^+:sodium ion; K^+: potassium ion; CEC: cation exchange capacity

bases necessary to improving soil fertility by providing essential nutrients for plant growth and development. However, its C/N ratio is very high leading to its slow decomposition (Wu *et al.*, 2001). Consequently, tomato plant growth and development were slowed down in treatment with Nofosuo compost in single use.One month's stay of this compost in the soil before planting was not then sufficient for it to be mineralized by soil microorganisms. The delay in plant growth and development observed in treatment combining Nofosuo compost with mineral fertilizer could be due to soil microorganisms that might use nitrogen from the mineral fertilizer and from the soil to accelerate the mineralization activity of organic matter from *Nofosuo* compost. This created a deficit in soil nutrients and had delayed plant growth in this T3 treatment. These results agree with those of Coulibaly *et al.* (2020) and Ba *et al.* (2014) on the effect of *Piliostigma reticulatum* leaf compost in sorghum production, where they reported that the combination of mineral fertilizer with this compost led to a delay in the development of sorghum plants due to the immobilization effect of nitrogen by soil microorganisms. This study also highlighted the importance of organic fertilizer in plant growth and crop yield as the T2 and T5 treatments based on Nofosuo compost combined with organic fertilizer and organic fertilizer use alone were the most improving tomato plant height and diameter and also tomato fresh fruit yield. The similar results were found by Kotaix *et al*. (2013) in Côte d'Ivoire, Mehdizadeh *et al.* (2013) in Iran, Ibrahim and Ibrahim and Fadni (2013) in Sudan and Diallo *et al.* (2018) in Burkina Faso.They showed that the use of organic fertilizer optimizes the mineral nutrition of tomato in the long term through its soil fertility improving properties. After two months (70 DAP), the number of ramification and the yield components of tomato were much improved in T3 treatment (Nofosuo compost + mineral fertilizer), indicating the end of the mineralization process leading to soil fertility increase and much improvement in tomato plant growth and yield components. After 70 days- stay in the soil, the microorganisms were able to release the nutrients from *Nofosuo* compost. This biofertilizer would have behaved like *Piliostigma reticulatum*. Its immobilization process took 62 days, and after,a significant amount of inorganic nitrogen is made available to sorghum plants (Dossa *et al*., 2009).

This study also showed that the treatments applied were beneficial to tomato production. However, the most profitable treatments were those from organic fertilizer (T5) and its combination with *Nofosuo* compost (T2) as their VCR and ROI were higher than the others. These two biofertilizers had their production cost low and could be recommended to garden growers.

Studying the chemical properties, treatments with the highest soil chemical properties (C, N, P, K, and available P and K) had a C/N ratio between 12.2 and 12.7 suitable for soil organic matter mineralization. This C/N ratio has been used to indicate soil quality and to assess the nutritional balance of soil carbon and nitrogen (Shunfeng *et al.*, 2013).A high C/N ratio slows down the decomposition rate of organic matter and nitrogen (Wu *et al*., 2001). When the C/N ratio is also low, soil microbial activity is limited. Therefore, the C/N ratio between 12.2 and 12.7 was the best in this study, as it would have accelerated the process of microbial decomposition of organic matter and nitrogen contained in *Nofosuo* compost. The improvement found in the CEC content was favorable for the mineral nutrition of tomato plants because the CEC refers to soil capacity to retain and exchange nutrients that are easily available to the plants. It is then used to assess soil fertility (FAO, 2021).

CONCLUSION

This study underscored the importance of biofertilizers in tomato production. Their utilization led to better tomato growth and production. After 70 days-stay in the soil, Nofosuo compost was found to improve plant growth and crop yield. In addition, its combination with other bio and mineral fertilizers contributed to enhancing the performance of these fertilizers. Biofertilizers increased soil fertility and had their production costs low. Their VCR and ROI were also the highest. Therefore, Nofosuo compost used in combination with organic fertilizer is economically beneficial andthese two biofertilizers could be recommended to garden growers. In addition, Nofosuo compost could increase the sources of organic matter. There is then a need to study its management practices that could better improve soil fertility and crop yield.

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