Contribution of cattle dung (organic fertilizer) as an alternative to mineral fertilization of soils in tomato (*Lycopersicom esculenta*) cultivation.production

ABSTRACT

The use of chemical fertilizersinputs, which in the long term constitutes a source of soil and environmental degradation, has led producers farmers to use –organic other sources as alternative soil amendmentsof fertilizers such as cattle dung in order to reduce inputs fertilizer chemicals. However, use of these organic fertilizers alone may do not restore the low level of soil fertility of highly degraded soils, hence the need for the integration of use of organic and o mineral fertilizersation. The objective of the study was to improve soil fertility and tomato productivityyield. The study was carried out using a Fisher block design, with three replicates etitionsestablished on sandy soils. Treatments T_0 (control treatment), T_{pp} (500 kg/ha of NPK), T_1 (40 kg/ha of cattle dung + 167 kg/ha of NPK), T_2 (40 kg/ha of cattle dung + 250 kg /ha of NPK), T_3 (40 kg/ha of cattle dung + 375 kg/ha of NPK), T_4 (40 kg/ha of cattle dung + 500 kg/ha of NPK) and T_5 (40 kg/ha of NPK of cattle dung) were applied to elementary plots of 20 m^2 (5 m x 4 m). Cattle dung was applied one week before dded as background fertilizer before transplanting was done. On the other hand, split application of and mineral fertilizer was applied adone at transplanting and at the start of flowering of the plants. The height of the plants, the circumference at the collar, the diameter of the fruits, the average number of fruits and weights of harvested the yield of the fruits were evaluated on 4 plants of the effective useful plot. The results obtained revealed that the addition of cattle dung to the soil made it possible to reduce the quantities of chemical fertilizer commonly used by tomato producers. Thus, the T_3 treatment (40 kg/ha of cattle dung as a single contribution of basal fertilizer + 375 kg/ha of NPK), or C¾ of the dose of chemical fertilizer commonly applied by producers, made it possible to improve the agronomic parameters of the tomato and obtained the highest tomato yields (16292.25 kg/ha). The cattleow dung combination at a dose of 40 kg/ha + 375 kg/ha of NPK 15 15 15 is therefore, the optimum dose to provide for better tomato production.

Keywords: Cattle dung, chemical fertilizer, tomato, Daoukro, Côte d'Ivoire.

1. INTRODUCTION

In Côte d'Ivoire, tomatoes are grown in all regions for homeself-consumption or marketing with an average national production estimated at 32,364 tons [1]. However, its cultivation in Côte d'Ivoire faces many constraints. Indeed, tomato cultivation is practiced mainly by small

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rural farmers characterized by ~~with~~ low household incomes [2] and ~~on small~~ subsistence farming. This has led to low ~~farms with low~~ tomato yields, causing a large importation of tomato paste to meet the needs of the population [3]. In addition, its cultivation is generally practiced near watercourses with ~~, which are~~ generally sandy soils characterized by ~~with very~~ high water permeability and low natural fertility [4]. Faced with this situation, the use of chemical fertilizers, which makes it possible to correct the deficit of mineral ~~the~~ soil ~~in mineral elements~~s and enhance tomato ~~to improve the~~ production and productivity ~~of crops~~ [5] has been considered. However, in addition to their high cost which makes them almost inaccessible to small-scale farmers, use of chemical fertilizers alone is not sustainable in an effort to improve tomato productivity~~are not sufficient, in the long term, to maintain soil fertility or increase crop yields~~ [6]. E~~Indeed, the e~~xcessive use of chemical fertilizers pollutes the environment. For instance, when wrongly applied, both surface and underground water bodies are prone to contamination. Further, excessive use of mineral fertilizers has been reported to destroy ~~tables, leads to an increase in acidity, a deterioration of~~ soil structure leading to changes in the physical soil characteristics~~the physical status and a drop in the organic matter of the soil~~ [7]. Moreover, the sandy texture of these soils does not optimize the effects of mineral fertilizers. In such a context, the use of organic manures, which constitutes a good substitute for chemical fertilizers, is one of the solutions among many others to improve soil fertility and ensure the good development of tomato plants [8]. In addition, organic fertilizers are able to reduce water consumption by plants [9]. Among these organic manures, livestock wastes, in particular, cattle dung plays an ~~occupy an~~ important role~~place~~ in crop production, especially in market gardening systems [10]. However, very few studies have been conducted with cattle dung as ~~, which is~~ an organic fertilizer as an alternative and cheap source of soil amendment for tomato production ~~at a lower cost compared to chemical fertilizers, available and accessible to most tomato producers~~. This study therefore aims to improve soil fertility and tomato ~~production~~ productivity by ~~adding~~ using cattle dung as soil amendmet~~to the soil~~.

~~2.~~ MATERIALS AND METHODS

~~2.1.~~ Characteristics of the experimental site

The study was carried out in Katimansou in the Ettrokro sub-prefecture in the Daoukro department (longitude 3°29' and 4°34' West and latitude 6°55' and 7°32' North) (Fig. 1) [11] with a humid tropical climate with two ~~(2)~~ rainy seasons separated by ~~and~~ two ~~(2)~~ dry seasons. Average monthly precipitation varies between 11 mm and 198 mm with an average annual rainfall of 1103 mm. The vegetation is grassy savannah in the West and degraded forest in the East, North and South. In addition to this vegetation, there are patches of forest, gallery forests and savannah-crop mosaics [11]. The terrain is ~~not very~~moderately rugged with altitudes varying between 120m and 500m. The department is drained by the N'zi rivers to the west and Comoé to the east. The soils are ferralitic and brownish, moderately or slightly desaturated, with a saturation rate of between 20 and 70%. The pH of the soils is between 5 and 6. However, ~~we find~~ hydromorphic soils also exist that favor~~able~~ production of both ~~to~~ perennial ~~crops~~and annual ~~, food~~ crops, some of which are common in ~~and~~ market gardening [12].

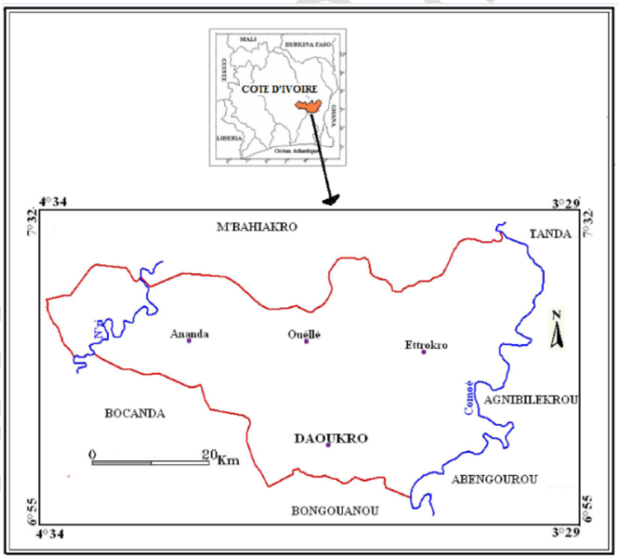

Fig. 1. Location map of the study area (Source: [12])

~~2.2.~~ Plant material

The plant material used consisted of tomato seeds of the variety called 'Cobra'. This variety has a cycle of 120 days and an average potential yield of around 30 t~~ons per~~ h~~ectare~~$^{-1}$. It is used by market gardeners because it is tolerant to most ~~resistant to~~ diseases compared to most varieties of tomato. The tomato was used for this study because it is one of the main vegetable crops in the Ettrokro sub-prefecture.

~~2.3.~~ Fertilizing material

The fertilizing material consists of cattle~~ow~~ dung and the chemical fertilizer NPK (15 15 15 + 0.3S + 4.5 MgO + 6.7 CaO) (Fig. 2) which are fertilizers commonly used by market gardeners in the region to tomato fertilization. Cattle dung was~~has been~~ used because it had become~~is~~ popular ~~the subject of growing interest by most~~ market gardeners who use it as an organic soil fertilizer. It was collected from grazing pastures, then dried and put in bags before use.

A: Cattle dung B: Granular form of NPK fertilizer

Fig. 2: ~~Fertilizing equipment~~Types of soil amendments used

~~2.4.~~ Experimental ~~apparatus~~design

The experiment was ~~test wa~~set up ~~s carried out~~ using a Fisher block experimental design (Fig. 3) on sandy soil with an area of 596 m^2 ~~in a rural environment~~. The blocks were arranged parallel and spaced 1 m apart from each other. The treatments were replicated ~~eated~~ 3 times and distributed randomly in each block. Therefore, e~~E~~ach block ~~included~~ had 7 treatments ~~or elementary plots~~each in a plot size ~~, each with an area of 20 m^2 (~~5 m x 4 m~~)~~. The effective ~~useful~~ plot consisted of 4 tomato plants on which the various plant parameters ~~readings~~ were carried out.

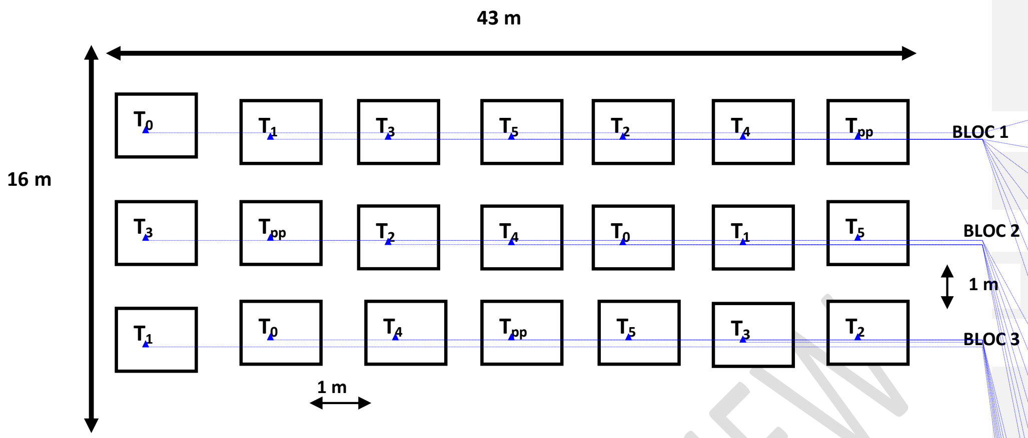

Fig. 3. Diagram of the experimental design of the study showing the distribution of applied soil amendments~~treatments~~.

~~2.5.~~ Treatments

The treatments consisted of cattle dung applied as basal fertilizer one week before transplanting and chemical fertilizer divided into two equal doses (one week after transplanting and at the start of flowering):

- **T_0** (control): Without fertilizer input;

- **T_{pp}** (full dose commonly used by producers): 500 kg ha^{-1} of NPK~~, or 20 g/plant~~;

- **T_1**: 40 t ha^{-1} of cattle dung + 167 kg ha^{-1} of NPK ~~(6.7 g/plant)~~, or ¼ of the dose of NPK commonly applied;

- **T_2**: 40 t ha^{-1} of cattle dung + 250 kg ha^{-1} of NPK ~~(10 g/plant)~~, or half the dose of NPK commonly applied;

- **T_3**: 40 t ha^{-1} of cattle dung + 375 kg ha^{-1} of NPK ~~(15 g/plant)~~, or ¾ of the dose commonly applied;

- **T_4**: 40 t ha^{-1} of cattle dung + 500 kg ha^{-1} of NPK ~~(20 g/plant)~~, or the full dose commonly applied;

- **T_5**: 40 t ha^{-1} of cattle dung.

~~2.6.~~ Land preparation

The preparation of the land and experimental management consisted of field clearing and weeding of the plots, which were carried out manually. The ~~plant mass~~weeds were removed and ~~was~~ placed outside the experimental field~~plot~~. The bush burning and application of ~~of plots, as well as~~ herbicide treatments were not used ~~, has been prohibited,~~ to avoid any uncontrollable interaction. The cattle dung was incorporated into ~~buried in~~ the soil with a hand hoe ~~fter plowing with a hoe as a background fertilizer~~ one week before transplanting ~~the plants~~tomato seedlings.

~~2.7.~~ Setting up the nursery

Setting up the nursery consisted of sowing tomato seeds on a 2 m^2 bed. After sowing, the bed ~~is~~ was covered with palm leaves using raised support stands. One week before transplanting, the shade-house ~~is~~ was lightened, by reducing the amount of palm leaves to allow plant hardening. The nursery ~~is~~ was regularly watered in the absence of any rain. Phytosanitary treatments were~~have been~~ carried out to control insect pests. Two days before transplanting, which occurred ~~s~~ at 21 days after sowing, the shade-house was is completely removed.

2.8. Transplanting and caring for tomato ~~plants~~seedlings

The 21-day-old tomato ~~plants~~ seedlings were transplanted with a spacing of 40 cm between plants on the same row and 1 m between rows (Fig. 4). Only vigorous seedlings with 4 and 5 blooming leaves were transplanted. Sanitary treatments based on Azadirachta Indica extract were carried out on the plants against pests every two weeks until flowering.

Two week old tomato plants

Fig. 4: Tomato plants ~~Plants transplanted on~~under different soil treatments applied in experimental field ~~beds~~

2.9. Crop fertilization

Cattle dung was applied as basal fertilizer at the rate of 40 t~~ons per~~ h~~ectare~~$^{-1}$ (recommended application rate~~dose per hectare~~ for organic waste). The NPK fertilizer was applied and mixed with the soil in planting holes~~brought to the feet of the tomato plants according to different fractions~~. The first and second fertilizer dozes ~~supply~~ of NPK were ~~as~~ made one week after transplanting and ~~the second,~~ at the start of flowering.

2.10. Sampling, conservation and evaluation of soil chemical parameters

A composite soil sample was obtained at 0-20 cm depth from the experimental field. The soil sample was air-dried, crushed and screened through a stainless sieve. The soil sample was later analyzed for chemical parameters as described by (LANO, 2020) ~~The chemical potential of the soil was determined on the composite samples of soil taken before the establishment of the test in the first 20 centimeters of the soil using an auger. The samples taken were dried and sieved and a composite sample of approximately 500g was made up for chemical analyze~~ from ~~s in~~ the P~~p~~lant and S~~s~~oil L~~l~~aboratory of the National Polytechnic Institute Houphouët-Boigny in Yamoussoukro. ~~These chemical analyzes concerned the following parameters:~~

~~- the pH, determined by the electrometric method [13];~~

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~~- measurements of total nitrogen (N), organic carbon, phosphorus and exchangeable bases (K, Mg, Na and Ca), carried out respectively, by the methods of Kjeldhal, Walkley and Black, modified Olsen and ammonium acetate at pH 7 [13];~~

~~- the organic matter (OM) content was determined by multiplying the carbon content by 1.72.~~

2.11. Evaluation of soil morphological parameters

The description of the morphological characteristics of the soil was made following …….. (……..) procedure. T~~from an open pit on the test site and the d~~he different horizons were described accordingly based on ~~to the following parameters:~~ thickness, ~~depth,~~ texture, rate of coarse elements and the presence of humus.

2.12. Evaluation of agronomic parameters of tomato

The agronomic parameters to of tomato plants be assessed were concerned:

- the height of the plants (from the collar to the ligule of the last leaf well deployed by the plant) was evaluated on 4 tomato plants previously identified at random in the center of the elementary plot. To do this, stakes were placed next to each plant and a rope is unwound around the plant to keep it straight and the height is determined with a graduated ruler every week, one week after transplanting until flowering;,

- the collar circumference is determined using a vernier caliper;, fruit diameter

- the diameter of the fruits was determined by dividing the measurement of the circumference of the fruits, evaluated by a caliper by 3.14;,

- the average number of fruits on each sampled plants of each plant was determined by counting the number of fruits of each useful plot during the different harvests;

and - the yield. Yield was determined by:

RDT = (D x PPu) / NPPu ……………………………………………………… eqn (i)

Where,

RDT= Yield;
PPu = Production from effective plot;
NPPu = number of plants in the effective plot
D = Density (number of plants ha^{-1}). (RDT) was determined from the production of each useful plot (PPu) using the following formula: RDT = (D x PPu) / NPPu.

Where, RDT= Yield; PPu = Production of the useful plot; NPPu = number of plants in the useful plot and D = Density (number of plants per hectare).

2.13. Statistical analysis of data

The data collected was subjected to an analysis of variance (ANOVA) using SAS 9.4 software. The means were separated using the Newman and Keuls test at the 5% threshold between the different treatments in order to evaluate the contributions of the different fertilizers on the evolution petrformance of the agronomic parameters of the tomato.

3. RESULTS

3.1. Physical characteristics of the soil of the study site

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The profile of the open pit on the study site ~~has~~ had four horizons (Fig. 5). The first horizon, which ~~is surface~~was horizon A_{11}, ~~is~~ was humus-rich, not very thick (10 to 12 cm) and made up of a layer of brown-colored organic matter debris (2.5YR 4/1). It ~~is~~ was sandy-loamy with approximately 20% coarse elements. The second horizon A_{12}, just below the first horizon, ~~is~~ was not very humus, not very thick (12 cm) and brown in color (2.5YR 4/3). This horizon ~~is~~ was sandy-silty with approximately 35% coarse elements. The third horizon B_{11} ~~is~~ was non-humus, thin (10 cm) and reddish brown in color (2.5YR 5/3). It ~~is~~ was a sandy horizon with approximately 40-~~ to~~ 45% coarse elements. The last B_{12} horizon ~~is~~ was also non-humus, thick (10-~~ to~~ 12 cm), reddish brown in color (2.5YR 5/4). It ~~is~~ was sandy with approximately 45-~~ to~~ 50% coarse elements. W~~e also observe in this last horizon, a w~~aterlogged layer, composed mainly of coarse sand was also observed in this horizon. The soil of the study site ~~is~~ was therefore, sandy gleysol.

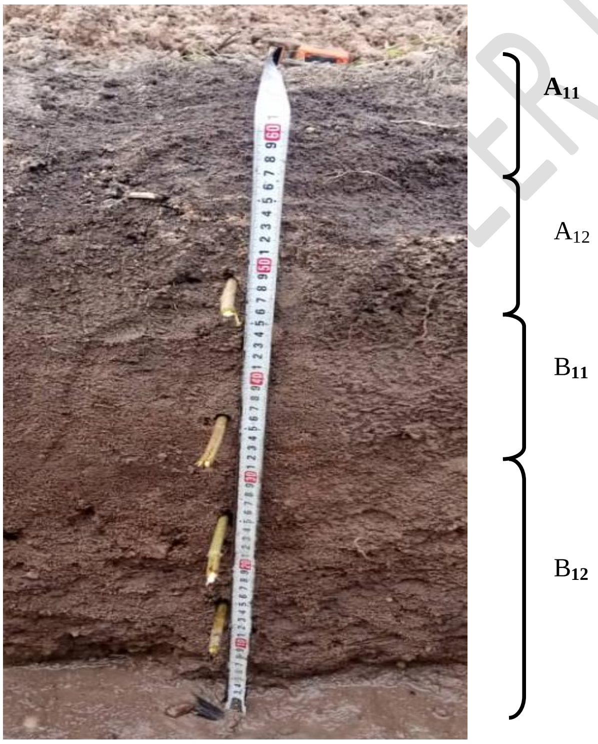

Fig. 5: Soil profile of the study site.

3.2. Chemical parameters of the soil of the study site

The physico-chemical properties of the soils, compared to the normative reference values show that the pH of the soil of the study site ~~is~~ was acidic with a value of 5.1, lower than the normative reference values of ~~which are between~~ 6.6~~- and~~ -7.3 (Table ~~I~~1). The levels of organic matter, carbon, nitrogen and phosphorus also indicated very low values compared to the normative reference values (MO = 3.15 ~~< 9.6-68.8~~ ; C = 0.61% ~~< 5.6 %~~ ; N = 0.05% ~~< 0.3%~~ ; P = 22 ~~< 50~~ ppm). The cation exchange capacity ~~is~~ was also very low (CEC= 5.97 cmol~~/~~ kg^{-1} ~~< 10 cmol/kg~~). The same ~~is~~ was true for potassium (K^+ = 0.05 cmol ~~/~~kg^{-1} ~~< 0.3 cmol/kg~~), magnesium (Mg^{2+} = 0.18 cmol ~~/~~kg^{-1} ~~< 1.5 cmol/kg~~), calcium (Ca^{2+} = 0.22 cmol ~~/~~kg^{-1} ~~< 5 cmol/kg~~) and sodium (Na^+ = 0.10 cmol ~~/~~kg^{-1} ~~< 0.3 cmol/kg~~) that were very low compared to the normative reference values.

Table ~~I~~1: Chemical parameters of the soil of the study site compared to the normative reference values

Parameters	Composants	Element contents in the 0-20 cm horizon	*Normative reference value*
Acidity	pH	5.1	6.6 -7.3
Organic mater	MO (%)	3.15	9.6-68.8
	C (%)	0.61	5.6-10
	N (%)	0.05	0.3-0.6
	C/N	13.5	9-12
Phosphorus	Pass (ppm)	22	50-100
Exchangeable cations	Ca^{2+} (cmol/kg)	0.22	5-8
	Mg^{2+} (cmol/kg)	0.18	1.5-3
	K^+ (cmol/kg)	0.05	0.3-0.6
	Na^+ (cmol/kg)	0.10	0.3-0.7
	CEC (cmol/kg)	5.97	10-15

*Normatives reference values [14], [15].

3.3. ~~Evolution~~ Growth response of tomato based on applied soil amendments~~growth parameters depending on the treatments~~

3.3.1. Diameter at collar

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The analysis of variances showed a very highly significant difference (P p< 0.0001) between the different treatments in terms of the evolution expansion of the collar diameter of the tomato plants (Table H2). The highest collar diameters were obtained at the T_3 (13.54 mm), T_4 (14.37 mm) and T_5 (11.14 mm) treatments and the lowest at the T_0 control treatments (10.20 mm) and T_{pp} (10.95 mm). Intermediate values are were obtained under by treatments T_1 (11.75 mm) and T_2 (12 mm).

3.3.2. Plant height

It emerged from the analysis of variances that there is was a very highly significant difference (P p<–0.0001) between the different treatments in terms of changes in the plant heights of tomato plants (Table H2). Treatments Tomato plants that received cattle dung as basal manure recorded higher heights measurements than those that did not receive the cattle dung. Indeed, treatments T_3 (61.41 cm) and T_4 (66.48 cm) recorded the highest plant heights. The control treatment T_0 (41.19 cm) recorded, on the other hand, the lowest height. The intermediate height values were obtained by under the treatments T_{pp} (49.31 cm), T_1 (50.02 cm), T_2 (51.66 cm) and T_5 (51.77 cm).

3.3.3. Fruit circumference

The circumferences of tomato fruits varied significantly with the applied soil treatments The different treatments had a very highly significant effect (P p<–0.0001) in terms of the evolution of the circumference of the tomato fruits (Table H2). Treatments T_3 and T_4 with values of 15.29 and 15.79 cm, respectively, recorded the highest fruit circumferences. The low values were obtained with the control treatment T_0 (12.31 cm); the intermediate values being obtained with the treatments T_{pp} (13.76 cm), T_1 (14 cm) and T_2 (14.41 cm).

Table H2: Evolution Variations of the diameter at the collarstem diameter, circumference of the fruitsfruit size and the height of the plantsplant heights with applied soil amendments depending on the treatments

	Growth parameters		
Treatments	Diameter at the collar of the plants (mm)	Fruit circumference (cm)	Plant height (cm)
T_0	10.20 ± 0.17 d	12.31 ± 0.19 c	41.19 ± 0.41 d

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T_{pp}	10.95 ± 0.20 d	13.76 ± 0.17 b	49.31 ± 0.35 c
T_1	11.75 ± 0.24 c	14 ± 0.21 b	50.02 ± 1.10 c
T_2	12 ± 0.33 c	14.41 ± 0.31 b	51.66 ± 0.95 c
T_3	13.54 ± 0.31 a	15.29 ± 0.27 a	61.41 ± 1.28 a
T_4	14.37 ± 0.36 a	15.79 ± 0.35 a	66.48 ± 1.29 a
T_5	11.14 ± 0.13 c	11.91 ± 0.38c	51.77 ± 1.02 c
CV	10.41	9.04	6.35
~~P~~p	< 0.0001	< 0.0001	< 0.0001

3.4. ~~Evolution~~ Variation of tomato plant growth under the different soil ~~production parameters according to~~ treatments

3.4.1. Average number of fruits on ~~aper~~ tomato plant

Number of tomato fruits on plants varied ~~The different treatments had a very highly~~ significant with the applied soil treatments~~ffect~~ (~~P~~ p<-0.0001) ~~on the average number of fruits per tomato plant~~ (Table ~~III~~3). The low number of fruits ~~per~~ plant^{-1} (11.16 fruits) was obtained ~~by~~ under the control treatment T_0. The average intermediate numbers of fruits ~~per~~ plant^{-1} were obtained with the treatments T_{pp} (12.23 fruits), T_1 (12.75 fruits), T_2 (12.75 fruits) and T_5 (13.41 fruits). Treatments T_3 and T_4 with average numbers of fruits per plant respectively of 15.75 and 16.79 ~~obtained~~ showed the highest number tomato fruits plant^{-1}~~s~~.

3.4.2. Average tomato yield

The analysis of variances showed a very highly significant difference (~~P~~ p<-0.0001) between the different treatments in terms of the average tomato yield per hectare (Table ~~III~~3). The highest yields were obtained with treatments T_3 (16292.25 kg/ha) and T_4 (16850.75 kg/ha). Intermediate average yields were observed with the T_{pp} (10285 kg/ha), T_1 (11018 kg/ha) and T_2 (11949.75 kg/ha) and T_5 (10863.5 kg/ha) treatments; the lowest yield being obtained with the control treatment T_0 (6513.5 kg/ha).

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Table ~~III~~3: ~~Evolution of the average~~Variations in number of fruits ~~per~~ on tomato plant and ~~of the y~~yield ~~according to the treatments.~~with the applied soil amendments

	Production parameters	
Treatments	Number of fruits	Yield (kg~~/~~ ha^{-1})
T_0	11.16 ± 0.39 c	6513.5 ± 21.13 e
T_{pp}	12.23 ± 0.41 b	10285 ± 21.02 d
T_1	12.75 ± 0.37 b	11018 ± 21.45 d
T_2	12.75 ± 0.36 b	11949.75 ± 21.03 c
T_3	15.75 ± 0.33 a	16292.25 ± 25.93 a
T_4	16.79 ± 0,41 a	16850.75 ± 25.27 a
T_5	13.41 ± 0.25 b	10863.5 ± 20.17 d
CV	11.98	13.75
~~P~~p	< 0.0001	< 0.0001

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4. DISCUSSION

4.1. Physical and chemical characteristics of the soil of the study site

The pH value which ~~is~~ was 5.1 indicate~~s~~d that the soil of the study site ~~is~~ was acidic. It therefore ~~has~~ had a low chemical fertility which could be explained by the sandy nature of the soil of the site. Indeed, according to [4], sandy soils generally have a very high water permeability and have a very low natural fertility. This low soil fertility would also be linked to the acidity of hyperdystric ferralsols, which ~~is~~ was the basis of many phenomena harmful to plant growth, such as the reduction in nitrification, the phosphorus deficiency and the high availability of ~~certain~~ heavy metals [16]. These results ~~agree~~ were similar with those of [17], which showed that tropical soils ~~are~~ were characterized by a low level of organic matter, high acidity~~,~~ and high desaturation in exchangeable cations ~~and slow mineralization of organic matter~~.

4.2. Effect of fertilizers on agronomic parameters of tomato

The values of the agronomic parameters at the level of the control treatment T_0 (without the addition of fertilizers) ~~are~~ were low compared to those of the treatments with ~~having received~~ fertilizers. These low values at the level of the control treatment would be linked to the low fertility of the soils due to their sandy texture [18]. Indeed, according to [19], sandy soils limit the growth and yields of cultivated plants. These low values therefore explain the effect of the law of the minimum or limiting factors or Liebig's law which stipulates that: "the yield obtained is determined by the assimilable fertilizing element which is found in the lowest quantity in the soil relative to the needs crops".

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The low values of the agronomic parameters obtained at the level of the T_{pp} treatment (treatment based on NPK only) compared to the values observed for the cattle dung only and the combination of the NPK fertilizer and the cattle dung, would be linked to the sandy texture of the experimental soils~~study site~~. ~~Indeed, S~~Sandy soils ~~are~~ were ~~poor~~ low in clay and organic matter, and ~~have~~ had a low retention capacity for mineral elements. Under these conditions, the mineral elements provided by the chemical fertilizer ~~will~~ would not be retained on the adsorbent complex to ensure the nutrition and development of tomato plants. These results ~~agree~~ were similar with those of [4] which showed that sandy soils generally ~~have~~ had low natural fertility and very high water permeability.~~, which does not make it possible to make the action of mineral fertilizers profitable brought.~~ On the contrary, these elements provided by chemical fertilizer further acidify the soil and degrade its fertility. ~~Indeed,~~A~~a~~ccording to [20], ~~the~~ continuous application ~~use~~ of chemical fertilizer ~~promotes, in the long term, an~~ increases ~~in~~ soil acidity. The work of [21] also showed in market gardening that the exclusive application of chemical fertilizer acidified the soil.

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The low values of the agronomic parameters of the tomato at the level of treatment T_5 (~~supply~~ application of only ~~of~~ cattle dung) compared to the other treatments would be linked to the fact that the mineral elements contained in the cattle dung could not be released in time or are not sufficient to satisfy the effective needs of tomato plants during their development [19].

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The values of tomato growth parameters obtained with the combination of fertilizers (NPK and cattle dung) were higher than those ~~recorded at the level o~~sole application of fertilizers ~~used alone~~ (NPK alone at the Tpp level or cattle dung alone at the T_5 level). These results obtained could be explained by the synergy of the combined effects of chemical fertilizer and cattle dung. The combined action of cattle dung and NPK fertilizer ~~is~~ was a good combination that improves soil fertility in the long term. ~~In fact, T~~T~~t~~he NPK chemical fertilizer ~~provides~~ provided nutrients ~~which can be~~that were directly used by the tomato plants to satisfy their

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initial needs. On the other hand, ~~and the~~ organic matter~~, for its part,~~ gradually underwent mineralization ~~es~~ subsequently to providinge other additional soil nutrients ~~to the soil~~. ~~The dung provided, which is an additional source of nutrients, reinforces the effectiveness of the mineral fertilizer, making it possible to improve soil fertility and plant growth.~~ Combination of ~~Furthermore, these results could also be explained by the nature~~ mineral ~~of the fertilizers which are~~ NPK fertilizer and cattle dung provided higher amounts of available nutrients and improved soil physical conditions that favored proper growth of tomato plants~~which have high contents of nitrogen and potassium, essential factors of plant growth especially at the level of the leaves, stems and plant height~~ [22]. These results confirm those of [10] who specified ~~y~~ that cattle dung ~~is~~ was a quality fertilizer, particularly due to its high nitrogen content. The work of [23] ~~has~~ had shown that the potassium (K) contained in the NPK fertilizer ~~allows~~ allowed ~~good plant~~optimum crop growth. In addition, the work of [23] ~~has~~ showned that the phosphorus contained in NPK fertilizer and cattle dung ~~is~~ was a nutrient that stimulates flowering and fruiting. The combination of these nutrients ~~brought to the soil will~~ therefore, improved ~~plant~~ tomato yields. According to [2], the combination of organic and mineral fertilizers creates the ~~best~~ optimum growing conditions for crops. The high values of the growth parameters of the tomato plants at the level of treatments T_3 (40 t/ha of cattle dung as a single contribution of basal fertilizer + 375 kg/ha of NPK) and T_4 (40 t/ha of cattle dung cattle with a single input of basal fertilizer + 500 kg/ha of NPK) compared to the other treatments, could be explained by the optimum soil conditions provided by these treatments~~the fact that these treatments have the optimum that tomato plants need for their growth~~. However, the non-significant differences observed in tomato agronomic parameters between treatments T3 (40 t/ha of cattle dung + 375 kg/ha of NPK) and T_4 (40 t/ha of cattle dung + 500 kg/ha of NPK-) confirm the law of surpluses or Mitscherlich's law, which states that: "when increasing doses of fertilizer are applied to a crop, equal increases in the quantities of fertilizer correspond to increasingly smaller increases in yield, at as fertilizer doses increase". Treatment T_3, or the dose of 375 kg of NPK, ~~is~~ was the optimal dose of NPK fertilizer to combine with cattle dung at a dose of 40 t/ha to obtain the ~~best~~ highest tomato plant responses~~results~~. This dose of NPK provided alloweds the cattle dung to be more effective in improving the agronomic parameters of the tomato.

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5. CONCLUSION

The development of sustainable agriculture requires the development of new farming practices that make it possible to limit the recourse to the heavy use of chemical fertilizers. This study aimed to improve soil fertility and tomato (*Lycopersicom esculenta*) production in the Daoukro region. The results obtained showed that the T_3 treatment (40 t/ha of cattle dung + 375 kg/ha of NPK 15 15 15), or ¾ of the NPK dose commonly used by producers, allowed better expression of all the parameters agro-morphology of tomato. With the highest average yield of 16292.25 kg/ha, the combination of cattle dung at a dose of 40 t/ha + 375 kg/ha of NPK 15 15 15 is the optimum dose to bring to the soil for ~~a better~~enhanced tomato production.

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