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Effects of Different Types of Mineral and Organic Fertilizers on the Production and Profitability of Tomato Cultivation (*Lycopersicon esculentum* Mill), Grown in the City of Korhogo, Northern Côte d'Ivoire

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Abstract— *The high cost of mineral fertilizers coupled with their low accessibility is a limiting factor in market gardening in tomato cultivation in Korhogo. This study was initiated with a view to contributing to the increase in tomato production, by adding different types of mineral and organic fertilizers, by evaluating their effects on yield and economic profitability. The experiment was conducted at the experimental site of Peleforo Gon Coulibaly University in Korhogo. The experimental device consisted of Fischer blocks, completely randomized, comprising 4 treatments and 4 repetitions (blocks). Treatments included control without fertilizer input (T1), one type of organic fertilizer (poultry droppings) and 2 types of mineral fertilizers (NPK and NPK + Urea). The results obtained showed that the yield and all its characteristics were improved by different types of fertilizers applied. Yields were 19.3 t/ha for T1, 25.1 t/ha for T2, 29.01 t/ha for T3 and 31.8 t/ha for T4. The profitability of mineral and organic fertilizers, determined from net profit, varied depending on the type of fertilizer. The contribution of mineral fertilizer (NPK + Urea), with a net profit of 14,492,500 FCFA, was the most economically profitable, therefore the most recommendable. In a context where the high price of fertilizers is a major obstacle to the intensification of tomato cultivation, this study is a contribution to the optimization of fertilization of the crop, by providing compost based on chicken droppings that would reduce the harmful effects of mineral fertilizers, for the health of populations consuming the vegetables produced.*

Keywords— *Mineral fertilizer, poultry droppings, yield, economic profitability, tomato, Côte d'Ivoire.*

I. INTRODUCTION

In Côte d'Ivoire, agriculture remains the bedrock of the economy, and employs more than 60% of the working population [1]. Aware of this asset, prospects have been developed for the proper exploitation and management of agricultural resources [2]. This agriculture consists of two main components. The first concerns export crops, such as cocoa, coffee, oil palm, rubber, etc. The second component, consisting of food crops, is used to feed the population, and is mainly dominated by rice, maize, yams, cassava and bananas [3].

In the food sector, vegetables play a major role in the daily diet of population. In Côte d'Ivoire, despite the natural assets that offer a gross food production of nearly 8 million tons per year, the demand for vegetable products is growing. Imports of vegetables and fruits cause a currency outflow estimated at more than 10 billion [4]. According to the National Agency for Support to Rural Development (ANADER), the quantities of vegetable products in 2009 amounted to 760,000 tons [5]. Among the vegetables grown, tomato (*lycopersicum esculentum* L.) occupies a prominent place, both nutritionally and economically. It is the most consumed vegetable in the world. In Côte d'Ivoire, tomato needs were estimated at more than 200,000 tons in 2009 [6] while national production of 52,000 tons/year remains much lower to cover this demand [7]. However, the development of tomato cultivation, like other vegetable crops in northern Côte d'Ivoire, is in the grip of enormous difficulties. On the one hand, the strong pest pressure added to the degradation of environmental and climatic factors and on the other hand, the lack of high-yielding varieties, supported by the persistence of rudimentary agricultural practices, which greatly reduce tomato production.

One of these major constraints is, without a doubt, soil degradation, which has a direct impact on production and yield. It should be noted that most soils in northern Côte d'Ivoire, dominated by ferruginous soils and ferralsols, have a low original fertility [8]: low exchangeable organic matter and base matter [9]. Indeed, this fertility decreases enormously with the clearing and cultivation of these soils. In addition, due to strong demographic pressure, long-term fallow land is less practiced [10]. Export without nutrient replacement contributes to land degradation [11]. To compensate for the declines in crop yields, several avenues can be considered: mineral fertilization by chemical fertilizers [12] and organic fertilization [13].

Mineral fertilization is a necessary practice to maintain or improve soil fertility and provide the nutrients the crop needs [14]. It therefore makes it possible to increase plant productivity [15].

The use of mineral fertilizer formulas, not adapted to vegetable crops, leads to unbalanced inputs and in the long term, to an accumulation of certain heavy metals in the soil [16]. Indeed, many studies have shown the negative effects of long-

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term mineral fertilizers on soil fertility, in particular through their acidifying effect on the soil [17].

Also, it must be recognized that the use of synthetic fertilizers in the north of the country is limited by (1) the exorbitant and increasing price on the market and (2) the acidification caused by their long-term applications [18]. Faced with these socio-economic and environmental challenges, it is becoming imperative to look for other sources of nutrients that can enable sustainable agriculture while imports of agricultural products are breaking the record because of low crop yields.

The Integrated Soil Fertility Management (GOES) approach then presents itself as a solution to this decline in soil fertility. This approach can be done through the use of organic fertilizers. Indeed, several studies have shown the beneficial effect of organic matter on the physico-chemical and biological properties of soil, and, consequently, on crop yields [19]. Studies conducted in the wild have shown that the contribution of organic amendments to poor and acidic Katangan soils provides the nutrients necessary for the feeding, growth and production of cultivated plants [20].

Given the importance of organic matter in crop production and the high price of synthetic fertilizers which makes them inaccessible to the majority of farmers on the one hand and on the other, Population growth resulting in high demand for food, this study tests the hypothesis that the use of compost would be an inexpensive alternative in tomato cultivation in the edapho-climatic conditions of Korhogo. The general objective of this study is to evaluate the behavior of a tomato variety opposite mineral fertilizers and organic fertilizers in order to develop a type of fertilizer that makes the cultivation of tomato profitable in the north of country.

II. Material and Methods

A. Study Environment

The study was conducted in the commune of Korhogo, located in the north of Côte d'Ivoire, whose geographical coordinates are 9° 26' north longitude and 5° 38' west latitude. The climate of the area, of the Sudanese type, is characterized by an alternation of two seasons. A great dry season, from October to May, precedes the rainy season, marked by two rainfall peaks, one in June and the other in September. The area is also characterized by average temperatures varying between 24 and 33 °C and an average monthly humidity of 20%. The annual rainfall is between 1100 and 1600 mm and the duration of insolation is 2600 hours per year. The soil is of tropical ferruginous type, formed on granite who's more or less intense leaching, and has reduced its fertility. The relief is, generally, flat and dotted in places with inselbergs [21].

B. Plant Material

The plant material consisted of tomato seeds (*Lycopersicon esculentum* Mill), of the Cobra 26 variety, from a seed production center in Korhogo. The average cycle of this variety is 90-100 days. It is resistant to bacterial wilt and chlorotic leaf curl virus, and has a medium tolerance to pests and disease pressure. The average weight of the fruit varies between 100 and 110 g. The yield of this variety can reach 35 t/ha, in a controlled environment.

C. Fertilization Products

The fertilization products consisted of two different types of mineral fertilizers and one organic fertilizer. These are:
- a mineral fertilizer, called NPK, of formula 23-10-5+3S+2MgO+0.3 Zn, existing in granular form;
- a mineral fertilizer, NPK Type (15-15-15) + Urea (46-0-0), existing in the form of granule;
- an organic fertilizer, consisting of chicken droppings.

D. Methods

a Experimental device, treatments and their application

The experimental device consisted of Fischer blocks, completely randomized, comprising 4 treatments and 4 repetitions (blocks). The study included 16 elementary plots. Each elementary plot consisted of 20 tomato seedlings, transplanted on 4 lines of 5 poquets, according to the respective spacings of 0.50 m x 0.50 m. The elementary plots and blocks were separated by a distance of 1 m and 1.50 m respectively.
The 4 treatments studied are as follows:
- T1: control without fertilizer input;
- T2: organic fertilizer, consisting of chicken droppings;
- T3: mineral fertilizer type NPK, with application in micro-dose per poquet;
- T4: mineral fertilizer type NPK + Urea, with application in micro-dose per plant.

These different treatments were applied during the vegetative phase of the tomato. The period of application and the doses used depend on the type of fertilizer.

Poultry droppings (chickens) were supplied at a dose of 500 g per poquet or plant, or 10 kg per elemental plot. Thus, 40 kg of chicken droppings were needed to cover the entire study plot.

The mineral fertilizer NPK, formulation 23-10-5+3S+2MgO+0.3 Zn, was buried at a depth of 2 cm and 5 cm around each plant. The fertilizer was fractionated and applied after transplanting. The first application was made, with a dose of 30 g/plant, on the 10^{th} day after transplanting (JAR) and the second was carried out on the 25^{th} JAR, at the dose of 15 g/plant.

Mineral fertilizer NPK (15-15-15) + Urea (46-0-0) (T3) was applied in a crown, around each tomato plant. Two applications, at different doses, were performed during the vegetative phase with NPK. The first application, with a dose of 30 g/plant, was carried out on the 20^{th} JAR and the second on the 30^{th} JAR, with a dose of 15 g/plant. Urea was brought at a dose of 30 g/plant to the 10^{th} JAR.

b. Measured parameters

Various morphological and yield parameters were measured per elementary plot during the study. The height of each plant was assessed by measuring its size, from the collar to the last newly opened leaf. The number of leaves, emitted per plant, was obtained by counting all the leaves formed. The diameter at the collar was obtained by measuring the circumference of the collar of each plant.

The number of fruits per plant was obtained by counting all the fruits produced by each tomato foot. The length and width of the fruits were obtained, using a tape measure, by measuring these dimensions of the fruits produced per tomato plant. Yield (R/ha) was determined from the following relationship:

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R = NF * PF * D, with
R: yield in kg/ha
NF: the total number of fruits per plant;
PF: Weight of each fruit in grams (g):
D: Planting density whose standard is 25,000 plants/ha.

The economic analysis carried out on the yield provided by each type of fertilizer applied was based on the determination of the rate of return of fertilizer application through net profit (Bn). This net profit (Bn) is based on the following formula:
Bn = Bb – Vi.
where,
Bn is the net profit (FCFA/ha), Bb is the gross profit (FCFA/ha/) and Vi is the total value investment (FCFA/ha).
The use of the different costs and fees made it possible to calculate the gross profit of each type of fertilizer (Bb)(Tx) and the total investment cost of each treatment (Vi)(Tx).
The purchase price of NPK fertilizers and urea are 500 F CFA/kg. The chicken droppings fertilizer was purchased at 50 F CFA/kg. The costs of spreading mineral fertilizer and organic fertilizer are set at 20000 F CFA/ha. The cost of buying seeds is 1000 F CFA/box. The selling price of tomatoes is 500 F CFA/kg.

c. Data processing and analysis

The data, collected and recorded using the Excel spreadsheet, was subjected to an analysis of variance using XLSTAT version 7.5 software. The significance level of the differences between the means was estimated using the Newman Keuls test, at the 5% threshold, for the classification of the means into homogeneous groups.

III. RESULTS

A. Effects of different types of fertilizers on morphological parameters

The effects of the different types of fertilizers applied during the study on growth parameters were assessed (Table 1). The analysis of variance, applied, showed that there are significant differences between the averages recorded with these different growth parameters, namely, the height of the plants, the number of leaves emitted and the diameter at the collar of each tomato plant.

At the level of plant height, the Newman Keuls test revealed the existence of four homogeneous groups. T4 treatment (NPK + Urea) produced the highest values. These averages formed the first homogeneous group, with a value of 67.5 cm high. As for the fourth group, with an average of 33.2 cm high, was formed by the value of the T1 (Control) treatment. This treatment produced the lowest value.

With regard to the number of leaves emitted and the diameter at the collar of the plants, the table revealed the existence of three homogeneous groups, according to the Newman Keuls test, at the threshold of 5%. At the level of these two parameters, the first group was constituted by the averages of the T3 (NPK) and T4 (NPK + Urea) treatments, with the highest values. These averages, in terms of the number of sheets emitted and the diameter at the collar, were, respectively, 43.5 sheets (T4), 33.6 sheets (T3) and 7.2 cm (T4), 7.6 cm (T3). The third group, with the lowest values in number of leaves (19.5 leaves) and neck diameter (5.5 cm), was formed with the means of the T1 treatment (Control). The application of different types of fertilizers influenced the growth of tomato plants during this study.

TABLE 1. Evaluation of the effectiveness of different types of fertilizers on tomato vegetative parameters

Treatments	Plants height (cm)	Leaves number	Collar diameter (cm)
T1 (Control)	33.2 d	19.5 c	5.5 c
T2 (Chicken droppings)	39.5 c	29.5 b	6.3 b
T3 (NPK)	48.3 b	33.6 b	7.6 a
T4 (NPK + Urea)	67.5 a	43.5 a	7.2 a

The averages assigned to the same letter, in the same column, are not significantly different at the 5% threshold, according to Newman Keuls' test.

B. Effect of different types of fertilizers on yield and its characteristics

The average values of all production characteristics, obtained after the addition of the different types of fertilizers, are presented in Table 2. On analysis of this table, it appears that in terms of fruit length, fruit width and number of fruits, the analysis of variance reveals significant differences between the averages obtained with the different treatments applied. The results show the formation of three homogeneous groups, according to the Newman Keuls test, at the level of these three yield characteristics. The first group, with the highest values, in terms of fruit length (4.7 and 4.9 cm), fruit width (3.7 and 3.4 cm) and number of fruits (27.5 and 25.8 fruits), was formed, respectively, with the averages of the T4 (NPK + Urea) and T3 (NPK) treatments. The second group, with average values, was formed by the treatment of T2 (poultry droppings). As for the third group, with the lowest values, was formed by the means recorded with the T1 (Control) treatment. These values were, in terms of length, width and number of fruits, respectively, 3.1 cm, 2.2 cm and 15.3 fruits. All these yield characteristics were influenced by the input of the different types of fertilizers.

TABLE 2. Variation in length, width and number of fruits depending on the type of fertilization

Treatments	Fruit length (cm)	Fruit width (cm)	Fruits number
T1(Control)	3.1 c	2.2 c	15.3 c
T2 (Chicken droppings)	3.9 b	2.9 b	20.3 b
T3 (NPK)	4.9 a	3.4 a	25.8 a
T4 (NPK + Urea)	4.7 a	3.7 a	27.5 a

In terms of yield, the analysis of variance revealed significant differences between the averages obtained with the different types of fertilizers applied (Figure 1). It emerges from this figure that three homogeneous groups, according to the Newman Keuls test, are at the threshold of 5%. The first group, with the highest values, was the averages of the T4 and T3 treatments, whose values were, respectively, 31.8 and 29.01 t/ha. As for the second group, with lower values (25.1 t/ha), was formed by the average of the T2 treatment (chicken droppings). The third homogeneous group was formed by the mean obtained with the T1 (Control) treatment. This treatment, with a value of 19.3 t/ha, produced the lowest average. The different

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types of fertilizers, applied, influenced the yield of tomato fruits.

The averages assigned to the same letter, in the same column, are not significantly different at the 5% threshold, according to Newman Keuls' test.

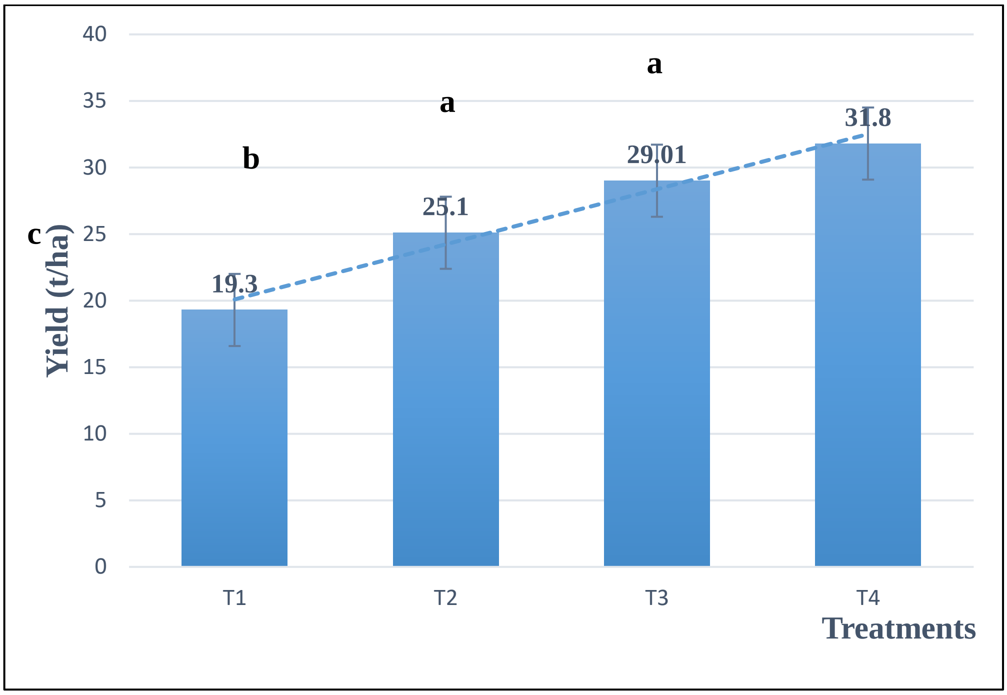

Fig. 1. Curve of evolution of the efficiency of the different types of fertilizers on the parameters of tomato production in the edapho-climatic conditions of Korhogo

TABLE 3. Effects of the different treatments applied on the economic profitability of tomato cultivation

Treatments	Fertilizer quantity (kg/ha)	Price of fertilizer purchase (Fcfa/ha)	Spreading cost (FCFA/ha)	Cost of purchase of seeds (Fcfa/ha)	Fixed and labour cos (Fcfa/ha)	Total cost (F CFA)	Yield (kg/ha)	Gross profit (F CFA/ha)	Net profit (F CFA/ha)
T1 (Control)	0	0	0	30,000	350,000	380,000	19,300	9,650,000	9,270,000
T2 (Chicken droppings)	12,500	625,000	100,000	30,000	350,000	1,105,000	25,100	12,550,000	11,445,000
T3 (NPK)	1,125	562,500	80,000	30,000	350,000	1,022,500	29,100	14,550,000	13,527,500
T4 (NPK + Urea)	1,875	937,500	90,000	30,000	350,000	1,407,500	31,800	15,900,000	14,492,500

NB: Planting density is 25,000 feet/ha (20 boxes); Purchase price of fertilizers: NPK fertilizer is 500 F CFA/kg; Urea fertilizer is 500 F CFA/kg; chicken droppings fertilizer is 50 F CFA/kg; Cost of mineral application and organic fertilizer is 20,000 CFA francs / ha; Cost of purchase of seeds is 1000 F CFA / box; Fixed and labour cost is 350,000 CFA francs/ha; Selling price of tomato is 500 F CFA/kg

The averages assigned to the same letter, on the histograms, are not significantly different at the 5% threshold, according to Newman Keuls' test.

C. Economic optimization of the use of the different types of fertilizers applied

The economic profitability of the use of the different types of fertilizers has been, essentially, on the basis of the specific yield (tons/ha), according to the determination of the net profit (Bn) provided by each type of fertilizer applied (Table 3). The net profit was obtained after deduction of the revenue from the selling price of tomato (gross profit or Bb) and the accumulated expenses (total investment cost).

Table 3 shows the value added, produced per hectare, resulting from the use of each type of fertilizer on that plot. An analysis of this table shows that the total investment cost increases according to the type of fertilizer applied. This cost ranged from 380,000 (T1 or Control) to 1,407,500 CFA francs (T4 or NPK + Urea) per hectare, with the highest investment costs obtained with the application of the mineral fertilizer NPK + Urea (1,875 kg/ha). The net profit (Bn) is a function of the type of fertilizer applied. It reaches a maximum of 14,492,500 CFA francs/ha, with an amount of 1,875 kg/ha of mineral fertilizer (NPK + Urea), then gradually decreases with the treatment without fertilizer (Control), to reach a value of 9,270,000 CFA francs / ha. Organic fertilizer (poultry droppings) recorded a net profit of 11,445,000 CFA francs/ha. As for mineral fertilizer (NPK), the net profit provided was 13,527,500 CFA francs/ha. Mineral fertilizer, being economically the most profitable, shows that the use of mineral fertilizer (NPK + Urea) and (NPK) under tomato cultivation is very interesting.

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IV. Discussion

This study demonstrated the ability of mineral and organic fertilizers to improve the growth and yield of tomato fruits on ferruginous Korhogo soil. These results are similar to those obtained in other regions of sub-Saharan Africa, notably, by [22] on maize in Nigeria and [13] on the same crop in Cameroon, showing that the general trend in the evolution of soil properties, tested, and yield was upward compared to control treatment, mineral and organic fertilization.

In this experiment, an improvement in production parameters was obtained, with the contribution of different types of fertilizers. It appears, therefore, that the study site best values fertilizers according to the initial chemical composition of the soil [23]. Mineral and organic manure had a significant influence on the growth and development of the vegetative apparatus of tomato seedlings. The production characteristics of the number of fruits, the length and width of the fruits per plant and the yield have been significantly improved by mineral fertilizers compared to organic fertilizer and control. The addition of chemical fertilizer significantly increased tomato yield, compared to plots controls and organic fertilizer.

The opportunity of the use of mineral fertilizers is revealed here, in the fact that almost all agronomic parameters have increasing values with the application of both types of chemical fertilizers. The beneficial effects of chemical fertilization through agriculture have been demonstrated by numerous authors ([24]; [25]). Mineral fertilizers have greater agronomic efficiency because their mineral elements are available and easily absorbed by crops compared to organic fertilizers. This gradual increase in the improvement of production parameters by mineral fertilizer is largely attributable to its availability to plants of mineral elements that create the best conditions of mineral nutrition for tomato plants. Mineral fertilizers have the advantage of availability of mineral elements for the plant as quickly as possible, thus promoting better production and productivity [26]. This would be due to the availability of nutrients, such as nitrogen by fertilizer, because it increases yield and its components [27]. Several authors have found similar results showing, for this reason, the importance of mineral fertilizer in increasing the weight of the corn cob ([28]; [26]).

The results also showed that the application of the mineral fertilizer NPK + Urea had significantly higher effects compared to the intake of NPK alone. This effect would be due to the surplus of nitrogen from the applied urea. However, as different authors have shown, nitrogen is the most important element for the life of the plant. Nitrogen is the engine and is used to build all the green parts that ensure the growth and life of plants ([29]; [30]); because nitrogen plays a key role in plant metabolism [25].

The work of [31] has highlighted, for a variety of tomato, the positive effect of the application every 3 weeks of NPK and Urea on the height and production of seedlings. Indeed, the significant difference in height recorded would be due to the effect of nitrogen, released by Urea, as shown by the work of [32] and [33].

Our results also corroborate those of [34] who showed the role of Urea and Potassium in increasing tomato production, both for improved and traditional varieties. They are also similar to those of [35] who showed that production is maximum for fractionation into two inputs of nitrogen combined with Potassium for an improved variety of tomato. [31] showed that the application of NPK and Urea, every two weeks, increased yields by 51% compared to conventional application (a single application for NPK), The study also showed that all growth and yield characteristics were significantly improved by the organic fertilizers provided compared to the control without fertilizer. Organic fertilizer (poultry droppings) had a much clearer influence on the production of tomato plants in the field, compared to the control treatment, without fertilizer, namely the improvement of all measured yield characteristics. This is explained by the amount of mineral elements made available to the plants. Indeed, chicken droppings are an important source of mineral elements. The positive role of organic matter on yield, demonstrated by the results obtained in this trial, is also confirmed by other authors, such as, [36] who recorded significant increases in barley yields, compared to the control, after application of mixed sludge and livestock manure.

The increase in yield, observed in this experiment, is largely due to improved soil properties that created better growing and nutrition conditions for crops, as described by [37]. It should also be noted that compost does not only affect the properties of the soil, which results in an increase in yield, but, it also plays an important role in plant health. Thus, good quality compost can be successfully used in the biological control of diseases, among others in vegetable crops [38]. The addition of organic fertilizers leads to the acceleration of the activity of microbial biomass and the improvement of its availability of organic matter to soil microorganisms [39]. Mineralization of organic matter by accelerating microbial biomass activity would be promoted by increasing nitrogen content in organic fertilizers and soil pH [39]. In addition, the nitrogen in the compost is provided in organic form; this requires a transformation of organic nitrogen into mineral nitrogen for proper assimilation by plants [40]. Nitrogen therefore plays a key role in plant metabolism [25].

This superiority of the effects of the contribution of organic fertilizer is also due to the fact that the compost used is chicken droppings, recognized as rich in phosphorus during composting. Indeed, phosphorus is an important element for fruit production [41]. This corroborates the results of [42] on the cultivation of Chinese cabbage after application of chicken manure composts. Composts are therefore recognized as rich in nutrients and recent research has shown that inputs of these products increase the levels of organic matter in the soil, the capacity for cation exchange, the biomass of microorganisms and their activities [43].

The control treatment, without fertilizer, generally had much smaller effects on the improvement of all measured production parameters. This could be due to the fact that the soils of the control contain very few nutrients, necessary for the improvement of the production characteristics and yield of tomato plants. The low production of control soils can be attributed to the initial characteristic factors of the soils of the Korhogo region. These soils are characterized by their low mineral content and acidity, al and mg toxicity, and nutrient deficiency (Ca, Mg, P, K, B and Zn) [44]. In addition, on control plots, the absence of organic and mineral inputs is accompanied by a loss of organic matter and nutrients, soil acidification, a reduction in biomass and microbial activity, and phosphorus insolubility [45], which together lead to low growth and under production of tomato seedlings. Lack of fertilizer inputs and mineral nutrients are accompanied by loss of organic matter and nutrients, soil acidification, reduced biomass and microbial activity [46].

The economic analysis, based on cumulative data for obtaining agricultural income (net profit), was made by the difference between, on the one hand, the revenues from the sale of tomato fruits, provided by each type of fertilizer, and, on the other hand, the total investment costs.

The contribution of less productive fertilizer significantly reduces the economic profitability of fertilizers under crops by a decrease in net profit. The application of a fertilizer is cost-effective when the increase in the production value (gross profit) it provides is greater than the cost of the input and the resulting additional costs [47]. The economic analysis, based on the determination of net profit, shows that the net benefits of all the different types of fertilizer applied are greater than that of the control without fertilizer; therefore, fertilizer inputs have been economically profitable. The resulting net profit allowed us to determine the types of manure that best value the contribution of mineral and organic fertilizer under tomato cultivation in the conditions of northern Côte d'Ivoire. These types of fertilizers are, therefore, considered, as, economically optimal for tomato cultivation.

Economically optimal types of fertilizer must allow farmers to cover the relative expenses incurred to a large margin and allow them to earn very interesting profits. This proves that there is a need to determine the type of fertilizer suitable for the new hybrid variety of tomato in a pedoclimatic context that is less and less favorable to the production of this speculation.

The most profitable type of fertilizer is the one with the highest net profit. In this study, the mineral fertilizer (NPK + Urea), having produced the highest net profit, was considered, as, economically profitable and to be recommended to the peasants of the locality of northern Côte d'Ivoire. However, for long-term production, the intake of mineral fertilizers only is not advised. Indeed, exclusively mineral fertilization accentuates the reduction of organic carbon and the desaturation of the complex into exchangeable bases; and in addition, increases acidity, consisting mainly of exchangeable aluminum [48].

As for the economic profitability of tomato cultivation, through the use of organic matter (poultry droppings), the results obtained show that this dose is profitable, since it makes it possible to cover the expenses incurred.

In view of the results, the profitability of the use of fertilizers is excellent for the low dose, thus showing that the profitability depends on the type of fertilizer applied. This confirms the studies by [49] and [37] which recommend the use of small amounts of manure in the cultivation of salad vegetable, wheat, cabbage, potato, etc. However, the economically optimal types of manure for which fertilizer use is cost-effective depend on the availability of resources and changes in crop prices in the markets [50].

V. Conclusion

The general objective of this work was to determine the type of fertilizer that best makes tomato cultivation in the Korhogo region profitable. The results obtained in this study reveal that the different types of fertilizers (organic and mineral), applied, and influenced all the observed parameters that are the yield with its components (number of fruits, length and width of fruits) and growth parameters.

The study, being relative to the profitability of mineral and organic fertilizers under tomato cultivation, showed that the treatment, with the mineral fertilizer (NPK + Urea), having provided the greatest net profit (14,492,500 CFA francs), is the most profitable and recommendable for tomato cultivation.

Under the conditions of this trial, organic amendment (chicken droppings) was an important source of nutrients and can be used to raise the productivity of soils low in major nutrients. The use of composts is of double interest. Not only does it improve the productivity of agriculture, but also the collection of products that are used in its manufacture cleans up the environment and improves the living environment of the populations.

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