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Effect of a Bio-Waste Based on Seed Cotton on Some Properties of Soils Under Market Gardening in the Department of Korhogo in the North of Côte d'Ivoire

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Abstract **Original Research Article**

Depletion of soils and climate change are currently reducing crop yields in West Africa. As a solution, soil improvement based on organic waste products is often considered. The experimental device used for this experiment is a File block with three repetitions which includes five treatments, namely T0: control plot, T1: treatment of bio-waste after one month of degradation, T2: treatment of bio-waste after three months of degradation, T3: NPK treatment drawn 15-15-15 (fertilizer for cotton), frequently used by populations in the fertilization of vegetable crops and T4: biofertilizer from the local market. The lettuce seedlings of the verdana variety (*Lactuca sativa*) from a nursery, were sown on the different treatments, then followed for 45 days. Biowaste samples at one month and three months of degradation, as well as soil samples taken in a depth of 0 to 20 cm, after the experiment were used for various laboratory analyzes. The results obtained indicate that the T2 treatment had a better carbon level (C = 2.04 g / kg) compared to the other treatments. Furthermore, the study revealed C / N ratios varying between 6.05 and 9.13 for treatments based on bio-waste compared to the control (C / N = 2). The lettuce yields obtained after the various applications of bio-waste have significantly improved compared to other treatments (control, biofertilizer and chemical fertilizer). Thus for T0 the yield obtained is 0.23T / ha against 1.39T / ha for T1, 0.57 T / ha for T2; 0.4 T / ha for T3 and 0.23 T / ha for T4. Compared to the technical data sheet for this variety of lettuce, the T1 treatment has a better yield compared to others.
Keywords: Soils, organic residual products, amendment, Fertilization, Côte d'Ivoire.

INTRODUCTION

Agriculture constitutes the pillar of the African economy and accounts for approximately 20% of the continent's GDP, 60% of its workforce, 20% of all its exports and constitutes the main source of income for rural populations. . In the dry tropical zone, the cultivation of land leads to a rapid reduction in the stock of organic matter and the appearance of nitrogen, phosphorus and various elements deficiencies [1]. The major constraint of agricultural production in Africa is the low level of soil fertility [2]. The problem of declining soil fertility is a concern both for farmers facing the high cost of inputs and for researchers whose research aims to maintain or restore the fertility of degraded soils for intensification of agricultural production [2]. One of the strategies for improving soil fertility, especially degraded soils, is the use of compost [3].

Bio-waste from cotton production can find its place in two new recovery sectors: agricultural and revegetation or restoration of the natural environment (renaturation). These channels would allow the recovery of large volumes of bio-waste and their recycling, allowing a considerable supply of materials for plant nutrition. In addition, the necessary agroecological transition in agriculture requires an increase in biological diversity and the intensification of ecological interactions between the biophysical components of ecosystems which promote fertility, productivity and resilience in the face of external disturbances [4]. In this context, the contribution of organic matter to the soil level in a highly degraded system appears promising. Thus, bio-waste based on seed cotton could lead to increased functional resilience to climate change [5, 6]. To understand the mechanisms, it is important to determine the effect of bio-waste based on seed cotton on the physical and chemical characteristics of some degraded soils under market gardening in the north of Côte d'Ivoire, still little studied. Indeed, the use of composts produced with organic waste can promote a wide range of ecosystem services, including those associated with underground biotic interactions such as C sequestration [7] and improve soil properties. They improve soil structure, increase the water and nutrient retention capacity of the soil, stimulate microbial activity and increase crop yields. In addition, organic fertilizer sources with a C / N ratio below 20 contain a high concentration of nutrients [8] and have nitrogen immobilization potentials. Agricultural recycling of this organic waste product will therefore, in the long term, improve organic status, liming and fertilizing the soil.

The objective of this study is to know the effects of bio-waste of vegetable origin on lettuce culture. It is specifically a question of evaluating the effect of biowaste based on seed cotton on the physical and chemical properties of soils under vegetable crops and on the yield of lettuce.

MATERIAL AND METHODS

Physiographic and climatic of the study area

The area of interest is the department of Korhogo, located in the North of Côte d'Ivoire, between longitudes 5° 15 and 6° 20 West and latitudes 8° 30 and 10° 25 North [9]. The relief of the area is monotonous with altitudes varying on average between 300 and 400 m. There are granite inselbergs in the landscape, sometimes reaching an altitude of more than 500 m. The Korhogo region is made up of lateritic plateaus varying in height from 0 to 3 m, witnesses of an ancient peneplain. These plateaus are affected by a very slight and regular slope towards the Bandama river. The humid tropical climate of the region results in an average annual precipitation fluctuating around 1200 mm.

Plant Material and Fertilizers

The bio-waste based on seed cotton at 1 month and 3 months of decomposition was used during this experiment. We have also used as an example of market gardening lettuce (*Latuca sativa*) plant widely consumed by the people of Korhogo. To do this, the variety verdana (Batavia) was selected. The seeds from this hybrid variety constitute a homogeneous first generation. Verdana lettuce has good heat resistance. Its large-caliber leaves are very tasty. It is a 50-60 day variety, disease resistant with 90% germination rate (Figure-1). We also used NPK (15-15-15) and a fertilizer from the local market, used by women for the fertilization of vegetable crops.

Green Lettuce (Batavia)

Cotton seed at 1 month of decomposition

Cotton seed at 3 months of decomposition

Fig-1: Lettuce and bio-waste used

METHODS

Experimental Apparatus

The essay was arranged in a File block with 3 repetitions. The elementary plot consisted of a board 3.5 m long and 1.5 m wide (5.25 m²). The plants were transplanted onto the board in double lines at the rate of 0.5 m between feet and 0.5 m between lines, i.e. 14 plants per elementary plot. Paths of 0.5 m have been observed between the elementary plots and the blocks. Soil field surveys were carried out on the horizon 0-20 cm deep, before and at the end of the experiment in order to assess the variation in soil fertility under each treatment. The treatments compared were:

- **T0** : control without fertilizer (soil of the experimental site);
- **T1**: bio-waste at 1 month of decomposition, 3t / ha;
- **T2**: bio-waste at 3 months of decomposition, 3t / ha;
- **T3**: NPK (15-15-15), 200 kg / ha;
- **T4**: biofertilizer from the local market.

Observations and Measures

The observations and measurements related to: the width of the leaves, the number of leaves, the size of the roots and the height at the collar of the lettuce plants. These observations were made on 5 lettuces selected at random at each measurement on each elementary plot. The height was measured from the collar to the end of the root. The yield component determined was the total weight of the fresh mass of lettuce leaves, after digging up and rinsing the plants. To determine this component, the number and total weight of the fresh leaf mass of all crops in the elementary plots was added using an electronic balance. Physical soil analyzes of the grain size, porosity and salinity of the soil were determined. Chemical analyzes were also carried out on the soil samples. These are the pH which has been measured according to standardized methods (AFNOR NF ISO 10-390, 2005) and macroelements (N, P and K), essential cations (Ca and Mg) and metallic trace elements (Pb, Zn, Mn and Fe). The Kjeldahl nitrogen content is determined in accordance with French standard AFNOR ISO 11-261. The contents of metallic elements (zinc, lead, manganese iron) and ionic species (calcium, sodium and potassium) are determined by flame atomic absorption spectrophotometry (SAA) after mineralization of the samples with aqua regia.

Statistical Processing of the Data Collected

The results of the observations and measurements were analyzed using SPSS version 20 software. An analysis of variance was first performed. Then, the means were separated by the TUKEY test at the threshold of 5% when the effects were significant. The normality of the data and the homogeneity of the variances were checked beforehand using the de, Kolmogorov-Smirnov and Shapiro-Wilk test, respectively.

RESULTS AND DISCUSSION

Physico-Chemical Characteristics of the Organic Manure Used

Table-1 reveals that the mineral content of bio-waste increases significantly with decomposition time. Indeed, in the bio-waste at three months of decomposition the content of mineral elements such as N, C, P, K, Ca, Mg, Ir, Na, Mn, Ld, Zn is significantly more marked compared to the stage of a months of decomposition. The C / N ratio is 12 for bio-waste at 3 months of decomposition, which indicates good mineralization of organic matter. As for bio-waste at 1 month of decomposition, the C / N ratio is equal to 13, which indicates slightly slow mineralization.

Effect of treatments on soil parameters

Granulometry, porosity and salinity of the experimental site soil

The analysis results indicate that after application of fertilizer and amendments, the clay content has significantly changed. Indeed, the control without intake had a clay content of 8.18 g / kg but after the various treatments the clay content increased to 18.21 g / kg for T1; 18.10 g / kg for T2; 18.8 g / kg for T3 and 16.2 g / kg for T4 treatment. As for the porosity, it is very low (24.52% thus testifying to a compact soil for the witness. After application, the porosity under the various treatments increased to 54.70% for T1; 50.94% for T2; 35.84% for T3 and finally 28.3% for T4. The porosity under treatment with bio-waste is highly significant compared to other treatments. The salinity of the soil has evolved in terms of T1 and T2 treatments; it is 0.05 mS / cm for T1 and 0.021 mS / cm for T2 against 0.02 mS / cm for the control T0. The salinity values at the level of T3 and T4 decreased compared to the control, ie 0.018 mS / cm for T3 and 0.013 mS / cm for T4. However, all these values remain at a level suitable for most plants (Table-2).

Acidity, organic matter, nitrogen and assimilable phosphorus

Examination of the results obtained after laboratory analyzes of the soil samples reveals a highly significant difference between the levels of organic matter (OM). The control soil had an OM content of 0.77 g / kg. After application of the various treatments the contents increased considerably. T1 and T2 treatments have contents of 12.8 g / kg and 14.5 g / kg respectively; at the level of T3 and T4, the values obtained are of the order of 9.74 g / kg and 11 g / kg. Also, the nitrogen content improved considerably after the various applications. The soil C / N ratio before application was 32.14, reflecting very slow mineralization of organic matter. The addition of fertilization and fertilization contributed to further lower this value, which fell to 6.05 for T1; 7.21 for T2; 9.13 and 8.3 for T3 and T4 showing moderately good mineralization at ground level (Table-3).

Cationical exchange complex and exchangeable base

The CEC values obtained after the different analyzes have a significant difference. The CEC before the treatments is low, ie 3.9 cmol $^+$ / kg. We note that after the treatments this value improved by passing to 8 cmol $^+$ / kg for T1, 8.1 cmol $^+$ / kg for T2, 6.5 cmol $^+$ / kg for T3 and 7 cmol $^+$ / kg for T4, i.e. double compared to the witness. With regard to calcium and magnesium, the values obtained before and after treatment are not significantly different. In terms of potassium, the values obtained are 0.32 cmol $^+$ / kg for T0, 0.3 cmol $^+$ / kg for T1, 0.4 cmol $^+$ / kg for T2 and T4, 0.44 cmol $^+$ / kg for T3. At the calcium levels the values obtained are. 1.9 cmol $^+$ / kg for T0; 3.72 cmol $^+$ / kg for T1; 3.3 cmol $^+$ / kg for T2; 3.02 cmol $^+$ / kg; 3.2 cmol $^+$ / kg respectively for T3 and T4. The sodium before treatment was 0.15 cmol / kg in the soil. After application this value dropped considerably and went to 0.01 cmol / kg for T1. T2, T3 and T4 treatments helped increase the sodium level in the soil, ie 1.04 at T2, 0.84 at T3 and 1.41 at T4 (Table-4).

Table-1: Chemical composition of bio-waste at different stages of decomposition

Parameters analyzed in $mg.kg^{-1}$												Mineralization level	Significance
Manures	**N**	**C**	**P**	**K**	**Ca**	**Mg**	**Ir**	**Na**	**Mn**	**Ld**	**Zn**	**(Repport C/N)**	
1 month (T1)	0.02a	0.26c	0.12a	0.02d	0.02c	0.03a	5.33b	0.09a	0.11b	0.06a	0.06c	13 a	Slow
3 months (T2)	0.17b	2.04a	0.96c	0.17c	0.19b	0.28b	39.99c	0.66b	0.81c	0.47b	0.48b	12 b	Good
F cal	215.7	692.5	294.22	795.6	120.91	564.85	419.22	531.03	668.63	335.64	104.69	27.31	
Cal Pr	0.0012	0.0023	0.0011	0.0043	0.0055	0.0024	0.0076	0.0047	0.0048	0.0021	0.0088	0.045	
Th Pr	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.05	

Legend : N : nitrogen , **C** : carbon, **P** : phosphorus, **K** : potassium, **Ca** : calcium, **Mg** : magnesium, **Ir** : Iron, **Na** : sodium, **Mn** : manganese, **Ld** : lead, **Zn** : zinc. not significantly different at the Probability threshold <0.05, according to the TUKEY method, (F.cal = File calculated, Pr cal = Probability calculated, Th Pr = Theoretical Probability). T1 = 1 month of decomposition, T2 = fertilization at 3 months of decomposition.

Table-2: Granulometry, porosity and salinity of the soil and treatments

		Treatments					Associated statistical tests	P cal	Significance
		T0	**T1**	**T2**	**T3**	**T4**			
Granulometry (g/kg)	A	8.18±0a	18.21±0b	18.10±0b	18.8±0b	16.2±0b	F =	0.00	**
	Lf	16.27±1.01a	15.3±1.03a	15.21±1.01a	16.5±1.1a	13.3±0a	χ^2 =	0.2	ns
	Lg	19.15±0a	20.4±1.01a	22.41±0.11a	21.35±0.01a	20.1±1.1a	χ^2 =	0.20	ns
	Sf	26.23±0a	19.05±0b	21.05±0b	26.18±0b	20.37±0b	F =	0.026	**
	Sg	30.17±0.1a	23.05±0.01a	23.23±0.11a	17.17±0.1a	22.63±0a	χ^2 =	0.2	ns
Porosity (%)	Por	24.52±8.8a	54.70±6.65b	50.94±2.51b	35.84±7.94b	28.30±8.8a	F =	0.00	**
Salinity	Sal	0.02±0.2a	0.05±0.15b	0.021±0.92a	0.018±0.008a	0.013±0.012a	F =	0.00	**

The means followed by the same letter, on the same line, are not significantly different at the Probability threshold <0.05, according to the TUKEY method, AST = applied statistical test: χ^2 = which two from Kruskal Walis, F = F of File, Cal pr = Calculated probability, Th Pr = Theoretical probability). T1 = 1 month of decomposition, T2 = fertilization at 3 months of decomposition. ** = significant, ns = not significant; c = clay; fs = fine silt; cs = coarse silt; fs fine sand; cs = coarse sand.

Table-3: Acidity, organic matter, nitrogen and assimilable phosphorus of the control soil and treatments

Parameters analyzed	Treatments					Associated statistical tests	P cal	Significance	
	T0	**T1**	**T2**	**T3**	**T4**				
Acidity	pH	5.4±0.13b	7.2±0.13a	6.1±0.1ab	6.2±0.16ab	6.7±0.13a	χ^2 =	0.2	ns
Carbon (g/kg)	C	0.45±0.01a	7.44±0b	8.43±0b	5.66±0b	9.3±0.01b	F =	0.024	**
Organical matter (g/kg)	OM	0.77±0.11a	12.8±1.5b	14.5±0.92b	9.74±0.98b	11±1.5b	F =	0.022	**
Nitrogen (g/kg)	N	0.01±0a	1.23±0.01b	1.17±0b	0.62±0.01b	1.12±0b	F =	0.027	**
Carbon/Nitrogen ratio	C/N	32.14±3.36a	6.05±0.12b	7.21±0.1b	9.13±0.15b	8.3±0.12b	F =	0.00	**
Assimilable phosphorus (mg/kg)	P_2O_5	41.37±0a	70.04±0b	62.32±0b	65.57±0b	62.7±0b	F =	0.01	**

The means followed by the same letter, on the same line, are not significantly different at the Probability threshold <0.01, according to the TUKEY method, AST = applied statistical test: χ^2 = which two Kruskal Walis test, F = F of File (anova), cal Pr = Calculated probability, T1 = 1 month of decomposition, T2 = fertilization at 3 months of decomposition. ** = significant, ns = not significant.

Table-4: Cationic exchange complex and exchangeable base.

Parameters of the soil analyzed ($cmol^+/kg$)		Treatments					Associated statistical tests (AST)	P cal	Significance
		T0	T1	T2	T3	T4			
Cationic exchange capacity	CEC	3.9±0.34b	8±0.3b	8.1±0.3b	6.5±0.34b	7±0.31b	χ^2 =	0.08	ns
Calcium	Ca^{2+}	1.9±0.02a	3.72±0.1b	3.3±0.04b	3.02±0.05b	3.2±0.1b	F =	0.008	**
Magnesium	Mg^{2+}	0.4±0.1b	0.8±0.11b	0.94±0.1b	0.93±0.2b	0.7±0.1b	χ^2 =	0.2	ns
Potassium	K^+	0.32±0.01a	0.3±0.01a	0.4±0.01a	0.44±0a	0.4±0a	χ^2 =	0.2	ns
Sodium	Na^+	0.15±0.11a	0.01±0.11a	1.04±0.11a	0.84±0.1a	1.41±0.1a	χ^2 =	0.174	ns

The means followed by the same letter, on the same line, are not significantly different at the Probability threshold <0.01, according to the TUKEY method, AST = applied statistical test: χ^2 = which two Kruskal Walis test, F = F of File (anova), cal Pr = Calculated probability, T1 = 1 month of decomposition, T2 = fertilization at 3 months of decomposition. ** = significant, ns = not significant.

Effect of treatments on the agronomic parameters measured at the lettuce level

Number of leaves

The various organic and fertilizing amendments had very significant effects on the number of leaves of lettuce plants. The greatest number of leaves was observed with the seed cotton treatment at 1 month of decomposition (T1) with an average number of 45 leaves per plant. Furthermore, the T3 and T4 treatment respectively have an average number of 23 leaves and 18 leaves per plant, on the other hand the NPK treatments and the control have the same average number of leaves, ie 21 leaves per plant. The analysis of variance (ANOVA 1) and the Tukey test applied to the data confirm that the T1 treatment has the significantly higher number of leaves (Table-5).

Height of Plants

The different treatments carried out had significant effects on the height at the root of the lettuce plants. The greatest height was recorded in the seed cotton treatment at 1 month of decomposition with an average plant height of 16.2 cm. The treatments based on seed cotton at 3 months of decomposition, the NPK, the organic fertilizer and the control recorded average heights of 13.6 cm, 10.6 cm, 12.3 cm and 8.8 cm respectively. The Kruskal Walis test applied confirms that the T1 treatment presented significantly higher plant heights (Table-5).

Root Size

The treatments had a significant impact on the size of the roots. The T1 treatment has a highly significant difference compared to other treatments with an average root size of 22.5 cm. Treatments T0, T2, T3 and T4 have a root size of 14cm, 15cm, 16.15 cm and 15 cm respectively. The variance analysis (KrusKal-Walis) and the post ANOVA test confirm that the largest root size is recorded at T1 level (Table-5**)**.

Root Width

Descriptive statistical analysis shows that the different organic fertilizer and fertilizer treatments had a significant effect on the leaves width. The analysis of variance and the TUKEY test applied to the data shows a very highly significant difference for the T1 treatment which records the largest leaves width (21.4 cm). Treatments T3 and T4 have leaves width of 12.6 cm and 12.2 cm respectively. T0 and T2 have a width relatively below and respectively 12.1 cm and 12.6 cm, Pcal = 0.000 **(**Table-5).

Productivities

Table-5 presents the effect of the different treatments performed on the yield of lettuces produced. Analysis of the results in this table shows that T1 significantly contributed to the increase in lettuce yield compared to the control (T0), treatments, T2, T3 and T4. The yields are in the proportions of 1.39t / ha for (T1) against 0.57t / ha for (T2), 0.23t / ha, 0.4 t / ha, and 0.23t / ha respectively for T0, T3, T4. The analysis of variance and the Tukey test shows that the performance at T1 level is significantly different compared to other treatments.

Table-5: Agronomic parameters from the different treatments

Agronomic parameters analyzed		Treatments					Associated statistical tests (AST)	P cal	Significance
		T0	T1	T2	T3	T4			
Leaf number	LN	19±1,53a	43±2,65b	21±2,52a	21±2,65a	19±2,65a	F =	0,00	**
Plants height	PH	8,5±0,15a	15,19±0,26b	13,3±0,31c	10,2±0,26d	12±0,21e	χ^2 =	0,009	**
Size root	SR	14,33±1,53a	22,5±0,26a	13,3±3,21a	16,15±0,3a	13,3±3,21a	χ^2 =	0,08	ns
Leaves width	LW	12,67±1,53ab	21,47±0,32c	15±2,65b	12,6±0,26ab	12,1±0,26a	F =	0,00	**
Productivity (t/ha)	P	0,23±0a	1,39±0,01b	0,57±0,01c	0,4±0,01d	0,23±0a	F =	0,00	**

The means followed by the same letter, on the same line, are not significantly different at the Probability threshold <0.01, according to the TUKEY method, (STA = statistical treatment applied: F = F of File (anova); χ^2 (Kruskal Walis test), Cal Pr = Calculated probability, T1 = 1 month of decomposition, T2 = manure at 3 months of decomposition, T3: NPK, T4: fertilizer from the local market. ** = significant; ns = not significant

DISCUSSION

Before the cultures were put in place and the various treatments applied, the study site had a low porosity of around 24.52%. This soil was poor in organic matter, carbon and nitrogen. It contained 0.77 g / kg of organic matter, 0.01 g / kg of nitrogen and 0.45 g / kg of carbon. The C / N ratio was 32.14, which indicates very slow mineralization of organic matter in this soil. The cationic exchange capacity is 3.9 cmol / kg, which indicates a low capacity of the soil to retain on its surface the ions necessary for plant nutrition. These characteristics are typical of degraded soils. The north of Cote d´Ivoire is no exception to this phenomenon. It tends to be accentuated in the department of Korhogo. This is certainly due to overgrazing and cultivation, which have greatly contributed to reducing the plant cover as well as the rate of organic matter, thus promoting soil compaction [10].

The aim of this work being the restoration of degraded soils, the application of organic manures based on seed cotton, allowed us to improve the soil fertility of the experimental site.

Laboratory analyzes indicated an improvement in the physical, physico-chemical and chemical properties of the soil. Indeed, the organic matter content (OM) which was 0.77 g / kg rose to 12.8 g / kg at the level of T1, 14.5 g / kg at the level of T2; 9.74 g / kg at T3 level and 11 g / kg at T4 level. The nitrogen (N) content has increased considerably. It went from 1.23 g / kg for T1, 1.17 g / kg for T2, 0.26 g / kg and 1.12 g / kg at the level of T3 and T4 compared to T0 (0.01g / kg). The C / N ratio which characterizes the state of mineralization of organic matter at the control level is 32.14 (very slow mineralization).

After applying the different treatments, the C / N ratio at the treatment level has improved significantly. This ratio at T1 level is 6.05; 7.21 at T2, 9.13 and 8.3 at T3 and T4. Although the values obtained at the level of T1 and T2 are below 8, they tend to have good mineralization. The results of the application of organic manure based on seed cotton indicates the beginning of restoration of this degraded soil. Indeed, if the C / N ratio obtained is less than 8, the degradation of the organic matter is excessive. The soil is unable to maintain the decreasing microbial mass due to the lack of carbon. When in a given soil the C / N ratio is between 8 and 12, the organic matter evolves correctly a priori, while if the C / N ratio is greater than 12, the evolution of the organic matter is slowed down due to the inability of the soil microflora to multiply (lack of nitrogen).

The consequence of a good evolution of the organic matter is that the humus, flocculating with the clay forms the clay-humic complex, true reserve and nourishing base of the earth. The formation and accumulation of humus allows the storage of most of the elements (C, O, H, N, P, K, S, trace elements) essential to life [11]. All microbiology (bacteria, fungi ...) and soil fauna (earthworms, termites ...) participate in its formation. Its degradation contributes to the release of CO^2, while its development fixing the carbon fights against the greenhouse effect [11]. It "protects" the clay and stabilizes the soil structure. Humic compounds, by binding to clay, help to improve the porosity of the soil. This porosity, which was 24.52% before the treatments, rose to 51.57% for T1, 55.34% for T2, 35.84% for T3 and 28.3% for T4. The soil is thus more aerated, less subject to compaction, leaching and erosion by rain and watering, and it stores water better; all of which make it more fertile.

In addition, the structural role of humus induces a good penetration of the soil by the air and therefore the oxygenation in depth allowing to stimulate a good biological activity of the macro and micro-fauna and flora of the soil [12]. The roots penetrate more easily in depth; which contributes to improving their exploration of the soil and subsoil and therefore their supply of water and minerals. This explains the relatively good size of the roots at the level of the T1 and T2 treatments which are 22.5 cm and 15 cm compared to the control (T0) which is 14 cm.

The manures made from seed cotton had very significant effects on the yield of lettuce. The highest production of lettuce is observed with seed cotton at 1 month and 3 months of decomposition of 1.39 T / ha and 0.57 T / ha respectively; NPK and biofertilizer treatments produced respective yields of 0.4T / ha and 0.23T / ha. The richness of seed cotton in nitrogen confirms the results cited above, hence the high yield recorded compared to NPK and organic fertilizer. The highest average number of leaves per plant was recorded in seed cotton at 1 month of decomposition, i.e. an average number of 45 leaves per plant, followed by seed cotton at 3 months of decomposition (23 leaves / plant), NPK (21 leaves / plant, control (21 leaves / plant and organic fertilizer (18 leaves / plant). The richness of manures made from seed cotton in nitrogen, organic matter, phosphorus, had a positive effect on the average number of leaves. Nitrogen is the key element in plant nutrition, it is involved in the synthesis of proteins, chlorophyll and other major compounds determining in plant metabolism. involved in the growth and development process of crops. Phosphorus promotes root development and is involved in maturation, the mobilization of nutrient reserves and the transmission of hereditary characteristics. an activator of several enzymes such as: Acetic Thiokinase, Aldolase, Pyruvate kinase and ATPase and promotes the synthesis of carbohydrates and amino acids. This corroborates with the observations made by certain authors [13] after using the compost enriched with poultry manure for the production of cabbage on sandy soil. Similar results have been reported by certain authors [14] after using compost enriched with poultry manure for the production of lettuce on ferrallitic soil. Nitrogen is a constituent element of chlorophyll, it is a determining factor in the growth and the determination of the yield of plants [15]. The positive effects of bio-waste based on seed cotton at 1 month of decomposition appeared more explicitly on the development of the root system with a root size of 22.5 cm. Unlike the bio-waste based on seed cotton at 3 months of decomposition which is 15 cm, the NPK (15-15-15) which is 16.15 cm and the organic fertilizer which is 15 cm. As for the witness, he developed a root size of 14 cm. The widths of the largest leaves are recorded at the level of the bio-waste based on seed cotton at 1 month of decomposition, with 21.47 cm, while T2, T3, T4 and T0 presented 15 cm, 12.6 cm, 12.1 cm and 12.67 cm, respectively. The improved yield in terms of seed cotton treatments can also be explained by the fact that inside organic matter, aluminum ion is complexed in particular by humic and fulvic acids. Organic matter reduces toxicities by complexing ions, therefore aluminum [15].

CONCLUSION

The work presented made it possible to identify the chemical characteristics of bio-waste which improve the agronomic parameters of cultivated plants even under degraded soil. The study showed that the contribution of biowaste from seed cotton at 1 month and 3 months of decomposition had improved soil fertility and therefore the yield of lettuce. The highest yields are recorded at the level of treatments based on bio-waste at 1 month and 3 months of decomposition, respectively 1.39T / ha and 0.57 T / ha, against 0.4T / ha for NPK, and 0, 23T / ha for organic fertilizer and control soil. This was very marked on the root system of the lettuce, the number of leaves, the width of the leaves and on the height at the collar of the lettuce plants. NPK and the biofertilizer did not significantly influence the yield of lettuce. The contribution of seed cotton to a decomposition 1 to help lower the Na^+ level, and to raise the rate of, N, OM, P_2O_5 and K^+. However, in view of the results obtained, bio-waste based on seed cotton at 1 month and 3 months of decomposition could be recommended to producers for the cultivation of lettuce at a dose of 0.012 t / ha. But for an efficiency of the organic amendment, we can suggest fractional contributions to avoid the losses of nutrients by leaching. Given these encouraging initial results, it would be envisaged to define standard characteristics of bio-waste and test more drastic reductions in water regime and more in line with the reality on the ground.

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