

Valorisation Of Agro-industrial Bio-waste From Seed Cotton In The Restoration Of Degraded Soils In The District Of Korhogo In Northern Côte d'Ivoire

ABSTRACT

Aims: This study was investigated to restore degraded soils with organic manure from agro-industrial bio-waste (seed cotton) in the Department of Korhogo in Northern Côte d'Ivoire.

Study design: The experimental design is a Fisher block with four treatments, namely T0 (control soil), T1 (bio-waste at 1 month of biodegradation), T2 (bio-waste at 3 months of degradation) and T3 (bio-waste at 6 months of degradation).

Place and Duration of Study: The work was carried out from 2018 to 2019 in the district of Korhogo in Northern Côte d'Ivoire.

Methodology: On each of the treatments, bio-waste was applied using spreading technique and the variety F8128 of corn was sown to evaluate the agronomic performance of bio-waste. Five agronomics parameter that are plant height, collar diameter, ear weight and grain yield were measured in corn. Likewise, the physical and physic-chemical and chemical analyses were achieved both the soil (before sowing and after corn harvesting) and organic fertilizer samples.

Results: Corn grain yield is more significant at the treatment level (T1 = 2.26 T/ha; T2 = 1.98 T/ha and T3 = 1.48 T/ha) than that of the control soil (T0 = 1 T/ha). Laboratory analyses of the soil and bio-waste indicate a very low level of organic matter (MO varies from 0.55 to 0.77 g.kg⁻¹) in the soil of the experimental plot and good mineralization of the organic matter in the bio-waste regardless of the decomposition time (C/N varies from 12 to 13). After application of the bio-waste, the organic matter content (T3 = 10.28 g.kg⁻¹; T1 = 23.61 g.kg⁻¹ and T2 = 23.63 g.kg⁻¹) and nitrogen content (T3 = 0.69 g.kg⁻¹; T1 = 1.16 g.kg⁻¹ and T2 = 1.21 g.kg⁻¹) of the various treatments significantly increased compared to the control soil (MO = 0.66 g.kg⁻¹ and N = 0.013 g.kg⁻¹). In terms of pH, from strongly acidic for the control soil (4.8 to 5.1), the soils after application of organic manure became slightly acidic (5.7 to 6.4).

Conclusion: Our study showed the effectiveness of organic fertilizer on corn yield. The seed cotton bio-waste has had an improving effect on the degraded soil of in Northern Côte d'Ivoire.

13 *Keywords: bio-waste, Côte d'Ivoire, corn, restoration and degraded soil.*

1. INTRODUCTION

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16 Land degradation is a phenomenon that leads to a permanent loss of the biological and
17 economic productivity of ecosystems and agro-ecosystems. It concerns all types of
18 environments exploited by human societies to ensure their livelihoods [1]. The soil, which is
19 one of the main bases of agroforestry production in sub-Saharan Africa, faces major
20 degradation problems. This natural resource is particularly affected by the loss of its multiple
21 potentialities [1]. High soil degradation, particularly in sub-Saharan Africa, is linked to

22 climatic conditions aggravated by high land pressure and inappropriate agricultural practices
 23 (mining agriculture) [2]. Indeed, as soon as litter is cleared and disappears, there is a rapid
 24 decrease in soil organic matter (MOS) and the beginning of chemical, biological and physical
 25 degradation of surface horizons. The fire brutally mineralizes the litters, temporarily
 26 straightens the pH, but releases CO₂ and ash which are blown by the wind or washed away
 27 during the first storms. Plowing in turn introduces oxygen into the soil, accelerates organic
 28 matter mineralization, and mixes the underlying humus and mineral horizons. In total,
 29 cultivated soils are becoming both less productive and less resistant to rainfall energy [3].
 30 Those in the Korhogo district (Northern Côte d'Ivoire) do not remain on the margins of this
 31 very advanced degradation because of their overexploitation, which is linked to population
 32 growth [4].

33 The general objective of this work is to improve the degraded soils with organic manure
 34 (seed cotton) from the waste come from the textile industry in the district of Korhogo.
 35 Specifically, it will be (i) evaluate the effect of the organic manure on corn cultivation, a plant
 36 that is widely consumed in Northern Côte d'Ivoire (ii) see the behaviour of this organic
 37 fertilizer on the properties of some degraded soils in the Korhogo district and (iii) establish a
 38 correlation between the decomposition time of cotton fibers and/or seeds (organic manures)
 39 and the properties of degraded soils in relation to corn yield.

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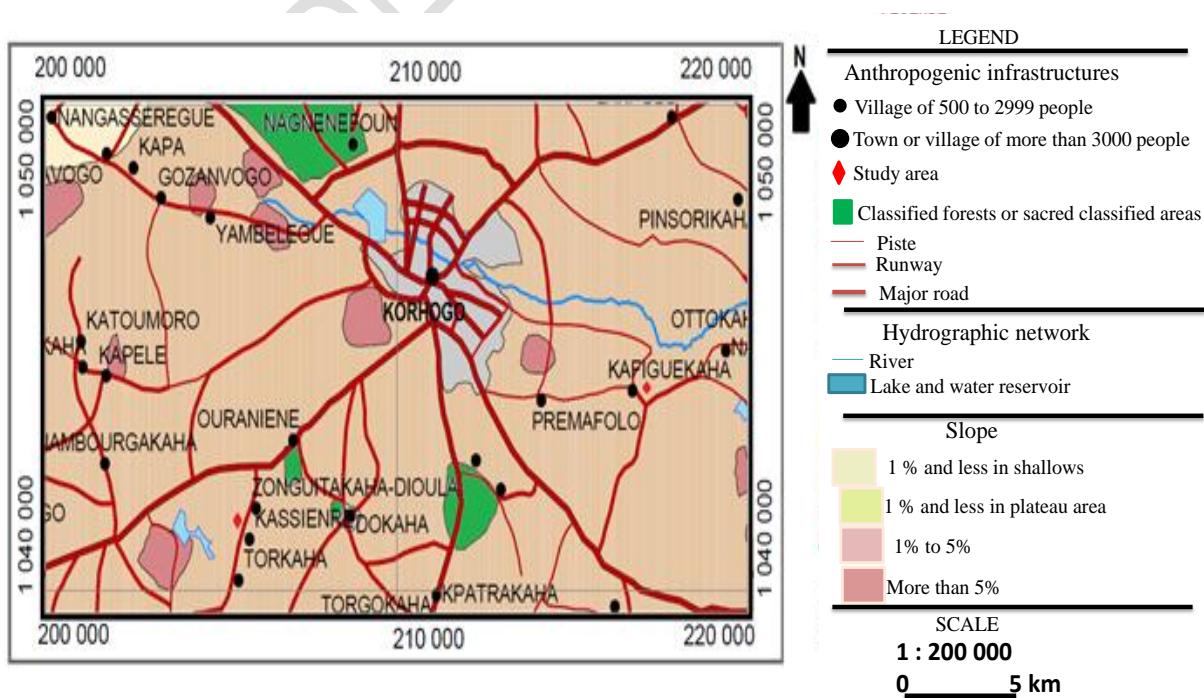
41 2. MATERIAL AND METHODS

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43 2.1 Study site

44 The work was carried out in the department of Korhogo in northern Côte d'Ivoire. The relief
 45 of the investigated area is monotonous, with altitudes varying, on average, between 300 and
 46 400 m. However, granitic inselbergs sometimes reaching altitudes of more than 500 m exist
 47 in the landscape. The department is made up of lateritic plateaus that can sometimes reach
 48 three meters in height, evidence of old peneplain. These plateaus are affected by a very
 49 slight and regular slope. The average annual rainfall oscillates around 1200 mm of rain. The
 50 area consists of forest galleries, wooded and shrubby savannah vegetation [5]. The
 51 geological formations of the area consist of a succession of bands of shale rocks, migmatite
 52 rocks and plutonic rocks. These are mainly granites, granodiorites, undifferentiated shales
 53 and sericite shales [6], from which several types of soils are derived, namely Ferralsols,
 54 Cambisols, Fluvisols and Luvisols [7]. The chosen area is the site around the village of
 55 Natiokobadara in Korhogo district (Fig.1).

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57 **Fig. 1. Geographical location of the studied sites**

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59 **2.2. Material**

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61 **2.2.1. Organic manure**

62 The organic manure (bio-waste) used is based on seed cotton from the waste from the
63 textile industry in the city of Korhogo. Three types of manure were used depending on the
64 duration of degradation: 1 month (T1), 3 months (T2) and 6 months (T3). In addition, soil
65 samples from horizons with thicknesses ranging from: 0-20 cm; 20-40 cm and 40-60 cm are
66 available (Fig. 2).



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68 **Fig. 2. Soil and organic manure used on the experimental site**

69 **2.2.2. Plant material**

70 The plant material used for our experiments consists of corn grains of the F8128 variety
71 improved by the Centre National de Recherche Agronomique (CNRA) an agronomic
72 research institution of Côte d'Ivoire [8]. It is a variety with a long cycle of 100 to 120 days
73 (Fig. 3; Table 1).

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83 **Fig. 3. Variety of corn coded F8128 used for experimentation**

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85 **Table 1. Some characteristics of the corn variety F8128 used for the experimentation**

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Long cycle	Yield t/ha		Particular Characteristic	Seed color	Origin
	Potential	Medium			
100-120 Days	7	3 à 5	Streaks tolerance	Yellow, Horny/toothed	CNRA, 2006

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88 2.3 Methods

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90 **2.3.1 Morpho-pedological characterization and soil sampling of the experimental site**

91 A morpho-pedological characterization was performed at the experimental site to determine
92 the soil type. Thus, two soil pits (100 cm x 80 cm x 120 cm) were opened and described,
93 taking care to indicate the date, location, map sheet, vegetation, local slope, topographical
94 position, microrelief, following the "ORSTOM" approach based on the method of [9].

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96 **2.3.2 Experimental design**

97 The experimental design used is a Fisher blocks. Total experimental site area is 338 m² (26
98 m x 13 m) divided into three blocks separated by 2 m lanes. The various treatments were
99 installed on elementary plots of 15 m² (5 m x 3 m). They are separated by 2 m aisles from
100 each other. Four processing operations have been set up and are as follows:

101 T0: Soil Control = no organic fertilizer applied,

102 T1: Bio-waste at 1 month of decomposition,

103 T2: Bio-waste at 3 months of decomposition,

104 T3: Bio-waste at 6 months of decomposition.

105 For each treatment, organic manure (bio-waste) was applied to each unit using the
106 spreading technique before the seedbed was prepared. Thus, according to the technical
107 data sheet of the variety used, 60 kg of manure was added to each elementary plot, i.e. 60
108 kg of manure (bio-waste) per plots (15 m²), which corresponds to 40 T/ha of organic manure
109 [8]. Manual ploughing to a depth of about 15 cm was carried out to bury this manure in the
110 first depths of the soil. Corn growth parameters measured were plant height (cm) and collar
111 diameter (cm). At the production level, the ear weight (kg/ha) and grain yield of corn in (T/ha)
112 were measured.

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114 **2.3.3. Analysis of soil and organic fertilizer samples**

115 Soil samples were analyzed using standard methods [10] before sowing and after corn
116 harvesting. This is the granulometry, by the Robinson Kölen method, of the organic carbon
117 (C) of the soil determined by titrimetry (Walkley-Black method) after oxidation using a
118 mixture of sulphuric acid (H₂SO₄) and potassium dichromate (K₂Cr₂O₇). Total nitrogen was
119 determined by the Kjeldahl method based on wet oxidation. Total phosphorus was
120 determined by colorimetry after reaction with phosphoric acid in the presence of ammonium
121 molybdate and ascorbic acid. The assimilable phosphorus (Olsen-Dabin method) was
122 extracted using sodium bicarbonate (NaHCO₃) at pH 8.5.

123 The exchangeable bases (K, Ca and Mg) were extracted using ammonium acetate.
124 Potassium was determined using flame photometers, while Ca and Mg were determined by
125 the flame atomic absorption spectrophotometer. The pH (water) was determined using the
126 pH meter after adding 50 ml of ionized water to 20 g of soil followed by agitation and settling.
127 The bulk density (da) was determined by the cylinder method, using undisturbed and fresh
128 samples, knowing the constant dry weight of the samples at 105°C and the volume of the
129 cylinders of the samples used [11].

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131 **2.3.4. Statistical analysis of data**

132 The results of the soil, bio-waste and corn agronomic parameters analyses obtained were
133 statistically processed by an analysis of variance (ANOVA 1) with the SPSS version 20 (IBM

134 Corp., USA) software, and in case of significant difference, TUKEY post-ANOVA test was
135 performed to differentiate the groups. The normality of the data and the homogeneity of the
136 variance were checked beforehand using the Kolmogorov-Smirnov and Shapiro-Wilk tests,
137 respectively.

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139 3. RESULTS

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141 3.1 Corn grain yields

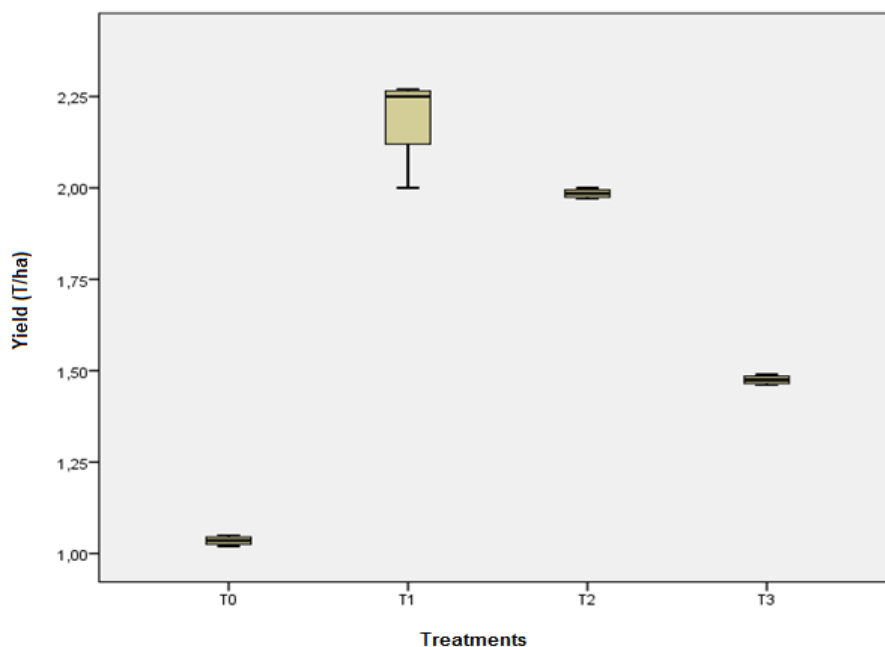
142 Statistical analysis applied to the data collected at the yield outcome level indicates a highly
143 significant difference ($F_{cal} = 39.66^{**}$ and $P_{cal} = 0.00023$). Corn kernel yields vary from
144 0.99 to 2.45 T/ha depending on the different treatments and the control soil. The results
145 indicate that the corn grain yield recorded at the control soil level is 1 T/ha compared to 2.26
146 T/ha for T1; 1.98 T/ha for T2 T/ha and 1.48 T/ha for T3 (Fig.4).

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148 3.2 Physical, physico-chemical and chemical characteristics of the soil at the 149 experimental site before sowing

150 The soil of the experimental site has a brown (10YR6/6) and spotted rusty ochre (7.5YR6/8)
151 colouring, with a depth of 60 cm. The horizons of subangular polyhedral structure and
152 sandy-clayey texture are apparently not humiferous. The drainage class is approximately
153 5.3. There is an indurated layer at medium depth. The charge in concretions and nodules is
154 greater than 40%. It is a Pisoplinthic Ferralsol in the WRB classification. The soil content low
155 organic matter (0.55 to 0.77 g.kg⁻¹) relatively and its decomposition is very slowly (Table 2).
156 The soil is very active ($IB > 2$) with a high acid pH (4.8 to 5.1) and a low nutrient reserve
157 ($CEC = 3.91$ to 4.85 cmol⁺/kg).

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160 **Fig. 4. Different yields (T / ha) in grain of corn depending on the treatments**

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162 **Table 2. Physical, physicochemical and chemical characteristics of the soil of the**
163 **experimental site**

Analyzed soil parameters	Depth of the horizon (cm)
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		0-20	20-40	40-60
Granulometry (g.kg ⁻¹) (Clay = A; Silt = L; Sand = S; thin = f et Coarse = g)	A	7.01	8.18	9.02
	Lf	17.02	16.27	16.95
	Lg	20.28	19.15	19.75
	Sf	25.11	26.23	23.35
	Sg	30.58	30.17	30.93
Apparent density (g.cm ⁻³)	Da	2.01	2.08	2.11
Porosity (%)	P	24.15	21.51	20.38
Carbon (g.kg ⁻¹)	C	0.32	0.45	0.39
Organic matter (g.kg ⁻¹)	MO	0.55	0.77	0.67
Index battance	IB	3.26	-	-
Potential hydrogen	pH eau	5.1	4.9	4.8
Total nitrogen (g.kg ⁻¹)	N	0.012	0.014	0.015
Ratio Carbon/ nitrogen	C/N	26.67	32.14	26.00
Phosphore assimilable (mg.kg ⁻¹)	P ₂ O ₃ ass	39.8	41.37	40.59
Cation exchange capacity (cmol ⁺ /kg)	CEC	4.85	3.91	4.41
Sum of exchangeable bases (cmol ⁺ /kg)	S	2.73	2.74	2.67

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165 3.3 Physico-chemical and chemical characteristics of the bio-waste used

166 The characteristics of the bio-waste used in our experiments are shown in Table 3. Thus, the
 167 nitrogen and carbon contents of bio-waste for the treatments T1 (N = 0.02 g.kg⁻¹; C = 0.26
 168 g.kg⁻¹) and T2 (N = 0.17 g.kg⁻¹; C = 2.04 g.kg⁻¹) are low compared to T3 (N = 1.38 g.kg⁻¹; C
 169 = 17.02 g.kg⁻¹). However, the degree of mineralization of organic matter is good for the T2
 170 (C/N = 12) and T3 (C/N = 12.33) treatment compared to the T1 (C/N = 13) treatment which
 171 is slightly slow. The iron content is high for T2 (Fe = 40 mg.kg⁻¹) and T3 (Fe = 33.21 mg.kg⁻¹)
 172 treatments and low for T1 (Fe = 5.33 mg.kg⁻¹) treatments.

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Table 3. Chemical composition of bio-waste (fibers and cotton seeds)

Manures	Parameters											Level of soil mineralization (Ratio C/N)
	N (g.kg ⁻¹)	C (g.kg ⁻¹)	P (mg.kg ⁻¹)	K (mg.kg ⁻¹)	Ca (mg.kg ⁻¹)	Mg (mg.kg ⁻¹)	Fe (mg.kg ⁻¹)	Na (mg.kg ⁻¹)	Mn (mg.kg ⁻¹)	Pb (mg.kg ⁻¹)	Zn (mg.kg ⁻¹)	
1 month (T1)	0,02	0,26	0,12	0,02	0,02	0,03	5,33	0,09	0,11	0,06	0,06	13
3 month (T2)	0,17	2,04	0,96	0,17	0,19	0,28	39,99	0,66	0,81	0,47	0,48	12
6 month (T3)	1,38	17,02	8,03	1,38	1,54	2,30	33,21	5,53	6,71	3,94	4,03	12,33

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178 3.4 Physical, physico-chemical and chemical characteristics of the soils of the 179 different treatments after corn harvesting

180 The rooting depth of the crop determines the size of the soil compartment that can be
 181 exploited by the root system. It is the lower limit of the system considered in the balance
 182 sheet method. Thus, after the various experiments, the treated soils sampled from a depth of
 183 30 cm and analyses gave the results indicated in Table 4 below. From granulometry,
 184 statistical analyses indicate a significant difference in clay content (F_{cal} = 134.14; P_{cal} =
 185 0.028). There is an enrichment of clay at the treatment level (T1 = 18.18 g.kg⁻¹; T2 = 18.46
 186 g.kg⁻¹ and T3 = 18.89 g.kg⁻¹) than in the control soil (T0 = 8.07 g.kg⁻¹). After application of the
 187 bio-waste, there is a decrease in coarse sand at the treatment level (T1 = 23.61 g.kg⁻¹; T2 =
 188 23.63 g.kg⁻¹ and T3 = g.kg⁻¹) compared to the control soil (T0 = 30.56 g.kg⁻¹). The soils under
 189 the various treatments had their porosity increased from 41.13% to 58.11% compared to the
 190 control soil (24.53%), i.e. a coefficient of variation of 35.6%. The control soils have an
 191 average pH value that is strongly acidic (pH water = 4.9). Six months after application of
 192 organic manures, the pH values obtained are moderately to slightly acidic (T1 = 6.2, T2 = 6.2
 193 and T3 = 5.9). The CEC values obtained after application of organic manures are relatively
 194 higher (T1 = 8.57 cmol+/kg; T2 = 7.8 cmol+/kg; T3 = 7.08 cmol+/kg) than those recorded at
 195 control soil level (T1 = 4.39 cmol+/kg).

Table 4. Characteristics of telltale soil and treatments after agricultural use

Analyzed soil parameters (sampling depth = 30 cm)	Treatments				F _{cal}	P _{cal}	P _{théor}	CV (%)	
	T0	T1	T2	T3					
Granulometry (g.kg ⁻¹) (Clay = A; Silt = L; Sand = S; thin = f et Coarse = g)	A	8.07 b	18.18 a	18.46 a	18.89 a	134.14*	0.028	< 0.05	32.7
	Lf	16.75 b	14.07 b	15.33 b	16.34 b	159.12ns	0.065	> 0.05	7.6
	Lg	19.73 b	21.53 b	21.73 b	20.62 b	129.35ns	0.074	> 0.05	5.7
	Sf	24.90 b	22.60 b	20.85 b	26.31 b	84.53ns	0.061	> 0.05	4.2
	Sg	30.56 a	23.61 b	23.63 b	17.84 b	113.01*	0.0134	< 0.05	21.6
Apparent density (g.cm ⁻³)	Da	2 a	1.56 b	1.21 b	1.11 b	122.57*	0.0142	< 0.05	34.8
Porosity (%)	P	24.53 b	41.13 a	54.34 a	58.11 a	145.16*	0.0341	< 0.05	35.6
Carbon (g.kg ⁻¹)	C	0.39 b	8.25 a	9.75 a	10.87 a	534.88**	0.0021	< 0.01	65.4
Organic matter (g.kg ⁻¹)	MO	0.67 b	14.19 a	16.77 a	18.70 a	919.90**	0.0053	< 0.01	67.1
Index battance	IB	2.71 a	0.23 b	0.21 b	0.19 b	816.34**	0.00312	< 0.01	71.5
Potential hydrogen	pH eau	4.9 b	6.2 a	6.2 a	5.9 a	6.69**	0.0057	< 0.01	25.71
Total nitrogen (g.kg ⁻¹)	N	0.01 b	1.24 a	1.34 a	1.41 a	913.42**	0.0045	< 0.01	62.2
Ratio Carbon/ nitrogen	C/N	28.29 a	6.65 b	7.28 b	7.71 b	853.02**	0.0027	< 0.01	61.61
Phosphore assimilable (mg.kg ⁻¹)	P ₂ O ₃ ass	40.59 b	68.35 a	62.24 a	62.33 a	935.39**	0.0032	< 0.01	37.8
Cation exchange capacity (cmol ⁺ /kg)	CEC	4.39 b	8.57 a	7.80 a	7.08 a	179.18**	0.0012	< 0.01	25.43
Sum of exchangeable bases (cmol ⁺ /kg)	S	2.71 b	6.60 a	5.79 a	5.10 a	185.91**	0.0024	< 0.01	27.47

198 The averages followed by the same letter on the same line, are not significantly different at
 199 the Probability threshold < 0.05, according to the method of Tukey, * = significatif, ** = highly
 200 significant, ns = not significatif (F_{cal} = Calculated Fisher, P_{cal} = Calculated Probability, P_{Théo} =
 201 Theoretical Probability), CV = coefficient of variation.

202 3.5 Relationship between the characteristics, physical, chemical and grain 203 yields of corn

204 The various correlation tests carried out between the soil properties of the different
 205 treatments and the grain yield of corn have yielded several levels of significance. Thus, at
 206 the control treatment level (T0) significant correlations are observed between A and CEC (r
 207 = 0.90); P and IB (r = - 0.81) and P and P₂O₃ass (r = - 0.76). The total porosity is therefore
 208 negatively correlated with the beat index and available phosphorus (Table 5). At the T1
 209 processing level, the highest correlations are observed between P and MO (r = 0.94); P and
 210 pH water (r = 0.85); P and C/N (r = 0.95). The grain yield of corn is highly correlated to the
 211 variables P, MO, C/N and CEC with correlation coefficients in the order of: 0.9; 0.90; 0.86
 212 and 0.90 respectively (Table 5). The correlation matrix obtained after linking the data at the
 213 T2 processing level gave significant correlations between the variables: P and IB; P and pH
 214 water; P and C/N with correlation coefficients of 0.97; 0.81 and 0.86 respectively. In the
 215 same treatment, negative and significant correlations exist between: Rend and P; Rend and
 216 N; Rend and P₂O₃ass with r respectively of: -0.88; -0.98 and -0.91 (Table 5). The linking of
 217 different data obtained through the T3 processing gave significant correlations between: IB
 218 and P; IB and N with correlation coefficients of: 0.96; 0.97 and respectively between Rend
 219 and P; Rend and IB; Rend and N; Rend and P₂O₃ass for respectively r coefficients which
 220 are: 0.97; 0.99; 0.97 and 0.92.

221 222 Table 5. Correlation between soil properties of different treatments and corn grain 223 yields

Treatments	Variable torque (X;Y)	r	r ²	t	Pr (> t)	Significativity
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T0	A - CEC	0.9	0.81	5,02	0,0024	**
	P - IB	-0.81	0.66	-3.40	0.0145	*
	P - P _{ass}	-0.76	0.58	-2,86	0,0285	*
T1	P - MO	0.94	0.88	5.43	0.0056	**
	P - pHeau	0.85	0.73	3.28	0.0302	*
	pHeau - MO	0.82	0.67	2.82	0.0474	*
	C/N - P	0.95	0.91	6.29	0.0033	**
	Yields - P	0.91	0.82	4.29	0.0127	*
	Yields - MO	0.9	0.81	4.18	0.0139	*
	Yields - C/N	0.86	0.73	3.3	0.0297	*
T2	Yields - CEC	0.9	0.81	4.12	0.0145	*
	P - IB	0.97	0.94	7.59	0.0016	**
	P - pHeau	0.81	0.66	2.78	0.0516	*
	P - C/N	0.86	0.74	3.39	0.0275	*
	Yields - P	-0.88	0.78	-3.8	0.0192	*
T3	Yields - N	-0.98	0.95	-8.84	0.0009	**
	Yields - P ₂ O ₃ ass	-0.91	0.83	-4.42	0.0115	*
	IB - P	0.96	0.92	6.62	0.0027	**
	IB -N	0.97	0.95	8.37	0.0011	**
	Yields - P	0.97	0.94	8.02	0.0013	**
T3	Yields -IB	0.99	0.98	20.09	0.0001	**
	Yields - N	0.97	0.95	8.37	0.0011	**
	Yields - P ₂ O ₃ ass	0.92	0.85	4.69	0.0093	**

* = significant. ** = highly significant;

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4. DISCUSSION

The different corn grain yields recorded show a significant difference. This yield is 1 T/ha at the level of the control plot (T0), 1.48 T/ha for plot T3, 2.26 for T1 and 1.98 T/ha for plot T2. These results can be explained by the fact that the control soil of our experimental site is rich in aluminum oxide, unlike oxides. However, an aluminium-rich soil creates plant toxicity and the consequence is the slowing down of plant growth, due to the precipitation of aluminium phosphates in the roots and the blocking of the cellular divisions of the terminal meristems of the roots and possibly of the aerial buds. Exchangeable aluminum strongly inhibits the activity of soil microflora and particularly blocks the development of rhizobiums [12]. The improved yields of the other treatments are explained by the fact that within the organic matter, the aluminium ion is complexed in particular by humic and fulvic acids. Organic matter reduces toxicities by complexing ions and therefore aluminium, on the browned soils of Toumodi located in Centre of Côte d'Ivoire [13]. Impacts of this improved soil fertility on maize yields have been established. A significant increase in soil fertility and maize yields due to manure is observed.

The morphopedological description of the soil (control, T0) of the experimental site revealed an indurated layer at medium depth. The drainage class is approximately 5.3. Physical, chemical and chemical analyses of soil samples indicate that the relatively low organic matter (0.55 to 0.77 g.kg⁻¹) decomposes very slowly (C/N = 26.67 to 32.14). The soil is very active (IB > 2) with a high acid pH (4.8 to 5.1) and a low nutrient reserve (CEC = 3.91 to 4.85 cmol+/kg). The total porosity negatively correlated to the beat index is low (about 22%). From results of previous works carried out on degraded soils in Northern region of Côte d'Ivoire the characteristics of soils (Pisoplinthic and Ferralsol) described above in present study would be degraded [4]. This degradation is certainly due to overgrazing and continuous cultivation, which have strongly contributed to reducing vegetation cover and organic matter levels, thus promoting compaction.

253 After the application of organic manure, the clay content in the various treatments T1 (18.18
254 g.kg⁻¹), T2 (18.46 g.kg⁻¹) and T3 (18.89 g.kg⁻¹), varied on average by 32.7% compared to
255 the control soil T0 (8.07 g.kg⁻¹). Indeed, sufficiently high concentrations of organic matter
256 make it possible to limit very significantly or even stop the soil leaching process [14].

257 The organic matter (OM) and nitrogen (N) content of the various treatments increased by
258 67% and 62.2% respectively compared to the control soil. At the water pH level the
259 improvement is about 25.71%, because at the control treatment level (T0) the values
260 obtained indicate that the soil is strongly acidic (pH=4.8 to 5.1) while after application of
261 organic manure, the soils have become slightly acidic (5.9 to 6.2). Initially, the C/N ratio that
262 characterizes the state of organic matter mineralization is 28.29 (very slow mineralization).
263 After the application of organic manure, the C/N ratios at the treatment level ranged from
264 6.65 to 7.71.

265 There is a clear improvement in the mineralization of organic matter, especially in the T3
266 treatment. The results of the application of bio-waste mark the beginning of the restoration of
267 this degraded soil. The consequence of a good evolution of organic matter is that humus,
268 flocculating with clay, forms the clay-humic complex, a real reserve and nourishing base of
269 the earth. The formation and accumulation of humus allows the storage of most of the
270 elements (C, O, H, H, N, P, K, S, trace elements) essential to plant life [15].

271 The soils under the various treatments had their porosity increased from 41.13% to 58.11%
272 compared to the control soil (P = 24.53%), i.e. a coefficient of variation of 35.6%. The
273 correlations established between porosity (P) and beat index (IB) are: negative at the control
274 soil level (r = -0.81) but positive and significant at the treatment levels (r ranges from 0.96 to
275 0.97). Indeed, humic compounds, by binding to clay, contribute to improving soil porosity and
276 water retention capacity. As a result, the soil is more aerated, less prone to compaction,
277 leaching and erosion by rain and watering, and it stores water better: all factors that make it
278 more fertile. In addition, the structural role of humus induces a good penetration of the soil
279 by the air and therefore oxygenation in depth to stimulate a good biological activity of the
280 macro and micro fauna and flora of the soil. Roots penetrate more easily at depth, which
281 contributes to improving their exploration of the soil and subsoil and thus their supply of
282 water and minerals [16].

283

284 **5. CONCLUSION**

285 The results of this study show that in the locality of Natiokobadara in Korhogo, the soils
286 investigated have, for the most part, a very low humiferous impregnation and a
287 predominantly sandy-clayey-silt texture, very compact, with a rare or total absence of
288 vegetation, especially on the upper slopes. They are highly acidic (pH=4.8 to 5.1) with very
289 slow mineralization (C/N=26 to 32.14) of organic matter. The nutrient supply is very low. Six
290 months after application of bio-waste at a rate of 50 kg per experimental unit or 33.33 tons
291 per hectare, the soils became slightly acidic (pH=5.7 to 6.4) compared to the baseline
292 (strongly acidic). The mineralization of soil organic matter has evolved towards normality
293 because the C/N ratio obtained at the treatment level varies from 6.65 to 7.71. Corn grain
294 yield is more significant at the treatment level (T1 = 2.26 T/ha; T2 = 1.98 T/ha and T3 = 1.48
295 T/ha) than that of the control soil (T0 = 1 T/ha). The seed cotton bio-waste has had an
296 improving effect on the degraded soil in Northern Côte d'Ivoire.

297

298 **COMPETING INTERESTS**

299 "Authors have declared that no competing interests exist."
300

301

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351

352 **DEFINITIONS, ACRONYMS, ABBREVIATIONS**

353 Here is the Definitions section. This is an optional section.

354 **ANOVA:**

355 **CNRA:**

356 **MO: Organic Matter**

357 **Term:** Definition for the term

358

UNDER PEER REVIEW