

1 **Mineralization and decomposition of four types of compost based on biomass of *Sida***
2 ***cordifolia* L. in a sandy soil in the semi-arid zone of Niger**

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4
5 **Abstract**

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7 The low nutrient availability of unpredictable rainfall patterns and regimes are the main
8 constraints to agricultural production in Niger. This is a food of the body of bio and compost.
9 Generally, this use has been taken into account in the quality, decomposition and release of
10 nutrients from these organic materials. This study of the decomposition and mineralization of
11 nutrients of four types of composts (M1P, M2P, M1H and M2H) a dune soil. It was carried
12 out at the experimental N'Dounga station (CERRA Kollo) located about 15 km from Niamey.
13 A randomized device with four blocks was used. For the evaluation of yield, two doses (1 t
14 ha⁻¹ and 1.5 t ha⁻¹) were applied per millet. Decomposition and mineralization were assessed
15 in depth at 10 cm depth between the lines of the small bag containing 100 g of each compost.
16 The characterization of the physico-chemical elements of composts has shown that composts
17 are relatively rich in nutrients. Nitrogen ranged from 0.8% to 1.1%, phosphorus from 9.99
18 mg.kg⁻¹ to 12.76 mg.kg⁻¹ and potassium from 19.94 meq k / 100g to 26.26 meq k / 100g. All
19 four composts are basic (pH> 7). Compost M2H lost more than 80% of its weight during the
20 10 weeks of the experiment compared to 48% for the M1P. the mineralization of N, P and K
21 is greater at compost M1P (83.6% N, 72.72% P and 89.5% K). This compost also gave the
22 highest yield (1272.5 kg ha⁻¹). The decomposition and mineralization of the main elements
23 (nitrogen, phosphorus and potassium) allow the synchronization between the release of
24 nutrients from these composts and the nutrient requirements of millet in a sandy soil.

25 **Keywords:** compost, mineralization, *Sida cordifolia*, millet, sandy soil

26 **Introduction**

27 Agricultural production in Sub-Saharan Africa is low and declining resulting from continued
28 decline in soil fertility due to poor soil management and other biophysical factors ([Voortman](#)
29 [2010](#)).

30 In Niger, low crop yields are often explained by poor soil nutrient supply, unpredictable
31 rainfall and low fertilizer use. This situation is aggravated by a population growth of about
32 3.8%, leading to frequent food shortages and persistent poverty in smallholder farming
33 communities.

34 To increase yields and improve the efficient use of scarce rainfall in the Sahelian region of
35 Niger, the use of mineral fertilizers is becoming increasingly necessary ([Payne 2000](#)). The
36 fertilizer recommendation in Niger is 200 kg ha⁻¹ of NPK compound (15-15-15) ([Hayashi et](#)

37 [al. 2008](#)). However, most farmers cannot afford to buy that amount of fertilizer. The high
38 price of inorganic fertilizers, and the risks associated with their use in dry areas are the key
39 factors limiting fertilizer use in Niger ([Abdoulaye and Sanders 2005](#)).

40 The option of integrated use of mineral and organic fertilizers to improve crop yields and
41 maintain soil fertility is well documented ([Yamoah et al. 2002](#), [Bationo et al. 2003](#),
42 [Akponikpe 2008](#)). However, the main sources of organic amendments such as crop residues
43 and animal manure, are not available in sufficient quantities.

44 It is therefore necessary to develop another alternative low-cost soil fertility management
45 option. The use of *Sida cordifolia* L., an herbaceous plant of the Malvaceae family as an
46 organic material for the production of compost, is one of the alternatives to explore. To do
47 this, an experimental study of composting the biomass of *Sida cordifolia* (BSC) was
48 conducted in 2018. Four types of composts were developed to be applied by hill on millet. To
49 be used as an organic amendment, these composts must be rich in nutrients but also, the
50 decomposition and mineralization of nutrients must synchronize with the need of the crop.

51 The objective of this work is to evaluate the decomposition and nutrient mineralization of
52 four types of composts based on the biomass of *Sida cordifolia* and their effects on millet
53 yield in sandy soil.

54 **Material and method**

55 *Study site*

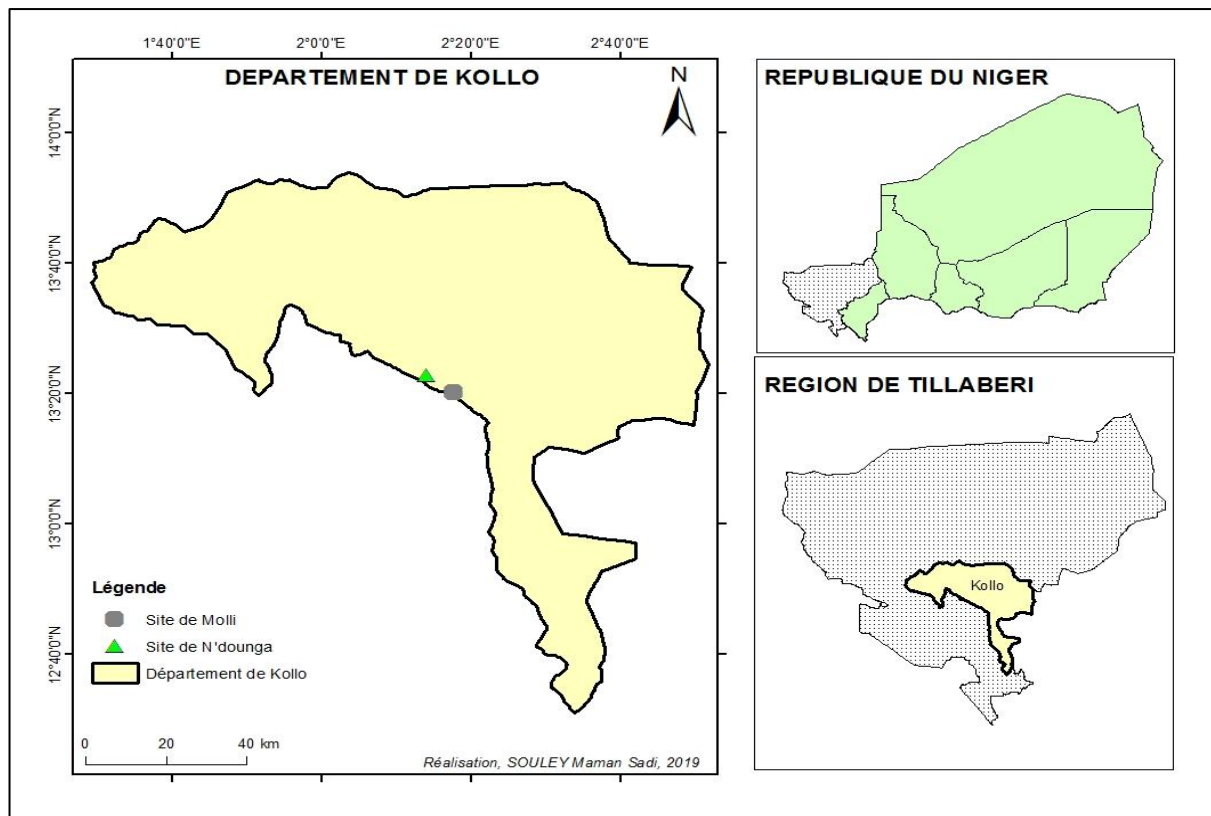
56 The trial was conducted during the rainy 2017 season at the experimental station of the
57 Regional Agricultural Research Centre (CERRA) of Kollo located at N'Dounga 15 km
58 southeast away from Niamey. The station is located at a latitude of 13° 29'088'North and a
59 longitude 2° 07'535'East (Figure 1). The climate of the study area is of the Sahel-Sahelian
60 type with an average annual rainfall of unclear. Average temperatures are around 30°C in the
61 dry season (March, April) and fall to 10°C in the harmattan season (December to February).

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66 **Figure 1: Study site location map**

67 ***Preparation of compost***

68 Four types of compost were developed in 2018: M1P =Pit composting with 75% biomass of
 69 *Sida cordifolia*, 20% of organic manure and 5% Ash, M2P =Pit composting with 95%
 70 biomass of *Sida cordifolia* and 5% organic manure, M1H =Heap with 75% biomass of *Sida*
 71 *cordifolia*, 20% organic manure and 5% Ash, M2H =Heap composing with 95% biomass of
 72 *Sida cordifolia* and 5% of organic manure. The biomass of *Sida cordifolia* was harvested
 73 between October and November 2017 at maturity stage. In terms of organic manure and ash,
 74 they were collected in the village of Molli near the station where the composts were made.

75 ***Physico-chemical characterization of composts and soil***

76 The physico-chemical characterization of the composts and soil was carried out by analyzing
 77 the physico-chemical elements on a composite sample of each compost. This analysis
 78 included the elements pH, carbon, nitrogen, phosphorus, and potassium.

79 The pH was measured according to the international standard ISO 10390 (1994) while the
 80 total organic carbon was determined by the method ([Walkley and Black 1934](#)). The Kjeldahl
 81 method (NT 76.05, 1983) was used assessing nitrogen content. The method of ([Murphy and](#)
 82 [Riley 1962](#)) was used to determine available phosphorus content.

83 Potassium (K⁺) was determined using a flame photometer. The analytical solution is
84 prepared using the Kjeldahl method (NT 76.05, 1983). The K⁺ content was read directly into
85 the mineralization.

86 Exchangeable bases (Na⁺, Ca⁺⁺, Mg⁺) were extracted by the ammonium acetate (NH₄OAc)
87 solution at pH 7 using the extraction method described by ([Van Reeuwijk 1993](#)).
88 To determine the soil particle size, the Robinson pipette sampling method was used.

89 ***Experimental Design***

90 The bag method was used to study decomposition of the compost. The 1.0mm nylon. The
91 litter bags measured of 20 cm x 15 cm and were produced from 1.0 mm nylon mesh.

92 The design was coupled with an experimental trial to evaluate the effects of *Sida cordifolia*-
93 based composts on the yield of HKP millet. They were installed on 02 July 2018. Five (5)
94 bags containing 100g of each compost repeated 4 times were buried 10 cm deep. Before
95 design installation, Physico-chemical elements of each compost were determined: dry weight,
96 nitrogen, phosphorus, potasuim and pH. Soil sampling was conducted to characterize the soil
97 sites composition.

98 ***Data collection***

99 Random sampling of one bag of each compost and in each block was performed at 2, 4, 6, 8
100 and 10 weeks. At each sampling, the remaining compost from each bag was manually
101 cleaned and a fresh weight was recorded before drying it in an oven at 65°C for 48 hours to
102 take the dry weight.

103 The site's automated agro-metrological station was used to collect: moisture, temperature and
104 rainfall data covering the trial period.

105 ***Statistical Analysis***

106 A variance analysis at the 5% threshold was performed on data from the physico-chemical
107 elements of composts. Each time a significant difference is detected, ANOVA is
108 accompanied by the Fisher test (LSD). Excel 2016 and GENSTAT 9th edition software were
109 used for all these analyses. The percentage of dry weight after sampling was determined
110 using the formula:

$$111 \quad (1) \text{ Ps (\%)} = 100 \times \frac{P_t}{P_0} \text{ where:}$$

112 Ps (%) = Dry weight percentage;

113 Pt = Compost weight at t time;

114 P0 = Initial weight of compost in the bag.

115 The rate of release of nutrients following decomposition was calculated using the following
116 formula:

117 (2) $T_n (\%) = 100 \times \frac{C_0 P_0 - C_t P_t}{C_0 P_0}$ where:

118 $T_n (\%)$ =Nutrient Release Rate,

119 C_0 =Initial Concentration of Chemicals (N, P, K) from Compost,

120 C_t =Concentration of chemicals (N, P, K) compost at t time,

121 P_t =Weight of compost at t time, P_0 =Initial weight of compost in the bag.

122 The decomposition model and decomposition rate constant (k) of each type of compost were
123 determined through the data that were modelled using a single exponential model described
124 by (Olson 1963):

125 (3) $M_t = M_0 e^{-kt}$ where:

126 M_t = dry weight remaining of the compost at time t,

127 M_0 = initial dry weight of the compost.

128 The time required for the compost to lose half its initial weight (t_{50}) was calculated using the
129 formula described by (Fening et al. 2010):

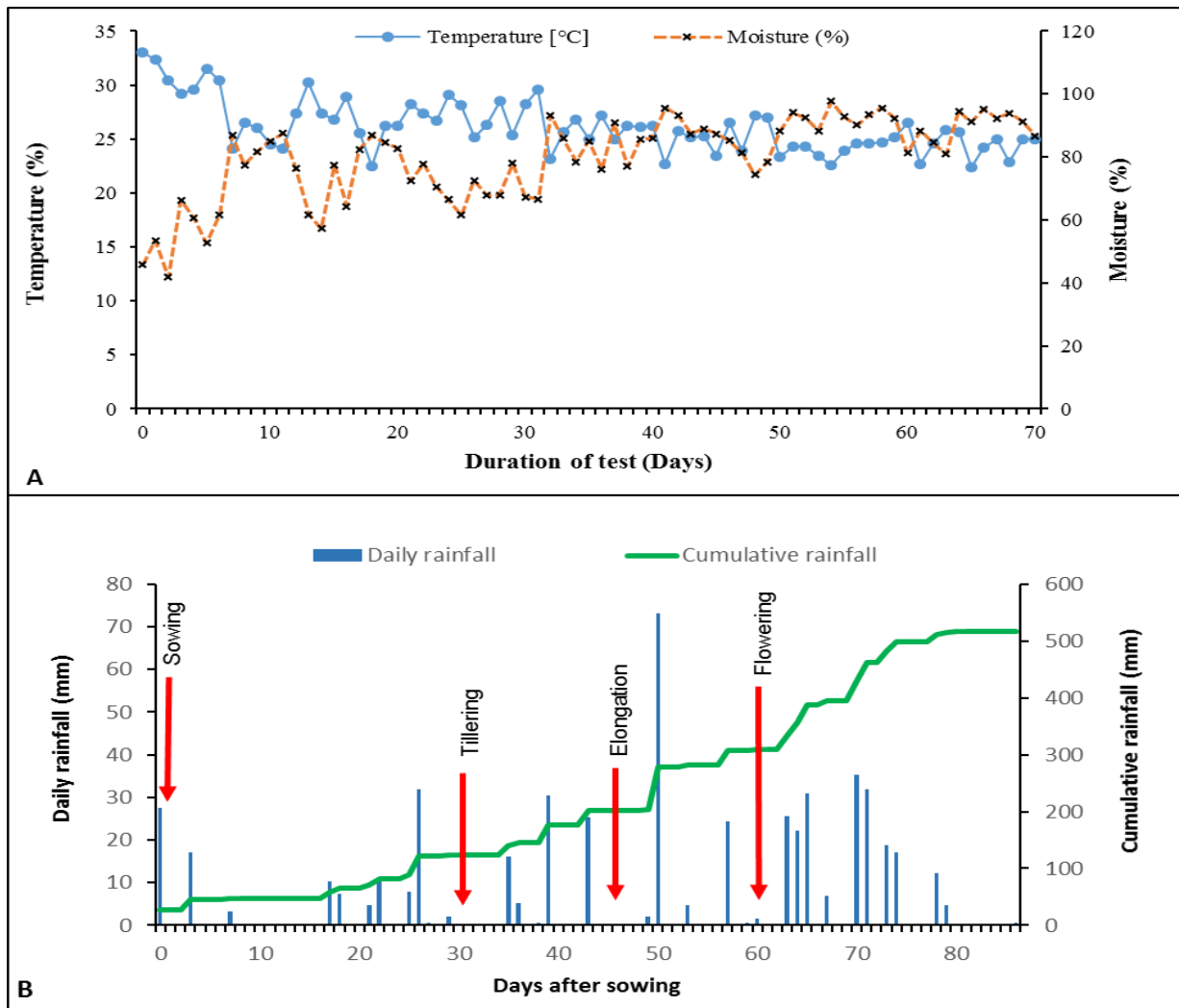
130 (4) $t_{50} = \frac{-\ln(0,5)}{k}$, where K is the decomposition factor.

131 Results

132 *Humidity, temperature and rainfall*

133 At the beginning of the experiment, the maximum mean temperature was 33°C and the
134 minimum value of 22.4% was obtained 65 days after the test was installed.

135 Site moisture content ranged from 41.8% to 97.7% during the 10 weeks of the trial The
136 cumulative rainfall during the growing period was 579.4 mm. The highest rainfall (73 mm)
137 was recorded on the 80th day after planting. Between the 30th and 59th day after the semi
138 (JAS), a small dry spell was observed. During this dry spell of 29 days the total rainfall was
139 only 12mm.



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 141 **Figure 2: Moisture and soil temperature (A) and rainfall distribution during the test**
 142 **period (B) at the site level**

143 *Source: <http://www.fieldclimate.com> INRAN REDSA ACC-3, Serial number 0020366.*

144 ***Physical and chemical composition of soil at the experimental site***

145 The results of the analysis of the soil samples (0-20 cm depth) collected at the site prior to the
 146 installation of the test (Table 2) showed that this is a sandy soil. The pH value was 6.77
 147 available phosphorus content remains average (26.81ppm). The nitrogen and carbon content
 148 of the soil is very low, 0.02% and 0.16% respectively. The low carbon and nitrogen content
 149 indicate that this soil has very soil fertility status. (Table 1).

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154 **Table 1: Physical and chemical characteristics of the test site soil (n=4)**

Measured parameters	Unit	Mean of values (depth 0-20 cm)
pH-H ₂ O (1 :2.5)		6.77±0.1
MO	%	0.28±0.02
C	%	0.16±0.01
Total N	%	0.02±0.002
Available P	ppm	12.81±8.11
Exchangeable bases		
CA ⁺⁺	Méq/100g	0.19±0.02
Mg ⁺⁺	Méq/100g	0.03±0.01
Na ⁺	Méq/100g	0.31±0.04
K ⁺	Méq/100g	1.02±0.47
Granulometry		
Clay	%	0.72±0.04
Silt	%	4.78±0.41
Sand	%	94.5±1.3

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156 ***Physio-chemical characteristics of composts***

157 The analysis showed clear differences with the composts with regard to organic matter
158 (p<.001), nitrogen (p = 0.008), and potassium (p= <.001). No significant difference was
159 observed for total and assimilated phosphorus and pH. The richest compost was the M1P
160 compost containing 12.31% C, 1.11% N content and 26.6 meq K/100g. The pit method gave a
161 better quality than heap composting as this compost was richer in carbon, nitrogen and
162 available phosphorus than the heap compost.

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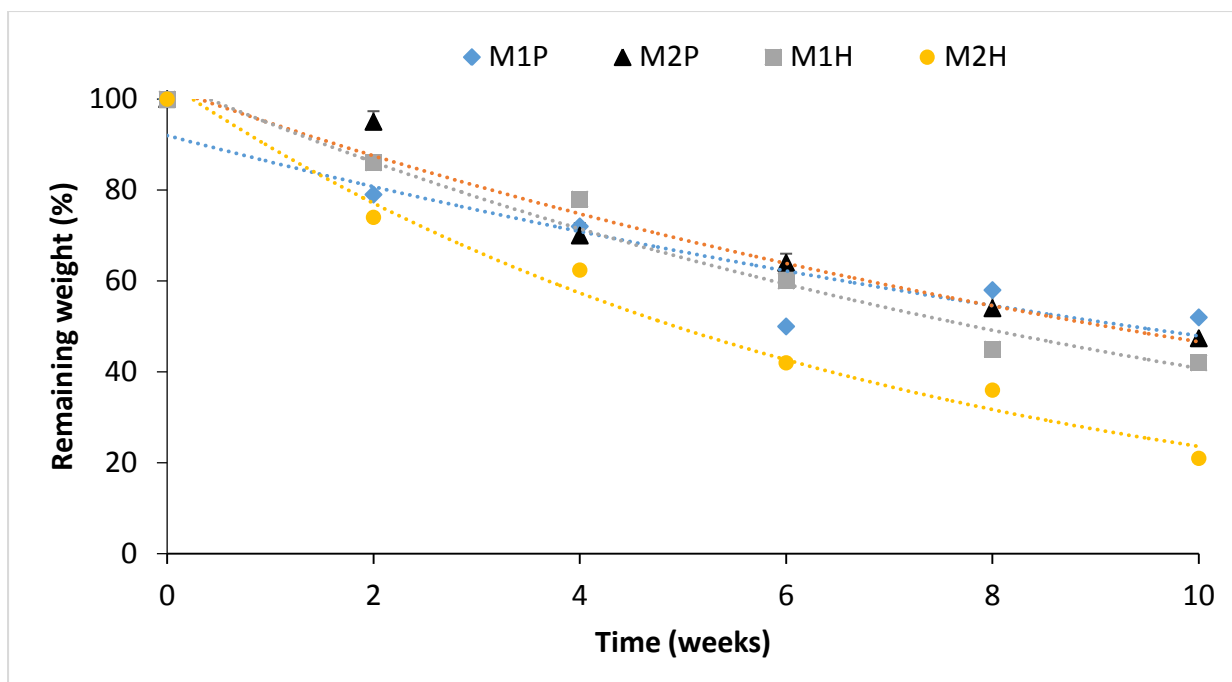
173 **Table 2: Mean composition in physio-chemical elements of composts (\pm SE)**

Physico-chemical element	Types of composts				F.pr (0.05)	CV (%)	Norme	
	M1P	M2P	M1H	M2H			FAO	AFNOR
pH-H ₂ O (1 :2.5)	7.95 ^a (\pm 0.26)	7.58 ^a (\pm 0.85)	8.09 ^a (\pm 0.53)	8.15 ^a (\pm 0.51)	0.467	6.7		
Organic matter (%)	21.21 ^b (\pm 1.13)	19.16 ^b (\pm 0.88)	13.61 ^a (\pm 1.07)	14.21 ^a (\pm 1.33)	<.001	6.9	10-30	> 5
C (%)	12.31 ^b (\pm 0.65)	11.12 ^b (\pm 0.51)	7.90 ^a (\pm 0.62)	8.25 ^a (\pm 0.77)	<.001	6.9		
N (%)	1.11 ^b (\pm 0.14)	0.88 ^a (\pm 0.07)	0.80 ^a (\pm 0.08)	0.83 ^a (\pm 0.06)	0.008	11.3	0.4-0.5	> 0.25
tot P (mg.kg ⁻¹)	122250 ^a (\pm 6850)	118000 ^a (\pm 4690)	125500 ^a (\pm 577)	126250 ^a (\pm 500)	0.086	3.5		
Available P (mg.kg ⁻¹)	11.25 ^a (\pm 1.48)	12.76 ^a (\pm 1.46)	9.99 ^a (\pm 1.58)	10.07 ^a (\pm 1.55)	0.112	29.8		
K+ (meq k/100g)	26.26 ^b (\pm 0.32)	24.95 ^b (\pm 1.09)	19.94 ^a (\pm 1.31)	20.83 ^a (\pm 0.38)	<.001	4.2		
C/N	11.25 ^a (\pm 1.48)	12.76 ^a (\pm 1.46)	9.99 ^a (\pm 1.58)	10.07 ^a (\pm 1.55)	0.112	14.4	10-15	< 20

174 **M1P** = Compost in pit with 75% SCB +20% OM+5% Ash, **M2P** = Compost in pit with 95% SCB +5% OM.
 175 **M1H** = Compost in heap with 75% SCB +20% OM+5% Ash, **M2H** = Compost in heap with 95% SCB+5%
 176 OM.
 177 **FAO**: World organization for agriculture and the food, **AFNOR**: Association French of Normalization.
 178 **tot P**= total P and available **P** = Available phosphorus.
 179 **Same letters within columns indicate no significant differences**

180 **Decomposition model for different types of composts**

181 The decomposition pattern of different types of composts based on the *Sida cordifolia*
 182 biomass during the 2018 rainy season is shown in Figure 2. The remaining weight of each
 183 decomposing compost is expressed as a percentage of the initial weight of the compost. The
 184 composts lost in average 59.4% its initial value after 10 weeks. Throughout the study, the
 185 M2H compost (Heaps compost with 95% of SC+5% FM) decomposed faster than the others
 186 with a weight loss of 26% to 79% from the first month to the fourth month. There is little
 187 variation in the percentage of decomposition between the other composts (M1P, M2P, M1H).
 188 Within 30 days of the experiment, M1P, M2P and M1H composts lost 21%, 14% and 5% of
 189 their initial weights, respectively. At the end of the fourth month study the remaining amount
 190 of compost 48%, 52.6% and 58 % for the M1P, M2P and M1H respectively.



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192 **Figure 3: Percentage of weight remaining in the litterbag**

193 *M1P* =Compost in pit with 75% SCB +20% OM+5% Ash, *M2P*=Compost in pit with 95% SCB +5% OM.

194 *M1H*=Compost in heap with 75% SCB +20% OM+5% Ash, *M2H*=Compost in heap with 95% SCB+5% OM
195 Trend lines are the best fit.

196 The composts differed greatly in number of weeks to loose half of its initial weight (t_{50}). The
197 two heap compost *M2H* and *M1H* had a t_{50} value of 2.33 and 3.85 weeks while the two peat
198 compost *M1P* and *M2P* had t_{50} values of 5.33 and 4.33 respectively. The higher k value of the
199 heap compost also reflects the higher decomposition rates for the heap composts as compared
200 to the pit composts.

201 **Table 3: Decomposition rate constant (k), coefficient of determination (R^2) and (t_{50}) of**
202 **composts**

Type of compost	Regression equation	K (day^{-1})	R^2	T_{50}
M1P	$M_t = 104,79e^{-0,13t}$	0,13	0,81	5,33
M2P	$M_t = 119,99e^{-0,158t}$	0,16	0,97	4,33
M1H	$M_t = 125,22e^{-0,187t}$	0,18	0,97	3,85
M2H	$M_t = 139,42e^{-0,296t}$	0,29	0,97	2,39

203 *M_t* = compost remaining weight at *t* time.

204 *M1P* =Compost in pit with 75% SCB +20% OM+5% Ash, *M2P*=Compost in pit with 95% SCB +5% OM.

205 *M1 H*=Compost in heap with 75% SCB +20% OM+5% Ash, *M2 H*=Compost in heap with 95% SCB+5% OM

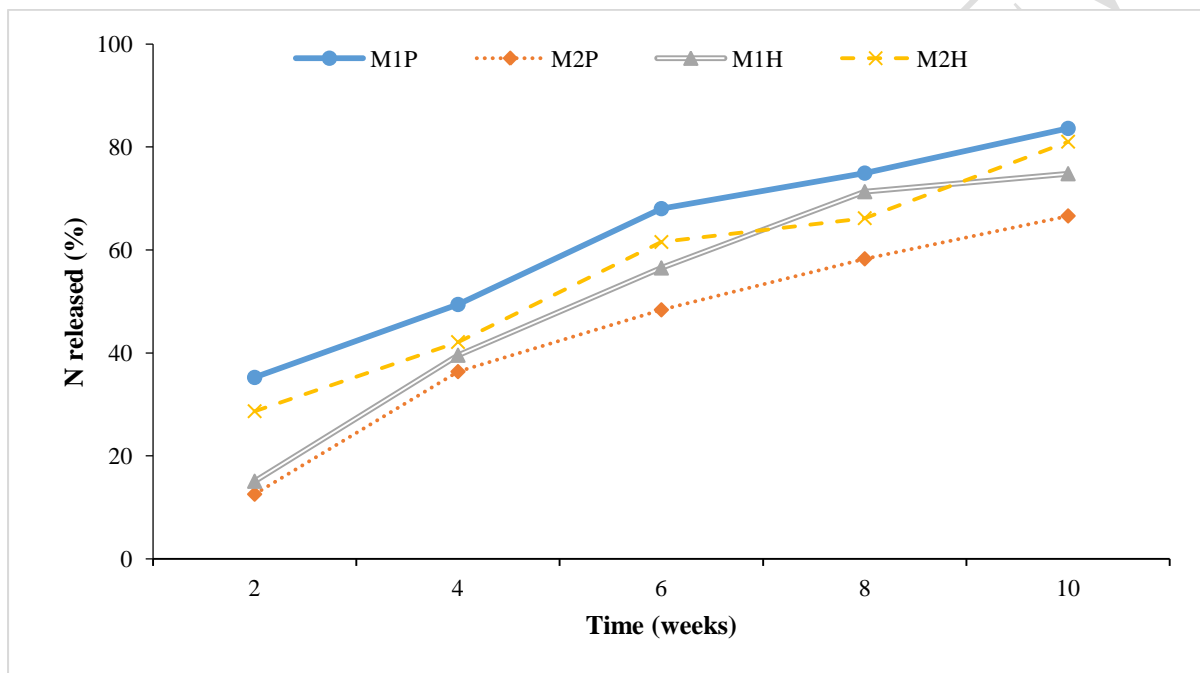
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207 **Model for nutrient liberalization of different composts**

208 **Mineralization of nitrogen**

209 None of the compost reached a 50% nitrogen liberalization during the first two weeks of the
210 experiment, but the M1P compost which is relative richer in nitrogen release a larger part of
211 its nitrogen than the other composts. This trend continued until the end of the experiment. At
212 the end of the trial the compost at lost in average 76.5 of its initial value.

213 At the end of the study period, M1P compost released 83.6% of its N, while M2P, M1H and
214 M2H composts released 66.6%, 74.8% and 81.02% of the N content, respectively.



215

216 **Figure 4: Proportion of nitrogen released from different composts over time**

217 *M1P = Compost in pit with 75% SCB +20% OM+5% Ash, M2P=Compost in pit with 95% SCB +5% OM.*

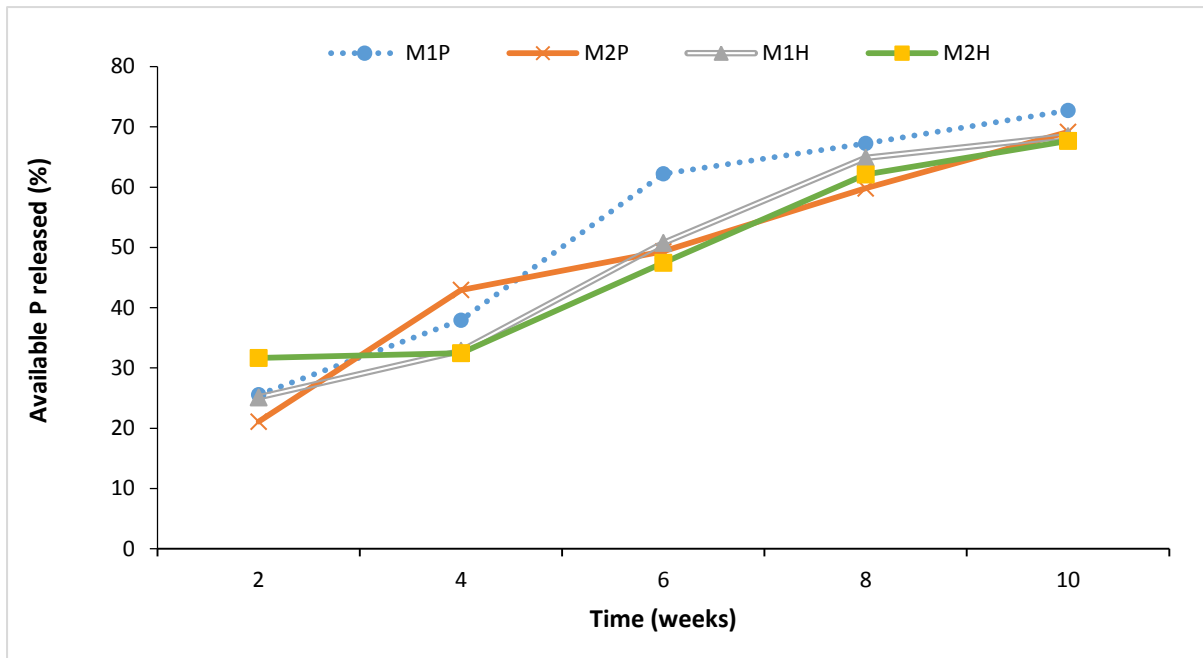
218 *M1 H=Compost in heap with 75% SCB +20% OM+5% Ash, M2 H=Compost in heap with 95% SCB+5% OM*

219 **Mineralization of available phosphorus**

220 During the first four weeks, the release of available phosphorus was slow. None of the
221 compost released 50% of its available phosphorus.

222 It was only a small difference in P release between the composts after 10 weeks Within 10
223 weeks, 72.72%; 69.17%; 68.47% and 67.68% of available phosphorus were released from
224 M1P, M2P, M1H and M2H composts giving and average loss during the 10-week period of
225 69.5%.

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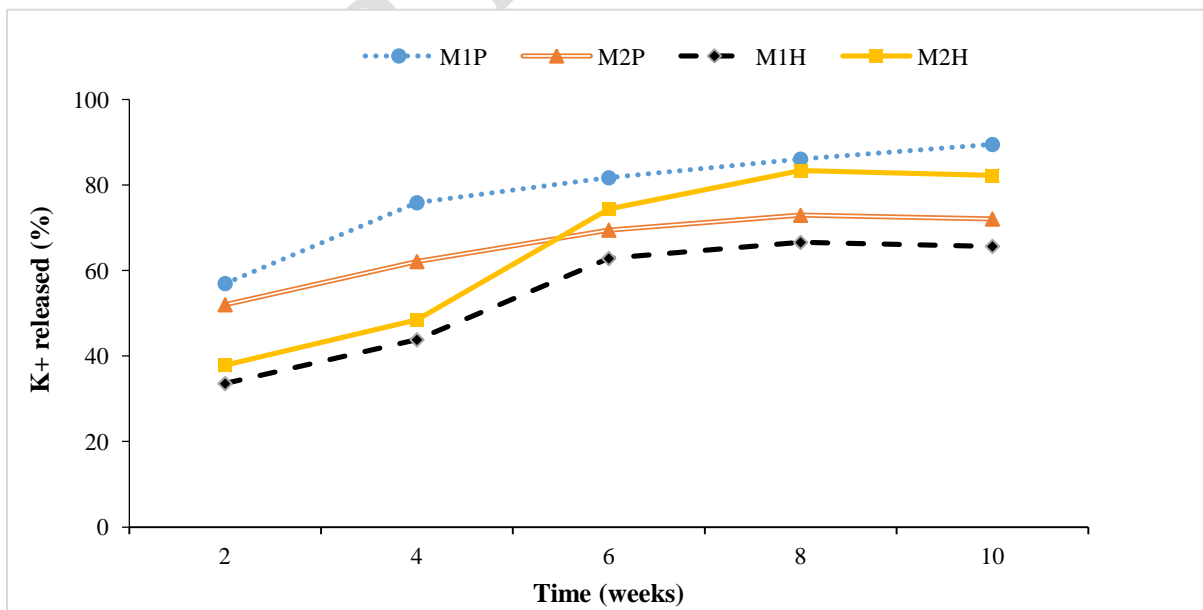
227 **Figure 5: Proportion of available phosphorus from different composts released over**
 228 **time**

229 *M1P = Compost in pit with 75% SCB + 20% OM + 5% Ash, M2P = Compost in pit with 95% SCB + 5% OM.*

230 *M1H = Compost in heap with 75% SCB + 20% OM + 5% Ash, M2H = Compost in heap with 95% SCB + 5% OM*

231 **Mineralization of potassium**

232 In this study, potassium mineralization was rapid as early as the second week for M1P and
 233 M2P compost, which released 56.98% and 52.02% of potassium respectively. The average



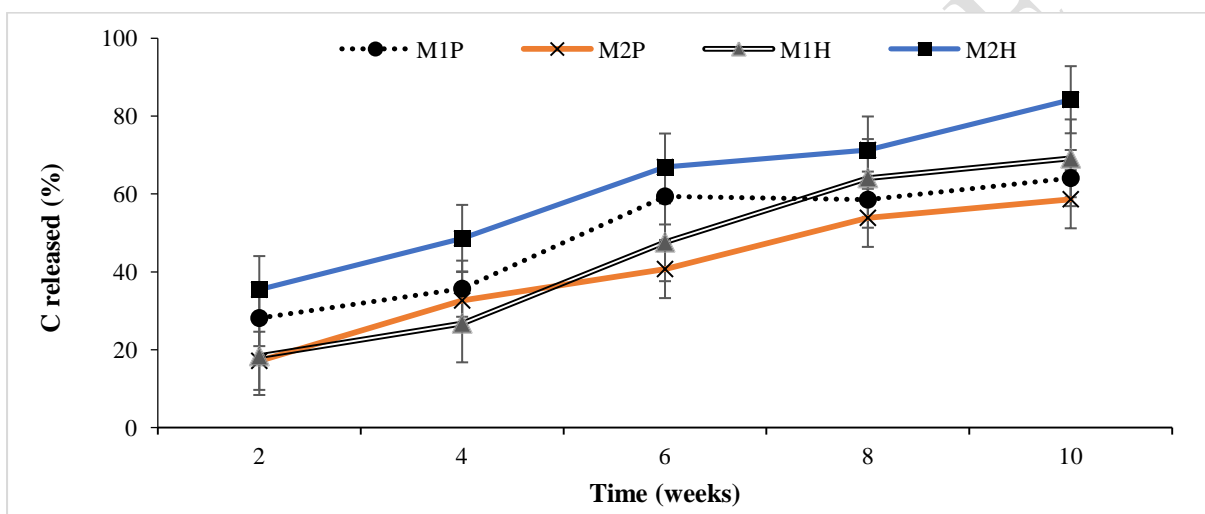
234 loss in potassium during the 10-week period was 77.3%.

235 **Figure 6: Proportion of potassium released from different composts released 10 weeks**

236 *M1P* =Compost in pit with 75% SCB +20% OM+5% Ash, *M2P*=Compost in pit with 95% SCB +5% OM.
 237 *M1H*=Compost in heap with 75% SCB +20% OM+5% Ash, *M2H*=Compost in heap with 95% SCB+5% OM
 238

239 **Mineralization of carbon**

240 The release of carbon from the different composts ranges from 18% to 35% in the second
 241 week of the experiment. Only the composts *M2H* and *M1H* released more than 50% of the
 242 carbon during the first 6 weeks. After 10 weeks, the compost *M2H* had the highest release of
 243 carbon and for this compost 84.2% of the carbon was released. The compost *M2P* had the
 244 lowest loss of carbon and this compost lost 58.4% of its carbon after 10 weeks. The compost
 245 lost in average 69,0% of its initial value during the 10 weeks' period.



246

247 **Figure 7: Proportion of total carbon from different composts released over time**

248 *M1P* =Compost in pit with 75% SCB +20% OM+5% Ash, *M2P*=Compost in pit with 95% SCB +5% OM.
 249 *M1H*=Compost in heap with 75% SCB +20% OM+5% Ash, *M2H*=Compost in heap with 95% SCB+5% OM

250 **Effects of composts on millet grain yield and biomass**

251 Analysis of variance showed significant effects of treatments on grain and biomass yields
 252 ($P < .001$). The highest grain yields were obtained with the 1t. ha^{-1} and 1.5t. ha^{-1} doses of
 253 the *M1P* compost. This compost applied at the 1t. ha^{-1} dose increased the grain yield by 652
 254 kg. ha^{-1} (105.2%) compared to the control.

255 For biomass yield, only *M1P* compost at 1t. ha^{-1} significantly increased the yield compared
 256 to the control ($1,377\text{ kg ha}^{-1}$).

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261 **Table 4: Mean yield in grains and in stover of HKP millet according to treatments and**
 262 **sites**

Treatments	yield (kg.ha ⁻¹)	
	Grain	Stover
Control	620 a	1776 a
1t.ha ⁻¹ M ₁ P	1272.5 e	3153 b
1.5t.ha ⁻¹ M ₁ P	1127.5 e	2836 b
1t. ha ⁻¹ M ₂ P	856 cd	1500 a
1.5t. ha ⁻¹ M ₂ P	790 bcd	1565 a
1. ha ⁻¹ M ₁ H	832.8 bcd	1563 a
1.5t. ha ⁻¹ M ₁ H	871.8 cd	1635 a
1t. ha ⁻¹ M ₂ H	692 abc	1835 a
1.5t. ha ⁻¹ M ₁ H	685 ab	1517 a
Probability	<.001	<.001
CV	12.1	25.3

263 *M1 P = Compost in pit with 75% SCB +20% OM+5% Ash, M2P = Compost in pit with 95% SCB +5% OM.*

264 *M1 H = Compost in heap with 75% SCB +20% OM+5% Ash, M2 H = Compost in heap with 95% SCB+5%*
 265 *OM.*

266 *Same letters within columns indicate no significant differences*

267 Discussions

268 The study assessed the decomposition and nutrient mineralization of four types of compost
 269 based on the biomass of *Sida cordifolia* under field conditions and their effects on millet
 270 yield. In general, the composts are of good quality because their nitrogen and potassium
 271 contents were much richer than in the soil they are supposed to fertilize. Soil analysis showed
 272 that the soil nitrogen content was 0.016%, while the composts had a nitrogen content of
 273 between 0.8 and 1.1% (Table 2). The low soil nitrogen content indicates that the soil has a
 274 very low capacity to supply nitrogen.

275 The decomposition study showed that between 50 and 80% of the plant nutrients contained
 276 composts in the were released within the 10 weeks' period. This shows that these composts
 277 can be used a fertilizer as this period corresponds to the period with high nutrient demand of
 278 the cereal crops. In this study pearl millet flowered after 8.5 weeks (Figure 2b). Cereals take
 279 up most of the nutrients during the period from sowing to flowering. There was a gradual
 280 release of plant nutrients during the 10 weeks' period even though there was considerable
 281 variation in soil water during the period of the experiment (Figure 2). Even though these
 282 composts may not release their plant nutrients very early in a growing season, this may not be
 283 of great importance since it has been previously shown that fertilization in pearl millet in
 284 Niger can be delayed until 20 days after sowing without causing a yield penalty ([Hayashi et](#)

285 [al. 2008](#)). It is likely that nutrients reserve in the seed are sufficient in the first days after
286 germination.

287 There was a variation in release pattern of the plant nutrients contained in the composts and
288 the weight loss did not correspond to the nutrient release. The average loss with regard to
289 weight, nitrogen, available phosphorous, potassium and carbon was in average 59.4, 76.5,
290 69.5, 77.3 and 69.0% respectively. The weight loss of the composts was therefore less than
291 the nutrients loss. The mechanisms causing weight loss and nutrient loss are different
292 explaining there was discrepancy between weight loss and nutrient loss. The losses were
293 highest for nitrogen and potassium. This can be explained by the fact that these cations (NH_4^+
294 and K^+) are easily leached from the soil while the particles in the compost are likely to be
295 more resistant degrading forces. Ammonium and potassium are not strongly chemically
296 bound in the soil. ([Andrist-Rangel et al. 2007](#)). Ammonium and potassium are therefore
297 strongly exposed to leaching

298 The heap composts have higher weight losses than the composts produced in the pit as the
299 heap composts lost half its weight in 3.12 weeks while the corresponding figure for pit
300 compost was 4.83 weeks. The physical structure and resistance to degrading forcing may not
301 be the same in pit and heap composting as there will be difference in temperature and water
302 conditions between pit and heap composting.

303 The carbon loss during the 10 weeks' period was in average 69%. Even though the carbon
304 decomposition will still continue for a few weeks, it is likely that not all the carbon supplied
305 in the compost will be lost. The remaining carbon is of great value for building the soil
306 organic carbon content.

307 The composts produced can supply considerable amount of nitrogen. If the composts are
308 applied a micro dosing in the form of 100 g compost hill⁻¹, the amount of compost applied
309 will be 1000 kg/ha if there are 1000 hills ha⁻¹ as commonly practiced in Niger. The average
310 nitrogen content in the compost was 0.90% corresponding to n nitrogen input of 9 kg N ha⁻¹.
311 The litter bag study showed that 78.5% was released during the first 10 weeks. If this is taken
312 into consideration the amount of easily available N will be 6.8 kg N ha⁻¹. The
313 recommendation by ([Tabo et al. 2007](#)) is to apply 2 g diammonim phosphate hill⁻¹
314 corresponding to an N input of 3.6 kg N ha⁻¹. It is therefore clear that the N input from micro
315 dosing of compost will be higher than the N input from micro dosing diammoium phosphate.

316 With regard to phosphorous input the *Sida cordifolia* compost can also provide a substantial
317 amount of P. The average available phosphorous content was 11.0 mg p kg⁻¹ compost (Table
318 2). Application of 1000 kg compost ha⁻¹ (100 g per hill) will apply 7.6 kg P ha⁻¹
319 (1000kg*0.011*69.5%) (69.5% is percent P released during the decomposition process)
320 (Figure 5). Application of 2 g diammonim hill⁻¹ as fertilizer will apply 4.0 P ha⁻¹ (20 kg
321 fertilizer/ha*46% P₂O₅*0.436) which is almost half the amount of phosphorous applied
322 with 100 g compost hill⁻¹.

323 The study also showed that a compost containing 95% and 5% manure can produce a
324 compost of good quality as shown in the nutrient analysis of compost (Table 2). This is an
325 indication that it will be easy to produce a compost were the main ingredient is SC since SC it
326 is easily available in the agro-pastoral areas in Niger. This can also stimulate the farmers to
327 *Sida cordifolia* as a weed control. The C/N ratio of the four composts were close to 10 which
328 is ideal value for a compost according to the norms of FAO. A C/N ratio of 10 implies that
329 this is a well decomposed compost than can be applied to the soil without causing nitrogen
330 immobilization.

331 The application of composts improved millet yield over controls. The largest grain and
332 biomass yield increase was achieved with M1P compost. The study of the mineralization
333 showed that this compost released 83.6% of N, 72.72% of the available phosphorus and
334 89.5% of the potassium in 3 months. This could explain the increase in yield seen with this
335 compost. Improved crop yield resulting from composting may be related to better crop
336 development due to increased availability of nutrients from compost ([Suge et al. 2011](#), [Badar
337 et al. 2015](#)). Studies by ([Esse et al. 2001](#), [Fatondji et al. 2009](#)) have also highlighted improved
338 grain and biomass yields of millet under organic fertilization due to the progressive
339 availability of nutrients for plants. In addition, M1P compost was the richest in nutrients
340 compared to other composts. The dose of 1t. ha⁻¹ compost M1P is equivalent to the
341 application of 1.11g N per pouch corresponding to 11.1 kg of N ha⁻¹ calculated on the basis
342 of the density of the seedling of 10,000 feet / ha. This compost is also richer in organic matter
343 (21.21%) and carbon (12.31). The use of this compost could durably improve the physical
344 properties of the soil. ([Bationo et al. 2007](#)) reported that soil organic carbon is a sustainable
345 land management index.

346 **Conclusion**

347 The study shows that the composts produced from *Sida cordifolia* are rich in plant nutrients
348 and the plant nutrients were release gradually after incorporation in the soil The weight loss
349 of the composts were in average 59.4% during the 10-week test period while the
350 corresponding release of N, P, and K was in 76.5, 69.5, and 77.3 respectively. This show that
351 the release of these nutrients are well synchronized with nutrient demand in pearl millet as
352 this crop reached flowering after 8.5 weeks. The plant nutrient release from the composts
353 were highest for nitrogen and potassium as these plant nutrients are not strongly chemically
354 bound in the soil. The composts can be a good source of plant nutrients as 1000 kg compost
355 ha⁻¹ applied as micro dosing will apply more nitrogen and phosphorous than applied in 2 g
356 diammonium phosphate hill⁻¹ corresponding to 20 kg DAP ha⁻¹. The *Sida cordifolia* mulch
357 will over time improve soil organic matter a considerable amount of carbon remained at the
358 end of the test period. Use of *Sida cordifolia* for compost production will not only increase
359 soil fertility, but will also stimulate the farms to cut this invasive weed species.

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