"VOICES OF AFRICA" PROJECT

UFLA-BRAZIL/ABC-MRE-BRAZIL/RD-CONGO PARTNERSHIP

PRESENTATION OF RESULTS AND COMPLEMENTS

BIOFERTILIZATION AND COMPOSTING

« Performance of biofertilizers' application versus conventional chemical fertilizers (NPK) on the growing parameters and yields of some staple crops in RDC.
Case studied: QPM 3, *Phaseolus vulgaris*, Haricot C.>>

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<<Biofertilizers and Composting - Complements>>
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2017

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Voices of Africa Project

The Innovative University Extension Project *"Voices of Africa"* was idealized in 2007 by Professor Gilmar Tavares, of the Engineering Department of the Federal University of Lavras - DEG/UFLA.
Extensionist by conviction, active in the areas of Agroecology, Family Agriculture and Innovative University Extension, took as creating inspiration, the poetry ***Vozes d'África (Voices from Africa)*** by **Castro Alves (June 11th of 1868)** in which the first stanza reads:

God! Oh God! Where art thou who doest not answer?
In which world, in which star do you hide yourself
Embedded in heavens?
Two thousand years ago I sent may cry,
That in vain since then has run the infinite...
Where art thou, Lord God?...

In March 2007, the first contact was made with the Free University of the Great Lakes Countries (ULPGL), in the city of Goma, North Kivu province, in the Democratic Republic of Congo. In September 2007, the Magnificent President of the ULPGL, Prof. Dr. Samuel Ngayihembako Mutahinga visited UFLA and, on September 21, 2007, a Protocol of Partnership Intentions was signed by the respective presidents. This historic event, gave an official format to the construction of the institutional participatory partnership UFLA / ULPGL, under the General Coordination of Prof. Gilmar Tavares.
In March, 2008, Professor Gilmar visited ULPGL at Goma and also its branch campuses of Butembo and Bukavu. During this week of visits, the first information for the future proposals of establishment of the Mutual Participative Cooperation Program was established.
In October 2010, the new president of the ULPGL, Profrssor Dr. Kambale Karafuli, visited UFLA and forwarded the UFLA / ULPGL Cooperation Agreement, signed on January 26, 2011, in definitive format.
Then, Professor Karafuli would then make a significant contribution to the UFLA / ULPGL partnership by visiting the Brazilian embassy in Kinshasa, succeeding in inserting the Voices of Africa project in the Prospecting Visit Agenda, which the Brazilian Cooperation Agency of the Brazilian Ministry of Foreign Affairs (ABC / MRE) would promote in DR Congo in February 2011.
This bold and timely action provoked the invitation of ABC/MRE to Professor Gilmar to take part in this event, together with Professor Karafuli. Both signed as future implementing partners, the "*Proces-verbal des Travaux between les Experts of L'Agence Brasilienne de Cooperation et les Experts Congolais*" on February 25, 2011. During the participatory constructions of the Prospecting Visit of the agenda in Kinshasa, Melissa Sandic, Project Analyst /Africa Management of ABC /MRE, who was in the charge of French/Portuguese translator and also a mediator of the Brazilian/Congolese participatory discussions, would make an unprecedented contribution by transforming the UFLA / ULPGL partnership into a RF Brazil partnership /DR Congo. Melissa Sendic, understood the worthy purposes of the Voices of Africa project and wrote in great detail the proposals submitted to the ABC/MRE, with a great humanistic vision, to be performed throughout the DRC and not only in Goma.
To Melissa Sendic, homage, respect and gratitude, forever, from all the organizers and especially those benefited by the project.
Thus, the ULPGL, UFLA and Kinshasa teams were permanently interconnected, forming a large working group in the areas of Agroecology, Family Farming and Innovative University Extension. The new project continued to be termed "Voices of Africa Project".
Thanks to these implementation proposals, it was possible to prepare at UFLA/Brazil 60 (sixty) Congolese teachers and technicians in Agroecology, Family Farming and Innovative University

Extension. There were 4 (four) groups of 15 (fifteen) participants in each one, from October 2011 to April 2013. Thirty ones were from the ULPGL and thirty from Kinshasa.
Then, three professors from the ULPGL were received by UFLA to participate in its master's program. One of them continued post-graduate studies at the doctoral level at UFLA.
In November and December 2013, Professor Gilmar returned to DRC and on-site visits to evaluate results. He attested with deep emotion the success of the training and the success of the project.
It succeeded that in 2012, in one of these classes of training ones coming from Kinshasa, Professor Dr. Thomas Mondjalis Poto, researcher at “Institut National pour l’Etude et la Recherche Agronomiques” (INERA) was pressent.
During the training, among the numerous socio-environmental technologies developed by Agroecology and presented to the training students, to verify economic viability in the DRC, Professor Mondjalis was particularly interested in one suitable for family farmers and small farmers, known as: Biofertilizers/Biofertilization/Biopesticides.
Upon returning to DRC, Professor Mondjalis devoted himself intensely to the study and the spread of this socioenvironmental technology, carrying out a number of practical experiments and cataloging its real results.
The current Technical Information is an overview of the main results cataloged by Professor Mondjalis and demonstrates in extension language, the economic/socio-environmental viability of Biofertilization.
A treatise on Composting was added to this publication, as a complement to the proposal to produce healthy food through Agroecology.

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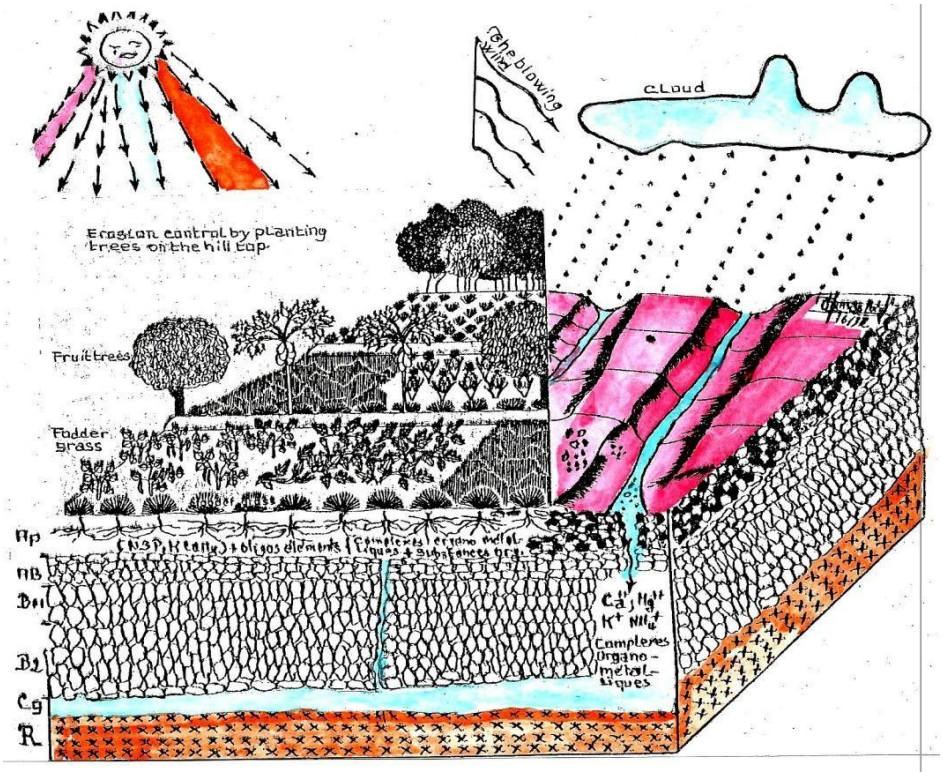
INERA

<<Performance of the application of biofertilizers versus conventional chemical fertilizers(NPK) on the growing parameters and yields of some staple crops in RDC. Case studied : QPM 3,Phaseolus vulgaris,Haricot C.>>

2017
By

Mosala M.,Mondjalis P. et Mbuya Nk.

Tome 1



Abstract

Most of cropable lands in DRC belong to the Oxisoils, Ultisoils and even to the Sopodosoil Orders characterized by low CEC values and water holding capacity and they are mainly acid soils.
Besides this, many of them are located in slopping areas and tremendous cares are to be made to avoid the depletion of superficial top and fertile soil horizons by water erosion.
A few years ago, the commercial and chemical fertilizers have been advised in those acid soils in order to maintain soil fertility level and sustain high yield achievements.

The problem we have found is that the NPK heavily used are not suited for all crops and do not correspond to the ion deficiency of our soils. Besides this, chemical fertilizers are too expensive for smallholding farmers and even not available in all DRC rural areas. 25 kg of NPK nowadays do cost 80 Us $.
As far as we can judge, the sustainability of agriculture production depends on the application of organic and natural fertilizers or on the homemade biofertilizers.

Following this way of thinking, we have set up, under Professor Tavares' supervision, experimental trials in some rural ecological areas in DRC mainly dealing with biofertilizer application using spray system or soil incorporation. The combination of those types of applications has been tried too.
For instance, 3 different biofertilizers have been used and compared with commercial NPK and Urea. The different staple crops involved in this experimental trial are: corn (QPM variety), beans (Phaseolus vulgaris) and some studies deal with cassava crop.

The results found run as the following for this selected QPM 3 variety which is rich in the protein substances, lysine and tryptophan

1°- the height and stem diameter are the 2 factors which are not at all influenced by the applied, biofertilizers

2°- the leaf surface area development and its beneficial aspect on the C02 sequestration from the atmosphere as $C_6H_{12}0_6$ is positively related to the biofertilizer sprays whereas yield improvements are positively related to the biofertilizer incorporation in the soil, the 2 application methods give good results too.

Remarks.

The results here reported have been obtained only with 5 applications of biofertilizers applied every 15 days while NPK and UREA have been incorporated in the soil 7 days after sowing and those chemical fertilizers have been available to the plant roots throughout the growing period and that is main reason why we scarcely take into consideration the results obtained with the chemical fertilizers.

The other beneficial effect of the application of bio fertilizers is the reduction of insects' attacks since Nicotiana tobacco, Thitonia diversifolia and Tephrosia vogelii are incorporated in the biofertilizers.

Experiment 1 << Effect of green manure incorporation in the soil on yield improvement, leaves and height length development >>.

By Mossala L., Mondjalis P. and Lokinga F., 2014

Justification . This topic has been selected since the major constraints of the cropable soils in the neighboring areas of Kikwit City and elsewhere in DRC are the permanent soil fertility depletion, they have very low soil pH values, the low water holding capacity as well as the low Cation Exchange Capacity(CEC) values as already mentioned.

Experimental design

The experiment has been conducted according to the CRD design with 3 replications(blocks).

Different selected treatments

T0: blank treatment;
TI : 15 Kg /m^2 of Cassia siamea leaves incorporated at 10 cm deep
T2 : 15 Kg/m^2 of Leuceana leucocephala leaves incorporated at 10 cm deep T3 : 15 Kg /m^2 of Paspalum notatum leaves incorporated at 10 cm deep
T4 : (∑ T1, T2, T3)

Experimental plot size: 15 m^2

Cropping period

The plots have been cropped just one month after the soil incorporation of the selected green manures.

Selected parameters

1°- Number of produced leaves/Treatment
2°- Plant height (cm)
3°- Produced yields.

Students' assignment

Facagro-experimental plot			**ISP/KKT-experimental plot**	
Targeted parameters	**Students 'names**		**Targeted parameters**	**Students 'name**
Height development	Melle Francine Lukinga Angiene		Height development	Mr Ngandu Panique
Leaf area index development	Melle Melissa Mupepe		Number of produced leaves	,,
Number of ears and weight	Mr Carmel Messa		Number of ears and weight	Mr Kiboko Norbert

Interpretation of the results

Table 1 and 2 show the ANOVAs for height development and for the number of produced leaves

Table 1: ANOVAS of mean leaf development/treatment

Source of 323	**Df**	**Sc**	**MS**	**Fc**	**Ft(p 0,05)**	**Conclusion**
Total	14	1323	-	-	-	
Block	2	0.966	0.483	0.06	4.3	NS
Treatment	4	4.5	1.125	1.14	2.77	NS
Error	8	1317.54	1317.54	-		

Table 2: ANOVAS of mean height development/treatment

Source of variation	Df	Sc	MS	Fc	Ft(p 0.05)	Conclusion
Total	14	177.24				
Block	2	20.74	10.37	1.29	4.3	NS
Treatment	4	27.36	6.84	0.85	2.77	NS
Error	8	123.14	16.14			

As expected, the ANOVAs show that there are no differences at all within blocks as well as between treatments.
This is mainly due to the fact that the green manures have been incorporated just 1 month before sowing. They did not have enough time for their decay and mineralization in the ground and that is why the ANOVAs did not show any significant differences either between blocks or between treatments.

Therefore, for the next cropping season, 2014, the same experiment must be repeated but the seeding procedure will be done 45 , 60 or 75 days after the soil incorporation of the green manures and we must definitely end up with significant differences between treatments and blocks.

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Experiment 2 << The sustainability of crop production in highly degraded tropical soils by using homemade biofertilizers >>

by Mondjalis P., Mbuya Nkakolongo, Ntambwe B.,Gabriel Nzau, 2015

2.1 << Comparison trial between commercial fertilizer application (NPK + Urea) versus homemade biofertilizers and their effect on QPM yields >>

Soil type. Isohyperthermic Haplortox/ISTA-experimental site

General objective

Find the best fertilizer composition to sustain QPM growing parameters (leaf area index, height development and the genetic yield of 5 tons/ha).

Specific objectives

Application of the best observed results of liquid plant manure composition to other staple crops

1- liquid plant manure application at 15 cm depth at 10 cm around the stem(5O cc of concentrated liquid; ⌈ 2 liters in 20 liters of distilled water⌋)

1 -diluted liquid plant manure on crop leaves (50 cc of diluted liquid ⌈1 liter diluted in 20 liters of distilled water ⌋).

Methodology

A) Different prepared bio-fertilizers and the corresponding treatments

Bio fertilizer **A** composition:

Sida acuda, Paspalum notatum, Tripsacum dactyloide, Pennisetum purpureum + 5 kg of cattle dump + 30 cc of coconut juice

Quantity of material used: 10 Kg/selected plant material

Bio fertilizer **B** composition:

Leucaena leucos. Leaves,Albizzia l. leaves,Tobacco and Titoniadiversifolia + 5 kg of cattle dump +30 cc of coconut juice.

Quantity of material used: 10 Kg/selected plant material

Bio fertiliser **C** composition:

Fern, plant regrowth (2 years), native grasses, *Acacia auri-culiformis* + 5 kg of poultry dump +30 cc of coconut juice.

Quantity of material used: 10 Kg/ selected plant material

Volume of the container : 180 liters, quantity of water used, **160 liters**, ratio; 1/4

B) Application methods:

T0 (blank treatment)

T1 (fertilizer incorporation at 15 cm deep, at 10 cm around the plant stem) this is an application of 120 ml which equals to 2 boxes of tomato paste of the product, every 15 days which is equal to 5 applications during the observation period.

T2 (fertilizer spray on the leaves), Spray twice /month (every 15 days),

T3 (= T1+T2) and T4 = ⌈NPK (17-17-17) + Urea⌋

Table 1.Chemical analysis of the biofertilizers

Biofertilizer	N(g/liter)	P(g/liter)	K(g/liter)	Cd(mg/liter)	Pb(mg/liter)
A	3.950	0.612	0.612	0.014	0.12
B	3.650	0.581	0.581	0.018	0.03
C	2.700	0.336	0.336	0.01	0.01

Source: laboratoire d'éco toxicologie/Faculté des Sciences/UNIKIN-RDC

RemarK. The above results are obtained with a ratio between organic matter and water of 1/4 but for better results, the ratio of 1/5 should be tried. The difference between fertilizer B and C may be due to the fact that, for the C fertilizer, poultry dump has been used instead of cattle dump. Consequently, we can compare the biofertilizer A ,B and C and (NPK+Urea).

C) Different treatments selected in the field Table 2. Different treatments and the application methods

Treatment	Application methods		
T0			
TA	T_1A	T_2A	T_3A
TB	T_1B	T_2B	T_3B
TC	T_1C	T_2C	T_3C

D) Experimental design: CRD with 3 blocks

Results interpretation

QPM yields (Kg/experimental unit (5. 5 m^2); mean values

Table 3. The obtained mean yields

Treatments	Different biofertilizers			
	A	B	C	
TO	0.24	0.22	O.66	Replicaation
T1	0.41	0.42	O.89	
T2	**0.61**	0.44	0.79	
T3	0.49	**0.62**	0.94	
T4	0.42	O.54	**1.15**	

Table 4. Diameter variation as affected by different treatments (Mean values/cm)

Treatments	Different biofertilizers			
	A	B	C	
TO	1.247	1.155	1.325	Replication
T1	1.142	1.235	1.429	
T2	1.374	1.259	1.327	
T3	1.172	1.339	1.424	
T4	1.428	1.332	1.518	

Variance analyses dealing with yield mean values.

Table 3.1 Variance analysis with A fertilizer

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F calculated	F tabulated 0.05	F tabulated 0.01	P-values	Decision
Treatment	4	0.2238	0.05595	**6.989381**	3.8378533	7.0060766	0.0100	**S**
Block	2	0.015293	0.00764	0.95505	4.45897	8.64911	0.4246	**NS**
Error	8	0.06404	0.00800					
Total	14	CV=20.65 %. P < 0.01. the variation coefficient between treatment is acceptable						

Table 3.2 Variance analysis with B fertilizer

Source de variation	**Degree of freedon**	**Sum of squares**	**Mean squares**	**F calculated**	**F tabulated 0.05**	**F tabulated 0.01**	**P-values**	**Decision**
Treatment	4	0.2731733	0.068293	**13.6906114**	3.83785335	7.00607662	0.00118	**THS**
Block	2	0.02676	0.01338	2.6824379	4.45897	8.64911	0.12838	NS
Error	8	0.0399066 7	0.004988					
Total	14	CV= 9.68 %, P < 0.001, the variation coefficient between treatment is acceptable						

Table 3.3 Variance analysis with C fertilizer

Source of variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.075	Ftabulated 0.01	P-values	Decision
Treatment	4	0.3888	0.0972	**6.82824025**	3.83785335	7.006076	0.01078	**S**
Block	2	0.86245333	0.431226	30.293431	4.45897	8.64911	0.00018	**THS**
Error	8	0.11388	0.014235					
Total	14	CV= %, P < 0.001						

Variance analysis dealing with stem diameter

Table 4.1 Variance analysis with A fertilizer

Source of variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	0.187205	0.04680	3.084331	3.8378533	7.0060766	0.082	NS
Block	2	0.077783	0.03889	2.563612	4.45897	8.64911	0.1379	NS
Error	8	0.121391	0.01517					
Total	14							

Table 4.2 Variance analysis with B fertilizer

Source de variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	F tabulated 0.05	F tabulated 0.01	P-values	Decision
Treatment	4	0.083609	0.0209	1.9463821	3.837853	7.006076	0.1961	NS
Block	2	0.008229	0.00411	0.382681	4.45897	8.64911	0.8693	NS
Error	8	0.085923	0.01074					
Total	14							

Table 4.3 Variance analysis with C fertilizer

Source de variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	0.078325	O.O1958	1.98710123	3.83785	7.00607	0.1895	NS
Block	2	0.229105	0.11455	1.16294416	4.45897	8.64911	0.0042	NS
Error	8	0.078833	0.00985					
Total	14							

Interpretation

The stem diameter is not affected by the applied treatments, neither with the biofertilizers A,B nor with biofertilizer C.

Variance analysis dealing with height variation

Table 5. Height variation as affected by different treatments (Mean values expressed in cm)

Treatments	Different biofertilizer			
	A	B	C	
TO	100.591	96.716	122.53	Repetitions
T1	94.758	108.355	175.778	
T2	112.146	106.8	158.655	
T3	96.396	125.216	135.534	
T4	109.591	112.799	142.599	

Table 5.1 Variance analysis of the fertilizer A

Source of variation	Degree of freedom	Sum of squares	Mean Squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	731.95555	182.988	0.955319	3.83785335	7.006076	0.4809	**Ns**
Block	2	444.5092	202.225	1.O55746	4.45897	8.64911	0.39183	**Ns**
Error	8	153.23778	191.547					
Total	14							

Table 5.2 Variance analysis of the fertilizer B

Source of variation	Degree of freedon	Sum of squares	Mean Squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	1286.326	321.5817	2.03188753	3.83785335	7.0060766	0.1825	**NS**
Block	2	47.61944	23.80972	0.1504397	4.45897	8.64911	0.8627	**NS**
Error	8	1266.1398	158.3674					
Total	14							

Table 5.3 Variance analysis of the fertilizer C

Source of variation	Degree of freedon	Sum of squares	Mean Squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	4634.54	115.8635	1.41392053	3.83785335	7.0060766	03129	**NS**
Block	2	4577.869	2288.934	2.7932631	4.45897	8.64911	01202	**NS**
Error	8	6555.587	819.4484					
Total	14							

Results interpretation dealing with height values

The variance analysis for the height development (Table 5.1 to 5.3) clearly shows that there is no difference between treatments and between blocks; these observations are exactly the same as those obtained with the stem diameter.

Table 5.4 Mean yield values obtained/experimental unit (5.5m^2)

Treatment	Biofert. A	Biofert. B	Biofert. C
T0	0.24	0.22	0.66
T1	0.41	0.42	0.89
T2	**0.61**	0.44	0.79
T3	0.49	**0.62**	**0.94**
T4	0.42	0 .54	**1.15**

The results of Table 5.4 can be presented also as % increment of yields based on TO treatment values and the results are the following:

a) T2/BioA : ⌈ (0.62-0.24/0.24⌋.100= 154

b) T3/BioB : ⌈ (0.62-0.22/0.22⌋.100= 182
c) T3/Bio C: ⌈ (0.94-0.66/0.66⌋.100= 42.48
d) T4 : :⌈ (1.15-0.66/0.66⌋. 100= 74

This only means that for Biofertilizer B, best results are obtained if the biofertilizer is applied as spray fertilization and the corresponding yield increase is 154 % as great as that of T0.

General interpretation

This experiment clearly shows that the height as well as the stem diameter development is not affected by the different fertilizers used, they are mainly governed by the genetic components of this corn variety.
Best results are obtained with the yields, the analysis of variance clearly shows that there are significant treatment differences with the biofertilizer A and C, the biofertilizer B has given better results, the ANOVA (Table 3.2) has shown highly significant differences.
But if we have to decide, we should rely upon our decision according to the calculated F values. And following this way of thinking, the biofertilizer B (F. calc. = 13.6906114) > fertilizer A (F. calc. = 6. 989381).
The best results seem to be, if we compare the two biofertilizers and the commercial fertilizers, as follow: $T_3B>T_2A>T_3A>T_2B>T_4$
and T_1B.
But if we compare results of each biofertilizer, the trend is the following:

1°-$T_2A>T_3A>T_2A>T_4>T_0$
2°-$T_3B> T_2B>T_1B>T_4>T0$
3°-$T4>T_3C >T_1C >T_2C >T_OC >T_O$

Due to the fact that we are dealing with acid soils with a very low CEC, the use of commercialized common fertilizers gives some results, for instance ,T4> biofertilizer C, but lower than some results obtained with the A and B biofertilizer,
therefore we do not take into consideration, the commercial fertilizers and also the C biofertilizer, since the former is as we have mentioned earlier, too expensive for smallholding farmers and are not available throughout the rural areas in DRC and for the C biofertilizer, the poultry dump has been used instead of the cattle dump.
One has, however, to bear in mind that the results found with commercial fertilizers can be taken into consideration, since they were applied incorporated in the soil, 7 days after the sowing period and the ions where available for the roots throughout the growing period, but for bio fertilizers, they were applied only every 15 days.

Future perspectives.
1°- for a better interpretation of the results, the chemical analysis of the bio fertilizers must be done
2° -the bio fertilizers must be kept in a dark room and the temperature should not exceed 20°C
3°- the spray application must be avoided during rain or wind

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Experiment 3 << Comparison trial between commercial fertilizer (NPK + Urea) versus homemade biofertilizers and their effect on QPM leaf area development >>

By Mondjalis P., Mbuya Nkakolongo and Ilonga Christ, **2015**

Justification of that assay

Up to now, most of the experimental trials made on corn were directed to the effects of soil management and fertilizer application on yields but none of them focuses its attention on the reduction of CO_2 in the troposphere through leaf area development the so called <<**Greenhouse effect**>>.

The major objective of this experimental trial is to detect the best biofertilizer and the best combination for leaf surface development and the corresponding CO_2 reduction through **$C_6H_{12}O_6$ production.**

Our reflection is based to the fact that 1 m^2 of leaf surface produces 1 g of $C_6H_{12}O_6$

The formula used for leaf surface determination is:

$La(cm^2) = L_w.W_m.K$ where,

La = leaf surface expressed in cm^2,
L_w= leaf length in cm,
W_m= leaf width en cm,
K= correction factor (0. 7 for lobulated leaves and 0. 5 for non lobulated leaves)

Methodology

1 experimental site.
ISTA-experimental site, Barumbu District, Kinshasa City, DRC.
2 Soil type : Isothermic Haplortox
3 Eperimental design : CRD with 3 blocks
3.1 experimental surface for each treatment : 5 x 5 m = 25 m^2
4 Different biofertilizers and their corresponding plant composition

Bio **A** :
Sida acuda, Paspalum notatum, Tripsacum dactyloide, Pennisetum purpureum + 5 kg of cattle dump + 30 cc of coconut . juice
Quantity of plant material: 10 kg

Bio **B** :
Leucaena leucos. Leaves,Albizzia l. leaves,Tobacco and Titonia diversifolia + 5 kg of cattle dump + 30 cc of coconut juice.
Quantity of plant material: 10 kg

Bio **C :**
Fern, plant regrowth (2 years), native grasses, *Acacia auri- culiformis* + 5 kg of poultry dump + 30 cc of Coco nuts juice.
Quantity of plant material: 10 kg

Container volume : 180 liter, quantity of pure water, **160** liter, rapport, ¼

Table 1. The biofertilizers' chemical analysis

A	3.950	0.612	0.612	0.014	0.12
B	3.650	0.581	0.581	0.018	0.03
C	2.700	0.336	0.336	0.01	0.01

Application methods.

T0 (blank treatment)
T1 (soil incorporation of the biofertilizer - concentration (2 liter of the bio fertilizer/10 liters of distilled water) applied at 15 cm depth on a ring system around the plant stem(radius= 10 cm); this is an application of 120 ml which equals to 2 boxes of tomato paste of the product every 15 days from April the 29th to June the 27th which equals to applications.
T2 (leaf spray application of the diluted biofertilizer, 1 liter of the solution/10 liters of distilled water), every 15 days: from April 29th to June 27th ,5 applications have been made.
T 3 (= T1+T2) and T4 = ⌈NPK (17-17-17) + Urea⌋
T4 : organic fertilizer (NPK 17-17-17), 3 g of the product and 3g of urea/plot has been applied 45 days after sowing.

T0 : treatment layout in the field

Treatments	Application type		
	T1	T2	T3
T0			
Bio A	T_1A	T_2A	T_3A
Bio B	T_1B	T_2B	T_3B
Bio C	T_1C	T_2C	T_3C
NPK + Urée			

Table 0.1.Quantity of the product used /120 ml for the spray application

Bio fertilizer	N(g/120 ml)	P(g/120 ml)	K(g/120 ml)	Cd(mg/120 ml)	Pb(mg/120 ml))
A	$3950.12.\ 10^{-7}$	$612.12.\ 10^{-7}$	$612.12.\ 10^{-7}$	$14.12.\ 10^{-7}$	$12.\ 12.10^{-7}$
B	$3650.\ 12.10^{-7}$	$581.12.10^{-7}$	$581.12.\ 10^{-7}$	$18.12.\ 10^{-7}$	$3.12.10^{-7}$
C	$2700.\ 12.10^{-7}$	$336.\ 12.10^{-7}$	$336.12.\ 10^{-7}$	$1.12.\ 10^{-7}$	$1.\ 12.10^{-7}$

Table 0.2.Quantity of the product used /120 ml for soil incorporation/plot

Bio fertilizer	N(g/120 ml)	P(g/120 ml)	Cd(mg/120 ml)	Pb(mg/120 ml))
A	$2 \times 3950.12.\ 10^{-7}$	$2 \times 612.12.\ 10^{-7}$	$2 \times 14.12.\ 10^{-7}$	$2 \times 12.\ 12.10^{-7}$
B	$2 \times 3650.\ 12.10^{-7}$	$2 \times 581.12.10^{-7}$	$2 \times 18.12.\ 10^{-7}$	$2 \times 3.12.10^{-7}$
C	$2 \times 2700.\ 12.10^{-7}$	$2 \times 336.\ 12.10^{-7}$	$2 \times 1.12.\ 10^{-7}$	$2 \times 1.\ 12.10^{-7}$

II Obtained results

Table 1. Leaf area variation (m2) and the corresponding produced $C_6H_{12}O_6$(98th day after sowing)

	Treatment	Leaf Surface (m^2)	Corresponding produced $C_6H_{12}O_6$ (gram)
Bio A	**T0**	17.934	
	T1	44.756	44.756
	T2	46.742	46.742
	T3	43.157	43.157
	T4	45.455	45.455
Bio B	**T0**	21.477	21.477
	T1	42.536	42.536
	T2	44.963	44.963
	T3	41.888	41.888
	T4	44.515	44.515
Bio C	**T0**	24.449	24.449
	T1	47.552	47.552
	T2	52.005	52.005
	T3	51.396	51.396
	T4	61.891	61.891

Preliminary Interpretation of the obtained mean values

There is a tremendous difference between biofertilizer C and the two other biofertilizers due to the fact that for the C bio fertilizer, the poultry dump has been used instead of the cattle dump as decay ingredient for the decay of the plant material and that is the reason why, we did not take into consideration the results derived from C biofertilizer.
With the above restriction, the best results run as the following:

T_2A>T4>T_2B>T_1A>T_3A>T_1B>T_3B>T0

The corresponding variance analyses are given in Table 2.1 to 2.3

Table 2.1 Variance analysis of the Bio A /leaf area

Source of variation	D.L	Sum of squares	Mean Square	F. calculated	F.tabulated 0.05	F. tabulated0.01	P-values	Decision
Treatment	4	1773339041	443334760	**142.810585**	3.83765335	7.00607662	1.799^{1E-07}	**ThS**
Block	2	31263337.7	15631668.8	**32.3613199**	3.83765335	7.00607662		**ThS**
Error	8	24834840.4	3104355.05					
Total	14	CV=4.45 %, P < 0.001						

Table 2.2 Variance analysis of the Bio B /leaf area

Source of variation	D . L	Sum of squares	Mean Squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	118150238.1	295375595	**24.1081765**	3.83765335	7.00607662	1.799^{1E-07}	**ThS**
Block	2	46640378.1	23320189	**12.666089**	3.83765335	7.00607662		**ThS**
Error	8	98016735.6						
Total	14	CV=8.96 %, P < 0.001						

Table 2.3 Variance analysis of the Bio C /leaf area

Source of variation	Degree of freedom	Sum of Squares	Mean Squares	F.calculated	F.tabulated 0.05	F.tabulated 0.01	P-values	Decision
Treatment	4	2515276888	628819222	**10.607932**	3.83765335	7.00607662	1.799^{1E-07}	**ThS**
Block	2	152093861	76046930	**8.26883112**	3.83765335	7.00607662		**ThS**
Error	8	474225664	592278208					
Total	14	CV=15.62 %. P < 0.001						

Interpretation of the results

There is a tremendous difference between biofertilizer C and the two other biofertilizers due to the fact that for the bio fertilizer c, the poultry dump has been used instead of the cattle dump as decay ingredient for the plant materials decay and that is the reason why, the results derived from biofertilizer C are not taken into consideration.
With the above restriction the best results run as the following:

T_2A>T4>T_2B> T_1A>T_3A>T_1B>T_3B>T0

This general trend can be better illustrated if we translate those results in terms of % leaf area increment based on T0 value and the trend runs as the following:

T_2A	T4	T_2B	T_1A	T_3A	T_1B	T_3B	T0
137,2	131	128	127	119	116	113	-

Conclusion

Due to the fact that the F. calculated for the biofertilizer A (142, 810585) is > the F. calculated of the bio fertilizer

B (24, 1081765) and the variation coefficient (CV value) is 4.45 % for biofertilizer A against 8.96 for biofertilizer B,

the technology transfer in rural areas should be done with the obtained results with biofertlizer A instead of those obtained with biofertilizer B.

We have to bear in mind that this trend is valid as long as leaf area variation is concerned. This only means that the observed trend will be modified if another growing parameter is concerned.

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Experiment 4 << Comparison trial between commercial fertilizer (NPK + Urea) versus homemade biofertilizers and their effect on protein content variation >>

Soil type. Isohyperthermic Haplortox/ISTA-experimental site

By Mbuya Nkankolongo,Mondjalis P. and et Kiana Tezo
Divine, 2015

Methodology

This experiment has been conducted in the same experimental site as the Nzau's former topic. The commercial fertilizers as well as the 3 locally produced biofertilizers (A,B,C) remain the same.
At the beginning, the objective was to see whether or not, the lysine and tryptophan content varies with the composition and origin of the fertilizer used.
But due to the fact that the different laboratories here in Kinshasa City did not have the methodology required for determination of those protein components, we have then decided to focus our attention on the total protein content produced by different selected fertilizers.

1 Method used for chemical analysis of the soil of the experimental field

1 The organic carbon has been determined by Waklay et Black's method, 1934
2 The CEC has been determined with Ammonium Acetate by Metson's method, 1956, 3 the exchangeable cations were determined by spectrophotometric method with the Ammonium solution, (1 N, pH 7)
4 Soil pH determined by potentiometric method with sol/water ratio of 2.5 5 Nitrogen, determined by Kjeldall's method
6 Available Phosphorus determined by Bray's method
7 The exchangeable Al^{3+} determined after soaking the soil sample in 1 N Kcl solution since the soil pH (H_20) has been ≤5 pH (H_20) ≤5
8 The particle size at 8 fractions, by the international method (Bourgeois, 1982)
9 **the formula used for protein content determination is : % Protein = % N x 6, 25**

2 Different treatments.

T0(blank),
T1 (soil incorporation of the biofertilizer, concentration (2 liter of the bio fertilizer/10 liters of distilled water) applied at 15 cm depth on a ring system around the plant stem (radius= 10 cm); this is an application of 120 ml which equals to 2 boxes of tomato paste of the product, every 15 days from April the 29th to June the 27th this equals to 5 applications.
T2 (leaf spray application of the diluted biofertilizer, 1 liter of the solution/10 liter of distilled water), every 15 days: from April the 29th to June the 27th , 5 applications have been made.
T 3 (= T1+T2) and T4 = ⌈NPK (17-17-17) + Urea⌋,3 g of the product and 3g of Urea/plot, has been applied, 7 days after sowing period.

Experimental surface for each treatment: 5 m^2

The different biofertilizers and the corresponding plant composition

Bio **A** :

Sida acuda, Paspalum notatum, Tripsacum dactyloide, Pennisetum purpureum + 5 kg of cattle dump + 30 cc of coconut juice.

Quantity of plant material: 10 kg

Bio **B** :

Leucaena leucos. Leaves,Albizzia l. leaves,Tobacco and Titonia diversifolia + 5 kg of cattle dump +30 cc of coconut juice.

Quantitty of vegetal material: 10 Kg

Bio **C :**

Fern, plant regrowth (2 years), native grasses, *Acacia auri- culiformis* + 5 kg of poultry dump +30 cc of Coco nuts juice.

Quantitty of palnt material: 10 Kg

Container volume : 180 liters, quantity of water to be used : **160** liters , gain, 1/4

Table 0.Chemical analyses of the selected biofertilizers

Bio fertilizer	N(g/liter)	P(g/liter)	K(g/liter)	Cd(mg/liter)	Pb(mg/liter)
A	3.950	0.612	0.612	0.014	0.12
B	3.650	0.581	0.581	0.018	0.03
C	2.700	0.336	0.336	0.01	0.01

Table 1. Quantity of chemical products/10 li to be used for the spray application (10 li = 10^4 ml)

Bio fertilizer	N(g/10 li)	P(g/10 li)	K(g/10 li)	Cd(mg/10 li)	Pb(mg/10 li)
A	$3950.\ 10^{-4}$	$612.\ 10^{-4}$	$612.\ 10^{-4}$	$14.\ 10^{-4}$	12.10^{-3}
B	$3650.\ 10^{-4}$	$581.\ 10^{-4}$	$581.\ 10^{-4}$	$18.\ 10^{-4}$	3.10^{-3}
C	$2700.\ 10^{-4}$	$336.\ 10^{-4}$	$336.\ 10^{-4}$	$1.\ 10^{-4}$	1.10^{-3}

Table 2. Quantity of chemical products /120 ml for the spray application

Bio fertilizer	N(g/120 ml)	P(g/120 ml)	K(g/120 ml)	Cd(mg/120 ml)	Pb(mg/120 ml))
A	$3950.12.\ 10^{-7}$	$612.12.\ 10^{-7}$	$612.12.\ 10^{-7}$	$14.12.\ 10^{-7}$	$12.\ 12.10^{-7}$
B	$3650.\ 12.10^{-7}$	$581.12.10^{-7}$	$581.12.\ 10^{-7}$	$18.12.\ 10^{-7}$	$3.12.10^{-7}$
C	$2700.\ 12.10^{-7}$	$336.\ 12.10^{-7}$	$336.12.\ 10^{-7}$	$1.12.\ 10^{-7}$	$1.\ 12.10^{-7}$

Table 3.Quantity chemical products /120 ml for soil incorporation

Bio fertilizer	N(g/120 ml)	P(g/120 ml)	Cd(mg/120 ml)	Pb(mg/120 ml))
A	$2 \times 3950.12.\ 10^{-7}$	$2 \times 612.12.\ 10^{-7}$	$2 \times 14.12.\ 10^{-7}$	$2 \times 12.\ 12.10^{-7}$
B	$2 \times 3650.\ 12.10^{-7}$	$2 \times 581.12.10^{-7}$	$2 \times 18.12.\ 10^{-7}$	$2 \times 3.12.10^{-7}$
C	$2 \times 2700.\ 12.10^{-7}$	$2 \times 336.\ 12.10^{-7}$	$2 \times 1.12.\ 10^{-7}$	$2 \times 1.\ 12.10^{-7}$

Table 4: treatment layout

Treatments	Types of application of the organic fertilizer		
	T1	T2	T3
T0			
Bio A	T_1A	T_2A	T_3A
Bio B	T_1B	T_2B	T_3B
Bio C	T_1C	T_2C	T_3C
NPK + Urea			

3 Results interpretation

The actual results have been obtained 98 days (14 weeks after the seeds' germination).

Table 5 Protein content expressed in %

	Treatment	Mean protein content %	Difference with TO	% of increment
Biof. A	T0	12.25	0	-
	T1	12.25	0	-
	T2	12.25	0	-
	T3	12.25	0	-
	T4	14	1.75	14.29
Bio f.B	T0	13.13	0	-
	T1	14	0.87	6.63
	T2	14	0.87	6.63
	T3	15.75	2.62	19.95= 20
	T4	14	0.87	6.63
Bio f.C	T0	13.13	0	-
	T1	12.25	-0.88	↓
	T2	14	0.87	6.63
	T3	14	0.87	6.63
	T4	16.75	3.62	28

Remark: the protein content has been determined 98 days after the seeds' germi- nation which happened 98 days after sowing.

Table 5.1 Variance analysis for (biofertilizer A)

Source of variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	7.35	1.8375	0.70503507	3.8378533	7.0060766	06103	NS
Block	2	4.9	2.45	0.940047	4.45897	8.64911		NS
Error	8	20.85	2.60625					
Total	14	CV=20.65 %, P < 0.01, the variation coefficient between treatment is acceptable						

Table 5.2 Variance analysis for (biofertilizer B)

Source of variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	11.025	2.75625	**10.5958674**	3.83785335	7.00607662	0.002774	TS
Block	2	1.10775	0.553875	2.1292647	4.45897	8.64911		NS
Error	8	2.081	0.260125					
Total	14	CV= 9.68 %, P < 0.001, the variation coefficient between treatment is acceptable						

Table 5.3 Variance analysis for (biofertilizer C)

Source of variation	Degree of freedom	Sum of squares	Mean squares	Fcalculated	Ftabulated 0.05	Ftabulated 0.01	P-values	Decision
Treatment	4	20.2125	5.053125	**70.7349081**	3.83785335	7.00607662	2.7955 E-06	TS
Block	2	0.58975	0.294875	4.127734	3.83785335	7.00607662		S
Error	8	0.5715	0.071437					
Total	14	CV= 9.68 %, P < 0.001, the variation coefficient between treatment is acceptable						

Table 5.4 Summary of the data of the experiment 2

Treatment	Mean + standard deviation	Decision
T0	12.250±0250	A
T1	13.125±0212515	A
T4	14±05	A
T2	14±05	A
T3	15.75±005	B

Interpretation: A = no significant differences
B = significative differences

General interpretation

Table 5.1 clearly shows that for biofertilizer A, there is no difference at all neither between treatments and nor between blocks. For this biofertilizer, interesting results have just been found by the incorporation of the NPK in the soil and the trend is the following :

T4 > T1, T2 and T3
(14%) (12,25 %)

Why is that so ?

That is the question to be solved and we do think that good results for this bio may be obtained by increasing the application rate. Instead of applying the biofertilizer just once every 15 days, we should apply once or 2 times/week . Besides this modification, the concentration of the product must be raised too and the following concentration may be tested(1,2 and 4 liters of digested product/10 liters of distilled water).
But for bioB, the variance analysis shows that highly significant differences have occurred between treatments but not between blocks. The observed trend is : **T3>T2=T4=T1>T0** and in terms of % increment this trend turns like that :

T3 > T2=T4=T1 > T0
(20) (6,63)

The same results have been obtained for the bio C, but the **%** of protein increment is 6.63 for T3 whereas it has been 20 % for bio B as mentioned earlier.
We can conclude that as long as the variation of maize protein content is concerned, the bio B must be used.

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Experiment 5 <<Effects of different application of biofertilizer spray on the major growing parameters and yields of Phaseolus vulgaris crop >>

By Mondjalis P. ,Mossala L. and Kabamb M.B, 2015

Abstract

For the moment, many experiments on fertilizer trials have been made on starch crops such as cassava, sweet potato, corn and scarcely done with leguminous crops.

In this topic, *Phaseolus vulgaris* has been selected just in order to see how this leguminous crop reacts once fertilizers are applied.

The comparison has been made with different biofertilizers, some characterized with a high lignin (C/N ratio ≥ 20) and others with a low lignin content (C/N ratio < 20). In some of them, insecticide plants have been added such as Treatment 3(T3 with *Thitonia diversifolia*) and Treatment 4(T4 with *Nicotiana tabacum*). The variance analyses have detected differences only with the observed grain yields and the results run as the following : **T3 > T2 > T4 > T5** > **T1 > T0**

The weekly yield encountered with T5 treatment may be due to the fact that the biofertilizer of this treatment is a combination of plant materials with both a high and low lignin content and the release of nutrients for plant growth is rather slow.

Experimental site

This experimental trial has been conducted in the experimental site of ISP-Kikwit which is located in Bandundu Province in DRC at 550 Km in the southern area of Kinshasa City.

The major soil type is: an iso-hypertermic Haplorthox

Experimental design: CRD with 3 blocks.

Number of treatments: 6

Different biofertilizers and the corresponding plant composition

Table 1. The different biofertilizers and the corresponding plant composition

Treatments	Composition		
	main plant	additional material	active decay agent (porc dump)
T0	-	-	-
T1	Acacia auriculiformis (2.5 kg)	Manguier(1.25 Kg)	1 kg/20 liters
		Avocatier(1.25 Kg)	
T2	Acacia auriculiformis (2.5 kg)	Soya(1.25 Kg)	1 kg /20 liters
		Arachide(1.25 Kg)	
T3	Acacia auriculiformis (1.25 Kg)	Manguier(1.25 Kg)	1 kg /20 liters
		Avocatier1.25 Kg)	
		Tithonia diversifolia(1.25)	
T4	Acacia auriculiformis (1.25 Kg)	Soya(1.25 Kg)	1 kg / liters
		Arachide(1.25 Kg)	
		Tabacum nicotiana(1.25 Kg)	
T5	Acacia auriculiformis	∑(T1.T2.T3.T4)	1 kg / 20 liters

Table 2. Subdivision of the biofertilizers into 3 groups

Bio fert.	Major component	C/N ratio	Included insecticide plant
T1 and T3	High lignin content	> 20	Tithonia diversifolia
T2 and T4	Low lignin content	< 20	Nicotiana tabacum
T5		≈ 20	Mixt

Biofertilizer container volume: 25 liters

Digestion time: 45 days and application rate: 2 times/week.

Selected growing parameters: germination (%), stem height, stem diameter, number of produced leaves, number of produced pods, number of grains/pod, weight of dry grains(seeds)

II The obtained results and the required interpretations

2.1 Germination results

Table 3. Germination %

Treatments	% checked
T0	90.3
T1	94
T2	92
T3	93
T4	96
T5	94
PPDS at 1%	2.91
PPDS at 5%	3.01

Table 4. Variance analyses (germination)

Source de variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	2149.4	-	-	-	-	
Blocks	3	17.57	586	0.04	3.29	5.42	**(NS)**
Treatments	5	83.9	16.78	0.12	2.90	4.56	**(NS)**
Error	15	2047.93	136.52	-	-	-	

Table 5 Height development (15 days after seeding)

Treatments	Plant height(15 days after sowing)	Plant height at harvest time (m)
T0	1.14	13.4
T1	1.16	18.2
T2	1.19	17.9
T3	1.16	19
T4	1.21	16.5
T5	1.19	15.4
PPDS at 1%	**2.20**	**2.73**
PPDS at 5%	**2 .68**	**5.41**

Table 6. Variance analyses /height (15 days after seeding)

Source of variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	1038	-	-	-	-	
Blocks	3	478	15966	5.43	3.29	5.56	**(TS)**
Treatments	5	118.2	23.64	0.80	2.90	4.56	**(NS)**
Error	15	441	29.4	-	-	-	

Table 6. 1 : Variance analyses /height (at harvest time)

Source of variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	676.6	-	-	-	-	
Blocks	3	342.2	114.07	6.90	3.29	5.42	**(THS)**
Treatments	5	86.52	17.3	1.04	2.90	4.56	**(NS)**
Error	15	247.88	16.52	-	-	-	

Partial interpretation.

The above table clearly shows that there is no difference detected neither between treatments nor between blocks. That is a matter of fact since the seed germination is governed by other factors such as: the genetic potential, the initial seed water content and the storage conditions including the conservation time.

For the height development, Tables 6 and 6.1 clearly show that the differences do exist between blocks and not between treatments. This is mainly due to the soil fertility trend in the experimental

site, which is due to the slope itself and the slope length intervention.

Other growing parameters (mainly, grain or seed weight)

7 Impact of the application of biofertilizers on grain yields

Table 7.1

Treatment	Number of pods/ plant
T0	51.3
T1	60.8
T2	65
T3	70.8
T4	55.5
T5	61.5
PPDS at 1%	**12.24**
PPDS at 5%	**16.13**

Table 7.2

Treatments	Number of grains/Plant
T0	30.8
T1	37
T2	37
T3	34.8
T4	35.5
T5	36
PPDS at 1%	
PPDS at 5%	

Table 7.3

Treatments	Mean weight of grain/plant(Kg)	Mean weight of grain/plant(g)	% of yield increment based on T0 results
T0	0.108	108	
T1	0.124	124	115
T2	0.150	150	139
T3	0.155	155	144
T4	0.145	145	134
T5	0.137	137	127
PPDS at 1%	**0.027**		
PPDS at 5%	**0.093**		

Table 7.4 Variance analyses based on the Number of pods/plant

Source of variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	10778	-	-	-	-	
Blocks	3	972.16	324.05	0.54	3 .29	5.42	**NS**
Treatments	5	945.75	189.15	0.32	2.90	4.56	**NS**
Error	15	8860.09	590.67	-	-	-	

Table 7.5 Nb of grains/pod

Source of variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	1713.4	-	-	-	-	
Blocks	3	1043.07	347.69	0.54	3 .29	5.42	**NS**
Treatments	5	108.9	21.78	0.32	2.90	4.56	**NS**
Error	15	561.43	37.42	-	-	-	

Table 7.6 Grain weight/Treatment

Source of variation	Dl	SC	CM	F.calc	F.tabulated (5%)	F.tabulated (1%)	Conclusion
Total	23	7419.09	-	-	-	-	
Blocks	3	234.31	78.10	1.35	3 .29	5.42	NS
Treatments	5	6316	1263.2	21.81	2.90	4.56	**THS**
Error	15	86878	57.92	-	-	-	

Partial interpretation about the collected yields (19/11/2016)

Up to now, the only parameter ending with differences between treatments is the weight of produced grains as depicted in Table 7.6.

The observed general trend is the following based on table T7.3: T3 > T2 > T4 > T1 > T5 >T0

This general grain increment relies on the presence of bio-insecticide plants (see Table 2) incorporated in the biofertilizer; that seems to be, the beneficial effect of incorporating insecticide plants while preparing biofertilizers.

With those included products, seeds and grains are well protected against insect attacks in the storage place.
The weak yield registered for T5 treatment may certainly be due to the fact that the mixture of leaves and sprouts with a high C/N ratio (> 20) have a very low decomposition rate and soil nutrient release.
Higher grain yields have been observed with Tithonia diversifolia than with Nicotiana tobacco despite the fact that those 2 plants have the insect expelling effect.
Those results are backed with the results found by Melisa, 2016.

Future perspective
We do think that this experiment must be resumed and tried even with corn which is a crop well suited to this kind of experimental trials.
The behavior of leguminous crop faced to biofertilizers application is quite normal. We must bear in mind that leguminous crops belong to the group of plants having a low demand soil nutrients since they produce nitrogen themselves through nodulation process and the rest of soil nutrients can be obtained on permanent basis if << ***the space-time crop rotation***>> is properly respected in the field.

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Experiment 6 << Effect of leaf spray application of homemade biofertilizer compared to commercial fertilizers (NPK, 17-17-17) and liquid fertilize(Digro) on apical brown disease of tomato crop>>

by Mondjalis P., Mossala L. and Miss Mellisa Mupepe, 2017

Justification

Here in DRC, we are still using commercial fertilizers (NPK) and other liquid fertilizers (Digro) without any knowledge of their chemical composition.
We already demonstrated some years ago that there is no need to use NPK in all our cropable lands since those fertilizers do not correspond to the ion deficiency of our major soils types.
Beside this, they are too expensive for most of our smallholding farmers.
We are bound to find less expensive alternative ways but able to increase food production in all our rural areas.
Biologic fertilizers exist such as guano and other mineral deposits. But we do think that it is wise to advise the use of homemade biofertilizers. Some biofertilizers have insecticide effects and all depends on the plant materials used to produce them.
This experimental trial has been set up in order to evaluate the beneficial effect of using them in order to reduce brown disease on tomato crop.

Experimental site

This experimental trial has been conducted in the experimental site of ISTA which is located in Kinshasa City, the main town of DRC .
Experimental site : d'ISTA/Meteorological Section Taxonomic unit: Iso hyperthermic Haplorthox Experimental design : CRD
Repetitions(blocks) : 3 Number of treatments : 4
T0,T1(NPK),T2(Di.Grow) et T3(bio fertilizer).

1 Methodology

Application methods

1.1

T1 : dissolution of 70 g of NPK (17-17-17) in 15 liters of distilled water, the application rate has been 140 ml(content of 2 boxes of tomato paste) every 10 days after transplanting a small plant 10 to 15 cm tall with at least 5 leaves, the 140 ml have been incorporated in the ground at 10 cm on a ring around the stem.

T2 : diluted solution of Di.Grow(2.5 liter/15 liters of distilled water),the application rate has been 140 ml(content of 2 boxes of tomato paste) every 10 days after transplanting a small plant 10 to 15 cm tall with at least 5 leaves,the 140 ml have been incorporated in the soil at 10 cm on a ring around the stem.

T3 : diluted solution of bio fertilizer(2.5 liter/15 liters of distilled water), the application rate has been 140 ml(content of 2 boxes of tomato paste) every 10 days after transplanting a small plant 10 to 15 cm tall with at least 5 leaves, the 140 ml have been incorporated in the soil at 10 cm on a ring around the stem.

Composition of T3 treatment

Tobaco leaves, palm tree male flowers (50Kg/180 liters of distilled water) + leaves of Leucaena l., Albizzia L., Colocasia, Jacinthe d'eau. For each selected leave type, 10 kg were required ; the anaerobic digestion was done during 60 days.

Table 1 Chemical analyses. Table 1.1 Tobaco leaves

Nicotine %	Anatabine %	nornicotine %	Anabasine %
93	3.9	2.4	0.5

Table 1.2 Starch of male flowers/Palm tree

Nicotine %	Anatabine %	nornicotine %	Anabasine %
2 to 9	14	1 to 4	0.5 to 2

Table 1.3 Chemical anlysis of the biodigestat

N(mg/li)	P(mg/li)	K(mg/li)	S(mg/li)	Mg(mg/li)	pH
2700	346	342	812	400	5.7

Table 1.4 Chemical composition of some animal species (effective biofertiliser)

Species	**Contents/ 100 g de produit**					
	N %	P_2O_5 %	K_2O %	Ca0 %	Mg0 %	(S03) %
Poultry dump	2.65	3.04	9.72	13.4	6.2	-
Sheep dump	2	1.5	3	4	2	1.5
Goat dump	1.5	1.5	3	2	-	-
Horse dump	3 to 6	1.5	2 to 5	1.5	1	0.5
Cattle dump	2	1.5	2	4	1	0.5

Source : Autissier, 1994. Jardins des villes, jardins des champs. Librairie Mon jardin, Ma maison. 17 rue du Montparnasse.75298 Paris Cedex 06

2 Results and required interpretation

Table 2.Number of affected plants

Treatment	**Block 1**	**Block 2**	**Block 3**	**Total**	**Mean values**
T0	9	6	5	24	7
T1	5	5	4	14	5
T2	4	4	6	14	5
T3	-	3	2	5	2

Table 3. Variance analyses

Source of variation	**Dl**	**SC**	**CM**	**Fcal**	**Ft (0.05)**	**Ft(0.01)**	**Decision**
Total	11	234.08	21.28	-	-	-	
Treatments	3	62.92	20.97	5.01	2.45	3.51	**THS**
Blocks	2	38.25	19.112	9.56	2.32	3.34	**THS**
Error	6	0.17	0.02				

Table 3 obviously shows that there is difference between blocks mainly due to the soil fertility trend in this experimental field but the differences between treatments is bound to the presence of nicotiana which has insecticide effects.

The application of Bio 3(T3) to the plants gives them high resistance to insects' attacks and the general trend is therefore:

T3 (75 %) > T1 and T2 (30 %)

25 Kg of NPK commercial fertilizer does cost around **80 Us $** if bought in Kinshasa City and one must add to this amount, the transportation fees to bring this product to the field, that is roughly the same for liquid Digro fertilizer; with less than that which is around **20 Us $,** the poorest farmer can afford it and prepare 20 liters by himself.

Consequently, we are allowed to transfer this technology to rural areas.

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Experiment 7 << Comparison trial dealing with the effect of soil incorporation Tithonia diversifolia leaves/stem, earthworm dejections, ground bed rock and ground termite hill on the selected growing parameters of corn, QPM3 >>

By Mondjalis P., Mossala L. and Pay-Pay N., 2017

Abstract

As far as we can judge, this is one of the best experimental trials since we have compared different available organic materials easily found in rural areas and their effect on the growing parameters of QPM 3, which is a cereal variety very rich in potine.

Better results have been obtained with the incorporation of *Tithonia* leaves and small cuttings at 10 cm in depth.

As already mentioned in previous studies, this species has a very low C/N ratio and has a high decomposition rate and therefore it rapidly releases nutrients and make them available to the growing trees.

The problem with ground termite hills and earthworm dumps is that they do not have available nutrients enough for plant growth, they contain just little amount.

The ground bed rocks definitely contain the macro as wells as microelements necessary for plant growth but in this experiment, the obtained results are weak or non-significant since the ground rocks do still have intact mineral crystals which must be destroyed by the alteration phenomenon before the release of the ions they contain.

Best results can and must be obtained either with ground lava or volcanic ashes and after sieving, small granules having a diameter of 2 mm can then be incorporated in the soil at 10 cm depth.

The lesson derived from this experiment is that we do not need, the country does not need to waste a lot of money to buy commercial fertilizers in order to improve soil fertility level and increase the agricultural production there are suitable available natural resources enough to give us the same results.

Geographical position of the experimental field Experimental site.

The experimental site is located in the alvial deposits of the Kwilu river and mainly in the experimental field of the University of Kikwit, which is located in Bandundu Province in DRC.

The major soil type: an typic Haplorthox.

Geographical position of the site

Southern latitude: 5°2’

Eastern longitude: 18°48’4’’

Altitude: 375 to 480 m.

Methodology

Experimental design: CRD

Number of treatments: 5

Number of replications: 4

Selected different growing parameters: the stem height, the stem diameter, the leaf surface development and grain yields.

Different treatments:

T0: blank treatment

T1: incorporation of Tithonia leaves and or cuttings, quantity of the product incorporated/10 Kg/m^2.

T2: Earthworm dejections: 10 Kg/m^2., **T3** : ground bed rocks : 10 Kg/m^2 and **T4**: ground termite hills 10 Kg/m^2 also.

Experimental plot size: 15 m^2.

Incorporation time: 45 days previous to sowing

The uptake period of ions by plant roots: 60 days approximately after sowing.

Obtained Results and interpretation

Table 1 : Germination %

Treatment	Blocs				Mean values ± S
	I	II	III	IV	
T0	60	50		40	1.0000 ± .00
T1	100	90	90	100	1.0000 ± .00
T2	80	90	90	70	1.0000 ± .00
T3	70	60	60	70	1.0000 ± .00
T4	60	40	60	50	1.0000 ± .00
Mean					1.0000 ± .00

Partial interpretation.

Table 1 clearly shows that the germination is not affected by the different treatments; the germination is bound to the genetic aspect of the cultivar and roughly to other environmental conditions.

Table 2. Results of plants' height

Treatment	Blocks				Mean values ± S
	I	II	III	IV	
T0	0.25	1.35	1.36	1.4	1.09 ± 0.56
T1	2.4	2.19	2.4	2.14	2.28 ± 0.14
T2	1.5	1.35	1.39	1.42	1.42± 0.06
T3	2.04	1.32	1.51	1.69	1.64 ±0.31
T4	1.8	1.03	1.47	1.02	1.33 ± 0.38
Mean					1.552± 0.29

Table 2.1Variance analyses

Source of variation	Dl	sc	µ sc	Fc	*Ft*		decision
					5%	1%	
Total	19	5.121055					
Block	3	43.115645	14.37188167	10.93	3.49	5.95	**Ths**
Treatment	4	3.29148	0.82287	2.61	3.89	6.93	**Ns**
Error	12	41.286038	3.440503167				

Partial interpretation.

Despite the fact that Table 2.1 does not show significant difference between treatments except for the blocks, this does not mean that there is no difference at all. The general observed trend derived from Table 2 and which is likely to be the case for all studied parameters is:

T1>T3>T2>T4>T0

Tithonia is a plant with a very low C/N value and it has the capacity of releasing ions to the root system very rapidly. Treatment T3 is composed of ground crystals of bed rock and the amount of beneficial ions for plant growth is high; T2 and T4 derived from organic compounds having weak cation concentration.

Table 3: Stem diameter (cm)

Treatment	Blocks				Means ± S
	I	II	III	IV	
T0	3.75	3.12	3.44	3.12	3.36± 0.30
T1	5.31	4.38	4.69	5.00	4.86 ± 0.4
T2	5.25	3.81	4.06	4.38	4.38 ± 0.63
T3	4.81	3.75	4	4.38	4.24 ±0.46
T4	4.38	4.00	3.75	3.75	3.97 ± 0.30
Mean					20.78± 2.090

Table 3.1 Variance analysis of the stem diameter variation

T6(6).Mean diamter of the stems (cm)							decision
Source of variation	Dl	sc	µ sc	Fc	Ft		
					5%	1%	
Total	19	96.904845					
Block	3	85.11938	28.37312667	1.39	3.49	5.95	**NS**
Treatment	4	63.0436	15.7609	0.77	3.89	6.93	**Ns**
Error	12	245.067825	20.42231875				

Partial interpretation.

The stem diameter of this plant is neither affected by the treatments nor by the soil fertility variation of the field (blocks). But the observed obtained values as depicted in Table 3 show the following trend: **T1>T2>T3>T4>T0**

Table 4. Number of leaves/plant

Treatment	Blocks				Mean ± S
	I	II	III	IV	
T0	9.3	9	9.38	9.12	9.2± 0.17
T1	11.69	10.31	10.5	10	10.62 ± 0.74
T2	10.69	9.88	10.25	10	10.2± 0.36
T3	10.5	9.38	9.75	10.25	9.97 ±0.5
T4	9.38	9	10.19	9.56	9.53 ± 0.5
Mean					49.52± 2.27

Table 4.1 Variance analysis

T6(3).Average number of leaves/plant							Decision
Source of variation	Dl	sc	µ sc	Fc	Ft		
					5%	1%	
Total	19	8.63					
Block	3	2.35	.78	3.39(Ns)	3.49	5.95	**Ns**
Treatment	4	3.5	.88	3.83(Ns)	3.89	6.93	**Ns**
Error	12	2.78	.23				

Partial interpretation.

The number of produced leaves of this plant is neither affected by the treatments nor by the soil fertility variation of the field (blocks). But the obtained values as depicted in Table 4 show the following trend: **T1>T2>T3>T4>T0**

Table 5. Number of tuft (≈ obtained yield)/Plant

Treatment	Blocks				Mean ± S
	I	II	III	IV	
T0	1	1	1	1	50.0 ± 8.16
T1	1	1	1	1	95.0 ± 5.77
T2	1	1	1	1	82.5± 9.57
T3	1	1	1	1	65.0 ±5.77
T4	1	1	1	1	52.5 ± 9.57
Mean					69.00± 7.77

Partial interpretation.

With the values obtained from Table T5, we cannot expect to have differences blocks and even between treatments but the general trend of the mean values in Table 5 shows the same results which mean that: **T1>T2>T3>T4>T0**

General interpretation

The positive aspect of this trial is that it clearly demonstrates that in our country, there is no need to spend a lot of money importing commercial fertilizers since we can improve the soil fertility level and improve at the same time the agricultural production by using natural organic fertilizers and small ground bed rocks.

Best results can be readily obtained by soil incorporation of green materials but they must have a low C/N ratio such as that of *Tithonia diversifolia*. Other organic materials can be used too but differences may occur due to the concentration variation of the major and minor nutrient ions they possess. That is the reason why we have this difference here between T2 and T3 treatments.

The incorporation of ground bed-rocks is another alternative to improve soil fertility level.

But all will depend on the chemical composition of the bed-rocks and the size of ground materials to be incorporated in the soil.

As far as we can judge, particles having a diameter ranging from 50 to 1000 µ will give the best results since they are likely able to rapidly release different ions they contain by degradation procedure.

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<<Biofertilizants Complements>>
By Prof. Titular Gilmar Tavares - DEG/UFLA/BRASIL
(Extensionist / Agroecology / Family Farming)

Toxicity

Biofertilizer, in principle, has indeed a very low toxicity to persons and anaimals and environment. Even, it is advised not to let it come into contact with the mouth, nose, ear and eyes. Then, as a precaution, all contact of the product with the skin should be washed with clean water. Cares mainly with children is recommended as a priority, when biofertilizers are being obtained, handled and applied.

Grown-ups who are handling biofertilizers, even not having evident contact, should wash their hands, arms all the face with clean water after handlings. There being contact with any part of the body, one should wash this part of the body with clean water.

Attention: These recommendations are only zealous. Biofertilizer, in principle, has very low toxicity indeed.

Biofertilizer can be used in all and any crop. But the utilization of biofertilizers should be controlled to avoid excesses.

Even having a number of advantages in its use, the excess biofertilizer may cause chemical, physical and biological imbalance, making the soil unfit for the cropping of certain species in the same way as chemical fertilizers.

The spraying of biofertilizer should be done always after waterings or rains or in the freshest times of the day. Both the frequency and time of fertilization obey the calendar of each species.

Recommendations:

Biofertilizers can be utilized for the direct leaf applications (sprays) on fruit-bearing trees (proportion of 1 L to 20 L of water), vegetables (200 mL to 20L of water) or bean, corn and cassava (400 mL to 20 L de water) and all the other crops, as well as pastures. These applications can be repeated weekly till the second month of growth of the crops. From the third month on, five applications every 15 days are recommended.

Leaf applications during the blooms of the plants are not recommended. Applications before the blooms and after the fecundation are recommended, the application being permitted on the growing fruits.

When sprayed directly on the leaves of the vegetables or on the fruits to be collected soon (almost ripe), one should wait at least 45 days for human consumption of these raw products. Even so, before consuming, it is recommended to wash the vegetables and fruits with solution 2% of vinegar in drinking water. The products fresh –cut with boils, roasted, cooked or others are safer.

If biofertilizer is obtained only with plant products, in other words, without the use of animal manure, the raw plant products will be able to be consumed after the seven-day waiting period, after being washed with running clean water. But the ideal is for them to be washed with 2% solution of vinegar before being consumed. If it is not possible to use vinegar, then plant products should be very well washed in drinking water.

Then in the case of doubts or distrust of the farmer, for vegetables of immediate consumption, only fertirrigation is recommended, that is, to apply the biofertilizer directly onto soil, diluted in clean water and wash the products before they are consumed. Directly on soil in the form of fertirrigation, the biofertilizer also confers excellent growth on plants.

The solid part of the biofertilizer, that is, the material which remains retained in the sieve after filtering for the liquid use in the field, also is an excellent source of organic matter and nutrients which can be applied in soil.

Attention: in the pastures, a seven –day waiting period is recommended for the resident animals to return to graze in the place of the application. The seeds will also be to be treated with the pure biofertilizer before planting, soaking for 20 minutes into pure syrup. Soon, next, one should wait for

them to dry and, then, they are planted.
At last, it is known that the single applications are not be done, since losses of nutrients can occur through leaching, erosion. The application even before collection is recommended, for the plant gets used to the food and when this is lacking it can become sick. But, remember that what distinct the medicine from the poison is the dose of the dilution.

<<Composting>>
By Prof. Titular Gilmar Tavares - DEG/UFLA/BRASIL
(Extensionist / Agroecology / Family Farming)

A Composting as a scientifically proven and approved social and environmental technology consists in creating conditions and disposing in an appropriate place, the natural raw materials, rich in organic nutrients and minerals, especially the carbon and nitrogen (C / N) ratio favorable to the development of agricultural plants and crops.
This favorable C/N ratio should be around 30/1, i.e, for each part manure (N-nitrogen host), 30 parts of straw (C-carbon host) should be present.
Therefore, the greater the diversity of natural materials for the preparation of the compound is, the better the quality of the final product in nutritional terms, in its physical and chemical aspects.
However, when such *in natura* raw material is taken to some place to be decomposed, but there, it is heaped in any way and/or anywhere, then there is a false composting. Composting becomes false, because lack of care in management cause the raw material to become insufficiently decomposed, or semi-decomposed, as it is randomly subject to the weather. In this state, it can cause the irretrievable loss of its fertile elements through the solubilization and leaching of the soluble nutrients.
In addition, with poor management, this semi-decomposed raw material can also cause serious environmental impacts, such as:
1) Contamination of surface waters and groundwaters through the transport of mineral and organic particles from the host soil.
2) Supporting of the development of harmful insect and rodent populations as well as undesirable microorganisms that will consume the available nutrients in organic matter, reducing nutrient reserves for plants, weakening them.
Example of diseases caused by the mismanagement of composting: coffee wilt disease, the wilt bacteria (*Erwinia tracheiphila* pathogen) and cassava mosaic, besides others.
Therefore, since the organic compost resulting from composting has the advantage of being an inexpensive and ecologically correct natural fertilizer, which is very easy to obtain, these findings (rodents and diseases) and also the difficulty of obtaining them contradict the main objectives of composting, which are:
1) Replace chemical fertilizers with economic, social and environmental advantages,
2) Reduce the amount of wastes produced in agricultural production;
3) Reduce environmental pollution.

Conditions necessary for the realização of the correct compostings:
The place chosen to do the composting should:
1- be of easy access,
2- to be close to the place the strawy material is stored, which will be used in great quantity;
3- be close to a water source, since the material will be wetted as the layers are placed and also when the material will be revolved, which will happen several times during the composting process;
4 - be in a place with suave slope (up to 5%), to facilitate preparation and handling of the compost pile, but allowing drainage of rainwater
Atention: lowland places, susceptible to flooding, should be avoided. The compost can be made in the open field, in beaten ground, being cemented floor unnecessary, but the ideal is under the top of a shady tree.

Material suitable for the composting process
All plant debris from crops, orchards (leaves, flowers, fruits and their barks), animal manures in general (except of dogs and cats) forage banks, grass trimmings, fruits and leaves of the natural and native flora, small branches (small branches, twigs), wood fuel stove ashes.

Important: Materials that should not be used to do composting are as follows:
1) Eucalyptus. Eucalyptus is the only plant strictly prohibited from being added to composting, including its leaves. Therefore, do not use eucalyptus derivatives (leaves, branches, barks and roots) under any circumstances.
2) Thick branches, bulky tree bark, wood treated with pesticides against termites or varnished, glass, metal, oil, paint, leather, plastic.
On the other hand, residues as whole stems also delay decomposition, because they retain little moisture and have a smaller contact surface with the microorganisms.
The presence of seeds of invading weeds, pests, pathogens and heavy metals, which adversely affect agricultural production, are also considered undesirable agents. But, the pathogens and seeds of invading weeds will be able to be eliminated through the complete composting process, conducted correctly.

The mounting of the heaps must obey the following sequence:

1) - distribute a layer of material of plant origin on the soil 15 cm high and 1.5 meters broad or so, the length may vary according to the amount of material to be composted,
2)-distribute a layer (10 cm or so) of animal manure over this first plant layer.
3)- If there is available wood fule stove, spray a thin layer of these ashes over the entire first layer of animal manure;
4) Repeat this construction, layer by layer, successively, until the available materials are exhausted;
5) The height of the heap is free, but it is recommended that it be enough to be handled easily;
6) Damp the entire heap with a watering can and from top to bottom. The amount of water should be sufficient for the water to flow off in small quantity, at the base of the heap itself.
7) Cover the ready heap with dry straw or even a plastic canvas to keep moisture and composting temperature constant.
8) Thoroughly stir the entire heap every two days and, after revolving, moisten it again, repeating step 6;

Time of composting

The time for decomposition of organic matter depends on several factors. The greater the control of temperature and moisture conditions the faster the process will be. If the nutrient requirements of the heap or small cultivated plot are satisfactory, the added materials of small sizes, the adequate moisture maintained and the heap revolved every week, the compound will be stabilized within 30 to 60 days and cured between 90 to 120 days.
After this period, it will be ready to be used. It is noticed that the compound is ready when there is no loss of water, it is dark in color, it is loose and it smells of earth. When rubbing the compound between the hands, they do not become dirty.

MOISTURE:

One of the ways to check the moisture content is to tighten the compound with your hands: if it has a suitable concentration of water (60%), we may feel the moisture and aggregation of the material.

TEMPERATURE:

It is desirable for it to vary from 60 oC to 70 oC in the first 25 days of composting and then naturally the temperature decreases.
The temperature and moisture can be controlled with a building iron bar inserted into the heap. This should be withdrawn daily, observing when withdrawn if:
1 - it is hot and wet, so there is no need to wet the compost heap;
2 – In case it is dry, you should wet the heap very well until water appears underneath

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1- Agroecological water filter;
http://repositorio.ufla.br/handle/1/15217

2- Some African tales;
http://repositorio.ufla.br/handle/1/11156