

## EFFECT OF COMPOSTING OF PALM OIL MILL WASTES AND ORGANIC MANURE ON TOMATO (*Lycopersicon esculentum* Mill.) GROWTH AND YIELD

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### Abstract

Compost made of palm oil empty fruit bunches, fibre, poultry manure and cattle dung composted in shelter were applied to tomato [*Lycopersicon esculentum* (Mill.)] to evaluate their effects on its growth and yield. The trials consisted in a split-split plot design with two levels of composting method (without cover or under cover) and the types (no manure, poultry manure, cow dung) and rates of compost application (0t/ha, 5t/ha, 10t/ha, 20t/ha) as secondary factors. *The height and stem girth of three plants per plot were measured weekly at 6 weeks after transplanting. The total number of fruits, marketable fruits and fruit weights were collected at production phase.* All data collected from the tree trials were put together and the analysis were made with four ways ANOVA with repeated measured to determine if there were significant differences amongst treatments. There were no significant effects between the compost made under cover and those made in the open on tomato plant height at 6 weeks after planting. There was no significant effect of composting method, type of manure and compost rate application on *Lycopersicon esculentum*. The effect of compost application on tomato yields was significant at 10t/ha compost application rate. The total number of tomatoes fruits depended significantly ( $p < 0.05$ ) on the compost application rate. The highest number of tomatoes fruits obtained was 19.4 at 20t/ha as compost application rate.

**Keywords:** Aricsol, compost, manure, palm oil mill wastes, tomato

### Introduction

**A**mong the local resources, palm oil mill wastes as empty fruit bunches and fibre were found to be a good alternative fertilizer for farmers of southern Benin to fertilize their soil (Koura *et al.*, 2014a; Koura *et al.*, 2014 b). These wastes can be sustainably managed through their composting (Rupani *et al.*, 2010; Singh *et al.*, 2011; Singh *et al.*, 2010; Embrandiri *et*

*al.*, 2012; Koura *et al.*, 2014b). Recent studies have shown that palm oil mill wastes mixed with poultry manure composts improved *Amaranthus hybridus* growth and yield (Koura *et al.*, 2015a). These palm oil mills wastes are rich in fibre and potassium (Nutongkaew *et al.*, 2011). According to FAO (2003), 170 kg of nitrogen, 80 kg of phosphorus, 340 kg of potassium and 60 kg of magnesium per hectare are necessary to obtain 10 to 12kg of tomato per m<sup>2</sup>.

Palm oil mills wastes composts enriched in manure can be a good organic fertilizer for cultures which need a high quantity of nitrogen and potassium as tomato (Rekken, 2012). Tomato is the most widely grown vegetable in the world, particular in Benin republic where it plays a vital role in social, economic and nutritional scheme. it is an important source of income to rural, urban and periurbans producers who involve in its production (Dossou *et al.*, 2006 ; Djidji *et al.*, 2010; Ezin *et al.*, 2012). The demand is very high and very far from being satisfied in any season by local production. Tomato production under rained conditions is prone to low yields despite the introduction of improved varieties with high yield, very demanding in soils with acceptable physical and chemical properties to express their potential (Newman, 2002; Agbossou and Newman, 2004 ; Assogba-Komlan and Chabi, 2001). Also in acrisol land area of South Benin, organic matter is a most deficient factor, which leads leaching and volatilization of nitrogen, and also a great loss of water because of the low water holding capacity of these soils (Agbossou and Newman, 2004; Affaton, 2008).

Therefore, this study was carried out to evaluate the effect of fertilization of acrisol with compost from palm oil mill residues and animal wastes, and at what dose for high tomato production.

### Material and Methods

#### Experimental site

Three field experiments were conducted in one palm oil mill, Ets “GBEMAWONMEDE” farm at Sakete district in Plateau department (Figure 1). Located between latitude 6° 44' 11"N and 2° 39' 29"E, this site is submitted to Guinean

climate with 2 rain seasons and 2 dry seasons with a cumulative monthly rainfall of 48.78 mm in 2000 to 169.56 mm in 2010. Monthly cumulative evapotranspiration from 2000 to 2010 in this area vary between 117.32mm and 159.81mm (CeCPA Sakété, 2012). During the experiments, the quantity of rain varied between 44.7mm in July to 177.1mm in September.

#### Experimental soil analysis and composts use characteristics

Soils samples were randomly taken at the surface (0-15cm) and physico-chemical properties were determined in Laboratory of Soil Science (LSS) of Faculty of Agronomic of Abomey-Calavi University. Soil pH was determined using the potentiometric method with a pH meter. Nitrogen was determined using kjeldahl method. Organic matter was determined with incineration method and carbon content was accessed though the formula: Carbon Content= Organic Matter/1.724. Metson method (1956) was used to evaluate CEC and Spectrophotometer of Atomic Absorption (SAA) for calcium, magnesium and potassium content determination in soil. Phosphorus was determined with Bray I method.

Six types of compost were used:

- i. Compost C1 made with Empty Fruit Bunches and Fibre in opened boxes
- ii. Compost C2 made with Empty Fruit Bunches and Fibre and Poultry manure in opened boxes
- iii. Compost C3 made with Empty Fruit Bunches and Fibre and Cow dung in opened boxes

- iv. Compost C4 made with Empty Fruit Bunches and Fibre in under shelter boxes
- v. Compost C5 made with Empty Fruit Bunches and Fibre and Poultry manure in under shelter boxes
- vi. Compost C6 made with Empty Fruit Bunches and Fibre and Cow dung in under shelter boxes

Table 1 presents composts physico-chemical parameters. The compost made from POMW and poultry manure under shelter or not showed higher nitrogen, phosphorus and lower calcium levels. Compared to composts made without manure (C1 and C4), composts made with manure were in calcium.

complete block design with four replications. The main plot was the composting method (open and cover systems) while the type of manure (No manure, poultry manure, cow dung) and rates composts (0t/ha, 5t/ha, 10t/ha, 20t/ha) are the two subplot factors. Three trials were installed. So there are 288 experimental plots. The experimental plot size was 1.5m x 1m. Plant spacing was 0.4m x 0.8m. Composts quantities applied depended on their dry matter and were mixed with the topsoil. Nuisibles and diseases were controlled by bio-pesticide recommended in CIEVRA. This pesticide was made with pepper powder, oil neem (*Azadirachta indica*), local soap « koto » and water and application to tomato at 2 weeks after

**Table 1: Composts physico-chemical parameters**

Composting method	Type of manure	pH	-----%-----				-----mg/g-----			
			H	DM	C	N	P	K	Ca	Mg
Under shelter	No Manure	7.3	49.29	50.71	42.93	1.4	0.38	2.26	8.29	3.77
	Poultry Manure	6.7	43.43	56.57	28.71	1.61	1.27	1.12	12.01	2.94
	Cow Dung	6.9	41.72	58.28	28.64	1.06	0.2	0.9	14.19	3.61
No shelter	No Manure	6.6	53.28	46.72	42.1	0.62	0.42	1.44	4.75	3.76
	Poultry Manure	6.5	47.07	52.93	35.53	1.22	1.26	0.74	15.71	2.95
	Cow Dung	6.5	45.48	54.52	28.15	0.7	0.3	1.76	12.41	4.01

### Planting material and Experimental design

Tomato variety Roma VF was used for this experiment. This variety has 75 days vegetative cycle and is well adapted to tropical conditions (Nzuki, 2011). This variety was provided by BENIN SEMENCE, a commercial center in Cotonou. The experiment was laid out as split split plot arrangement fitted into a randomized

transplantation (WAT) was not effective. A biopesticide which consisted of ails juice and neem cake extract was therefore added and applied at 3, 4 and 5 WAT.

### Data Collection and analysis

Data collection begins a week after transplantation. Three plants were randomly

selected in each plot and tagged. Plant height and stem girth were determined weekly with a ruler and veneer caliper respectively. Fruit yield was determined by weighing and counting the number of marketable and non- marketable fruits. Data

collected were subjected to four ways Analysis of Variance (ANOVA) using SAS software and means were separated with LSD at 5% propability level.

**Table 2 : Effect of composting methods, type of manure and compost rate on stem girth of tomato**

Source	F value (signifiacnce)			
	DDL	Height	DDL	Stem girth
Time	6	14026.9*****	5	16613.4*****
Time x Essai	12	4.51***	10	12.58*****
Time x B(Essai)	54	0.7	45	0.44
Time x MC	6	0.36	5	0.43
Time x TF	12	0.61	10	0.74
Time x D	18	0.42	15	1.03
Time x Essai x MC	12	2.62*	10	2.81**
Time x Essai x TF	24	0.98	20	0.72
Time x Essai x D	36	1.04	30	1.12
Time x MC x TF	12	1.49	10	0.95
Time x MC x D	18	1.04	15	1.07
Time x TF x D	36	0.9	30	0.87
Time x B x MC (Essai)	54	2.83*****	45	3.06*
Time x B x TF (Essai)	108	1.48*	90	1.93*
Time x B x D (Essai)	162	1.28	135	1.17
Time x B x MC x TF (Essai)	132	1.32	110	1.37*
Time x B x MC x D (Essai)	198	1.13	165	1.22
Time x B x TF x D (Essai)	396	1.13	330	1.20*
Time x MC x TF x D	36	0.97	30	0.57
Time x B x MC x TFx D (Essai)	396	1.17	330	1.24*

**Note:** B: Block; MC: Composting method; TF: Type of manure; D: compost application rate; \*: the effect of the factor was significant at 0.05; \*\*: the effect of the factor was significant at 0.01; \*\*\*: the effect of the factor was significant at 0.001;\*\*\*\*: the effect of the factor was significant at <0.000 1

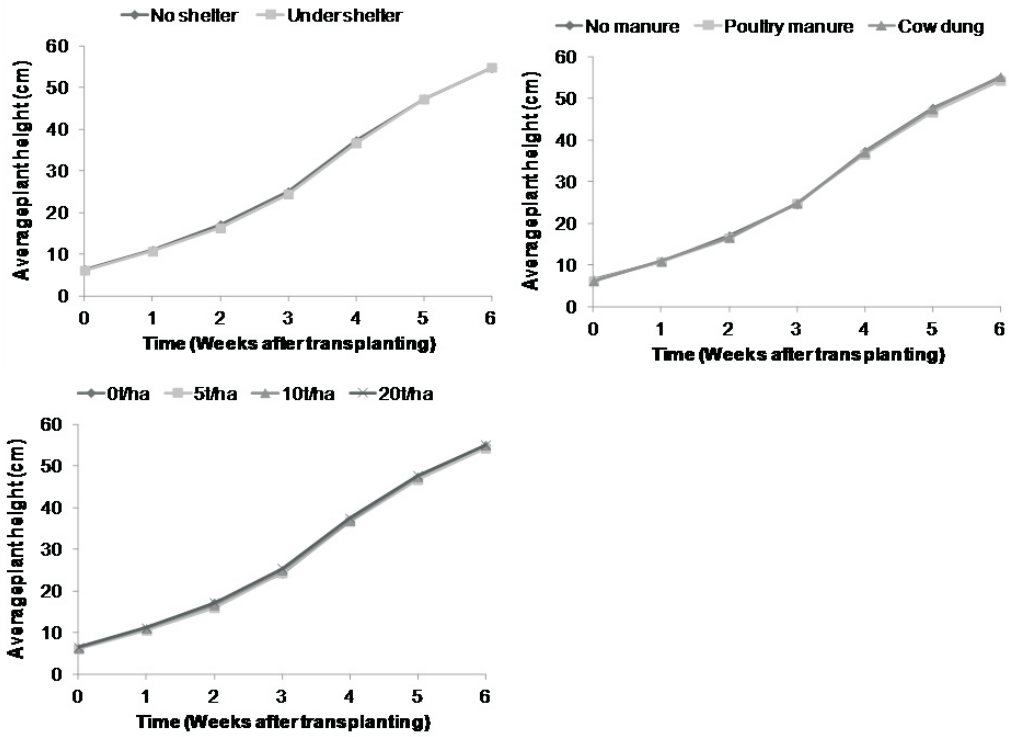


Figure 1. Effect of composting method on *Lycopersicon esculentum* height

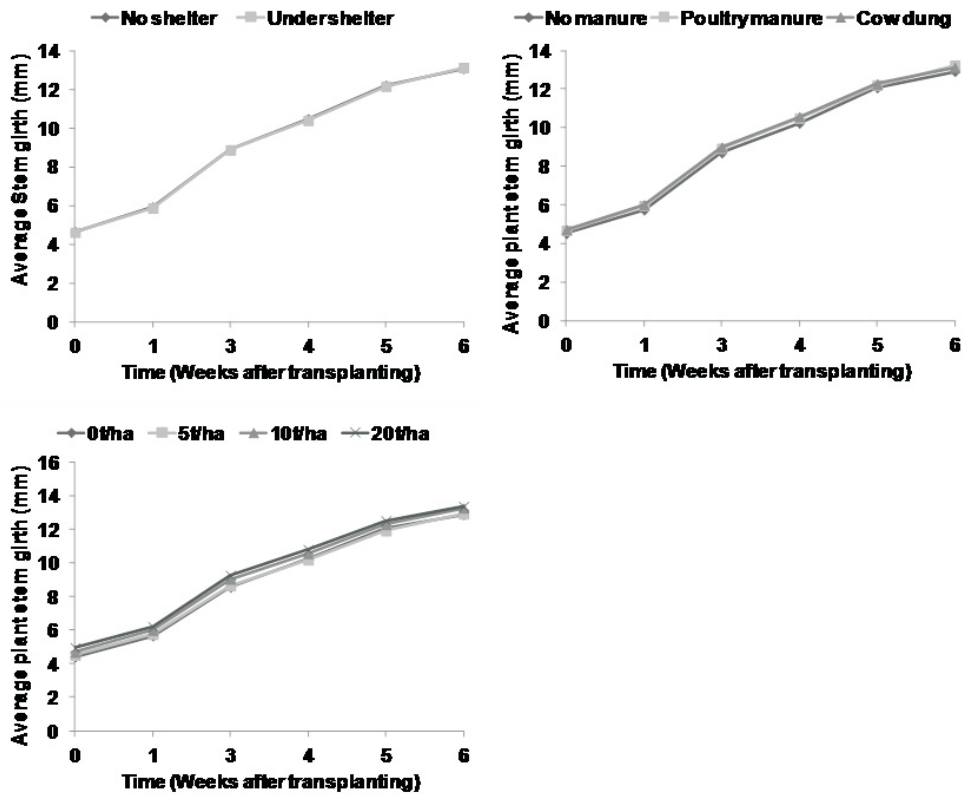


Figure 2. Effect of composting methods on tomato stem girth

## Results

### Soil physico-chemicals

The results of the soil analysis revealed a sandy soil, relatively acid (pH (H<sub>2</sub>O) = 6.4, pH (KCl)=6.2), poor in nitrogen (0.1%) but with appreciable exchangeable bases (13.38 meq/100g), phosphorus (72.41 p.p.m) and potassium (1.14 meq/100g). C/N mass ratio was 12.6.

### Effect of composting method, type of manure and compost application rate on tomato growth

At six weeks after transplanting (WAT), tomato plant height was 54.7 cm and 54.8cm respectively for plants with compost made in the open and those made under shelter (Figure 1). Similar results were obtained for stem girth, however, these means were not statistically different from each other (Table 2 and Figure 2).

### Effect of composting method, type of manure and compost application rate on tomato yield

Table 3 presents the yield component of tomato according to the various treatments. There was no significant difference between yield (total number of fruits, total number of marketable fruits and marketable fruit weight) obtained when the composting was made in the open system and when it was made under cover. Although the total number of fruits, total number of marketable fruits and marketable fruit weight (18.7 per plant, 15.4 per plant and 9.3t/ha respectively) obtained with compost made with cow dung was superior to those obtained with compost made with poultry manure (18.4, 14.8 and 27.3t/ha respectively) and those made without manure (17.9, 14.2 and 27.6/ha respectively), there were no significant (P<0.05) difference among these three treatments. The effect of compost application rate was

**Table 3: Effect of composting methods, types of manure and compost rate on tomato yield**

Treatments	Total number of fruits	Total number of marketable fruits	Marketable fruit weight (t/ha)
Composting method (A)			
Open system	18.2	14.7	28
Covered system	18.4	14.9	28.1
LSD <sub>0.05</sub>	0.81	0.86	0.94
Type of manure (B)			
No manure	17.9	14.2	27.6
Poultry manure	18.4	14.8	27.3
Cow dung.	18.7	15.4	29.3
LSD <sub>0.05</sub>	0.56	0.28	0.73
Compost application rate (C)			
0t/ha	16.9b	13.6	25.8
5t/ha	18ab	14.5	28
10t/ha	19a	15.4	28.6
20t/ha	19.4a	15.7	29.9
LSD <sub>0.05</sub>	0.03	0.07	0.15
A*B	NS	NS	NS
A*C	NS	NS	NS
B*C	NS	NS	NS
A*B*C	NS	NS	NS

**Note:** test showed significant effect of each treatment on *Lycopersicon esculentum* yields (P<0.05). a; b; and c: figures followed by different letters are significantly different (LSD test, P<0.05).

significant at 10t/ha. There was no significant difference among the compost application rates for these two parameters. The highest total number of marketable fruits obtained and marketable fruit weight was about 15.7 and 29.9 t/ha respectively with 20t/ha as compost application rate. There were no significant differences in the interactions between the treatments.

### Discussion

In this study, palm oil mill wastes composts did not enhance tomato growth. There was no significant effect observed when manure was incorporated in palm oil mill wastes composting. These results differed from those obtained with *Amaranthus hybridus* where the compost application affected the growth (leaf number, height and stem girth) *hybridus* significantly ( $P < 0.05$ ) and cow dung significantly increased more the plant height of *hybridus* than poultry manure (Koura *et al.*, 2015a). *Lycopersicon esculentum* yields components (total number of fruits, number of marketable fruits and weight of marketable fruits) increased when the composts were made under cover and when manure was incorporated. The none significant effects difference observed among the treatments could be as a result of the component of palm oil mill solid wastes which was rich in lignin and cellulose. Their degradation took time and generated humus that differed from labile organic amendments which decompose more quickly and release important quantities of plant nutrients (Affaton, 2008). The total number of fruits depends significantly ( $P < 0.005$ ) on the composts application rate. The highest number of fruits obtained was 19.4 per plant with 20t/ha as compost application rate. The number of

marketable fruits and marketable fruit weight increased with compost application and with the increase of its rate. These results were similar to those obtained by Babajide *et al.* (2008) who found that compost made with *Tithonia* (tournesol) without manure was self-sufficient for plant nutrition to reach optimum tomatoes fruits number and yield in comparison to other composts obtained from mixture of crops residues and various manures. However, the positive effect of composts that contain manure was due to their richness in organic matter. This is in conformity with the finding of Togun *et al.* (2004).

Effect of composts application on this vegetable yields was noticeable at 5/ha of application and was significantly different for those obtained at 0t/ha application rate. For tomato, the 10t/ha compost application rate was also sufficient to increase its yield. This confirms Assogba Komlan *et al.* (2007) who recommended 20t/ha to grow vegetables.

### Conclusion

From this study palm oil mill wastes compost did not improve tomatoes growth. However the use of poultry manure or cow dung to improve palm oil mill wastes composts didn't enhance tomatoes growth. Despite of that, these composts improve tomatoes fruits number. Farmers can don't need to use manure in palm oil mill wastes composting to improve tomatoes growth and yield. Others studies must be done on the effect of these composts on other tomatoes varieties.

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