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Sustainable Management of Biodegradable Waste in Guinea: Effect of Compost on Eggplant and Chilli Crop Yields Pepper

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Abstract

The fight against insalubrity in large urban and peri-urban agglomerations is a major challenge in developing countries. This problem is compounded by that of sustainable waste management mechanisms. Indeed, the current waste collection system in Guinea has proved inadequate, as moving garbage from point "A" to point "B" is tantamount to "moving the problem". The aim of this experimental work is to demonstrate the cost-effectiveness and benefits of sustainable waste management. As part of this drive to valorize biodegradable waste, the Waste Management Research Center has undertaken a series of activities ranging from composting organic waste to testing compost on certain crop varieties. An experimental field of 8024 m^2 was laid out and treated with 1500 Kg of fine compost in doses ranging from 2.5 to 5 T/ha. Two crop varieties, eggplant and chili, were tested. Compost application increased production yields: 15 to 21 tonnes of eggplant and 10.4 to 11.1 tonnes of chili per hectare. Growth rates compared with usual yields varied from 50% to 64% and from 11% to 17% for eggplant and chili, respectively. This study resulted in an optimum compost dose of 2.5 T/ha for this phase.

Keywords

Sustainable Waste Management, Compost, Eggplant, Chilli, Yield, IREG, CREGED

1. Introduction

The Republic of Guinea, located in West Africa, has a population of around 12

million and a surface area of 245,857 km^2. With the urbanization and population explosion of recent years, the problem of waste management in general, and solid waste in particular, from households and markets, is a major challenge. In large conurbations, such as the capital Conakry, we are witnessing a proliferation of waste of various origins from health establishments, schools and/or universities, markets and households.

The Guinean capital has just 20 waste transit and sorting zones (TSZ) and fewer than 100 controlled dumps for a population of around 2 million [1]. This shortage of TSZs and collection sites has led municipalities to opt for a public-private partnership approach, with small and medium-sized enterprises (SMEs) contributing to the sanitation of Greater Conakry. However, despite the existence of these SMEs, households still resort to a number of practices, including open-air waste incineration [2]. These recurrent practices are largely responsible for a number of environmental and health problems [1] [3]-[7]. In addition, Conakry's only landfill site is saturated and constitutes a real ecological and social disaster. As a result of recurrent malfunctions at this landfill, solid waste is proliferating all over the Guinean capital, leading to the closure of roads and drains and polluting the coastline and waterways. In its quest for a solution, the Waste Management Research Centre (CREGED), part of the Guinean Environmental Research Institute (IREG) is convinced that transporting waste from point A to point B is not a sustainable solution to the problem of waste management. On the other hand, setting up mechanisms for recycling and processing waste with a view to its recovery is a sure and promising way of combating insalubrity in the country's towns and cities. To this end, the processing and recycling of solid waste represents a real opportunity. Biodegradables can be used as fertilizers to boost agricultural yields; red sludge and plastic waste can be transformed and recycled to produce building materials [8]-[12]. This waste management alternative will kick-start eco-construction and green agriculture in Guinea in a drive for innovation and respect for environmental standards to achieve the Sustainable Development Goals (SDGs) through improved, efficient and consistent waste management in the Guinean capital. With this in mind, CREGED has embarked on a program to recover biodegradable waste by producing compost and using it as a natural soil fertilizer to improve the agricultural yield of certain crop varieties. In the coastal region of Guinea, market gardening occupies a prime position and is practiced mainly by women's market gardening groups. Despite their precarious access to agricultural inputs, these market gardening groups contribute to the supply of staple products in Conakry's various markets. The management of biodegradable waste through composting is a sure way to help these women's vegetable-growing groups in their production drive by providing natural, environmentally-friendly fertilizers. Compost could thus be positioned as a principal and effective substitute for chemical fertilizers, with a contribution upstream to the fight against insalubrity in the Guinean capital [13]-[16].

With this in mind, two widely consumed crop varieties, eggplant and chili, were

tested in Guinea to demonstrate the effectiveness of compost on yield. The choice of these two varieties was motivated by their popularity with market gardening groups, as well as their nutritional value. Eggplant has diuretic virtues thanks to its high potassium content. Several studies have shown that this vegetable is effective in reducing lipid intake and excess cholesterol in the blood. Chilies, for their part, contain significant nutritional and energy values; 100 g of chili powder has been shown to contain 263 kcal and several other nutrients such as fibre, protein, etc. [16]-[21]. Beyond the vital importance of these two crop varieties, there's also the contribution they make to protecting the environment by recovering biodegradable waste and minimizing the use of chemical fertilizers.

2. Methodology

2.1. Experimental Field

For this experimental work, a rectangular field of 8024 m^2 was laid out in six (06) identical beds of 1092 m^2 each, as shown in Figure 1. A total of 1500 kg of compost was used to treat the experimental beds.

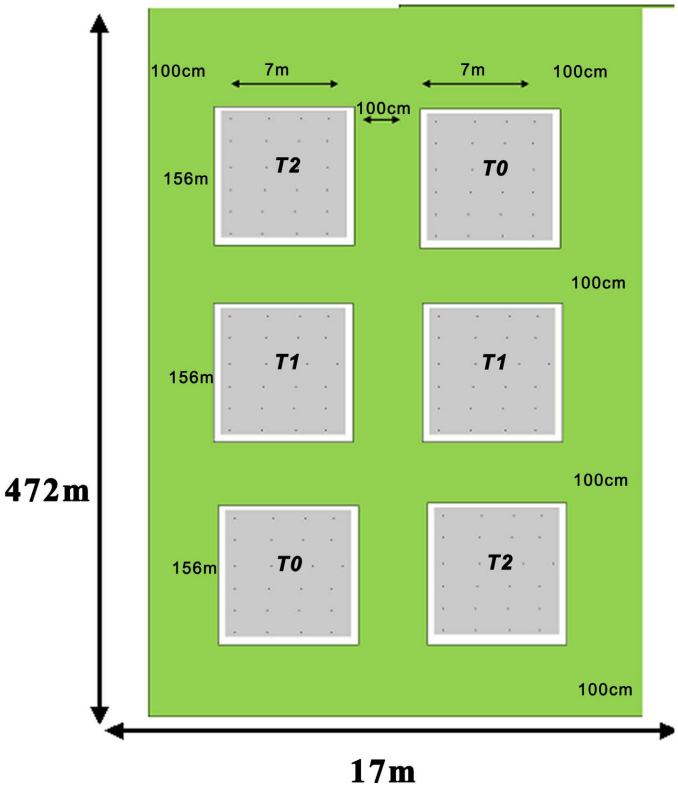

Figure 1. Experimental field.

2.2. Vegetable Material

The Barbentane variety for eggplants and the Shamsi variety for chilies were used as plant material. The development cycle and recurrent use of these varieties prevailed in their choice.

2.3. Fertilizer

Fine compost, resulting from the anaerobic decomposition of biodegradable waste, was used to provide additional nutrients to the soil in the experimental field. Obtained essentially from household waste and characterized at the National Soil Laboratory, several doses of compost were used to evaluate its effect on yield and to obtain an optimal dose for each variety tested [12] [14].

2.4. Doses of Compost Used

In order to achieve optimum dosage, two doses of compost, T1 and T2, were used on 4/6 of the beds, while 2/6 served as controls. Table 1 shows the different doses used.

Table 1. Compost doses used.

Treatment		Doses (T/ha)
Type of crop	Eggplant	Chilli
T0	0	0
T1	2.5	2.5
T2	5.0	5.0

3. Results and Discussion

Following the observations made during this experimental work, the results of the chemical analysis of the compost and yield by type of crop variety are presented. Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar.

3.1. Chemical Characteristics of Compost

The results obtained from the characterization of soil samples and the compost produced are shown in Table 2.

Table 2. Results of chemical analysis of compost in terms of major fertilizers.

Major fertilizers	N_2 (Méq/Kg)	P_2O_5 (Ppm)	K_2O (Méq/100 g)
Fraction	247.5	58.0	2.2

The results obtained (Table 2) show that the compost used as fertilizer is rich in major fertilizing elements. The assimilable nitrogen content of the compost was 247.5 meq/Kg. This content is more than sufficient to contribute to foliage formation and fruit development. Phosphorus content, in terms of P_2O_5, is 58 ppm; despite its relatively low content, phosphorus application by spreading promotes root system development [12] [14] [22]. It must, therefore, be present before the semi. The potassium present in this compost is in its oxide form (potassium oxide), K_2O, with a content of 2.2 milli-equivalents per 100 g of sample, compared with 1.9 in the soil sample [13] [14]. This nutrient promotes good plant hydration

and productivity, *i.e.* flowering and fruit formation. Its presence, even at low doses, also increases the young plant's natural defense capacity [12] [14] [23]-[25].

3.2. Effect of Compost and Yield

When the fruit reached maturity, harvesting was carried out several times due to the repetitive nature of fruiting. The average results for all the plots in the experimental field, expressed in tonnes of eggplant and chili per hectare, are shown in Figure 2. The effect of compost applied at different doses was assessed by comparing production yields.

Analysis of the results obtained shows a remarkable evolution in yield for the two crop varieties tested. For eggplant, yields of 21 and 15 tonnes per hectare were obtained for T1 and T2, respectively, compared with 7.5 tonnes per hectare for the control plots (T0). For the chili variety and with T1 and T2 doses, 11.1 and 10.4 tonnes were obtained per hectare compared with 9.2 tonnes for the control plots (T0). It should also be noted that the dose of 2.5 tonnes of compost per hectare, treatment T1, provided the best yield in this study. However, a dose of 5 tonnes of compost per hectare was found to be unfavourable.

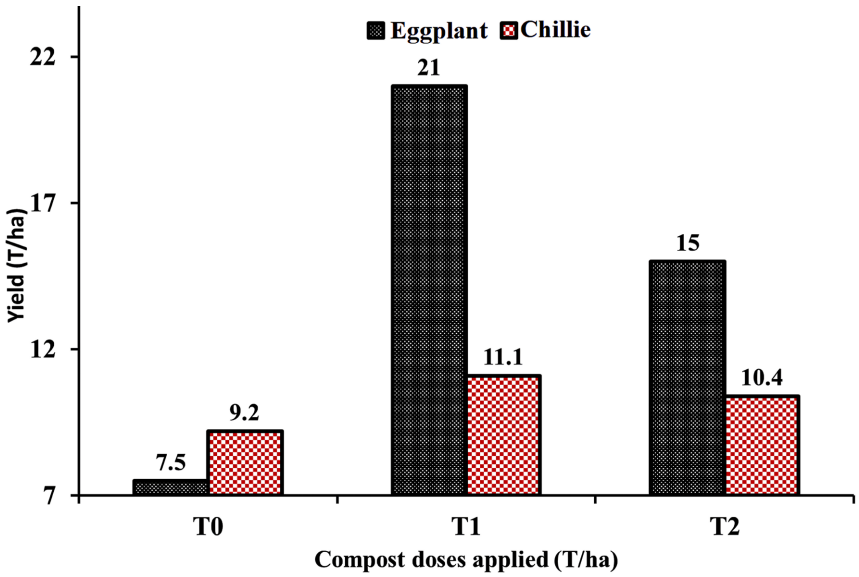

Figure 2. Yield trends as a function of compost application rates.

This appears to be an overdose which, despite the significant vegetative development observed in the experimental field, does not encourage fruiting. The increase in yield, compared with the control plots, is illustrated in Figure 3.

Examination of Figure 3 clearly shows that a compost dose of 2.5 tonnes per hectare of land promotes a 64.29% increase in eggplant production yield, compared with a 50% rate for the 5-tonne compost dose per hectare. For the pepper variety tested, a similar increase was observed. For a dose of 2.5 tonnes of compost (T1), the increase was 17.12%, compared with 11.54% for the dose of 5 tonnes of compost per hectare.

This result is in line with the previous finding of overdosing for these varieties. This might suggest an optimum of 2.5 tonnes of fertilizer applied.

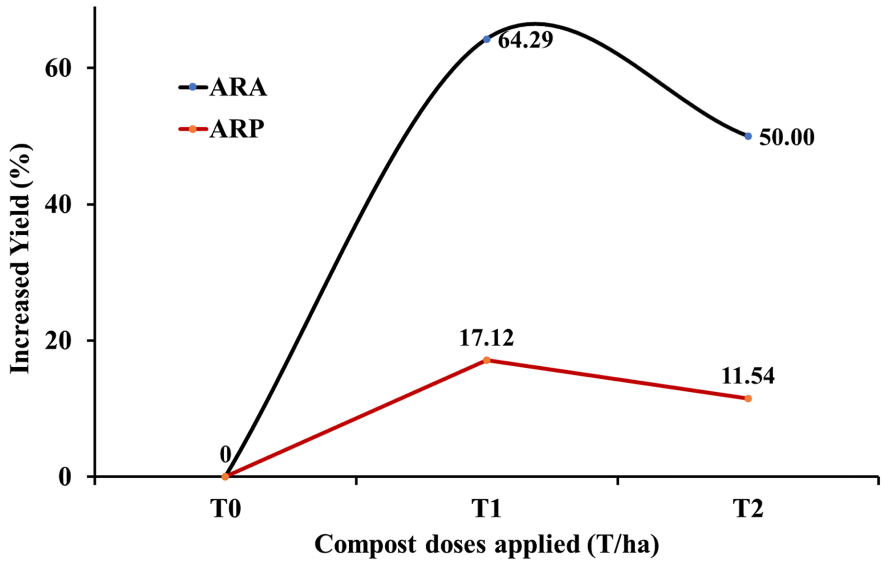

Figure 3. Effect of compost on production yield.

The addition of compost will, therefore, have helped improve the profitability of eggplant and chili production. This improvement can be explained by the increase in soil fertility and the creation of conditions for plant growth and fruiting. This finding is also in line with some authors' assertions on the effectiveness of compost on certain crop varieties and the existence of a threshold relative to optimal doses [11] [12] [14] [26] [27]. Compost enriches the soil with organic matter and plant-available nitrogen. Many authors agree on the benefits of using natural fertilizers such as grasses, leaves and biodegradable waste in the form of compost. This is due to their effectiveness in providing nutrients to improve soil quality, rapid plant growth, yield and crop quality [11] [15] [28].

As far as composted biodegradable waste is concerned, the advantage is multifaceted: while the use of compost improves agricultural yields, its production by composting contributes to sanitation and limits the use of chemical fertilizers, which are often toxic for the environment. Excessive use of chemical fertilizers can lead to soil impoverishment, eutrophication of waterways and groundwater pollution. In addition, the 1500 Kg of fine compost used to fertilize the experimental field corresponds to 6900 Kg, or around 7 tonnes of raw waste collected, sorted and processed. So, over and above the practical benefits in terms of contributing to sanitation through composting, the use of compost is economically beneficial compared with the cost of industrial mineral fertilizer, and in terms of productivity.

4. Conclusions

The aim of this work was to experiment with compost on two crop varieties widely

grown in Guinea, with a view to demonstrating its effectiveness on yields and creating opportunities for the valorization of biodegradable waste.

The results obtained show a clear improvement in eggplant and chili production with the optimum dose of 2.5 tonnes of compost per hectare of cultivable land. Indeed, for each crop tested, the following yields were obtained:

- ✓ For eggplant, 21 tonnes per hectare were obtained by applying a dose of 2.5 T/ha of compost, compared with 7.5 tonnes of eggplant on the control plots (T0);
- ✓ For chilies, 11.1 tonnes are obtained per application of the same optimum dose, compared with 9.2 tonnes for the control plots (T0);
- ✓ The application of a dose of 5 T/ha of compost proved ineffective due to overdosing, resulting in abrupt plant development and poor fruiting.

Furthermore, despite yield increases of over 50% for eggplants and over 11% for chilies, further experimentation focusing on nutritional quality is required to better assess the substitution of compost for conventional fertilizers. However, the development of the composting of biodegradable waste could contribute to improving agricultural yields and the living environment of the population through efficient treatment and sustainable waste management.

Conflicts of Interest

The authors make no mention of any conflict of interest.

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