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Adaptation and Observation Trial of the Influence of Three Composts on the Yield of Carrot (Daucos Carota L.) Under The Agro-Ecological Conditions of Gbadolite in the Democratic Republic of Congo

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Abstract: *The aim of the present study was to initiate an adaptation trial and observe the influence of three composts on carrot yield under the agro-ecological conditions of Gbadolite. The experimental design adopted was that of randomized complete blocks with 4 treatments distributed over 3 replications. The total area of the experimental field was 28.8 m2, i.e. 8 m long and 3.6 m wide. Each elementary plot had an area of 2.4 m², i.e. 2 m long and 1.20 m wide. The distance between the blocks was 0.50 m and the plots were also 1.00 m apart. Treatments were as follows: T0: Unamended control plot; T1: Bursary; T2: Chromolaena+legume amendment; T3: Chromolaena+grass amendment. Each treatment was amended with 15kg of compost per bed following the composts. Final planting was carried out at 0.15 m x 0.40 m spacing, with one plant per stake, i.e. a density of 30 plants per plot of 2.4 m2 each. The plot enriched with dung compost yielded 16.75 t/ha (T3); the plot amended with C. odorata + grasses yielded 14.25 t/ha; the plot amended with C. odorata + legume mulch yielded 13.33 t/ha; and the control plot yielded 8.17 t/ha. Carrot cultivation is therefore feasible in the agro-ecological conditions of gbadolite.*

Keywords: *Adaptation; composts; yield; carrot; Gbadolite; Democratic Republic of Congo*

I. Introduction

In dry tropical zones, land cultivation leads to a rapid decline in organic matter stocks and the appearance of deficiencies in nitrogen, phosphorus and other elements (Yoni et al., 2005).The major constraint to production in Africa on fragile soils is the low level of soil fertility (Saïdou et al., 2009).

Economic and social development relies heavily on agriculture, which makes a significant contribution to poverty reduction and food security (IFDC, 2002).

In the Democratic Republic of Congo, the problem of declining soil fertility is a concern both for farmers, who are faced with the high cost of inputs, and for researchers, whose work aims to maintain or restore the fertility of degraded soils in order to intensify agricultural production (Saïdou et al., 2009).

One strategy for improving soil fertility, particularly in ferralitic soils known for their low nitrogen and phosphorus content (Koné et al., 2009), is the use of compost. A good farming practice involving the input of organic substances such as organic fertilizers, crop residues or different types of compost could improve soil fertility (Weber et al., 2007).

Indeed, the use of composts produced from organic waste improves soil properties, makes nutrients available in the soil and reduces pollution risks (Crichton et al., 2000; Douglas et al., 2003; Kowaijow and Mazzarino, 2007; Weber et al., 2007). They improve soil structure, increase soil water and nutrient retention capacity, stimulate microbial activity and increase yields (Kowaljow and Mazzarino, 2018).

Furthermore, organic fertilizer sources with a Carbon to Azotz ratio below 20 contain a high concentration of nutrients (Chaves et al., 2007; Tognetti et al., 2008) and possess nitrogen immobilization potentials (Deneve et al., 2004). In view of all these advantages, a great deal of research into the contribution of organic residues to soil fertility regeneration has been carried out in the Democratic Republic of Congo (Amadji et al., 2009).

But very little information exists on the contribution of guano (compost made from bat droppings) and composts enriched with poultry droppings and sheep droppings on carrot production. Knowledge of this information will make it possible to provide market gardeners with organic fertilizer formulas for sustainable production on ferralitic soils (Gbessemehlan et al., 2022).

It is in this context that we place this work, whose main objective is to enhance the use of composts for carrot (Daucus carota) production in Gbadolite, Democratic Republic of Congo.

Although this exotic crop is presumed to be unsuited to the edapho-climatic conditions of Gbadolite, it nonetheless embodies so many virtues - food, health and socio-economic - that it's worth trying to cultivate it. It is within this framework that this study seeks to answer the main question: can the crop adapt and can the use of three composts increase carrot yield under the conditions of Gbadolite in the Democratic Republic of Congo?

Specifically, what type of compost can influence the carrot yield parameter?

In general, we assume that the use of three composts would influence carrot (Daucus carota) yields under the agro-ecological conditions of Gbadolite. Specifically, it seems that the yield parameters of this crop would be influenced by the nature of the composts.

The overall aim of this study is to observe the adaptation and influence of the use of three composts on carrot yield under Gbadolite conditions.

II. Review of Literature

2.1 Environment

The present study was carried out in the town of Gbado-Lite, capital of the Nouvelle Province du Nord-Ubangi in the Democratic Republic of Congo, from 20 January to March 2022, i.e. 90 days. The geographical coordinates of the research site using GPS were as follows: North Latitude: 4° 15′ 48″; East Longitude: 21° 0′ 28″ East and Altitude: 392.93 m and with an accuracy of 6 m. The climate predicted here is tropical, which is characterized by two seasons (Molongo et al, 2015):

- The dry season: 4 months, from November 15 to March 15 and from June 15 to July 15 respectively major and minor dry seasons;
- The rainy season: 8 months, from March 15 to June 15 and August to November 15, long and short rainy seasons respectively.

The soil is generally clayey-sandy. The vegetation was once characterized by an evergreen rainforest, but has been replaced by a grassy savannah dominated by Imperatacylindrica, Penisetumpurperum and Chromolaena odorata. It is relatively abundant, with an average annual rainfall of over 1,600 mm (Molongo, 2022).

2.2 Materials

The seeds used in the trial were carrot seeds purchased from a farmer in Gemena, South Ubangi Province. The organic fertilizers used consisted of cow's purse, an amendment to Chromolana odorata, Panicum and the legume.

III. Research Method

The experimental set-up adopted was that of randomized complete blocks with 4 treatments distributed over 3 repetitions. The total surface area of the experimental field was 28.8 m2, i.e. 8 m long and 3.6 m wide. Each elementary plot had an area of 2.4 m², i.e. 2 m long and 1.20 m wide. The distance between the blocks was 0.50 m and the plots were also 1.00 m apart.

Treatments were as follows: T0: Unamended control plot; T1: Bursary; T2: Chromolaena+legume amendment; T3: Chromolaena+grass amendment. Each treatment was amended with 15kg of compost per bed following the composts. Final planting was carried out at spacings of 0.15 m x 0.40 m, with one plant per stake, giving a density of 30 plants per plot of 2.4 m2 each. Cultivation consisted of replanting, watering twice a day (morning and evening), weeding and ridging.

3.1. Observed Parameters

The following parameters were observed:

- Diameter at collar by caliper;
- Number of leaves counted;
- Diameter of carrot tubers using calipers:
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Figure 2. *Carrot tuber*

- The plot yield using the scale;
- Tuber yield in tonnes per hectare by extrapolating plot yield.

The data were processed using SPSS 20.0 software; the results were analyzed using a single-criterion analysis of variance without sampling, using the F Snedecor and Tukey tests to identify the difference between treatments and their affinities, respectively, at the 0.05 probability threshold.

IV. Results and Discussion

4.1 Neck diameter

Neck diameter data were collected and the results are shown in figure

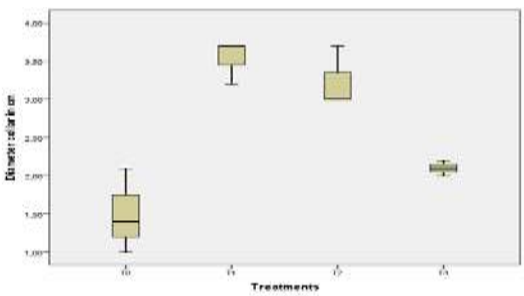

Figure 3. *Diameter at collar (in cm)*

It was observed that the basal dimension was 3.5 cm; 3.2 cm; 2.1 cm and 1.5 cm respectively for composts from cow dung; Chromoléana odorata + legume; Chromoléana odorata + grass and control plots. In this study, cow dung and substrate from Chromoléana odorata + legumes contributed significantly to this parameter, thanks to their nitrogen content.

4.2 Leaf count

Leaves were counted and the results are shown in figure 4.

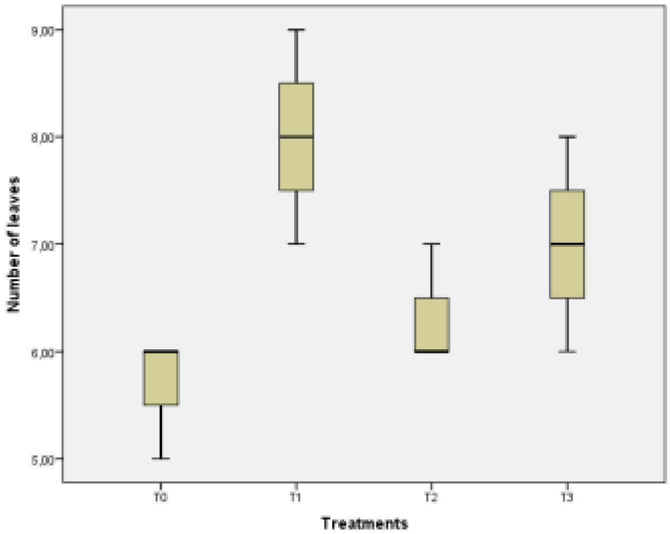

Figure 4. *Number of leaves*

These results show that, at the end of the crop cycle, the highest number of leaves was counted on plants planted on the cow dung substrate (8 leaves), followed by those transplanted to the C. odorata + grass plot (7 leaves), C. odorata + legume plot (6 leaves) and the control plot (5 leaves).

4.3 Carrot length (cm)

Carrot tuber length was measured, and the results for these parameters are shown in figure 5.

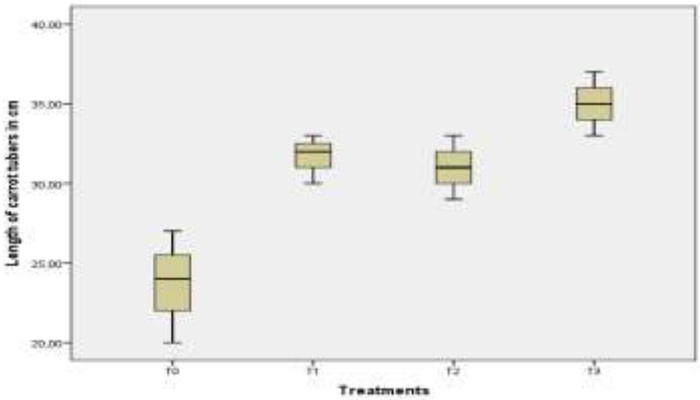

Figure 5. *Tuber length (in cm)*

In view of the results shown in Figure 3, it was observed that the longest tubers were obtained from the plot enriched with C. odorata + grass composts (35.0 cm); followed by those sown on the plot amended with cow dung (31.7 cm); then C. odorata + legume (31.0 cm) and finally the control plot (23.7 cm) under Gbadolite conditions.

4.4 Tuber diameter

Results relating to tuber diameter are shown in figure 6.

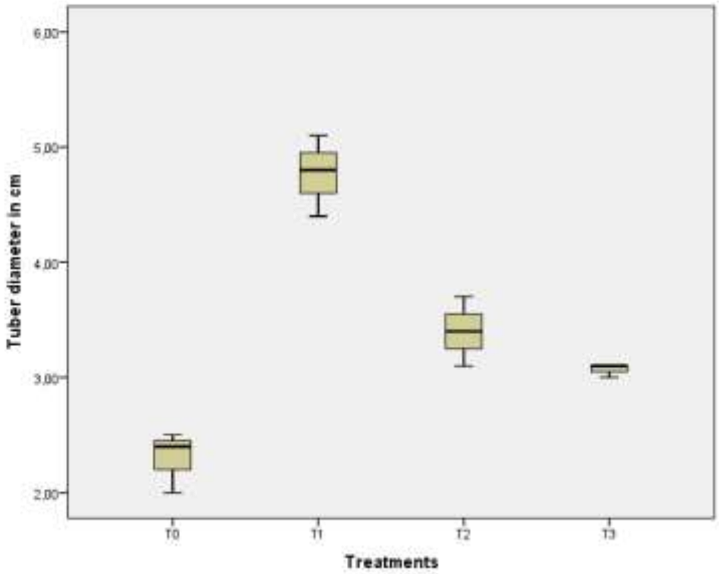

Figure 6. *Tuber diameter (in cm)*

In terms of tuber diameter, 4.8 cm was obtained using compost from dung; 3.4 cm from Chromolaena+legume; 3.1 cm from Chromolaena+grass and 2.3 cm from the control plot. In other words, carrots respond well to compost from dung.

4.5 Yield in tonnes per hectare (in T/ha)

Plot yields were extrapolated into tons per hectare, and the results are shown in figure 7.

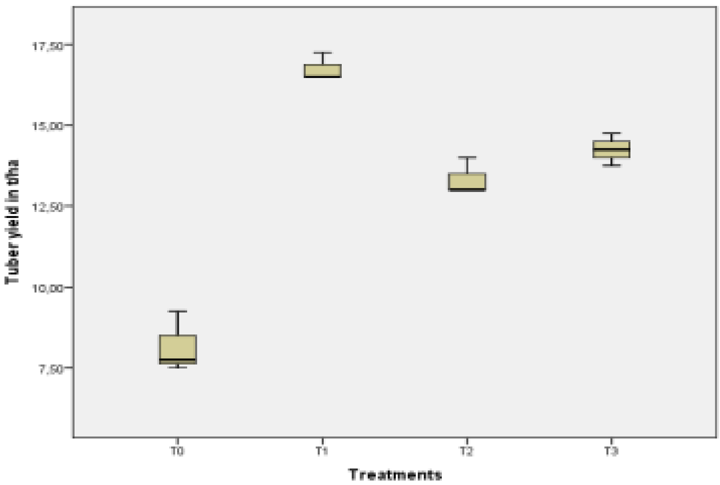

Figure 7. *Tuber yield in tons per hectare*

The following yields in tonnes per hectare were obtained in this experiment: the plot enriched with compost from dung produced 16.75 t/ha (T3); the plot amended with C. odorata + grasses produced 14.25 t/ha; the plot amended with C. odorata + legume mulch produced 13.33 t/ha; and the control plot produced 8.17 t/ha. The best yields were obtained from plots amended with composts, as composts are rich in minerals useful to the plant, notably nitrogen, phosphorus and potassium.

4.6 Discussion

On the other hand, the effects of organic fertilizers were superior for the rest of the vegetative parameters, notably on leaf number compared with the unamended control soil. These effects may be linked to the combined action of improved soil properties and nutrient mineralization. These minerals are favorable agents for plant physiology in this case in leaf emission (Kimuni et al., 2014).

The single-criterion analysis of variance without sampling showed that there was a significant difference at the 0.05 threshold between treatments; Tukey's test concluded that the best treatment was the dung-amended substrate (T1), which was no different from the Chromolaena odorata+ grass-amended substrate and the C. odorata + legume-amended substrate, all of which were different from the control under Gbadolite conditions. This result, pending laboratory analysis, suggests that these organic materials are therefore rich in nitrogen.

The effect of compost on core length as a function of compost was proven in this experiment as the best yields were obtained in plants transplanted onto composts from Chromolaena + grass; however, control plots gave weaker results due to insufficient mineral matter as noted by Mrabetet al. (2011). The analysis also showed that the compost was that of Chromolaena odorata + grass, cow dung and C. odorata + legume in this parameter which statistically, the results of the amended soils are not different from each other but different from the control in the market garden conditions of Gbadolite.

Yields expressed in tonnes per hectare during this study were as follows: 16.75 t/ha harvested from the plot amended with dung; 14.25 t/ha from the plot enriched with Chromoléana + grasses; 13.33 t/ha from the plot amended with Chromolaéna + legumes and 8.17 t/ha from the control plot. Tuberous leguminous plants responded favorably to the application of the composts offered by Chromoléana + grasses purse and mulch, rich respectively in nitrogen-phosphate matter; elements that activate growth, biomass and reserves.

Statistical analysis indicated that there was a significant difference between treatments, and Tukey's test grouped them in such a way that the best compost to use to improve carrot yields was that derived from cow dung, followed by those from Chromolaena odorata + grass and C. odorata + legume in market gardening. In this experiment, the composts contributed 105.02%, 74.42% and 63.16% to yield respectively for cow dung, Chromolaena odorata + grass and Chromolaena odorata + legume composts. These materials consequently increased the yield of useful product as was the observation that organic matter contributes to the stability of physical, chemical and biological soil conditions (Kimuni et al., 2014).

Crops planted on these soils, which are well endowed with organic matter, are more resistant to random climatic variations and give stable yields, demonstrating the effectiveness of compost on production (CIRAD-GRET, 2007). Mrabet et al. (op. cit) note that plants planted in a growth medium containing compost are stronger and give the best yields than those without. Furthermore, this high value has been linked to soil fertility due to the decomposition of composts, which are a source of nutrients and organic materials for plant physiology (Dhed'a et al., 2011).

The use of composts is a better strategy as these materials consequently increase the yield of useful product, as was the observation that organic matter contributes to the stability of the physical, chemical and biological conditions of the soil; as crops installed on soils that are well provided with organic matter (composts) are more resistant to random climatic variations and give stable yields. Furthermore, it has been observed that the combination of two composts offers synergistic effects that are capable of producing higher yields than the use of single composts (Dupriez, 2000; N'Dayegamiye et al., 2005; Dupriez and De Leener, 2009).

It was observed that our yields were less than 19 and 49 tonnes per hectare using bottom dressing, spreading 4 carts of well-decomposed manure, i.e. nearly 1,000 kg per 1,000 m²; maintenance dressing: 25 kg of 15-15-15 mineral fertilizer per 1,000 m² (Perret, 2011; Maradi, 2018).

V. Conclusion

This study was conducted to observe the adaptation and evaluate the effect of three composts on carrot yield under the agro-ecological conditions of Gbadolite in the Democratic Republic of Congo.

The results suggest the following:

- The basal dimension was found to be 3.5 cm; 3.2 cm; 2.1 cm and 1.5 cm respectively for composts from cow dung; Chromolaena odorata + legumes; Chromolaena odorata + grasses and the control plot ;
- A basal dimension of 3.5 cm, 3.2 cm, 2.1 cm and 1.5 cm was obtained for composts from cow dung, Chromolaena odorata + legume, Chromolaena odorata + grass and control plots respectively ;
- Tuber diameters of 4.8 cm were found using compost from cow dung; 3.4 cm from Chromolaena + legume; 3.1 cm from Chromolaena + grass and 2.3 cm from the control plot. In other words, carrots respond well to compost from dung ;
- In the course of this experiment, the following yields in tonnes per hectare were achieved: the plot enriched with compost from dung produced 16.75 t/ha (T3); the plot amended with C. odorata + grasses produced 14.25 t/ha; the plot amended with C. odorata + legume composts produced 13.33 t/ha; and the control plot produced 8.17 t/ha.

Thus, carrot cultivation is possible in the edaphoclimatic conditions of Gbadolite, in the province of Nord-Ubangi in the Democratic Republic of Congo using biodegradable waste.

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