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Effect of a Biological Compost Based on *Tithonia diversifolia* on the Growth of *Ocimum basilicum* L.

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Abstract: The cultivation of vegetable crops faces many problems, including the lack of quality and vigorous seeds, soil fertility problems and pest attacks. In order to improve crop productivity and soil quality, some farmers have adopted the use of synthetic inputs (herbicides, fertilizers and pesticides) that are harmful to the environment and to humans, but also not affordable to the small holders farmers. The use of a biological compost could be an alternative to these numerous problems through the improvement of crop growth directly and protection indirectly. The aim of this study was to evaluate the effect of a biological compost based on *Tithonia diversifolia* on the growth of *Ocimum basilicum*. The production of the various composts was done according to the technique of heap composting. The effect of compost amendment on the growth of basil seeds was evaluated and correlated to the synthesis of total chlorophyll, total proteins, total phenols and plant defense related enzymes notably peroxidases and polyphenol oxidases. Mature composts were obtained after four (04) months based on the kinetic of temperature variations during the composting process. The compost amendment increased basil plant growth including height by 50%, stem diameter by 52%, number of leaves by 75%, leaf length by 160% and leaf width by 125% compared to controls plants. The treatment improved the accumulation of total chlorophylls, total proteins and total phenols in the leaves, as well as peroxidases and polyphenol oxidases content. These results show the positive effect of compost amendment on the growth of *Ocimum basilicum*. The soil amendment with biological composts seems to intervene directly in the stimulation of the physiological processes of the basil plants by a fertilizing action and indirectly, possibly confer a pool of defense biomarkers. This biological compost could therefore be an effective tool for promoting eco-responsible and resilient agriculture.

Keywords: Biological Compost, *Tithonia diversifolia*, *Ocimum basilicum*, Biofertilizer, Growth, Defense Biomarkers

1. Introduction

In agriculture, soil is the essential resource for the production of plants used for food, medicine and animal husbandry. It is a natural environment rich in nutrients essential to the growth of crops. It sometimes presents fertility problems which have a negative impact on crop production yields. The depletion of soil nutrient reserves is becoming increasingly important and is the cause of high production costs. The management of problematic soils generally leads to an overconsumption of synthetic inputs that are harmful to the environment and living beings, thus not environmentally friendly. Therefore, special soil management is important for the sustainability of agriculture. The use of less costly techniques favoring sustainable agriculture must be encouraged, in particular composting. It is a process of decomposition and transformation of biodegradable organic waste, of vegetable and/or animal origin, under the action of diversified microbial populations evolving in an aerobic environment and leading to the formation of a humified and stabilized material called compost [1]. This is an old practice which is done at low cost and therefore the basic products are generally biodegradable organic waste.

Compost is an organic fertilizer that can improve crop yields, protect soil from pollution, and provide a significant economic increase in soil biological activity [2]. Studies on the production and profitability of vegetable crops such as tomatoes using different doses of compost have shown that their production and profitability are optimal with the lowest dose [3]. A recent study has shown that compost is a good amendment as a biopesticide against Verticillium Wilt of tomato [4], having thus a protective effect against plant diseases. Suggesting thus, that the use of compost as a soil amendment could be an effective way to promote the growth of good quality and vigorous crops.

Seed is material used to plant or regenerate plants and the most vital and crucial element for agricultural production in general according to the Food and Agriculture Organization of the United Nations [5]. In Cameroon, seed production is favored by the quality of its soils, which are rich in nutrients that plants need to grow [6]. However, seed production is increasingly facing many problems, including the use of synthetic inputs (herbicides, fertilizers, pesticides), the lack of quality and vigorous seeds, attacks by pathogens and poor management of agricultural techniques. This is why it is important to adopt eco-responsible agricultural techniques that limit their use such as the use of organic fertilizers based on natural products such as weeds, shells, … that reduces the number of residues present in plants, fruits and the environment.

T. diversifolia is an herbaceous plant of the Asteraceae family, rich in mineral elements. It is a non-nitrogen-fixing plant that does not only enriches the surrounding soil with nutrients as it decomposes, but also produces secondary metabolites that are important in controlling pests. Indeed, the use of *T. diversifolia* biomass in cassava production in the forest zone of Cameroon has shown that it acts as a fertilizer as well as a biostimulant which promotes plant development such as cassava and plantain, increases yields and also improves the productivity of ferralitic soils [7-10]. Moreover, the biopesticidal activity of *T. diversifolia* has been recently highlighted, particularly in the fight against *Mycosphaerella fijiensis,* a pathogen responsible for black Sigatoka disease of banana leaves [11-12].

Therefore, the use of *Tithonia diversifolia* in the production of biological compost could improve plant growth and protection. The objective of this study was to evaluate the effect of a biological compost based on *Tithonia diversifolia* on the growth of *Ocimum basilicum*.

2. Materials and Methods

2.1. Materials

Tithonia diversifolia was collected in the city of Yaoundé near the Higher Teacher's Training College and the Bilingual Application School of Yaoundé-Cameroon.

The activating plant, which accelerated the process of decomposition of organic matter in composters, was collected in the city of Yaoundé-Cameroon.

Banana peels were collected from bunches of bananas purchased at the Mokolo market in Yaoundé and from some corn fritter vendors.

Banana by-products (trunks, leaves) were collected from a small plantain banana field located in Melen in the 6th district of the city of Yaoundé.

Sand and black soil taken in proportions of 1/3 and 2/3, used as substrates for the germination of seeds and the emergence of basil plants, were collected near the Biotechnology Center of the University of Yaoundé 1 in the 7th district of the city of Yaoundé.

2.2. Methods

2.2.1. Experimental Design

This study was carried out at the Laboratory of Plant Physiology and Biochemistry (LPVB) of the Higher Teacher's Training College of the University of Yaoundé 1 in Cameroon (03°51 North, 664 and 011°30 East, 515 meters altitude). It is located in the 3rd district of the city of Yaoundé, Centre region of Cameroon.

The different composts were produced in a composter from the following main materials: *Tithonia diversifolia*, activator plant, banana peels, banana by-products and soil. Six (06) completely randomized blocks (04 treatments and 02 controls) were formed in fields for basil cultivation.

1) *Tithonia diversifolia* + Banana peels + Activator plant + Soil (F1)
2) *Tithonia diversifolia* + Banana peels + Activator plant (F2)
3) *Tithonia diversifolia* + Banana by-products + Soil (F3)
4) *Tithonia diversifolia* + Banana by-products + Banana peels + Soil (F4)
5) Soil mix with chemical fertilizer 20.10.10 (Positive control)
6) Soil and water (Negative control)

2.2.2. Production of Composts

The production of the various composts was done according to the technique of heap composting, a technique belonging to the type of aerobic composting. The materials were mixed and then placed in the prefabricated composters in alternating layers. The pile was turned after 10 days, while the temperature of the pile was taken every 6 days until the composts reached maturity. The composting process lasted for 4 months before obtaining mature composts, that were dried for 2 weeks before conservation.

2.2.3. Evaluation of the Effect of Different Composts on the Growth of Basil

The germination and pre-emergence of the plants (Grand Vert variety) took place for a duration of 03 weeks in a greenhouse at a temperature of 25-29°C. Transplantation of 3-week-old plants was carried out in the field at controlled soil temperatures of 20-27°C.

At the end of these three weeks, the plants having approximately the same weight and the same height were transplanted into the fields on the various randomized blocks.

Throughout the experiment, the measurement of soil temperature (T), pH, relative humidity and sunshine was carried out with a probe (4-in-1 measuring instrument) every 03 days during one month.

The agromorphological parameters were recorded every six days on each of the three (03) plants selected and marked at each treatment and control till 42 days. The effect of different treatments on plant growth and development was assessed by measuring the following parameters:

1) Diameter of stems with the Vernier caliper.
2) Height of stems with graduated ruler.
3) Length and width of leaves with the graduated ruler.
4) Number of leaves was counted.

2.2.4. Evaluation of the Effect of Different Composts on Biomarker Accumulation in Basil Plants

The evaluation of the accumulation of total proteins, total chlorophyll, total phenols, peroxidase, polyphenoloxidase was made at two (02) ages i.e. 33 days and 55 days. For each treatment, 0.5 g of fresh leaves were used for the biochemical analysis samples, with the exception of total chlorophyll, of which 0.1 g was used for this analysis. The extraction and the quantification of the samples were made according to the modified method described by [13-17] for the total proteins (595 nm), the total chlorophylls (652 nm), the total phenols (760 nm), peroxidase (470 nm) and polyphenol oxidase (330 nm) respectively. Total phenols were measured in mg equivalent (Eq) of cinnamic acid per g of fresh material (FM), while the total protein concentration was expressed in mg equivalent (Eq) of bovine serum albumin (BSA) per g of fresh material (FM). The concentration of peroxidases and polyphenol oxidases was expressed in ΔDO/min/g MF.

2.2.5. Statistical Analysis

Analysis of the pH and temperature of the substrates throughout the growth of the basil plants, height and diameter of the stems, number of leaves, length and width of the leaves, total chlorophyll, total proteins, polyphenols, peroxidase and polyphenol oxidase contents were the subject of a two ways mixed analysis of variance (ANOVA) carried out with the XLSTAT software. Each plant was taken as experimental unit, treatment and days as factors. Several comparisons of means were made by applying Tukey's test at a probability level of 5%. The principal component analysis (PCA) using the Pearson correlation between the different variables was also carried out with the XLSTAT software.

3. Results

3.1. Production of Composts

The kinetic of the temperature variations of the different composts based on *Tithonia diversifolia* and banana by-products during the formulation presents for each, four distinct phases which vary during the composting process (Figure 1).

The first mesophilic phase (I) was observed from day 0 to day 6 of the composting process with an overall temperature variation between 0°C and 58°C. The variation was precisely between 0-44°C for F1, 0-56°C for F2, 0-48°C for F3 and 0-58°C for F4. The second thermophilic phase (II) was observed from day 6 to day 12 of the composting process with an overall temperature variation between 44°C and 59°C. The difference was precisely between 44-47°C for F1, 56-57°C for F2, 48-52°C for F3 and 58-59°C for F4. In phase (I) and (II), the lowest temperature rise range was indicated by the formulation F1 while the highest one was shown by F4 (Figure 1).

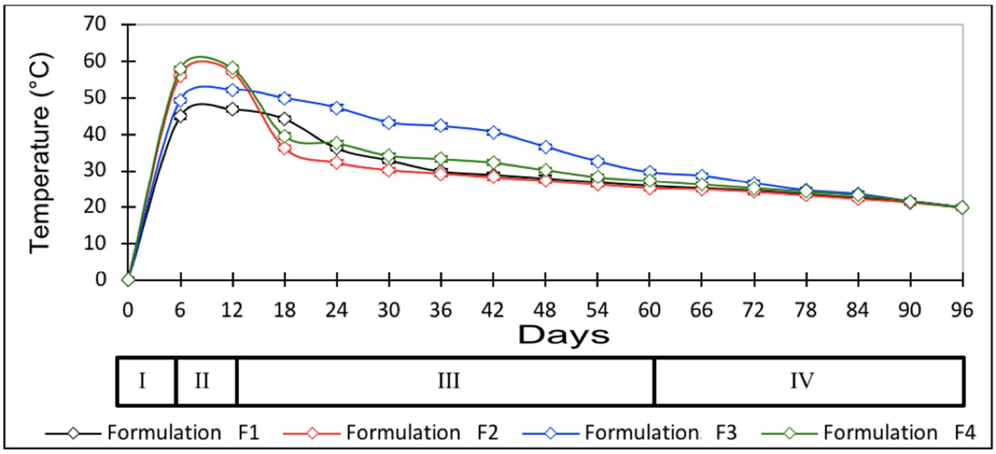
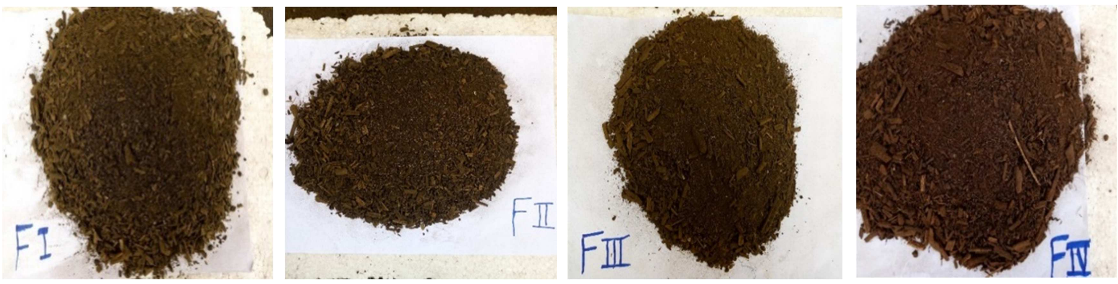


Figure 1. *Kinetic of temperature variations during the composting process of Tithonia diversifolia and banana by-products: (I) mesophilic phase, (II) thermophilic phase, (III) cooling phase and (IV) maturation phase.*

The third phase (III) of cooling was observed from day 12 to day 60 of the composting process with an overall temperature variation between 47°C and 28°C. The variation was precisely between 47-28°C for F1, 57-28°C for F2, 52-30°C for F3 and 59-29°C for F4. The fourth phase (IV) of maturation was observed from day 60 to day 96 of the composting process with an overall temperature variation between 28 and 20°C. The variation was precisely between 28-20°C for F1 and F2, 30-20°C for F3 and 29-20°C for F4. The lowest temperature decrease range was indicated by the formulation F1 in phase (III), F1 and F2 in phase (IV) while the highest one was shown by F4 and F3 respectively (Figure 1).

The various composts obtained have a more pronounced fibrous texture, in particular for the formulations F3 and F4 composts. F1 and F2 composts formulations have a darker brown color than F3 and F4 composts which have a light brown color (Figure 2).



F_1 F_2 F_3 F_4

Figure 2. *Appearance of the different mature compost formulations obtained after four months of experimentation.*

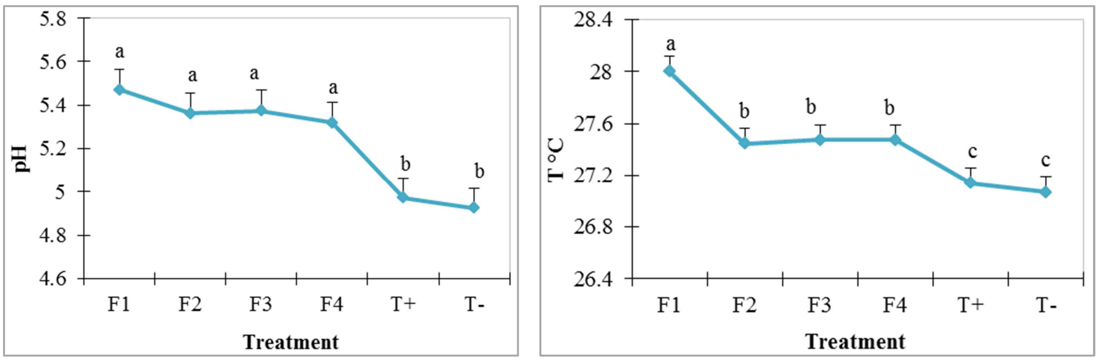
3.2. Effect of the Different Composts on the Growth of Basil

Table 1. *Analysis of variance (ANOVA) of soil characteristics (pH and T °C) during the growing period of Ocimum basilicum.*

Source	Df	pH (R^2= 82%)		T °C (R^2= 96%)	
		F	*P*	F	*P*
Treatment	5	23,954	<0.0001	31,011	<0.0001
Days	11	23,680	<0.0001	237,387	<0.0001
Treatment * Days	55	5,363	<0.0001	8,160	<0.0001

The values in bold correspond to tests where the null hypothesis is not accepted with a level of alpha significance = 0.05.
Df is the degree of freedom, F is the value of the test F and P is the probability.

The analysis of variance (ANOVA) of the pH, temperature, insolation and relative humidity of the substrates recorded throughout the growth of the basil plants shows that the treatment, the day and the interaction between treatment and day had a highly significant effect (P< 0.0001) on soil pH and temperature (Table 1). The coefficient of determination (R^2) for all the variables is close to 100% indicating that the model is reliable and reproducible. The variable that has most influenced pH and temperature when growing basil plants, is treatment. Low insolation and high relative soil humidity were recorded throughout the experiment (Table 1). The pH and the temperature of the compost-treated soils were significantly higher than that of the control soils (Figures 3A and B). Two and three distinct statistical groups were obtained for pH and temperature respectively.



A B

The means are those of three replicates with their standard deviations and the letters a, b and c represent the significantly different statistical groups obtained.

Figure 3. *Average pH (A) and temperature (B) of substrates (compost and control blocks) during the experiment.*

Table 2. *Analysis of variance (ANOVA) of agromorphological characteristics (stem diameter and height, number of leaves, length and width of leaves) during the growing period of Ocimum basilicum plants.*

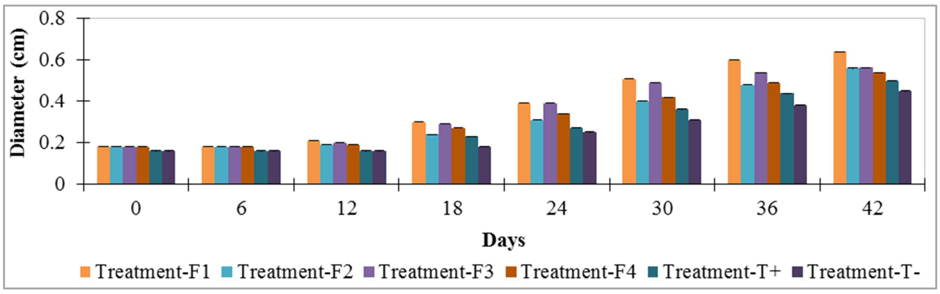
Source	Df	Seedling leaves									
		Diameter (cm) (R^2= 100%)		Height (cm) (R^2= 94%)		Number (R^2= 94%)		Length (cm) (R^2= 94%)		Width (cm) (R^2= 92%)	
		F	*P*	F	*P*	F	*P*	F	*P*	F	*P*
Treatment	5	252760,000	<0.0001	18,186	<0.0001	18,545	<0.0001	134,287	<0.0001	73,756	<0.0001
Days	14	906093,143	<0.0001	206,860	<0.0001	173,918	<0.0001	121,250	<0.0001	105,789	<0.0001
Treatment*Days	70	7188,571	<0.0001	0,518	0,999	1,074	0,349	3,152	<0.0001	1,906	0.000

The values in bold correspond to tests where the null hypothesis is not accepted with a level of alpha significance = 0.05.
Df Is the degree of freedom, F is the value of the test F and P is the probability.

The analysis of variance of agromorphological parameters of basil throughout this experiment revealed that treatment and day had highly significant ($P< 0.0001$) effects on plant responses (stem diameter and height, number of leaves, length and width of leaves). The interaction between treatment and day had a highly significant effect ($P< 0.0001$) on leaf diameter and length, and a significant effect on the width of leaf (Table 2). The coefficient of determination (R^2) for all the vegetative variables is close to 100% indicating that the model used is reliable and reproducible (Table 2). Among all these variables, the one that mostly influences the growth of basil plants is the treatment.

Stem diameter and height were larger for basil plants in compost soil amendment block F1 compared to other plants in compost blocks F2, F3, and F4 as well as for plants in the positive control block T+ and the negative control block T- (Figures 4A and B). This difference was one time and two time more important compared to the others respectively. Four (04) distinct statistical groups were obtained for the stem diameter while three were obtained for stem height (Figures 5A and B).

The number of leaves as well as the length and width of the leaves were higher for the basil plants in the F1 compost soil amendment block compared to the other plants in the F2, F3 and F4 compost blocks and the plants in the control blocks T+ and T- (Figures 4C, D and E). This difference was two time and four time more important compared to the others respectively. Three distinct statistical groups were obtained for leaf number and leaf width, while four were obtained for leaf length (Figures 5C, D, and E).



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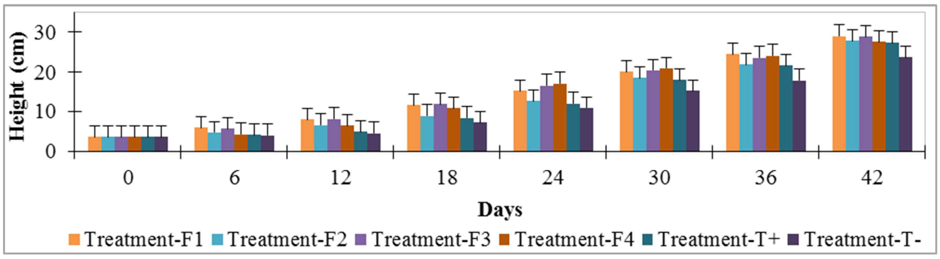

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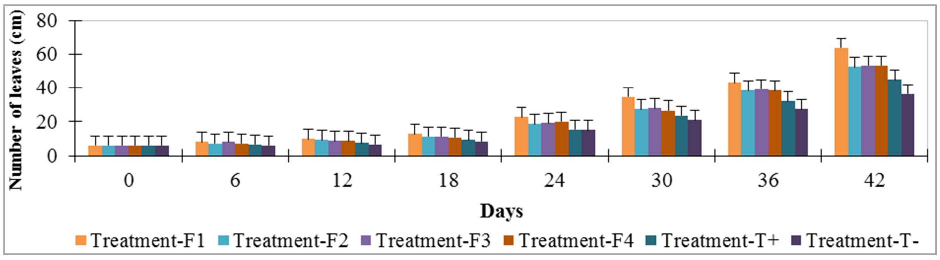

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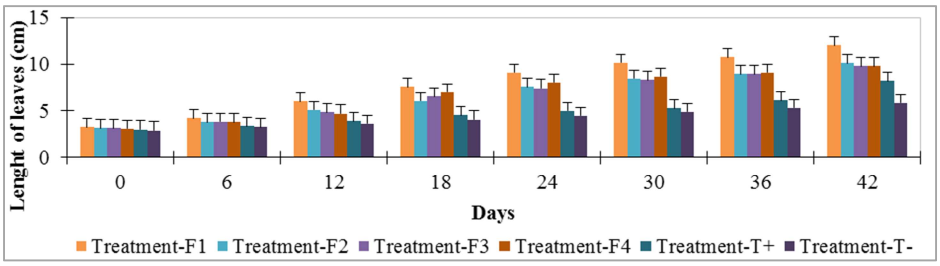

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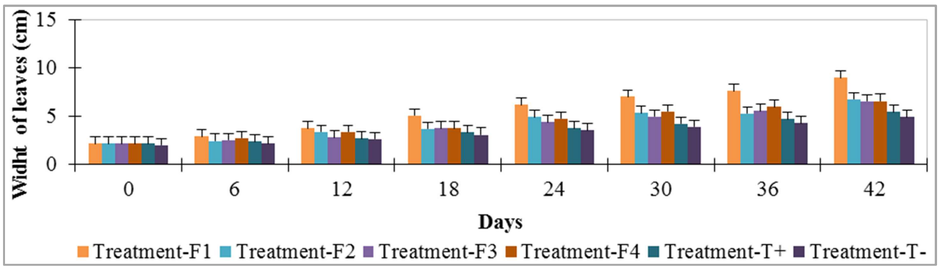
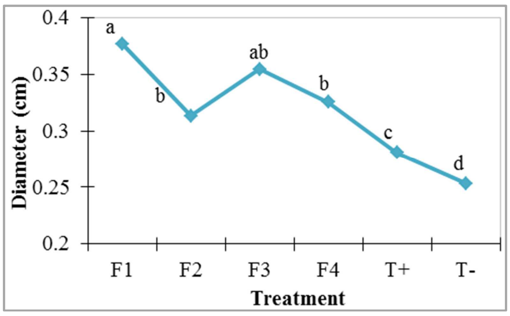


E

Each point represents the average mean of three (03) replicates with the standard deviation for each treatment.

Figure 4. *Variation of Ocimum basilicum plants agromorphological parameters: diameter (A), height (B), number of leaves (C), length of leaves (D) and width of leaves (E) in course of time.*



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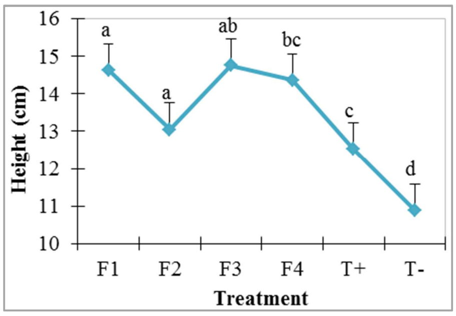

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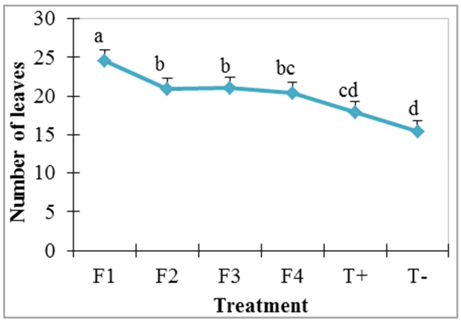

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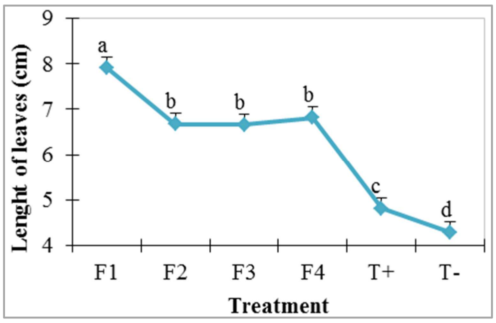

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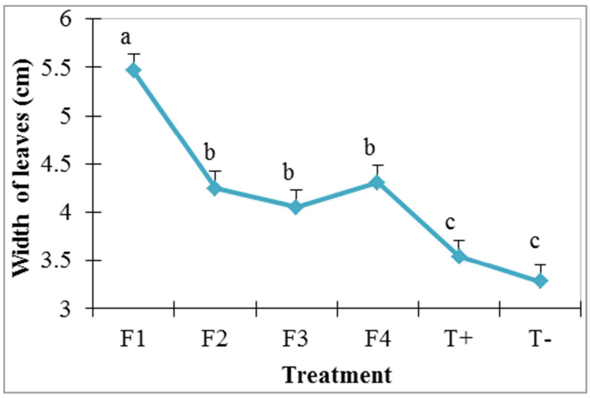


E

Figure 5. *Comparison of treatments effect on Ocimum basilicum plants agromorphological parameters: diameter (A), height (B), number of leaves (C), length of leaves (D) and width of leaves (E).*

Each point represents the average mean of three (03) replicates with the standard deviation for each treatment and the letters a, b, c and d represent the significantly different statistical groups obtained.

The best compost in terms of rapidly increasing stem diameter and height, number of leaves, leaf length and width of basil plants was the compost formulation F1, followed by F3 and F4 while the most lower was the F2.

3.3. Effect of the Different Composts on Biomarkers Accumulation in Basil Plants

The different composts used as field amendments significantly (*P*= 0.003) influenced the accumulation of total chlorophyll. The coefficient of determination (R^2) is 84%, indicating thus that the model used is reliable and reproducible. Among the two variables treatment and day, the one with the greatest influence on total chlorophyll accumulation was treatment.

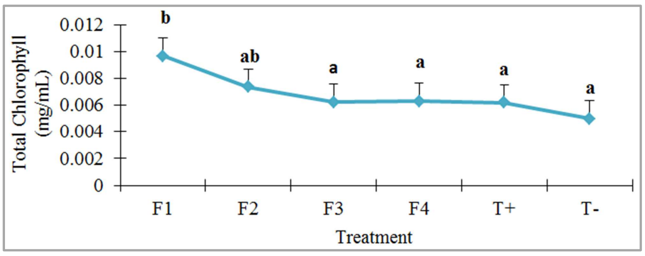


Figure 6. *Effect of different composts on total chlorophyll accumulation in basil plants.*

Each point represents the average mean of three (03) replicates with the standard deviation for each treatment and the letters a and b represent the significantly different statistical groups obtained.

The chlorophyll content in basil plants in the blocks that received F1 compost formulation as a soil amendment was higher compared to the other composts formulation blocks (F2, F3 and F4). This chlorophyll content is much higher than that obtained for plants in the control blocks (Figure 6). Two statistical groups were obtained, one for the F1 compost formulation and another for all other composts and controls. The best compost formulation in terms of chlorophyll accumulation in basil leaves was the F1 compost.

Analysis of variance of the responses of basil plants at two different ages (33 and 55 days) shows a highly significant effect *(P*< 0.0001) of the treatment and day variables on the accumulation of total proteins, total phenols, peroxidases and polyphenol oxidases. The interaction between treatment and day has a highly significant effect (*P*< 0.0001) on the accumulation of peroxidases in basil leaves, while this interaction has a significant effect on the accumulation of total phenols, total proteins and polyphenol oxidases (Table 3). The coefficient of determination (R^2) for all these variables is close to 100% indicating therefore that the model used is reliable and reproducible. Among the two variables (treatment and day) with respect to biomarker accumulation in basil leaves, the most influential was the treatment.

Table 3. *Analysis of variance (ANOVA) of the effect of the different composts on the accumulation of biomarkers in basil plants (total protein, total phenols, peroxidase, polyphenol oxidase).*

Source	**Df**	**Total proteins (mg/gMF) R2= 99%**		**Total phenols (mg/gMF) R2= 99%**		**Peroxidase (ΔDo/min/g) R2= 99%**		**Polyphenol oxidase (ΔDo/min/g) R2= 99%**	
		F	**P**	**F**	**P**	**F**	**P**	**F**	**P**
Days	1	264,213	<0.0001	61,482	<0.0001	460,422	<0.0001	124,590	<0.0001
Treatment	5	1508,831	<0.0001	79,245	<0.0001	426,213	<0.0001	379,777	<0.0001
Days*Treatment	5	7,468	0,000	2,732	0,043	15,051	<0.0001	4,770	0,004

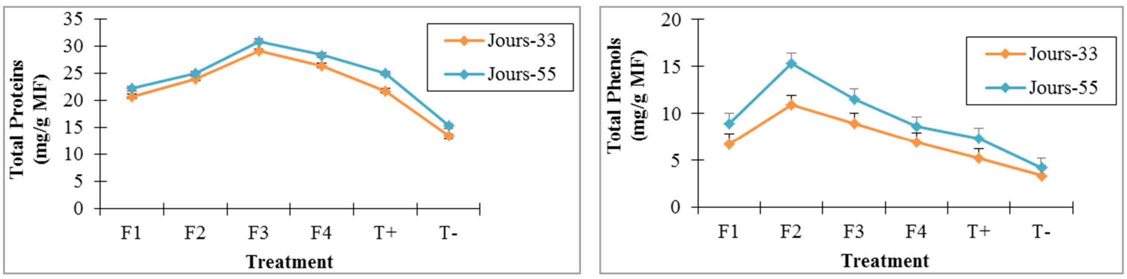
The values in bold correspond to tests where the null hypothesis is not accepted with a level of alpha significance = 0.05.
Df is The degree of freedom, F is the value of the test F and P is the probability.

Total proteins and total phenols content were higher in 33 day old and 55 day old basil plants in the F3 and the F2 compost soil amendment block compared to the control blocks plants T+ and T- and the ones of other formulations F1, F2 and F4 as well as F1, F3 and F4 respectively (Figures 7A and B). Three distinct statistical groups were obtained at both ages for total proteins and total phenols content.

Peroxidase and polyphenol oxidase content was higher in 33 day old and 55 day old basil plants in the F1 and the F4 compost soil amendment block compared to ones in the other compost blocks F2, F3 and F4 as well as F1, F2 and F3 and the control blocks T+ and T- (Figures 7C and D). Four distinct statistical groups were obtained at both ages for peroxidase and polyphenol oxidase content.

The best compost in terms of protein accumulation in basil leaves was F3, while it was F2 for phenolic compounds, F1 for peroxidase and F4 polyphenol oxidases.

Globally, according to the means squares analysis, the best compost based on *Tithonia diversifolia* that stimulate basil plant growth was the formulation F1, followed by F3 and F4 ones while the lowest one was F2 (Figure 8A). In the other hand, the best formulation in terms of biomarkers accumulation in basil plants was the formulation F3, followed by F2 and F1 ones while the lowest one was F4 (Figure 8 B).



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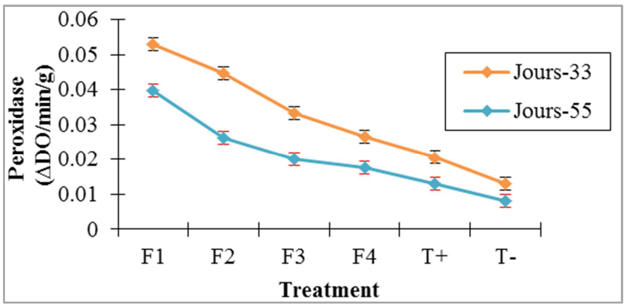

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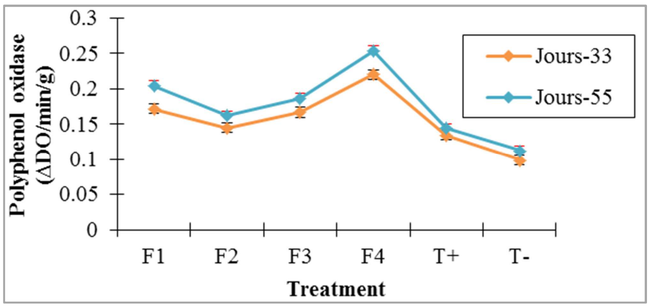
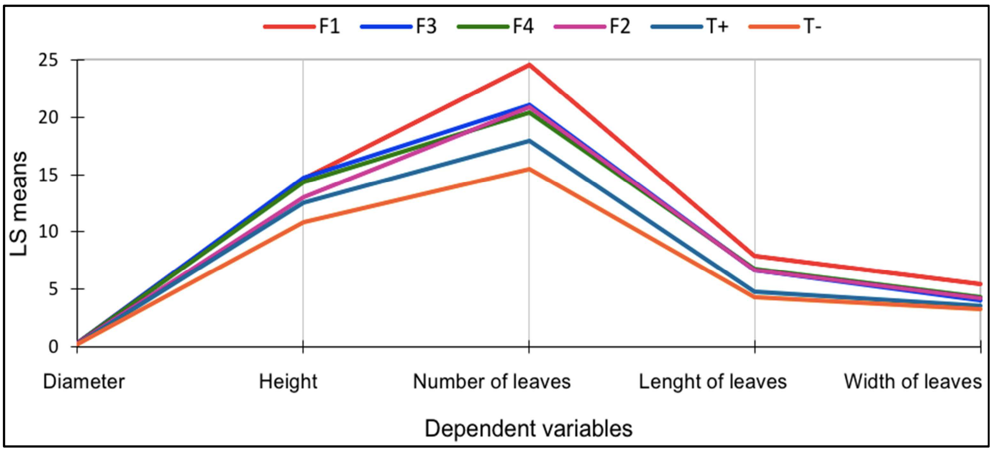


D

Each point represents the average mean of three (03) replicates with the standard deviation.

Figure 7. *Effect of different compost formulations on biomarkers accumulation in basil plants aged of 33 and 55 days. Interactions between treatments and days for total proteins (A), total phenols (B), peroxidase (C), polyphenol oxidase (D).*



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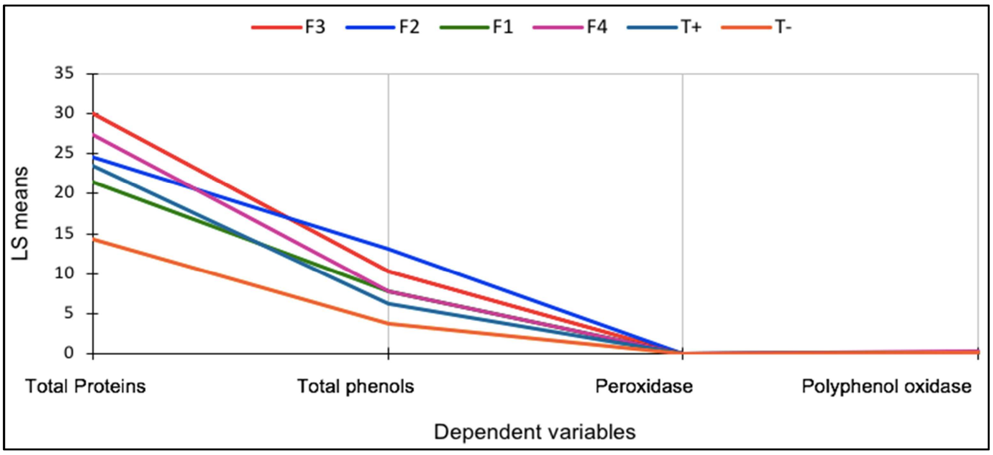

B

Figure 8. *Least Squares (LS) means summary of different compost formulations on plants (A) agromorphological parameters (diameter, size, number of leaves, length and width of leaves) and (B) biomarkers accumulation (total proteins, total phenols, peroxidase and polyphenol oxidase) in basil plants.*

3.4. Principal Component Analysis of All Variables

Principal component analysis (PCA) of all plant responses (stem diameter and height, number of leaves, leaves length and width) to the different composts shows that there is a strong positive correlation between the measured agro-morphological parameters (Figure 9). A medium positive correlation was observed between the biomarkers (total chlorophylls, total proteins, total phenols, POX and PPO). However, there is a weak positive correlation between the soil pH and temperature. This analysis reveals that there is a strong positive correlation between all biomarkers and pH, but also a positive correlation between the different biomarkers and the agro-morphological parameters. Temperature has a weakly negative correlation with all plant responses (Figure 9).

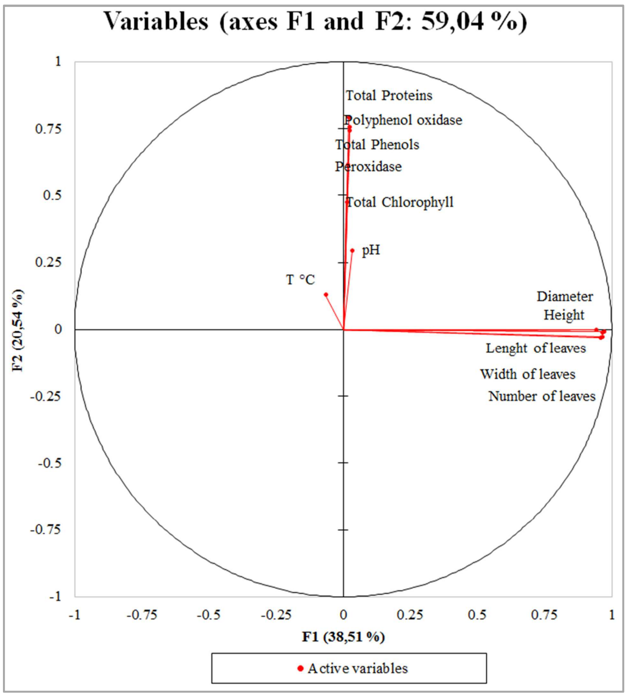

Figure 9. *Principal component analysis (PCA) of all plant responses to the different formulations: Stem diameter, plant height, leaf length and width, total protein, phenolic compounds, peroxidases, polyphenol oxidases, total chlorophyll, pH, temperature. The PCA gives the positive or negative correlations but also the strength of the relationship between these variables.*

4. Discussion

The overall objective of this study was to evaluate the effect of a biological compost based on *Tithonia diversifolia* on the growth of *Ocimum basilicum* plants.

The different temperature variations of each phase observed during the composting process could be explained by the succession of diversified micro-organisms (bacteria, fungi, actinomycetes...) which break down the organic matter contained in the composters differently. Indeed, mesophilic microorganisms degrade sugars, amino acids and proteins contained in materials while thermophiles degrade cellulose, hemicellulose, fats and certain lignin's [18]. The different temperature curves of each compost obtained reveal a very high biological activity of the microorganisms contained in these composts. This result is in accordance with a previous study that clearly demonstrated four phases in the composting process [18].

The fibrous texture of the composts obtained could be explained by the nature of the raw material since *T. diversifolia* used to produce the composts is a woody plant, but also the duration of production of the composts which was relatively short (04 months) compared to the same types of composts produced in six or eight months. This could also explain the color obtained from the different composts. This result is in accordance with that of [3] who has made a compost containing of *T. diversifolia*, banana leaves, brewery dregs and chicken droppings in three months.

The compost amendment gave the basil plants exceptional growth promotion compared to the controls, especially the plants in the F1 formulation compost block. This positive fertilizing action results from the direct action of compost on the growth of basil plants by providing them with nutrients [7-10]. The presence of *T. diversifolia*, which is a plant very rich in biofertilizing elements that allow harmonious plant growth [19] could suggest an abundance of nutrients in the compost including nitrogen, phosphorus and potassium. A similar positive effect was recently observed on *in vivo* plantain plants treated with flakes, mulch and fermented extracts of *T. diversifolia* [12, 19, 20].

Compost amendment appears to effectively influence the accumulation in basil plants of large amounts of total phenols, total proteins, total chlorophylls, and defense-related enzymes such as peroxidases and polyphenol oxidases. The accumulation of total chlorophylls was further enhanced by compost amendment, which promoted good plant development and made the plant less prone to biotic or abiotic stress effects [21]. Older basil plants (55 days) are richer in biomarkers than young plants (33 days) and this accumulation is positively correlated with agromorphological characteristics. A similar enhancement effect of biomarkers accumulation was recently observed on plantain vivoplants treated with *T. diversifolia* based products [12, 19, 20].

Biomarker accumulation was greater in treated plants than in control plants. Indeed, compost seems to act as an elicitor inducing the accumulation of total phenols, total proteins, peroxidases and polyphenol oxidases, known as biomarkers of resistance or tolerance to biotic and abiotic stresses [22]. These phenolic secondary metabolites seem to act in synergy to inhibit fungal growth due to biotic stress, but also to all other sources of stress such as abiotic stress [23], thanks to the use of preformed compounds and the *de novo* synthesis of biochemicals markers [24].

5. Conclusion

The aim of this work was to evaluate the effect of a biological compost based on *Tithonia diversifolia* on the growth of *Ocimum basilicum*. The results show that the compost formulation F1 is the best. Compost amendment effectively increased not only all basil plant responses (stem height and diameter, number of leaves, leaf length and width), but also the accumulation of total chlorophylls, total phenols, total proteins and plant defense enzymes (peroxidases and polyphenols oxidases). This compost is acting as a vitality stimulator since its use as an amendment, not only important for quality production and productivity, but also seems to improve the physico-chemical properties of the soil and favor the reduction of the use of chemical inputs. There is therefore a need to characterize biologically, physico-chemically and biochemically the compost formulation F1.

Farmers, especially market gardeners, should use this type of compost based on *Tithonia diversifolia* for quality production and productivity at a lower cost, but also for a reduction in chemical inputs not conducive to eco-responsible agriculture.

Conflicts of Interest

The authors declare that they have no competing interests.

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