Evolution of *Lippia multiflora* Biomass by the Fertigation Technique on a Ferralsol in the South of Côte d’Ivoire

Marie-Paule Hien1, Thierry Philippe Guety1, Louan Odile Blé1, Koffi Patrick Elysée Konan1 & Albert Yao-Kouamé1

1 Soil, Water and Geomaterials Sciences Laboratory, UFR Earth and Mineral Resource Science, Soil Science and Sustainable Agriculture, University of Félix Houphouët-Boigny, Côte d’Ivoire

Correspondence: Marie-Paule Hien, Soil, Water and Geomaterials Sciences Laboratory, UFR Earth and Mineral Resource Science, Soil Science and Sustainable Agriculture, University of Félix Houphouët-Boigny 22 BP 582 Abidjan 22, Côte d’Ivoire. E-mail: mhienboidi@gmail.com

Received: July 20, 2022      Accepted: August 27, 2022      Online Published: September 15, 2022
doi:10.5539/jas.v14n10p57          URL: https://doi.org/10.5539/jas.v14n10p57

Abstract

In order to domesticate *Lippia multiflora* for its perpetuation, study was carried out at the National Center of Floristics (CNF) of the University Félix Houphouët Boigny of Côte d’Ivoire. The objective of this work is to estimate the biomass of *Lippia multiflora* (Verbenaceae), called “savannah tea”, under the effect of urea diluted in water (fertigation) over time on a ferralsol in southern Côte d’Ivoire. The trial was set up in a completely randomized Fisher block design with three replications. *Potted Lippia multiflora* plants received two doses of urea T1 (0.5 g) and T2 (1 g) previously diluted 1 liter of water and a control treatment T0 without urea addition. The effects of these different doses on the growth parameters of *Lippia multiflora* were compared with each other using analysis of variance to assess the growth parameters of the plant. The observations were made on the average height of the plants in centimeters (cm), the average diameter of the stem, the average number of leaves and roots. From the results obtained, the contribution of urea influenced the growth of *Lippia multiflora* because different from those of the T0 control. It appears that the application of urea T1 (0.5 g) best promotes the growth of *Lippia multiflora*.

Keywords: *Lippia multiflora*, domestication, soils, urea, fertigation, Côte d’Ivoire

1. Introduction

Soil contains chemicals elements that plants need for growth and development. However, tropical soils are generally degraded and nutrient poor due to misuse (Roose, 2015; Monroe *et al.*, 2018). This leads to low crop productivity in the absence of low use of mineral and organic fertilizers (Vanlauwe *et al.*, 2010; Gerstenmier & Choho, 2015) in countries where farmers live in extreme poverty. However, these nutrients, which are lacking in tropical soils, are necessary for flourish (Lessard *et al.*, 2018; Tchaniley *et al.*, 2020). Indeed, nitrogen for example, is one of the essential chemical elements in the nutrients of plant and its deficit in soil can be filled by fertilization or amendement. Mineral fertilization has encountered shortcomings in its application and significant nitrogen losses have been noted, negatively affecting crop yields (Saïdou *et al.*, 2014; Macauley & Ramadjita, 2015). Fertigation, wich consists of the addition of soluble mineral fertilizer previously diluted in irrigation water, could limit the use of nitrogenous fertilizers in order to increase yields and meet the challenge of sustainability in plantations (Ilunga *et al.*, 2018; Ganyo *et al.*, 2018; Siene *et al.*, 2020). Thus, the use of urea on soil containing *Lippia multiflora* did not affect the quality of *L. multiflora* leaves (Kané *et al.*, 2010). So, it should be noted that water remains an essential element for plant growth (Skhiri, 2017). Indeed, *Lippia multiflora* is one the main aromatic plants whose leaves with many virtues are dried and then marketed by women (N’guessan, 2012). Its leaves are used for the production of natural substances or active ingredients (Diomandé *et al.*, 2014; Soro *et al.*, 2015; Soro 2016). These are therapeutic properties (Gandonou *et al.*, 2018; Masunda *et al.*, 2020; Samba, 2021; Ngaibi *et al.*, 2021). The regular drink of *L. multiflora* in the form of herbal tea is remedy against high blood pressure, malaria, colds, coughs, but also against febrile and flu attacks and diarrhea (Etou-Ossibi *et al.*, 2016; Abena *et al.*, 2017). *Lippia multiflora* is so used for its anti-inflammatory, relaxant and sedative effects (Abena *et al.*, 2017; Mebarki, 2021). It also has pesticidal (Sirima *et al.*, 2020) and artisanal (Atanasso *et al.*, 2017). In addition to its therapeutic virtues, the socio-economic importance of this plant is proven at national and...
For these virtues, it is important to domesticate this plant which is still product of recolt. While the development and yield of a crop are closely linked, among other things, to soil fertility, the application of a method to increase the production of L. multiflora to facilitate its domestication is urgent. It’s in this perspective that study “Evolution of the biomass of L. multiflora by the fertigation technique” was initiated. Thus the present study aims to determine the effect of urea on the biomass yield of L. multiflora during its growth.

2. Material and Methods

2.1 Study Area

The National Floristic Center is located within Felix Houphouet Boigny University of Abidjan. The limits of the Center are to the north by the boulevard François Mitterand and to the south by the Faculté of Law of the University. It is located west of the ravine separating the Cocody Campus and the Riviera Golf, east of District. The center is located between 5°20’9″ and 5°20’8″ North longitudes and 3°59’1″ and 3°59’0″ West latitudes (Kouamé, 2013), (Figure 1).

![Figure 1. Geographical location of the CNF](image)

2.2 Soil Characteristics of the Study Site

Soils of Abidjan, including those of the CNF are mostly ferralsols (Ouattara 2016) and have a shallow humus horizon in District (Guillaume and Adjanohoun, 1071). This part is reworked soils, that is to say with a gravelly or thick granular horizon. It occupies the the more or less undulating contours resulting from granites and shists, particularly in the north- east part of District where the CNF is located. The soil in the study area is very acidic (Pitta 2017).

2.3 Plant Material

The plant material consists of seeds of Lippia multiflora collected from wild plants (Figure 2).
2.4 Input

The input used is urea (CH₄N₂O), a fertilizer very rich in nitrogen and completely soluble in water. It acts less quickly than nitrates and effects lasts longer (Figure 3).

2.5 Experimental Design

Study was carried out under controlled conditions in May 2021 for 60 days. The installation of the device began with manual clearing with a machete. The construction of the shelter was done on an area of 16.5 m² (5.5 m × 3 m). Seeds were sown on the fly on a germinator filled with potting soil and covered with straw for three (03) days, then watered after emergence every two (02) days for one month. After a month sowing, transplanting was carried out in plastic pots measuring 8.5 cm in height and 10 cm in diameter previously filled with 1 kg of soil from the CNF, potting soil was added to this soil. The type of device used for the trial plot is a complete randomized block with (03) treatments T0 (0 g Urea), T1 (0.5 g Urea) and T2 (1 g Urea) with three (03) repetitions (R1, R2, R3). Dose of 35 mL of water was brought every 02 days in the morning before sunrise (Figure 4).

2.5 Growth Parameters Observed

Parameters observed are number of roots, number of leaves, height of plants and diameter of the stem. These observations and measurements were made on the plants at 45 days after transplanting (45 DAT) and 52 days after transplanting (52 DAT).
3. Result

3.1 Growth of Parameter of L. multiflora Having Received Urea, 45 Days After Transplanting (45 DAT)

3.1.1 Number of Root

Study of number of roots of plant, 45 days after transplanting, shows that the volume of the roots has statistically varied from treatment to another. Analysis of the data shows that the contribution of the dose of urea had a significant effect on the number of roots \((p = 0.022)\). This number varied from an average of 18 for the T0 treatment and to 27 for the T1 treatment (Figure 5).

3.1.2 Plant Height (cm)

Figure 6 shows the evolution of the height of L. multiflora plants having received or not urea. At 45 DAT, result indicate that the supply of urea had a significant effect on the height growth of the plant \((p = 0.024)\) and there is
a difference between the treatment (T0, T1, T2). Plant height increased from 2.76 cm for the T0 control treatment to 3.43 cm for the T1 treatment (0.5 g).

3.1.3 Number of Leaves
The data shows us a variation according to the effect of the doses of urea provided on the number of leaves produced per plant. Statistical analysis shows us that treatment with urea had a highly significant effect on the number of leaves produced ($p = 0.005$). This increase in the number of leaves is higher for treatment T1 (0.5 g urea) with 9 leaves (Figure 7).

![Figure 6](image1.png)

Figure 6. Evolution of the height of *L. multiflora* according to the contribution of urea at 45 DAT

![Figure 7](image2.png)

Figure 7. Evolution number of the leaf of *L. multiflora* according to the contribution of urea at 45 DAT

3.1.4 Stem Diameter (mm)
Data of 45 DAT shows variation in diameter of the according to the treatments. Data analysis shows that there is no significant difference between the treatments applied ($p = 0.562$) in Figure 8.
3.2 Urea Treatment on L. multiflora Growth 52 Days After Transplanting (52 DAT)

3.2.1 Number of Roots

Analysis of the data in (52 JAR) shows high number of roots in treatments T1 and T2. We note mean value of 34.33 roots for the T2 treatment and 36.33 roots for the T1 treatment. Statistical analysis of data shows that urea application has a significant effect on number of root growth (p = 0.033). The lowest value is noted for the control treatment T0 with 26.33 (Figure 9).

3.2.2 Plants Height (cm)

Analysis of the data reveals difference between the different treatments applied. This difference is higher for the T1 treatment, which increases from 3.43 cm (45 DAR) to 6.16 cm (52 DAR). The treatments had significant effects on plant height growth (Figure 10).

Figure 8. Evolution in stem diameter of L. multiflora as a function of urea supply at 45JAR

Figure 9. Variation in number of root of L. multiflora as a function of urea supply at 52DAT
3.2.3 Number of Leaves

Data shows a variation in the number of leaves according to the doses of urea applied. It can be seen that the urea doses applied had a significant effect on the average number of leaves produced (p = 0.010). This increase was highest for T1 treatments, which went from 9.33 in (30 DAT) to 12.00 (52 DAR) and from 7.33 (45 DAT) to 11.33 for T2 treatment (1 g urea). The smallest increase in leaf number observed was for the T0 (0 g) control treatment which varied from 6.00 in 45 DAT to 8.00 in 52 DAT (Figure 11).

3.2.4 Stem Diameter (mm)

The analysis of data indicates that there is no significant difference between treatments T0 and T2 applied, but for treatment T1, difference in stem diameter is observed with 0.21 mm. The stem diameter changes with the dose of urea applied (Figure 12).

Figure 10. Evolution in height of L. multiflora as function of urea application at 52DAT

Figure 11. Evolution of the number of leaves of L. multiflora according to the treatments at 52DAT
3.2.5 Fresh Matter Mass (g)

The analysis of data shows evolution of the weight of the fresh material at level of treatments T1 and T2. We note the highest value for the T1 treatments with 0.70 g and the lowest for the T0 treatments with 0.08 g. Statistical analysis of our data shows urea addition had significant effect on fresh matter production ($p = 0.013$) (Figure 13).

4. Discussion

Results obtained indicate that the addition of urea had positive impact on growth parameters of *L. multiflora*. Indeed, urea supply had impact on the growth of *L. multiflora*, the plants that received urea had higher parameters than the T0 control that did not receive urea as demonstrated by the work of Ilunga et al. (2018) and Nsiku *et al.* (2019) on maize on Ferralsol in DRC, the work of Ganyo *et al.* (2018) on lettuce and the work of Tchaniley *et al.* (2020) on sorghum. This shows the nutrient poverty of the control plot. Results show that T1 treatment (0.5 g) promoted plant growth compared to T2 treatment (1 g), which suggests that this dose is the one that promotes optimal growth of *L. multiflora*. T2 dose (1 g) would be considered limiting. For stem height, statistical analyses show that there is significant difference between the average heights obtained with the different doses of fertilizer applied. Results show the clear importance of the contribution of urea, Stevenson 1994 approached in the same direction through his work which proved that nitrogen supports the use of carbohydrates which stimulate the development and the root activity thus supporting the export of the other
mineral elements and the growth of plants. Treatment T1 has the highest average plant height of 3.33 cm (45 DAT) and 6.17 cm (52 DAT). On the other hand, treatment T0 had the lowest average plant height of 2.70 cm (45 DAT) and 2.90 cm (52 DAT). These results confirm those of Nyembo et al. (2012) who showed that the large plant height observed on the plots fertilized with mineral fertilizers would be more related to the amount of nitrogen applied. With regard to the number of leaves, the analysis of variances reveals that there is a significant difference between treatments, with a statistically identical average value for treatments T1 and T2, respectively 12 and 11 (52 DAT); this increase in the number of leaves in relation to the dose of urea applied is linked to the growth in plant height. These results are in agreement with the work of Kouakou (2013) who showed that the more the plant evolves in height, the more leaves it produces. For the diameter of the stem the statistical analysis of our results indicates that there is no significant difference according to the treatments (45 DAT) however we note a slight evolution of it (52 DAT) which is 0.21 cm. Regarding the number of roots, the results show a significant difference depending on the treatments. T1 treatments present the high number of roots which is 27 (45 DAT) and 36 (52 DAT), on the other hand for T0 and T2 the data show that there is no significant difference we note average values respectively of 19 and 18 (45 DAT).

5. Conclusion

Objective of the study was to determine effect of urea on the development of *Lippia multiflora*. Study conducted at the National Floristic Center of the Felix Houphouet Boigny University contributed to a knowledge of the response of *L. multiflora* to chemical fertilizer. The study highlighted the evolution of growth parameters following the different treatments. Concerning the growth characteristics of *Lippia multiflora* we can say that the quantity of urea brought to the plant has an impact on the development of the various agronomic parameters. Indeed, during our study, we could notice that an average quantity of urea favors the development in length, in number and in volume of the growth parameters. This allows us to affirm that our hypotheses are verified:

- Application of urea affects the growth of *L. multiflora*.
- Dose of urea influences the production of fresh material.

Growth characteristics at the root level showed that the highest growth rates were observed with the 0.5g urea doses. On the other hand T0 control treatments gave the lowest growth rates. This root development influenced by the amount of urea applied had an impact on the growth of the aerial parts of *Lippia multiflora*. Growth of the aerial parts evolves in the same order of growth as the roots under the influence of the dose of fertilizer applied to the plant. We can therefore say that *Lippia multiflora* is a plant that requires an adequate amount of urea for it to give better yields.

Acknowledgements

The authors express their gratitude to the University Félix Houphouët Boigny of Cocody, Abidjan and to National Floristic Center of Cocody where the study was conducted.

References


Kouakou, K. E. (2013). *Caractérisation physico-chimique et aptitude à la culture de Lippia multiflora moldenke (verbenaceae) des sols des sites expérimentaux d’Azaguié (zone de foret) et de Blé (zone de savane) en côte d’Ivoire* (p. 61, Mémoire de Master en Sciences de la Nature de l’Université Nangui Abrogoua, Abidjan).


Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (http://creativecommons.org/licenses/by/4.0/).