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Impact of the Mixture of Water from Cooked Bean and Human Urine on the Growth of Some Common Plants in Cameroon: Case Study of *Talinum fruticosum L.* and *Ocimum gratissimum L.*

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Authors' contributions

This work was carried out by author JCFT under the supervision of authors JPN and PT. Author SDB has contributed to the exploitation of results. All authors read and approved the final manuscript.

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ABSTRACT

The sustainable improvement of plant nutrition can provide sufficient food for all and can keep the environment clean. In that point of view, the present study aims to provide to farmers some contextualized and efficient fertilizers. In the present work, 161 plants of *Talinum fruticosum L.* and 161 plants of *Ocimum gratissimum L.* were regularly treated with a mixture of human urine and water from cooked beans (*Phaseolus vulgaris)* in a 1:1 ratio during three months. 161 of each of these plants were used as control. The experimental design was a randomized complete block in 4 replicates. The size of the studied parts of the targeted plants was highly enhanced in three months in response to the use of the mixture. The leaves of *Ocimum gratissimum L.* treated shew an average of 22 cm of length and 7.7 cm of width while those of the control shew an average

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length of 8 cm and 4.8 cm of width. Concerning the leaves of *Talinum fruticosum L.* treated, they measured 10.1 cm of length and 4 cm of width in average and those of the control 4.1 cm of length and 2 cm of width in average. Peasants could thus save a lot of money by using their excreta and some of their sewages as fertilizers to promote the sustainable development of their ecosystems. Further lab analysis on water from cooked beans alone and on the mixture made of human urine and water from cooked beans could ease in the future the acquirement of new knowledge about them. The consequence of that improvement will simply be the capitalization of those fluids as source of easily absorbable nutrients for plants nutrition.

Keywords: Agriculture; fertilizer; nutrient; nutrition; yield.

1. INTRODUCTION

In ACP countries, the demographic explosion [1], the reduction of tillable lands, and the reducing of the fallow periods [2] represent today the most perceptible phenomenon. This part of the world is peopled essentially by resource-poor farmers, with soils as their principal source of earnings [3]. Hence, to insure their survival, they cultivate even the most sloping plots [4]. Various and risky farming techniques are noticeable here [4], the aim being the desire of the daily satisfaction of their needs in food. In consequence, the yields decrease years after years [5,3], attesting then the permanent depletion of soils fertility. If a minority among these peoples can easily acquire synthetic fertilizers to solve in short term this problem of soils fertility depletion [6,7,8] the majority can't. But, even in the first group of these populations, the solution for soil fertility is not completely acquired because of the remaining of queries. In fact, a fraction of them up to today lacks knowledge about the use of these chemicals, since they could be pollutants when poorly used [9]. Moreover, those chemicals are sometimes rare, and their solubility is not often guaranteed [10]. Concerning the second group of these peoples, represented by resource-poor farmers, possess synthetic fertilizers is simply a fairytale. Their survival then appears today with aquite. That's why day after days, researchers investigate different sectors since the beginning of the twentieth century in order to provide fertilizers at low costs, easily used, efficient, and available for the poorest people worldwide. The tendencies of the results obtained today are encouraging. So, in some parts of the world, many were taught in how to use rocks [11,12], plants as *Titonia diversifolia* [13] among all as fertilizers. These approaches already constitute exits for that problem despite their local character; in fact, geological and floral diversity all over the world generates variations in their application. In front of these signs of potential victories, scientists have not given up; in that way, [14] recently show that human urine and water from cooked beans, single or combined, can pertinently enhanced the fertility parameters of soils.

The present study, following logically the previous aims to make larger the opening created concerning the potential agronomical use of these two sewages, even if human urine, that the fertility capacities were demonstrated in field conditions [15], due to some cultural considerations and suspicions, will not be easily proposed to those people [16]. The aim of the present study is thus to test the mixture made of human urine and water from cooked beans on plants in order to verify their efficacy on plants growth and crop yield. For the present case, the response of two common plants in Cameroon to the application of this mixture, often used as food and medicines, notably *Talinum fruticosum L.* and *Ocimum gratissimum L.,* will be put into relief.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 *Ocimum gratissimum* L. and *Talinum fruticosum* L.

Ocimum gratissimum L. is a shrub. It is known in many countries because of its feeding and pharmaceutical properties [17,18,19].

Talinum fruticosum L. is an herb [20]. It is a perennial, straight, and fleshy plant. It is commonly used as dietetic and medicinal plant in many countries worldwide [20]. Humans will then gain in producing them in great quantity. We need thus to propose in the case of the present study a combination of fluids as fertilizers that could improve the production of those crops in terms of sustainable management of the environment.

2.1.2 Human urine

Urine is a liquid feces [21,22]. It contains great quantity of nitrogen, phosphorus, potassium, and calcium easily absorbable by plants, and quite no heavy metals [23]; it is therefore a high quality fertilizer to be focus on with great attention. The pH values of the urine vary between 4.5 and 8.5 [24,21] in general; those used in the case of the present studies have pH values ranging between 6 and 8 [14]. This fluid can in some rare cases bear germs such as those responsible of the transmission of leptospirosis, typhoid, paraty-phoid, bilharzia, and many other urinary infections [25,26,27,28,29]. In the details, the principal risk of contamination while manipulating them is due to their cross contamination by fecal matter and not by urine itself. However, the strict respect of the multiple barriers proposed by [30] is an issue to manipulate that fluid safely.

2.1.3 Water from cooked beans

Beans belong to leguminous family. It is rich in vegetal proteins and carbohydrates, with little quantity of fats [31]. Its chemical composition shows out great quantity of nitrogen, phosphorus, sulphur, potassium, iron, calcium, and a few amount of sodium [32,31]. Water from cooked beans is obtained at the end of the cooking process of beans seeds. This water is rich in chemical elements concentrated in the beans seeds according to the response of soils treated with that fluid as it was shown by [14]. Its pH values range between 6 and 6.5 [14]. The issue of the present work is therefore to verify if that water can improve significantly the growth of plants and crop yields. Seeds used here is commonly called “Meringue”, a subgroup of *Phaseolus vulgaris* [32].

2.1.4 The mixture of human urine and water from cooked beans

The mixture of human urine and water from cooked beans was prepared following [14]. In fact, in its former studies about the fertilization trials on the Andosols from Western Highlands of Cameroon, this author mixed those two fluids in the 1:1 ratio, implying one part of human urine for one part of water from cooked beans. The pH value of that mixture was 6.85 [14].

2.1.5 The area of the study

The study was carried out in Yaoundé, in the Center Region of Cameroon (Fig. 1).

Fig. 1. The position of Yaoundé in Cameroon

It belongs to the Central Plateau, a portion of Congo Craton. The bedrock is made of metamorphic rocks. The landscape is characterized by interfluves with half-orange shape. Soils are of ferralitic types. The climate is equatorial of guinean subtype with two rainy and two dry seasons [33].

2.2 Methods

2.2.1 Preparation of parcels

On a virgin land in Badoumou village, a flatty experimental parcel of 292,500 cm^2 was chosen at the summit of an interfluve. It was then cleaned and subdivided into sixteen equal sub-plots of 12,600 cm^2 each and ramified paths of 30 cm width as shown on the Fig. 2.

2.2.2 Selection and treatment of seeds

Talinum fruticosum L. and *Ocimum gratissimum L.* were chosen because they are often used in Cameroon as food and medicines as in many others countries all over the intertropical zone [15]. For *Talinum fruticosum L.,* seeds were stem cuttings of 1cm of circumference and 10cm of length, while for Ocimum *gratissimum L.,* seeds were mature, healthy, and homogenous grains selected according to [18] recommendations.

2.2.3 Sowing

Eight of the sixteen parcels received the seeds of *Talinum fruticosum L.* and the eight others received the seeds of *Ocimum gratissimum L.* at the beginning of the short rainy season (15^{th} of March to the 14^{th} of June). Each of those seeds were sowed in a square of 625cm^2 to make the feeding and the growth process of the young plants easier [34,18]. However, the seeds of the *Talinum fruticossum L.* were sown in the portion of the parcel where the shadow can easily reach at a certain time of the day [35].

2.2.4 Fertilization

One week after the germination of the different seeds, eight of the sixteen sub-plots received fertilizers. In the detail, once per week, five liter of the mixture [14] were used as treatment for each of those eight sub-plots. For that purpose, the concoction was poured in a furrow dug around each plant and buried directly after in order to avoid the loose of nitrogen [15].

2.2.5 Measurements

Measurements were done on 322 plants, 161 on *Talinum fruticosum L.* and 161 on *Ocimum gratissimum* L. The measurements took place one time three months after the sowing. Concerning *Talinum fruticosum L.,* measurements were taken on the leaves (LfT: length of the leaves of *Talinum fruticosum L.* plants treated; LfNT: length of the leaves of the control of *Talinum fruticosum L.* plants; lFT: width of the leaves of *Talinum fruticosum L.* plants treated; lFNT: Width of the leaves of the control of *Talinum fruticosum L.* plants) and on the stems (CTWIT: circumference of the stem of the *Talinum fruticosum L. treated;* CTWINT: circumference of the stem of the control of *Talinum fruticosum L.* plants) of treated plants and control since those two parts are edible. Regarding *Ocimum gratissimum L.,* the measurements were taken only on the leaves (LfWIT: length of the leaves of *Ocimum gratissimum L.* plants treated; LfWINT: length of the leaves of the control of *Ocimum gratissimum* plants; lFWIT: width of the leaves of *Ocimum gratissimum L.* plants treated; lFWINT: width of the leaves of the control of *Ocimum gratissimum L.* plants and) of the treated plants and control since they are the only organs edible of those plants. These measurements taken on the leaves concerned the principal axis on the length and width directions, and those taken on the stems dealt only with their circumference.

3. RESULTS AND DISCUSSION

3.1 *Ocimum gratissimum L.* Growth and Yield

Three months after the beginning of the germination of the seeds, many facts can be notified. The lengths of the leaves of the plants that have grown on fertilized soils range between 20 and 25 cm (Fig. 3), for an average of about 22 cm, meanwhile those of the control are less than 10 cm in general, with an average of about 8 cm. Concerning the widths, those of the leaves of plants that have grown on fertilized soils range between 7 and 9 cm (Fig. 4), with an average of 8 cm, meanwhile those of the leaves of the control range between 4 and 6cm, for an average of about 5 cm (Fig. 4). Figs. 3 and 4 show that the length is often more important that width independently of the status of the soil on which the concerned plants have grown on. When we divide the lengths of the leaves of plants developed on fertilized soils by those of leaves of the control, we can realize that the lengths of the leaves of plants developed on fertilized soils are about 3 times (2.75 times) higher than that of the control, with a difference in length of about 14 cm (Fig. 3); the same pattern was observed with

the width (plants developed on fertilized soils are about two times (1.6 times) higher than that of the control, for a difference of 2.9 cm). The stems of plants that have grown on fertilized soils are more resistant under finger pressure than that of the control. In addition, the control loss easily their leaves compared to the plants that have grown on fertilized soils.

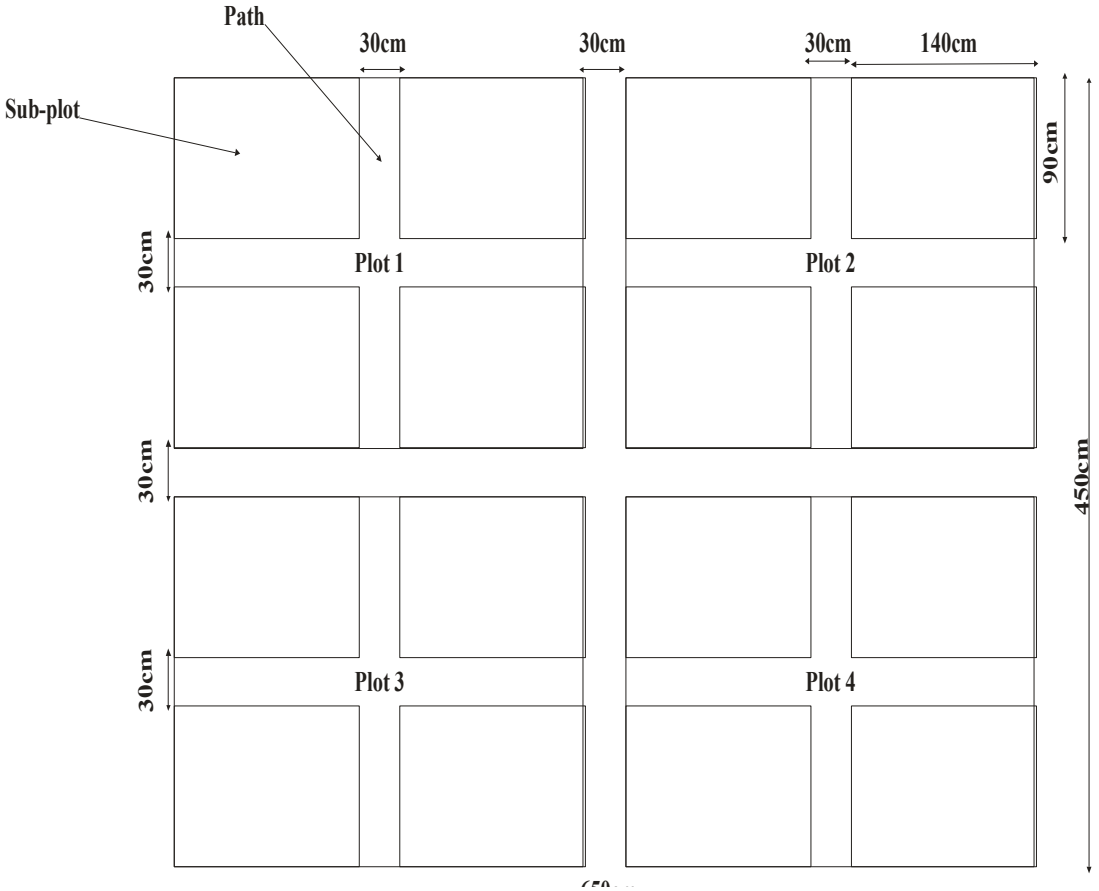

Fig. 2. Experimental design

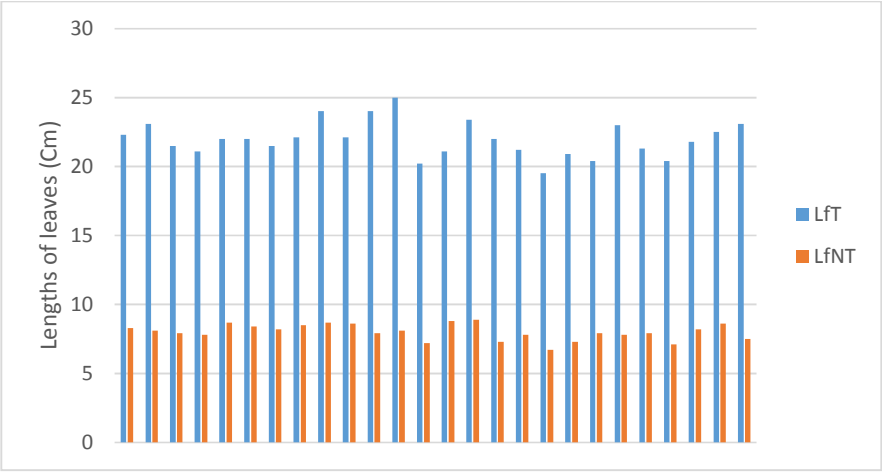

Fig. 3. Comparison between the lengths of the leaves of plants that have grown on fertilized soils and those of the control

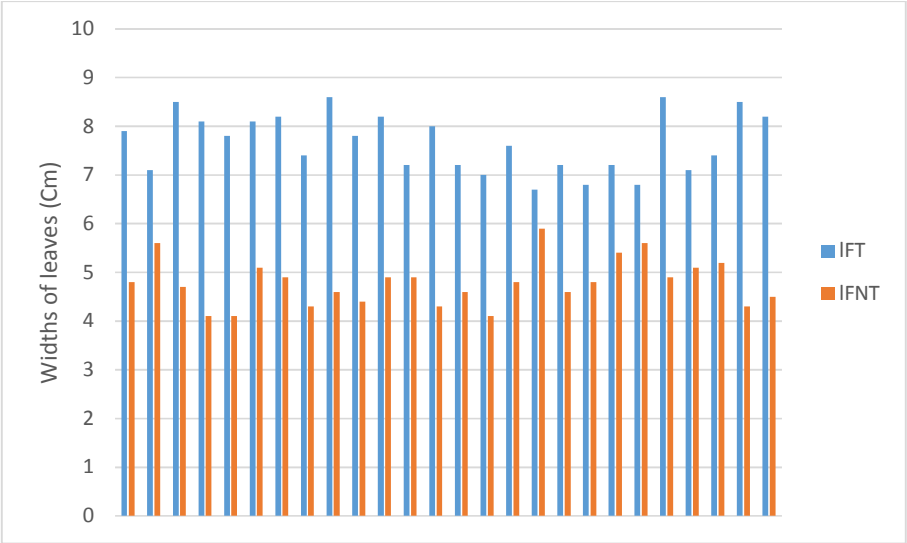

Fig. 4. Comparison between the widths of the leaves of plants that have grown on fertilized soils and those of the control

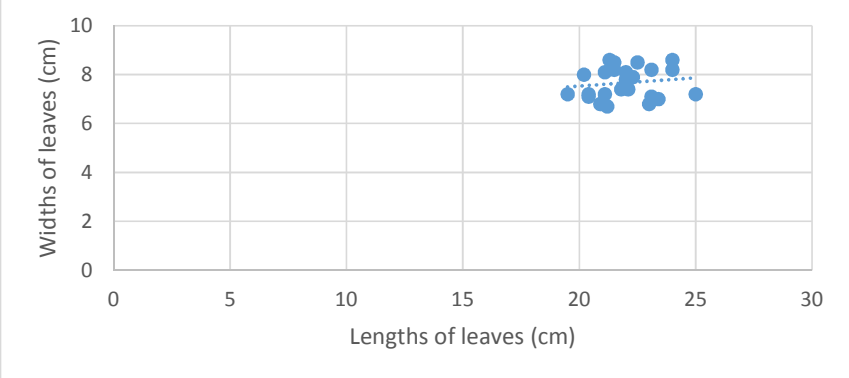

Fig. 5. Correlation between the lengths and the widths of the leaves of plants developed on fertilized soils

These observations corroborate those made by [16,36,37], who noticed that in optimal conditions, *Ocimum gratissimum L.* can reach wonderful sizes, certifying then the high concentration of mineral salts in the mixture made of human urine and water from cooked beans (*Phaseolus vulgaris,* particularly the Meringue) used as fertilizers in the present case study. This theory of availability of nutrients in that mixture was previously demonstrated by [14]. In fact, they noticed a high enrichment of Andosols from Western Highlands of Cameroon in nitrogen, potassium, sodium, calcium, and available phosphorus, after have been treated with the same mixture. The importance of the magnesium in the synthesis of the chlorophyll was proved by [38] and [39]. The steadiness of the stems and the reduction of the loose of leaves by *Ocimum gratissimum L.* is the consequence of a good nutrition of plants developed on fertilized soils with nitrogen, responsible as it was shown by [38] of the firmness of the different parts of plants.

The correlation established between the lengths and the widths of the leaves of plants developed on fertilized soils are slightly positive. The Pearson coefficient calculated for that is 0.15 (Fig. 5 and Table 1).

The correlation between the widths of leaves and the circumferences of the stems is negative (Fig. 6). The Pearson coefficient calculated for that fact is -0.05 (Table 1).

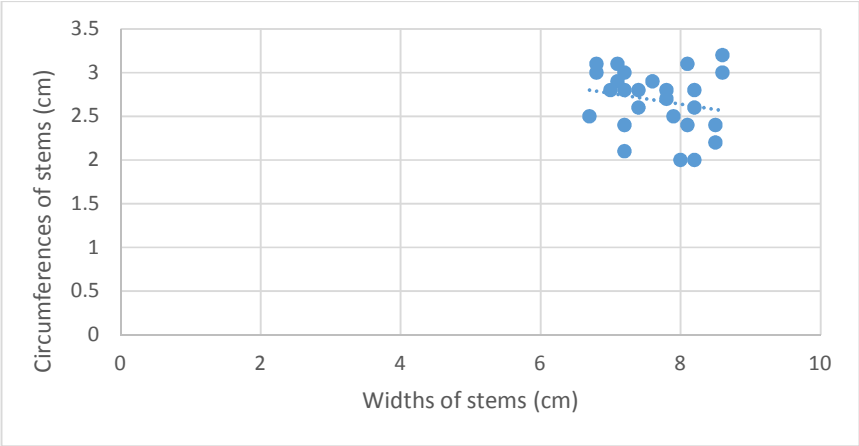

Fig. 6. Correlation between leaves widths and stems circumference of the plants developed on fertilized soils

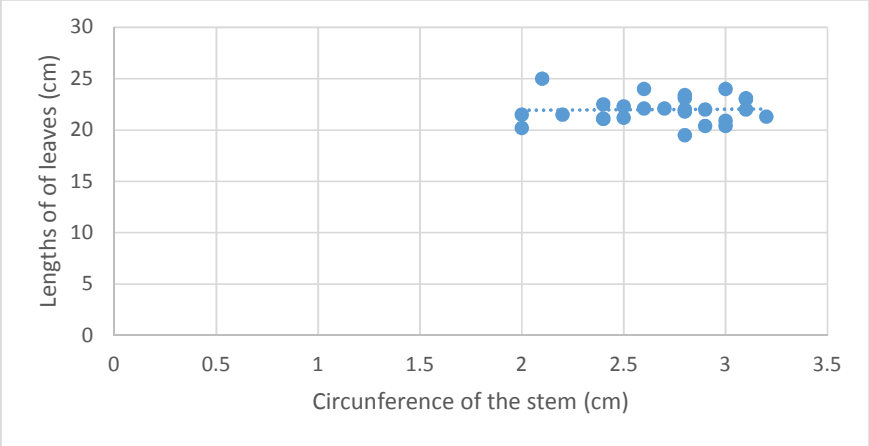

Fig. 7. Correlation between the leaves lengths and the stems circumferences of plants developed on fertilized soils

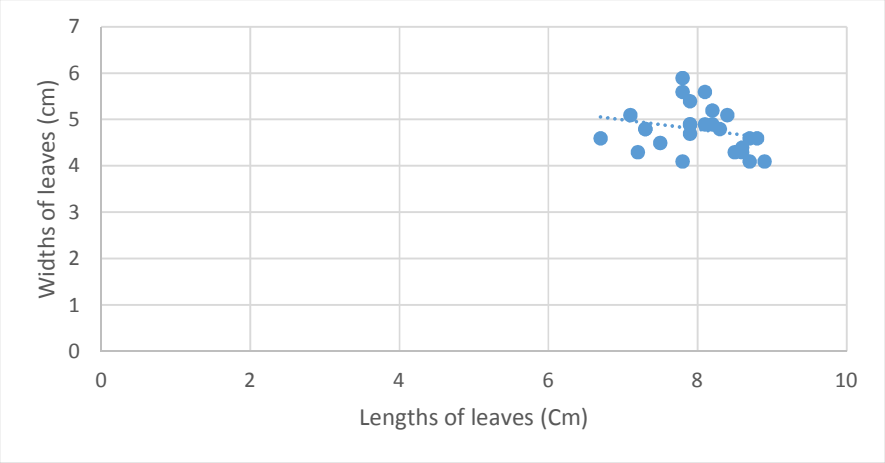

Fig. 8. Correlation between the widths and the lengths of the leaves of control

Table 1. Correlation matrix for plants developed on fertilized soils

	Lf	lf	Cf
Lf	1		
lf	0.15	1	
Cf	0.000471	-0.05	1

Lf: Length of the leaves; lf: Width of the leaves; Cf: circumference of the stems

As shown in the Fig. 7, it seems not to exist a correlation between the leaves lengths and the stems circumferences of plants developed on fertilized soils. The Pearson coefficient calculated for that is 0.000471 (Table 1).

The correlation between the lengths and the widths of the leaves of control is negative (Fig. 8). The Pearson coefficient calculated for that is -0.24 (Table 2).

Table 2. Correlation matrix for the control

	Lf	lf	Cf
Lf	1		
Lf	-0.24	1	
Cf	-	-	1

Lf: length of the leaves; lf: width of the leaves; Cf: circumference of the stems

The length of the leaves of *Ocimum gratissimum L.* increases faster than the width. This observation justifies without a doubt the ovoidal shape of the leaves of this plant as shown by [40, 18], and [19]. Furthermore, if after have grown up on fertilized soils the leaves of this plant can reach wonderful sizes, it is not the same thing with the circumference of the stem which remains modest [40]. But, when this plant grow on fertilized soils, its stem gains in firmness [40]. For a shrub [17,41,42], the sizes reached after three months of development on fertilized soils demonstrate once more an ability of the mixture made of human urine and water from cooked beans as nutrients provider. This fact corroborates once more the observations made by [14] in their work on Andosols fertilization trials. This is in accordance with the chemical composition of that plant as shown by [18] and [19] who in their respective studies shew that for their nutrition, this category of plant needs great quantity of macro nutrients such as nitrogen, potassium and phosphorus in the same order as well as micro nutrients like calcium and magnesium, and oligo nutrients, notably sodium, iron, manganese, zinc, and copper.

The leaves of the control of *Ocimum gratissimum L.* plants have many yellowish spots while the leaves of the same plants fed with the mixture tested here are dark green. The presence of the yellowish spots seen on the leaves of the control of *Ocimum gratissimum L.* plants can firstly be justified by the deficiency of soils in magnesium [38]. That presence can also be explained by an Mg/K ratio less than 6 [14]. In fact, [38] demonstrated that for such a quotient, magnesium is poorly absorbed in the presence of potassium. Then, the plants behave as if there wasn't magnesium in the soil. The consequence of that situation for the plant will be an insufficient nutrition in magnesium alongside with a possible toxicity in potassium [34]; therefore, it will be difficult for the concerned plant to manufacture chlorophyll, inescapable at the time of the photosynthesis process [38]. The dark green coloration of the leaves of *Ocimum gratissimum L.* plants developed on treated portions exposes thus logically an important input of magnesium in soils among all in response of the use of the mixture of human urine and reserved water from cooked beans as fertilizer [14].

Finally, the mixture of human urine and water from cooked beans (*Phaseolus vulgaris)* is a good nutrients provider for plants as shown by the response of *Ocimum gratissimum L.* through their leaves after have been developed on soils fertilized with this mixture. People who often use it as medicines and food [41,18,19] can then find trough this study a nice way to improve the production of *Ocimum gratissimum L.*

3.2 *Talinum fruticosum L.*

After three month of growth, the lengths of the leaves of *Talinum fruticosum L.* developed on fertilized soils range between 8 and 12 cm (Fig. 9), being an average of 10cm about. The leaves length of the control plants range between 1.8 and 5 cm (Fig. 9) with an average of 4 cm about. The widths of the leaves of plants developed on fertilized soils range between 3 and 5cm for an average of 4cm (Fig. 10). At the same time, the widths of the leaves of the control are all lower than 2.5 cm, for an average of 2 cm about. When we divide the lengths of the leaves of the plants developed on fertilized soils by the lengths of the leaves of the control, we can realize that the lengths of the leaves of the plants developed on fertilized soils are about 2.5 times higher than that of the control. The difference is about 6 cm. When we divide the widths of the leaves of the plants developed on

the soils fertilized with the mixture by that of the leaves of the control, we realize that the width of the leaves of the plants developed on fertilized soils is about 2 times higher than those of the control; the difference is 2 cm. The control easily loses their leaves compared to the plants developed on fertilized soils.

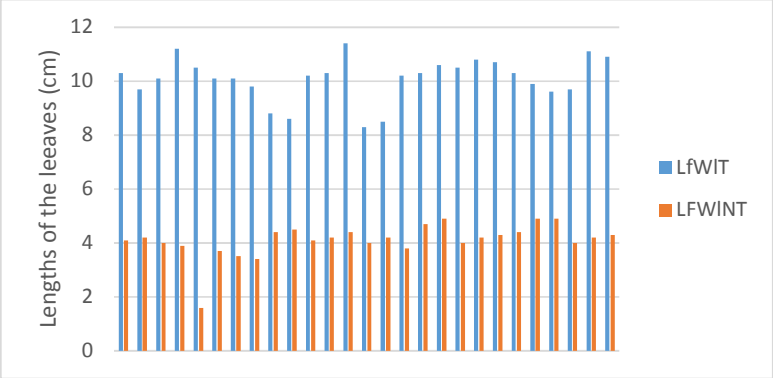

Fig. 9. Comparison between the lengths of the leaves of the plants developed on fertilized soils and the lengths of the leaves of the control

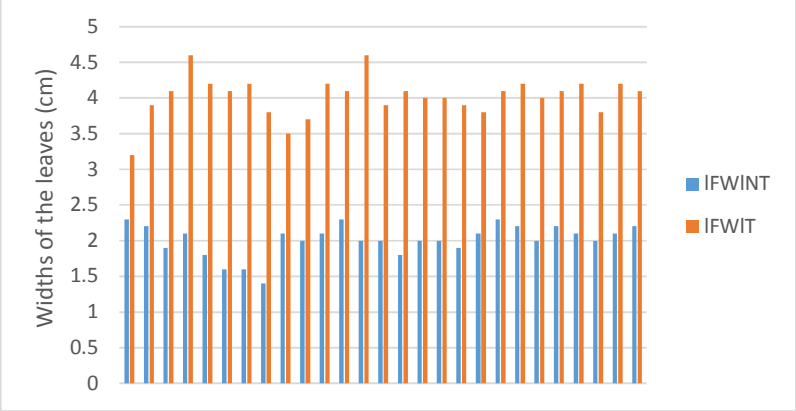

Fig. 10. Comparison between the widths of the leaves of plants developed on fertilized soils and the widths of the leaves of the control

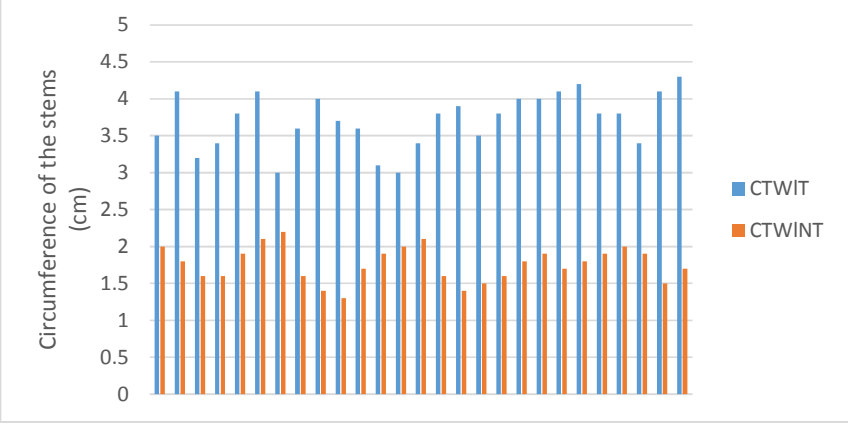

Fig. 11. Comparison between the stems of plants developed on fertilized soils and the stems of the control

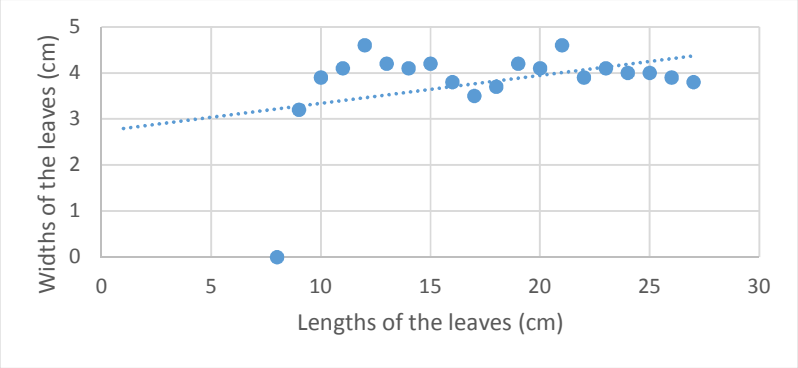

Fig. 12. Correlation between the lengths and the widths of the leaves of plants developed on fertilized soils

The density of the leaves of plants developed on the fertilized parcels is very high compared to what is noticed in the control. In the details, the plants that have received the mixture grow quickly than the control. This observation is the proof of the importance of the mixture because of its supposed chemical composition that makes us guess its worth in nutrients required for the optimal growth of the plants as noticed by [43,24, 37]. These authors observed that in optimal conditions, the leaves of *Ocimum fruticosum L.* can grow quickly and reach about three times the sizes that they could have if they were grown in unfertile soils.

A comparison established between the stems circumferences of the plants developed on fertilized soils and those of the control reveals a great difference (Fig. 11). In fact, if that parameter is lower than 2.5cm in the control as shown by the Fig. 11, it reaches and surpasses 4 cm in the plants developed on fertilized soils. The ratio between these two circumferences is about 2 (1.6). This shows that in optimal conditions, the circumference of a plant developed on fertilized soils can simply double compare to what would have happen in conditions of poverty as observed by [43]. This intense development of the circumference of the stems of plants developed on fertilized soils is without a doubt due to the high availability of the nutrients contained in the mixture made of human urine and water from cooked beans (*Phaseolus vulgaris L.)* used here as fertilizer. This corroborates perfectly the observations made by [44,34,45,46,3] and [15]. In fact, the growth of this plant requires great quantities of calcium, phosphorus, and nitrogen amongst others [3], substances brought to the soils treated during the studies of [14] by the mixture of human urine and water from cooked beans, two fluids particularly rich in many nutrients [47,48]. This is in accordance with the great fixation of the leaves on the stems of plants developed on fertilized soils.

The correlation is positive between the lengths and the widths of the leaves of plants developed on fertilized soils as shown by the Fig. 12. The Pearson coefficient of correlation is 0.41 (Table 3).

Table.3. 15: Correlation matrix for *Talinum fruticosum L.*

	Lf	Lf	Cf
Lf	1		
lf	0.41	1	
Cf	-0.06	-0.19	1

Lf: length of the leaves; lf: width of the leaves; Cf: circumference of the stems

The correlation established between the leaves widths of the plants developed on fertilized soils and the stems circumferences is relatively negative (Fig. 13). The Pearson coefficient calculated for that is thus -0.19 (Table 3).

The correlation established between the lengths of the leaves of plants developed on fertilized soils and the circumferences of the stems is quite nil; this simply shows that these two parts of the plant grow at different speed (Fig. 14). The Pearson coefficient of correlation is thus -0.06 (Table 3).

The correlation is positive between the lengths and the widths of the leaves of the control (Fig. 15). The Pearson coefficient calculated here is 0.271(Table 4).

The correlation between the widths of the leaves and the circumference of the control is slightly negative (Fig. 16). The Pearson coefficient calculated is -0.154 (Table 4).

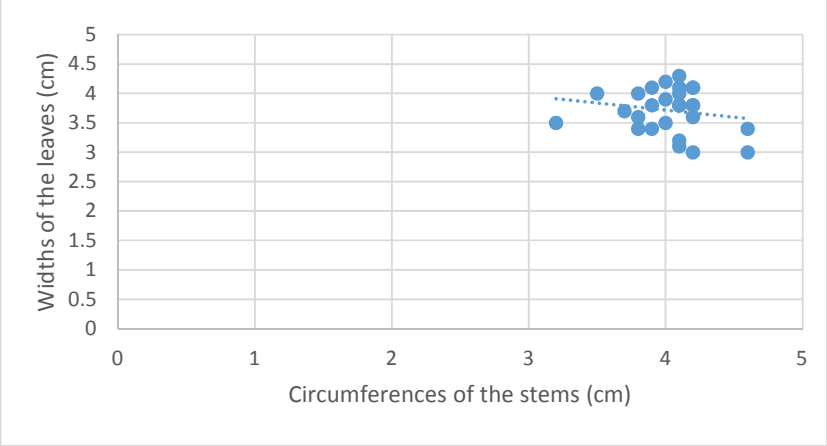

Fig. 13. Correlation between the widths of the leaves of plants developed on fertilized soils and the circumferences of the stems

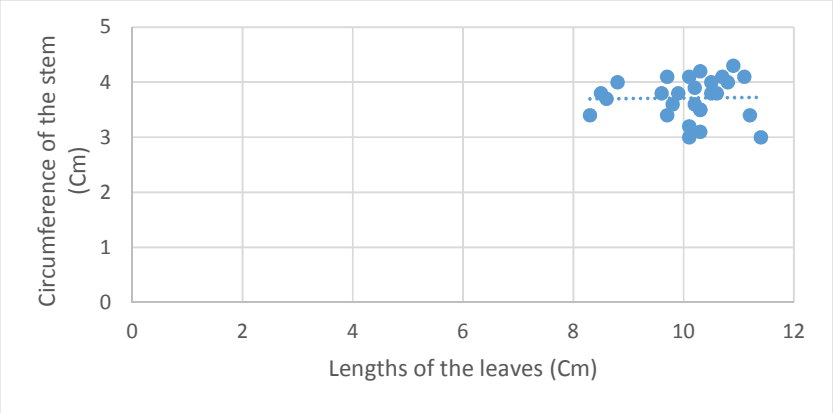

Fig. 14. Correlation between the lengths of the leaves of plants developed on fertilized soils and the circumferences of the stems

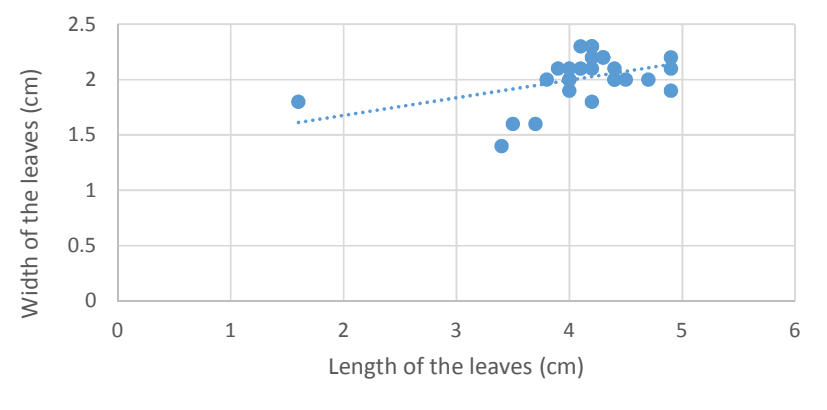

Fig. 15. Correlation between the lengths and the widths of the leaves of the control

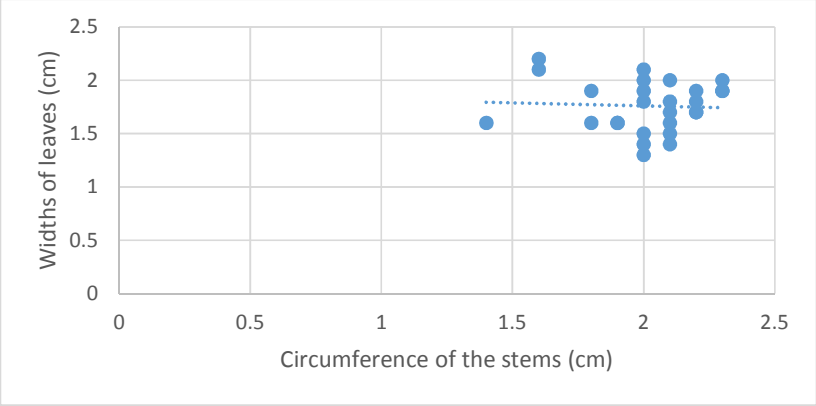

Fig. 16. Correlation between the widths of the leaves and the circumference of the stems of the control

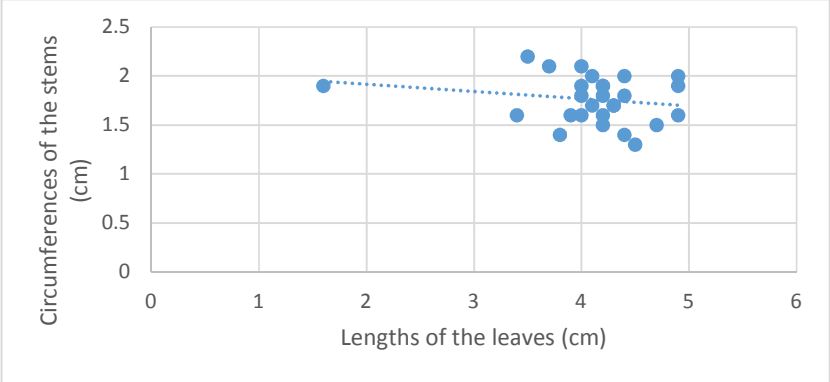

Fig.17. Correlation between the lengths of the leaves and the stems of the control

Table 4. Correlation matrix of the control

	Lf	lf	Cf
Lf	1		
lf	0.271	1	
Cf	-0.04	-0.154	1

Lf : length of the leaves ; lf : width of the leaves ; Cf : circumference of the stems

The correlation between the lengths of the leaves and the circumference of the stems in control is quite negative (Fig. 17). The coefficient of Pearson calculated is -0.04 (Table 4).

These facts demonstrate that the behavior of the lengths and the widths during the growth of the leaves are closed to each other. However; the length grows faster than the width. This is then in accordance with the ovoidal shape of the leaves of *Talinum fruticosum L.* as described by [45], [20], and [3]. Moreover, the lengths and the widths of the leaves grow faster than the circumference. This is in accordance with the Pearson index calculated here. But the mixture used here as fertilizer contributes highly in the increase of those different parameters, notably the lengths and the widths of the leaves and the circumference of the stem, since they are often used in pharmacology and as food in many countries [20]. Hence, this mixture contributes highly in the production of mater in *Talinum fruticosum L.* as consequence of the high availability of the nutrients contained in the mixture made of human urine [15] and water from boiled beans [14].

4. CONCLUSION

At the end of the present study that the aim was the investigation of the mixture made of human urine and water from cooked beans as fertilizer, we can easily notice that after three month of treatment, *Ocimum gratissimum L.* and *Talinum fruticosum L.* that the response to this particular fertilizer was tested here reached wonderful sizes. This mixture is then a way of sustainable

improvement of the yield of these two plants highly used as food and medicines for the peasants who grow them.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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