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INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/15338
DOI URL: http://dx.doi.org/10.21474/IJAR01/15338

RESEARCH ARTICLE

INFLUENCE OF THE LEVEL PRUNING ON AGRONOMIC PARAMETERS OF SAVANNAH TEA (L*ippia multiflora* L., Verbenaceae) IN YAMOUSSOUKRO, CENTRAL CÔTE D'IVOIRE

N. Kouame, B.B.N.B. Voui, Y.G. Gnamien, K.A. Kouassi, N.J. Kouassi and Y.J. Kouadio
Agricultural Production Improvement Laboratory, UFR Agroforestry, University of Jean Lorougnon Guédé (UJLoG), BP 150 Daloa, Côte d'Ivoire.

Manuscript Info

Manuscript History
Received: 05 July 2022
Final Accepted: 09 August 2022
Published: September 2022

Key words:-
Yamoussoukro, Receipt Level, Growth Parameters, Buds, Lippia Multiflora

Abstract

On Yamoussoukro autonomous district, a study on the ability of *Lippia multiflora* L. (Verbenaceae) to shoot and grow was carried out at six soil height levels: 0 cm, 5 cm, 10 cm, 15 cm, 20 cm, 25 cm and 30 cm. The objectif was to determine the favourable levels of pruning for better leaf production. From 28 samples grouped in 7 batches, the pruning was carried out. After 3 months of vegetation, the agronomic parameters of vigour were determined. The results showed that various growth parameters such as number of buds, number of leaves per bud, bud height, leaf length and width as well as budding time and leaf span were measured. Receiving levels at 10 cm, 15 cm and 20 cm from the ground resulted in good leaf production and bud growth.

Introduction:-

Lippia multiflora, also known as Gambia tea, or savannah tea, is an aromatic plant of the Verbenaceae family, which grows spontaneously and preferentially in the savannas of subtropical Africa [1, 2]. Information provided by bibliographic research, from studies carried out in Ghana, Togo, Benin, Côte d'Ivoire, Congo, etc., indicate that the plant has enormous economic potential [3], thanks to its leaves, which have a variety of food uses [3, 4, 5], biomedical and/or pharmacological uses [4, 6, 7], cosmetics and pesticides [8]. Several research programs in humid tropical Africa have focused on the chemical composition of *Lippia multiflora* leaves, particularly on the extraction and study of the properties of essential oils [9, 10, 11]. In Côte d'Ivoire, the dietary, biomedical and pharmacological importance of Lippia multiflora leaves has also been reported [6, 12]. However, very few studies have focused on understanding the functioning of the Lippia multiflora plant stand or on developing appropriate cultural techniques.

The agronomic research programs carried out on Lippia multiflora, in humid tropical Africa and in Côte d'Ivoire, have focused, most often, on vegetative propagation [7, 13], knowledge of the characteristics of the soil on which the plant naturally develops [1], the type of soil suitable for its cultivation [14], mulching[15], the mode of re-picking [16], varietal characterization [17].

From all this information, it is to be noted that many studies have been made on *Lippia multiflora*, but no study has been made on the receptive zone favorable to a better yield of *Lippia multiflora* leaves. Receiving plants is an operation that consists in cutting a tree or a shrub near the collar or a little higher. This action causes, under certain conditions, the appearance of shoots on the stump or sometimes suckers on the tracing root. Receiving is done in order to regenerate the injured or malformed aerial part of a plant in order to form a new straight trunk or a vine; that is, several trunks developing on the same stump [18]. The main objective of this study was to improve the production of

Corresponding Author:- N. Kouame
Address:- Agricultural Production Improvement Laboratory, UFR Agroforestry, University of Jean LorougnonGUEDE (UJLoG), BP 150 Daloa, Côte d'Ivoire.

Lippia multiflora in order to domesticate it and generate additional income. Specifically, the aim was to determine the favourable pruning height for better production of *Lippia multiflora* leaves.

Materials and Methods:-

Study Area

The Autonomous District of Yamoussoukro is a special type of territorial collectivity located in central Côte d'Ivoire. It covers a territory between 06°49 and 06°47 North latitude and 05°16 and 05°15 West longitude. It covers an area of 3500 km2, with an estimated population of 300,000 (INS, 2014). The Yamoussoukro Autonomous District is bordered to the north by the department of Tiébissou, To the south by the department of Toumodi, to the east by the department of Dimbokro and to the west by the departments of Bouaflé and Sinfra. The study site is located northwest of the city between the Zatta corridor and the Yamoussoukro airport (Figure 1). The vegetation of the Yamoussoukro autonomous district belongs to the Guinean domain. It is characterized by pre-forest savannahs which are essentially Guinean grassy areas. It is dotted with gallery trees. The floristic composition is that of the semi-deciduous forest. The relief of the Autonomous District of Yamoussoukro is, on the whole, a type of relief of plains and plateaus. Several levels of plateaus can be distinguished, ranging from 200 to 300 meters, separated from each other by low slopes (10 to 30 meters). Isolated plateaus called inselbergs appear; for example, the Baoulé chain or the Rombo mountain. The study area is subject to a mild transitional equatorial climate (Baulean climate), between the Guinean and Sudanian climates [14].The region is characterized by a dry season that extends from November to March and a rainy season marked by two rainfall maxima, one in June and the other in September. Rainfall averages 1145.6 mm, with an average temperature of 26°C. The hydrographic network is essentially composed of the Marahoué (or red Bandama), the white Bandama, as well as several tributaries of the Bandama River and the Kossou Dam. The soil of the Yamoussoukro Autonomous District is ferralitic, ranging from sandy-clay to sandy-clay rich in coarse sand [1].

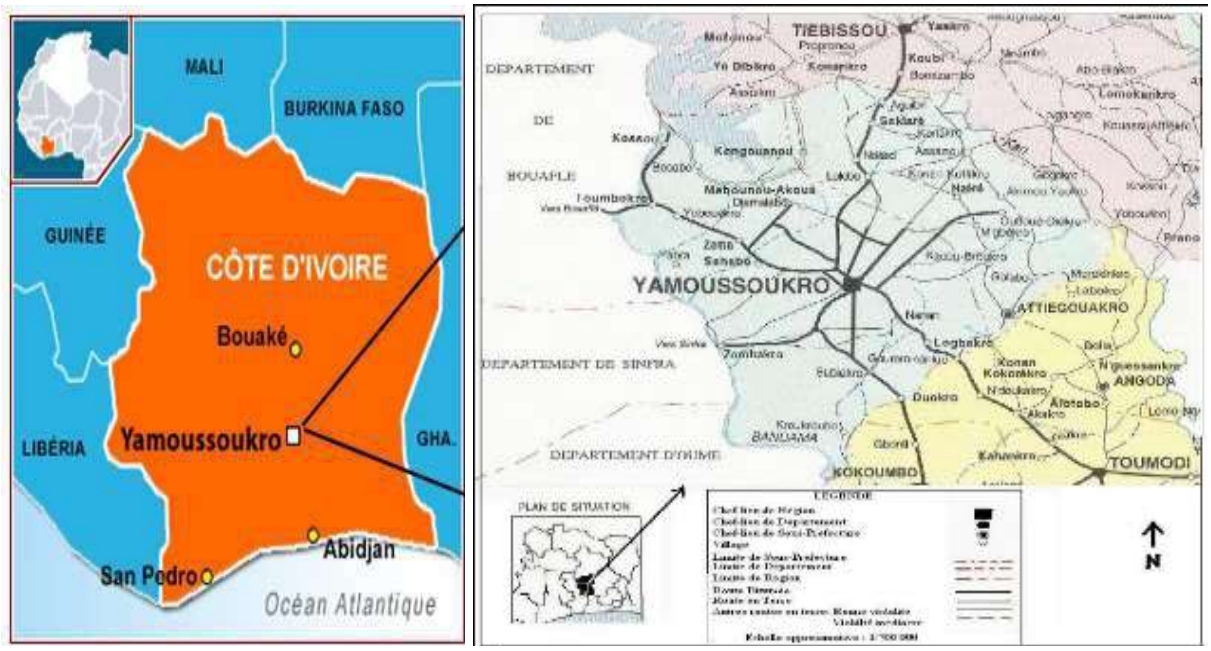

Figure 1:- Map showing the study site [1].

Materials:-

Biological material

The biological material consisted of *Lippia multiflora* plants (Figure 2).

Figure 2:- Plants of *Lippia multiflora*.

Methods:-

Experimental setup

The study took place in a domestication field of Lippia *multiflora* on a plot of about 0.50 ha. It consisted in selecting 28 samples grouped in 7 batches of 4 each. The 4 samples of each lot were cut with a saw blade at different levels. Thus, the cuttings were made at the following different heights from the ground: 0, 5, 10, 15, 20, 25, 30 cm from the crown to the stem apex (Figures 3).

Figure 3:- Different levels of retention. A: receiving at 00 cm from the ground, B: receiving at 05 cm from the ground, C: receiving at 10 cm from the ground,D: receiving at 15 cm from the ground, E: receiving at 20 cm from the ground, F: receiving at 25 cm from the ground, G: receiving at 30 cm from the ground.

Field maintenance

In order to avoid competition, undesirable weeds were eliminated with a machete and a daba, whenever necessary, from the time of rooting until the end of the experiment, which lasted about 3 months.

Data collection

Data collection began when the first leaves appeared.

Data were collected by measuring the following parameters with the tape measure or by counting some parameters. These are the average height of regrown buds, the average number of leaves per bud, the average number of regrown buds, the average leaf length, the average leaf width, and the span of foliage of the stand. Bud height was measured from the collar to the top of the plant, i.e., at the highest apex. The number of leaves was assessed by simply counting the number of leaves weekly until the end of the observations. The number of buds was assessed as they budded all around the stumps after receiving. The length of the leaves is taken from the base of the petiole to the end of the last mature leaf. It was made on a set of 10 leaves on the plant while taking into account their good bloom.

The width of the leaf was taken on the same leaves as the lengths in the largest dimension of the leaf that is to say in the middle of it. The span is measured by taking the distance between two most extreme leaves. In addition to all the parameters studied, the dates of appearance of the first buds were taken in order to determine the budding time.

Statistical analysis

A one-criteria classification analysis (ANOVA) was performed with R. version 3.1 software to evaluate vegetative variables as a function of *Lippia multiflora* catchment area. When a significant difference was noted between factors for a given variable, multiple comparisons were performed by the least significant difference (LSD) test. Test significance was determined by comparing the probability (P) associated with the test statistic to the theoretical value $\alpha = 0.05$ [19].

Results and Discussion:-

Results:-

Time to budding

Table 1 shows the number of days before the first budding according to the level of receptivity. The analysis of this table shows that, when the level of receptivity is low, the *Lippia multiflora* stump buds more quickly. For a level of receptive between 0 and 5 cm, the budding takes place from the 4th day. Between 10 and 20 cm, it is 5 days and 6 days when the transplanting is done at 25 and 30 cm from the ground.

Table 1:- Time to budding according to the level of transplanting.

Reception level (cm)	Buddingtime (days)
C_0 C_5	4
C_{10} C_{15} C_{20}	5
C_{25} C_{30}	6

With C0 = cut at 0 cm, C5 = cut at 5 cm, C10 = cut at 10 cm, C15 = cut at 15 cm, C2 0 = cut at 20 cm, C25 = cut at 25 cm, C30 = cut at 30 cm.

Study of the vegetative parameters of *Lippia multiflora*

Average number of buds

The analysis of figure 4 indicates that the average number of buds according to the level of reception varies from 30 to 50 buds. The highest average number of buds was recorded in C15 and C10. They are 50 and 48 buds respectively. The comparative analysis carried out also indicates significant differences between the average number of buds. The homogeneous groups according to the ppd tests are: C15; C10; C20 and C25; C30; C0 and C5.

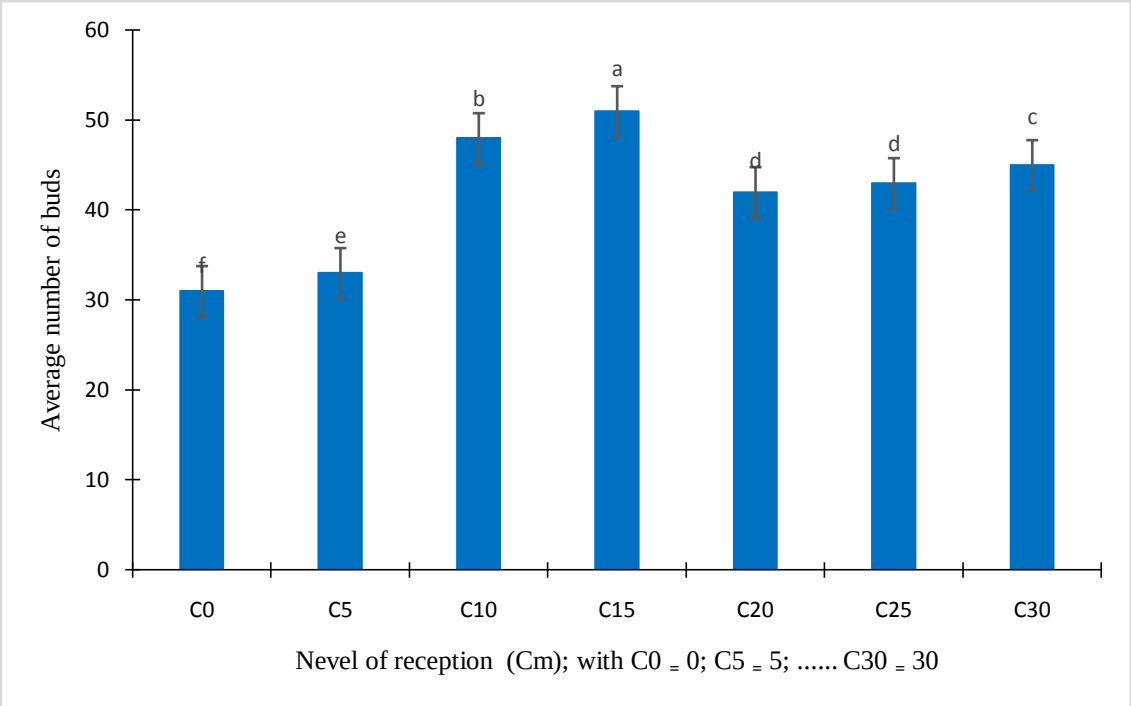

Figure 4:- Histogram of the average number of regrown buds as a function of the level of reception.

Histograms followed by a common letter are not significantly different

Average number of leaves per bud

The analysis of figure 5 indicates that the average number of leaves per bud according to the level of reception varies from 80 to 140 leaves. The highest values were recorded in C15 and C20. They are 140 and 110 leaves respectively. The comparative analysis carried out indicates a significant difference between the average number of leaves. The homogeneous groups according to the ppd tests are: C0 and C5; C10 and C20; C15; C25 and C30.

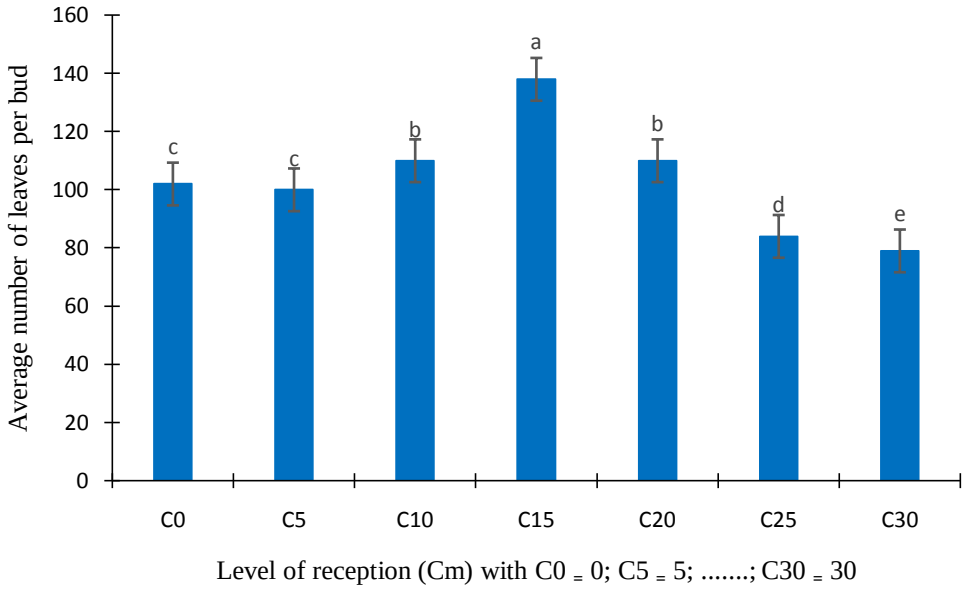

Figure 5:- Histogram of the average number of leaves per bud according to the level of reception.

Histogramsfollowed by a common letter are not significantly different

Average height of buds

The analysis of figure 6 indicates that the average height of the buds according to the level of reception varies from 205 to 240 cm. The highest values were recorded in C20 and C10. They are 240 and 232 cm respectively. The comparative analysis carried out indicates a significant difference between the average bud heights. The homogeneous groups according to the ppd tests are: C20; C10; C0 and C15; C5; C25 and C30

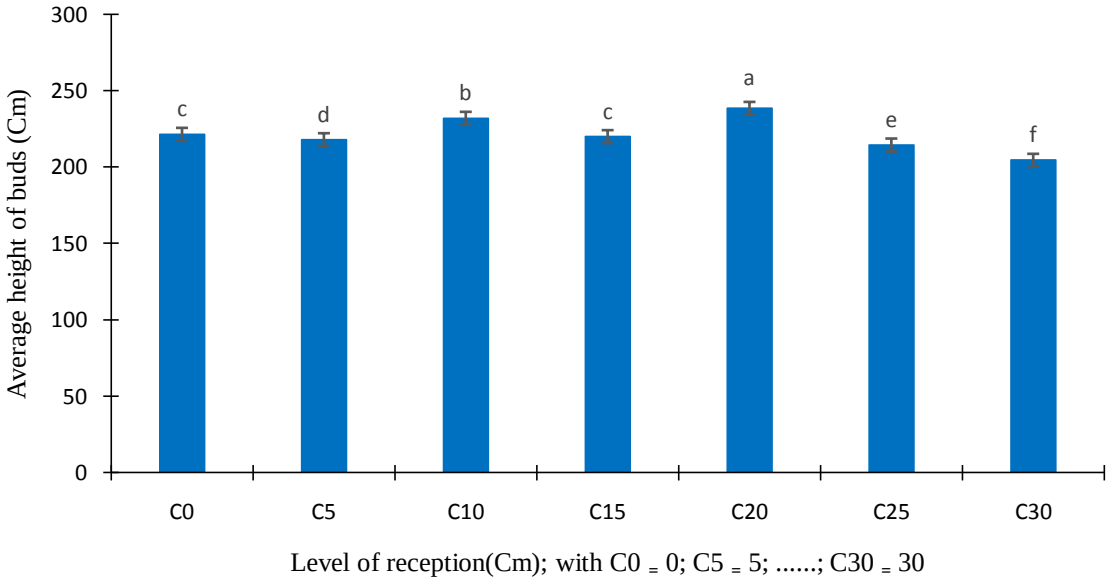

Figure 6:- Histogram of average height of the buds according to reception level

Histogramsfollowed by a common letter are not significantly different

Average leaf length

The analysis of figure 7 indicates that the average length of the leaves according to the level of reception varies from 15 to 17 cm. The highest values were recorded in C5 and C15. They are 17 and 16.95 cm respectively. The comparative analysis carried out indicates a significant difference between the average lengths of the leaves. The homogeneous groups according to the ppds tests are: C5; C15 and C20; C10; C25 and C30; C0.

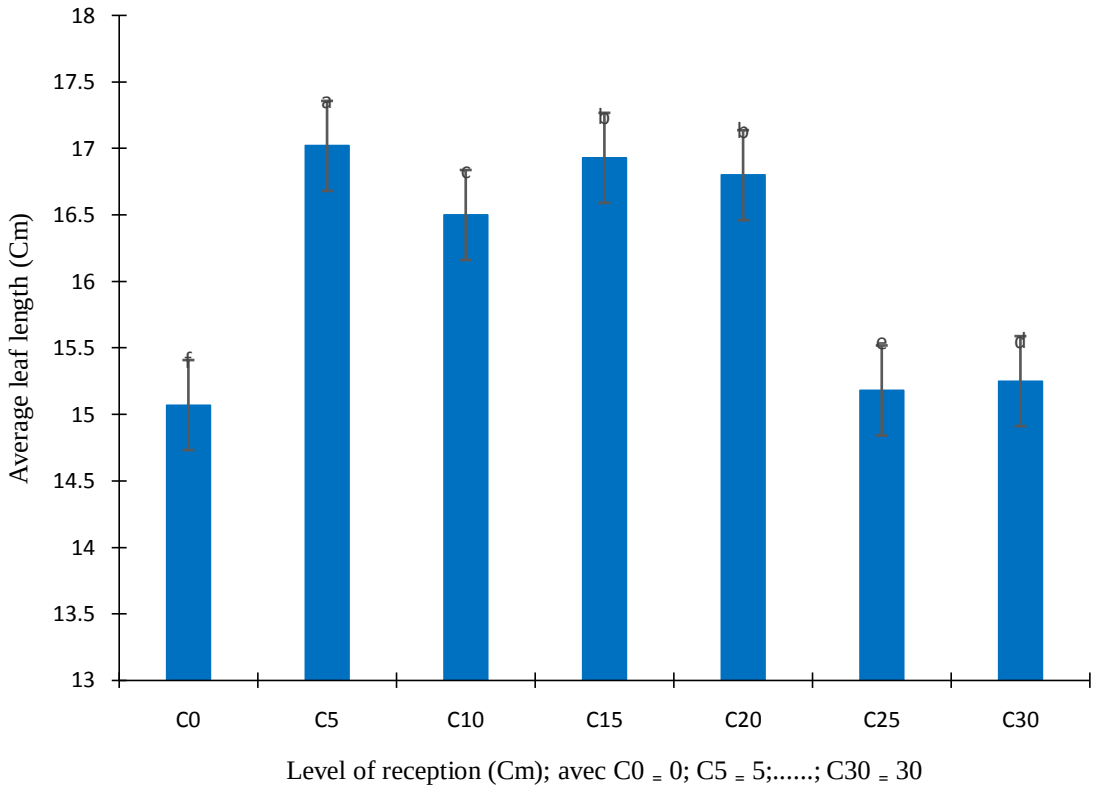

Figure 7:- Histogram of average leaf length according to reception level.

Histogramsfollowed by a common letter are not significantly different

Average leaf width

The analysis of figure 8 indicates that the average width of the leaves according to the level of reception varies from 5 to 7 cm. The highest values were recorded in C10 and C5. They are 7.05 and 6.93 cm respectively. The comparative analysis carried out indicates a significant difference between the average widths of the leaves. The homogeneous groups according to ppd tests are: C10; C15 and C5; C0 and C20; C25 and C30.

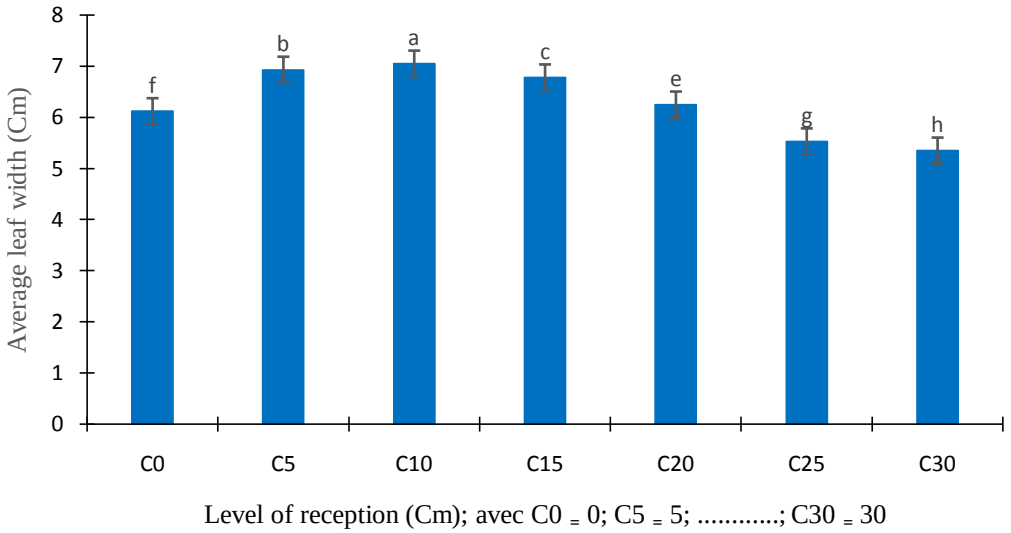

Figure 8:- Histogram of average leaf width according to reception level.

Histogramsfollowed by a common letter are not significantly different

Average leaf span

The analysis of figure 9 indicates that the average leaf span according to the level of reception varies from 135 to 175 cm. The highest spans were recorded in C10 and C25. They are 175 and 170 cm respectively. The comparative analysis carried out indicates a difference between the average spans of foliage. There is no homogeneous group between the spans, according to the ppd tests.

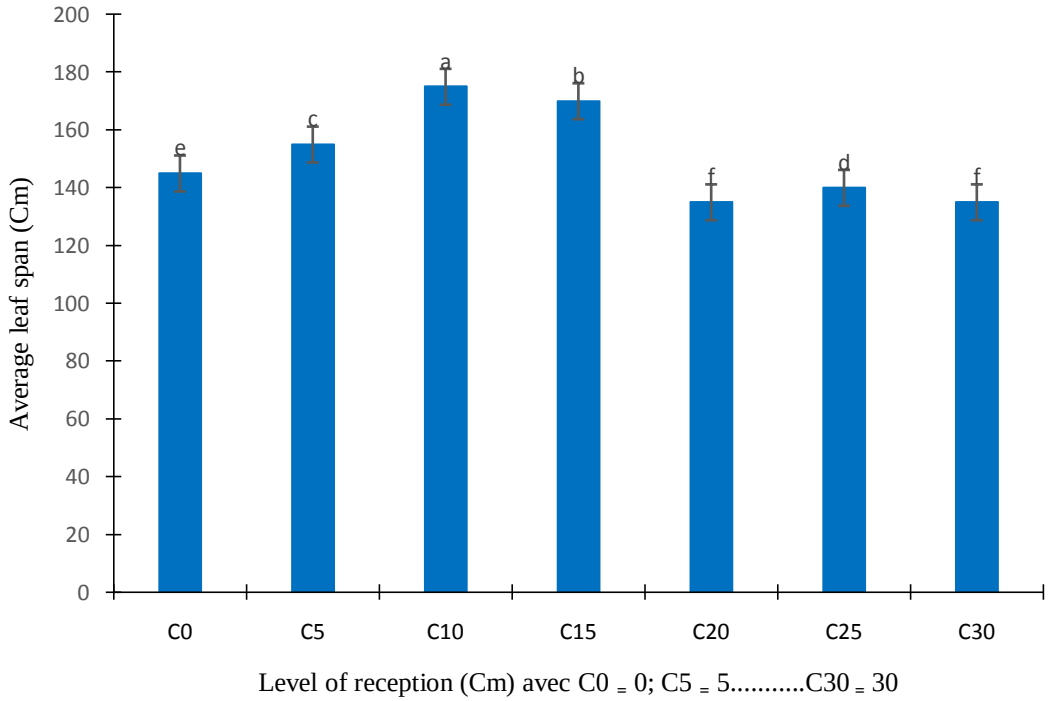

Figure 9:- Histogram of average leaf span according to reception level.

Histogramsfollowed by a common letter are not significantly different

Combined study of all vegetative parameters of Lippia multiflora

Table 2 presents the influence of all agronomic parameters according to the level of reception. The analysis of this table shows that there is a significant difference between all the receptive levels for all the parameters ($P \leq 0.001$).

Table 2:- Influence of receptive level on vegetative variables of Lippia multiflora after reception.

NivC	NbB	NbF	HB	LgF	LrF	EnvF
C_0	31.00^{e}	102.00^{c}	221.50c	15.07^{e}	6.12^{d}	145.00^{d}
C_5	33.00^{e}	100.00^{c}	218.00^{d}	17.02^{a}	6.93^{b}	155.00^{c}
C_{10}	48.00^{b}	110.00^{b}	232.00^{b}	$16.50\pm^{c}$	7.05^{a}	175.00^{a}
C_{15}	51.00^{a}	138.00^{a}	220.00^{cd}	16.93^{ab}	6.78^{b}	170.00^{b}
C_{20}	42.00^{d}	110.00^{b}	238.50^{a}	16.80^{bc}	6.25^{c}	135.00^{f}
C_{25}	43.00^{d}	84.00^{d}	214.50^{e}	15.18^{d}	5.53^{e}	140.00^{e}
C_{30}	45.00^{c}	79.00^{e}	204.50^{f}	15.25^{d}	5.35^{f}	135.00^{f}
P	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001	≤ 0.001

With NivC = cutting level; NbB = number of buds NbF = number of leaves; HB = bud height; LgF = leaf length; LrF = leaf width; EnvF = leaf span. P = probability.All values expressing any length (LgF, LrF, and Env) are expressed in cm. Means in a column followed by a common letter are not significantly different.

Discussion:-

The comparison of the profitability of receiving levels was done based on different agronomic parameters namely, number of leaves, length and width of leaves, bud height, number of buds and also the time to budding.

The time of budding depends on the reception level of the *Lippia multiflora* plant. The more the level of reception is low, the more the plant of *Lippia multiflora* regenerates quickly. Indeed, for a low reception, the stumps being short, the nutritive elements to be brought are sufficient. On the other hand, for higher cuttings, the stumps to be supplied with nutrients are larger, hence a less rapid and less abundant supply. It is therefore this distribution of nutrients that would be the basis of the different budding times according to the reception zone. This result is contrary to that of [20]. According to this author, the budding delay of Garcinia kola is not influenced by the level of receptivity. This can be explained by the fact that, all plants being arranged in the same growing conditions (sunny) and in the same growing media (substrate), the duration of budding can only be the same regardless of the level of reception. On the other hand, [21]obtained different regrowth times in cashew depending on the reception area. In this plant, the best results were recorded in trees with a receiving height between 120 and 140 cm.

The level of rooting significantly influenced the growth in height of the new shoots. This difference was much more pronounced at the 20 cm level. These results are contrary to [22], who states that in Arthémisia annua, cutting at 5-10 cm from the ground yields up to twice the biomass. Similarly, according to [20], the lower reception level in Garcinia kola results in faster bud growth. On the contrary, according to [21], in cashew, the greatest bud heights are observed for reception levels above 140 cm from the ground.

The largest spans, the highest number of buds and the highest number of leaves are found at the 10 cm and 15 cm recepies. The spread and the number of leaves characterize the vigor of the buds. This vigor gives an important production of leaves where photosynthesis takes place and where the production of organic matter is enormous. On the contrary, for low (less than 10 cm) or very high (more than 15 cm) shoots, the photosynthetic production is low. This could be explained by the competition of the high buds on the low buds or by the competition between the buds having practically the same sizes (low reception). The high number of buds for reception at 10 cm and 15 cm, is explained by the fact that at this level, there is a great number of nodes able to make the maximum of bud break without any competition. Above 10 cm, there is competition in the budburst process. Below 10 cm, there is a smaller number of nodes able to make the bud break. These results are similar to those obtained by [22] in Artemisia annua were cutting at 5-10 cm from the ground allows to harvest up to twice as many leaves

These results are also in line with those of N'zué et al. who showed that in cassava, receiving at 10 cm from the ground followed by the use of harvested cuttings for new plantings, gives a very high multiplication rate. This cumulative multiplication rate is estimated to average 35 cuttings per plant per 15-month cycle; three times higher than the conventional technique. These results are also consistent with those of [23] when banana plants are pruned. The removal of plantain from 5 to 10 cm above the ground produces more offshoots. Furthermore, according to.

[21]in cashew, the greatest number of shoots was obtained at the level of pruning above 140 cm. These results illustrate those obtained in tea tree (Camellia sinensis) where training pruning is the most common method that by cutting the stems at a certain height, causes the stimulation of axillary buds and the formation of a spreading framework[24].

The greater number of leaves obtained at the 15 cm reception level could also be explained by strong branching during bud growth. Indeed, when there is branching, the number of leaves produced is greater. On the other hand, due to the high production of leaves, their length and width could decrease. These results are different from those of [21] in which the greatest number of leaves is obtained at the reception level (140 cm).

Conclusion:-

The objective of this study was to propose a receiving area of *Lippia mlultiflora* that can allow a good production of leaves. To do so, *Lippia multiflora* plants were received at different heights (0, 5, 10, 15, 20, 25 and 30 cm) from the ground. From the beginning of budding, agronomic parameters (number of leaves, bud height, number of buds, leaf length, leaf width (the leaf area), leaf span and budding time) were measured during the experimental process. The results showed that the low reception allows a fast budding. However, it does not result in a very high biomass and higher buds. The same is true when the trapping level is very high. The best yields were obtained for the medium rooting zones between 10 and 20 cm from the ground.

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