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Assessment of the Plants Emergence And the Cuttings Resumption Rate of Trema Orientalis From Kinshasa Region in The Democratic Republic of Congo

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ABSTRACT: In Kinshasa, the Mont-Amba region is subjected to a soil degradation whose considerable evidence is the manifestation of erosions within and around the University of Kinshasa. Implementation of afforestation / reforestation as an alternative to rebuild soil stability and fertility from Trema orientalis, one of the rapidly growing local species, however raises problems with the low germination rate of the species. In this study, we compare the germinative method and cuttings of different T. orientalis trees in Kinshasa. The different mother trees of the species by their characteristics allowed the prediction on the T. orientalis population's heterogeneity in Kinshasa. After experimentation, the germinative method was statistically superior to the cuttings. The individuals of T. orientalis in Kinshasa do not have the same characteristics.
Key words: cuttings resumption, germination, *Trema orientalis*, tropics

I. INTRODUCTION

The question about the protection and upgrading of marginal land is very topical in the tropics and thus acquires since longtime special importance in Central Africa, particularly around the Graben in the eastern part of the Democratic Republic of Congo, in regions characterized by a rugged relief and a high density of population (De Backer, 1958). In Kinshasa, the Mont-Amba region is not excluded of the soil degradation, of which there is considerable evidence of erosion within this site (Makanzu et *al*. 2014; Kayembe et Wolff, 2015). It is therefore undeniable that the only remedy to stop this rapid evolution towards a defective profile is undoubtedly afforestation or reforestation, which is an essential initiative for sustainable ecological development (Brynaert and Toussaint, 1949; Khasa, 1995; Thomas et *al*., 2004; Lamb et *al*., 2005). African flora in general and Congolese in particular has a power of survival and colonization. In the same opinion as Aubreville (1949) and Alfaro et *al*. (2012), it can be used to stop land degradation.

In the area of species' choice or of the afforestation/ reforestation's technique, empiricism has almost always set the tone to this day, which results in a marked preference for exotic species at the expense of native species. Leonard (1962) argues that our current knowledge of vegetation in general and of forest vegetation in particular is still very fragmentary. Shonil et *al*. (2014), Brynaert and Toussaint (1949) question how to explain that reforestation trials based on nature and carried out with native species have not yet been undertaken and that the choice of species seems to have been guided by fancy rather than by the observation or the desire of donors financing reforestation projects. This study is part of the valorization of local forest species that can be used in afforestation or reforestation for the protection and reclamation of marginal lands as well as for other environmental services (sequestration of greenhouse gases) and biomass production (agroforestry). Specifically, this study is devoted to the determination of the effects of ages, cultural methods and sites of material origin on the plants emergence and the recovery of cuttings. The main hypothesis of this study is that the species *Trema orientalis* can be used in the reforestation project because of its emergence's rate. Age, cultivation methods and sites of material origin would influence the plants' emergence and the cuttings' resumption.

II. MATERIAL AND METHODS

2.1 Study area

The experimental device was placed in the southern part of the city of Kinshasa province, therefore at the University of Kinshasa (figure 1). The City-province of Kinshasa covers 9.965 km^2. It is located to the west of the country between, 3.9 and 5.1 degrees south latitude and between 15.2 and 16.6 degrees east longitude. (Ministry of Planning, De Saint Moulin, quoted by Biloso, 2008). The soil of the Kinshasa province is mainly sandy and has little utility for agricultural activities (PNUD, 2009). According to the CREN-K report (Holu, 2011), the soil of the University of Kinshasa is 80% sandy, weakly acid with a pH of about 5.7, low in nitrogen, organic matter and humus. Different nutrients needed for crop growth. All the town of Kinshasa enjoys a climate of type AW4 according to Köppen classification. It is a hot and humid tropical climate with 4 months of dry season between the second half of May and the first fortnight of September with an absolute dryness in June and July. The rainy season extends between the end of September and the first fortnight of May, with an interruption between the second fortnight of February characterized by a relative dryness, the greatest volume of precipitation is observed in November. (Tshiabembi, 2002). The annual average relative humidity of the air is 79%. The average of the maximum values is 84%. These values are recorded between November and May with a slight inflection in February-March. The average of the minimum equivalent to 71% is mainly observed in September (Mbikayi, 2003).

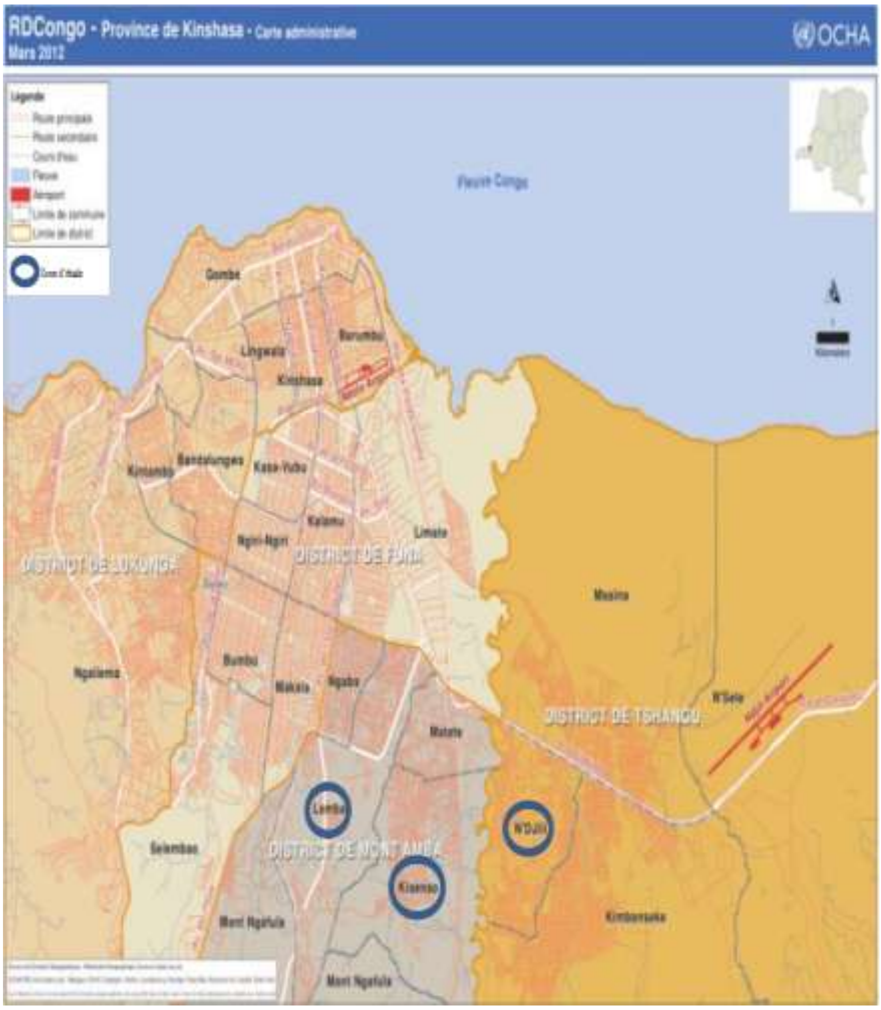

Figure 1. Location of study area (Administrative map of Kinshasa, 2012)

2.2 Plant material

The plant material used was firstly seeds and cuttings of *Trema orientalis* harvested from twenty-three trees from Kisenso, Lemba and N'djili townships, respectively, in a ratio of 9, 8, and 6.

2.3 Methodological approach

The methodology consisted of the establishment of a four-block replicated factorial device with three factors (sites of material origin, cultivation methods and ages of material planted per week) with levels of 3, 2, and 5. Each rehearsal comprising material from 23 trees in a ratio of 9.8 and 6 respectively in Kisenso, Lemba and N'djili. For each tree, ten cuttings were taken and planted one cut per pole (figure 2 and3), and thirty seeds due to three seeds per pole, ie thirty seeds out of ten pockets (figure 2 et 3).

Figure 2. Experimental device for cuttings and gérmination of T. orientalis

Figure 3. Seedlings of T. orientalis in nursery

Thus, the test on the emergence and cuttings was carried out as a whole on 1840 pockets without fertilization. Observations during this phase concerned the emergence and recovery of material from different trees located in three different places, notably Kisenso, Lemba and N'djili communes for five weeks. The seeds were previously dried in the sun for two days and stored in porous envelopes before sowing for about one week in a relatively ventilated room. All the seeds were sown the same day, but the cuttings were planted after a one-week lag. The cuttings harvested each time during the evening were stored in a relatively humid place before the establishment carried out each morning. The dimensions used for cuttings are about one centimeter in diameter and a length equivalent to four knots. The temperature reading that the entire germination and recovery period characterizes, was carried out at a frequency of three times a day, ie seven hours, twelve hours and seventeen hours (Figure 4). The mother trees on which the seeds and cuttings harvested, were geo-localized and characterized by their DHP, crown height and surface crowns.

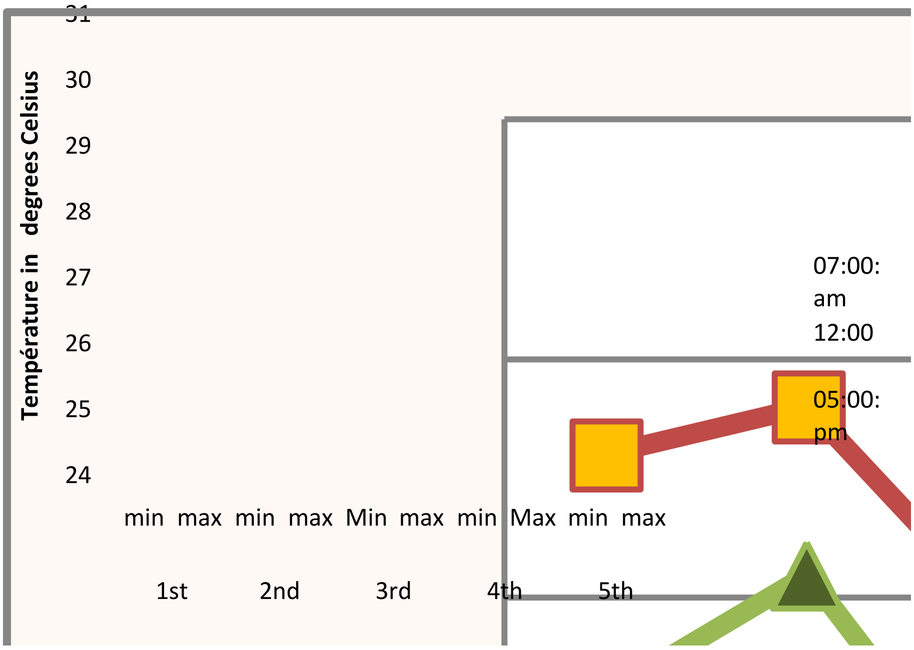

Figure 4. Evolution of temperatures according to the weeks under shade characterizing the period of cuttings and lifting of the plants of *Trema orientalis* from October 24th to November 28th 2015.

2.4. Statistical analysis

For the statistical processing of the data, the mean values found were imported on the R software for the analysis of the variances of the planting rate and the cutback recovery at the 5% probability threshold.

III. RESULTS

Table I. Seedling lifting and cutting recovery rate (in%) of *Trema orientalis* according to origin sites and plant material, and cultural methods

	Cultural methods		
Sites of origin	Seeding	Cutting	Average effects of sites
Kisenso	24	4.058	14.029
Lemba	21.143	3.550	12.346
N'djili	14.042	3.741	8.891
Average effects of methods	19.728	3.783	11.755

These are observations on the plants lifting and the cutting resumption or the cuttings breaking down. These different data are listed in table 1 above-mentioned. Out of 2760 seeds of *T. orientalis* Sown, the lifting rate is 19.728 % and the rate of unpacking on 920 earthed cuttings is 3.783%. The emergence of seedlings and the cuttings of T. orientalis ranged from 11 to 30 days.

Table II. Seedling lifting and cuttings recovery rate (in %) of *Trema orientalis* according to origin sites and age

	Age (week)					
Sites of origin	1	2	3	4	5	Average effects of sites
Kisenso	2.028	4.771	7.570	6.786	6.904	5.612
Lemba	1.766	4.765	5.596	5.902	6.666	4.939
N'djili	1.750	3.359	4.565	4.155	3.953	3.556
Average effects of age	1.848	4.298	5.910	5.614	5.841	4.702

Table 2 above-mentioned shows that the highest averages in percentage are observed in descending order at 3 weeks of age. The material from Kisenso was well behaved in relation to the material from Lemba and N'Djili. Three hundred seeds per square meter were counted in the first five centimetres of the soil and germination was rapid: 11 days for early emergencies and 30 days for the late in experimental conditions.

Table III. Seedling lifting and cuttings recovery rate (in %) of *Trema orientalis* according to cropping methods and age

	Age (week)					
Cultural methods	1	2	3	4	5	Average effects of methods
Cuttings	2.828	2.130	2.130	2.130	2.130	2.270
Seeding	2.715	10.765	15.600	14.712	15.392	11.837
Average effects of age	2.771	6.447	8.865	8.421	8.761	7.053

Table 3 above-mentioned notes that the germination method has yielded far superior results than cuttings. The largest percentage of lifts being observed in the third week, followed by the fifth, fourth, second, and first week.

Table IV. Summary of ANOVA on the seedlings emergence and cuttings recovery of *Trema orientalis*

Source of variation	Df	SS	AS	F_c	$F_{0,05}$	Conclusion
Total	119	604.626	5.081	5.794	1.28-1.52	*
Rehearsals	3	3.041	1.014	1.156	2.70-2.72	NS
Treatment	29	525.23	18.111	20.651	1.57-1.60	*
Sites (S)	2	21.955	10.978	12.518	3.09-3.11	*
Méthods (M)	1	305.108	305.108	347.90	3.94-3.96	*
Ages (A)	4	71.387	17.847	20.35	2.46-2.48	*
S X M	2	20.219	10.11	11.528	3.09-3.11	*
S X A	8	8.03	1.004	1.145	2.03-2.05	NS
M X A	4	88.364	22.091	25.189	2.46-2.48	*
S X M X A	8	10.167	1.271	1.449	2.03-2.05	NS
Error	87	76.285	0.877	-	-	-

- *: Significant at the 5% probability threshold; - NS: Not significant ; Df–degree of freedom. SS– squares sum. AS– Average square

Table 4 summarizes the analysis of the variance on the removal of plants and the resumption of *Trema orientalis* cuttings. The analysis of the variance at the 5% threshold confirmed that there are significant differences between the material from the different sites and the two cultural methods used in different treatments. The analysis of variance between seed provenance sites and age did not show significant differences between treatments at the 5% probability threshold. The analysis of the variance at the 5% threshold showed that the combination of factors (cultural methods and age) gave significant differences in treatments.

IV. DISCUSSION

The results presented in table I show that the factors of harvesting of crop material and cultivation methods combined had effects on the results. The highest average is observed on the material coming from Kisenso, followed respectively by Lemba and N'djili. The germinative method compared to the cuttings was superior. Analysis of variance at the 5% threshold confirmed that there are significant differences between the material from the different sites and the two cultural methods used in different treatments (Table IV). It can be seen from the above-mentioned texts that the germinative method or the seedling cannot under these conditions be substitutable by the cuttings. Also, the individuals of *T. orientalis* encountered in Kinshasa have different characteristics. These differences can be due to both the ecological factors and the genetic factors of the parent trees. The altitudinal differences between the three origin sites of plant material may in part induce behaviors specific to the material tested under the same conditions at Lemba (University site of Kinshasa). Some authors agree that every 200 meters of altitude corresponds to a reduction in temperature of the order of 1 ° C. High temperatures reduce the final percentage of buds budged, and even cause the formation of abnormal buds. This situation could explain the low success rate of material from Lemba (University of Kinshasa) harvested between 372 and 479 m altitude and tested in their environment compared to the material from N'djili (between 291 and 314 m) and Kisenso (between 354 and 405 m), where the temperature would have influenced the emergence of the plants and the clearing of the cuttings. From a genecological point of view, the differences in the emergence and material recovery rates from different sites could be explained by the fact that the diameter, height and overlap of the middle tree crown are lower for the mother-trees of Kisenso compared to those of N'djili and Lemba (University of Kinshasa) in general. Since there is a relationship between the dendrometric parameters and the age of the trees, and is generally assimilated to a higher diameter, this age is also high, it is likely that the mother trees of Kisenso are younger as those of N'djili and Lemba (University of Kinshasa). As a result, the Kisenso site would have provided good plant material due to the quality of these mother trees on which the seeds and cuttings were taken. These results on the emergence of plants compared to those of Breyne (1976) on germination under conditions of 25 ° C temperature for the seeds of the different *Harungana madagascariensis*

trees confirm that the seeds of *T. orientalis* germinate with difficulty Seeds of the species *Harungana madagascariensis*.
The table II gives the highest averages in percentage which are observed in descending order at the age of 3 weeks. The material from Kisenso behaved well in relation to the material from Lemba and N'djili.
For determining the influence of the combination of factors (seed origin sites and age) in the treatments, the analysis of variance was done and showed that this combination did not give significant differences between treatments (Table 4).
Three hundred seeds per square meter were counted in the first five centimeters of the soil and germination is rapid: 11 days for early emergences and 30 days for later one under experimental conditions. The germination times are longer in natural conditions (4 to 5 weeks). According to Latham and Konde (2006) the germination rate is about 30%. These results confirm that *T. orientalis* is difficult to germinate and that the optimal germination or emergence rate is high from the third week onwards.
Table III shows that the germination method yielded results far superior to that of cuttings. The highest percentage of emergence was observed in the third week, followed by the 5th, 4th, 2nd, and 1st week. Analysis of variance at the 5% threshold showed that the combination of factors (cultivation methods and age) gave significant differences in treatments (Table IV).

V. CONCLUSION

This study was devoted to the determination of the effects of ages, cultural methods and material origin sites on the plants emergence and the cuttings recovery of the species *T. orientalis* in the Kinshasa region. Although the emergence rate of the species was low, the emergence rate still reached its optimum after three weeks. Cuttings were less responsive under the ecological conditions of Kinshasa. In view of the above-mentioned texts, the main hypothesis is verified. *T. orientalis* can at this stage be integrated into the species batch for afforestation and reforestation. Which, if the presumption of its rapid growth is confirmed, would contribute to the solution to mitigate the effects of climate change in the context of REDD +. Thus we suggest improving the germination conditions of this species for producing seedlings on an industrial scale for these afforestation and reforestation. As a heliophyte, *T. orientalis*, a pioneer species, with others can contribute to the creation of an interesting microclimate for the installation of other forest species.

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