International Journal of Recent Engineering Research and Development (IJRERD)
ISSN: 2455-8761
www.ijrerd.com || Volume 04 – Issue 11 || November 2019 || PP. 61-68

Influence of the ploughing and organic amendment system on the domestication of *Coleus esculentus* under Lubumbashi cultivation conditions

Baderhekuguma Bafunembaka Innocent[1&3], Abedi Ramazani[2], Muchiza Bachinyaga Israel[4], & Mazinga Kwey Michel[1&3], Kanyenga Franck[5], Ngoie Longwa Léontine[6], Kisimba Ngobola Tresor[7]

[1]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Plant Technology, Research Unit in Plant Production, Lubumbashi, DR Congo BP: 1825.*
[2]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Plant Technology, Plant Breeding Research Unit, Lubumbashi, DR Congo BP: 1825.*
[3]*Agro-Food Research Centre, Lubumbashi, DR Congo BP :*
[4]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Management of Renewable Natural Resources, Research Unit in Ecology and Ecological Restoration and Landscape, Lubumbashi, DR Congo BP: 1825.*
[5]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Plant Technology, Research Unit in Plant Production, Lubumbashi, DR Congo BP: 1825.*
[6]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Plant Technology, Lubumbashi, DR Congo BP: 1825.*
[7]*University of Lubumbashi, Faculty of Agronomic Sciences, Department of Management of Renewable Natural Resources, Lubumbashi, DR Congo BP: 1825.*

Abstract: Human activities are among the causes of the disappearance of several plant species, while food demand increases with population growth. However, the objectives of this study were to evaluate the effect of the ploughing and organic amendment system on the domestication of *Coleus esculentus* under Lubumbashi's growing conditions.

To do this, a test was installed using a complete randomized block system with three treatments (flat plough, no-till and ridge) repeated six times. Flat plough, no-till and ridge treatment received 10.5 Tonnes/ha of organic fertilizers. During the study, vegetative and yield parameters were observed.

Statistical analyses of the data collected for the growth parameters show that no significant differences were observed ($p>0.05$), while significant differences were observed for the yield parameters ($p<0.05$).

This study is important in the fight against the food crisis while limiting the risk of the extinction of forest plant species that swallow food.

Keywords: Domestication, *Coleus escualentus*, organic amendment, Lubumbashi.

1. Introduction

For centuries, the livelihoods of rural African communities have been based on goods and services provided by plants and animals harvested from forest ecosystems (Loubelo, 2012). The collection of non-timber forest products was an important source of income, food and medicines for rural communities to complement agriculture, livestock or fisheries, (Ezebilo & Mattsson, 2010; Dossou et *al*., 2012). However, there are various spontaneous species of obvious food interest in the Congolese flora, many of which have been used for millennia and very few are used today. These species are now poorly appreciated and even ignored (Vietmeyer, 1989). Indeed, these native plant species are an important part of the daily diet of local populations (Moupela et al., 2014). The contribution of these species to food security and primary health care is well documented as nearly 80% of the population in developing countries use them for food (Allabi et *al*., 2011; de Wet et al., 2010). In the past, the exploitation of these resources was mainly on a small scale and seemed ecologically less aggressive than other forms of forest use (agricultural production systems or forestry exploitation) (Dan et *al*., 2012). The marketing of non-timber forest products has resulted in huge amounts of these resources being taken, threatening their availability near residential areas (Lescuyer, 2010). In addition, rural populations seek to ensure their livelihood in an alarming economic context, by all means and with little concern for the sustainability of resources (Vermeulen et *al*., 2011). Abusive harvesting, bushfire, ecosystem degradation, poor farming practices and population poverty make these species vulnerable and increase their vulnerability (Lejoly, 2003). The overexploitation of plant resources with high food value without a conservation policy leads to their

scarcity on the market and constitutes a loss of biodiversity at the local level. Given their economic, food and environmental importance for local populations, the only way to maintain these resources would be to conserve them ex-situ for rational use (Menzepoh, 2011). This is the case of the species Coleus esculentus consumed in some villages of the greater Katanga: Kasomeno, Mpweto, Kasenga, Mitwaba etc. whose domestication has not been reported so far.

It is with this in mind that this regeneration study (*ex-situ*) of Coleus esculentus was initiated in order to protect plant species from the danger of the future and integrate them into the farm to ensure food security for the population. Its objective is to evaluate the effect of the ploughing and organic amendment system on the domestication of *Coleus esculentus* under Lubumbashi's growing conditions.

2. Materials and methods

The experiment was conducted in Lubumbashi, Haut-Katanga (DRC), at the experimental field of the Faculty of Agronomic Sciences of the University of Lubumbashi. The experimental site is located at 27°48'61" East longitude, 11° 61'55'55 3" South latitude and 1257 m altitude (Figure 1).

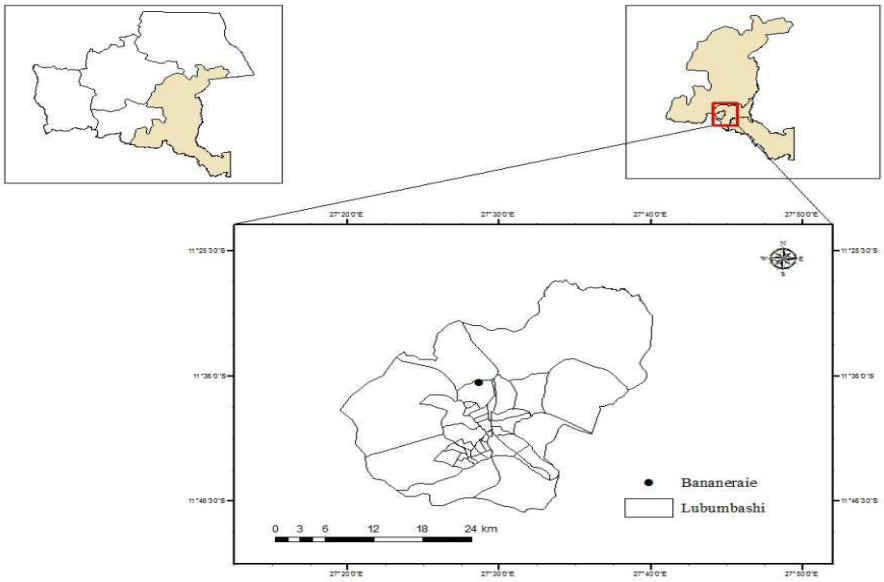

Figure 1: Location of the experimental field of the Faculty of Agronomic Sciences

2.1. Materials

The biological materials used for the experiment are Coleus esculentus tubers.

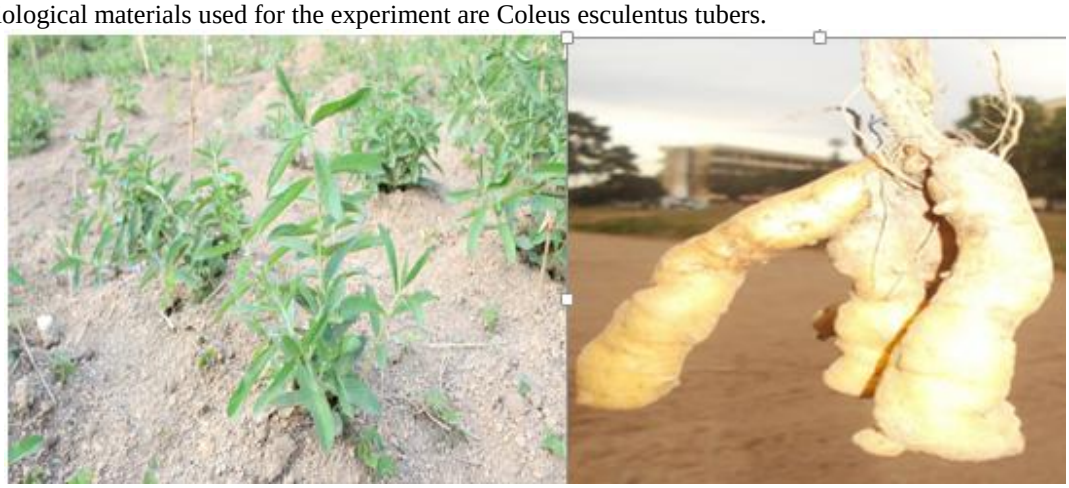

Figure 2: Image of the species *Coleus esculentus* and its tubers

2.2. Methodology

The test was installed in a randomized block system with 3 treatments and 6 replicates per treatment, including: flat ploughing (T1); non-ploughing (T2); and ridges (T3), each with 0.21 kg of organic matter. The

tubers were planted at 50 cm x 40 cm spacing over a total area of 120 m² of the experimental plot, 12 m long and 10 m wide. The blocks were separated by 0.5 m. Within the blocks, each elementary plot was 1.5 m wide and 2.4 m long, covering an area of 3.6 m²; it included 3 rows spaced 50 cm apart and 40 cm apart between the plants in the row. The plots were separated by 0.5 m.

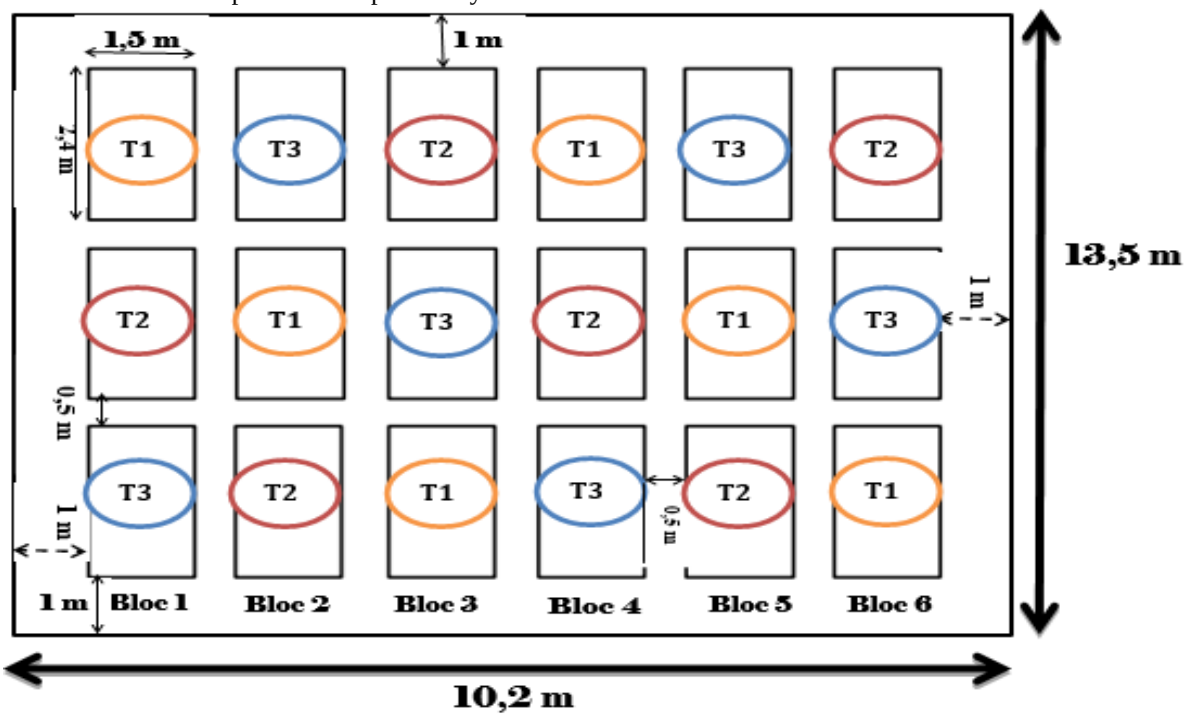

Figure 2.1. Experimental set-up: T1= flat ploughing; T2=no ploughing and T3=billons

During the experiment, the following parameters were observed: recovery rate (at 20 and 40 days), survival rate (at 60, 80 and 100 days); height; collar diameter and leaf area. At the end of the experiment, yield parameters were observed (length, diameter, number and weight of tubers).

Statistical analyses for vegetative parameters were performed using the Mini tab 16 software. The analysis of variance and the TUKEY test were used to compare the different means.

3. Results

3.1 Influence of ploughing system and organic amendment on the recovery and survival rate

The results obtained showed that the ploughing system and organic amendment favoured the recovery and survival of *Coleus esculentus* but no significant differences were found for all treatments at all observation periods as shown in Table 3.1 below.

Table 3.1: Influence of ploughing system and organic amendment on the recovery and survival rate (at 20 and 40 days) and survival rate (at 60; 80 and 100 days): B = broth ; L = flat ploughing ; NL = no ploughing ; TR = recovery rate and TS = survival rate

Treatments	**TR à 20 days (%)**	**TR to 40 days (%)**	**TS to 60 days (%)**	**TS to 80 days (%)**	**TS to 100 days (%)**
B	74,05 ± 17,42	94,40 ± 5,01	97,20 ± 4,69	97,20 ± 4,69	81,47 ± 40,16
L	76,82 ± 20,32	88,85 ± 16,87	89,78 ± 17,02	88,85 ± 16,87	88,85 ± 16,87
NL	75,88 ± 15,57	90,70 ± 7,61	91,63 ± 7,68	91,63 ± 7,68	83,30 ± 25,34
P	**0,964**	**0,683**	**0,501**	**0,431**	**0,901**

3.2 Influence of ploughing system and organic amendment on plant height

Table 3.2 below shows the influence of the ploughing and organic amendment system on the height of *Coleus esculentus* plants. It can be seen from this table that the types of ploughing and organic amendment

influenced the height of the plants but, after analysis of variance, the result found underlines that there is no significant difference between the treatments at any given time of observation.

Table 3.2: Influence of ploughing system and organic amendment on plant height at 20; 40; 60; 80 and 100 days: B=billon; L=flat plough; NL=not ploughed; H= height.

Treatments	H to 20 days (cm)	H to 40 days (cm)	H to 60 days (cm)	H to 80 days (cm)	H to 100 days (cm)
B	8,883 ± 2,161	16,267 ± 3,508	25,800 ± 4,689	45,567 ± 7,611	55,45 ± 28,90
L	9,500 ± 2,209	18,300 ± 3,149	30,550 ± 6,005	53,300 ± 9,108	72,08 ± 12,27
NL	9,133 ± 1,378	17,333 ± 2,589	27,633 ± 3,881	49,100 ± 6,940	64,98 ± 9,34
P	0,861	0,539	0,274	0,271	0,338

3.3 Influence of ploughing system and organic amendment on collar diameter

Table 3.3 below shows the influence of ploughing and organic amendment on the diameter of the neck of *Coleus esculentus*. A similar result was observed for all treatments after analysis of variance (P > 0.05).

Table 3.3: Influence of the ploughing and organic amendment system on the diameter of the collar at 20; 40; 60; 80 and 100 days: B=billon; L=flat ploughing; NL=non ploughing and Dc=diameter at the collar.

Treatments	Dc to 20 days (cm)	Dc to 40 days (cm)	Dc to 60 days (cm)	Dc to 80 days (cm)	Dc to 100 days (cm)
B	1,7167±0,1472	2,2000±0,3347	2,4667±0,2160	2,7667±0,2944	2,58 ± 1,29
L	1,8500±0,1643	2,1833±0,1169	2,4667±0,1506	2,7833±0,2639	15,15 ± 28,78
NL	1,8000±0,0632	2,1667±0,0816	2,4167±0,0753	2,7833±0,2858	3,22 ± 0,25
P	0,244	0,963	0,821	0,993	0,362

3.4 Influence of the ploughing and organic amendment system on the leaf surface

After statistical analysis, the results showed that ploughing and organic amendment influenced the leaf area of the plants. In addition, the analysis of variance revealed no significant differences for all treatments (P > 0.05) on any observation day as shown in Table 3.4.

Table 3.4: Influence of the ploughing and organic amendment system on leaf area at 20; 40; 60; 80 and 100 days: B=billon; L=flat ploughing; NL=non ploughing and Sf= leaf area

Treatments	SF to 20 days (cm^2)	SF to 40 days (cm^2)	SF to 60 days (cm^2)	SF to 80 days (cm^2)	SF to 100 days (cm^2)
B	6,667 ± 1,864	13,883±2,438	17,867±6,096	23,200 ± 3,618	14,083 ± 7,200
L	8,400 ± 2,717	15,717±1,563	23,200±4,510	24,750 ± 2,657	11,150 ± 4,838
NL	8,410 ± 1,368	15,617±2,460	22,200±2,445	22,950 ± 5,275	13,950 ± 5,347
P	0,271	0,295	0,137	0,706	0,631

3.5. Influence of the ploughing and organic amendment system on the diameter, length, number and weight of tubers.

Table 3.5 below illustrates the influence of the ploughing and organic amendment system on the diameter, length, number and weight of *Coleus esculentus* tubers. After analysis of variance, a similar result was observed for tuber diameter, length and weight for all treatments (P > 0.05). On the other hand, a different result was observed on the number of tubers (P < 0.05).

Table 3.5. Influence of the ploughing and organic amendment system on the diameter, length, number and weight of tubers: B=billon; L=flat ploughing; NL=non ploughing; DT=diameter of tubers; LT= length of tubers; NT=number of tubers and PT (kg) = weight of tubers.

Treatments	DT (cm)	LT (cm)	NT	PT (kg)
B	5,983 ± 2,949	10,767 ± 5,528	6,667 ± 4,131 a	0,1397 ± 0,1010
L	7,183 ± 0,313	12,217 ± 1,630	14,333 ± 2,338ab	0,2672 ± 0,0875
NL	6,083 ± 3,008	10,150 ± 5,649	9,667 ± 5,955b	0,2098 ± 0,1363
P	0,648	0,737	0,027	0,168

3.6 Influence of the ploughing and organic amendment system on the yield of Coleus esculentus

Figure 3.1 Below illustrates the influence of ploughing and organic amendment on the yield of *Coleus esculentus*. After analysis of the variance, the results obtained highlight that the flat ploughing treatment gave a high yield compared to the non-ploughing and ridge treatment.

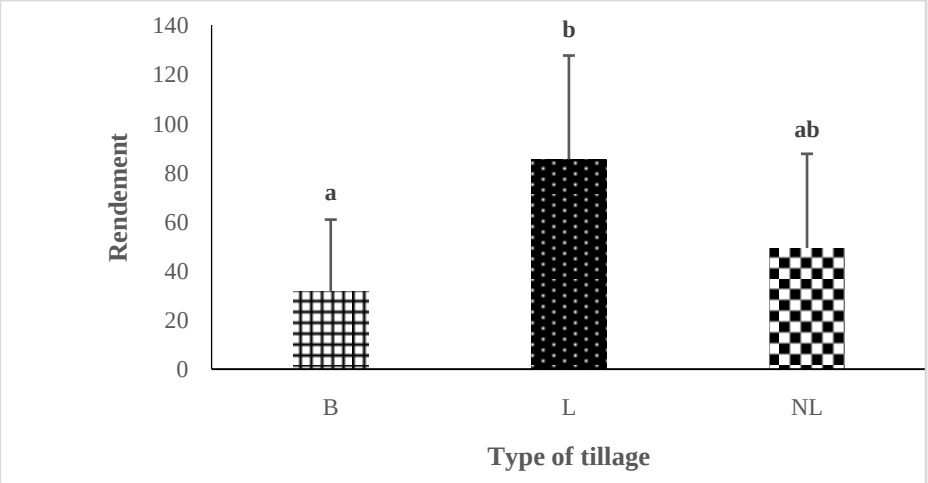

Figure 3.1 Influence of ploughing and organic amendment on the yield of *Coleus esculentus*: B=billon ; L=labour ; NL=non ploughing.

4. Discussion of the results

4.1 Influence of ploughing and organic amendment on the recovery and survival rate of Coleus esculentus.

The results obtained showed that the ploughing system and organic amendment favoured the recovery and survival of *Coleus esculentus* without revealing any significant difference for all treatments at any observation period.

On average, the recovery rate is between 76% and 94% for all types of work (flat ploughing, no-till and ridge ploughing). These results are in line with those found by Jacques Miege and Charles Moncousin (1989) carried out *in vitro* culture, particularly for the species: *Solenostemonrotundifolius* and *Plectranthus esculentus*, whose results had recovery rates between 82% and 96% at the end of the acclimatization phase. As for survival, the estimated average is 81 to 97%, which indicates that there has been good crop maintenance and the presence of necessary nutrients in the soil. Jacques Miege and Charles Moncousin (1989) found the lower results (55%) compared to the one found on the *Coleus esculentus*. It is estimated that knowledge of a species' experimental niche is the key to its successful domestication (Tshibangu, 2012). In addition, soil conditions are crucial in the domestication of new species (Shutcha et al., 2010).

4.2 Influence of ploughing and organic amendment on the height of Coleus esculentus

The result shows that the ploughing system and organic amendment influenced the height of the plants but, after analysis of variance, the result found shows that there was no significant difference between the treatments at any given time.

Plant development began after one week of recovery and the first samples were taken three weeks later. J. Miege and C. Moncousin (1989) had found a similar result on Coleus solenostemon and Coleus Pleutranthus whose height was on average 15 and 35 cm. The result found on *Coleus esculentus* is almost identical because the average height was between 22 and 40 cm.

Influence of ploughing and organic amendment on the diameter of the collar:

The analysis of variance shows that no significant difference was observed for the collar diameter at any time of observation. This would be influenced not only by the spacings used but also by the same density in each plot. Victor et *al.*, (2008) states that planting density significantly affects certain growth parameters, such as collar diameter, leaf count and leaf area.

4.3 Influence of ploughing and organic amendment on leaf area

After statistical analysis, the results obtained indicate that there was no significant difference between the treatments at each observation period. It should be pointed out that foliar analysis is essentially a diagnosis of nutrition applied under well-defined conditions, it indicates the mineral diet of trees which is a factor limiting or not their growth and production. If the foliar diagnosis reports nutritional anomalies, it does not account for their origins. Knowledge of the soil and growing conditions remains essential for anyone wishing to propose solutions to acritical situation (Jean-Francois Larrieu, 2019). This situation attests to the observations found during the trial, in the sense that plant growth was not critical in the experimental field.

4.4 Influence of ploughing and organic amendment on the length, diameter and weight of tubers

The analysis of variance shows that no significant differences were observed for the length, diameter and weight of tubers between treatments, only the number of tubers showed significant differences. The tubers measured on average: 10 to 12cm long, 6 to 7cm in diameter, the weight from 0.14 to 0.2kg and a foot gave 7 to 14 tubers.

According to Hyatt et al, (2003), P. esculentus tubers are irregularly cylindrical, bristly and rough. They are 5 to 15-20 cm long, one individual produces 8 to 50 tubers with white flesh. These characteristics are similar to those observed at the end of the Coleus esculentus experiment for all treatments.

Several authors show that soil is the main nutritional source of the plant, the latter by the fact of immobility is linked to its substrate and its response is a function of it (Kasongo et *al*., 2013). Considering that Lubumbashi's soils are naturally poor, have low agronomic characteristics and can constrain crop adaptation, fertilization remains the only way to maintain production (Mpundu, 2010). It is recognized that in Lusha agriculture, the increase in yield is directly proportional to the types and quantity of fertilizers provided (Nyembo et *al*., 2013).

These same authors show that the diameter of the tuber is 1.5 to 3 cm, which is slightly contrary to the results observed at Coleus esculentus where the diameter was 6 to 7 cm, which proves a specificity of the local variety if can be improved more would have a very good yield.

4.5. Influence of ploughing and organic amendment on yield

With regard to yield, the analysis of variance showed that flat ploughing treatment gave a high yield compared to no-till and ridge treatment.

Because the tubers of P. esculentus are elongated and break easily, harvesting is delicate. Indeed, yields are often low although various authors cite harvests of 15 to 25 tons/ha. In general, the poorly maintained field provides much less tubers than the well maintained field (Baraloto C., 2003). These results attest to the yield found in experimental fields of 13 tons/ha *esculentus coleus* generally low for all treatments. It is also important to show that if only ploughing is taken into account, the yield is a little high, at 15.3 tons/ha. Yemefack et al, (2004) believe that light, deep and aerated soil is preferable for better tuber plant production. Therefore, it is more recommended to improve the physical properties of the soil than the chemical properties for optimal production of tuber plants. This preference for deep soil could explain the result obtained.

5. Conclusion

This study was initiated as part of the domestication of plant species of food value with the objective of evaluating the effect of the ploughing and organic amendment system on the domestication of *Coleus esculentus*.

Analysis of the variance of the data collected for the growth parameters shows that no significant differences were observed for all treatments, while significant differences were observed for the yield parameters.

In view of the above, it was concluded that the cultivation of Coleus esculentus adapts well to the soil and climate conditions of Lubumbashi.

6. References

[1]. Allabi A.C., Busiac K., Ekanmiana V. & Bakiono F., 2011. The use of medicinal plants in self-care in the Agonlin region of Benin. *Journal of Ethnopharmacology*. 133, 234-243.

[2]. Baraloto C., 2003. Régénération forestière naturelle : de la graine à la jeune tige. *Rev. For. Fr.*LV, 9 : 179-189.

[3]. Dan C. B. S., Sinsin B. A., Mensah G. A., & Lejoly J. 2012. Influence des activités anthropiques sur la diversité floristique des communautés végétales de la forêt marécageuse de Lokoli au Sud-Bénin.*Int. J. Biol. Chem. Sci.* 6(6): 3064-3081.

[4]. Wet H., Nkwanyana M.N. & van Vuuren S.F., 2010. Medicinal plants used for the treatment of diarrhoea in northern Maputaland, KwaZulu- Natal Province, South Africa. Journal of Ethnopharmacology: 130(2) : 284-289.

[5]. Dossou M.E., Houessou G.L., Lougbégnon O.T., Tenté A.H.B. & Codjia J.T.C. 2012.Etude ethnobotanique des ressources forestières ligneuses de la forêt marécageuse d'Agonvè et terroirs connexes au Bénin.*Tropicultura*: 30 (1), 41-48.

[6]. Ezebilo E.E. & Mattsson L., 2010, Contribution of non-timber forest products to livelihoods of communities in southeast Nigeria. *International Journal of Sustainable Development and World Ecology*. 17(3), 231-235.

[7]. Hyatt L.A., Rosenberg M.S., Howard T.G., Bole G., Fang w., Anastasia J., Brown K., Grella R., Hinman k., Kurdziel J.P., Gurevitch J., 2003. The distance-dependent prediction of the Janzen-Connell hypothesis: a meta-analysis. — *Oikos*, vol. 103, pp. 590-602.

[8]. Kasongo L.M.E, Mwamba M.T, Tshipoya M.P, Mukalay M.J, Useni S.Y, Mazinga K.M, Nyembo K.L. 2013. Réponse de la culture de soja (*Glycine max* L. (Merril) à l'apport des biomasses vertes de Tithonia diversifolia (Hemsley) A. Gray comme fumure organique sur un Ferralsol à Lubumbashi, R.D. Congo. *Journal of Applied Biosciences* 63: 4727 – 4735

[9]. Lejoly J. 2003. Introduction à l'ethnobotanique Substances naturelles, Notes à l'usage des étudiants du DESS2 Aménagement et Gestion des Ressources Naturelles, Université d'Abomey Calawi, Faculté des Sciences agronomiques, Département d'aménagement et de Gestion de l'Environnement, Année académique 2002-2003, inéd., 20 p.

[10]. Lescuyer G. 2010. Importance économique des produits forestiers non ligneux dans quelques villages du Sud-Cameroun. *Boiset Forêts des Tropiques*. 304(2): 15-24.

[11]. Loubelo E. 2012. *Impact des produits forestiers non ligneux (PFNL) sur l'économie des ménages et la sécurité alimentaire: cas de la République du Congo*. Thèse dedoctorat, Université de Rennes 2, 260 p.

[12]. Menzepoh S. B. 2011. Les orchidées comestibles chez le peuple Bagam, au Cameroun.*Biotechnol. Agron. Soc. Environ.* 15(4) : 509-514.

[13]. Moupela C., Vermeulen C., Doucet J.-L., Daïnou K. & Lebailly P. 2014.Importance de *Coula edulis* Baill. Pour les populations du Sud-Est du Gabon: niveaux de prélèvement et potentiel économique de l'espèce.*Tropicultura*: 32 (1) : 37-45.

[14]. Mpundu M.M., 2010. *Contaminations des sols en éléments traces métalliques à Lubumbashi (Katanga RDC).Evaluation des risqué de contamination de la chaine alimentaire et choix des solutions de rémédiation.* Université de Lubumbashi. Thèse de doctorat en sciences agronomiques. 401p.

[15]. Nyembo M.L., Useni S.Y., Chukiyabo K.M., Tchomba K.J., Ntumba N.F., Muyambo M.E., Kapalanga K.P., Mpundu M.M., Bugeme M.D., Baboy L.L., 2013. Rentabilité économique du fractionnement des engrais azotés en culture de *Zeamays L:* cas de la ville de Lubumbashi, sud-est de la RDC. *Journal of applied biosciences.* 11: 4945-4956.

[16]. Shutcha N. M..; Michel M. M., Faucon M. P., Ngongo M. L., Visser M., Colinet G., Meerts P. 2010. Phytostabilisation of Copper-Contaminated Soil in Katanga: An Experiment with Three Native Grasses and Two Amendments. *International Journal of Phytoremediation. 12 (6) : 616-632*

[17]. Tshibangu K.A., 2012. Mise au point des techniques de multiplication en pépinière d'espèces arborescentes produisant des produits forestiers non-ligneux. Mémoire de DEA, Université de Lubumbashi. 51p

[18]. Vermeulen C., Dubiez E., Proces P, Diowo S. M., Yamba T. Y., Mutambwe S., Peltier R., Marien J-N, Doucet J-L. 2011.Enjeux fonciers, exploitation des ressources naturelles et Forêts des Communautés Locales en périphérie de Kinshasa, RDC.*Biotechnol. Agron. Soc. Environ.*15(4) : 535-544.

[19]. Yemefack M., Nounamo L., Njomgang R. & Bilong P. 2004.Influence des pratiques agricoles sur la teneur en argile et autres propriétés agronomiques d'un sol ferralitique au sud Cameroun. *Tropicultura*. 22 (1) : 3-10.

[20]. Jacques Miege et Charles Moncousin, 1989. Deux espèces à tubercules comestibles menacées de disparution : *Solenostemon rotundifolius* et *plectranthus esculentus* (Lamiacées). Possibilité de leur conservation par micro propagation.

[21]. Victor Désiré Taffou, Jacques Etame, NdongoDin, Marc le prince Nguelemeni, Yves Jean-Francois Larrieu, 2019. Fertilisation raisonnée en arboriculture fruitière.