Available online at www.worldnewsnaturalsciences.com

World News of Natural Sciences

WNOFNS 9 (2017) 35-44 EISSN 2543-5426

Growth Rate and Biomass Production of *Entandrophragma angolense* (Welw.) Seedlings as Affected by Different Organic Soil Amendments

Agboje Ivie[1], Ehondor Nosayaba[2], Imogoh Shegun[2], T. O. A. Adeyemi[1,*]

[1]Moist Forest Research Station, Forestry Research Institute of Nigeria, Benin City, Nigeria

[2]Department of Forestry and Wildlife, Faculty of Agriculture, University of Benin, Benin City, Nigeria

*E-mail address: adeyemi.to@frin.gov.ng

ABSTRACT

Entandrophragma angolense is a tropical tree species with a very slow growth rate. To overcome this barrier, a study on the effect of organic amendment on the growth rate of *Entandrophragma angolense* seedlings was conducted in the nursery section of the Department of Forestry and Wildlife, University of Benin, Benin City, Nigeria. Herein, 2kg polythene pots, each containing top soil were all amended with Poultry droppings (PRD), Cow dung (CWD) and Compost (CPT) at a ratio of 2:1, while top soil alone served as the control. Employing a completely randomized design (CRD), growth variables were recorded on a fortnight basis. The seedlings were assessed for height, number of leaves and collar diameter for a total period of 20 weeks. Fresh weights and total dry weights of the seedlings were also determined at the end of the experiment. No significant difference ($p>0.05$) was observed in the effect of organic amendments on the plant mean height and number of leaves throughout the study period, however, a significant difference was observed in collar diameter at 2 weeks after treatment and 12 weeks after treatment alone. Organic amendment was found to influence general biomass production in the specie, although there was no significant difference ($p>0.05$) in stem biomass production. Conclusively, organic amendment can be said not to have significantly ($p>0.05$) affected the growth of *E. angolense*, while this cannot be said of the biomass production, albeit at a low level of significance.

***Keywords*:** *Entandrophragma angolense*, organic amendment, seedlings, biomass production

1. INTRODUCTION

Entandrophragma, belonging to the *Meliaceae* family comprises about 10 species and is confined to Tropical Africa. *Entandrophragma angolense* is a large tree of up to 60m tall; bole branchless for up to 40 m, usually straight and cylindrical, up to 2 m in diameter, often with blunt buttresses up to 6m high, often extending into surface roots. *E. angolense* is widespread, occurring from Guinea east to southern Sudan, Uganda and western Kenya, and south to DR Congo and Angola. It is most common in moist semi-decidous forests of West Africa particularly regions with annual rainfall of 1600 – 1800 mm. However, it can be found in evergreen forest but its abundance strongly declines in regions with annual rainfall of more than 2300 mm. Although *Entandrophragma angolense* is widely distributed, it may become liable to genetic erosion in the near future. The commercial interest in its timber has resulted in extraction of large individuals from the forest throughout the distribution area. In some parts of West and Central Africa, *Entandrophragma angolense* is considered threatened. It is included in the IUCN Red list as vulnerable. There is serious over exploitation of this specie and a reduction in biodiversity is occurring. The available species in both natural and artificial forest cannot meet the demand of their raw materials in industrial and domestic uses.

Plate 1. *Entandrophraga angolense* (wild) distribution in Africa marked by shaded portion (PROTA, 2012)

There is an increasing need to domesticate this highly valuable *Meliaceae* species to meet the utilization demand which ranges from traditional medicine to furniture, musical instruments and light construction etc. One of the ways to conserve indigenous timber species under threat of extinction is to domesticate such species. Improving nutrient supply in nursery soils is relevant for successful domestication. Organic manure provides more than one of the many substances needed by plants for their growth. Inorganic manures on the other hand usually provide only one of the many substances needed by plants for their growth, have deleterious effects on soil micro-organisms and soil structures and are expensive to procure. These factors limit their utilization.

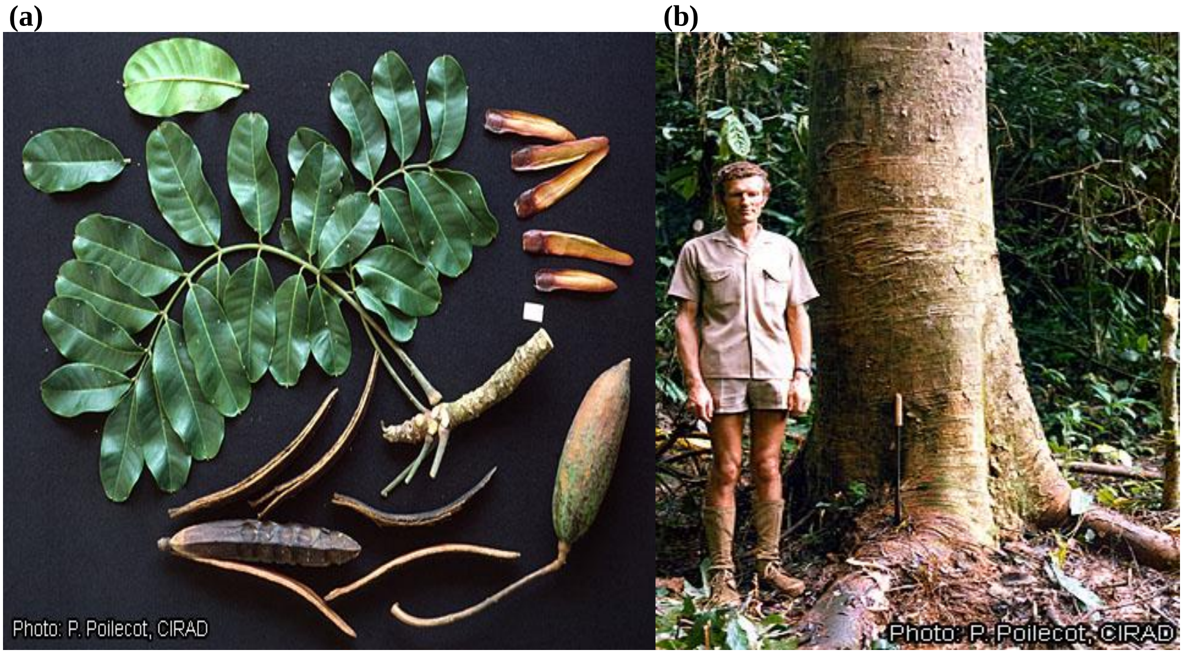

Plate 2. (a) Leaves, seeds and fruits of *Entandroghpragma angolense*, **(b)** Bole base of *Entandroghrama angolense* (PROTA, 2012)

Under optimal conditions *E. angolense* seedlings grow fairly fast, about 1 m/year during the first two years, but under normal conditions, seedlings have a slower growth. Improving the fertility of soil is essential to guarantee the production of high quality and fast growing seedlings. The proper application of organic manure to forest nursery soils is of considerable importance. A healthy seedling must be well supplied with all nutrients in proper proportion for efficient growth. Due to ease of measurement as well as success in predicting seedlings performance after out-planting, morphology has been widely used to evaluate seedlings quality [8]. Some major drawbacks affecting the large scale establishment of *E. angolense* include its rather slow growth rates under natural conditions and the long time needed to reach maturity in terms of fruit production. This study however aims at assessing the growth rate and biomass production of *Entandrophragma angolense* seedlings raised in top soil amended with different organic sources. This is essential in ensuring improved agronomic and management practices of this tree species at seedling stage.

2. METHODOLOGY

Study area

The study was carried out at the nursery section of the Department of Forestry and Wildlife, Faculty of Agriculture, University of Benin, Benin City, Nigeria. The experimental site lies between Lat 6°24'3''N and Long 5°37'24''E. It is within the rainforest zone, where mean annual rainfall is about 2200mm with over 95% of the rain obtained between the months of March and October. Relative humidity is between 80-99%, while the temperature ranges from 19-33 °C.

Treatments and experimental design

Mature seeds of *Entandrophragma angolense* were collected under the mother tree at Ubiaja, Edo State, Nigeria. The seeds of the test plant were de-winged and sown in bed of topsoil inside the nursery of the Department of Forestry and Wildlife, University of Benin, Benin City, Nigeria.

Topsoil was collected from the agroforestry floor of the same Department. The soil was sieved with a 2 mm wire mesh. Already cured poultry dropping was collected from the University Farm House. Compost was prepared from succulent grasses, leaves of leguminous plants such as *Leucena leucocephala, Glyricidia sepium* as well as peelings of yam, cassava and potato. Fresh cow dung was used to line the bottom of the pit before turning the materials in for quick solemnization of microorganisms to facilitate early decomposition of materials. Mixtures of topsoil + poultry dropping; topsoil + compost; topsoil + cow dung; were prepared and each was used to fill 2kg polythene pots. Topsoil alone was used as the control making a total of four (4) treatments, all of which were replicated 12 times. Seedlings of the test specie were transplanted into the polythene pots of treatments two weeks after germination.

The experiment was carried out in a Completely Randomized Design (CRD).

The Statistical Model for CRD is:

$$Y_{ij} = \mu + tj + e_{ij}$$

where, Y_{ij} = individual observation

μ = overall population mean

t_j = effect of organic manure

e_{ij} = experimental error containing all uncontrolled sources of variation

Growth and biomass production were used to assess the response of test plant to different organic manure for a period of 20 weeks. The following growth parameters: number of leaves, plant height and collar diameter were measured and recorded and this was carried out fortnightly. At the termination of the experiment, the seedlings were separated into roots, stems and leaves for biomass production evaluation. These specimens were oven dried for 60 °C until the dry biomass of the specimens showed constant weight.

Data collected were subjected to analysis of variance (ANOVA) using GENSTAT and the least significant differences (LSD 0.05) were used to separate the means between the treatments.

3. RESULTS AND DISCUSSION

Effect of organic soil amendment on seedling growth of *Entandrophragma cylindricum*

Plant height

Plant height for the control ranged from 7.33 cm - 14.94 cm, while it was 8.04 cm - 19.14 cm, 8.39 cm - 18.18 cm and 7.01 cm - 17.60 cm for Cow dung, Compost and Poultry droppings respectively. No significant difference ($P < 0.05$) of the treatment was observed in plant height throughout the period of study. However, Cow dung had the highest mean value while Control had the least mean value (Table 1).

Table 1. Effects of organic soil amendment on plant height of *Entandrophragma cylindricum* seedlings.

Variables	Control	CWD	CPT	PRD	$LSD_{(0.05)}$
2 WAT	7.33[a]	8.08[a]	8.39[a]	7.01[a]	ns
4WAT	7.53[a]	9.22[a]	8.80[a]	7.28[a]	ns
6WAT	8.51[a]	11.0[a]	10.30[a]	9.01[a]	ns
8WAT	9.46[a]	12.45[a]	11.79[a]	10.69[a]	ns
10WAT	10.33[a]	13.46[a]	12.45[a]	11.74[a]	ns
12WAT	11.53[a]	15.56[a]	13.96[a]	13.56[a]	ns
14WAT	12.61[a]	15.59[a]	15.00[a]	13.94[a]	ns
16WAT	12.83[a]	17.06[a]	15.19[a]	15.78[a]	ns
18WAT	13.71[a]	18.08[a]	16.19[a]	17.53[a]	ns
20WAT	14.94[a]	19.14[a]	18.18[a]	17.60[a]	ns

Means with the same letters along rows are not significantly different at $p<0.05$.
Abbreviations- CWD: Cow dung; CPT: Compost; PRD: Poultry droppings; WAT: Weeks after transplanting

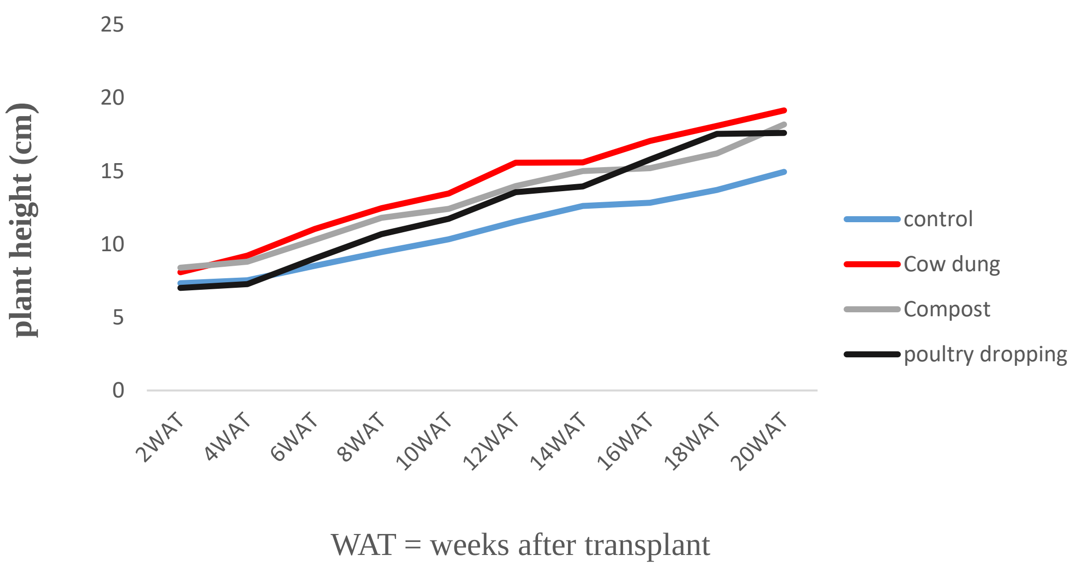

Figure 1. Effect of organic soil amendment on plant height of *Entandrophragma angolense* seedlings

Number of leaves

The leaves number ranged from 3 - 7 for control, 3 - 8, 3 - 8 and 3 - 7 for the Cow dung, Compost and Poultry droppings respectively. No significant difference ($P < 0.05$) of the treatment was observed on the leaves number throughout the period of study. However at 20 weeks, Cow dung and Compost had the highest mean value while Poultry dropping had the least mean value (Table 2).

Table 2. Effects of organic soil amendment on number of leaves of *Entandrophragma cylindricum* seedlings.

Variables	Control	CWD	CPT	PRD	$LSD_{(0.05)}$
2WAT	3^a	3^a	3^a	3^a	ns
4WAT	3^a	4^a	3^a	3^a	ns
6WAT	4^a	5^a	4^a	4^a	ns
8WAT	4^a	5^a	5^a	5^a	ns
10WAT	5^a	6^a	5^a	6^a	ns
12WAT	5^a	7^a	6^a	7^a	ns
14WAT	5^a	7^a	6^a	7^a	ns
16WAT	5^a	8^a	7^a	7^a	ns
18WAT	6^a	7^a	7^a	7^a	ns
20WAT	7^a	8^a	8^a	7^a	ns

Means with the same letters along rows are not significantly different at $p<0.05$.
Abbreviations- CWD: Cow dung; CPT: Compost; PRD: Poultry droppings; WAT: Weeks after transplanting

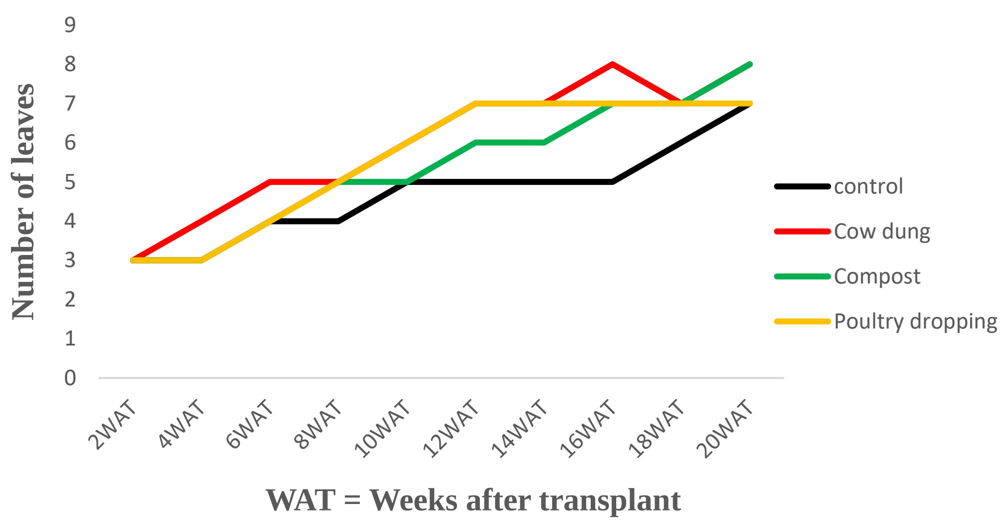

Figure 2. Effect of organic soil amendment on number of leaves of *Entandrophragma angolenses* seedlings

Collar diameter

Collar diameter for Control ranged from 0.23 cm - 0.53 cm, while the range of values for Cow dung, Compost and Poultry dropping were 0.28 cm - 0.64 cm, 0.29 cm - 0.62 cm and 0.26 cm - 0.66 cm respectively. There was a significant difference ($P < 0.05$) on collar diameter at 2weeks and 12weeks with cow dung outperforming the other treatments at both weeks (Table 3).

Table 3. Effects of organic soil amendment on collar diameter of *Entandrophragma cylindricum* seedlings.

Variables	Control	CWD	CPT	PRD	$LSD_{(0.05)}$
2WAT	0.23^{b}	0.28^{a}	0.29^{a}	0.26^{ab}	0.021
4WAT	0.26^{a}	0.34^{a}	0.32^{a}	0.26^{a}	ns
6WAT	0.28^{a}	0.36^{a}	0.35^{a}	0.31^{a}	ns
8WAT	0.29^{a}	0.40^{a}	0.38^{a}	0.31^{a}	ns
10WAT	0.30^{a}	0.40^{a}	0.37^{a}	0.36^{a}	ns
12WAT	0.32^{b}	0.51^{a}	0.42^{ab}	0.43^{ab}	0.092
14WAT	0.38^{a}	0.55^{a}	0.50^{a}	0.51^{a}	ns
16WAT	0.38^{a}	0.60^{a}	0.57^{a}	0.58^{a}	ns
18WAT	0.43^{a}	0.64^{a}	0.63^{a}	0.63^{a}	ns
20WAT	0.46^{a}	0.64^{a}	0.62^{a}	0.66^{a}	ns

Means with the same letters along rows are not significantly different at $p<0.05$.
Abbreviations- CWD: Cow dung; CPT: Compost; PRD: Poultry droppings; WAT: Weeks after transplanting

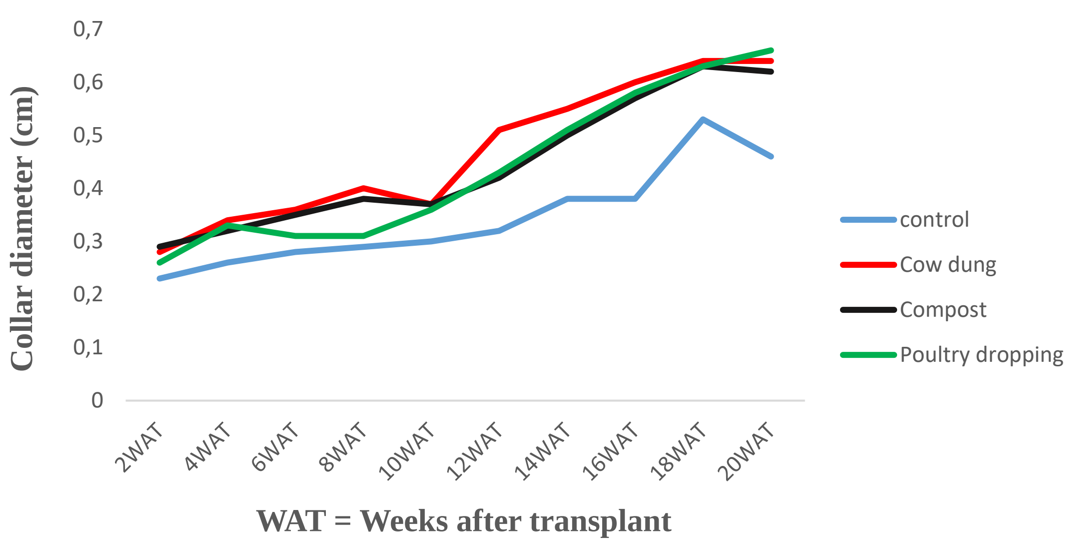

Figure 3. Effect of organic soil amendment on collar diameter of *Entandrophragma cylindricum* seedlings.

Effect of organic amendment on fresh seedlings biomass of *Etandrophragma angolense*
Root fresh weight (RDW)

Poultry droppings produced the highest mean value of 10.2 g which was not significantly different from Compost (9.78 g) and Cow dung (9.53 g). Control produced the least mean value of 8.42 g and was significantly different from the other treatments (Table 4).

Leaf fresh weight (LDW)

Poultry dropping produced the highest value of 11.82 g. This was significantly different from Control, Compost and Cow dung of mean values 9.39 g, 11.02 g and 9.88 g respectively. Control, Compost and Cow dung did not significantly differ from one another at 20 weeks (Table 4).

Stem fresh weight (SDW)

The treatments were not significantly different ($p < 0.05$) from one another. However, poultry droppings produced the highest mean value of 10.11 g while Control produced the least mean value of 9.66 g (Table 4).

Table 4. Effects of organic soil amendment on fresh weight biomass of *Entandrophragma angolense* seedlings.

Variables	Root	Leaves	Stem
Control	8.42^b	9.39^b	9.66^a
CWD	9.53^a	9.88^b	9.53^a
CPT	9.78^a	11.02^b	9.44^a
PRD	10.2^a	11.82^a	10.11^a
$LSD_{(0.05)}$	0.71	0.7	ns

Means with the same letters along columns are not significantly different at $p<0.05$.
Abbreviations- CWD: Cow dung; CPT: Compost; PRD: Poultry droppings

Effect of soil amendment on dry seedlings biomass of *Etandrophragma angolense*

Root dry weight (RDW)

Poultry droppings produced the highest mean value of 1.50 g which was not significantly different from Compost and Cow dung. Control produced the least mean value of 0.62 g and was significantly different from the other treatments (Table 5).

Leaf dry weight (LDW)

Poultry dropping produced the highest value of 2.82 g. This was significantly different from Compost, Cow dung and Control of mean values 2.02 g, 1.28 g and 0.89 g respectively. Compost and Cow dung and Control did not significantly differ from one another at 20 weeks (Table 5).

Stem dry weight (SDW)

The treatments were not significantly different from one another. However, poultry droppings produced the highest mean value of 1.51 g while Control produced the least mean value of 1.07 g (Table 5).

Table 5. Effects of organic soil amendment on dry weight biomass of *Entandrophragma angolense* seedlings.

Variables	Root	Leaves	Stem
Control	0.62^b	0.89^b	1.07^a
CWD	1.03^a	1.28^b	1.13^a
CPT	1.18^a	2.02^b	1.11^a
PRD	1.5^a	2.82^a	1.51^a
$LSD_{(0.05)}$	0.5	0.79	ns

Means with the same letters along rows are not significantly different at $p<0.05$.
Abbreviations- CWD: Cow dung; CPT: Compost; PRD: Poultry droppings

Table 6. Major nutrient composition of the growth media treatment

Variables	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Control	0.26	0.11	0.07
Cow dung	0.76	0.31	0.25
Compost	0.9	0.44	0.41
Poultry dropping	1.1	0.23	0.32

4. CONCLUSION

Generally, there was no significant difference observed in the effect of organic soil amendment on *E. angolense* seedlings, except in the collar diameter where Cow dung (CWD) gave the best performance. However, there was an observable significant difference ($p<0.05$) in the effect of organic soil amendment on the biomass production of the specie although this was only exclusive to the leaves and root biomass with the exception of the stem biomass. This may not be unexpected because dry matter allocation at the seedling stage of perennial species is often not in favor of the stem. It can therefore be concluded that organic soil amendment may not be enough to improve the growth performance of this slow-growing tree specie as revealed from the results obtained in this trial. It is therefore imperative to look in the direction of genetic improvement in order to overcome the slow growth rate of this specie. Further studies can also be carried out on alternate sources of plant nutrient that will have significant effect on the growth performance of *Entandrophragma angolense* seedlings.

References

[1] Rafiqul H.M., Hossian M.K., Mpoinddon M., Hosqure M.M (2004): Effect of inorganic fertilizers on the initial growth performance of Anthocephalus chinensis (Lam) Rich.Ex Wap. Seedling in nursery. *J. Appl.. Sci.* 4, 477-485.

[2] Davis A.S (2005). Quantifying root system quality of nursery out-planting performance. *New Forests* 30: 295-311.

[3] Akisanya, A., C. W. L. Bevan, J. Hirst, T. G. Halsall & D. A. H. Taylor: West African timber part III: Petroleum ether extract from the genus Entandrophragma. J. Chem. Soc. 1960, XX, 3827–3828.

[4] Banerji, B. & S. K. Nigam: Wood constituent of Meliaceae: A review: *Fitoterapia* 1984, 55, 3–36.

[5] Costall, B., R. J. Naylor & V. Nohria: Climbing behaviour induced by apomorphine in mice. A potent model for the detection of neuroleptic activity. *Eur. J. Pharmacol.* 1978, 50, 39–50.

[6] Crawley, J. N.: Exploratory behaviour models of anxiety in mice. *Neurosci. Behav.* Rev. 1985, 9, 37–44.

[7] Doir, M., H. Steinberg, M. Tomkiewicz, D. Joyce, R.D. Porsolt & A. Summerfield: Persistence of dose related behaviour in mice. *Nature* 1971, 23, 121–123.

[8] File, S. E.: Effects of chlorpromazone on exploration and habitation in the rat. *Brit. J. Pharmacol.* 1973, 49, 303–310.

[9] File, S. E. & A. G. Wardill: Validity of head-dipping as a measure of explorating a modified hole-board. *Psychopharmacol.* 1975, 44, 53–59.

[10] File, S. E. & S. Pellow: The effects of triazolobenzodiazepines in two animal tests of anxiety and in the holeboard. *Brit. J. Pharmacol.* 1985, 86, 729–735.

[11] Mansur, J., R. M. W. Martz & E. A. Carlini: Effects of acute and chronic administration of Cannabis sativa and (-) 9-trans-tetrahydro cannabinol on the behaviour of rats in an open-field arena. *Psychopharmacol.* 1971, 19, 338–397.

[12] Moore, N. A. & M. S. Axton: Production of climbing behaviour in mice requires both D1 and D2 receptor activation. *Psychopharmacol.* 1988, 94, 263–266.

[13] Njar, V. C. O, J. K. Adesanwo & Y. Raji: Methyl angolensate: the antiulcer agent of the stem extract of Entandrophragma angolense. *Planta medica* 1995, 61, 91–92.

[14] Orisadipe, A. T., S. Amos, A. A. Adesomoju, L. Binda, M. Emeje, J. I. Okogun, C. Wambebe & K. Gamaniel: Spasmolytic activity of methyl angolensate: a triterpenoid isolated from Entandrophragma angolense. *Biol. Pharm. Bull.* 2001, 24, 364–367.

[15] Perez, G. R. M., I. J. A. Perez, D. Garcia & M. H. Sossa: Neuropharmacological activity of Solanum nigrum fruit. *J. Ethnopharmacol.* 1998, 62, 43–48.

[16] Protais, P., J. Costertin & J. C. Schwartz: Climbing behaviour induced by apomorphine in mice. A simple test for the study of dopamine receptors in the striatum. *Psychopharmacol.* 1976, 50, 1–6.

(Received 24 February 2017; accepted 07 March 2017)