Tropical and Subtropical Agroecosystems

Short Note [Nota Corta]

FERTILIZER RESPONSE IN SEEDLINGS OF A MEDICINAL PLANT- *Enantia chlorantha* Oliv

[RESPUESTA DE LA PLANTA MEDICINAL *Enantia chlorantha* Oliv A LA FERTILIZACIÓN]

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SUMMARY

The effect of fertilizer types and their rates on the growth and biomass accumulation in juvenile seedlings of the medicinal plant *Enantia chlorantha* (Oliv) was studied. Seedlings were raised from mature seeds collected from Lafe (lat. 6° 44' N and long. 4° 52' E). One hundred and thirty uniformly growing seedlings were selected and transplanted into medium sized polythene bags containing 2kg sandy soil each. N.P.K. (20:10:10), Urea (46:0:0) and matured Compost at different rates of 0.1g, 0.2g, 0.3g, 0.4g and control (no fertilizer application) were investigated. Height, collar diameter and number of leaves were measured. Biomass accumulation in the seedlings under each fertilizer treatment was also investigated at the end of the experimental period. Fertilizers and their dosage as well as their interactions affected ($P < 0.01$) seedling height, collar diameter and number of leaves of *E. chlorantha*. Compost fertilizer at 0.3g per seedling gave the highest mean collar diameter of 2.5cm and leaf number (9.6). However, Compost at 0.4g per seedling gave the highest mean height of 11.6cm. The lowest mean values for seedling collar diameter (0.6cm) and number of leaves (1.9) were obtained with 0.4g Urea while the lowest mean height of 3.4cm was recorded with 0.4g N.P.K.

Key words: Compost, biomass, urea, growth.

RESUMEN

Se estudio el efecto del tipo de fertilizante y tasa de aplicación sobre el crecimiento y acumulación de biomasa de plántulas de *Enantia chlorantha* (Oliv). Las plántulas fueron germinadas a partir de semillas colectadas en Lafe (Lat. 6º 44' y Long. 4º 52' E). Ciento treinta plántulas uniformes fueron seleccionadas y trasplantadas en bolsas de polietileno conteniendo 2 kg de suelo arenosos. Se aplicó N-P-K (20:10:10), Urea (46:0:0) y composta a las tasas de 0.1g, 0.2g, 0.3g y 0.4g, un tratamiento sin aplicación de fertilizante fungió como control. Se evaluó la altura, diámetro y número de hojas, así como la acumulación de biomasa al final del periodo experimental. Se observó un efecto del tipo y tasa de fertilización, así como de su interacción sobre altura, diámetro y número de hojas. La composta a una tasa de 0.3g proporcionó los mejores resultados en diámetro y número de hojas. Sin embargo la mejor respuesta en altura fue para la aplicación de composta a razón de 0.4g. El menor diámetro y número de hojas se obtuvo con 0.4g urea, mientras que la menor altura se obtuvo con 0.4g N.P.K.

Palabras clave: Composta, urea, biomasa, crecimiento.

INTRODUCTION

Increasing human population and the quest for economic development elicited the unrestrained exploitation of natural resources. Henne and Thies (2001) reported that of the original forest cover, half is gone and only one-fifth remains as large tracts of ancient forest – that is, forest ecosystems shaped mainly by nature where human impacts have been comparatively small. There is the urgent need to promote ways of enhancing the productivity of the remaining forest to meet the increasing needs of man for forest products. Osara (1967) noted that some increase in wood production could be achieved through the application of technology, efficient administration, management and general silviculture. An alternative way that holds promise under many conditions is to improve growth of the trees by improving the fertility of the site through the application of chemical fertilizer. According to Nwoboshi (1982), fertilization has greater potential for increasing timber production than most other forms of intensive silviculture.

Trees like all other plants require certain mineral elements for growth and other physiological activities

(Krammer and Kozlowski, 1960). These nutrient elements are essential because they have specific role to play in the metabolism of the plant and in their absence, the complete process of vegetative or reproductive life cycle of the plant is impaired.

The potentials of soils to supply nutrients for the growth of trees depend on the physical and chemical properties of the soil. Therefore, intensive tree farming inevitably requires a comprehensive knowledge of the nutrient requirements of forest trees species.

Enantia chlorantha is a medicinal tree species used in the treatment of malaria fever and other diseases. It naturally spreads from Nigeria to Cameroon and is often found in middle storey of lowland rainforest (Keay, 1989). It is known as “Awopa” in Yoruba, and “Evenbavbogo” in Bini. Tan *et al*. (2000) reported that the dried bark of the species is used in the treatment of ulcers in Cameroon; Virtamen *et al*. (1988) observed that extract from the plant is used in liver regeneration stimulation. Despite the present campaign for the need to domesticate useful forest tree species, Gbadamosi (2002) noted that the species occur as individual trees in natural and/or reserved forests far from human settlements as those earlier found around villages have been felled for medication. He reported further that the species is slow growing with intermittent flushes.

Therefore, this study was carried out to document the response of *E. chlorantha* seedlings to different fertilizer types and their rates with a view to enhancing its growth rate and consequently its competitive ability on farms and plantations.

MATERIAL AND METHODS

Seedlings of *E. chlorantha* were raised from mature seeds collected from Lafe in Ondo State, Nigeria (lat.6º 44’ and long. 4º 52’ E). One hundred and thirty uniformly growing seedlings (seedlings of the same average size) were selected and transplanted into medium sized polythene bags (16 x 14 x 12 cm) containing 2 kg sandy soil. Three types of fertilizer namely N.P.K. (20:10:10), Urea (46:0:0) and mature Compost (Table 1) at four different rates (0.1g, 0.2g, 0.3g, 0.4g) and a Control with no fertilizer treatment were applied to the seedlings. The compost fertilizer was obtained from the Institute of Agricultural Research and Training, Moor Plantation Ibadan. There were thirteen (13) different treatment combinations on the whole. The treatments were randomly allocated to the seedlings with ten (10) single plant replicates under each treatment making a total of 130 seedlings used. Fertilizers were applied in rings around the seedlings in the pot. The seedlings were allowed to adjust to the fertilizer treatment for two weeks before the following growth parameters were measured - height, collar diameter and number of leaves. Heights of seedlings were measured from the collar to the tip of the apical bud using a meter ruler, seedlings stem diameter at the collar were measured with a vernier caliper. Number of leaves on each experimental seedling were counted and recorded.

Table 1. Chemical analysis of compost fertilizer used for the growth of seedlings of *E. chlorantha* (g/kg dry weight)

Properties	Poultry manure	Maize stover	Mature compost
Total N	17.1	7.3	16.1
P	22.9	11.4	10.4
K	20.9	11.7	29.3
Ca	9.5	8.0	21.5
Mg	4.1	1.7	6.0
Fe	14.6	3.2	6.7
Zn	180.5	140.0	129.0
Cu	38.5	22.5	29.5
Pb	0.0	0.0	0.0
Se	0.0	0.0	0.0

Five seedlings were randomly selected under each treatment at the end of the experimental period (5 months) for biomass assessment. These seedlings were uprooted by placing them in a bowl containing water and the soil around the root carefully washed off. The uprooted seedlings were then divided into root and shoot components. The shape of each leaf per seedling was traced on a graph sheet to determine its area through the grid method (Oni, 1989). The root and shoot components of each seedling were put into separate envelopes and adequately labeled for ease of identification. The envelopes were weighed in the laboratory to determine the fresh weights of the samples. The envelopes containing the root/ shoot components of the seedlings were then oven dried for 24 hours at 80 ºC. The samples were allowed to cool to a constant temperature before the dry weights of the samples were measured using an electronic weighing balance. The data collected were subjected to analysis of variance using the SAS package.

RESULTS

Seedling Height

The effects of fertilizer and their rate, and the interaction between types and rates of fertilizer were significant ($P \leq 0.01$) on the height growth of the seedlings of *E. chlorantha*. Among the seedlings supplied with compost fertilizer, height performance of seedlings increased progressively with increased dosage. The height performance of seedlings treated with NPK fertilizer was inversely proportional to the dosage. Among the Urea fertilized seedlings, the highest value of 8.5cm was recorded among seedlings given 0.1g and 0.3g (Table 2). The heights of seedlings supplied with Urea fertilizer were not significantly different from that of seedlings under the Control treatment. However, the height of seedlings supplied with Compost was significantly different from those treated with Urea fertilizer, NPK fertilizer and the Control treatment (Table 3).

Table 2. Seedling height, collar diameter and number of leaves of *E. chlorantha* under different fertilizers and rates

Fertilizers (g/2kg soil)	Height (cm)	Diameter (cm)	Leaves
Compost (0.1g)	8.3	2.3	8.3
Compost (0.2g)	9.1	2.2	7.6
Compost (0.3g)	10.6	2.5	9.6
Compost (0.4g)	11.6	2.4	8.9
Urea (0.1g)	8.5	2.2	5.8
Urea (0.2g)	8.3	2.1	6.1
Urea (0.3g)	8.5	1.9	6.0
Urea (0.4g)	2.9	0.6	1.9
NPK (0.1g)	7.4	2.2	5.7
NPK (0.2g)	7.2	2.3	5.5
NPK (0.3g)	6.6	1.6	4.3
NPK (0.4g)	3.4	0.9	2.7
Control (0g)	6.9	2.2	4.5
Means	7.6	2.0	5.9
C V (%)	42.3	35.4	67.2
S. E.	3.23	0.69	3.98
L.S.D (0.05)	0.60	0.13	0.24

Table 3. Seedling height, collar diameter and number of leaves in *E. chlorantha* under different fertilizers.

Fertilizer	Height (cm)	Diameter (cm)	Leaf area (cm^2)	Leaves
Compost	9.87^a	2.35^a	860.58^a	8.59^a
Urea	7.05^b	2.18^b	731.67^a	4.95^b
Control	6.92^b	1.74^c	414.00^b	4.55^b
NPK	6.15^c	1.70^c	489.25^b	4.50^b
L.S.D. (0.05)	0.60	0.13	176.4	0.24

Values in the same column with similar letters are not significantly different from each other.

Seedling Collar Diameter

Fertilizer types and their rates, and the interaction between fertilizer types and rate had significant effects ($P \leq 0.01$) on the diameter growth of *E. chlorantha* seedlings. Collar diameter among seedlings treated with Compost fertilizer was highest among those given 0.3g per pot (2.5cm). Among the seedlings treated with Urea fertilizer, diameter growth decreased with increased dosage. The highest mean Collar diameter value of 2.2cm was recorded among seedlings supplied with 0.1g. Among the seedlings, which received NPK fertilizer treatment, dosage of 0.2g per seedling stimulated the highest mean collar diameter growth of 2.3cm. The means of diameter of seedlings fed with NPK fertilizer and those supplied with Urea were not significantly different from each other. On the other hand, the mean diameter of seedlings supplied with Compost, NPK, and the Control treatment were significantly different (Table 3).

Number of Leaves

Type of fertilizer and rate, and the interaction between fertilizer types and rate were highly significant ($P \leq 0.01$) on leaf production in *E. chlorantha* seedlings. Among the seedlings supplied with Compost fertilizer, the highest number of leaves (9.6) was obtained among seedlings given 0.3g per pot, Seedlings treated with Urea fertilizer had the highest number of leaves (6.1) with 0.2g per pot. Number of leaves under NPK fertilizer treatment decreased progressively as dosage per pot increased. The highest number of leaves was recorded among seedlings supplied with 0.1g of NPK (Table 2). There were no significant differences among the number of leaves of seedlings supplied with Urea, NPK and the Control treatment. However, the number of leaves among the seedlings fed with Compost was significantly different from those of other treatments (Table 3).

Biomass production

Root dry weight of seedlings (RDW)

Root dry weights of the seedlings differed significantly ($P \leq 0.01$) under different fertilizers and rate. However, the interaction between fertilizers x rate showed no significant effect on RDW of the seedlings. Seedlings fed with 0.4g of NPK/pot had the highest RDW (0.11g) followed by seedlings given 0.4g of Compost/pot (0.10g). The lowest value (0.02g) was obtained with 0.1g of Urea/pot (Table 4). RDW of seedlings under Compost fertilizer was significantly different from those under the Control, NPK and Urea fertilizer treatments (Table 5).

Stem dry weight of seedlings (SDW)

Fertilizer types and rate, and the interaction between fertilizer type x rate had no significant effect on the stem dry weight (SDW) of the seedlings of *E. chlorantha*. The highest SDW value (0.12g) was obtained with Compost at 0.4g/pot (Table 4). The means of SDW of seedlings under Compost, NPK and Urea fertilizers were not significantly different from each other. However, these values were significantly different from Control treatment (Table 5).

Leaf dry weight (LDW)

The effects of types of fertilizer and rate were highly significant ($P \leq 0.01$) on leaf dry weight (LDW) of the seedlings of *E. chlorantha*; but the interaction between fertilizers x rate failed to show any significant effect on LDW. Seedlings fed with 0.4g of Urea/pot had the highest mean LDW (0.12g) (Table 4). Mean LDW under Compost and Urea treatment were significantly different from those under Control and NPK (Table 5).

Table 4. Seedlings Biomass (g dry weight) and Leaf area (cm^2) of *E. chlorantha* under different fertilizers and rates.

Fertilizer	Root	Stem	Leaf	Leaf area	TW
Com (0.1g)*	0.09	0.08	0.08	707.33	0.25
Com (0.2g)	0.08	0.11	0.08	807.67	0.27
Com (0.3g)	0.10	0.11	0.11	1092.33	0.32
Com (0.4g)	0.10	0.12	0.12	835.00	0.34
Urea (0.1g)	0.02	0.08	0.04	403.67	0.14
Urea (0.2g)	0.06	0.10	0.06	704.33	0.22
Urea (0.3g)	0.06	0.11	0.10	914.33	0.27
Urea (0.4g)	0.06	0.07	0.12	904.33	0.25
NPK (0.1g)	0.03	0.07	0.005	368.67	0.10
NPK (0.2g)	0.04	0.10	0.008	423.67	0.15
NPK (0.3g)	0.07	0.12	0.05	559.33	0.24
NPK (0.4g)	0.11	0.08	0.09	605.33	0.28
Control	0.06	0.04	0.04	414.00	0.14
Mean	0.066	0.092	0.07	672.31	0.22
C.V.	43.48	39.89	36.10	23.65	28.76
S. E.	0.03	0.037	0.025	159.03	0.06
L.S.D (0.05)	0.03	0.04	0.028	176.4	0.07

Com= compost, TW= total weight, *Values in parenthesis are rates.

Table 5. Biomass (g dry weight) among the seedlings of *E. chlorantha* under different fertilizers

Fertilizer	Root	Stem	Leaf	Total
Compost	0.0927^{a}	0.11^{a}	0.096^{a}	0.30^{a}
Urea	0.0477^{b}	0.09^{a}	0.082^{a}	0.22^{ab}
NPK	0.0588^{b}	0.094^{a}	0.039^{b}	0.19^{bc}
Control	0.0555^{b}	0.044^{b}	0.039^{b}	0.14^{c}
S.E.	0.03	0.037	0.025	0.06

Values in the same column with similar letters are not significantly different.

Total dry weight (TDW)

The effect of fertilizers and rate were highly significant ($P \leq 0.01$) on the total dry weight (TDW) of seedlings of *E. chlorantha*. The interaction between fertilizer x rate had no significant effect on TDW of seedlings of the species (Table 5). Seedlings fed with Compost at 0.4g/pot had the highest mean TDW (0.34g) (Table 4). The mean TDW of seedlings under Compost was significantly different from those of NPK and Control treatment (Table 5).

DISCUSSION

The highly competitive demand for land has led to the establishment of forests on depleted and low productivity marginal lands. Also, the increasing demand by rising human population for forest produce compels the production of these products as quickly as possible. Improving the fertility status of a site through the application of fertilizer increases forest productivity more than any other silvicultural practice (Osara, 1967; Nwoboshi, 1982; Oni, 1997).

The results of this study revealed that fertilizers and rate of application significantly influenced the vegetative growth of *E. chlorantha.* The best performance in terms of stem diameter, number of leaves and leaf area was obtained among seedlings supplied with Compost at 0.3g each while seedlings given 0.4g of Compost each had the highest value for height and shoot dry weight. On the other hand, seedlings supplied with 0.4g Urea gave the highest value for root and leaf dry weights. Overall, seedlings supplied with Compost had superior performance over other fertilizers and rate.

The optimum performance of seedlings under compost treatment may not be unconnected with the medium of growth for the seedlings (sand), organic fertilizers has the distinct advantage of holding soil particles together thereby improving the structure of such soil. The poor performance of the two inorganic fertilizers can also be attributed to the medium, which could not readily hold the dissolved mineral nutrients contained in these fertilizers as they were watered. Olagunju and Ekwebelam (1985), Lombin *et al.* (1991) and Fagbenro (2000) all supported this observation.

The death of some seedlings supplied with high rates of Urea and N.P.K. fertilizers may be due to the desiccating impact of nitrogenous fertilizers on young plants. This notwithstanding, the application of Urea enhanced leaf production in terms of number and size, this is promising as it can promote the photosynthetic rate of the seedlings and subsequently lead to increased biomass production. *E. chlorantha* is a slow growing species and to enhance the growth rate through fertilizer application will go a long way in relieving exploitation pressure on natural stands of the species. The results of this study also have some economic implications on raising the seedling of *E. chlorantha.* Compost fertilizer is relatively cheaper and more readily available compared to inorganic fertilizers. This will reduce the cost of producing the seedlings thus making them readily available for domestication.

CONCLUSION

Seedlings fertilized with compost had superior performance, however the result might be partly attributed to the nature of the soil used in the experiment (sandy). Further studies are required before final conclusions are drawn.

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