Assessment of the early growth and development of *Nauclea diderrichii* (de wild) to NPK and some organic fertilizer

Shodeke, D.K.A; Aluko, A.P and Adejoh, O.P

Forestry Research Institute of Nigeria, PMB 5054, Jericho Hills, Ibadan

ABSTRACT

The study investigated the effects of composted leaf litter of *Gliricidia sepium* (GS) and *Tithonia diversifolia* (TD), poultry manure (PM) and N.P.K (15:15:15) on the early growth and development of *Nauclea diderrichii* seedlings. The treatments were applied at the rate of 10t/ha GS, 10t/ha TD, 10t/ha PM, 10t/ha GS +10t/ha TD, 10t/ha GS + 10t/ha+ 10t/ha PM and 100kg/ha NPK 15:15:15 at 8weeks after transplanting. However, *N diderrichii* seedlings that did not receive neither organic nor NPK fertilizer served as the control. Seedlings of the *Nauclea diderrichii* of uniform height were selected and transplanted into medium sized polypots containing 2kg topsoil at 2months. The experiment was laid out in a completely randomized design (CRD) with four replicates. Seedlings were watered daily to field capacity. Application of 10t/ha GS +10t/ha TD gave the best growth performance after six months as compared with the control in terms of plant height, stem diameter, number of leaves, leaf area and total dry matter yield. Thus, the composted leaf litter of *Gliricidia sepium* and *Tithonia diversifolia* at 10t/ha mixture combination (10t/ha GS +10t/ha TD) can be applied as organic amendment to improve the growth performance of *Nauclea diderrichii* during the seedlings stage instead of using NPK 15:15:15.

Keywords: *Nauclea diderrichii*, organic amendment, forest, NPK, growth performance

Corresponding author: shofoluwade@yahoo.com

INTRODUCTION

Nauclea diderrichii (de wild) a commercial timber of West Africa belongs to the family Rubiaceae (Keay, 1989). It is the one of the best sources of timber commonly called Nauclea, "Opepe" in Yoruba, "Obliakehe" by Edo people. "Awesu" by the Itsekiri, "Urherekor" by the Urhobo, "Owoso" by Ijaw, "Uburu" by Igbo and "Ochi Kanrung" by Boki.

N. diderrichii is found in Angola, Cameroun, Central African Republic, Republic of the Congo, Ivory Coast, Gabon, Ghana, Liberia, Mozambique, Nigeria, Sierra Leone and Uganda. Mature trees can attain 40m height and 5m in girth, with a rounded crown. The leaves are usually 7.5 – 15cm long and 3.5 – 10cm broad (Keay, 1989). It is a multipurpose tree with a long history of cultivation in the tropical and subtropical moist lowland rainforest regions of the world (CABI, 2000). Medicinally, its bark decoction is prescribed for anaemia, stomach-ache and indigestion and as part of an infusion for treating jaundice. Its bark infusion is also used to treat gonorrhea and a decoction of its leaves is used as a wash for measles. Despite the economic importance of *Nauclea diderrichii*, it has not been extensively raised in plantations and has become rated as a vulnerable and endangered tree species.

Nauclea diderrichii has been grown in taungya farming practices within its range of natural distribution in Nigeria. It has been grown in Nigeria since 1918 as a nurse species for many valuable mahoganies (*Khaya sp*.) and as a useful species in its own right. Plantations or trials have also been established in Cameroon, Côte d'Ivoire and Liberia (CABI, 2000).

Information about the growth performance and fertilizer requirement of *N. diderrichii* is lacking and it is important for future successful forest plantation establishment. There is need to use cheap, locally sourced agricultural wastes that could enhance its seedling growth. Thus, this study was conducted to compare the effect of different organic fertilizers with that of the proven NPK 15:15:15 fertilizer on the seedling growth of *N. diderrichii,* as a means of fostering establishment in plantations.

MATERIALS AND METHODS

The study was conducted in the greenhouse of Forestry Research Institute of Nigeria (FRIN) Ibadan (Latitude 7^0 2'N and Longitude $3^0$56'E), in South West Nigeria. Seeds of *Nauclea diderrichii* were obtained from Onigambari Forest Reserve, Ibadan and sown in sterilized river sand /sawdust (1:1) media and watered daily. After one month seedlings of uniform heights were selected and transplanted into 2kg topsoil in polypots .

The experiment was laid out as a completely randomized design with four replicates. There were seven treatments which were: 10t ha^{-1} *Tithonia diversifolia* leaf litter (TD) compost; 10t ha^{-1} *Gliricidia sepium* leaf litter (GS) compost; 10t ha^{-1} Poultry manure (PM); 10t ha^{-1} TD + 10t ha^{-1} GS; 10t ha^{-1} TD + 10t ha^{-1} GS + 10t ha^{-1} PM; 100kg ha^{-1} NPK 15:15:15 fertilizer and control (no fertilizer) served as checks. Treatments were mixed with the soil and watered to field capacity. At 2 months after transplanting, plant height, stem diameter, number of leaves and leaf area were measured. Data collection was carried out bimonthly for 6months. At 6 months of growth *Nauclea diderrichii* plants were harvested by uprooting. The harvested *Nauclea diderrichii* plants were oven dried at 60^0C to constant weight. Thereafter leaf, stem and root dry weights were determined.

Bulked soil samples (0-15cm) were collected from the Aboratum of FRIN, air – dried, crushed with a wooden rolling pin and passed through 2mm sieve for physical and chemical analysis.

Data obtained were subjected to statistical analysis of variance and means were separated by Duncan's multiple range test (Duncan, 1955) at 5% probability level.

RESULTS AND DISCUSSION

The soil used was slightly acidic (pH 5.6) and sandy loam in texture. It is moderate in total N (2.03%), available P (2.35 mg/kg) and CEC (2.83cmol/kg). N, P, K in poultry manure and composted leaf litters were higher than that of topsoil (Table 1).

Two (2) months after transplanting (Table 2), *Nauclea diderrichii* seedlings growth did not differ significantly from each other

in terms of mean collar diameter. Application of 10t/ha PM recorded the highest (4.95±0.22mm) while control recorded the least (3.43±0.74mm). Mean plant height ranged from 12.00 ±1.22 cm to 17.00±1.17cm at 2months after transplanting. The application of 10t/ha GS + 10t/ha TD, had the highest mean plant height, but it was not significantly different from treatments 10t ha^{-1} TD and 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM, while the application of (100kg/ha NPK 15:15:15) recorded the least value (12.00±1.22mm). Although 10t/ha TD had the highest number of leaves 20.88±2.27, it was not significantly different from other treatments (Table 2). 10t/ha GS recorded the least number of leaves (13.00±4.08) and this was not significantly different from other treatments. Mean leaf area at 2 months after transplanting ranged from 805.17±16.79cm^2 to 1245.86±19.13 cm^2. There was also no significant difference among treatments (Table 2).

As shown in (Table 3), the mean stem diameter ranged from 5.82±0.28 mm to 6.60±0.14 mm at 4 months after transplanting. Treatment of 10t/haTD, recorded the highest and was significantly different from the control, which recorded the least value (Table 3). The application of 10t ha^{-1} GS + 10t ha^{-1} TD and control were not significantly different from each other. Application of 10t/ha GS + 10t/ha TD, recorded the highest mean plant height of 36.95±2.45cm, which was significantly different from Control and 10t ha^{-1} TD. These followed the order 10t ha^{-1} GS + 10t ha^{-1} TD > 10t ha^{-1} PM > 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM > 10t ha^{-1} TD > 100kg/ha NPK (15:15:15) > Control > 10t ha^{-1} GS respectively. 10t ha^{-1} PM and 10t ha^{-1} GS + 10t ha^{-1} TD were significantly greater than Control and 10t ha^{-1} GS. Mean number of leaf per plant ranged from 8.50±0.51 to 6.00±0.00. 10t/ha GS recorded the highest and was significantly higher than 10t ha^{-1} GS, 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM and100kg/ha NPK (15:15:15) respectively. 100kg/ha NPK (15:15:15) recorded the least value.

Treatments of 10t ha^{-1} TD, 10t ha^{-1} PM and 10t ha^{-1} GS + 10t ha^{-1} TD were not significantly different from each other. Also treatments 10t ha^{-1} GS, 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM , and 100kg/ha NPK(15:15:15) were not significantly different in their number of leaves. The mean leaf area ranged from 509.95±40.84 cm^2 to 1812.50±18.29cm^2. Treatment 10t/ha TD, recorded the highest, while control recorded the least at 4 months after transplanting.

At 6 months after transplanting (Table 4) application of 10t/ha GS+ 10t/ha TD recorded the highest significant values in terms of all the growth parameters considered. It had mean collar diameter, plant height, number of leaves produced and leaf area of 8.07±0.26mm, 44.37±4.31cm, 20.50±0.29 and 3362.00±17.34cm^2 respectively. Other treatments with organic amendment also performed significantly better than the control and 100kg/ha NPK (15:15:15)

Table 1: Initial properties of soil, poultry manure and *Gliricidia sepium* and *Tithonia diversifolia* leaf litter compost

Parameters	Soil	PM (%)	GS (%)	TD (%)
Soil pH in KCl	5.63	-	-	-
Organic C	6.67	-	-	-
Total N (%)	2.03	8.00	11.61	9.8
Avail P (mg/kg)	2.35	3.40	3.22	2.9
Exchangeable cation (cmol/kg)				
Ca	1.35	9.60	18.4	8.2
Mg	0.69	4.80	7.93	1.9
Na	0.09	1.48	3.67	1.3
K	0.16	4.53	2.24	3.20
Exchangeable Acidity	0.80	-	-	-
Base saturation (%)	68.6	-	-	-
Cation exchange capacity	2.82	-	-	-
Available micronutrient (mgkg-^{1})				
Mn	18.57	0.00	0.01	0.00
Fe	8.60	0.00	0.02	0.01
Cu	5.71	-	-	-
Zn	4.41	-	-	-
Physical Analysis (%)				
Sand	70.70	-	-	-
Silt	23.30	-	-	-
Clay	6.00	-	-	-
Textural class	Sandy loam	-	-	-

Table 2: Effect of NPK and organic amendment on the growth characteristics of *Nauclea diderrichii* at 2 months after transplanting

TREATMENTS	COLLAR DIAMETER(mm)	PLANT HEIGHT(cm)	NUMBER OF LEAVES	LEAF AREA(cm^2)
T1	3.48±0.74^{a}	12.95±1.57^{b}	14.25±1.49^{ab}	830.03±15.8^{a}
T2	3.60±0.09^{a}	12.88±0.53^{b}	13.00±4.08^{a}	1131.56±20.85^{a}
T3	4.35±0.22^{a}	15.00±1.51^{b}	20.88±2.27^{a}	1059.13±18.9^{b}
T4	4.95±0.63^{a}	16.00±0.61^{ab}	16.00±0.58^{ab}	1245.86±19.13^{a}
T5	4.81±0.08^{a}	17.00±1.17^{a}	17.75±1.65^{ab}	1211.29±18.67^{a}
T6	4.15±0.51^{a}	16.00±1.73^{ab}	13.75±1.81^{ab}	1128.12±17.18^{a}
T7	3.52±0.24^{a}	12.00±1.22^{b}	13.50±1.44^{ab}	805.17±16.69^{a}

Means followed by the same letters within the same column are not significantly different ($p< 0.05$)

T1: Control, T2; 10t ha^{-1} *Gliricidia sepium* leaf litter (GS)*;* T3:10t ha^{-1} leaf litter *Tithonia diversifolia* (TD); T4: 10t ha^{-1} Poultry manure (PM); T5: 10t ha^{-1} GS + 10t ha^{-1} TD; T6: 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM; T7: 100kg/ha NPK fertilizer (15:15:15)

Table 3: Effect of NPK and organic amendment on the growth characteristics of *Nauclea diderrichii* at 4 months after transplanting

TREATMENTS	COLLAR DIAMETER(mm)	PLANT HEIGHT(cm)	NUMBER OF LEAVES	LEAF AREA(cm^2)
T1	5.69±0.35^{b}	26.48±3.82^{b}	7.50±0.29^{abc}	509.95±40.82^{b}
T2	6.29±0.21^{ab}	26.29±0.21^{b}	7.00±0.41^{bcd}	1683.53±48.92^{a}
T3	6.60±0.14^{a}	29.50±1.93^{ab}	8.00±0.00^{ab}	1812.50±18.29^{a}
T4	5.83±0.38^{ab}	36.65±2.96^{a}	5.75±0.63^{a}	1526.50±32.72^{b}
T5	6.16±0.22a^{b}	36.95±2.45^{a}	8.50±0.51^{a}	1692.25±33.12^{a}
T6	5.82±0.28^{ab}	31.20±3.78^{ab}	6.50±0.50^{cd}	1508.70±78.48^{b}
T7	5.79±0.16^{ab}	28.40±3.83^{ab}	6.00±0.00^{d}	545.15±38.71^{b}

Means followed by the same letters within the same column are not significantly different ($p< 0.05$)

T1: Control, T2: 10t ha^{-1} *Gliricidia sepium* leaf litter (GS)*;* T3:10t ha^{-1} leaf litter *Tithonia diversifolia* (TD); T4: 10t ha^{-1} Poultry manure (PM); T5: 10t ha^{-1} GS + 10t ha^{-1} TD; T6: 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM; T7: 100kg/ha NPK fertilizer (15:15:15)

Table 4: Effect of NPK and organic amendment on the growth characteristics of *Nauclea diderrichii* at 6 months after transplanting

TREATMENTS	COLLAR DIAMETER(mm)	PLANT HEIGHT(cm)	NUMBER OF LEAVES	LEAF AREA(cm^2)
T1	5.44±0.14[b]	25.48±4.26[a]	8.50±1.70[b]	634.00±11.72[b]
T2	7.67±0.26[a]	38.07±0.26b[b]	9.00±0.71[b]	1686.00±18.54[b]
T3	7.81±0.23[a]	35.63±1.28[a]	12.75±2.43[b]	1879.75±17.54[b]
T4	7.61±0.32[a]	39.98±2.13[a]	9.25±0.63[b]	1638.25±13.41[b]
T5	8.07±0.26[a]	44.37±4.31[a]	20.50±0.29[a]	3362.00±17.34[a]
T6	7.67±0.33[b]	40.10±3.09[a]	11.00±1.58[b]	1759.00±19.10[b]
T7	7.07±0.13[ab]	40.15±5.74[a]	8.50±0.87[b]	686.50±19.76[b]

Means followed by the same letters within the same column are not significantly different ($p< 0.05$)

T1: Control, T2: 10t ha^{-1} *Gliricidia sepium* leaf litter (GS)*;* T3:10t ha^{-1} leaf litter *Tithonia diversifolia* (TD); T4: 10t ha^{-1} Poultry manure (PM); T5: 10t ha^{-1} GS + 10t ha^{-1} TD; T6: 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM; T7: 100kg/ha NPK fertilizer (15:15:15)

Table 5: Biomass dry weight among the seedlings of *Nauclea diderrichii* grown with NPK and different organic amendments at 6 months after transplanting

TREATMENTS	LEAF DRY WEIGHT(g)	STEM DRY WEIGHT(g)	ROOT DRY WEIGHT(g)	TOTAL WEIGHT OF SEEDLING(g)
T1	3.43±0.35[c]	4.11±0.24[c]	3.95±0.32[c]	11.49±0.24[c]
T2	5.10±0.34[ab]	6.36±0.00[ab]	4.53±0.23[bc]	15.99±0.25[b]
T3	5.02±0.40[ab]	6.20±0.69[ab]	6.15±0.47[a]	17.37±0.71[ab]
T4	4.70±0.19[b]	5.99±0.91[ab]	5.52±0.63[ab]	16.21±1.32[b]
T5	6.06±0.24[a]	7.11±0.58[a]	6.35±0.31[a]	19.52±0.66[a]
T6	5.84±0.43[a]	6.62±0.76[ab]	5.72±0.58[ab]	18.18±1.30[ab]
T7	3.40±0.35[c]	5.11±0.24[bc]	3.95±0.32[ab]	12.46±0.28[c]

Means followed by the same letters within the same column are not significantly different ($p< 0.05$)

T1: Control, T2: 10t ha^{-1} *Gliricidia sepium* leaf litter (GS)*;* T3:10t ha^{-1} leaf litter *Tithonia diversifolia* (TD); T4: 10t ha^{-1} Poultry manure (PM); T5: 10t ha^{-1} GS + 10t ha^{-1} TD; T6: 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM; T7: 100kg/ha NPK fertilizer (15:15:15)

The biomasss dry weight of *Nauclea diderrichii* (Table 5) shows that the mean leaf dry weight of seedlings under Control and treatment of 100kg/ha NPK (15:15:15) were significantly different from others. Treatment of 10t ha^{-1} GS + 10t ha^{-1} TD had the highest mean leaf dry weight of 6.06±0.24g (Table 5), this was followed in the order 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM >10t ha^{-1} GS > 10t ha^{-1} PM > 100kg/ha NPK (15:15:15) > Control. Control of the stem dry weight was significantly lower than other treatments, while treatment 100kg/ha NPK (15:15:15) was significantly different from 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM and control. No significant difference existed between 10t ha^{-1} GS, 10t ha^{-1} TD, 10t ha^{-1} PM T4 and 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM respectively. The mean root dry weight of seedlings of control and 100kg/ha NPK (15:15:15) were significantly lower than other treatments. 10t ha^{-1} GS + 10t ha^{-1} TD also recorded the highest total weight of 19.52g and was followed by 10t ha^{-1} GS + 10t ha^{-1} TD + 10t ha^{-1} PM >10t ha^{-1} TD > 10t ha^{-1}GS > 100kg/ha NPK (15:15:15) > control respectively.

Other research workers who have applied organic amendment like poultry manure in raising other forest seedlings, obtained very high collar diameter, plant height, number of leaves, leaf area and biomass yield with organic amendments (Gbadamosi, 2006; Okunnomo, 2010; Osaigbovo *et al*., 2010). Aluko and Aduayi (1984) found that the application of 100 and 200ppm of nitrogen to *Terminalia ivorensis* and 200 and 400ppm nitrogen to *Terminalia superba* increased plant height, stem diameter, leaf production and inducted healthy growth of seedlings.

The performance of seedlings treated with compost treatment could be due to fact that organic fertilizers can hold soil particles together, thereby improving the structure of the soil unlike mineral fertilizers which cannot readily hold dissolved mineral nutrients (Olagunju and Ekwebelam, 1985; Lombin et al., 1991; Fagbenro, 2000; Gbadamosi, 2006). Results obtained by Gbadamosi (2006) show that seedlings of *Enantia chlorantha* oliv, a medicinal plant, supplied with 0.3g and 0.4g compost recorded the best growth performance in terms of stem diameter, number of leaves and leaf area, while 0.4g compost had the highest value for root and leaf dry weights.

CONCLUSION

The organic based treatments appeared to produce higher growth in this study. Composted leaf litter of *Gliricidia sepium* and *Tithonia diversifolia* applied at 10t/ha mixture combination (10t/ha GS + 10t/ha TD) can be applied as organic amendment to improve the growth performance and early development of *Nauclea diderrichii* seedlings instead of mineral fertilizers – NPK 15:15:15. Mixture combination of 10t/ha GS + 10t/ha TD is therefore recommended for the enhanced early growth and development of *Nauclea diderrichii*.

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