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EARLY GROWTH RESPONSE OF *Azanza garckeana* (Exell & Hillc) AS INFLUENCED BY ORGANIC AND INORGANIC FERTILIZERS

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Abstract
Thespesia garckeana (also known by its synonym *Azanza garckeana*) is a tree in the family Malvaceae, found throughout the warmer parts of Southern Africa. The use of organic and inorganic fertilizer is a way of providing adequate nutrition to growing seedlings, while improving their quality, resistance and adaptation. The study was carried out at the screen house and laboratory of the Department of Soils and Tree Nutrition of the Forestry Research Institute of Nigeria Ibadan (FRIN). The experiment was a completely randomized design (CRD), with sixteen (16) treatments and replicated 4 times. The data collected include; stem girth (mm), plant height (cm) and number of leaves at interval of 2 weeks for a period of 16 weeks, while plant dry matter were obtained at the 16th week. Data collected were subjected to statistical analysis of variance (ANOVA) using GenStat 9th Edition, while significant different means were separated using the Duncan Multiple Range Test (DMRT) at 5% probability level. The result showed that the experimental soil was loamy sand with low nutrient status, while the combination of compost and NPK 15:15:15 at ratio 1:2 (T13) in the soil showed a significantly higher mean height at the end of the study. Treatment T6 (NPK 15:15:15 at 125kgNha^{-1}) maintained the widest stem diameter of 7.33mm among all the treatments and was significantly wider than that of T14 (NPK 15:15:15 at 33.3kgNha^{-1}+ AC at 66.6kgNha^{-1}) with 5.24mm stem diameter, which was the least. The dry matter yield for the plant's stem showed a significant higher influence from treatment T13 (NPK 15:15:15 at 66.6kgNha^{-1} + AC at 33.3kgNha^{-1}) with 1.84g, while treatment T6 significantly influenced root production (6.80g) compared to those of treatments T14 and T16 (0.39 and 0.12g respectively) with a combination of both organic and inorganic fertilizers. As shown in this study, a combination of NPK 15:15:15 at 66.6kgNha^{-1} + AC at 33.3kgNha^{-1} (T13) significantly increased plant height and stem dry matter yield compared to all other treatment combinations. Likewise, higher rate of inorganic fertilizer as seen in treatment T6 also significantly increased plant's stem growth and root dry matter yield, while NPK 15:15:15 at 50 kgNha^{-1} + AC at 50kgNha^{-1} also increased plant leaves dry matter yield. Therefore, for a productive early growth response of *Azanza garckeana,* the use of the combinations of NPK 15:15:15 and *Aleshinloye* compost is recommended.

Keyword: Soil, *Aleshinloye* compost, *Azanza garckeana,* Organic, Inorganic, Fertilizer

Introduction

Thespesia garckeana (also known by its synonym *Azanza garckeana*) is a tree in the family Malvaceae, found throughout the warmer parts of Southern Africa in wooded grasslands, open woodland and thickets. It also grows in semi-arid areas, receiving lowest annual rain fall of 250mm and highest rain fall of 1270mm (Orwa *et al*., 2009). *A. garckeana* grows in a variety of soils and is found near termite mounds and deserted areas, while in Nigeria it grows in open woodlands in the North-East part of the country. FAO (1983) reported that *A. garckeana* grows naturally in semi-arid areas receiving annual rain fall that range from 250mm to 1270mm. It is one of the indigenous fruit tree species found in Nigeria (Ochokwu *et al*., 2014). The plant is semi domesticated in Kaltungo and Michika Local Government Area of Gombe and Adamawa States, Nigeria. *A. garckeana* wood is used as construction material, poles, fencing posts, farm implements, tool handles, domestic utensils and knife sheaths (Orwa *et al*., 2009; Mojeremane and Tshwenyane, 2004; Ochokwu *et al*., 2014), while the leaves are eaten by livestock and are a source of fodder during the dry season. The leaves also provide bees with forage (ICRAF, 1992). The roots are medicinal and are taken orally for painful menstruation and to treat coughs and chest pains. An infusion made from the roots and leaves is dropped into the ear to treat ear ache or taken orally as an antiemetic, (Orwa *et al*., 2009). Application of organic and inorganic fertilizer is a way of providing adequate nutrition to growing seedlings, while improving their quality, resistance and adaptation in the field (Adejoh *et al.*, 2015). Compost is a soil amendment produced through the metabolism of an organic substrate by aerobic (oxygen-requiring) microbes under controlled conditions and it's known to provide a primary source of nutrients for the crop, while NPK Fertilizer (15:15:15) is used as an active bio-fertilizer and can be directly mixed within the soil in which crops are to be cultivated (Dressler *et al*., 2014). There is paucity of information on *A. garckeana* cultivation and soil fertilization with most reports being that the plant is semi domesticated and naturally growing.

Materials and Methods

The study was carried out at the screen house and laboratory of the Department of Soil and Tree Nutrition, Forestry Research Institute of Nigeria Ibadan (FRIN), located on longitude 07°23'18 N to 07°23'43N and latitude 03°51'20E to 03°23'43E (FRIN, 2018).

Collection of Soil Samples

The soil samples used were collected from FRIN arboretum, Ibadan, at top soil depth of 0 – 20cm. It was air dried; grounded and sieved using 2mm sieve. Two kilogram each of soil was weighed in experimental polythene bags, while a sub soil sample was analyzed for it nutritional composition.

Organic Amendments

The Compost used in the study was analyzed in the laboratory to determine soil nutrient content. The organic fertilizers were incorporated into the soil at different rates at two weeks before planting.

Experimental Design

The experiment was a completely randomized design (CRD) with sixteen (16) treatments: T1 (control), T2(NPK 15:15:15 at 25kgNha^{-1}), T3(NPK 15:15:15 at 50kgNha^{-1}), T4(NPK 15:15:15 at 75kgNha^{-1}), T5(NPK 15:15:15 at 100kgNha^{-1}), T6(NPK 15:15:15 at 125kgNha^{-1}), T7[*Aleshinloye* Compost (AC) at 25kgNha^{-1}], T8(AC at 50kgNha^{-1}), T9(AC at 75kg Nha^{-1}), T10(AC at 100kgNha^{-1}), T11(AC at 125kgNha^{-1}), T12(NPK 15:15:15 at 50kgNha^{-1} + AC at 50kg Nha^{-1}), T13(NPK 15:15:15 at 66.6kgNha^{-1} + AC at 33.3kgNha^{-1}), T14(NPK 15:15:15 at 33.3kgNha^{-1} + AC at 66.6kgNha^{-1}), T15(NPK 15:15:15 at 25kgNha^{-1} + AC at 75kgNha^{-1}), T16(NPK 15:15:15 at 75kgNha^{-1} + AC at 25kgNha^{-1}), and this were replicated 4 times.

Data Collection

The data collected include; stem girth (mm), plant height (cm) and number of leaves at interval of 2 weeks for a period of 16 weeks, while plant dry matter were obtained at the 16th week. The Number of leaves was determined through physical counting of the leaves per plant; the plant height was measured from soil surface with the aid of a meter rule, while Venire calipers was used to measure the diameter at breast height and recorded in millimeter. The plant was harvested at 16th week and gently rinsed in clean water before separating into leaves, stem and root parts. These parts were oven dried at 65°C until a constant weight were recorded for the plant dry matter (g/plant) for stem, root and leaf portions of the seedlings at the end of the experiment.

Statistical Analysis

Data collected were subjected to statistical analysis of variance (ANOVA) using GenStat 9th Edition, while significant different means were separated using the Duncan Multiple Range Test (DMRT) at 5% probability level.

Results and Discussion

Soil and Compost Properties

The soil pH was 6.07 and slightly acidic; Organic C was 11.4g/kg, while total N was 1.1g/kg which was below the critical value (1.5 g/kg). The available P value was 2.2mg/kg, exchangeable bases; K^+, Na^+, Ca^{2+} and Mg^{2+} had values of 0.13, 0.31, 3.60 and 2.43cmol$^+$ kg^{-1} respectively, which were all low (Agbede, 2009). The micro-nutrients; Mn^{2+}, Fe^{2+}, Cu^{2+} and Zn^{2+} had values of 22.3, 56.0, 15.5 and 10.4mgkg^{-1} respectively (Table 1). The soil was classified as loamy sand based on the proportion of its particle size. The nutrient composition of compost used was high (Becher *et al;* 2018).

Table 1: Pre-planting soil and compost chemical and physical properties

Properties	Soil	Compost (g/kg)
pH (H_2O, 1:2)	6.07	7.03
Organic C (g/kg)	11.4	107.9
Total N (g/kg)	1.10	20.8
Available P (mg/kg)	2.22	16.2
K (cmol/kg)	0.13	2.1
Ca (cmol/kg)	3.60	7.4
Mg (cmol/kg)	2.43	10.0
Na (cmol/kg)	0.31	1.2
Fe (g/kg)	56.0	181
Mn (mg/kg)	22.3	63.1
Zn (mg/kg)	10.4	29.0
Cu (mg/kg)	15.5	10.6
Sand (g/kg)	834	
Clay (g/kg)	97	
Silt (g/kg)	69	
Textural class	Loamy sand	

Plant Height (cm)

There was no significant difference (p<0.05) in *Thespesia garckeana*'s height during the first 10 weeks after transplanting (WAT) (0WAT-10WAT). However, at 12WAT to 16WAT, some treatments significantly increased the plant height with T13 (24.80cm) recording the highest value, while T8 (14.33cm) had the lowest value. Till the final week of the experiment, T13 (26.0cm) maintained the highest height value, while that of T8 (15.57cm) was also the least (Table 2). With the combination of compost and NPK 15:15:15 at ratio 1:2, T13 showed the highest mean height, this is in agreement with similar findings in plant height obtained by various researchers where the application of mixed fertilizers influenced plant height (Rai, 2013). This also agreed with Patil *et al*. (2004) findings that combined organic and inorganic fertilizer application enhanced plant height and growth.

Table 2: Effect of Fertilizer on plant height

Treatment	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16WAT
T1	9.50[a]	11.37[a]	14.87[a]	16.33[a]	16.50[a]	16.83[a]	17.10[ab]	17.67[abc]	18.13[abc]
T2	10.63[a]	12.50[a]	13.67[a]	15.00[a]	15.17[a]	16.00[a]	16.67[ab]	17.00[abc]	17.57[bc]
T3	11.07[a]	12.77[a]	14.00[a]	15.50[a]	15.67[a]	16.00[a]	16.50[ab]	17.17[abc]	17.40[bc]
T4	10.93[a]	13.50[a]	15.93[a]	16.67[a]	17.67[a]	18.00[a]	18.33[ab]	19.00[abc]	20.17[abc]
T5	10.30[a]	11.67[a]	15.53[a]	16.33[a]	17.33[a]	18.50[a]	19.13[ab]	19.83[abc]	21.03[abc]
T6	10.30[a]	11.50[a]	15.33[a]	17.50[a]	18.23[a]	19.33[a]	20.27[ab]	22.17[abc]	24.17[abc]
T7	10.67[a]	11.93[a]	12.33[a]	13.67[a]	14.00[a]	15.17[a]	15.17[ab]	15.97[bc]	17.27[bc]
T8	10.50[a]	11.50[a]	12.33[a]	13.13[a]	13.40[a]	14.17[a]	14.33[b]	14.73[c]	15.57[c]
T9	11.50[a]	13.00[a]	15.67[a]	17.00[a]	17.67[a]	19.50[a]	19.97[ab]	20.67[abc]	21.27[abc]
T10	12.60[a]	13.07[a]	14.30[a]	15.83[a]	16.50[a]	17.20[a]	17.67[ab]	19.00[abc]	20.50[abc]
T11	10.97[a]	13.00[a]	14.83[a]	16.33[a]	17.33[a]	15.67[a]	16.00[ab]	17.13[abc]	19.00[abc]
T12	12.00[a]	13.17[a]	17.07[a]	17.50[a]	18.57[a]	19.67[a]	21.00[ab]	23.60[ab]	25.67[ab]
T13	10.13[a]	13.00[a]	14.60[a]	17.83[a]	19.23[a]	21.00[a]	23.50[a]	24.80[a]	26.60[a]
T14	12.40[a]	12.67[a]	15.67[a]	16.90[a]	18.40[a]	19.60[a]	20.83[ab]	21.60[abc]	23.37[abc]
T15	11.97[a]	12.50[a]	15.50[a]	16.80[a]	18.93[a]	20.33[a]	21.50[ab]	22.53[abc]	24.33[abc]
T16	9.73[a]	10.67[a]	13.33[a]	14.47[a]	15.33[a]	16.33[a]	17.63[ab]	18.67[abc]	20.53[abc]

Means followed by the same letter in each column are not significantly different (P=0.05)
WAT = weeks after transplanting

Number of Leaves

There was a gradual increase in leaves production by the plant as influenced by the different treatments from 0WAT to 8WAT, before a gradual decline in the number of leaves was observed on the plants which can be attributed to leaves infection noticed from 6WAT, and continued to increase till the end of the study, thereby, adversely affecting the plant's leaves production. However, the application of the combination of compost and NPK 15:15:15 which significantly influenced the plant height generally showed no significant influence on the number of leaves from 0WAT to 6WAT, where less leaves infection was noticed. As at 6WAT, Treatment T1 with no fertilizer application was not significantly different from all other treatments with fertilizer input in terms of number of leaves, which suggest that the application of fertilizer to the plant at early stage may not directly influence leaves production (Table 3).

Table 3: Fertilizer influence on plant NUMBER OF LEAVES

Treatment	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16WAT
T1	5[a]	6[a]	9[ab]	9[a]	10[a]	8[a]	8[a]	6[a]	6[a]
T2	7[a]	7[a]	10[ab]	12[a]	11[a]	9[a]	9[a]	5[a]	3[a]
T3	5[a]	7[a]	9[ab]	10[a]	8[a]	8[a]	7[a]	5[a]	4[a]
T4	6[a]	8[a]	9[ab]	10[a]	9[a]	10[a]	10[a]	7[a]	7[a]
T5	7[a]	7[a]	9[ab]	10[a]	11[a]	8[a]	9[a]	5[a]	5[a]
T6	7[a]	7[a]	10[ab]	11[a]	11[a]	9[a]	9[a]	7[a]	5[a]
T7	6[a]	6[a]	13[a]	11[a]	10[a]	10[a]	10[a]	8[a]	6[a]
T8	8[a]	6[a]	9[ab]	10[a]	8[a]	7[a]	8[a]	6[a]	5[a]
T9	7[a]	7[a]	11[ab]	10[a]	11[a]	9[a]	8[a]	6[a]	6[a]
T10	7[a]	6[a]	9[ab]	9[a]	10[a]	8[a]	9[a]	6[a]	4[a]
T11	7[a]	7[a]	10[ab]	11[a]	10[a]	9[a]	8[a]	7[a]	6[a]
T12	7[a]	8[a]	10[ab]	11[a]	11[a]	9[a]	9[a]	5[a]	4[a]
T13	6[a]	8[a]	10[ab]	10[a]	10[a]	10[a]	10[a]	8[a]	4[a]
T14	6[a]	6[a]	8[b]	9[a]	10[a]	6[a]	6[a]	5[a]	4[a]
T15	6[a]	7[a]	10[ab]	11[a]	8[a]	9[a]	8[a]	6[a]	4[a]
T16	7[a]	6[a]	9[ab]	10[a]	10[a]	8[a]	8[a]	5[a]	5[a]

Means followed by the same letter in each column are not significantly different (P=0.05)
WAT = weeks after transplanting

Stem Diameter

As from 4WAT, plants with T6 (NPK 15:15:15 at 125kgNha^{-1}) recorded significantly wider stem diameter (4.17mm) when compared to other treatments used in this study. This trend continued till 16WAT where plant with T6 maintaining the widest stem diameter of 7.33mm among all the treatments, and was significantly wider than that of T14 (NPK 15:15:15 at 33.3kgNha^{-1} + AC at 66.6kgNha^{-1}) with 5.24mm stem diameter which had the least value that was observed in the study (Table 4). This agrees with the summation of Adediran and Banjoko (2003) that the use of inorganic fertilizers on crops increased yield and that there was substantial depletion of nutrients with the yields where no NPK fertilizer was applied. Uyovbisere *et al*. (2001) also reported substantial depletion of nutrients when no NPK fertilizer was applied and nitrates and available phosphorus were substantially reduced with cropping in humid zone of South-West Nigeria. Generally, plants with treatments T4, T5, T6, T7 and T13 (7.07, 6.99, 7.33, 6.83 and 7.19mm) respectively, recorded wider stem diameters compared to that of control (6.71mm), implying that the various fertilizer rates and combinations positively influenced the growth of the plant in terms of stem diameter, while every other treatment rates and combinations in this study had a negative influence on the diameter of the plant with resulting less stem diameters recorded (Table 4).

Table 4: Fertilizer influence on plant Stem diameter (mm)

Treatment	0WAT	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16WAT
T1	2.19^{ab}	3.05	3.42^{ab}	3.86^{ab}	4.32^{a-d}	4.68^{c-e}	5.04^{c-e}	6.18^{a-d}	6.71^{a-e}
T2	2.523^{ab}	3.2	3.45^{ab}	4.29^{ab}	4.80^{a-d}	5.08^{b-e}	5.72^{a-e}	6.15^{a-d}	6.44^{a-e}
T3	2.13^{b}	2.93	2.96^{b}	3.92^{ab}	3.68^{cd}	4.45^{de}	5.07^{c-e}	5.48^{a-d}	5.75^{b-e}
T4	2.66^{ab}	2.93	3.88^{ab}	4.6^{ab}	5.47^{ab}	6.35^{a}	6.58^{ab}	6.93^{a}	7.07^{ab}
T5	2.61^{ab}	3.07	3.56^{ab}	4.59^{ab}	5.37^{a-c}	6.02^{ab}	6.44^{ab}	6.74^{ab}	6.99^{a-c}
T6	2.49^{ab}	3.12	4.17^{a}	5.18^{a}	5.73^{a}	6.55^{a}	6.79^{a}	7^{a}	7.33^{a}
T7	2.2^{ab}	2.92	3.34^{ab}	4.31^{ab}	4.64^{a-d}	5.36^{a-e}	5.9^{a-d}	6.37^{a-c}	6.83^{a-d}
T8	2.46^{ab}	2.93	3.75^{ab}	4.08^{ab}	3.83^{b-d}	4.73^{c-e}	5.09^{c-e}	4.81^{cd}	5.38^{de}
T9	2.27^{ab}	3.12	3.35^{ab}	4.5^{ab}	3.90^{b-d}	4.44^{de}	4.77^{de}	5.34^{a-d}	5.83^{a-e}
T10	2.6^{ab}	3.32	3.90^{ab}	4.57^{ab}	4.82^{a-d}	5.47^{a-e}	5.69^{a-e}	5.92^{a-d}	6.15^{a-e}
T11	2.35^{ab}	3.42	3.89^{ab}	4.46^{ab}	5.00^{a-d}	5.56^{a-d}	5.93^{a-d}	6.1^{a-d}	6.48^{a-e}
T12	2.04^{b}	3.38	4.03^{ab}	4.33^{ab}	4.56^{a-d}	4.87^{b-e}	5.06^{c-e}	5.16^{b-d}	5.67^{b-e}
T13	2.84^{a}	3.56	3.5^{ab}	4.60^{ab}	4.87^{a-d}	5.82^{a-c}	6.26^{a-c}	6.83^{a}	7.19^{ab}
T14	2.16^{ab}	2.92	3.31^{ab}	3.19^{b}	3.58^{d}	4.2^{e}	4.503^{e}	4.81^{cd}	5.24^{e}
T15	2.19^{ab}	2.86	3.3^{ab}	4.09^{ab}	4.14^{a-d}	4.59^{c-e}	5.05^{c-e}	5.36^{a-d}	5.77^{b-e}
T16	2.28^{ab}	3.05	3.45^{ab}	4.49^{ab}	4.7^{a-d}	4.97^{b-e}	5.26^{b-e}	4.60^{d}	5.51^{c-e}

Means followed by the same letter in each column are not significantly different (P=0.05)

WAT = weeks after transplanting

Dry Matter Yield (g)

Treatment T12 (NPK 15:15:15 at 50kgNha^{-1} + AC at 50kgNha^{-1}) had significant influence on plant leaves dry matter yield (3.12g) compared to those of T3, T10, T14 and T16 (0.05, 0.01, 0.14 and 0.01g) respectively, which had less rate of organic fertilizer, except that of T10 with organic fertilizer alone at a higher rate. The dry matter yield for the plant's stem shows a significant higher influence from treatment T13 (NPK 15:15:15 at 66.6kgNha^{-1} + AC at 33.3kgNha^{-1}) with 1.84g which can be attributed to the positive combination of both organic and inorganic fertilizers contributing to ensure a constant supply of plant nutrient throughout the duration of the study. Conversely, treatment T6 (NPK 15:15:15 alone at 100kgNha^{-1}) significantly influenced root production (6.80g) compared to those of treatments T14 and T16 (0.39 and 0.12g respectively) with a combination of both organic and inorganic fertilizers. This can also be attributed to an early and adequate supply of nutrients for early root production to support the plant by treatment T6 compared to those of other treatments (Table 5).

Table 4: Fertilizer influence on plant Dry matter yield (g)

Treatment	Leaves	Stem	Root
T1	1.49^{c-g}	0.46^{e-g}	4.35^{e}
T2	1.03^{fg}	0.80^{cd}	1.82^{fg}
T3	0.05^{h}	0.48^{e-g}	1.15^{gh}
T4	1.95^{bc}	1.21^{b}	4.67^{de}
T5	1.56^{b-f}	1.04^{bc}	4.04^{e}
T6	1.34^{d-g}	1.11^{b}	6.80^{a}
T7	1.87^{b-d}	0.56^{d-f}	4.77^{de}
T8	0.94^{g}	0.49^{e-g}	4.49^{de}
T9	1.65^{b-e}	0.64^{d-f}	0.64^{hi}
T10	0.01^{h}	0.44^{e-g}	2.08^{f}
T11	1.42^{-g}	0.65^{d-f}	6.04^{b}
T12	3.12^{a}	1.24^{b}	5.60^{bc}
T13	2.08^{b}	1.84^{a}	2.26^{f}
T14	0.18^{h}	0.35^{fg}	0.39^{j}
T15	1.17^{e-g}	0.74^{de}	5.16^{cd}
T16	0.01^{h}	0.25^{g}	0.12^{j}

Means followed by the same letter in each column are not significantly different (P=0.05)
WAT = weeks after transplanting

Conclusion

As shown in this study, a combination of NPK 15:15:15 at 66.6kgNha^{-1} + AC at 33.3kgNha^{-1} (T13) significantly increased plant height and stem dry matter yield compared to all other treatment combinations. Likewise, higher rate of inorganic fertilizer (NPK 15:15:15 at 125kgNha^{-1}) as seen in treatment T6 also significantly increased plant's stem growth and root dry matter yield, while NPK 15:15:15 at 50kgNha^{-1} + AC at 50kgNha^{-1} also increased plant leaves dry matter yield. Therefore, for a productive early growth response of *Azanza garckeana,* the use of the combinations of NPK 15:15:15 and *Aleshinloye* compost is recommended.

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