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Effects of Nitrogen and Phosphorus Fertilizer on Agro-Morphological Traits and Yield Performance of Gum Bush (Thevetia peruviana J.) in Southern Guinea Savanna Zone of Nigeria

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Abstract

Growth and yield parameters of Thevetia peruviana J. were evaluated under varying rates of nitrogen and phosphorus fertilizers at the Research Farm of the Bio-fuel and Alternate Renewable Energy Ltd., Kwara State in the southern guinea savanna zone of Nigeria. Three levels of phosphorus (0, 30 and 60 kg P_2O_5 ha^{-1}) and three levels of nitrogen (0, 30 and 60 kg N ha^{-1}) were tested. The experimental design was a factorial in Randomized Complete Block replicated three times. Nitrogen fertilizer rate of 60 kg N ha^{-1} significantly produced higher values for plant height, number of primary branches, number of days to fruit maturity and dry weight of 10 seeds than the control which was statistically similar with fertilizer application of 30 kg N ha^{-1}. Number of days to first flower appearance and number of harvested seeds were also found to increase significantly with application of 60 kg N ha^{-1}. The effect of application of 0 kg P_2O_5 ha^{-1} was not significant on any of the tested parameters but the application of 30 kg P_2O_5 ha^{-1} increased plant height and number of primary branches which was not significant with other phosphorus rates. It was also observed from the study that application of 60 kg P_2O_5 ha^{-1} reduced the number of days to first flower appearance, number of days to 50% flower appearance, increased seed length, seed diameter, dry weight of 10 seeds and number of harvested seeds. However, all these parameters were statistically similar when 30 kg P_2O_5 ha^{-1} was applied. Application of 60 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} is therefore recommended for enhanced growth and seed yield.

Keywords:- Nitrogen and phosphorus fertilizer, Growth, Yield and *Thevetia peruviana*,

Introduction

The Gum bush (*Thevetia peruviana* J.) is an evergreen tropical arborescent shrub in the family Apocynaceae of the order Gentianales. It is commonly known as lucky nut, be-still tree, yellow oleander, bush milk, exile tree (India), cabalonga (Puerto Rico) and olomi ojo (Yoruba; Nigeria). The fruit is green in colour when unripe and brown to black as it ripens, producing between 400-800 fruits yearly depending on the rainfall and plant age (Ibiyemi *et al*., 2002). The plant has annual seed yield of 52.5 tonnes ha^{-1} after it has reached full maturity (i.e after 4 years old) and about 1,750 litres of oil can be obtained from an hectare of waste land where the plant is growing (Balusamy and Manrappan, 2007).

In spite of the high oil content (67%) of its kernel (Azam *et al*., 2005) and high protein content (37%) in de-oiled cake (Ibiyemi *et al*., 2002), it has remained only an ornamental, fencing or wasteland plant. It is found in all climatic and vegetational belts of Nigeria and grows to an average height of about 4.5 to 6.0 m with deep green linear sword-shaped leaves and funnel shaped (yellow, white or pinkish coloured) flowers. Apart from the high quality and sizable bio-diesel obtainable form the seeds, *Thevetia peruviana* seeds have a wider range of uses than some plants such as physic nut (*Jatropha curcas*) and castor-oil plant (*Ricinus communis*), which include the following: (i) the succulent outer covering of the fruits which is rich in sugar may be harvested when matured and the sugar extracted to provide supplement feed/meal, or crushed when fresh to obtain a juice for fermentation to ethanol; (ii) the hard coat of the seed is powdered to make particle board (Ibiyemi *et al*., 2002); (iii) the seed cake when detoxified is a good protein supplement in livestock feed/meals (Oluwaniyi *et al.*, 2007); (iv) the toxin isolate (thevetin) from the seed can also be used for cardiac stimulant preparation and breast cancer drugs (Bose *et al*., 1999); (v) the seeds when pressed to obtain a semi-drying bio-oil (50-67%) is good for the production of bio-diesel and its oleic acid (55%) is close to the value computed for an ideal bio-diesel (70%).

In recent years, the world's demand for energy to power combustion engines for the numerous human activities has increased exponentially with population growth, while fossil fuel supply has been continually inadequate to meet the demand. The most common alternative being developed and used at present are biodiesels, which are fatty acid methyl esters (FAMEs) of seed oils and fats. Although a myriad of edible and non-edible oils could be used as bio-diesel feedstocks, an appropriate alternative could be to utilize the abundantly available native non-edible oil from feedstocks such as *Thevetia peruviana* J. The importance of utilizing such an alternative is borne out of the fact that the exhaust gas produced when bio-fuel burns does not pollute the air as fossil fuel does and the products are readily biodegraded when they, or their products or wastes, are disposed of or spilled. Ibiyemi *et al.* (1995) reported that *Thevetia peruviana* J. has superior oils in terms of quality and quantity than Jatropha *curcas*.

Several countries including China, Columbia, India, the Philippines and Thailand, have made major commitments to bio-fuel research in recent years. For example, the Swedish government has projected the end of the country's dependence on fossil fuel as 2020, with bio-fuels slated to play the major role (Anonymous, 2007). The objectives of the study were to determine the effects of different levels of nitrogen and phosphorus fertilizers on the performance of the plant.

Materials and Methods

The research was carried out during the 2010 and 2011 rainy seasons at the Research Farm of the Bio-fuel and Alternate Renewable Energy Ltd, Edidi, Kwara State in the southern guinea savanna of Nigeria.

Pre-cropping soil samples were randomly taken from six spots using the soil auger at 0-30cm soil depth from the experimental field. The samples collected were bulked to obtain a composite sample for routine soil analysis to determine some physico-chemical properties of the soil; including the particle size using the hydrometer method (Bouyoucos, 1951), soil reaction determined by the glass electrode pH meter in a 1:1 soil to water ratio, exchangeable cations were analyzed by the flame photometry method for sodium and potassium, while calcium and magnesium were determined by the benzoate titration method. Effective cations exchange capacity was determined by the summation of the exchangeable bases, and organic carbon was determined by the wet oxidation method (Nelson and Sommers, 1982) while the organi**c** matter content was obtained by multiplying organic carbon value by 1.724. The available phosphorus was determined using Bray-P_1 method (Bray and Kanz, 1945) and total nitrogen was determined by the Macro-Kjeldahl meth**o**d (Black, 1965).

Three levels of phosphorus (0, 30 and 60 kg P_2O_5 ha^{-1}) and three levels of nitrogen (0, 30 and 60 kg N ha^{-1}) were tested. The experimental design was a factorial in Randomized Complete Block and each treatment factorial combination was replicated three times. The size of each plot in the experiment was 10.0 x 4.0 m. The seeds used for this experiment were collected from the wild. In each season, using different sites, land was ploughed once and harrowed twice to give a well pulverized soil. Thereafter, the field was marked out to the appropriate number of treatment plots. The seeds were pre-germinated in a covered and protected nursery in plastic bags for 6 weeks before they were transplanted to the field at a spacing of 2m by 2 m on the flat.

Nitrogen fertilizer in form of Urea (46% N) was applied at the rate of 0, 30 and 60 kg N ha^{-1} in two split doses. The first dose of 0, 15 and 30 kg N ha^{-1} was applied at 2 weeks after transplanting (WAT) while the second dose of 0, 15 and 30 kg N ha^{-1} was applied at 6 WAT. Phosphorus fertilizer in the form of single superphosphate (18% P_2O_5) was applied at the rate of 0, 30 and 60 kg P_20_5 ha^{-1} once at transplanting by deep side placement using the ring method at about 8-10 cm away from the base of the plant. Glyphosate, a systemic and non-selective herbicide, was used at the rate of 2.5kg a.i ha^{-1} at interval of ten weeks using Knapsack sprayer to control both annual and perennial weeds. The herbicide was carefully applied using the nozzle shield such that it did not have contact with any part of the tree, including the trunk.

Methods of Data Collection

a) Plant height (cm)

The heights of five tagged plants per plot were measured at 24 and 32 weeks after transplanting, using meter rule from ground level to the tip of the highest growing point, and the mean recorded.

b) Number of primary branches

This was determined at intervals of 24 and 32 WAT by counting the numbers of branches that were 5cm long and above in length that emerged directly from the main stem from each of the five tagged plants per plot and the mean recorded.

c) Number of days to first flower appearance

This was determined by calculating the number of days from planting the seeds to when the first flower appeared in each plot.

d) Number of days to 50% flower appearance

This was done by calculating the number of days from planting the seeds to when 50% of the plant in each plot flowered.

e) *Number of days per plot to first fruit maturity*

This was done by counting the number of days per plot of each treatment from planting to when the first fruits matured, and the mean value determined and recorded.

f) Number of mature seeds harvested per plot after one year

Harvested mature seeds were counted per plot and the mean value recorded as number of seeds per hectare.

g) Seed diameter (cm)

The diameter of each of the randomly selected ten seeds per plot was measured using Vernier Caliper and the mean diameter recorded.

h) Seed length (cm)

The lengths of the randomly selected ten seeds from each plot were measured using Vernier Caliper, and mean recorded.

i) Dry weight of 10 seeds per plot (kg)

After harvest and drying of the seeds, 10 seeds were randomly picked from each plot per treatment and weighed.

Statistical Analysis

The data collected were subjected to analysis of variance (ANOVA) (Gomez and Gomez, 1984) using Statistical Analysis Software (SAS Institute Inc., 2000). Significant treatment means were compared using the Least Significant Difference (LSD) at 0.05 level of probability ($p \leq 0.05$).

Results

Soil analysis:- The results of some physical and chemical characteristics of the soil samples collected from the sites of the field experiments show that the soils were inherently low in native fertility (Table 1).

Table 1: Physico-Chemical properties of the soil of the experimental sites during 2010 and 2011 rainy seasons.

Soil characteristics	Soil Depth 2010 0--30cm	2011 0-30cm
Physical characteristics (g/kg)		
Clay	236.0	236.0
Silt	40.0	80.0
Sand	724.0	684.0
Textural class	Sandy loam	Sandy loam
Chemical characteristics		
pH 1:1 in H_2O	5.70	6.20
Organic Carbon g/kg	1.63	0.85
Organic matter g/kg	2.82	1.47
Total Nitrogen g/kg	0.64	0.42
Available Phosphorus mg/kg	1.68	1.73
Exchangeable bases (cmol kg^{-1})		
K	1.44	1.43
Na	1.92	1.63
Ca	0.90	0.68
Mg	0.36	0.32
CEC	4.62	4.06

***Plant Height*: -** In 2010 and 2011, increase in rates of nitrogen fertilizer from 0 to 30 kg N ha^{-1} significantly increased plant height at 24 and 32 weeks after transplanting. Further increase in nitrogen fertilizer to 60 kg N ha^{-1} increased plant height, but the increase was statistically similar with the application of 30 kg N ha^{-1} (Tables 2 and 3). Varying rates of phosphorus fertilizer had no significant effect on plant height in 2010 and at 32 WAT in 2011, while application of 30 kg P_2O_5 ha^{-1} was significant on plant height, compared with the control (0 P) at 24 WAT in 2011. The interaction between nitrogen and phosphorus was not significant.

Table 2: Effects of rates of nitrogen and phosphorus fertilizers on the plant height (cm) of *Thevetia peruviana* at 24WAT in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	71.31	74.52	74.58	109.08	111.30	111.81
30	72.75	74.80	74.87	111.29	113.51	114.02
60	72.44	73.36	73.43	110.31	112.54	113.05
$LSD_{0.05}$	2.20			2.40		

Table 3: Effects of rates of nitrogen and phosphorus fertilizers on the plant height (cm) of *Thevetia peruviana* at 32WAT in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- Rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	93.20	95.28	95.46	143.28	147.28	147.33
30	94.78	98.86	97.04	145.20	149.23	149.26
60	93.28	95.36	95.54	143.43	147.46	147.51
$LSD_{0.05}$	3.92			4.00		

Primary branches: - Application of 30 kg N ha^{-1} significantly increased the number of primary branches at 24 and 32 weeks after transplanting in 2010 and 2011. Further increase in nitrogen fertilizer to 60 kg N ha^{-1} reduced the number of primary branches, but it was statistically similar with the application of 30 kg N ha^{-1} (Tables 4 and 5). At both 24 and 32 WAT in 2010, application of 30 kg P_2O_5 ha^{-1} significantly increased the number of primary branches over the no phosphorus treatment, and the application of 30 kg P_2O_5 ha^{-1} was statistically similar with the application of 60 kg P_2O_5 ha^{-1}. However, at both sampling periods in 2011, number of primary branches did not vary significantly with varying rates of phosphorus fertilizer. Application of zero phosphorus gave the least number of primary branches in both years. There was no significant interaction between nitrogen and phosphorus fertilizers on number of primary branches.

Table 4: Effects of rates of nitrogen and phosphorus fertilizers on mean number of primary branches of *Thevetia peruviana* at 24WAT in 2010 and 2011

	2010 N- rate (Kg N ha^{-1})			2011 N- Rate (kg N ha^{-1})		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	22.00	24.96	24.06	25.25	27.26	26.67
30	24.56	26.89	25.99	26.00	27.94	27.13
60	23.64	25.55	24.95	25.73	27.74	26.86
$LSD_{0.05}$	1.83			1.93		

Table 5: Effects of rates of nitrogen and phosphorus fertilizers on mean number of primary branches of *Thevetia peruviana* at 32WAT in 2010 and 2011

	2010 N- rate (Kg N ha^{-1})			2011 N- Rate (kg N ha^{-1})		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	31.49	33.92	32.64	40.07	43.26	43.20
30	32.21	35.23	34.55	42.09	45.38	45.32
60	32.34	34.80	33.49	42.16	44.76	44.30
$LSD_{0.05}$	2.41			2.45		

***Days to first flower appearance*:-** In both years, application of 60 kg N ha^{-1} significantly delayed the number of days to first flower appearance compared with those treated with 30 kg N ha^{-1} and the control, but there was no significant difference between the control and application of 30 kg N ha^{-1} (Table 6). The number of days to first flower appearance decreased with increasing rates of phosphorus fertilizer in 2010 and 2011. Interaction effect was not significant.

Table 6: Effects of rates of nitrogen and phosphorus fertilizers on mean number of days to first flower appearance of *Thevetia peruviana* in 2010 and 2011

	2010 N- rate (Kg N ha^{-1})			2011 N- Rate (kg N ha^{-1})		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	240	240	245	285	285	289
30	239	238	243	283	284	288
60	238	237	242	282	283	287
$LSD_{0.05}$	4.05			3.96		

***Days to 50 % flower appearance*:-** The effect of rates of nitrogen and phosphorus fertilizer on number of days to 50% flower appearance in 2010 and 2011 is presented on Table 7. There was a non significant increase in the number of days to 50% flower appearance when the application of nitrogen fertilizer was increased from 0 to 60 kg N ha^{-1} in both years. In 2010, the control phosphorus fertilizer gave a significantly higher number of days to 50% flower appearance while the difference in the number of days on application of 30 and 60 kg P_2O_5 ha^{-1} was not significant. In 2011, varying rates of phosphorus fertilizer was not significant on number of days to 50% flower appearance. There was no significant interaction between nitrogen and phosphorus fertilizers on number of days to 50% flower appearance.

Table 7: Effects of rates of nitrogen and phosphorus fertilizers on mean number of days to 50% flower appearance of *Thevetia peruviana* at 32WAT in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- Rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	281	281	283	293	293	294
30	271	271	273	292	292	293
60	269	269	271	292	292	292
$LSD_{0.05}$	9.54			N.S		

N.S = Not significant

***Number of days per plot to first fruit maturity*:-** The response of the shrub in terms of number of days to first fruit maturity to rates of nitrogen and phosphorus fertilizers in 2010 and 2011 is presented on Table 8. In both years, plants not treated with nitrogen fertilizer matured earlier than those treated with 30 and 60 kg N ha^{-1} but the difference was only significant in 2010. Application of varying rates of phosphorus fertilizer from 0 to 60 kg P_2O_5 ha^{-1} resulted in a non significant reduction in the number of days to first fruit maturity in 2010. In 2011, application of 60 kg P_2O_5 ha^{-1} significantly reduced number of days to first fruit maturity although statistically similar with the application of 30 kg P_2O_5 ha^{-1}. There were no significant interaction effects between nitrogen and phosphorus on number of days per plot to first fruit maturity.

Table 8: Effects of rates of nitrogen and phosphorus fertilizers on mean number of days to first fruit maturity of *Thevetia peruviana* in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- Rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	316	322	322	371	373	375
30	315	321	321	372	373	374
60	312	318	318	369	370	372
$LSD_{0.05}$	5.25			2.90		

***Seed length*:-** The seed lengths of *Thevetia peruviana* as influenced by application of rates of nitrogen and phosphorus fertilizer in 2010 and 2011 are shown on Table 9. In 2010, there was a significant increase in seed length when rate of nitrogen fertilizer was increased from 0 to 30 kg N ha^{-1}. Further increase in nitrogen fertilizer to 60 kg N ha^{-1} reduced the seed length, although statistically similar with 30 kg N ha^{-1}. In 2011, increase in seed length with varying rates of nitrogen fertilizer was not significant. Varying rates of phosphorus fertilizer from 0 to 30 kg P_2O_5 ha^{-1} increased seed length but the increase was only significant in 2010. Further increase to 60 kg P_2O_5 ha^{-1} decreased seed length which was also statistically similar with the application of 30 kg P_2O_5 ha^{-1}. In 2011, varying rates of phosphorus fertilizer did not significantly affect the seed length.

***Seed diameter*: -** Table 10 shows the responses of *Thevetia peruviana* in terms of seed diameter to nitrogen and phosphorus fertilizers in 2010 and 2011. Varying rates of nitrogen fertilizer from 0 to 60 kg N ha $^{-1}$ in both years did not significantly affect the seed diameter. However, application of phosphorus fertilizer at a rate of 30 kg P_2O_5 ha $^{-1}$ increased the seed diameter in 2010 and 2011, with significant differences only in 2011. There were however no significant differences when the application rate was increased to 60 kg P_2O_5ha^{-1}. No significant interaction effects on were observed on seed diameter.

Table 9: Effects of rates of nitrogen and phosphorus fertilizers on the mean seed length of *Thevetia peruviana* in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- Rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	3.05	3.29	3.25	2.79	2.79	2.84
30	3.22	3.37	3.33	2.83	2.83	2.88
60	3.19	3.34	3.30	2.83	2.83	2.88
$LSD_{0.05}$	0.13			N.S		

N.S = Not Significant

Table 10: Effects of rates of Nitrogen and Phosphorus fertilizers on the mean seed diameter (cm) of *Thevetia peruviana* in 2010 and 2011

	2010 N- rate (Kg N ha^{-1})			2011 N- Rate (kg N ha^{-1})		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	1.61	1.62	1.63	1.45	1.47	1.48
30	1.62	1.63	1.63	1.51	1.53	1.53
60	1.62	1.63	1.63	1.46	1.48	1.49
$LSD_{0.05}$	N.S			0.05		

Dry weight of 10 seeds: The effects of nitrogen and phosphorus fertilizers on dry weight of 10 seeds in 2010 and 2011 are shown on Table 11. In 2010, application of 30 kg N ha^{-1} significantly increased weight of 10 seeds. Further increase to 60 kg N ha^{-1} reduced the weight of 10 seeds although statistically similar with the application of 30 kg N ha^{-1}. However, application of varying rates of nitrogen fertilizer had no significant effect on weight of 10 seeds in 2011. Increasing rates of phosphorus fertilizer from 0 to 30 kg P_2O_5 ha^{-1} increased weight of 10 seeds in 2010 and 2011, with the increase being significant only in 2010. The interaction effects between N x P on weight of 10 seeds was significant. Significant N x P effects on Table 12 show that while the effect of P application were not significant at 0 and 30 kg N ha^{-1} on the dry weight of 10 seeds, the application of 30 kg P_2O_5 ha^{-1} significantly increased the parameter as compared with the control and 60 kg N ha^{-1}.

Table 11: Effects of rates of nitrogen and phosphorus fertilizers on mean dry weight of 10 seeds (g) of *Thevetia peruviana* in 2010 and 2011

	2010 N- rate (Kg N ha^{-1})			2011 N- Rate (kg N ha^{-1})		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	10.56	11.42	11.28	9.42	9.50	9.54
30	11.40	12.26	12.12	10.03	10.11	10.15
60	11.40	12.25	12.11	9.93	10.03	10.00
$LSD_{0.05}$	1.05			N.S		
Interaction						
N x P		*				

• = Significant at 0.05 level of probability
N.S = Not Significant

Table 12: Interactive effects of Nitrogen and Phosphorus on weight of 10 seeds (g) of *Thevetia peruviana* in 2010

Treatment	Phosphorus rate Kg P_2O_5 ha^{-1}		
	0	30	60
Nitrogen rate Kg N ha^{-1}			
0	11.27	11.80	12.10
30	11.78	12.30	12.77
60	10.55	13.62	11.83
LSD (0.05)		2.16	

Number of Harvested Seeds:- Table 13 shows the effect of rates of application of nitrogen and phosphorus fertilizer on the number of harvested seeds in 2010 and 2011. Application of varying rates of nitrogen fertilizer resulted in a non significant increase in the number of harvested seeds in 2010 while in 2011, the effect of application of 0 kg N ha^{-1} and 30 kg N ha^{-1} was statistically similar. However, further increase in the application of nitrogen fertilizer to 60 kg N ha^{-1} significantly increased the number of harvested seeds. In both years, increasing application of phosphorus fertilizer from the 0 to 60 kg P_2O_5 ha^{-1} increased the number of harvested seeds. Application of 60 kg P_2O_5 ha^{-1} gave a significantly higher number of harvested seeds, although statistically similar with the application of 30 kg P_2O_5 ha^{-1} while 0 kg P_2O_5 ha^{-1} gave significantly lowest number of harvested seeds. Interaction was not significant.

Table 13: Effects of rates of nitrogen and phosphorus fertilizers on the mean number of harvested seeds of *Thevetia peruviana* in 2010 and 2011

	2010			2011		
	N- rate (Kg N ha^{-1})			**N- Rate (kg N ha^{-1})**		
	0	30	60	0	30	60
P – Rate (P_2O_5 ha^{-1})						
0	3,399	4,327	4,602	5,617	6,118	9,885
30	5,222	5,750	6,026	6,986	7,188	10,952
60	5,681	6,609	7,084	8,764	9,965	12,729
$LSD_{0.05}$	2,190			3,009		

Discussion

The results of this study showed that application of nitrogen fertilizer significantly increased the vegetative growth of the plant (height and number of primary branches). The reason for this could be that the native nitrogen in the soil was low and insufficient for the growth of *T. peruviana* (Table 1) or could be that nitrogen fertilizer is most required during the plant vegetative growth. This agrees with the findings of Menzel *et al.* (1994) that reported that young trees of lychee (*Bengal lychee*) need small split applications of N to promote flush growth and develop strong canopies. Yin *et al*. (2010) also observed that different levels of nitrogen fertilizer significantly affected growth, development, kernel set and yield of physic nut. Application of 60 kg N ha^{-1} delayed the number of days to first flower appearance, number of days to 50% flower appearance and number of days per plot to first fruit maturity. The effect of varying rates of nitrogen fertilizer was not significant on fruit length, and fruit diameter. Raese *et al.* (2007) had earlier reported that neither fruit size nor trunk girth of apple tree (*Malus domestica*) was appreciably affected by different rates of N fertilizer. The numbers of harvested seeds of *T. peruviana* were also found to increase significantly with increased rates of nitrogen fertilizer up to 60 kg N ha^{-1}. This can be attributed to some of the functions of nitrogen fertilizer in enhancing greater plant height and more number of branches produced with the application of 60 kg N ha^{-1}. This result agrees with the findings of Yong *et al*. (2010) who observed that high N nutrition improved the overall plant oil yield of Jatropha by increasing the total number of fruits/seeds produced per plant. Several earlier investigators (Calvert, 1970; Jones *et al.,* 1970; Shawky *et al.,* 1973; Koo *et al.,* 1974) had reported that an increase in N rate is associated with an increase in yield of different species of fruit trees.

The results indicated that application of phosphorus fertilizer up to 30 kg P_2O_5 ha^{-1} increased plant height, number of primary branches and stem girth. This finding agrees with that of Das *et al*. (1991) who reported an increase in black cumin (*Nigella sativa*) height, number of branches and fresh and dry weights of shoots and roots with increasing phosphorus concentration from 20 to 40 kg ha^{-1}. Munshi *et al*. (1990) also reported an increase in plant height and number of branches of caraway plant (*Carum carvi*) grown from root tubers when phosphorus was applied at the rate of 40 kg/ ha. The significant reduction in the number of days to first flower appearance, number of days to 50% flower appearance and first fruit maturity with increasing rates of phosphorus fertilizer showed that well P-fertilized *T. peruviana* mature earlier than the unfertilized one. Gayle *et al*. (2001) reported that phosphorous fertilizer is an essential nutrient for root formation, flowering, fruiting and ripening. Neilsen *et al*. (1990) and Taylor and Goubran, (1975) also found out that responses to P application have included increased vigor and accelerated flowering of newly planted trees. Seed size, dry weight of 10 seeds and number of harvested seeds were found to increase with the application of phosphorus fertilizer. This may be due to some of the functions of phosphorus fertilizer in stimulating seed production and its translocation into the fruiting of the plants. Aboyeji and Olofintoye, (2011) observed that 30 kg P_2O_5 ha^{-1} rate of phosphorus fertilizer was appropriate in enhancing the fruit yield of *Thevetia peruviana*. Scheffel (1999) observed that as plant matures, phosphorus is translocated into the fruiting of the plant where high-energy requirements are needed for the formation of seeds and fruits.

The reason for the non significant increase in the dry weight of 10 seeds, number and weight of harvested seed on the application of 60 kg P_2O_5 ha^{-1} could be that phosphorus requirement for *T. peruviana* had been reached at 30 kg P_2O_5 ha^{-1} for seed production. Akintayo (2004) explained a similar observation by postulating that increasing phosphorus supply above what is required by the plant does not increase the growth and yield further but lead to a continuing increase in phosphorus content of the leaves due to luxury consumption.

Conclusion

Based on the result of this study it is therefore recommended that application of 60 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} will enhance the agro-morphological traits, fruits development and the overall seed yield of *Thevetia peruviana* J. in the study area.

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