Journal of Forestry Research and Management. Vol. 18(1).151-159; 2021, ISSN 0189-8418

www.jfrm.org.ng

INFLUENCE OF GREEN MANURES ON EARLY GROWTH OF THORN APPLE (*Datura stramonium LINN*) SEEDLINGS: A PROSPECTIVE MEDICINAL PLANT

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ABSTRACT

The role of green manuring in tree production has been known since ancient time and importance of this soil ameliorating practice is increasing in recent years due to some challenging factors like high cost of inorganic fertilizers, increased risk of environmental pollution and need of sustainable tree production systems. This study therefore investigated the influence of green manure on early growth of *Datura stramonium* seedlings. Green manures comprising mixtures of top soil, *Gliricidia sepium* and *Adenanthera pavonina* leaves in varying proportions (top soil mixture; 10g, 50g, 100g of *Gliricidia sepium* leaf), (top soil mixture; 10g, 50g, 100g of *Adenanthera pavonina* leaf), (top soil mixture (1:1); 10g, 50g, 100g of *Gliricidia sepium* + *Adenanthera pavonina* leaves) were applied to the 4-weeks-old thorn apple (*D. stramonium*) seedlings. While control seedlings were left untreated and growth of seedlings were measured to compare the treatments. Results obtained in this study revealed that out of the three sets of green manure applied to *D. stramonium* seedlings, 100g *Gliricidia sepium + Adenanthera pavonina* mixture had the highest in stem diameter (11.05mm), while 100g *Adenanthera pavonina* leaf manure had the best in plant height (45.25cm) and leaf production (35.25). These findings confirm that green manure derived from *Gliricidia sepium* and *Adenanthera pavonina* leaves in right quantity can improve the soil fertility therefore, can be utilized in the production of medicinal plant's seedlings of economic value like *D. stramonium*.

Keywords: Green manuring, medicinal plant, growth performance, *Datura stramonium*

Introduction

Datura stramonium is an annual herb commonly called Jimson weed or Thorn apple belongs to *Solanaceae* family. *D. stramonium* originated from America and was introduced in many tropical, subtropical and temperate regions of the globe but has naturalized in many African countries including Nigeria(CABI 2011). Thorn apple is found around homes as ornamental due to its termiticidal effect and some medicinal uses (Fatoba *et al*., 2013). *D. stramonium* is medicinal but toxic; it is traditionally use to relieving asthma, cough, tuberculosis, ear pain, fever, bronchitis, fungal infections, tumors and ulcers (Mairura, 2014). In Nigeria, *D. stramonium* leaves are used to expel intestinal worms, while seeds with palm oils are externally used for poisonous insect bites and stings (Al-Snafi, 2017).In the developed country like France, *D. stramonium* is used in various drug productions due to its analgesic, anti-asthmatic, antimicrobial and antioxidant properties (PFAF 2020). The economic potentials of *D. stramonium* in the domestic and foreign market necessitate for its commercial production through cultivation for reforestation and afforestation programs. Presently, there is limited information on the

silvicultural requirements of *D. stramonium* especially in the area of nutrient application which is essential for mass production of vigorous and healthy seedlings or plants.

Furthermore, the growth and development of plant is greatly dependent on nutrient availability in soil which is the major supplier of plant nutrient both in the nursery and on the field however, previous studies have revealed that decline in soil nutrient is a major constraint in the tropics including Nigeria (Rahbarian, 2014; Afa *et al.,* 2011). Over decades, inorganic fertilizer are used to ameliorate low inherent fertility of soils in the tropics (Adekiya and Agbede, 2009) but in recent years, there is increased advocacy for organic farming and produce in the agricultural sector nationwide (Gruhn *et al*., 2000) so, attention are shifting to use of organic inputs such as crop residues, manures and compost which have great potentials for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Quansah, 2010).Green manuring is one of the established organic ways to restore soil fertility and increase soil organic matter (OM) content in the tropics. They are environmentally safe due to the fact that they are non-polluting, less toxic and biodegradable with no hazardous residues in soil, water, air and stored food product (Adekiya *et al*., 2019). Several research works (Igua and Huasi, 2009; Crespo *et al*., 2011; Hafifah *et al*., 2016; Oroka and Ureigho, 2019) have reported a significant influence of soil physio-chemical properties, soil nutrients and enhancing microbial activity with the use of green manure.

Gliricidia sepium (Jacq.) Kunth ex Walp.is a perennial, medium sized, leguminous tree commonly known as *Gliricida* belonging to the family *Fabaceae*. It is an important multi-purpose legume tree (Rani 2007). It is native to tropical dry forests in Mexico and Central America but introduced to other tropical zones of the world (POWO 2020).*G. sepium* uses include tree shading, fencing, as fodder, fuelwood, green manure, intercropping and rat poison (Lowes et al. 2004; Elevitch 2004).

Adenanthera pavonina commonly known as Red bead tree is a leguminous, perennial and non-climbing tree species belonging to the family *Fabaceae*. It is commonly found within the tropics of the world (Bisby 1994). *A. pavonina* is majorly used as food and drink, soap and dye making, traditional medicine and timber (Bisby 1994). It is also useful as green manure specifically for nitrogen fixation and often cultivated for forage, as an ornamental garden plant and as a medicinal plant (ILDIS 2014). Its chemical constituents include aliphatic natural products, carbohydrates, simple aromatic natural products, alkaloids, flavonoids, terpenoids, steroids and amino acids (Bisby 1994).

The nutritional effect of plants like *Gliricidia sepium* and *Adenanthera pavonina* used as green manure is dependent on residue quality because plants differs in their chemical composition, rate of decomposition and nutrient elements released to the soil. Hence, there is the need to evaluate different plant materials as potential green manure sources and their relative effect on soil chemical properties as well as mineral composition of crops planted on them. This study therefore sought to compare the influence of different

green manures at different rate on early growth of *D. stramonium* seedlings.

Materials and Methods

Experimental site

The experiment was carried out at the Herbal Garden Nursery, Forestry Research Institute of Nigeria (FRIN), Ibadan which is located on the longitude 7° 23' 18"N and 7 ° 23' 43"N and latitude 3° 51' 20"E and3° 51' 43"E. The climate of the study area is the West African monsoon with dry and wet seasons. The dry season is usually from November through March and is characterized by dry cold wind of Harmattan. The wet season usually starts from April to October with occasional strong winds and thunderstorms. Mean annual rainfall is about 1548.9 mm, falling within approximately 90 days. The mean maximum temperature is 31.9°C, minimum 24.2°C while the mean daily relative humidity is about 71.9% (FRIN, 2015).

Physico-chemical analysis

Soil samples collected from FRIN herbal garden at five (5) different points were thoroughly homogenized prior to the application of manure then, a representative sample taken from it, was air dried, ground and sieved using a 2 mm sieve. Also, one representative sample was taken from each of the green manures (*Gliricidia sepium, Adenanthera pavonina)* powdered samples. The physico-chemical properties of both the soil sample and green manure samples were determined at the soil laboratory, Forestry Research Institute of Nigeria Ibadan, using the methods described by Amhakhian and Isaac (2016).

Experimental procedure and treatments

Matured, fresh fruits of *D. stramonium* were harvested from the FRIN herbal garden and the seeds were extracted and air-dried at room temperature before sowed directly into germination basket containing already washed, sterilized river sand. The fresh leaves of *G. sepium and A. pavonina* were collected, air-dried at room temperature and grounded into powder. Polythene pots were filled with the mixture of 2kg top soil and green manure (*Gliricidia sepium*, *Adenanthera pavonina*and combination (1:1)) that had been powdered for easy mixing and aiding decomposition in the soil. The mixture was watered daily and allows to decompose and mineralize for a month to avoid concentration of manure before seedlings were transplanted. Forty (40) uniform seedlings of *D. stramonium* were pricked and transplanted into the polythene pots and watered daily. The experiment was laid out in a Completely Randomized Design (CRD) with 10 treatments replicated 4 times. The mixture of top soil and green manure treatments are prepared as follows:

T_1 – 2 kg top soil + 10 g of *Gliricidia sepium* leaf manure
T_2 – 2 kg top soil+ 50 g of *Gliricidia sepium* leaf manure
T_3 – 2 kg top soil +100 g of *Gliricidia sepium* leaf manure
T_4 – 2 kg top soil +10 g of *Adenanthera pavonina* leaf manure
T_5 – 2 kg top soil +50 g of *Adenanthera pavonina* leaf manure
T_6 – 2 kg top soil +100 g of *Adenanthera pavonina* leaf manure
T_7 – 2 kg top soil +10 g of *Gliricidia sepium+Adenanthera pavonina*leaf manure (1:1)
T_8 – 2 kg top soil + 50 g of*Gliricidia sepium+Adenanthera pavonina*leaf manure (1:1)

T_9 – 2 kg top soil +100 g of*Gliricidia sepium+Adenanthera pavonina*leaf manure (1:1)
T_{10} – Control (Top soil only).

D. stramonium seedlings under each treatment were monitored for a period of 12 weeks and the growth parameters such as plant height (cm), stem diameter (mm) and number of leaves with the aid of a graduated ruler, veneer caliper and by counting the leaves on each plant were taken respectively.

Statistical analysis

The data collected were subjected to descriptive statistics, one-way analysis of variance (ANOVA) at 5 % level of significance to compare the effect of the different treatments on the early growth characteristics of *D. stramonium* seedlings. Means were separated using Duncan Multiple Range Test (DMRT) procedure.

Results and Discussion

Physicochemical properties of soil and green manure

The physicochemical properties of soil and green manure used in this study were analysed and the results were presented (Table1). The results revealed that the soil is loamy-sand and the soil pH was found to be 7.22 which is classified as Neutral. The organic carbon and organic matter content detected in the soil used were 1.26% and 2.17 % respectively. The organic carbon and total nitrogen present in the soil is rated low but the available phosphorus is adequate in Landon's (1996) classification. Furthermore, the result also showed that the organic carbon content of the green manures used is higher in *Adenanthera pavonina* (46.78 %) than *Gliricidia sepium* (21.32 %) but both are rated higher. However the total nitrogen was noticed to be higher in *G. sepium* (4.21 %) but the available phosphorus is deficient in both green manures with *G. sepium***(**0.0081) and *A. pavonina* (0.0010). For exchangeable cation it was noted that *A. pavonina* had the higher content of calcium (Ca), magnesium (Mg), and sodium (Na) with (2.68, 0.42 and 0.027 respectively) while only potassium (K) was higher in *G. sepium* with (0.54). In addition *A. pavonina also* had the highest content (0.0092cmol/kg, 0.0048cmol/kg, 0.0005cmol/kg and 0.0022cmol/kg) for manganese (Mn), iron (Fe), copper (Cu) and zinc (Zn) respectively. The soil used for the experiment was loamy-Sand texture with high sand (86.5 %), averagely low silt (11 %) and low clay (2.5 %). The pH of the soil was found to be neutral according to the United State Department of Agriculture (USDA) classification, this implies the soil pH fall in between the pH range that is most favorable for plant growth because all plant required nutrient are readily available USDA (1998). The soil organic carbon was rated very low based on the classification of Landon (1996) and Amhakhia and Isaac (2016) which signify the need for manure application to improve the soil fertility. However the green manure used had organic carbon ranging from high to very high. The total nitrogen is low in the soil but found to be very high in the green manures while phosphorus is adequate in the soil but deficient in the manure base on Landon's classification (Landon 1996).

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Table 1: Physical and chemical properties of soil and green manures

Element	Soil	*Gliricidia sepium* leaf	*Adenanthera pavonina* leaf
pH (1:1)	7.55	-	-
Organic C	1.26	12.37	27.13
Organic Matter	2.17	21.32	46.78
Total N (%)	0.11	4.21	3.37
Available P	31.8	0.0081	0.0010
	Exchangeable Cation (cmol/Kg)		
Ca	7.39	1.32	2.68
Mg	2.86	0.21	0.42
K	0.16	0.54	0.38
Na	0.97	0.024	0.027
	Extractable micronutrient (mg/kg)		
Mn	19	0.0045	0.0092
Fe	50	0.0025	0.0048
Cu	6	0.00035	0.0004
Zn	9	0.0012	0.0022
	Mechanical analysis		
Sand	86.5	-	-
Silt	11	-	-
Clay	2.5	-	-
textural class	Loamy sand		

Influence of green manure on the growth parameters of *Datura stramonium* seedlings

The result obtained from this study showed that all three classes of green manure treatments used performed better in plant growth height than the top soil only (control) (Table 2). Treatment-T_6 (100g of *A. pavonina* leaf manure) had the highest height with mean value of 45.5cm and was closely followed by treatment-T_9 (100g of *Gliricidia sepium+Adenanthera pavonina* leaf manure) with mean value of 45.10cm. The control had the least performance in height with mean value of 9.78 cm.

Table 2: Mean effects of organicmanures on the early growth of *D. stramonium* seedlings

Treatments description	Treatment quantity	Plant height (cm)	Collar diameter (mm)	Leave production
Gliricidia sepium only (T_1)	10g	25.90^{bcd}	9.28^{bc}	12.25^{ab}
Gliricidia sepium only(T_2)	50g	34.65^{de}	10.30^{bc}	23.75^{bd}
Gliricidia sepium only(T_3)	100g	40.05^{de}	11.03^{c}	27.00^{cd}
Adenanthera pavonina only	10g	23.98^{abc}	8.93^{bc}	12.50^{ab}

(T_4)				
Adenanthera pavonina only(T_5)	50g	30.50^{bcde}	7.97^{bc}	15.75^{abc}
*Adenanthera pavonina*only(T_6)	100g	45.25^{e}	10.94^{c}	35.25^{d}
G. sepium + *A. pavonina*(T_7)	10g	18.00^{ab}	6.44^{b}	9.25^{a}
G. sepium + *A. pavonina*(T_8)	50g	33.85^{cde}	9.58^{bc}	26.50^{cd}
G. sepium + *A. pavonina*(T_9)	100g	45.10^{e}	11.05^{c}	33.50^{d}
Control (Top soil only) (T_{10})	0	9.78^{a}	2.08^{a}	3.75^{a}
Sig.		0.00*	0.00*	0.00*

***Mean with same superscripts along same column is not significantly different

In addition, results of analysis of variance (ANOVA)as presented (Table 3) confirmed that there were significant differences among all the treatments in this study. Again, the results obtained from this study revealed that all the three classes of green manures applied significantly influence the collar diameter *of D. stramonium* seedlings. At the end of this study, treatment-T_9 (100g of *Gliricidia sepium+Adenanthera pavonina* leaf manure) had the highest collar diameter with mean value of 11.05 mm and closely followed by treatment-T_6 (100g of *A. pavonina* leaf manure) with mean value of 10.98 mm, while the control had the lowest mean value of 2.08 mm. The analysis of variance (ANOVA) results as presented (Table 2) affirmed that there were significant differences among all the treatments used for the study. Meanwhile, results of the leaf production of *D. stramonium* seedlings grown with different soil mixtures of green manures in varying quantities are presented (Table 2).

Table 3: Analysis of variance of growth parameters of *D. stramonium* seedlings

Parameters	SV	Df	SS	MS	F-cal	P-value
Plant height	Treatment	9	4798.031	533.115	5.914	0.000
	Errors	30	2704.314	90.144		
	Total	39	7502.345			
Collar diameter	Treatment	9	276.705	30.745	5.325	0.000
	Errors	30	173.227	5.774		
	Total	39	449.932			
Leaf production	Treatment	9	4136.400	459.600	6.708	0.000
	Errors	30	2055.500	68.517		
	Total	39	6191.900			

Significant at 5% level of Probability ($P < 0.05$)

It is obviously shown that all green manure treatments enhanced the leaf production better than the control (top soil only).Treatment-T_6 (100 g of *A. pavonina* leaf manure) was found to be the highest (35.5) and was closely followed by treatment-T_9 (100 g of *Gliricidia sepium+Adenanthera pavonina* leaf manure) having 33.50, while the control recorded the least (3.75). In addition, the result of analysis of variance (ANOVA) (Table 3) showed that the treatments were significantly different from one and other. Organic manure has been reported to contain both macro and micro elements needed by plant for its optimum growth and development, when applied in right quantity, it leads to an increased productivity. The results obtained in this study confirmed that the three classes of green manures used have an appreciable increase in all the growth parameters measured such as plant height, collar diameter and leaf production of *D. Stramonium* seedlings. However, this corroborates the findings of Adekiya *et al*., (2019) who reported that various green manures (*Carica papaya*, *Azadirachta indica*, *Moringa oleifera* and *Prosopis africana*) and NPK fertilizer increased plant height, stem girth, number of leaves and pod yield of okra as compared with the control. The study then further revealed that *Adenanthera pavonina* leaf manure had better performance on the growth of *Parkia biglobosa* seedlings than *Tithonia diversifolia* at nursery stage when compared with *Gliricidia sepium*as previously reported (Ogunsiji *et al.*, 2016). This could be attributed to higher nutrient content in *Adenanthera pavonina* leaves which increased the soil nutrient and consequently improved nutrient and water uptake in plant.

Conclusion

This study has proven that the addition of green manure can better enhance the early growth performance of D*atura stramonium* in the nursery, therefore for production of vigorous and healthy seedlings for mass propagation it is recommended that 100g *A. pavonina* leaves or 100g combination of *G. sepium and A. pavonina* leaf manure be applied to every 2kg soil few weeks before transplanting.

Acknowledgements

Authors are grateful to Miss Ajayi, E.O and Mr Kolawole, A.T of Herbal garden, Forestry Research Institute of Nigeria Jericho Hill Ibadan, for their technical supports toward the success of this research work.

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