Effects of Inorganic Fertilizer Application on Early Growth of *Vitellaria paradoxa* C.F.Gaertn

Abstracts

Declining soil fertility is a main reason for the slow growth in food production in Africa. However, the practices of incorporating fertilizers could potentially improve soil fertility and productivity. This experiment was carried out to determine the efficacy of inorganic fertilizer on the early growth performance of *Vitellaria paradoxa* under a greenhouse conditionet up at the Department of Forestry Technology, Federal College of Forestry Ibadan, located within the Government Reserve Area (GRA) Jericho Ibadan. The treatments includes two fertilizer types, (Urea and NPK 15:15:15) at different concentration level used were; Urea at three (3) levels; 50mg kg^1, 100 mg $kg^1$and 150 mg kg^1: NPK (15:15:15) at three levels; 50 mg kg^1, 100 mg kg^1 and 150 mg kg^1, combination of Urea + NPK and Control (no application). The results showed that application of inorganic fertilizer at any rate produces higher growth in plant height and collar diameter than the control experiment. Application of different rates of fertilizer on leaf production are comparable with the control experiment. However, there was no appreciable variation in all fertilizer rates, the highest value was obtained with the combination of NPK and urea at 150/100 mg $kg^1$for plant height, number of leaves and leaf area while the application of NPK/Urea: 150/150 mg kg^1 produced the highest collar diameter. Nutrient supply from NPK and Urea could help enhance the growth performance of *vitellaria paradoxa* seedlings and help improve the mass propagation of target species in the nursery. Further studies are recommended to validate the fertilizer requirements of the plant species.

Keywords: Growth, Urea, NPK, *Vitellaria paradoxa*, inorganic fertilizer application

Introduction

The semi-domesticated shea butter tree *Vitellaria paradoxa* of the family Sapotaceae is wildly distributed in the Sudano-Sahalian region from Senegal to Uganda (Hall *et al*., 1996; Salle *et al*., 1991). Presently two subspecies have been identified with *V. paradoxa* subsp. *paradoxa* found in West and Central Africa (Hall *et al*., 1996; Salle *et al*., 1991; Allal *et al*., 2008; Kelly *et al*., 2004), while *V. paradoxa* subsp. *nilotica* is common in East Africa such as Soudan, Ethiopia, Uganda and Democratic Republic of Congo, (Byakagaba *et al*., 2011; Okiror *et al*., 2012).

Various environmental factors influences the tree shape and it is identified by farmers according to the folk classification. In wet season, the tree produces fruits edible by both animals and human beings. The fruits contains 1 to 3 large solitary seeds, rich in fat and oil used in a variety of purposes such as cooking (Abbiw, 1990), medicinal, hair and skin ointments and as a base for industrial manufacture of confectioneries (Cidell and Alberts, 2006). The oil is also used in traditional and social rituals such as marriages, funerals, coronations and rainmaking (Ferris *et al*., 2004; Hall *et al*., 1996; Moore, 2008).

Inorganic and organic fertilizers are essential for plant growth. Both fertilizers supply plants with the nutrients needed for optimum performance. Organic fertilizers have been used for many centuries, whereas chemically synthesized inorganic fertilizers were only widely developed during the industrial revolution. Inorganic fertilizer has significantly supported global population growth, it has been estimated that almost half the people on the earth are currently fed as a result of artificial nitrogen fertilizer use (Erisman *et al*., 2008). Both commercial and subsistence farming has been and is still relying on the use of inorganic fertilizers for growing crops (Masarirambi *et al*., 2010). This is because they are easy to use, quickly absorbed and utilized by crops. The continued dependence of developing countries on inorganic fertilizers has made prices of many agricultural commodities to sky rock. The chemical fertilizers used in conventional agriculture contain just a few minerals which dissolve quickly in damp soil and give the plants large doses of minerals (Masarirambi *et al*., 2010). Therefore this research focused on the influence of various types of inorganic fertilizer on the early growth of *Vitellaria paradoxa*, shea butter seedlings at nursery stage

2.0 MATERIALS AND METHODS

2.1 Experimental site

The experiment was carried out in Federal College of Forestry, Ibadan located within the Government Reserve Area (GRA), Jericho Ibadan Oyo state Nigeria. It lies on latitude $7^0 90^{'}$N and longitude $3^0 54^{'}$E, the climate pattern of the area is tropically dominated by annual rainfall which ranges from 1,200-1,250 mm and average relative humidity of about 37.2^0C. The ecoclimate of the dry season (usually commencing from November- March) and the raining season start from April to October (FRIN, 2016).

2.2 Procurements of materials

Soil samples was collected from Farm Practical area (FAP), Federal College of Forestry, Ibadan. Top soil of 0 – 20 cm depth was used for the experiment. The soil was air dried; grounded and sieved using 2 mm sieve to remove gravel sand and other debris like large plant roots. The soil samples was physically and chemically analyzed and four kilogram (4kg) of the sample soil was weighed in each polythene bag for the experiment. Seedlings of *V. paradoxa* that were 10 weeks old was used for the experiment, 64 healthy seedlings were selected on the bases of uniform treatments and transplanted into a 4kg pots filled with soil after which it was allowed to stabilize for 2 weeks before applying different fertilizer concentration in a ring form. Watering was done regularly and data collection was taken every three (3) weeks on plants height (cm) using meter rule, collar diameter (mm) using venier caliper, leaf production and leaf area (cm^{2}) for a period of 20 weeks. The experimental design was a Completely Randomized Design (CRD) with sixteen treatments (16) and four (4) replicates each making a total of 64 experimental samples. Treatments used were; Urea 50mg kg^{1}, 100 mg kg^{1}, 150 mg kg^{1}; NPK 50 mg kg^{1}, 100 mg kg^{1}, 150 mg kg^{1}; NPK 50 + Urea 50 mg kg^{1}, NPK 50 + Urea 100 mg kg^{1}, NPK 50 + Urea 150 mg kg^{1}; NPK 100 + Urea 50 mg kg^{1}, NPK 100 + Urea 100 mg kg^{1}, NPK 100 + Urea 150 mg kg^{1}; NPK 150 + Urea 50 mg kg^{1}, NPK 150 + Urea 100 mg kg^{1}, NPK 150 + Urea 150 mg kg^{1} and control (no fertilizer).

2.3 Data collection

The following growth parameters of *V. paradoxa* were taken

- i) Plant height (cm)
- ii) Leaf production
- iii) Collar diameter (mm)
- iv) Leaf Area (cm^{2})

2.4 Soil Laboratory analysis

Pre-planting soil was analyzed for the essential elements. Soil pH was determined in 1:1 soil-water suspension, organic carbon (OC) by Walkley-Black oxidation method, total nitrogen (N) by micro- Kjeldahl distillation method, available P by Bray 1 method; exchangeable K and Na by the flame photometer method; Ca and Mg by EDTA titration method; Particle size analysis was done using hydrometer method. The analyses were carried out at Soil and Tree Nutrition Laboratory, Bioscience Department of Forestry Research Institute of Nigeria (FRIN).

2.5 Statistical analysis

Quantitative data were analyzed using the ANOVA procedure and means separated using the Duncan Multiple Range Test (DMRT) at 5% probability (SAS Institute, 2002).

3.0 **Results and Discussion**

3.1 Physicochemical characteristics of experimental soil

Soil status: The soil used for the experiment was sandy loam with low total nitrogen (0.22%), implying low soil fertility. The soil is moderately acidic. Also from the results of the soil analyses, it could be inferred that the soil has lower organic carbon (1.18%). This suggests that it has little humus, resulting in fewer nutrients and poor fertility thereby justifying the needs for additional fertilizer inputs to boost the growth. The soil is also moderately furnished with Phosphorus and potassium (15.13) and (0.32) respectively.

Table 1. Physical and chemical properties of the experimental soil

Properties	Soil
pH H_2O (1:1)	5.9
Sand g kg^{-1}	792
Silt g kg^{-1}	84
Clay g kg^{-1}	124
Textural Class	Sandy loam
Organic Carbon %	1.18
Total. N %	0.22
Available Phosphorus mg kg^{1}	15.13
Exchangeable bases	

K cmol/kg^{-1}	0.32
Mg cmol/kg^{-1}	2.1
Ca cmol/kg^{-1}	0.25
Na cmol/kg^{-1}	1.86

Table 2: Influence of fertilizer types on plant height, stem diameter, leaf production and leaf area of *V. paradoxa* seedlings.

Fertilizer Types (ppm)	Growth Parameter			
	Plant Height (cm)	**Stem Diameter (mm)**	**Number of Leaves**	**Leaf Area (cm^2)**
No fertilizer (Control)	12.65a	4.51a	4.97a	49.23a
Urea:50 mg kg^1	13.22abc	4.54a	4.97a	50.36ab
Urea:100 mg kg^1	13.34abc	4.54a	5.00a	50.89ab
Urea:150 mg kg^1	12.88ab	4.56a	4.99a	50.70ab
NPK:50 mg kg^1	13.65abc	4.59a	4.98a	50.74ab
NPK/Urea:50/50 mg kg^1	13.75abc	4.64a	5.02a	51.14ab
NPK/Urea:50/100 mg kg^1	13.97abc	4.69a	5.04a	52.37bc
NPK/Urea:50/150 mg kg^1	14.02abc	4.76a	4.97a	53.15bc
NPK:100 mg kg^1	14.26abc	4.79a	4.97a	53.20bc
NPK/Urea:100/50 mg kg^1	13.88abc	4.77a	5.02a	54.15e
NPK/Urea:100/100 mg kg^1	14.22abc	4.86a	5.11ab	54.35e
NPK/Urea:100/150 mg	14.24abc	4.91a	5.15ab	54.57e

kg^{1}				
NPK:150 mg kg^{1}	14.15abc	4.95a	5.17ab	54.80e
NPK/Urea:150/50 mg kg^{1}	14.31abc	4.95a	5.25ab	54.07e
NPK/Urea:150/100 mg kg^{1}	14.82ab	5.16a	5.64c	53.96e
NPK/Urea:150/150 mg kg^{1}	14.51bc	5.27a	5.20ab	53.79e

Mean Value±SE; numbers with different alphabets in column are significant different ($P \leq 0.05$)

Results as presented in Table 2 revealed that, there was no significant response among all fertilizers used in respect to the plant height. Combination of NPK and urea at 150/100 mg kg^{1} produced the highest height with mean value 14.82cm as compared with the control which recorded the least with 12.65cm. Hence, all other treatments are comparable to one another as much difference was not recorded among them. This shows the importance of nitrogen for the growth of the plant, which is in agreement with the report of Tisdale *et al*. (2003) who showed that N is necessary for most physiological growth and its absence or deficiency causes stunted growth Fashina *et al*. (2002). There was increase response of plant height with increase in the combined doses of fertilizers and the sole application. Paul and DrisColl (1997) observed that the primary target of N limitation is the growing meristem of the plant and decreased rate of photosynthetic activity, which can be attributed to reduction in plant heights under N deficiency. This could explain the reason for the lowest value obtained in the control treatment.

The collar diameter was not influenced by all the treatments used. However, most inorganic fertilizers applied (Sole and combination) increases the stem girth of *V .paradoxa*. The highest collar diameter was observed with the application of NPK/Urea: 150/150 mg kg^{1} recording a mean value of 5.27mm, while the lowest was obtained in the control treatment with mean value of 4.51mm. The application of urea at 50mg/kg, 100 mg kg^{1} and 150 mg kg^{1} are comparable with the control as there was no significant variation when compared together.

The addition of (NPK/Urea150/100 mg kg^{1}) was significantly different from other treatments used in terms of leaf production. The highest number of leaves was recorded when NPK/Urea: 150/100ppm was applied, with a mean value of 5.64 while the least number of leaves was observed with the control (no application) Urea50mg/kg, NPK: 100mg/kg and NPK/Urea: 50/150mg/kg with mean value of 4.97 each. Sole application, combined application as well as the control are relatively comparable with one another. This result is in line with Akinrinde (2006) that showed significant response of various crop species to the application of inorganic fertilizers. The results of the analyses of variance on the number of leaves showed that the effect of fertilizer application was significant on leaf production at the end of the experiment.

There was significant difference among all treatments used in the leaf area (cm^2). The highest leaf area was recorded with NPK/Urea: 150/100 mg kg^1 having a mean value of 50.96cm^2 when compared with the control that had the least with mean value of 49.23cm^2, the control pot was significantly different from pots that received various combination of fertilizers (Urea + NPK) and sole application of NPK at 100 mg kg^1

Conclusion

The various concentration level of NPK and Urea have improved the early growth of *V.paradoxa* but has not significantly influenced the growth, as the lowest values of the measured parameters were obtained with no fertilizer application throughout the period of evaluation. Fertilizer rates at NPK/Urea: 150/100 mg kg^1 recorded higher values of the measured parameters in this study. However, from the results of this study, application of NPK and urea at (150+100mg kg ^{1} gave the optimum growth of *V.paradoxa* seedlings. The inorganic fertilizer NPK and Urea have potential to improve the growth of the specie. More studies are recommended to further evaluate the effects of inorganic fertilizers at various application rates on *V.paradoxa* for optimum growth.

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