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PRELIMINARY STUDY ON THE SOIL NUTRIENT REQUIREMENTS FOR NEEM (*Azardirachta indica* A. Juss)

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ABSTRACT

Plants require 16 essential elements for optimum growth. Notwithstanding, the growth of a plant is limited by the deficiency of one out of any of these nutrients even when others are abundant. Moreover, the rate at which each species requires these nutrients differs. Neem is a tree species which requires a balance nutrition but with no established rate of requirement. Hence this experiment was carried out to investigate the effects of soil nutrient combinations on the early growth of *Azardiratchta indica* using minus one elemental technique. Seedlings of 3-4 weeks were transplanted into 2kg capacity experimental polythene pots containing washed river sand. The study was set up in a completely randomized design (CRD) with 16 treatments consisting of N, P, K, Mg, Ca, Zn and B in both deficient and excess dosage and each nutrient combinations were replicated three times. The growth variables which include plant height, stem diameter and number of leaves were assessed at two week intervals for sixteen weeks. The different nutrient combinations significantly affected the height of the plant from 2 weeks after transplanting (WAT) as the plant with nutrient combination (+N) recorded the highest plant height (14 cm) while the plant with nutrient combination (-N) recorded the least (7.5 cm). Plant with nutrient combinations (-K and –Mg) recorded significantly higher plant height values till the end of the experiment. Deficiency of Potassium in the nutrient combinations significantly increased plant stem diameter from 12 WAT while Zinc deficiency in the nutrient combinations also reduced the plant stem diameter. For best growth and yield performance of *Azadirachta indica* in the early stage as shown in this study, high potassium supply should be avoided to promote a positive interaction of potassium with other nutrient element within the soil solution.

Keywords: Minus-one element technique, Soil, *Azadiracta indica*, Nutrient

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INTRODUCTION

One of the most critical aspects of soil use and management is the maintenance of soil productivity, which is affected by soil nutrient status or soil fertility (Kyuma, 1996). Plants require 16 essential elements. Carbon, hydrogen, and oxygen are derived from the atmosphere and soil water. The remaining 13 essential elements (nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, manganese, copper, boron, molybdenum, and chlorine) are supplied either from soil minerals and soil organic matter or by organic or inorganic fertilizers. (Silva and Uchida, 2000). Knowing the nutrients required to grow plants is only one aspect of successful crop production. Soil fertility limitations can be evaluated by soil analysis, field experiments, plant tissue analysis, observations on the incidences of deficiency or toxicity symptoms, and biological test. Recently a biological method known as minus-one element technique (MOET) was developed by PhilRice (Descalsota *et al*., 1999, 2001, 2003). MOET is based on the principle that plant growth responds to the most limiting nutrients. Results of past studies (Descalsota *et al*., 1999) showed that MOET was able to identify deficiencies, which could not be checked by soil analysis.

Neem is considered as sacred species by Indian's from ancient time. It is projected as an elegant species because of its pesticidal and medicinal virtues planted in large scale by community development and social forestry department (Chandra, 2013). It is known to clean the environment of industrial and polluted area, conserve soil, augment aesthetic value, provides shelter in summer and improves physical and chemical properties of soil (Bramhachari, 2004). The leaves and seed kernel of the species is being used as major ingredient in formulations against several insects of vegetable and field crops (Bramhachari, 2004). Querejeta *et al.* (2003) identified nutrient deficiency and water stress as major limiting factors for Neem survival and growth after transplanting in tropical soils. Application of the knowledge of optimum nutrient requirement of tree species is expected to improve the economic productivity (Troch and Thompson, 1993). Hitherto there is paucity of information on soil nutrient requirement of these species compared to those of agricultural crops. In this context the study was conducted to determine nutrient requirement and record the effect of mineral deficiencies and the effect of a super abundance of a particular nutrient under nursery conditions.

METHODOLOGY

The study was carried out in a screenhouse at the Bioscience Department of Forestry Research Institute of Nigeria, (FRIN) located on the longitude 07 º 23’18”N to 07 º 23’43”N and latitude 03 º 51’20”E to 03 º 23’43”43E (FRIN, 2015). River sand was used as the supporting medium for plant. The river sand was collected and thoroughly washed with water before being sterilized for an hour and then allowed to cool down before being filled into poly-pots of 13cm X 23cm capacity. Pre-germinated seedlings in top soil were then transplanted at 4 leaves stage into the pre-filled poly pots and were watered with nutrients solution. The nutrients solutions were formulated using Minus-one technique (MOET) (Descalsota *et al.,* 2001). The nutrients used were Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Zinc and Boron. Stock solutions of each nutrient were prepared and nutrients solution used was then prepared using 1ml of stock/l of distilled water. The experiment was laid out in a completely randomized design with sixteen (16) treatments replicated three (3) times. The treatment definition/ summary of nutrients solution composition were presented in Table1.

Table1. Treatments summary of nutrient solution composition

S/NO	Treatment	KNO_3	$Ca(NO_3)_2$	$Cacl_2$	K_2SO_4	$MgSO_4$	$Mg(NO_3)_2$	NaH_2PO_4	ZnO	BO_4^-
1	Complete	✓	✓	-	-	✓	-	✓	✓	✓
2	-N	-	-	✓	✓	✓	-	✓	✓	✓
3	-P	✓	✓	-	-	✓	-	-	✓	✓
4	-K	-	✓	-	-	-	✓	✓	✓	✓
5	-Ca	✓	-	-	-	-	✓	✓	✓	✓
6	-Mg	✓	✓	-	-	-	-	✓	✓	✓
7	-Zn	✓	✓	-	-	✓	-	✓	-	✓
8	-B	✓	✓	-	-	✓	-	✓	✓	-
9	+N	✓	✓	-	-	-	✓	✓	✓	✓
10	+P	✓	✓	-	-	✓	-	✓✓	✓	✓
11	+K	✓	✓	-	✓	✓	-	✓	✓	✓
12	+Ca	✓	✓	✓	-	✓	-	✓	✓	✓
13	+Mg	✓	-	✓	-	✓	✓	✓	✓	✓
14	+Zn	✓	✓	-	-	✓	-	✓	✓✓	✓
15	+B	✓	✓	-	-	✓	-	✓	✓	✓✓
16	Control	-	-	-	-	-	-	-	-	-

The growth variables: plant height, stem diameter and number of leaves were assessed at two weeks intervals starting from two weeks after transplanting. Data collected were subjected to Analysis of Variance and Means was separated using DMRT at 5% level of probability.

RESULTS AND DISCUSSION

The results of the plant nutrient requirement investigation on Neem plant showed that different combinations of the nutrients significantly affected the plant height at successive growth stages.

At 2 weeks after transplanting (WAT), the plant height obtained from the plant supplied with +N nutrient combination recorded the highest plant height (14 cm) compared with others while the least height (7.5 cm) was observed from –N nutrient solution (Table 2). This showed that at such an early stage, the concentration of each nutrients in the plant system were adequate except for nitrogen which is required in large quantity for rapid vegetative growth (Bloom, 2015). This was revealed by the result obtained from the –N solution. Similarly, the results at 4 WAT, indicated that application of + K, -N and - Z solution significantly reduced the height of the plant (7.83 cm, 7.23 cm and 8.0 cm) respectively when compared to complete and control solution (16.37 cm and 20.03 cm) respectively (Table 2).

From 6 to 16 WAT, it was observed that in the absence of K and Mg, the plant height ranged from 24.5 cm – 29 cm and 23 cm – 30 cm respectively which were higher than others whereas, in the presence of excess dosage of K, the plant height which ranges from 6.33 cm – 6.33 cm was hampered across the weeks. This is in line with the submission of Well, (1940); that when plants get too much potassium, the absorption of other nutrients is inhibited, which leads to the symptoms caused by the deficiency of these nutrients. This effect also significantly reduced the plant leaves, stem and root dry matter yield (DMY) as shown in (figures 1, 2, and 3.) and (Table 3). At 12WAT, Zinc deficiency started showing expression on plant height (5.3 cm – 4.2 cm) till the end of the experiment.

Furthermore, nutrient combinations did not significantly affect the plant stem diameter from 2 to 6 WAT but at 8WAT, Magnesium deficiency and Potassium toxicity began to show expression (Table 4). Deficiency of Potassium in the nutrient combinations significantly increased plant stem diameter (4.23 mm – 4.87 mm) from 12WAT till the end of the experiment while Zinc deficiency in the nutrient combinations also reduced the plant stem diameter (1.05 mm – 1.13 mm) over the same period.

Similarly, the plant number of leaves were not significantly affected by the nutrient combinations from 2 to 8 WAT but from 10WAT, plant with nutrient combinations -Mg recorded a significantly higher number (50) compared to other combinations while plant with nutrient combinations +K recorded the least value (9) (Table 5). From 12WAT till the end of the experiment, plant with nutrient combinations -K recorded significantly higher plant leaves number while plant with nutrient combination +B and -Zn recorded the least values. Plant dry matter yield (DMY) of leaves, stem and root were significantly affected by nutrient combination -K which recorded the highest values (1.47g, 1.62g and 4.42g) respectively while nutrient combinations -Zn and +K recorded the least values(0.22g, 0.133g, 0.31g and 0.167g, 0.127g, 0.26g) respectively (Figures 1, 2 and 3).

CONCLUSION

The recognition of the importance of nutrient balance in crop production is an indirect reflection of the contribution of interactions to yield. The highest yields were obtained where nutrient concentrations are in a favorable state of balance for a positive interaction as shown in (Figures 1, 2 and 3). Therefore, for optimum growth and yield of Neem at nursery stage, it is recommended that nutrient sources with high potassium supply should be avoided to encourage a positive interaction of potassium with other nutrient element within the soil solution.

Table 2: Effect of Nutrient combinations on Neem Plant Height (cm)

SAMPLE	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16 WAT
B+	11.17abc	12.73abc	10.00abc	12.7abc	13.5ab	10.0ab	10.2ab	8.3b
B-	11.00abc	13.33abc	15.7abc	16.3abc	10.0ab	15.0ab	16.7ab	14.0ab
C	13.67ab	20.03a	18.3abc	25.0abc	15.3ab	20.0ab	20.0ab	18.7ab
Ca+	10.17abc	13.83abc	13.00abc	17.5abc	14.3ab	15.7ab	15.3ab	12.2ab
Ca-	10.17abc	13.60abc	18.3abc	25.2abc	20.2ab	24.7ab	26.7ab	23.5ab
CT	13.33ab	16.37abc	10.83abc	20.8abc	18.2ab	18.3ab	18.2ab	15.7ab
K+	9.00abc	7.83c	6.33c	6.0c	6.3b	6.3b	6.3ab	6.3b
K-	13.00abc	19.40ab	24.50a	28.3ab	27.5a	31.7a	27.0ab	29.0a
Mg+	11.00abc	12.77abc	12.33abc	14.3abc	12.0ab	16.3ab	15.7ab	13.0ab
Mg-	12.33abc	19.27ab	23.00ab	30.5a	23.6ab	27.7ab	30.3a	24.2ab
N+	14.00a	14.47abc	21.00abc	24.5abc	20.4ab	25.7ab	25.7ab	21.0ab
N-	7.50d	7.23c	10.33abc	13.7abc	11.7ab	16.3ab	18.3ab	13.5ab
P+	8.17bc	9.57abc	11.00abc	15.3abc	13.8ab	18.3ab	19.0ab	16.7ab
P-	8.77abc	9.20bc	14.00abc	18.3abc	13.3ab	17.0ab	18.0ab	15.0ab
Zn+	10.52abc	11.00abc	9.7bc	13.3abc	11.0ab	13.7ab	15.5ab	11.7ab
Zn-	8.000bc	8.00c	8.5bc	11.2bc	8.7b	5.3b	5.3b	4.2b

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

WAT = weeks after transplanting

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Table 3: Effect of Nutrient combinations on Neem Dry matter yield (g)

SAMPLE	Root	Leaves	Stem
B+	1.38bc	0.397bcde	0.310ab
B-	1.97abc	0.693abcde	0.523bc
C	1.62abc	0.837abcde	0.910abc
Ca+	1.00ab	0.637abcde	0.477bc
Ca-	1.89abc	1.233abc	0.893abc
CT	0.38c	0.107e	0.297ab
K+	0.26c	0.167e	0.127b
K-	4.42a	1.470a	1.617a
Mg+	1.55abc	0.610abcde	0.503bc
Mg-	3.89ab	1.173abcd	1.097ab
N+	3.28abc	1.373ab	0.853abc
N-	0.85c	0.510abcde	0.310ab
P+	1.99abc	0.950abcde	0.723bc
P-	0.85b	0.373cde	0.403ab
Zn+	1.25bc	0.560abcde	0.390ab
Zn-	0.31c	0.217de	0.133b

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

Table 4: Effect of Nutrient combinations on Neem stem diameter (mm)

SAMPLE	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16 WAT
B+	0.840abc	1.027cd	1.02a	1.05ab	1.84a	1.13b	1.14c	1.28b
B-	1.130abc	1.323abc	1.63a	1.65ab	1.22a	2.16ab	2.31abc	2.68ab
C	1.263ab	1.430abc	1.96a	1.60ab	2.80a	2.46ab	2.94abc	3.18ab
Ca+	0.903abc	1.303abc	1.73a	2.07ab	1.93a	2.01ab	2.57abc	2.49ab
Ca-	1.133abc	1.637abc	1.92a	2.12ab	5.55a	3.31ab	3.81abc	4.13ab
CT	1.367a	1.930a	2.00a	1.99ab	1.95a	2.33ab	2.65abc	2.77ab
K+	0.620d	0.627d	1.01a	0.89b	0.92a	1.24b	1.60bc	1.30b
K-	1.213ab	1.363abc	2.25a	2.30ab	2.89a	4.23a	5.22a	4.87a
Mg+	1.040abc	1.223bcd	1.24a	1.41ab	1.51a	2.10ab	2.37abc	2.43ab
Mg-	1.180ab	1.767ab	2.25a	2.67a	2.92a	3.63ab	4.45ab	4.28ab
N+	1.297ab	1.710abc	2.20a	2.37ab	2.80a	3.37ab	3.68abc	4.05ab
N-	0.740bc	1.090bcd	1.46a	1.56ab	1.78a	2.47ab	2.93abc	2.75ab
P+	1.100abc	1.353abc	1.32a	1.47ab	1.47a	2.00ab	2.55abc	2.84ab
P-	0.973abc	1.610abc	1.73a	1.85ab	1.83a	3.05ab	2.46abc	2.70ab
Zn+	0.927abc	1.177bcd	1.33a	1.48ab	1.62a	2.07ab	2.23abc	2.30ab
Zn-	0.870abc	1.140bcd	1.35a	1.38ab	1.44a	1.05b	0.97c	1.13b

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

WAT = weeks after transplanting

Table 5: Effect of Nutrient combinations on Neem number of Leaves

SAMPLE	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT	16 WAT
B+	8.00a	11.00ab	13.3a	15.0a	28.3abc	0.17e	16.3b	16.3b
B-	7.00a	13.0ab	21.3a	23.3a	15.0abc	30.0bcde	37.3ab	30.0ab
C	8.67a	20.7ab	27.0a	28.7a	20.0abc	33.3abcde	39.0ab	42.7ab
Ca+	7.00a	12.33ab	22.7a	19.3a	24.3abc	33.3abcde	34.0ab	40.3ab
Ca-	7.00a	20.33ab	27.3a	33.3a	36.3abc	58.0abcd	46.7ab	42.3ab
CT	10.67a	21.0ab	23.7a	17.3a	33.0abc	20.0de	22.3ab	28.0ab
K+	6.00a	5.00b	10.3a	11.7a	8.7c	18.7de	19.7ab	19.7b
K-	12.00a	21.7ab	31.3a	40.0a	46.0ab	74.0a	66.7a	74.7a
Mg+	7.67a	14.33ab	17.3a	36.7a	30.7abc	31.3bcde	29.0ab	32.3ab
Mg-	11.67a	26.7a	37.7a	36.7a	50.0a	64.0abc	51.7ab	57.0ab
N+	11.33a	18.0ab	36.7a	44.0a	35.7abc	72.3ab	61.7ab	61.7ab
N-	6.00a	7.67b	13.3a	23.3a	23.0abc	39.7abcde	33.0ab	32.0ab
P+	7.67a	11.0ab	17.0a	21.7a	26.0abc	43.7abcde	44.3ab	38.7ab
P-	7.67a	14.67ab	23.0a	28.0a	23.0abc	27.7cde	30.0ab	24.3b
Zn+	7.67a	11.3ab	15.0a	21.7a	22.7abc	26.0cde	26.7ab	29.3ab
Zn-	6.33a	8.33ab	11.3a	12.3a	11.3bc	13.3e	16.7b	11.7b

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

WAT = weeks after transplanting

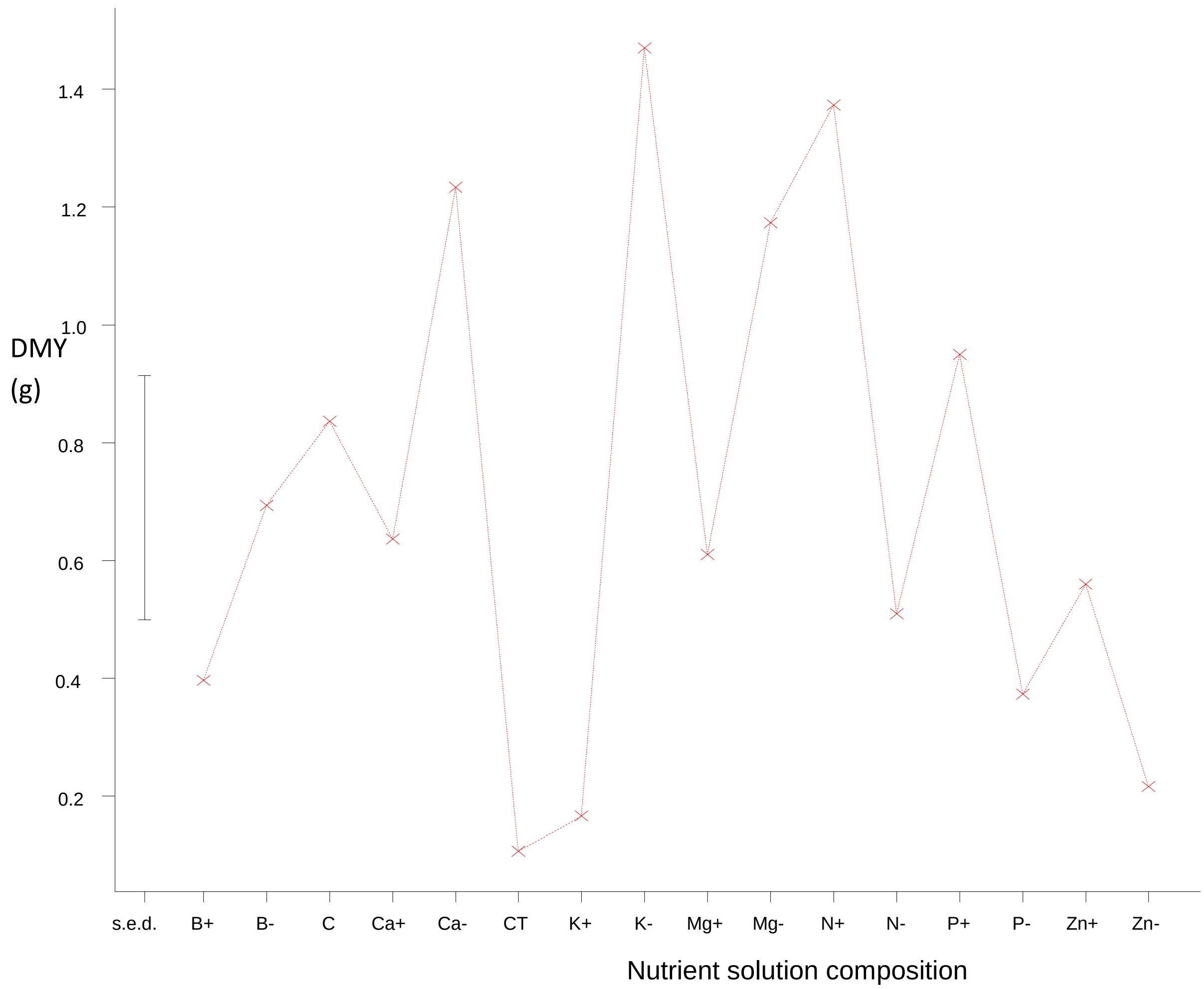

Figure 1: Effect of Nutrient solution composition on Neem leaves Dry matter yield (g)

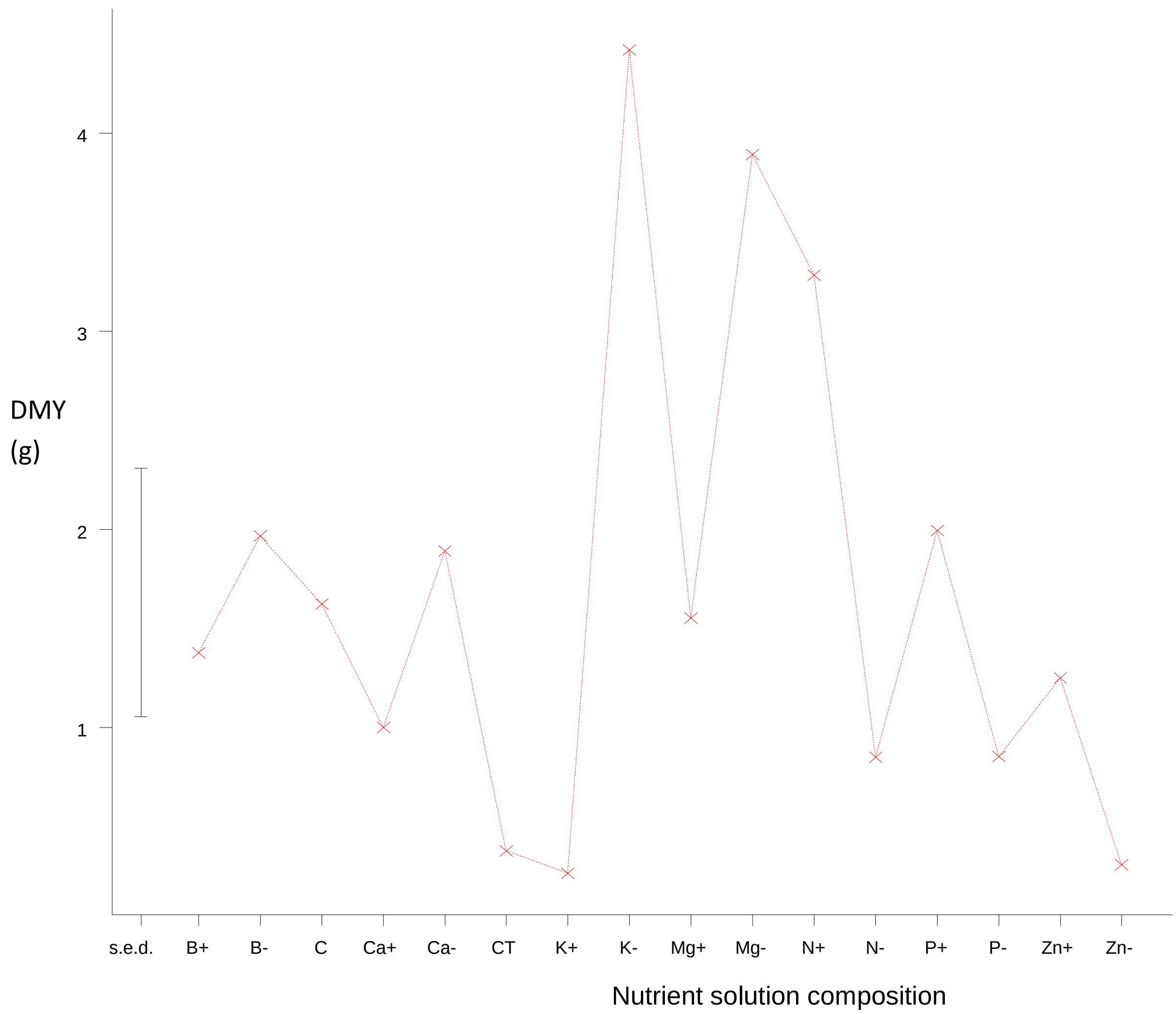

Figure 2: Effect of Nutrient solution composition on Neem root Dry matter yield (g)

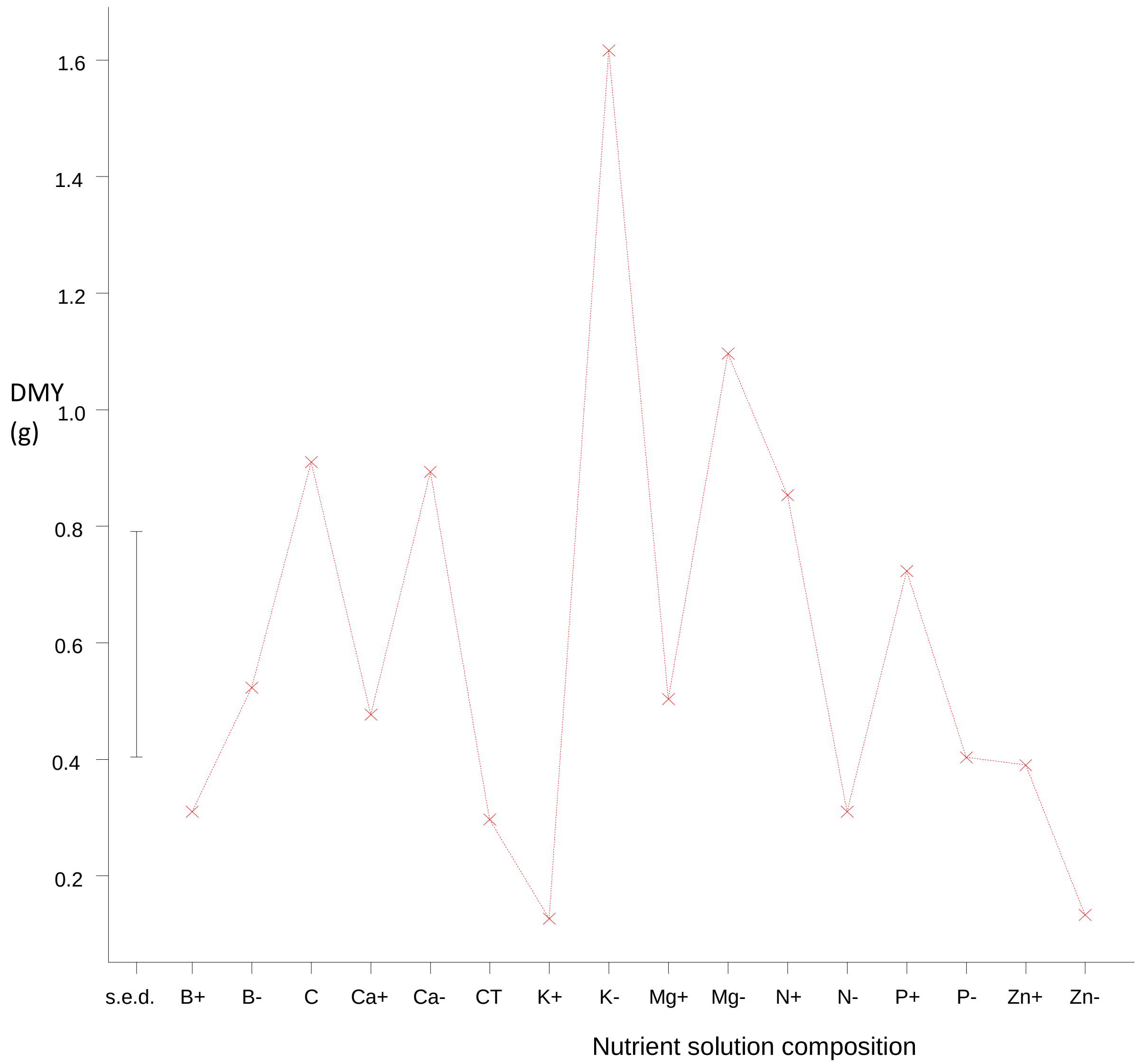

Figure 3: Effect of Nutrient solution composition on Neem stem Dry matter yield (g)

REFERENCES

Bloom, A.J. (2015). The increasing importance of distinguishing among plant nitrogen sources. Current opinion in plant biology, 25: 10-16.

Bramhachari G. (2004). Neem: An omnipotent plant: A retrospection. *Chemical Biochemistry*, 5 (1), 408-421.

Chandra K. K. (2013). Seedling quality, biomass promotion and nutrient uptake potential of AMF, Azotobacter and Pseudomonas in *Azadiracta indica* under nursery condition. *Journal of Biodiversity and Environmental Sciences* (JBES) ISSN: 2220-6663

Descalsota J.P., Mamaril C.P. and Valentin G.O. (1999). Evaluation of the soil fertility status of some rice soils in the Philippines. Paper presented at the 2nd annual meeting and symposium of the Philippine Society of Soil Science and Technology Inc, Benguet State University, La Trinidad, Benguet, May 20-21

Descalsota J.P., Mamaril C.P. and Valentin G.O., Ayo A.L., Corton T.M., and Obien S.R. (2001). Minus-one element technique of diagnosing nutrient limitation and balancing fertilizer application in lowland rice soils. Paper presented in 14th National Rice Research and Development Conference, PhilRice, Maligaya, Muñoz, Nueva Ecija, March 7-9

Descalsota J.P., Mamaril C.P. and Valentin G.O. (2003). Fertility status of rice soils in the Philippines. *Philippine Journal of Crop Science* 28(2): 45-57

FRIN (2015). Environmental Modeling and Management Department. Forestry Research Institute of Nigeria, Annual Meteorological Report.

Kyuma K. (1996). Ecological sustainability of paddy soil-rice system in Asia. In Appropriate Use of Fertilizers In Asia And The Pacific,A Saleem (ed), Proceedings of the APO-FFTC Seminar on Appropriate Use of Fertilizers, held in Taiwan, pp 128-142

Querejeta J.I., Barea J.M., Allen M.F., Caravac F. and Roldan A. **(**2003). Differential response of a C13 and water use efficiency to arbuscular mycorrhizal infection in two arid land woody plant species. *Oecology* 135, 510-515

Silva J. A. and Uchida R., (2000). Plant Nutrient Management in Hawaii's Soils, Approaches for Tropical and Subtropical Agriculture, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa

Troch F.R. and Thompson L.M. (1993). Soil and Soil Fertility. Oxford University Press, New York.

Well M.E. (1940). The Role of Potassium in Plants. *Soil Science*, 49, 393 - 408.