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EVALUATION OF NPK FERTILIZER FORMULATIONS ON THE GROWTH AND DRY MATTER YIELD OF COFFEE SEEDLINGS

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ABSTRACT

A greenhouse study was carried out at Cocoa Research Institute of Nigeria, Ibadan to evaluate the effect of NPK fertilizer formulations on the growth and dry matter yield of coffee seedlings. The treatments consisted of NUTRICO-1 (NPK-liquid fertilizer) applied at rate 5 and 10 ml/15L water) and NPK- solid fertilizer 15:15:15 applied at 1, 3 and 5g/coffee seedling and a control. Data on growth of coffee seedlings were taken for six months. All the fertilizers irrespective of rates and types of NPK formulations enhanced the growth parameters. The effect of NUTRICO-1 was comparable to NPK on height and stem diameter of seedlings. NPK-solid fertilizer increased the height of coffee seedlings at 6 months after transplanting (MAT) by 19 % compared to NUTRICO-1. The effect of NUTRICO-1 was comparable to NPK-solid 15: 15: 15 on the growth of coffee seedlings. The positive influence of NPK fertilizer formulations on the growth of coffee seedlings particularly NUTRICO-1 is a pointer that there is need to explore alternative fertilizer formulations that will combine efficiency with cost effectiveness and ease of application in the production of coffee and other fruit trees.

Keywords: NPK fertilizer, coffee seedlings, dry matter, nutrient uptake

INTRODUCTION

Coffee is an important export crop traded globally and is a major foreign exchange earner for Brazil, Colombia, Cote d'Ivoire, Indonesia, Mexico, Costa Rica, Ugandan, Kenya, Ethiopia and Kenya (Montagnon *et al*., 1998). Consuming countries are in Asia, Europe and America. In Nigeria, Robusta coffee (*Coffea canephora* Pierrie ex. Froehner) constitutes up to 96 %, while Arabica (*Coffea arabica* Linus) is less than 4 % (Omolaja, 2009). The two commercial species are cultivated in thirteen states namely: Taraba, Plateau, Adamawa, Cross River, Ondo, Ekiti, Osun, Ogun, Oyo, Edo, Abia, Delta and Kogi. *Coffee* was a means of livelihood for more than 2, 800,000 farmers between 1960s and the 1980s in Nigeria. Production in Nigeria declined due largely to old age of plantations, poor yield resulting from poor planting materials, pests and disease attack. Currently, the coffee market is improving. In order to take advantage of this positive trend, there is need to assist the coffee farmers to increase yield through efficient production methods

particularly the use of inorganic fertilizers such as NPK fertilizers to boost its production. Most soils upon which coffee is grown are generally poor in nutrients such as nitrogen, phosphorus and potassium (Ibiremo *et al*., 2011b). In Nigeria, different NPK formulations (liquid and solid) are seen in the markets and they are being utilized by farmers for both arable and some tree crops production. Liquid fertilizers are mostly foliar fertilizers that contain high purity NPK and trace elements. They are quick and effective by spraying on leaves and dissolve in water. Countries like China, Vietnam and Indonesia have found liquid fertilizers very helpful in increasing crop productivity particularly tree crops. This study evaluated the effect of NPK fertilizer formulations on the growth and dry matter accumulation of coffee seedlings.

MATERIALS AND METHODS

The study was carried at Cocoa Research Institute of Nigeria, Ibadan (Lat.7^0 25^1 N, Long. 3^0 25^1 E) during the 2010 seedling production season to evaluate the effect of NPK fertilizer formulations on the growth and dry matter yield of coffee seedlings. The soil of Ibadan used for the study has been classified as Ferric Luvisols (FAO, 1990) and Ibadan series (Smyth and Montgomery, 1962) lying on 122 m above sea level. Top soil (0-30 cm depth) was collected within the coffee plantations at Ibadan and was air-dried and sieved using 2 mm sieve. The sieved soil was mixed with gutter sand at 50:50 ratio and placed in five kilogrammes plastic buckets and watered to field capacity. The treatments consisted of NPK-liquid fertilizer (NUTRICO-1 20:2:4 + TE) applied at rate 5 and 10 mls/15L water and NPK-solid fertilizer 15:15:15 applied at 1, 3 and 5g/coffee seedling and a control (no fertilizer application). The treatments were applied to two months old-coffee seedlings (two-leaf stage) in the greenhouse. The coffee seedlings that received NUTRICO-1 fertilizer treatments were sprayed with the fertilizer dissolved in water and allowed to run freely while the solid NPK fertilizer was applied in a ring form at the base of each seedling. The six treatments were replicated three times in a Completely Randomized Design (CRD) and data on growth of coffee were taken for six months. Watering was done regularly thrice a week. Agronomic data were collected on height (measured from the seedling base to the tip), stem diameter (1 cm above cotyledon), number of leaves and leaf area (Area = length x width x 0.6) (Gonthier *et al*., 2011). The accumulation of leaves and stem diameter was compared by subtracting initial from final total number of leaves and stem diameter respectively. At the end of the experiment, destructive sampling was done and plant materials were separated into leaf, stem and root and soil samples collected from each pot for chemical analysis. The fresh plant samples were oven-dried at 72^0C to a constant weight for the dry matter yield to be obtained. Soil samples collected within the coffee plantations were analyzed for both physical and chemical properties using the methods described in International Institute of Tropical Agriculture Manual (IITA, 1982). Analysis of variance was performed on all data to test the treatment effect on different parameters measured using a SAS analytical package of 9.20 version. Standard Error ($p<0.05$) was used to separate the means.

RESULTS AND DISCUSSION

The test soil had the value of sand, silt and clay fractions to be respectively 892, 143 and 165 g/kg soil (Table 1). The clay + silt content was sufficient to hold enough water for sustainable coffee plant growth and to guard against short duration drought (Ipinmoroti *et al.*, 2009). The pH of the sandy loam soil was adequate for coffee production. The soil is marginal in terms of nutrient compositions particularly N, P and K (Cambrony, 1992., Wrigley, 1988). The effect of NUTRICO-1 applied at 5ml/15L of water was comparable to NPK (15: 15: 15) on height and stem

diameter of coffee seedlings. Application of NUTRICO-1 at 5mls/15L of water and NPK 15-15-15 applied at 5g/plant significantly ($p<0.05$) enhanced the height and stem diameter of coffee seedlings at 2 to 6 MAT relative to the control and the other application rates (Table 2). However, application of NUTRICO-1 at 10mls/15L of water seemed to depress the height and stem diameter of coffee at 2 to 6 MAT compared to the control. Although the manufacturer's recommendation was 10mls/15 L of water for adult plants in the field particularly for cocoa and other fruit trees, this recommendation might be excessive for seedlings by causing the depression in the growth of coffee seedlings. Similarly, the application of NPK 15 – 15- 15 at 1 and 3 g/plant progressively depressed the height and stem diameter of coffee seedlings. The lower dosages of solid NPK fertilizer (15-15-15) seemed to depress the height and stem diameter of coffee seedlings. This might be due to the fact that some of the soil applied nutrients were immobilized by soil micro-fauna, soil organic matter and other edaphic factors thereby making them unavailable to the seedlings. This observation is consistent with the earlier findings of Ibiremo *et al*. (2011a) in which NPK fertilizer imposed depression on the growth parameters of cocoa in the field. The improvement on the height and stem diameter of coffee seedlings as a result of NUTRICO-1 applied at 5mls in 15 litres of water may be as a result of direct application to the leaves and stem and better absorption of the nutrients through the leaves rather than through the roots. NPK-solid fertilizer increased the height of coffee seedlings at 6 months after transplanting (MAT) by 19 % compared to NUTRICO-1. The height of coffee seedlings at 6 MAT ranged for 34.17 cm in 10mls/15 of H_2O to 54.33 cm NPK-solid fertilizer at 5g/seedling. The effect of NPK (15-15-15) fertilizer applied at 3 and 5g/plant was significantly ($p<0.05$) higher on the number of leaves and leaf area of coffee seedlings compared with the control and NUTRICO-1 applied at both rates of 5 and 10 mls/15 L of water. Similarly, the influence of NPK liquid fertilizer applied at 5 mls/15L of water was significantly ($p<0.05$) higher on the leaf area of coffee seedlings at 2 to 6 MAT. However, the influence of liquid fertilizer applied 5 and 10 mls/15 L of water was not significant on the number of leaves of coffee seedlings. Similarly, the effect of NPK-liquid fertilizer applied at 10 mls/15L of water was not significant on the leaf area of coffee seedlings at 2 to 6 MAT. The number of leaves ranged from 20 to 26 per plant in 5 mls/15L of water and 5g NPK-solid/plant respectively while the leaf area ranged from 124 to 208.85 cm^2 in 5 mls/15L of water and 5g NPK - solid/plant respectively. The effect of NUTRICO-1 applied at 5mls/15L of water and NPK 15-15-15 applied at 5g/plant significantly ($p<0.05$) enhanced the root, stem and leaf dry matter yield of coffee seedlings at 6MAT relative to the control and the other application rates (Table 4). However, the shoot: root ratio was not significantly affected by NPK fertilizer formulations. The shoot: root ratio ranged from 2.53 to 3.11. This implies that the NPK fertilizer formulations did not distort the proportion of shoot to the root in all the various fertilizer treatments. Conversely, the influence of NUTRICO-1 applied at 5 and 10mls in 15 L of water both enhanced the root length of coffee seedlings significantly ($p< 0.05$) compared to the control and NPK 15-15-15 solid fertilizer. The superior performance of NUTRICO-1 on some of the growth attributes of coffee seedlings could be attributable to the presence of some trace elements in it as claimed by the manufacturer. The positive influence of NPK fertilizer formulations on the growth of coffee seedlings particularly NPK liquid fertilizer is a pointer that there is need to explore alternative fertilizer formulations that will combine efficiency with cost effectiveness and ease of application in the production of coffee and other fruit trees.

Table 1: Some Physical and Chemical Characteristics of Ibadan soil

Soil Properties	**Ibadan Value**
Physical Properties	
Sand g/kg	892.00
Silt g/kg	143.00
Clay g/kg	165.00
Texture	Sandy clayey laom
Chemical properties	
pH (H_2O)	6.50
Organic Carbon g/kg	9.80
Total N g/kg	2.00
Avaiblae P mg/kg	8.00
Exchangeable cations	0.50
K cmol/kg	10.00
Ca cmol/kg	2.00
Mg cmol/kg	2.00

Table 2: Height and Stem diameter of coffee seedlings as influenced by NPK fertilizer formulations

Treatment	Height of coffee seedlings (cm)					Stem diameter of coffee seedlings (cm)				
	2	3	4	5	6	2	3	4	5	6
Control	13.53	19.97	28.28	38.43	47.13	0.28	0.29	0.40	0.43	0.60
5mls NPK (L)	14.13	23.17	30.73	45.93	51.76	0.28	0.31	0.46	0.59	0.74
10mls NPK (L)	13.54	18.47	29.80	39.63	34.17	0.28	0.31	0.35	0.48	0.58
1g NPK (S)	13.37	18.52	26.34	36.60	50.53	0.28	0.28	0.40	0.47	0.61
3g NPK (S)	14.67	17.63	26.11	38.07	48.80	0.27	0.30	0.42	0.51	0.57
5g NPK (S)	14.13	20.50	31.39	43.27	54.33	0.29	0.32	0.42	0.50	0.67
SE (0.05)	0.27	1.05	1.21	1.40	1.34	0.00	0.01	0.01	0.01	0.0
CV (%)	3.60	10.15	7.78	8.81	14.89	5.69	2.26	4.91	8.78	10.31

NPK (L) -NUTRICO-1 (NPK 20-2-4+TE liquid fertilizer), NPK (S) - NPK 15-15-15 fertilizer

Table 3: Number of Leaves and Leaf Area of coffee seedlings as influenced by NPK fertilizer formulations

Treatment	**Number of Leaves of coffee seedlings**					**Leaf Area of coffee seedlings (cm^2)**				
	2	**3**	**4**	**5**	**6**	**2**	**3**	**4**	**5**	**6**
Control	10.00	13.87	15.56	17.87	22.63	48.51	101.93	162.94	182.80	168.80
5mls NPKL	9.87	13.90	16.78	13.10	20.53	65.65	136.95	189.83	206.10	124.93
10mlsNPK-L	9.67	12.77	16.00	19.00	21.23	41.87	91.57	188.59	178.07	I83.00
1g NPK-S	8.77	13.67	13.78	17.07	21.00	49.16	87.23	163.77	194.37	185.63
3g NPK –S	10.10	12.43	14.89	17.67	25.33	51.39	90.96	151.25	211.87	208.00
5g NPK –S	10.57	13.53	16.44	22.37	26.47	66.52	122.12	191.90	231.51	208.85
SE (0.05)	0.19	0.31	0.42	0.62	1.01	3.02	9.67	7.54	9.22	6.57
CV (%)	6.10	4.64	7.06	16.81	10.85	18.57	19.10	10.00	9.90	8.53

NPK (L) -NUTRICO-1 (NPK 20-2-4+TE liquid fertilizer), NPK (S) - NPK 15-15-15 fertilizer

Table 4: Root length and dry matter yield of coffee seedlings as influenced by NPK fertilizer formulations

Treatment	Root Dry matter (g/pot)	Stem Dry matter (g/pot)	Leaf Dry matter (g/pot)	Shoot: Root Ratio	Root Length (cm)
Control	3.07	3.15	6.41	3.11	37.91
5mls NPK (L)	4.75	4.74	7.27	2.53	44.89
10mlsNPK (L)	2.98	3.08	6.13	3.09	50.35
1g NPK (S)	3.20	3.13	6.64	3.06	36.86
3g NPK (S)	2.86	3.20	7.44	3.72	35.06
5g NPK (S)	4.26	4.25	9.02	3.06	36.92
SE (0.05)	0.32	0.29	0.40	1.27	2.44
CV (%)	22.44	20.06	13.85	12.26	14.83

NPK (L) -NUTRICO-1 (NPK 20-2-4+TE liquid fertilizer), NPK (S) - NPK 15-15-15 fertilizer

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