Research Article

Vegetative Growth Performance of Oil Palm (*Elaeis guineensis*) Seedlings in Response to Inorganic and organic fertilizers

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ABSTRACT:

In this study, the effect of agricultural waste on growth of oil palm seedlings was conducted at the NIFOR main nursery, Benin City, Nigeria using three agricultural wastes (EFB(empty fruit bunches) ash, poultry manure and cow dung). The experiment consists of four treatments namely; EFB ash, poultry manure, cow dung and NPK Mg 12-12-17-2 each applied at the rate of 3.36g N/seedling and a control without treatment. The Experiment was laid down as Randomized Complete Block Design replicated three times. The physico-chemical properties of the nursery soil was analyzed prior to the trial and the result showed mean amount of 0.20% C, 6.55 mg/kg P, 0.17% N, 2.64cmol/kg CEC. The soil was slightly acidic with pH 5.60. Palm circumference (girth) was highest in plot treated with NPK Mg while plant height was highest in plots treated with cow dung and EFB ash; leaf area, leaf number and chlorophyll contents were highest in EFB ash while nitrogen content was highest in palm treated with NPK Mg. Statistical analysis showed significant difference in height and girth of seedlings. Performance of oil palm seedlings on soil amended with agricultural wastes which is cheaper and easily available is comparable to oil palm seedlings grown on soil amended with inorganic fertilizer.

Keywords: Cow dung, Chlorophyll, Poultry manure, EFB ash, Oil palm

INTRODUCTION

The loss of nutrient through surface erosion and runoff has resulted in the use of fertilizer (organic and inorganic) in supplementing poor indigenous soil nutrient supply in oil palm cultivation. The nutrient requirements of the oil palm is large, vary widely and depend on the target yield, the type of planting material used, palm spacing, palm age, soil type, groundcover conditions, climate and other environmental factors.

Mineral nutrients are inorganic elements that have essential and specific functions in plant metabolism which results in normal plant growth and crop production (Mengel and Kirkby, 1987). Numerous studies have revealed the functions of mineral nutrients in metabolic processes as constituents of organic structures, activators of enzyme reactions, charge carriers and osmoregulators (Kogbe and Adediran, 2003; Goh and Hardter, 2005). Young nursery palms contain about 1.4% N (Mohamed, *et al*., 2008; Ng, *et al*., 1968). Nitrogen application to young palms increases leaf area, improves leaf production and the net assimilation rate thus resulting in increased biomass production (Corley and Mok, 1972; Breure, 1982). Hence an adequate supply of N is very important during the first five years after planting (Goh and Hardter, 2005).

Organic farming is one of the fastest growing sectors of agriculture worldwide. The regulation of nutrient regime in organic farming is achieved through balanced crop rotations and application of organic fertilizers such as compost, green manure and animal wastes (Karanatsidis and Berova, 2009; Brady and Well, 1999; Meludu, 2005; Odiete, *et al*., 2005). In the oil palm plantation, nutrients removed in the harvested crop are replaced by recycling crop residues such as empty fruit bunches (EFB) and palm oil mill effluent (POME). EFB ash with a high K content can be use as fertilizer to substitute for KCl at a rate of 2:1. The EFB ash is strongly alkaline and has an ameliorative effect on very acid soils by increasing pH on soil microbiological activity and thus enhancing the release of N from soil organic matter. EFB ash is very hygroscopic and can be use as source of P, K, Mg and Ca in oil palm cultivation (Lim, 2000).

Cow dung fertilizer is important in helping to improve the structure of the soil (aggregation). Animal manure has been used for centuries as a fertilizer in farming, improving the soil structure so that it holds more nutrients and water and becomes more fertile. Animal manure also encourages soil microbial activity which promotes the soil's trace mineral supply, improving plant nutrition. It also contains nitrogen and other nutrients which assist the growth of plants.

The objective of this research was to investigate the effectiveness of cow dung, poultry manure and EFB ash as manure for a sustainable improved oil palm production.

MATERIALS AND METHODS

The nursery experiment was conducted at the Nigerian Institute for Oil Palm Research (NIFOR), Benin City during the growing season of 2010/2011. The soil physico-chemical characteristics are given in Table 1. The trials consisted of treatments namely; EFB ash, poultry dung, cow dung and NPK Mg 12-12-17-2. Treatments dose applied at a single dose of 3.36g N/seedling. The trial was laid down as a randomized complete block design (RCBD) replicated three times. Plastic spade was used to collect soil from 0 -15cm depth into NIFOR standard polyethylene bags of 400-500 gauge. Oil palm seedlets from pre-nursery were transplanted to the main nursery bags. NIFOR hybrid tenera seedlets was planted one per bag. The fertilizers were applied three weeks after transplanting to main nursery bags in a ring at 10 cm from the oil palm plant. Watering of seedling was done before seedlets were transplanted and this continued throughout the experimental period. Biometric observation; girth (cm), height (cm) and leaf area (cm^3) were taken. Four seedlings were measured from each plot per treatments per replicates three months after transplanting. Fully expanded leaf samples were used to determine total chlorophyll content according to Harborne (1973) by using spectrophotometer (Hach DR 2010). Immature and well developed oil palm seedlings from each treatment were harvested. Fully expanded leaves were selected for tissue nitrogen content analysis (Tandon, 1995). Leaves samples were oven dried at 60°C for 72 h to the constant weight and grounded to reduce the material to a fineness suitable size by using a mechanical grinder. The samples were stored in airtight plastic containers for chemical analysis. Total nitrogen was determined by digesting 0.2 g dry leaf samples with 98% H_2SO_4 and selenium catalyst in Kjeldahl digestion unit until sample became colourless. Nitrogen content was then determined colorimetrically using Hach spectrophotometer (IITA, 1982). Analysis of variance was performed on data obtained.

Results and discussion

Soil physico-chemical properties

The pretreated soil analysis as shown in Table 1 indicated the soil to be sandy loam with a composition of 79.20% sand, 13.10% clay and 7.70% silt while the chemical properties indicated that the nursery soil is moderately acidic with pH 5.60. The result also showed that phosphorus (6.55mg/kg), total nitrogen (0.17%), organic matter (0.35%) and potassium (0.25cmol/kg) contents were low.

Table 1: Physico-chemical characteristics of soil

pH	5.60 ± 0.01
Sand (%)	79.20 ± 0.02
Clay (%)	13.10 ± 0.20
Silt (%)	7.70 ± 0.10
C (%)	0.20 ± 0.02
OM%	0.35 ± 0.02
N (%)	0.17 ± 0.04
P (mg/kg)	6.55 ± 0.10
Ca (cmol/kg)	1.40 ± 0.20
Mg (cmol/kg)	0.84 ± 0.10
Na (cmol/kg)	0.15 ± 0.00
K (cmol/kg)	0.25 ± 0.00
CEC (cmol/kg)	2.64 ± 0.14

Nutrient composition of organic fertilizers

The nutrient contents of the organic fertilizers used for this study are presented in Table 2. The results of the chemical analysis showed that the EFB ash had the highest amount of P, K Mg and Ca while poultry dung had the highest amount of N (Table 2). Earlier works reported similar findings of significantly high amount of P, K, Mg and Ca in EFB ash (Konsomboon, *et al*., 2011; Lim, 2000).

Effect of treatment in oil palm truck parameters

The effects of applied organic and inorganic fertilizers on growth of the oil palm seedling are given in Table 3. On comparing biometric observation results obtained for the organic fertilizer with the result for the inorganic fertilizer, it was observed that the organic fertilizer effected vegetative growth of the oil palm seedling more than the inorganic fertilizer. Statistical analysis conducted showed significant difference in biometric observation results.

Table 2: Nutrient status of organic fertilizer

	Cow dung	Poultry manure	EFB ash
N (%)	0.39 ± 0.01	0.44 ± 0.01	0.30 ± 0.10
P (%)	0.76 ± 0.01	0.43 ± 0.00	1.56 ± 0.40
K (%)	0.13 ± 0.00	0.49 ± 0.01	4.60 ± 0.90
Ca (%)	2.27 ± 0.10	1.44 ± 0.28	6.90 ± 1.10
Mg (%)	0.52 ± 0.00	0.06 ± 0.02	1.15 ± 0.60

The highest number of leaves, palm height and leaf area were obtained in the application of EFB ash. This effect may be due to the availability of nutrients and could be due to the improvement of soil water holding capacity as stated by Roe and Comforth (2000). Also, it is pertinent to note that organic manure activates many species of living organisms, which release phyto-hormones and may stimulates the plant growth and absorption of nutrients (Arisha, *et al*., 2003).

The highest girth of oil palm seedling was obtained by the application of inorganic fertilizer (NPK Mg) and cow dung. The positive effect of the inorganic fertilizer on the girth may be due to the better availability of soil nutrients while the positive effect of organic fertilizers on the girth may be due to improvement of soil chemical and physical properties (Arisha, *et al*., 2003).

Table 3: Effect of organic and inorganic fertilizers on growth of oil palm seedlings

	Leaf no	Girth	Height	Leaf Area
Control	3.50 ± 0.70	3.00 ± 0.00	14.00 ± 0.71	33.95 ± 0.99
NPK Mg	4.50 ± 0.70	3.50 ± 0.210	17.25 ± 2.90	42.98 ± 7.11
Cow dung	4.00 ± 0.00	3.50 ± 0.00	19.50 ± 1.34	52.35 ± 4.03
Poultry manure	4.00 ± 0.00	3.10 ± 0.70	19.25 ± 0.71	59.20 ± 11.31
EFB ASH	5.00 ± 0.00	3.35 ± 0.70	19.50 ± 1.41	71.85 ±9.22

The application of EFB ash induced the highest leaf chlorophyll content while the lowest chlorophyll content was induced by cow dung in soil amended with fertilizers (organic and inorganic) although chlorophyll content for fertilizer amended soils were higher than the content for the control. A promotion effect of organic fertilizers on chlorophyll contents might be attributed to the fact that N and Mg are constituents of chlorophyll molecule.

The leaf nitrogen content was highest by the application of NPK Mg while the lowest amount was obtained by cow dung in the amended samples although leaf nitrogen content of plants on amended soils were higher than on control soil. The high values of leaf N contents in soil amended with organic manure could be attributed to its ability to supply nutrients throughout mineralization and improvement of the physical and chemical properties of the soil and the ability of organic fertilizer to release nutrients gradually throughout the growing season.

Table 4: Chlorophyll and nitrogen content

	N (%)	Chlorophyll content (ppm)
Control	0.37 ± 0.30	21.90 ± 1.00
NPK Mg	0.87 ± 0.10	33.59 ± 1.00
CD	0.72 ± 0.14	23.44 ± 0.60
PD	0.86 ± 0.18	30.51 ± 1.30
EFB ASH	0.79 ± 0.20	34.57 ± 1.30

Conclusion

This study revealed that oil palm seedlings can grow well on soil amended with organic fertilizer as oil palm seedlings grown on organic fertilizer amended soil showed vigorous vegetative growth, high chlorophyll and nitrogen content. Furthermore oil palm seedlings grown on organic amended soil are expected to be healthy as inorganic fertilizer contains metal impurities and may be more profitable than use of inorganic fertilizer which is costly and not readily available. Further studies are needed to determine optimal rates of organic fertilizer for proper growth of oil palm seedlings

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