

Fertilizer Effect on Soil, Oil Palm (*Elaeis guineensis*) Seedling Growth and Leaf Nutrient Content in Directly Sown Nursery

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Abstract – Oil Palm (*Elaeis guineensis*) requires adequate care and nourishment in the nursery stage for field optimal performance. This experiment was carried out to examine the effect of fertilizer treatments on soil, Oil palm (*Elaeis guineensis*) seedling growth, biomass and leaf nutrient content in the directly sown nursery. The fertilizer treatment comprised of Sunshine Organic and Organomineral, poultry manure and cow dung. Oil palm sprouted nuts were planted in black polybags (40 cm by 40 cm in size with lower half of each bag perforated with three rows of hole 5 cm apart and 3-4 mm in diameter) filled with 20 kg of topsoil. A sample of the topsoil was collected for chemical analysis. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replicates. Each plot was made up of sixteen polybags. Fertilizer treatment application was carried out at eight weeks after planting using ring method. Growth parameters (leave number, stem girth and plant height) were collected at 2, 4, 6, 8 and 12 weeks after treatment application. Data were collected on the plant total, root and stem biomass. Five soil samples were collected from each plot for the determination of pH, OC, OM, Available P, Exch K, Na, Mg, Ca and Mg, Exchange acidity and Base Saturation (%). Leaf nutrient analysis was carried out to determine N, P, K, Na, Ca and Mg. Initial top-soil analysis revealed OC, OM, N, P and Mg below critical level for crop production. In the final soil analysis, 200kg ha⁻¹ SOMF (organomineral) gave significant ($P<0.05$) and highest pH, OC, OM, N, P, K and Mg. 200kg ha⁻¹ NPK gave high N, P, K compared to sole organic fertilizers while sole organic fertilizers gave corresponding high OM. The percent (%) increase in leaf number adduced to 200kg ha⁻¹ SOMF (organomineral) over the control, NPK, SOF, CD and PM were 26, 6, 5, 8 and 3%, that of stem girth were 27, 17, 19, 14, 20 and that of plant height 12, 4, 5, 10 and 6 respectively. 200kg ha⁻¹ SOMF gave the highest leaf N and K. 6 t ha⁻¹ SOF gave the highest P and Mg and 6 t ha⁻¹ CD gave the highest Ca and Mg.

Keywords – Oil Palm Seedling, Nursery, Potting Medium, Polyethylene Bag, Growth Parameters, Leaf Nutrient.

I. INTRODUCTION

Oil palm belongs to the warm tropical rain forest area; it could tolerate a fair range of pH, although neutral soils are most favorable [1]. It is used in commercial agriculture for the production of oils. The oil are used domestically for cooking and industrially for manufacturing of soap, margarine, detergent, candle, oil paint and polish etc. it's by-product such as bunch refuses are used as fuel especially in pioneer oil mills.

The 6.0 t ha⁻¹ average yield of oil palm in Nigeria [2] is far below Malaysia 10.6 t ha⁻¹. The difference is attributed to poor soil nutrient management leading to high reduction in potential yield of crop plant. The main contribution of organic and organo-mineral fertilizer to soil fertility restoration is the supply of nutrient and protection of soil from both physical and chemical degradation. Effort to increase soil nutrient status through the use of sole inorganic fertilizer is accompanied by high price, nutrient imbalance and soil acidity.

The type of care that oil palm seedlings require during the early period of growth is better provided in the nursery. Nursery is necessary for growing sprouted seeds to produce strong, healthy and viable seedlings for field/plantation establishment. Polybag seedlings establish much better after transplanting to the field [3]. Direct sowing of nurseries skips prenursery stage. Germinated seed are transferred directly into large bags. Efforts aimed at obtaining high yield of oil palm therefore warrant augmentation of the nutrient status of soils used in filling polybags at the nursery stage, this is achievable through organic and inorganic fertilization.

The generation of livestock waste is enormous in Nigeria [4], most of which have potential for use in the maintenance of soil fertility. Organic manure supplies organic matter and nutrients required by plant in limited quantities, it improves soil structure and stimulates the biological processes in the soil that help to build fertility [5-7]. Sunshine organomineral combined both chemical and organic fertilizer, such combinations lower P fixation and enhance P mobility [8]. This study therefore examines the effect of organic, inorganic and organomineral on oil palm in direct sown nursery.

II. MATERIALS AND METHODS

Description of the Experimental Site

The experiment was conducted at the nursery section of Daisi Oluyi Agro Allied Farm, located at Ala Ajabusi via Ilu dada at Akure north local government, Ondo State, Nigeria. The climate of the area is humid tropical, bimodal and marked by alternating wet and dry seasons. Annual rainfall ranges between 1200 – 1500 mm and annual temperature is between 21 and 32°C. Mean relative humidity is generally high (about 80%), reaching the peak between May and October.

Site Preparation and Procurement of Materials

The site was cleared manually and the debris packed and the land leveled. 5m X 5m land area was fenced round with bamboo and wire mesh to prevent the attack of rodents. Oil palm sprouted nuts were procured from the Nigerian institute for oil palm research (NIFOR), Benin. Black polybags (40 cm by 40 cm in size with lower half of each bag perforated with three rows of hole 5 cm apart and 3-4 mm in diameter) and insecticide were purchased from LETS Farm Agro Chemical Shop in Akure and Organomineral and Organic fertilizer procured from Ondo State Sunshine Fertilizer Company. Poultry manure and cow dung's was collected from the livestock unit of the Federal University of Technology, Akure.

Filling of Polythene Bags with Potting Soil

Each of the polybags was filled with 20 kg topsoil collected from Daisi Oluyi Agro Allied Farm, Akure and was arranged on polythene sheet to prevent red ants termites attacked. The bags and the surroundings were sprayed with insecticide (karat) twice before planting of the sprouted nuts. Oil palm sprouted nuts were dipped into a diluted insecticide solution and immediately removed for planting so as to prevent pest and diseases infestation.

Cultural Operations

Seedlings were maintained by watering. Light weeding (hand pulling) was carried out as soon as weed was noticed to prevent competition for water and nutrients, while those in the site surrounding was manually cleared with hoe and cutlass twice every month.

Experimental Design and Treatment Application

The experiment was laid out in Randomized Complete Block Design (RCBD), with three replicates. Each replicates consists of five fertilizer treatments and a control namely; (1) 200 kg ha⁻¹ NPK 15:15:15 (2) 150 kg ha⁻¹ Sunshine Organomineral fertilizer (3) 6 ton ha⁻¹ poultry manure (4) 6 ton ha⁻¹ cow dung (5) 6 ton ha⁻¹ organic fertilizer and (6) Control (No fertilizer treatment). Each plot was made up of sixteen potted plant in polyethylene bag. Fertilizer treatment application was carried out eight (8) weeks after planting using ring method. Sampling was carried out on five representative polybags in each plot.

Soil Analysis

Sample of the topsoil was collected for chemical analysis. Soil samples were also taken from five representative polybags in each plot at the end of the experiment for chemical analysis. The soils were air dried and passed through 2mm sieve. Soil pH was determined in 1:2 (soil:water) ratio with reference/glass electrode. Soil Organic Carbon (SOC) was estimated using Black/Walkley procedure [9] and soil organic nitrogen quantified by Kjeldahl digestion procedure [10]. Available P was determined by Bray and Kurtz P-1 method [11].

Exchangeable Bases (Ca, Mg, Na and K) were extracted by leaching with 1N NH₄OAC (pH 7.0). Ca and Mg were determined by atomic absorption spectrophotometer and Na and K by flame emission spectrophotometer. Cation exchange capacity (CEC) was determined by ammonium saturation method. Exchange acidity (EA) was by KCl extraction method [12].

Leaf Analysis

Leaf samples were collected from all replicates of each treatment by detaching a leaf per replicates and oven dried to constant weight, ashed in a muffle furnace and analysed for N by the micro – kjeldahl method and K by flame photometer, P by calorimetry and Ca and Mg by EDTA titration

Collection of Growth Parameters

Parameters measured include plant height, stem girth, leaf population, which started two weeks after treatment application stem girth was measured using venier caliper, which is placed round the circumference of the plant. The plant height was measured with meter rule from the soil surface inside the polybag to the tip of the highest leaf and leaf population by counting. Growth parameters were collected at 2, 4, 6, 8 and 12 weeks after fertilizer application.

Data Analysis

Replicated data were subjected to analysis of variance (ANOVA). The treatment means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

III. RESULTS AND DISCUSSION

Table 1 shows the chemical properties of topsoil used to fill polybag in which Oil palm sprouted nuts were planted. The soil was neutral in reaction and has low OC and OM content. Its N was moderately low, P and CEC was very low, Mg was low and K high. The %BS was very high. Organic C, OM, N, P and Mg were below critical level for crop production [13- 15]. The soil and oil palm seedlings were therefore designed to profit from the application of fertilizer treatments.

Table 2 shows the effect of inorganic, organic and organomineral fertilizers on soil chemical properties at the end of the experiment. There were significant differences ($P<0.05$) in all fertilizer treatments applied and for all nutrient elements considered. 200kg ha⁻¹ SOMF gave significant ($P<0.05$) and highest pH, OC, OM, N, P, K and Mg for all treatments considered. Such formulated materials (containing both organic and inorganic compounds) have been reported to improve soil fertility [16- 17].

200kg ha⁻¹ NPK revealed high N, P and K value compared with 6 t ha⁻¹ SOF, 6 t ha⁻¹ CD and 6 t ha⁻¹ PM. This is because nutrients in NPK fertilizers are concentrates and as such present in large quantity compared with organic fertilizers that normally presents low level of mineral nutrients, but in balance proportion. The high level of OC and OM revealed in organic fertilizers application is consistent with the work of MoyinJesu and Charles, 2003 [18]. They have implication for soil physical properties [19].

Table 3 shows the effect of inorganic, organic and organomineral fertilizer on selected oil palm growth parameters. All treatments differ significantly ($P<0.05$) from control. There was no significant ($P<0.05$) difference between the fertilizer treatments with regards to leaf

population and plant height. 200kg ha⁻¹ SOMF gave the highest leaf population, stem girth and plant height.

Percent increase in leaf population of Oil palm seedlings treated with SOMF over that of Control, NPK, SOF, CD and PM was 26, 6, 5, 8 and 3% respectively, that for stem girth was 27, 17, 19, 14, 20 respectively and that for plant height was 12, 4, 5, 10, 6 respectively. Uwumarongie-Iloria *et al.* 2012 [20] reported highest stem girth in plots treated with NPK Mg, highest plant height in plots treated with cow dung and empty fruit bunch ash. He reported the highest leaf number in plots treated with empty fruit bunch ash. Amending inorganic fertilizer with composted green materials has been reported to have prospect for use as growth medium to raise oil palm seedlings in the nursery [21].

Table 4, shows the effect of Inorganic, organic and organomineral fertilizer on oil palm leaf nutrient, there were significant difference among treatments considered.

200kg ha⁻¹ SOMF gave the highest leave N and K, 6 t ha⁻¹ SOF gave the highest P and Mg, there was no significant ($P < 0.05$) difference in the P value revealed by 200kg ha⁻¹ SOMF and 6 t ha⁻¹ SOF. The highest Ca and Mg were revealed by 6 t ha⁻¹ CD. The addition of organic materials to soil has been reported to increase N-uptake by crops [22]

IV. CONCLUSION

Organic fertilizers application gave high soil OC and OM, 200kg ha⁻¹ NPK most improves soil N, P and K, 200kg ha⁻¹ SOMF generally improves soil nutrient, gave the highest leaf population, stem girth and plant height and the highest leave N and K, It is therefore recommended for oil palm seedling directly sown in nursery.

Table 1: Chemical properties of topsoil used to fill polybag in which Oil palm sprouted nuts were planted

pH (H ₂ O)	OC %	OM %	N %	P mg kg ⁻¹	K cmol/kg	Ca cmol/kg	Na cmol/kg	Mg cmol/kg	CEC cmol/kg	Exch Acidity	% BS
6.87	0.75	1.29	0.15	1.28	1.20	2.42	0.28	0.95	5.05	0.20	96

Table 2: Inorganic, organic, and organomineral fertilizer effect on soil chemical properties

Treatment	pH (H ₂ O)	OC %	OM %	N %	P mg kg ⁻¹	K cmol/kg	Ca cmol/kg	Na cmol/kg	Mg cmol/kg	CEC cmol/kg	H ⁺ cmol/kg	Al ⁺ cmol/kg	%BS
Control	5.60c	0.28f	0.47f	0.03d	36.86f	0.27e	6.32bc	0.23d	2.93a	11.27f	4.68c	2.18b	82.37a
200kg ha ⁻¹ SOMF	6.16a	2.08a	3.38a	0.19a	91.93b	1.55a	4.10d	0.35bc	3.17a	17.34c	6.25a	2.83a	38.28e
200kg ha ⁻¹ NPK	5.65bc	0.72e	1.24e	0.16b	91.64a	0.73b	6.07c	0.45a	2.17a	16.34c	6.13b	2.83a	59.41c
6 t ha ⁻¹ SOF	5.17d	0.90d	1.56d	0.08c	79.68c	0.44d	7.07a	0.25d	3.10a	18.20b	3.91d	2.33b	63.88b
6 t ha ⁻¹ CD	5.92ab	1.87b	3.24b	0.07c	48.18d	0.54c	6.60b	0.36b	2.80a	19.30a	7.18a	3.20a	52.69d
6 t ha ⁻¹ PM	5.82bc	1.00c	2.87c	0.15b	44.18e	0.47d	7.07a	0.31c	1.40b	13.37e	6.21a	3.00a	85.82a

SOMF: Sunshine organomineral fertilizer SOF; Sunshine Organic fertilizer CD: Cow dung PM: Poultry manure.

Table 3: Effect of Inorganic, organic and organomineral fertilizer on selected oil palm growth parameters

Treatment	Leaf population	Stem girth (cm)	Plant height (cm)
Control	7.13b	6.48b	42.12b
200kg ha ⁻¹ SOMF	9.00a	8.23a	47.05a
200kg ha ⁻¹ NPK	8.47a	7.05ab	45.15a
6 t ha ⁻¹ SOF	8.53a	6.90ab	44.92a
6 t ha ⁻¹ CD	8.33a	7.21ab	42.95a
6 t ha ⁻¹ PM	8.73a	6.85ab	44.22a

SOMF: Sunshine organomineral SOF; Sunshine Organic fertilizer CD: Cow dung PM: Poultry manure.

Table 4: Effect of Inorganic, organic and organomineral fertilizer on oil palm leaf nutrient

Treatment	N %	P mg kg ⁻¹	K cmol/kg	Ca cmol/kg	Na cmol/kg	Mg cmol/kg
Control	1.69f	2.08d	105.34b	4.76c	2.12c	22.28d
200kg ha ⁻¹ SOMF	2.81a	3.35a	164.37a	7.98b	7.98b	37.41c
200kg ha ⁻¹ NPK	2.09e	2.72bcd	110.42b	8.60b	8.60b	22.28d
6 t ha ⁻¹ SOF	2.68b	3.37ab	143.78ab	3.32c	3.32c	48.96c
6 t ha ⁻¹ CD	2.20d	2.82bc	42.95ab	10.45a	10.45a	45.91b
6 t ha ⁻¹ PM	2.42c	2.36cd	132.49ab	3.53c	3.53c	37.88c

SOMF: Sunshine organomineral SOF; Sunshine Organic fertilizer CD: Cow dung PM: Poultry manure.

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