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# Productivity and Economics of Some Soil Fertility Management Practices on Cucumber Production in Abakaliki, Southeastern Nigeria

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**Abstract:** ***Field experiments on the productivity and economics of some soil fertility management practices on cucumber production were conducted in a randomized complete block design (RCBD) in three replications on the research farm of Ebonyi State University, Abakaliki, located at latitude 06$^0$ 19´ 407´´ N, longitude 08$^0$ 7´ 831´´ E, at an altitude of 447 m above sea level, with annual rainfall of 1700 mm to 2060 mm. In all the trials, NPK (15:15:15) consistently gave the highest number of fruits (79.21 plot$^{-1}$) and fruit weight (29.18 kg plot$^{-1}$), followed by dry slaughterhouse refuse with 67.25 plot$^{-1}$ and 24.77 kg plot$^{-1}$, black plastic mulch with 64.26 plot$^{-1}$ and 24.26 kg plot$^{-1}$, poultry manure with 63.73 plot$^{-1}$ and 23.48 kg plot$^{-1}$, dry grass mulch with 62.78 plot$^{-1}$ and 23.27 kg plot$^{-1}$, urea with 43.29 plot$^{-1}$ and 15.94 kg plot$^{-1}$ while, the control was the least with 41.02 fruits plot$^{-1}$ and weighed 15.12 kg plot$^{-1}$. Higher income was as well generated to the farmer by NPK (15:15:15) fertilizer application with a conservative sum of 2.86 million naira per hectare, 2.74 million naira from DSHR, 2.40 million naira from DGM, 2.32 million naira from BPM, 2.22 million naira from poultry manure, 1.52 million naira from the control and 1.44 million naira from urea. These results show that the soil fertility can be managed profitably under cucumber for high productivity and income generation to the farmer and to any youth who would want to seek for livelihood in crop production.***

**Keywords:** Soil fertility management practices, cucumber, Black plastic mulch, dry grass mulch, dry slaughterhouse refuse, poultry manure, plsticulture

## 1. Introduction

The global assessment of soil degradation (GLASOD) has estimated that nearly 2 billion hectares worldwide or 22% of all cropland, pasture, forest and woodland have been degraded since 1945 (LEISA, 2003). Land degradation entails a decline in the productive capacity of soil as a result of erosion, and changes in the hydrological, biological, chemical and physical functions of the soil. Of the 1.5 billion hectares of cropland worldwide, 38% has been affected to some degree by human induced soil degradation and more than 60% has been degraded to such an extent that rehabilitation is only possible with large capital investment (LEISA, 2003). Degraded soils and low soil fertility are the major constraints to food security and income levels of smallholder farmers in developing countries who depend so much on the land and are deeply attached to it for their survival (WOCAT, 2007; Spore, 2009). Currently, 1.9 billion hectares of land (three times the size of India) is affected by significant land degradation (Jiggins, 2008) at the time the earth is predicted to host more than 9 billion people in 2050 as against the 6.8 billion people presently (Spore, 2010). The rapid growth of human population globally (expected to increase by almost 40% in the next 4 decades), has made the traditional shifting cultivation once known to be suitable and ecologically stable and biologically efficient for the fragile tropical soils no longer sustainable (Spore, 2010; Gichuru and Kang, 1987).

Improved food production systems and access to food are needed to halt the mass drift of young people to urban areas in search of the inadequate and inequitably distributed and politically maneuvered white collar jobs in the developing countries. Also, the dominant peasant agricultural economy characterized by tedium and drudgery helps to reduce the interest of the youths which adds to swell the unemployment level among the youths, such that they easily fall prey to clandestine activities and easy tools in the hands of politicians for all forms of crimes. However, the recent paradigm shift from green revolution to gene revolution, from conventional agriculture to high value agriculture and from domestic to global markets, has underscored the need for strategic research on technologies which on the one hand are pro-smallholder farmers, pro-poor and pro-nature, and on the other, competitive in global markets (Bosan, 2006). Accelerated and sustainable agricultural intensification, increased agricultural productivity and improved rural livelihoods require investment in soil fertility maintenance (Place *et al*., 2003). The use of research technologies and concepts do improve soil fertility, but their application is generally bolstered when they fulfill indirect benefits among the resource-deprived smallholder farmers (Misiko, 2007). Obviously, sustainable land management is an important prerequisite for meeting the millennium development Goals (MDGs), especially on poverty reduction, hunger and environmental sustainability and protection (Gichuru *et al.*, 2003, WOCAT, 2007).

Different mulching materials modify the micro-climate environment and enhance crop growth and yield but their effectiveness depend on the type of mulch. Different mulch types influence the vegetative growth and yield of many crops treated with them and the soil conditions under them. Plastic films (as mulch) improved the soil temperature from 27.5 – 28.3$^0$C under cassava plants at Nsukka, Nigeria, a derived savanna environment (Aniekwe *et al*., 2004), improved the growth and yield of okra at Abakaliki, Southeastern Nigeria (Aniekwe, 2002), and improved the growth and yield of cucumber at Kaha experimental station, Cairo, Egypt (Maged, 2006).

Jacques Diouf declared in 2007, "You cannot feed six billion people today and nine billion in 2050 without judicious use of chemical fertilizers". Aniekwe and Mbah (2001) found that organic and in organic fertilizers improved growth and yield in vegetable cowpea especially where 10 tons of poultry droppings was applied and where NPK (20:10:10) at 400 kg $ha^{-1}$ were applied. Van Luijk (2004) indicated that cucumber requires the incorporation of organic manure of about 25-35 t/ha during soil preparation and responds well to fertilizers. He pointed out that in addition to the initial organic manure, a general recommendation of 700 kg/ha NPK mixture, followed by nitrogen fertilizer every 2-3 weeks until the fruits form. However, it is best to base fertilizer application on a soil analysis before planting.

Cucumber a fruit vegetable, whose seed has some anthelmintic property, is used as ingredient in a variety of health and beauty products for the skin. It has very important nutritional composition per 100 g of the edible portion (edible part is 97% with ends trimmed and not peeled, 85% when peeled), such as: water 96.4 g, energy 42 kJ or 10 kcal, protein 0.7 g, fat 0.1 g, carbohydrate 1.5 g, dietary fibre 0.6 g, Ca 18 mg, Mg 8 mg, P 49 mg, Fe 0.3 mg, Zn 0.1 mg, carotene 60 µg, thiamin 0.03 mg, riboflavin 0.01 mg, niacin 0.2mg, folate 9 µg, ascorbic acid 2 mg (Holland et al., 1991), yet has little attention from smallholder farmers but proves to be highly productive in this zone. hence, some field trials were conducted to determine the productivity and economics of some soil fertility management practices on cucumber. The result may lead to revival of interest among the youths and attractive revenue resource to the resource-constrained farmers, thereby proving that cucumber can be grown in the southern Nigerian climate. It is a crop that can be relied on for income generation to farmers especially during off seasons if prophylactic treatment against its numerous pests and diseases are carried out.

## 2. Materials and Methods

Field trials were carried out on the research farm of Department of Crop Production and Landscape Management, Ebonyi State University, Abakaliki located at latitude $06^0$ $19^{'}$ $407^{''}$ N, longitude $08^0$ $07^{'}$ $831^{''}$ E and at an altitude of 447 m above sea level, with about 1700 mm to 2060 mm annual rainfall. The trials were designed to determine the effects of seven soil fertility management practices on the productivity and income generation of cucumber production in a randomized complete block design (RCBD) in three replications. The experiments tried the effects of two chemical fertilizers (NPK (15:15:15) and urea (46 % N), two organic manures [poultry manure (PM) and dry slaughter house refuse (DSHR)], two mulching materials [black plastic mulch (BPM) and dry grass mulch (DGM)] and a control, on a cucumber variety (Poinsett 76). The trial was designed to evaluate these practices for possible adoption by students of the faculty of agriculture who intend to augment their feeding money through farming. Data were collected on fruit number and fruit weight (kg) in five harvest intervals at which time the number of marketable fruits reduced significantly. The fruits were sold in kilograms at farm-gate price of eighty naira per kilogram (₦80 $kg^{-1}$) and the total sales were calculated per plot and per treatment. The plot size 2 m x 2 m was manually prepared with large-blade West African dwarf hoe, after the area (84 $m^2$) was cleared with machetes and raked. The organic manures were applied on the plots randomly selected and worked into the soil allowing it three weeks before planting at the rate of twenty tons per hectare (20 tons $ha^{-1}$). The black plastic mulch measuring 2.5 m x 2.5 m were laid on the designated randomly selected plots with the 0.5 m projections on either sides buried in the soil at the edges of the plots to prevent the plastic sheets from being blown away by wind. Routinely, from time to time, more soils were heaped on the edges when washed away by rainfall until harvests were concluded. The soil surface of the plots was made as flat as possible to prevent water from collecting on the plastic films without reaching the holes made on the plastic sheets. Prior to planting the seeds, holes large enough to admit the seeds and rainfall were cut on the plastic sheets at the spacing of 50 cm x 30 cm. Dry grass mulch was applied to the randomly selected plots to a height of 5 cm covering the plots as much as possible. NPK (15: 15: 15) fertilizer was applied at 400 kg $ha^{-1}$ while urea (46 % N) was applied at 200 kg $ha^{-1}$ three weeks after planting. Daksh, (Dichlorvos 1000 % EC, W/V at 500 active ingredients $ha^{-1}$) insecticide was applied as a prophylactic treatment against leaf bugs five days after germination to avert pest incidence. Weeding was done as regular as weeds appeared on the plots without plasticulture. The dry grass mulch was not expected to control weed growth sufficiently.

## 3. Results and Discussion

Table 1 showed that NPK (15: 15: 15) fertilizer consistently and significantly ($p<0.05$) improved the number of cucumber fruits per plot, confirming the observations of Grubben and Denton (2004) who reported that cucumber responds well to proper fertilizer application. The highest mean number of fruits per plot was obtained in the first to the fifth harvests (19.72, 22.30, 17.70, 13.70 and 5.79 giving a total of 79.21 fruits $plot^{-1}$). DSHR was second with 15.34, 22.11, 15.31, 10.72 and 3.77 with a total of 67.25 fruits $plot^{-1}$. Grubben and Denton (2004) also recommended a generous incorporation of organic manure of about 25 – 35 t $ha^{-1}$ which was the reason dry slaughter house refuse was second to NPK (15:15:15). Although, it was expected that dry grass mulch decomposing would add to the soil fertility of the plot to come third, the inherent quality of plasticulture technique made black plastic mulch occupy the third position with a total number of 64.76 fruits per plot (14.02, 20.60, 12.70, 9.76 and 7.68 per harvest respectively). Black plastic films (as mulch) was reported to have improved the soil temperature from 27.5 – 28.3$^0$C under cassava plants at Nsukka, Nigeria, a derived savanna environment and effected a 100% weed suppression (Aniekwe *et al*., 2004), improved the growth and yield of okra at Abakaliki, Southeastern Nigeria (Aniekwe, 2002), and improved the growth and yield of cucumber at Kaha experimental station, Cairo, Egypt (Maged, 2006). In addition to its modulating effect on the environment, plastic films were also found useful in producing cleaner and quality produce, better efficient use of water resources and fertilizer inputs, reduced leaching of fertilizer on light sandy soils, reduced soil erosion by wind and water, soil compaction, root pruning, better management of certain pests and reduced disease incidence and earlier crop production (Harrison-Murray and Lal, 1979, Lamont, 1999, Terry *et al*., 1987). It was observed that nitrogen fertilizer (urea) depressed fruit production as well as poultry manure which was reported as holding more nitrogen than other organic manures (Khaliq *et al*., 2004) yet, poultry manure occupied the fourth position with a total number of 63.73 fruits per plot while, dry grass mulch occupied the fifth position with 62.78 fruits per plot. Less tonnage off poultry manure and less dosage of urea can be studied further. Table 1 also revealed that number of fruits increased more in the second harvest than in the first and subsequent harvests. Table 2 presented the weight of fruits per plot (kg $plot^{-1}$) and showed that weight of fruit $plot^{-1}$ corresponded with the number of fruits $plot^{-1}$ in being the highest in NPK (15:15:15) fertilizer (29.18 Kg), followed by DSHR (24.77 kg), BPM (24.26 kg), PM (23.48 kg), dry grass mulch (23.27 kg), but PM was the highest in the second harvest (8.60 kg).

The smallholder farmers who are usually resource-constrained and young school leavers could make a living by embarking on cucumber production based on the result of this experiment with NPK (15:15:15), if affordable or with DSHR which would be more affordably available. The amount of income estimated based on theoretical plant population per hectare at a conservative price per kilogram can turn a farmer naira millionaires in a single planting season (Table 3). A plot of 2m x 2m under NPK (15:15:15) nets in as much as two thousand one hundred and seventeen naira one kobo to the farmer in a single planting, which multiplies into millions of naira per hectare, especially, with more than one single planting which is very possible in a year. Moreover, with the formidable nutritional profile of cucumber in these days of health threatening ailments, the market for the crop is enormous.

## 4. Conclusion

Since the issue of soil fertility management is a complex one, it can be concluded that an interdisciplinary approach should be intensified and research priorities be based on ecological regions as functional unit to overcome production constraints in relation to environmental and sustainable income to farmers. It can be stated without equivocation that cucumber production is a promising enterprise capable of halting rural – urban drift by young people, reduce poverty among the smallholder farmers, rejuvenate and improve the health status of the rural populace through its high nutritional content and rehabilitate the psyche of our sick society by its cash spinning potentials. It may not be possible to plant up a hectare with cucumber, but with adequate cultural practices, any meaningful plot size will be rewarding in three to four months of farming.

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**Table 1:** Effects of soil fertility management practices on the mean number of cucumber fruits harvested per plot.

**Key:** DSHR – Dry slaughterhouse refuse

| *Treatment* | *Number of harvest* | | | | | |
|---|---|---|---|---|---|---|
| | *1st* | *2nd* | *3rd* | *4th* | *5th* | *Total* |
| NPK (15:15:15) | 19.72 | 22.30 | 17.70 | 13.70 | 5.79 | 79.21 |
| Urea (N) | 9.73 | 12.92 | 9.70 | 6.70 | 4.24 | 43.29 |
| DSHR | 15.34 | 22.11 | 15.31 | 10.72 | 3.77 | 67.25 |
| Poultry manure | 13.03 | 23.30 | 12.80 | 7.78 | 6.82 | 63.73 |
| Black plastic mulch | 14.02 | 20.60 | 12.70 | 9.76 | 7.68 | 64.76 |
| Dry grass mulch | 15.71 | 20.61 | 12.71 | 9.15 | 4.60 | 62.78 |
| Control | 7.04 | 15.12 | 9.04 | 6.60 | 3.22 | 41.02 |
| **F-LSD (0.05)** | 2.44 | 7.95 | 1.87 | 12.04 | 2.89 | |

**Table 2:** Effects of soil fertility management practices on the fruit weight (kg/plot) of cucumber

| **Treatment** | **Number of harvest** | | | | | |
|---|---|---|---|---|---|---|
| | **1st** | **2nd** | **3rd** | **4th** | **5th** | **Total** |
| NPK (15:15:15) | 7.20 | 8.24 | 6.54 | 5.06 | 2.14 | 29.18 |
| Urea (N) | 3.55 | 4.77 | 3.58 | 2.47 | 1.57 | 15.94 |
| DSHR | 5.60 | 8.17 | 5.65 | 3.96 | 1.39 | 24.77 |
| Poultry manure | 4.76 | 8.60 | 4.73 | 2.87 | 2.52 | 23.48 |
| Black plastic mulch | 5.12 | 7.61 | 5.09 | 3.60 | 2.84 | 24.26 |
| Dry grass mulch | 5.74 | 7.61 | 4.82 | 3.38 | 1.72 | 23.27 |
| Control | 2.57 | 5.58 | 3.34 | 2.44 | 1.19 | 15.12 |
| **F-LSD (0.05)** | 2.31 | 0.99 | 1.17 | 1.84 | 0.61 | |

**Key:** DSHR – Dry slaughterhouse refuse

**Table 3:** Economics of soil fertility management practices on cucumber production in Abakaliki, Southeastern Nigeria on plot basis

| *Treatment* | *No of fruits/plot* | *Weight of fruit/plot (kg)* | *Gross income: fruit sale @₦80/kg* | *Cost of material/plot* | *Cost of weeding/plot @₦100* | *Net income/plot (₦)* |
|---|---|---|---|---|---|---|
| NPK | 79.21 | 29.18 | 2,334.4 | 117.3 | 100.0 | 2,117.1 |
| Urea (N) | 43.29 | 15.94 | 1,275.2 | 10.7 | 100.0 | 1,165.5 |
| DSHR | 57.25 | 24.77 | 1,981.6 | 19.2 | 100.0 | 1,862.4 |
| PM | 63.73 | 23.48 | 1,878.4 | 19.2 | 100.0 | 1,759.2 |
| BPM | 64.76 | 24.26 | 1,940.8 | 60.0 | - | 1,880.8 |
| DGM | 72.78 | 23.27 | 1,861.6 | - | 100.0 | 1,761.6 |
| Control | 41.02 | 15.12 | 1,209.6 | - | 100.0 | 1,109.6 |

**Key:** NPK = NPK (15:15:15), DSHR = Dry slaughter house refuse, PM = Poultry manure, BPM = Black plastic mulch, DGM = Dry grass mulch