International Journal of
Advanced Research in Social Engineering and Development Strategies
ISSN Print: 2315-8379 ISSN Online: 2354-161X Vol. 4, No. 1 January, 2016

Effect of Fertilizers and Arbuscular Mycorrhizal Inoculation in Melon (Citrullus Lanlatus (Thumb) Mansf) Production: Preliminary Study for Land use to Enhance Food Security

[1]Olugbemi, Peter Wusu & [2]Fagbola, Olajire
[1]Department of Agricultural Education, Michael Otedola College of Primary Education, Noforija, Epe. Lagos Nigeria
.[2]Department of Agronomy, Faculty of Agriculture and Forestry University of Ibadan, Oyo state Nigeria

Abstract
A preliminary investigation on the response of two cultivars of melon (Citrullus lanlatus (Thumb) Mansf): (egusi bara and sewere) to three fertilizers was carried out at Michael Otedola College of Primary Education, Lagos Nigeria under pot conditions in an open space. The experiment was 2 x 2 x 2 factorial, laid in complete randomized design (CRD) and replicated three times; two levels of each factor (Arbuscular mycorrhiza fungi (AMF), organomineral fertilizer (OF) and compost were applied at 0 and 25, 12.5 g per 10 kg soil for NPK fertilizer with 0 and 10 g of mycorrhizal inoculum to each fertilizer level. Melon seeds were sown at two seeds per pot and were thinned to one seedling per pot two weeks after. Melon plant growth parameters such as number of leaf, vine length, fruits weight and number of fruits were observed. All data collected were subjected to ANOVA and means were separated using DMRT ($P < 0.05$). The results showed that mycorrhizal inoculation under compost gave the highest number (10) of leaf at three weeks after sowing for both melon cultivars, other treatments were not significantly different ($P \leq 0.05$) when compared. Similar trend was observed at the fifth week after sowing. The vine length was significantly increased by mycorrhizal inoculation with organic fertilizers compared to NPK application with mycorrhizal inoculation. Similar trend was observed under fruits yield (weight) and number of fruits at harvest. The highest number of (4) fruits per plant were observed with sewere under OF application with mycorrhizal inoculation. The results revealed that OF and compost with mycorrhiza are compatible soil amendments for melon production, however, it may be recommended that equivalent rate of 2.5 t ha^{-1} of OF be applied on field with AM inoculation for higher melon production using sewere melon cultivar.

Keywords: Fertilizers, Melon, Mycorrhiza, Pot Conditions

http://internationalpolicybrief.org/journals/science-publishing-corporation-journals/social-engr-and-dev-vol4-no1-january-2016

Background to the Study

Many lands are under continuous cultivation and greater percentages are subjected to construction and other non crop production purposes. The outcome is reduction of farmland and this posed a threat to food production and food security (SSS, 2003). As reported by Charles et al. (2010), continuing population and consumption growth will mean that the global demand for food will increase for at least another 40 years. Growing competition for land, water, and energy, in addition to the overexploitation of fisheries, affects farmers' ability to produce food.

In an attempt to reduce this problem, various land management techniques were being advocated and employed; such as continuous cropping, intercropping, application of soil amendments such as fertilizers among others (Ekwere et al., 2013). Hence, a reduced dependence on chemical fertilizers has been advocated, because sole uses of chemical fertilizers often lead to a decreased in soil organic matter content and increased in soil erosion. Besides, the quantities and qualities of crop produce and products under such system are impaired (Irwin, 2010 and Lege, 2013).

The uses of mineral fertilizers alone also result in soil physical degradation, increased soil acidity level and soil nutrient imbalance which negate land use management (SSS, 2003). However, organic manure when efficiently and effectively used ensures sustainable crop productivity by immobilizing nutrients that are susceptible to leaching (Ibiremo, 2010 and Lege, 2013). The management and conservation of the soil to guide against decreased crop yields under intensive cropping have become major areas of agronomic research (Ayoola, and Adeniyan, 2006).

Complementary use of organic and mineral fertilizers which resulted in integrated nutrient management and organo mineral fertilizer has been proved to be a sound soil fertility management and land use strategy in many countries of the world. (Omueti et al, 2000; Fagbola et al, 2009). High and sustained crop yield has been reported with judicious use of mineral fertilizers combined with organic matter amendment (Kiani et al., 2005). This implied that, in sustainable low input agriculture systems where nutrients availability is a serious constraints to crop production, the use of organic manures are inevitable and supplementing such manures with mineral fertilizers might be the key to attaining good yield and proper land use management technique. (Kiani et al., 2005).

The use of inorganic fertilizers is associated with a number of factors limiting its use, although high crop yield can be obtained with its judicious use. However, the cost and distribution system of chemical fertilizers, and heavy inputs of it to manage a marginal soils can be detrimental to the soil and to the environment as well as food quality (Jadoon et al., 2003). Organic fertilizers are further modified to improve their efficiency through fortifications with mineral fertilizers leading to organo mineral fertilizer (Omueti et al., 2000). The merits of the two entities are blended into the soil systems for better crop production that can make soil to be healthy. Manures improve soil structure, aggregation, infiltration, microbial activity and water holding capacity (Ekwere et al., 2013). Hence, such fortified organic fertilizers are valuable soil amendments when properly used to manage soil (Castillo et al, 2003).

Beneficial Soil micro Organisms and Crop Production: According to Ogungbe and Faagbola (2007), the crave for increased crop yields to meet the food demands for teaming growing population has resulted to high rate of the use of different soil amendments. These soil amendments are fast becoming predominant in most parts of the humid tropics such as Nigeria. However, much has not been documented about the use of these soil amendments and Arbuscular Mycorrhizal inoculation with some crops like melon.

Benefits of Arbuscular Mycorrhizae (AM) to Crops: Arbuscular mycorrhizae (AM) are symbiotic associations formed between plants and soil fungi that benefit both partners (Okon et al., 2012).The plant species that are involved in this association are approximately 80% and the soil fungi concerned are classified in the Phylum Glomeromycota (Dalpe and Monrel, 2004). These fungi (AM) are ubiquitous in the soil with about one hundred and seventy described species. These fungi are beneficial to crops in various ways such as water stress reduction, nutrient uptake enhancement among others (Jeffries and Barrea, 1994, Fagbola et al, 2009, Okon et al., 2012). Other benefits from these associations to plants include: improved water and nutrient uptake, enhanced phosphorus (P) transport, drought and diseases resistance. Benefits to fungi are the supply of photosynthesis to the fungal network located in the cortical cells of the plant and the surrounding soil (Joseph and Sidney,2008). Exchanges of water, nutrients and photosynthesis occur via the fungal filament network that bridged plant rhizosphere and plant roots (Carla da Silva et al., 2012).

Melon (Citrullus lanlatus (Thumb) Mansf): Melon (Egusi) belongs to the family Cucurbitaceae, which comprises cucumber, water melon and pumpkin. Melon has bitter fleshy pulp with different pulp colour that distinguishes it from water melon (Ayoola and Makinde, 2007). According to Deton and Oluforiji (2000), melon originated from the tropical and sub-tropical Africa and is a native of West Africa, where it was distributed and grown throughout the Mediterranean (Giwa, 2010). Melon is an important component of traditional cropping system in Nigeria. It can be intercropped with some staple crops such as cassava, maize and sorghum (Yusuf et al., 2008).

The ability of melon to cover the ground makes it to be useful in controlling weeds and reduces soil run off when intercropped with other crops (Moser, 2009). It is at times grown as sole crop in large field, market garden near large urban centre or backyard crop in Nigeria (Marvey, 2009). In Nigeria, there are two common types of egusi melon among others, (these two are differentiated by the presence or absence of a seed edge). According to Denton and Olufolaji (2000); Olaniyi and Tella (2011), the two types are referred to as 'bara' (with prominent thick seed edge with black or white colour) and 'serewe' (without pronounced seed edge). In all the types, melon seeds are rich in protein, carbohydrate and crude fibre and ash at about 34%, 5% and 12% respectively. The oil obtained from the seeds is of high quality, often used for cooking and other industrial products, such as soap making, medicine, illuminant, (Adewusi et al, 2000).

However, works focusing on the response of melon to organic and mineral fertilizers as influenced by Arbuscular Mycorrhiza Fungi (AMF) have been of interest of this trial. The objectives therefore are to assess:

i. the response of melon to organic fertilizers under Arbuscular Mycorrhiza Fungi (AMF)
ii. the response of melon to mineral fertilizer under Arbuscular Mycorrhiza Fungi (AMF)

Materials and Methods

Location and Description of the Experiment: The experiment was pot experiment conducted at Michael Otedola College of Primary Education Teaching and Research Farm, Department of Agricultural Education, Noforija, Epe Lagos State, Nigeria. The College teaching and research farm (location coordinates; 6^0 35' 0' North 30 59' 0'). The farm is located about 7 km away from northern shore of Lagos lagoon and about 32 km south of Ogun State.

Experimental Procedures: The pot experiment was conducted between January and April, 2010. The soil used for the experiment was collected from the College teaching and research farm at 0 - 30 cm depth. The samples were bulked, air-dried, and passed through 2mm sieve. Pre-cropping physical and chemical analyses of the soil were carried out. Plastic pots of 20 cm circumference and 30 cm deep perforated at the bottom to facilitate proper drainage. These pots were used for raising melon plant. Each pot was filled with 10 kg air-dried soil for the experiment.

Experimental Materials and Design: The treatments consisted of two cultivars of egusi melon (sewere and bara) and three different fertilizers; organo mineral fertilizer, compost and NPK 15-15-15 fertilizer and mycorrhizal inoculum. The treatments are: (i). mycorrhiza inoculums applied at 0 and10 g per pot, (ii). Fertilizers (organomineral fertilizer; OF, compost and NPK) applied at 0, 25 g for of and compost; and NPK 15-15-15 at 12.5 g (equivalent to 2.5 t ha^{-1} and 250 kg ha^{-1}) respectively. The treatments were laid out in a completely randomized design (CRD) with three replicates, making a total of 48 experimental units.

Compost was prepared using Almond leaves and poultry manure at 1:1 using pile method (Aiyelari et al, 2012) NPK, OF (grade A) and melon seeds were procured from Department of Agronomy, University of Ibadan Oyo State, Nigeria. The Compost and organomineral fertilizer were applied two weeks before sowing while the NPK fertilizer was applied a week after sowing. Two seeds of each cultivars of melon were sown per pot and later thinned to one seedling per pot after two weeks. Hand weeding was carried out and plants were manual irrigated throughout the growing period except raining days. The experiment was terminated after twelve weeks when melon fruits were matured.

Data Collection and Analysis: Melon vine lengths (cm), number of leaf were taken (third and fifth weeks after sowing), number of fruits per plant, fresh melon fruit's weight and fresh biomass per pot. Test of significance on data collected was carried out using analyses of variance (ANOVA) and mean separation was carried out by Duncan's Multiple Range Test (DMRT).

Results and Discussion

Nutrient Composition of Fertilizers used: The table above showed the nutrients compositions of organ mineral fertilizer used for the trial. The total of N is higher enough for crop production and the available P is 11.0 g/kg while the total K is adequate for melon production. However, the micro nutrients are higher in values compared to compost. The compost nutrient constituents is very low in most nutrients required for crop production; with exception of total N and total P which were up to required levels (Table 1).

Chemical and Physical Properties of the Soil used: From the laboratory analysis results, the soil used for this trial was marginal in nutrients especially in Nitrogen (1.7 g/kg) and high in available Phosphorus (21.4 g/kg). The extractable micro nutrients ranged from 2.6 – 80.9 mg kg^{-1} with Mn (80.9 mg/kg) followed by Fe with th value of 62.6 mg/kg with the least value of 2.6 mg/kg. Furthermore, the sol CEC of the if 5.7 mg/ha (table 2)

Melon Vegetative Growth Parameters at 3 and 5 Weeks after Sowing

Melon Vine Length: At three weeks after sowing (3 W A S), the melon vine length ranged from 16.3 – 39.0 cm (Table 3). It was observed that all applications of organic fertilizers with myucorrhizal inoculation increased the performance of melon vine length as observed with bara melon cultivars, with specific interaction among mycorrhizal and melon cultivars (Table 3). Similar, trend was observed with sewere cultivars as the vine length ranged from 16.3 –39.6 cm; where compost application with mycorrhizal inoculation gave the longest vine length of both melon cultivars (Table 3).

At 5 weeks after sowing, the vine length ranged from 45.3 – 76.7cm. The highest value was observed under compost application without mycorrihizal inoculation (76.7cm) but not significantly different from OF application without mycorrhizal inoculation. From the results, mycorrihizal inoculation with fertilizer application reduced vine lenth in both melon cultivars except where there was no fertilizers application where mycorrhizal inoculation significantly increased the vine length of sewere (103.7cm).

Number of leaf per Melon Plant: At 3 W A S, the bara number of leaf ranged from 6 – 10 per plant and was significantly higher (average of 10 leaves per plant) under compost with mycorrhizal inoculation. However, all other treatments were not significantly different ($P < 0.05$) from each other when compared in terms of number of leaves produced. But for sewere, melon cultivars, the number of lead produced were not significantly different when compared among all the fertilizers application and mycorrhizal inoculation levels (Table 4).

At 5 WAS, bara had a number of leaf ranging from 15.7 – 30.3 as observed when no fertilizer non mycorrhizal was applied and under compost with mycorrhizal inoculation respectively. Similar trend was observed with sewere number of leaf as it ranged for 25.7 – 39 leaves per plant (Table 4).

Melon Yield Parameters as Influenced by Fertilizers

Number of melon fruits: At harvest, the highest numbers of fruits per plant in bara cultivar was 2, no fruits was recorded where no fertilizer is applied with mycorrhizal inoculation and where NPK was applied without mycorrhizal application (Fig. 1).

Melon Fruit weight: The fruits weights for bara ranged from 20.6 – 161.7 per plant under no fertilizer application without mycorrhizal inoculation and under NPK and mycorrhizal inoculation respectively (Fig. 2) while the fruits weight of sewere melon cultivar ranged from 78.3 – 171.7 g per plant as observed when no fertilizer and mycorrhizal was applied and under OF and mycorrhizal inoculation respectively (Fig. 2). This performance was in agreement with report from Ayoola and Makinde (2007); Ibiremo (2010), that addition of organic manure increased crop yield. Similarly, the performance of these melon cultivars were in agreement with the report from Ekwere et al.(2013), that melon yield was influenced positively by cropping systems and fertilizer application.

Table 1: Nutrient composition of Organo mineral Fertilizer and Compost

Parameters	Organomineral Fertilizer	Compost Manure
Total N (g/kg)	44.2	22.7
Total P (g/kg)	11.0	6.9
Total K (g/kg)	7.0	1.0
Ca (g/kg)	7.0	2.7
Mg (g/kg)	0.57	0.2
Mn (mg/kg)	558.0	0.1
Fe (mg/kg)	8153.0	392.0
Cu (mg/kg)	275.0	188.0

Source: (2010) Soil Science Laboratory, Dept. of Agronomy University of Ibadan, Oyo state Nigeria

Table 2: Chemical and Physical properties of the Soil used for the pot Experiment

Parameter	Values
pH (H_2O)	6.4
Organic C (g kg^{-1})	16.5
Total N (g kg^{-1})	1.7
Available P (mg kg^{-1})	21.4
Exchangeable Bases (cmol kg^{-1})	
K	0.23
Ca	4.34
Na	0.30
Mg	0.53
Extractable Micronutrients (mg kg^{-1})	

Mn	80.9
Fe	62.6
Cu	3.82
Zn	2.59
C.E.C	5.70
Particle size distribution (g kg^{-1})	
Sand	832.0
Clay	48.0
Silt	120.0
Textural class	Sandy Loam

Source: (2010) Soil Science Laboratory, Dept. of Agronomy University of Ibadan, Oyo state Nigeria

Table 3: Melon vine length (cm) at three and five weeks after sowing as affected by Mycorrhizal Inoculation and Fertilizers Application under pot Conditions

Treatments	3 WAS		5 WAS	
	Bara	Sewere	Bara	Sewere
Control without Mycorrhiza	16.3^{d}	16.3^{d}	52.0^{b}	83.7^{c}
Control with Mycorrhiza	23.3^{c}	23.3^{c}	49.0^{b}	103.7^{a}
OF without Mycorrhiza	22.0^{c}	22.0^{c}	75.7^{a}	95.0^{b}
OF with Mycorrhiza	30.0^{b}	25.0^{b}	51.3^{b}	90.0^{b}
NPK withouth Mycorrhiza	18.7^{c}	18.1^{cd}	45.3^{c}	94.0^{b}
NPK with Mycorrhiza	16.7^{d}	16.3^{d}	46.3^{c}	85.7^{c}
Compost without Mycorrhiza	18.7^{cd}	18.9^{d}	76.7^{a}	98.3^{b}
Compost with Mycorrhiza	39.0^{a}	39.6^{a}	50.3^{b}	99.0^{b}
Fert. x cultivars	Ns	Ns	Ns	*
Myco x cultivars	*	*	Ns	Ns
Fert. x cultivars x Myco.	Ns	Ns	*	*
S E (df = 23)	1.7	1.7	4.1	3.7

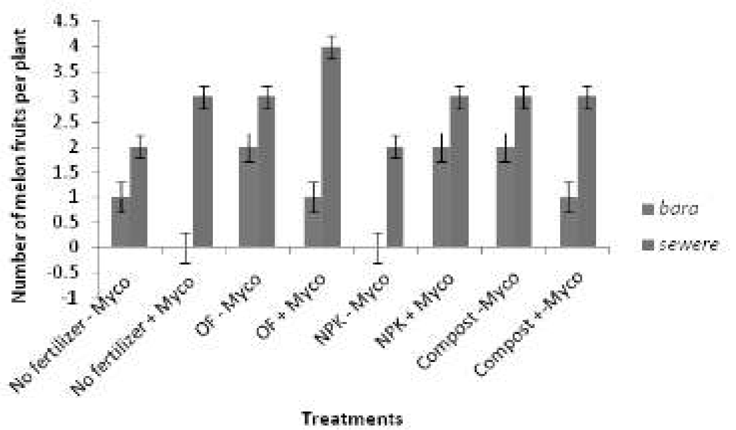
Means in the same column followed by the same letters are not significantly different (P = 0.05) according to Duncan's multiple range tests.

Table 4: Number of leaf of Melon Plant at 3 and 5 weeks after Sowing under pot Experiment

Treatments	3 WAS		5 WAS	
	Bara	Sewere	Bara	Sewere
Control without Mycorrhiza	7.0[b]	7.0[b]	15.7[e]	29.7[b]
Control with Mycorrhiza	6.0[b]	6.0[b]	19.0[cd]	32.0[b]
OF without Mycorrhiza	7.0[b]	8.3[ab]	18.0[d]	39.7[a]
OF with Mycorrhiza	7.3[b]	7.7[ab]	28.7[a]	30.7[b]
NPK without Mycorrhiza	6.0[b]	7.3[b]	21.3[c]	35.0[a]
NPK with Mycorrhiza	6.0b[b]	9.7[a]	20.7[c]	37.7[a]
Compost without Mycorrhiza	7.7[b]	10.0[a]	25.7[b]	25.7[b]
Compost with Mycorrhiza	10.0[a]	9.0[a]	30.3[a]	39.0[a]
Fert. x cultivars	Ns	Ns	ns	Ns
Myco x cultivars	*	*	ns	*
Fert. x cultivars x Myco.	Ns	Ns	*	*
S E (df = 23)	0.32	0.33	1.9	1.5

Means in the same column followed by the same letters are not significantly different (P = 0.05) according to Duncan's multiple range tests.

Legend
OF = Orgnomineral Fertilizer
WAS = Weeks After Sowing
ns = not significant different
* = significant



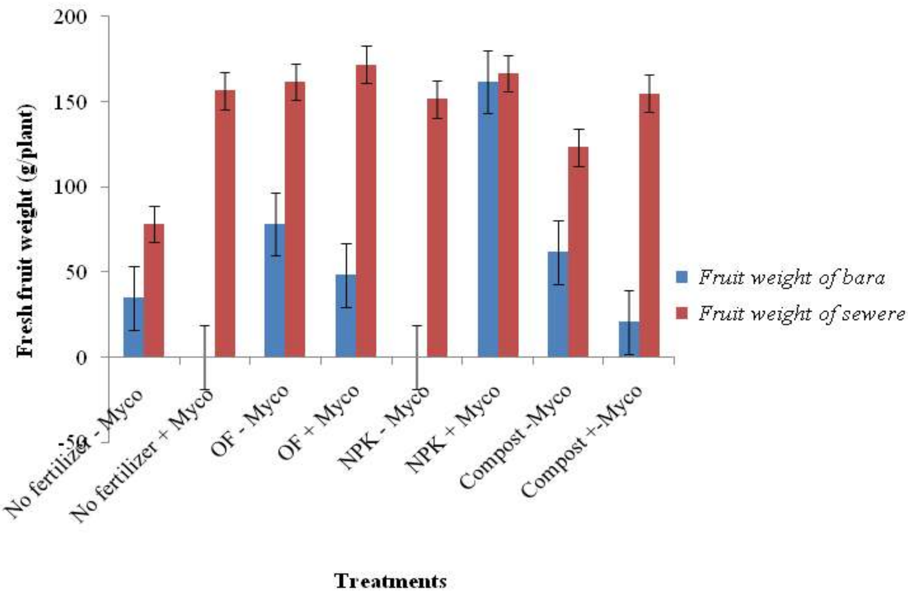
Bars represent standard error

Figure1: Number of melon fruits as influenced by fertilizers and Arbscular Mycorrhiza fungi Inoculation on two cultivars of melon under pot conditions

Legend

- Myco	=	without mycorrhizal,
+ Myco	=	with mycorrhizal,
OF	=	Orgnomineral Fertilizer

The number of fruits recorded at harvest for sewere was 4 under OF and mycorrhizal application. In term of sewere melon cultivar, fruit number ranged from 1 – 4, and there were fruits even when neither fertilizer nor mycorrhiza was applied (Fig. 1).



Bars represent standard error

Figure 2: Weight of melon fruits as influenced by fertilizers and Arbscular Mycorrhiza fungi inoculation on two cultivars of melon under pot conditions

Legend

-Myco	= without mycorrhizal,
+ Myco	= with mycorrhizal,
OF	= Orgnomineral Fertilizer
AMF	=

Summary of Findings

This trial revealed that application of organic fertilizers with mycorrhizal inoculation will go a long way to improve land use management for melon production; it is also revealed that only one cultivar is positively increased in fruits yield (sewere) compared to bara melon cultivar where there was no fruit in some cases of fertilizer application. It was observed that arbuscular mycorrhiza fungi (AMF) increased the growth performance of melon significantly. Similarly, the melon fruit yield was significantly increased by fertilizers when compared to where no fertilizer nor mycorrhizal were applied. This was in line with report from Fagbola et al. (2009) and Olaniyan and Tella, (2010) that soil amendments with mycorrhizal inoculation increased egusi melon yield.

However, from this preliminary study these two cultivars of melon, compost manure may not be a recommended organic fertilizer for sewere, but for bara, but both cultivars of melon may be promising for high productivity when organomineral fertilizer (OF) is applied at 2.5 t ha^{-1} with mycorrhizal inoculation. Likewise, NPK at 250 kg ha^{-1} with mycorrhiza may be promising for both melon cultivars. This is in agreement with the works of Ogbonna and Obi (2007) and Giwa et al. (2010).

Conclusion

In conclusion, for improved food production especially melon, the application of organic fertilizers with mycorrhizal inoculation will go away long to maximally use the available land for proper soil fertility management and secure quality food in term of melon and other crops species that are known of their high yielding capacities under organic manures and mycorrhizal application. However, to reduce the use of chemical fertilizer for safety of food product and improve food security, the available farmland should be used in a way that encourage flourishing of beneficial soil microorganisms to increase crop produce.

Recommendations

Therefore, it is recommended that on field conditions 2.5 t ha^{-1} compost and organomineral fertilizer (OF) each with arbuscular mycorrhiza fungi (AMF) be used. There should be reduction in the use of chemical fertilizer for food security and encourage multiplication of beneficial soil fungi (AMF) as part of land use management for crop production.

References

Adewusi, H. G, Ladipo, D. O, Sarumi, M.B. Adebisi, A. A., & Vodouhe, R (2000). *Egusi production, utilization and diversity in Nigeria*. Agronomy in Nigeria: Compiled by M. O. Akroda pp 43 – 56

Aiyelari, E. A, Ogunsesin, A., & Adeoluwa, O.O (2011). Effects of terminalia catappa leaves with poultry manure compost, mulching and seedbed preparation on the growth and yield of okra (abelmoschus esculentus l. Moench). Ilorin: Proceedings of International Soil Tillage Research Organization 21-24 February, 2011. Ogunlela, A. O. Eds. University of, Nigeria. 356-370.

Ayoola O.T, & Makinde, E.A (2007). Complementary Organic and Inorganic Fertilizer Application: Influence on Growth and Yield of cassava/maize/melon intercrop with a relayed Cowpea". *Australian Journal of Basic and Applied Sciences, 1*(3)187 – 192

Ayoola, O.T, & Adeniyan, O.N (2006). Influence of poultry manure and npk fertilizer on yield and yield component of crops under different cropping systems in southwest Nigeria. *African Journal of Biotechnology ,5(*15)1386 – 1392

Castillo, A. E., Benito, S. G., & Fernadez, J.A. (2003). *Using organic manures as living materials.* Agro Chemica XLVII: 14-20.

Carla da Silva, S. Romulo., S.C.M, Evarardo, V. S. B. S, Fritz. O., Leonor. C. M, Marlon S. G, & Francico, S. L (2012). Occurrence of arbuscular mycorrhizal fungi after organic fertilization in Maize, Cowpea and Cotton Intercropping Systems". *ACTA Scientiarum Agronomy of Moringa, 34*(2) Pp 149- 156. http:/www/uem./acta.retrieved September 12, 2014.

Charles, H. J., Godfray, J. R., Beddington, I. R., Crute, L. H., Lawrence, J. F., Muir, J. P., Sherman R., Sandy, M., & Thomas, C. T. (2010). *Food security: the challenge of feeding 9 billion people*. February 2010 (327) Science www.sciencemag.org Downloaded November, 2015 from www.sciencemag

Dalpe, Y., & Monrel, M. (2004). *Arbuscular mycorrhiza to support sustainable cropping systems*. Online Crop Management. 10. 1094/cm-2004-0301-09 RV.

Denton, O. A., & Oluforiji, Adenike, O. (2000). *Nigeria's most important vegetable crops: agronomy in Nigeria*. M. O. Akroda (ed). Pp 43 – 56

Ekwere, O. J., Muoneke, C. O., Eka, M. J, & Osodeke, V. E. (2013). Growth and yield parameters of maize and egusi melon in intercrop as influenced by the cropping system and different rates of NPK fertilizer. *Journal of Agricultural and Crop Research 1*(5)69-75. http://sciencewebpublishing.net/jacr/archive.

Fagbola, O, Oyetunji, O. J & Olugbemi, P.W (2009). Mycofertigation production of of okra (abelmoschus esculentus, l, moench) under pot and field conditions. *Nigerian Journal of Horticultural Science (NHJS), 4,* 38 – 43ISSN 118- 2733 .

Giwa, S, & Lukman, C A, (2010). *Investigating egusi seed oil as potential biodiesel feedstock*. Energies. 3: 607-618

Ibiremo, O.S. (2010). Effect of organic fertilizer fortified with phosphate fertilizer and arbuscular mycorrhizal fungi inoculation on the growth of cashew in two ecologies in Nigeria. *Journal Agricultural science, 1*(2)101 – 107

Irwin, B.Y. (2010). Fertilization and mineral nutrition of cassava. *Fertilizer and Food Science*

Jadoon, M.A., Bhatti, A.U., Khan, F., & Sahibzada, Q.A. (2003). Effect of farm yard manure in combination with npk on the yield of maize and soil physical properties. *Pakistan Journal of Soil Science, 22,* 47-55.

Jasper, D.A, Robson, A.D, & Abbort, I.K (1987). The effect of surface mining on the infectivity of vesicular arbuscular mycorrhizal fungi. *Austrialian Journal of Botany, 35*, 641 – 652.

Joseph, D.B., & Sidney, L.S. (2008). Arbuscular Mycorrhizal Fungi (AMF). *Handbook of Tropical Soil Biology Sampling and Characterization of Below-ground Biodiversity.* Fatima M.S. Moreira, E. Jeroen Huising and David E. Bignell (eds) Pp131 -147

Kiani, M.J., Abbas, K.M., & Rahim, N. (2005). Use of organic manure with mineral n. Fertilizer increases wheat yield at rawalot azad-jammu and kashmin. *Archives of Agronomy and Soil Science, 51,* 299-309.

Lege, B. N. (2012). Soil chemical properties as affected by phosphorus and nitrogen – based manure and compost application. *Soil Science Research, 71,* 666 – 673.

Marvey, B. B (2009). Oil crops in biofuel applications: South Africa gearing up for a bio-based economy. *J Trans Res S Afr., 5*(2):153–161

Moser, B. R, (2009). *Biodiesel Production, Properties and Feedstocks.* In Vitro cell Developmental Biology of Plant. 45: 229-266

Ogbonna, P.E, & Obi, U. I. (2007). Effect of time of planting and poultry manure application on growth and yield of egusi melon (colocinthis citrullus) in a derived savannah agro-ecology. *J Agric Food Ev Ext., 6*(2) 33-39

Ogungbe, P.W, & Fagbola, O. (2008). Influence of mycorrhiza and organo-mineral fertilizers application on growth of maize cultivars in nutrient depleted soil. *Nigeria Journal of Mycology (The official Journals of the Mycological Society of Nigeria (MYCOSON)* Pp 111 – 118

Okon, I. E. (2011). Field response of two cassava genotypes inoculated with arbuscular mycorrhizal fungus to gliricidia sepium mulch in tropical alfisol. *Botany Research international ,4*(1)04 – 08 ISSN 2221 – 3635 IDOSI Publication

Olaniyi, J.O (2006). *Influence of nitrogen and phosphorus fertilizers on seed yield and quality of egusi melon (citrallus lanatus (thumb) mansf) in ogbomoso, southwestern Nigeria*. PhD Thesis, University of Ibadan, Ibadan pp 157

Olaniyi, J.O, & B.A. Tella (2011). Effects of nitrogen and potassium fertilizers on the growth seed yield and nutritional values of egusi melon (citrullus lanatus (thumb) mansf.) in ogbomoso south west Nigeria. *International Journal of plant Science. 2*(11) 328 – 331. www.intersjournals.org/RJPS.

Omueti, J.A.I., Shridhar, M.K.C., Adeoye, G.O., Bamiro, O. & Fadare, D. A. (2000). *Organic fertilizer in Nigeria: our experience*. Agronomy in Nigeria, M.O. Akoroda (Ed) pp. 208-215.

Yusuf, O, Sanni, S. A. Ojuekaiye, E. O., & Ugbade, O. O. (2008). In profitability of egusi melon (citrusllus lanatus (thumb) masf) production under sole and mixed cropping systems in kogi state, nigeria. *Journal of Agricultural and Biological zSciences 2*(2)