Greener Journal of Agricultural Sciences
ISSN: 2276-7770; ICV: 6.15
Vol. 3(4), 280-285, April 2013

http://gjournals.org/GJAS

Research Article

Comparative Shoot Responses of two Nigerian Crops to Glomus clarum and other Fertilizers

Fapohunda S.O.[1]*, Olawuyi O.J.[2], Bello O.B.[3] and Lawal T.[4]

*[1]Department of Biosciences and Biotechnology, Babcock University, Ilishan remo, Nigeria.
[2]Department of Botany, University of Ibadan, Nigeria.
[3,4]Department of Biological Sciences, Fountain University, Osogbo, Nigeria.

ARTICLE INFO

Article No.: *021913478*
DOI: *10.15580/GJAS.2013.4.021913478*

Submitted: *19/02/2013*
Accepted: *22/04/2013*
Published: *24/04/2013*

***Corresponding Author**
Fapohunda S.O.
E-mail: *oystak@yahoo.co.uk*

Keywords:
Glomus clarum, maize, cowpea, fertilizers, shoot

ABSTRACT

The comparative efficiency of organic and synthetic fertilizers were studied on maize and cowpea, two staple Nigerian crops. Chemical fertilizer did not support yield as much as poultry manure (PM) or arbuscular mycorrhizal fungi(AMF), individual or in a combined state. The combination of PM and AMF was the best application expressing yield in form of shoot productivity. *Glomus clarum* was a good fertilizing candidate in this study.

INTRODUCTION

Non chemical system of fertilizing crops has, in recent years demonstrated an attraction to farmers and researchers across the world. The advantages over application of synthesized fertilizers include environment –friendly by eliminating chemicals from the immediate environment, building healthier soil, improved efficiency in nutrient release and the overall guarantee of enhanced yield . In addition, specific application of arbuscular mycorrhizae was reported to aid phytoremediation of a soil polluted by dangerous chemicals (Stanhill, 1990;Bengtsson et al., 2005; Ten et al., 2010). All chemical fertilizers are regarded as salts of diverse elements which contributes little or nothing to feed the soil. On the contrary, chemical fertilizers leave the soil depleted than it met it.Unused nutrients in poultry manure represent an economic loss to poultry producers and society at large (Hussein, 1997). Arbuscular mycorrhizal fungi (AMF) are bio-control agents (Fapohunda *et al*., 2011) which improve the growth and yield performance, disease and drought resistance, fertilizer utilization and rooting depth of plants (Olawuyi *et al*., 2011; Olawuyi *et al*., 2012).

The 2 test crops – maize (*Zea mays* L.) and cowpea (*Vigna unguiculata* (L) walp -- are widely grown crops with great economic value in countries like Nigeria. They are staple crops that constitute the main diet of many people and livestock fodder in tropical and subtropical Africa especially in the Northern and Southern Guinea Savanna of Nigeria.

Poultry farmers in the country tend to generate large amount of poultry droppings which ordinarily are wastes but have high organic manure valueand essential plant nutrients likely to be an asset to crop production. These animal droppings are considered to be one of many naturally occurring organic fertilizers. Others include slurry, worm castings, peat and seaweed.

The aim of the study was to examine a comparative study involving some fertilizers on the productivity/biomass of two Nigerian crops-maize and cowpea.

MATERIALS AND METHOD

The experiment was conducted in the screen house located at Fountain University, Osogbo. Each of the 10 litre plastic bucket was filled with 9kg of the sterilized soil. Each of the potted plant was spaced out at 35cm by 65cm on each of 2 axes among the pots.

Maize and Cowpea, were obtained from Oja Oba market in Osogbo, Osun state, while the Poultry Manures (PM) was collected from a local poultry farm situated at Ejigbo, Osun state. Arbuscular mycorrhizal fungus (*Glomus clarum*) mixtures of soil and root fragment were obtained from the Soil Microbiology unit of the Department of Botany and Microbiology, University of Ibadan, Nigeria.

The soil collected was later sieved with 2mm sieve material and sterilized for 90minutes at temperature 125^0C using electric oven, and filled into 10kg plastic pots.

The poultry manure, AMF and urea fertilizer each was used at the rate of 16g per plant in each pot. The treatment which consists of the potted plants was spaced out at 35cm by 65cm between and within the pot. The maize varieties include M_1 (control), M_2 (urea), M_3 (AM), M_4 (PM) and Maize 5 (AM+PM) and cowpea variety B_1 (control), B_2 (urea), B_3(AM), B_4 (PM) and Beans 5(AM+PM) were used. Planting was done with two to three seeds sown per pot. Three replicates were made of each treatment

Thinning was done 14days after planting to achieve one plant stand. Watering of the potted plant and agronomic practices were duly carried out.

Urea fertilizer was applied into the soil, a week after emergence of the test plants at the rate of 16g. The arbuscular mycorrhizal and poultry manure were incorporated into the potted soil at 16g per pot same day. Arbuscular mycorrhizal and poultry manure were combined at ratio 1: 1 i.e. 8g of A.M and 8g of P.M. It was later incorporated into the potted soil before the planting was carried out. Untreated soil was also included in the experiment to serve as standard check.

Observations were made at 1,2,3,4,5 and 6 weeks after planting (WAP). The growth parameters determined were: the length, width, height, leaf area, number of leaves, number of branches, stem height, stem girth, pod length and pod number.

The experimental design was Complete Randomized Design with three replicates. The data collected were subjected to statistical analysis using analysis of variance (ANOVA), while significant means were separated with Duncan Multiple range test at 1% or 5% probability level.

RESULTS AND DISCUSSION

On the final (6^{th}) week after planting it was observed that the application of PM and AMF alone to maize did not give the maximum yield (Table 1) in leaf area although PM alone was the best treatment on cowpea. The shoot height had the best response from poultry manure application (Table 2), while urea gave the least value for both crops at 6^{th} WAP and 4^{th} WAP. The administration of AMF alone in maize resulted in values not significantly different ($p<0.05$) from the control at 2, 3 and 4 WAP (Table 3). This indicates that AMF alone did not support the production of leaves in maize. However PM gave the largest number of leaves for both crops. It will be noted that carbohydrate productivity is directly related to leave production in plants. In Table 4 it is shown that PM and a combination of AMF and PM expressed the best performance in the number of branches produced. In cowpea, the values were significantly better than the control. All the treatments and control gave no significant difference in maize.

In cowpea, none of the treatments gave values that were significantly different from the control. However, PM and the combination with AMF proved supportive in stem growth increase in maize (Table 5).

The experiment monitored stem growth only at 4WAP. Cowpea responded satisfactorily to the combination of AM and PM in seed production per pod, per plant as well as pod number per plant and seed weight per pod. The same was applicable to grain weight at maturity. It is therefore concluded that for cowpea to attain the best productivity, a combination of AM and AMF is recommended. This result has given further impetus to the present embrace of organic agriculture which is a system that discourages all form of chemical additives to the soil to aid crop production. In all, the general productivity and biomass were aided by PM and AMF combination as compared to urea fertilizer and untreated plant.Fungal hyphae release enzymes like chitinase, cellulase and protease which allow them to digest and penetrate through organic substrates that can then be absorbed and used by the fungus and /or host plant as energy and nutrient sources for growth and reproduction Arbuscular mycorrhizae are known to be significant for the understanding of phosphorus acquisition in plant nutrition.(Hata *et al*., 2010;Smith *et al.,* 2011).

Soil hyphae are critical to nutrient cycling by helping to prevent losses from the system, even when roots are inactive (Lussenhop and Fogel, 1999), mycorrhizal fungi contribute to the overall carbon storage in the soil (Ryglewicz and Andersen, 1994).

Different responses to treatment between cowpea and maize could be attributed to their anatomy. Whereas the one runs an adventitious root system that quickly taps organic manure from the near soil surface, the other maintains a root system that could go further down the soil.

Table 1: Effect of PM, AMF and urea fertilizer on *leaf area*of cowpea and maize.

Treatment	1WAP cowpea	1WAP Maize	2WAP Cowpea	2WAP Maize	3WAP Cowpea	3WAP Maize	4WAP cowpea	4WAP maize	5WAP Cowpea	5WAP Maize	6WAP Cowpea	6WAP maize
PM	30.1a	26.1a	37.1a	62.8b	47.8a	110ab	58.1a	167.2a	67.0a	183a	78.9a	230a
AMF+PM	29.1a	31.1a	40.5a	47.9b	43.8a	109ab	49.4ab	141a	46.5b	130ab	63.4b	172ab
AMF	27.0a	24.6a	39.0a	60.7b	42.9a	88.4bc	44.6ab	109b	41.5b	90b	50.2c	108bc
Control	26.6a	35.2a	34.9a	90.1a	39.8a	122a	42.5b	152a	35.4b	120ab	38.6d	137bc
Urea	24.5a	26.8a	13.4b	47.9ab	14.9b	60.6c	42.2b	60.1c	34.4b	60b	41.5cd	65c

AMF-Arbuscular Mycorrhizal Fungi, PM-Poultry Manure and Urea Fertilizer.
****Each value is the mean for 3 replicates value in column followed by the same letters are not significantly different according to Ducan's multiple range tests (p<0.05).***

Table 2*:* Effect of PM-AMF, Urea, AMF and PM on *height* of cowpea and maize

Treatment	1WAP Cowpea	1WAP maize	2WAP Cowpea	2WAP Maize	3WAP Cowpea	3WAP Maize	4WAP Cowpea	4WAP Maize	5WAP Cowpea	5WAP Maize	6WAP Cowpea	6WAP Maize
PM	11.7a	6.77a	13.8a	11.3ab	17.7a	15.7a	18.3a	20.9a	23.3a	25.7a	58.0a	30.5ab
AMF+PM	11.2a	6.83a	13.8a	11.7ab	15.7a	14.2a	17.0ab	18.4a	23.0a	22.5ab	47.0b	33.1a
AMF	9.5a	6.73a	11.6a	10.2b	13.7a	13.9a	14.2b	15.8ab	18.5b	17.5bc	16.9c	22.5c
CONTROL	10.0a	6.57a	12.1a	12.8a	14.0a	16.3a	15.1b	20.3a	14.8c	23.7ab	13.9c	26.0bc
UREA	9.6a	6.07a	11.2a	7.23c	13.7a	8.87b	15.2b	11.8b	16.7bc	13.5c	17.4c	15.2d

AMF-Arbuscular Mycorrhizal Fungi, PM-Poultry Manure and Urea Fertilizer.
****Each value is the mean for 3 replicates value in column followed by the same letters are not significantly different according to Ducan's multiple range tests (p<0.05).***

Table 3: Effect of PM, AMF and Urea fertilizer on *number of leaves* on cowpea and maize

Treatment	1WAP	lWAP	2WAP	2WAP	3WAP	3WAP	4WAP	4WAP	5WAP	5WAP	6WAP	6WAP
	Cowpea	maize	Cowpea	Maize	cowpea	maize	Cowpea	Maize	Cowpea	Maize	cowpea	Maize
Poultry Manure	3.00b	3.33ab	8.00a	4.00a	13.7b	5.00a	16.0a	7.33a	26.0a	8.67ab	28.0a	8.67b
AMF+PM	3.00b	3.00b	7.00a	4.67a	11.0a	5.33a	14.00ab	7.00a	19.0b	8.33b	19.0b	8.33bc
AMF	3.00b	3.00b	5.00a	4.33a	9.30ab	5.33a	10.0c	7.33a	15.0bc	7.67b	13..0bc	7.33c
Control	3.67a	3.67a	8.00a	4.67a	10.0ab	5.67a	10.0c	7.00a	11.3c	9.67a	11.3c	10.33a
Urea	3.00b	3.00b	4.67a	3.67a	5.67b	5.00a	10.7bc	6.07a	11.7c	8.67ab	12.0c	8.33bc

AMF-Arbuscular Mycorrhizal Fungi, PM-Poultry Manure and Urea Fertilizer.

Each value is the mean for 3 replicates value in column followed by the same letters are not significantly different according to Ducan's multiple range tests ($p<0.05$).

Table 4: Effect of PM, AMF and Urea fertilizer on *number of branches* of cowpea and maize

Treatment	3WAP	3WAP	4WAP	4WAP	5WAP	5WAP	6WAP	6WAP
	cowpea	Maize	cowpea	Maize	cowpea	Maize	Cowpea	Maize
Poultry Manure	4.00a	3.00ab	9.00a	9.00a	5.00a	5.67a	18.0a	5.67a
AMF+PM	2.00b	3.33ab	6.00ab	4.00a	5.67a	5.67a	14.0ab	5.67a
AMF	3.00ab	3.00ab	6.00ab	5.00a	5.33a	5.33a	10.3bc	5.33a
Control	2.00b	3.67a	4.00b	4.67a	6.33a	6.33a	6.67c	6.67a

Table 5:Effect of PM, AMF and Urea fertilizer on *stem girth* of cowpea and maize.

Treatment	1WAP	1WAP	2WAP	2WAP	3WAP	3WAP	4WAP	4WAP	5WAP	5WAP	6WAP	6WAP
	Cowpea	maize	Cowpea	maize	Cowpea	maize	cowpea	Maize	Cowpea	Maize	Cowpea	Maize
PM								3.80ab	1.27a	4.07a	1.27a	4.07ab
AMF+PM								3.13ab	1.20ab	3.50b	1.20a	3.57a
AMF								2.87c	1.07ab	2.63c	1.07a	2.70c
Control								4.07a	1.00b	3.23b	3.00a	3.37b
Urea								2.67c	1.13ab	2.47c	1.13a	2.67c

AMF-Arbuscular Mycorrhizal Fungi, PM-Poultry Manure and Urea Fertilizer.

****Each value is the mean for 3 replicates value in column followed by the same letters are not significantly different according to Ducan's multiple range tests (p<0.0)***

Table 6 : EFFECT OF PM, AMF AND UREA FERTILIZER. ON OVERALL YIELD OF COWPEA

Treatment	No of seed per pod	No of seed per plant	Pod length/ Plant	Pod No/ plant	Total No of pod	Pod weight per plant	Total pod weight	Grain weight per pod	Seed weight per pod	Seed weight/ Pod	Length at maturity
Poultry Manure	3.33ab	5.67ab	5.00ab	1.00b	1.33b	0.60ab	1.07b	0.13b	0.93b	4.33b	1.17ab
AM+PM	4.67a	11.33a	9.63a	2.33a	3.33a	1.67a	2.87a	0.37a	2.20a	8.33a	1.87a
AMF	3.00ab	3.67ab	7.67a	1.00b	1.33b	0.57bc	0.63b	0.17ab	0.50b	4.00b	1.47ab
Control	1.33ab	1.33b	2.03bc	0.03c	o.33b	0.13bc	0.13b	0.33b	0.10b	1.00b	0.67ab
Urea	0.00b	0.00b	0.00c	0.00c	0.00b	0.00c	0.00b	0.00b	0.00b	0.67b	0.27b

AMF-Arbuscular Mycorrhizal Fungi, PM-Poultry Manure and Urea Fertilizer.

****Each value is the mean for 3 replicates value in column followed by the same letters are not significantly different according to Ducan's multiple range tests (p<0.05).***

The present results show that PM &AMF can be used to replace mineral fertilizer in the cultivation of cowpea & maize especially in the organic farming system which advocate for no chemical application. In addition to that,
our environment will be far better protected when using these organic materials since it has been reported that inorganic fertilizer contributes to environment degradation.

- Poultry manure is a very rich manure source in that it contains elements like nitrogen, phosphorus and potassium and organic carbon(Nicholson *et al.,* 1996). An appropriate mycorrhizal symbiosis or a form of co function is important in maintaining cytokinin levels in leaves that are drought –stressed (Goicoechea *etal*., 1995) . The extrametrical mycelium of arbuscular mycorrhizae fungi are known to be significant in enhancing nutrient phytoextraction in soil, thus increasing the overall fertilizer efficiency (Yu *et al.,* 2005; Jin *et al.,* 2005).

Since PM can be got cheaply from poultry farms, the production of AMF at a very affordable price to end users is now an attraction to scientific research. This will encourage the production of *Certified Naturally Grown* crops at a commercial scale for human consumption in Nigeria.

REFERENCES

Bengtsson J; Ahnstr J and Weibull AC (2005). The effects of organic agriculture on biodiversity and abundance in a meta analysis. *J Appl. Ecol* 42: 261-9.

Fapohunda S.O, Olawuyi O.J and Okei CP (2011). Antimicrobial and phytochemical potentials of arbuscular mycorrhizal fungi in Nigeria. The *South PacificJournal of Natural and Applied Sciences ,* 29 : 21-25 .

Goicoechea N; Dolézal K, Antoĺin MC, Strnad M and S´nchez-Díaz M (1995). Influence of mycorrhizae and Rhizobium on cytokinin content in drought-stressed alfalfa*J. Exp. Bot*. 46(10) 1543-49.

Hata S; Kobae Y and Bamba M (2010). Interactions between plants and arbuscular mycorrhizal fungi *Int Rev. Cell. Mol. Biol*. 281: 1-48.

Hussein TO (1997). Effect of poultry manure on growth of tomato proceeding of 15th annual conference. HORTSON Apr. 8-11, 1997. NIHORT, Ibadan, Nigeria. Pp 43-45.

Jin H; Pfeffer PE; Douds DD; PiotrowskiE; Lammers PJ and Sachar-hill Y (2005). The uptake, metabolism, transport and transfer of nitrogen in an arbuscular mycorrhizal symbiosis. *New Phytologist* 168: 687-696.

Lussenhop J and Fogel R (1999). Seasonal changes in phosphorus content of Pinusstrobuds-*Cenococcum geophilum* ectomycorrhizae. *Mycologia* 91 742-46.

Nicholson FA; Chambers BJ and Smith KA (1996). Nutrient composition of poultry manures in England and Wales.*Bioresource Technology* 58, (3) 279–284.

Olawuyi OJ; Babatunde FE; Akinbode; OA, Odebode; AC and Olakojo SA (2011). Influence of Arbuscular mycorrhizal and N.P.K fertilizer on the productivity of cucumber (*Cucumis sativus*). International *Journal of Organic Agriculture Research and Development* 3 : 22-31.

Olawuyi, OJ, Ezekiel-Adewoyin DT, Odebode AC, Aina DA and Esebanenm G (2012). Effect of arbuscular mycorrhizal (Glomus clarum) and organimineral fertilizer on growth and yield of okra (Abelmoschus esculentus). African Journal of Plant Science 6(2): 84-88.

Ryglewicz PT and Andersen CP (1994). Mycorrhizae alter quality and quantity of carbon below ground. *Nature* 369 58-60.

Smith SE; Jacobsen I; Grunlund M and Smith FA (2011). Roles of arbuscular mycorrhyzas in phosphorus nutrition :Interactions between pathways of phosphorus uptake in arbuscular mycorrhizal roots have important implications for understanding and manipulating plant phosphorus acquisition. *Plant Physiology* 156 1050-1057

Stanhill G (1990). The comparative productivity of organic agriculture. *Agric Ecosyst Env*.30(1-2)1-26

Teng Y; Luo Y; Sun X; Tu C; Xu L; Liu W; Li Zand Christie P (2010).Influence of arbuscular mycorrhiza and Rhizobium on phytoremediation by alfalfa of an agricultural soil contaminated with weathered PCBs: a field study.*Int J Phytoremediation*.12(5):516-33.

Yu X; Cheng J and Wong MH (2005). Earthworm mycorrhiza interaction on Cd uptake and growth of ryegrass. *Soil Biology and Biochemistry* 37: 195-201.

Cite this Article: Fapohunda SO, Olawuyi OJ, Bello OB and Lawal T (2013). Comparative Shoot Responses of two Nigerian Crops to Glomus clarum and other Fertilizers**.** Greener Journal of Agricultural Sciences, 3(4), 280-285, http://doi.org/10.15580/GJAS.2013.4.021913478**.**