Influence of Arbuscular Mycorrhizal and NPK Fertilizer on the Productivity of Cucumber (*Cucumis sativus*).

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ABSTRACT

Greenhouse studies were conducted in 2008 and 2009, at the Institute of Agricultural Research and Training, Ibadan, to investigate the effect of arbuscular mycorrhizal (AM) fungi and NPK fertilizer on the growth and yield of Cucumber plants. There were eleven treatments in three replicates laid out in a completely randomized design. The AM fungi and NPK fertilizer were applied into 8kg soil each at the rates of 0kg/ha, 250kg/ha, 500kg/ha, 750kg/ha, 1000kg/ha and 1250kg/ha.The results showed that plants treated with 500kg/ha fungi produced higher fruit weight per plant. This yield was significantly higher than other treatments. It thus appeared that 500kg/ha is the optimum level of AM fungi that is required for cucumber cultivation. The values of phosphorus in soil post harvest were lower in all the AM treated pots than the plants treated with NPK fertilizer. The fruit yield of Cucumber with 500kg/ha AM fungi reduced P toxicity in the soil.

Keywords : Mycorrhiza, fertilizer, Cucumber, fruits, yield.

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INTRODUCTION

Cucumber, *Cucumis sativus* L. is an important fruit vegetable with great economic potentials, as medicinal plant and source of industrial raw materials. Cucumber is a dependable laxative food for those who suffer constipation. The juice of cucumber is a valuable medicinal food in the treatment of hyperacidity gastric and duodenal ulcers (Ernestina, 2001).

In Nigeria, Cucumber production and utilization has not been a viable option to farmers despite the numerous benefits and economic importance of this crop. This might be in part due to the declining soil fertility, which prevents optimum yield and the short shelf life of cucumber fruits which leads to early deterioration. An understanding of crop nutrient requirements and the use of appropriate fertilizer are important keys to production of cucumber crop. Cucumbers do not perform well in acid soil but do well under slight acidity The optimum pH is 5.5 7.0 (Donald, 1980). Valenzuela *et al.* (*2005*) recommended that if the soil pH is below 5.8 and available calcium is less than 95kg/acre, 95/acre of agricultural lime must be applied at 8-12 weeks before planting. Although chemical fertilizers promote healthy, robust plant growth and give high yield, there is a point at which they become toxic and retard plant growth and fruit production. Hence, to prevent the toxicity of soil due to fertilizers and to overcome drooping of the plant, alternatives to inorganic fertilizers should be developed. This alternative should be environmentally friendly, readily available and cheap for a common farmer. These reasons have brought to mind the use of Arbuscular mycorrhizal fungi.

AM fungi are particularly important in improving uptake of phosphorous because of the very short transmission distance of phosphate ions in the soil. They also enhance the uptake of secondary and micro-nutrients including calcium, sulphur, zinc and copper (Blat *et al.,* 1990). George *et al*. (1992) asserted that most agricultural crops can perform better and are more productive when they are well colonized by AM Fungi on the roots. Fungi have also been reported to enhance phytoaccumulation of heavy metals such as zinc, cadmium, arsenic and selenium (Khan *et al.*, 2000; Al-agely *et al.,* 2005). To overcome these deficiencies of nutrients required in cucumber production, the use of Arbuscular mycorrhizae and NPK fertilizer was investigated on the crop. Therefore, the objective of this study was to investigate the effects of the Arbuscular mycorrhizae fungi and NPK fertilizer on the growth and yield of cucumber.

MATERIALS AND METHODS

Experiments were conducted for two years (2008 and 2009) in the greenhouse of the Institute of Agricultural Research and Training (IAR&T), Ibadan, Nigeria. Top-soil (0-30cm depth) was collected randomly at the Research farm of the institute. The soil was air-dried and sieved using 2mm sieve. Sample of the soil was analysed for physical and chemical parameters. The experimental design used was completely randomized design (CRD) with 3 replicates. The AM fungus,(consisting of mixture of soil and root fragments) and NPK fertilizer were applied into 8kg soil at the rate of 250, 500, 750, 1000 and 1250kg/ha while, the control was not treated. The AM fungus used for the study was *Glomus deserticola.* The soil used was hot air sterilized at 270°C, filled into 8kg plastic pots and arranged at 50 x 50cm spacing distance in the greenhouse. Three seeds of 'Palomar' variety of Cucumber obtained from National Institute of Horticultural Research and Training (NIHORT) were planted per pot and later thinned to two seedlings. Both NPK15-15-15 and *G.deserticola* were applied into the pots immediately after planting according to the treatments with the exception of the control pots that were not treated with either fertilizer or *G.deserticola*. All agronomic practices were duly carried out. Plants were watered twice a week.

Data collected two, four, six, eight weeks after planting were; vine length (cm), number of leaves per plant as well as number of branches per plant. Harvesting of tubers was carried out nine times at weekly intervals and yield parameters were taken at each harvest. These include number of harvested fruits per plant, weight of harvested fruits per plant and weight of harvested fruits per pot. Also, soil samples were taken for post harvest analysis to ascertain the soil nutrient contents. All the data were subjected to statistical analysis of variance (ANOVA) using statistical analysis system (SAS) (1992) version 5 statistical package, while the means were separated with Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Growth and Yield parameters

There was no significant difference in the number of leaves produced per plant among the plants treated with different rates of Arbuscular mycorrhiza at two, four, six and eight weeks after planting (WAP). However, plant treated with 1250kg/ha AM produced highest number of leaves (5,12 and 17) leaves per plant at 4, 6 and 8 weeks after planting respectively

compared with other AM treatments (Table 1). The treatment also produced significantly higher number of leaves than the control plant at 8WAP (Table 2). Plants to which NPK 15-15-15 was applied were not significantly different from each other with respect to the number of leaves per plant at four, six and eight WAP. Irrespective of the dosage, plants treated with 250kg/ha of NPK had highest values at 4th and 6th week after planting (6 and 13 respectively). Both the NPK and AM treatments were not significantly different from each other with the exception of the lowest rate of AM at 250kg/ha that recorded significantly lowest mean number of leaves than plant treated with 250kg/ha of NPK fertilizer at 4th and 6th WAP. This is corroborated by the findings of Schippers (2000) who reported that application of nitrogen is particularly useful in promoting the vegetative growth of the plant, producing large green leaves and also necessary for setting of fruits.

The vine length of plants treated with AM (irrespective of the rates) were not significantly ($P<0.05$) from those that received higher doses of fertilizer (750, 1000 and 1250kg/ha NPK) at two, four, six and eight WAP. Though, plants treated with the lowest rate of 250kg/ha NPK recorded the longest vine length at two, four, six and eight WAP but these were not significantly different from those plant that received 500kg/ha of NPK (Table 2).

The leaf area of plants treated with 250 and 500kg/ha of NPK were not significant ($P<0.05$) at two, four, six and eight WAP while the highest rate of NPK (1250kg/ha) produced the largest leaf area at 8 WAP. However, these were not significantly different from leaf area of plants treated with 500,750, 1000, 1250kg/ha AM and the control.

Irrespective of the rates used, plants treated with both AM and NPK produced non-significant mean number of branches per plant at 8 WAP (Table 3).

Mean number of fruits produced per plant on cucumber grown with 500kg/ha of AM was found to be the highest among all the treatments. The value (5.00) was not significantly different from those recorded in plants treated with 750kg and 1000kg/ha of AM, and plants treated with 500kg and 1250kg/ha of NPK fertilizer but significantly different from other treatments and the control (Table 4). This is supported by the findings of Bamidele (2000) who reported that an increase in the yield of cucumber as the NPK rate increases from 200 to 400kg/ha. This is however at variance with the findings of Glumtsov *et al*. (1975) who reported a depression in cucumber yield as the NPK rate increased 1000 to 1200Kg/ha.

With respect to the weight of harvested fresh fruit of Cucumber per plant, those that were treated with 500kg/ha of AM produced significantly

Table 1. Effects of AM fungi and NPK fertilizer on the number of leaves of Cucumber (Mean of two years).

Treatment	2WAP	4WAP	6WAP	8WAP
Control	3.00ab	4.67ab	9.00ab	7.33b
250kg/ha NPK	3.33ab	6.33a	13.00a	10.33ab
500kg/ha NPk	3.67a	5.67ab	12.67a	12.33ab
750kg/ha NPK	2.00b	4.33ab	7.67ab	10.00ab
1000kg/ha NPK	2.67ab	3.67ab	8.67ab	6.67ab
1250kg/ha NPK	2.33ab	4.33ab	10.00ab	14.67ab
250kg/ha AM	2.67ab	4.00ab	8.00ab	8.67ab
500kg/ha AM	2.00b	3.00b	6.33b	9.67ab
750kg/ha AM	2.33ab	4.00ab	7.00ab	13.67ab
1000kg/ha AM	3.00ab	4.67ab	8.33ab	8.33ab
1250kg/ha AM	2.00b	5.00ab	12.00ab	17.00a

Means with the same alphabet along the column are not significantly different from each other (P<0.05).
WAP = Weeks after planting

Table 2: Effect of AM fungi and NPK fertilizer on the vine length (cm) of Cucumber (Mean of two years).

Treatment	2WAP	4WAP	6WAP	8WAP
Control	13.67ab	30.67c	85.00c	93.00ab
250kg/ha NPK	26.00a	67.00a	167.00a	181.00a
500kg/ha NPk	19.33ab	60.33ab	145.67ab	179.00a
750kg/ha NPK	14.33ab	35.67bc	89.33bc	109.33ab
1000kg/ha NPK	14.67ab	44.33abc	97.67bc	110.33ab
1250kg/ha NPK	9.67b	40.00bc	113.00abc	166.00ab
250kg/ha AM	13.00b	21.33c	69.33c	81.00b
500kg/ha AM	11.67b	18.33c	62.33c	110.33ab
750kg/ha AM	14.00ab	29.33c	69.33c	127.67ab
1000kg/ha AM	14.00ab	30.67c	75.33c	79.33b
1250kg/ha AM	13.00b	39.67bc	83.67c	121.67ab

Means with the same alphabet along the column are not significantly different from each other (P<0.05).
WAP = Weeks after planting

Table 3. Effects of AM fungi and NPK fertilizer on the number of branches of Cucumber (Mean of two years).

Treatment	2WAP	4WAP	6WAP	8WAP
Control	1.67ab	3.67ab	11.33b	141.33
250kg/ha NPK	3.67a	6.33a	21.67a	17.67
500kg/ha NPk	3.67a	6.33a	16.67ab	17.00
750kg/ha NPK	2.00ab	4.00ab	10.00b	11.67
1000kg/ha NPK	1.67ab	4.67ab	14.67ab	11.00
1250kg/ha NPK	2.00ab	3.67b	17.33ab	19.67
250kg/ha AM	1.30b	2.67b	9.67b	12.00
500kg/ha AM	1.00b	2.33b	7.67b	12.67
750kg/ha AM	1.67ab	3.67ab	10.00b	13.00
1000kg/ha AM	2.00ab	3.67ab	13.33ab	19.00
1250kg/ha AM	2.33ab	5.67ab	15.67ab	16.00ns

Means with the same alphabet along the column are not significantly different from each other (P<0.05).

WAP = Weeks after planting

Table 4. Effects of AM fungi and NPK fertilizer on cumulative fruit yield of Cucumber (mean of two years).

Treatment	number of fruit Per plant	weight of fruit per plant (g)
Control	1.00d	131.35cd
250kg/ha NPK	2.67c	57.88cd
500kg/ha NPk	3.67abc	364.57b
750kg/ha NPK	1.00d	50.34d
1000kg/ha NPK	3.33bc	182.42cd
1250kg/ha NPK	3.67abc	215.10c
250kg/ha AM	1.33d	165.18cd
500kg/ha AM	5.00a	590.65a
750kg/ha AM	4.33ab	377.80b
1000kg/ha AM	3.67abc	446.10b
1250kg/ha AM	2.67ab	406.94b

Means with the same alphabet along the column are not significantly different from each other (P<0.05).

Table 5: The result of pre and post planting soil analysis on Ca, Mg, Na, K, P, and pH (Mean of wo years)

Treatment	Ca	Mg	Na	K	P	pH
Pre-planting	2.68ab	0.27b	0.23a	1.19ab	3.53c	6.53b
Control	3.01ab	0.36b	0.19ab	0.34ab	3.89c	7.37ab
250kg/ha NPK	2.93ab	0.30b	0.26a	0.22b	5.02bc	6.77c
500kg/ha NPK	2.62ab	0.29b	0.20ab	0.35ab	5.61bc	7.23ab
750kg/ha NPK	2.89ab	0.31b	0.25a	0.61ab	11.76ab	6.87ab
1000kg/ha NPK	2.41b	0.29b	0.23a	0.84ab	15.63a	7.70a
1250kg/ha NPK	3.00ab	0.29b	0.24a	0.34ab	9.74b	6.77ab
250kg/ha AM	3.57a	0.53a	0.26a`	0.34ab	2.25c	7.07ab
500kg/ha AM	2.76ab	0.33b	0.25a	1.63a	3.18c	7.13ab
750kg/ha AM	2.79ab	0.33b	0.20ab	0.34ab	1.96c	7.13ab
1000kg/ha Am	2.28b	0.29b	0.14b	0.34ab	1.96c	7.53ab
1250Kg/ha Am	3.05ab	0.32b	0.24a	0.36ab	4.23c	7.13ab

Means with the same alphabet along the column are not significantly different from each other ($P<0.05$).

higher yield per plant (590.65g plant) compared with the other treatments (Table 4). Akinsanmi (1996) revealed that phosphorous is essential for flowering and fruit formation in vegetables. However, large quantities of phosphorous sometimes may be present in the soil but not available to the growing plant because it may be insoluble in such situation.

Physical and Chemical properties of Soil before planting and Post harvest soil analysis on Ca, Mg, Na, K, P and pH.

The physical analysis of the soil used for this experiment revealed that it contained 88.4% sand, 8.4% clay and 3.2 % silt which was sandy loam in texture. The soil was slightly acidic with pH value of 6.53. The available phosphorous level in the soil was 3.53mg/kg which is suitable for growing of cucumber according to Valenzuela *et al.* (2005). Calcium (Ca) and magnesium (Mg) contents of the post harvest soil was significantly higher for 250kg/ha AM than pre-planting and other treatments. AM showed the tendency of reducing the pH level of the soil. Post harvest soil analysis for Potassium (K) was significantly higher for 500kg/ha AM while, 1000kg/ha NPK was significantly higher for phosphorus (P) than pre-planting and other treatments.

The value of calcium content in post harvest soil for 250kg/ha AM recorded highest significant value compared with 1000kg/ha AM and 1000kg/ha NPK but not with the other treatments.

Magnesium value of soil treated with 250kg/ha AM was highest and this was significantly different from all other treatments. Sodium (Na) value was significantly lower (0.14) in soil treated with 1000kg/ha AM than other treatments. Potassium value was significantly higher in soil treated 500kg/ha AM (1.63) than that treated with 250kg/ha NPK but not different from others. Phosphorous was significantly higher in soil treated with 1000kg/ha NPK (15.63) than other treatments except that treated with 750kg/ha NPK and the control pots.

Lower values of P were observed in all the AM treated soil relative to the NPK treatment and significantly higher than the value in control soil as well as soil treated with higher rate of NPK fertilizer (Table 5). This confirms the ability of AM to enhance absorption/uptake of P in the soil as reported by Smith and Read (1997) that AM are very effective in helping the plants to absorb P from the soil and invariably prevents P run off that leads to eutrophication(undesired biological growth and productivity). Increased phosphorous uptake by mycorrhiza plants can help to reduce the quantity of this nutrient added to the soil.

NPK fertilizer also increased phosphorous level in the post harvest soils and might cause phosphorous pollution in the environment because P is an immobile nutrient and it is susceptible to fixation by certain chemical agent such as aluminium and iron (Akinsanmi, 1996). Sometimes large quantities of phosphorous may be present in the soil but not available to the growing plants because it is insoluble.

CONCLUSION

The use of 500kg/ha AM fungus can be recommended for farmers since most agricultural crops can perform better and more productive when colonized by AM fungus, especially in the cultivation of cucumber. The farmers should be encouraged to use AM fungi as it is environmentally friendly, required no specialized skill for its application and there is no need of frequent application as it is in the case of NPK fertilizer.

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