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Effects of organo-mineral fertilizers on growth, yield and mineral nutrients uptake in cucumber

Olaniyi, J.O*; Ogunbiyi, E. M. and Alagbe, D. D.
Department of Agronomy, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

** Correspondence author E- mail:* Olaniyikunle2005@yahoo.com

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Cucumber, cultivars, organo-mineral fertilizers

1 SUMMARY

Experiments were conducted to determine the effects of organomineral fertilizers on the growth, yield and mineral nutrients uptake of cucumber. The treatments involved three varieties of cucumber (Ashley, Poinsett and Royal F1) subjected to four levels of organomineral fertilizer (0, 2, 3 and 4 t. ha$^{-1)}$. The twelve treatment combinations were laid out in a factorial experiment and fitted into a complete randomized block design with three replications. Growth parameters, nutrient uptake and yield attributes were assessed. Organomineral fertilizer significantly ($P \leq 0.05$) improved the growth and yield of cucumber varieties. The growth parameters (vine length and number of leaves), yield and yield components showed increasing response as the rate of organomineral fertilizer increased from 0 to 4 t. The yield and yield components of cucumber varied significantly ($P \leq 0.05$) among the varieties. Although Poinsett recorded the highest fruit weight, Royal F1 gave highest number of fruits, which is more preferred in cucumber production. The yield of cucumber could significantly be improved by the application of organomineral fertilizer at the optimum rate of 3 t. ha^{-1} considering the cost and the poor economic standard of local farmers in Nigeria. Variety Royal F1 and Poinsett performed well in term of fruit yield and can be recommended for the southwestern region of Nigeria.

2 INTRODUCTION

Among the vegetables, the cucurbitaceae crops form one of the largest groups and their wide adaptation from acid to the humid tropic environments makes them a universal crop (Bates *et a*l., 1990). Cucumber is a native of Asia and Africa, where it has been consumed for 3,000 years. It is adapted to wide variety of soil types, but preferably in areas with good drainage, adequate soil water holding capacity and optimum pH of 5.5 – 7.0. It is a popular fresh market vegetable for making salads. Fruits are sliced into pieces and served with vinegar or a salad dressing, on their own or mixed with other vegetables. Young or ripe cucumber fruits are usually used as cooked vegetables or made into chutney (Grubben & Denton, 2004).

Food security is a major issue in the developing nations of the world as a result of unreliable rainfall, marginal soil fertility and low input levels causing declining crop yields (Akinrinde, 2006). Major factors that constrain tropical soil fertility and sustainable agriculture are low nutrient capital, moisture stress, erosion, high P fixation, high acidity with aluminum toxicity and low soil biodiversity (Akinrinde *et al.*, 2005).

Most of the plant essential nutrients especially phosphorus (P) and potassium (K) occur in complex forms in the soil and substantial proportions may be transformed into fixed state, making them relatively unavailable for plants to absorb. Monitoring of both soil and crop nutrient status have been advocated among best management practices for fertilizers (Hartz, 2001). Fertilizers are important to crops, especially cucumber (Harts & Nelian, 2000) as they promote growth and they are usually applied via the soil for uptake by plant roots, or by foliar feeding for uptake through leaves. They can be naturally occurring compounds such as peat and mineral deposits, or manufactured through natural process (composting) or chemical processes (Haber processes).

Organic fertilizers could occur naturally as manure slurry, worm casting, peat, seaweeds, sewage, guano or grown as green manure to add nutrients to soil as minerals mine rock phosphate, potash and limestone. Fertilizers could also be manufactured as in compost, blood meal, bone meal and seaweed extract, or as natural enzymes digested proteins, fishmeal and feather meal. Although the density of nutrients in organic materials is comparatively modest, they have some advantages. Growth is achieved with lower nutrient densities while wasting less, release of nutrients at a slower rate and they help to retain soil moisture by reducing the stress due to temporary moisture stress.

Tejeda *et al.* (2005) in their study of the effect of application of two organomineral fertilizer (OMF) on nutrients leaching losses in wheat crop concluded that application of OMF gave a significant increase in grain gross protein content of 2.9%, an increase in number of grain per spike of 22%, a significant increase in number of spikes per square meter of 3.4%, an increase in 1000 – grain weight of 3.9% and a significant yield increase of 2.5% with respect to the O + IF treatment.

In view of the growing environmental awareness in recent years and shortage of raw materials for chemical fertilizer production, increased recycling of urban industrial and agricultural residues with the objective of controlling environmental pollution and creating new alternative products for agricultural uses, such as organomineral fertilizers/bio-fertilizer (Fernandes, *et al.*, 2003) is a worthwhile idea. Therefore, the objective of this research work was to assess the effect of organomineral fertilizer on the growth, yield and nutrient uptake of three cucumber varieties (Ashley, Royal F1 hybrid and Poinsett).

3 MATERIALS AND METHODS

The experiments were carried out in the experimental plot of Crop Types Collection (CTC) unit, Ladoke Akintola University of Technology, during the cropping seasons of 2006 and 2007. The study was done to examine organomineral fertilizer's effect on growth, yield and nutrients uptake of cucumber varieties. Ogbomoso lies between longitude 4^0 10'E and latitude 8^0 10'N with mean annual rainfall of between 1,150 and 1,250mm (Olaniyi, 2006).

Soil samples were collected for analysis before the field was manually cleared. The pH was determined using digital electronic pH meter using 1:2 (soil: water) suspension. Ammonium Acetate (NH_4AC) was used to leach 10g of soil sample. The calcium content was obtained through titration; the magnesium was determined by atomic absorption spectrophotometer, while the potassium and sodium contents were determined by flame photometry and total nitrogen by the micro-Kjeldahl method. The particle size analysis was done by hydrometer method.

Three varieties of cucumber (Ashley, Poinsett and Royal F1) obtained from The Seed Project Company Ltd, Kano were grown for two consecutive growing seasons from April to June on beds. The experimental plot was cleared in each cropping season with the aid of a hoe and cutlass. The land was cleared and beds were made before planting. The area of land used was 175.5m^2. This was divided into three blocks, each containing 12 beds to give a total of 36 beds. Each bed size was 2m by 1m in dimension, with a spacing of 1m between and 0.5m within the plot to ease movement during cultural operations.

The treatments consisted of three varieties of cucumber, Ashley, Poinsett and Royal F1 subjected to four rates of organomineral fertilizer,

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i.e. 0, 2, 3 and 4 t. ha^{-1}. These treatments were laid out in a factorial experiment and fitted into a randomized complete block design with three replications. The 3 varieties were randomly assigned to plots within each replicate and seeds were planted with a spacing of 1 x 0.5m^2. Organomineral fertilizer rates were applied to the respective plots three weeks after sowing (WAS) to ensure better crop performance. The plants were thinned after germination to one plant per stand just before fertilizer application. Crop protection practices were carried out with spraying of neem extract at 2, 4 and 6 WAS against defoliating pests and weeding was done manually twice at 3 and 6 WAS.

Data recording: Data collection on growth and yield of cucumber varieties were taken from six tagged plants per plot. At 8 WAS, when all the vegetative development of cucumber had reached maximum and at flower initiation, 6 plants per treatment were destructively sampled to determine the growth parameters and dry matter yields of the shoot. Vine length was measured with a meter ruler from the base to the tip of the main shoots. Number of leaves were counted and recorded. The fruits were harvested when the heads were fully dried, from six sampled plants in each replicate three months after sowing. The yield parameters recorded to measure the response of cucumber varieties to organomineral fertilizer were: number of fruit, fruit length, fruit diameter and fruit yield. Fruit yield was recorded by weighing the harvested fruits from each plot on an electric weighing balance.

Plant shoots were dried at 65^{0}C for 48 h in an oven and weighed using an electric weighing balance to get the dry matter yield. Dried samples were milled and ground for tissue analysis. Total P was determined by the Vanadomolybdate method, K and Ca were determined by flame photometry and Mg was determined by atomic absorption spectrophotometer. Total N was analyzed by the micro-Kjeldahl procedure. Data collected were subjected to analysis of variance and the means were separated by the least significant difference at 5% probability level.

4 RESULTS AND DISCUSSION

4.1 Soil analysis: The result of the soil analysis carried out before the preparation of vegetable beds at establishment of the experiment is presented in table 2. It was shown that the soil was sandy loam with low organic matter content and good moisture retaining properties. Most of the nutrients in this soil were below the critical level, hence there was need for application of soil amendment in form of inorganic or organics fertilizers.

4.2 Growth parameters: The application of organomineral fertilizer had significant effect on the mean plant height and the number of leaves of the different cucumber varieties (table 2). These growth parameters increased as the organomineral rate increased from 0 to 4 t. ha^{-1}. There were no significant differences between the values obtained with 3 or 4 t. ha^{-1} of applied organomineral fertilizer. This showed that organomineral fertilizer used contained N, which promotes the vegetative growth of cucumber. This finding is similar to that of Akanbi et al. (2005) and Olaniyi *et a*l. (2008) who reported better vegetative growth of vegetables with N addition. The increase in height and number of leaves as organomineral rates increased confirmed the role of organominerals in promoting vigorous vegetative growth in fruit vegetables (Olaniyi *et a*l., 2006; Olaniyi & Ajibola, 2008).

The highest growth parameters were recorded for Poinsett while Royal F1 gave the least values with and without organomineral fertilizer application. Significant differences ($P \leq 0.05$) were observed in the plant height among the cucumber varieties. These results might be due to the effective use of the applied soil amendment at this stage of growth by Poinsett as compare to other varieties.

4.3 Fruit yield and yield components: The fruit yield and yield components (number of fruit, fruit length, fruit diameter, fruit weight per plant, and fruit yield per hectare) produced by cucumber plants were significantly ($P \leq 0.05$) affected by the applied treatments (table 3). These yield attributes increased as the organomineral fertilizer rates increased from 0 to 4 t. ha^{-1} for all the varieties. Although the highest fruit yield and yield components were recorded at the maximum rate of 4 t. ha^{-1}, there was no significant difference between the values obtained at 3. and 4 t. ha^{-1} of applied organomineral rates. The increase in cucumber yields as organomineral rate increases is similar to the findings of Olaniyi et al. (2006) for sweet corn and Tejeda et al. (2005) for maize. Although the highest fruit yield was recorded for Poinsett, Royal F1 gave the highest number of fruits, while the least values were obtained from Ashley for both parameters with and without organomineral application.

The interactive effects of applied organomineral rates and variety were significantly different on the yield attributes. The highest fruit yield or weight obtained from Poinsett may be attributed to the large size fruit produced as compare to the small size and more fruit recorded from Royal F1. This small size characteristic of Royal F1 makes it better and recommended for growing in southwest Nigeria. This is due to the high consumers' preference for the small sized cucumber fruit in the area.

Table 1: Chemical and physical properties of the soil at Ogbomoso study site.

Parameter	**Value**
Ph in water	6.53
Ph in Kcl	5.98
Total N (%)	0.63
Available P (mg/g)	6.99
Exchangeable Cation (mg/g)	
Ca^{2+}	1.96
Mg^{2+}	7.71
K^{+}	0.44
Na^{+}	0.10
Al^{3+}	0.02
Exchangeable Acidity (meq / 100g)	
Organic carbon	2.74
C.E.C	4.2
Acidity	0.05
Mn	6.41
Fe(Fe (ppm)	21.14
Cu	1.63
Zn	3.47
Physical Characteristics	
Sand (%)	79.2
Silt (%)	15.4
Clay (%)	5.4
Textural Class	Sandy loam

Table 2: Effect of fertilizer application on growth of cucumber assessed at 50% flowering stage.

Variety	Fertilizer level (t/ha)	Vine length (cm)	No of leaves (cm)
Ashley	0	23.00	16.50
	2	28.75	13.56
	3	36.15	23.25
	4	37.25	25.75
Poinsett	0	25.00	18.25
	2	30.35	19.75
	3	39.05	26.00
	4	42.50	27.23
Royal	0	20.75	12.65
	2	25.50	19.50
	3	31.75	21.75
	4	34.50	22.35
Prob. :			
Variety (V)		0.0001*	Ns
Fertilizer (F)		0.0001*	0.0001*
V x F		0.0001*	Ns

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Table 3: Yield and yield components of cucumber varieties as affected by organomineral fertilizer.

Variety	Fertilizer	Number of fruit	Mean fruit weight (g)	Fruit weight per plant (g)	Total fruit yield (t/ha)	Fruit length (cm)	Fruit Diameter (cm)
Ashley	0	2.5	66	165.00	1.65	11	5.0
	2	4.20	80	336.00	3.36	13	6.0
	3	7.00	86	602.00	6.02	18.5	7.5
	4	7.25	85.9	623.50	6.24	19.00	7.5
Poinsett	0	2.00	75	150.00	1.50	12	5.5
	2	3.5	100	350.00	3.50	15	7.00
	3	5.75	125	718.75	7.19	21	8.00
	4	6.5	113.0	735.00	7.35	23	8.05
Royal	0	3.33	57	189.81	1.80	9	4.25
	2	5.00	57	285.00	2.85	10.5	5.50
	3	9.35	60	561.00	5.61	14	6.25
	4	9.50	61.5	584.25	5.84	15	7.00
Prob. of F:							
Variety (V)		0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0002*
Fertilizer (F)		0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
V x F		0.0001*	0.0001*	0.0001*	0.0001*	0.0005*	ns

Table 4: Nutrient uptake of cucumber as affected by organomineral fertilizer application.

Variety	**Fertilizer**	**N**	**P**	**K**	**Ca**	**Mg**
Ashley	0	126.14	18.12	145.00	114.15	31.87
	2	202.50	38.54	260.10	156.50	36.40
	3	291.11	54.45	305.17	189.52	42.06
	4	280.84	57.07	275.00	189.20	37.58
Poinsett	0	120.44	12.25	135.65	109.11	26.00
	2	133.45	20.00	148.12	125.55	31.53
	3	165.05	29.35	194.02	142.00	36.32
	4	159.15	31.05	165.25	141.75	35.75
Royal	0	119.65	12.00	125.50	105.25	23.35
	2	128.73	15.00	133.35	115.10	30.53
	3	160.25	21.33	185.13	130.50	35.65
	4	155.00	23.45	177.45	130.00	34.15
Prob. of F:						
Variety (V)	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
Fertilizer (F)	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*
V x F	0.0001*	0.0001*	0.0001*	0.0001*	0.0001*	0.0162

4.4 Nutrient uptake: N, P, K, Ca and Mg uptake by cucumber varieties were significantly ($P \leq 0.05$) influenced by the organomineral, variety, and the interactive effects of the two factor (table 4). The nutrient uptake increased as the fertilizer rates increased from 0 to 3 $t.ha^{-1}$ and thereafter declined. The highest nutrient uptake was obtained from Ashley variety while the lowest value was recorded for Royal F1 with and without organomineral fertilizer application.

The interaction between variety and fertilizer was significant with exception of magnesium concentration. The increase in mineral nutrient contents in plant shoots of cucumber as organomineral rate increased is similar to the findings of Olaniyi *et al.* (2006) for sweet corn and

Tejeda et al. (2005) for wheat. The N, P, K, Ca and Mg uptake was significantly improved in fertilized than unfertilized plants and increased as the applied fertilizer rates increased. This shows that there is positive relationship between soil nutrient content and plant nutrients uptake. This response is in accordance with that reported for tomato by Akanbi *et al.* (2005).

The results of the plant nutrients uptake revealed that fertilizer application should be based on crop nutrient demands and stage of crop growth. Plant tissue analysis can help to determine how much fertilizer to apply to complement the nutrient levels already available in the soil. Excessive application of fertilizer, especially nitrogenous fertilizers beyond crop needs may lead to toxic effects on plant growth, ground water contamination, delayed harvest due to excessive foliage growth and capital losses due to purchase of needed fertilizer.

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