The Effects of Inorganic Fertilizer on the Yield of Two Varieties of Cucumber (*Cucumis sativus* L.)

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Abstract: Field experiments were conducted for three years during the rainy seasons of 2006 to 2008 at the Teaching and Research Farm of Ambrose Alli University, Ekpoma (Lat. 6^0 45^1 North and Long. 6^0 08' East and an altitude of 460 meters above sea level). Compound fertilizer (N.P.K.20:10:10) was applied at 0, 100, 200, 300 and 400 kg/ha to two cucumber varieties (Ashley and Palmetto) using a 2 x 5 factorial scheme replicated three times. Data were collected on vegetative traits, yield and yield components of cucumber and statistically analyzed. Results revealed significant differences ($P< 0.05$) among the varieties in terms of vine length, number of branches and leaf area, The growth and yield attributes of cucumber including the vine length, number of leaves per plant, number of branches, leaf area, number of fruits per plant, fruit length, fruit girth, fruit weight per plant, fruit number per plant and total yield per hectare increased significantly ($P< 0.05$) with increase in inorganic fertilizer application up to the highest level.
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I. Introduction

Cucumber (*Cucumis sativus* L.) is an ancient vegetable and one of the most important members of the Cucurbitaceae family (Thoa, 1998) that is cultivated for its fruit which is a rich source of minerals and vitamins. The fruit is eaten fresh in salads in accompaniment with other vegetables.

The soils where cucumber is cultivated require moderate to high nutrient levels so as to achieve high yields. Infertile soils result in bitter and misshapen fruits which are often rejected by consumers thereby reducing farmers' income.

Most soils in Edo State as a result of cultivation over time, have suffered nutrient depletion such that high yields can only be attained through the judicious application of inorganic fertilizers. The invention of chemical fertilizers has allowed man to raise soil productivity higher than could be attained by relying on natural recycling process. Farmers in this locality for a long time had relied on natural soil recycling process for fertility restoration but as a result of high population, the fallow periods in many communities have been shortened and also cultivation has been extended for more than two years, hence there is a decline in crop yield. Many studies of various crops have shown significant advantages of applying inorganic fertilizers (Akinride,2006).

Many varieties of cucumber exist with varying shapes and sizes, skin colour and carotene content (Simon, 1992). The variation in the performance of cucumber varieties has been widely documented by many scholars (Axelson *et al*., 1980; Manyvong, 1997), which could be as a result of genetic composition or environmental factors.

The study was therefore carried out to determine the effects of inorganic fertilizer on the performance of two varieties of cucumber.

2. Materials and Methods

The experiment was conducted at the Teaching and Research farm of Ambrose Alli University, Ekpoma on Lat. 6^0 45^1 N and Long. 6^0 08^1 E in a forest - savanna transition zone of Edo State, Nigeria. The area is characterised by a bimodal rainfall pattern which starts in late March and ends in late July while the short rainy season extends from September to late October after a dry spell in August. The soil order is a ultisol and the site is classified locally as kulfo series (Moss, 1957).

The site was left fallow for three years after it was cropped to maize, yam and cassava for two years prior to the establishment of the experiment. A composite soil sample was collected from 0-30 cm depth prior to planting to determine the pH and the nutrient status of the soil. Soil pH was analyzed by 1:2 in H_2O, total N content was determined by Kjeldahl method (Bremner, 1965); available phosphorus was analyzed using the modified method of Walkley and Black (Nelson and Sommers,1982) . The NPK fertilizer was bought from the Edo State Ministry of Agriculture and Natural Resources. Chemical analysis of the soil is presented in Table 1.

The experimental site was cleared of existing vegetation and packing of the debris was carried out before it was marked into plots. Tilling of the soil was carried out by using hoes. Planting was done on

23 April 2007 at a spacing of 75 cm x 75 cm. Two seeds were sown per hole which was later thinned down to one plant per stand three weeks after planting giving a plant population of 17,778 plants per hectare. The three inner rows were considered the net plot and five plants from the net plot were tagged from which the growth and yield parameters were recorded.

Fertilizer was applied at three weeks after planting at the rates of 0, 100, 200, 300 and 400kg/ha^{-1} using the side band method. The field was weeded manually using a hoe. A total of three weedings were carried out for adequate weed control at 3, 5 and 7 weeks after planting. The crops were sprayed three times with lamdacyahalothrin as 'Karate' (insecticide) and benomyl (benlate) fungicide at the rates of 2 litres and 1.5kg/ha respectively at 4, 6 and 8 WAP to protect the plants against insect pests and fungal diseases. Harvesting of the cucumber fruits commenced at six weeks after planting when the fruits had turned deep green in colour. Harvesting was done by handpicking the matured fruits twice weekly.

The parameters recorded were vine length, number of leaves, number of branches, leaf area, yield and yield components. Growth parameters were assessed at 4, 6 and 8 weeks after planting. Cucumber vine length was measured by using a flexible tape rule. Number of leaves was assessed by visual count of the green leaves. At every harvest the fruit girth was assessed by using a vernier calliper, the fruit length was measured by using a flexible tape before the fruits was weighed using a 10kg scale. The cumulative weights of the entire harvests (10 times) were summed up for data analysis.

Table 1. Chemical analysis of soil sample at the experimental site.

Properties	Value
pH (in 2: 1 H_2O)	6.18
Organic matter content (g/kg)	20.90
Organic carbon (g/kg)	12.16
Nitrogen (%)	0.06
Exchangeable Ca (cmol/kg)	8.80
Exchangeable Mg (cmol/kg)	0.96
Available P (mg/kg)	15.59
Exchangeable K (cmol/kg)	1.14

3. Results

The vine length of two cucumber varieties as affected by varying rate of inorganic fertilizer at 4, 6 and 8 WAP are shown in Table 2a. At 4 WAP, the vine length ranged from 16.65 to 18.07cm and any increase in the fertilizer rate from 0 - 400kg/ha resulted in significant increase in length of vines. Both varieties produced the longest vine at 300 and 400 kg^{-}ha^{-1} fertilizer rate, which was significantly different from the other rates. The control produced the least length of vine, which was significantly different from the 100 kgha^{-1} fertilizer rate ($P<0.05$). At 6 WAP, the vine length ranged from 54.89 to 130.35cm. The longest vines were produced by the Palmetto variety at 400 kgha^{-1} and the control treatments of the two varieties produced the least vines. At 8 WAP, the vine length of the two cucumber varieties ranged from 152.10 to 277.10cm. Any increase in the fertilizer rate led to significant ($P<0.05$) increase in the vine length in both varieties. The Palmetto variety had the longest vines at the fertilizer rate of 400 kg/ha and the control treatments had the least.

The number of branches of two cucumber varieties as affected by varying inorganic fertilizer rate at 4, 6 and 8 WAP is presented in Table 2a. At 4 WAP, the number of branches ranged from 0.81 to 1.28. There were significant differences between the treatment means ($P<0.05$) though the branches formed were few. Increase in the fertilizer rate resulted in subsequent increase in the number of branches in both varieties. At 6 WAP, the number of branches ranged from 4.38 to 11.10 and the differences between the treatments were significant ($P<0.05$). The highest number of branches was recorded in the Ashley variety at 400 kgha^{-1}, which was only slightly different from the Palmetto variety at the same fertilizer rate. The least number of branches was recorded in the control treatments. At 8 WAP, the number of branches ranged from 5.90 to 11.87. There was increase in number of branches with increase in NPK application in both varieties. The highest number of branches was produced by the Ashley variety at 400 kgha^{-1} and the lowest was in the control treatments. The

differences between the treatment means were significant (P<0.05).

The number of leaves of two cucumber varieties as affected by inorganic fertilizer rate at 4, 6 and 8 WAP are shown in Table 2b. At 4 WAP, the number of leaves ranged from 5.67 to 7.50. The highest number of leaves was observed in the Palmetto variety at 400 $kgha^{-1}$ fertilizer rate which was significantly different (P<0.05) from the other fertilizer rates. At 6 WAP, the number of leaves ranged from 16.20 to 16.54. The differences between the treatment means were significant (P<0.05). The highest number of leaves was observed in the Palmetto variety at the 400 $kgha^{-1}$ fertilizer rate, which was significantly different from the other variety at the same level of fertilizer application. The number of leaves at 8 WAP ranged from 28.52 to 46.95. The highest number of leaves was produced by the Ashley variety at 400 $kgha^{-1}$ fertilizer rate and the lowest by the control treatments. There were no significant differences between the two varieties.

The mean leaf area of the two cucumber varieties as affected by varying rates of inorganic fertilizer at 4, 6 and 8 WAP are shown in Table 2b. At 4 WAP, the leaf area ranged from 856.22 to 1236.36 cm^2. Leaf area increased with increase in fertilizer application up to the highest level. The differences between the treatment means were significant (P<0.05). At 6 WAP, the mean leaf area ranged from 3102.20 to 4199.21 cm^2. The highest leaf area was observed in both varieties at 400 kg/ha fertilizer rate. There was a trend as each successive unit of inorganic fertilizer applied resulted in a corresponding increase in the leaf area. The untreated plots for both varieties produced the least leaf area. There were significant differences between the treatments (P<0.05).The leaf area at 8 WAP ranged from 3762.79 to 4987.56 cm^2. At this stage of cucumber growth, there were significant differences between the treatment means (P<0.05). The highest leaf area was observed in the Ashley variety at the 400 $kgha^{-1}$ fertilizer rate with the Palmetto variety having similar value and the control of Palmetto variety, the lowest. Any increase in the fertilizer resulted in an increase in the leaf area.

Fertilizer application had no significant effect on length and girth of cucumber fruits (Table 3). The number of fruits increased significantly (P<0.05) with increase in NPK application (Table 3). Ashley variety responded more to fertilizer application than Palmetto variety. Fruit number was more than double at the highest rate of NPK application in both varieties.

There was an increase in fruit weight of the Ashley variety with increase in NPK application but the pattern was not so clear in the Palmetto variety (Table 3). There was significant (P<0.05) increase in yield in the two varieties when NPK application was increased up to the highest level (Table 3). Yield was more than double with the application rates of 300 and 400 kg/ha of NPK. The varietal means were however not significantly different.

4. Discussion

The result of this study showed significant increase in some vegetative traits such as vine length, number of leaves, leaf area, and number of branches with increase in the rates of fertilizer application for the two cucumber varieties. Diaz *et al*. (1973), Pandey *et al*. (1974), Bradley *et al*. (1976), Kmiecik (1976), Yuasa and Aboaba (1981), El-Badawi (1994), Lawal (2000) and Agba and Enya (2005) had all reported increase in growth and yield components of cucumber to applied fertilizer. The improved supply of plant nutrients to cucumber by the application of fertilizer would led to better utilization of carbon and subsequent synthesis of assimilates (Lawal, 2000). Grubben (1997) also obtained good vegetative growth in cucumber due to the application of fertilizer in northern Nigeria. Similarly, Ibrahim *et al.* (1997) reported increase in vegetative growth in watermelon treated with fertilizer. Increasing the rate of NPK fertilizer resulted in an increase in dry matter accumulation per plant. The dry matter weight of cucumber increased with increase in the rate of fertilizer application. This increase was in conformity with the findings of Lamido (1994). El-Badawi (1994) also reported significant increase in cucumber growth and yield with increasing fertilizer levels up to 75 kgN/ha in Samaru Zaria.

The significant response of parameters evaluated (leaf area, vine length, number of branches, number of fruits per plant, weight of fruits per plant, fruit length and girth and yield) to applied NPK fertilizer may be an indication that the nutrients taken up by the plant were well utilized in cell multiplication, amino acid synthesis and energy formation hence increase in photosynthesis. The products of photosynthesis were then translocated to the sinks (fruits and growing buds).This was in consonance with the findings of of El-Badawi (1994) and Lawal (2000) who reported significant response of cucumber fruit weight per plant and total yield to applied inorganic fertilizer.

The cucumber vegetative characters such as vine length, number of leaves, number of branches and leaf area responded significantly to applied inorganic fertilizer up to the 400 kg/ha .This

resulted in the development of the crop and its photosynthetic apparatus and therefore enhancing assimilate production and accumulation. The assimilates produced during photosynthesis were translocated to the various sinks which resulted in the increase in the number of fruits per plant and total yield. The result of this study is also in agreement with the findings of Ogunremi (1990) who reported increase in the yield of melon fruits due to fertilizer application. The number of female flowers in all fertilizer treatments showed significantly higher mean number than the control. From the study, there is the need for effective fertilizer application as infertile soils result in bitter and misshapen fruits which are often rejected by consumers and hence reduction in the farmers earnings.

CONCLUSION

The use of inorganic fertilizer increased the growth and yield attributes of two varieties of cucumber. Increasing the rate of fertilizer up to the highest level of 400 kg/ha gave the highest yield for the two varieties.

Table 2a. The effects of inorganic fertilizer application on the vegetative traits of two cucumber varieties evaluated at 4, 6 and 8 WAP

Varieties	NPK (kg/ha)	Vine length (cm) WAP			No of branches/plant WAP		
		4	6	8	4	6	8
Ashley	0	16.65	54.89	152.10	0.81	4.38	5.90
	100	17.17	60.90	179.35	0.96	5.20	7.18
	200	17.51	75.72	196.01	1.05	7.48	8.73
	300	17.90	118.63	229.86	1.20	8.65	10.35
	400	18.07	119.75	274.17	1.28	11.10	11.87
	Mean	17.46	85.90	206.30	1.06	7.35	8.80
Palmetto	0	16.69	55.13	156.47	0.85	4.60	5.70
	100	17.20	65.50	185.65	0.98	5.58	6.60
	200	17.68	83.27	196.34	1.12	6,63	7.40
	300	17.94	113.19	239.99	1.22	8.68	11.03
	400	18.05	130.35	277.10	1.29	10.45	11.05
	Mean	17.51	89.49	208.71	1.09	7.18	8.35
LSD(P<0.05)							
Fertilizer means		0.336	9.486	14.266	0.066	0.797	0.825
Variety means		0.213	5.999	9.023	0.042	0.505	0.523
Interaction means		0.416	13.415	20.175	0.093	1.128	1.165

Table 2b. The effects of inorganic fertilizer application on the vegetative traits of two cucumber varieties evaluated at 4, 6 and 8 WAP

Varieties	NPK (kg/ha)	No of leaves/plant WAP			Leaf area (cm^2)/plant WAP		
		4	6	8	4	6	8
Ashley	0	5.77	16.20	28.52	856.22	3102.20	3762.79
	100	6.41	19.33	32.84	950.91	3481.35	4276.59
	200	6.54	21.06	37.04	995.90	3647.85	4400.41
	300	6.77	27.67	40.91	1155.01	3962.14	4670.21
	400	5.77	32.87	45.97	1236.36	4103.12	4987.56
	Mean	6.25	23.61	37.06	1038.67	3659.85	4419.69
Palmetto	0	5.67	16.54	29.49	886.80	3195.49	3464.37
	100	6.43	20.39	32.84	951.69	3507.74	3961.99
	200	6.58	27.07	33.95	999.22	3717.60	4168.01
	300	6.74	33.38	40.66	1080.91	4023.95	4784.16
	400	7.50	36.01	43.65	1170.88	4199.21	4930.92
	Mean	6.58	28.68	36.63	1028.22	3728.82	4340.79
LSD(P<0.05)							
Fertilizer means		0.419	2.464	1.366	42.555	129.366	150.300
Variety means		0.265	1.599	0.864	26.917	81.819	95.058
Interaction means		0.592	3.485	1.931	60.189	182.952	212.556

Table 3. The effects of inorganic fertilizer application on the yield and yield components of two cucumber varieties.

Varieties	NPK (Kg /ha)	Fruit length (cm)	Fruit girth (cm)	Fruit number/ plant	Fruit wt (kg)/plant	Yield (kg/ha)
Ashley	0	16.54	5.13	4.72	1.18	21037.02
	100	16.70	5.02	6.27	1.28	22755.54
	200	17.79	5.25	8.47	2.30	32029.61
	300	16.67	5.01	12.24	2.40	42607.38
	400	16.50	5.01	12.99	2.61	46340.72
	Mean	16.80	5.08	8.94	1.90	33754.05
Palmetto	0	16.83	5.07	4.80	1.15	20385.17
	100	18.06	5.49	6.85	1.29	22933.32
	200	17.63	5.56	8.89	1.14	38044.42
	300	16.63	5.14	12.54	2.46	43792.59
	400	16.93	5.32	12.71	2.57	45748.13
	Mean	17.22	5.31	9.16	1.92	34180.72
LSD(P<0.05)						
Fertilizer means		1.190NS	0.244NS	0.692	0.205	3355.372
Variety means		0.753NS	0.154NS	0.438	0.130	2122.123
Interaction means		1.683NS	0.345NS	0.978	0.290	4745.212

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