Effects of Nutrient Sources on the Growth and Yield of Cucumber (*Cucumis Sativus*) and on Soil Properties in Ikorodu Agro-Ecological Zone

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Abstract: Deficiency of the tropical soils in nutrients constitutes one of the main factors limiting crop production in Sub-Saharan Africa. An experiment laid out in randomized complete block design replicated four times was conducted to evaluate the comparative effects of different organic manure in the recapitalization of soil fertility to improve cucumber cultivation in Ikorodu agro-ecological zone of Lagos State. The treatments consisted of 20 tons/ha^{-1} cow manure, goat manure, pig manure poultry manure and control. The parameters evaluated were: number of leaves, plant height, vine height at 4, 6 and 8 weeks after planting (WAP), number of days to 50% flowering, number of harvested fruits, fruit circumference and weight of harvested fruits. Results obtained shows that application of poultry manure amended plots significantly influenced growth parameters and yield attributes of cucumber. Soil physico-chemical at the experimental site was greatly improved with the application of various organic manure. Organic carbon, total nitrogen, available phosphorus, exchangeable bases, Fe, Cu, Mn and Zn levels were progressively increased with application organic manures, while pH level was slightly increased.
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Introduction

Cucumber (*Cucumis sativus* L.) is an important vegetable and a popular member of the family, Cucurbitaceae (Lower and Edwards, 1986). The crop is one of the most important vegetables and the second most important vegetable crop after tomato in Western Europe (Phu, Tatlioglu, 1997). In Nigeria, cucumber is a relatively recent addition to the diet. Apart from eating cucumber raw or in mixes, young or ripe cucumber fruits are usually used as cooked vegetables or made into chutney (Grubben and Denton, 2004). The leaf juice is medicinal and is used to treat dyspepsia in children (Messien, 1998) and in skin care.

Cucumber (*Cucumis sativus* L) is a high nutrient demanding crop and performs poorly on nutrient deficient soils leading to low yields, bitter and misshapen fruits (Grubben and Denton, 2004). In order to sustain high yield of cucumber, there is need to augment the nutrient status of the soil to meet the crop's need, thereby maintaining soil fertility. Ipinmoroti *et al.* (2002) recommended the complementary use of organic and inorganic fertilizers for sustenance of long-term cropping in the tropics. One of the ways of increasing soil nutrient status is by boosting soil nutrient content either with the use of organic materials such as PM, animal waste and composts or with the use of inorganic fertilizers (Dauda *et al.*, 2005).

The need for renewable forms of energy and reduced cost of fertilizing crops, have revived the use of organic manures worldwide (Ayoola and Adeniran, 2006). Improvement in environmental conditions and public health are important reasons for advocating increased use of organic materials (Ojeniyi, 2000; Maritus and Vleic, 2001). Farmyard manure acts as an alternative source of fertility enhancement for inorganic fertilizers as they release nutrients slowly and steadily over longer periods of time and also improve the soil fertility status by activating the soil microbial biomass (Ayuso *et al.*, 1996; Belay *et al.*, `2001).

Materials and Methods

The experiment was conducted at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu, Lagos State Nigeria lies between (Latitude 5° 10' N and Longitude 3° 16' E) and located in the humid tropical rainforest agro-ecological zone. The mean average temperature is 25°C - 29°C with December and February being the hottest. The annual rainfall ranges between 1000mm – 1500mm and relative humidity between 65 – 68% (LASPOTECH Meteorological station, 2013).

Land clearing and ploughing were done mechanically and thereafter seed bed was made manually and each experimental plots measuring 3m x 3m with 0.5m discard between plots. The total plot

size used was 252^2m. Prior to commencement of the experiment and after the experiment, top (0-20cm) soil samples were collected randomly over five (5) spots using soil auger, to determine the soil physio-chemical properties following standard laboratory procedure Mylavapus and Kennelley (2002) and Okalebo et al (2002).

Cucumber seeds (Poinsett 76 variety) used for the study was obtained from Lagos State Agricultural Input Supply Agency (LAISA) Ikorodu, Lagos State, Nigeria and was planted two (2) seeds per hole at a spacing of 75cm x 50cm, thereafter thinned to one seedlings per stand given a total of 24 plants/plot. Ultimax plus® a synthetic fungicide was applied 3 week after planting (WAP) when severe infestation of damping off disease was noticed. Lambdacyhalothrin was sprayed at 8ml to 8 l of water at 2 weeks after planting (WAP) against foliage insect pest infestation and repeated at 2 weeks interval before harvesting. Weeding was done as at when due to eliminate competition and ensure efficient use of the manure.

Cow manure, poultry manure, pig manure and goat manure were collected from the livestock unit, Teaching and Research Farms, Lagos State, Ikorodu, Nigeria. The manures were shade dried and sample taken for routine laboratory analysis to determine its nutrient composition (Table 2).

The experiment was laid out in Randomized Complete Block Design (RCBD) having five (5) treatments namely: T1 = cow manure, T2 = Goat manure, T3 = Pig manure, T4 = Poultry manure and T5 = control and replicated four (4) times to give a total of twenty (20) experimental plots. The amount of organic manures was calculated based on the manure recommendation for cucumber (20t ha^{-1}). The manures were measured as required (18kg/plot) and worked into the soil with hand hoe two (2) weeks before planting to allow for decomposition, mineralization and nutrient release into the soil. Data on growth parameters: number of leaves, plant height (cm), vine length (cm) at 4, 6 and 8 WAP and yield attributes: number of days to 50% flowering and number of fruit, fruit length, (cm) fruit circumference (cm^3) and fruit weight (kg) were collected from Six (6) plants randomly sampled and tagged plant per plot. Data collected were subjected to Analysis of Variance (ANOVA) and significant treatment means were separated using Least Significant Difference (LSD) at 5% probability.

Results and Discussion

Effects of organic manures on soil chemical properties

The physiochemical properties of the experimental soil were presented in Table 1. The soil was sandy loam in texture with high proportion of coarse sand before and post experiment that aid proper drainage and root penetration. This is in agreement with the characteristics of the experimental site soil type – Alagba series. The pre-soil analysis shows that pH was 6.06, while the result for post soil analysis the soil pH increased to 6.18. Soil acidity has been reported as one of the major constraints to crop growth in tropical region. This implies that organic manures could serves as good soil amendment materials in ameliorating acidic soil.

The pre-soil analysis revealed that the soil was low in organic carbon (1.07%), total N (0.11%) and available P (8.30mg/kg^{-1}) recommended for sustainable crop production in agro-ecological zones of Nigeria (Akinrinde and Obigbesan, 2000); as these components (Organic carbon, N and P) are important nutrients required for plant growth, development and yield formation. Therefore, the soil requires amendment from different sources of nutrients to ameliorate their deficiencies and responses to organic manures applied is highly anticipated. Organic carbon, total N available P, Ca and CEC were increased in the post-soil analysis due to the fact that cucumber requires little of these nutrients compared to K, Mg and Na. The addition organic manure in this study leads to accumulation of soil nutrients due to its gradual release to the soil. In addition, cucumber has a large triangular leaves and are arranged alternately on the vines which form canopy over the soil and thus reduces the volatilization of nutrients. These observations contribute to the additional nutrient reported in the post-soil analysis. Furthermore, K was higher (0.30mol/kg^{-1}) in the pre-soil analysis but was drastically reduced to 0.15mol/kg^{-1}; Mg and Na were also reduced. Abou-Hussein (2001) reported that cucumber fruits made used of more K and Mg than other major nutrients in the soil which helps in increasing fruit sets; encourage root growth; promotes leaf growth and reduces plant respiration.

Addition of poultry manure brought about improvement in soil chemical properties soil pH, total N, available P, organic matter, exchangeable cations and cation exchange capacity were improved. Poultry manure could be used for soil management as it improves soil nutrient status and could be used for sustainable production of crops. In support of this, Ano and Agwu (2006) had reported that animal manure increased soil pH and macronutrient of soil. The reduction in exchange acidity in plots that received organic manure suggests their ability to supply calcium to the soil (Cooper and Warman, 1999). Akande *et al*., (2003) reported that application of organic materials could ameliorate slightly acidic tropical soil to improve crop production. Poultry manure also increased soil organic matter, nitrogen,

pH, phosphorus and cation exchange capacity (Adeniyan and Ojeniyi, 2003; Ayeni *et al* 2008).

Table 1. Pre and Post soil analysis of experimental site

Soil properties	Pre-soil analysis	Post-soil analysis
Sand (%)	83.60	86.40
Silt (%)	6.00	4.80
Clay (%)	10.40	8.80
Textural composition	Sandy loam	Sandy loam
pH	6.06	6.18
organic carbon(%)	1.07	1.62
Total N (%)	0.11	0.16
Available P (m/kg^{-1})	8.30	14.90
K ($cmol/kg^{-1}$)	0.30	0.15
Mg ($cmol/kg^{-1}$)	2.30	1.89
Ca ($cmol/kg^{-1}$)	3.90	5.06
Na ($cmol/kg^{-1}$)	0.32	0.13
CEC ($cmol/kg^{-1}$)	6.93	7.33

Table 2: Chemical composition of nutrient sources used

Properties	Cow	Goat	Pig	Poultry
% N	1.56	1.11	2.51	1.22
P (m/kg^{-1})	0.76	0.48	1.57	2.93
organic carbon (%)	30.80	30.08	57.92	26.20
K ($cmol/kg^{-1}$)	3.02	2.47	0.65	2.21
Na ($cmol/kg^{-1}$	0.62	0.69	0.48	1.40
Ca ($cmol/kg^{-1}$)	3.20	5.25	0.89	6.30
Mg ($cmol/kg^{-1}$)	0.10	0.10	0.11	0.09
Fe ($cmol/kg^{-1}$)	0.29	0.62	0.68	0.32
Zn ($cmol/kg^{-1}$)	0.02	0.04	0.04	0.06
Cu ($cmol/kg^{-1}$)	0.01	0.01	0.01	0.01

Effects of Nutrient sources on Growth parameters

The number of leaves increases with the plant age and nutrient sources. The number of leaves per plant was significantly influenced by nutrient sources ($P<0.05$). The highest number of leaves was found in poultry manure amended plots (16.96), closely followed by goat manure (16.83); control (15.21) and the least number of leaves was recorded in plots amended with pig manure (14.08) at 4 WAP (Figure 1). At 6 and 8 WAP, poultry manure amended plots had the highest number of leaves (26.50 and 34.00); followed by goat manure treatment (25.58 and 29.83) then control plots (24.50 and 29.08) and the plant with least leaves number was recorded from cow manure amended plots at 6 and 8 WAP (22.58 and 27.42) respectively. The improved number of leaves was due to nutrient sources and could be related to the release of mineral elements such as N, P, K and exchangeable cations (Ca, Mg and Na) to the soil by the different organic manure used which established and maintained optimum soil physical condition for plant growth Mangila *et al.,* (2007) and Enujeke *et al.*, (2013). Agbede *et al.,* (2008), and Ewulo *et al.,* (2008) who reported that organic manure sources of nutrients are cheap and effective source of N for sustainable crop production, but also improves soil physical properties by reducing temperature, bulk, density, and increasing total porosity. The better crop performance; relative to plant height, obtained in the organic treatment as against the control could be the result of the presence of growth promoting factors like enzymes and hormones as previously reported (Egene, 2011). Simpson (1986) reported that the application of organic manure significantly increased crop growth parameters and yield, and attributed it to the high level of N supplied by the organic manure, an essential plant nutrient for growth.

C. sativus plant height was significantly affected by nutrient sources. At 4 and 6 WAP, PM treatments recorded the highest plant height (34.59cm and 51.06cm); closely followed by pig manure amended plots (31.63cm and 47.38cm); goat manure (31.63cm and 45.99cm); cow manure applied soil had 30.64cm and 43.68cm while plot with no amendment had the shortest plant height (Figure 2) respectively. At 8 WAP, similar trend was equally observed poultry manure > pig manure > goat manure > cow manure > control plots. The result showed that different sources

of organic manure enhanced plant growth; taller plants capture more light energy and had more photosynthate available for plant growth and development.

Vine length is a key factor that contributes significantly to cucumber biological and fruit yield. Mean value of the data showed that at 4WAP, poultry manure treatments resulted in producing the longest vine (29.18cm), with goat manure (26.61cm) and cow manure (26.18cm) having closest vine length and pig manure amended plots having the shortest vine (24.15). While at 6 and 8 WAP poultry manure source had the longest vine (46.57cm and 54.01cm), plot with no nutrient sources (control) (43.32cm and 48.05cm); cow manure sources (42.72cm and 47.79cm) recorded close range vine length and pig manure sources recorded the shortest vine length (37.52cm and 42.90cm) respectively at 6 and 8 WAP.

Different sources of nutrients significantly affect cucumber vine length growth. Cucumber plants that received poultry manure source of nutrient had longer vine length than other nutrient sources; this is probably because poultry manure improved moisture availability which enhanced the release of more nutrient elements for increased vine growth. This is consistent with the findings and reports of Adekiya and Ojeniyi (2002), and Ewulo *et al.,* (2008) which attributed increased growth of crop plants to the release of more nutrient elements through the moisture that has been made available by the manure. The result obtained from this study conform with the findings of Sanni *et al* (2013); Bamikole *et al* (2011) who found out that poultry manure influenced water melon vine length growth. This could also be due to the fact that poultry manure released essential elements which promoted high photosynthetic activities that enhanced growth and yield (John *et al.,* (2004).

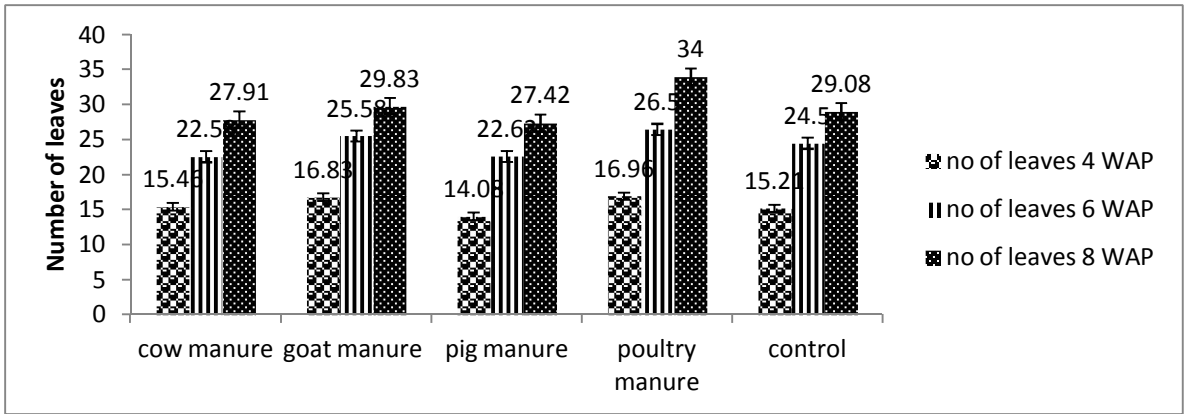

Figure 1: Effect of nutrient sources on number of leaves produced by cucumber at 4, 6 and 8 WAP

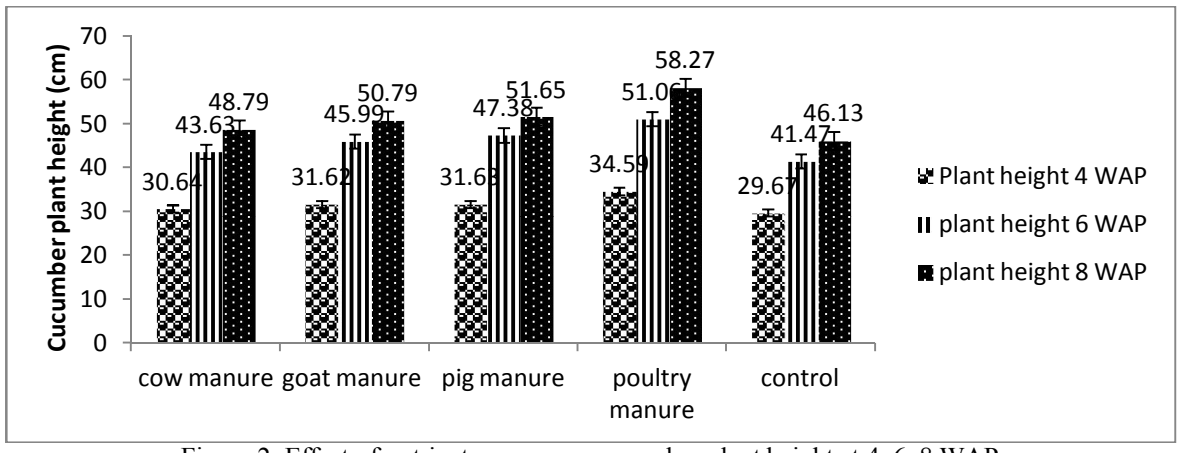

Figure 2: Effect of nutrient sources on cucumber plant height at 4, 6, 8 WAP

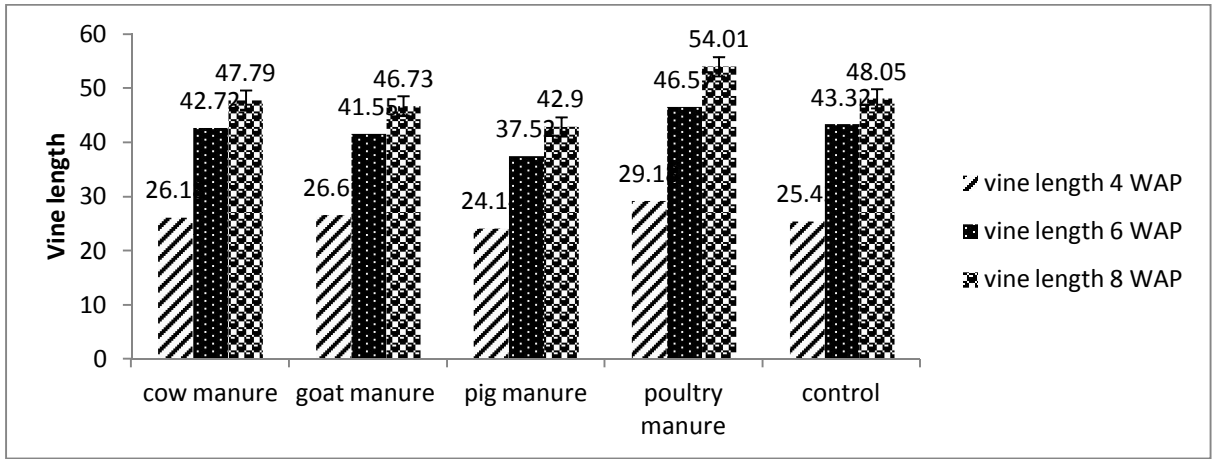

Figure 3: Effects of nutrient sources on cucumber vine length at 4, 6 and 8 WAP

Number of Days to 50% Flowering

Results presented in Figure 4 shows that cucumber planted on soil amended with poultry manure nutrient sources flowered at 24.96 days earlier that other nutrient sources; goat manure plots comes to flowering 27.83 days after planting, while cucumber fertilized with cow manure, pig manure and control plot flowered at 28 days after planting. The nutrient sources had no significant effect on the number of days of cucumber to 50% flowering. The early flowering of cucumber to different sources of nutrient might be due to availability of micro nutrients present in the various organic manures used. Abd-Allah *et al* (2001); Bayoumi, (2005) and Ehaliotis *et al* (2005) had reported that Fe, Zn and Mn encourages vegetative growth, total chlorophyll and the photosynthetic rate of plants which enhance flowering and fruiting thus leading to an increase early fruit maturity. The longest day to flowering in the control is as a result of insufficient P and K. Jilani *et al*., (2009) reported that a deficiency of major nutrients results in longer days to flowering. Dekker (1995) opined that applying manure about two weeks before planting of crops, helps increase nutrient availability especially in high rainfall areas and on porous soils, therefore having rapid percolation is assured and in returns improved plant vegetative and reproductive parameters.

Effects of nutrient sources on yield and yield attributes of cucumber

Statistical analysis indicated that number of harvested cucumber fruits and its length were significantly boosted by sources of nutrients. Poultry manure amended plot had the highest number of fruits (6.25) and fruit length (23.08cm) followed by application of goat manure sources (5.50) for number of fruits and fruit length (18.52cm), while lowest number of fruits were harvested from cucumber supplied with pig manure nutrient sources and plots with no nutrient sources (4.25). However, the shortest fruits (13.25cm) were produced in plot without nutrient sources (control) (Figure 5). Decreased in fruit yield in control plots is due to the low fertility level of the soil and the improvement observed is as a results of the availability of nutrients in the soil, due to application of different nutrient sources which expectedly led to increased uptake of N, P, K, Ca and Mg; thus ultimately significantly increase crop growth and yield. These results agree with previous report from Ayoola and Adeniran (2006) that variation in nutrients source among treatments will result in a significant variation on fruit length per plant in most crops. The increased in cucumber yield is attributable to improved soil physiochemical properties. Enujeke (2013) reported that organic manure sources of nutrient soil amendment reduced soil erosion, increased water holding capacity, and increased moisture availability which favoured the release of more nutrients for higher growth and yield. Better utilization of nutrients might also be the reason towards the increase in cucumber yield obtained in this study. The higher yields obtained from plots with nutrient sources may be due to higher nutrient content particularly Fe, Zn and Mn in the different organic manure sources used in this study. This is in consonance with the findings of John *et al*., 2004 who attributed the vigorous growth and increased fruit yield of watermelon to higher supply of nutrient elements from the applied manure.

The fruit diameter of plants that received 20 tha-1 of poultry manure was higher than the fruit diameter

of plants that received other rates of manure possibly because the high rate of manure reduced soil erosion, increased water holding capacity, and increased moisture availability which favoured the release of more nutrients for higher growth and yield. This is in consonance with the findings of John *et al*., 2004 who attributed the vigorous growth and increased fruit yield of watermelon to higher supply of nutrient elements from the applied manure. Organic manures have been said to improve soil fertility by activating soil microbial biomass, which in turn leads to development in corps (Ayuso *et al*., 1996) and this may have been responsible of the observed increase in fruit diameter resulting from nutrient application. That manures provide source of all necessary macro-and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil (Abou El - Maged *et al*., 2005) must have accounted for the better yield performance obtained in nutrient treated plots as against the control.

Fruit weight of cucumber was significantly increased by sources of organic manure. From the result (Figure 5) it is clear that among the tested manure, PM amended plots produced cucumber with the highest fruit weight (70.08kg/plot) > goat manure (68.16kg/plot) > cow manure (60.72kg/plot) > (55.44kg/plot) > control plot (50.40kg/plot). The results of the study showed that the treatments are capable of improving crop yield. The significant effected due to poultry manure application could be attributed to easy solubilisation effect of released plant nutrient leading to improved nutrient status of the soil the results obtained were in agreement with the findings of Sanwal *et al*., (2007) and Premsekhar and Rajashree (2009) in which they reported that higher yield response of crop due to organic manure application.

The application of farmyard manure increased the dry matter and yield. This increase could be attributed to nutrient availability and its uptake by the plants. This dry matter accumulation is a result of nutrient uptake and affected the number of fruits per plant, fruit length and fruit girth and fruit weight per plant and yield per hectare.

The results obtained from the study revealed cucumber responded well to the application of 20t/ha poultry and goat manure. Base on the finding, it may be recommended that application 20t/ha of poultry manure and goat manure could be used to minimize cost of production as this will improve soil organic matter and nutrient availability and high yield in Ikorodu agro-ecological zone of Lagos, Nigeria since these manures are currently being wasted and constitute environmental nuisance, it can be converted to wealth by using them as organic fertilizers.

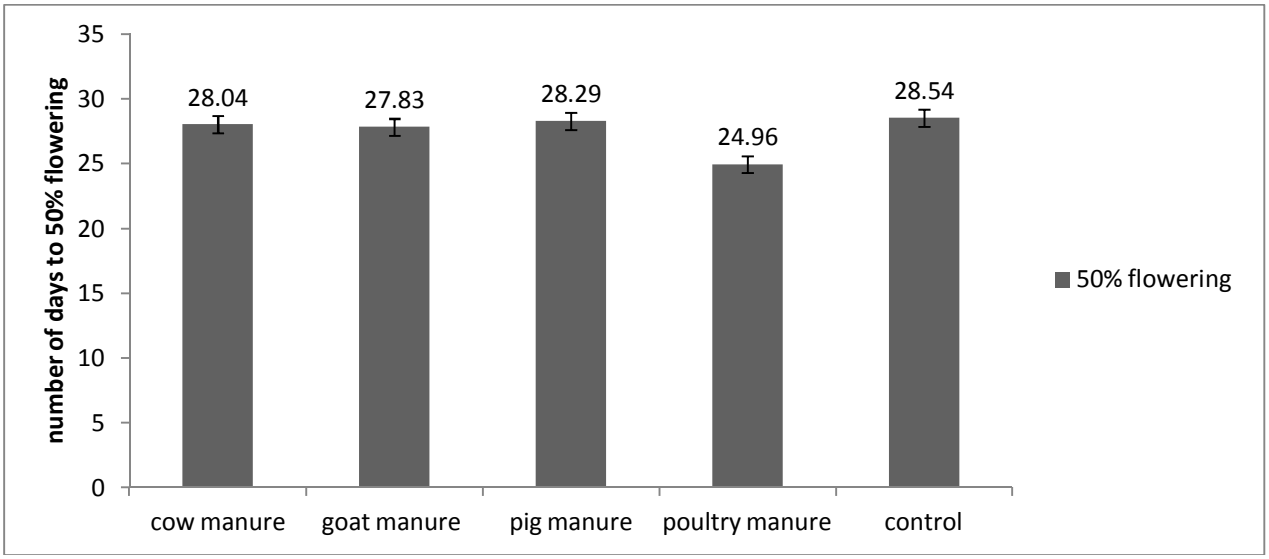

Figure 4: Effects of nutrient sources on number of days to 50% flowering of cucumber

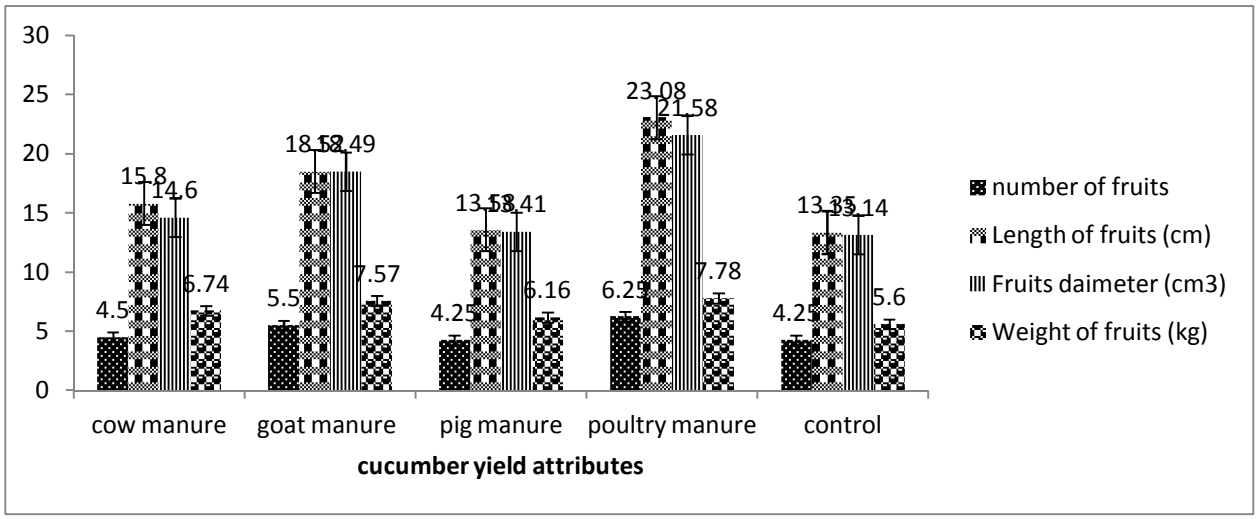

Figure 5: Effects of nutrient sources on yield attributes of cucumber

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