International Journal of Plant & Soil Science

25(1): 1-7, 2018; Article no.IJPSS.44292
ISSN: 2320-7035

Effect of Varying Rates of NPK 15:15:15 Fertiliser on the Physicochemical Properties of the Soil, Growth and Yield of Cucumber, (*Cucumis sativus* L.)

O. E. Ngwu[1*] and V. N. Edeh[1]

[1]Department of Agronomy & Ecological Management, Faculty of Agriculture Enugu State University of Science and Technology, P.M.B. 01660, Enugu, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author OEN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author VNE managed the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/44292
Editor(s):
(1) Dr. Alejandro Hurtado Salazar, Professor, Departamento de Produccion Agropecuaria, Universidad de Caldas, Colombia.
(2) Dr. Hon H. Ho, Biology, State University of New York, New York, USA.
(3) Dr. Slawomir Borek, Professor, Department of Plant Physiology, Faculty of Biology, Adam Mickiewicz University, Poland.
Reviewers:
(1) Tange Denis Achiri, Cukurova University, Turkey.
(2) Chibor, Bariwere Samuel, Rivers State University, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/26832

Original Research Article

Received 06 August 2018
Accepted 11 October 2018
Published 25 October 2018

ABSTRACT

The research was conducted at the Teaching and Research Farm of the Faculty of Agriculture and Natural Resources Management, Enugu State University of Science and Technology within latitude, 06° 17^1 58° 6" N and longitude 07°, 32^1, 58° 8"E on a total land area of 225m^2 (15 m x 15 m). The research was aimed at finding the effect of different rates of NPK 15:15:15 fertiliser on the physicochemical properties of the soil, growth and yield of cucumber (*Cucumis sativus* L.). was designed in a Randomized complete Block Design (RCBD), with five replications and four treatments which are 0 kg/ha (T_1) 50 kg/ha (T_2), 100 kg/ha (T_3) and 150 kg/ha (T_4). The study showed that a significant (P = .05) effect in the yield was obtained at the rate of 150 kg/ha at 8 weeks after planting. The following yield and other agronomic parameters were obtained using 150 kg/ha. Fruit yield 18.75 t/ha and vine length 181.37 cm. Therefore cucumber farmers are advised to apply 150 kg/ha of NPK 15:15:15 fertiliser for their optimum yield.

**Corresponding author: E-mail: ngwuoe@yahoo.com;*

Keywords: Inorganic fertilizer; soil properties; leaf area index; fruit weight cucumber.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the family *cucurbitaceae*. It originates from India and was introduced to West Africa by the Europeans in 1940 [1]. Cucumber is a major fruit vegetable that has a cylindrical, green-skinned fruit that is eating raw, cooked or used in salad. The plant has large leaves which are triangular in shape. Cucumber can adapt to a wide variety of soil types which have good drainage and adequate source of vitamins. It is also used to produce facial cleanser, body cream, soap and shampoo. It helps to reduce high blood pressure when eaten regularly and also helps to cure kidney ailments.

Fertilisers have been established to be important in vegetables such as cucumber, garden egg, and tomatoes cultivation. Inorganic fertilisers are chemical compounds made in industries or obtained by natural materials composed mainly of wastes and residues from plants and animals for plant growth [2]. Inorganic fertilizer supplies essential plant nutrients such as Nitrogen, Phosphorus, Potassium and serves as soil amendment. Nitrogen promotes vegetative growth, helps the plant in photosynthesis and phosphorus is needed to stimulate flowering, fruiting and seed formation, while potassium promotes starch and sugar formation, increase strength to the plant [3].

According to Beckmare [4], of organic and inorganic fertiliser enhances soil productivity, increase the soil organic carbon content, enhances the activity of soil-microorganism and the nutrient status of soil as well as crop yield. However, before nutrients in the soil can be taken u p by plant, the soil physical properties must be in good condition to enhance free flow of water and nutrients in the soil. In modern agriculture, soil must be resistant to various forms of degrading factors and soil properties must meet the requirements of sustainability and input saving crop cultivation technologies [5]. Presently, because of high population densities, continuous farming is replacing bush fallowing which adds a lot of nutrients and organic matter to the soil.

The bush fallowing improves not only the nutrient content but also the physicochemical properties of the soil. The chemical and physical properties by the bush fallowing system are due to the addition of organic matter of the soil. It is therefore important to know the right amendment that may improve physical properties of the soil as to improve growth and yield of crops [6]. His study is to determine the effect of different rates (0kg/ha, 50kg/ha, 100kg/ha and 150kg/ha) of NPK 15:15:15 fertiliser on the physicochemical properties of the soil, growth and yield of *Cucumis sativus*.

2. MATERIALS AND METHODS

The research experiment was carried out during 2018 planting season at the Research and Teaching Farm of the Faculty of Agriculture and Natural Resources Management, Enugu State University of Science and Technology, Enugu. The area is characterised by an annual rainfall between 1700mm to 1800mm, a humid tropical climate with wet season (April – October) and a dry season (November – March). The experimental site is located between latitude 06° 17^1 58° 6" N and longitude 7° 32, 58"E in the derived zone of the South East agro-ecological zone of Nigeria. The soil is typical paleustult.

2.1 Field Preparation and Soil Sampling

The experimental site was cleared and all the trashes were removed. The size of the experimental plot was mapped out with the aid of measuring tape, roped and pegged to obtain a total land area of 15m x 15m ($255m^2$). The soil was tilled and further prepared into 20 sub plots each with a dimension of 3m x 2m having an alley of 1m between each subplot. A composite soil sample was collected with the aid of soil auger from four different points in the experimental site before and after planting at a depth of 0-15cm and was taken to the laboratory for proper analysis to find their physical and chemical properties.

2.2 Source of Material

Cucumber seeds and NPK 15:15:15 fertiliser used for the experiment were obtained from Enugu State Agricultural Development programme, ENADEP.

2.3 Experimental Design and Treatments

The experiment was laid out in a randomized complete Block Design (RCBD) with five

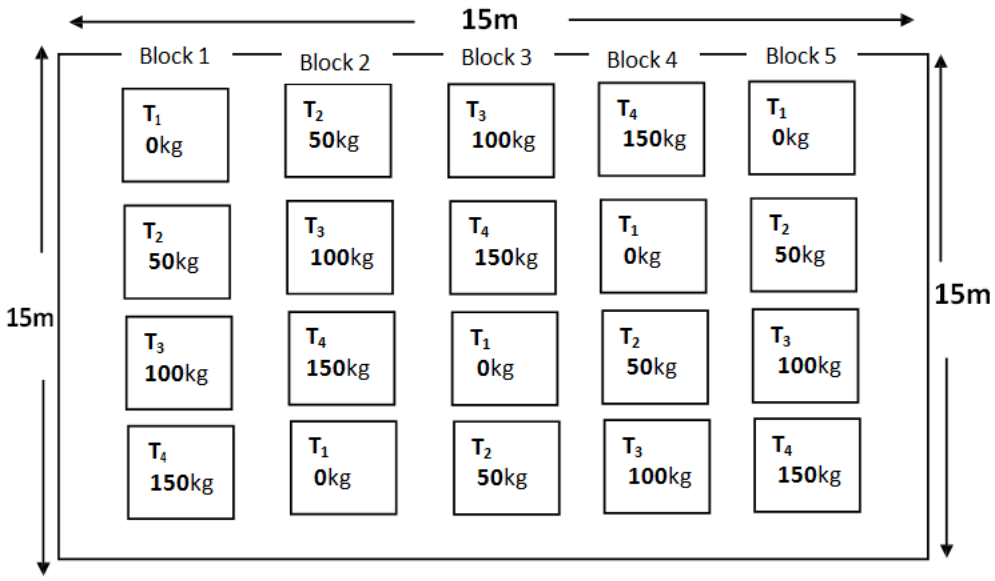

Fig. 1. Field layout of the experiment

replications and four treatments. The treatments used was NPK 15:15:15 fertiliser applied at the rates of 0 kg/ha, 50 kg/ha, 100 kg/ha and 150 kg/ha designated as T_1, T_2, T_3 and T_4 respectively.

2.4 Crop Planting

The test crop cucumber seeds were planted at a spacing of 70cm x 90cm (0.7m x 0.9m). Two seeds were sown per hole at six different points in each subplot.

2.5 Fertiliser Application

NPK 15:15:15 fertiliser was applied two weeks after planting at the rate of 0 kg/ha, 50 kg/ha, 100 kg/ha and 150 kg/ha in the respective plots using side band method.

2.6 Cultural Practices

Weeding of the plot was done manually using traditional holes, cutlass and hand pulling to uproot the grasses. The field was weeded at 3, 5 and 7 weeks after planting.

2.7 Laboratory Method

Samples were air dried, ground and passed through a sieve of 2 mm standard mesh size. The soil pH was determined with a pH meter using 1:2.5 soil to water ratio and 1: 2.5 soil to 0.1 N KCl (potassium chloride) suspension [7]. Organic carbon was determined using the Walkley and Black wet digestion method [8]. Soil organic matter content was obtained by multiplying the value of organic carbon by 1.724 (Van Bemmeler factor). Total nitrogen was determined by micro-kjeldahl procedure [7]. Available phosphorus was extracted with Bray II extractant [9] and determined colorimeterically using ascorbic acid method [10]. Exchangeable potassium was extracted using 1 N ammonium acetate (NH_4OAC) solution and determined by the flame emission spectroscopy [11]. Aluminium and Hydrogen content (exchangeable acidity) were determined by titrimetric method after extraction with 1.0 N KCl [12]. The cation exchange capacity was determined by NH_4OAC displacement method [13]. Calcium and magnesium were determined by the complexiometeric titration method as described by [14]. Particle size distribution analysis was done by the hydrometer method [15] and the corresponding textural class determined from the United States Department of Agriculture Soil Textural Triangle. Base saturation was determined by the method outline by Page et al. [7].

2.8 Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) test for randomized complete block design [16]. Significant means were separated using Fisher's least significant difference (F-LSD) at 5% probability level.

Statistical analysis was executed using statistical software [17].

3. RESULTS AND DISCUSSION

The result presented in Table 1 shows the physiochemical properties of the soil before planting. The soil was loamy sand and slightly acidic, low in Carbon, Potassium, Calcium and Magnesium.

The data in Table 2 show the effect of varying rates of NPK 15:15:15 fertiliser application on chemical properties of the soil. There were no significant difference between the pH value of the control (0kg/ha) and that of treatment 50kg/ha, 100kg/ha and 150kg/ha, although the levels increased from 6.34 in treatment 2 (50kg/ha) to 6.50 in treatment 4 (150kg/ha). In control (0kg/ha) organic carbon and organic matter were 0.22 and 0.11% and later to 0.50 and 0.21%. This shows that organic carbon and organic matter were not significantly increased by NPK 15:15:15 fertiliser at the planting season, because no treatment was added to the control plot (0kg/ha).

The result in Table 2 shows that the treatment had significant effect on the available phosphorus. The total Nitrogen indicated in Table 1 is low at 0.12%. This low level of total Nitrogen is also observed in the result at the different levels of treatment in Table 2. At 150kg/ha total Nitrogen was observed to be 0.20%. However, the application of NPK 15:15:15 fertiliser in the various treatments with a low level of nutrient especially at the highest level of 150kg/ha confirms that Nitrogen is essential in lifecycle of the cucumber plant.

The exchangeable cations such as Ca^{+} was found to be at 1.24 $Cmol^{+}kg^{-1}$ in 0kg/ha was measured to be 1.75$cmol^{+}kg^{-1}$in 150kg/ha and mg^{+} found to be at 0.86 $Cmol^{+}$ kg^{-1} in 0kg/ha was increased to 1.27 $cmol^{+}kg^{-1}$ in 150kg/ha. This increase of Ca^{+}, K and Mg^{+} due to NPK 15:15:15 fertiliser is consistent with the analysis recorded for improving soil fertility in crop production [18].

Table 1. Physiochemical properties of the experimental site before planting

Properties	Quantity
Textural class	Loamy sand
Clay (%)	11
Silt (%)	18
Fine sand (%)	31
Coarse sand (%)	40
P^{H} (H_2O)	6.2
P^{H} (KCl)	3.6
Organic carbon (%)	0.40
Organic matters (%)	0.52
Total Nitrogen (%)	0.12
Exchangeable Bases ($Cmol^{+}$ Kg^{-1}	
Na^{2+}	0.008
K^{+}	0.04
Ca^{2+}	1.22
Mg^{2+}	1.0
CEC	11.40
Base saturation (%)	12.05
Exchangeable Acidity ($Cmol^{+}kg^{-1}$)	
Al^{3+}	0.3
H^{+}	0.8
P (mg kg^{-1})	7.13

Table 2. Effect of varying rates of NPK 15:15:15 fertiliser on chemical properties of the soil after harvesting

Properties	0kg/ha	50kg/ha	100kg/ha	150kg/ha
Physical properties Clay (%)	12.11	15. 70	15.21	15.80
Silt (%)	14.22	15.39	16.62	17.10
Fine	27.46	29.33	30.40	32.94
P^H (KCl)	4.03	4.51	4.84	5.10
Organic carbon (%)	0.22	0.34	0.42	0.50
Organic matter (%)	0.11	0.14	0.17	0.21
Total Nitrogen (%)	0.06	0.15	0.18	0.20
Available P (Mg/kg)	10.15	14.32	18.26	21.57
Exchangeable Bases($Cmol^+kg^{-1}$				
Na^+	0.10	0.28	0.34	0.41
K^+	0.02	1.58	1.72	1.90
$Ca2^+$	1.24	1.33	1.52	1.75
$Mg2^+$	0.86	1.03	1.12	1.27
CEC	12.05	12.28	12.46	12.51
Base saturation (%)	12.20	13.31	15.00	16.44
H_+	0.09	0.11	0.13	0.14

CEC significantly increased from the result in Table 2. At 0kg/ha it was found that (12.05 cmol+kg-1), 50kg/ha (12.28 cmol+kg-1,), 100 kg/ha (12.46 $cmol^+kg^{-1}$) and 150kg/ha (12.51 $cmol^+kg^{-1}$). The increase in CEC is observed with the rate of application of treatment and this is consistent with the demonstration by Dewis & Freitas [19] that the exchangeable properties increase according to the level application of treatment.

Cucumber vine length increased significantly (P=0.05) as the fertiliser rate increased from 0kg/ha to 150kg/ha when measured at 4,6 and 8 WAP as indicated by the mean vine length in Table 3.

Table 3. Effect of varying rates of NPK15:15:15 fertilizer application on mean vine length (cm) of cucumber at 4,6, and 8 weeks after planting

Treatment	4WAP	6WAP	8WAP
0 kg/ha	14.49	49.20	150.10
50 kg/ha	15.29	54.23	164.61
100 kg/ha	16.24	59.34	175.27
150 kg/ha	16.98	62.07	181.37
FLSD (p=0.05)	1.067	1.094	1.743

At 4 WAP, there was no treatment effect on the mean vine length although 150kg/ha gave the longest vine length of 16.98cm At 6WAP, there was a significant difference between the treatment means, although the longest vine length of 62.07cm was observed in the plot treated with 150kg/ha and 0kg/ha has the shortest vine of (40.20cm). the difference between the vine lengths is as a result of the application of NPK 15:15:15 fertiliser after 6WAP, this increase the nutrient of the soil which enhances the general growth of the plant.

At 8WAP, it indicated that 150kg/ha had the longest vine (181.37cm) and 0kg/ha produced the shortest vine length (150.10cm).

The leaf area index can be calculated as: No of leaves per plant X length X width Planting Distance/Area covered by the plant.

The result presented in Table 4 shows that there was a significant difference between all the treatment means at 4,6 and 8 WAP. This is because NPK 15:15:15 fertiliser applied has enhanced the soil nutrient base, thereby increasing the Nitrogen, Phosphorus and Potassium level in the soil. This increases the growth rate of leaf area index, that is, plot treated with 150kg/ha.

At Table 5, different rates of application of NPK 15:15:15 fertiliser indicated changes in fruit yield.

At control plot 0kg/ha where fertiliser is not applied to the soil the fruit yield is 12.90. With the fertiliser application of 50kg/ha the fruit yield was 13.80; there was increase in the fruit yield (15.00)at fertiliser application of 100kg/ha, while soil that received fertiliser application of 150kg/ha has fruit yield of 18.75.

The research shows that soil enriched with Nitrogen, Phosphorus and Potassium enhances proper growth of cucumber. However, the research shows specifically that NPK 15:15:15 fertiliser application at the rate 150kg/ha yield more crops than other level of application.

Table 4. Effect of varying rates of NPK 15:15:15 fertilizer application on mean leaf area index at 4, 6, and 8 Weeks after planting

Treatment	4WAP	6WAP	8WAP
0 kg/ha	0.1749	0.8320	1.490
50 kg/ha	0.24	0.93	2.04
100 kg/ha	0.33	1.16	3.11
150 kg/ha	0.38	1.43	3.65
FLSD (p=0.05)	0.05	0.07	0.11

Table 5. Effect of varying rates of NPK 15:15:15 fertilizer application on mean fruit yield

Treatment	Fruit yield (t ha^{-1})
0 kg/ha	12.90
50 kg/ha	13.80
100 kg/ha	15.00
150 kg/ha	18.75
FLSD (p=0.05)	1.15

4. CONCLUSION AND RECOMMENDATION

The application of NPK 15:15:15 fertiliser at the rate of 150kg/ha has enriched the soil nutrient and thus enhances the gross yield of the crop. It was observed that at 150kg/ha fruit yield was 18.75 ton/hectare. This increase can be observed in all parameters measured, and this observed increase is application increased from 50kg/ha to 100kg/ha to 150kg/ha. This research has proven that the application of NPK 15:15:15 fertiliser at the rate of 150kg/ha is the most productive of all the rates of application.

I recommend the application of NPK 15:15:15 fertiliser at the rate of 150k/ha for cucumber farmers to achieve optimum output.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Sinnadurai S. Vegetable cultivation. Asempa publishers Advent Press. Accra. 1992;166-170.
2. Cooke GW. Fertilizing for maximum yield. Chaucer press. Ltd. Bungay Suffok. 1982;81-277.
3. Ngwu OE. Fundamentals of soil science for college and universities. Fidginia Global Service Ltd. Enugu Soil Colloids and Reaction. 2006;12:194-195.
4. Beckmare EO. Organic fertilization vegetative farming luxury or necessity. Tech. Commun. ISHA. 1975;29:247.
5. Balesdent J, Chenu C, Balabane M. Relationship or soil organic matter dynamics to physical protection and tillage. Soil and Tillage Research. 2016;53:215-230.
6. Palojarvi A, Nuutinen V. The soil quality concept and its importance in the study of Finnish arable soils. Agricultural and Food Science in Finland. 2000;11:329-342.
7. Page JR, Miller RH, Keeney DR, Baker DE, Roscoe Ellis JR, Rhoades JD. Methods soil analysis 2. Chemical and Microbiology Properties (2nd Edn.) Madison, Wisconsin, U.S.A. 1982;1159.
8. Bremner JM, Mulvaaney CS. Total nitrogen. In: Page, A.L. (eds.). Methods of Soil Analysis, Part 2. Chemical and Microbial Properties, Second edition Agronomy Series no. 9 Madison, WI, USA, ASA, SSSA; 1982.
9. Bray RH, Kurtz LT. Determination of total, organic and available forms of phosphorus in soils. Soil Science. 1945;91-96.
10. Murphy J, Riley JP. A modified single solution method for determination of phosphate in natural waters. Anal. Chem. Acta. 1962;27:31-36.
11. Anderson JM, Ingram JSI (eds). Tropical Soil Biology and Fertility: A Handbook of Methods (2nd edition) CAB international. 1993;221.
12. McLean EO. Soil pH and lime requirements. In: Page, A.L. (eds.). Methods of Soil Analysis, Part 2. Chemical and Microbial Properties, Second edition Agronomy Series no. 9 Madison, WI, USA, ASA, SSSA; 1982.

13. Rhoades JD. Cation exchange capacity. In; Page, A.L.., Miller, R.H. and Keeney, D.R. (eds.). Methods of soil analysis, Part 2: Chemical methods. Agronomy Monograph no. 9, American Society of Agronomy Madison, Wisconsin, USA; 1982.
14. Chapman HD. Total exchangeable bases. In. C.A. Black (ed.), methods of soil analysis, Part 2. ASA. 1982;9:902-904. Madison, USA.
15. Gee GW, Bauder D. Particle size analysis. In: Dane, J.H. and Topp, G.C. (eds.). Methods of Soil Analysis. Part 4, Physical methods. Soil sci. soc. Am. 2002;5:255-293.
16. Gomez KA, Gomez AA. Statistical producers for agricultural research. 2nd Edition. John Wiley and Sons. Inc. New York, USA. 1984;32.
17. Genstat Release 7.2DE, Discovery Edition 3, Lawes Agricultural Trust, Rothamsted Experimental Station. GENSTAT; 2007.
18. Nottidge OO, Ojeniyi S, Asawalam D. A comparative effect of plant residue and NPK fertilizer on nutrient status and yield of Maize in a humid ultisol. Nigeria Journal of Soil Science. 2005;15:1-8.
19. Dewis J, Freitas F. Physical and chemical method of soil and water analysis. Soil Bulletin. 1970;10. FAO Rome.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/26832