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Comparative Assessment of the Impact of Organic and Inorganic Fertilizers Application on the Growth and Development of *Solanum nigrum* L. (Angiosperm; Solanaceae)

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Authors' contributions

This work was carried out in collaboration between all authors. Author CNO designed the study, served as the principal supervisor and wrote the protocol. Author CDN served as the principal investigator, performed the statistical analysis and wrote the first draft of the manuscript. Authors KUE and CGU participated in taking the routine measurement of the growth parameters and managed the analyses of the study. Author CON managed the literature searches, contributed in statistical analyses as well as drafting of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The application of organic and inorganic fertilizers to the soil is considered a good agricultural practice as it helps to improve the fertility of the soil and the quality of plant products. However, the effect of some fertilizers on crop yield is not always positive when compared with others. This study assessed, comparatively, the effects of organic and inorganic fertilizers on the growth and development of *Solanum nigrum* L. (Angiosperm; Solanaceae).

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Study Design: This was an observational field study.
Place and Duration of Study: Department of Applied Biology experimental plot, Faculty of Science, Ebonyi State University, Abakaliki from July, 2015 to September, 2015.
Materials and Methods: The field study was arranged in a randomized complete block design (RCBD) in a 3.5 m x 2.5 plot, selected, cleared with ridges made for each treatment and control groups. The blocks were treated with 10 g/m^2 each of N.P.K. 15:15:15, cow dung and fowl excreta after which *Solanum nigrum* L. seedlings were transplanted from the nursery at 20 plants per ridge and spacing of 0.2 m between plants. Growth parameters such as stem diameter, plant height and girth were monitored and readings taken for a period of 8 weeks starting from the 30th day after planting. Data collected were tested statistically (ANOVA) using SPSS version 20.0 at $p<0.05$.
Results: The results revealed that there was a significant difference in the growth of *Solanum nigrum* L. in plants height (F-ratio = 4.735; p = 0.00855), stem diameter (F-ratio = 23.46; p = < 0.00001) and plant girth (F-ratio = 5.675; p = 0.003627) with respect to the different fertilizers applied. N.P.K. 15: 15: 15 treated group showed a greater increase in the growth parameters. However, the control group performed better than the groups treated with cow dung and fowl excreta.
Conclusion: There was a significant difference in the overall effects of the different fertilizers applied on the growth and development of *Solanum nigrum* L. (F-ratio = 18.30836; P = 0.000673) and application of N.P.K. 15:15:15 in the cultivation of *Solanum nigrum* L. improved the growth of the plant better than cow dung and fowl excreta. However, further studies are hereby recommended to determine the soil profile analysis of the study plot as well as the physico-chemical analysis of the organic fertilizers used with respect to plant yield under erosion-controlled planting condition.

Keywords: Solanum nigrum L.; N.P.K. 15:15:15; cow dung; fowl excreta; growth; fertilizer.

1. INTRODUCTION

Traditional societies have always exploited edible wild plants to provide an adequate level of nutrition [1,2]. Recent studies on agro pastoral societies in Africa indicate that these plant resources play a significant role in nutrition, food security and income generation [3]. The nutritional composition of these food resources, although not well documented, could be comparable to or even sometimes superior to the introduced cultivars [2]. It is, therefore, worthwhile to note that the incorporation or maintenance of edible wild and non-cultivated plant resources could be beneficial to nutritionally marginal populations or to certain vulnerable groups within populations, especially in developing countries. The domestication and cultivation of wild edible plants are, therefore, essential to increase the food base in developing countries. This will lead to diversification, which will ensure dietary balance and the intake of essential micronutrients. Edible wild leafy vegetables play an important role in African agricultural and nutritional systems [4]. Some of these vegetables are treated as weeds in different parts of the world and as indigenous/traditional vegetables in others. Likewise, *Solanum nigrum* L*.,* the Black nightshade and related species are worldwide weeds of arable land, gardens, rubbish tips, soils rich in nitrogen, which occur from sea to montane levels. They also widely serve like most other leafy herbs and vegetables, as a source of fruit and for various medicinal purposes. Therefore, human consumption of their leaves and fruits as food is widespread, particularly in Africa and South East Asia.

The cultivation and growth of food-producing plants have constantly been challenged by the nature and infertility of the soil in which they are planted. Soil containing low amounts of macronutrients such as Nitrogen (N) and Phosphorus (P) and high amount of micronutrients such as B, Cu, S, Mn and Zn are not suitable for crop production [5]. Inadequate supply of N frequently results in slow growth, low protein levels and poor quality yield; hence N is one of the most limiting elements to efficient and profitable crop production [6]. Soil with low levels of nutrients need to be boosted with soil amendments in order to improve them for crop production. Man, over the years has devised several means of improving the fertility of the soil. Organic fertilizers or manures are good options as they improve the soil structure and microbial mass [7] as well as provide nutrients through mineralization. However, depending on the quality and source of the manure, minerals are often slowly mineralized and may not be available during the first season of application

[7]. Inorganic fertilizers are the most preferred by farmers because they quickly become available to the plant after application but they may be toxic to soil organisms and humans [8]. This study, therefore, was conducted to determine the comparative effects of different fertilizer application (both organic and inorganic) on the growth and development of *S. nigrum.*

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out at the Department of Applied Biology experimental field plot, Ebonyi State University Abakaliki, geographically located between latitude 6015'N and 6020'N and longitude 8005'E and 8010'E in southeastern Nigeria. The region has luxuriant vegetation of the tropics and is densely populated with grasses and trees of different sizes. It is a humid tropical region, which experiences eight months of rainy season and four months of dry season. The mean annual temperature stands at 28℃ and the mean annual rainfall is 2500 mm. The soil type is loamy clay.

2.2 Seed Collection and Viability Check

S. nigrum seeds used in this study were sourced from a local market in Abakaliki (Abakpa market). The viability of the seeds was also checked, by pouring them into bowl containing water and seeds that floated on the surface of the water were considered non viable and the ones that sank were considered viable and were used for the study.

2.3 Study Design and Treatment

A portion (3.5 m x 2.5 m) of the experimental plot of the Department of Applied Biology, Faculty of Science, Ebonyi State University Abakaliki, was cleared, ploughed, harrowed manually and used for this study; the experimental layout was a randomized complete block design (RCBD) of 2.0 m x 0.4 m per block. Four blocks were made one for each of the treatment and control groups. Ten gram per square metre (10 g/m^2) of each of N.P.K. 15:15:15, cow dung and fowl excreta were applied to their respective blocks while the control was left without any further treatment. The seeds were sown by spraying on a nursery bed and seedlings emerged after six days of sowing. *S. nigrum* seedlings were transplanted from the nursery to the plot at the rate of 20 plants per ridge and spacing of 0.2 m between plants after 30 days of seedlings emergence. The *S. nigrum* experimental plot was irrigated all through the period of cultivation, except when there was sufficient rainfall. Weeding was carried out manually from time to time on the experimental plots throughout the period of the study. The parameters measured included: height of the plant, stem diameter and girth of the plant. Ten plants were tagged on each ridge and measured weekly for 8 weeks.

2.4 Determination of Plant Biomass

At the end of the 8 weeks of cultivation, the tagged plants of *S. nigrum* were uprooted, cut into pieces, masked, and then taken to the Department of Biological Science Laboratory, Ebonyi State University, Abakaliki for the determination of the fresh weight of the plants using an electronic weighing scale. After the fresh weight was determined, they were dried for 24 hours using an oven at a temperature of 55˚C and weighed again to determine the dry weight of the plant.

2.5 Data Analysis

Data sets were analyzed using statistical package for social sciences (SPSS) version 20.0. A one-way analysis of variance was used to compare the means of various growth parameters among the treatment. Levels of significance, means and standard deviation were obtained for various data sets.

3. RESULTS

The comparative assessment of the effects of different fertilizers application on the growth and development of *S. nigrum* revealed a significant difference in the growth of *S. nigrum* in plants height (F-ratio = 4.735; p = 0.00855), stem diameter (F-ratio = 23.46; $p < 0.00001$) and plant girth (F-ratio = 5.675; p = 0.003627) with respect to the different fertilizers applied (Figs. 1-3). N.P.K. 15:15:15-treated group showed a greater mean increase in the plant height over the sampling period, followed by the control group, while the least effect was observed in the group treated with fowl excreta (Fig. 1). Also, N.P.K. 15:15:15-treated group performed best with respect to the stem diameter and girth of the plant on a weekly basis throughout the sampling period still closely followed by the control group and cow dung-treated group while the grouped treated with fowl excreta showed least performance by the end of the 8-week period (Figs. 2 and 3). However, on the average, the groups treated with fowl excreta performed better

than the group treated with cow dung in increasing plant height (Table 1). The mean difference in performance shown by the different parameters with respect to the different fertilizers used was significant, statistically (F-ratio = 18.30836; p = 0.000673).

4. DISCUSSION

Soil fertility can be improved by application of organic and inorganic fertilizers; however, the use of any fertilizer type depends on several factors such as soil type, crop and socio-economic condition of the area [9]. This study investigated the comparative effects of organic and inorganic fertilizers on the growth and development of *S. nigrum* and the results revealed a significant difference in the effects of the different fertilizers used on the height, girth and stem diameter of the plant. These findings corroborates several previous reports that different fertilizers application affects soil fertility and influences the overall growth and development of plants [10-12].

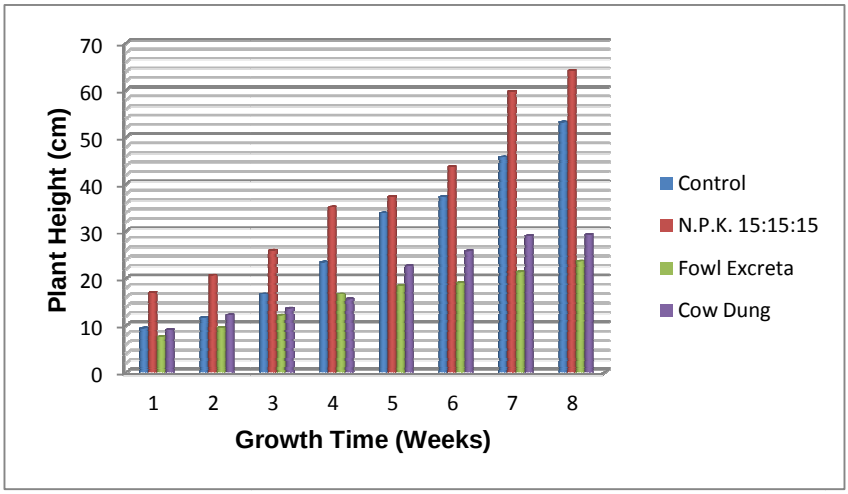

Fig. 1. Effect of different fertilizers application on *S. nigrum* plant height (cm) at different weeks of sampling

There was a significant difference (F-ratio = 4.735; p = 0.00855) in the effect of the different fertilizers on S. nigrum height

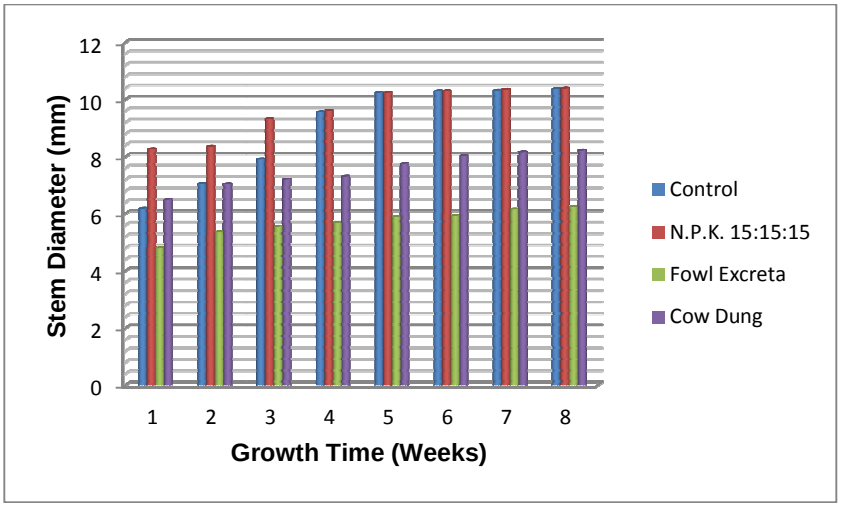

Fig. 2. Effect of different fertilizers application on *S. nigrum* stem diameter (mm) at different weeks of sampling

There was a significant difference (F-ratio = 23.46; p < 0.00001) in the effect of the different fertilizers on S. nigrum stem diameter

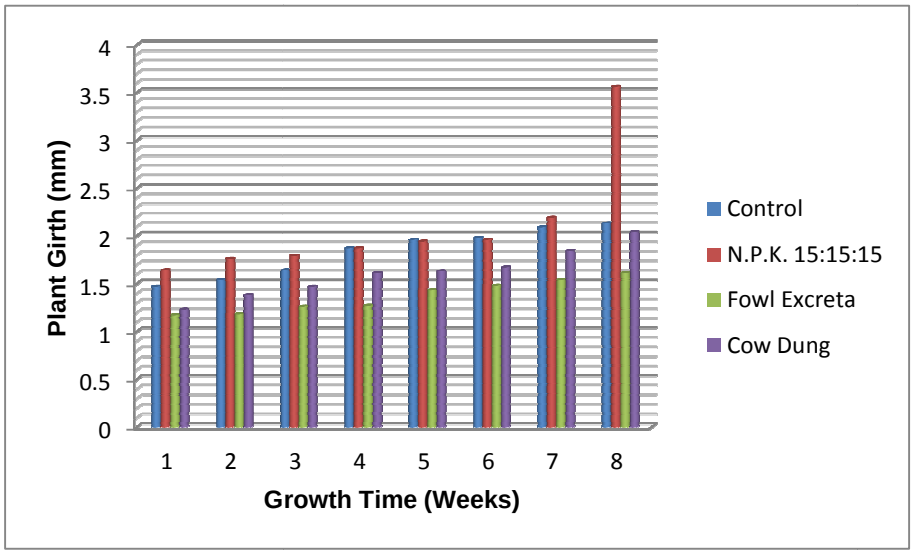

Fig. 3. Effect of different fertilizers application on *S. nigrum* plant girth (mm) at different weeks of sampling

There was a significant difference (F-ratio = 5.675; p = 0.003627) in the effect of the different fertilizers on S. nigrum plant girth

Table 1. Mean effect of different fertilizers application of the growth and development of *S. nigrum*

Treatment	Growth parameters			Plant biomass	
	Height (cm)	Stem diameter (mm)	Girth (mm)	Fresh weight (g)	Dry weight (g)
Control	28.84±16.17	9.02±1.72	1.84±0.25	0.04060.01608	0.0057±0.00258
N.P.K. 15:15:15	37.88±17.25	9.58±0.86	2.09±0.62	0.0442±0.02714	0.0068±0.00377
Fowl excreta	19.57±7.96	5.57±0.56	1.37±0.17	0.0119±0.00438	0.0028±0.00092
Cow dung	15.95±5.73	7.48±0.60	1.61±0.26	0.0250±0.1392	0.0045±0.00207

There was a significant difference in the overall effects of the different fertilizers applied on the growth and development of S. nigrum (F-ratio = 18.30836; P = 0.000673)

The results showed that inorganic fertilizer (NPK 15:15:15) produced the greatest growth among all the fertilizers, showing a significant increase above all the other treated blocks or ridges throughout the duration of the experiment; this result is in agreement with the findings of Masarirambi et al. [11] who reported better performance of okra when NPK fertilizer was applied and Babatola and Olaniyi [6] who also reported a significant increase in fresh food yield as a result of phosphorous application up to 13kg.p/ha and application of 25kg p/ha in the forest zone gave an optimum yield of wild okra, while the plant height, leaf number, number of primary branches, leaf stem and total dry weight were all reported to be increased by phosphorous application up to 26kg p/ha [6]. This significant increase in all growth parameters may be attributed to the quick release of nutrient to the soil, which helps in the rapid growth and development of the plant.

Second to the NPK in terms of increase in all the growth parameters was the control, which showed an increase in all the growth parameters throughout the period of the study. This result contradicts the findings of Keller et al. [12] who reported an increase in growth attributes of *Solanum villosum* upon application of various rates of farmyard manures and Kipkosgei [9] who observed the same trend with application of nitrogen fertilizers. This increase in all the growth parameters of the control block might be due to excessive runoff of nutrients from other treated blocks due to erosion due to constant rainfall due to sloppiness of the land.

The cow dung also showed an increase in the growth of the different parameters only for the first 3 weeks, and throughout the subsequent weeks there was a slow decline in the rate of growth of the parameters when compared to the NPK and control. This result did not agree with the findings of Masarirambi et al. [11] who reported that okra responded well to the dressing of organic manure. Also, Masinde et al. [13], reported that organic fertilizer plays a vital role as a major contributor of plants nutrients which also act as a store house for cation exchange capacity and as a buffering agent against undesirable pH fluctuations. This decrease in the growth parameters may be attributed to the low mineralization of organic manure as well as insufficient/improper application of the organic manure. This result is also in line with the findings of Mikkelsen and Hartz [14] who reported that organic fertilizer significantly increased the number of fruit yield of okra with optimum value recorded at 3 tons per hectare then thereafter, there was a slight decline.

Among all the treatments, the fowl excreta showed the least effect in all the growth parameters throughout the duration of the study. This result is in disagreement to the findings of Ondieki et al. [15] who reported the application of fortified manure on okra significantly increased most growth parameters including number of leaves, shoot, fresh and dry weights of plant. The significant decrease in all the growth parameters in the group treated with fowl excreta may be attributed to inappropriate application and also might be due to excessive runoffs of the nutrient due to erosion, through constant rainfall which accrue during the cause of the study.

5. CONCLUSION

From the study it can be concluded that different fertilizers had different effects on the growth and development of *S. nigrum.* While physical growth was enhanced, more specifically by the application of inorganic fertilizer (NPK 15:15:15), the application of organic manure (cow dung and fowl excreta) negatively affected the growth parameters as the untreated group (control) performed better. This negative effect may be due to low mineralization and subsequent runoff of the nutrient as a result of erosion. However, further studies are hereby recommended to determine the soil profile analysis of the study area as well as the physico-chemical analysis of the organic fertilizers used with respect to plant yield under erosion-controlled planting condition.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adejoro SA, Okunlola AI, Fakanlu G. Evaluation of some manure types for the growth and yield of watermelon in southwestern Nigeria. Researcher. 2011; 3:393-395.
2. Adeniyan ON, Ojo AO, Akinbode OA, Adediran JA. Effect of poultry manure, NPK 15-15-15 and combination of their reduced levels on maize growth and soil chemical properties. Journal of Soil Science and Environmental Management. 2011;2:9-13.
3. Adepetu JA, Corey SA. Organic phosphorus predictor of plant available phosphorus in soils of southern Nigeria. Soil Science. 1975;122(3):22-38.
4. Arisha HM, Bradisi A. Effect of mineral fertilizers and organic fertilizers on growth, yield and quality of potato under sandy soil conditions. Zagazig Journal of Agricultural Research. 1999;26:391-405.
5. Mandiringana OT, Mnkeni PNS, Mkile Z, van Averbeke W, Van Ranst E, Verplancke H. Mineralogy and fertility status of selected soils of the eastern Cape Province, South Africa. Communications in Soil Science and Plant Analysis. 2005;36:2431–2446.
6. Babatola LA, Olaniyi JO. Effect of N P K 15:15:15 level and plant spacing on performance and shelf-life of okra. Annal of Agricultural Sciences. 1999;1:24-29.
7. Chweya JA. Genetic enhancement of indigenous vegetables in Kenya. In Traditional African Vegetables. Promoting the conservation and use of underutilized and neglected crops. 1997;90-99.
8. Dauda SN, Ajayi FA, Ndor E. Growth and yield of water melon (*Citrullus lanatus*) as affected by poultry manure application. J. Agric. Soc. Sci. 2008;4:121-124.
9. Kipkosgei LK, Akundabweni LS, Hutchinson MJ. The effect of farmyard manure and nitrogen fertilizer on vegetative growth, leaf yield and quality attributes of *Solanum villosum* (Black nightshade) in Keiyo district, rift valley. African Crop Science Conference Proceedings. 2003;6:514-518.

10. Masarirambi MT, Dlamini P, Wahome PK, Oseni TO. Effects of chicken manure on growth, yield and quality of lettuce (*Lactuca sativa* L.) 'Taina' under a Lath House in a semi-arid sub-tropical environment. American-Eurasian Journal of Agriculture and Environmental Science. 2012;12:399-406.
11. Masarirambi MT, Sibandze N, Wahome PK, Oseni TO. Effects of kraal manure application rates on growth and yield of wild okra (*Corchorus olitorius* L.) in a sub-tropical environment. Asian Journal of Agricultural Science. 2011;4:89-95.
12. Keller W, Muskat E, Valder E. Some observations regarding economy, diet and nutrition status of Kikuyu farmers in Kenya. First edition. Weltforum Verlag, Munich. 1969;241-266.
13. Masinde P, Wesonga J, Ojiewo C, Agong S, Masinde M. Plant growth and leaf nitrogen content of *Solanum villosum* genotypes in response to nitrogen supply. Dynamic Soil, Dynamic Plant. 2009;3(1): 36-47.
14. Mikkelsen R, Hartz TK. Nitrogen sources for organic crop production. Better Crops. 2008;92:16-19.
15. Ondieki MJ, Aguyoh JN, Opiyo AM. Fortified compost manure improves yield and growth of African nightshades. Indian Journal of Engineering and Material Science. 2011;2(2):231-237.

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