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Effects of Organic and Inorganic Fertilizers on the Growth Performance of *Solanum nigrum* L.

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Authors' contributions

This work was carried out in collaboration between all authors. Authors ABO and AMJ designed the study. Author SRA wrote the protocol and wrote the first draft of the manuscript. Author AMJ managed the literature Searches. Author ABO carried out the analyses of the study. All authors managed the experimental process, read and approved the final manuscript.

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ABSTRACT

Pot experiments were conducted to assess the effects of organic and inorganic fertilizers on the growth of *Solanum nigrum* L. The experiment was carried out at the experimental site of the Department of Plant Science, Ekiti State University Ado- Ekiti Nigeria (7°40'N and 5°15'E). Ado-Ekiti is in the rainforest zone of south- western Nigeria. The treatments included two organic fertilizers (cow dung and poultry manure) and Inorganic fertilizers (NPK and Urea). NPK and Urea (200 $kgha^{-1}$) and 6t ha^{-1} of cow dung and poultry manure were used. The experimental design was a complete randomized design replicated six times. Results obtained showed that poultry manure produced the tallest plants (29.37 cm) at 6 weeks after transplanting and highest number of green leaves (76.25) at harvest (6 weeks after transplanting). These values were not significantly different from those of NPK fertilizer. Also, the leaf area at harvest, number of green leaves at harvest, fresh shoot biomass and relative growth rate were highest in poultry manure but similar to those of NPK applied pots. The results obtained were directly proportional to the stem girth as poultry manure

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recorded the highest values for stem girth. All the growth parameters observed showed that the control experiments gave the least performance. The results further revealed that poultry manure, NPK and cow dung gave comparable growth factors. It is suggested that poultry manure and cow dung (organic fertilizers) might be a good option in the cultivation of *Solanum nigrum* L. by resource poor farmers, who might not be able to afford the cost of inorganic fertilizers in cultivation of the vegetable. This research advocates for the use of naturally produced fertilizers as products from such is safe for human consumption. This can also reduce the harmful effect of inorganically produced crop on mankind.

Keywords: Solanum nigrum; poultry manure; cow dung; NPK; Urea; South western Nigeria.

1. INTRODUCTION

The use of leafy vegetables for food security in South Western Nigeria cannot be underestimated. Vegetables serve as food for the nation with the growing population of this millennium. They are rich in essential minerals, vitamins that have nutritional qualities [1]. Vegetables have medicinal values for the treatments of various ailments affecting mankind. The indigenous vegetables are more nutritious for food and medicine [2]. It had been reported that traditional vegetables have medicinal properties for the management of HIV/AIDS, stomach related ailments and other diseases [3]. Vegetables contain chemical and nutritional health benefits to man [4,5]. The medicinal uses of plants include; treatment of ringworms, wounds, headache and other ailments and conditions in South Africa [6]. *S. nigrum* is an indigenous vegetable, consumed during the raining season in south western Nigerian. It belongs to the family Solanaceae. The genus Solanum has about 1,700 species which are widespread in distribution. They are dicotyledonous plants bearing berries with numerous seeds. They are mostly twiners with 90 genera and 2000 species [7]. Solanum species are herbs with simple leaves, pinnate or alternate. The flowers are radially or rarely bilaterally symmetrical. The fruits are succulent, 2- locular, many seeded globuse to ovoid black brown red, orange, yellow or green berries, 6-10 mm diameter [8]. Also, *S. nigrum* had been used to treat tuberculosis [9]. *S. nigrum* has high nutritional value and rich in β- carotene, minerals such as iron and calcium and protein especially methionine, an essential amino acid [10,11].

Vegetarians depend solely on vegetables to supply their nutritional needs. The local vegetables are endangered which might have resulted in the shift of people's taste from wild species to cultivated or exotic vegetables. Also, urbanization through which forested areas were deforested for the construction of social amenities such as schools, health centres, factories among others. The migration of people to urban areas influences the choice of vegetables as food. The deforestation of forested areas had led to the use of inorganic fertilizers in the production of most food crops [11]. The benefits derived from the use of organic fertilizers in crop production includes enhancement of soil productivity, increase in the soil organic carbon content, soil microorganism activities, improvement of soil structure and increase in nutrient status balance of the soil enhancement of drop yield [12-14].

Plants need nutrients in specific proportion in the soil [15] which can be improved with the use of fertilizers. Fertilizer use is the key factor in soil fertility management and yield increase in crop production [16]. There is a global awareness on the production of foods/ vegetables through the use of organic fertilizers, to avert the problems or diseases caused by the use of inorganic fertilizers thereby improving the good health of mankind.

In lieu of this, the study was designed to examine the effects of organic and inorganic fertilizers on the growth and yield of *Solanum nigrum* L. an important vegetable in south western Nigeria.

2. MATERIALS AND METHODS

The experiment was carried out at the experimental site of the Department of Plant Science, Ekiti State University Ado- Ekiti Nigeria (7°40'N and 5°15'E). Ado- Ekiti is in the rainforest zone of south- western Nigeria.

The experiment was carried out between October 2014 and March 2015. Seeds of *Solanum nigrum* were collected from Ikoga market, Badagry Lagos State. Cultivated soil was obtained on campus, air dried for a week and sieved through a 5 mm mesh. Equal amount of soil (4.8 kg) was measured with weighing

balance and was put in planting pots. Routine soil analysis was carried out and the soil was analysed to be sandy clay loam with soil organic matter of 7.54%, 0.85%N, 16.21 $mgkg^{-1}$P and 21.50 $mgkg^{-1}$K with a pH of 7.54. The treatments included two organic fertilizers (cow dung and poultry manure) obtained from Teaching and Research Farm, Faculty of Agricultural Science in Ekiti State University, Ado- Ekiti. Inorganic fertilizers (NPK and Urea) were obtained from Agricultural Development Project (ADP), Ado-Ekiti. NPK and Urea (200 $kgha^{-1}$) and 6t ha^{-1} of cow dung and poultry manure were used. The poultry manure was analysed to have 2.50% N, 5.13 $mgkg^{-1}$P, 5856.64 $mgkg^{-1}$K with pH of 7.52. Likewise the cow dung was analysed to have 2.19% N, 4.27 $mgkg^{-1}$ P, 8366.53 $mgkg^{-1}$K with pH of 8.20. The organic fertilizers were mixed with the soil two weeks before transplanting while the inorganic fertilizers were applied into the soil two weeks after transplanting of the seedlings using the ring method. The seedlings had earlier stayed in the nursery for four weeks.

The pot experiments were laid down in completely randomized design with the treatments replicated four times. A control experiment without any fertilizer was also replicated four times. The parameters assessed were weekly heights, leaf area, number of leaves at harvest, stem girth, relative growth rate, number of fruits and biomass. Leaf area and relative growth rate were determined according to Hoffmann and Poorter; and Kayode and Tedela [17,18].

The data collected from the experiments were subjected to statistical using Analysis of Variance (ANOVA) and Duncan Multiple Range Test (DMRT) was used to separate the means.

3. RESULTS

The effects of organic and inorganic fertilizers on the weekly height of *Solanum nigrum* are shown in Table 1. It was revealed that *S. nigrum* heights obtained in poultry manure was the highest at 6 weeks after transplanting. The control had the shortest plants.

Statistical analysis revealed that the initial heights of *S. nigrum* and 2 weeks after transplanting were not significantly different irrespective of the treatments. However there were taller plants observed in *S. nigrum* in all the treatments compared to the control experiment from 3 weeks after transplanting.

The effects of organic and inorganic fertilizers on the mean number of leaves at harvest are presented in Table 2. The mean number of leaves at 6 weeks after transplanting showed that poultry manure, NPK and urea were similar but highest. These three variants were significantly higher than cow dung and the lowest values were in the control treatment. No significant difference was observed in the initial leaf area of *S. nigrum* compared to the control experiment.

Table 3 shows the effects of organic and inorganic fertilizers on the leaf area (cm^2) and the number of green leaves at harvest of *S. nigrum.* The leaf area was highest in poultry manure and NPK fertilizer. However, poultry manure and NPK values were higher than cow dung and urea. Control treatment had the lowest leaf area. This was similar to the results obtained in the number of green leaves at harvest. Statistical analysis showed that significant differences were observed in both the leaf area and number of green leaves at harvest of *Solanum nigrum* when compared to the control treatment.

The effects of organic and inorganic fertilizers on the stem girth, number of fruits and relative growth rate of *S. nigrum* are shown in Table 4. The stem girth of *S. nigrum* observed in the control was lowest while other treatments were not significantly different. Relative growth rate were similar in poultry manure and NPK while the least was observed in the control treatment. Cow dung produced the highest number of fruits at harvest. The control experiment produced the least in the three parameters respectively. Statistical analysis showed that significant differences were observed in the stem girth and the relatively growth rate of the treated seeds compared to the control treatments. No differences were observed in the number of fruits.

The effects of organic and inorganic fertilizers on the biomass of *S. nigrum* are presented in Table 5. Poultry manure produced the highest fresh root weight, fresh shoot weight dry root weight and dry shoot weight respectively. These results were not significantly different from those of NPK and cow dung. The control treatment produced the least fresh and dry shoot biomass while the poultry manure, cow dung and NPK were similar and highest. Statistical analysis showed that significant differences were observed in the fresh and dry root weights of *S. nigrum* in the treated seeds compared to the control treatment.

Table 1. Effects of organic and inorganic fertilizer on the height (cm) of *Solanum nigrum*

Treatment	Initial height	2 WAT	3 WAT	4WAT	5 WAT	6 WAT
Control	1.83a	1.80a	3.68c	5.91d	13.16c	17.45c
PM	1.25a	2.58a	8.19a	16.73a	22.06a	29.37a
CWD	1.29a	3.08a	9.73a	15.59a	22.08a	25.73a
NPK	0.85a	3.39a	5.90b	12.36b	21.46a	27.29a
Urea	1.19a	3.00a	4.54b	9.44c	18.35b	23.25b

Mean followed by the same letter within column are not significantly different at (P=0.05)
**Note: PM- Poultry manure, CWD- Cow dung*

Table 2. Effects of organic and inorganic fertilizer on the number of leaves *Solanum nigrum*

Treatment	Initial	2 WAT	3 WAT	4 WAT	5 WAT	6 WAT
Control	4.88a	5.34c	6.68c	6.68d	14.54d	18.75c
PM	5.50a	8.75a	22.50a	65.63a	67.13a	76.25a
CWD	5.00a	8.63a	26.50a	50.00b	56.75b	60.00b
NPK	4.75a	8.38ab	15.00b	39.75c	65.50a	75.63a
Urea	4.15a	7.75b	13.00b	35.25c	44.63c	71.25a

Mean followed by the same letter within column are not significantly different at (P=0.05),
**Note: PM- Poultry manure, CWD- Cow dung*

Table 3. Effects of organic and inorganic fertilizer on the leaf area and number of green leaves of *Solanum nigrum* at harvest

Treatment	Number of green leaves at harvest	Leaf area (cm^2)
Control	18.75c	47.89c
PM	73.75a	93.38a
CWD	60.00b	75.12b
NPK	70.63a	83.99a
Urea	61.88b	70.25b

Mean followed by the same letter within column are not significantly different at (P=0.05).
**Note: PM- Poultry manure, CWD- Cow dung*

Table 4. Effects of organic and inorganic fertilizer on the stem girth, number of fruits and relative growth rate of *Solanum nigrum* L.

Treatment	Stem girth (cm)	Number of fruits	Relative growth rate
Control	10.75b	16.00a	0.23c
PM	14.25a	21.63a	0.34a
CWD	14.13a	26.75a	0.27b
NPK	14.00a	9.50a	0.34a
Urea	13.00a	11.50a	0.29b

Mean followed by the same letter within column are not significantly different at (P=0.05).
**Note: PM- Poultry manure, CWD- Cow dung*

Table 5. Effects of organic and inorganic fertilizer on the biomass of *Solanum nigrum*

Treatment	Fresh root biomass	Fresh shoot biomass	Dry root biomass	Dry shoot biomass
Control	1.62b	13.55c	0.48b	2.14c
PM	3.23a	24.73a	0.90a	5.07a
CWD	2.75a	19.70ab	0.88a	4.40a
NPK	1.36b	21.38a	0.86a	4.67a
Urea	0.78c	18.97b	0.36b	3.71b

Mean followed by the same letter within column are not significantly different at (P=0.05).
**Note: PM- Poultry manure, CWD- Cow dung*

4. DISCUSSION

The highest growth parameters of *S. nigrum* occurred in poultry manure. This might be as a result of the highest release of nitrogen and phosphorus from the organic fertilizer. This was in accordance with earlier reports that organic amended soils possess essential nitrogen twice the level of nitrogen as convectional soils [19,20].

It had earlier been reported that poultry manure possesses essential nutrients which are associated with the photosynthetic activity capable of promoting roots and vegetative growth of plants [21]. Research report had shown that pepper (Capsicum) can successfully be produced organically with poultry manure [22].

In the present work, poultry manure consistently increased the vegetative growth of *Solanum nigrum* more than cow dung did. This might have resulted from higher nitrogen content in poultry manure than the cow dung. Higher essential nutrients in poultry manure had been reported to increase photosynthetic efficiency and so increase higher vegetative growth [23]. Poultry manure had also been reported to enhance the growth parameters of crops [24] due to high content of essential nutrient elements resulting to high photosynthetic activities [25].

Poultry manure is readily available as waste from poultry farmers. It cost less than the synthetic inorganic fertilizers. It is environmental friendly as it does not damage the soil as against the inorganic fertilizer which can cause soil acidity due to continuous use. The organic fertilizer (poultry and cow dung) does not require expertise for its application [22].

It is recommended that *S. nigrum* should be cultivated with organic fertilizers. The vegetables produced through this medium will be safer for mankind to avert the likely diseases derived from the consumption of foods produced through inorganic fertilizers.

5. CONCLUSION

The present work suggests that either poultry manure or cow dung (organic fertilizers) might be a good option in the cultivation of *Solanum nigrum* L. by resource poor farmers, who might not be able to afford the cost of inorganic fertilizers in cultivation of this all important vegetable. The use of organic manure especially poultry manure in producing *Solanum nigrum* L. for consumption as a vegetable will further support the global advocacy for organic farming.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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