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THE RESPONSES OF TOMATO (*Solanum lycopersicon L.)* IN GROWTH, YIELD AND NUTRITIONAL QUALITIES TO GROUNDNUT SHELL AND OTHER SOURCES OF NUTRIENT

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ABSTRACT

The study was carried out to evaluate the effect of granulated groundnut shells and other sources of nutrients (poultry droppings, burnt groundnut shell, NPK 10:10:10) on the growth and yield of tomatoes. The experiment comprised five treatments with three replicates each. The treatment consisted of 3 organic nutrient sources (poultry droppings, burnt groundnut shell, and raw groundnut shell) and one inorganic source of nutrients (NPK 10:10:10). They were applied at different rates depending on what quantity of the nutrient sources can supply the recommended kilogram (100) of Nitrogen per hectare. Groundnut shell was applied at the rate of 94.34 g per 20kg of soil, burnt groundnut shell was applied at the rate of 161.29g per 20kg of soil, poultry dropping was applied at the rate of 99.01g per 20kg of soil, a mixture of groundnut shell. Poultry dropping was also applied (groundnut shell was 47.17g+49.50g poultry droppings) = 96.67g per 20kg of soil, and NPK 10:10:10 was applied at 10g per 20kg of soil. The experiment was laid out in a completely randomized design. Data were collected on morphological parameters, including the number of leaves, plant height, stem girth, number of branches, days to first flowering, days to 50% flowering, days to first fruiting, number of fruits, and weight of fruits. Data collected were subjected to analysis of variance (ANOVA) using a Statistical Analysis System (SAS) package. Means were separated using Duncan's Multiple Range Test (DMRT), and statistical means were tested at a 5% significance level. The *result of the study showed that a mixture of groundnut shells and poultry droppings enhanced the growth and yield of tomatoes more than any other treatment used. This finding suggests that this specific combination of organic nutrient sources can be a more effective and sustainable alternative to inorganic sources for tomato cultivation.*

Keywords: Groundnut shell, Growth, Nutrients, Organic, Yield

INTRODUCTION

Tomatoes are a very important vegetable cultivated and consumed in most parts of the world, from home gardens and greenhouses to large commercial farms, due to their wider adaptability to various agro-climatic conditions. The crop is rich in vitamin C and contains lycopene, a vital antioxidant that prevents cancers (Beckles, 2012). Tomato quality and yield are greatly reduced by nutrient shortage in the soil (Sainju *et al.,* 2003). Organic manure provides crops with essential nutrients when decomposed and acts as a soil conditioner (Makinde *et al.*, 2007). Soil organic amendments such as cow dung, goat manure and poultry manure are valuable sources of plant nutrients (Takahashi *et al*., 2010). Most developing countries are trying to eliminate expensive chemical fertilizers by supplementing them with some organic-based sources. A mixture of organic and inorganic fertilizers is a good soil fertility management strategy. Organic farming restricts the use of agrochemicals and offers a way to reduce the adverse effects of chemical fertilization (Aguilera *et al., 2013;* Aires *et al., 2013*). Although the most significant disadvantage of organic crop production has been low yields compared to intensive farming (Seufert *et al*., 2012), thus farmers choose to use industrial synthetic chemical fertilizers to grow vegetables (Matsumoto and Yamano, 2009). However, large-scale use of inorganic fertilizers can contribute to environmental pollution, such as groundwater contamination, eutrophication of waterways, soil acidification and increased denitrification, resulting in higher emission of nitrous oxide, which contributes to global warming (Molla *et al*., 2012). The need to examine the effect of different fertilizer sources on the growth and productivity of tomatoes is quite important as it helps farmers to make better choices that will reduce cost and improve yield while also considering ecological sustainability. Groundnut hulls make up around 25% of the several million tons of mass-produced hulls generated yearly but are not used. Most groundnut hulls are currently burned and discarded in forests. As a result, its collection and commercialization as an organic source of nutrients hold great promise as a potential substitute for chemical fertilizers and for controlling environmental pollution. Thus, this research was conducted to evaluate the growth and yield of tomato crops in response to groundnut shells and other sources of nutrients.

METHODOLOGY

Study Location, Treatment Sources and Experimental Designs

The study was carried out at the screenhouse of the Department of Crop Production, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Niger State. Monarch Tomato seed was used in the research. It was sown in the seed tray and tinned to 30 seedlings per tray two weeks after sowing. The experiment was arranged in Completely Randomized Design (CRD) with five treatments (granulated groundnut shell, burnt groundnut shell, poultry dropping, mixture of granulated groundnut shell and poultry dropping, and NPK 10:10:10) replicated three times. A recommended nitrogen rate of 100 kg/ha was used to calculate the needed quantity per pot for the tomatoes. Treatment 1 (Granulated groundnut shell at 94.34g per pot. Treatment 2 (Burnt groundnut shell at 161.29g per pot. Treatment 3 Poultry dropping at 99.01g per pot. Treatment 4 (Mixture of poultry manure and groundnut shell = 47.17+49.50=96.67g. Treatment 5 (N. P. K 10:10:10 at 10g per pot. A total of 15 pots were filled with soil weighing 20kg per pot. The pots were arranged properly on a sturdy support. The organic treatments were applied a week before transplanting, while the inorganic treatments were applied two weeks after transplanting.

Pre-Planting Soil Analysis

The soil was slightly acidic. Table 1 shows the result of the physicochemical pre-planting analysis used to assess the soil fertility status. The result showed that the soil needed amendment before being used for tomato production, and thus, it was fit for use in a fertilizer experiment.

Transplanting and Management Practices

Disease-free, vigorous, and uniform-size seedlings were transplanted using the naked root method. The nursery bed was properly watered to help remove the seedlings without damage. Manual weeding was carried out by hand picking when weeds were noticed. Staking was done to keep the plant erect and for proper fruit development.

Table 1: Physicochemical Pre-Planting Analysis of the Sample of Experimental Soil

Properties	Values
Physical	
Sand (g kg^{-1})	800
Silt (g kg^{-1})	80
Clay (g kg^{-1})	120
Textural class	Loamy Sandy
Chemical	
PH (H_2O)	6.33
PH ($CaCl_2$)	5.6
Organic carbon (g kg^{-1})	2.3
Total nitrogen (g kg^{-1})	1.2
Available phosphorus (mg kg^{-1})	10.06
Exchangeable bases (cmol kg^{-1})	
Na+	0.16
K+	0.06
Mg2+	1.0
Ca2+	2.0
Exchangeable acid (cmol kg^{-1})	0.11

Data Collection

Plant height was measured from each replicate from the respective treatment once a week using a tape measure from the base to the apex of the plants. Leaves from each replicate from the respective treatment were counted at a two-week interval from two weeks after sowing.

Number of Fruits per Plant

The number of fruits per plant was recorded by counting the number of ripe fruits harvested on each plant.

Weight of Fruits per Plant

The fruit weight per plant was recorded by weighing the number of ripe fruits harvested on each plant.

Post Harvest Analysis

Three post-harvest analyses were carried out. Proximate analysis on the harvested fruit was carried out at the laboratory of the Department of Water Resources, Fisheries and Aquaculture, Federal University of Technology, Minna, Niger State, Nigeria, using the methods outlined by the Association of Official Analytical Chemists (AOAC, 2000). This was to determine which of the applied nutrients produced better fruit qualities. Post planting soil analysis was also carried out to know which of the treatments used leave the soil in a better condition than at the beginning. Plant tissue analysis was carried out to show the nutrient status of the plants and to indicate if the supplied nutrient was adequate.

Data Analysis

The data were subjected to analysis of variance (ANOVA), and means were separated using Duncan's Multiple Range Test (DMRT) at a 5% level of significance.

RESULTS AND DISCUSSION

Effect of Granulated Groundnut Shell and Other Nutrient Sources on The Number of Leaves of Tomato

The effect of nutrient sources on the number of tomato leaves at 2, 4, 6, and 8WAT are shown in Table 2. T5 (NPK 10:10:10) was consistently low in value in all the treatment, and differed significantly ($p \leq 0.05$) from the other treatments all through the weeks. The result obtained with T5 is not consistent with what is known with inorganic fertilizers especially that it raises root development (Scholl and Nieuwenhuis, (2004), which could aid in proper plant development.

Table 2: Effect of Granulated Groundnut Shell and other Nutrient Sources on the Number of Leaves of Tomato

	Number of Leaves			
Treatments	2WAT	4WAT	6WAT	8WAT
T_1	23.00^a	56.00^b	100.00^a	155.00^b
T_2	35.00^a	71.00^a	116.00^a	171.00^{ab}
T_3	36.00^a	84.00^a	129.00^a	172.00^{ab}
T_4	48.00^a	89.00^a	140.00^a	202.00^a
T_5	16.00^b	39.00^b	65.00^b	73.00^c
SE_+	4.18	7.12	8.74	12.28

$^{a, b}$ means on the same column with different superscripts are significantly different at P<0.05
T_1 = groundnut shell, T_2 = burnt groundnut shell, T_3 = poultry droppings, T_4 = groundnut shell and poultry droppings, T_5 = NPK 10:10:10

Effect of Granulated Groundnut Shell and Other Nutrient Sources on Plant Height

The effect of nutrient sources on plant height on tomatoes at 2, 4, 6 and 8 Weeks After Transplanting (WAT) are shown in Table 3. There were no significant (p>0.05) differences for the plant height at 2WAT across all the treatments. However, a different trend was observed for the remaining weeks, as there were significant differences (p≤0.05) across all the treatments. T4 (groundnut shell and poultry droppings) was consistently high in value in all the treatments and differed significantly (p≤0.05) from the other treatments all through the weeks. This suggests that T4 could be a more effective nutrient source for promoting plant growth.

Effect of Granulated Groundnut Shell and Other Nutrient Sources on Number and Weight of Fruits of Tomato

The effect of nutrient sources on number of fruit and weight of fruit are shown in Table 4. There were no significant (p>0.05) differences among the treatment means. However, the Table shows that T4(groundnut shell and poultry droppings) significantly influenced a higher number of fruits compared to the other treatments, demonstrating its impressive performance in fruit production. Similarly, T4 (groundnut shell and poultry droppings) consistently produced fruit with a significantly higher weight compared to the other treatments, showcasing its effectiveness and the potential for increased yield.

Table 3: Effect of Granulated Groundnut Shell and other Nutrient Sources on Plant Height

	Plant height (cm)			
Treatments	2WAT	4WAT	6WAT	8WAT
T_1	23.33^a	39.00^{ab}	69.33^b	106.33^c
T_2	27.33^a	46.67^{ab}	86.00^{ab}	123.00^b
T_3	27.67^a	54.67^a	92.00^a	130.33^{ab}
T_4	33.67^a	63.33^a	105.00^a	138.00^a
T_5	15.67^a	25.00^b	53.00^c	59.67^d
SE_+	2.28	4.64	5.36	7.55

[a,b,c,d] Means on the same column with different superscript are significantly different ($p<0.05$)

T_1 = groundnut shell , T_2 = burnt groundnut shell, T_3 = poultry droppings, T_4 = groundnut shell and poultry droppings, T_5 = NPK 10:10:10

Table 4: Effect of granulated groundnut shell and other nutrient sources on number and weight of Tomato

Treatments	Number of fruits	Weight of fruits (g)
T_1	2.0^a	29.0^a
T_2	1.0^a	32.0^a
T_3	3.0^a	45.6^a
T_4	4.0^a	107.0^a
T_5	2.0^a	76.6^a
SE±	1.11	26.39

T_1 = groundnut shell, T_2 = burnt groundnut shell, T_3 = poultry droppings, T_4 = groundnut shell and poultry droppings, T_5 = NPK 10:10:10

Proximate Analysis of Fresh Tomato Fruit

The result of the proximate composition of fresh tomato fruit is shown in Table 5. There were no significant differences (P>0.05) in the moisture content of the treatments. The ash contents were significantly different (P≤0.05). T3 and T4 showed highest level, followed by T2. There were significant (P≤0.05) differences in the crude protein content of the treatments. The highest significance level was observed in T4, followed by T3 and T2. For the fat content, T4 varied significantly when compared to the rest of the treatments and had the highest value, while T1 had the lowest value. No significant differences (P>0.05) were observed in the crude fibre contents among the treatments. There were significant differences (P≤0.05) in the NFE of the samples; T2 had the highest value, and the lowest value was obtained in T3.

Table 5: Proximate Analysis of Fresh Tomato Fruit

Treatments	MC (%)	CF (%)	CP (%)	Ash (%)	Fat (%)	NFE
T_1	30.40^a	0.68^a	0.70^b	0.04^b	0.24^b	1.27^b
T_2	30.07^a	0.70^a	0.87^a	0.05^{ab}	0.28^b	1.33^a
T_3	30.47^a	0.79^a	0.87^a	0.07^a	0.41^a	0.73^d
T_4	30.21^a	0.70^a	0.98^a	0.07^a	0.49^a	0.88^c
SE±	0.41	0.02	0.03	0.00	0.03	0.08

^{a,b} Mean on the same column with different superscript are significantly different at p<0.05

T_1 = groundnut shell, T_2 = burnt groundnut shell, T_3 = poultry droppings, T_4 = groundnut shell and poultry droppings.

Tissue Analysis of Tomato Shoot

The result of the tissue analysis of tomato stalk is shown in Table 6 below. There were no significant (p≥0.05) differences in the Nitrogen contents of the treatments, T2 (burnt groundnut shell) had the highest value of (0.43%), while the lowest value was recorded for T1 (groundnut shell) and T3 (poultry droppings) (0.37%). The Potassium contents of the treatments varied significantly (p≤0.05), with T1 having the highest value (143.67mg/100g), while the lowest value (126.33mg/100g) was recorded for T4 (groundnut shell and poultry droppings). The phosphorus content of the treatments was highest in T4, and no significant differences (p≥0.05) were observed among the treatments. These findings lend credence to past research showing that manures and other organic sources provide adequate nutrients plants need to develop and produce (Atiyeh *et al*., 2002; Ojeniyi, 2008; Mehdizadeh *et al.,* 2013).

Table 6: Tissue Analysis of Tomato Stalk

Treatments	N (%)	K (mg/100g)	P (mg/100g)
Groundnut shell	0.37^{a}	143.67^{a}	135.33^{a}
Burnt groundnut shell	0.43^{a}	134.00^{b}	137.33^{a}
Poultry Droppings	0.37^{a}	131.33^{b}	134.00^{a}
Groundnut shell + Poultry droppings	0.41^{a}	126.33^{b}	139.33^{a}
SE±	0.13	1.10	2.19

^{a,b} Means on the same column with different superscripts are significantly different at $p<0.05$

Post Soil Analysis

The post-soil analysis of tomatoes is shown in Table 7 below. The result shows that the various treatments had no significant ($p>0.05$) differences in the post-soil parameters (O/C%, O/M%, and N%). However, the groundnut shell treatment had higher organic carbon and organic matter content than the rest. It revealed that the treatment could leave the soil better after a cropping season.

Table 7: Post Soil Analysis of Experimental Soil

Treatments	O/C (%)	O/M (%)	Nitrogen (%)
Groundnut shell	0.75	1.30	1.20
Burnt groundnut shell	0.53	0.91	1.60
Poultry Droppings	0.62	1.06	1.30
Groundnut shell + Poultry droppings	0.56	0.91	1.40

CONCLUSION AND RECOMMENDATIONS

In all the parameters, treatments with groundnut shells, either as a whole or in other forms, had the highest value and were significant in some of the analyses. The mixture of poultry droppings and groundnut shells produced plants with more leaves. It also produced taller plants and plants with a higher number of fruits and fruits that weigh higher. Also, groundnut shell treatment showed the potential to leave the soil in a better condition after a cropping season, judging from levels of organic matter, organic carbon, and Nitrogen remnant in the soil in the post-harvest soil analysis.

Based on the findings from this study, groundnut shells should be considered an alternative source of nutrients either as a whole, being ploughed into the soil, or in combination with other nutrient sources like poultry manure. Researchers can focus more research on the potential of groundnut shells to change the world of vegetable production so that the full benefits can be discovered.

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