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KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2 : 162-170
p-ISSN: 1595-5776

ENHANCING HOUSEHOLD FOOD SECURITY THROUGH EFFICIENT USE OF POULTRY MANURE IN SPRING ONION *(ALLIUM FISTULOSUM L.)* PRODUCTION ON SANDY SOIL

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ABSTRACT

Spring onion is handy for potting as an easy-to-grow bulb vegetable; it is delicious, nutritious, and important in many dishes. To meet the nutritional demands of small households, poultry manure is utilised as a natural input, and sandy soil is low in metal toxicity. Hence, a two-planting period pot experiment was conducted, using erosion-deposited soil for spring onion production in Epe, Lagos State. The trial investigated the response of spring onion to different levels of poultry manure- (PM) on sandy soil of the University Teaching and Research Farm (simulated coastal soil), using 10 kg of soil per pot. Treatments (0 – 6 t/ha of PM application; at 5g, 10g, 15g, 20g, 30g, and No Fertiliser Application (0-NFA) per 10kg. The experiment was arranged in a completely randomised design, replicated thrice. Data collected were: Plant height-(PH), number of leaves/tiller-NL at bi-weekly After Sowing (WAS) Bulbs, Leaf-(L_w), and Biomass weights (B_w) were taken at harvest. All data collected were analysed using Analysis of Variance ($p \leq 0.05$). The nutrient content of the soil used was low and PM used was adequate and supported onion production. The results showed that spring the onion plant height at 6WAS of the first planting, ranged from 9.6±0.78cm to 14.5±0.78cm under NFA and 30g-PM application, and at the second planting, it ranged from 12.3±1.08cm – 19.9±1.08cm under the same fertiliser application. The lowest B_w yield (8.8±3.44g) was obtained under NAF, and the highest (32.3±3.44g-PM) under 30g/10kg poultry manure application. At the second planting, the fresh biomas' yield increases with increase in PM level in this trend: 30g ≥ 20g ≥ 15g ≤ 10g/10kg soil. It can be recommended that poultry manure application to sandy soil for spring onion production should range from 30g/10kg of sandy soil under a pot experiment in an open space.

Keywords: onion, poultry manure, sandy soil, yield

Introduction

Spring onion (*Allium fistulosum)* belongs to the *Liliaceae* family, and is also known as green onion. Traditionally, it has been used in medicine to treat the common cold, influenza, abdominal pain, headache, and cardiovascular disease (Inden & Asahira, 2017). Extracts from spring onions are a potential source of natural antioxidants and antimicrobial agents (Aoyama and Yamamoto, 2017; Sang, Lao &Wang, 2002; Sung, Kim, & Kim, 2020). It is also reported to improve eyesight and help in digestion, perspiration, recovery from wounds, festering sores, and diabetes among health

related issues (Kang, Kim, & Choi, 2010; Liu, Feng, & Chen, 2019).

Several studies indicated that *Allium fistulosum* is a rich source of vitamins C, A, and B_6, thiamine, folate, potassium, copper, manganese, iron, and chromium (Zhang, Sun & Mao, 2019). Leaf blades are rich in rhamnose, galactose, glucose, arabinose, and xylose (Żurawik, Jadczak & Żurawik, 2019). Spring onion is known to contain amino acids and peptides such as cysteine and glutathione, which act as redox agents in the dough, improving bread-making properties (Seguchi & Abe, 2018). Flavonoids, carotenoids, and some sulfur compounds are phytonutrients found in spring onions. Sung, Kim, Kim, and Kim (2020) suggested that *Allium fistulosum* extracts could be used as functional food materials for weight control in obesity. The roots contain allicin and diallyl disulfide and can potentially reduce body fat mass (Zhang, Sun, & Mao, 2019).

Poultry manure presents a promising organic fertiliser option due to its nutrient-rich composition and potential to improve soil structure. Despite the recognised benefits of poultry manure, there is limited scientific literature specifically investigating its effects on the growth and yield of spring onions.

Poultry manure is a valuable organic input that increases the growth and yield of spring onions. Several studies have shown that its application to spring onion crops increased the plant height, leaf length, and bulb diameter among other growth and yield parameters (Warade & Kadam, 2018). A study by Kumar, Mahapatra & Patra (2018) found that spring onions with an application of 10 tons/ha of poultry manure had optimum yields and better nutritional quality when compared to those treated with synthetic fertilisers. Poultry manure application increases the nitrogen, phosphorus, and potassium content of spring onion plants (Ogunleke, Olawale & Adeyeye, 2019). As a good soil amendment material in soil fertility and crop production, excessive application of poultry manure can lead to nutrient imbalances and environmental pollution. Hence, poultry manure can be a valuable fertiliser for spring onion production, but its application should be carefully managed to avoid adverse effects (Kumar *et al*.,2018).

Poultry manure is recognised as a valuable source of organic nutrients essential for plant growth and soil fertility. However, the optimal application rate of poultry manure for specific crops such as spring onions remains inadequately understood. Addressing this knowledge gap is crucial for enhancing this essential plant production, ensuring sustainable nutrient management, and maximising spring onion yields. Besides, cultivation of spring onion in coastal regions of countries like Chad, Accra and other sandy or alluvial deposited soil areas. However, to replicate this environment for culti]vating spring onions, erosion-deposited sandy soil was used in this trial.

This trial will have a direct impact on household food production, as spring onion is a common crop grown in many households. On the other hand, the use of poultry manure as an organic fertiliser promotes sustainable agriculture practices, reducing the reliance on synthetic fertilisers.

Existing studies often focus on general aspects of poultry manure application on other crops, leaving a gap in understanding the crop-specific responses of spring onions to varying levels of poultry manure.

Furthermore, variability in soil conditions, climate, and management practices necessitates localised research to provide relevant and applicable recommendations for farmers. Therefore, this trial aims to examine the different levels of poultry manure on the growth and yield of spring onions under pot conditions.

This study, therefore, aimed at examining the effects of poultry manure on the growth and yield of spring onions under pot conditions. The objectives of the trial are: to evaluate the growth and yields of spring onion on six levels of poultry manure and to assess the performance of spring onion on sandy soil in Epe under pot conditions.

Hence, a pot experiment was conducted using erosion-deposited sandy soil as a simulation of the coastal soil for spring onion production was carried out in Epe, Lagos State.

Materials and Methods

The experiment was conducted at Lagos State University of Education (LASUED) Teaching and Research Farm (TR&F), Noforija, Epe Campus, Lagos State. The experimental pots were placed in an open space to provide field conditions. The trial was conducted between March and May 2024.

Each experimental pot was filled with 10 kg of air-dry sandy soil collected from erosion-deposited spots in the valley portions of the Teaching and Research Farm. The choice of soil was made to simulate the coastal soil of Accra, where the selected cultivar of spring onion is predominantly grown.

The spring onions were sourced from Anglon village in Ghana, Accra, from the farmer, in December 2023. The best and most viable seeds (bulbs) were selected for sowing. The poultry manure was obtained from the Agricultural Education Teaching and Research Farm, Lagos State University of Education, Odo-Noforija, Epe Campus, Lagos. The dried poultry manure was applied for two weeks to the erosion-deposited sand before spring onion seeds were sown. The experiment was manually irrigated throughout. The physio-chemical analyses of the soil and the poultry manure used were done in the laboratory (as shown in Table 1).

Eighteen (18) experimental pots were used for the trial, comprising six (6) poultry manure application levels: 5g, 10g, 15g, 20g, 30g, and No Fertiliser Application (NAF-0) per 10kg of soil. This is equivalent to 0 – 6 t/ha of poultry manure as recommended for other crops. The treatments were replicated three times.

Growth parameters such as plant height (cm), number of leaves/ tillers were collected bi-weekly after planting, and at harvest, the number of bulbs, fresh bulb weight, and total biomass (g/pot) were taken for yield. All the data collected on growth and yield of onion were analysed using analysis of variance at $p=0.05$ (ANOVA < 0.05). Treatment means (poultry manure application levels) were separated where there were significant differences, using Standard Error (SE, $p=0.05$).

Results and Discussion

Soil and poultry manure used

Samples of the soil and poultry manure used for the experiment were analysed chemically in the laboratory. The physical properties of the soil were determined, and the nutrient compositions of both the soil and the poultry manure were also assessed, as shown in Table 1.

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2 : 162-170
p-ISSN: 1595-5776

Table 1: Chemical and physical properties of soil and manure used for the experiment

Parameters	**Values**	
	Soil	Poultry manure
pH	6.4	6.7
Organic C (g kg^{-1})	3.9	1.4
Total N (g kg^{-1})	0.2	3.4
Available P (mg kg^{-1})	3.0	55.1
Exchangeable cations (cmol kg^{-1})		
K	0.21	0.65
Ca	0.75	26.5
Na	0.36	0.38
Mg	2.50	2.82
Micronutrients (mg kg-1)		
Mn	11.33	253.04
Fe	12.84	670.05
Cu	0.53	87.24
Textural analysis of the soil (g kg^{-1})		
Clay	42.0	
Silt	25.0	

The chemical properties of the soil used showed the following values: pH 6.4, organic carbon 3.9 g kg^{-1}, total nitrogen 0.20 g kg-1, and Available Nitrogen. P 3.0 mg kg^{-1}, while the Exchangeable cations are K, 0.21 cmol kg^{-1}, Ca 0.75 cmol kg^{-1}, Na 0.36 cmol kg^{-1}, and Mg 2.50 cmol kg^{-1}. The micronutrients of lowest values and particle size (g/kg) Sand 933.0 gkg^{-1} Silt 25.0 gkg^{-1} Clay 42 gkg^{-1}, and the textural class is sandy as shown by the analysis.

The chemical composition of the poultry manure used showed the status of the principal nutrients, namely, nitrogen, phosphorus and potassium, to be moderate to support the raising of spring onion. The micronutrients are moderately high, especially iron. However, all the micronutrients are within the threshold for uptake by plants for human consumption.

Response of spring onion to different levels of poultry manure

Spring onion plant height: Table 2 presents the spring onion growth in terms of height (cm) at various levels of poultry manure application, measured at 2, 4, and 6 weeks after sowing at both the first and second planting stages, under the same application levels.

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2 : 162-170
p-ISSN: 1595-5776

Table 2: Spring onion plant height (cm) at 2, 4, and 6 weeks after sowing

Poultry manure (g/10kg)	First planting			Second planting		
	Weeks after planting			Weeks after planting		
	2	4	6	2	4	6
5g	4.6	9.8	10.0	4.2	8.4	12.1
10g	5.6	10.4	10.7	6.5	10.3	12.8
15g	4.4	9.6	10.3	5.4	9.6	14.3
20g	5.2	10.2	11.2	6.8	10.4	15.5
30g	6.3	7.6	10.3	8.4	12.2	17.3
NAF (0)	3.2	7.6	8.3	4.3	6.5	8.2
	±0.45	±0.90	±0.52	±0.66	±1.55	±1.29

NAF = *No fertilizer application,* S.E = *Standard Error*

In the first 2 weeks after sowing, the spring onion heights range from 3.2cm – 6.3cm under poultry manure application of NAF-0 and 30g per 10 kg soil, respectively (Table 2).
Similarly, at the second planting, it ranged from 4.3 to 8.4cm under the same application rate. However, at 6 weeks after sowing (6WAS), the highest plant heights (10.3cm and 17.3cm) were obtained under 30g poultry manure application at the first and second planting.

Response of spring onion to different levels of poultry manure

Spring onion Number of leaves: Table 3 shows the spring onion number of leaves at various levels of poultry manure application, counted at 2, 4, and 6 weeks after sowing at both the first and second planting stages.

Table 3: Number of leaves per pot at 2, 4, and 6 weeks after planting

Poultry manure (g/10kg)	First planting			Second planting		
	Weeks after planting			Weeks after planting		
	2	4	6	2	4	6
5g	7.6	12.6	12.8	9.3	15.3	18.7
10g	9.3	14.3	10.0	12.6	16.4	17.3
15g	5.6	10.3	10.6	13.2	15.8	17.4
20g	6.6	11.6	11.8	14.3	16.2	18.1
30g	4.3	9.0	14.5	16.4	18.2	19.9
NAF (0)	4.0	9.0	9.6	10.3	11.1	12.3
	±0.49	±0.86	±0.78	±1.07	±0.95	±1.08

NAF = *No fertilizer application,* S.E = *Standard Error*

The number of leaves at 2, 4, and 6 weeks after sowing (WAS) followed similar patterns as obtained in plant heights. The highest number of leaves was recorded at both planting periods under 30g per 10 kg of soil. It was noticed that,

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2 : 162-170
p-ISSN: 1595-5776

at the first planting, the plant height was 14.5 cm and 19.9 cm at the second planting period.

The influence of different levels of poultry manure on spring onion bulbs' weight

Fresh onion bulbs' weight (g/pot): Figure 1 shows the spring onion bulbs' weight per experimental pot as influenced by various levels of poultry manure application, at harvest for both the first and second planting.

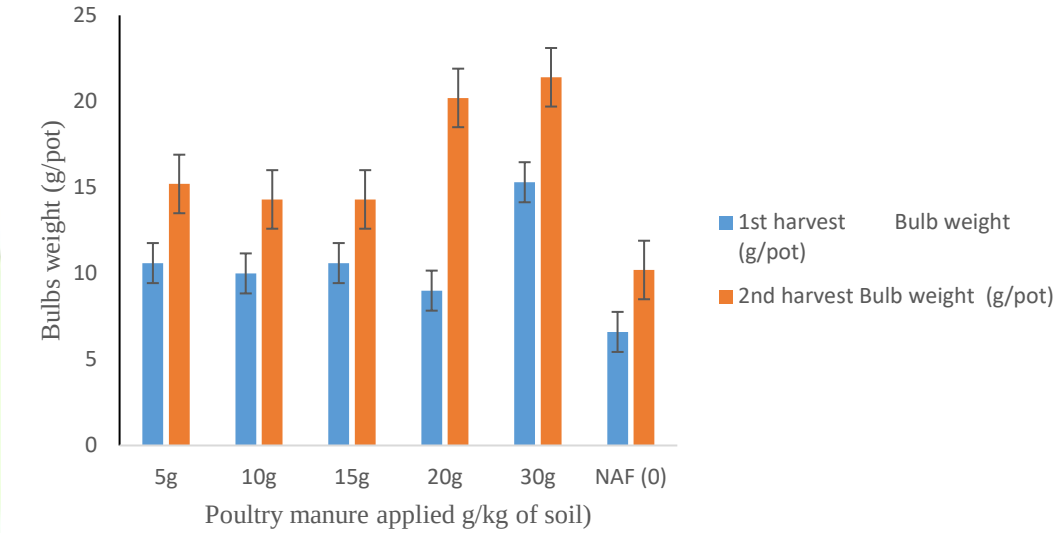

Figure 1: Spring onion bulbs' weight at first and second harvests
NAF = *No fertiliser application; Bars represent Standard Error*

The onion bulb weight was significantly increased in the second harvest compared to the yield obtained from the first harvest. However, the yield values (21.4g/pot) were obtained under 30g poultry manure application, which was not significantly different when compared to the value (20.2g) under 20g poultry manure application (Figure 1).

KEBBI JOURNAL OF AGRICULTURE AND NATURAL SCIENCES (KEJAANS)
September, 2025: Volume 1, Issue 2 : 162-170
p-ISSN: 1595-5776

The influence of different levels of poultry manure application on the number of spring onions at harvest

Number of bulbs per experimental pot: Figure 2 shows the number of spring onion bulbs per experimental pot as influenced by various levels of poultry manure application. The bulbs were counted for each experimental pot.

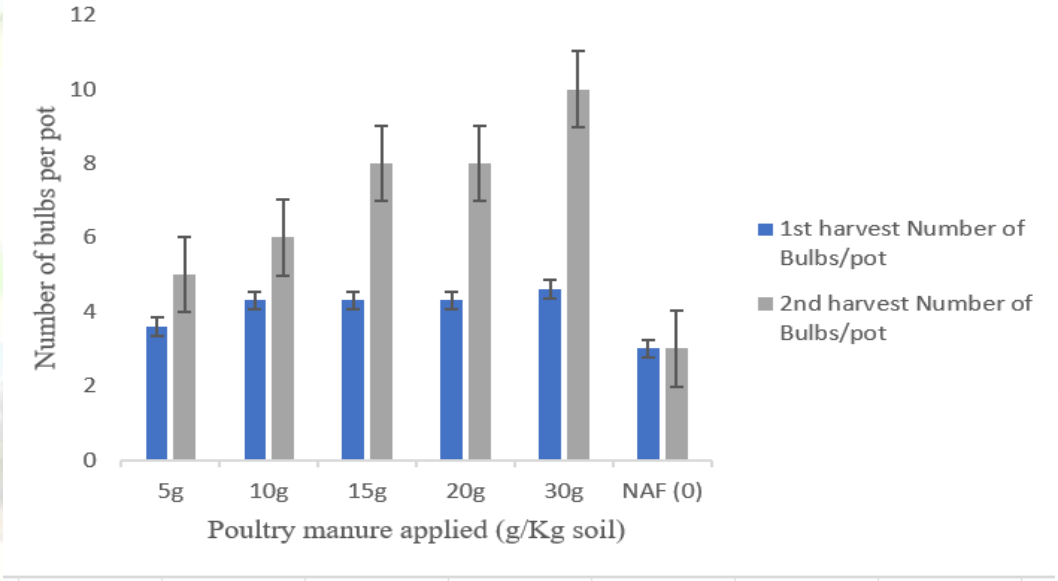

Figure 2: Spring onion number of bulbs at first and second harvests
NAF = *No fertiliser application; Bars represent Standard Error*

Similarly, the number of spring onion bulbs followed the same pattern, but the number of bulbs (8.0) obtained under 20g application was not significantly different when compared to the application rate of 15g/10 kg soil. However, the highest value (10) was obtained under a 30g application rate, while the lowest value (3.0) was obtained under NAF- no fertiliser application (Figure 2).

Discussion

The use of erosion-deposited soil in this experiment aimed to simulate coastal sandy soil, which serves as the primary cultivation medium for spring onion production. Additionally, the low micronutrient content of this soil type makes it suitable for small-scale household production, promoting healthy vegetable consumption (Zhang et al., 2022). Extending the planting period of spring onions to 12 weeks allowed for the maximal utilisation of poultry manure, facilitating the gradual release of nutrients and optimising yield (Adnan et al., 2021).

For healthy spring onion cultivation, erosion-deposited sandy soil is recommended for

smallholder production due to its low micronutrient content, which can be improved through poultry manure and other natural, non-toxic soil amendments (Omondi et al., 2023). The positive response of spring onions (both bulbs and leaves) across both planting periods, with the second harvest showing optimal yield, can be attributed to the slow nutrient release from poultry manure as decomposition and mineralisation progressed—a characteristic feature of organic fertilisers (Kumar et al., 2020).

The performance of spring onions in erosion-deposited soil reflects the natural growing conditions of this species. The application of poultry manure enhances the soil's water-holding capacity, improving moisture retention and supporting onion production in sandy soils (Singh et al., 2023). The recommended poultry manure application rate of 20–30g per 10kg of soil (equivalent to 5–6 t/ha) aligns with findings from recent studies (Karma et al., 2018; Ogunleke et al., 2019). Therefore, for small-scale spring onion cultivation, erosion-deposited soils with minimal trace or heavy metal content should be used, supplemented with poultry manure at 20–30g per 10kg of soil, and cultivated for multiple harvests to maximise yield.

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