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Effect of Combined Application of Fortified Poultry Manure with Ash and NPK Fertilizer on the Performance of Sakanal Onions (*Allium cepa* L.) in Sokoto, Sudan Savanna, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AMI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MA, AUD and UA managed the analyses of the study while author EAM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to determine the effect of combined application of fortified poultry manure with ash and NPK fertilizer on the performance of sakanal onions (*Allium cepa* L.) variety during 2018/2019 dry season in Chimola (Gwadabawa LGA) and Wurno (Wurno LGA), Sokoto State. The treatments consisted of three (3) levels combination of fortified poultry manure with ash (1:3 ratio) at 5, 10 and 15t ha^{-1} and three (3) levels of NPK at 30, 45 and 60kg ha^{-1} which were combined and laid-out in a randomized complete block design (RCBD) replicated three (3) times.

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Sakanal onion variety was used as a test crop. The data generated were subjected to analysis of variance (ANOVA) procedure for RCBD using SPSS version 23.0. The results revealed that fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected Growth and yield parameters such as plant height (71 - 62 cm), number of leaves (8), fresh bulb yield (70t ha^{-1}), crop growth rate (1.52g cm^{-1}) in Chimola and Wurno. Individual bulb weight (300g), bulb diameter (7.8cm) were significantly ($P<0.05$) affected in Wurno location. Cured buld yield (55t ha^{-1}) responds significantly ($P<0.05$) to the application of fortified poultry manure with ash and NPK fertilizer in Chimola location. The result of the study revealed that application of fortified poultry manure with ash and NPK fertilizer (P15NPK3) significantly improved the performance and shelf-life of sakanal onion variety and physical and chemical properties of the soils in the study area.

Keywords: Fortified poultry manure; ash; fertilizers; sakanal onion and performance.

1. INTRODUCTION

Onion (*Allium cepa* L.) belongs to member of the family Alliaceae, is the most important vegetable crops and most widely cultivated all over the world [1]. It is grown from the coldest area of the temperate to the tropics [2]. Onion is biennial herbaceous plant with tubular leaves and a swollen pithy stem which functions as a drought resisting organ. Onions are relatively high in food value, intermediate in protein, rich in calcium and riboflavin. Mature onion contains approximately 86% water, 1.4% protein, 0.2% fat, 11.0% carbohydrate, 0.8% fiber and 0.6% ash [1].

Soils in the Savannah region of Nigeria are relatively low in nutrient and organic matter contents, as soil degradation has increased and becomes a serious threat to agricultural production [3] and [4]. Productivity of these soils has steadily declined due to low level of nitrogen, phosphorus, potassium, sulphur and zinc thus, faced a high risk of degradation as they have become chemically fragile and physically weak [5] and [3].

Fortified poultry manure with ash has high potassium element and adequate potassium content in bulb is also important to increase storage quality of the crop. Potassium deficiency in onion is expressed in the appearance of brown tip in older leaves and poor bulb formation. Fertilizer high in Potassium element plays a pivotal role in plant growth and development. Like other vegetable crops, onion is very responsive to potassium fertilization. It has a crucial role in the energy status of the plant, translocation and storage of assimilates and maintenance of tissue and water relation. Also, potassium plays a key role in crop quality, improves size of bulb and stimulates root growth. It is necessary for the translocation of sugars and formation of carbohydrates [6].

According to [6] trials with Onion, Punjab 48 with the application of 185:117:105 kg N, P_2O_5 and K_2O ha^{-1} gave the maximum bulb yield. Similarly, [7] also noticed that application of K alone and in combination with zinc (100 kg K_2O + 25 kg $ZnSO_4$) increased plant growth, (61.62, 64.9 cm) in terms of height, while onion dry matter production, bulb size and bulb yield increased with the increase in levels of K from 0 to 150 kg ha^{-1} [8]. Similar results were observed by the study of [9] who reported significant differences among the fertilizer doses with respect to onion plant height, the tallest plants were recorded when 90 kg N and 120 kg K_2O were applied.

The objective of this paper is to evaluate the effect of different rates of fortified poultry manure with ash and NPK fertilizer on performance of onion.

2. MATERIALS AND METHODS

2.1 Site Description

The experiment was conducted during 2018/2019 dry seasons in two (2) locations: Chimola (Gwadabawa LGA) located at latitude 13°18'693''E and longitude 5°24'962''E and Wurno (Wurno LGA) located at latitude 13°30'489''N and longitude 5°37'059''E, both located in Sudan Savannah agro-ecological zone of Nigeria. The climate prevailing in the location is characterized by long dry season extending from October to May, and a short raining season from May/June to the end of September or early October [1]. The mean annual rainfall is about 704.2 mm, with over 60% falling within July and August. Harmattan wind blows from the North east, often with dust from the Sahara Desert.

Relative humidity varies between minimum of about 10% in February to a maximum of about 90% in August [10].

2.2 Soil Sample Collection and Experimental Materials

The soil samples were collected from the trial sites using auger at the depth of 0-15 cm. The composite sample obtained was air dried and sieved through 2 mm sieve. A sub-sample was analyzed for some physical and chemical properties. Soil samples were also collected from each of the experimental plots at harvest and analyzed for the physical and chemical properties. Poultry manure used was sourced from Marina Farms, Nigeria Limited located along Bodinga Road, Sokoto state, which was air dried, from where a sub-sample was collected and crushed using pestle and mortar for laboratory analysis while the ash was sourced from burnt wood fuel, sub-sample was also analyzed in the laboratory. All the analysis of soil samples, poultry manure and ash were done according to standard laboratory procedures.

2.3 Treatments and Experimental Design

The treatments consisted of two (2) factors: three (3) levels combination of fortified poultry manure with ash in (1:3 ratio) at 5, 10 and 15t ha^{-1}; three (3) levels of NPK fertilizer at 30, 45 and 60kg/ha. Sakanal onion variety was used as test crop which was sourced from Bejo Seed Company (Tays Food Limited). The treatments were as follows: 5t of fortified poultry manure with ash + 30kg of NPK; 10t of fortified poultry manure with ash + 30 kg of NPK; 5 t of fortified poultry manure with ash + 30 kg of NPK; 5 t of fortified poultry manure with ash + 45 kg of NPK; 10 ct of fortified poultry manure with ash + 45 kg of NPK; 15 t of fortified poultry manure with ash + 45 kg of NPK; 5t of poultry manure and Ash + 60 kg of NPK; 10 t of fortified poultry manure with ash + 60 kg of NPK; 15t of fortified poultry manure with ash + 60kg of NPK and a control. They were combined and laid in a randomized complete block design and replicated three (3) times making a total of 30 plots.

2.4 Cultural Practices

2.4.1 Nursery operation

Nursery was established at the experimental site at Wurno and Chimola. Seed beds of 2 x $1m^2$ were constructed after the land has been ploughed and harrowed, 10 Kg of compost manure mixed with 0.6 Kg of NPK was worked into the soil thoroughly. The seed was broadcast on the beds and thin layer of soil, mulch material was used to cover the beds for a period of one week. Weeding was done manually by hand picking and the beds were kept wet through irrigation for six weeks.

2.4.2 Transplanting

The seedlings were transplanted at 4 leave stage at 6 weeks after sowing at a spacing of 10 x 10 cm and depth of 5 cccm. A day before transplanting, the nursery beds were watered to facilitate uprooting and to reduce root damage. Immediately after transplanting, the plots were irrigated.

2.4.3 Fertilizer application

Poultry manure with ash was applied at the rate of 5 t, 10 t, and 15t ha^{-1} plus 3 levels of NPK at 30, 45 and 60kg ha^{-1}. Fortified poultry manure with ash were applied before planting, NPK fertilizer was applied in three doses at 20, 40 and 60 days after transplanting (vegetative stage and during bulb formation). The soil was watered to field capacity before fertilizer application.

2.4.4 Irrigation

The field was irrigated at 3 - 5 days' intervals depending on the weather condition except for period prior to fertilizer application and harvesting.

2.4.5 Weeding

Weed management began at 2 weeks after transplanting with a 2^{nd} and 3^{rd} weeding at 4-5 weeks and at 7 - 8 weeks after transplanting respectively.

2.4.6 Harvesting

Harvesting was done after 50% of the onion leaves had fallen. Harvesting was done using hoe and the harvest per plot were packed together and allowed to cure for 14 days.

2.4.7 Curing

The harvested onion was covered with the onion leaves and allowed to stay in the field for 14 days; this enhanced the color of the onion and storage.

2.5 Data Collection

Measurements were taken on five (5) tagged plants in each plot, measurement per plant was obtained by computing averages of measurements on the tagged plants.

2.5.1 Plant height

The plant height was measured from the base of the plant to the tip of the leaf using meter rule at 2 weeks' interval; 2,4,6 and 8 weeks after transplanting (WAT)

2.5.2 Number of leaves

The number of leaves per plant were counted and recorded at 2 weeks' interval.

2.5.3 Crop Growth Rate (CGR)

Crop growth was measured at 7^{th} and 9^{th} WAT by harvesting the plants at these intervals and calculating the increase in dry weight from one harvest to the next, using the equation CGR= $(W_2-W_1)/SA\ (T_2-T_1)$ as described by [11].

2.5.4 Weight of fresh bulbs

The weight of tagged bulbs in the net plot after discarding border rows were measured using digital electronic weighing balance and extrapolated to per hectare.

2.5.5 Weight of individual bulb

Weight of individual bulbs was recorded by weighing five tagged bulbs from each net plot and average weight recorded for each plot.

2.5.6 Cured bulb yield

Bulbs in the net plot harvested and cured were weighed and expressed in tone per hectare.

2.5.7 Bulb diameter

The diameter of the sampled bulb was measured using a vernier caliper and expressed in cm.

2.6 Data Analysis

The data generated were subjected to analysis of variance (ANOVA) procedure for RCBD using SPSS version 23.0. All the data were expressed as mean ± standard deviation (SD). Followed by Bonferroni post hoc test. Data were considered statistically significant at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Soil Characterization

The result in Table 1 shows the initial physical and chemical properties of soils collected from Wurno and Chimola at 0 – 15cm depth. The result indicated that the soils were sandy loam and clay loam in texture respectively. The initial values of the soils show that pH was slightly acidic (6.4 and 6.5) in both locations. In Wurno, the organic carbon content, organic matter, total nitrogen and exchangeable magnesium were low. Exchangeable calcium was medium while exchangeable potassium, sodium and cation exchange capacity were high. In Chimola, the organic carbon, exchangeable potassium and sodium were high, total nitrogen, available phosphorus, exchangeable calcium and magnesium were low while cation exchange capacity was high based on standard ratings of [12] and [13].

3.2 Effect of the Combined Application of Fortified Poultry Manure with Ash and NPK Fertilizer on the Growth Parameters of Onions at Wurno and Chimola

3.2.1 Plant height

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on plant height of onions at Wurno and Chimola are presented in Table 2. The result shows that combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected plant height throughout the vegetative growth stage of onions from 2 – 8 weeks after transplanting (WAT). It was observed that at Wurno, application of P15NPK1 fertilizer significantly ($P<0.05$) gave taller plant at 2 and 4 WAT, while application of P5NPK1 and P15NPK3 significantly ($P<0.05$) produced taller plants at 6 WAT and the tallest plant was observed at 8WAT with application of P15NPK3. It was shown that at Chimola location, the treatment combinations of P5NPK1, P10NPK1 and P15NPK2 significantly ($P<0.05$) produced taller plant of onions at 2 WAT, while at 4 WAT, application of P5NPK1, P10NPK2, P10NPK1 and P15NPK3 significantly ($P<0.05$) gave taller onions. Application of 5

tonnes of poultry manure and ash plus 60 Kg ha^{-1} NPK was observed to significantly ($P<0.05$) produced taller plants of onions at 8 WAT than the other treatment combinations.

High rate and availability of nitrogen in the poultry manure and NPK fertilizer applied could have been the major contributing factor of this favourable onion parameters observed, also the supplementation of the critical essential nutrients such as phosphorus and potassium through fortification of poultry manure with ash and NPK fertilizer could have led to vigorous growth of the crop. This result is in agreement with the findings of [14], who reported that application of appropriate quantity and source of potassium to onion at critical growth stage is thus essential for maintenance of its growth and quality. This was similarly reported by [15], who reported that, shoot dry matter, leaf area and plant height showed highly significant difference due to nitrogen fertilizer, as they increased significantly and linearly with increasing rate of nitrogen application. Similar result was also observed by the study of [9] who reported significant differences among the fertilizer doses applied with respect to onion plant height. The tallest plants were recorded were 90 kg N and 120 kg K_2O ha^{-1} were applied.

3.2.2 Number of leaves

The effect of combined application of fortified poultry manure with ash and NPK fertilizer on number of leaves of onions at Wurno and Chimola is presented in Table 3. The result showed that the combined application of fortified poultry manure with ash and NPK fertilizer significantly ($P<0.05$) affected number of leaves throughout the vegetative growth stage of onions (2 – 8 WAT) at both locations. It was observed that at both locations, the treatment combination of P10NPK2 and P15NPK3 fertilizer significantly ($P<0.05$) gave the highest number of leaves at

Table 1. Physical and chemical properties of soils and nutrient composition of ash and poultry manure

Property	Value	
	Wurno	**Chimola**
pH	6.4	6.5
Organic carbon (g/kg)	10.0	10.2
Total nitrogen (g/kg)	0.52	0.84
Available phosphorus (mg kg^{-1})	0.77	0.79
Cation exchange capacity (cmol/kg)	10.0	11.6
Exchangeable bases (Cmol kg^{-1})		
Calcium (Ca^{2+})	1.50	0.5
Magnesium (Mg^{2+})	0.35	0.45
Potassium (K^{+})	0.90	0.87
Sand (g/kg)	553.0	363.0
Silt (g/kg)	294.0	210.0
Clay (g/kg)	153.0	427.0
Textural class	Loam	Clay Loam
Chemical Property of Poultry Manure		
Total nitrogen (%)		1.83
Available phosphorus ($mgkg^{-1}$)		8.03
Potassium ($Cmolkg^{-1}$)		2500
Chemical Property of Ash		
Calcium (mg/kg)		4.15
Magnesium (mg/kg)		4.9
Potassium (mg/kg)		12600
Sodium (mg/kg)		1650
Phosphorus (mg/kg)		0.73

Table 2. Effect of combined application of fortified poultry manure with ash and NPK fertilizer on plant height (cm) of onions in Wurno and Chimola

Treatment	Plant Height (cm)							
	Wurno				Chimola			
	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT
Control	17.67 ±0.58^{d}	19.67 ± 0.29^{d}	27.00 ± 1.00^{d}	50.33 ± 1.53^{e}	16.83±0.76^{d}	22.00±1.00 ^{d}	25.33±0.58 ^{c}	44.33±1.53 ^{e}
P5NPK1	19.67 ± 1.15^{c}	21.50 ± 0.50^{d}	32.00 ± 2.00^{a}	51.17 ± 0.29^{e}	23.00±0.50^{a}	25.17±0.29^{a}	34.33±1.53^{ab}	56.17±2.25 ^{d}
P5NPK2	19.00 ± 1.00^{c}	21.00± 0.00^{d}	30.67 ± 0.58^{b}	52.33 ± 1.53^{d}	20.67±1.15^{b}	23.50±0.50 ^{c}	36.00±4.36^{ab}	63.67±1.53 ^{bc}
P5NPK3	19.50 ± 0.50^{c}	23.00 ±0.00^{ab}	30.00 ± 1.00^{b}	52.00 ± 1.00^{d}	21.50±0.78^{ab}	24.50±1.32 ^{ab}	27.33±1.15 ^{b}	71.67±3.06 ^{a}
P10NPK1	17.50 ± 0.50^{d}	21.00 ± 0.00^{d}	31.33 ± 0.58^{ab}	58.67 ± 0.58^{c}	23.00±0.00^{a}	24.50±0.50 ^{ab}	40.67±0.58 ^{a}	64.00±2.00 ^{bc}
P10NPK2	21.00 ± 1.00^{ab}	23.33 ± 0.58^{ab}	27.33 ± 0.58^{d}	49.33 ± 1.53^{e}	21.00±1.00^{ab}	25.50±2.60 ^{a}	31.00±1.00 ^{b}	57.00±2.65 ^{d}
P10NPK3	17.67 ± 0.58^{d}	22.00 ± 1.00^{c}	29.33 ± 0.58^{c}	57.67 ± 1.53^{b}	21.67±1.53^{ab}	24.33±0.58 ^{ab}	28.00±0.00 ^{b}	60.67±4.16 ^{c}
P15NPK1	22.67 ± 1.53^{a}	24.00 ± 0.00^{a}	30.00 ± 2.00^{b}	59.00 ± 1.00^{ab}	18.67±1.53^{c}	21.50±0.50 ^{d}	34.00±1.00^{ab}	63.67±1.53 ^{bc}
P15NPK2	20.00 ± 0.00^{b}	22.00 ± 0.00^{c}	30.67 ± 0.58^{b}	52.33 ± 0.58^{d}	22.00±1.32^{a}	24.67±2.31 ^{ab}	34.67±1.15^{ab}	66.17±2.93 ^{b}
P15NPK3	21.17 ± 0.29^{ab}	23.67 ± 1.15^{b}	32.00 ± 1.00^{a}	62.00 ± 2.00^{a}	21.67±2.08^{ab}	25.67±0.58 ^{a}	31.67±1.53 ^{b}	68.67±1.15 ^{ab}
SE	0.221	0.233	0.311	0.446	0.152	0.100	0.205	0.232
Significance	*	*	*	*	*	*	*	*

*Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability, P5NPK1 (5t of poultry manure + Ash + 30 kg NPK), P5NPK2 (5t of poultry manure + Ash + 45 kg NPK), P5NPK3 (5t of poultry manure + Ash + 60 kg NPK), P10NPK1 (10t of poultry manure + Ash + 30 kg NPK), P10NPK2 (10t of poultry manure + Ash + 45 kg NPK), P10NPK3 (10t of poultry manure + Ash + 60 kg NPK), P15NPK1 (15t of poultry manure + Ash + 30 kg NPK), P15NPK2 (15t of poultry manure + Ash + 45 kg NPK), P15NPK3 (15t of poultry manure + Ash + 60 kg NPK*

4WAT, while treatment combination of P5NPK3 and P10NPK2 significantly (P<0.05) produced the highest number of leaves at 6 WAT in both locations while control gave the least number of leaves at 8 WAT. It was shown that at Chimola, the treatment combinations of P10NPK2 significantly (P<0.05) produced the highest number of onion leaves 4 WAT, while at 6 WAT, application of P5NPK1 and P15NPK2 significantly (P<0.05) gave the highest number of leaves.

This result is in consistence with the inherent fertility status of the two experimental locations and the supplementation of critical essential nutrients by the treatment which led to vigorous growth of the crop. This result is in agreement with the findings of [14], who reported that application of appropriate quantity and source of potassium to onion at critical growth stage is essential for maintenance of its growth and quality. Similarly [16], observed that, vegetative growth parameters tended to increase with increasing application of mineral fertilizer and different forms of organic manure. Again, a study by [17] also recorded higher number of leaves length per plant (11.56, 11.68 cm), weight of bulb (50.42 from 51.83 g) and bulb yield (226.66 from 227.66 q/ha) with increase in potassium application from 100 to 150 kg ha^{-1}.

3.3 Effect of Combined Application of Fortified Poultry Manure with Ash and NKP Fertilizer on Yield and Yield Components of Onion Grown in 2018/2019 Dry Season at Wurno and Chimola

3.3.1 Fresh and cured bulb yield (t/ha)

The result of the effect of combined application of fortified poultry manure with ash and NPK fertilizer on fresh and cured bulb yield at Wurno and Chimola are presented in Tables 4 and 5. The results showed that the combined application of fortified poultry manure with ash and NPK fertilizer significantly (P<0.05) affected fresh bulb yield at both Wurno and Chimola. At Chimola, it was observed that combined application of fortified poultry manure with ash and NPK fertilizer significantly (P<0.05) affected cured bulb yield, however, application of P15NPK3 fertilizer significantly (P<0.05) gave the highest fresh bulb yield (70 t ha^{-1}). While treatment P15NPK3 significantly (P<0.05) gave the highest cured bulb yields (55.65 t ha^{-1}) than any other treatment combination in Chimola. This result is also in agreement with the findings of [14], who reported that application of appropriate potassium to onion at critical growth stage assisted in maintenance of growth.

3.3 2 Weight of individual bulb (WIB)

The result of the effect of combined application of fortified poultry manure with ash and NPK fertilizer on weight of individual bulb yield at Wurno and Chimola are presented in Table 4 and 5. The result shows that the combined application of fortified poultry manure with ash and NPK fertilizer did not significantly (P>0.05) affect weight of individual bulb at Chimola. However, it was observed at Wurno that the effect on the weight of individual bulb was significant (P<0.05), but treatment combination of P15NPK2 fertilizer significantly (P<0.05) gave the maximum weight of individual bulb (300g). The result of the study shows that application of P15NPK3 at Chimola gave the best weight of individual bulb that was between 250 – 300g, this value is higher than the acceptable weight (200-250 g) of onion bulb at the international market. [18] reported that, increase in K application significantly increased dry weight of bulbs, bulb diameter, 100 bulb weight and bulb yield up to 40 kg K_2O ha^{-1}

3.3.3 Bulb diameter (BD)

The data on the effect of combined application of fortified poultry manure with ash and NPK fertilizer on bulb diameter at Wurno and Chimola are presented in Tables 4 and 5. The result shows that combined application of fortified poultry manure with ash and NPK fertilizer did not significantly (P<0.05) affect bulb diameter at Chimola location, however, at Wurno, their effect significantly (P<0.05) affected weight of bulb diameter. The treatment combination of P15NPK2 fertilizer significantly (P<0.05) gave the overall longest length of a bulb (7.80cm) diameter in the study areas. Despite there was no significant effect of the treatments on bulb diameter at Chimola, values of bulb diameter recorded in all treatments were within the acceptable range (5-7cm) for onion bulb at both local and international markets. [18] observed that increase in K application up to 40kg K_2O ha^{-1} significantly increased the dry weight of onion bulbs, bulb diameter, 100 bulb weight and bulb yield.

Table 3. Effect of combine application of fortified poultry manure with ash and NPK fertilizer on number of leaves of onion grown at Wurno and Chimola

Treatment	Number of Leaves							
	Wurno				Chimola			
	2WAT	4WAT	6WAT	8WAT	2WAT	4WAT	6WAT	8WAT
Control	3.00±0.00[b]	4.00± 0.00[b]	5.67 ± 0.29[c]	7.00 ± 0.00[b]	3.17± 0.00	4.00± 0.00[c]	6.00± 0.00[b]	7.33± 0.00[b]
P5NPK1	3.00±0.00[b]	4.00 ±0.00[b]	5.50± 0.00[c]	8.43 ± 0.40[a]	3.00± 0.00	5.00± 0.00[b]	7.00± 0.00[a]	8.00± 0.00[a]
P5NPK2	3.00±0.00[b]	4.00 ±0.00[b]	5.50 ±0.00[c]	8.00± 0.00[a]	3.00± 0.00	5.50± 0.00[b]	6.67± 0.00[b]	8.00± 0.00[a]
P5NPK3	3.00±0.00[b]	4.50 ±0.00[b]	7.00 ±0.00[a]	8.00 ± 0.00[a]	3.00± 0.00	5.00± 0.00[b]	7.00± 0.00[a]	8.00± 0.00[a]
P10NPK1	3.00±0.00[b]	4.50 ±0.00[b]	6.00± 0.00[b]	8.00 ± 0.00[a]	3.00± 0.00	5.00± 0.00[b]	6.33± 0.00[b]	8.33± 0.00[a]
P10NPK2	3.00 ±0.00[b]	5.00 ±0.00[a]	7.00 ±0.00[a]	8.00 ± 0.00[a]	3.00± 0.00	6.33± 0.00[a]	7.33± 0.00[a]	8.33± 0.00[a]
P10NPK3	3.00±0.00[b]	4.00 ±0.00[b]	7.33 ±0.58[a]	8.00 ± 0.00[a]	3.00± 0.00	5.00± 0.00[b]	6.83± 0.00[b]	8.00± 0.00[a]
P15NPK1	3.00±0.00[b]	4.00 ±0.00[b]	7.00 ± 0.00[a]	8.00 ± 0.00[a]	3.00± 0.00	5.00± 0.00[b]	6.17± 0.00[b]	8.00± 0.00[a]
P15NPK2	3.00±0.00[b]	4.00 ±0.00[b]	6.67 ± 0.29[b]	8.00 ± 0.00[a]	3.00± 0.00	4.67± 0.00[c]	7.67± 0.00[a]	8.00± 0.00[a]
P15NPK3	4.00±0.00[a]	5.00 ±0.00[a]	6.00 ± 0.00[b]	8.00 ± 0.00[a]	3.00± 0.00	5.00± 0.00[b]	6.67± 0.00[b]	8.00± 0.00[a]
SE	0.017	0.055	0.067	0.058	0.000	0.000	0.041	0.023
Significance	*	*	*	*	*	*	*	*

*Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability, P5NPK1 (5t of poultry manure + Ash + 30 kg NPK), P5NPK2 (5t of poultry manure + Ash + 45 kg NPK), P5NPK3 (5t of poultry manure + Ash + 60 kg NPK), P10NPK1 (10t of poultry manure + Ash + 30 kg NPK), P10NPK2 (10t of poultry manure + Ash + 45 kg NPK), P10NPK3 (10t of poultry manure + Ash + 60 kg NPK), P15NPK1 (15t of poultry manure + Ash + 30 kg NPK), P15NPK2 (15t of poultry manure + Ash + 45 kg NPK), P15NPK3 (15t of poultry manure + Ash + 60 kg NPK)*

Table 4. Effect of combined application of fortified poultry manure with ash and NPK fertilizer on yield and yield parameters of onions grown at Wurno

Treatment	FBY(t/ha)	CBY(t/ha)	WIB (g)	BD(cm)
Control	35.00±2.00^{e}	33.80±0.96	0.08± 0.03^{e}	6.17±0.75^{e}
P5NPK1	43.35±0.42^{e}	38.40±1.18	0.15±0.000^{d}	6.80±0.00^{d}
P5NPK2	54.80±0.75^{d}	48.30±0.35	0.15±0.000^{d}	6.80±0.00^{d}
P5NPK3	60.20±1.42^{b}	48.80±1.24	0.23±0.06^{b}	7.07±0.23^{b}
P10NPK1	63.55±2.32^{c}	50.00±601.89	0.17±0.03^{c}	6.93±0.23^{c}
P10NPK2	60.90±0.87^{b}	52.40±0.67	0.17±0.03^{c}	7.20±0.00^{ab}
P10NPK3	66.10±0.33^{ab}	52.30±2.18	0.15±0.00^{d}	6.80±0.00^{d}
P15NPK1	57.90±1.19^{cd}	52.60±1.10	0.15±0.00^{d}	6.93±0.23^{c}
P15NPK2	67.70±0.94^{ab}	53.80±1.48	0.30±0.17^{a}	7.80±1.04^{a}
P15NPK3	70.00±1.00^{a}	54.40±1.59	0.25±0.05^{ab}	7.20±0.00^{ab}
SE	0.738	109.892	0.036	0.245
Significance	*	NS	*	*

*Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability,*
P5NPK1 (5t of poultry manure + Ash + 30 kg NPK),
P5NPK2 (5t of poultry manure + Ash + 45 kg NPK),
P5NPK3 (5t of poultry manure + Ash + 60 kg NPK),
P10NPK1 (10t of poultry manure + Ash + 30 kg NPK),
P10NPK2 (10t of poultry manure + Ash + 45 kg NPK),
P10NPK3 (10t of poultry manure + Ash + 60 kg NPK),
P15NPK1 (15t of poultry manure + Ash + 30 kg NPK),
P15NPK2 (15t of poultry manure + Ash + 45 kg NPK),
P15NPK3 (15t of poultry manure + Ash + 60 kg NPK)

Table 5. Effect of combined application of fortified poultry manure with ash and NPK fertilizer on yield and yield parameters of onions grown at Chimola

Treatment	FBY(t/ha)	CBY(t/ha)	WIB (kg/bulb)	BD(cm)
Control	21.1± 0.58	29.40± 1.40	0.13 ± 0.03	6.60 ± 0.35
P5NPK1	47.0 ± 0.90	40.01± 0.76	0.13 ± 0.03	6.73 ± 0.12
P5NPK2	59.6 ± 2.67	47.50± 0.52^{c}	0.20 ± 0.09	6.80 ± 0.00
P5NPK3	65.6 ± 0.36^{c}	53.75 ±0.87^{b}	0.23 ± 0.03	6.93 ± 0.23
P10NPK1	54.0 ±0.32	44.85± 1.74	0.17 ±0.03	6.93 ± 0.23
P10NPK2	52.2± 2.05	47.60± 0.53^{c}	0.15 ± 0.05	6.93 ± 0.23
P10NPK3	69.0 ± 0.45^{ab}	54.10 ± 1.01^{ab}	0.17 ±0.03	6.93 ± 0.23
P15NPK1	54.2 ± 0.39	54.10± 1.00	0.15± 0.00	6.80 ± 0.00
P15NPK2	49.6± 1.55	42.15±0.60	0.25 ± 0.00	7.20 ± 0.00
P15NPK3	70.0 ± 0.50^{a}	55.65±2.07^{a}	0.25 ± 0.09	7.07 ± 0.23
Significance	*	*	NS	NS
SE	0.724	0.672	0.027	0.115

*Means followed by the same letter(s) within the same column are statistically the same at 5% level of significance, SE: Standard Error, * = Significant at 5% level of probability, P5NPK1 (5t of poultry manure + Ash + 30 kg NPK), P5NPK2 (5t of poultry manure + Ash + 45 kg NPK),*
P5NPK3 (5t of poultry manure + Ash + 60 kg NPK),
P10NPK1 (10t of poultry manure + Ash + 30 kg NPK),
P10NPK2 (10t of poultry manure + Ash + 45 kg NPK),
P10NPK3 (10t of poultry manure + Ash + 60 kg NPK),
P15NPK1 (15t of poultry manure + Ash + 30 kg NPK),
P15NPK2 (15t of poultry manure + Ash + 45 kg NPK),
P15NPK3 (15t of poultry manure + Ash + 60 kg NPK)

4. CONCLUSION

The application of 15 tons of poultry manure and ash plus 60kg of NPK led to significant improvement of cured bulb yield of 55t ha^{-1} and there was a positive correlation between potassium application to onion and its shelf- life. The paper revealed that growth and some yield parameters of onion were influenced by combined application of fortified poultry manure with ash and NPK fertilizer in the study area.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ojanuga AG. Agroecological Zones of Nigeria Manual. FAO/ NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. 2006;124.
2. FAO. Production Year Book. Food & Agriculture Organization of United Nations, Rome, Italy; 2008.
3. Enwenzor WO, Udo EJ, Usoroh NJ, Ayotade KA, Adepetu JA, Chude VO, Udegbe CI. Fertilizer use and Management Practices for Crops in Nigeria .p:bobma publishers U.I Ibadan, Nig. 1989;147.
4. Usman A, Osunde OA, Bala A, Ezenwa MIS. Carbon and Nitrogen Mineralization of Some Selected Legume Species. In: Oyivbisere EO, Raji BA, Yusuf AA, Ogunwole O, Aliyu L, Ojeniyi SO. (Eds.). Soil and Water Management for Poverty Alleviation and Sustainable Environment. Proceedings of the 31st Annual Conference of the Soil Science Society of Nigeria, held at Ahmadu Bello Univeristy, Samaru Zaria Nov 13th-17th 2006. 2007;489-495.
5. Abdullahi A, Lombin LG. Long Term Fertility Studies at SAMARU Zaria II. Comparative effectiveness of separate and combined application of mineral fertilizers and farm yard manure in maintaining soil productivity under continuous cultivation in the savanna, (Long-Term Fertility Studies at Samaru, Nigeria). Institute of Agricultural Research, Ahmadu Bello University, Samaru, Zaria, Nigeria; 1978.
6. Madan MR, Sandhu N. Economic analysis of nitrogen, phosphorus and potassium fertilization in onion. Haryana Journal Horticulture Science. 1983;12:221-223.
7. Singh J, Dankhar BS. Effect of nitrogen, potash and zinc on storage loss of onion bulbs (*Allium cepa* L.). Vegetable Science. 1991;18:16-23.
8. Salimath SS. Studies on status of potassium and sulphur in soils and their effect on onion (*Allium cepa* L.). M. Sc. (Agri) Thesis, University of Agricultural Sciences, Dharwad. 1990;25.
9. Nandi RK, Deb M, Maity TK. Response of onion (*Allium cepa* L.) to different levels of irrigation and fertilizer. Crop Research. 2002;23(2):317-320.
10. National Agricultural Extension and Research Liaison Services (NAERLS). Annual Report held in Ahmadu Bello University, Zaira; 2016.
11. Forbes JC, Drennan W. Plants in Agriculture. Cambridge University Press; 1992.
12. Esu IE. Detailed Soil Survey of NIHORT Farm at Bunkure, Kano State, Nigeria. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. 1991;72.
13. Chude VO, Olyiwol AO, Osho, Daudu CK. Fertilizer use and management practices for crops in Nigeria. Fourth edition, Federal Fertilizer Department, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. 2011;215.
14. Subba Rao A, Brar MS. Potassium. In: Fundamentals of Soil Science. Indian Society of Soil Science, IARI, New Delhi. 2002;369-380.
15. Najim AA, Hay MR, Fazali F, Shamorady R. Effect of utilization of Organic and Inorganic Nitrogen Source on the Potatoes shoots, dry matter, leave area index and plant height, during middle stage of growth. International Journal of Agricultural Science. 2010;1:1.
16. El-Ghamry AM. Integrated effects of bio and mineral fertilizers and humic

Substances on Growth, Yield and Nutrient Contents of Fertigated Cowpea (*Vigna unguiculata* L.) Grown on Sandy Soils. Journal of Agronomy. 2011;10(1):34-39.

17. Vachhani MU, Patel ZG. Effect of nitrogen, phosphorus and potash on bulb yield and quality of onion (*Allium cepa* L.). Indian Journal of Agronomy. 1993;38:333-334.

18. Kumar A, Ranbir Singh, Chhillar RK. Influence of nitrogen and potassium application on growth, yield and nutrient uptake by onion (*Allium cepa.* L). Indian Journal of Agronomy, 2001;46(4):742-6.

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