EFFECT OF POULTRY MANURE FERTILIZATION ON GROWTH, YIELD AND STORABILITY OF ONION VARIETIES (*ALLIUM CEPA L.*) AT SAMARU NIGERIA GROWN UNDER IRRIGATED CONDITIONS

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ABSTRACT

The study was conducted for two years, 2017 and 2018 dry season at the Institute for Agricultural Research (IAR) Farm, Samaru located 686m above sea level in the Northern Guinea Savanna of Nigeria to investigate the poultry manure fertilization on growth and yield of onion varieties to under irrigated conditions. Treatments consisted of four (4) levels of poultry manure (0, 2, 4, 6 t ha^{-1} and a Recommended NPK), three varieties of onion (Red creole, GalmiSpv, Wuyan- Bijimi). All the treatments were factorial combined and laid out in a randomized complete block design (RCBD) which was replicated 4 times.The result revealed that the use of 6 t ha^{-1} poultry manure significantly influenced number of leaves, crop growth rate, onion bulb weight and yield. The results indicated that plot treated with NPK significantly had more percent rotted and sprouted bulbs during storage compared to poultry manure plots while the local varieties Wuyan-bijimi and Galmi produced less percent rotted bulbs. However, variety Wuyan-bijimi gave the least percentage on sprouted bulbs than Red Creole and Galmi which gave more sprouted bulbs that were statistically similar. Based on the result obtained, growing Wuyan-bijimi or Red Creole with application of 6 t ha^{-1} PM or 120:45:45 kg ha^{-1} NPK are recommended for possible adoption by farmers

Keywords: Poultry Manure, Onion, Varieties, Growth, Yield, Storability

INTRODUCTION

Onion (*Allium cepa* L.) is an important worldwide vegetable crop (Best,2000) and it is cultivated commercially in most parts of the world. The crop is grown for consumption both in the green state as well as in mature bulbs. In Nigeria onion is an indispensable item in every kitchen, as a condiment and onion is used in soups, sauces and for seasoning of foods. Onions have a wide range of climatic and soil adaptation,and they are cultivated both under irrigation and rain fed conditions (Getachew and Asfaw, 2000; Rabinowitch and Currah, 2002). Despite the ranking of onions as second most important vegetable in Nigeria, the present production levels do not meet the demand of the teeming populace (Gambo., Magaji., Yakubu, and Dikko,.2008).Lack of improved varieties and production practices have been the major bottlenecks of onion production and productivity in Nigeria. Highly adaptable and well performing varieties with improved cultural practice could be a possible way of boosting both quality and marketability of the crop.

The use of inorganic fertilizers alone has not been helpful under intensive agriculture because; it aggravates soil degradation (Sharma

and Behara, 2009). The inorganic fertilization is associated with soil which is brought about by loss of organic matter which consequently results in soil acidity, nutrient imbalance and low crop yields (Ayoola and Makinde, 2007).

Organic fertilizer sources (such as animal manures), which are locally available and may constitute cheaper sources of maintaining soil fertility, offer good alternatives to the use of inorganic fertilizers (Russel and Marsah, 1997). Furthermore, added organic sources may improve soil texture and water holding capacity; enhance microbial activity and eventually promote improved plant growth and yield.

The benefit of organic manure in crop production is well known and the popular domestic sources are farmyard manure and animal dropping (Isah., Amans., Odion, and Yusuf, 2014).Organic manure also supplies the necessary minor nutrients that are lacking in inorganic fertilizers. Apart from increasing soil fertility, organic manure also serves as soil amendments by adding organic matter into the soil, this greatly improves the soil physical structure thereby enhancing and improving the water holding capacity of the soil, soil aeration, soil structure and texture, nutrient retention, soil porosity and infiltration rate.The application of poultry manure can have a significant impact on the productivity of onion varieties. Poultry manure is a rich source of organic matter and essential nutrients such as nitrogen, phosphorus, and potassium, which are crucial for plant growth and development. This research investigated the response of onion varieties to poultry manure rate on growth,yieldand storability of onion under irrigated conditions.

Materials and Methods

The field study was carried out in 2017 at the Institute for Agricultural Research (IAR) farm ($11^0$11'N, $07^0$38'E) 686m above sea level in the Northern Guinea Savanna of Nigeria. The treatment consisted of four (4) levels of poultry manure (0, 2, 4, and 6 t ha^{-1}), three varieties of onion (Red creole, GalmiSpv, Wuyan- Bijimi). All the treatments were factorial combined and laid out in a randomized complete block design (RCBD) which was replicated 4 times. The poultry manure (Layers) rates (0, 2, 4, and 6 tons per hectare) was incorporated into the ridges after land preparation and allowed to decompose for two weeks before preparing to sunken beds. The treated seeds were sown in the nursery bed 1m x10 width and length using drilling method 10 cm apart for four weeks before transplanting. Prior to the experiment, composite soil samples were collected from the field using a soil auger with diameter of 15 cm. The 20 onions bulbs were selected according to treatments and stored under room temperature for 60 days to assess storability. All the data collected were subjected to analysis of variance (ANOVA) using general linear procedure with Statistical Analytic Software (SAS, 2009) and treatment means were compared using Duncan Multiple Range Test (DRMT).

Results and Discussion

The soil physical and chemical properties are given in (Table 1) The study area was characterized as loam with low N and K contents and high in available P. The low N contents might be attributed to low organic carbon and highly depleted maize crop grown in that year under wet seasons. The poultry manure analysis showed that the amount N, Kand organic carbon are moderate with slightly acidic and low P contents.

Table 1: Physical and chemical properties of soil at Samaru in 2017, 2018 and poultry manure composition

Physical properties (g kg^{-1})	**2017**	**2018**	**Poultry manure**
Sand	430	440	NA
Silt	460	460	NA
Clay	110	100	NA
Textural class	Loam	Loam	NA
Chemical properties			
pH in water	5.81	6.08	6.40
pH in 0.01m $CaCl_2$	5.29	5.43	5.76
Nitrogen (g kg^{-1})	0.45	0.39	1.94
Phosphorus (mg kg^{-1})	5.26	5.19	4.21
Potassium (cmolkg^{-1})	0.11	0.37	1.12
Organic carbon (g 100g)	0.52	0.44	23.0
Exchangeable Bases (cmolkg^{-1})			
Ca	2.98	2.34	3.86
Mg	0.51	0.63	NA
Na	0.18	0.19	NA
K	0.11	0.13	NA
Exchangeable Acidity (cmolkg^{-1})			
$Al^{+++} + H^{+}$	0.21	0.31	NA
ECEC	4.76	4.58	NA

Source: Analyzed Soil Sample at Department of Agronomy, ABU, Zaria NA= Not Available

Number of leaves was significantly affected by treatment (Table2). Application of poultry manure at 2 t ha^{-1} significantly ($p \leq 0.05$) produces higher number of leaves which was similar with the check NPK fertilizer. However, application of poultry manure at 4 and 6 t ha^{-1} were significantly similar with the control. At 9 WAT, number of leaves significantly ($p \leq 0.05$) increased correspond with the application of poultry manure up to 6 t ha^{-1}.Wuyan-bijimi statistically produceda greater number of leaves than Galmi and Red creole that are statistically similar.

This might be attributed to improved soil with adequate nutrients and subsequent release to fulfil the requirements of the crop. This in line with the reports of (Faladunand Egharevba, 2018) reported that the application of 10 t ha^{-1} poultry manure has a superior effect on proximate composition and most of growth parameters and yield components achieved the highest nutrient concentrations and uptake on most of the macro and micronutrients in leaves and bulbs.

Table 2: Response of irrigated onion varieties to poultry manure rate on number of leaves per plant at Samaru in 2017 dry season

	2017			2018		
Treatment	5WAT	7WAT	9WAT	5WAT	7WAT	9WAT
Poultry Manure (t ha^{-1}) P						
0	3.14b	4.58	4.92e	3.20	4.67	5.02
2	3.78a	5.03	5.72d	3.86	4.73	5.83
4	3.31ab	4.72	6.50c	3.58	4.81	6.63
6	3.44ab	4.86	7.08b	3.51	4.57	7.22
NPK (120:45:45)	3.86a	5.11	7.67a	3.94	4.74	7.82
SE±	0.195	0.254	0.072	0.199	0.259	0.073
Variety (V)						
Red Creole	3.30b	4.57b	6.09c	3.50	4.66	6.54
Galmi	3.37b	4.63b	6.38b	3.44	4.72	6.21
Wuya-bijimi (Local)	3.85a	5.38a	6.65a	3.93	4.74	6.78
SE±	0.151	0.197	0.056	0.154	0.201	0.057
Interaction						
P x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. NS= Not Significant. WAT=Weeks after Transplanting

Response of onion varieties and poultry manure rate significantly influenced crop growth rate of onion at 7-9 WAT (Table3). Application of poultry manure at 6 t ha^{-1}significantly produced more crop growth rate than the other treatments however, applied 4 t ha^{-1} of poultry manure had similar crop growth rate with the other treatments but NPK fertilizer significantly produced more crop growth rate when compared to poultry manure treatment.This might be attributed to genetic makeup coupled with availability of growth resources. At 5-7 WAT, Wuyan- bijimi significantly ($p \leq 0.05$) produced higher crop growth rate that was similar toGalmi, however Galmi and Red creole had similar crop growth rate. At 7-9 WAT, Wuyan-bijimi significantly produced crop growth rate than Galmi and Red creole that had similar crop growth rate. This is attributed to the sufficient amount of nutrients from the poultry manure in the soil proportional to the demand by the plants (Adekiya and Agbede, 2009).

There was significant interaction between poultry manure and varieties on crop growth rate at 7-9 WAT at Samaru (Table 4). Variety Wuyan-bijimi and application of NPK recommended rate significantly produced higher crop growth rate when compared to other treatments interaction. However, lower crop growth rate was produced in all the varieties and applied 2 t ha^{-1} poultry manure and control treatment. Generally, at Samaru, Red creole produce lower crop growth rate through the application of poultry manure.

Table 3: Response of irrigated onion varieties to poultry manure rate on crop growth rate at Samaru in 2017 and 2018 dry season

	2017		2018	
Treatment	5-7WAT	7-9WAT	5-7WAT	7-9WAT
Poultry Manure (t ha^{-1}) P				
0	0.38	0.09c	0.28	0.39c
2	0.40	0.19c	0.60	0.49c
4	0.40	0.39c	0.60	0.69c
6	0.42	0.83b	0.62	1.13b
NPK (120:45:45)	0.49	2.35a	0.69	2.65a
SE±	0.075	0.120	0.185	0.720
Variety (V)				
Red Creole	0.30b	0.53b	0.90b	0.83b
Galmi	0.40ab	1.71a	1.00ab	1.10a
Wuya-bijimi (Local)	0.56a	1.08a	1.16a	1.21a
SE±	0.058	0.093	0.058	0.391
Interaction				
P x V	NS	**	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. NS= Not Significant. * *=significant at 1% level of probability. WAT=Weeks after Transplantings

Table 4: Interaction between Poultry manure rate and variety on crop growth rate at 7- 9 WAT in 2017

	Poultry manure rate (t ha^{-1})				
Variety	0	2	4	6	NPK kg ha^{-1}
Red Creole	0.05f	0.16f	0.31ef	0.55def	1.58bc
Galmi	0.10f	0.19ef	0.41ef	0.86de	1.96b
Wuyan-bijimi	0.13f	0.23ef	0.44ef	1.09cd	3.51a
SE±			0.207		

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. WAT=Weeks after sowing.

Table 5 indicated that application of poultry manure at 6 t ha^{-1} significantly ($p \leq 0.05$) increased bulb weight per plant which is statistically similar to applied 4 t ha^{-1}. However applied poultry manure at 2 and 4 t ha^{-1} had similar bulb weight per plant than control treatment but the check NPK fertilizer application significantly produced higher bulb weight per plant when compared to poultry manure application and control.Wuyan- bijimi significantly had more bulb weight per plant than Galmi and Red creole however, Galmi and Red creole were statistically similar.Magdi., Mousa, and Mohammed. (2009) reported the

yield of onion was significantly influenced by fertilizer types. The highest yield of onion bulbs was obtained by the application of 5 t ha^{-1} of chicken manure which increased onion dry matter, weight of individual bulb and bulb diameter.

Table 5: Response of irrigated onion varieties to poultry manure rate on bulb weight (g) per plant in 2017, 2018 and mean during the dry season

Treatment	2017	2018	Mean
Poultry Manure (t ha^{-1}) P			
0	125.3bc	132.2	128.8
2	134.8bc	141.8	138.3
4	147.9c	154.6	151.3
6	172.3b	179.8	176.1
NPK (120:45:45)	224.1a	230.2	227.2
SE±	14.60	20.55	16.80
Variety (V)			
Red Creole	138.3b	145.3	141.7
Galmi	114.8b	121.9	118.4
Wuya-bijimi (Local)	229.7a	236.0	233.0
SE±	11.30	15.95	12.63
Interaction			
P x V	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. NS= Not Significant.

Table 6 revealed that application of poultry manure did not significantly increased bulb yield per hectare kg ha^{-1} but NPK fertilizer application significantly increased bulb yield per hectare kg ha^{-1}in 2017. However, in 2018 application of 4 and 6 t ha^{-1} PM are at par but significantly produced higher bulb yields compared to lower rate of poultry manure and the control treatment plots. Blay., Danquahe., Ofosu-Anim, and Ntumy(2002) reported that when poultry litter is applied at the recommended rate, it promotes plant growth and bulb yield.The varieties differ significantly on bulb yield(Table6) where Wuyan-bijimi significantly produced more bulb yield per hectare kg ha^{-1} than Galmi and Red creole. However, Galmi and Red creole are similar bulb yield per hectare kg ha^{-1} in both years of study and the combined mean.

Table 7 showed the response of irrigated onion varieties to poultry manure rate on percentage rotten and sprouted bulbs in 2017 and 2018 at Samaru. Percent rotted bulbs significantly increased with application of poultry manure rate up to 6 t ha^{-1} which was similar to the check (NPK fertilization) in both years of study. This might be resulted of accumulation excess nitrogen in the bulb at harvest and result in soft onion bulbs and poor storage quality. This finding corroborates with the finding of Muluneh., Alli and Amsalu.(2019) the keeping qualities of the Onion bulbs are highly influenced by application of N at different levels during the three-month storage time at ambient temperature.

In both years of study variety Galmi significantly produced more percent rotted

bulbs compared to red Creole and the local variety (Wuyan-bijimi) that produced statistically similar rotten bulbs. Vintila., Niculescu, and Romas. (2014) observed that rotten and sprouting bulbs was common to all varieties of onion stored at different temperatures where Daytona presented lowest degree of sprouting.

Table 6: Response of irrigated onion varieties to poultry manure rate on bulb yield per hectare kg ha^{-1} in 2017, 2018 and mean during the dry season

Treatment	2017	2018	Mean
Poultry Manure (t ha^{-1}) P			
0	6199.0b	6078.1b	6138.9c
2	6579.0b	7200.4b	6889.7c
4	9619.0b	15338.8a	12478.9b
6	11298.0b	18009.0a	14653.5ab
NPK (120:45:45)	19259.0a	20267.5a	19763.3a
SE±	2558.40	2050.30	1957.20
Variety (V)			
Red Creole	7131.0b	8906.9b	8018.9b
Galmi	8373.0b	11334.7b	9853.5b
Wuya-bijimi (Local)	16269.0a	19894.6a	18081.8a
SE±	1981.80	1508.50	1358.10
Interaction			
P x V	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. NS= Not Significant.

Table 7: Response of irrigated onion varieties to poultry manure rate storability at Samaru in 2017 and 2018 dry season

	Rotten bulbs (%)		Sprouted bulbs (%)	
Treatment	2017	2018	2017	2018
Poultry Manure (t ha^{-1}) P				
0	10.6b	11.6c	12.0abc	11.8b
2	12.8b	10.8c	11.2bc	14.6ab
4	14.2b	16.2b	9.9c	10.7b
6	20.8a	23.1a	12.1abc	11.9b
NPK (120:45:45)	25.9a	24.9a	16.8a	15.8a
SE±	1.90	1.51	1.74	1.53
Variety (V)				
Red Creole	12.6b	14.9b	12.6a	14.8a
Galmi	27.5a	23.4a	14.7a	14.6a
Wuya-bijimi (Local)	10.8b	13.7b	9.9b	9.5b
SE±	1.22	1.10	0.91	0.86
Interaction				
P x V	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. NS= Not Significant.

Effect of poultry manure application from 0 to 6 t ha^{-1} had no significant difference in both years of study on % sprouted bulbs except plots where NPK fertilizer were applied which significantly produced higher % sprouted bulbs. Dapaah., Amoh-Koranteng., Darkwah and BorteiBorketey-La (2014) reported that high uptake of nitrogen produced thick-necked bulbs that increased sprouting in storage due to greater access of oxygen and moisture to the central growing point. In 2017 and 2018, varieties Red Creole and Galmi were similar but significantly gave higher percent sprouted bulbs than Wuyan-bijimi that produced the least sprouted bulbs. There were no significant interactions observed on percent (%) rotten and sprouted bulb in both years of study.

Conclusion

From the result, it can be concluded that growing Wuyan-bijimi or Red Creole with application of 6 t ha^{-1} PM or 120:45:45 kg ha^{-1} NPK are recommended for possible adoption by farmers. Wuyan-bijimi or Red Creole is recommended since it has a longer shelf life and can store better than Galmi.

Competing Interests

Authors have declared that no competing interests exist.

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