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Effect of seed bed types on growth and yield of onion seedlings (*Allium cepa L.*) Under the influence of fertilizer types in Makurdi, Nigeria

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ABSTRACT

Field experiments was conducted at the Teaching and Research Farm, Joseph Sarwuan Tarka University Makurdi to evaluate the effect of bed types and fertilizer types on the growth and yield of onion seedlings/bulbs (*Allium cepa L.*). The study was a 2x4 factorial experiment {2 types (bed and ridge) and four fertilizer types (NPK20:10:10, poultry manure, cattle dung, and no application served as control)} laid out in a Randomized Complete Block Design (RCBD) replicated thrice. Data were collected were subjected to Analysis of Variance (ANOVA) and Fisher's least significant difference (FLSD) was used to separate means. Results of the study revealed that onions raised on beds had statistically higher growth and yield parameters than the ridge bed system. Therefore, the onion planted on bed type system recorded the highest yields with bulb weight (13.45t/ha) and (23.35 t/ha) in both years. On the fertilizer types, NPK 20:10:10 application recorded the highest bulb weight of 14.57t/ha and 35.75t/ha in both years, followed by poultry manure with bulb weight of 11.29t/ha and 11.61t/ha and cattle dung with bulb weight of 10.70t/ha and 12.94t/ha while untreated (control) gave the lowest yields with bulb weight/plot 9.21t/ha and 7.40t/ha respectively. It is recommended that the application of NPK 20:10:10 fertilizers on bed type system be adopted for optimum yield of Onions in Makurdi, Nigeria. Furthermore, in the scarcity or high cost of NPK fertilizers, smallholder farmers in the study location can adopt either poultry manure or cattle dung as a substitute to boost yields of onions.

Contribution/Originality: The findings from this research contributes to the knowledge of the use of either poultry manure or cattle dung as a source of fertilizer on the bed type production of onions in North central Nigeria most especially with the high cost or scarcity of NPK fertilizers for smallholder farmers.

1. INTRODUCTION

The onion (*Allium cepa* L.) is a member of the liliaceae family. Aside from its excellent nutritional value, it is a significant vegetable that is utilised in every kitchen; it is also a good source of money for vegetable producers. The pungent flavour of onion bulbs is caused by the presence of allylpropyl disulfide, a volatile oil (Jilani, 2004).

According to Kusnarta et al. (2006) the soil management system regulates root spread as well as soil qualities such as porosity, compaction, water content, and organic matter concentration. Several additional researchers have found that seedbed types influence seedling emergence, growth, and agricultural productivity by influencing soil physical, chemical, and biological qualities (Tijani-Eniola, 2002).

The use of chemical fertilisers alone could have a number of negative effects on the environment and human health, especially since they must be applied at the start of each crop growing season because synthetic N, P, and K fertiliser is rapidly lost through evaporation or leaching (Aisha, Rizk, Shaheen, & Abdel-Mouty, 2007). Whereas organic fertilisers, on the other hand, have the benefits of improving soil organic matter, structure, chemical characteristics, and microbial activity, thus restoring soil productivity (Bhattacharyya et al., 2010; Chandra, 2005; Lasmini, Kusuma, Santoso, & Abadi, 2015; Tirol-Padre, Ladha, Regmi, Bhandari, & Inubushi, 2007). Furthermore, Dapaah, Amoh-Koranteng, Darkwah, and Borketey-La (2014) found that an integrated soil management approach to soil amendment application is required to reap the benefits of organic and inorganic fertilisers.

According to research, certain production strategies may have an impact on vegetable productivity. These include sowing time (Asiegbu, 1985), tillage practice (Awodun, 2007a) manure rate (Awodun, 2007b; Ogar & Asiegbu, 2005) plant staking (Chukwudi & Agbo, 2013; Egun, 2007) and cutting frequency (Chukwudi & Agbo, 2013; Ogar & Asiegbu, 2005). Low plant nutritional status and poor soil physical condition are important agronomic restrictions in the Nigerian savannah, where the majority of agriculture is done (Salako, 2003).

The seedbed type is critical for soil water conservation. Farmers in many regions of the world have been using raised seedbed systems since time immemorial (Govaerts, Sayre, Lichter, Dendooven, & Deckers, 2007). Their use has traditionally been associated with water management challenges, such as draining farmed farms of excess water or irrigating crops through furrows in semi-arid and desert locations (Sayre & Hobbs, 2004).

In vegetable crops like onions with shallow and unbranched root structures, the crop are the most susceptible crop plants in extracting nutrients, particularly the immobile types, thus, the require and typically respond effectively to fertilizer addition (Rizk, Shaheen, Abd El-Samad, & Sawan, 2012). Hence nutrients management as well tillage practices (such as bed types) play an important role in increasing the yield and quality of vegetable crops. For a decent onion production, optimal fertiliser use and cultivation of compatible varieties with adequate agronomic procedures in a specific environment are required. Therefore, the objective of this study was to determine effect of two seed bed types and fertilizer types on the leaf growth and yield of onion in Makurdi, Benue state.

2. MATERIALS AND METHODS

Two field experiments were carried out, at the Teaching and Research Farm, University of Agriculture Makurdi, Nigeria to evaluate the effect of bed types and fertilizer types on the growth and yield of onion (*Allium cepa* L.). Soil samples (0-15cm) were collected at the beginning of the experiment and air dried and prepared for laboratory analysis. Soil samples were analyzed using standard laboratory procedures (Table 1). The meteorology information for Makurdi during the experiment was also recorded (Table 2). The experiment was laid out as a 2 x 4 factorial laid out in a Randomized Complete Block Design (RCBD) with three replications. The bed types were flat bed and ridge bed types while the fertilizer treatments comprised of cattle dung at 20t/ha, N.P.K 20:10:10 at 150kg/ha Poultry manure at 20t/ha and no application as control). The land was cleared with cutlass and hoe. The field was ploughed, harrowed, ridged and beds were constructed using a big African handled hoe. The treatments were assigned to each experimental unit using a table of random numbers. Spacing was 64cm x 15cm x 1 plant per stand, planted 2cm deep on top of ridges and on bed (flat). Weed control (both manual and chemical) were carried out in the field as need arose. Four plants were selected from each plot and data on plant height (cm), number of leaves per plant, leaf area (cm^2), leaf length (cm), bulb diameter and length (cm) and bulb weight (t/ha) of onions were collected weekly. The data obtained were subjected to statistical analysis of variance (ANOVA) we used

Fisher's Least Significant Difference (LSD) to separate the means at 5% probability level (P≤0.05) using (GENSTAT Release 17.1 DE, 2017).

3. RESULTS AND DISCUSSION

3.1. Physico-Chemical Properties of the Experimental Soil and Meteorological Information for Makurdi, Nigeria (August to October) in Year 2018/2019

Table 1 presents the meteorological information for Makurdi during the months of August to October in year 2018/2019 cropping season. The month of August in the study location recorded the highest amount of rainfall (288.3 mm) and highest number of rain days (18). The average monthly temperature ranged from 20.3 ^{0}C to 31.5 ^{0}C while the average relative humidity ranged from 73.6 % to 77.8 %. The meteorological data obtained for the study location is ideal for onions production as earlier reported by Muhammad, Gambo, and Ibrahim (2011).

Table 2 shows the physicochemical parameters of the soil at the experimental location during the 2018/2019 cropping season. The soil's total nitrogen value (0.19%) was low. The soil had a low phosphorus level (5.6 ppm) and a low potassium level (0.39%). The percentages of sand, silt, and clay were 78.5%, 9.9%, and 14.6%, respectively. pH in Water was slightly acidic. The soil's textural class was sandy-loam. The experimental soil parameters are excellent for onion production since they support previous findings by Muhammad et al. (2011); Adeyeye, Ishaku, Gadu, Olalekan, and Lamid (2017) and Sirajo and Namo (2018).

Table 1. Meteorological information for Makurdi, Nigeria (August to October) in year 2018/2019 season.

Months	Average monthly rainfall (mm)	Number of rain days	Average monthly temperature (^{0}C)		Average relative humidity (%)
			Min.	Max.	
August	288.3	18	24.4	30.2	77.5
September	243.3	16	20.3	29.8	77.8
October	98.7	9	22.4	31.5	73.6

Source: UAM meteorological science laboratory, Makurdi, Nigeria.

Table 2. Physico-chemical properties of the experimental site before planting in year 2018/2019 season.

Parameters	Value	Method of analysis
Organic matter (%)	2.30	Walkley-Black
Nitrogen (%)	0.19	Kjeldahl method
P_2O_5 (ppm)	5.60	Flame photometric
K (Cmol kg^{-1} of soil)	0.39	Oxidation method
Ca^{2+} (Cmol kg^{-1} of soil)	5.90	AAS
Mg^{2+} (Cmol kg^{-1} of soil)	2.74	AAS
Sand (%)	78.50	Hydrometer method
Clay (%)	14.60	Hydrometer method
Silt (%)	9.90	Hydrometer Method
pH (H_2O)	6.70	pH meter
pH ($CaCl_2$)	5.60	pH meter
Textural class	Sandy-Loam	USDA Soil Texture Triangle

Source: Soil science laboratory, university of agriculture, Makurdi, Nigeria.

3.2. Plant Height (Cm)

Table 3 shows that the effect of bed types and fertiliser sources on onion plant height in the 2018 and 2019 cropping seasons was significant (P≤0.05). In both years the flatbed recorded considerably higher plant height as compared to onions seedlings planted on ridges. At some point onions on ridges had superior performance as compared to the onions seedling planted on flat beds, however, the difference was not statistically significant. This could be possibly due to flatbed tendency of retaining moisture than ridges thus the resultant effect on plant height. This finding agrees with Loth, Tarimo, Reuben, and Lena (2006) in their study showed that flatbed showed consistent and significant good performance as compared to other seedbed types evaluated. Also, Mohammedali,

Elshukry, Alamin, and Elhag (2022) reported flatbed superior performance on the onion growth over ridge type. When fertilizer sources was compared, NPK consistently recorded the highest plant height of onion followed by poultry manure and cattle dung while the control obtained the lowest plant height and the difference was significant at 2018 and 2019 cropping seasons (Table 3). The plant height were all influenced by the fertilizers treatments which were different from the control. This finding support the work of Funda, Ceylan, Mordogan, and Esetlili (2011) that fertilizers produced and supply adequate plant nutrients for proper growth and development of crop. Furthermore, the incorporation of nitrogenous fertilizers into the soil has been shown to increase the amount of soluble organic matter which is mainly organic acid that improves the available P content in the soil (Adeyeye et al., 2017).

Table 3. Effect of bed types and fertilizer sources on the plant height of onions in Makurdi.

	2018					2019				
	Plant height (cm)					Plant height (cm)				
BED type	1WAP	2WAP	3WAP	4WAP	5WAP	1WAP	2WAP	3WAP	4WAP	5WAP
BED	2.01	2.48	2.75	3.43	4.00	1.58	1.98	4.64	6.55	7.02
RIDGE	1.51	1.99	2.30	3.05	4.39	1.56	2.08	3.93	5.92	6.62
F-LSD (P≤0.05)	0.32	0.33	0.30	0.26	NS	NS	NS	0.67	0.62	NS
F.pr	0.005	0.007	0.007	0.011	0.321	0.846	0.339	0.036	0.049	0.177
Fertilizer types										
NPK	2.50	3.32	3.62	4.43	5.82	1.90	2.73	5.94	7.44	8.27
PM	1.96	2.23	2.63	3.01	4.71	1.65	1.87	4.33	6.27	6.62
COW DUNG	1.54	2.03	2.17	2.86	3.24	1.50	1.91	3.72	6.07	6.98
CONTROL	1.03	1.37	1.68	2.66	3.01	1.23	1.61	3.16	5.15	5.39
F-LSD (P≤0.05)	0.45	0.47	0.43	0.37	1.15	0.28	0.29	0.94	0.88	0.85
F.pr	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Note: PM – Poultry manure, CD- Cattle dung; NS – Not significant; WAP – Weeks after planting; F.pr – Probability value at 5% level; F-LSD – Fishers least significant difference at 5% level of probability.

3.2.1. Leaf Area (Cm²)

Table 4 shows the effect of bed types on the leaf area of onions recorded no significant (P≥0.05) difference during the both cropping season. However, bed types showed significant (P≤0.05) difference on the leaf area of onions only at 3WAP.

Table 4. Effect of bed types and fertilizer sources on the leaf area of onion in Makurdi.

	2018					2019				
	Leaf area (cm²)					Leaf area (cm²)				
BED type	1WAP	2WAP	3WAP	4WAP	5WAP	1WAP	2WAP	3WAP	4WAP	5WAP
BED	1.45	2.25	2.40	7.34	8.03	1.30	2.16	3.15	4.11	4.93
RIDGE	1.43	2.34	2.31	6.76	7.28	1.26	2.22	2.68	3.70	4.71
F-LSD (P≤0.05)	NS	NS	NS	NS	NS	NS	NS	0.25	NS	NS
F.pr	0.870	0.304	0.491	0.082	0.387	0.144	0.614	0.001	0.106	0.490
Fertilizer types										
NPK	1.95	2.41	2.48	8.33	8.87	1.44	2.49	3.24	4.71	6.60
PM	1.37	2.42	2.45	7.19	7.60	1.29	2.42	3.24	4.10	4.78
COW DUNG	1.32	2.41	2.25	7.34	8.11	1.27	2.29	3.01	3.80	4.27
Control	1.13	1.92	2.23	5.33	6.02	1.12	1.55	2.16	3.02	3.63
F-LSD (P≤0.05)	0.32	0.26	NS	0.95	NS	0.08	0.32	0.36	0.72	0.93
F.pr	0.001	0.002	0.338	0.001	0.155	0.001	0.001	0.001	0.002	0.001

Note: PM – Poultry manure, CD- Cattle dung; NS – Not significant; WAP – Weeks after planting; F.pr – Probability value at 5% level; F-LSD – Fishers least significant difference at 5% level of probability.

The study revealed that, although no significant difference was obtained, flatbed gave higher leaf area as compared to onions planted on ridges in both seasons. This study confirmed the findings of Sarker, Ratna, Ray, Fahim, and Tithi (2017) that reported bed type obtained higher growth and yield of onions in Bangladesh. The application of NPK fertilizer produced the highest leaf area while the organic fertilizers of cattle dung and poultry manure followed and the least leaf area was obtained from control (untreated) plants in both seasons of the experiment. The present study also agrees with the earlier reports of Funda et al. (2011) and Adeyeye et al. (2017) who also reported higher growth parameters of onions when applied with NPK.

3.2.2. Leaf Length

The effect of seedbed type showed no significant difference on onions leaf length in 2019 and in 2018, bed type showed significant difference only at 1 and 5WAP (Table 5). At 1WAP and 5WAP, bed type significant had higher leaf length as compared to ridge type and the difference was statistically significant. At both cropping year, NPK significantly produced higher leaf length followed by poultry manure and cattle dung while the untreated (control) treatment recorded the lowest leaf length and the difference was statistically significant. This study agrees with earlier findings of Adeyeye et al. (2017) who also found that onions growth were superior when applied with NPK in Wukari. Working on Toungos (2019) also affirmed that growth and yield of maize increased with the application of NPK fertilizer in Mubi.

Table 5. Effect of bed types and fertilizer sources on the leaf length (cm) of onions in Makurdi.

	2018					2019				
	Leaf length (cm)					Leaf length (cm)				
BED type	1WAP	2WAP	3WAP	4WAP	5WAP	1WAP	2WAP	3WAP	4WAP	5WAP
BED	7.92	9.17	13.29	16.29	22.59	6.72	9.31	30.30	39.24	42.10
RIDGE	6.15	9.23	12.14	14.96	21.04	7.25	8.73	30.50	38.82	41.30
F-LSD (P≤0.05)	1.31	NS	1.12	NS	1.46	NS	NS	NS	NS	NS
F.pr	0.012	0.866	0.044	0.256	0.039	0.157	0.336	0.917	0.838	0.692
Fertilizer types										
NPK	8.83	9.58	13.95	18.37	26.02	7.86	10.03	39.50	45.97	49.90
PM	7.42	9.58	12.81	15.79	23.32	7.72	8.60	30.80	40.81	43.40
CD	6.50	9.51	13.22	15.58	22.16	6.80	8.75	28.80	37.54	40.40
CONTROL	5.39	8.11	10.89	12.75	15.75	5.56	8.72	22.50	31.80	33.20
F-LSD (P≤0.05)	1.85	1.03	1.58	3.61	2.07	1.08	NS	6.48	6.03	6.09
F.pr	0.009	0.020	0.006	0.045	0.001	0.002	0.305	0.001	0.001	0.001

Note: PM – Poultry manure, CD- Cattle dung; NS – Not significant; WAP – Weeks after planting; F.pr – Probability value at 5% level; F-LSD – Fishers least significant difference at 5% level of probability.

3.2.3. Number of Leaves

Table 6 shows that the effect of bed types on the number of leaves of Onions was significant at 3WAP and 4WAP in 2018 and at 3WAP and 5WAP in 2019. Effect of fertilizer sources on the number of leaves was significant throughout the experimental period both in years.

The bed types in 2018 and 2019 3WAP, 4WAP and 5WAP produced significantly higher values when compared with the ridge type (Table 6). This finding agrees with Loth et al. (2006) in their study showed that flatbed showed consistent and significant good performance as compared to other seedbed types evaluated. Also Aisha, Elsadig, Abdellatief, and Ayoub (2022) reported flatbed superior performance on the onion growth over ridge type. When fertilizer sources was accessed, NPK produced significantly highest number of leaves of onions and significantly different from the other fertilizer sources such as poultry manure and cattle dung while the control (no application) produced significantly the lowest onions of number of leaves in both seasons. Working on Onions in Wukari, Adeyeye et al. (2017) affirmed that onions growth showed superior performance when applied with NPK

and this agrees with the current study. Toungos (2019) also agrees that growth and yield of maize increased with the application of NPK fertilizer in Mubi.

Table 6. Effect of bed types and fertilizer sources on the number of leaves of onions in Makurdi.

	2018					2019				
	Number of leaves					Number of leaves				
Bed type	**1WAP**	**2WAP**	**3WAP**	**4WAP**	**5WAP**	**1WAP**	**2WAP**	**3WAP**	**4WAP**	**5WAP**
BED	3.53	4.35	4.64	5.25	6.83	3.70	7.06	8.98	10.63	11.46
RIDGE	3.25	3.93	4.29	4.96	6.70	3.36	6.36	7.68	9.94	10.76
F-LSD (P≤0.05)	NS	NS	0.22	0.23	NS	NS	NS	1.13	NS	0.28
F.pr	0.207	0.068	0.018	0.022	0.861	0.123	0.186	0.028	0.242	0.017
Fertilizer types										
NPK	4.22	4.61	5.11	5.87	9.08	3.97	7.13	8.99	11.55	12.39
PM	3.64	4.25	4.50	5.21	6.50	3.64	7.47	8.81	10.55	11.59
CD	3.11	4.20	4.32	5.21	6.16	3.75	7.75	9.36	10.96	11.52
Control	2.59	3.50	3.94	4.13	5.31	2.77	4.48	6.16	8.07	8.94
F-LSD (P≤0.05)	0.66	0.65	0.57	0.33	2.29	0.64	1.53	1.60	1.70	1.47
F.pr	0.001	0.018	0.005	0.001	0.019	0.007	0.002	0.003	0.003	0.001

Note: PM – Poultry manure, CD- cattle dung; NS – Not significant; WAP – Weeks after planting.

3.2.4. Bulb Diameter and Length

The bulb diameter, length and weight of onions as influenced by bed and fertilizer types showed significant difference (P≤0.05) is presented in Table 7. In the both years, bed type produced higher bulb length, diameter and weight and the difference was significant.

However, at 2019, the value produced from the bed and ridge type on bulb length were at par and the difference was not significant (Table 7). In agreement with this findings, Kanwar and Ishfaq Akbar (2013) reported that flatbed system produced significantly highest bulb yield parameters of onions as compared to other bed types on the growth and yield of onion under cold desert conditions. Similar findings have also been reported by Loth et al. (2006); Sarker et al. (2017) and Mohammedali et al. (2022) that flatbed type showed consistently good performance for many variables of common bean and onions evaluated in Tanzania and Sudan respectively.

A cursory look on the fertilizer types, it is revealed that NPK fertilizer obtained higher bulb diameter and length of onions while the control plots produced the lowest values for diameter, length and weight of onion bulb and the difference was significant. However, Poultry manure and cattle dung produced similar values for bulb diameter, length and yield as no significant difference was recorded among the two fertilizer types, and poultry manure recorded high values than cattle dung.

This finding agrees with Islam, Alam, and Islam (2007) who reported that onion yield is higher with the application of NPK fertilizers. Similar findings have also been reported documented by Adeyeye et al. (2017) and Yohannes, Derbew, and Adugna (2013) that N fertilization increased bulb length and other yield parameters of onions. Contrary to this finding, Yassen and Khalid (2009) had earlier reported that poultry manure increased the bulb diameter of onion over the recommended NPK fertilizer applications.

This could possibly be linked to the low soil pH of the NPK fertilizer amendment plot. More-so, low pH status of the soil have a positive correlation to the yield of onions.

This had earlier been asserted by Norman (1992) and Sinnadurai (1992) that onions are sensitive to low soil pH and can perform well when planted in less acidic soil.

Table 7. Effect of bed types and fertilizer sources on the yield parameters of onions in Makurdi.

	2018			2019		
Bed type	Bulb diameter (cm^2)	Bulb length (cm)	Bulb weight (t/ha)	Bulb diameter (cm^2)	Bulb length (cm)	Bulb weight (t/ha)
BED	54.70	47.49	13.45	59.97	53.04	23.35
RIDGE	50.90	41.71	11.43	58.06	47.14	12.75
F-LSD (P≤0.05)	3.24	3.65	1.98	Ns	3.54	1.03
F.pr	0.017	0.010	0.019	0.305	0.003	0.038
Fertilizer types						
NPK	64.90	49.78	14.57	67.89	57.12	35.75
P. M	57.20	46.42	11.29	60.54	48.21	16.11
CD	53.50	44.93	10.70	57.03	48.07	12.94
Control	35.50	37.29	9.21	50.59	46.95	7.40
F-LSD (P≤0.05)	8.82	5.15	2.80	5.46	5.01	15.46
F.pr	0.002	0.007	0.007	0.001	0.001	0.032

Note: PM – Poultry manure, CD- Cattle dung; NS – Not significant.

4. CONCLUSIONS

The results of this study indicated that flatbed type showed superior performance on the growth and yield of onion over ridge bed type. Additionally, it was found that the application of NPK fertilizers showed superior performance over poultry manure and cattle dung while the untreated (control plots) produced the lowest growth and yield of onions. Based on this findings, it is recommended that the application of NPK fertilizers at 150kg/ha on bed type system of tillage be adopted for optimum yield of Onions in Makurdi, Nigeria. Furthermore, the study also recommends that in the scarcity or high cost of NPK fertilizers, smallholder farmers in the study location can adopt the poultry manure or cattle dung at 20t/ha as a substitute to boost yields of onions.

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