https://dx.doi.org/10.4314/dujopas.v11i1a.4
ISSN (Print): 2476-8316
ISSN (Online): 2635-3490
Dutse Journal of Pure and Applied Sciences (DUJOPAS), *Vol. 11 No. 1a March 2025*

Effect of Organic and Inorganic Fertilizers on Growth and Yield of Two Onion Cultivars (*Allium cepa* L.) grown in Bauchi State, Nigeria

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Abstract
Experiment was conducted at the Tatari Ali farm in Azare, Bauchi State Nigeria. To determine the effect of organic and inorganic fertlizers on the growth and yield of Onion. The recommended rates of poultry manure (10 t ha^{-1}), cow dung (10 t ha^{-1}), NPK (400 kg ha^{1}), and Urea (200 kg N ha^{-1}) were used as treatments with a control (0 kg ha^{-1}). These were arranged in a randomized complete block design with three replications. The data collected was analyzed using analysis of variance (ANOVA) and significant means separated by GenStat at 5% probability level. The results revealed that all the treatments significantly (P<0.05) improved the growth and yield parameters of onion. NPK produced significant higher number of leaves (10.85a), Urea (9.52b) poultry manure (9.34b) cow dung (9.25b) and control 0 kg ha^{-1} (8.04c). The highest bulb diameter was recorded with poultry manure (6.16 cm) and bulb length was recorded with NPK (6.84a cm) and fresh bulb weight was significantly higher in poultry manure and cow dung applications. The onion bulb yield is in order of poultry > cow dung > NPK > Urea > control. It is concluded that poultry manure application is better for the production of onion.

Keywords: Fertilizer**,** inorganic, Organic, Onion, Yield.

Introduction
Onion (*Allium cepa* L.) is an important vegetable crop produced majorly in the parts of the world (Shaheen *et al.*, 2017). They are pungent when chopped and contain certain chemical substances which irritate the eyes (Alkaff *et al.*, 2012). Onions have some medicinal attributes and found applicable in the treatment of ailments such as; coughs, snakebite and hair loss

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(Patricia *et al*., 2014). In addition, it is used by athletes to rub down their muscles in order to firm it and for blood balance, as well as to facilitate bowel movement and erection in men Fern e*t al*., (2013) stated that the pungent juice of onions has been used as insects' repellant as well as dyes used in fabric industries. The bulb onion (*Allium cepa* L.) or onion is the most widely cultivated species of the genus Allium (Brewster *et al*., 2016).

These onion cultivars are classified into the common Onion Group (*A. cepa* var. *cepa*), which include most of the economically important varieties (cultivars grown for green or salad onions) and the Aggregatum Group, which includes shallots and potato onions and typically produce clusters of small bulbs (Brewster *et al*., 2016). At maturity, food reserves begin to accumulate in the leaf bases and the bulb of the onion swells (Patricia *et al*., 2014). The seeds on maturity become glossy black and take triangular shape (Shaheen *et al*., 2017).

It also improves the soil structure and helps to build the organic matter of the soil, among many other advantages fertility (Funda *et al*., 2021). Organic fertilizers have positive effect on root growth by improving the root rizosfer conditions (structure, humidity, *etc*.) (Savant *et al*., 2017). It improves the ability of crop to resist or tolerate the biotic stresses, such as attack of insect, pests and fungal disease (Datnoff *et al*., 2017) and abiotic stresses like toxicity of soil with Al, Fe, Mn (Sistani *et al*., 2017) and excessive salts. Furthermore, its application reduces the cuticular transpiration and provides strength to crop against lodging caused by excessive Nitrogen supply (Savant *et al*., 2019). Effect of Organic and Inorganic Fertilizers on Growth and Yield of Two Onion Cultivars (*Allium cepa* L.) grown in Bauchi State, Nigeria was studied.

Materials and Methods

Study Area

Field experiment was carried out at Tatari Ali farm in Azare; Azare is the second largest town in Bauchi State after the state capital. It is located at the center of the northern part of the state and situated at 11.68° North latitude, 10.19° East longitudes. Azare is located at an elevation of 436 meters. It has an area of 1,436 km^2 (554 sq. miles) and a population of approximately 295,970. Pre-soil sample was collected and was taken to the soil science laboratory Faculty of agriculture Federal University Dutse, for chemical routine analysis.

Experimental Treatments

The experiment was laid out in a randomized completed block design (RCBD) with three replications. The treatments consisted of two organic fertilizers and their rates which are: cow dung (10 t ha^{-1}), poultry manure (10 t ha^{-1}) and two inorganic fertilizers which are NPK 15:15:15 (400 kg ha^{-1}), Urea (200 kg N ha^{-1}) and the control (0 kg ha^{-1}) (Kumar *et al*., 2020).

Experimental Design

The seeds of the onion were planted in the nursery for a period of four weeks before transplanting. The plot size used for the experiment was 2 m × 2 m and the spacing of 10 cm by 10 cm marked a total of 40 plants per plot, the total number of plots is 30. The organic fertilizers were thoroughly incorporated into the soil two weeks before transplanting while the mineral fertilizers were applied a week after transplanting (Rumpel *et al*., 2021).

Preparation of land

Land preparation was done manually with hoe and rake respectively. Weeding was done manually at two weeks after transplanting and as when necessary, although severe pest

infestation did not occur during the experiment but cypermethrine at the rate of 2 ml to 1 litre of water was applied two weeks after transplanting (Stolton *et al*., 2017).

Morphological Parameters

Number of Leaves Per Plant
Fully developed leaves of five randomly selected plants counted from the middle rows of the net plot size at physiological and morphological maturity and the average was computed for each plant.

Plant Height (cm)
Plant height was measured from the ground level up to the tip of the longest leaf using a measuring tape. It was measured used five randomly selected plants from the two central rows of each plot at physiological and morphological maturity of the plant and the average values computed.

Bulb Length (cm)
The vertical average length of matured bulbs of five randomly selected plants in each plot was measured using vernier caliper.

Bulb Diameter (cm)
Bulb diameter was measured at right angles to longitudinal axis at the widest circumference of the bulb of five randomly selected plants in each plot by using vernier caliper.

Fresh and Dry Bulb Weight (g)
The average bulb weights of five randomly selected bulbs from the net plot was taken and calculated as the mean fresh bulb weight and dry bulb weight after harvesting (Seran *et al*., 2020).

Data Analysis
Data was collected and were subjected to statistical analysis using two way analysis of variance (ANOVA), treatment means were separated using statistical analysis software package (GenStat).

Results and Discussion

The particle size analysis of soil samples from Azare farm in Bauchi State, Nigeria before treatments with organic and inorganic fertilizers are shown in table 1.

Table 1: Physico-chemical Parameters analysis of soil samples levels of pH, micronutrients and CEC of Azare Farm

Soil Physico-chemical Parameters	
pH (H_2O)	6.66
pH ($CaCl_2$)	5.3
Organic carbon (g kg^{-1})	10.4
Total N (g kg^{-1})	1.36
Available P (mg kg^{-1})	6.85
Copper (mg kg^{-1})	1.47
Iron (mg kg^{-1})	366.83
Zinc (mg kg^{-1})	9.92
Exchangeable bases (cmol kg^{-1})	
Ca	2.36
Mg	37.09
K	0.11
Na	0.03
Exchangeable acidity	0.04
Base saturation (%)	98.9
Particles size (g kg^{-1})	
Sand	65.68
Silt	18
Clay	16.32
Textural class	Sandy loam

The levels of pH (H_2O and $CaCl_2$ solution), micronutrients (Cu, Mn, Fe and Zn) as well as cation exchange capacity (CEC). The texture of a soil affects its health. Soil health usually impacts directly on plant health. Similar soil textural before treatments were also reported (Usman *et al*., 2013).

Table 2: Effect of organic and inorganic fertilizers on growth and yield parameters on selected Onion

Treatment	**Number of leaves**	**Plant Height (cm)**	**Bulb Diameter (cm)**	**Bulb Length (cm)**
Cultivar				
C_1 Kwadon	9.72	50.80	5.65	5.19b
C_2 Agrifound	9.09	51.65	5.18b	5.52a
LSD	0.810	1.438	0.426	0.3191
Fertilizers				
T_1 Cow dung	9.25b	44.77c	5.73a	5.71b
T_2 Poultry	9.34b	52.51b	6.16a	6.21b
T_3 Control	8.04c	9.12d	3.87c	4.08d
T_4 Urea	9.25b	60.63a	5.44b	5.52a
T_5 N.P.K	10.88a	59.10a	5.85a	6.84a
LS	N.S.	N.S.	N.S.	N.S.
LSD	1.281	2.274	0.674	0.5046
Interactions				
V×F	N.S	N.S	N.S	N.S

LSD Least significant differences of means (5% level)
Legends: N.S = no significant; LSD = Least significant differences

The results showed that the number of leaves was significantly higher in both cultivars and in all the treatments. In the cultivar 'kwadon local' showed the highest number of leaves (9.72), while there were no signifcant differences 'Agrifound' showed the lowest number of leaves (9.09). Among the fertilizers N.P.K application also resulted in the highest number of leaves

(10.88), while the lowest number was with the control (8.04). Yagoub *et al*., (2012) reported the highest level of nitrogen significantly increased plant height and number of green leaves per plant as compared to the control treatment.

A significant variation was observed in plant height of two cultivars of onion due to the application of fertilizers from organic and inorganic sources. The 'Agrifound' significantly showed the highest plant height (51.65), while 'kwadon local' showed the lowest plant height (50.80) there was significant differences with control 0kg/ha) influenced plant height positively. Among the fertilizer treatments, urea significantly showed the highest plant height with (60.63) followed by N.P.K (59.10), then poultry manure (52.51), cow dung (44.77) and the control (39.12), treated plots gave higher plant height compared with untreated plots (Reddy *et al*., 2015). This result corroborates with that of Hague *et al*. (2014), who stated that plant height of onion increased significantly with increasing levels of Urea (from 200 kg/ha) and N.P.K fertilizer (from 400 kg/ha). Plant growth parameters such as bulb diameter related to the yield of onion (Nasreen *et al*., 2017).

The application of different organic fertilizers significantly affected the bulb diameter depending on the cultivars. 'Kwadon local' showed the largest bulb diameter (5.65), while there were no signifcant differences between 'Agrifound' (5.18). Craig *et al*., 2018) the treatments which bulb diameter was poultry manure (6.16) N.P.K (5.85) followed with cow dung (5.73) then urea (5.44) applications, while the smallest bulb diameter was recorded for the Control 0kg/ha (3.87).

The highest bulb length between two cultivars of onions were showed in (Table 4.3) the Agrifound had the highest bulb length with (5.52) was achieved from treatment with poultry manure where 'Kwadon local had a lowest bulb length (5.19) there was no statistically differences. Among The fertilizers N.P.K had the highest bulb length (6.84) followed with poultry fertilizers (6.21). Cow dung had (5.71) and Urea had (5.52) which was significantly differences with control 0kgha (4.08). Probably integration of organic and inorganic sources of Nitrogen supplied the necessary requirements for the proper vegetative growth of plant that helps in obtained the highest bulb length. (Hussain *et al*. 2018) reported that organic manures increased the efficiency of chemical fertilizers. Similar views were reported by (Reddy and Reddy 2015) they observed that combination of 10 t/ha poultry, cow dung manures and 400 kg/ha, N.P.K 200/ha.

Table 3: Interaction effect between cultivars and fertilizers on number of leaves

Treatment	**Fertilizers**				
Cultivar	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
1	9.35b	9.54b	8.76c	9.65b	11.32a
2	9.15b	9.14b	7.32c	9.39b	10.44a
LSD					1.811

Interaction Effect between Variety and Fertilizer on Number of Plant Leaves

There was a significant result was observed in between cultivars and fertilizers and observation, which are represented in table 3. The number of leaf area per plant was significantly higher in cultivar one 'kwadon local' with (9.72a) recommended dose of fertilizer with N.P.K 400 kg\ hacter^{-1} (11.32a) treatment. Whereas, other treatment combination registered lower leaf area per plant (Filella *et al*., 2015).

Table 4: Interaction effect between cultivars and fertilizers on plant height

Treatment	Fertilizers				
Cultivar	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
1	43.52c	51.72b	38.08d	61.49a	59.20a
2	46.03c	53.30b	40.17c	59.77a	59.00a
LSD					3.216

Least significant differences of means (5% level)

Interaction Effect between Cultivars and Fertilizers on Plant Height

There was significant results were observed in between variety and fertilizer observation which are represented in table 4. The total plant height per plant was significantly higher (61.49a) respectively in the combination of recommended dose of fertilizers along with (Urea 200 kg/ hacter^{-1} treatment. The cultivar which are found with 'Agrifound' (51.66a); whereas, other treatment combination registered lowest plant height (Clark *et al*., 2010).

Table 5: Interaction effect between cultivars and fertilizers on bulb diameter

Treatment	Fertilizers				
Cultivar	**T1**	**T2**	**T3**	**T4**	**T5**
1	6.28a	6.51a	3.78c	61.49a	6.01a
2	5.18b	5.81a	3.97c	5.23b	5.70a
LSD					0.953

Least significant differences of means (5% level)

Interaction Effect between Cultivars and Fertilizers on Bulb Diameter

There was a significant results were observed in between cultivars and fertilizers observation which are represented in table the bulb diameter was significantly higher (6.51a) respectively in the association of recommended dose of fertilizers along with (poultry manure 10 tons hacter^{-1} treatment. The variety which found was 'kwadon local' with (5.63a); whereas, other treatment combination registered lowest on bulb diameter (Carter *et al*., 2014).

Table 6: Interaction effect between cultivars and fertilizers on bulb length

Treatment	Fertilizers				
Cultivar	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
1	5.803b	6.690a	4.343c	5.250b	7.003a
2	5.607b	5.720b	3.817c	5.797b	6.670a
LSD					0.7136

Least significant differences of means (5% level)

Interaction Effect between Cultivars and Fertilizers on Bulb Length

There was a significant results were observed in between cultivar and fertilizer observation. Those are represented. The bulb length per plant was significantly higher in the association of recommended dose of fertilizers along with (7.003a N.P.K 200 kg hacter^{-1} treatment. The variety which is found was 'Agrifound (5.52a); whereas, other treatment combination registered lowest bulb length per plant (Filella *et al*., 2015).

Table 7: Effect of organic and inorganic fertilizers on growth and yield parameters of Onion

Treatment	Fresh bulb weight (g)	Dry Weight (g)
Cultivar		
C_1 Kwadon	30.17	23.98
C_2 Agrifound	29.38	22.91
LSD	1.354	1.725
Fertilizers		
T_1 Cow dung	32.44b	24.65b
T_2 Poultry	41.06a	29.52a
T_3 Control	20.16d	15.29d
T_4 Urea	23.69c	21.86c
T_5 N.P.K	31.54b	25.91b
LS	N.S.	N.S.
LSD	2.141	2.728
Interactions		
V×F	N.S	N.S

Least significant differences of means (5% level)

Showed Significant variation in respect of fresh bulb weight (g) was observed of two cultivars of onion. There was a remarkable variation in fresh bulb 'kwadon local' had the highest bulb weight with (30.17) followed with 'Agrifound' (29.38) there were no significantly differences. Among the four different treatments, the variation of bulb weight was recorded due to the application of fertilizers from different sources of organic and inorganic fertilizers. Results revealed that treatment of poultry manure showed the highest bulb weight (41.06) where cow dung had (32.44) followed by N.P.K (31.54) then Urea (23.69) and the lowest bulb was control (20.16) there was significant difference with control 0kg/ha.

The dry bulb weight of 'kwadon local' was higher (23.98) than 'Agrifound' with (21.91) both in poultry manure treatment no significant differences. There was no significant difference observed with application of poultry manure in dry bulb weight of onion cultivars. The fertilizer treatments with poultry manure showed highest (41.06) followed by cow dung (32.44) then N.P.K (31.54), urea (23.69) and control showed the lowest bulb weight (20.16d). The differences between the cultivars studied might be related to different genetic factors (Nasreen, *et al*., 2012).

Table 8: Interaction effect between cultivars and fertilizers on fresh bulb weight

Treatment	Fertilizers				
Cultivar	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
1	33.23b	41.81a	19.89d	22.60c	33.34b
2	31.65b	40.31a	20.43d	24.78c	29.75
LSD					3.028

Least significant differences of means (5% level)

Interaction Effect between Cultivar and Fertilizers on Fresh Bulb Weight

There was significant results were observed in between cultivars and fertilizers observation which are represented. The total fresh bulb weight was significantly higher (41.81a) (gram) respectively in the combination of recommended dose of fertilizer along with (poultry manure 10 tons/ hacter) treatment. (Moran *et al*., 2010).

Table 9: Interaction effect between cultivars and fertilizers on dry bulb weight

Treatment	Fertilizers				
Cultivar	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
1	25.17b	29.99a	15.83d	22.39c	26.52b
2	24.13b	29.05a	14.75d	21.32c	25.30b
LSD					3.858

Least significant differences of means (5% level)

Interaction Effect between Cultivars and Fertilizers on Dry Bulb Weight

There was a significant results were observed in between variety and fertilizer observation. Those are represented. 'Kwadon local' (23.98a) yield was significantly higher in the association of recommended dose of fertilizer along with (poultry fertilizers 10 tons hacter^{-1}) treatment (29.99a). Though, the other treatment combination registered lower yield (Lahai *et al*., 2013).

Conclusion

Organic fertilizer produced and supplied adequate plant nutrients for proper growth and development of crop. Furthermore, the incorporation of organic manure into the soil has been shown to increase the amount of soluble organic matter which is mainly organic acid that improves the available Phosphorus content in the soil. The yield in weight of the onion bulb was increased through the application of poultry manure followed by cow dung and NPK, least in urea which showed the supremacy of organic manure over inorganic fertilizers in vegetable production. This is in line with the works of Akanbi *et al*., (2017)., poultry manure whenever is available is better for the production of onion in the study area.

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