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Effects of Organic and Inorganic Fertilizers on the Growth and Yield of Red Onion (*Allium Cepa* L.) in Michika, Northern Guinea Savannah, Nigeria

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Abstract:
Field experiments were carried out for two dry seasons (2012/13 and 2013/14) to study the effects of organic and inorganic fertilizers on growth and yield of red onion in the soils of Michika, northern guinea savannah, Nigeria. Nine (9) treatments each were used in the experiments which included different combinations of urea, single superphosphate, poultry droppings, sheep manure and cow dung. The treatments were arranged in a Randomized Complete Block Design with three replications. Data were obtained on plant height, number of leaves, bulb height, bulb weight; bulb width, bulb diameter, and bulb dry matter weight of onion and were analyzed using the one way ANOVA. Where significant, means were separated using the Duncan New Multiple Range Test. Result of the analysis revealed that plant height, number of leaves, bulb height, bulb width, bulb diameter, and dry matter weight were significantly ($P \leq 0.05$) affected by s(5500 kg/ha) poultry dropping application singly and with its combination of 70.65 kg N/ha, plus 125 kg P/ha (inorganic fertilizer). Similarly, yield per plot and per hectare were significantly ($P \leq 0.05$) affected by the application of 5,500 kg/ha and 70.65 N kg/ha plus 125P kg/ha plus 2750 kg/ha poultry dropping. Application of 70.65 N kg/ha plus 125 P kg/ha plus 2750 kg/ha poultry dropping, resulted in better plant growth, development and yield and therefore recommended. Combined use of organic and inorganic fertilizers should be adopted in growing red onion at Moda-Michika and similar soils.

Keywords: *Organic, Inorganic Fertilizers, Red Onion, Growth, Yield, Michika, Northern Guinea Savannah, Nigeria.*

1. Introduction

Soil fertility management remains one of the key areas of focus in sustaining crop production especially in inherent low fertility soils of Savanna region in Nigeria. The initial attempt to improve crop production was with the wide use of inorganic fertilizers not only on the high yielding varieties (HYV) but even on the indigenous crops. However, cost of inorganic fertilizers and poor distribution system forced farmers to resort either to organic farming or at best the use of organic manures with supplementary application of inorganic fertilizer especially on horticultural crops. Notably among the horticultural crops is onion, widely cultivated as cash crop. Red onion is widely cultivated by farmers in Northern Guinea Savanna, Michika in particular. However, despite the wide acceptance of cultivation of the crop, its production level is abysmally low. The low production level is attributed to poor fertilization combination since the variety is adapted to the environment. Integrated nutrient management (INM) has proved to be an alternative by sustaining production and ensuring environmental safety.

The primary goal of integrated nutrient management is to combine old and new methods of nutrient management into ecologically sound and economically viable farming systems that utilize available organic and inorganic sources of nutrients in a judicious and efficient way (Usman, 2008). Integrated nutrient management optimizes all aspects of nutrient cycling. It attempts to achieve tight nutrient cycling with synchrony between nutrient demand by the crop and nutrient release in the soil, while minimizing losses through leaching, runoff, volatilization and immobilization.

The consequences of poor fertilizer distribution policy coupled with the inherently low soil fertility status and poor management practices of famers necessitates the use of INM for sustained onion production, particularly in Moda district of Michika LGA where the crop is grown but with low yield per hectare.

2. Materials and Methods

The experiment was conducted at Moda in Michika local government area of Adamawa state. Michika is located in the north eastern corner of Adamawa state between latitudes 10^0 36'N- 10^0 40' N, longitudes 13^0 21 E-13^O 35' E (It shares common boundaries with Madagali local government area of Adamawa state to the north, Lassa (Bornu state) in the West Cameroun Republic to the east and south, Mubi local government area.

Red onion seeds of Yar-ankara-Ja (Ex-Accra Red) were sourced from Institute for Agricultural Research, Ahmadu Bello University, Zaria. While the organic manures (poultry droppings, cow dung and sheep) were obtained from the farmers of Moda-Michika. The inorganic fertilizers were obtained from Adamawa Agricultural Development Programme (AADP) Yola.

The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of (9) treatments replicated three times giving a total of 27 plots with each plot measuring 3 X 3 m. The treatments consisted of; T1 = Control Zero Fertilizer Application, T2 = 141.3kg/ha N from Urea + 250kg/ha P from SSP, T3 = 5500kg/ha Poultry Manure**,** T4 = 5500kg/ha Sheep Manure T5 = 5500kg/ha Cow dung, T6 = 70.65kg/ha N + 120kg/ha P + 2750kg/ha Poultry Manure, T7 = 70.65kg/ha N + 125kg/ha P + 2750kg/ha Sheep Manure,T8 = 70.65kg/ha N + 125kg/ha P + 2750kg/ha cow dung, T9 = 35.33kg/ha N + 62.50 kg/ha P + 1375kg/ha Poultry + 1375kg/ha sheep manure + 1375kg/ha cow dung. Nitrogen was supplied from urea, P from single superphosphate (SSP), while organic manures were supplied by poultry manure, sheep manure and cow dung. With organic manure applied at land preparation as recommended by Enwezor *et al*. (1989) for onion production in the Savannah soils.

2.1. Cultural Practices

The experimental site was cleared of shrubs and stumps and prepared into beds manually using farm tools such as cutlass, hoe and rake where necessary. Plot size is 3 x 3mand was pegged and separated from each other by 1 and 2m between the replicates. Similarly, a 2 X 2 m nursery bed was prepared and covered with light layer of soil and mulched.

Onion seeds were broadcasted on the nursery bed of 2 X 2m and covered with light layer of soil and mulched. Watering was done twice daily (morning and evening) when the seedling was due for transplanting. The seedlings were transplanted to the experiment site six weeks after nursery establishment when they were about pencil size (10-12 cm of height) at a spacing of 30cm within row and 30cm between rows.

The organic fertilizers (poultry droppings, cow dung and sheep manure) at 5.5 tons/ha and single superphosphate supplied phosphorus P at 250 kg/ha were applied at land preparation, while the nitrogen was supplied by urea 46 % N fertilizer at141.3 kg/ha was applied in 2 equal doses at 3 and 6 weeks after Planting (WAP) using broadcasting method as recommended by Enwezor *et al*.(1989).During the growth period, weeds were controlled manually with hoe on regular bases

2.2. Data Collection

The organic manures were analyzed for total N, P and K as described by Kanwar and Chopra (1959) before applying them to the experimental plots. Data were also collected on plant height, numbers of leaves, bulb height, and bulb diameter and bulb weight.

The plant height was measured using tread using meter rule from the ground level to the tip of the longest leaf when held vertically at 30 and 75 days after transplanting. The mean of six plants in all the blocks was worked out for further computation and it was expressed in centimetres (cm). The number leaves were recorded at 30 and 75 days after transplanting from six randomly selected plants per plot and average number of leaves per plant was worked out.

The bulb height of onion at harvest was measure from the base of bulb to neck of the bulb and expressed in centimetres in six randomly selected bulbs after harvest by using meter rule. The circumference of six bulbs selected randomly after harvest from each treatment with the help of thread and scale and the average bulb diameter was determined expressed in centimetre

The bulbs from six randomly selected bulbs weighed individually on an electronic balance and the average fresh weight was computed and expressed as kilogram (kg).The bulbs harvested from the net plot from each treatment and total bulb weight were recorded. The bulb weight was expressed as bulb yield in kilogram per plot and converted to bulb yield in kg/ha.

The estimation of dry matter was done by slicing fresh bulb sample (excluding outer skin) and the sliced samples were kept in the hot air oven for 48 hrs at a temperature of 70°C. Then the dried slices were weighed and the per cent dry matter was worked out.

3. Results and Discussion

Characterization of organic manures showed that highest nitrogen content was recorded in poultry manure followed by sheep manure while the lowest was recorded in cow dung (Table 1). Vanlauwe *et al.* (2001) reported high N, P and Kcontents while characterizing poultry droppings. However, N content in poultry droppings was not as high as that recorded by Vanlauwe *et al.* (2001). This may be due to the release of ammonium- nitrogen through volatilization losses during handling due to high temperature. Solomon *et al.* (2014a) reported higher N content in poultry droppings compared to cow dung. However, the highest P value was recorded in sheep manure while the lowest P value was recorded in cow dung. With regard to K content, highest value was recorded in sheep manure followed by poultry manure while the least was recorded in cow dung.

The highest plant height and the maximum number of leaves recorded by sole poultry manure and its combination with inorganic fertilizer (Table 2) may not be unconnected to the ability of poultry droppings and inorganic fertilizer to provide adequate nutrients required by the plant for growth and development perhaps due its ease of solubility. Similar results were reported by Erisman *et al.* (2008) who emphasized organic and inorganic fertilizers combination in plant growth and development. Reddy and Reddy (2005) observed that plant height of onion increased significantly with increasing levels of vermicompost (from 10 to 30 t/ha) and N fertilizer (from 50 to 200kg/ha). Haque *et al*. (2004) stated that height of onion increased with increasing rates of N up to 125kg/ha and decreased thereafter.

The non significant differences with respect to number of leaves (Table 2) concurred with the findings of El-Oksh *et al*. (1993) who observed that N application had no significant effect on number of leaves of onion. However, Singh *et al*. (2004) reported that a combination of 120kgN/ha with green manure gave the tallest plants and the maximum number of leaves/plant of onions. Reddy and Reddy (2005) also observed that highest number of leaves/plant was recorded with 30t/ha vermicompost with 200kgN/ha. Kumar *et al*. (2001) also reported that 130kgN/ha resulted in the highest number of green leaves per plant of onion.

The highest bulb height recorded by sole inorganic fertilizer (Table 3) may be due to the availability of the nutrients to crop as the nutrients are in their soluble forms which facilitated quick response on its height. Marschener (1986) revealed that inorganic fertilizers are readily available to crops on application compared to organic fertilizers. In the second year, the highest bulb height was recorded by sole application of poultry manure. This may be due to high nutrient content of poultry manure and ease of solubility compared to other treatments of cow dung and sheep manure (Table1).

Highest bulb weight and bulb dry matter recorded by sole poultry droppings and combined application of poultry manure with inorganic fertilizers (Table 3) may be due to increased nutrients availability with the combined effects of organic and inorganic fertilizer application and improved soil physical condition. Fatideh and Asil (2012)reported higher bulb weight and height as well as dry matter yield with increasing N-levels up to 150kgN/ha. . Fatideh and Asil (2012) linked their results to the role of N, P and K in protein synthesis, root growth and development as well the promotion of enzyme activity and enhancing the translocation of assimilate respectively. Similarly, Singh *et al*.(2004)obtained similar result and attributed it to the availability of nutrients for plant absorption with vegetative growth and yield of onions.

The highest bulb width was recorded by the sole application of poultry manure (T_3) in first year (Table 4). In the second year, highest bulb width was recorded by the combined application of poultry manure and inorganic fertilizer (Table 4).The maximum bulb width and diameter recorded by the application of sole poultry manure and its combination with inorganic fertilizers (Table 4) may be attributed to their ability to provide the necessary nutrients as required by plant for proper growth and development. It may also be attributed to improved soil structure due to the organic fertilizer addition and encourage growth of onions. Soleymani and Shahrajabian (2012) obtained similar result and associated it to improved soil physical properties on organic manure application. Similarly, Metwally and Abdu-Bray (1999) recorded the smallest bulb diameter and average bulb weight in the control plot and attributed the higher values obtained in the combined organic and inorganic fertilizer application to the role of organic manure in improving soil structure, thereby reducing nutrient loses by leaching and deep percolation compared to the application of inorganic fertilizer alone. Jeyathilake *et al*. (2006) also reported increased bulb diameter weight on combine organic and bio fertilizer application and linked it to accelerated synthesis of chlorophyll and amino acids resulting in more translocation of photosynthates from leaves to the bulbs translating to increased bulb and diameter of onions. Mondal *et al*. (2004) reported increased onion bulb diameter and vitamin c content with combined organic manure and NPK application.

The highest bulb yield recorded with the application poultry manure singly and combined with inorganic fertilizer (Table 5) may be due to the supply of optimum amount of nutrients required for plant growth and development coupled with improved soil physical condition. Shaheen *et al.* (2007) attributed the yield increase to increased availability and uptake of N, P and K. Similarly, Fatideh and Asil (2012); Soleymani and Shahrajabian (2012) reported that the application of manure either singly or in combination with inorganic fertilizer reduce bulb rot, reduce field defects and increased onion bulb yield.

The increased total yield recorded in the second year could be attributed to residual effect of organic manure of providing adequate and balanced proportion of nutrients as well as improved soil physical condition. Carol *et al*. (1999) reported higher yield in subsequent season and linked it to the ability of applied organic manure to retain nutrients over a long period of time with minimal leaching problems compared to that of inorganic fertilizer alone.

4. Conclusion

Combined organic and inorganic fertilizer application significantly influenced the growth and yield of red onion in Moda- Michika. Better crop performance and higher yield were recorded in the second year and is attributed to residual effect of applied organic fertilizers. Thus, combined use of organic and inorganic fertilizers should be adopted in growing red onion at Moda-Michika and similar soils.

Sample	N (g/kg)	P (mg/kg)	K (g/kg)
Poultry manure	1.10	11.83	1.18
Sheep manure	0.4	11.88	1.35
Cow dung	0.6	7.58	0.69

Table 1: Characterization of Organic Manures

	2012/2013 season					2013/2014 season			
	30 DAT		75 DAT			30 DAT		75 DAT	
Treatments	Plant height (cm)	Number of Leaves	Plant height (cm)	Number of Leaves		Plant height (cm)	Number of Leaves	Plant height (cm)	Number of Leaves
1.	23.65^{ab}	5.12^{ab}	22.89^{c}	4.83^{c}		41.43^{c}	9.41^{a}	42.16^{b}	8.41^{b}
2.	14.90^{c}	4.00^{b}	31.45^{a}	6.65^{a}		51.58^{b}	10.33^{a}	57.00^{a}	10.01^{ab}
3.	28.00^{a}	5.36^{a}	30.72^{a}	6.05^{ab}		61.91^{a}	10.83^{a}	57.32^{a}	11.53^{a}
4.	21.95^{abc}	4.95^{ab}	26.32^{bc}	5.41^{bc}		50.11^{bc}	9.75^{a}	47.05^{ab}	10.10^{ab}
5.	21.16^{abc}	4.95^{ab}	28.29^{ab}	5.18^{bc}		47.36^{bc}	10.59^{a}	56.67^{a}	9.46^{ab}
6.	26.54^{ab}	5.36^{a}	27.89^{ab}	5.18^{bc}		61.14^{a}	10.50^{a}	58.21^{a}	10.50^{ab}
7.	19.72^{bc}	4.46^{ab}	25.30^{bc}	5.13^{bc}		46.21^{bc}	8.73^{a}	57.25^{a}	10.45^{ab}
8.	19.53^{bc}	5.06^{ab}	23.28^{c}	4.80^{c}		49.50^{bc}	11.18^{a}	51.27^{ab}	9.26^{ab}
9.	21.88^{abc}	4.82^{ab}	28.30^{ab}	6.20^{ab}		53.43^{ab}	11.43^{a}	52.75^{ab}	9.55^{ab}
Mean	21.76	4.90	27.16	5.51		51.41	10.30	53.31	9.92
SE	3.39	0.63	2.19	0.63		5.15	1.52	5.92	1.19
P of f	0.02	0.28	0.00	0.02		0.00	0.48	0.04	0.18

Table 2: Effects of Organic and Inorganic Fertilization on Plant Height and Number of Leaves at 30 and 75 Days after Transplanting (DAT) First and Second Year

Means with the same letters in the same column are not significantly different

	First Year				Second Year		
Treatments	Bulb Height (cm)	Bulb Fresh Weight (t/ha)	Dry weight (t/ha)		Bulb height (cm)	Bulb Fresh weight (t/ha)	Dry weight (t/ha)
1.	6.11^{d}	1.80^{e}	0.46^{e}		5.85^{d}	1.61^{d}	0.43^{c}
2.	7.35^{a}	2.53^{d}	0.58^{d}		6.02^{cd}	3.07^{cd}	0.68^{b}
3.	7.33^{a}	4.76^{a}	1.13^{a}		7.03^{a}	4.47^{a}	1.08^{a}
4.	6.98^{b}	2.94^{cd}	0.77^{c}		6.35^{bcd}	3.20^{bcd}	0.79^{b}
5.	6.47^{c}	2.79^{d}	0.70^{c}		6.52^{abc}	3.26^{bc}	0.83^{b}
6.	7.34^{a}	4.59^{a}	1.17^{a}		6.84^{ab}	4.52^{ab}	1.13^{a}
7.	6.36^{cd}	3.48^{b}	0.91^{b}		6.13^{cd}	3.49 ^{bc}	0.80^{b}
8.	7.22^{ab}	2.79^{d}	0.67^{cd}		5.93^{cd}	3.64 ^{bc}	0.81^{b}
9.	6.50^{c}	3.20^{c}	0.74^{c}		6.46^{abc}	3.83^{b}	0.82^{b}
Mean	6.85	3.21	0.79		6.35	63.46	0.74
SE	0.19	0.I7	0.05		0.03	0.31	0.10
P of f	0.00	0.00	0.00		0.00	0.00	0.00

Table 3: Effects of Organic and Inorganic Fertilization on Bulb Height, Bulb Fresh Weight and Dry Weight in the First and Second Year.

Means with the same letters in the same column are not significantly different

	First year			Second year	
Treatments	Bulb diameter(cm)	Bulb width (cm)		Bulb diameter (cm)	Bulb width (cm)
1.	6.69^{e}	7.47^{e}		7.08^{e}	7.45^{e}
2.	8.85^{b}	9.20^{bc}		8.86^{b}	10.17^{a}
3.	9.41^{a}	10.29^{a}		9.42^{a}	10.22^{a}
4.	8.37^{c}	8.66^{cd}		8.49^{c}	9.08^{c}
5.	9.20^{a}	9.08^{bc}		9.34^{a}	9.45^{b}
6.	9.21^{a}	9.59^{b}		9.45^{a}	10.28^{a}
7.	7.52^{d}	6.21^{f}		7.68^{d}	6.30^{f}
8.	8.39^{c}	8.40^{d}		8.37^{c}	8.52^{d}
9.	9.27^{a}	9.48^{b}		9.34^{a}	10.12^{a}
Mean	8.54	8.70		8.67	9.06
SE	0.24	0.31		0.10	0.10
P of f	<..00	<.00		<.00	<.00

Table 4: Effects of Organic and Inorganic Fertilizers on Bulb Diameter and Width in First and Second Year.

Means with the same letters in the same column are not significantly different

	2012/2013 Season		2013/2014 Season	
Treatments	Yield/plot (kg)	Yield/ha (ton)	Yield/plot(kg)	Yield/ha (ton)
1	21.60^{e}	24.00^{e}	19.58^{d}	21.75^{d}
2	33.07^{d}	36.75^{d}	37.35^{c}	41.50^{c}
3	57.82^{a}	64.25^{a}	54.32^{a}	60.35^{a}
4	35.77^{cd}	39.75^{cd}	38.93^{c}	43.25^{c}
5	33.97^{d}	37.75^{d}	39.50^{bc}	44.00^{bc}
6	55.80^{a}	62.00^{a}	54.99^{a}	61.11^{a}
7	44.77^{b}	49.75^{b}	42.39^{bc}	47.10^{bc}
8	33.97^{d}	37.75^{d}	44.33^{b}	49.25^{bc}
9	39.92^{c}	43.25^{c}	46.58^{b}	51.75$^{b<}$
Mean	39.52	43.92	42.00	46.67
SE	2.30	25.53	3.98	44.17
P of f	<.0001	<.0001	<.0001	<.0001

Table 5: Effects of Organic and Inorganic Fertilizer on Onion Yield in the First and Second Year

Means with the same letters in the same column are not significantly different

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