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GROWTH AND YIELD OF ONION AS INFLUENCED BY ORGANIC AND INORGANIC FERTILIZER IN EDO RAINFOREST OF NIGERIA

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ABSTRACT

The current study was to determine the effect of NPK 15:15:15 and poultry manure on the growth and yield of onion plant (Allium cepa L.). Two field experiments were carried out at the Faculty of Agriculture Teaching and Research Farm, University of Benin during the 2010/2011 and 2011/2012 dry croppping seasons of October – March . The experiment was a factorial combination of four levels of NPK 15:15:15 inorganic fertilizer at 0, 40, 80 and 120 kg /ha NPK and four levels of poultry manure at 0, 5, 10 and 15t/ha laid out in a randomized complete block design (RCBD) with three replications. Each replicate had 16 plots making it a total of 48 plots. Data were collected on growth and yield characters and analysed. Results of this study indicated that there was a significant interaction between the poultry manure and NPK 15:15:15 fertilizer on some growth and yield attributes. Application rates of 80 kg/ha NPK 15:15:15 in combination with 15t/ha poultry manure enhanced the growth and yield of onion in terms of crop growth rate, chlorophyll content, harvest index and individual bulb weight of onion and significantly produced the highest yield of (29.55 t/ ha) in 2011/2012 and (28.17 t /ha) in 2012/2013. However, application rates of 120 kg/ha and 15 t /ha produced the highest (7.06 and 6.89 t / ha) shoot yield for 2011/2012 and 2012/2013 respectively .

Keywords: onion, manure, harvest index, crop growth rate,

INTRODUCTION

A system that integrates different practices of soil fertility programme is required for optimum growth and development of crops and this include the use of mineral fertilizers and organic manures. Decline in soil fertility is especially serious in the tropical regions where the soil lacks adequate plant nutrients and organic matter due to leaching and erosion of topsoil by intense rainfall. The complementary application reduces the dependence of the farmer on inorganic fertilizer. It also reduces the exposure of the soil to the consequences of inorganic fertilizer application. Jeyathilake *et al.* (2006) have observed that the nutrient use efficiency of a crop is increased through a combined application of organic manure and mineral fertilizer.

Organic manures alone are unable to give economic yield in some crops and it is vital to find appropriate combination of inorganic and organic manure to obtain financially viable yield of crops. Jeyathilake *et al.* (2006) stated that integrated use of organic manure and chemical fertilizers resulted in onion yield increase in comparison with the exclusive application of chemical fertilizers. Replenishing the nutrients removed by crops with recycling of agricultural wastes into the soil can sustain soil and crop productivity (Paul and Mannan 2006). There is ample opportunity for nutrient recycling in the tropics where huge

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amounts of agricultural wastes are generated ye ec integrated nutrient management packages for sustaining the changing needs of intensive vegetable production in the tropics. Combine use of organic wastes and mineral fertilizer is reported to reduce the cost and amount of fertilizer required by crops (International Atomic Energy Agency [IAEA] 2003; Krupnik *et al.,* 2004). This practice as documented by Dobermann and Cassman (2004) is also known to improve nutrient use efficiency and chemical and nutritional quality of crops. Renewable management of organic sources of N through use of agricultural waste materials would improve the quality of the environment and soil health.

Combination of organic and inorganic fertilizers could produce better yields than organic or inorganic alone because inorganic fertilizers release the nutrients quickly and fulfill the plants need at the appropriate time, while the organic manure being slow releasing recaptures the growth rate in latter stages. This combination could possibly increase yield and reduce the cost of production in onion cultivation.

Continuous use of inorganic fertilizers as reported by Jeyathiake *et al.,* (2006) resulted in deficiency of micronutrients, imbalance in soil physiochemical properties and unsustainable crop production. As a result, farmers are currently changing from conventional to organic farming systems which used no synthetic fertilizers and pesticides (Colla *et al.,* 2002). This could also be due to the continuous increase of prices of synthetic chemicals in the world market. However, organic,. like poultry manures alone are unable to give economic yield because it discharges nutrients very slowly to the plants and these nutrients are not directly absorbed by plants, therefore plants are unable to access required amount of nutrients in the critical yield forming period. Therefore it is vital to find appropriate combinations of inorganic and organic manure to obtain financially viable yield of crops (Jeyathilake *et al.,* 2006).

According to Bayu *et al.* (2010), Inorganic fertilizer treated plants exhibited quick growth of leaves at the early stage of onion plants because the rate of release of nutrients are much higher, which was recompensed by the organic manure in the later stages and this contributed to the final yield, thus combination of organic and inorganic fertilizer could produce better yields than organic or manure alone. Combine use of fertilizers have a positive effects on plants due to the better availability of soil nutrients that produce properties, which is l (1998) researched the effect of 20, 40, 60 t/ha animal manure doses, NPK (75: 50:100 kg / ha) inorganic fertilizer and combination of these and reported higher increase with their combinations. Sharma *et al* (2003) revealed that 125, 33 and 50kg/ha N P and K in combination with 0, 10 and 20t/ha manure increased onion yield and nutrient uptake. According to Ouda and Mahadeen (2008), leaf chlorophyll content was significantly higher when inorganic fertilizer in combination with poultry manure were used compared with using organic or inorganic fertilizer alone. Application dose of 80t/ha poultry manure in combination with 60kg/ha N,P and K induced the highest leaf chlorophyll content, while the lowest chlorophyll content was obtained by control treatment. A promotion effect of organic and inorganic fertilizers on chlorophyll contents might be attributed to the fact that N is a constituent of chlorophyll molecule. This was again emphasized by Arisha and Bradisi (1999); Al-Tarawneh (2005) that nitrogen is the main constituent of all amino acids in protein and lipids that act as a structural compounds of the chloroplast. Therefore, utilization of locally produced manures in combination with inorganic fertilizer at the recommended dose by vegetable production operations may increase crop. The objective of this study therefore was to investigate the optimum combination rate of NPK 15:15:15 and poultry manure for the production of onion in Edo state.

MATERIALS AND METHODS

The Experiments were carried out in the 2011/2012 and 2012/2013 dry season at the Teaching and Research Farm of the University of Benin, Ugbowo Campus, Benin-City, in Edo State and Lies within the geographical coordinates of longitude $5^{0,}$ $04^{''}$ and 06^{0} $43^{''}$E and latitude 05^{0} $44^{''}$N and 07^{0} $34^{''}$N. The climate is tropical and the vegetation is low-land rainforest in the south (with mean annual rainfall of 2300mm) to guinea savanna in Edo North with 1400mm mean rainfall. Prior to analysis, the soil samples were air dried and crushed to pass through a 2mm sieve. Soil pH was determined using a pH meter. Organic carbon was determined by (Walkley and Black, 1962) wet oxidation method as modified by Jackson (1969). Total nitrogen was obtained by macro Kjeldahl methods as modified by Jackson (1969). Available P was extracted by Bray I method (Bray and Kurtz, 1945) and the P was estimated by the blue colour method of Murphy and Riley (1962).

Exchangeable K and Na were determined using flame photometer, and Ca and Mg using the Atomic Absorption Spectrophotometer. The result of the soil and poultry manure analysis is as presented in Table 1.

The experiment was laid out as a 4 x 4 factorial arrangement fitted into a randomized complete block design (RCBD) in three replications. The treatments comprised of combination of four levels of organic fertilizer application (0, 5, 10 and 15 tha^{-1}) in combination with four levels of inorganic fertilizer at (0, 40, 80 and 120kg/ha of NPK 15:15:15). The land was cleared with the debris worked into the soil with a hoe. Beds for planting were prepared and onion seeds (Kano red) were sown on 25/10/2011 and 25/10/2012 for two consecutive field trials in drills spaced at 8cm apart in the nursery and observed for germination after 14 days of sowing (Akoun, 2004). Two weeks before transplanting, the field was marked out and beds of 1x1m spaced at 0.5m apart were prepared. Each replicate had 16 beds for a total of 48 beds. The treatment were assigned to each experimental unit using a table of random numbers. Onion transplanting to the field was done on 13 December 2011 and 2012 for two consecutive field trials when seedlings were seven weeks after sowing and at about 14cm tall. Plots were mulched to conserve soil moisture and suppress weeds.

Poultry manure at 0, 5, 10 and 15 t/ha were applied two weeks before transplanting to the respective plots depending on the treatment. The inorganic fertilizer application at (0, 40, 80 and 120kg /ha of NPK 15:15:15 compound fertilizer were applied in split applications. The first dose was applied two weeks after transplanting and the remaining half at six weeks after transplanting by side placement along the rows to the respective plots depending on the treatment. The field was weeded manually using hoe. A total of three hand weedings were done at 3, 6 and 8 weeks after transplanting. Insects were handpicked when necessary. Data collection started four weeks after transplanting. Four plants were randomly selected from each plot and tagged for the purpose of collecting data for plant height, number of leaves, chlorophyll content, crop growth rate individual bulb weight, bulb diameter, bulb length, fleshy thickness, harvest index, bulb yield and total fresh yield per hectare. The data obtained were subjected to statistical analysis of variance (ANOVA) using SAS following the model for factorial experiment in a randomized complete block design and means separated by Duncan Multiple Range Test (DMRT).

RESULTS

Crop growth rate (CGR)

Increase in the rate of fertilizer application increased the crop growth rate of onion plant up to 80 kg ha^{-1} NPK. A further increase in inorganic fertilizer to 120kgha^{-1} depressed the growth rate significantly. Plants treated with 80kgha^{-1} produced the highest growth rate and this was followed by plants which received either 40 or 120kgha^{-1} which were at par and significantly increased CGR above the controls treatment which produced significantly lowest CGR. Poultry manure application increased the CGR of onion plant up to 15 kg ha^{-1}. Plants treated with 15 kg ha^{-1} poultry manure resulted in the highest CGR and this was significantly increased above other treatments. This increase was followed by those plants which received 10 kg ha^{-1} and then 5 kg ha^{-1} and the least CGR was observed in the control (Table 2).

NPK by poultry manure interaction was highly significant. In Table 4, when the same level of NPK was examined across the poultry manure levels, it was observed that at 0 kg ha^{-1}NPK, each level of poultry manure significantly increased CGR. At 40 kg ha^{-1} NPK, the CGR produced was the same at 10 and 15 t ha^{-1} poultry manure and were significantly higher than that produced at 0 and 5 t ha^{-1}. However, 5 t ha^{-1} increased CGR above the 0 t ha^{-1} application rate.

At 80 kg ha^{-1}NPK, each level of poultry manure increased CGR and the highest CGR was produced at 15t ha^{-1} poultry manure, followed by 10 t ha^{-1}, then 5 t ha^{-1} and the lowest was at the control. At 120 kg ha^{-1} NPK, CGR increased significantly up to 5 t ha^{-1} and a further increase in poultry manure up to 10 and 15 t ha^{-1} did not affect CGR.

When the same level of poultry manure was examined across the NPK levels, there was a significant increase in CGR, increase in NPK level from 0 to 80 kg ha^{-1} NPK resulted in increase in CGR. A further increase in NPK level to 120 kg ha^{-1} did not affect the CGR. At 5 t ha^{-1} poultry manure, there was a significant increase in CGR when NPK was increased from 0 to 120 kg ha^{-1}. The difference between the control and 120 kg ha^{-1} was significant. At 10t ha^{-1} and 15t ha^{-1} poultry manure, each increase in NPK level significantly increased CGR up to 80 kg ha^{-1}, but a further increase to 120 kg ha^{-1} significantly decreased CGR The highest CGR was produced at 80 kg ha^{-1} in combination with 15 t ha^{-1} poultry manure.

Table 1: Physical and chemical properties of poultry manure and soil of the experimental ite pre plant and post harvest

Soil properties	Experimental site		poultry manure
	Pre	Post	
pH (H_2O)	4.80	5.26	6.40
Organic carbon (g $100g^{-1}$)	0.40	0.73	23.00
Total N ($g100g^{-1}$)	0.05	0.03	2.13
Total P (mg kg^{-1})	18.9	14.7	4.30
K (cmol kg^{-1})	0.19	0.12	1.12
Ca (cmol kg^{-1})	1.15	0.81	3.76
Mg (cmol kg^{-1})	0.74	0.56	-
Mn (cmol kg^{-1})	-	-	1.14
Zn (cmol kg^{-1})	-	-	0.13
Fe (cmol kg^{-1})	-	-	3.27
Na (cmol kg^{-1})	-	-	0.17
Sand (g kg^{-1})	752.1	756.0	-
Clay (g kg^{-1})	198.0	163.4	-
Silt (g kg^{-1})	46.0	48.2	-
Textural class	Sandy loam		-

Table 2: Effect of NPK 15:15:15 fertilizer and poultry manure on crop growth rate (CGR) $gm^{-2}wk^{-1}$, Chlorophyll content (mg g-1), Bulb diameter (cm) and Bulb length (cm) of onion (2011/2012) and 2012/2013 dry cropping season

Treatment	2011/2012 Cropping season				2012/2013 Cropping season			
	CGR ($gm^{-2}wk^{-1}$)	Chloro content (mgg-1)	Bulb diameter (cm)	Bulb length (cm)	CGR ($gm^{-2}wk^{-1}$)	Chloro content (mg g-1)	Bulb diameter (cm)	Bulb length (cm)
NPK 15:15:15 Fertilizer ($kgha^{-1}$)								
0	0.32^c	17.14^c	4.08^c	4.32^b	0.30^c	18.12^c	4.10^c	4.08^d
40	0.58^b	23.32^b	5.53^b	5.22^c	0.55^b	23.60^b	5.50^b	5.34^c
80	0.66^a	25.75^a	6.09^a	5.81^a	0.62^a	25.73^a	5.68^a	5.60^a
120	0.60^b	24.51^a	5.71^b	5.54^b	0.60^a	25.14^a	5.63^a	5.42^b
SEM	0.01	0.64	0.09	0.08	0.01	0.55	0.08	0.09
Poultry manure (tha^{-1})								
0	0.30^d	11.90^d	4.05^c	4.19^d	0.30^d	15.32^d	4.08^c	4.10^c
5	0.58^c	22.87^c	5.28^b	4.99^c	0.56^c	23.62^c	5.38^b	4.84^b
10	0.65^b	25.60^b	6.09^a	5.25^b	0.64^b	25.60^b	5.61^a	5.65^a
15	0.68^a	29.35^a	6.14^a	5.91^a	0.67^a	27.30^a	5.65^a	5.72^a
SEM	0.01	0.64	0.09	0.08	0.01	0.55	0.08	0.09
Interaction								
1*P	**	**	**	**	**	**	**	**

WAT = Weeks After Transplanting
Means followed by the same letter in a column are not significantly different at 5% level of probability. ** Significant at 1% level of probability

Chlorophyll content of leaves

Increase in the rate of application of inorganic fertilizer resulted in an increase in chlorophyll content up to 80 kg ha^{-1} NPK. A further increase to 120 kg ha^{-1} of NPK did not result in a significant increase. 80 and 120 kg ha^{-1} NPK were at par and significantly increased leaf chlorophyll above the control and 40 kg ha^{-1} application. However, 40 kg ha^{-1} NPK significantly increased chlorophyll content above the control treatment which received no fertilizer and significantly produced the least chlorophyll content (Table 2). On the other hand, the effect of poultry manure on chlorophyll content was highly significant. 15 t ha^{-1} poultry manure significantly increased chlorophyll content above all other treatments, this was followed by plants which received 10 t ha^{-1} poultry manure and then 5 t ha^{-1} poultry manure. The control produced the least chlorophyll content for onion leaves.

The NPK by poultry manure interactions was highly significant. In Table 3, when the same level of NPK was examined across varying poultry manure levels, it was observed that chlorophyll content increased with increase in poultry manure up to 10 t ha^{-1}, with 10 and 15 t ha^{-1} poultry manure producing similar chlorophyll content. At 40 kg ha^{-1} NPK, 5 and 10 t ha^{-1} were similar and significantly higher than the control, but 15 t ha^{-1} poultry manure produced higher chlorophyll content than the other poultry manure values. At 80 kg ha^{-1} NPK, each increase in poultry manure levels significantly increased chlorophyll with 15 t ha^{-1} poultry manure producing the highest chlorophyll content. At 120 kg ha^{-1} NPK, chlorophyll increased up to 5 t ha^{-1} poultry manure and a further increase did not affect the chlorophyll content (Table 3). When the same level of poultry manure was examined across the NPK levels, it was observed that at 0 and 5 t ha^{-1} poultry manure, 40, 80 and 120 kg ha^{-1} NPK produced similar chlorophyll content but were significantly higher than the control. At 10 t ha^{-1} poultry manure, increase in NPK increased the chlorophyll content up to 80 kg ha^{-1} and a further increase to 120 kg ha^{-1} NPK producing similar chlorophyll but significantly higher than the control. At 15 t ha^{-1} poultry manure, 80 kg ha^{-1} NPK produced the highest leaf chlorophyll and this was followed by 40 kg ha^{-1} NPK and the 120 kg ha^{-1}, the least chlorophyll content was produced at the control (Table 3).

Table 3: Interactions between NPK 15:15:15 fertilizer and poultry manure on chlorophyll content (gm^{-2}wk^{-1}) and crop growth rate (CGR) gm^{-2}wk^{-1} of onion (2011/2012) and 2012/2013 dry cropping season

	Poultry manure							
	0	**5**	**10**	**15**	**0**	**5**	**10**	**15**
	CGR 2011/2012 Cropping season				**CGR 2012/2013 Cropping season**			
NPK 15:15:15 fertilizer (kgha^{-1})								
0	0.28^{i}	0.35^{h}	0.41^{g}	0.48^{ef}	0.32^{i}	0.35^{h}	0.42^{g}	0.48^{ef}
40	0.42^{g}	0.48^{ef}	0.60^{bc}	0.62^{b}	0.40^{g}	0.48^{ef}	0.56^{d}	0.62^{bc}
80	0.43^{g}	0.50^{e}	0.62^{b}	0.65^{a}	0.48^{ef}	0.50^{e}	0.64^{b}	0.67^{a}
120	0.43^{g}	0.51^{d}	0.52^{d}	0.52^{d}	0.43^{g}	0.50^{e}	0.48^{ef}	0.40^{g}
SEM	0.02				0.02			
	Chlorophyll content 2011/2012				**Chlorophyll content 2012/2013**			
NPK 15:15:15 fertilizer (kgha^{-1})								
0	7.32^{i}	12.36^{h}	20.18^{ef}	22.15^{ed}	7.49^{i}	12.49^{h}	20.78^{ef}	22.48^{ed}
40	12.48^{h}	23.28^{de}	25.10^{c}	27.42^{b}	12.95^{h}	25.93^{de}	26.81^{cd}	29.09^{b}
80	13.21^{h}	24.16^{cd}	27.66^{b}	29.98^{a}	14.68^{gh}	25.48^{de}	31.06^{b}	38.20^{a}
120	14.80^{h}	24.03^{cd}	25.86^{c}	25.20^{c}	17.86^{g}	26.23^{de}	26.74^{cd}	25.64^{de}
SEM	0.75				0.77			

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Yield characters

Bulb diameter

Increase in the rate of application of NPK fertilizer resulted in a significant increase in bulb diameter up to 80 kg ha^{-1} NPK (Table 4). A further increase to 120 kg ha^{-1} application depressed the bulb diameter. Plants treated with 80 kg ha^{-1} NPK produced the highest bulb diameter and was significantly higher than other treatments. Plants treated with either 40 or 120 kg ha^{-1} NPK were at par and were significantly increased above the control treatment.

The effect of poultry manure on bulb diameter was highly significant. 10 and 15 t ha^{-1} poultry manure significantly increased bulb diameter above the control and 5 t ha^{-1} poultry manure . The control produced the least value for bulb diameter. In Table 4, the NPK X Poultry manure interaction was highly significant. When the same level of NPK was examined across the poultry manure levels, it was observed that at 0 kg ha^{-1} NPK, bulb diameter increased with increase in poultry manure up to 10 t ha^{-1}.

At 40 kg ha^{-1} NPK, increase in poultry manure increased bulb diameter up to 15 t ha^{1}, with 10 and 15tha^{-1} poultry manure producing similar bulb diameter. At 80 kg ha^{-1} NPK, bulb diameter increased significantly with increase in poultry manure up to 10 t ha^{-1} and a further increase to 15 t ha^{-1} did not affect bulb diameter. At 120 kg ha^{-1} NPK, bulb diameter increased significantly up to 5 t ha^{-1} a further increase did not affect bulb diameter was produced at 80 kg ha^{-1} poultry manure.

When the same level of poultry manure was examined across the NPK levels, it was observed that at 0 t ha^{-1} poultry manure bulb diameter increased significantly At 5 t ha^{-1} poultry manure, bulb diameter increased with increase in NPK up to 80kgha^{-1} NPK but there was no further increase at 120 k gha^{-1} NPK. At 10 and 15 t ha^{-1} poultry manure, each increase in NPK increased bulb diameter from 0 to 80 kg ha^{-1}. A further increase to 120 kg ha^{-1} NPK decreased the bulb diameter significantly, with 40 and 120 kg ha^{-1} NPK producing similar bulb diameter. The highest bulb diameter was produced at 80 kg ha^{-1} NPK in combination with either 10 t ha^{-1} or 15 t ha^{-1} poultry manure. However, 5 t ha^{-1} poultry manure increased bulb diameter significantly above the control treatment.

Table 4: Interactions between NPK 15:15:15 fertilizer and poultry manure on bulb diameter and bulb length of onion (2011/2012) and 2012/2013 dry cropping season

	Poultry manure							
	0	**5**	**10**	**15**	**0**	**5**	**10**	**15**
	Bulb diameter (cm) 2011/2012				**Bulb diameter (cm) 2012/2013**			
NPK 15:15:15 fertilizer (kgha^{-1})								
0	4.00^{i}	4.15^{h}	4.32^{fg}	4.84^{de}	4.08^{g}	4.19^{fg}	4.80^{e}	5.28^{d}
40	4.22^{fg}	4.95^{e}	5.48^{d}	5.60^{cd}	4.32^{ef}	5.48^{e}	6.30^{bc}	6.55^{b}
80	4.30^{fg}	5.55^{d}	6.05^{b}	6.20^{a}	4.42^{ef}	5.67^{d}	6.69^{b}	7.27^{a}
120	4.45^{ef}	5.68^{cd}	5.98^{b}	5.65^{cd}	4.43^{ef}	5.80^{cd}	6.30^{d}	5.69^{d}
SEM	0.09				0.10			
	Bulb length (cm) 2011/2012				**Bulb length (cm) 2012/2013**			
NPK 15:15:15 fertilizer (kgha^{-1})								
0	4.02^{g}	4.04^{g}	4.35^{f}	4.51^{f}	4.05^{h}	4.08^{h}	4.86^{f}	5.16^{e}
40	4.10^{g}	4.90^{de}	5.40^{c}	5.78^{b}	4.08^{h}	5.38^{de}	6.14^{cd}	6.22^{c}
80	4.10^{g}	5.60^{c}	6.00^{a}	6.08^{a}	4.30^{g}	5.32^{de}	6.62^{b}	7.25^{a}
120	4.38^{f}	5.42^{c}	5.96^{a}	4.49^{d}	4.38^{g}	5.22^{e}	6.60^{b}	5.08^{ef}
SEM	0.09				0.09			

Means followed by the same letter(s) within a column are not significantly different at 5% level using DMRT.

Table 5: Interactions between NPK 15:15:15 fertilizer and poultry manure on yield of onion (2011/2012) and 2012/2013 dry cropping season

	Poultry manure (t ha^{-1})							
	0	5	10	15	0	5	10	15
	Bulb fresh yield (t ha^{-1}) 2011/2012				Bulb fresh yield (t ha^{-1}) 2012/2013			
NPK 15:15:15 fertilizer (kg ha^{-1})								
0	9.48^{i}	9.74^{i}	17.38^{fg}	18.73^{efg}	8.92^{j}	9.35^{i}	15.90^{g}	17.81^{fg}
40	11.54^{h}	20.48^{ef}	25.29^{cd}	27.58^{c}	10.56^{i}	19.74^{ef}	25.00^{c}	25.85^{c}
80	12.66^{g}	22.37^{de}	28.85^{b}	29.55^{a}	12.32^{h}	20.65^{def}	27.04^{b}	28.17^{a}
120	13.21^{g}	21.87^{de}	23.13^{d}	20.06^{def}	13.71^{h}	21.40^{def}	22.85^{de}	20.26^{efg}
SEM	0.53				0.50			
	Shoot fresh yield (tha^{-1}) 2011/2012				Shoot fresh yield (tha^{-1}) 2012/2013			
NPK 15:15:15 fertilizer (kg ha^{-1})								
0	3.76^{g}	3.95^{f}	4.76^{cde}	5.07^{bcd}	3.56^{f}	4.12^{de}	4.21^{de}	4.97^{de}
40	4.55^{ef}	5.18^{bcd}	5.09^{bcd}	5.17^{cd}	4.04^{ef}	5.02^{bcd}	5.03^{bcd}	5.64^{bc}
80	4.69^{cde}	5.64^{c}	5.72^{bcd}	6.01^{bc}	4.05^{ef}	5.50^{bc}	5.07^{bcd}	6.03^{b}
120	4.75^{cde}	6.02^{bc}	6.47^{b}	7.06^{a}	4.10^{def}	6.04^{b}	6.28^{b}	6.89^{a}
SEM	0.11				0.10			

Means followed by the same letter in a column are not significantly different at 5% level of probability.

Bulb diameter and length

The effect of inorganic fertilizer on bulb diameter and length was highly significant. There was increase in bulb diameter and length up to 80 kg ha^{-1}, a further increase to 120 kg ha^{-1} NPK, did not result in a significant increase. On the other hand, the effect of poultry manure was also highly significant. Plants treated with either 10 or 15 tha^{-1} poultry manure were at par and significantly increased above the 5 t ha^{-1} and no manure application treatment (control). However, 5tha^{-1} poultry manure significantly increased bulb diameter and length above the control which produced the least values. The NPK X poultry manure interactions was highly significant. In Table 4 when the same NPK level was examined across the poultry manure levels, it was observed that at 0 kgha^{-1} NPK 15 t ha^{-1} significantly increased bulb diameter above the other treatments with 5 and 10 t ha^{-1} poultry manure producing similar bulb diameter but higher than the control. At 40 kg ha^{-1} NPK, bulb diameter increased with increase in poultry manure up to 10 tha^{-1},with 10 and 15 t ha^{-1} producing similar bulb diameter and significantly higher than 5 t ha^{-1} and the control.
At 80 kg ha $^{-1}$ NPK highest bulb diameter was produced at 15 t ha^{-1}, followed by 10 t ha^{-1} then 5 tha^{-1}, the control produced the least bulb diameter. At 120 kg ha^{-1} NPK, bulb diameter increased up to 5t ha^{-1} poultry manure and a further increase in poultry manure did not affect bulb diameter.

When the same poultry manure level was examined across the NPK level, it was observed that at 0 poultry manure, 40, 80 and 120 kg ha^{-1} NPK produced similar bulb diameters, but were significantly increased above the control. At 5 t ha^{-1} poultry manure, bulb diameter increased up to 80 kg ha^{-1} producing similar bulb diameter as 120 kg ha^{-1} (Table 4). At 10 t ha^{-1} poultry manure, increase in NPK fertilizer up to 40 kg ha^{-1} significantly increased bulb diameter, with 40 and 80 kg ha^{-1} NPK producing similar bulb diameter but significantly increased above the control and 120 kg ha^{-1} NPK. At 15 t ha^{-1} highest bulb diameter was produced at 80 kg ha^{-1} NPK, followed by 40 kg ha^{-1} NPK. The least bulb diameter was produced at the control and 120 kg ha^{-1} NPK treatments which produced similar bulb diameter. When the same level of NPK was examined across the poultry manure level, it was observed that at 0 kg ha^{-1}, bulb length increased up to 10 t ha^{-1} producing similar value with 15 t ha^{-1}. At 40 kg ha^{-1}NPK, each increase in poultry manure increased bulb length from 0 to 15 t ha^{-1}. At 80 kg ha^{-1}NPK, bulb length increased significantly with increase in poultry manure up to 10 t ha^{-1}. A further increase in the rate of poultry manure to 15 t ha^{-1} did not affect bulb length. At 120 kg ha^{-1} NPK, bulb length increased with increase in poultry manure up to 10 t ha^{-1} and a further increase in poultry manure decreased the bulb length.

When the same level of poultry manure was examined across the NPK levels, it was observed that at 0 tha^{-1} poultry manure bulb length was the same from 40 to 80 kg ha^{-1} NPK and increased at 120 kg ha^{-1}. At 5tha^{-1} poultry manure, bulb length increased significantly from 0 to 80 kg ha^{-1} NPK. A further increase in NPK to 120 kg ha^{-1} did not affect the bulb length. At 10 and 15 tha^{-1} poultry manure, each increase in NPK fertilizer increased the bulb length up to 80 kg ha^{-1} NPK. A further increase to 120 kg ha^{-1} decreased the bulb length significantly. The highest bulb length was produced at either 10 or 15 t ha^{-1} poultry manure in combination with 80 kg ha^{-1} NPK..

Bulb yield

The inorganic fertilizer X poultry manure was highly significant. In Table 5, when the same level of NPK was examined across the poultry manure, it was observed that at 0 kg ha^{-1} NPK, bulb yield increased with increase in poultry manure up to 10 t ha^{-1} and a further increase to 15 t ha^{-1} did not affect the bulb yield. At 40 and 80 kg ha^{-1} NPK, bulb yield increase with each increase in poultry manure up to 15 t ha^{-1}. At 120 kg ha^{-1} NPK, bulb yield increased up to 5 t ha^{-1} poultry manure and a further increase in poultry manure did not affect the bulb yield of onion.

When the same level of poultry manure was examined across the NPK levels, it was observed that at 0 and 5 t ha^{-1} poultry manure, bulb yield was increased from 0 to 40 kg ha^{-1} NPK and a further increase in NPK level did not affect the bulb yield. At 10 and 15 t ha^{-1} poultry manure, each increase in NPK fertilizer significantly increased the bulb yield of onion up to 80 kg ha^{-1} NPK. A further increase to 120 kg ha^{-1} NPK decreased the bulb yield significantly. The highest bulb yield was produced at 80 kg ha^{-1} NPK in combination with 15 t ha^{-1} poultry manure.

Shoot yield

The inorganic X poultry manure interaction was highly significant. In Table 5, when the same level of NPK was examined across the poultry manure, it was observed that at all levels of NPK, shoot yield increased with increase in poultry manure up to 15 t ha^{-1} with 5 and 10 t ha^{-1} poultry manure producing similar shoot yield, but 15 t ha^{-1} poultry manure significantly increased shoot yield above all other treatments. When the same level of poultry manure was examined across the NPK levels, it was observed that at 0 tha^{-1} poultry manure, shoot yield increased from 0 to 40 kg ha^{-1} NPK and a further increase did not affect the shoot yield. At 5 t ha^{-1} poultry manure, shoot yield increased with increase in fertilizer with similar shoot yield produced at 40 and 80 kg ha^{-1} NPK, but a further increase to 120 kg ha^{-1} NPK significantly increased shoot yield above other treatments. At 15tha^{-1} poultry manure shoot yield increased significantly with each increase in poultry manure up to 15 t ha^{-1}. The highest shoot was produced at 120 kg ha^{-1} in combination with 15t ha^{-1} poultry manure.

DISCUSSION

The increase in leaf length of onion as a result of combine use of fertilizers indicated that onion plants responded positively to combined use of organic and inorganic fertilizers. The quick response to combine use of fertilizer by onion plant may be due to the fact that fertilizers mineralized quickly, releases its nutrients to crop faster and eventually leached beyond the root zone of crops and organic manure in combination complements this effect by exerting their effect for a longer periods compared to sole application of these fertilizer thereby resulting in better crop growth and yield of the crop.

Number of leaves per plant and stem diameter increased significantly as a result of combine application of both organic and inorganic fertilizer. Inorganic fertilizer treated plant exhibited quick growth of leaves and stem diameter at the early stage. The rate of release of nutrients were much higher in the inorganic fertilizers since they provided major elements at the early stage of plant growth and development. Thus, plants exhibited accelerated growth rate than poultry manure. Babajide *et al* (2008) in their work on onion stated that relatively high levels of nutrients are required for optimum growth and development at the early stage of growth. In poultry manure, nutrients element content are low and the nutrient are not readily available for plant uptake. In this present study, plants treated with poultry manure alone showed reduced number of leaf production at the early stage of growth. At the later stage of growth, leaf and stem diameter growth, was almost similar to the growth rate observed with the inorganic fertilizer treated plants, this observation could be linked to the slow availability of nutrients from the poultry manure at the early stage. Thus inorganic hasten early growth of onions, but that could recompense by the organic manure in the later stages.

Combined application of organic and inorganic fertilizer enhances the bulb formation in onion. Combined applied treatments produced larger bulbs per plants than sole application of inorganic fertilizer or organic fertilizer. Bulb formation of onion could be affected by soil structure at the time of bulb initiation in order to enhance larger bulbs per plant, addition of organic manure to inorganic fertilizer is needed to increase soil organic matter content, activates soil micro and macro organisms and improves the soil structure. Babajide *et al* (2008) stated that combine application of organic and inorganic fertilizer gave better results than their sole application in onion production, they emphasized that high and sustainable crop yield can be obtained with judicious use of combine application The crop growth rate, chlorophyll content, increased with increase in application of inorganic fertilizer Control plot produced the lowest values for bulb yield of onion, due to the absence of inadequate nutrient level which is an important factor needed for proper growth and development of every plant including onion.

CONCLUSION

Generally, these results showed that onion plants responded to lower rates of inorganic fertilizer in combination with higher rates of poultry manure for optimum bulb yield while higher rates of both inorganic and organic fertilizers in this study favoured shoot yield. The trend of increasing tendency for vegetable production can be sustained through combined use of organic manure and mineral fertilizers in order to optimized plant nutrition and obtain high yields and good quality of vegetable products. The use of combined application of organic and inorganic fertilizer reduces the dependence of the farmer on inorganic fertilizer use. It also reduces the exposure of the soil to the consequences of inorganic fertilizer application and also would reduce the cost of mineral fertilizers. From this study, it can therefore be concluded that higher total bulb yield could be obtained by applying 40 or 80kg/ha of NPK 15:15:15 in combination with 10 or 15t/ha poultry.

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