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Research Paper

Effects of selected nitrogenous and potassium fertilizers on growth and yield of onion *(Allium cepa* L.) in Ogbomoso, South Western Nigeria

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Field experiments were conducted during the 2012 and 2013 cropping seasons at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso to determine the effects of nitrogen and potassium containing fertilizers on growth and yield of onion. The treatments were four nitrogen (N) levels (0, 45, 60 and 75 $kgha^{-1}$) and five potassium (K) levels (0, 60, 90, 120 and 150 $kgha^{-1}$) from urea and muriate of potash, respectively. The treatments were laid out in a randomized complete block design replicated three times. Data were collected on growth parameters (plant height and number of leaves), and the yield attributes of onion. The growth parameters increased with increase in nitrogen rates up to 75 kg N ha^{-1} but there was no significant difference from the values obtained at 60 kg N ha^{-1} and 75 kg N ha^{-1} fertilizer application. The highest plant height (2.7 cm) was obtained at 75 kg N ha^{-1} followed by 2.6 cm with application of 60 kg N ha^{-1} while the control gave the least values. Application of K significantly ($P \leq 0.05$) increased the growth parameters with the optimum values obtained at 120 kg K_2O ha^{-1} in 2012 and 2013, respectively. The highest mean marketable yield of 1.4 t ha^{-1} was obtained with application of 60 kg Nha^{-1}. The highest marketable yields of 2.2 t ha^{-1} and 2.0 t ha^{-1} were obtained with application of 120 kg K_2Oha^{-1} in 2012 and 2013, respectively. In conclusion, application of 60 kg N and 120 kg K_2Oha^{-1} produced the optimum growth and marketable yields of onion in the study area.

Key words: Nitrogen and potassium fertilizers, onion growth and yield

INTRODUCTION

Onion is a bulbous herb of Alliaceae family which is one of the most important vegetable condiment crops demanded worldwide (Singh and Joshi, 1995). It is a popular vegetable grown for its pungent bulbs and flavourful leaves. Bulb onion is widely grown throughout the world whose utility ranked second to tomatoes (Brice et al., 1997) and it is used in every home virtually on a daily basis (Hussaini and Amans, 2000; Randle, 1992). In Nigeria, onion cultivation is confined to the semi-arid northern Guinea and Sudan Savanna zones such as Kaduna, Kano, Jigawa, Sokoto, Plateau and Bauchi states (Amans, 1989). The role of onion in daily diet cannot be over-emphasized due to its high value in food, medicinal in nature, moderate in protein content and rich in calcium and riboflavin (Schippers, 2001). In Nigeria, it is an important condiment in the preparation of curry and

spicy dishes (Amans, 1989).

Inadequate mineral nutrition in soils has been reported as one of the major constraints to increase crop yield. Nutrients N, P and K are deficient in many soils of tropical Africa (Richardson, 1968), which might also be true for many Nigerian soils. Nitrogen is needed for vigorous vegetative leaf and stem growth and dark green leaf colour that encompass chlorophyll production (Al-Moshileh, 2001). Nitrogen is essential to growth and yield of onion but excessively high doses cause delay in bulb maturity and encourage bolting which is an undesirable characteristic. Pandey *et al*. (1994) reported that application of nitrogen at the rate of 80 kg N ha^{-1} increased the yield of onion bulbs. Wiederfield, (1994) also found no additional yield increase from applying N rates higher than 84 kg N ha^{-1}. Al-Moshileh (2001), in Saudi Arabia also reported significant yield increase due to N application at 92 kg N ha^{-1}. However, Halvorson *et al.* (2002) in Colorado reported that nitrogen resulted in only small increase in bulb yield. These arguments may be due to variations in the soil fertility and weather condition of different locations.

Potassium is essential for root development and when the availability is limited, plant growth is usually reduced. Researches from different parts of the world revealed that potassium nutrition greatly influenced growth and yield of onion. Pire *et al.* (2001) and Salo *et al.* (2002) reported significant effect of potassium on the growth and yield of onion. Potassium deficiency is one of the largest constraints to crop production in many tropical soils, owing to low native content and high K immobilization within the soil (Fairhurst *et al.,* 1999). Accordingly, K fertilizer application is usually recommended in these soils. In onions, K deficiencies reduced root and leaf growth, bulb size and yield and cause a delay in maturity (Brewster, 1994; Greenwood *et al.,* 2001). In soils that are moderately low in K, onion growth and yield can be enhanced by application of K contacting fertilizers. Onions are more susceptible to nutrient deficiencies than most crop plants because of their shallow and un-branched root system; hence they require and often respond well to addition of fertilizers (Brewster, 1994). Despite the importance of onion in Nigerian diet, very limited works on its fertilizer requirement has been reported in Ogbomoso, South Western Nigeria. Growth and nutritional qualities of onion realized by farmers are usually lower than what is being reported under experimental condition. In view of this, the study was set with the objective to determine the effects of N and K containing fertilizers on onion growth and yield in Ogbomoso, South Western Nigeria.

MATERIALS AND METHODS

Experimental site

Field trials were conducted during the 2012 and 2013 cropping seasons at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, South Western Nigeria. Ogbomoso is located on latitude 8°10' N and longitude 4°10' E in the Guinea Savanna zone of Southwest Nigeria. The climate of Ogbomoso is mostly influenced by the northeast trade wind, which is characterized by cold wind and a drying effect starting from November until March. It also experiences the south west trade wind, which is warm and moist from April to October. The bimodal mean rainfall of the area is between 1150 mm and 1250 mm of rain. The temperature regime is high all year round. The mean minimum temperature is 28°C and the maximum is 33°C with high humidity of about 74% all year round except in January when the dry wind blows from the north (Olaniyi, 2006). The soil is moderately drained, ferruginous tropical soil (Bromfield, 1969) with a sandy loam texture. The vegetation cover of the area is characterized by weeds and the prominent ones are *Tithonia diversifolia* (Wild sun flower), *Chromolea naodorata* (Siam weed) and *Cynodon dactylon* (Guinea grass).

Treatments and experimental design

One onion variety (Red creolo) obtained from KAL seed centre, Ogbomoso was used as a test crop. The treatments tested were four levels of N: (0, 45, 60 and 75 kg in N ha^{-1}) applied as urea fertilizer and five levels of K: (0, 60, 90,120 and 150 kg K_2O ha^{-1}) applied as muriate of potash (MOP). These were arranged in a randomized complete block design with three replications.

Field preparation and layout

The experimental site was manually cleared and 24 raised beds were prepared with the use of hoe. These were divided into three replicates with each replicate containing 8 beds. The size of each bed is 1.2 m x 1.2 m with the spacing of 0.5 m between treatments in a replicate and 1 m between replicates. The total area of the experimental plot is 74.48 m^2 equivalents to 0.0074 ha.

Sowing of onion and cultural practices

The planting was done by direct seeding; three seeds were sowed per hole at 0.5 cm depth due to small nature of the onion seed. Sixteen stands of plants were planted on a bed at the spacing of 30 cm x 30 cm giving a plant population of 384 plants for the whole experimental plot. Gap filling as well as thinning of excess plants in a single stand were done one week after sowing. The fertilizers were randomly applied to their respective beds at 4 weeks after sowing. The field was fumigated against

fungus attack in the soil. Supplementary water supply was carried out after sowing and continued during the dry period of the experiment. Watering was done in the morning and late in the evening to ensure better crop establishment in the first four weeks and to minimize the environmental stress. Mulching was done immediately after sowing with the use of dried *Cynodon dactylon* (guinea grass) and *Andropogon gayanus* (southern gamba grass) which were carefully placed on each bed to help retain soil moisture. These also reduce weed problems among the plants and improve the soil fertility. Weeding was done manually as soon as weeds were noticed around the plant to ensure proper establishment, reduce competition and avoid infestation by pest and diseases. Insect pests were controlled by insecticides, sprayed at two weeks interval with the use of Knapsack sprayer. Cypermethrin was used to control insect pests especially when grasshopper was noticed on the field at 10 ml per 10 litres of water.

Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) (SAS, 1999) and significant means were separated using least significant difference (LSD) at 5% probability level.

RESULTS

Soil characteristics

The chemical composition of the soil before cropping is shown in (Table 1). The soil is sandy loam; it contains 2.53% organic carbon, 0.26% total N, 6 mg/kg available P, 0.31cmol (+)/kg exchangeable K, 0.32 cmol (+)/kg exchangeable acidity. The soil pH is 5.8, which indicates that the soil is moderately acidic and can be used for onion production.

Table 1. Chemical and Physical properties of the soil of the experimental site.

Parameters	SI- units	Values
pH (H_20)		5.8
Organic carbon	%	2.53
Total N	%	0.26
Available P	mg/kg	6.00
Extractable Fe	mg/kg	11.40
Extractable Cu	mg/kg	2.70
Extractable Zn	mg/kg	1.96
Exchangeable K	cmol(+)/kg	0.31
Exchangeable Na	cmol(+)/kg	0.26
Exchangeable Ca	cmol(+)/kg	3.42
Exchangeable Mg	cmol(+)/kg	0.70
Exchangeable acidity	cmol(+)/kg	0.32
Sand	%	78
Silt	%	20
Clay	%	2
Textural class		Sandy loam

Effect of N and K on onion growth measured variables

Plant height

The mean height of onion plant is presented in (Figure 1). The plant height increased as the plant aged. The plant height was significantly ($P < 0.05$) influenced by the application of N fertilizer at all sampling periods. The plant height increased as the N rates increases from 0 to 75 kg N ha^{-1}, but there was no difference between the values obtained at 60 kg N ha^{-1} (2.7 cm) and 75 kg N ha^{-1} (2.7 cm). Onion plants produced with the application of 60 and 75 kg N ha^{-1} recorded the highest height of 2.7 cm in both 2012 and 2013 cropping seasons. The plant height was significantly ($P < 0.05$) influenced by the application of K fertilizer. Onion grown on soil amended with 150 kg K_2O ha^{-1} produced the highest plant height of 3.6 cm in both 2012 and 2013 cropping seasons. There was no significant difference between the values recorded at 120 kg K_2O ha^{-1} and 150 kg K_2O ha^{-1} fertilizer treatments in both years.

Number of leaves

The mean number of leaves of onion plant is shown in (Figure 2). The number of leaves was significantly ($P < 0.05$) influenced by the application of N fertilizer. The mean number of leaves increased as the applied N increases from 0 to 60 kg N ha^{-1}, thereafter a decline in both years. Onion plant produced with the application of 60 kg N ha^{-1} recorded the highest mean number of leaves of 5.6 and 5.7 in 2012 and 2013, respectively. This was followed by plants treated with 75 kg N ha^{-1}, which gave the mean of 5.5 leaves in both years. Similarly, the number of leaves of onion was significantly ($P < 0.05$) influenced by the application of K fertilizer in both years. The highest mean values of 5.3 and 5.5 were obtained from plants treated with 120 kg K_2O ha^{-1} in 2012 and 2013, respectively.

Effect of N and K on onion yield and yield components

The onion bulb, leaf and total marketable yields are shown in (Table 2). The onion bulb yield was significantly ($P < 0.05$) influenced by the application of N fertilizer during the two cropping seasons. The onion bulb yield increased as the applied N increases from 0 to 60 kg N ha^{-1}, and declined thereafter in 2012 cropping season. However, it increased from 0 to 75 kg N ha^{-1} in 2013 cropping season. The highest onion bulb yield recorded in 2012 cropping season at an application of 60 kg N ha^{-1} was 887.8 kg ha^{-1} compared with the highest onion bulb yields of 962.2 kg ha^{-1} recorded from the N fertilizer

Table 2. Onion leaves and bulb yields as affected by N and K fertilizers application.

Fertilizer level (kg/ha)	Bulbs yield (kg/ha)		Leaves yield (kg/ha)		Total marketable yield (t/ha)	
	Cropping season					
	2012	2013	2012	2013	2012	2013
Control (0)	372.22	434.44	124.44	208.89	0.5	0.6
N: 45	662.22	691.10	389.99	392.22	1.1	1.2
60	887.78	785.55	466.66	583.33	1.3	1.4
75	667.77	962.21	462.22	527.77	1.1	1.4
K: 60	536.66	615.55	231.11	219.99	0.8	0.7
90	1,369.99	1,281.09	367.77	226.66	1.7	1.4
120	1,778.87	1,682.21	372.22	291.11	2.2	2.0
150	1,001.10	564.44	257.78	231.11	1.3	0.8
LSD (0.05):						
N	0.75	0.34	Ns	0.16	0.42	0.49
K	0.71	0.35	0.31	0.23	0.46	0.41

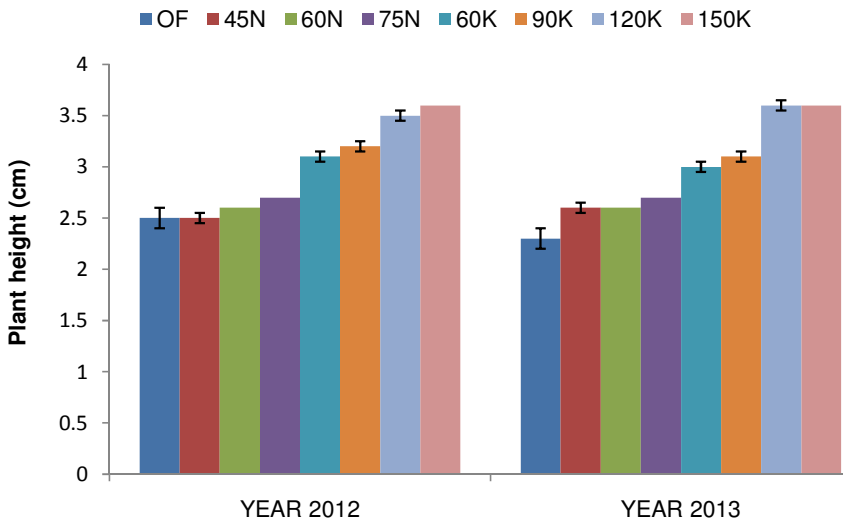

Figure 1. Effect of nitrogen and potassium fertilizers on the height of onion plant.

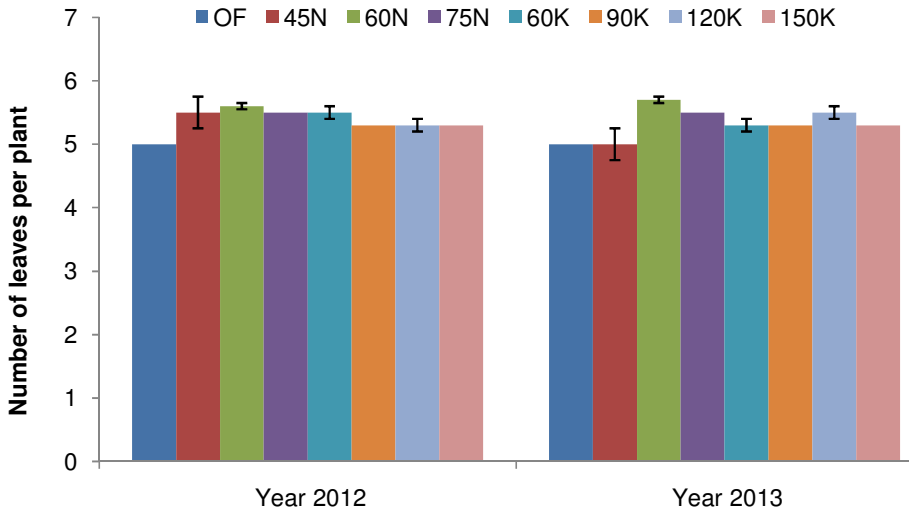

Figure 2. Effect of nitrogen and potassium fertilizers on the number of leaves of onion plant.

application of 75 kg N ha^{-1} in the 2013 cropping season. The control recorded the lowest onion bulb yields of 371.2 kg and 434.4 kg ha^{-1} in 2012 and 2013, respectively.

Similarly, onion bulb yield was significantly ($P < 0.05$) increased by the application of K fertilizer. The highest bulb yields of 1,778.9 kg and 1,682.2 kg ha^{-1} were recorded in 2012 and 2013, respectively, for plants that received 120 kg K_20 ha^{-1} fertilizer treatment. The control recorded the lowest values in both years. The onion leaf yield increased with increases in N fertilizer application from 0 to 60 kg Nha^{-1} then declined thereafter. The highest onion leaf yields of 466.7 kg and 583.3 kg were obtained from application of 60 kg N ha^{-1} in 2012 and 2013, respectively. The onion leaf yields were significantly ($P < 0.05$) influenced by the K fertilizer. The highest onion leaf yields of 372.2 kg and 291.1 kg were recorded from onion plants that received K fertilizer rates of 120 kg K_2O ha^{-1}, while the least values of 124.4 kg and 208.9 kg were obtained from control in 2012 and 2013, respectively.

Total marketable yield of onion increased as the applied N increases from 0 to 60 kg N ha^{-1} then declined or remained stable thereafter in both years. The total marketable yield was significantly ($P \leq 0.05$) influenced by the application of N fertilizers. Onion plants produced with the application of 60 kg N ha^{-1} recorded the highest total marketable yields of 1.3 t/ha and 1.4 t/ha in 2012 and 2013, respectively. This was followed by 75 kg N ha^{-1} treated plants, which gave 1.1 t/ha and 1.4 t/ha in 2012 and 2013, respectively. Similarly, the total marketable yield was significantly ($P \leq 0.05$) improved by the sole application of K fertilizer in both years. The highest values of 2.1 t/ha and 1.9 t/ha were obtained from plants treated with 120 kg K_20 ha^{-1} in 2012 and 2013, respectively.

DISCUSSION

The increase in growth parameters as the plant aged might be due to the increase in the cell number and size. This result is similar to the report of Olaniyi and Akanbi, (2008) who reported that there was increased in the plant height and number of leaves of cabbage as the plant aged. Yamasaki and Tanaka, (2005) reported that nitrogen fertilizer application of 60-92kg Nha^{-1} extends the vegetative growth of onion compared to control. This positive response may be due to the role of N in promoting the growth of onion plant and replacement of dead cells. This result is in agreement with Kadayifli *et al*. 2005 who reported that increasing N application generally increase growth parameters and nutrients uptake of onion plant. The optimum rate of 60kgNha^{-1} obtained in this study reconfirmed the earlier work of Cizauskas *et al.* (2003) who reported that application of 60kg Nha^{-1} gave the highest bulb yield of onion. The significant increase in the growth nutrient uptake and yield parameters of onion with sole K fertilizer application is in accordance with the findings of other researchers (Greenwood *et al.* 2001). The highest total marketable yield obtained when 120kgK_2Oha^{-1} was applied is similar to the report of some researchers who reported bulb yield improvement in response to K fertilization (Singh and Joshi, 1995; Patel and Patel, 1990; Pandey and Ekpo, 1991; Vachhani and Patel, 1993b; Patel and Vachhani, 1994).

In the same manner, the significant influence of applied K rates on onion growth, yield and nutritional quality reconfirmed the work of researchers that K nutrition greatly influenced growth, nutrient uptake and yield of onion (Brice *et al.,* 1997). Pire *et al.* (2001) and Salo *et al.* (2002) reported significant effect of K on the growth, nutrient uptake and yield of onion. Greenwood *et al.* (2001) reported that K deficiency in onion resulted into reduced root and leaf growth, bulb size and yield and caused a delay in maturation. Woldetsadik, (2003) in Ethiopia reported that K fertilization at the rate of 120kg K_2Oha^{-1} increased yield and bulb weight of onion even when soil analysis did not show deficiency.

Conclusion and recommendation

The result of present study showed that onion can be produced successfully in the study area with appropriate fertilizers application especially N and K. The application of N and K fertilizers significantly improved the plant height, number of leaves and yield of onion in both years. The onion plants treated with 60 kg N ha^{-1} showed optimum growth and yield compared with plants treated with other N fertilizer rates. Also, K fertilizer at a rate of 120 kg K_20 ha^{-1} gave the highest yield among other K rates. Therefore, application of nitrogen and potassium fertilizers at the rates of 60 kg N $ha^{-1}$and 120 kg K_20 ha^{-1}, respectively, could be recommended for high yield of onion in Ogbomoso.

AUTHORS' DECLARATION

We declare that this study is an original research by our research team and we agree to publish it in the journal.

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