Available online at www.worldscientificnews.com

World Scientific News

WSN 54 (2016) 73-86 EISSN 2392-2192

Influence of different methods of fertilizer application on the growth of maize (*Zea mays* L.). for increase production in south Nigeria

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ABSTRACT

The study was conducted to determine the influence of different methods of fertilizer application on the growth of maize (*Zea mays* L.) at the Teaching and Research Farm, Faculty of Agriculture and Forestry, Cross River University of Technology. Maize seed variety Ikom Local White were treated to one level of NPK (15:15:15) fertilizer (0.128 kg ha^{-1}) and four methods of fertilizer application (Broadcasting, Ring Application, Hole Application and Liquid Application). The experiment was laid out in a Randomized Complete Block Design (RCBD). The treatments were replicated four times to give a total of sixteen field plots. The result obtained indicated that NPK (15:15:15) significantly ($p< 0.05$) increase growth parameters (plant height and number of leaves) of maize obtained at 0.128 kg ha^{-1} and Ring method of application seems appropriate for maize production at 1 m spacing between plants on bed.

***Keywords*:** Ring method; NPK fertilizer; *Zea mays*; application rate; influence; indicate; corn

1. INTRODUCTION

Mankind has always utilized crops for His; survival, nutrition, development, industrial and for research purposes. Among the most widely explored crops on the globe is maize. Maize is a cereal crop, and belongs to the grass family *Poaceae*. Maize is also known as corn,

with its origin from Central American tropics and Mexico (Brewbaker, 2003). Corn has been found useful in human/animal nutrition, medical, pharmaceutical, industrial, economic and herbal value. Corn is widely produced in the United States, with an annual production of 310 million metric tons and a world production at 177.3 million tons and yield of 3.6tons per acre. Presenting USA as the largest corn producer in the world. Nigeria produces 8 million tons of maize (IITA, 2014), giving Nigeria a leading step in corn production within the Sub-Saharan Africa.

Combating the major problem of tropical agriculture which include rapid deterioration of soil productivity (Akande *et al*., 2007) then the need for inorganic fertilizer arises. The use of inorganic fertilizer due to soil-nutrient deterioration, short fallow time and associated problems in land acquisition has been promoted (Amuioyegbe *et al*., 2007). Maize requires adequate supply of nutrients for good vegetative growth, and yield. Nitrogen, phosphorus and potassium is required by maize for normal growth.

Nitrogen is an important plant nutrient element, and this element determines the vegetative phase and subsequent reproductive phase, especially in a nutrient indicator-crop like maize. The nitrogen content of the soil can determine the yield of maize in a particular area (Adediran and Banjoko, 1995; Subedi and Ma, 2005). Nitrogen was reported by Amonymous (2000) to make up 1-4% of maize dry matter. Nitrogen plays a key role in maize (plant) growth processes, especially in chlorophyll and enzymes, and its deficiency may lead to reduction in maize growth.

Phosphorus is another essential element that plays a crucial role in maize growth. It functions in enzymatic reactions, essential in cell division, it helps in seed and fruit formation including maturity of the crop.

Potassium also plays a significant role in maize growth, potassium occurs in the soil only in inorganic form and exerts a profound influence on the synthesis of a lot of organic constituents in plants. It is essential in all cell metabolic processes. Specifically, it is important in synthesis of carbohydrate (CHO), proteins, fat and oils, it is also important in translocation of synthesized constituents and in the development of chlorophyll.

Maize responds differently to Nitrogen (N), Phosphorus (P) and Potassium (K) application depending on plant variety and existing fertility status of the soil. Katsvairo *et al*. (2003) report shows that different maize cultivars differ in response to N fertilizer application. Research findings by Arain *et al*. (1989) reported an increase in plant height when nitrogen fertilizer was applied to three maize cultivars. Research on fertilizer programmes has been stressed, a further work by Khan *et al*. (2007) shows an increased growth and subsequent yield when broadcasting, banding and placement methods of fertilizer application was experimented on Potato (*Solanum tuberosum* L.). Banding method of fertilizer application as well as other methods are employed depending on the layout, planting method, planting distance, crop verity, nature of crop, crop nutrient requirement and possibly the soil/weather conditions of an area. Fertilizer application method is an essential point in a good agricultural practices. For good growth and subsequent yield of crops, the practionner (farmer) needs to ensure optimum crop use efficiency and further minimizing environmental-related pollution and degradation by applying crop nutrient elements (fertilizer) close to the time the crop needs it, this is of high importance especially for mobile nutrients such as nitrogen, which is easily leached.

While significant increase/improvement is usually desired in the use of mineral fertilizer (inorganic fertilizer) in crop production, the improvement in growth, yield, biomass and

chlorophyll production largely depends on the methods of application adopted. In other to strike a balance in the face of rapid deterioration of tropical soil productivity and to produce maize as one of the major crops to feed the ever increasing human population, it is imperative to employ the appropriate fertilizer application method, hence, to avoid waste, maximize production and avoid further damage to the soil, then the need for this study arises with the following objectives:

1. Seeking the best method of fertilizer application on maize (*Zea mays* L.) in other to maximize profit and for food security
2. To determine the influence of different methods of fertilizer application on the growth of maize in the study area.

2. MATERIALS AND METHODS

2. 1. Plant material selection

The field experiment was conducted at Teaching and Research Farm, Faculty of Agriculture and Forestry, Obubra, Cross River University of Technology (CRUTECH), Nigeria. The area lies within the Derived Savanna at 160 kilometers from Calabar, the state capital. The study area lies on the geographical Latitude of 6° 06' N and Longitude 8° 18' E in the rainforest zone of Nigeria. Obubra has an annual rainfall of 2250-2500 mm per annum (CRADP, 1992) with an annual temperature of 25 °C to 27 °C. The experiment was conducted between July and December 2013 and repeated in 2014.

2. 2. Treatments

The treatments used in the experiment were;

Treatment one (T_1) – Broadcasting application method
Treatment two (T_2) – Ring application method
Treatment three (T_3) – Hole application method
Treatment four (T_4) – Liquid application method
Treatment five (T_5) – Control

Five treatments were used and replicated four times.

2. 3. Source of material

Maize (*Zea mays* L.) seed, variety Ikom Local white was obtained from Agricultural Extension Office, Ikom, Cross River State, Nigeria. Seed dressing chemical (Apron plus) was procured from the crop protection unit of Department of Agronomy, Faculty of Agriculture, CRUTECH. NPK (15:15:15) fertilizer was also obtained from Agric Extension Office, Ikom.

2. 4. Land preparation

The experimental site was cleared, packed and tilled manually into beds.

2. 5. Planting and cultural practices

Maize seed (Ikom Local White), an early maturing maize cultivar were sown on August 1st, 2013. Healthy and clean seed were collected and treated with Apron plus (seed dressing chemical) in other to get a disease-free seeds, and to control soil borne pest (pathogens) before sowing. An insecticide- Sniper (Vinyl dimethyl phosphate DDVP, 1000EC) was sprayed on maize plants to control insect attack. Three seeds were planted per hole at a spacing of 1m between plants on bed.

Maize seedlings were later thinned to two plants per stand at 14 days after sowing. Weeds were controlled manually with the use of weeding hoe; this was done every four weeks to keep the farm weed-free.

2. 6. Fertilizer application (Experimental procedures)

NPK (15:15:15) fertilizer was applied five (5) Weeks after Planting (WAP)

In Ring method (treatment two (T_2)) of application, 0.032 kg ha^{-1} of NPK (15:15:15) was applied in a ring of 10cm and depth of 5 cm, round each stand and covered with soil. The ring method was applied to the four plots replicated for the same treatment. A total of 0.128kg ha^{-1} of NPK (15:15:15) was applied in the ring method.

Hole method of fertilizer application was achieved by digging a hole of about 10cm from each maize plant and 0.032 kg ha^{-1} of fertilizer was put into the hole and covered with soil. 0.128 kg ha^{-1} of the NPK (15:15:15) was applied to the four set of plots replicated for the hole method of application.

Broadcasting method of fertilizer application was carried out by applying 0.032 kg ha^{-1} of the NPK (15:15:15) in each of the replicates, with a total of 0.128 kg ha^{-1} NPK fertilizer in all the replicates for broadcasting. The fertilizer was tossed all over each of the plots replicated for broadcasting. The fertilizer was distributed (spread) uniformly over the soil around each maize plant.

Liquid fertilizer used in the liquid method of application was obtained by dissolving 0.128 kg ha^{-1} of the NPK (15:15:15) in four (4) liters of water. One (1) liter of the mixture was applied to each of the four (4) plots assigned for this treatment. The mixture (dissolved fertilizer) was applied by watering the root zone of the randomly tag (selected) maize plant. No fertilizer was applied in the control plot in all the replications.

3. RESULTS AND DISCUSSION

3. 1. Data collection

Data was collected on the following growth parameters; plant height and number of leaves across all the tag plants in all the replicates.

Plant height were measured first at 6 Weeks after planting (WAP) (one Week after fertilizer application (WAFA)). Subsequent measurements of plant height were taken at one Week interval (WI) in all the plots. Number of leaves were counted and recorded for each treatment throughout all the replications. This was done at 6WAP (1WAFA) and at 1WI.

3. 2. Statistical analysis

All the data were analyzed using the procedure for analysis of variance (ANOVA) for Randomized Complete Block Design (RCBD). Separation of means was done using Fishers Least Significant Difference (f-LSD) at 0.05% probability level.

Table 1. Details of treatments, material used and their codes.

Treatment	Treatment Code	Treatment (T)	Fertilizer Rate (kg)
T_1	BC	Broadcasting method	0.128 kg ha^{-1}NPK (15:15:15) fertilizer
T_2	RA	Ring Application	0.128 kg ha^{-1}NPK (15:15:15) fertilizer
T_3	HA	Hole Application	0.128 kg ha^{-1}NPK (15:15:15) fertilizer
T_4	LF	Liquid Application	0.128 kg ha^{-1}NPK (15:15:15) fertilizer
T_5	CR	Control	0.128 kg ha^{-1}NPK (15:15:15) fertilizer

BC, RA, HA, LF: Methods used to apply fertilizer to maize plant. CR: control.

3. 3. Plant height

Data generated for plant height were analyzed using ANOVA procedures. Data obtained in the analysis indicated increase in height across all the treatments, except in the control ((T_5) CR), as presented in Table 2.

Table 2. Influence of Different methods of fertilizer application on maize (*Zea mays* L.) height after NPK (15:15:15) fertilizer application (cm)

2013 Experiment.

Treatment S/N	**Treatment code**	**Treatment**	**Maize mean height at 1WAFA**	**Maize mean height at 5WAFA**
Treatment 1 (T_1)	BC	0.128 kg ha^{-1} NPK (15:15:15) by Broadcasting method	62.71	76.44

Treatment 2 (T_2)	RA	0.128 kg ha^{-1} NPK (15:15:15) by Ring Application method	72.70	86.30
Treatment 3 (T_3)	HA	0.128 kg ha^{-1} NPK (15:15:15) by Hole Application method	63.61	77.67
Treatment 4 (T_4)	LF	0.128 kg ha^{-1} NPK (15:15:15) by Liquid Application method	63.75	77.30
Treatment 5 (T_5)	CR	Control	53.66	62.66
LSD ($P < 0.05$)			10.80	11.00

Mean was separated using Fishers separation (f -LSD). The least mean produced minimum plant height

Result obtained in plant height at one Week after fertilizer application (1WAFA) showed that plant height increase across the treatments at all stages of growth. Ring application method (RA) T_2 had the highest plant height of (72.70 cm) at 1WAFA. Application of 0.128 kg ha^{-1} NPK (15:15:15) by liquid fertilizer application method recorded a height of 63.75cm which was closely followed by 63.61cm at an application rate of 0.128kg ha^{-1} NPK (15:15:15) by Hole application method. 0.128 kg ha^{-1} NPK (15:15:15) fertilizer applied by broadcasting recorded a mean value of 62.71 cm. Plant heights differed significantly ($P < 0.05$) across all treatments. The least (minimum) plant height was obtained in the control plot (CR) with a mean value of (53.66 cm).

Plant height at 5WAFA indicated an increase in height of the plants over the control. Application of 0.128 kg ha^{-1} NPK (15:15:15) fertilizer by Ring application (RA) gave the highest ($P = 0.05$) plant height of 86.30 cm. This was followed by Hole application method which recorded a mean value of (67.67 cm). Liquid fertilizer application method recorded a mean value of 77.30 cm indicating that LF and HA influenced the plant height almost at the same frequency by recording a mean value at the same mean separation grade. Application of 0.128 kg ha^{-1} NPK (15:15:15) fertilizer by Broadcasting influenced the plant height to 76.44 cm at 5WAFA, indicating a significant difference in maize height over the control. The control mean height was recorded at (62.66 cm) 5WAFA, presenting the control as the least in maize height recorded at five (5) weeks after fertilizer application. The increase in plant height at 1WAFA and at 5WAFA indicated that application of 0.128 kg ha^{-1} NPK (15:15:15) fertilizer by Broadcasting, Ring application, Hole application, Liquid fertilizer application

significantly ($P < 0.05$) influenced the plant height, thereby resulting in a height which stands over the control.

The result obtained in plant height in this experiment agrees with the findings of Omotoso and Shittu (2007) who reported increase in *Abelmoschus esculentus* (L.) growth parameters when NPK fertilizer was applied by ring method of application.

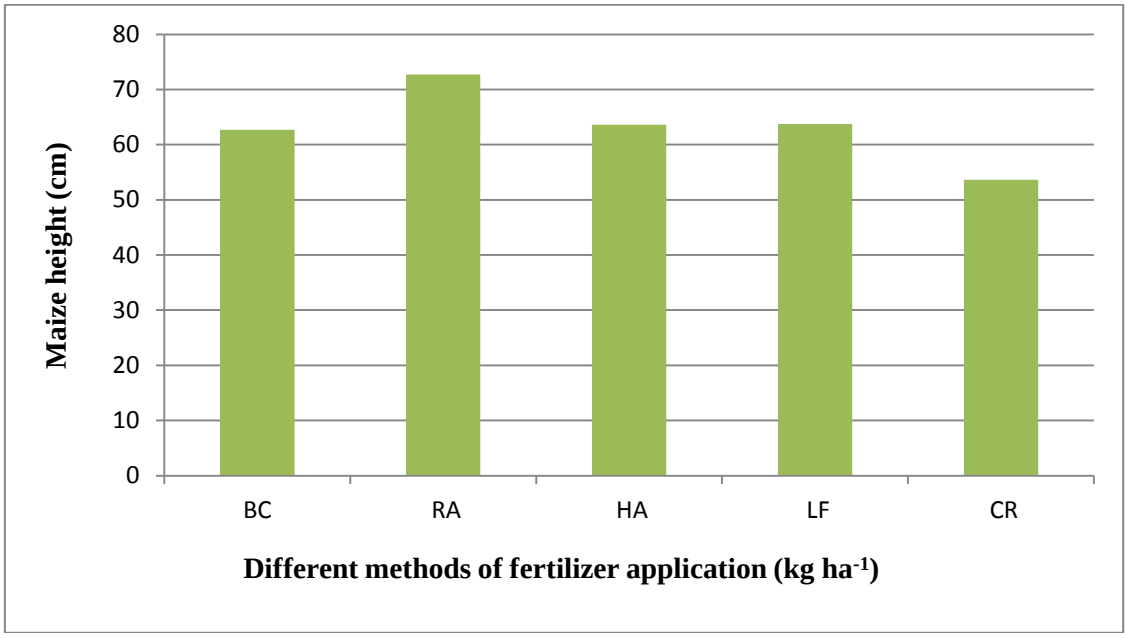

Fig. 1. Influence of Different methods of NPK (15:15:15) fertilizer application on corn height at 1WAFA.

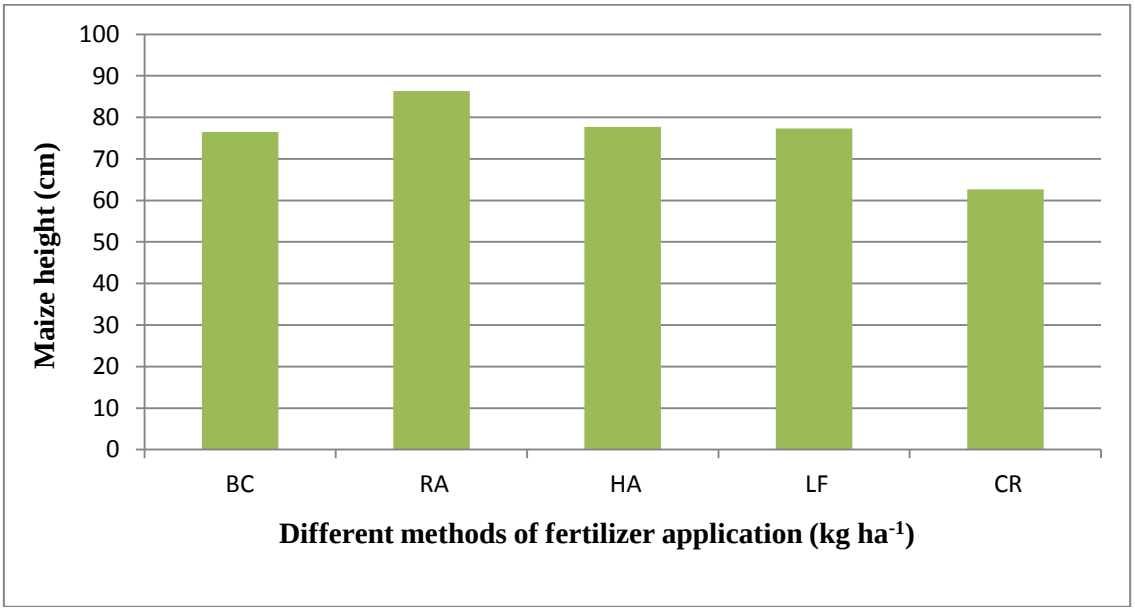

Fig. 2. Influence of Different methods of NPK (15:15:15) fertilizer application on corn height at 5WAFA.

Table 3. Influence of Different methods of fertilizer application on maize (*Zea mays* L.) height after NPK (15:15:15) fertilizer application (cm)

2014 Experiment

Treatment S/N	Treatment code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	BC	0.128 kg ha^{-1} NPK (15:15:15) by Broadcasting method	61.51	77.23
Treatment 2 (T_2)	RA	0.128 kg ha^{-1} NPK (15:15:15) by Ring Application method	74.73	87.78
Treatment 3 (T_3)	HA	0.128 kg ha^{-1} NPK (15:15:15) by Hole Application method	63.87	77.69
Treatment 4 (T_4)	LF	0.128 kg ha^{-1} NPK (15:15:15) by Liquid Application method	62.88	79.09
Treatment 5 (T_5)	CR	Control	54.18	62.15
LSD ($P < 0.05$)			7.69	10.66

Mean was separated using Fishers separation (f -LSD). The least mean produced minimum plant height

Analysis of variance for plant height at 1WAFA indicates a significant ($P < 0.05$) difference with Ring application producing (74.73 cm) maximum plant ($P = 0.05$) height over the all other treatments. Hole application produced a mean value of 63. 87cm, followed by 62.88cm in Liquid application, presenting these treatments as effective compared to the control. Broadcasting application recorded a figure at 61.51 cm, indicating the effect of this treatment over the (54.18 cm). At 5 Weeks after fertilizer application, treatment two ((T_2) RA) produced plants with a mean height of 87.78cm, reflecting the influence of this treatment to consistently increase the height of the plants. Result obtained for RA shows significant ($P = 0.05$) increase in the height of maize plant over the control. Treatment one ((T_1) BC) and treatment three ((T_3) HA) produced a mean height of 77.23 cm and 77.69 cm) respectively. Liquid application recorded a mean maize height of (79.09 cm), presenting liquid application

as effective on the plant height. The least plant height was recorded in the control plot with a mean value of (62.15 cm) in this experiment. Data obtained in the 2013 experiment is similar with 2014 experiment and agrees with the experiment of Omotoso and Shittu (2007) which recorded increased growth characteristics in *Abelmoschus esculentus* (L.) when NPK fertilizer was applied by ring method. Olufolaji *et al*. (2002) reports also agrees with this findings, where they recorded an increase growth parameters using ring application method.

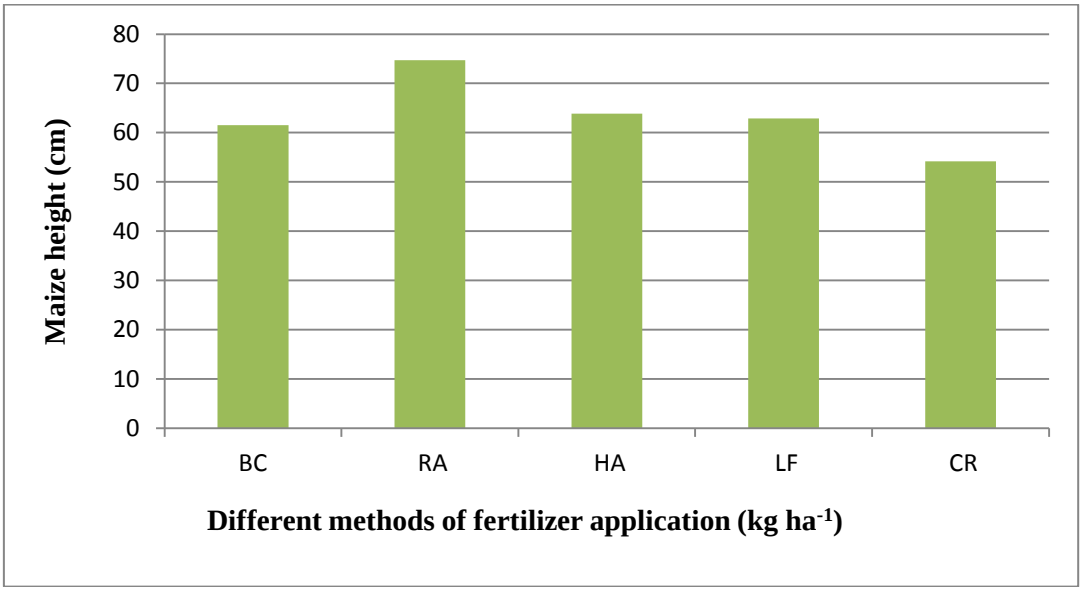

Fig. 3. Influence of Different methods of NPK (15:15:15) fertilizer application on corn height at 1WAFA.

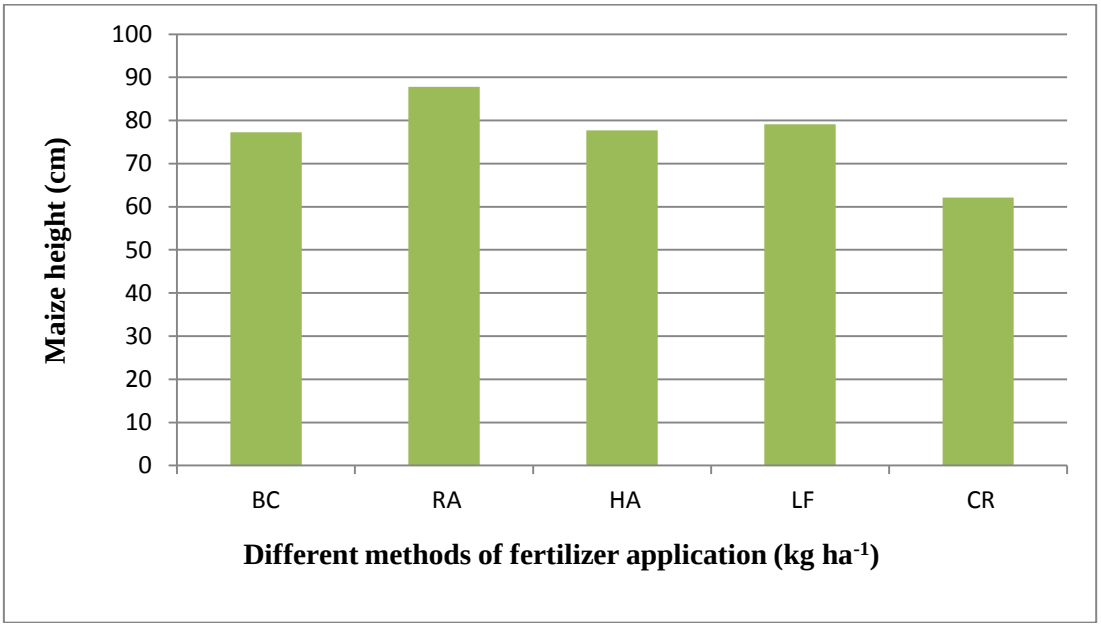

Fig. 4. Influence of Different methods of NPK (15:15:15) fertilizer application on corn height at 5WAFA.

3. 4. Number of leaves

Table 3 presents the trend observed and recorded in the number of leaves as influence by various application methods of NPK (15:15:15) fertilizer.

Table 4. Influence of Different methods of fertilizer application on maize (*Zea mays* L.) number of leaves after NPK (15:15:15) fertilizer application

2013 Experiment

Treatment S/N	**Treatment code**	**Treatment**	**Maize mean height at 1WAFA**	**Maize mean height at 5WAFA**
Treatment 1 (T_1)	BC	0.128 kg ha^{-1} NPK (15:15:15) by Broadcasting method	11.18	17.93
Treatment 2 (T_2)	RA	0.128 kg ha^{-1} NPK (15:15:15) by Ring Application method	11.70	20.36
Treatment 3 (T_3)	HA	0.128 kg ha^{-1} NPK (15:15:15) by Hole Application method	11.73	19.73
Treatment 4 (T_4)	LF	0.128 kg ha^{-1} NPK (15:15:15) by Liquid Application method	12.33	17.75
Treatment 5 (T_5)	CR	Control	10.75	16.96
LSD ($P < 0.05$)			NS	2.76

Mean was separated using Fishers separation (f -LSD). The least mean produced minimum number of leaves

The data recorded in Table 3, showed the trend observed in the number of leaves produced by the plant at different stages of growth. At 1WAFA there was no significant ($P > 0.05$) difference in the number of leaves per plant among the various treatments. At one Week after fertilizer application Liquid fertilizer application produce the highest number of leaves (12.33), giving it an edge over the control. Hole application recorded a mean value of 11.73, which was closely followed by Ring application (RA) which recorded a mean value of

(11.70). Broadcasting application method produced a mean number of leaves at 11.18, indicting an increase over the control which recorded a mean value of 10.75. At five (5) weeks after fertilizer application, Ring application produced 20.36 mean number of leaves, which was significantly ($P < 0.05$) different, producing the maximum ($P = 0.05$) number of leaves over all other treatments. Hole application method recorded a mean value of (19.73), placing HA over LF, BC and the CR. Broadcasting application and Liquid fertilizer application produced (17.93 and 17.75) mean value respectively, presenting these treatments as preferred over the control which recorded a value of 16.96 mean number of leaves.

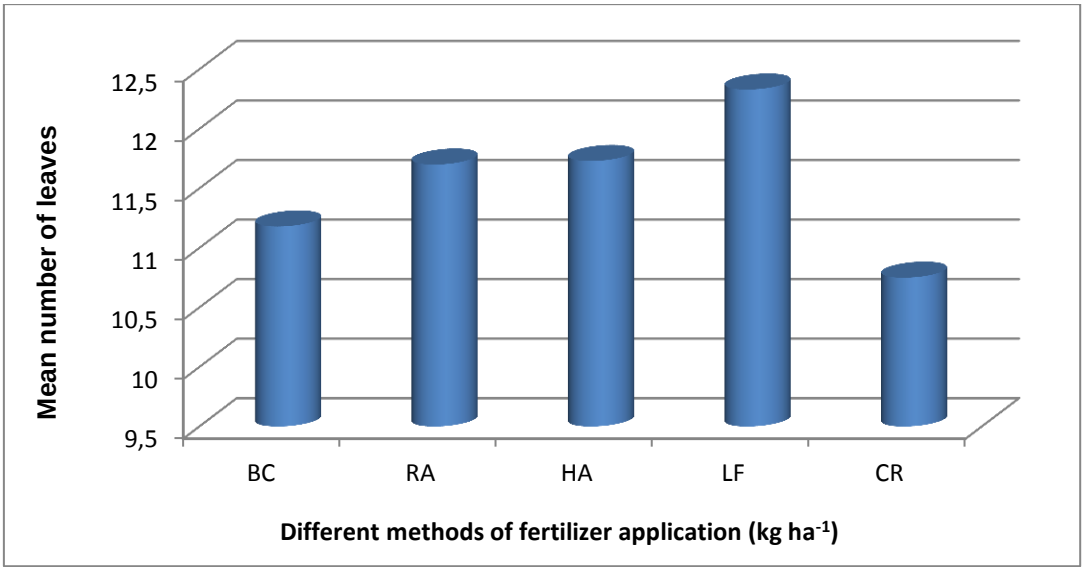

Fig. 5. Influence of Different methods of NPK (15:15:15) fertilizer application on corn number of leaves at 1WAFA.

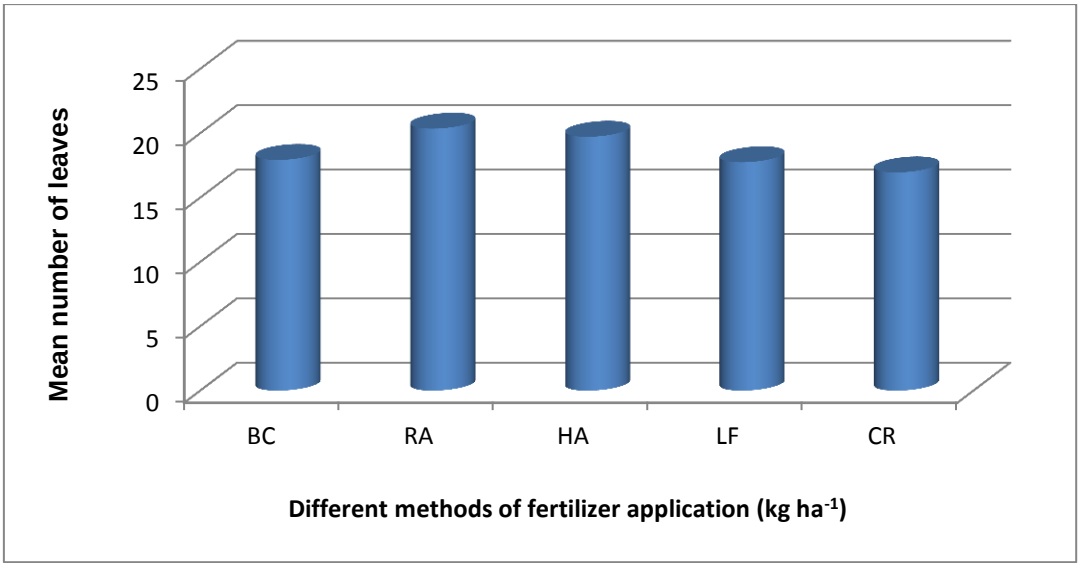

Fig. 6. Influence of Different methods of NPK (15:15:15) fertilizer application on corn number of leaves at 5WAFA.

Table 5. Influence of Different methods of fertilizer application on maize (*Zea mays* L.) number of leaves after NPK (15:15:15) fertilizer application.

2014 Experiment

Treatment S/N	Treatment code	Treatment	Maize mean height at 1WAFA	Maize mean height at 5WAFA
Treatment 1 (T_1)	BC	0.128 kg ha^{-1} NPK (15:15:15) by Broadcasting method	12.30	18.54
Treatment 2 (T_2)	RA	0.128 kg ha^{-1} NPK (15:15:15) by Ring Application method	13.51	21.75
Treatment 3 (T_3)	HA	0.128 kg ha^{-1} NPK (15:15:15) by Hole Application method	12.45	20.68
Treatment 4 (T_4)	LF	0.128 kg ha^{-1} NPK (15:15:15) by Liquid Application method	12.93	20.86
Treatment 5 (T_5)	CR	Control	11.10	17.21
LSD ($P < 0.05$)			1.40	3.05

Mean was separated using Fishers separation (f -LSD). The least mean produced minimum number of leaves

Result obtained by ANOVA analysis indicates maximum ($P = 0.05$) number of leaves in Ring application method, with a mean value of (13.51). 12.45 mean value was recorded in Hole application which shows an increase in the number of leaves produced. Broadcasting application produced 12.30 mean numbers of leaves. Liquid fertilizer application recorded a mean value of 12.93, indicating an increase over the control. The least number of leaves was produced in the control. At 5 Weeks after fertilizer application, Ring application still maintained it positive influence on the crop, producing a mean value of (21.75) number of leaves, indicating a significant ($P < 0.05$) difference over the control. Hole application and Liquid application recorded a mean value at (20.68 and 20.86) respectively, presenting these treatments as been positively influencing the growth parameters of maize. Broadcasting

application method recorded a mean value at (18.54), indicating an increase over the control. All treatments increased the number of leaves of the crop, except the control which produced the least number of leaves (17.21). The result obtained in number of leaves in this experiment is in line with the submission of Olufolaji *et al*. (2002); Omotoso and Shittu (2007) where they recorded an increase in growth parameters with the application of NPK fertilizer by Ring application method.

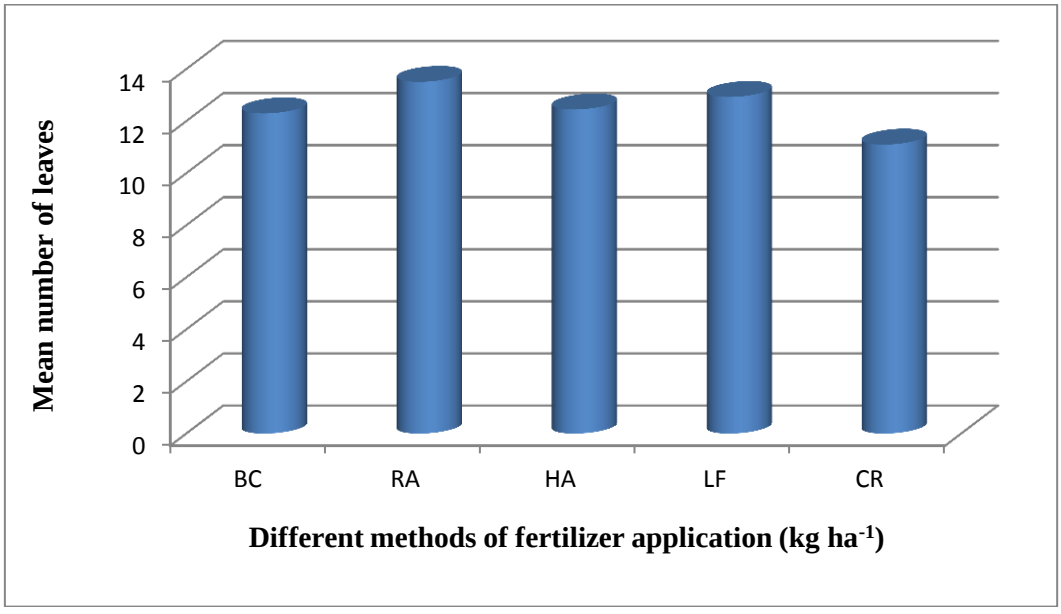

Fig. 7. Influence of Different methods of NPK (15:15:15) fertilizer application on corn number of leaves at 1WAFA.

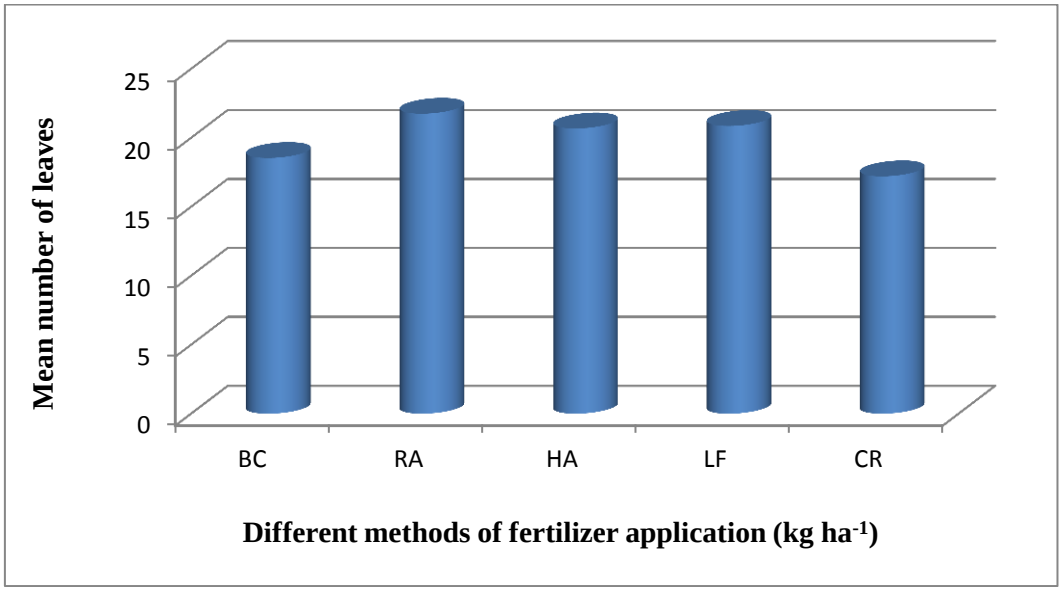

Fig. 8. Influence of Different methods of NPK (15:15:15) fertilizer application on corn number of leaves at 5WAFA.

4. CONCLUSION

The result obtained showed that NPK fertilizer rates and methods of application influenced the overall growth performance of maize. Application of NPK (15:15:15) fertilizer at the different application methods had significant influence on the growth of maize. Application of 0.128 kg ha^{-1} NPK (15:15:15) fertilizer by ring application method significantly influenced the growth of maize over the control. Studying all the methods of fertilizer application, it is concluded that ring application method is efficient and responsive as compared to others, when maize is planted at 1 m spacing between plants on bed.

References

[1] J. L. Brebaker, *University of Hawii Press Ltd*. (2003) 141-152.

[2] IITA, *International Institute of Tropical Agriculture* (2014).

[3] M. O. Akande, F. I. Oluwatoyinbo, E. A. Makinde, A. S. Adepoju, I. S. Adepoju, *Nature and Science* 8(11) (2010) 261-266.

[4] B. J. Amiyoyegbe, J. T. Opabode, A. Olayinka, *African Journal of Biotechnology* 6(16) (2007) 1869-1873.

[5] J. A. Adediran, V. A. Banjoko, *Soil Sci. Plant Anal*. 26 (1995) 593-606.

[6] K. D. Subedi, B. L. Ma, *Crop Science Journal* 45 (2005) 2246-2257.

[7] Anonymous, *Food and Agriculture Organization, Rome*, 2000, pp. 35-38.

[8] T. W. Katsvairo, W. J. Cox, M. Glos, *Agronomy Journal* 95 (2003) 1012-1022.

[9] A. S. Arain, S. Alam, A. K. G. Tunio, *Journal of Agriculture* 5 (1989) 623-626.

[10] M. S. Khan, N. Jan, I. Uillah, M. Younas, H. Ullah, Sarhad *Journal of Agriculture* 23 (2007) 4.

[11] CRADP, Cross River Agricultural Development Project, *Cross River State Government Press* (1992).

[12] S. O. Omotoso, O. S. Shittu, *International Journal of Agricultural Research* 2(7) (2007) 614-619.

[13] A. O. Olufolaji, A. A., K. O. Alasiri, *Plant Science Journal* 3 (2002) 73-80.

(Received 10 August 2016; accepted 25 August 2016)