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Growth and Yield Response of Maize (*Zea mays* L.) to Different Rates of Nitrogen and Phosphorus Fertilizers in Southern Nigeria

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Abstract: The effect of twelve different rates of nitrogen and phosphorus fertilizers on growth and yield of maize (*Zea mays L.*) in southern Nigeria was evaluated between June and October, 2007. The results of the study showed that application of 120kgN/ha + 0kgP/ha and 60kgN/ha + 40kgP/ha significantly increased the growth of maize than other treatments. The application rate of 120kgN/ha +40kgP/ha significantly (P =0.05) enhanced grain yield. This study further confirms the role of nitrogen and phosphorus fertilizers in increasing growth and grain yield in maize production. From the result of the study, application rate of 120kgN/ha + 40kgP/ha may be recommended for increasing maize yield particularly in the study area. However, application of 60kgN/ha + 40kgP/ha can also bring about increase in the yield of maize. This will greatly benefit farmers in area where supply of nitrogen fertilizer is low and cases where farmers cannot afford the cost of high fertilizer input.

Key words: Nitrogen and phosphorus fertilizer · Growth · Yield · Maize

INTRODUCTION

Maize (*Zea mays L.*) is an important cereal crop which ranks the third after wheat and rice in the world [1]. Maize is grown widely in many countries of the world. In Pakistan, maize is cultivated on an area of 880.8 thousand hectares giving annual production of 128.3 thousand tonnes with average yield of 1445kg/ha [2]. The major producers are the United States, Brazil, France, India and Italy. In Africa, the bulk of maize produced is used as human food although it is increasingly been utilized for livestock feed. According to FAO data [3], the area planted of maize in West and Central Africa alone increased from 3.2 million in 1961 to 8.9 million in 2001. This phenomenal expansion of the land area devoted to maize resulted in increased the production from 2.4 million metric tones in 1961 to 10.6 million metric tonnes in 2001 [3].

In spite of the increase in land areas under maize production, yield is still low. Some of the major causes of low maize yield are declining soil fertility and insufficient use of fertilizers resulting in severe nutrient depletion of soils [4]. Maize requires adequate supply of nutrients particularly nitrogen, phosphorus and potassium for good growth and high yield. Nitrogen and phosphorus are very essential for good vegetative growth and grain development in maize production. The quantity required of these nutrients particularly nitrogen depends on the pre-clearing vegetation, organic matter content, tillage method and light intensity [5].

Nitrogen is a vital plant nutrient and a major yield-determining factor required for maize production [6,7]. It is very essential for plant growth and makes up 1 to 4 percent of dry matter of the plants [8]. Nitrogen is a component of protein and nucleic acids and when Nitrogen is sub-optimal, growth is reduced [9]. Its availability in sufficient quantity throughout the growing season is essential for optimum maize growth. It is also a characteristic constituent element of proteins and also an integral component of many other compounds essential for plant growth processes including chlorophyll and many enzymes. It also mediates the utilization of phosphorus, potassium and other elements in plants [10]. The optimal amounts of these elements in the soil cannot be utilized efficiently if nitrogen is deficient in plants. Therefore, nitrogen deficiency or excess can result in reduces maize yields.

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Phosphorus is another essential nutrient required to increase maize yield. Consequently, the lack of phosphorus is as important as the lack of nitrogen in limiting maize performance. The importance of phosphorus as yield limiting factor in many Nigerian soils is well established [11]. Phosphorus plays an important part in many physiological processes that occur within a developing and maturing plant. It is involved in enzymatic reactions in the plant. Phosphorus is essential for cell division because it is a constituent element of nucleoproteins which are involved in the cell reproduction processes. It is also a component of a chemical essential to the reactions of carbohydrate synthesis and degradation. It is important for seed and fruit formation and crop maturation. Phosphorus hastens the ripening of fruits thus counteracting the effect of excess nitrogen application to the soil. It helps to strengthen the skeletal structure of the plant thereby preventing lodging. It also affects the quality of the grains and it may increase the plant resistance to diseases. However, the requirement and utilization of these nutrients (nitrogen and phosphorus) in maize depends on environmental factors like rainfall, varieties and expected yield.

The response of maize plant to application of nitrogen and phosphorus fertilizers varies from variety to variety, location to location and also depends on the availability of the nutrients. Research results have shown that various maize cultivars differ markedly in grain yield response to nitrogen fertilization [12]. Previous findings indicated that the increase in maize grain yield after nitrogen fertilization is largely due to an increase in the number of ears per plant, increase in total dry matter distributed to the grain and increase in average ear weight [13-15]. Other studies indicated that maize cultivars differ in grain yield response to nitrogen application [16-18].

The results of various fertilizer experiments carried out in Nigeria showed that hybrid maize cultivars were found to require high fertilizer rate for optimum yield. Findings from this research work also indicated that maize responded to nitrogen better in the savanna than in the forest ecology [19]. It was further suggested that 60-70kg N/ha served as economic rate for maize in the rain forest and over 100kg/ha in the savanna. The difference between the two zones was however attributed to the presence of higher insulation in the savanna [19].

Some earlier studies were carried out with phosphorus fertilizer indicated positive response of maize to low rates of phosphorus [20,21]. Positive response of maize to low phosphorus application in the derived and southern guinea savanna zones of Nigeria has been reported by Adediran and Banjoko [6]. Application of 40kg P_2O_5/ha appeared to be optimum since at higher rates, the yield was depressed. However, there was steady increase in grain yield up to 60kg P_2O_5/ha, at Mokwa (Southern guinea savanna). The yield at this rate was significantly higher than applying 20kg P_2O_5/ha, but not different from 40kg P_2O_5/ha. Application of high rate was reported to be capable of causing nutrient imbalance and consequently yield depression of Western yellow maize [22]. Various factors could be responsible for phosphorus availability to crop plants. These include the form of native soil phosphorus, the type of phosphorus applied to the soil and soil reaction. It has been reported that total phosphorus was higher in forest soils than in the savannah [23,24]. It has been reported that maize crop responds very well to variable rates of nitrogen and phosphorus fertilizers and thus increase grain yield and protein contents [25]. In an experiment carried out in southern Highland, it was estimated that a crop that produces 5-6t/ha will have removed 100-150kg of nitrogen and 40-60kg of P_2O_5/ha from the soil by harvest [26]. Study has showed increase in plant height and number of grains per ear with increasing nitrogen levels when 50, 100 and 150 kg N/ha with 60kgP/ha were applied to three maize cultivars [27]. Plant height and number of grains per ear were increased with 110kgN + 60kgP/ha. Further increase in nitrogen rate decreased plant height and grains per ear. Average grain yield was the highest with 100KgN+60kgP. Maximum yield of about 3.0t/ha have been reported in maize when 92kgN and 40kgP was applied [28].The aim of the present study was to evaluate the effect of different rates of nitrogen and phosphorus fertilizers on the growth and yield of maize (*Zea mays* L.) in Akure, Ondo State in Southwest Nigeria.

MATERIALS AND METHODS

Description of the experimental site: The experiment was conducted at the Teaching and Research Farm (crop section) of the Federal University of Technology, Akure located within the University premises. The area lies within the tropical rainforest belt, between latitude 5°N and longitude 15°E. The rainfall pattern of Akure is bimodal with a wet season of about eight months occurring in April to October/November through February/March. The mean daily temperature ranges from 25°C and 37°C.

Cropping History: The experimental site had been used over the years for continuous maize cropping. Prominent weed species noted were *Panicum* and *Pennisetum* species and *Chromolaena odorata.*

Table 1: Detains of fertilizer treatment used in this study

Treatment Code	Treatment
T1	Control
T2	60KgN + 0KgP
T3	120kgN + 0KgP
T4	0KgN + 20KgP
T5	0KgN + 40KgP
T6	0KgN + 60KgP
T7	60KgN + 20KgP
T8	60KgN + 40KgP
T9	60KgN + 60KgP
T10	120KgN + 20KgP
T11	120KgN + 40KgP
T12	120KgN + 60KgP

N= Nitrogen; P=Phosporous; Kg=kilogram

Land Clearing and Preparation: The land was ploughed and harrowed to pulverize the soil. The field was then marked out into plots. The size of each plot was 2m x 4m with a distance of 50cm between the plots. The land area was 31.5m x 16m (504m^2).

Soil Sampling: Soil samples were collected from the experimental site at the depth of 0-15cm before sowing. The samples were transferred to the laboratory for analysis. The collected samples were air-dried and passed through 2mm sieve to remove large particles, debris and stones. The sieved samples were analyzed for pH in 1:1 soil to water ratio using the Coleman's pH meter. Organic carbon was determined by Wakley and Black procedure [29]. Organic matter was estimated as organic carbon multiplied by 1.724. Total Nitrogen was determined by the micro Kjeldahl method [30], while available phosphorus was extracted by Bray's P1 method [31] and read from the atomic absorption spectrometer. Textural analysis was by hydrometer method.

Experimental Design: The experiment was laid out in a randomized complete block design (RCBD). There were twelve treatments (Table 1) replicated three times. Nitrogen and phosphorus sources used for the experiment were Urea and Single Super Phosphate (SSP), respectively.

Planting and Cultural Practices: Maize seeds (TZB-SR), a widely grown late maturing maize cultivar obtained from the International Institute of Tropical Agriculture (IITA) Ibadan) were sown on June 23, 2007. The seeds were treated with Apron plus to control soil pathogens before sowing. An insecticide Punch was also applied on maize plants to control insect and rodent attack. Two seeds were planted per hole at a spacing of 75cm x 25cm. maize seedlings were later thinned to one plant per stand. The treatments (Nitrogen and Phosphorus fertilizer at different levels) were applied two weeks after planting by spot placement. Weeds were controlled through the use of herbicides (Paraquat + Atrazine) to reduce competition for space, water, light and nutrients between the crops and weeds. The field borders were kept clean to minimize encroachment by insects and rodents.

Data Collection: Data collection started two weeks after the treatments were applied. Growth and yield parameters recorded at different stages of crop growth and development were: Plant height, number of leaves, stem girth, leaf area, ear length, ear girth, number of grains per ear, weight of grains per ear, weight of grain per plot, weight of 1000-grain and grain yield. These parameters were determined in the following ways: Plant height: This was taken from a sample of six randomly selected maize plants marked within each plot. A carpenter's tape was used for measuring the height from the ground level to the top-most leaf. The mean from the six plants was then determined. Number of leaves: Visual counting of leaves on the six randomly selected plants was made and the number was recorded for each plant. The mean values were then calculated for each plot. Stem girth: The ear girth of the six selected maize plants was measured with a thread and the actual measurements were determined on a carpenter's tape in centimeter for each plot and the values were averaged. Leaf area: The leaf area was determined by the non destructive length x width method [32] using the relation: Leaf area = 0.75 (length x width), where 0.75 is a constant. Six leaves were measured with a tailor's tape for each plot and the leaf area determined. Ear length: The length of six dehusked maize ear per plot was measured with a tape and the mean value calculated. Ear girth: This was also taken from a sample of six ears per plot with the use of tailor's tape and the values were recorded and averaged. Number of grains per ear: The number of grains in six ears from each plot was counted after they had been dried and shelled and was divided by the number of ears to determine the mean. Weight of grains per ear: The grains of the same six ears mentioned above were weighed separately and then averaged for each plot. Weight of grains per plot: The weights of the six ears for each treatment plot were added to obtain the weight of grains per plot. 1000-grain weight: One thousand number of grains were counted from each plot and weighed.

Data Analysis: All the data were analyzed using IRRISTAT software. The data collected were statistically analyzed using the Analysis of Variance (ANOVA) procedures. The treatment means were separated using the Duncan Multiple Range Test (DMRT) at 5% level of probability.

RESULTS

Soil Analysis: The physical and chemical properties of the soil prior planting are shown in Table 2. The soil was sandy clay loam in texture. The soil had a pH of 5.04 which is moderately acidic. The soil available P was low and the exchangeable cations (K, Na, Ca and Mg) were not also high. The percentage nitrogen organic matter and organic carbon were moderate.

Plant Height: The data recorded in Table 3 showed that plant height increased across the treatments at all stages of growth. At 5 and 6 weeks after planting (WAP), there were no significant differences in the plant heights. At 50% tasselling (7WAP) and 8WAP, plant heights differed significantly ($P\leq 0.05$). The minimum plant height was recorded in the control plot (T_1). Plant height at 8WAP ranged from 167.06cm in the control (T_1) to 192.50 cm in T_3 (120kgN/ha + 0kgP/ha).

Number of Leaves: The results presented in Table 4 showed the trend observed in the number of leaves produced by the plants at different stages of growth. At 5WAP, there were no significant differences in the number of leaves per plant among the treatments. At 6, 7 and 8WAP, number of leaves were significantly affected by the different rates of fertilizer application. At 8WAP, T_3 (120kgN/ha + 0kgP/ha) produced the maximum number of leaves which differ significantly from all other treatments. T_1 (control) had the least number of leaves per plant.

Table 2: Physical and chemical properties of the soil

Soil properties	
pH 1:1(H_2O)	5.04
Organic C (%)	2.03
Soil organic matter (%)	3.5
Total N (%)	3.5
P ($mgkg^{-1}$)	0.13
Exchangeable cations ($Cmolkg^{-1}$)	
Ca	0.14
Mg	0.02
Na	0.5
K	0.04
Particle size (%)	
Sand	50
Silt	26
Clay	24

Leaf Area: The highest leaf area was recorded in T_{10} (120kgN/ha + 20kgP/ha) at 8WAP (Table 5). However, this was not significantly different from T_{11} (120kgN/ha + 40kgP/ha) and T_3 (120kgN/ha + 0kgP/ha). The control plot (T_1) gave the lowest value of leaf area.

Stem Girth: The data presented in Table 5 showed the effect of phosphorus and nitrogen application on the stem girth of maize plant at 8 WAP. Stem girth differed significantly (P=0.05) amongst the treatments. The highest stem girth was recorded in T_{10} (120KgN + 20KgP/ha), while the lowest stem girth was recorded in the control. The stem girth ranged from 7.33cm in the control (T_1) to 8.44cm in T_{10} (120KgN + 20KgP/ha), respectively.

Ear Length: There were significant differences in ear lengths among the treatments (Table 6). The highest ear length was recorded in T_{11} (120kgN/ha + 40kgP/ha). This was significantly different from all other treatments. The control plot (T_1) had the lowest ear length. Ear lengths varied from 13.39cm in the control plot (T_1) to 17.06cm in T_{11} (120kgN/ha + 40kgP/ha).

Table 3: Effect of different rates of nitrogen and phosphorus on plant height (cm)

		Weeks After Planting			
Treatment Code	Treatment	5	6	7	8
T1	Control	60.00_a	85.00_a	137.72_b	167.06_c
T2	60KgN + 0KgP	59.72_a	95.00_a	143.06_b	179.22_{abc}
T3	120kgN + 0KgP	69.44_a	100.00_a	168.50_a	192.50_a
T4	0KgN + 20KgP	66.10_a	97.78_a	142.61_b	182.22_{abc}
T5	0KgN + 40KgP	59.44_a	101.50_a	144.34_b	174.44_{bc}
T6	0KgN + 60KgP	66.10_a	103.89_a	144.00_b	187.00_{ab}
T7	60KgN + 20KgP	69.17_a	103.33_a	156.22_{ab}	186.89_{ab}
T8	60KgN + 40KgP	61.39_a	93.06_a	152.94_{ab}	191.94_a
T9	60KgN + 60KgP	62.50_a	101.11_a	151.11_{ab}	190.61_{ab}
T10	120KgN + 20KgP	62.78_a	96.11_a	142.95_b	184.95_{ab}
T11	120KgN + 40KgP	56.94_a	95.17_a	139.72_b	180.95_{abc}
T12	120KgN + 60KgP	58.33_a	91.66_a	150.22_{ab}	187.89_{ab}

In a column means with the same letters are not significantly different (DMRT 5%)

Table 4: Effect of different rates of nitrogen and phosphorus on number of leaves

		Weeks After Planting			
Treatment Code	Treatment	5	6	7	8
T1	Control	7.83_{a}	8.44_{d}	10.00_{cd}	10.27_{e}
T2	60KgN + 0KgP	8.17_{a}	9.28_{bcd}	10.78_{abc}	11.00_{cde}
T3	120kgN + 0KgP	8.06_{a}	10.06_{ab}	11.56_{a}	12.39_{a}
T4	0KgN + 20KgP	8.34_{a}	9.11_{bcd}	10.62_{bcd}	11.33_{abcd}
T5	0KgN + 40KgP	7.99_{a}	8.83_{cd}	9.67_{d}	10.51_{de}
T6	0KgN + 60KgP	8.72_{a}	8.89_{cd}	10.17_{bcd}	11.66_{abcd}
T7	60KgN + 20KgP	8.39_{a}	9.89_{abc}	11.11_{a}	11.27_{bcde}
T8	60KgN + 40KgP	8.00_{a}	9.67_{abc}	10.89_{ab}	11.72_{abc}
T9	60KgN + 60KgP	8.00_{a}	10.56_{a}	10.89_{ab}	11.78_{abc}
T10	120KgN + 20KgP	8.44_{a}	9.78_{abc}	10.89_{ab}	11.89_{abc}
T11	120KgN + 40KgP	7.81_{a}	9.50_{abcd}	11.00_{ab}	11.92_{abc}
T12	120KgN + 60KgP	8.17_{a}	9.22_{abc}	11.28_{a}	12.11_{ab}

In a column, means with the same letters are not significantly different (DMRT 5%)

Table 5: Effect of different rates of nitrogen and phosphorus on stem girth and leaf area at 8 WAP

Treatment Code	Treatment	Stem girth (cm)	Leaf Area (cm^2)
T1	Control	7.33_{c}	501.22_{e}
T2	60KgN + 0KgP	7.89_{abc}	674.01_{cd}
T3	120kgN + 0KgP	8.17_{ab}	954.82_{a}
T4	0KgN + 20KgP	7.61_{bc}	650.01_{de}
T5	0KgN + 40KgP	7.56_{abc}	691.51_{bcd}
T6	0KgN + 60KgP	7.89_{ab}	827.26_{abc}
T7	60KgN + 20KgP	8.11_{ab}	830.76_{abc}
T8	60KgN + 40KgP	8.33_{a}	845.80_{abc}
T9	60KgN + 60KgP	7.94_{abc}	822.17_{abc}
T10	120KgN + 20KgP	8.44_{a}	964.71_{a}
T11	120KgN + 40KgP	8.06_{ab}	959.28_{a}
T12	120KgN + 60KgP	7.94_{abc}	860.42_{abc}

In a column, means with the same letters are not significantly different (DMRT 5%)

Table 6: Effect of different rates of Nitrogen and Phosphorus on the yield and yield components of maize

Treatment Code	Treatment	Ear Length (cm)	Ear Girth (cm)	No of grain/ear	Weight of grain/ear (g)	Weight of grain/plot (g)	Weight of 1000grain (g)	Yield (t/ha)
T1	Control	12.50e	13.67c	262.28e	57.79e	577.93f	220.93e	3.08f
T2	60KgN + 0KgP	13.39de	14.01c	365.23d	81.01d	810.10e	227.07de	4.32e
T3	120kgN + 0KgP	14.28bc	14.50bc	405.37bcd	99.20bcd	991.97bcde	240.17abcde	5.29bcde
T4	0KgN + 20KgP	14.86bcd	15.06ab	375.20cd	86.03cd	860.30de	231.57cde	4.59de
T5	0KgN + 40KgP	15.31bc	15.22ab	384.17cd	96.74bcd	967.37bcde	234.97cde	5.12bcde
T6	0KgN + 60KgP	15.00bcd	15.12ab	403.53bcd	95.74bcde	967.37bcde	234.07cde	5.11cde
T7	60KgN + 20KgP	16.58ab	15.22ab	454.27abc	103.04abc	1030.37bcd	253.23abcd	5.54bcd
T8	60KgN + 40KgP	15.97abc	15.09ab	454.27abc	116.62ab	1166.23ab	261.50ab	6.22ab
T9	60KgN + 60KgP	15.97abc	14.99ab	416.50bcd	103.04abc	1030.37bcd	253.23abcd	5.50bcd
T10	120KgN + 20KgP	15.31bc	15.21ab	403.83bcd	100.21bcd	1002.07bcde	242.50abcde	5.34bcde
T11	120KgN + 40KgP	17.06a	15.31ab	497.30a	133.66a	1336.63a	265.67a	7.13a
T12	120KgN + 60KgP	16.47ab	15.61a	473.67ab	113.32bc	1133.17bc	255.47abc	6.04bc

In a column, means with the same letters are not significantly different (DMRT 5%)

Ear Girth: The highest significant ear girth was obtained with the application of 120kgN/ha + 60kgP/ha (Table 6). This was followed by T_{11} (120kgN/ha +40kgP/ha) with ear girth value which differed significantly (P=0.05) from T_{10} (120kgN/ha + 20kgP/ha), T_9 (60kgN/ha +60kgP/ha), T_8 (60kgN/ha +40kgP/ha), T_7 (60kgN/ha + 20kgP/ha), T_6 (0kgN/ha + 60kgP/ha), T_5 (0kgN/ha + 40kgP/ha) and T_4 (0kgN/ha + 20kgP/ha). The control (T_1) gave the least ear girth although this was not significantly different from T_2 (60kgN/ha + 0kgP/ha). Ear girths varied from 14.01cm in the control (T_1) to 15.61cm in T_{12} (120kgN/ha + 60kgP/ha).

Number of Grains per Ear: Data presented in Table 6 showed that the effect of different rates of nitrogen and phosphorus fertilizers on number of grains per ear. Application of 120kgN/ha + 40kgP/ha ($T_{11)}$ produced the maximum number of grains per ear which was significantly different from all other treatments. The minimum number of grains per ear was obtained in the control (T_1). Grain number varied from 262.28 in the control to 497.30 in T_{11} (120kgN/ha + 40kgP/ha) respectively. Similar trend was observed in the weight of grains per ear. The treatment T_{11} (120kgN/ha + 40kgP/ha) gave the highest significant weight of grains per ear. Application rate of 60kgN/ha + 40kgP/ha (T_8) also produced a higher weight of grains per ear and differed significantly (P=0.05) from T_{12} (120kgN/ha + 60kgP/ha). There were no significant differences between T_7 (60kgN/ha + 20kgP/ha) and T_9 (60kgN/ha + 60kgP/ha) and also between the treatments T_{10} (120kgN/ha + 20kgP/ha) and T_5 (120kgN/ha + 0kgP/ha). The lowest weight of grains per ear was recorded in T_1 (control). Average weight of grains per ear varied from 81.01g in the control (T_1) to 133.66g in T_{11} (120kgN/ha + 40kgP/ha), respectively. This result agreed with the findings on the effects of increasing rates of application of Nitrogen and Phosphorus to a certain level on average grain weight of maize [33].

Weight of 1000 Grains: The treatment T_{11} (120kgN/ha + 40kgP/ha) produced the maximum 1000-grain weight which was significantly different from the rest of all the treatments (Table 6). T_8 (60kgN/ha + 40kgP/ha) also gave a higher 1000-grain weight over others. The minimum weight of 1000 grains was obtained in T_1 (control).

Weight of Grains per Plot: The maximum significant grain weight per plot was recorded in T_{11} (120kgN/ha + 40kgP/ha) (Table 6). There was no significant difference between T_7 (60kgN/ha+ 20kgP/ha) and T_9 (60kgN/ha + 60kgP/ha). The control plot (T_1) gave the minimum grain weight per plot.

Grain Yield: Data presented in Table 6 showed that the effect of different rates of nitrogen and phosphorus fertilizers on grain yield of maize. Application of 120kgN/ha +40kgP/ha (T_{11}) gave the highest significant (P=0.05) grain yield. This was followed by T_8 (60kgN/ha+ 40kgP/ha). The lowest yield was recorded in the control plot (T_1). The grain yield ranged from 3.08t/ha in the control plot (T_1) to 7.13t/ha in T_{11} (120kgN/ha + 40kgP/ha).

DISCUSSION

The result obtained from this study showed that different application rates of nitrogen and phosphorus fertilizers significantly improved maize growth and yield. Growth was mostly supported with application rates of 120kgN/ha + 0kgP/ha and 60kgN/ha + 40kgP/ha. This was evident in the plant height and number of leaves produced. It can be observed that number of leaves per plant tended to increase as nitrogen rate increased. The maximum number of leaves were produced with the application rate of 120kgN/ha + 0kgP/ha. This can be attributed to the fact that nitrogen promoted vegetative growth in maize [34].

Leaf area was also affected by rates of nitrogen application. There was an increase in leaf area with increasing rate of nitrogen. This result is in agreement with the previous findings that reported that higher rate of nitrogen promote leaf area during vegetative development and also help maintain functional leaf area during the growth period [35]. Application of 120kgN/ha + 40kgP/ha significantly (P=0.05) enhanced grain yield. Number of grains per ear, weight of grains per ear, weight of grains per plot and 1000-grain weight were maximum with this application rate. Fertilizer rate of 60kgN/ha + 40P/ha also appeared to give a higher grain yield compared to the rest of the treatments. A slight decline in yield which was observed when 120kgN/ha + 60kgP/ha was applied may be due to increase in the phosphorus rate from 40kg/ha to 60kg/ha. Application of high rate of phosphorus was reported to be capable of causing nutrient imbalance and consequently yield depression of maize [23]. Similar report was also given by Adediran and Banjoko [6] on the response of maize to low and high rates of phosphorus.

CONCLUSION

This study further confirms the role of nitrogen and phosphorus fertilizers in increasing growth and grain yield in maize production. From the result of the experiment, application rate of 120kgN/ha + 40kgP/ha may be recommended for increasing maize yield particularly in the study area. However, application of 60kgN/ha + 40kgP/ha can also bring about increase in the yield of maize. This will greatly benefit farmers in area where supply of nitrogen fertilizer is low or in cases where farmers cannot afford the cost of high fertilizer input.

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