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Effect of Different Levels of Nitrogen and Phosphorus Fertilizers on the Growth and Yield of Maize (*Zea mays* L.) in Southwest Nigeria

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Abstract: An experiment to determine the effects of different levels of nitrogen and phosphorus fertilizers on the growth and yield of maize was conducted between June and October, 2007 at the Teaching and Research Farm of the Federal University of Technology, Akure. The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of twelve treatments with three replicates. The treatments were, 0 kg N ha^{-1} + 0 kg P ha^{-1} (T_1), 60 kg N ha^{-1} + 0 kg P ha^{-1} (T_2), 120 kg N ha^{-1} + 0 kg P ha^{-1} (T_3), 0 kg N ha^{-1} + 20 kg P ha^{-1} (T_4), 0 kg N ha^{-1} + 40 kg P ha^{-1} (T_5), 0 kg N ha^{-1} + 60 kg P ha^{-1} (T_6), 60 kg N ha^{-1} + 20 kg P ha^{-1} (T_7), 60 kg N ha^{-1} + 40 kg P ha^{-1} (T_8), 60 kg N ha^{-1} + 60 kg P ha^{-1} (T_9), 120 kg N ha^{-1} + 20 kg P ha^{-1} (T_{10}), 120 kg N ha^{-1} + 40 kg P ha^{-1} (T_{11}) and 120 kg N ha^{-1} + 60 kg P ha^{-1} (T_{12}). The result of the study showed that application of 120 kg N ha^{-1} + 0 kg P ha^{-1} and 60 kg N ha^{-1} + 40 kg P ha^{-1} significantly increased the growth of maize than other treatments. The application rate of 120 kg N ha^{-1} +40 kg P ha^{-1} significantly ($p = 0.05$) enhanced grain yield. The study therefore suggests that, for optimum grain yield, 120 kg N ha^{-1} + 40 kg P ha^{-1} should be applied particularly in the study area and its environment.

Key words: *Zea mays* L., rainfall, fertilizer levels, nitrogen, phosphorus, grain yield response, production, Southwest Nigeria

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop which ranks third after wheat and rice in the world (David and Adams, 1985). 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 1445 kg ha^{-1} (Bismillah Khan *et al.*, 2001). 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 (2002) data, the area planted to 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 production from 2.4 million metric tones in 1961 to 10.6 million metric tonnes in 2001 (FAO, 2002).

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

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resulting in severe nutrient depletion of soils (Christina, 2002). 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 (Liu *et al*., 2006).

Nitrogen is a vital plant nutrient and a major yield-determining factor required for maize production (Adediran and Banjoko, 1995; Subedi and Ma, 2005). It is very essential for plant growth and makes up 1 to 4 percent of dry matter of the plants (Anonymous, 2000). Nitrogen is a component of protein and nucleic acids and when Nitrogen is sub-optimal, growth is reduced (Haque *et al*., 2001). 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 (Brady and Weil, 2002). 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.

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 (Adepetu and Corey, 1976). 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 (Katsvairo *et al*., 2003). These findings are supported by studies conducted by Beauchamp *et al.* (1976), Balko and Russell (1980) and Mkhabela *et al.* (2001). According to Kamprath *et al.* (1982), 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. Oikeh *et al.* (2003) also reported that maize cultivars differ in grain yield response to nitrogen application.

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 (Sobulo, 1980). It was further suggested that 60-70 kg N ha^{-1} served as economic rate for maize in the rain forest and over 100 kg ha^{-1} in the savanna. The difference between the two zones was however attributed to the presence of higher insulation in the savanna (Sobulo, 1980).

Some work earlier carried out with phosphorus fertilizer indicated positive response of maize to low levels of phosphorus (Adediran and Banjoko, 1995). Adediran and Banjoko (1995) also reported positive response of maize to low phosphorus application in the derived and southern guinea savanna zones of Nigeria. Application of 40 kg P_2O_5 ha^{-1} appeared to be optimum since at higher levels, the yield was depressed. However, there was steady increase in grain yield up to 60kg P_2O_5 ha^{-1}, at Mokwa (Southern guinea savanna). The yield at this rate was significantly higher than applying 20 kg P_2O_5 ha^{-1}, but not different from 40 kg P_2O_5 ha^{-1}. Application of high rate was reported to be capable of causing nutrient imbalance and consequently yield depression of Western yellow maize (Ayodele and Akinola, 1982). 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 (Kwabiah *et al*., 2003; Adepetu and Corey, 1976). Osiname *et al*. (2000) reported that maize crop responds very well to variable levels of nitrogen and phosphorus fertilizers and thus increase grain yield. In an experiment carried out in southern Highland, it was estimated that a crop that produces 5-6 t ha^{-1} will have removed 100-150 kg of nitrogen and 40-60 kg of P_2O_5 ha^{-1} from the soil by harvest (Hergert *et al*., 1996). Arain *et al*. (1989), reported increase in plant height and number of grains per cob or ear with increase nitrogen levels when 50, 100 and 150 kg N ha^{-1} with 60 kg P ha^{-1} were applied to three maize cultivars. Plant height and number of grains per ear increased with up to 110 kg N + 60 kg P ha^{-1}. Further increase in nitrogen rate decreased plant height and grains per ear. Average grain yield was highest with 100 kg N + 60 kg P. The aim of the present study was to evaluate effect of different levels 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 5^0N 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 and 37°C. The experiment was conducted between June and October in the year 2007.

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.*

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 2×4 m with a distance of 0.5 m between the plots. The land area was 31.5×16 m (504 m^2).

Soil Sampling

Soil samples were collected from the experimental site at the depth of 0-0.15 m before cropping. The samples were transferred to the laboratory for analysis. The collected samples

Table 1: Detains of fertilizer treatment used in this study

Treatment code	Treatments
T_1	Control
T_2	60 kg N + 0 kg P
T_3	120 kg N + 0 kg P
T_4	0 kg N + 20 kg P
T_5	0 kg N + 40 kg P
T_6	0 kg N + 60 kg P
T_7	60 kg N + 20 kg P
T_8	60 kg N + 40 kg P
T_9	60 kg N + 60 kg P
T_{10}	120 kg N + 20 kg P
T_{11}	120 kg N + 40 kg P
T_{12}	120 kg N + 60 kg P

N: Nitrogen, P: Phosphorous, kg: Kilogram

were air-dried and passed through 2 mm 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 (Yash, 1996). Organic carbon was determined by Wakley and Black procedure (Nelson and Somers, 1992; Grewal *et al*., 1991). Organic matter was estimated as organic carbon multiplied by 1.724. Total Nitrogen was determined by the micro Kjeldahl method (Bremner, 1965) while available phosphorus was extracted by Bray's P1 method (Bray and Kurtz, 1945) and read from the atomic absorption spectrometer. Textural analysis was by hydrometer method (Gee and Bauder, 1979).

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 0.75×0.25 m. Maize seedlings were later thinned to one plant per stand at 14 days after sowing. 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, cob length, cob girth, number of grains per cob, weight of grains per cob, weight of grain per plot, weight of 1000 grains 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 cob 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 described by Subedi and Ma (2005) 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
- **Cob length:** The length of six dehusked maize cob per plot was measured with a tape and the mean value calculated
- **Cob girth:** This was also taken from a sample of six cobs per plot with the use of tailor's tape and the values were recorded and averaged
- **Number of grains per cob:** The number of grains in six cobs from each plot was counted after they had been dried and shelled and was divided by the number of cobs to determine the mean
- **Weight of grains per cob:** The grains of the same six cobs mentioned above were weighed separately and then averaged for each plot
- **Weight of grains per plot:** The weights of the six cobs 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 (Xiaoping and Ognjen, 2005). The data collected were statistically analyzed using the Analysis of Variance (ANOVA) procedures (Bruckner and Slanger, 1986). The treatment means were separated using the Duncan Multiple Range Test (DMRT) at 5% level of probability (Aleong and Howard, 1985).

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

Table 2: Physical and chemical properties of the soil

Properties	Values
Soil properties	
pH 1:1(H_2O)	5.04
Organic C (%)	2.03
Soil organic matter (%)	3.50
Total N (%)	3.50
P (mg kg^{-1})	0.13
Exchangeable cations (Cmol kg^{-1})	
Ca	0.14
Mg	0.02
Na	0.50
K	0.04
Particle size (%)	
Sand	50.00
Silt	26.00
Clay	24.00

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

		Weeks after planting			
Treatment code	Treatments	5	6	7	8
T_1	Control	60.00a	85.00a	137.72b	167.06c
T_2	60 kg N + 0 kg P	59.72a	95.00a	143.06b	179.22abc
T_3	120 kg N + 0 kg P	69.44	100.00a	168.50a	192.50a
T_4	0 kg N + 20 kg P	66.10a	97.78a	142.61b	182.22abc
T_5	0 kg N + 40 kg P	59.44a	101.50a	144.34b	174.44bc
T_6	0 kg N + 60 kg P	66.10a	103.89a	144.00b	187.00ab
T_7	60 kg N + 20 kg P	69.17a	103.33a	156.22ab	186.89ab
T_8	60 kg N + 40 kg P	61.39a	93.06a	152.94ab	191.94a
T_9	60 kg N + 60 kg P	62.50a	101.11a	151.11ab	190.61ab
T_{10}	120 kg N + 20 kg P	62.78a	96.11a	142.95b	184.95ab
T_{11}	120 kg N + 40 kg P	56.94a	95.17a	139.72b	180.95abc
T_{12}	120 kg N + 60 kg P	58.33a	91.66a	150.22ab	187.89ab

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

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

		Weeks after planting			
Treatment code	Treatments	5	6	7	8
T_1	Control	7.83a	8.44d	10.00cd	10.27e
T_2	60 kg N + 0 kg P	8.17a	9.28bcd	10.78abc	11.00cde
T_3	120 kg N + 0 kg P	8.06a	10.06ab	11.56a	12.39a
T_4	0 kg N + 20 kg P	8.34a	9.11bcd	10.62bcd	11.33abcd
T_5	0 kg N + 40 kg P	7.99a	8.83cd	9.67d	10.51de
T_6	0 kg N + 60 kg P	8.72a	8.89cd	10.17bcd	11.66abcd
T_7	60 kg N + 20 kg P	8.39a	9.89abc	11.11a	11.27bcde
T_8	60 kg N + 40 kg P	8.00a	9.67abc	10.89ab	11.72abc
T_9	60 kg N + 60 kg P	8.00a	10.56a	10.89ab	11.78abc
T_{10}	120 kg N + 20 kg P	8.44a	9.78abc	10.89ab	11.89abc
T_{11}	120 kg N + 40 kg P	7.81a	9.50abcd	11.00ab	11.92abc
T_{12}	120 kg N + 60 kg P	8.17a	9.22abc	11.28a	12.11ab

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

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 (7 WAP) and 8 WAP, plant heights differed significantly ($p \le 0.05$). The minimum plant height was recorded in the control plot (T_1). Plant height at 8 WAP ranged from 167.06 cm in the control (T_1) to 192.50 cm in T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}).

Number of Leaves

The results shown in a Table 4 showed the trend observed in the number of leaves produced by the plants at different stages of growth. At 5 WAP, there were no significant differences in the number of leaves per plant among the treatments. At 6, 7 and 8 WAP, number of leaves were significantly affected by the different levels of fertilizer application. At 8 WAP, T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}) 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 5: Effect of different levels of nitrogen and phosphorus on stem girth and leaf area at 8 WAP

Treatment code	Treatments	Stem girth (cm)	Leaf area (cm^2)
T_1	Control	7.33c	501.22e
T_2	60 kg N + 0 kg P	7.89abc	674.01cd
T_3	120 kg N + 0 kg P	8.17ab	954.82a
T_4	0 kg N + 20 kg P	7.61bc	650.01de
T_5	0 kg N + 40 kg P	7.56abc	691.51bcd
T_6	0 kg N + 60 kg P	7.89ab	827.26abc
T_7	60 kg N + 20 kg P	8.11ab	830.76abc
T_8	60 kg N + 40 kg P	8.33a	845.80abc
T_9	60 kg N + 60 kg P	7.94abc	822.17abc
T_{10}	120 kg N + 20 kg P	8.44a	964.71a
T_{11}	120 kg N + 40 kg P	8.06ab	959.28a
T_{12}	120 kg N + 60 kg P	7.94abc	860.42abc

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

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

Treatment code	Treatments	Cob length (cm)	Cob girth (cm)	No of grain/cob	Weight of grain/cob (g)	Weight of grain/plot (g)	Weight of 1000 grain (g)	Yield (t ha^{-1})
T_1	Control	12.50e	13.67c	262.28e	57.79e	577.93f	220.93e	3.08f
T_2	60 kg N + 0 kg P	13.39de	14.01c	365.23d	81.01d	810.10e	227.07de	4.32e
T_3	120 kg N + 0 kg P	14.28bc	14.50bc	405.37bcd	99.20bcd	991.97bcde	240.17abcde	5.29bcde
T_4	0 kg N + 20 kg P	14.86bcd	15.06ab	375.20cd	86.03cd	860.30de	231.57cde	4.59de
T_5	0 kg N + 40 kg P	15.31bc	15.22ab	384.17cd	96.74bcd	967.37bcde	234.97cde	5.12bcde
T_6	0 kg N + 60 kg P	15.00bcd	15.12ab	403.53bcd	95.74bcde	967.37bcde	234.07cde	5.11cde
T_7	60 kg N + 20 kg P	16.58ab	15.22ab	454.27abc	103.04abc	1030.37bcd	253.23abcd	5.54bcd
T_8	60 kg N + 40 kg P	15.97abc	15.09ab	454.27abc	116.62ab	1166.23ab	261.50ab	6.22ab
T_9	60 kg N + 60 kg P	15.97abc	14.99ab	416.50bcd	103.04abc	1030.37bcd	253.23abcd	5.50bcd
T_{10}	120 kg N + 20 kg P	15.31bc	15.21ab	403.83bcd	100.21bcd	1002.07bcde	242.50abcde	5.34bcde
T_{11}	120 kg N + 40 kg P	17.06a	15.31ab	497.30a	133.66a	1336.63a	265.67a	7.13a
T_{12}	120 kg N + 60 kg P	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%)

Leaf Area

The highest leaf area was recorded in T_{10} (120 kg N ha^{-1} + 20 kg P ha^{-1}) at 8 WAP (Table 5). However, this was not significantly different from T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) and T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}). The control plot (T_1) gave the lowest value for 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} (120 kg N + 20 kg P ha^{-1}) while the lowest stem girth was recorded in the control. The stem girth ranged from 7.33cm in the control (T_1) to 8.44 cm in T_{10} (120 kg N + 20 kg P ha^{-1}), respectively.

Cob Length

There were significant differences in cob lengths among the treatments (Table 6). The highest cob length was recorded in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}). This was significantly different from all other treatments. The control plot (T_1) had the lowest cob length. Cob lengths varied from 13.39 cm in the control plot (T_1) to 17.06 cm in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}).

Cob Girth

The highest significant cob girth was obtained with the application of 120 kg N ha^{-1} + 60 kg P ha^{-1} (Table 6). This was followed by T_{11} (120 kg N ha^{-1} +40 kg P ha^{-1}) with cob girth value which differed significantly (p = 0.05) from T_{10} (120 kg N ha^{-1} + 20 kg P ha^{-1}), T_9 (60 kg N ha^{-1} + 60 kg P ha^{-1}), T_8 (60 kg N ha^{-1} +40 kg P ha^{-1}), T_7 (60 kg N ha^{-1} + 20 kg P ha^{-1}), T_6 (0 kg N ha^{-1} + 60 kg P ha^{-1}), T_5 (0 kg N ha^{-1} + 40 kg P ha^{-1}) and T_4 (0 kg N ha^{-1} + 20 kg P ha^{-1}). The control (T_1) gave the least cob girth although this was not significantly different from T_2 (60 kg N ha^{-1} + 0 kg P ha^{-1}). Cob girths varied from 14.01 cm in the control (T_1) to 15.61 cm in T_{12} (120 kg N ha^{-1} + 60 kg P ha^{-1}).

Number of Grains per Cob

The data shown in Table 6 on the effect of different levels of nitrogen and phosphorus fertilizers on number of grains per cob showed that the application of 120 kg N ha^{-1} + 40 kg P ha^{-1} (T_{11}) produced the maximum number of grains per cob which was significantly different from all other treatments. The minimum number of grains per cob was obtained in the control (T_1). Grain number varied from 262.28 in the control to 497.30 in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) respectively. Similar trend was observed in the weight of grains per cob. The treatment T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) gave the highest significant weight of grains per cob. Application rate of 60 kg N ha^{-1} + 40 kg P ha^{-1} (T_8) also produced a higher weight of grains per cob and differed significantly (P=0.05) from T_{12} (120 kg N ha^{-1} + 60 kg P ha^{-1}). There were no significant differences between T_7 (60 kg N ha^{-1} + 20 kg P ha^{-1}) and T_9 (60 kg N ha^{-1} + 60 kg P ha^{-1}) and also between the treatments T_{10} (120 kg N ha^{-1} + 20 kg P ha^{-1}) and T_3 (120 kg N ha^{-1} + 0 kg P ha^{-1}). The lowest weight of grains per cob was recorded in T_1 (control). Average weight of grains per cob varied from 81.01 g in the control (T_1) to 133.66 g in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) respectively.

Weight of 1000 Grains

The treatment T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}) produced the maximum 1000 grain weight which was significantly different from the rest of all the treatments (Table 6). T_8 (60 kg N ha^{-1} + 40 kg P ha^{-1}) 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} (120 kg N ha^{-1} + 40 kg P ha^{-1}) (Table 6). There was no significant difference between T_7 (60 kg N ha^{-1}+ 20 kg P ha^{-1}) and T_9 (60 kg N ha^{-1} + 60 kg P ha^{-1}). The control plot (T_1) gave the minimum grain weight per plot.

Grain Yield

The data shown in Table 6 on the effect of different levels of nitrogen and phosphorus fertilizers on grain yield of maize showed that the application rate of 120 kg N ha^{-1} +40 kg P ha^{-1} (T_{11}) gave the highest significant (p = 0.05) grain yield. This was followed by T_8 (60 kg N ha^{-1}+ 40 kg P ha^{-1}). The lowest yield was recorded in the control plot (T_1). The grain yield ranged from 3.08 t ha^{-1} in the control plot (T_1) to 7.13 t ha^{-1} in T_{11} (120 kg N ha^{-1} + 40 kg P ha^{-1}).

DISCUSSION

Effect of different levels of nitrogen and phosphorus fertilizers on the growth and yield of maize (*Zea mays* L.) in Southwest Nigeria has been revealed by this study. The result obtained from this study showed that different levels of nitrogen and phosphorus fertilizers significantly improved maize growth and yield. Growth was mostly supported with application levels of 120 kg N ha^{-1} + 0 kg P ha^{-1} and 60 kg N ha^{-1} + 40 kg P ha^{-1}. 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. Maximum number of leaves were produced with the application rate of 120 kg N ha^{-1} + 0 kg P ha^{-1}. This can be attributed to the fact that nitrogen promoted vegetative growth in maize. Similar results have been reported by Shah *et al.* (2005).

The leaf area was also affected by levels of nitrogen application. There was increase in leaf area with increased rate of nitrogen. This result is in agreement with the findings of Cox *et al.* (1993), who reported that higher rate of nitrogen promote leaf area during vegetative development and also help maintain functional leaf area during the growth period. Application rate of 120 kg N ha^{-1} + 40 kg P ha^{-1} significantly ($p = 0.05$) enhanced grain yield. This result agreed with the findings of Zeidan *et al.* (2006) on the effects of increasing levels of application of nitrogen and phosphorus to a certain level on average grain weight of maize. Number of grains per cob, weight of grains per cob, weight of grains per plot and 1000 grain weight were maximum with this application rate. Fertilizer rate of 60 kg N ha^{-1} + 40 P ha^{-1} also appeared to give a higher grain yield compared to the rest of the treatments. A slight decline in yield which was observed when 120 kg N ha^{-1} + 60 kg P ha^{-1} was applied may be due to increase in the phosphorus rate from 40 to 60 kg ha^{-1}. Application of high rate of phosphorus was reported to be capable of causing nutrient imbalance and consequently yield depression of maize (Ayodele and Akinola, 1982). Similar report was also given by Adediran and Banjoko (1995) on the response of maize to low and high levels of phosphorus. On the other hand, some studies have shown that application of high rate of phosphorus and nitrogen are capable increasing growth and yield of maize under irrigated and Mediterranean conditions and intercropping system (Berenguer *et al.*, 2009; Luiz and Willey, 2008). This suggests possible linkage between increased water availability and high rate phosphorus and nitrogen inputs with corresponding increase in growth and yield of maize.

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 120 kg N ha^{-1} + 40 kg P ha^{-1} may be recommended for increasing maize yield particularly in the study area. However, application of 60 kg N ha^{-1} + 40 kg P ha^{-1} 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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