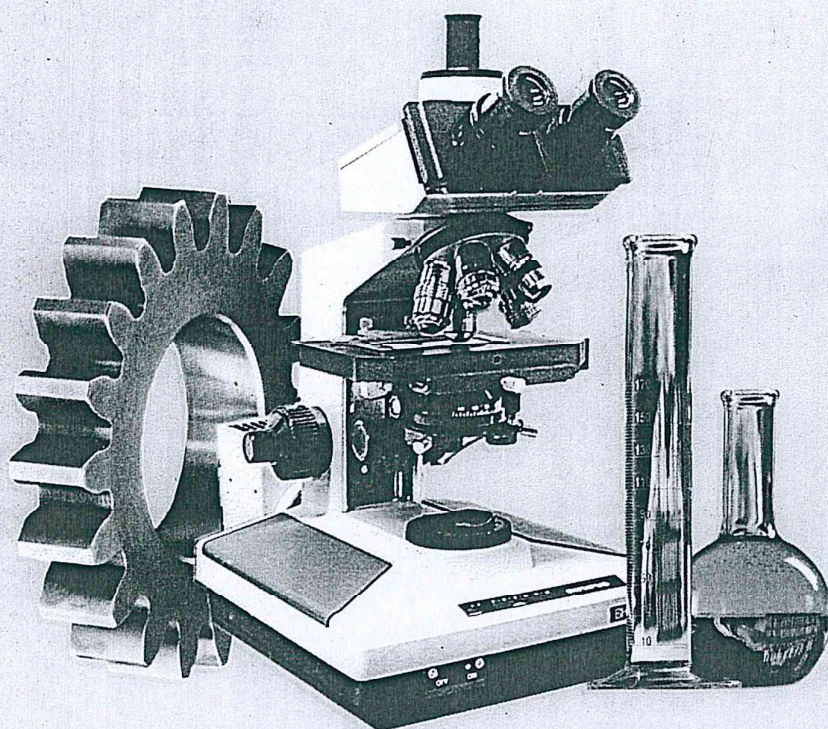


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Growth and Yield Responses of Maize Under Different NPK Levels in the Southern Guinea Savanna Zone of Nigeria

I. Kareem¹, T. O. Amusa², O. F. Adekola¹ and G. Palmer¹

¹Department of Agronomy, University of Ilorin, Ilorin, Nigeria

²Department of Agronomy, University of Ilorin, Ilorin, Nigeria

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ABSTRACT: The seemingly high production levels projected for maize in Nigeria still falls short of the domestic demand. Thus, efforts on the use of fertilizer to achieve the objective are a necessity. This work investigated the use of NPK 16:16:16 fertilizer in improving the growth performance and yield of maize. The study was conducted at the Teaching and Research Farm, Faculty of Agriculture, University of Ilorin during 2010 cropping season. The experiment tested the effects of five levels of NPK 16:16:16 (0, 30, 60, 90 and 120kg/ha) on maize variety Swan-1-SR-Y and the study was designed in Randomized Complete Block with three replications. Data were collected on plant height, leaf area, number of leaves, cob and grain weights and overall yield. All data collected were statistically analyzed using Analysis of Variance (ANOVA) and significant means were separated using Least Significant Difference (LSD) at 5% probability level. Results showed application of NPK fertilizer at 60kg/ha improved both growth and yield performances of maize significantly well. Fertilizer application had significant effect on the plant height, leaf area, number of leaves, cob weight and grain weights. The performance and yield of maize improved with increase in fertilizer levels. The pattern was very clear with lowest grain and cob yield obtained from plants without fertilizer application (0kg/ha of NPK), while the highest grain yield was obtained at 60kg/ha of NPK fertilizer which was taken as the optimum for maize production. It is recommended that further research be carried out by interested researchers to confirm or amend this result to quicken its usefulness for the end users (farmers).

Key words: Cereal; Maize; NPK fertilization; Growth performance and; Yield.

Corresponding Author's E-mail Address- ishaaqabdulkareem@yahoo.com
Phone number- 08032454636

Introduction

Maize (*Zea Mays* L.) and all major cereal crops are members of the grass family, Gramineae (Poaceae). Across the globe, wheat, maize and rice are produced in greater quantities than any other crops. Of these, maize has the highest average yield per hectare. It is one of the most important cereals grown in Nigeria stretching from the coast to the savannah. The production of maize in the Nigeria savanna has since been transformed from that of a minor crop status to a major commercial grain crop competing with sorghum and millet crops in the grain economy of the nation (Elemo, 1993). Maize is a major food crop and accounts for about 75% of the total value of small-holder crop production (INE, 2001). Maize plays a very important role in human and animal nutrition worldwide.

As a result of the importance of this crop, there is need for its yield increase which could be achieved through different means of which plant fertilizer application is one. It is a well known fact that the yield potential of a crop is mainly dependent upon its genetic makeup as well as the environment in which it is grown. The genetic potential however, can be exploited to the maximum by providing favorable growth environments. Maize as a typical cereal responds favorably to fertilizer application especially in the Savanna where the soils are generally low in fertility. It has been established that maize has a strong exhausting effect on the soil and generally it fails to produce good grain yield in plots without fertilizer application (Kamar, 1993). Thus, fertilizer plays a pivotal role in increasing maize yield provided balanced and optimum use of nitrogen, phosphorus and potassium fertilizers are considered when application is being embarked upon. Despite the yield potential of our present varieties is high, it has not yet been fully explored due the fact that to some production constraints including the supply of optimum nutrient to the soil (Asghar *et al.*, 2010). Improving maize production through application of complete fertilizer, therefore, becomes a *sin qua non* strategy for food security in Nigeria.

NPK 15-15-15 or 16-16-16 (complete) fertilizer supplies the elements nitrogen, phosphorus and potassium in equal proportions and, therefore, higher rates result in provision of higher amounts of the nutrient elements to the soil. The best luxuriant growth expressed through higher total leaf area resulted from application of 200, 250 and 300 kg NPK fertilizer per hectare and such could be adduced to higher availability of potash accelerated with sufficient quantities of nitrogen which had been described to stimulate the synthesis of carbohydrates for the development of the framework substance of maize plants (Hershey, 2002; Kiran, 2004). There has been some work on the use of NPK 15:15:15 but there is dearth of information on the use of NPK 16:16:16 in Southern Guinea Savannah the zone where this experiment was conducted. This work was, therefore, carried out to evaluate the effectiveness of NPK 16:16:16 fertilizer in improving growth and yield of maize in Southern Guinea Savanna zone of Nigeria to know if the effectiveness and rate would compare favourably with the already circulated NPK 15:15:15.

Materials and Methods

The experiment was conducted during the 2010 cropping season at the University of Ilorin Teaching and Research Farm, University of Ilorin, Ilorin, Kwara State, in the southern Guinea savanna, ecological zone (8°29'N, 4°32'E) of Nigeria. The site is about 307 meters above the sea level and the area is characterized by a bimodal rainfall pattern that peaks in June and September, with a temperature of 19°C to 33°C. The land was mechanically ploughed, harrowed and ridged. Samples of the soil of the experimental site were taken randomly in a systemic manner and bulked together to have a composite sample which was then analyzed for its physico-chemical characteristics. The soil texture class was sandy-loam. The maize cultivar planting materials comprised a cultivar of maize variety Swan-1-SR-Y treated with Apron plus collected from National Agricultural Seeds Council, Federal Ministry of Agriculture and Water Resources, Abuja. Maize seeds already treated with apron plus for prevention against soil borne disease (Downey mildew), rodents and birds were planted four seeds per hole at the spacing of 0.75m by 0.5m. The resultant germinated seedlings were later thinned to two per stand at two weeks after planting (2WAP). Data collection began 5 weeks after planting (5WAP) and at interval of 2 weeks and continued up to the physiological maturity of the plants. Parameters measured at various periods included plant height, number of leaves, leaf area, days to tassel and silk appearance and days to 50% tassel and silk production, dry matter yield and lastly grain yield per treatment on hectare basis. All these parameters were taken from three representative plants tagged at the middle of each plot to avoid border line effect. The data collected were then subjected to analysis of variance and the significant means were separated using the least significant differences (LSD) at 5% probability.

Table 1: Treatments and their Denotations

T1	0kg/ha
T2	30kg/ha
T3	60kg/ha
T4	90kg/ha
T5	120kg/ha

Results

The results showed that the differences among the leaf areas of maize produced by different levels of NPK were not significantly different from one another except at 11 and 13 WAP. The leaf area from T3 (60kgNPK/ha) at 11 and 13WAP were significantly higher than the control. The increment was 44.23% and 52.59% respectively. The highest leaf area throughout the period of data taking was from T3 while the least was from the control.

Number of leaves per plant was not significantly different from one another at any instance of data taking. In the last two periods of data taking, all the treatments produced leaves that were above the control in number. In the final measurement, T3 was 16.67% above the control.

The plant height increased linearly from the very first time of data collection to the last period in all the treatments examined. At final period of the exercise (13WAP), the highest height was from T4 plants while the least was from the control, though throughout the growth period the control had the shortest plant on the field. T4 plants were 41.85% better than the ones from the control.

The ear weight was highest in T3 while the least was from the control. T3 was 129.13% higher than the control and it was significantly different from it. T2, T4 and T5 were 78.10, 97.86 and 109.37% respectively. Cob weight was highest in T4 and least in the control. T4 was 113.51% above the control while T2, T3 and T5 were 87.16, 89.86 and 106.10% respectively.

Table 2: Effects of Different Levels of NPK on Leaf Areas of Maize (cm²)

Treatments	5WAP	7WAP	9WAP	11WAP	13WAP
T1	244	308	317	364	367
T2	290	375	401	431	495
T3	312	536	491	525	560
T4	251	432	475	510	537
T5	304	354	481	498	518
LSD (5%)	ns	ns	ns	107.5	107.8

LSD: Least Significant Difference; ns: no significant difference.

Table 3: Effects of Different Levels of NPK on Number of Leaves of Maize

Treatments	5WAP	7WAP	9WAP	11WAP	13WAP
T1	8	10	10	10	12
T2	9	10	10	11	13
T3	9	10	11	11	14
T4	9	10	10	11	13
T5	9	10	11	11	13
LSD (5%)	Ns	ns	ns	Ns	Ns

LSD: Least Significant Difference; ns: no significant difference.

Table 4: Effects of Different Levels of NPK Fertilizer on Maize Height (cm)

Treatments	5WAP	7WAP	9WAP 42	11WAP	13WAP
T1	20.0	28.2	36.4	67.6	111.1
T2	26.4	40.8	55.4	87.1	150.9
T3	24.8	45.9	60.5	108.2	141.6
T4	26.2	38.7	48.6	107.7	157.6
T5	25.7	45.8	65.2	108.9	152.6
LSD (5%)	ns	ns	ns	Ns	24.3

LSD: Least Significant Difference; ns: no significant difference.

Table 5: Effects of Different Levels of NPK Fertilizer on the Cob and Grain weight (kg/ha)

Treatments	Ear weight	Cob weight	Grain weight
T1	889	148	741
T2	1583	277	1306
T3	2037	281	1756
T4	1759	316	1443
T5	1861	305	1556
LSD (5%)	678	108	500

Discussion

The leaf is so important to plants because it represents the photosynthetic surface of the plant upon which the function and growth of the plant during its developmental stages hinge. For better and effective photosynthetic activities, higher leaf area is *sin qua non*. As the photosynthetic activities increase so also does the manufacturing of assimilates which will later be partitioned to various growing parts of the plant for physiological upkeep of the growth activities. From this work, the leaf area was significant by fertilizer application and this could be attributed to the presence of nitrogen from higher mitotic cell division that is aided by nitrogen. This is why vegetative parts of the plants are normally aided by nitrogen application. In some other cases, this type of result is associated with premature leaf fall which

paves way for the remaining ones to maximize the use of assimilates present in the plant as a whole (Okwuowulu, 1995). The best luxuriant growth expressed through higher total leaf area could be adduced to higher availability of potash which had been described to stimulate the synthesis of carbohydrate for the development of the framework substances of maize plants and it was said that it is accelerated with sufficient quantities of nitrogen (Heisey, 2002; Kiran, 2004).

The higher the number of leaves, the better the solar energy interception which is a summation of solar energy trapped by individual leaves. Since the leaf is a vegetative part of the plant, it is equally aided by the nitrogen included in the complete fertilizer used in the experiment. The leaf area, the number of leaves as well as the angle of inclination of the leaves to the stem come together to determine the effectiveness of solar energy trapped by the plant which aid higher yield production. In this study, the number of leaves in the control was lower than those of the fertilizer treated plots which is a positive result of how the applied fertilizer aided better vegetative growth and in particular leaf production. Fertilizer application results in luxuriant growth with higher number of leaves resulting from fertilization of soil contributing to a better canopy production and suppression of weeds (Stafano *et al.*, 2001).

There was positive correlation between the fertilizer rate and height of maize which means that the nutrients contained in the fertilizer were effective in causing better apical growth which is primary to higher height in plants (Odiye *et al.*, 2005). The potassium increases the amount of ash production through production of better and firm stem as it does in grain filling and bulking in root and tuber production. The phosphorus in the fertilizer is a part of the nucleic acid as well as phospholipids without which the growth of the plant is impeded. So, the higher height recorded in the fertilized plant is attributed to the summative effects of the individual nutrient elements present in the complete fertilizer used and the optimum was 90kg per hectare.

The untreated plants were almost stunted in growth as they had to rely on the native soil fertility which, from the result of chemical analysis, was deficient in these nutrients. The height of plant is an important growth character directly linked with the productive potential of plants in terms of grains. An optimum plant height is positively correlated with productivity of plant (Saeed *et al.*, 2001). The use of NPK 16:16:16 fertilizer affected the performance and yield of maize, positively producing higher leaf area, higher number of leaves, higher plant height and higher yield than the control. Therefore, the higher the leaf area, number of leaves, plant height, the leaf surface exposed to solar radiation produced from the sun for photosynthesis, the higher the grain filling of the cob representing the yield of maize.

The use of inorganic fertilizer is associated with increase in crop yield (Adediran and Banjoko, 2003). Occasions may result in yield reduction as a result of application of the same inorganic fertilizer (Ayoola and Adeniyi, 2006). This can result from

toxicity which is consequential to over addition of nutrients to the soil when the soil has reached the optimum level of its nutrient requirement. It was observed that increase in fertilizer rate increased number of grain/cob, cob weight/plant, cob yield/hectare, grain weight/plant, grain yield/hectare and 100-grain weight. This may probably be attributed to NPK being part of the essential nutrients required for better activities of the plant meristem which result in better root development leading to an efficient absorption of water & nutrients which paves way for luxuriant leaf production and spread as well appreciable height for optimum interception of solar radiation and assimilation of carbon dioxide for promotion of higher photosynthetic activities. These in turn lead to the production of enough assimilate for subsequent translocation to various sinks and hence the production of higher yield and yield component of maize as well as appreciable dry matter. This is in conformity in with the findings of Adediran and Banjoko (2003) who observed that the crucial yield and yield components such as 100-grain weight was produced with increase in fertilizer. From this study, 60kg/ha can be regarded as the optimum rate of NPK fertilizer while 90 and 120kg/ha of NPK fertilizer may be said to be the toxic level since it retarded growth (dry matter accumulation) and grain yield. Such excessive inorganic fertilizer application can induce nutrient imbalance, acidity, pollution of ground water resulting from leaching and reduce the palatability of the produced grains (Sridher and Adeoye, 2003). This could be as a result of interference in the absorption and utilization of other elements that would have improved the yield (Uguru,1996). The plants without fertilizer treatment had the lowest yield which could have been partly due to deficiency of nutrients as revealed by low nutrient status of the soil.

The highest maize grain yield resulting from higher fertilizer application at the appropriate distances of 10 and 15 cm showed the efficient economic returns to maize farmers. Zhiying Xu et al. (2009) observed that application of fertilizer to maize farms gave significantly higher yield with correspondingly improved financial status to producers while Bifarin et al.(2008) observed an economic empowerment for maize farmers when there was an increased production resulting from increased use of fertilizer application.

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