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SHORT COMMUNICATION

Effects of nitrogen fertilizer and planting seasons on the reproductive performance of maize (*Zea mays* L.)

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ABSTRACT

Maize (*Zea mays*) serves as a crucial staple in tropical and subtropical regions; yet, productivity in these areas is suboptimal due to diminishing soil nutrient levels resulting from continuous land agriculture. This study assessed the impact of nitrogen fertiliser and planting seasons on the reproductive efficacy of maize. The study was conducted using a Randomized Complete Block Design (RCBD) with three replications. The maize seeds were sown at three per hole and subsequently thinned to two per stand at the Research Farm of the Faculty of Agriculture, Delta State University, Abraka. The experiment has five nitrogen levels (0, 40, 80, 120, and 160) and two planting seasons: early (May-August) and late (August-November), utilising Urea (46% N) as the nitrogen source. At a treatment level of 120 kg ha^{-1}, the maize crop exhibited the best performance during the reproductive stage compared to other treatments applied throughout the planting seasons.

Keywords: maize, nitrogen fertilizer, planting seasons, reproductive performance, yield,

INTRODUCTION

Maize (*Zea mays*), is among the most extensively farmed cereal crops globally. It is utilized for human food, animal feed, and industrial applications such as biofuels and starch (Rajangam et al., 2024). It exhibits significant adaptability to many climates and soil conditions, rendering it a crucial agricultural crop. It employs the C_4 photosynthetic pathway, which improves its effectiveness in carbon fixation in warm and sunny environments (Badu-Apraku & Fakorede, 2017). This adaptation enhances biomass output and increases drought resilience.

A study in Ado-Ekiti, South-West Nigeria, revealed that the use of inorganic fertilizers, especially nitrogen, significantly enhanced maize growth and production. Nitrogen is a critical component influencing yield in maize cultivation, highlighting its significance for optimal crop performance (Omotoso, 2015). Urea fertiliser is an efficient nitrogen source that enhances maize yield in nutrient-deficient Nigerian soils. It has 46% nitrogen, rendering it one of the most potent nitrogen fertilizers accessible. Nitrogen is crucial for chlorophyll synthesis, leaf development, and grain maturation in maize. It mitigates chlorosis from nitrogen deficit (Adebayo et al., 2009).

Urea promotes vegetative growth, augmenting leaf area to provide enhanced photosynthesis. It enhances ear and cob development, increasing maize grain yields (Adeniyan and Ojeniyi, 2008). The repeated occurrences of inadequate nutrient soils and excessive nitrogen treatment to maize plants have resulted in economic losses. Environmental restrictions detrimental to sustainability and the subpar yield of maize cultivated in Nigeria have consistently posed challenges to maize production. The majority of soils in Nigeria are deficient in nutrients, particularly nitrogen, resulting in diminished maize yield (Adejuyigbe, 2015; Olaniyi, 2018). Another reason is the inadequate technical expertise in balancing and successfully utilising nitrogen-based fertilisers to get the desired outcome. Considering these issues, it is essential to ascertain the effects of nitrogen fertiliser on vegetative growth, yield, yield components, and reproductive performance, which is crucial for grain yield.

MATERIALS AND METHODS

This research was carried out at the Teaching and Research Farm of the Faculty of Agriculture, Delta State University, Abraka (Longitude 6° 00" and 6° 15" E and Latitude 5°.45" and 5°50" N of the Greenwich meridian). Abraka is located in the rainforest zone, with annual temperature, rainfall and relative humidity of 25 °C - 32 °C, 1400mm - 3000mm and 60% - 90% respectively. The experimental site was cleared manually of the existing vegetation. The soil was ploughed slightly to loosen the soil. The plot size was 27.43m × 18.28m, with a border space of 3m on both sides of the experimental site. Treated seeds were obtained from the Delta State Agriculture and Rural Development Agency (DARDA) research institute, Asaba. The cultivar that was used for this experiment was Kapam-6, which is an early-maturing maize. Each of the fifteen (15) experimental units had a measurement of 4.5m × 3m. Inter-plot space in between each plot was 0.6m (60cm). Maize seeds were sown at a spacing of 90cm × 30cm. The treatments consist of five levels (0, 40, 80, 120 and 160). The experiment was conducted in the early planting season (May-August) to late planting season (August- November). The source of nitrogen used was urea (46% N). The five (5) treatments were laid out in a randomized complete block design (RCBD), with three (3) replicates.

Maize seeds were sown on flat ground. The seeds were planted at three per stand and later thinned to two per stand. Nitrogen fertilizers were applied in two equal splits at three weeks after planting (vegetative stage) and six weeks after planting (silking stage). Regular weeding using a hoe (manual weeding) was done till harvest periods. During the experiment, morphological characteristics were collected from three (3) tagged maize within the middle row in each plot. The following plant parameters like number of days to 50% tasselling, number of days to 50% silking, number of days to 100 % maturity and Tassel-silk interval were obtained for maize during the early and late planting seasons. Statistical analysis was done by using the SAS 12.0 version. Significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

The data on physico-chemical properties, as illustrated in Table 1, it delineates the characteristics of the soil at the experimental site. The soil exhibited a pH of 6.1, organic matter content of 20 g/kg, total nitrogen concentration of 1.80 g/kg, accessible phosphorus level of 14 mg/kg, exchangeable potassium amounting to 0.52 cmol/kg, and a cation exchange capacity of 11.62 cmol/kg. The composition consisted of 59% sand, 22% silt, and 19% clay. The findings indicated that the textural classification was sandy loam.

Table 1. The physicochemical properties of the experimental site

Parameters	Values
Particle size distribution	
Sand (%)	59
Silt (%)	22

Clay (%)	19
Textural Class	Sandy loam
pH (H_2O)	6.1
Organic matter (g kg^{-1})	20.0
Total Nitrogen (g kg^{-1})	1.80
Available P (mg kg^{-1})	14.0
Exchangeable K (Cmol kg^{-1})	0.52
CEC (Cmol kg^{-1})	11.62

Significant changes were observed among the treatments during the two cropping seasons at tasselling, silking, maturity, and tassel-silk intervals. Table 2 indicates that the overall mean values for days to 50% tasseling, days to 50% silking, and days to 100% maturity were elevated in the late cropping season, however, the tassel-silk rate was lower in the late cropping season. The impact of nitrogen fertilizer on the duration to reach 50% tasselling varied significantly across the treatments. Treatment at 0 kg ha-1 exhibited the highest mean values of 62.67 and 64.00, whereas treatment at 120 kg ha^{-1} recorded the lowest mean values of 54.00 and 54.33 for the early and late cropping seasons, respectively. Additionally, mean values for each treatment during the early cropping season were found to be lower than those observed in the late cropping season. The maize crop achieved 50% tasseling earlier than the late variety, attributed to extended vegetative growth.

In the early cropping season, there were significant differences in the days to 50% silking among treatments. 0 kg ha^{-1} and 40 kg ha^{-1}, 0 kg ha^{-1} and 80 kg ha^{-1}, 0 kg ha^{-1} and 120 kg ha^{-1}, 0 kg ha^{-1} and 160 kg ha^{-1}, and 120 kg ha^{-1} and 160 kg ha^{-1} showed no significant difference (Table 2). However, there was no significant difference between the treatments of 40 kg ha^{-1} and 80 kg ha^{-1}. In contrast, for the late cropping season, significant differences were observed among the treatment means. In comparing the performance of early and late cropping seasons, the early cropping season exhibited shorter silking durations than the late cropping season, resulting in lower mean values for the early season. These results were aligned with the findings of Hammad et al. (2011).

The days to reach 100% maturity in the early cropping season exhibited a significant difference between the 0 kg ha^{-1} and 40 kg ha^{-1} treatments. No significant differences were observed among the treatments of 80 kg ha^{-1}, 120 kg ha^{-1}, and 160 kg ha^{-1}. During the late cropping season, significant differences were observed between the treatments of 0 kg ha^{-1} and 40 kg ha^{-1}, 80 kg ha^{-1} and 120 kg ha^{-1}, as well as between 120 kg ha^{-1} and 160 kg ha^{-1}. However, no significant difference was found between the treatments of 80 kg ha^{-1} and 160 kg ha^{-1}. Significant differences were observed between treatments at 0 kg $ha^{-1}$and 40 kg ha^{-1}, 80 kg $ha^{-1}$and 120 kg ha^{-1}, as well as between 120 kg ha^{-1} and 160 kg ha^{-1}during the tassel-silk interval. However, no significant difference was found between the 160 kg ha^{-1} and 80 kg ha^{-1} treatments during the early cropping season. During the late cropping season, treatments of 0 kg $ha^{-1}$and 40 kg ha^{-1}, 80 kg ha^{-1}, 120 kg ha^{-1} and 160 kg ha^{-1} were observed. The study's findings indicated that maize planted in early cropping seasons exhibited superior performance compared to that planted in late seasons. Early-planted maize exhibited reduced days to tasseling, leading to decreased durations for silking and maturity. Treatment at 120 kg ha^{-1} exhibited the shortest duration to reach 50% tasseling, 50% silking, and 100% maturity compared to other treatments across the two distinct cropping seasons. These results were aligned with the findings of Hammad et al. (2011), which indicate that treatments requiring a longer duration for tasseling resulted in delayed silking.

CONCLUSION

Based on the result derived from this research, maize grown during the early cropping seasons performed better in the reproductive (except that of tassel-silk interval that had lower interval mean values) stages, than that of the late cropping season. The effect of the different fertilizer rates were significant during 50% silking and 50 % tasseling. This implies that nitrogen fertilizer has significant influence on the reproductive performance most especially during the silking and tasseling stages which is the determinate for yield production.

Table 2. Effects of nitrogen fertilizer on the reproductive stage of maize for early cropping seasons

Rate N (kg ha^{-1})	Days to 50% tasseling	Days to 50 % silking	Days to 100% maturity	Tassel –silk interval
Early				
0	62.67^{a}	67.67^{a}	89.67^{a}	7.67^{a}
40	57.33^{c}	62.33^{bc}	85.00^{b}	6.44^{b}
80	56.33^{d}	61.00^{bc}	81.67^{cd}	4.55^{c}
120	54.00^{e}	58.67^{d}	80.00^{cd}	2.89^{d}
160	58.67^{b}	63.00^{b}	82.33^{cd}	4.44^{c}
Mean	57.80	62.53	83.73	5.20
LSD	0.94	1.41	1.99	0.78

Table 3. Effects of nitrogen fertilizer on the reproductive stage of maize for late cropping seasons

Rate N(kg ha^{-1})	Days to 50% tasseling	Days to 50 % silking	Days to 100% maturity	Tassel –silk interval
Late				
0	64.00^{a}	69.00^{a}	91.00^{a}	7.00^{a}
40	58.67^{b}	63.67^{b}	88.00^{b}	5.66^{b}
80	56.00^{c}	60.67^{c}	83.33^{c}	4.78^{c}
120	54.33^{d}	59.33^{d}	81.67^{d}	2.89^{e}
160	58.33^{b}	63.00^{b}	84.67^{c}	4.00^{d}
Mean	58.27	63.13	85.73	4.87
LSD	1.15	1.15	1.63	0.45

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AUTHORS CONTRIBUTIONS

This article was written and research carried out by Ajiboye, T.G. and Oroka, F.O.

CONFLICT OF INTERESTS

The authors declare no conflict of interest.

ETHICAL APPROVAL

Not applicable

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