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EFFECT OF SOWING DATE AND NPK FERTILIZER RATE ON THE GROWTH AND YIELD COMPONENTS OF TOMATOES

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***Abstract**: A field experiment was conducted at the Teaching and Research Farm of Ramat Polytechnic, Maiduguri, during the dry season, to evaluate the performance of tomatoes as affected by different sowing dates and NPK fertilizer application. The study utilized a Randomized Complete Block Design (RCBD) with five NPK fertilizer rates (25%, 50%, 75%, 100%, and 125% of the recommended rate). Results indicated that the sowing date significantly affected the phenological days to flowering, with earlier sowing reducing the days to flowering of early-sown tomatoes, while late sowing delayed flowering. NPK fertilizer application significantly increased plant height at flowering and physiological maturity for both early and late-sown tomatoes. Moreover, late sowing significantly reduced head diameter, number of seeds per head, and seed yield, though it did result in a 23% increase in yield relative to the control. The seed yield range (850.45–1,525.78 kg/ha) recorded was comparable to national and global averages. The study concludes that early sowing, coupled with appropriate NPK fertilizer application, significantly enhances tomato yield and seed quality. It is recommended that tomatoes be sown early to optimize yield, with further research on fertilizer interactions to improve production practices.*

***Keywords:** Inorganic fertilizer; Tomatoes; Nitrogen; Phosphorus; Potassium and Sowing date*

1.0 Introduction

Tomatoes (*Solanum lycopersicum*) are among the most widely cultivated vegetable crops globally, with immense nutritional and economic significance. Tomatoes thrive across a variety of agro-ecological zones due to their adaptability to diverse climatic and soil conditions (Seiler et al., 2008). They are a rich source of essential nutrients such as vitamins, antioxidants, and dietary fiber, contributing significantly to global food security and health (Kaleem *et al.,* 2011). However, tomato production in tropical regions often faces challenges such as suboptimal fertilizer

application, limited access to agricultural inputs, and climatic variability (Rodriguez et al., 2002). Fertilizer application is a critical factor influencing tomato growth and yield. NPK fertilizers are particularly important as they supply essential nutrients—nitrogen (N), phosphorus (P), and potassium (K)—that enhance vegetative growth, root development, and fruit production. Several studies have demonstrated the positive effects of NPK fertilizers on crop yield when applied at optimal rates (Nasim *et al*., 2012b; Posner *et al*., 2008). Additionally, sowing date plays a significant role in determining tomato productivity by aligning the crop's growth cycle with favorable weather conditions (Olowe *et al*., 2005). For instance, staggered sowing has been shown to maximize yield by mitigating the risks associated with environmental stressors, such as temperature fluctuations and rainfall variability (Shakuntula *et al*., 2012). In Nigeria, tomato productivity is often limited by poor agronomic practices, resulting in yields that are significantly lower than the global average (USDA, 2012). The application of NPK fertilizers in combination with optimal sowing dates has the potential to bridge this yield gap by enhancing the growth and yield components of tomatoes. This study aims to investigate the effect of varying sowing dates and NPK fertilizer rates on the growth and yield of tomatoes, with the goal of identifying practices that optimize production under tropical conditions.

1.2 An -Overview

Tomato production is heavily influenced by environmental and agronomic factors such as sowing date, fertilizer application, and crop variety. Sowing date determines the crop's exposure to environmental conditions such as temperature, rainfall, and sunlight, which directly affect growth and yield (Kaleem *et al*., 2011). Research by Shakuntula *et al*. (2012) demonstrated that early and staggered sowing dates improve tomato yield by synchronizing crop growth with favorable climatic conditions. Similarly, Lawal *et al*. (2011) reported that delayed sowing can lead to reduced yields due to shortened growing periods and adverse weather conditions. Fertilizer application, particularly NPK, has been extensively studied for its role in enhancing tomato productivity. Nitrogen is essential for vegetative growth, phosphorus supports root development, and potassium improves fruit quality and resistance to stress (Nasim *et al*., 2012b). Studies conducted in Nigeria by Olowe *et al*. (2005) and Rasool *et al*. (2013) have highlighted the importance of optimizing NPK fertilizer rates to achieve maximum yield. However, excessive application can lead to environmental degradation and reduced economic returns, necessitating a balanced approach to fertilizer management. Recent studies have also explored the combined effects of sowing date and fertilizer application on crop performance. For example, Petcu *et al*. (2010) observed that the interaction between sowing date and NPK fertilizer rate significantly influenced the growth and yield components of tomatoes. In addition, research in tropical regions has highlighted the potential of using integrated nutrient management systems, combining organic and inorganic fertilizers, to sustain soil fertility and improve crop productivity (Posner *et al*., 2008). Despite significant progress in tomato agronomy, there remains a dearth of information on the combined effects of sowing date and NPK fertilizer rates under tropical conditions. This study seeks to fill this gap by evaluating the growth and yield components of tomatoes in response to varying sowing dates and fertilizer rates, providing insights that can inform best practices for tomato production in tropical regions.

2.0 Materials and Methods

2.1 Growth Conditions and Experimental Site Description

Field experiments were conducted at the Teaching and Research Farm of Ramat Polytechnic, Maiduguri, Nigeria (11.4°N, 13.05°E, altitude 354 m) during the dry season from February to April 2018. The site is located in the Sudano-Sahelian region within the Lake Chad Basin, which was formed during the Pleistocene period. The region experiences a tropical climate with three distinct seasons: a cool-dry season (October to March), a hot season (April to June), and a rainy season (June to September). The soil at the experimental site was classified as loamy sand with the following characteristics: low to medium nitrogen and phosphorus levels, adequate potassium, and a slightly acidic pH (Table 1). Two tomato varieties, Funtua and SAMSUN-3, both late-maturing (110–120 days), were used for the study. Meteorological data indicated decreasing rainfall, rainy days, and sunshine duration as sowing was delayed. Growing degree days (GDD) ranged as follows:

- **SAMSUN-3**: Early sown (2,073.39°–2,423.07°C), Late sown (1,942.37°–2,038.43°C)
- **Funtua**: Early sown (2,067.90°–2,370.06°C), Late sown (2,052.29°–2,189.27°C)

Table 1: Physico-Chemical Characteristics of the Experimental Fields (0–30 cm)

Soil Characteristics	Early Sown Field	Late Sown Field
Sand (%)	84.0	85.0
Silt (%)	7.0	7.0
Clay (%)	9.0	8.0
Textural Class	Loamy Sand	Loamy Sand
pH (H2O)	5.37	5.50
Carbon Level (%)	0.5	0.85
Total N (%)	0.18	0.20
Available P (mg/kg)	1.49	0.80
Exchangeable K (cmol/kg)	0.23	0.67

2.2 Treatments and Experimental Design

The experiment was a two-factorial study laid out in a Randomized Complete Block Design (RCBD) with 20 treatments replicated three times, resulting in a 5 × 4 factorial arrangements. The factors included five rates of NPK fertilizer application and four sowing dates, with three plots serving as controls. A total of 63 plots were used, with each plot measuring 3 m × 3 m (9 m²).

2.2.1 Effect of NPK Fertilizer Rates

The recommended rate for NPK fertilizer in the region, based on established crop management practices, is:

- **100 kg N**
- **50 kg P_2O_5**
- **30 kg K_2O**

Three fertilizer types were used to achieve the required nutrient rates:

1. **NPK (15:15:15)**
2. **Urea**
3. **Single Super Phosphate (SSP)**

Fertilizers were applied either individually or in combination to obtain the desired rates. A full dose of phosphorus (P) and potassium (K) was applied at sowing, while nitrogen (N) was split, with half applied at sowing and the other half at the bud initiation stage. The fertilizer rates used were:

- **FR1**: 25% of the recommended rate
- **FR2**: 50% of the recommended rate
- **FR3**: 75% of the recommended rate
- **FR4**: 100% of the recommended rate
- **FR5**: 125% of the recommended rate

The control consisted of plots sown on the first date (SD1) without any NPK fertilizer application.

2.3 Crop Husbandry

The experimental plots were ploughed twice and harrowed once before demarcation. Tomato seeds were sown at a spacing of 60 cm × 30 cm, equivalent to a plant population of 56,000 plants per hectare. Three seeds were sown per hole and later thinned to one plant per stand two weeks after sowing (WAS). Organic fertilizer was applied and incorporated into the soil during seedbed preparation, one week before sowing. Manual weeding was conducted at 3 and 6 WAS. Five plants were randomly selected from the middle rows of each plot for growth measurements and yield analysis. No agrochemicals were applied during the experiment to simulate the practices of resource-constrained farmers. The crop was grown under rain-fed conditions. No incidences of pests or diseases were observed during the cropping period, likely due to the crop's limited cultivation history in the agro-ecological zone.

2.4 Data Collection

Data were collected on a plot basis for the following parameters:

1. Phenological days to flowering (R5) and physiological maturity (R9).
2. Plant height (cm) at R5 and R9, measured from the soil surface to the plant tip.
3. Yield components, including fruit weight (g), fruit diameter (cm), number of fruits per plant, and total fruit yield (kg ha^{-1}).
4. Fruit quality parameters, including total soluble solids (%) and vitamin C content (mg/100g).

2.5 Data Analysis

The collected data were statistically analyzed using the MSTATC software package (Freed et al., 1989). Treatment means were separated using the least significant difference (LSD) test at a 5% probability level, and significance was determined at $P < 0.05$

2.6 Results of the Experiment

2.6.1 Effect of Sowing Date and NPK Fertilizer on Phenology and Height Characteristics of Tomatoes

As shown in Table 2, sowing date significantly ($P \leq 0.05$) influenced the number of phenological days to flowering (R5) for early and late-sown tomatoes, as well as the number of phenological days to physiological maturity (R9) for late-sown tomatoes. However, sowing date did not significantly affect plant height at flowering or physiological maturity for both early and late-sown

tomatoes. NPK fertilizer application significantly (P ≤ 0.05) reduced the number of phenological days to flowering in early-sown tomatoes and increased plant height at flowering and physiological maturity for both early and late-sown tomatoes.

Table 2: Effects of Sowing Date and NPK Fertilizer Application on Plant Height and Phenological Days to Flowering (R5) and Physiological Maturity (R9) of Early and Late-Sown Tomatoes

Treatment	Early Sown	Late Sown
	Days to R5	Days to R9
Sowing Date (SD)		
SD1	70.8	110.8
SD2	72.8	114.0
SD3	77.4	116.0
SD4	85.2	114.6
LSD 5%	2.57**	ns

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2.6.2 Effect of Sowing Date and NPK Fertilizer on Seed Yield, Yield Attributes, and Seed Quality

As presented in Table 3, sowing date did not significantly affect seed yield, yield attributes, or seed quality of tomatoes, except for protein content in early-sown tomatoes (P ≤ 0.05). NPK fertilizer application significantly (P ≤ 0.05) improved seed yield, yield attributes, and seed quality of early-sown tomatoes, except for oil yield. Late-sown tomatoes exhibited significant (P ≤ 0.05) differences in head diameter, the number of seeds per fruit, and seed yield under NPK fertilizer application.

Table 3: Effects of Sowing Date and NPK Fertilizer Application on Tomato Seed Yield and Yield Attributes

Treatment	Head Diameter (cm)	Head Weight (g)	No. of per Fruit	Fruit Weight (g)	fresh Weight (g)
Sowing Date (SD)					
SD1:	16.4	87.5	1,150.6	79.2	7.9
SD2:	16.6	94.9	1,143.5	87.5	8.4
SD3:	16.3	90.5	1,158.9	82.8	7.9
SD4:	14.6	72.8	884.4	64.4	6.9
LSD 5%	1.28*	ns	93.25**	ns	ns

2.7 Discussion of the Experiment

Tomato productivity is strongly influenced by cultural practices, such as sowing date and fertilizer application, alongside environmental factors like temperature and rainfall (Kaleem *et al.,* 2011a). In this study, the timing of sowing significantly impacted the phenology of tomatoes, with early sowing resulting in extended vegetative growth and later flowering compared to delayed sowing. The application of NPK fertilizer significantly enhanced plant height and phenological development, particularly in early-sown tomatoes, demonstrating the vital role of nutrient

supplementation in optimizing growth and productivity. Seed yield and yield attributes were also positively influenced by NPK fertilizer, emphasizing its importance in improving overall crop performance. These findings align with previous studies that highlight the significance of sowing date and fertilizer application in achieving optimal yields (de la Vega & Hull, 2002; Olowe et al., 2013). The seed yield range observed (852.45–1,525.78 kg/ha) corresponds to regional and global averages, affirming the potential of tomatoes under appropriate cultural practices.

2.8 Conclusion

The results of this study demonstrated that sowing date and NPK fertilizer application significantly influenced the phenology, plant height, and seed yield of tomatoes. Early sowing resulted in longer vegetative growth and delayed flowering, whereas late sowing shortened the time to flowering and physiological maturity. Fertilizer application, particularly NPK, played a crucial role in enhancing plant height and hastening the number of phenological days to flowering. The application of organic fertilizers also positively impacted the seed yield and quality of early-sown tomatoes. Despite sowing date having no major effect on certain seed yield attributes, the overall impact of NPK fertilizer on seed yield and yield attributes was notable, especially in late-sown tomatoes. This study confirms that adopting optimal sowing dates and proper fertilizer management can significantly improve tomato productivity.

2.9 Recommendations

1. Early sowing, is recommended for better plant growth, higher yield, and improved quality. This timing allows tomatoes to flower at optimal conditions, avoiding the negative effects of late sowing.
2. The application of NPK fertilizer should be recommended for both early and late-sown tomatoes to boost growth, flowering, and seed yield. Fertilizer application was found to significantly enhance plant height and seed quality, particularly for late-sown varieties. Therefore, incorporating proper fertilizer management into tomato cultivation practices is crucial for improving productivity.
3. Organic fertilizers should be considered, especially for early sown tomatoes, as they significantly enhance growth and yield characteristics. Organic farming practices could improve both soil fertility and environmental sustainability while increasing yields.
4. Further research should be conducted to explore the impact of different combinations of organic and inorganic fertilizers on tomato productivity to fine-tune agricultural practices in the tropics.
5. Given that sowing date affects phenological development, farmers should take into account seasonal variations in rainfall and temperature when planning their sowing schedules. This can mitigate risks associated with unpredicted weather patterns and optimize yield.

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