

THE VEGETATIVE AND PHYSIOLOGICAL EFFECT OF NPK FERTILIZER CONCENTRATIONS ON THE SEEDLINGS OF TOMATO (*Lycopersicon esculentum* Mill)

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ABSTRACT

This study looked at the morphological characteristics and physiological behaviour of tomato (*Lycopersicon esculentum* Mill.) seedling to five different concentrations of 3.00g, 5.00g, 7.00g, 8.00g and 10.00g per 2kg of soil and control in a randomized complete blocks design made up of ten replicates. Seeds were sown in a plastic pot and left for ten days to germinate before they were transplanted to polythene bags. Varying concentrations of NPK fertilizer (3.00g, 5.00g, 7.00g, 8.00g, and 10.00g per 2kg of soil) were applied. Number of leaflets, leaflets with lesions, and number of dead leaves were counted for twenty days after NPK fertilizer application. The findings revealed that higher concentration (8.00g and 10.00g) had unusual growth while 5.00g and 7.00g concentrations had more leaflets than the control. Moreover, increase in NPK fertilizer concentration resulted in the rise of leaves with lesions and dead leaflets. 10.00g had the highest number of leaves with lesions and increase in leaflets death. This result revealed that 5.00g and 7.00g per 2kg of soil is ideal for proper plant growth. Meanwhile, undue concentration leads to tissue destruction and physiological strain. An ideal NPK fertilizer application and carrying out soil test to ascertain nutritional composition is recommended.

Keywords: Dead Leaves, Leaflets Number, Lesion, NPK fertilizer, Tomato.

INTRODUCTION

The tomato, or *Lycopersicon esculentum* Mill. is a basic fruit and vegetable that has become increasingly popular over the past century (Umeohia & Olapade, 2024) and is acknowledged as one of the most significant cash and industrial crops worldwide (Massrie & Zewdie, 2025). It is a delicate, sensitive to compression fruit that is categorized as a berry in botany and is a member of the Solanaceae family (Alhaji *et al.*, 2025).

Even though tomatoes are never ending plant, some species are grown as annual crop in some parts of the world (Alhaji *et al.*, 2025). Beside potatoes, tomato is the second most important vegetable plant (Almekinders & Nuijten, 2026). Tomato is an essential ingredient in many indigenous foods and an important part of Nigerian nourishment in both rural and urban locations because it provides essential vitamins and minerals (Chukwuma *et al.*, 2026). It is rich in water soluble vitamins and minerals, essential amino acids, carbohydrates, and dietary fibre, less fat and calories, and a major source of vitamins A, B, C, iron, phosphorus, protein, edible oil, and lycopene (Singh *et al.*, 2025). Also, tomato can be manufactured into enhanced products as such juices, paste, puree, ketchup, and canned goods, or it can be eaten raw in salads, sauces, soups and meat and fish foods (Sen *et al.*, 2022). Tomato consumed everyday provides the body with elements such

as lycopene, carotene, and vitamins that reduces the risk of cardiovascular illness and cancer (Balali *et al.*, 2025). Furthermore, tomatoes have antioxidant properties that help with bone metabolism, asthma, cataracts and lessen the risk of prostate and breast cancer (Fagbohun *et al.*, 2023). Tomato is 18% of Nigeria's daily consumption (Olaniran *et al.*, 2022).

It is now regarded as an important cash and industrial crop in many parts of the world (Albertsen *et al.*, 2026). Tomato yield and consumption in the world have increase substantially in the last 25 years (Gomez *et al.*, 2026). About 3.9 million hectares of land yielded about 105 million tons of fresh fruit (Monday *et al.*, 2024). Prior to 1990, Nigeria supposedly produced 6 million tons of tomatoes yearly, which makes it the second largest producer in Africa after Egypt and ranked 13th in the world (Ambreen *et al.*, 2025). In Nigeria, tomatoes are grown in a diverse agro- ecological zones, which are semi-arid/arid in the northern part, humid in the southern part, and sub-humid in the middle belt (Idris *et al.*, 2025). It is mostly grown in the country's northern regions, at temperatures between 25 and 34 °C and latitudes between 7.5 °N and 13 °N. Nigeria is said to produce enormous amounts of fruits and vegetables, yet estimates of the nation's yearly production are sometimes given with erratic figures (Mukaila *et al.*, 2022).

The majority of arable farm land has insufficient soil fertility due to continuous cropping caused by land availability, which is one of the limiting factors affecting tomato yield (Echebiri *et al.*, 2025). The answer to this problem is the application of inorganic fertilizers. Inorganic fertilizers are also used by farmers to grow crops and vegetables (Roleda *et al.*, 2025). Several research have documented how applying these fertilizers increases the yield of several crops (Roleda *et al.*, 2025). One of the inorganic fertilizers that vegetable farmers commonly use is NPK (Musana *et al.*, 2025). Diminishing soil fertility is a crucial issue in a lot of African small holder farms, which has been worsen by constant agriculture without relevant soil fertilizer enhancement measures (Raheem *et al.*, 2025). However, the fact that chemical fertilizers can promote agricultural yields, their use is restricted as a result of their high cost, scarcity, nutritional imbalance, and acidic soil (Hayat *et al.*, 2026).

MATERIALS AND METHODS

Description of the experimental site: The experiment was conducted at an open space behind the Biological Sciences laboratory, Bosso Campus, Federal University of Technology Minna, the area lies on latitude 3° 20" East and longitude 11° 3" North.

Experimental Design: The experimental field was arranged in a randomized complete block design (RCBD) comprising five treatments: NPK (15:15:15) per 2kg and a control, each replicated ten (10) times.

Nursery Operation: The seeds were broadcasted in three plastic flower pots to germinate and grow for a period of two weeks (14 days). The plastic flower pots were filled with loamy clay soil obtained from the school farm.

Transplanting: Transplanting was done to nursery polythene bags containing loamy clay soil after one month. A set of ten polythene bags (26.8cm x 19.8cm) were assigned for each concentration of NPK fertilizer, and the control. They were left to stabilize for ten days before NPK fertilizer application.

NPK Fertilizer Application: NPK fertilizer was applied in a ring form 5cm from the seedling ten days after sowing with the exception of the control. Varying concentrations of 3.00g, 5.00g, 7.00g, 8.00g and 10.00g per 2kg of soil was applied to the tomatoes to ascertain the optimum NPK fertilizer for growth and development.

Statistically Analysis: Data collected were subjected to analysis of variance (ANOVA) using Duncan multiple range test (DMRT).

RESULTS AND DISCUSSION

Number of leaflets on the seedlings of *Lycopersicon esculentum* Mill treated to varying concentrations NPK Fertilizer:

The effect of NPK fertilizer concentration on the number of leaflets of *Lycopersicon esculentum* Mill seedlings is present in Figure 1 below. Prior to NPK fertilizer application, there was no significant difference ($p > 0.05$) in all the treatment, showing a uniform in the experimental seedlings. Whereas, after NPK application, there was an increase in the number of leaflets across all treatments. Across day five of NPK applications, seedlings showed higher leaflet numbers in contrast to the control but it was not statistically different in some cases. There was a significant difference ($p > 0.05$) in day ten and fifteen, where 5.00g treatment recorded the highest leaflets number followed by 7.00g and 3.00g treatment respectively. Day twenty after NPK application, 7.00g had the highest leaflets number, whereas the control recorded the lowest leaflets number all through the period of the study.

Number of leaflets on the seedlings of *Lycopersicon esculentum* Mill with lesions treated varying concentrations NPK Fertilizer:

The effect of NPK fertilizer concentration on the number of leaflets with lesions of *Lycopersicon esculentum* Mill seedlings were presented in Figure 2. Five days after the application of NPK fertilizer on the seedlings, there was no significant difference ($p > 0.05$) across the treatments. At day ten, the number of leaflets with lesions increased exponentially in all the treatments, especially seedlings with high treatments. Seedlings with 10.00g treatment showed the highest number of lesions, followed by 5.00g and 8.00g treatment respectively. At day twenty, all the seedlings treated with varying concentration of NPK fertilizer showed significantly higher lesions on their leaflets compared to the control.

Number of dead leaflets on the seedlings of *Lycopersicon esculentum* Mill treated to varying concentrations NPK Fertilizer:

The effect of NPK fertilizer concentration on the number of dead leaflets of *Lycopersicon esculentum* Mill seedlings were presented in Figure 3 below. There is no significant difference among treatments ten days after NPK fertilizer application. With higher NPK fertilizer concentrations at fifteen and twenty days, there was an increase in leaf mortality. 5.00g and 8.00g showed a considerable higher number of dead leaflets in day twenty of NPK fertilizer application, while that of the control treatment had the lowest values.

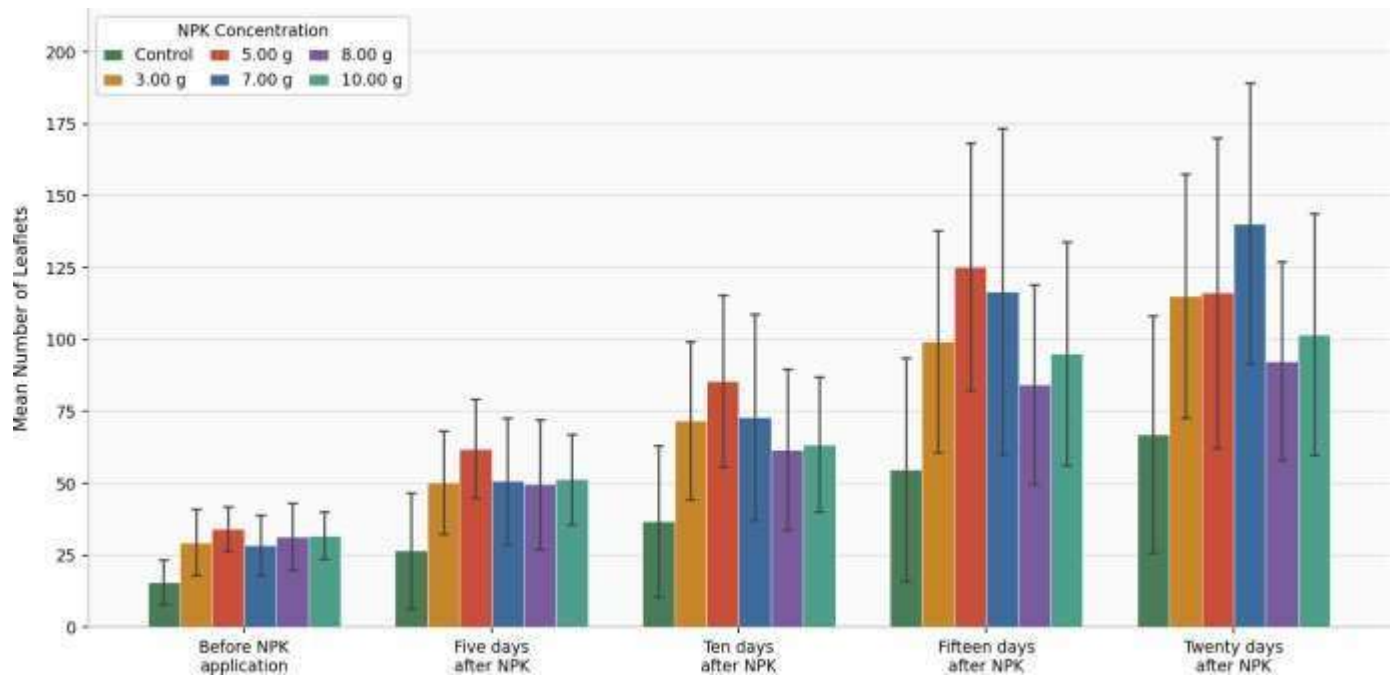


Figure 1: Mean Leaflet Counts of *Lycopersicon esculentum* Mill by NPK Concentration and Sampling Interval. (Error bars represent $\pm$ SD. Each colour represents one NPK treatment concentration.)

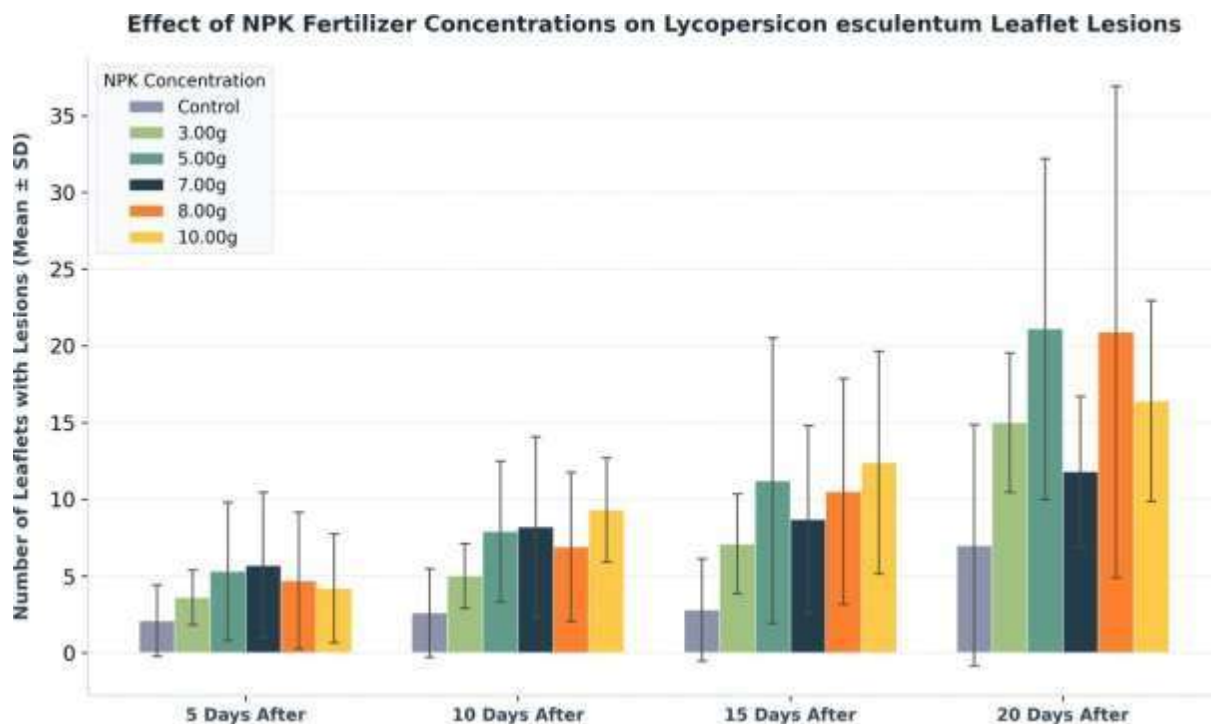


Figure 2: Mean number of leaflets with lesions across varying sampling intervals and NPK fertilizer applications. (Error bars represent Standard Deviation ($\pm$ SD))

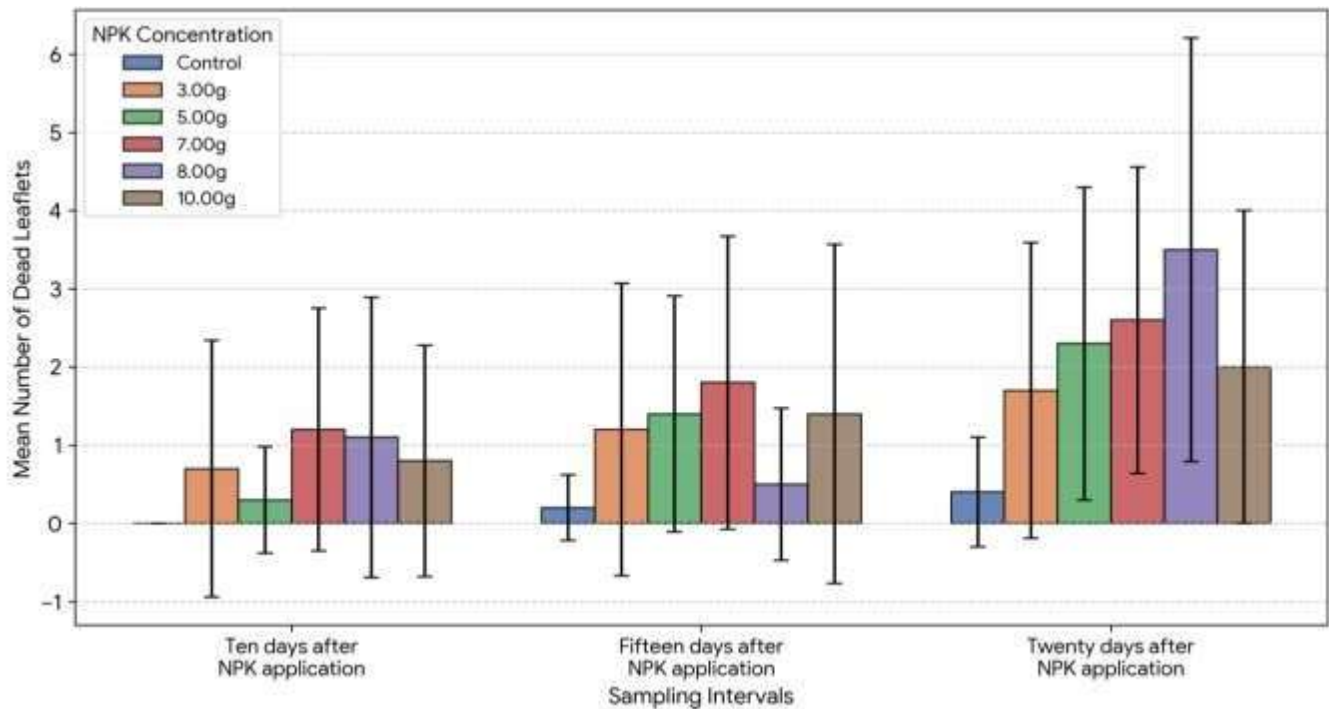


Figure 3: Clustered bar chart showing mean numbers of dead leaflets with standard deviation error bars.

The present study evaluated the response of *Lycopersicon esculentum* Mill (tomato) seedlings to varying concentrations of NPK fertilizer, focusing on leaflet production, lesion development, and leaflet mortality. The findings reveal a clear relationship between fertilizer application rate in relation to growth performance and physiological stress in tomato seedlings.

The results showed the effect of varying concentrations of NPK fertilizer on the seedlings of *lycopersicon esculentum* Mill (tomato) on the number of leaflets, lesion development on the leaflets, and leaflets mortality. The result revealed a relationship between NPK fertilizer application with growth development and physiological stress in tomato seedlings. Increase in the number of leaflets in all the treatment ascertains the importance nitrogen, phosphorus, and potassium with regards to plant growth. The 5.00g and 7.00g treatments showed that reasonable amount of fertilizer concentrations leads ideal nutrient accessibility, boosting vegetative growth. The decrease in the growth development as a result of high NPK fertilizer concentrations (8.00g and 10.00g) revealed nutrient imbalance. High fertilizer application interrupt nutrient absorption which causes osmotic tension, leading to restriction of plant growth. This is in agreement with the findings of Adaramoye *et al.* (2022), where the highest number of leaves were obtained from plants that received

60 kg N/ha and the least number of leaves was recorded for 90 kg N/ha. Also, this study is similar to the findings of Daocheng *et al.* (2023); who observed that N, P, and K play critical roles in plant growth and development. Under conditions of excesses or deficiencies of these major nutrients, plants respond by adjusting their morphology, physiology, photosynthetic ability, and metabolism.

The higher NPK fertilizer concentrations result in increase in leaflet lesions as a result of too much nutrient uptake, which negatively affect plant health. Soft plant tissues as a result of high nitrogen levels are prone to environmental stress and disease invasion. This aligns with the study of Daocheng *et al.* (2023), who observed that excesses or deficiencies of major nutrients makes plants adjust their physiological processes. Likewise, high number of dead leaflets with respect to higher NPK fertilizer concentrations imply that extended risk to undue nutrient uptake causes cellular damage, senescence, and tissue death. This agrees with the study of Daocheng *et al.* (2023), who observed that under conditions of excesses or deficiencies of these major nutrients, plants respond by adjusting their morphology, physiology, photosynthetic ability, and metabolism. Generally, the results showed a poise with regards to growth and plant health. Likewise, modest NPK fertilizer application improves vegetative

growth, too much NPK application cause detrimental effects, comprising elevated lesions and leaf mortality.

CONCLUSION

This research evidently proves that the application of NPK fertilizer has a substantial impact on both the growth performance and physiological state of tomato (*Lycopersicon esculentum* Mill) seedlings. The results reveal that reasonable amount of NPK fertilizer, especially at 5.00g and 7.00g concentrations support ideal vegetative growth as demonstrated by the elevated number of leaflets. This finding also substantiates the crucial part of nitrogen, phosphorus, and potassium in promoting plant development and enhancing general productivity.

Nevertheless, this research also divulges that extreme application of NPK fertilizer (particularly at 8.00g and 10.00g) leads to detrimental impact on plant vigour. This comprise of growing prevalence of leaflets lesions and elevated rates of leaf death. Such unfavourable result propose that undue nutrient supply can interrupt physiological stability, cause stress conditions, and eventually diminish plant vigour. The findings hence emphasize the fragile stability between nutrient adequacy and harmfulness in crop production.

Basically, whilst NPK fertilizer is essential for improving tomato growth, its application need to be cautiously controlled. Both deficient and extreme use NPK fertilizer can restrict plant performance, ensuring appropriate amount a vital determinant in attaining sound growth and viable.

RECOMMENDATIONS

NPK fertilizer should be applied at a reasonable rate to get ideal growth and to avoid physiological stress. Steer clear of excessive use of NPK fertilizer to avoid nutrient imbalance, heightened vulnerability to infection, and damage to leaf which eventually leads to diminished harvest quality. After NPK fertilizer application, farmer should closely monitor their crops for early detection of signs of stress such as leaf lesions or wilting, to enabling prompt adjustments. Also, carrying out soil analysis before applying NPK fertilizer is of vital importance to ascertain the exact nutrient levels and to avoid excessive use of fertilizer. Furthermore, follow-up studies should be done under natural conditions and across diverse soil types and ecological zones to substantiate these findings and expand

a region-specific guideline for applying the right type and amount of nutrients to crops.

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