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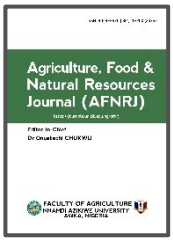

Original Article

Effect of nitrogen and potassium fertilizers on the growth and yield of watermelon in Ibadan, Nigeria

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Ibukunoluwa Abigael ADENIRAN[1], Odunayo Olamide AKINBILE[2], Gabriel Olabode ELUMALERO[3], Ayobami Mauyon SAMUEL[2], Tobi Israel AKINREMI[4] & Abiodun Abass OTUN[5]

[1] *Department of Crop and Horticultural Sciences, University of Ibadan*
[2]*Department of Soil Resources Management, University of Ibadan.*
[3]*Forestry Research Institute of Nigeria, Jericho, Ibadan, Nigeria*
[4]*Department of Nutrition and Dietetics, Ladoke Akintola University, Ogbomoso, Nigeria*
[5]*Livestock Bioresources Development Center, National Biotechnology Research and Development Agency, Iwo, Nigeria*

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ABSTRACT

Watermelon (Citrullus lanatus Thunb) is a widely cultivated and consumed fruit crop, though limited information exists on the nitrogen (N) and potassium (K) influence on its growth, yield, and fruit quality. This study evaluated the effects of N (urea) and K (muriate of potash) fertilizer rates on the growth and yield of watermelon under field conditions at Akerele Village, Ibadan, Oyo State, Nigeria. Three N levels (0, 30, and 60 kg ha^{-1}) and three K levels (0, 30, and 60 kg ha^{-1}) were arranged in a 3 × 3 factorial experiment using a split-plot design with three replications, giving nine treatment combinations. Data collected were subjected to analysis of variance (ANOVA), and significantly different treatment means were separated using Duncan's Multiple Range Test at $p < 0.05$. Nitrogen significantly increased the number of branches at 60 kg N ha^{-1} but had no significant effect on vine length, number of leaves, weight of vine, or fruit weight. Potassium significantly increased vine length and fruit weight, with 30 and 60 kg K ha^{-1} giving the highest fruit weight, but had no significant effect on the number of leaves or weight of the vine. The N × K interaction significantly affected vine length, vine weight, and fruit weight, with N_0K_2 and N_2K_2 giving the longest vines, N_1K_0 the highest vine weight, and N_0K_1 the highest fruit weight. Fertilizer application therefore produced only limited, parameter-specific improvements over the control. Soil nutrient analysis before fertilizer application is recommended to ensure efficient nutrient management and optimum watermelon production.

KEYWORDS: *Fertilizers, Interactions, Nitrogen, Potassium, Watermelon*

INTRODUCTION

Watermelons [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] belong to the family Cucurbitaceae and amongst the cucurbits, it is one of the widely cultivated and most consumed cucurbit in the world (Huh, *et al*., 2008; Prasanth, & Pradeepkumar, 2025). It is grown extensively in Africa and in tropical and sub-tropical countries of Europe and India (Kacha *et al*., 2017; Dhillon, 2025) and some of the major producers include China, Turkey, United States, Iran and Republic of Korea (Huh, *et al*., 2008; Dube *et al*., 2021; Deveci, 2025). Watermelon accounts for about 6.8% of the world area devoted to vegetable production (Goreta, *et al*., 2005; Xu *et al*., 2024). It ranks among the top five most frequently purchased and cultivated fruits globally with a per capital annual consumption of 7 kg (NWPB, 2008). There are over 1,200 varieties of watermelon

*Corresponding author: olamideodunayoakinbile@yahoo.com

worldwide (Miles, 2004; Zheng, 2024) and a wide variety of watermelons have been cultivated in Africa. These include 'Sugar-baby', 'Crimson Sweet', 'Charleston Gray', 'Chilean Black', 'Congo', 'Fairfax' and 'Tom Watson' (Dube *et al*., 2021; Sebati *et al*., 2025).

In Nigeria, its cultivation which was originally confined to the drier savannah regions of the North, is now gradually gaining ground in the southern parts of the country. It is a crop with huge economic importance to man (Mangila *et al*., 2007; Oloso *et al*., 2025). Its growth is favored by long period of warm, dry weather. A temperature ranging from 25^0C to 30^0C is ideal for growth and 25^0C is the best temperature for fruit setting of watermelon. Environmental factors such as temperature, sunlight intensity, and soil moisture availability during fruit development are known to significantly influence the flavour and sweetness of watermelon (Kumar & Reddy, 2021; Jeon *et al*., 2026).

Most vegetable crops require major nutrients especially nitrogen (N), phosphorus (P) and potassium (K) as well as micronutrients for proper growth and development (Anjorin *et al.,* 2018). These nutrients are available as chemical fertilizers (inorganic), manure and composts (organic fertilizer). Commercially available inorganic fertilizers include; N.P.K, Single Super phosphate (S.S.P), Murate of Potash (M.O.P) and Urea provide nutrients in readily available form for plant use (Marenya and Barrett, 2009; Swify *et al*., 2023). N-containing fertilizers are applied to fulfill the plant requirements and it is associated with high photosynthetic activity, vigorous vegetative growth and a dark green colour of the leaves, (John *et al*., 2004; Xu *et al*., 2026). About 30% to 40% of the fertilizer is utilized by the crops and the remaining amount of fertilizer is wasted by means of leaching and volatilization which results in loss of resources and environmental pollution (Hakeem *et al*., 2011). Potassium fertilizer also plays an important role in the functions of enzymes needed for the vital process, likewise in the growth and development of watermelon. (Wang *et al*., 2011; Nastari & Shirmohammadi, 2024; Hossain *et al*., 2026).

Most soils in Nigeria are inherently low in fertility, when watermelons are planted in a very heavy soil, the plants develop slowly and fruit size and quality are usually inferior (Abdel *et al*., 2005; Kaur *et al*., 2025). Watermelons grow best on sandy loam soils, slightly acidic in pH, well drained and rich in organic matter content (Kaur *et al*., 2025; Oloso *et al*., 2025). The major constraint to crop growth and yield is soil fertility, and peasant farmers in Nigeria depend on inorganic fertilizer for the restoration of lost nutrients, but its continuous use can lead to soil acidity. Given this dependence on inorganic fertilizer and its potential drawbacks, it is important to understand the specific role of individual nutrients The long-term use of NPK fertilizer has a depressing effect on yield which can cause a decline in fruit number and delay in fruit setting with subsequent delay in ripening, leading to the proliferation of vegetative parts (Krasilnikov *et al*., 2023; Friedman *et al*., 2026).

Nutrients play a very important role in growth and development of watermelon and it is also one of the main factors which govern the yield and quality of fruit of watermelon (Kacha *et al*., 2017). The first limiting factor required to promote growth and to increase the size of the fruit of watermelon is Nitrogen (N). Nitrogen application markedly influences the vegetative growth, bearing habit, yield and quality of fruits and also helpful for the production of female flowers (Kacha *et al*., 2017). Potassium (K) is an essential mineral element for plants as it is involved in many biochemical and physiological processes vital to plant growth, yield, quality and stress (Praveen & Singh, 2024; Houmani & Corpas, 2026). It is also involved in stomata regulation of transpiration and photosynthesis, photo-phosphorylation, transportation of photo assimilates from source tissues via the phloem to sink tissues, enzyme activation, and turgor maintenance and stress tolerance (Khare *et al*., 2025; Pandey & Saharan, 2025).

While previous studies have examined Nitrogen and Potassium fertilization of watermelon separately, few have evaluated their combined factorial effects, together with their interaction, under the specific soil and climatic conditions of Ido Local Government Area, Oyo State. Hence, this study addresses that gap by testing the growth and yield response of watermelon to N and K rates applied singly and in combination on this soil type. The study was carried out to determine the effect of various rates of nitrogen and potassium fertilizer on the growth and yield of watermelon.

MATERIALS AND METHOD

Experimental Location and Materials

The experimental site was located at Akerele Village Road, Ido, Ibadan (Latitude: 7° 10' 52" N and Longitude: 3° 49' 1" E), Ido Local Government Area, Oyo State. It is located in the rainforest agro-ecological zone, with rainfall of over 1800mm annually and a temperature of 25 º C – 35 º C. It has two distinct seasons- rainy April to October and Dry November to March. The field has been under cultivation of crops like maize, sweet potato, cassava, cowpea, etc. during the cropping season. Akerele Village in the Ido Local Government Area of Ibadan operates under a tropical wet and dry climate. Its weather patterns are governed by specific macro-level and localised climatic factors typical of southwestern Nigeria.

The materials used for the experiment include Hybrid Seeds of Watermelon (Heracles) obtained from Agro-tropics, inorganic fertilizers (Urea, Murate of Potash and Single Super Phosphate) which was obtained from the Department of Agronomy and International Institute of Tropical Agriculture (IITA) respectively.

Experimental Design

The experiment was a 3 × 3 factorial arranged in a split-plot design with three replications (blocks). Nitrogen rate was assigned to the main plots and potassium rate was assigned to the sub-plots within each main plot, giving nine treatment

combinations per replicate. The main plots and sub-plots were randomly allocated within each replicate. The field area of 768 m^2 was marked and laid out into plots and blocks, each plot measured 4 m × 4 m with 1 m spacing between plots and blocks (Figure 1), giving a total number of 27 plots.

Experimental Treatments

The treatments applied were Urea (N) and Murate of Potash (K_2O) at 0, 30 and 60 kg/ha with a basal application of Single Super Phosphate (SSP) to all the plots at 45 kg P_2O_5/ha. The treatment combinations for N and K were carried out such that N was the Main plot factor while K was the sub plot factors. The treatment combinations were presented in Table 1. The 0, 30, and 60 kg ha^{-1} N and K rates used in this study were chosen to evaluate a practical, farmer-affordable fertilizer range recommended for the study soil, and to determine whether comparatively modest rates could still elicit a measurable growth and yield response. The full basal SSP dose was applied once at planting, while the N and K treatments were applied in two split doses, at planting and at four weeks after planting, by side placement about 5 cm from the base of each plant.

Pre-planting and Planting Operations

Pre-planting Practices

A pre-planting desiccation and systemic herbicide (Glyphosate) was applied at recommended rate to the existing vegetation on the field and was left for two weeks before land clearing. The land was tilled manually with hoe and flat ridges were made for planting.

Planting

The seeds were sown directly into the soil at a minimal depth and were covered slightly with soil. Sowing was done at one seed per hole with a spacing of 1 m × 1 m. Vacant stands after germination and emergence was re-planted in order to have the desired plant population. This was done because gap-filling by re-planting rather than thinning from extra seeds sown per hole was used to maintain plant population, a small difference in plant age of a few days existed between original and re-planted stands; this is noted as a limitation of the establishment method.

Agronomic Practices

Weeding (Rogueing) was carried out after 15 days of planting and proper weeding was done manually at about 1 month after planting. Watering was also carried out due to inconsistent rainfall and insecticide (Lambda) was applied at 1 L/ha at early days of planting due to high susceptibility of watermelon to pests and diseases.

Data Collection

The following parameters were collected on watermelon fertilizer trials at 4, 6, and 8 weeks after planting for the growth parameters (number of branches, number of leaves, and vine length (cm)), while weight of vine (kg) and fruit weight (kg) were recorded once at harvest, about 12 weeks after planting

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using SAS 9.4 Software and significantly different treatment means were separated using Duncan's Multiple Range Test at ($p \leq 0.05$)

Table 1: Treatment Combinations with their Description

Treatments	Description
N_0K_0	0 Kg N/ha × 0 Kg K/ha
N_0K_1	0 Kg N/ha × 30 Kg K/ha
N_0K_2	0 Kg N/ha × 60 Kg K/ha
N_1K_0	30 Kg N/ha × 0 Kg K/ha
N_1K_1	30 Kg N/ha × 30 Kg K/ha
N_1K_2	30 Kg N/ha × 60 Kg K/ha
N_2K_0	60 Kg N/ha × 0 Kg K/ha
N_2K_1	60 Kg N/ha × 30 Kg K/ha
N_2K_2	60 Kg N/ha × 60 Kg K/ha

N – Nitrogen, K – Potassium, ha – Hectare

RESULTS

Pre-Planting Physical and Chemical Property of the Soil on the Study Site

The result of the physical and chemical properties of the soil, prior to treating the soil with fertilizer and sowing of watermelon seeds is shown in Table 2. Soil pH was determined in water (1:2 soil-water ratio) using a glass electrode pH meter; organic carbon by the Walkley-Black wet oxidation method; total nitrogen by the micro-Kjeldahl method; available phosphorus by the Bray-1 method; exchangeable cations by ammonium acetate extraction followed by flame photometry (K) and atomic absorption spectrophotometry (Ca, Mg); and particle size distribution by the hydrometer method.

The result of the analysis shows that the soil on the experimental site is sandy clay. The organic carbon content of the soil was 10.02 g/kg with total nitrogen of 1.6 g/kg and Potassium level was 0.3 cmol/kg and pH was 6.9. Other nutrients and the particle size distribution are as presented in the table. The soil textural class was sandy clay loam.

Effects of Nitrogen and Potassium Rates on Growth and Yield Parameters of Watermelon

The results on the effects of application rates of nitrogen over the rates of potassium application on yield parameters of watermelon are presented in Table 3. The effects of Nitrogen rates over Potassium for number of branches and vine length were significant while the effects on Number of leaves and Weight of Vine were not significant. Application of 60 kg N/ha resulted in higher number of leaves than others. The Vine Length as a result of No Nitrogen application (0 kg N/ha) has a

longer vine length but when compared with 60 kg N/ha was not significant 30 kg N/ha resulted in higher weight of vine, though this was not significantly different from others.

The results on the effects of rates of application of potassium across the rates of nitrogen on the growth and yield parameters of watermelon are also presented in Table 3**.** The effects of Potassium rates over Nitrogen rates for number of branches and vine length were significant while the effects on Number of leaves and Weight of Vine were not significant. Application of 30 kg K/ha resulted in higher number of branches than others. The vine length as a result of application of 60 kg K/ha and 0 kg K/ha produces longer vine length when compared to others. No application of K_0 produces higher weight of vine but not significantly different from others. The fruit weight at 30 kg K/ha and 60 kg K/ha was significantly higher when compared to others.

Comparing the two nutrients directly (Tables 3), both Nitrogen and Potassium significantly affected number of branches and vine length but not number of leaves or weight of vine. Nitrogen's main effect on fruit weight was not significant, whereas Potassium significantly increased fruit weight at 30 and 60 kg ha^{-1}, indicating that Potassium had a comparatively stronger influence on fruit weight than Nitrogen under the conditions of this study.

Interaction of Nitrogen and Potassium Rates on Vine Length, Weight of Vine and Weight of Fruits of Watermelon.

The results of the interaction of Nitrogen and Potassium on the vine length, weight of vine and weight of fruits of watermelon of watermelon are presented in Table 4 The interaction of Nitrogen and Potassium in respect to vine length shows that N_0K_2 and N_2K_2 is significantly higher when compared to the vine length of N_0K_1, N_1K_1, N_1K_2, and N_2K_1. Although the vine length of N_0K_2 and was not significantly different than the vine length of N_0K_0, N_1K_0 and N_2K_0 respectively. The interaction of N × K rates with respect to the weight of vine at N_1K_1 was found to be significant while the remaining interactions were not significant. Meanwhile the interaction of N × K rates on the fruit weight show that N_0K_1 were significantly different from the fruit weight of N_0K_0 and N_2K_1 but not significantly different from N_0K_2, N_1K_0, N_1K_1, N_1K_2, N_2K_0 and N_2K_2.

Table 2: Pre- Planting Analysis of Some Physical and Chemical Properties of the Soil Taken From 0 – 15 cm Depth

Parameters	Values	Critical Value
pH (H_2O)	6.9	6-6.5
Organic C (g/kg)	10.02	1.5
Total N (g/kg)	1.6	1.5
Avail. P (mg/kg)	0.55	17
Exchangeable Cations (cmol/kg)		
Ca	0.8	3.80
Mg	0.7	1.9
K	0.3	0.24
Micronutrients (mg/kg)		
Mn	43.1	10.3-15.7
Fe	27	3-4.5
Cu	2	6.35
Zn	5	5-10
Particle size distribution (g/kg)		
Sand	660	
Silt	110	
Clay	230	
Textural Class	Sandy Clay Loam	

Organic C – Organic Carbon, Total N – Total Nitrogen, Avail P – Available Phosphorus, Ca – Calcium, Mg – Magnesium, K – Potassium, Mn – Manganese, Fe – Iron, Cu – Copper, Zn - Zinc

Table 3: Effects of Nitrogen and Potassium Rates on Growth and Yield Parameters of Watermelon

Nitrogen Rates	Potassium Rates	Number Branches	Number of Leaves	Vine length (cm)	Weight of vine (kg)	Fruit weight (kg)
N_0	K_1	4.44	155.6	341.4	0.296	4.43
N_1	K_2	4.44	138.7	283.2	0.426	4.572
N_2	K_3	4.89	141.3	318.1	0.373	4.551
LSD	LSD	0.418	NS	44.91	NS	NS

N – Nitrogen, K – Potassium, LSD – Least Significant Difference, NS – Not Significant

Table 4: Interaction of Nitrogen and Potassium Rates on Vine Length and Weight and Weight of Fruits of Watermelon

Treatment	Vine length (cm)	Vine weight (kg)	Fruit weight (kg)
N_0K_0	$351.33^{ab} \pm 57.752$	$0.3067^{b} \pm 2.000$	$3.39^{c} \pm 0.020$
N_0K_1	$277.67^{bcd} \pm 0.020$	$0.24^{b} \pm 0.020$	$5.6767^{a} \pm 0.020$
N_0K_2	$395.33^{a} \pm 0.020$	$0.34^{b} \pm 0.020$	$4.2233^{abc} \pm 0.020$
N_1K_0	$330.33^{abc} \pm 0.020$	$0.6367^{a} \pm 0.020$	$4.4067^{abc} \pm 0.020$
N_1K_1	$231.33^{d} \pm 120.089$	$0.3467^{b} \pm 0.020$	$4.5233^{abc} \pm 0.020$
N_1K_2	$288^{bcd} \pm 2.00$	$0.2933^{b} \pm 0.020$	$4.7867^{abc} \pm 0.020$
N_2K_0	$321.33^{abc} \pm 0.020$	$0.3467^{b} \pm 0.020$	$4.7167^{abc} \pm 0.020$
N_2K_1	$243.33^{cd} \pm 0.020$	$0.38^{b} \pm 0.020$	$3.83^{bc} \pm 0.012$
N_2K_2	$389.67^{a} \pm 0.020$	$0.3933^{ab} \pm 0.020$	$5.1067^{ab} \pm 0.020$

N – Nitrogen; K – Potassium

DISCUSSION

Findings from this study showed that the application of Nitrogen and Potassium fertilizers had varying effects on the growth and yield performance of watermelon. The result of the pre-planting soil analysis showed that the experimental soil was sandy clay loam with moderate soil pH and relatively low nutrient status in some essential elements. This confirms the importance of fertilizer application in improving soil fertility and enhancing watermelon productivity (El-Kersh *et al*., 2026; Wang *et al*., 2026). As this soil analysis was conducted before any fertilizer was applied, it reflects the site's inherent fertility status rather than a fertilizer effect; it is presented here only to justify the need for the N and K treatments imposed. The sandy clay loam texture of the soil also favoured watermelon cultivation because watermelon performs better in well-drained soils rich in nutrients (Nethra *et al*., 2024; Pontsho *et al*., 2025).

Studies reports that the application of Nitrogen fertilizer significantly influenced some of the growth parameters of watermelon, particularly the number of branches and vine length (Yechshanova *et al*., 2024; Wang *et al*., 2026). This is evident in this study which reports increase in number of branches at 60 kg N/ha suggesting that Nitrogen promoted vegetative growth and enhanced cell division and leaf development. This agrees with the findings of Kacha *et al.,* (2017), who reported that Nitrogen plays an important role in vegetative growth and development of watermelon. Nitrogen is a major component of chlorophyll and proteins, thereby improving photosynthetic activities and vigorous vine growth.

However, the result also showed that plots without Nitrogen application produced longer vine lengths than some fertilized plots. This may be attributed to the initial nutrient status of the soil rather than to an excessive Nitrogen supply, even at this comparatively low rate, the highest N level did not translate into the greatest vine length, suggesting that other factors such as soil moisture and inherent soil fertility also influenced vine elongation. Similar reduced vegetative response at higher Nitrogen levels was reported by Chedha (2006), Nethra *et al.,* (2024) and Khare *et al.,* (2026) who stated that excessive Nitrogen under high temperature conditions may promote excessive vegetative growth and reduce reproductive performance.

The effects of Potassium fertilizer on watermelon growth and yield parameters also showed significant variations. The application of 30 kg K/ha resulted in the highest number of branches while 60 kg K/ha improved vine length and fruit weight. Potassium is known to regulate water movement, enzyme activation, translocation of assimilates and fruit development in plants (Liaqat *et al*., 2022; Cao *et al*., 2025). The improvement in fruit weight observed at higher Potassium levels may be due to the role of Potassium in carbohydrate synthesis and transportation of photosynthates to developing fruits. This observation is consistent with the findings of Jifon and Lester (2009), Hossain *et al.,* (2025) and Liu *et al.,* (2025) who reported that Potassium enhances fruit quality and fruit setting in watermelon.

The interaction between Nitrogen and Potassium fertilizers significantly affected vine length, vine weight and fruit weight. The combinations N_0K_2 and N_2K_2 produced the highest vine lengths, indicating that the combined presence of high Potassium with either the lowest or the highest Nitrogen level, rather than Potassium acting alone, favoured vine elongation. Meanwhile, the highest vine weight recorded at N_1K_0 suggests that moderate Nitrogen application without additional Potassium favored vegetative biomass accumulation. Jiang (2026) also reported that nitrogen fertilizer supported vegetative growth of watermelon as conformed in this study.

The fruit weight response further revealed that N_0K1 produced the highest fruit weight among the treatment combinations. This indicates that moderate Potassium application without Nitrogen supplementation may have enhanced fruit development more effectively under the soil conditions of the study area. Hossain *et al* (2025) and El Kersh *et al* (2026) also reported these same findings indicating that potassium enhances fruit formation in watermelon. The result implies that excessive Nitrogen may not always translate to increased fruit yield, especially when soil nutrient balance and environmental conditions are considered.

Generally, the findings of this study support the assertion that balanced fertilizer application is essential for optimum growth and yield of watermelon. (Yechshanova *et al*., 2024; Khare *et al.,* (2026); Wang *et al*., 2026). Both Nitrogen and Potassium play complementary roles in vegetative growth, flowering, fruit setting and fruit development. However, excessive or imbalanced fertilizer application may result in excessive vegetative growth with little improvement in yield.

CONCLUSION AND RECOMMENDATION

The key insight from this study is that Nitrogen and Potassium influenced watermelon growth and yield only in a parameter-specific and interactive manner rather than through a simple, additive dose-response, so no single rate of either nutrient produced a uniform improvement across all growth and yield traits. This indicates that fertilizer recommendations for watermelon on soils similar to the study site should be guided by the specific yield component of interest and, ideally, by prior soil nutrient testing, rather than by a blanket high-rate application.

The study therefore emphasizes the need for proper soil testing before fertilizer application in order to determine the nutrient status of the soil and the appropriate fertilizer rates required for optimum watermelon production. Farmers should adopt balanced nutrient management practices to improve crop yield, maintain soil fertility and reduce unnecessary fertilizer losses that may lead to environmental pollution.

Based on the specific results of this study, a rate of about 30 kg N ha^{-1} combined with 30–60 kg K ha^{-1} is recommended for watermelon production on soils similar to the study site, as this range gave the most consistent improvements in fruit weight and vine weight without the diminishing returns observed at the higher combined N-K rates.

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Authors' Contributions

OOA & GOE managed all the corrections and proofread the work. IAA & AAO worked on the materials and methods; AMS & TIA engaged in writing the original draft. All authors contributed from the beginning to the end and all approved the final manuscript.

Ethical Statement

Not applicable

AI Declaration Statement

The authors declare that no Artificial Intelligence (AI) tools were used in the generation, analysis, interpretation, or writing of this manuscript.

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