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Effects of tuber size and NPK 15-15-15 fertilizer rates on the performance of tigernut (*Cyperus esculentus* L) in Southwestern Nigeria

[1,2]Olatinwo, G.O. [1]Olabode, O. S. and [*1]Kolawole, G. O.
[1]*Department of Crop Production and Soil Science, PMB 4000, Ladoke Akintola University of Technology, Ogbomoso, Nigeria*
[2]*Department of Crop and Animal Science, Ajayi Crowther University, Oyo*

***Corresponding Author:** *ogkolawole@lautech.edu.ng*

Abstract

*Tigernut (*Cyperus esculentus L.*) is a highly nutritious and economically valuable crop with diverse food and industrial uses. Despite its growing demand in Nigeria, there is inadequate research on the appropriate size of the planting propagule and fertilizer requirements. Therefore, the performance of tigernut was evaluated at the Teaching and Research Farm, Ajayi Crowther University, Oyo, in 2025 in response to the size of the tuber planted and NPK 15:15:15 mineral fertilizer rates. Two pot experiments were laid out in Completely Randomized Design with three replications. The first assessed the influence of tuber sizes (Big (0.89 g), Medium (0.52 g), and Small (0.32 g)) and the second evaluated the response of tiger nut to NPK 15:15:15 fertilizer rates (0, 150, 300, and 450 kg/ha). Data were collected on sprouting, plant height, number of tillers, growth vigor, number and weight of tubers. Data were subjected to Analysis of Variance, and treatment means were separated by Duncan's Multiple Range Test at 5% probability level. Tuber size had no significant effect on sprouting but significantly ($p \leq 0.005$) influenced plant height, vigor, and yield. Big-sized tubers produced the tallest plants (69 cm), highest growth vigor (3.7), and highest tuber weight (48.5 g/pot), while small-sized tubers produced plants with the shortest height (46 cm), vigor (2.2) and tuber weight (24.8 g/pot). NPK fertilizer rates significantly influenced growth parameters, with 450 kg/ha NPK producing the tallest plants (86.1 cm), while 150 kg/ha produced the highest number of tubers (98) and weight (107 g/pot). The control produced the shortest plant (73.9 cm), and the least number of tubers (66.0). In conclusion, big-sized planting tubers and moderate fertilizer rate; 150 kg/ha NPK 15:15:15 were appropriate agronomic practices for optimal growth and yield of tigernut in the study area.*

Keywords: Growth Vigor, Tiger nut, Tuber size, NPK 15:15:15, Tuber weight

Introduction

Over the past decade, the agricultural sector in Nigeria has witnessed a gradual shift towards the commercialization of non-traditional cash crops, with tiger nut (*Cyperus esculentus* L.) emerging as a promising option for smallholder farmers (Ayambila *et al*., 2023; Novor, and Donkor, 2024). Tiger nut farming, primarily concentrated in northern Nigeria has gained attention due to its adaptability to semi-arid conditions and low fertile soil (Tan *et al*., 2024), high nutritional value, and expanding market demand both domestically and internationally (Munialo *et al*., 2024). The crop, known for its resilience to drought and minimal input requirements, has the potential to significantly enhance rural livelihoods and contribute to economic diversification (Wongnaa *et al*., 2019). However, despite its increasing importance, the economic viability and impact of tiger nut farming remain underexplored, particularly in the context of smallholder farmers (Novor and Donkor, 2024). There is limited research on the specific agronomic requirements of tigernut, such as size of planting propagule, planting depth, spacing, fertilizer rate, and optimal plant population density. These factors significantly influence tuber yield and quality, yet smallholder farmers continue to rely on traditional methods such as planting of mixed sizes of tubers, inadequate or non-application of fertilizers among others, leading to inconsistent and often suboptimal outcomes.

According to Timon *et al.* (2019), the lack of standardized agronomic protocols for tigernut cultivation results in low productivity compared to its potential in tropical agro-ecologies. Farmers commonly use mixed-sized tubers as planting materials without understanding the impact of tuber size on germination and crop performance. Larger or uniform-sized tubers may significantly improve stand establishment and yield, yet there is limited empirical evidence guiding this practice. Fadeyi *et al*. (2023) identified that tuber size strongly affects growth vigor and yield in tuber crops but remains an overlooked factor in tigernut cultivation.

Tigernut cultivation thrives on well-drained soils, yet little attention has been given to the impact of soil fertility and nutrient management on yield quality. The indiscriminate application of fertilizers or neglect of soil nutrient replenishment has led to poor productivity. Accordingly, Fabunmi and Amalahu *et al*. (2019) advocated for site-specific nutrient management practices to enhance soil fertility and productivity in tigernut farming. Addressing these challenges through the development of suitable agronomic practices, will contribute to enhanced tigernut productivity and profitability in Oyo State and beyond. The need for improved production techniques to unlock the economic value of tigernut therefore, cannot be overemphasized. Therefore, the objectives of these studies were to evaluate the effects of tuber size and NPK 15:15:15 rates on the sprouting, growth, and yield performance of tigernut.

Materials and Methods

The pot experiments were conducted at the Teaching and Research Farm, Ajayi Crowther University, Oyo, Oyo State, Nigeria. Soil sample was collected (0-15 cm depth), air-dried, ground, sieved (4 mm), and weighed into pots (20 kg/ pot).

The study consisted of two experiments. The first experiment which was laid out in a Completely Randomized Design (CRD) with three (3) replicates had three tuber size treatments: Big (0.89 g), Medium (0.52 g), and Small (0.32 g).

The second experiment which was also laid out as CRD with three replicates had three rates of NPK 15-15-15 fertilizer (150, 300, and 450 in kg/ha) with a control (no fertilizer) for comparison.

Cultural Practices

Twenty kilogram each of the prepared soil was weighed into each pot. Each treatment was assigned to three pots replicated three times. The soil in each pot was watered to field capacity and left to equilibrate for two weeks. Four tigernut tubers were planted per pot (for the first experiment, planting was based on the different tuber sizes, while for the second experiment, big-sized tubers were used) and the seedlings were thinned to two plants at two weeks after planting. Watering and rouging of weeds were done as and when due. Fertilizer was applied to designated pots in a ring form about 5 cm away from the base of the plants at two weeks after planting.

Data Collection

Data were recorded on the following parameters:

- Sprouting percentage
- Plant height: (measured at two-week interval from 4 WAP),
- Number of tillers (measured at two-week interval from 4 WAP)
- Growth Vigor (Scale 1–5: 1= poor/stunted; 5=excellent/robust).
- Total number of tubers, fresh tuber weight, and fresh vegetative weight were recorded at harvest.

Data Analysis

Data were subjected to analysis of variance using SAS (2009) and treatment means were separated using the Duncan's Multiple Range Test at $p \leq 0.05$.

Results

Experiment 1: Growth parameters, plant vigor, and tuber yield of tigernut

The tuber size had no significant effect on the sprouting percentage of tigernut. All the tuber sizes planted sprouted 100% (Data not shown). However, big-sized tubers gave the crop early establishment advantage over the other tuber sizes. The big-sized tuber significantly influenced the tallest plants (52.1 cm) and most number of tillers (9) at 4 WAP, while the small-sized tuber had the shortest plants (39.2 cm) and the least number of tillers (7). There were no significant differences on these parameters at 6 and 8 WAP (Table 1).

Plant vigor was significantly affected by the tuber size planted. Big-sized tuber plants were healthy having good leaf production with light green color, thick tillers, with vigor score of 3.7, while small-sized tuber shows poor vigor; tiny leaves, weak stems, and slightly pale leaves with a vigor score 2.2 (Table 2).

Small-sized tubers produced significantly the highest number of tubers (78.0) while medium-sized tuber produced the least number of tubers (46.0). Big-sized tuber produced significantly the highest tuber weight (48.5 g/pot) while small-sized tuber produced the least (24.8 g/pot). (Table 2).

Table 1: Effects of tuber size on the height and number of tillers of tiger nut plants in Oyo, 2025.

Tuber size	Plant height (cm)			No. of tillers/plant		
	Weeks after planting			Weeks after planting		
	4	6	8	4	6	8
Big	52.1^{a}	61.8^{a}	69^{a}	9.0^{a}	10.0^{a}	10.0^{a}
Medium	44.5^{b}	59.4^{a}	67.2^{a}	8.0^{ab}	8.0^{a}	10.0^{a}
Small	39.2^{c}	56.4^{a}	62.7^{a}	7.0^{b}	9.0^{a}	10.0^{a}

Mean in the same column with different letter (s) superscripts are significantly different from each other according to Duncan Multiple Range Test $p \leq 0.05$

Table 2: Effects of tuber size on the number of tubers, weight of tubers and vigour score of tigernut plant in Oyo, 2025

Tuber size	No. of tubers/pot	Weight of tubers (g/pot)	Vigor score
Big	56.0^{b}	48.5^{a}	3.7^{a}
Medium	46.0^{b}	42.7^{a}	3.0^{b}
Small	78.0^{a}	24.8^{b}	2.2^{c}

Mean in the same column with different letter (s) superscripts are significantly different from each other according to Duncan Multiple Range Test $p \leq 0.05$

Experiment 2: Growth parameters, plant vigor, and tuber yield of tigernut

Fertilizer rates had no significant effects on the sprouting of tigernut. All fertilizer rates produced 100% sprouting at 8 days after planting (Data not shown).

Application of NPK at 450 kg/ha produced significantly the tallest tigernut plants (62.2 cm) at 4 WAP while the control produced the shortest plant height (49.1), There was no significant difference in the plant heights of the other fertilizer rates at 6 and 8 WAP except the control which produced significantly shortest plants (Table 3). Application of NPK at 300 kg/ha produced significantly the most number of tillers (12) at

4 WAP, while 450 kg/ha significantly influenced the most number of tillers (14.0 and 15.0) at 6 and 8 WAP, respectively. The control produced the least number of tillers (9.0, 9.0 and 10.0) throughout the sampling period (Table 3)

Application of NPK at 300 kg/ha produced the highest plant vigor score (5.0) while the control had the least value (3.4) (Table 4).

Application of NPK at 150kg/ha produced significantly highest number of tubers (98.0), weight of tubers (107.0 g/pot) and while the control (0 kg/ha) produced least number and weight of tubers (66.0, 58.5 g/pot) respectively (Table 4).

Table 3: Effects of NPK fertilizer rates on the height and number of tillers of tigernut plant in Oyo, 2025.

Fertilizer rate (kg/ha)	Plant height (cm)			No. of tillers/pot		
	Weeks after planting			Weeks after planting		
	4	6	8	4	6	8
Control	49.1^{c}	62.7^{b}	73.9^{b}	9.0^{b}	9.0^{b}	10.0^{b}
150	57.4^{b}	75.2^{a}	81.7^{a}	10.0^{ab}	13.0^{a}	14.0^{a}
300	57.8^{b}	78.3^{a}	84.3^{a}	12.0^{a}	14.0^{a}	15.0^{a}
450	62.2^{a}	82.0^{a}	86.1^{a}	10.0^{ab}	14.0^{a}	15.0^{a}

Mean in the same column with different letter (s) superscripts are significantly different from each other according to Duncan Multiple Range Test $p \leq 0.05$

Table 4: Effects of fertilizer rates on the number of tubers, weight of tubers and plant vigor of tiger nut plant in Oyo, 2025.

Fertilizer rate (kg/ha)	Number of tubers/pot	Weight of tubers (g/pot)	Vigor score
Control	66.0^{b}	58.5^{c}	3.4^{b}
150	98.0^{a}	107.0^{a}	4.7^{a}
300	97.0^{a}	102^{ab}	5.0a
450	87.0^{a}	85.1^{b}	4.8a

Mean in the same column with different letter (s) superscripts are significantly different from each other according to Duncan Multiple Range Test $p \leq 0.05$

Discussion

Effect of tuber size on the performance of tigernut

The observation in this study that the tuber sizes (big, medium and small) exhibited similar sprouting percentage could be due to the fact that environmental factors such as temperature, aeration, and growth medium mostly modify germination behavior, often reducing size-related differences. This is supported by the findings of Liu (2024) who reported that while tuber size affected the release of dormancy and sprouting rate, final germination percentages were similar across all sizes, suggesting that size may not directly influence germination. Big-sized tigernut tubers consistently outperformed medium and small-sized tubers in terms of plant height, number of tillers, plant vigor, and tuber weight. This influence on plant growth was pronounced during the early growth stage and by the end of the observation period, all tuber sizes eventually exhibited a similar growth trend. This trend can be explained by the fact that large tubers possess higher carbohydrate reserves and more viable buds, which enhanced early sprouting and rapid tiller initiation, giving them a temporary early growth advantage (Liu *et al.,* 2024). This superior performance of big-sized tubers has been consistently reported in several studies, which attributed the advantage to their higher nutrient reserves and greater number of viable buds that promote early shoot elongation, rapid root establishment and vigorous vegetative development. According to Tucho *et al.* (2024), larger tubers exhibit better physiological efficiency, resulting in taller plants and enhanced photosynthetic activity during early growth stages. Similarly, Zheng *et al.* (2024) reported that big tigernut tubers produced broader and more productive canopies, which increased light interception and improved assimilate production for storage in developing daughter tubers. Liu (2024) further observed that bigger tubers possess more viable buds and stronger sprouting capacity, leading to increased tiller formation and ultimately higher tuber yields. Likewise, Fabunmi *et al.* (2016) confirmed that big tigernut tubers demonstrated superior sprouting ability. Although, the magnitude of the size advantage may be influenced by environmental and agronomic factors such as soil fertility, moisture availability, planting density and nutrient management, the consistent evidence suggests that selecting large planting tubers remains a highly effective and practical agronomic strategy for enhancing early establishment, promoting vigorous vegetative growth and achieving higher tuber productivity in tigernut cultivation.

The observation that the number of tubers was evidently enhanced by small-sized tuber was probably due to the plant's compensatory reproductive strategy under limited initial reserve conditions. Small tigernut tubers often generate more numerous but smaller offspring tubers because their low carbohydrate and nutrient reserves shift carbon allocation towards producing more tillers and more tuber initiation sites, rather than enlarging fewer tubers. This aligns with the findings of Fabunmi *et al.* (2016), who reported that small tubers can result in a higher count of new tubers, though with reduced individual mass. However, Liu (2024) indicated that medium or big tubers often produce superior individual tuber weights.

Effect of NPK 15:15:15 fertilizer rates on of the performance of tigernut

Application of NPK 15:15:15 fertilizer enhanced the height of tigernut plants compared to the control (no fertilizer). This might be as a result of balanced and sufficient supply of nitrogen (N), phosphorus (P) and potassium (K), which are vital for vigorous vegetative growth. Nitrogen promotes leaf and stem elongation, phosphorus supports robust root establishment, and potassium enhances nutrient translocation and water regulation, collectively contributing to increased plant height and vigor. Zheng *et al.* (2024) emphasized that adequate nitrogen availability is essential for maximizing canopy development and biomass accumulation in tigernut, resulting in taller and more vigorous plants. Fabunmi *et al.* (2016) reported that higher nutrient availability improved sprouting and shoot performance in tiger nut across different soil media.

Also, NPK 15:15:15 applied at the rate of 300 kg/ha produced more tillers than the other rates at the initial stage of the observation period, but by the end of the growth period both 300 and 450 kg/ha had similar number of tillers. This observation agrees with the findings of Novor *et al.* (2025) who indicated that a moderate rate of NPK 15:15:15 enhances early tiller formation more effectively than lower or excessively high rates. In particular, the 300 kg/ha rate has been shown to stimulate rapid vegetative growth, improve leaf area development and boost nitrogen availability for axillary bud activation, resulting in early tiller proliferation (Wang, 2016). Similarly, NPK 15:15:15 applied at 300 kg/ha enhanced plant vigor of tigernut. This is in alignment with the results of Novor *et al.*(2025) who reported that NPK 15:15:15 at 300 kg/ha improved plant vigor and yield components compared with lower inputs. Application of 150 kg/ha of NPK 15-15-15 improved the number and tuber weight of tigernut. This performance pattern suggests that nutrient demand differs between vegetative development and tuber formation, depending on the fertilizer rate supplied. This shows that a moderate and balanced N.P.K supply often optimizes the crop's sink-source relationships and nitrogen-use efficiency (NUE) and excessive fertilizer application beyond the optimum requirement may not further increase yield and could cause nutrient imbalance or environmental risks (Zheng *et al.,* 2024). This supports the findings of Timon *et al*. (2019) who reported that a moderate application of 100 kg NPK/ha in combination with poultry manure produced the highest tuber weight of tigernut.

Conclusion and Recommendation

In conclusion, tuber size and fertilizer rate influenced the growth and yield performance of tiger nut, although sprouting was not affected by tuber size or fertilizer application. Big-sized tubers supported better growth and yield performance of tigernut, while small-sized tubers produced more daughter tubers and are therefore more suitable for propagation purposes. Application of 150 kg/ha of NPK 15:15:15 improved the number of tubers and yield of tigernut. Farmers in the study are encouraged to use big-sized planting propagule with application of 150 kg/ha of NPK 15-15-15 for improved yield of tigernut.

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