

Response of Ginger (*Zingiber Officinale* L.) to Propagation Methods and Mulching in Ogbomoso, Southwest, Nigeria

 Fawole Tolulope Olaoluwa¹;  Akanbi Wasiu Babatunde²;  Kolawole Ganiyu Oladeji²;  Olaniyi Joel Oyekunle²;  Lawal Babatunde Akeem²;  Oyeyiola Yetunde²; &  Onarinde Christianah Ronke³

¹Department of Crop Production Technology, Oyo State College of Agriculture and Technology, P.M.B. 10, Igboora, Oyo State. ORCID iD: 0009-0003-2948-5187. ²Department of Crop Production and Soil Science, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Oyo State. ³Department of Agricultural Science, Federal College of Education, Ilawe Ekiti, PMB 1089, Ilawe Ekiti, Ekiti State.

Corresponding Author: olaoluwapeju@gmail.com

DOI: <https://doi.org/10.70382/hujaesr.v10i1.037>

Keywords:

Propagation method,
mulching, Ginger,
Growth and Yield

Abstract

Field experiment was conducted to determine the effects of propagation methods and mulching on the growth and yield of ginger. Two propagation methods (25 – 30 g rhizome seed sett and equivalent weight of rhizome seedling sett raised from the rhizome seed sett for one month) in combination with 2 levels of mulching (mulching and no mulching). The 2 x 2 factorial experiment was fitted into a randomized complete block design in three replicates. Data collected were plant height, number of tillers, number of leaves, rhizome length, rhizome width, rhizome thickness, number of rhizome fingers and fresh rhizome yield. Data collected were subjected to Analysis of Variance, while the treatment means were compared using Duncan's Multiple Range Test at a 5% probability level. Rhizome seed was significantly higher compared to rhizome seedling in plant height (63.70 cm, 35.84 cm), number of leaves (24.89, 16.47), number of tillers (14.52,

6.86), rhizome width (51.58 mm, 40.77 mm), rhizome thickness (23.35 mm, 18.48 mm), number of rhizome fingers (6.20, 4.90) and fresh yield (9.92 tons/ha, 7.77 tons/ha). Also, the application of mulching produced significant growth and yield performance. The interaction between propagation method and mulching was significant for all growth and yield parameters. The use of 25-30 g of rhizome seed in combination with use of 15 tons/ha of dry plant materials as mulch are therefore recommended as best cultural practice for ginger production in the study area.

Introduction

Ginger (*Zingiber officinale* L.) is a rhizomatous crop in the family Zingiberaceae. It is an economically and nutritionally important crop widely cultivated in tropical and subtropical regions, including Nigeria, where it contributes significantly to household incomes and export revenues (Okwuowulu *et al.*, 2021). However, the productivity of ginger in Nigeria remains suboptimal due to poor agronomic practices, including ineffective propagation techniques, mulching and improper fertilizer application (Eze and Onwubiko, 2020). The effect of propagation methods on the growth and yield of ginger has been a subject of interest in Nigeria. The two main methods used for propagating ginger are rhizome seed propagation and rhizome seedling propagation. However, the products of some research works are conflicting and inconclusive as some workers reported optimum yield from the use of seedlings as planting materials (Fariyike *et al.*, 2016), others either reported optimum crop yield from ginger rhizome or no significant yield difference in the type of seed materials used (Adeyemi and Oladimeji, 2022). Though, mulching is widely recognized for its agronomic benefits, there is limited research on its specific impact on ginger performance. The extent to which mulching influences ginger growth and yield in the study area remains unclear and need to be determined. There is high demand for ginger both locally and internationally, which call for need to optimize agronomic practices for sustainable productivity. This study aims to assess the combined effects of propagation methods and mulching on the growth and yield of ginger in Ogbomoso, Southwest of Nigeria.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso in 2025. Ogbomoso lies on latitude 8° 08'N and longitude 4° 14'E in the Southern Guinea Savanna Zone of Nigeria. It is characterized by mixed grassland and scattered trees, and support both crop cultivation and livestock grazing (Owoade, 2021). The climate of the environment of Ogbomoso can be expressed as fairly hot, tropical with marked wet and dry seasons. There is usually a bit of harmattan between these seasons. The mean annual rainfall is about 1400 mm and bimodal in distribution which is at peak in June and September and a break in August, while the mean annual temperature is about 27°C (Owoade, 2021).

Prior to treatment application, initial soil samples were collected from a depth of 0–20 cm to analyze soil texture and chemical properties (IITA, 1982). Particle size was assessed using the hydrometer method (Gee and Or, 2002). Soil pH was measured in water at a 1:1 ratio, and available phosphorus was determined using the Bray P-1 method (Bray and Kurtz, 1945). Organic carbon content was evaluated via the dichromate wet oxidation method (Nelson and Sommers, 1982). Exchangeable potassium (K), sodium (Na), calcium (Ca), and magnesium (Mg) were extracted with 1 M ammonium acetate at pH 7 and quantified through atomic absorption spectrophotometry. Effective Cation Exchange Capacity (ECEC) was calculated by summing exchangeable bases and acidity. Cation Exchange Capacity (CEC) was determined using the neutral 1 N ammonium acetate method, and Total Nitrogen was analyzed following the Macro Kjeldahl method as outlined by Bremner and Mulvaney (1982).

Treatments were ginger rhizomes seed setts ranging from 25 - 30 g sizes containing 2 – 3 buds (Ravindran and Babu, 2005), their equivalent rhizome seedlings and mulching with dried plant material. The rhizome seeds were selected and weighed using Falcon electronic scale BL 3002 and rinsed in 1 L water containing 20 g Mancozeb powder to disinfect them (FAO, 2017). The mulching material was obtained from the dried plant materials around the experimental field, and was applied at 15 tons/ha (Ojeniyi *et al.*, 2020). The control plots were left un-mulched. The yellow variety of ginger (UG1) obtained from National Root Crop Research Institute Substation, Kaschia, Kaduna, Kaduna State was used for the study. The experimental field was manually cleared and twelve (12) plots, each plot measured 1.5 × 1.0 m, containing 24 ginger plants spaced out at 30 × 30 cm were constructed (Tiwari *et al.*, 2019). Experimental plots were separated by 0.5 m gaps while, 1.0 m gaps separated the replicates. Weeding was manually done to prevent weed interference.

The 2 × 2 factorial experiment was fitted into a randomized complete block design with main plot factor of 2 levels propagation method and 2 levels of mulching as sub - plot factor giving 4 treatment combinations, replicated 3 times to give 12 experimental units.

Three ginger plants at the center of the experimental plot were selected as samples per treatment for the assessment for growth, yield and yield parameters. These were: plant height measured using a measuring tape from the base of the plant to the apex, number of tillers per plant obtained by counting the number of tillers per stand and number of leaves per plant obtained by counting number of fully expanded green leaves.

At 7 months after planting, rhizome length, rhizome width, rhizome thickness, number of rhizome fingers and fresh rhizome yield were collected. Data were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System version 9.4 (SAS, 2022) software package. The treatment means were compared using Tukey's Honest Significant Difference (HSD) at a 5% level of probability.

RESULTS

The soil physical and chemical properties of the field used for the experiment are presented in Table 1. The soil textural class was sandy loam, with 91.10% sand, 3.40% silt, and 5.50% clay, with slightly alkaline pH (6.58), very low in organic carbon (0.65 g/kg), total nitrogen (0.08 g/kg) and available phosphorus (mg/kg). The exchangeable cations range from low (K and Ca) to medium

(Mg and Ca) (Esu, 1991). The general low nutrient status of the soil might be due to continuous cultivation of the land prior to cropping.

There were significant effects of propagation methods and mulching with respect to the plant height of ginger. Rhizome seed produced a significant effect on the plant height all through the sampling period when compared to rhizome seedling except at 1 month after planting. At 2 months after planting, rhizome seed had 25.73 cm plant height, which was significantly higher than rhizome seedling with 12.73 cm (Table 2). Also, at 7 months after planting, rhizome seed produced a significant plant height of 63.70 cm compared to 35.84 cm produced by rhizome seedling. The application of mulching material had no significant effect on the plant height of ginger at 1 month after planting. However, from 2 to 7 months after planting, mulched ginger plants were significantly higher in plant height compared to un-mulched plants. At 7 months after planting, mulched plants had 55.02 cm plant height, and was significantly higher than un-mulched plants with 44.52 cm height.

As shown in Table 3, rhizome seed produced a significant number of ginger leaves which increased from 9.84 at 2 months after planting to 24.89 at 7 months after planting compared to rhizome seedling with 6.02 and 16.47 respectively. Also, the mulched ginger plants increased to a significant 21.74 leaf number compared to 19.62 obtained by the un-mulched plants. The interaction between propagation methods and mulching was significant with respect to number of ginger leaves all through the sampling period.

Table 4 shows that the number of ginger tillers increased produced by rhizome seedling increased from 1.16 to 6.86 at 1 to 7 months after planting respectively. However, these values are significantly lower than the number of ginger tillers produced at corresponding number of months after planting by rhizome seed except at 1 month after planting. Also, the un-mulched ginger plants produced significantly lower tiller numbers compared to the mulched plants all through the sampling period. The highest significant number of tillers (12.18) was produced by the mulched plants compared to the un-mulched plants (9.20).

There was significant difference in propagation methods and mulching with respect to the yield and yield parameters (Table 5). Rhizome seedling had the highest significant rhizome length (99.92 mm) compared to rhizome seed (77.77 mm), while the mulched ginger plant produced the significant rhizome length (86.10 mm) compared to the un-mulched plants (79.39 mm). However, rhizome seed had the highest significant rhizome width and thickness (51.58 mm and 23.35 mm) compared to rhizome seedlings with 40.77 mm and 18.48 mm respectively. The application of mulching material produced significant rhizome width (49.35 mm) compared to the un-mulched plant (43.01 mm). However, there was no significant difference in rhizome thickness between the mulched and un-mulched ginger plants. Also, rhizome seed produced a significant higher number of rhizome fingers (6.20) compared to rhizome seedling (4.90), but the effect of mulching was not significant with respect to number of rhizome fingers. Significant higher fresh rhizome yield/ha was produced by rhizome seed (9.92 ton/ha) compared to rhizome seedlings (7.77 tons/ha), and mulched plants produced a higher yield (9.92 ton/ha) compared to un-mulched plants (7.77 tons/ha). The interaction of propagation methods and mulching was significant for the growth and yield parameters of ginger.

Interaction Effect of Propagation Method and Mulching on the Growth and Yield of Ginger

The interaction between propagation method and mulching significantly influenced all the yield parameters of ginger (Fig. 1a-b). The Rhizome length, width, and thickness, number of rhizome fingers and fresh rhizome yield were consistently higher under mulched conditions compared to un-mulched treatments across both propagation methods.

Rhizome seeds + mulched produced significant ($P \leq 0.05$) performance under mulched with a mean rhizome length of 100.53 mm, width of 55.87 mm, thickness of 25.33 mm, and an average of 6.87 rhizome fingers per plant. This treatment combination also produced the highest significant fresh rhizome yield of 11.97 tons per hectare. In contrast, the corresponding Rhizome seeds + un-mulched plots yielded significantly lower values across all parameters, with a fresh yield of 7.86 tons per hectare, representing a notable yield reduction of approximately 34%.

Rhizome seedlings + mulched also enhanced yield performance, although the response was less pronounced than in rhizome-seed-propagated plants. Rhizome seedlings + mulched produced rhizomes with a mean length of 71.68 mm, width of 42.83 mm, thickness of 19.44 mm, and an average of 5.14 rhizome fingers, resulting in a yield of 9.20 tons per hectare, while Rhizome seedlings + un-mulched seedling treatment produced the lowest yield (6.33 tons per hectare), indicating that moisture conservation through mulching remains beneficial even in seedling propagation systems.

Table 1: Physical and chemical properties of the experimental field used for the experiment

Element	Value
pH (H ₂ O) 1:1	6.58
Organic carbon (g/kg)	0.65
Total nitrogen (g/kg)	0.08
Available P (mg/kg)	2.64
Exchangeable cations (c mol/kg)	
Ca ²⁺	1.26
Mg ²⁺	0.43
K ⁺	0.19
Na ²⁺	0.81
EA	0.15
ECEC	2.84
Micronutrients (mg/kg)	
Zinc	3.45
Copper	0.63
Iron	104.71
Manganese	101.21
Particle size (%)	
Clay (%)	5.50
Silt (%)	3.40
Sand (%)	91.10
Textural class	Sandy loam

Table 2: Effects of propagation methods and mulching on plant height of ginger in Ogbomoso, Oyo State, Nigeria

Treatment	1	2	3	4	5	6	7
Months after planting							
Propagation methods (PM)							
Rhizome Seed	0.00a	25.73a	39.26a	47.75a	51.82a	56.56a	63.70a
Rhizome Seedling	9.35a	12.73b	18.28b	22.28b	28.52b	31.31b	35.84b
Prob. F (0.05)	*	*	*	*	*	*	*
Mulching (M)							
Mulched	3.49a	21.33a	31.99a	38.19a	44.76a	48.42a	55.02a
Un-mulched	3.85a	17.13b	25.55b	31.84b	35.58b	39.45b	44.52b
Prob. F (0.05)	*	*	*	*	*	*	*
Interaction							
PM x M	*	*	*	*	*	*	*

Means with the same letters along the column are not significantly different using Duncan's Multiple Range Test at a 5% probability level.

Table 3: Effects of propagation methods and mulching on number of leaves of ginger in Ogbomoso, Oyo State, Nigeria

Treatment	1	2	3	4	5	6	7
Months after planting							
Propagation methods (PM)							
Rhizome Seed	0.00b	9.84a	12.73a	15.10a	18.12a	20.32a	24.89a
Rhizome Seedling	4.95a	6.02b	7.17b	8.85b	11.70b	13.07b	16.47b
Prob. F (0.05)	NS	*	*	*	*	*	*
Mulching (M)							
Mulched	2.62a	8.51a	10.88a	13.04a	15.58a	17.54a	21.74a
Un-mulched	2.34a	7.36b	9.02b	10.91b	14.24b	15.84b	19.62b
Prob. F (0.05)	*	*	*	*	*	*	*
Interaction							
PM x M	*	*	*	*	*	*	*

Means with the same letters along the column are not significantly different using Duncan's Multiple Range Test at a 5% probability level.

Table 4: Effects of propagation methods and mulching on number of tillers of ginger in Ogbomoso, Oyo State, Nigeria

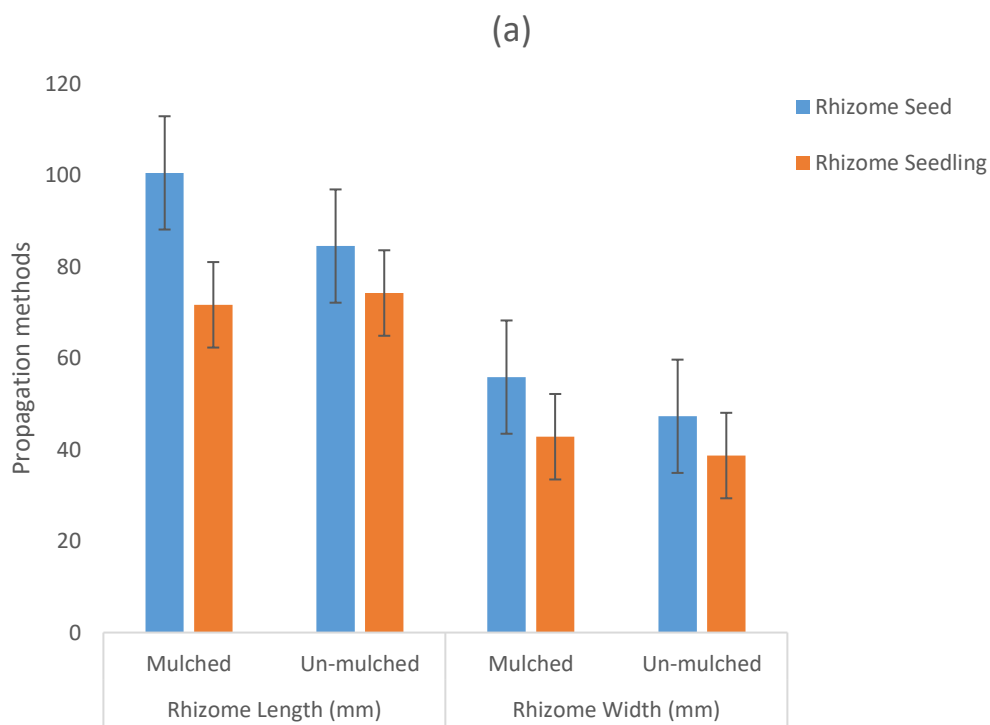
Treatment	1	2	3	4	5	6	7
Months after planting							
Propagation methods (PM)							
Rhizome Seed	0.00b	3.25a	5.07a	6.93a	9.30a	11.88a	14.52a
Rhizome Seedling	1.16a	1.75b	2.08b	2.72b	4.26b	5.35b	6.86b
Prob. F (0.05)	NS	*	*	*	*	*	*
Mulching (M)							
Mulched	0.60a	2.78a	4.06a	5.26a	7.84a	9.85a	12.18a
Un-mulched	0.56a	2.22b	3.10b	4.39b	5.73b	7.37b	9.20b
Prob. F (0.05)	*	*	*	*	*	*	*
Interaction							
PM x M	*	*	*	*	*	*	*

Means with the same letters along the column are not significantly different using Duncan's Multiple Range Test at a 5% probability level.

Table 5: Effects of propagation methods and mulching on yield and yield parameters of ginger in Ogbomoso, Oyo State, Nigeria

Treatment	Rhizome length (mm)	Rhizome width (mm)	Rhizome thickness (mm)	Number of Rhizome fingers	Fresh Rhizome yield/ha
Propagation methods (PM)					
Rhizome Seed	77.77b	51.58a	23.35a	6.20a	9.92a
Rhizome Seedling	99.92a	40.77b	18.48b	4.90b	7.77b
Prob. F (0.05)					
Mulching (M)					
Mulched	86.10a	49.35a	22.39a	6.01a	9.92a
Un-mulched	79.39a	43.01b	19.44a	5.10a	7.77b
Prob. F (0.05)					
Interaction					
PM x M	*	*	*	*	*

Means with the same letters along the column are not significantly different using Duncan's Multiple Range Test at a 5% probability level.



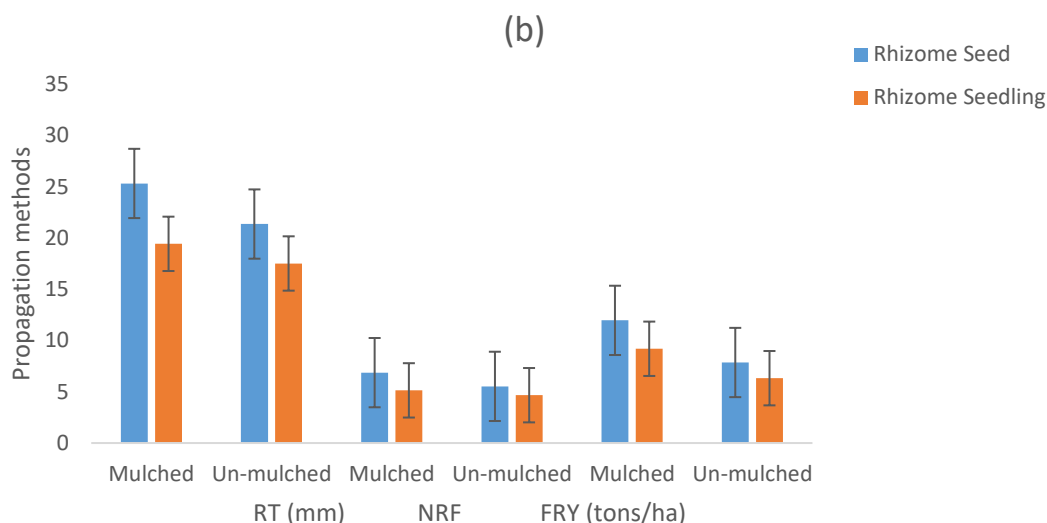


Fig. 1: (a) Interactive effect of propagation methods and mulching on rhizome length and rhizome width of ginger (b) Interactive effect of propagation methods and mulching on rhizome thickness (RT), number of rhizome fingers (NRF) and fresh rhizome yield (FRY)

DISCUSSION

The use of rhizome seeds as a propagative units increased the growth and yield of ginger. This may due to rhizome seeds contain more stored carbohydrates, proteins, and minerals, which provide the initial energy and nutrients for sprouting and early shoot/root development. This gives the plant a faster and stronger start compared to rhizome seedlings. This is in line with Prasad *et al.* (2017) who reported that rhizome seeds with more than 2 viable buds and larger size contributed to higher sprouting percentages and better growth than rhizome seedlings. Also, the reason why rhizome seeds performed significantly higher in growth and yield may be due to the fact that rhizome seeds generated more vigorous root systems that enhanced water and nutrient uptake, which directly translated into improved plant growth and rhizome development. This corroborates the finding of Joseph and Baby (2010) that reported that ginger plants from larger rhizomes had 30–40% more root biomass, which was associated with higher chlorophyll content and yield. Mulching ginger with dry plant materials significantly improves its growth and yield compared to un-mulched plants. This enhancement is attributed to the fact that dry plant mulch acts as a protective cover that reduces evaporation from the soil surface. This help to conserve moisture which is an essential factor for ginger growth due to its shallow root system. This corroborates with the reports of Adetunji *et al.* (2014) that mulching conserved 15–25% more soil moisture than bare soil and Ojeniyi *et al.* (2020) that mulching significantly enhanced moisture conservation and increased rhizome yield of ginger. Also, the use of dry plant materials as mulch suppresses weed emergence by blocking sunlight, which reduces competition for water and nutrients. This leads to more efficient use of resources by ginger plants. Uwah and Iwo (2011) reported that dry mulch reduced weed density by over 50% and increased ginger growth parameters. As mulch decomposes, it adds organic matter to the soil

and slowly releases nutrients like nitrogen, phosphorus, and potassium, which are crucial for ginger development. This was supported by Tiwari *et al.* (2019) who reported better uptake of nutrients in mulched ginger plots compared to un-mulched plots.

The superior performance of the Rhizome seed + mulched treatment could be attributed to the combined effects of improved soil moisture retention, moderated temperature fluctuations, and enhanced nutrient availability, which favor the physiological and morphological growth of ginger rhizomes. This is in line with the findings of Okwuowulu *et al.*, 2018 who reported that mulching improved soil moisture retention and rhizome yield significantly under tropical conditions and Wang *et al.*, 2020 who reported that mulching stabilizes soil temperature and enhances rhizome development by maintaining favorable microclimatic conditions.

CONCLUSION

The findings show that using rhizome seeds setts ranging from of 25 – 30 g sizes as planting material consistently produced stronger vegetative growth and higher yields than the rhizome seedlings of equivalent sizes. Larger rhizome pieces generally store more carbohydrates and nutrients, which support faster sprouting, stronger shoot development and better root establishment.

The study also demonstrated that mulching significantly improved ginger performance compared to unmulched plots. Mulch helps conserve soil moisture, regulate temperature, suppress weeds and improve soil structure as it decomposes. These conditions are especially favorable for ginger production.

RECOMMENDATION

For optimum growth and yield of ginger, rhizome seeds should be used as the planting material, along with mulching with dried plant residues at a rate of 15 tons per hectare. This combination significantly improved the growth and yield of ginger in the study area, and is therefore recommended for enhanced ginger production.

REFERENCES

- Adetunji, M. T., Akanbi, W. B., Fagbola, O. and Ojeniyi, S. O. (2014). The use of organic mulch for improving soil physical properties and ginger performance in a tropical environment. *Journal of Organic Agriculture and Environment*, 2(1), 22–28.
- Adeyemi, A. O. and Oladimeji, O. (2022). Evaluation of seed rhizome sources on growth and *Agricultural Society of Nigeria*, 54, 45–50.
- Brayr. H. and Kurtz, L. T. (1945). Determination of total organic carbon and available forms of phosphorus in soils. *Soil Science*, vol. 59 pp. 39–45.
- Bremner, J. and Mulvaney, C. (1982). Nitrogen – Total: Chemical and Microbiological properties. Madison: ASA and SSSA, pp. 595–624.
- Esu, I. E. (1991). Detailed soil survey of NIHORT Farmat Bunkure, Kano State, Nigeria. Zaria: Institute for Agricultural Research, Amadu Bello University.
- Eze, C. N. and Onwubiko, N. C. (2020). Evaluation of propagation methods and nitrogen levels

- on ginger yield in southeastern Nigeria. *Proceedings of the Annual Conference of the Agricultural Society of Nigeria*, 54, 45–50.
- FAO (Food and Agriculture Organization) (2017): "Ginger production and trade".
- Fariyike, T. A., Odeleye, O. M., Adebayo, O. S. and Aminu-Taiwo, B. R. (2016). Influence of propagule size and organic manure on the growth and yield of ginger (*Zingiber officinale*). *Agrofor International Journal*, 1(2), 189–198.
- Gee, G. W. and Or, D., (2002). Particle size distribution. In: Dane, J. H, Topp, G. C. (Eds.). *Methods of Soil Analysis, Part 4. Physical Methods*. Madison: SSSA, pp. 255–293.
- IITA (International Institute for Tropical agriculture). (1982). *Selected Methods for Soil and Plant Analysis*. International Institute of Tropical Agriculture, Ibadan, Nigeria. IITA Manual Series, no. 7, pp. 53–56.
- Joseph, J. and Baby, U. I. (2010). Influence of planting materials on root development and yield of ginger. *Journal of Spices and Aromatic Crops*, 19(1–2), 45–49.
- Nelson, D. W. and Sommer, L. E. (1982). Total carbon, organic carbon, and organic matter. In: Sparks, D.L. (Ed.). *Methods of Soil Analysis Chemical Methods*. Madison: American Society of Agronomy, pp. 961–1010.
- Ojeniyi, S. O., Adetunji, M. T. and Ogunyemi, S. (2020). Effects of dry plant mulching on growth and yield of ginger (*Zingiber officinale*) in a derived savannah zone. *Journal of Soil and Water Conservation*, 9(2), 110–117.
- Okwuowulu, P. A., Okoli, O. O., & Okonkwo, C. A. (2018). Effect of mulching and organic manure on the growth and yield of ginger (*Zingiber officinale* Roscoe) in southeastern Nigeria. *Journal of Agricultural Science and Technology*, 20(4), 785–793. DOI:10.5897/JAST2018.0304
- Okwuowulu, C. I., Chukwu, G. O., & Ofor, M. O. (2021). *Socio-economic and agronomic factors affecting ginger yield in southeastern Nigeria*. In *Proceedings of the Annual Conference of the Agricultural Society of Nigeria (ASN)*, University of Abuja, Nigeria, October 2021, pp. 215–220.
- Owoade, O. A. (2021). Climatic variability and its impact on agricultural productivity in Nigeria. *Journal of Climatology and Weather Forecasting*, 9(2), 112–124.
- Prasad, R. N., Tiwari, R. S. and Tiwari, B. S. (2017). Effect of size of rhizome on growth and yield of ginger under agro-climatic conditions of Chhattisgarh. *Journal of Pharmacognosy and Phytochemistry*, 6(5), 1518–1521.
- Ravindran, P. N., and Babu, K. N. (2005). *Ginger: The Genus Zingiber*. CRC Press.
- SAS Institute Inc. (2022). *SAS/STAT User's Guide*. Cary, NC: SAS Institute Inc.
- Tiwari, R. S., Tiwari, B. S. and Shukla, K. P. (2019). Influence of plant spacing and organic mulching on growth and yield of ginger (*Zingiber officinale* Rosc.). *International Journal of Chemical Studies*, 7(2), 1033–1036.
- Uwah, D. F. and Iwo, G. A. (2011). Effectiveness of organic mulch on the productivity of maize (*Zea mays* L.) and weed growth. *The Journal of Animal and Plant Sciences*, 21(3), 525–530.
- Wang, J., Huang, Y., & Li, H. (2020). Influence of different mulching materials on soil temperature, moisture, and ginger growth. *Scientia Horticulturae*, 263, 109114. <https://doi.org/10.1016/j.scienta.2020.109114>