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# Plant growth and yield Performances of four Turmeric (*Curcuma longa* L.) accessions in a high rainforest agro-ecology of Nigeria

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## Abstract

*Four turmeric (Curcuma longa L.) Accessions; Atale temidire, Uromi, Red ginger, and Kaddiodowere assessed for growth and yield performances in a high rainforest agro-ecology of Rivers State Nigeria. Single plantlets of the 4 accessions were raisedin 20kg of soil contained in perforated polythene bags. The research was conducted with 3 replications in a completely randomized design. The following data were analysed using the F-test in ANOVA; plant height, number of tillers andleaves, lamina lengthand width, length of parent/mother rhizome and yield per plant.Mean values obtained were comparedwith LSD (P=0.05). Uromi 36.9cm, and Red ginger 33.8cm, were significantly taller than Atale temidire 20.3cm, and Kaddiodo 17.8cm and had significantly higher lamina width; Uromi 12.8cm, Red ginger 11.7cm, than Atale temidire 7.5cm and Kaddiodo 6.3cm. Red ginger 15, Uromi 13, Atale temidire 13, had significantly more leaves than Kaddiodo 8. Length of mother rhizomes of Atale temidire 12.2cm, Uromi 12cm and Red ginger 11.2cm were significantly different from Kaddiodo 6.2cm. Yields of Atale temidire 925g, Red ginger 873g and Uromi 848g were significantly higher than Kaddiodo 504g. The 3 genotypes are recommended for further evaluation and cultivation over larger areas of the region.*

**Keywords:** Accession, Growth traits, High rainforest agro-ecology; Parent/Mother rhizome.

## Introduction

Turmeric (*Curcuma longa* L.) is a medicinal plant[1] of the genus *Curcuma* in the Zingiberaceae family[2]; propagated vegetatively by rhizome and is a triploid with $2n = 3x = 63$[3,4]. It is a condiment used as spice to enhance flavour in sauces, soups and stews, a natural colouring agent in certain foods and also as relish in some foods. In addition it is used in the pharmaceutical, confectionary, food and textile industries, etc.[5-8]. Moreover, it is reputed to be an anti-asthmatic, and antiseptic which is also effective against bacterial, and fungal infections. It is efficacious against diabetes, ulcer, inflammations, and parasites as well as having anti-oxidant, insect repellent and wound healing properties[9-14]. Furthermore, its anti-mutagenic and anti-cancer properties are said to induce apoptosis in many cancer cells[15-18]. Curcuminoids/ curcumin contained in the plant[6] have been found to have antidepressant and hypolipidimic properties[19]. Curcuminoids/ curcumin are the main active ingredients responsible for its numerous and wide ranging therapeutic effects[1,20,21]. They consist of phytochemicals like alkaloids, flavonoids, saponins, steroids, tannins, glycosides, terpenoids and phenols[22].

The plant is native to Asia and has been cultivated for centuries in India, the largest producer, consumer and exporter - $190.3 million in 2019[23-25]. It is cultivated also in Bangladesh, China, Cambodia, Indonesia, Malaysia, Philippines and Thailand, from where it spread to other tropical regions like South America and Africa. It is growing in importance in the global economy due to its use in the food and confectionary, textile, pharmaceutical, cosmetics and skincare industries; traditional medicine systems and cultural and religious ceremonies have been reported extensively[26,27]. Globe Newswire[28], forecasts that the global curcum in market will jump from about $56million to about $144million between 2017 and 2027 at a 9.3% cumulative annual growth rate. Turmeric cultivation is gaining gradual acceptance among farmers in Nigeria although this is mostly limited to the savannah agro-ecological region of Northern Nigeria at the moment although it has been reported to grow in the wild as far as the rainforest[29,30]. The country has seen an increase in turmeric cultivation, particularly in states like Jigawa, Kaduna, Kano, Kebbi, Sokoto, and Zamfara. Northern Nigeria seems to provide the ideal climate and soil conditions for turmeric cultivation. Farmers in the region have started exploiting turmeric's potential as a valuable cash and export crop and Nigeria's emerging turmeric exploitation is propelled by increasing culinary and medicinal utility[31]. The increasing awareness of the health benefits, numerous uses and its potential as a cash and export crop has led to a growing awareness among farmers in other parts of Nigeria. However no variety has been officially released to Nigerian farmers for cultivation due to limited information on suitable cultivars of turmeric for cultivation in various agro-ecological regions of Nigeria[32]. This is because a high level of variability exists in almost all morphological traits as well as content of curcuminoids/ curcumin of turmeric because of the influence of soil and environmental/ climatic factors[3,33,34]. It is imperative therefore to ascertain how turmeric accessions cultivated predominantly in the savannah agro-ecology of Northern Nigeria will perform in their growth and yield in the high rainfall agro-ecology of Port Harcourt in Rivers State, Southern coastal Nigeria.

## Materials and Methods

**Experimental Site and Duration of Research:** This research was conducted from March 2022 to December 2023 in the botanical garden of the Plant Science and Biotechnology Department, Rivers State University, Port Harcourt,to assess growth and yield performances of four turmeric (*Curcuma longa* L.) accessions; Atale temidire, Uromi, Red ginger, and Kaddiodo suitable for production in a high rainforest agro-ecology.

**Experimental Materials and Planting:** Four turmeric (*Curcuma longa* L.) accessions; Atale temidire, Uromi, Red ginger, and Kaddiodo were obtained from the National Root Crops Research Institute, (NRCRI) Umudike, Umuahia, Abia State. Single plantlets of the 4 accessions raised from 10g weight of rhizomes with 2 nodes each were transplanted into 20kg of loamy soil contained in large perforated polythene bags (55 x 45 x 45 cm). No manures or fertilizers were added to the soil. Weeds were removed by hand.

**Experimental Design and Data Collection:** The experiment was laid out in a CRD with 3 replications in the field. Data collected were plant height (soil surface to highest leaves of the main tiller), number of fully formed tillers, number of leaves (fully opened leaves on the main tiller), lamina length measured from bottom of midrib to tip of leaf blade, lamina width at point of maximum width, length of parent/mother rhizome per plant and yield per plant of rhizome. All data were analysed using ANOVA at $P$=0.05 and means of significant characters compared by LSD at $P$ = 0.05.

## Results and Discussion

**Plant height:** Analysis of data showed that Uromi hadthe tallest plants (36.9cm) followed by Red ginger (33.8cm) as presented in Table-1. Both turmeric accessions were significantly ($P$=0.05) taller than Atale temidire (20.3cm) and Kaddiodo (17.8cm). Other studies have reported variation in plant height oF turmeric genotypes[25,35-37]. In fact, some researchers[38], had stated earlier that height of the plant determines the yield capability of turmeric genotypes indicating that plant height is a very important trait that could be used when selecting for high rhizome yields in turmeric.

**Number of tillers per plant:** In Table-1, the number of tillers per plant of the turmeric accessions are shown. There were no significant differences ($P$=0.05) in the number of tillers per plant of Atale temidire (4), Kaddiodo (4), Red ginger (5) and Uromi (6). However in their experiment conducted in the derived savannah of Nigeria using mulch and a high rate (400kg/ha) of NPK fertilizer added, Amadi *et al.*[32] found significant differences in number of tillers per plant. Rajyalakshmi *et al.*[39] opined that high estimates of heritability were observed for the number of shoots / tillers per plant in turmeric suggesting that a significant part of the phenotypic variability in this trait could be contributed by additive gene effects that are highly influenced by the environment.

**Number of leaves, Lamina length and Lamina width:** The number of leaves of the four turmeric accessions are presented in Table-1. Red ginger had the highest number of leaves (15) followed by Atale temidire (13) and Uromi (13). These 3 were significantly more ($P$=0.05) than the leaves of Kaddiodo (8). Other researchers, Jilani *et al.*[2], Gaur *et al.*[25] and Kallur *et al.*[40] in their studies reported significant variations in number of leaves per plant among different genotypes of turmeric. However lamina length of leaves of the four accessions did not differ significantly ($P$=0.05) from each other though Uromi 19.3cm and Red ginger 18.8cm had higher lamina length than Atale temidire 15.9cm and Kaddiodo 14.7cm (Table-1). A similar result of non-significant differences in lamina length of leaves was reported earlier by Basak and Jana[7]. With respect to lamina width there were significant differences ($P$=0.05) with significant higher lamina width in Uromi 12.8cm, and Red ginger 11.7cm, than in Atale temidire 7.5cm and Kaddiodo 6.3cm (Table-1). The primary site of photosynthesis in most plants are the leaves. Therefore the more the number of leaves, the longer and wider the leaves, the greater the rate of photosynthesis. The leaves thus become a critical factor that usually determine the nature of vegetative growth and vigour of the plant and ultimately its yield.

**Length of parent/mother rhizome:** Length of mother rhizome of the turmeric accessionsin Table-1 show that Atale temidire 12.2cm, Uromi 12cm and Red ginger 11.2cm were significantly higher ($P$=0.05) than those of Kaddiodo 6.2cm. This is in contrast to the findings of Basak and Jana[7] who said that length of mother rhizome did not differ significantly among varieties of turmeric. However Dudekula *et al.*[1], stated that 15 out of the 200 germ plasm accessions they studied, that is 7.5%, showed higher length of mother rhizome over the mean.

**Table-1:** Growth and yield performance of four turmeric accessions.

| Turmeric accessions | Plant height (cm) | No. of tillers/ plant | No. of leaves/ plant | Lamina length (cm) | Lamina width (cm) | Length of mother rhizome /plant (cm) | Total rhizome yield (g) |
|---|---|---|---|---|---|---|---|
| Atale temidire | 20.3 | 4 | 13 | 15.9 | 7.5 | 12.2 | 925 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Kaddiodo | 17.8 | 4 | 8 | 14.7 | 6.3 | 6.2 | 504 |
| Red ginger | 33.8 | 5 | 15 | 18.8 | 11.7 | 11.2 | 873 |
| Uromi | 36.9 | 6 | 13 | 19,3 | 12.8 | 12.0 | 848 |
| LSD (0.05) | 10.7 | 2.4 | 4.4 | 6.7 | 5.8 | 7.2 | 103.7 |

**Total rhizome yield:** The yields of the four cultivars of turmeric are presented in Table-1. Atale temidire had the highest yield of 925g suggesting a higher and more robust response for rhizome yield than its vegetative traits indicated. It was followed by Red ginger 873g and Uromi 848g. The yields of these 3 genotypes did not differ significantly from each other. Kaddiodo with 504g had the lowest yield which was significantly (*P*=0;05) less than the yields of the other 3 cultivars. Several researchers[1,32,35,41-44] have reported similar significant differences in rhizome yield of different genotypes of turmeric. In contrast, Olojede *et al.*[45] in their study, stated that the yields of 2 cultivars of turmeric did not differ significantly. Recommendations on morphological traits being indicative of high yields were made by Roy *et al*.[3], Padmadevi *et al.*[46] and Mohan Kumar *et al*.[47]. They claimed that tall plants with long and wide leaves possessing a high number of tillers per plant suggestive of a plants good health and vigour should be selected for high rhizome yield. On the other hand Chadha[48] and Singh *et al.*[42] declared that the most important contributor to yield in turmeric is the number of tillers because it is directly proportional to the number of rhizomes. Although these assumptions ordinarily should be valid, the rhizome yield of Ataletemidire would suggest that these may not be the only traits to look out for when selecting for high rhizome yields because of the high variability existing in traits of turmeric genotypes[1,49]. The yield of most crops depend on their genetic makeup[50] and the climatic conditions under which they are cultivated[49]; the level of expression of some morphological traits in some genotypes in comparison to others would suggest that some genotypes could be better adapted to the environmental conditions in which they are grown[25,48]. Other studies have reported such unexpected divergence/ deviations from the norm in turmeric. For example Krishna *et al*[49] found that the accession that had the maximum fresh rhizome yield per plant was different from that with the highest dry rhizome yield per plant. Also, Dudekula *et al.*[1], declared that the accession that had the highest significant rhizome yield was the one having one of the significantly lowest dry recovery percentage; whereas the accession with the highest dry recovery percentage had rhizome yield six times less than the highest yielder.

## Conclusion

This study showed that turmericaccessions, Atale temidire, Red ginger and Uromi are promising accessionscombining good morphological traits with superior potential yields compared to Kaddiodo that could be grown successfully in a high rainfall agro-ecology of Port Harcourt, Rivers State.

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