*J Agric. Res., 2017, Vol. 55(1):185-196*
*ISSN: Online: 2076-7897, Print:0368-1157*
*http://www.jar.com.pk*

# PRODUCTIVITY RESPONSE OF TIGER NUT (*CYPERUS ESCULENTUS* VAR.SATIVA) TO PLANTING MATERIAL SIZE AND MOISTURE STRESS

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## ABSTRACT

**The Productivity response of tiger nut (*Cyperus esculentus*) to size of planting material (tubers) and moisture stress was evaluated in a greenhouse at Federal University of Agriculture, Abeokuta during March- June 2014. The trial was a 3 X 4 factorial experiment arranged in completely randomized design and replicated three times. There were large, medium and small tuber sizes as well as four intervals of irrigation (3, 7, 12 and 17 days) imposed between 4$^{th}$ and 7$^{th}$ week after planting. The results showed that emergence was significantly ($p<0.05$) affected by tuber size. At 14 days after planting it was 67, 39 and 28 percent for large, medium and small tubers, respectively. Fresh weight of biomass, total number of tubers and total weight of tubers were significantly reduced ($p<0.05$) as moisture stress increased. The significant interaction between tuber size and number of tubers produced showed the medium sized tubers to be more consistent. It was concluded that large and medium sized tubers gave better emergence; and exposure to moisture stress for 12-17 days led to as high as 41-46 percent reduction in tiger nut productivity.**

**KEYWORDS: *Cyperus esculentus;* Tiger nut tuber size; moisture; emergence; productivity; Nigeria.**

## INTRODUCTION

Meeting the nutrition demand of ever-increasing human population is a continuous challenge that must be confronted and overcome from generation to generation. It is also being understood that this challenge must be confronted in ecologically friendly and sustainable manner. Increasing diversity of crops cultivated is one of the ways to promote ecological stability. Some crops have been well cultivated and utilized by man at local,

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continental and/or global level; while others despite their great potentials; have been under-cultivated as well as underutilized. According to Bamishaiye and Bamishaiye (7), the hunt for under-exploited crops which are potentially valuable as human and animal foods, has recently been on the increase in order to retain the equilibrium between population growth and agricultural productivity, especially in the tropical and sub-tropical areas of the world.

The nutritional and health benefits of tiger nut are well documented. Tiger nut tubers when processed give different products of high nutritional values and of great economic potentials (16). Tiger nut is high in fibre content than oat bran, cabbage and carrot, thus helps prevent constipation, act as appetite suppressant and control body weight (4). It is rich in unsaturated fatty acids comparable to olive oil (3, 4, 5). In china tiger nut milk is used as liver tonic, heart stimulant, used as medication to heal stomach pain, promotes normal menstruation; heal mouth and gum ulcers and the black species being an excellent medicine for breast lumps and cancer (6). Tiger nut is a good source of magnesium, 100g of tiger nut furnishes 13 or 17 percent of daily recommended dose of magnesium and magnesium participates in more than 300 biochemical reactions in the body (4). Further, tiger nut is reported to be beneficial in controlling blood pressure, prevent cancer and heart diseases, supplies high amount of potassium which helps regulate muscular contractions. It serves as a good source of non-animal protein, furnishes vitamins C and E and helps to control diabetes (4). Tiger nut can also help fight malnutrition in developing countries (4).

In spite of both health benefits and nutritive values, tiger nut has attracted very little scientific and technological attention (13).Tiger nut is one of 32 plants listed as uncultivated plants with agriculture potentials in Nigeria (7) and according to Ukwunu *et al*.(16) there is limited awareness of its importance in Nigeria. Nigeria is a country with diversity of ecology; this include the mangrove swamp at the extreme south, the rain forest, derived savanna, guinea savanna, Sudan savanna, and Sahel savanna as we advance from the south to extreme north. A major varying element across the climatic zones is rainfall. Variation between successive rains also exists; this could sometimes be for a few days or several days/weeks. Problems of drought as well as acute shortage of water for irrigation purposes have been reported to be some of the most terrible constraints for agricultural development in arid and semi-arid areas and that judicious and economic usage of available water under such conditions will unquestionably affect crop production (11). Although the southern part of Nigeria has several wet months, fewer rainy periods and drought is sometimes experienced in the drier savannah.

Matching water requirements to water availability in selection of crops as well as careful irrigation management at critical crop growth stages will lead to increased crop yield and reduce quality losses associated with moisture stress (1).

Plant response to water stress is depends upon the severity and duration of the stress as well as the developmental stage of the plant (10). Critical period of moisture requirement for many crops in the developmental phases is the time of reproductive growth; like tasselling and grain filling in maize and time of tuberization in tubers and root crops like sweet, potato and cassava. Tuber development takes place between 6-8 weeks after seedling emergence in tiger nut (17). Propagation of tiger nut is commonly by planting of tubers which can easily be classified as small, medium or large and range between 0.3-1.9 cm in diameter (17). Earlier research on crops propagated by vegetative means showed size of planting material to have had significant effect on the productivity. Hossain *et al.* (9) reported that that the foliage coverage, plant height, stems/hill, number and weight of tubers/plant varied significantly due to variation of tuber size in potato. However, Tibebu (15) reported that tuber size had no significant effect on the productivity of potato.

Understanding the behavior of different tuber sizes of tiger nut with respect to emergence, growth and productivity, when exposed to some measure of moisture stress is therefore important in advancing the production of this seemingly orphan but important crop.

The present study was conducted to evaluate the effect of tuber sizes on emergence and productivity of tiger nut and to determine effect of moisture stress on the developmental and reproductive phases of tiger nut

## MATERIALS AND METHODS

### Experimental design and treatments

This study was conducted at Federal University of Agriculture, Abeokuta during the year 2014. The trial was conducted in a greenhouse between March and June, 2014. The 3*4 factorial experiment was arranged in a CRD and replicated three times. The factors were three tuber sizes: large (22g/20 tubers), medium (14g/20 tubers) and small (7g/20 tubers); 1.1, 0.7 and 0.35

g per tuber respectively and moisture stress for 3,7,12 and 17 days from four weeks after planting (WAP).

Fresh tubers were obtained from local market and sorted into three categories: large, medium and small. Sorting was by visual assessments after which the sorted tubers were weighed.

Top soil was collected from the field; It was homogenized by mixing thoroughly using a garden spade. Then 6.5 Kg each of soil was then put into 36 buckets and wet to field capacity. The field capacity of soil was determined by the gravimetric method. Fresh tubers of tiger nut were planted @ ten tubers per each category per pot and emergence counts taken from the 4-14 days after planting. After two weeks of planting, the pots were thinned to six seedlings per pot.

At 4 WAP the moisture stress treatment was commenced. The first category across the tuber sizes was irrigated at three days intervals; the second , third and fourth categories were denied water for 7, 12,and 17 days, respectively and were irrigated at three days intervals from therewith.

### Emergence count

The number of emerged tubers were taken from the 4-14th DAP and percentage emergence was calculated.

### Plant height, fresh and dry weight

Plant height of two plants per pot was taken at 2, 4, 6 and 8 WAP. Fresh and dry weight of biomass was taken as the average from two plants at 2, 4, 6 and 12 WAP.

### Weight of root mass and shoot to root ratio

These were taken at harvest after the detachment of formed tubers from the roots. The shoot was also severed from the root, oven dried and the weight taken.

### Tuber weight

Weight of fresh tuber from each pot was taken using a sensitive scale, weight of small, medium and large tubers were also taken, as well as total number of tubers and number of small, medium and large tubers.

## RESULTS AND DISCUSSION

### Emergence of tiger nut as influenced by the tuber sizes

The Data (Table 1) show significant difference between the number of emerged seedlings from different tuber sizes through 11 days of observation. Large tuber size recorded 52 percent emergence six days after planting (DAP) which was significantly higher than 20 and 13 percent recorded for medium and small tubers respectively. Total percentage emergences at 14 DAP were 67, 39 and 28 percent, for large, medium and small tuber size respectively. The significant difference observed in the emergence of tiger nut as influenced by the tuber sizes can be attributed to more food reserve in larger tubers relative to smaller ones at one hand, on the other, given similar soil nutrient condition, the larger the tubers, the more mature they are, thus one can deduce that the maturity of the large tubers will affect their ability to sprout and emerge faster than medium and small-sized tubers. The low emergence percentage across three tuber sizes as well as reduction in percentage emergence with reduction in tuber sizes, can be attributed to manner of handling by local tiger nut seller. Dried tubers, irrespective of the size, are soaked in water for days before selling as fresh tubers to consumers. Larger tubers are likely to require longer soaking duration than smaller ones before full imbibitions. Tetteh and Ofori (14) reported that farmers in Ghana soak tiger nut tubers for as long as four days before planting. The scientists, however, suggested that the water should be changed daily to prevent the tubers from getting rotten.

**Table1. Effect of tuber size on emergence of seedlings at different days after planting.**

| Treatment | Number of emerged seedlings (out of 10 tubers planted) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tuber size** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** |
| Large | 3.5 | 4.4 | 5.2 | 5.6 | 5.8 | 6.1 | 6.3 | 6.4 | 6.6 | 6.6 | 6.7 |
| Medium | 1.2 | 1.5 | 2.0 | 2.9 | 3.2 | 3.3 | 3.4 | 3.4 | 3.8 | 3.8 | 3.9 |
| Small | 0.3 | 0.5 | 1.3 | 1.4 | 2.0 | 2.4 | 2.6 | 2.8 | 2.8 | 2.8 | 2.8 |
| LSD | 0.97 | 1.09 | 1.14 | 1.38 | 1.47 | 1.53 | 1.45 | 1.45 | 1.58 | 1.52 | 1.54 |

### Growth of tiger nut as influenced by tuber sizes and moisture stress

Plant height of tiger nut did not show significant response to either size of tuber planted or the moisture stress imposed during part of the growth period (Table 2). Maximum plant height recorded across all treatments was approximately 60 cm.The non-significant response of plant height to size of planting material and severity of moisture stress suggests that other growth attributes other than plant height will be better estimate of growth performance of tiger nut given similar condition as in this study. The general decline in values of plant height at the 8$^{th}$ week was due to the fact that leaves bent over even though logging or death was not recorded. This could also be attributed to the fact that plant was gradually approaching maturity. Tiger nut has been reported to mature in 90-110 days (17), whileTetteh and Ofori (11) reported its maturity between 2.5-3 months.

**Table 2. Effect of tuber sizes and irrigation intervals on plant height of tiger nut.**

| Plant height (cm) | | | | |
|---|---|---|---|---|
| **Treatment** | 2 WAP | 4 WAP | 6 WAP | 8 WAP |
| **Tuber size** | | | | |
| Large | 49.3 | 60.0 | 61.7 | 44.3 |
| Medium | 40.2 | 61.3 | 59.2 | 44.3 |
| Small | 44.5 | 61.8 | 59.6 | 45.3 |
| LSD | NS | NS | NS | NS |
| **Days between successive Irrigation (from 4-7 WAP)** | | | | |
| 3 | | 64.4 | 62.7 | 47.3 |
| 7 | | 58.3 | 60.7 | 45.2 |
| 12 | | 60.8 | 61.1 | 40.2 |
| 17 | | 61.4 | 56.1 | 45.3 |
| LSD | | NS | NS | NS |
| S * I | | NS | NS | NS |

At 2 WAP both large and medium sized tubers produced similar biomass i.e. 1.87 and 1.79g per plant ($p>0.05$) which was significantly higher ($p<0.05$) than that of small sized (0.71) tubers. Similarly, severity of moisture stress reduced the biomass accumulated by tiger nut at 12$^{th}$ week (Table 3).

**Table3. Effect of tuber sizes and irrigation intervals on fresh weight of tiger nut biomass.**

| **Treatment** | **4WAP** | **6WAP** | **12WAP** |
|---|---|---|---|
| **Tuber size** | | | |
| Large | 8.33 | 6.20 | 16.3 |
| Medium | 5.17 | 7.58 | 19.0 |
| Small | 5.42 | 6.8 | 21.0 |
| LSD | NS | NS | NS |
| 3 | 6.87 | 7.77 | 25.9 |
| 7 | 6.00 | 8.60 | 19.1 |
| 12 | 6 .11 | 7.02 | 16.5 |
| 17 | 6.22 | 4.14 | 13.5 |
| LSD | NS | NS | 6.51 |
| S * I | NS | NS | NS |

The dry weight of biomass of tiger nut was significantly affected by tuber size planted at the second and fourth week after planting (Table 4). Large and medium sized tubers had similar dry weight per plant at(0.20 and 0.22) 2 WAP but significantly higher than small ones (0.05g). However, large sized tuber produced significantly higher plant biomass (1.32g) at 4 WAP than (0.6g) medium and small sized tubers (0.52g).

**Table 4. Effect of tuber sizes and irrigation intervals on dry weight of tiger nut.**

| Dry weight (g/plant) | | | | |
|---|---|---|---|---|
| **Treatment** | **2 WAP** | **4 WAP** | **6WAP** | **12 WAP** |
| **Tuber size** | | | | |
| Large | 0.20 | 1.32 | 1.80 | 2.42 |
| Medium | 0.22 | 0.67 | 1.85 | 2.79 |
| Small | 0.05 | 0.52 | 1.61 | 3.09 |
| LSD | 0.08 | 0.43 | NS | NS |
| **Days between successive Irrigation (between 4-7 WAP)** | | | | |
| 3 | | 0.94 | 2.11 | 3.81 |
| 7 | | 0.76 | 1.76 | 2.81 |
| 12 | | 0.80 | 1.60 | 2.43 |
| 17 | | 0.84 | 1.52 | 0.95 |
| LSD | | NS | NS | NS |
| S * I | | NS | NS | NS |

Further at 12 WAP, large sized tubers produced lower plant biomass i.e. 2042g ($p>0.05$), even though the reverse was the case at 2 and 4 WAP (Table 4). Higher biomass produced by large and medium sized tubers at 2 WAP could be attributed to the larger food reserve in these tubers as well as faster emergence, thus leading to to the fact that higher growth rate since early emergence will mean early photosynthesis resulting in better growth rate. This is so because relative growth rate operates using the compound interest principles. The result obtained with dry weight was similar to the fresh weight. More severe reduction in growth in the large tubers due to moisture stress can be attributed to higher initial large mass produced by large sized tubers so, when moisture was withdrawn, initial rate of loss of moisture will be more in pots with bigger plants due to transpiration causing the plants to be more severely affected in relatively shorter period compared to smaller plants. Generally, reduction in biomass accumulation with increased severity of moisture stress in this study suggests that although tiger nut had been reported to be drought tolerant (17), exposure to moisture stress for a period of 17 days will lead to reduction in growth. These results were similar to earlier report that moisture stress makes extraction of water from the soil more difficult for plants due to exertion of greater energy (matrix effect), closure of stomata also occurs which limits entry of carbon (IV) oxide into the leaves, availability of water is equally hindered resulting in reduced photosynthesis and by extension, reduced growth and development (3).

### Productivity of tiger nut as influenced by tuber size and moisture stress

The size of tubers planted had no significant effect on the number of medium, large and total number of tubers produced; However small sized tubers produced significantly more number of small tubers i.e. ($p<0.05$) relative to the number of small tubers produced by large tubers i.e 25.9 (Table 5). The effect of moisture stress on both the number and size of tubers produced revealed that moisture stress had no significant effect on the number of large size tubers produced. The number of medium and small sized tubers produced as well as the total number of tubers generated were significantly ($p<0.05$) reduced by the severity of moisture stress. The number of medium sized tubers produced were significantly ($p<0.05$) reduced by increasing the interval between watering to 12 or 17 days, thus more medium sized tubers were produced when irrigation interval did not exceed 7 days. Plots with irrigation interval of 3 days had significantly ($p>0.05$) higher small (47.3) and total tiger nut (68.6) than those obtained from irrigation interval of 17days (26.4 and 38.3). Generally it was observed that the longer the intervals the lesser the number of tubers produced; this holds for small and large tubers as well as total number of tubers produced. A significant interaction was also observed between size of tubers planted and severity of moisture stress on the total number of tubers harvested per plant.

**Table 5. Effect of tuber sizes and irrigation intervals on total number of tubers.**

| Number of tubers | | | | |
|---|---|---|---|---|
| **Treatment** | **Large** | **Medium** | **Small** | **Total** |
| **Tuber size** | | | | |
| Large | 4.8 | 10.7 | 25.9 | 41.4 |
| Medium | 6.7 | 13.2 | 31.0 | 50.9 |
| Small | 3.4 | 11.3 | 46.7 | 61.4 |
| LSD | NS | NS | 16.5 | NS |
| **Days between successive Irrigation (from 4-7 WAP)** | | | | |
| 3 | 6.8 | 14.3 | 47.3 | 68.6 |
| 7 | 5.7 | 15.8 | 35.4 | 56.9 |
| 12 | 4.0 | 8.1 | 28.8 | 40.9 |
| 17 | 3.3 | 8.6 | 26.4 | 38.3 |
| LSD | NS | 5.8 | 19.0 | 18.5 |
| S * I | NS | NS | NS | 32.0 |

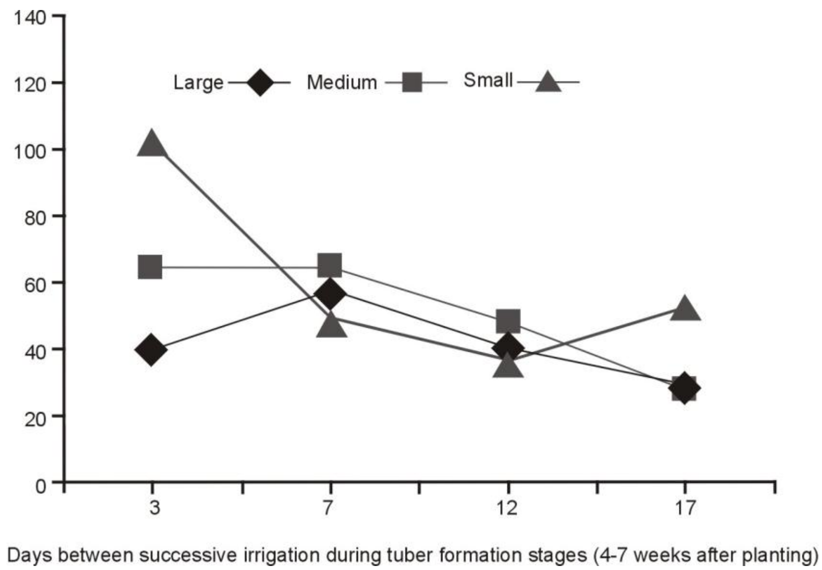
There was no significant difference between the weight of tubers from each class. Similarly the size of tuber planted did not affect the total weight of tubers produced. On the other hand both the weights of medium sized tubers produced and total weight of tubers were significantly affected by severity of moisture stress. There were 41.3 and 46.4 percent reduction in productivity by withholding moisture from 3 days to 12 and 17 days respectively (Table 6).

**Table 6. Effect of tuber sizes and irrigation intervals on weight of different categories of harvested tubers and cumulative weight of each treatment**

| Weight of harvested tubers (g/plant) | | | | |
|---|---|---|---|---|
| **Treatment** | **Large** | **Medium** | **Small** | **Cumulative** |
| **Tuber size** | | | | |
| Large | 3.0 | 4.0 | 5.3 | 13.0 |
| Medium | 3.5 | 5.0 | 5.2 | 13.9 |
| Small | 2.0 | 4.0 | 7.4 | 13.7 |
| LSD | NS | NS | NS | NS |
| **Days between successive Irrigation (from 4-7 weeks)** | | | | |
| 3 | 3.5 | 5.3 | 8.3 | 17.9 |
| 7 | 3.4 | 5.9 | 6.7 | 16.2 |
| 12 | 2.5 | 3.3 | 4.5 | 10.5 |
| 17 | 1.9 | 3.2 | 4.3 | 9.6 |
| LSD | NS | 2.1 | NS | 5.2 |
| S * I | NS | NS | NS | NS |

There was a significant interaction between size of tuber planted and the number of days between irrigation on the number of tubers produced (Fig.). Small sized tubers produced the highest numbers of tubers when irrigation was done at three days interval, while both at 7 and 12 days intervals, fewer numbers of tubers were generated from small tubers relative to tubers produced from medium and large tubers. At 17 days intervals the number of tubers produced from both the large and medium sized tubers were more severely reduced compared with the small sized tubers. The general trend for large sized tubers was that the number of tubers produced declined more severely as the exposure to moisture stress increased from 7 to 17 days. While for medium sized tubers, irrigation at 7 days interval produced the most number of tubers and the numbers declined as the severity of stress increased from 3 to 17 days.

Production of more number of smaller tubers from small sized tubers in this study might be environmentally controlled. This is because small sized tubers equally produced large sized as well as medium sized tubers which were not significantly different from one another.




The reduction in both the size as well as the number of tubers produced as the interval between successive irrigation was increased from 3 and 7 to 12 and 17 days which suggests that although tiger nut would withstand moisture stress upto 12 or 17 days, reduction in both the size as well as the number of tubers produced is inevitable. This is because as moisture stressed days increased photosynthesis is reduced as plants tend to close up the stomata to reduce loss of water through transpiration, this will well reduce the entry of carbon (IV) oxide into the leaves as well and rate of photosynthesis will be reduced.it results in limited assimilate to be partitioned for tuber formation as well as filling of formed tubers, hence reduction in both the number as well as the size of tubers produced. Production of potato under moisture stress condition has resulted in 24-33 percent reduction in yield, 18-22 percent fewer tubers as well as 19-22 percent fewer large tubers (7)

Similar observation was made in the total weight of tubers produced by different tuber sizes. This suggests that once tiger nut is successfully established, the size of tubers used does not determine the final yield. However, continuous decline in productivity with intensity of moisture stress just for a period less than 21 days implies that environmental factors, particularly water availability is very critical in successful production of tiger nut and dry spell of up to two weeks can lead to almost 50 percent reduction in productivity.

The interaction between size of tubers planted and moisture stress suggest that if moisture stressed condition is envisaged, medium sized tubers should be preferred as planting material since medium sized tubers gave relatively more stable productivity in this study. The findings in this study can be further established by future studies.

## CONCLUSION

The results of this study suggests that sorting of tiger nut tubers should be done to achieve similar and uniform emergence in the field. The bigger the size of the tuber, the faster the rate of emergence. Once established tuber size may not determine the final yield. Adequate moisture should be ensured for optimum productivity of tiger nut, However severe moisture stress can still be tolerated by the crop.

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***Received: July 31, 2015*** ***Accepted: April 27, 2016***

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| **Olufemi Olufisayo Adebayo** | **:** | **Participated in practical work and data collection** |