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Effect of Seed Tuber Size and Fertilizer Mixture on the Growth and Yield of Tiger Nut (*Cyperus esculentus* L.) in Mubi Adamawa State Nigeria

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Abstract:- Fertilizer is any material from organic or inorganic source having a potential of supplying the required nutrient to the soil to enhance plant growth and productivity. A field experiment was therefore carried out to evaluate the effect of seed tuber size and fertilizer mixture on the growth and yield of tiger nut (*Cyperus esculentus* L.), with the objective of selecting the best fertilizer mixture in combination with tuber seed that will enhance the yield of tiger nut. The treatments consisted of two fertilizer mixture FM_1= 100kg ha^{-1} SSP + 100 kg ha^{-1}Urea + 200kg ha^{-1}cow dung + 100kg ha^{-1}poultry dropping. FM_2= 150 kg ha^{-1}NPK + 200 kg ha^{-1}cow dung + 150kg ha^{-1}poultry dropping and C =control no fertilizer applied. Seed tubers were categorized into. Large (L) ≥ 1000g ≤ 1300g per 1000 tuber weight, Medium (M): ≥ 700≤ 900g per 1000 tuber weight and Small (S): ≥ 100≤ 300g per 1000 tuber weight. The experiment was laid out in a Randomized Complete Block Design (RCBD) in three replicates. Data collected was subjected to Analysis of Variance (ANOVA), significant means were separated using Duncan Multiple Range Test (DMRT) at $P < 0.05$. The result showed that, FM_2 containing the mixture of 150 kg ha^{-1}NPK + 200 kg ha^{-1} CD + 150kg ha^{-1}PD yielded the highest 1000 tuber weight of 451.85, highest tuber yield per plot 0.55 kg and tuber yield in kg ha^{-1} 1375. Significant interaction was observed between seed tuber size and fertilizer mixture for plant height, days to 50 % flowering, days to 90 % maturity, 1000 tuber weight, tuber yield per plot and tuber yield in kg ha^{-1} suggests that both the tuber size and fertilizer jointly contributed in the expression of those characters. Significant positive correlation was observed between tuber yield in Kg ha^{-1} with Tuber yield per plot (r=1.00) , and one thousand tuber weights (r=0.6436**), suggest that improving those character can enhance the yield of tiger nut. From this research therefore, the fertilizer mixture 150 kg ha^{-1}NPK + 200 kg ha^{-1} cow dung + 150kg ha^{-1} poultry droppings FM_2, applied at the rate of 0.015 kg m^{-2}NPK + 0.02kg m^{-2}CD + 0.015kg m^{-2} PD using large seed tuber of size ≥ 1000g ≤ 1300g per 1000 tuber weight will enhance the yield of tiger nut**

Keywords:- *Tuber Size, Fertilizer Mixture, Growth, Yield, Correlation, Tiger Nut.*

I. INTRODUCTION

Tiger nut (*Cyperus esculentus* L.) is an emergent grass like plant belonging to the sedge family, it is found to be a cosmopolitan perennial crop of the same genus as the papyrus plant that is common in seasonally flooded wetlands [4]. Tiger nut is commonly known as earth almoud, Chufa nut grass and Zulu nut. It is known in Nigeria as “Ayaya” in Hausa, “Ofio” or “Imumu” in Yoruba and “Aki-hausa” in Igbo where three varieties black, brown and yellow are cultivated [1].

Tiger nut is preferably grown in well-drained sandy or loamy soils and its production increases as the ambient temperature increases [6]. The nuts are usually eaten uncooked, pounded into cake and served at the end of a meal [2]. The plant has been described as an important food of high nutritional and economic values and a good source of starch for human consumption and industrial use [8]

According to [14], tiger nuts have long been recognized for their health benefits as they have a high content of soluble glucose and oleic acid, along with high energy content (starch, fats, sugars and proteins), they are rich in minerals such as phosphorous, potassium, calcium, magnesium and iron necessary for bones and tissue repair. Sugar-free tiger nut milk is suitable for diabetic people and also helps in weight control [13]. Due to its content of carbohydrates with a base of sucrose and starch, and its high content of Arginine, this liberates the hormone that produces insulin [7]. Tiger nut contains a good quantity of vitamin B1, which assists in balancing the central nervous system and helps to encourage the body to adapt to stress [9].

Despite the important of tiger nut as food and medicine, it is considered economically disadvantage crop due to difficulty in cultivation, lack of high yielding varieties among others. Fertilizer is any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more plant nutrients essential for growth of plants. Conservative estimates report 30 to 50% of crop yields are attributed to natural or synthetic commercial fertilizer [16]. Naturally occurring organic fertilizers include Goat manure, cattle dung, poultry droppings etc. The complementary application of organic and inorganic fertilizers has been found to meet the immediate soil nutrient deficits, improve the soil physical properties and enhance yield stability.

The current global scenario firmly emphasizes the need to adopt eco-friendly agricultural practices for sustainable food production. The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. The organic fertilizers provide nutritional requirements, suppress plant pest populations, and increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers [18]. [15], reported their findings on the application of a combination of cow dung and a half dose of inorganic fertilizer.

The higher yields from organic manure plus inorganic fertilizer treatment than sole inorganic fertilizer treatment is an indication that integrated use or organic and inorganic nutrient sources of N is advantageous over the use of inorganic fertilizer alone. Earlier studies demonstrated that use of organics could enhance efficiency of chemical fertilizer [11].

Cyperus esculentus generally requires fertilizer to improve growth performance and yield. The yield and economic performance of *Cyperus esculentus* was impressive with the application of 60 kg ha^{-1} of nitrogen fertilizer or 2.5 N ha^{-1} of poultry manure. [12] showed that nitrogen promote vegetative growth and impact the characteristic green color to foliage because it is component of chlorophyll which is essential for photosynthesis. [3] observed that fertilizer recommendation for *Cyperus esculentus* in Nigeria is lacking and farmers have attempted the fertilizer rate for *Cyperus esculentus* a crop of the same family and also a fiber that is biochemically and botanically different. [3] stated that the increase in time to the attainment of flowering with increase in application of nitrogen fertilizer may be attributed to the role of nitrogen in crop vegetative development. [10] observed that nitrogen fertilization can promote vegetative growth of *Cyperus esculentus*.

Seed size is an important factor to consider during mass seed selecting seeds for planting, in some crops, medium seeds gives a better growth performance than small and large seeds, tiger-nuts may not be an exception, there is a little knowledge on the size of seed tuber that is suitable for the tiger-nuts propagation. A research of this nature will help to clear the doubt on which seed size and in combination with which fertilizer can help enhance the yield of tiger-nuts. It is on this background that this research is carried out to evaluate the effect of seed tuber size and fertilizer mixture on the growth and yield of tigernut.

II. MATERIALS AND METHODS

- *Description of study area*

The research was carried out at the Adamawa State University. Department of Crop Science Teaching and Research Farm at Gidan Madara, Mubi South Local Government Area, latitude 10^{o} 10' and, longitude 13^{o} 10' East of Greenwich meridian and at an altitude of 696m above sea level.

- *Description of experimental materials*

The seed tuber was obtained from local farmers in Mubi, which was identified by an expert in the Department of Crop Science Adamawa State University Mubi. The seed tuber was tested for viability using floatation method. Seed tuber were categorized into Large (L) ≥ 1000g ≤ 1300g per 1000 tuber weight, Medium (M): ≥ 700≤ 900g per 1000 tuber weight and Small (S): ≥ 100≤ 300g per 1000 tuber weight.

- *Treatments and Experimental Design*

The treatments consisted of the following FM_1 L, FM_1M, FM_1S, FM_2L, FM_2M, FM_2S, C_L, C_M C_S. Large (L) ≥ 1000≤ 1300g/1000 tuber weight, Medium (M): ≥ 700≤ 900g per 1000 tuber weight and small (S): ≥ 100≤ 300g per 1000 tuber weight. Fertilizer mixture FM_1= (100kgha^{-1} SSP + 100 kg ha^{-1}Urea + 200kg ha^{-1}cow dung + 100kg ha^{-1}poultry dropping). Fertilizer mixture FM_2= 150 kg ha^{-1}NPK + 200 kg ha^{-1}cow dung + 150kg ha^{-1}poultry dropping) and control C =no fertilizer. The experiment was laid out in a Randomized Complete Block Design (RCBD) in three replicates.

- *Experimental procedure and cultural practices*

The land was disc ploughed, harrowed and leveled; it was divided into sub-plot of 2 m x 2 m. leaving a gap of 0.5m and 1m between plots and within blocks respectively for easy water passage. The treatments were allocated randomly across the experimental plots using simple randomization technique. Weeds were controlled manually using hand at various stages of the plant development.

- *Data Collection*

The data was collected from five randomly tagged plants from each treatment on the following

- *Phonological parameters:*

Days to 50% flowering: Days from sowing to the time at which 50% of the plants has flowered.

Days to 90% maturity: The number of days from sowing to the time at which 90% of the crop matured were recorded.

- *Growth parameters:*

Plant height (cm): Plant height was measured using ruler from the base of the plant to the tip of the main branches in each treatment.

➢ *Yield parameters:*

1000 tuber weight (g): 1000 tubers were selected from each treatment and weighed using electronic weighing balance.

Tuber yield per plot (kg): it was obtained from the weight of all the tuber harvested from each sub-plots.

Tuber yield kg ha^{-1}: seed yield in kg ha$^{-1.}$ was calculated using the formula

$$\text{Tuber yield kg ha}^{-1} = \frac{\textit{Tuber yield per plot }(kg) \times 10{,}000\, m^2}{\textit{Plot size }(m^2)}$$

➢ *Data Analyses*

Data was subjected to Analysis of Variance (ANOVA), using MINITAB computer software program. Significant mean were separated using Duncan Multiple Range Test (DMRT) at P ≤ 0.0

III. RESULTS

➢ *Effect of seed tuber size and fertilizer mixture, on plant height, days to 50% flowering and days to 90% maturity.*

The Analysis of Variance (ANOVA) showed no significance different in plant height at P > 0.05 for the different fertilizer mixture. Days to 50% flowering shows significance difference at P < 0.05 across the different fertilizer mixture , with soil treated with mixture of FM_1 i.e (150 kg ha^{-1}NPK + 200 kg ha^{-1}cow dung + 150kg ha^{-1}poultry dropping) took longer days of 46.22 to flowered followed by the one treated with the mixture of 100kg ha^{-1} SSP + 100 kg ha^{-1}Urea + 200kg ha^{-1}cow dung + 100 kg ha^{-1}poultry dropping FM_2 recorded a mean days to 50% flowering of 45.33 while the least days to 50% flowering was recorded in the control 34.11 days. Days to 90% maturity showed significance difference at P<0.05 across the different fertilizer mixture with the FM_1 recorded the highest mean days to 90% maturity of 139.89 followed by FM_2 133.33 while the control took the least days to attain maturity of 132.11 to (Table 1).

The Analysis of Variance also revealed significance difference at P<0.05 for plant height across the different size tuber with large tuber attended a height of 66.98cm followed by the medium sized tuber 64.98cm while the small size tuber yielded least mean plant height of 60.09cm. The interaction of seed size and fertilizer was highly significant for plant height and days to 90% maturity. (Table 1)

➢ *Effect of seed Tuber size and fertilizer mixture on 1000 tuber weight, seed yield per plot and seed yield in kg ha^{-1}*

The Analysis of Variance showed significant difference for 1000 tuber weight at P<0.05 with the soil treated with a mixture FM_1 yielded the heaviest 1000 seed weight of 451.85g followed by FC_2 which yielded 349.38g. Seed yield per plots showed significance difference at P<0.05 with FM_1 yielded the highest mean of 0.55*kg* followed by FM_2 0.54Kg while the control recorded the least seed yield per plot of 0.36kg. (Table 2)

Seed yield in kg/ha showed significance difference at P<0.05 with FM_1 yielded of 1375 kg ha^{-1} followed by FM_1 with the yield of 1350 kg ha^{-1}, while the control yielded 900 kg/ha The Analysis of Variance (ANOVA) showed significance difference for tuber size for 1000 tuber weight at P<0.05 with large tuber size produced the highest mean 1000 tuber weight of 433.09g followed by the medium tuber weight of 432.09g while the small tuber size recorded the least 1000 tuber weight of 333.33g. Significant interaction was observed between tuber size and fertilizer for 1000 tuber weight, seed yield per plot and seed yield in kg/ha. Table 2.

➢ *Pearson correlations for Yield and related traits in Tiger Nut*

The results showed significant positive correlation at P<0.01 tuber yield in kg/ha between days to 50% flowering and days to 90% maturity (r= 0.4864**), seed yield kg/ha (r = 0.4706**) and seed yield per plot (r = 0.4701**) and negatively correlated at P<0.01 with tuber size (r = -0.5734**). 1000 tuber weight showed positive correlation with seed yield kg/ha. (r = 0.6436**), seed yield per plot (r = 0.6433**) and negatively correlated at P<0.05 with tuber size (r=-0.4375*). Seed yield in kg/ha recorded high significant correlation with seed yield per plot (r= 1.0000**) and negatively correlation at P<0.01 with tuber size (r = n-0.4375**). Seed yield per plot showed negative correlation with tuber size (r= -0.5540*) Table 3

Treatments	Plant height (cm)	Day to 50% flowering	Days to 90% Maturity
Fertilizer mixture FM$_1$=100kgha^{-1} SSP + 100 kg ha^{-1} Urea + 200kg ha^{-1} CD + 100kg ha^{-1} PD	65.98^a	45.33^a	133.33^b
FM$_2$=150 kg ha^{-1} NPK + 200 kg ha^{-1} CD+ 150kg ha^{-1} PD	62.71^a	46.22^a	139.89^a
Control (no fertilizer)	62.62^a	34.11^b	132.11^b
Significance	NS	**	**
SE ±	2.08	2.47	2.59
Tuber size			
Large (L) = ≥ 1000g ≤ 1300g / 1000 TW	66.98^a	40.22^a	135.22^a
Medium (M) = ≥ 700≤ 900g /1000 TW	64.98^a	43.11^a	135.22^a
Small (S)= ≥ 100≤ 300g /1000 TW	60.09^a	42.33^a	134.89^a
Significance	NS	NS	NS
SE ±	2.08	2.47	2.59
Interaction Tuber size * fertilizer mixture	**	NS	**
CV %	6.72	12.49	4.06

Table 1:- Effect of seed tuber size and fertilizer mixture on plant height, days to 50% flowering and days to 90% maturity.

Mean followed by the same superscript within the same column and treatments are not significantly different from each other at P<0.05
* =significant at P<0.05, ** =significant at P<0.01; NS=not significant

Treatments	1000 tuber weigh (g)	Tuber yield per plot (kg)	Tuber yield (kg ha^{-1})
Fertilizer mixture FM$_1$=100kgha^{-1} SSP + 100 kg ha^{-1}Urea + 200kg ha^{-1} CD + 100kg ha^{-1} PD	417.28^{ab}	0.54^a	1350.00^a
FM$_2$=150 kg ha^{-1}NPK + 200 kg ha^{-1} CD + 150kg ha^{-1} PD	451.85^a	0.55^a	1375.00^a
Control	394.38^b	0.36^b	900.00^b
Significance	*	*	*
SE ±	34.62	0.05	74.20
Tuber size			
Large (L) = ≥ 1000g ≤ 1300g / 1000 TW	453.08^a	0.52^a	1300.00^a
Medium (M) = ≥ 700≤ 900g / 1000 TW	432.09^a	0.47^a	1175.00^a
Small (S)= ≥ 100≤ 300g / 1000 TW	333.33^b	0.47^a	1175.00^a
Significance	*	NS	NS
SE ±	34.62	0.05	74.20
Interaction Tuber size * fertilizer	**	**	**
CV %	18.08	23.48	23.36

Table 2:- Effect of seed Tuber size and fertilizer mixture on 1000 tuber weight, seed yield per plot and seed yield in kg ha^{-1}

Mean followed by the same superscript within the same column and treatments are not significantly different from each other at P<0.05
* =significant at P<0.05, ** =significant at P<0.01; NS=not significant

	DFF	DNM	1000TW	TYkg/ha	TYPP
DNM	0.4864** 0.0101				
OTWP	0.2729 0.1685	0.0582 0.7730			
TY Kg/ha	0.4706** 0.0132	0.0790 0.6952	0.6436** 0.0003		
TYPP	0.4701** 0.0134	0.0794 0.6939	0.6433** 0.0003	1.0000** 0.0000	
TS	-0.5734** 0.0018	-0.0914 0.6504	-0.4375* 0.0225	-0.5565** 0.0026	-0.5540** 0.0027

Table 3:- Pearson Correlations for Yield and Related Traits in Tiger Nut

*: Significant at P<0.05 **: Significant at P<0.01
DFF = days to 50% flowering, DNM = days to 90% maturity, 1000TW = one thousand tuber weight, TY kg/ha. = Tuber yield in kg/ha, TYPP = Tuber yield per plot TS = Tuber size

IV. DISCUSSION

Plant height showed no significant difference at P<0.01 across the two fertilizer mixture and tuber size, this suggest that the fertilizer mixture and rate used in this study does not result to difference in plant height of tiger-nuts, also the different tuber sizes does not lead to difference in plant height, as all the plants raised from large, medium, small seeds attended the same height at harvest across the seed size and fertilizer mixture. This result agree with the findings of [17] who reported no significant difference in plant heights in tiger-nuts at different fertilizer mixture,

The high significant difference for days to 50% flowering across the different fertilizer mixture and the control suggest that days to flowering are delayed in tiger-nuts raised in the soil treated with fertilizer compared with the control. This suggests that tiger nuts raised under certain levels of fertilizer grow vegetatively at the expense of flowering.

There was significant difference in the days to maturity with respect to the different fertilizer mixture, seed size and control. The control plant that has flowered earlier, matured earlier than those raised in the soil treated with the different fertilizer mixture. Therefore, planting large tuber size of tiger-nuts with no fertilizer may lead to early maturity in tiger nut. The delay in maturity observed with the application of fertilizer in this research suggests that fertilizer application facilitates vegetative growth at the expense of maturity. Our results agree with the finding of [17] who reported early maturity of tiger-nuts in soil with no fertilizer application, while plants raised in the soil containing fertilizer mixture FM_2 matured late, this confirmed our results. The result that seed size showed no significant difference in days to maturity across the different fertilizer mixture suggests that tuber size has no effect on the days to maturity in tiger-nuts.

Significant interaction observed between fertilizer and tuber size for plant height, days to 90% maturity. Suggests that both the tuber size and fertilizer has a joint effect for the expression of these characters.

1000 tuber weight showed variation across the different fertilizer mixture, with the plant raised with FM_2 recorded the heaviest 1000 seed weight, then FM_1 and the control. Suggests that FM_2 with large seeds tuber yielded heaviest seed weight. This may be attributed to the fact that tuber size may be under genetic influence and not the environment, since larger seed tubers yielded large tubers and smaller seed tuber yielded smaller tubers. Our results agree with the findings of [17] on tiger-nuts who reported the mixture of (NPK + cattle dung + Poultry droppings) yielded heaviest 1000 tuber weight in tiger nut.

Significant interaction was observed between fertilizer and tuber size for 1000 tuber weight, tuber yield per plot, and tuber yield in kg/ha. This suggests that tuber size and fertilizer has jointly contributed to the expression of these characters.

Tuber yield per plot also showed significant difference across the fertilizer mixture with the plant raised in the soil containing FM_2 yielded the highest tuber yield per plot. This suggest that FM_2 resulted into a high tuber yield per plot this may be attributed to the fact that fertilizer mixture and rate has provided the necessary macro and micro nutrients necessary for the growth and yield of tiger-nuts. Our results also agree with the findings of [17] who reported the mixture of (NPK + cattle dung + Poultry droppings) as the best ratio that will enhance the tuber yield of tiger-nuts. This confirmed our results.

In every breeding procedure, aimed at improving yield in any crop, yield in kg/ha is the most important character to consider. Tiger-nuts raised in the soil containing FM_2 gave the highest tuber yield in combination with large tuber size, these result suggests that planting larger tubers of tiger-nuts in the soil containing the FM_2 will give high yield of tiger-nuts compared with FM_1 and the control, as this fertilizer mixture supply the plant with necessary nutrients that help boosts its yield. Our results agree with the findings of [17] on tiger-nuts who reported that the mixture of (NPK + cattle dung + Poultry droppings) gave the highest tuber yield of tiger-nuts. The results also agree with the findings of [5] who reported that, Cassava, performed best in terms of growth and yield under poultry manure + NPK fertilizer treatments.

There was also significant positive correlation between days to 50% flowering and days to 90% maturity. This suggests that as the days to flowering increases the days to maturity also increases. The results agree with the findings of [17] on tiger-nuts. Days to 50% flowering showed significant positive correlation with seed yield in kg/ha and seed yield per plot this suggested that a change in days to flowering will affects the yield of tiger-nuts.

Tuber size also showed significant correlation with 1000 tuber weight, seed yield per plot and seed yield in kg/ha suggests that as the size of tuber changes from large to medium to small, it also affect the productivity of tiger-nuts.

Tuber yield in kg/ha also showed significant positive correlation with seed yield per plot, 1000 seed weight suggests that increase in these characters will bring about increase in the yield of tiger-nuts. This result agrees with the findings of [17] on tiger-nuts who reported significant positive correlation between tuber yield in kg/ha with 1000 tuber weight and seed yield per plot. This confirmed our result.

V. CONCLUSION

There was high significant difference at $P < 0.05$ for days to 90% maturity, 100 tuber weight, tuber yield per plot and tuber yield in kg/ha with FM_2 performed better in all the above listed characters, suggest that the FM_2 has supply the soil with the adequate nutrient required for growth and yield of tigernut. There was also high significant difference for plant height, days to 90% maturity, and 1000 tuber weight with across the tuber size, with large tuber size performed better in those characters. Suggest that large seed tuber is the correct tuber size to be used as seed for tiger nut propagation. Significant interaction observed between fertilizer and tuber size for plant height, days to 90% maturity, 1000 tuber weight, tuber yield per plot and tuber yield in kg ha^{-1}. Suggests that both the tuber size and fertilizer has contributed jointly in the expression of those characters.

Therefore, planting large seed tuber between ≥ 1000g ≤ 1300g per 1000 tuber weight in soil inn 150 kg ha^{-1}NPK + 200 kg ha^{-1}cow dung + 150kg ha^{-1}poultry dropping FM_2 is the best fertilizer mixture and tuber size that can enhanced the yield of tiger-nuts. As the performance of the crop is outstanding in those combinations. Also the significant positive correlation between tuber yield in kg ha^{-1} and 1000 seed weight and seed yield per plot suggest that these characters are very important characters to be considered when planning for breeding program aimed at improving the yield of tiger-nuts, because of their positive contribution to yield.

RECOMMENDATIONS

- Further research to be carried out using different rates of organic and in-organic fertilizers on mixture on tiger nut.
- I recommend the fertilizer mixture of 150 $kgha^{-1}$ NPK + 200 kg ha^{-1}cow dung + 150kg ha^{-1}poultry dropping using large seeds tuber of size ranges between ≥ 1000g ≤ 1300g per 1000 tuber weight for yield enhancement.
- The research should be replicated over several locations and seasons.

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