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Growth and Yield Response of Tiger Nut (*Cyperus esculentus* L.) to Different Rates of NPK, Cattle Dung and Poultry Droppings in Mubi Adamawa State Nigeria

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ABSTRACT

A field experiment was conducted at Teaching and Research Farm, Adamawa State University, Mubi, in the Northern Guinea Savanna of Nigeria during the 2017 growing season June to December 2017, to investigate the response of tiger nuts (*Cyperus esculentus* L.) to NPK, Cattle dung and Poultry droppings with the objective of selecting the best fertilizer combinations that can boost the yield of tiger nut. The treatments consisted of T1=240kgha^{-1} NPK, T2= 240kgha^{-1} Poultry droppings (PD), T3= 480kg^{-1} Cow dung (CD) T4=177.5kgha^{-1} NPK+62.5kgha^{-1} Poultry droppings (PD), T5=177.5kg^{-1} NPK +302.5kg^{-1} Cow dung (CD) T6=100kgha^{-1} NPK+ 140kgha^{-1} Poultry droppings (PD)+240kg^{-1} Cow dung (CD) T7= Control (no fertilizer treatment). The experiment was laid out in a Randomized Complete Block Design (RCBD), in three (3) replicates data was collected on Plant height, Number of leaves, Days of 50% flowering, Days to 90% maturity, Number of tuber per plant, 100 tuber weight, tuber yield per plot and tuber yield kg/ha. Data collected was subjected to Analysis of Variance (ANOVA) using MINITAB computer software program, significant means were separated using Duncan Multiple Range Test (DMRT) at P ≤ 0.05. Simple Pearson correlation was also conducted to show the relationship between these observed characters to yield. The result revealed that, the soil treated with the mixture of 100kgha^{-1} NPK+ 140kgha^{-1} Poultry droppings (PD)+240kg^{-1} Cow dung (CD) recorded the fastest growth, yielded the highest number of leaves, produced the heaviest tuber weight, highest number of tuber per plan, tuber yield per plot and tuber yield in Kgha^{-1} compared with the other treatments. The findings from this research revealed that a mixture of 100kgha^{-1} NPK+ 140kgha^{-1} Poultry droppings (PD) + 240kgha^{-1} Cow dung is the best fertilizer combination and rate that can enhance the yield of tiger nut. Significant positive correlation between tuber yield and plant height number of leaves, hundred tuber weights, number of tuber per plant, and tuber yield per plant suggest that increase in these characters will lead to increase in tuber yield of tiger nut, hence these are important characters to be considered when planning for hybridization involving tiger nut for yield improvement.

1. INTRODUCTION

Tiger nut (*Cyperus esculentus*) is a tuber crop belonging to the family cyperaceae. It produces edible tubers that are between 0.3-1.9 cm in diameter. The tuber is rich in dietary fiber, carbohydrate [1] and protein [2];[3].
Like any other sedges, the plant is most frequently found inhabiting wet marshes and edges of streams and ponds where it grows in coarse turfs [4]. Tiger nut or yellow nutsedge (*Cyperus esculentus* (L). has many names in English, it is called tiger nut, yellow nut sedge, earth almond, ground almond, and yellow nutgrass [5]. It is also named Habelaziz in Arabic, Chufa in Spanish, and Ayaya and Zulu nuts in Africa [6].

Tiger nut, (*Cyperus esculentus* L.) is considered underutilized due to lack of information on their nutritional potential [7]. It is considered a mere weed in many areas.

In Nigeria, tiger nut is well grown in the middle belt and northern region [8], where it is sold locally and consumed uncooked. The tuber grows freely and is consumed widely in Nigeria and other parts of West Africa, East Africa, parts of Europe particularly Spain as well as in the Arabian Peninsula [9].

Nutritionally, the tubers are the economical parts of the plant since they contain about 50% digestible carbohydrates, 4-8% proteins and 9% crude fibers, and about 20-36% oil. In addition, many products can be obtained from it like tiger nut oil, flour and milk [10]. He also reported that the oil of the tiger nut tuber contains 18% saturated fatty acids (palmitic and stearic) and 82% unsaturated fatty acids (mainly olieic and linoleic acids) and therefore, has excellent nutritional qualities with a fat composition similar to olives and can be used as food oil as well as for industrial and medicinal purposes [11].

The plant was reported to help in preventing heart diseases, thrombosis and activates blood circulation, responsible for preventing and treating urinary tract and bacterial infection, assists in reducing the risk of colon cancer [12]. They are thought to be to diabetic patients and those seeking to reduce cholesterol or lose weight, the very high fiber contents combined with a delicious taste make them ideal for healthy eating [13]

Tiger nut is considered underutilized, due to certain factors but exploiting the potentials of such underutilized food crops will become more and more cardinal to achieving food security especially in the developing countries and ensuring ecological stability in the face of ever increasing human population and climate change. According to [7] tiger nut has attracted very little scientific and technological attention in the recent past. Constraints identified to be restricting the cultivation of tiger nut include; the label of the crop as a mere weed in many areas, difficulties in harvesting the tubers, problems of pest like red ants, termites and rodents, lack of adequate knowledge on the type of fertilizer to be used to enhance its yield [14]

Information regarding tiger nut fertilizer is little in published literature and fertilizer requirement of tiger nut were variable [15], [16]. Due to intensive farming, Nigeria is a heavy consumer of chemical fertilizer. The application of farmyard manure is recommended in order to improve the biological, physical and chemical properties of soil

In recent times, attention has been directed towards organic manure because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health. Poultry manure, sometimes called chicken manure, is an excellent soil amendment that provides nutrients for growing crops and also improves soil quality when applied wisely, because it has high organic matter content combined with available nutrients for plant growth [17]. Poultry manure has been reported to contain more plant nutrients than all other organic manures [18].

Poultry manure contains high percentage of nitrogen and phosphorus for the healthy growth of plants [19]. Nitrogen is equally said to be the motor of plant growth [20]. Organic matter is the ultimate determinant of the soil fertility in most tropical soils and this account for its use to raise seedling in tropical areas, the fertility of the soil could be sustained with the addition of poultry manure. [21]

The use of inorganic fertilizer to enhance yield of crop has been found to be effective only within few years, demanding consistent use on long-term basis [12]. The hazardous environmental consequences and high cost of inorganic fertilizers make them not only undesirable but also uneconomical and out of reach of the poor farmers who still dominate the Nigerian agricultural sector. This has led to increased use of organic manure, a readily available alternative, which proves more environmentally friendly. It is on this background that this research is aimed at evaluating the response of tiger nut to NPK, cattle dung and poultry droppings with the objective of selecting the best fertilizer combinations that can help enhance the yield of tiger nut in Nigeria.

2. MATERIALS AND METHODS

1) *Description of Experimental Site*

The research was carried out at the Adamawa State University faculty of Agricultural Research Farm at Gidan Madara, Mubi South Local Government Area of Adamawa State latitude $10^{0}10'$ and 10^{0} $30'$ North of the Equator and between longitude 13^{0} $10'$ and 13^{0} $30'$ East of Greenwich meridian at an altitude of 696m above sea level, during the 2017 rainy season.

2) *Crop establishment and treatments*

The tiger nuts tubers were purchased from Mubi market and were tested for viability using floatation method, with the assumption that the tubers that settled at the bottom were considered viable while those that float on the surface were considered non viable and hence discarded.

3) Land Preparation

The land was disc plough and harrowed, it was then divided into plots of 2 x 2 m^2, different fertilizer treatments were incorporated into the sub plots before planting.

4) Experimental design

The experiment was laid out in a Randomized Complete Block Design (RCBD) in three replicates. The treatment combinations were as follows:

Table 1: Detailed fertilizer treatments used during the study

Treatment code	Treatments
T1	240kgha^{-1}NPK
T2	240kgha^{-1}PD
T3	480kgha^{-1}CD
T4	177.5kgha^{-1}NPK + 62.5kgha^{-1} PD
T5	177.5kgha^{-1} NPK + 302.5kgha^{-1} CD
T6	100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD
T7	Control (No fertilizer application)

Source: Field Work 2017

5) Cultural practices

Weeds were controlled manually using hand wherever they emerged. Strict agronomic practices were followed to allow for full expression of the plant characters.

6) Data Collection and analyses

Data were collected on 10 randomly selected plants from each treatment on the following characters: Plant height, number of leaves, Days to 50% flowering, Days to 90% maturity, number of tuber per plant, hundred tuber weight, tuber yield per plot, tuber yield in kgha^{-1}.

The data collected was subjected to analysis of Variance (ANOVA) using MINITAB 14 statistical package (MINITAB Inc., U.S.A). Duncan Multiple Range Test (DMRT) was used to identify significant differences among means ($P \leq 0.05$). Simple Pearson correlation was also conducted to show the relationship between some of the observed character to yield.

3. RESULTS

1) Effect of fertilizer combination on plant height

The Analysis of Variance (ANOVA) showed significant different at $P \leq 0.01$ for plant height at 4 and 8 weeks after sowing (WAS). The tiger nut raised in the soil containing the mixture of 100kgha^{-1}NPK+140kgha^{-1}PD+240kgha^{-1}CD produces the highest plant height of 42.37cm at 4WAS, 85.40cm at 8WAS and 85.37 cm at 12WAS. While the control recorded the shortest plant height of 26.0cm 4WAS, 46.69cm at 8WAS and 68.45 cm at 12WAS (Table 1).

2) Effect of Fertilizer combination on Number of Leaves

The Analysis of Variance (ANOVA) showed significant difference at $P<0.05$ for number of leaves at 8 and 12 WAS. With tiger nuts raised in the soil treated where the combination of 177.5kgha^{-1}NPK + 62.5kgha^{-1} PD produced the highest mean number of leaves of 8.5 at 4WAS 7.7 at 8WAS and 9.5 at 12WAS while the control plants produced fewer number of leaves 3.47 at 4WAS 6.50 at 8WAS and 9.07 at 12 WAS (Table 2).

3) Effect of Fertilizer combination on Days to 50% flowering, days to 90% maturity and hundred tuber weight

Analysis of Variance (ANOVA) showed significant difference at $P \leq 0.05$ for days to 50% flowering among the different treatments, with the plants raised in the soil containing the combination with 240kgha^{-1}NPK only. flowered earlier at 69.33 days, the control flowered late at 75.33days. Hundred tuber weight varies widely among the various treatments, the Analysis of Variance (ANOVA) revealed significant difference in hundred tuber weight. Between the treatments at $P<0.01$ with the 100kgha^{-1} NPK + 140 kgha-1 PD+ 240 kg ha-1 CD produced the heaviest hundred seed weight of 70.50g followed by the ones raised in the mixture of NPK +PD 53.77g. While the control performed poorly with 38.53 g. (Table 4)

4) Effect of Fertilizer combination on Number of tuber per plant (NTPP), Tuber yield per plot (TYPP) and tuber yield (TY) Kg/ha.

The analysis of variance revealed significant difference for the number of tuber per plant (NTPP) at $P \leq 0.05$ with the plant raised in 100kgha^{-1} NPK + 140kgha^{-1}(PD)+240kgha^{-1}CD produced the highest number of tuber per plant of about 3.93 while the control produced the least number of tuber per plant of 2.57 (Table 4). Tuber yield per plot varies significantly among the treatments at P≤0.01, with plant raised in the soil with the combination of 100kgha^{-1} NPK+ 140kgha^{-1}(PD)+240kgha^{-1} CD produced the highest tuber yield per plant of about 196.6g, followed by the soil combination of 177.5kgha^{-1} NPK + 302.5kgha^{-1} CD with 146.93g , and the least yield per plot was produced by the control 122.00g (Table 4). The yield of tiger nut in Kg/ha varies widely among the various treatments. The Analysis of Variance (ANOVA) showed significant variability among the various treatment combinations at P≤0.01, with plants raised in the soil containing the mixture of 100kgha^{-1}NPK+ 140kgha^{-1}(PD)+240kgha^{-1}CD produced the highest yield of 492.20kg/ha followed by those raised in the soil mixture of 177.5kgha^{-1} NPK + 302.5kgha^{-1} CD with 367.30 kg/ha, while the control performed poorly with 307.5 kg/ha (Table 5)

5) Matrix for correlation coefficient of some growth and yield parameters of tiger nut

Significantly positive correlations were found between tuber yield (kg/ha) and plant height at four weeks(r=0.76**), plant height at eight weeks(r=0.62*), plant height at twelve weeks (r=0.65*), number of leaves at twelve weeks(r=0.77**), one hundred tuber weight (r=0.93**), number of tuber per plant (r=0.96**) and tuber yield per plot (r=1.00**) Table 5.

Table 2: Effect of Fertilizer combination on Plant Height at 4, 8 and 12 weeks after sowing (WAS)

TREATMENTS	4WAS	8WAS	12WAS
CONTROL	26.0^{d}	46.69^{d}	68.45^{a}
240kgha^{-1}NPK	31.14^{bcd}	65.00^{c}	78.91^{a}
240kgha^{-1} PD	29.04^{cd}	67.78^{bc}	83.17^{a}
480kgha^{-1} CD	24.43^{d}	48.07^{d}	74.88^{a}
177.5kgha^{-1}NPK + 62.5kgha^{-1} PD	36.65^{ab}	77.92^{ab}	72.65^{a}
177.5kgha^{-1} NPK + 302.5kgha^{-1} CD	35.38^{bc}	74.59^{abc}	80.82^{a}
100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD	42.37^{a}	85.40^{a}	85.37^{a}
Significance	**	**	NS
SE ±	3.10	5.92	10.89
CV%	11.81	10.91	17.15

Source: field work 2017. PD=Poultry droppings CD=Cattle dung NPK=Nitrogen phosphorus and potassium
Mean followed by the same superscript within the same column and treatment are not significantly different at P≤ 0.05 (DMRT)
*=Significant at P≤ 0.05 **= significant at P≤ 0.01 NS = Not significant

Table 3: Effect of Fertilizer combination on number of leaves at 4, 8 and 12 weeks after sowing (WAS)

TREATMENTS	4WAS	8WAS	12WAS
CONTROL	3.47^{a}	6.50^{b}	9.07^{bc}
240kgha^{-1}NPK	3.50^{a}	7.40^{a}	9.00^{c}
240kgha^{-1} PD	4.30^{a}	7.50^{a}	9.50^{c}
480kgha^{-1} CD	3.70^{a}	7.60^{a}	9.60^{c}
177.5kgha^{-1}NPK + 62.5kgha^{-1} PD	8.50^{a}	7.70^{a}	9.50^{c}
177.5kgha^{-1} NPK + 302.5kgha^{-1} CD	7.60^{a}	7.60^{a}	9.70^{b}
100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD	4.30^{a}	7.70^{a}	10.40^{a}
Significance	NS	*	*
SE ±	2.83	0.36	0.40
CV%	68.06	5.92	3.90

Source: Field work 2017. PD=Poultry droppings CD=Cattle dung NPK=Nitrogen phosphorus and potassium
Mean followed by the same superscript within the same column and treatment are not significantly different at P≤ 0.05 (DMRT)
*=Significant at P≤ 0.05 **= significant at P≤ 0.01 NS = Not significant

Table 4: Effect of Fertilizer combination on Days to 50% flowering, days to 90% maturity and one hundred seed weight

TREATMENTS	D50%F	D90%M	100TW
CONTROL	75.33[a]	95.33[c]	38.53[f]
240kgha^{-1}NPK	66.67[d]	94.33[c]	49.07[cd]
240kgha^{-1} PD	70.67[bcd]	98.00[bc]	43.77[e]
480kgha^{-1} CD	72.33[abc]	101.67[abc]	46.07[de]
177.5kgha^{-1}NPK + 62.5kgha^{-1} PD	69.33[cd]	98.33[abc]	53.77[b]
177.5kgha^{-1} NPK + 302.5kgha^{-1} CD	74.67[ab]	106.67[a]	52.40[bc]
100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD	72.33[abc]	104.67[ab]	70.50[a]
Significance	*	NS	**
SE ±	2.08	3.95	2.04
CV%	3.56	4.84	4.94

Source: field work 2017. PD=Poultry droppings CD=Cattle dung NPK=Nitrogen phosphorus and potassium
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
*=Significant at $P \leq 0.05$ **= significant at $P \leq 0.01$ NS = Not significant

Table 5: Effect of Fertilizer combination on Number of tuber per plant (NNPP), Nut yield per plot (NYPP) and Nut yield (NY) Kg/ha.

TREATMENTS	NTPP	TYPP(g)	TY (Kgha^{-1}
CONTROL	2.57[b]	122.00[c]	307.5[d]
240kgha^{-1}NPK	2.87[b]	140.67[b]	351.10[c]
240kgha^{-1} PD	2.60[b]	125.43[c]	307.58[d]
480kgha^{-1} CD	2.67[b]	127.87[c]	319.58[d]
177.5kgha^{-1}NPK + 62.5kgha^{-1} PD	2.67[b]	127.03[c]	314.40[d]
177.5kgha^{-1} NPK + 302.5kgha^{-1} CD	2.67[b]	146.93[b]	367.30[b]
100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD	3.93[a]	196.60[a]	492.20[a]
Significance	*	**	**
SE ±	0.39	3.78	7.57
CV%	16.61	3.26	18.86

Source: Field work 2017. PD=Poultry droppings CD=Cattle dung NPK=Nitrogen phosphorus and potassium
Mean followed by the same superscript within the same column and treatment are not significantly different at $P \leq 0.05$ (DMRT)
*=Significant at $P \leq 0.05$ **= significant at $P \leq 0.01$ NS = Not significant

Table 6: Matrix for correlation coefficient of some growth and yield parameters of tiger nut in Mubi Adamawa State.

	PLH4	*PLH8*	*PLH12*	*NL4*	*NL8*	*NL12*	*D50%F*	*D90%M*	*100TW*	*NTPP*	*TYPP*	*TY(kg/ha)*
PLH4	1											
PLH8	0.96**	1										
PLH12	0.39	0.44	1									
NL4	0.42	0.48	-0.38	1								
NL8	0.57	0.47	-0.13	0.54	1							
NL12	0.62*	0.52	0.50	0.06	0.76**	1						
D50%F	0.15	0.01	0.29	0.26	0.53	0.67*	1					
D90%M	0.40	0.29	0.33	0.30	0.63*	0.78**	0.95**	1				
100TW	0.89**	0.76**	0.42	0.11	0.63*	0.79**	0.23	0.49	1			
NTPP	0.71**	0.57	0.59	-0.28	0.39	0.75**	0.12	0.34	0.92**	1		
TYPP	0.77**	0.63*	0.66*	-0.17	0.39	0.78**	0.29	0.52	0.93**	0.96**	1	
TY(kg/ha)	0.76**	0.62*	0.65*	-0.17	0.38	0.77**	0.29	0.52	0.93**	0.96**	1.00**	1

Source: Field work 2017. ** Correlation is significant at 0.01 level of probability (2-tailed): * Correlation is significant at 0.05 level of probability (2-tailed)

4. DISCUSSION

The significant difference observed for plant height among the fertilizer treatments suggests that fertilizer contributed significantly to the growth of tiger nut, tallest plant was noticed in the plot treated with the combination of 100kgha^{-1}NPK+140kgha^{-1}PD + 240kgha^{-1}CD. It may be due to accumulation of dry matter as a result of more vigorous vegetative growth with the application of fertilizer. These results therefore indicated that, to enhance vegetative growth in tiger nut, a combination of 100kgha^{-1}NPK + 140kgha^{-1}PD + 240kgha^{-1}CD is suggested. The result agrees with the findings of [22] who reported that, NPK fertilizer; poultry litter and cow dung application significantly influenced the growth of the NH-Ae 47-4 variety of okra, these results agree with those obtained by [23] on tiger nut and [24] on groundnut plants.

Significant difference observed for number of leaves across the different fertilizer combinations suggest that fertilizer has influenced the number of leaves produced by the plant as noticed in the combination of 100kgha^{-1}NPK+140kgha^{-1}PD + 240kgha^{-1}CD which produced the highest number of leaves compared with the other treatments and the control. The importance of leaves to plants cannot be overemphasized, it is the photosynthetic organ of the plant, which enable the plant to manufacture its food, therefore the greater the photosynthetic area the higher the yield, this is further validated by the positive correlation between number of leaves with number of tuber per plant, tuber yield per plant and tuber yield (kg/ha).

Variation in the days to 50% flowering across the different treatments indicated that fertilizer has affected the days at which the tiger nut began flowering, with plant raised in NPK fertilizer at the rate of 240kgha^{-1} flowered earlier compared with the other treatments. This suggests that early flowering can be initiated in tiger nut at a certain level of NPK fertilizer application, even though days to 50% flowering varies significantly across the treatments, days to maturity does not differ across the treatments. This suggests that even though fertilizer treatments has affected vegetative growth in tiger nut, it has no effect on the days it took the plant to attain maturity. These clearly indicated that maturity in tiger nut is mostly controlled by genes and not the environment, and therefore the character can be improved through selection. Our results agree with the earlier report by [25] on cowpea who reported high heritability for days to first pod maturity.

The significant difference observed in the number of tuber per plant and tuber yield per plant across the different treatments suggest that those characters were influenced by the different fertilizer treatments, where the combination of 100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD produces the highest tuber per plant and tuber yield per plot. The least number of tubers per plant and tuber yield per plot was recorded in the control. This indicated that to enhance the tuber yield of tiger nut, the combination of 100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD is suggested. The result is in agreement with the findings of [26] who reported that addition of suitable organic manure in the soil improves the soil structure and hence encourage the plant good root and lead to higher yields. This could be attributed to the fact that the nutrients in the organic manure are released gradually through the process of mineralization [27] aiming optimal soil levels over prolonged periods of time

Tuber yield in kgha^{-1} varies widely across the different treatments with the tiger nut raised in the soil containing the combination of 100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD producing the highest tuber yield in kgha^{-1} and the lowest yield was produced by the control. These suggest that all the fertilizer combinations have contributed significantly to increase yield of tiger nut compared with the control. Therefore to enhance tiger nut productivity, the combination of 100kgha^{-1}NPK+140kgha^{-1}PD + 240kgha^{-1}CD is suggested. The results was supported by the findings of [4] who reported that, Cassava, maize and melon performed best in terms of growth and yield under poultry manure + NPK fertilizer treatments. This is also in agreement with the findings of [28] who reported that the most satisfactory method of increasing maize yield was by judicious combination of organic wastes and inorganic fertilizers. It has been observed that addition of manure increases soil water holding capacity and this means that nutrient would be made available to crops where manure has been added to the soil [29]. [30] also reported that nutrients from mineral fertilizers enhance the establishment of crops while those from mineralization of organic manure promoted yield when both fertilizers were combined. [31] observed that nutrient use efficiency might be increased through the combination of manure and mineral fertilizer.

Significant correlation between tuber yield in Kg/ha and plant height (PLH), number of leaves (NL), one hundred tuber weight (100TW), number of tuber per plant (NTPP) and tuber yield per plot (TYPP) suggest that positive change in any of this characters will enhance tuber yield in tiger nut. Therefore these characters are very important characters to consider when planning breeding program aimed at improving the tuber yield of tiger nut.

5. CONCLUSION

The mixture of 100kgha^{-1}NPK+140kgha^{-1}PD +240kgha^{-1}CD recorded the fastest growth, yielded the highest number of leaves, produced the heaviest tuber weight, highest number of tuber per plant, tuber yield per plot and tuber yield in Kgha^{-1} compared with the other treatments. We can therefore conclude that, the above fertilizer mixture and rate is the best combination that will enhance the growth and yield of tiger nut. Characters like one hundred tuber weight (100TW), number of tuber per plant (NTPP), tuber yield per plot (TYPP) and one hundred tuber weight recorded significant correlation with tuber yield, and are therefore important characters to be considered when planning breeding programs aimed at improving the yield of tiger nut.

RECOMMENDATIONS

(i) I therefore recommend for further research with different fertilizer rate and type for optimum yield in tiger nut.
(ii) The research needs to be replicated over locations and seasons to further confirm our results.

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