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CORRELATION AND PATH COEFFICIENT ANALYSIS BETWEEN GRAIN YIELD AND SOME GROWTH AND YIELD COMPONENTS OF MAIZE (*ZEA MAYS* L.) GENOTYPE AS INFLUENCED BY DROUGHT AND HEAT STRESS CONDITIONS IN SUDAN SAVANNAH OF NIGERIA

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ABSTRACT

Experiments were conducted at the Teaching and Research farm of the Department of Crop Science Kano University of Science and Technology, Wudil and on a farmer's field at Dambatta Local Government Area, with eight maize genotypes to assess the character associations among the genotypes for yield attributes. The experiment was conducted during February to June 2021 and also 2022, in a lattice design with three replications in both years and locations and are made to determine the performance of the genotypes in interacting environments. The genotypes differed significantly for most of the studied traits. Grain yield was significantly associated with plant height, anthesis silking interval, days to maturity, ear height, ears per plant, grain weight per plant in a positive direction and associated negatively with tassel blast, barren plant and leaf senescence. Path co-efficient analysis revealed that the maximum positive direct contribution towards yield was through grain weight per plant, plant height, and ears per plant whereas ear height showed negative direct contribution to grain yield due to negative indirect effects of

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several other parameters such as ear height via grain weight per plant, plant height via grain weight per plant.

Keywords: Maize Genotypes, Drought and Heat Stress.

1. INTRODUCTION

Maize is one of the most staple food crops in Nigeria; the crop is mostly grown for its dry seeds or green cobs. However, there few large scale farm that grow the crop for use as Animal feeds. The results of the development of early maturing varieties have given rise to the cultivation of the crop in areas with short rainy season like Sudan Savannah. The reason for the wide adoption of the crop in this area is mainly due to the fact that it produced more yield than the local and more adaptable crops like sorghum and millet. For good growth and high yield the maize plant must be adaptable to abiotic constraint such as drought stress (DS) and heat stress (HTS) are two major limiting factors affecting maize productivity in the tropical regions. High temperatures and changes in rainfall pattern can cause significant decline in maize yields under rain fed conditions in the tropical region with Africa being one of the worst affected areas. For this, it is necessary for promising inbred lines as well as their combinations to be tested under both normal and heat stress conditions. Heat tolerance can be accomplished through genetic management approach. Development of stress tolerant varieties would be a cheap input technology that would play a vital role in lessening the harmful impacts of abiotic stresses on agricultural production more especially the heat and drought that reduce grain yield of maize (Edmeades, 2013). There is evidence that use of drought tolerant inbred lines in this development can lead to a significantly higher proportion of good progenies that exhibit good performance under drought and other stresses like heat and climate changes (Meseka, *et al.*, 2013), and this indicate the importance of the inbred line approach in developing stress tolerant maize genotypes (Oyekunle, *et al.*, 2015).

Farmers have realised that the new early maize varieties though with smaller cobs, grains stature can produced as good yield as the medium or late maturing maize varieties. This they attribute to production of more filled cobs when compared to late type. Thus studies have been conducted to find out the contributions of both growth and yield attributes of many crops including maize to the final economic yield through the use of correlation and path analysis (Babaji, *et al.*, 2006 and Garko, *et al.*, 2020). The objective of the study is to identify traits that contributed to better performance under drought and heat Stress conditions in Sudan Savannah.

2. MATERIALS AND METHODS

The Experiments was conducted during the dry seasons of 2021 and 2022 at research farm of Kano University of Science and Technology Wudil (8º 45´ N and 9º 20´ E and 495 m above sea level) and Farmers field at Dambatta Local Government Area (8º 25´ N and 9º 11´ E and 645m

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above sea level), to evaluate the genetic analysis of maize (*Zea mays* L.) inbred lines under combined drought and heat stress conditions. The parental materials comprised of eight inbred lines that were crossed in a complete diallel pattern and in all possible combinations, the checks, parents and resultant F_1 were evaluated using (9x9) lattice design with three replications in each location.

The temperature during the dry season ranges from 33 to 45 ˚C. Maize seeds were planted in mid-February for two consecutive years in those locations and anthesis was in mid-April, the hottest period. Two maize seed were planted per hole and later be thinned to one plant at a spacing of 0.25 x 0.75m, with a seed bed of 2.5 x 2.5 m (6.25 m^2) and a discard of 0.5m was left to avoid water spillage. The trial was grown under well-watered conditions prior to exposure to drought and heat stress. A gravity irrigation system was used to supply sufficient water through furrows to the crop every four days during the first 45 days after planting. Thereafter, irrigation was withdrawn in mid-April when mean day temperature ranges from 36 to 45˚C and night temperature were at about 27 to 30 ˚C, inducing the combined effects of drought and heat stress that coincided with flowering stage. Irrigation was resumed after 21 days and was applied only once a week to allow for grain filling of the cobs up to physiological maturity. The well-watered blocks received irrigation once a week until physiological maturity. Meteorological data was recorded during the trial period using an automated weather station at Wudil and Dambatta in Kano State. Soil temperature and soil moisture content were determined accordingly for the two locations at regular intervals.

3. DATA COLLECTION

Data were recorded on a plot basis. Plant height was measured at physiological maturity as the distance in centimetres from base of plant to the first tassel branch of the same plant, and a mean of six plants was recorded. Anthesis-silking interval was calculated by subtracting days to anthesis from days to silking. Leaf senescence was scored visually under drought conditions on a 1 to 10 scale, where 1 represented green leaves and 10 represented completely senesced leaves. Tassel blast was visually scored from the milk to dough stages of grain filling, on a 1 to 5 scale where 1 represented very small tassel with few branches and 5 represented a large tassel with many branches. Ear height was measured at physiological maturity as distance in centimetres from the base of the plant to the insertion of the top (uppermost) ear of the same plant and mean of six plants was recorded. Ears per plant were determined by counting the number of ears with at least one kernel in a plot, and dividing by the total number of plants. Ear aspect was visually rated on a scale of 1 to 5, where 1 represented clean, uniform, large, and well-filled ears and 5, ears with most undesirable (diseased, insect damaged, small, partially filled, and variable) features. Days to maturity were determined as the number of days from planting date to the date

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when 75% of plants in a plot had dry cob husks. Grain weight per plant was determined by weighing shelled grains from six plants and getting an average for a single plant. Grain yield was determined as grain yield per plot in tons per hectare, adjusted to 15% moisture content.

3.1 Statistical Analysis

Mean data collected were subjected to simple correlation analysis as described by Little & Hill (1978). The direct and indirect effect on and individual and combined contributions of growth and yield components to grain yield were determined by path analysis as described by Dewey & Lu (1959).

4. RESULTS AND DISCUSSION

In the combined (2021 – 2022) the correlation coefficients between grain yield and various growth and yield attributes of maize are presented in Table 1. There was positive and highly significant (ρ = <.0001) correlation between grain yield and some characters such as plant height, Anthesis silking interval, ear height and grain weight per plant. A highly significant negative correlation was observed between grain yield and days to maturity, tassel blast, barren plant and leaf senescence, except ears per plant which showed a non significant correlation to grain yields. Positive and significant (ρ = <.05) was observed between grain yield and plant aspects.The strongest positive relationship between growth parameters in the combined data was that recorded between Plant height and ear height (r = 0.984**), days to 50% flowering and days to 50% silking (r = 0.937**) and that of days to 50% silking and Anthesis silking interval (r = 0.794**). A positive and highly significant (ρ = <.001) correlation associations were obtained between days to maturity with the anthesis silking interval. Anthesis silking interval with the plant height, barren plant and Ear aspect, Plant aspect was also significantly positively correlated with ear aspect in this study. Grain weight per plant was highly negatively correlated (ρ = <.001)with the days to 50% flowering, days to 50% silking, Anthesis silking interval, days to maturity, leaf senescence, tassel blast and barren plant in the combined result of the two seasons. This finding is in line with those of Haruna *et al.* (2012) who reported significant and positive correlations between growth characters and final seed yield in Sesame and that of Sesay, *et al.,*(2017), who correlated characters after top-crossing and three-way cross hybrid maize populations and found similar results.

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Table 1: Matrix of Correlation Coefficient between Grain Yield, Growth and Yield Attributes of Maize Genotypes as Affected by Drought and Heat stress Conditions in Sudan Savannah of Nigeria 2021 and 2022 Dry Seasons. (Combined)

	GYL	DFF	DFS	ASI	DM	TB	BP	LS	PH	EH	EEP	PAT	EAT	GWT
GYL	1.000													
DFF	-0.508**	1.000												
DFS	-0.541**	0.937**	1.000											
ASI	0.314**	0.588**	0.794**	1.000										
DM	-0.470**	0.537**	0.592**	0.557**	1.000									
TB	-0.202**	0.188**	0.190**	0.113*	0.122*	1.000								
BP	-0.412**	0.370**	0.383**	0.277**	0.272**	0.398**	1.000							
LS	-0.429**	0.391**	0.401**	0.291**	0.289**	0.448**	0.563**	1.000						
PH	0.344**	-0.127*	-0.127*	0.196**	0.069*	-0.043	-0.072	-0.094*	1.000					
EH	0.346**	-0.099*	-0.102*	0.215**	0.086*	-0.044	-0.066	-0.081*	0.984**	1.000				
EPP	0.090	0.168**	0.228**	0.193**	0.119*	0.018	0.060	0.093*	0.201**	0.180**	1.000			
PAT	-0.244*	0.124*	0.102*	0.056	0.087	0.267*	0.192**	0.287*	0.093	0.076	-0.103*	1.000		
EAT	0.358**	0.243**	0.212**	0.127*	0.255**	0.168**	0.307**	0.335**	-0.105	-0.097	-0.114	0.323**	1.000	
GWT	0.791**	-0.453**	-0.487**	-0.249**	-0.425**	-0.125*	-0.334**	-0.319**	0.284**	0.294**	0.159*	0.121*	0.258**	1.000

DFF = Days to 50% flowering, DFS = Days to 50% Silking, ASI = Anthesis Silking Interval, DM = Days to Maturity, TB = Tassel Blast, BP = Barren Plant, LS = Leaf Senescence, PH = Plant Height, EH = Ear Height, EPP = Ear per Plant, PAT = Pant Aspect, EAT = Ear aspect, GWT = Grain Weight per Plant and GYL = Grain Yield.

In the combined data with exception of Ear height which was negative, the direct contribution of the other growth and yield components to grain yield measured were positive (Table 2). Grain weight per plant made the greatest direct effect on grain yield (0.8066) while the weakest direct effect was from Ear height (-0.2675). In the same vein, the highest combined indirect effect on grain yield was from grain weight per plant via plant height (0.0976), while the effect of anthesis silking interval via grain weight per plant (-0.0037) made the weakest contribution. The highest direct and indirect contribution to grain yield was made by grain weight per plant. The finding of this study emphasized that, grain weight per plant made the greatest direct contribution to grain yield. This could be attributed to the fact that, assimilates produced were translocated to the sink (capsule) which bear the grains (Haruna, *et al.*, 2012).

Table 2: The Direct and Indirect contribution of some growth and yield attributes to grain yield (tha^{-1}) of maize genotypes as affected by drought and heat stress conditions in Sudan Savannah of Nigeria 2021 to 2022 dry Seasons (Combined)

	PH	**ASI**	**EPP**	**EH**	**GWT**	**Total correlation**
PH	**0.34 37**	-0.0046	0.0391	-0.2632	0.2291	0.344
ASI	-0.1079	**0.0147**	0.0375	-0.0575	-0.2009	-0.314
EPP	0.0691	0.0029	**0.1945**	-0.0482	-0.1283	0.090
EH	0.3382	0.0032	0.0351	**-0.2675**	0.2372	0.346
GWT	0.0976	-0.0037	-0.0309	-0.0787	**0.8066**	0.791

Bold = Direct effect. PH = Plant Height, ASI = Anthesis Silking Interval, EPP = Ear per Plant, EH = Ear Height and GWT = Grain weight per plant.

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Grain weight per plant made the highest percentage contribution to grain yield (60.07%) in the combined (2021 to 2022) year (Table 3). This was followed by plant height (11.81%), Ear per plant (8.78%) and Ear height (7.16%). The greatest and positive combined contribution of 7.78% was made by plant height via grain weight per plant, followed Ear per plant via grain weight per plant (4.46%), Plant Height via Ear per Plant (1.34%). The individual or combined percentage of two parameters to grain yield made the highest contribution to grain yield. This is probably could be attributed to the facts that the dry matter produced was translocated more to the developing grains. In a similar finding Haruna *et al.*, (2012) reported that the highest percentage contribution to seed yield in sesame was made by and via total dry matter. Gelalcha and Hanchinal (2013), Pointed out that, It is also established that yield and its components are polygenic and strongly affected by environment as well as yet to be identified factors, this probably could have been responsible for the unaccounted effect or contribution to grain yield observed (Residual) in this study.

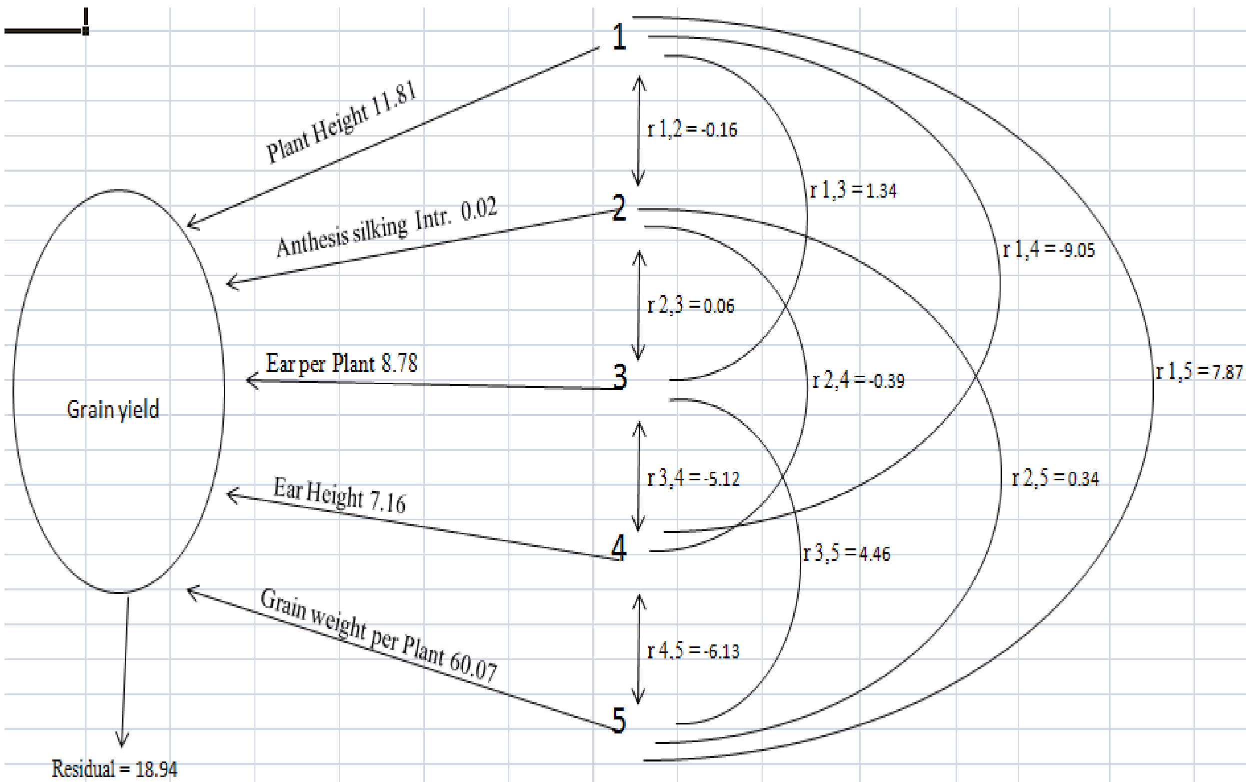

Fig 1: Path Diagram Indication the contribution and Correlation of some character to Grain Yield of Maize as Affected by Drought and Heat Stress Conditions in Sudan Savannah of Nigeria 2021 to 2022 Dry Seasons (Combined)

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5. CONCLUSION

Based on the results obtain from this study, it can be concluded that all growth and yield characters measured contributed positively and significantly to grain yield. The highest direct effect to grain yield was by grain weight per plant than any growth and yield attributes. The greatest direct effect and individual factor contribution were by grain weight per plant; while the combination was by grain weight per plant through plant height. The overall results suggested that due consideration be given to those traits for improving the grain yield of maize.

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