EAS Journal of Biotechnology and Genetics
Abbreviated Key Title: EAS J Biotechnol Genet
ISSN: 2663-189X (Print) & ISSN: 2663-7286 (Online)
Published By East African Scholars Publisher, Kenya

Volume-5 | Issue-1 | Jan-Feb-2023 | DOI: 10.36349/easjbg.2023.v05i01.002

OPEN ACCESS

Original Research Article

Interactions between Yield and Associated Traits of Tropical Maize Hybrids under Non-Drought and Drought Stress Environments

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Article History
Received: 11.12.2022
Accepted: 18.01.2023
Published: 22.01.2023

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: Yield is one of the most important component in breeding program and it depends on the relationship between plant traits. Twenty (20) hybrids of tropical maize were evaluated to investigate the relation between various traits and yield at the research and development farm of the faculty of Agriculture, Nasarawa State University Keffi, Nigeria. Two environment were used for this experiment which include 2021 for non-stress and 2022 for stressed and the experiment was laid out in a complete randomized block design with three replications. The result showed significant difference among the studied traits exception for Days to anthesis, Days to maturity, Protein content and Days maturity for stress and non-stressed respectively. Correlation analysis suggest that there is a perfect relationship between Days to silking and Days to anthesis (0.98) for non-stress and a moderate relationship (0.55) under stressed environment while there is a moderate negative correlation between Days to silking and Protein content (0.52) for stress condition.

Keywords: Correlation, Drought, Maize, Hybrid, Stress, Yield.

INTRODUCTION

Maize among other cereals is one of the most valuable stable food in Nigeria, it is second in terms of production after rice with the total production of 1,210 million tonnes in 2021 with an average growth of 3.18%. Nigeria only produces 11.6 million metric tons of maize in 2021 which is higher than its production in the last six (6) years. Maize is a source of food as well as protein and calories for millions of people most especially in the developing countries (Prasanna B, *et al.*, 2001). Drought among other stress is one of the most important maize stress that leads to loss in yield depending on the growth stage of the plant (Urechean and Bonea, 2017; Pandia O, *et al.*, 2013; Urechean and Bonea, 2011; Pandia O, 2006). Screening for drought tolerant trait in maize is difficult due to its complex nature (Petcu E, *et al.*, 2018). Grain yield is said to be one of the most important complex traits that is dependent on different plant traits (Mirosavljevic M, *et al.*, 2015). Creating cultivars with high combining potentials and resistance to environment stress is said to be the major priority of plant breeders (Georgieva and Kosev, 2018). The principal goal of a maize program is to develop inbred and hybrid that possess superior traits that will outperform the existing ones. As such special attention is given to grain yield as the most important agronomic characteristics. Grain yield been a complex trait is affected by a number of factors. Therefore, understanding the interrelationship between traits and other contributing trait will improve the efficiency of breeding program through the use appropriate selection procedures (Belay N, 2018; Mohammadi S, *et al.*, 2003). The objective of the study is to determine the association among yield and other traits of importance through correlation analysis for grain yield under varied conditions.

MATERIALS AND METHODS

Twenty (20) tropical maize hybrid were used for the study. The study was carried out at the research and development farm of Nasarawa State University, Keffi, Nigeria during 2021 and 2022 growing season. The field was laid out in a complete randomized block design with three replications in a 5 meters double rows plot with the spacing of 0.75 meters between rows and 0.30 meters between plants. Three seeds were sown per hole and later thin to one plants per hole after two weeks. All agronomic best practices was carried out. Observations were carried out for Days to anthesis, days to silking, ear height plant height, days to maturity, thousand grain weight, protein content, oil content and

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grain yield. The materials used for the study were sourced from IITA comprising of single cross hybrids.

The data collected was subjected to analysis of variance using statistical tool for Agricultural research (STAR) software. Differences between the mean values were tested using F test and separated using LSD at 5% level of probability. Pearson correlation coefficient was used to determine the association between the studied traits.

RESULTS AND DISCUSSIONS

Tables 1 and 2 shows the mean values and significant levels of yield and associated traits. The result indicated that under non stress condition most of the traits were significantly different exception of days to maturity while under stress condition most of them are significantly different exceptions for Protein content, days to maturity and days to anthesis that are non-significant. Numerous researchers have reported significant differences on grain yield and associated traits. Dorina and Elena (2019); Raut S *et al.*, (2017); Muchie and Fentie, 2016); Shengu M, 2017); Izam A *et al*., (2017) and Singh G, *et al*., (2017) reported that plant height, ear height, days to tasseling, days to silking and grain yield were positively and significantly correlated suggesting that hybrids with such trait possess high yield potential.

Table 1: Mean, standard deviation, Coefficient of variation, Standard error, F test, and of Yield and other associated traits of hybrid maize under non-drought condition

hybrid	DS	DA	EHT	PHT	DM	TGW	PC	OC	GY
TZH1	70	68	92	234	117	301	12.5	4.1	7.27
TZH2	72	70	84	217	125	216	13.6	3.9	7.07
TZH 3	74	72	94	229	127	303	13.2	3.9	7.03
TZH 4	69	68	97	239	125	320	11.8	3.6	8.89
TZH 5	65	64	77	254	117	337	10.8	2.8	8.05
TZH 6	66	65	84	212	126	373	11.1	2.6	8.81
TZH 7	67	65	97	244	117	288	12.6	4.3	8.44
TZH 8	67	66	102	229	124	302	12.8	3.8	9.16
TZH 9	67	65	102	239	121	289	12.5	3.8	6.98
TZH 10	65	63	94	214	125	361	12.5	3.8	7.85
TZH 11	69	66	99	274	117	322	11.4	3.4	7.9
TZH 12	67	65	79	234	127	324	12.6	3.8	9.43
TZH 13	69	67	79	234	125	343	13.5	4.3	8.74
TZH 14	73	71	107	249	117	267	13.6	3.7	7.3
TZH 15	70	68	104	269	127	374	13	3.9	8.88
TZH 16	70	68	109	264	125	257	12.8	4.9	8.78
TZH 17	67	65	99	229	121	273	12.8	3.9	7.48
TZH 18	71	69	114	284	125	409	13.6	3.8	8.91
TZH 19	67	65	102	234	121	369	13.5	3.8	7.84
TZH 20	74	72	104	259	124	348	13	4.0	9.6
mean	68.95	67.1	95.95	242.05	122.65	318.8	12.66	3.805	8.2205
standard deviation	2.710627	2.586503	10.29794	19.46401	3.691544	45.87112	0.804612	0.475894	0.823969
cv	0.039313	0.038547	0.107326	0.080413	0.030098	0.143887	0.063555	0.125071	0.100233
standard error	0.606115	0.57836	2.302689	4.352284	0.825454	10.2571	0.179917	0.106413	0.184245
F test	*	*	*	*	ns	*	*	*	*

DS days to silking, DA days to anthesis, EHT ear height, PHT plant height, DM days to maturity, TGW thousand grain weight

PC protein content, OC oil content, GY grain yield, *significant at 5%, Ns non significance

Table 2: Mean, standard deviation, Coefficient of variation, Standard error, F test, and of Yield and other associated traits of hybrid maize under drought stress condition

hybrid	DS	DA	EHT	PHT	DM	TGW	PC	OC	GY
TZH 1	84	82	76	199	127	175	14.1	4.6	4.71
TZH 2	83	81	74	187	127	189	14.4	4.0	3.47
TZH 3	85	83	72	192	127	261	14.2	4.3	4.56
TZH 4	85	83	77	209	127	253	13.6	3.6	5.20
TZH 5	86	84	74	194	127	289	12.9	3.5	5.52
TZH 6	94	82	69	182	127	209	11.9	3.9	4.87

hybrid	DS	DA	EHT	PHT	DM	TGW	PC	OC	GY
TZH 7	85	84	72	189	117	247	12.3	3.6	3.59
TZH 8	82	80	69	189	124	253	13.4	3.9	4.52
TZH 9	84	82	82	182	124	209	14.0	4.1	4.21
TZH 10	82	81	77	174	117	211	12.6	3.9	4.81
TZH 11	83	81	72	176	124	203	14.2	3.7	4.01
TZH 12	83	81	74	168	124	245	13.4	3.9	3.40
TZH 13	84	82	69	169	124	261	14.1	4.4	4.31
TZH 14	82	80	64	199	124	257	14.1	4.5	4.10
TZH 15	80	79	69	159	124	261	13.2	4.6	4.18
TZH 16	84	80	74	184	124	251	13.7	4.1	3.66
TZH 17	86	82	104	229	124	243	13.7	3.7	3.72
TZH 18	86	82	62	159	124	223	13.2	4.4	3.77
TZH 19	81	78	59	161	117	225	14.3	4.5	3.8
TZH 20	85	81	64	162	122	247	13.6	4.9	3.97
mean	84.2	81.4	72.65	183.15	123.75	235.6	13.545	4.105	4.219
Standard deviation	2.785678	1.496663	9.029258	17.64164	3.191786	28.00786	0.677846	0.389198	0.573227
cv	0.033084	0.018387	0.124284	0.096323	0.025792	0.118879	0.050044	0.094811	0.135868
Standard error	0.622896	0.334664	2.019003	3.944791	0.713705	6.262747	0.151571	0.087027	0.128177
F test	*	ns	*	*	ns	*	Ns	*	*

DS days to silking, DA days to anthesis, EHT ear height, PHT plant height, DM days to maturity, TGW thousand grain weight

PC protein content, OC oil content, GY grain yield, *significant at 5%, Ns non significance

The highest positive correlation was observed for days to silking and days to anthesis (0.98) under non stressed condition (Table 3), while days to silking and protein content (0.56), days to anthesis and protein content (0.51), ear height and plant height (0.55) and protein content and oil content (0.66) recorded moderate positive correlation while other traits show low to negative correlation under non stress environment as present in Table 3. Similar observations was reported by many researchers (Filipovic M, *et al.*, 2014; Fakorede M, *et al.*, 2011; and Ashofteh B, *et al.*, 2010).

Table 3: Pearson's correlation coefficient among yield and yield associated traits of hybrids maize under non-drought conditions

	DS	*DA*	*EHT*	*PHT*	*DM*	*TGW*	*PC*	*OC*	*GY*
DS	1								
DA	0.984874**	1							
EHT	0.359947	0.326818	1						
PHT	0.320368	0.270044	0.549057*	1					
DM	0.158149	0.202656	-0.06096	-0.19738	1				
TGW	-0.22567	-0.21391	0.057772	0.262377	0.255292	1			
PC	0.556166*	0.513663*	0.38958	0.031416	0.261257	-0.15763	1		
OC	0.360667	0.296124	0.380607	0.166769	0.126225	-0.3694	0.662558*	1	
GY	-0.09312	-0.04249	0.041192	0.302691	0.4309	0.485591	-0.11129	0.036079	1

DS days to silking, DA days to anthesis, EHT ear height, PHT plant height, DM days to maturity, TGW thousand grain weight

PC protein content, OC oil content, GY grain yield, *significant at 5%, Ns non significance, ** significant at 1%

Highest positive correlation was recorded for plant height and ear height (0.71), days to silking and days to anthesis (0.55), this agrees with the findings of Dorina and Elena, (2019) and Beiragi M, *et al.*, (2011). However, high negative correlation was observed for days to silking and protein content (-0.52), days to anthesis and oil content (-0.50), and ear height and oil content (-0.50) while the other traits showed low positive to negative correlation under stressed condition as presented in table 4.

Table 4: Pearson's correlation coefficient among yield and yield associated traits of hybrids maize under drought conditions

	DS	***DA***	***EHT***	***PHT***	***DM***	***TGW***	***PC***	***OC***	***GY***
DS	1								
DA	0.556459*	1							
EHT	0.141934	0.350754	1						
PHT	0.233396	0.440849	0.714432**	1					
DM	0.37115	0.303536	0.182602	0.366509	1				
TGW	-0.08485	0.135024	-0.07272	0.068427	0.017339	1			
PC	-0.52376*	-0.32824	0.009926	0.078042	0.217814	-0.15049	1		
OC	-0.27302	-0.50129	-0.50033*	-0.49238	-0.06339	-0.10119	0.381989	1	
GY	0.291328	0.387445	0.019156	0.262211	0.348297	0.185776	-0.28092	-0.21759	1

DS days to silking, DA days to anthesis, EHT ear height, PHT plant height, DM days to maturity, TGW thousand grain weight

PC protein content, OC oil content, GY grain yield, *significant at 5%, Ns non significance, ** significant at 1%

These findings shows that improvement in each of the trait will lead to overall improvement of the plant genotype. Such correlation helps in decision making in selecting traits controlled my minor genes. Grain yield (quantitative trait) is polygenically controlled (Bello O, *et al.*, 2010). These findings implies that effective grain yield improvement relies on the simultaneous improvement of other traits.

CONCLUSIONS

Selection for high yielding hybrid should focus more on the positive correlated trait for a successful and effective maize breeding program. However, more attention should be given to plants that exibit high positive correlation between days to anthesis and days to silking during selection for a super performing hybrid.

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Cite This Article: Sheidu, A & Igyuve, T. M (2023). Interactions between Yield and Associated Traits of Tropical Maize Hybrids under Non-Drought and Drought Stress Environments. *EAS J Biotechnol Genet*, *5*(1), 10-14.