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Evaluation of advanced drought tolerant maize (*Zea mays* L.) hybrids for grain yield and other agronomic traits under combined drought and heat stress

S. Meseka
A. Menkir*
O. Bossey
O. Azeez

International Institute of Tropical Agriculture, PMB 5320, Oyo Road, Ibadan, Nigeria

Introduction

Drought and high temperature are two major environmental factors limiting maize productivity in Sub-Saharan Africa. An increase in temperature over 30ºC reduces grain yield by 1% under optimal rain-fed and by 1.7% under drought conditions[1]. It is projected that by 2030, drought and higher temperatures may reduce 40% of more than 300 million Africans currently maize growing area unsuitable for maize varieties available today[2]. Integrated approaches that improve the performance of maize genotypes to alleviate impacts of these stresses are essential to sustain productivity.


Leaf firing and tassel blast due to drought stress at elevated temperatures (36 - 42ºC) in April.

Objective

To evaluate the performance of advanced drought tolerant maize hybrids and identify those combined high grain yields with tolerance to drought and heat stress.

Materials and methods

A trial composed of 37 advanced drought tolerant (DT) three-way cross hybrids developed at IITA, 10 commercial hybrids and a local cultivar commonly grown in the area. The entries were arranged in (8 x 6) alpha lattice design with three replications and planted during the dry season (February – May), with day temperatures ranging from 32ºC to 42ºC and night temperatures from 22ºC to 27ºC at Kadawa, Nigeria in 2013. It was initially grown under well watered conditions for the first 40 days after planting, thereafter subjected to drought at elevated temperatures (36ºC - 42ºC) during the flowering and grain filling period by withdrawing irrigation for 21 days. Irrigation was resumed once a week till physiological maturity. Data were recorded on 50% anthesis and silking, anthesis-silking interval (ASI), tassel blast (TB) and number of barren plants (BP) scores (scale:1 – 5), plant and ear heights, leaf death scores 1 & 2 (scale:1 – 10), number of ears per plant (EPP).

Results and Discussion

Highly significant differences (P<0.001) were found among the hybrids for grain yield and most agronomic traits. Repeatability estimates were high for days to anthesis and silking, TB score and EPP, and moderately high (0.49) for grain yield, first leaf death score (LDS1) and other traits. Grain yield was significantly and positively correlated with EPP (r = 0.69, P<0.001), but negatively related to days to anthesis and silking, TB, BP and ASI. LDS1 had strong correlation with TB (r = 0.61, P<0.001) and BP (r = 0.59, P<0.001). Plot of grain yield on TB showed a significant negative trend (Fig 1). This trend was also observed when grain yield was regressed on day temperatures during the critical flowering and grain filling stages in April (Fig 2).

Table 1. Grain yield and other traits of the best eight DT hybrids, five commercial hybrids and a local check under combined drought and heat stress.

Hybrid	GYLD ($t\ ha^{-1}$)	EPP (no.)	LDS1 (1 - 10)	TB (1 - 5)	BP (1 - 5)
M1124-23	**3.24**	**0.5**	**4**	**1.7**	**1.6**
M1227-18	**3.11**	**0.6**	**4**	**1.7**	**1.5**
M1227-15	3.09	0.7	5	2.2	1.5
M0826-3	**3.08**	**0.6**	**4**	**1.0**	**1.3**
M1124-27	2.96	0.5	5	2.0	1.7
M1227-17	2.65	0.6	5	2.3	1.9
M1227-4	2.42	0.7	4	1.5	1.3
M1124-22	2.33	0.7	5	1.7	1.6
Oba 98	**2.04**	**0.4**	**5**	**2.7**	**1.8**
SC637	0.87	0.3	5	3.0	2.3
Oba Super I	0.38	0.4	6	2.5	1.9
Oba Super 7	0.00	0.2	6	4.2	2.7
Oba Super 9	0.00	0.2	4	2.8	1.8
Local check	**0.99**	**0.3**	**5**	**2.7**	**2.1**

GYLD = grain yield; EPP = ear per plant; LDS1 = first leaf death score; TB = tassel blast and BP = barren plant

Mean grain yield of all hybrids was 1.42 $t\ ha^{-1}$. The best hybrid (M1124-23) produced 3.24 $t\ ha^{-1}$ while the worst one (M1227-12) produced 0.25 $t\ ha^{-1}$. The mean grain yields of the two best commercial hybrids, Oba Super 2 and Oba 98, were 2.1 and 2.0 $t\ ha^{-1}$, respectively (Table 1). Three of the six commercial hybrids produced zero (0) grain yield. The eight hybrids produced 10 to 37% more grain yields than Oba Super 2 and Oba 98. Three of the eight hybrids (M1124-23, M0826-3, and M1124-22) had longer stay-green and low TB scores, suggesting their ability to maintain green leaves and fresh tassel contributing to less damage at reproductive stage under combined drought and heat stress.

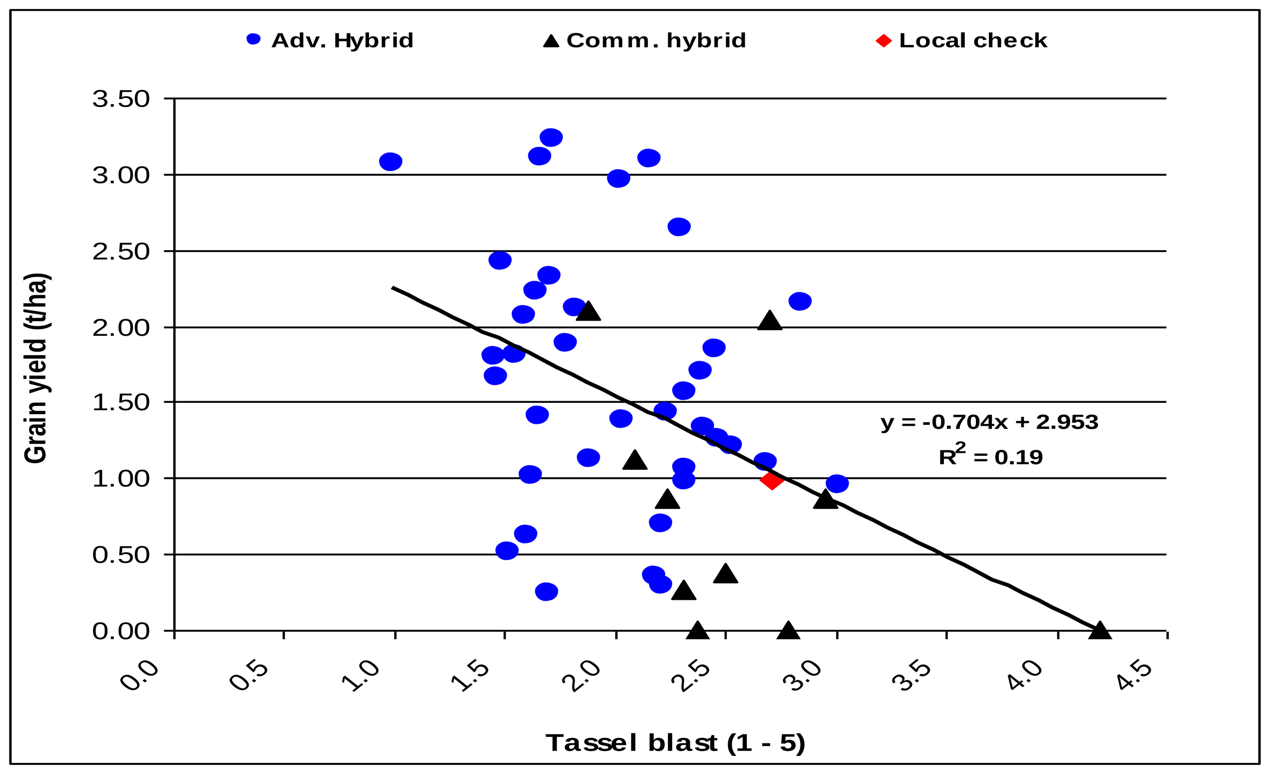

Figure 1. Relationship between grain yield ($t\ ha^{-1}$) on tassel blast (1 – 5) observed during flowering stage.

Conclusion

Our results showed the greatest impact of heat and drought stress occurred during the 21 days of severe stress around flowering and grain filling stages. Some productive DT hybrids were also tolerant to combined heat and drought stress. High repeatability estimates of TB, EPP and strong relationships between grain yield and TB, BP, EPP, and LDS1 suggested that these secondary traits can be used in an index to select for improved yield performance under combined drought and heat stress.

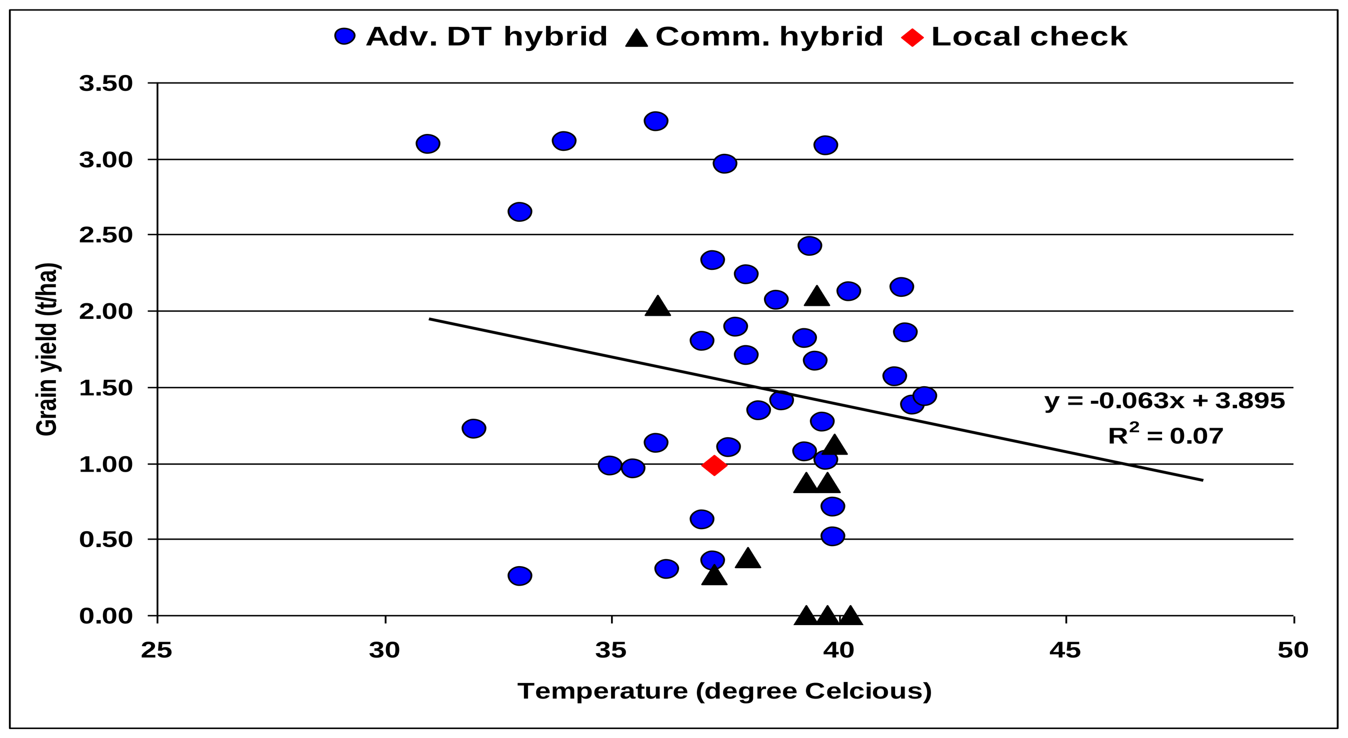

Figure 2. Relationship between grain yield and day temperature observed during flowing and filling period.

Acknowledgements

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References

[1]Lobell, D.B., M. Bänziger, C. Magorokosho, and B. Vivek .2011. Nonlinear heat affects African maize as evidenced by historical yield trials. Nature Climate Change 1:42 – 45.

[2]Nate, P. 2013. Climate-Smart agriculture success stories from farming communities around the world. Booklet produced in cooperation between the CGIAR's CRP on Climate Change, Agriculture and Food Security (CCAFS) and the CTA.

Contact:
A.Menkir@cgiar.org