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Abstract

Purpose: The main purpose of this paper was to determine the yield of the testcrosses across the different environments.

Methods: The lines used in the study were derived from a segregating population in the $F_{4.}$ They were crossed to two single cross testers CIMMYT Tester A (CML312/CML442) and Tester B (CML395/CML444) through the Line by tester mating design. The 98 crosses developed through line by tester cross of 49 lines in the F_4 and two testers Tester A and Tester B were studied for resistance to NLB and other yield related traits including : days to anthesis, days to silking, ear aspect, plant height, ear height, field weight and Grain moisture. The experiment was conducted in the 2017 main growing season in three mid-altitude maize growing regions of Kenya (Kakamega, Muranga, Embu).The yield was evaluated by analyzing the grain weight of the crosses using CIMMYT IMIS field book. The data collected for NLB and other yield related traits was analyzed using the CIMMYT META R and AGD R (2015). In the analysis, lines, plots and site were used as fixed factors. Replications, incomplete blocks were used as random factors

Results: The study found out that the maize crosses exhibited different yield performance across the three locations even under similar agronomic management practices. Testcrosses developed with Tester A recorded higher yields in Kakamega and Embu while in Muranga the crosses developed from Tester B recorded higher average yields.

Unique Contribution to Theory, Practice and Policy: The study recommeded that The top performing crosses could hence be subjected to further trials hence recommended for high yielding varieties in best suited regions in the country. The lines could further be developed to breed for high performing hybrids that would be best suited for different agro-ecological zones across the country in different combinations.

Key Words: *Yield, Testcrosses, Environments*

1.0 INTRODUCTION

1.1 Yield potential of the crosses in t/ha

Maize is a staple to over 85% of the Kenyan population. Individual consumption ranges at 98-100 kilograms that is an estimate of 2700 thousand metric tonnes annually (Nyoro *et al*., 2004). Small scale growers account for 70% of the total production. The other 30% is from large scale growers (Export processing zone Authority, 2005).

Most of the crop is grown for subsistence by the small scale growers who then retain some 58% for household use from the total output (Mbithi, 2000). With the annual consumption requirement annually, deficits have to be acquired through importation. Unsuitable weather conditions are mostly said to be the cause for low yields in some years. However, average yields have been at a constant average of 2 tonnes per hectare which is below the 6 tonnes per hectare which should be the potential. This has been attributed to inadequate uptake of technology which includes planting of high yielding hybrid seed maize, lack of fertilizer use to avoid incurring high input costs and lack of credit (Republic of Kenya, 1997; 2004; Kangethe, 2004).

Lack of credit impacts inadequate capital hence farmers cannot afford to procure inputs which include certified seed, fertilizers and pesticides. Kenya incurs higher costs of production than other maize growing regions of other countries. This hence impacts negatively the maize surplus due to cheaper imports from other countries like Uganda (Nyoro *et al*,. 2004).

Maize yield is highly determined by growth and development of the plan, photosynthesis and the efficiency of the photosynthate partitioning into grain. Yield is also as a result of interaction between genotype, environment and management (Fageria *et al*., 2006). The environmental factors of importance are water, temperature and solar radiation. The factors vary with the different growing seasons and cannot be controlled by the growers. Maize growth could be Sub-divided into two growth stages, the vegetative growth and the reproductive growth stages. The vegetative stage growth occurs between seedling emergence and vegetative growth stage. After the maize crop reaches physiological maturity, environmental stress does not affect yield. Factors such as lodging, stalk breakage and ear dropping can damage the plant and decrease the harvestable yield.

Yield comprises of physical elements that correlate to the produced grain directly. These components are interrelated and have compensatory effects. The primary components which are the first order yield traits (number of ears, number of kernels, kernel weight) effects directly impact on the final yield and also the yield components whose effects are indirect that may develop later (Fageria *et al*,. 2006).

Genotype by Environment interactions in maize breeding are challenging as they are an indication of failure in genotypes consistent response across different environmental conditions. On the basis of diverse biotic and abiotic factors, Africa's maize production environments vary. Africa is variable. This hence results in GxE interactions that are complex for important traits disease resistance and yield (Vivek *et al*., 2010; Sibiya *et al*., 2012). Identification of stable genotypes for wide range of environments is the best way in minimizing GxE interactions. Presence of the interactions could also be exploited by selection of superior genotypes to suit specific environments (Alwala *et al*., 2010).

When variations caused by hybrid x environment are partitioned into GCA x E and SCA x E, both the components are mostly significant for yield and other agronomic components. It is an indication that the GCA of the parent lines and SCA of the hybrids change with environments. Apart from identifying crosses that are high yielding, it is important to identify parent lines that possess not only high grain yield means but also with high stability for GCA effects for adjustment of environmental changes (Fan *et al*., 2013).

2.0 METHODOLOGY

The lines used in the study were derived from a segregating population in the F_4. They were crossed to two single cross testers CIMMYT Tester A (CML312/CML442) and Tester B (CML395/CML444) through the Line by tester mating design. The 98 crosses developed through line by tester cross of 49 lines in the F_4 and two testers Tester A and Tester B were studied for resistance to NLB and other yield related traits including : days to anthesis, days to silking, ear aspect, plant height, ear height, field weight and Grain moisture. The experiment was conducted in the 2017 main growing season in three mid-altitude maize growing regions of Kenya (Kakamega, Muranga, Embu).The yield was evaluated by analyzing the grain weight of the crosses using CIMMYT IMIS field book. The data collected for NLB and other yield related traits was analyzed using the CIMMYT META R and AGD R (2015). In the analysis, lines, plots and site were used as fixed factors. Replications, incomplete blocks were used as random factors.

3.0 RESULTS

3.1 Yield of the testcrosses across the environments in tonnes per hectare

Table 1: Yield of the testcrosses across the environments in tonnes per hectare

	Kakamega		Embu		Muranga	
Line	Tester A	Tester B	Tester A	Tester B	Tester A	Tester B
1	4.94	3.29	4.47	3.94	8.16	10.25
2	5.38	2.08	6.08	3.64	8.18	7.42
4	3.89	2.26	5.16	2.75	5.98	8.37
5	5.43	3.87	5.49	3.66	7.68	7.95
9	5.71	3.84	5.55	2.73	9.21	8.50
12	5.13	3.55	6.93	4.36	6.27	8.40
17	5.19	3.18	5.69	4.19	4.72	8.82
18	5.34	2.17	6.14	2.69	5.02	8.23
19	5.23	3.48	4.33	4.28	6.02	10.32
24	5.42	2.94	5.08	4.42	8.02	8.89
26	3.27	2.83	3.78	5.06	4.30	8.53
27	4.79	2.58	6.89	5.32	7.45	7.98
29	4.98	3.00	5.52	5.51	8.69	8.67
31	4.46	3.88	5.59	4.51	8.50	8.47
32	5.37	3.99	4.65	3.58	6.19	8.24
33	4.47	3.64	5.18	4.51	8.42	8.43
34	5.05	4.63	4.66	5.45	8.42	8.54
35	4.65	4.38	4.66	4.00	8.59	8.18
38	4.99	4.07	7.20	4.43	6.56	8.96
40	3.37	4.26	5.29	3.46	6.87	8.30
41	4.39	3.46	5.39	3.57	8.18	8.64
43	4.72	4.63	5.63	5.17	7.67	7.84
44	5.38	4.12	3.38	5.18	5.88	8.53
45	4.90	4.02	6.66	3.41	9.31	7.68
46	6.17	3.74	4.06	2.09	6.83	8.58
47	4.04	4.97	4.81	5.82	4.09	8.95
48	4.52	2.99	5.44	3.10	6.56	9.03
50	5.47	3.63	6.37	3.13	7.26	8.46
51	3.52	3.05	5.12	4.38	3.99	8.99
52	4.61	3.44	3.18	1.93	7.03	7.21
53	4.32	3.99	4.27	3.53	7.25	8.57
54	4.48	3.01	4.86	2.85	6.34	8.20
58	5.32	4.78	3.03	4.45	6.50	8.59
61	3.65	4.64	3.94	3.74	8.52	9.02
62	6.10	4.39	6.11	4.60	6.22	7.17
63	3.65	4.65	3.88	3.95	3.12	9.00
66	4.29	3.03	4.75	4.21	8.02	7.96
67	3.65	2.67	4.95	2.21	2.17	7.58
69	4.85	2.73	4.57	5.39	7.55	8.90
71	4.28	3.70	5.94	2.42	7.56	8.19
72	3.43	2.36	4.21	2.42	7.62	8.00
73	4.37	2.31	5.29	2.44	9.73	10.13
74	3.09	2.49	7.34	3.37	7.68	9.47
75	4.99	2.23	6.60	1.61	7.37	9.50

76	4.41	3.32	5.39	3.88	6.37	9.07
78	5.33	3.21	5.29	2.77	8.97	7.93
79	5.53	3.25	5.88	5.04	9.33	7.99
81	5.33	5.51	6.29	4.06	5.68	8.88
87	3.38	1.86	5.82	3.52	7.71	8.00
Tester	2.07	2.68	2.62	5.31	6.29	6.18
Mean	**4.63**	**3.46**	**5.19**	**3.84**	**7.00**	**8.47**
LSD (0.05)	**1.72**	**1.75**	**2.33**	**2.45**	**0.98**	**1.53**
Mse	**1.19**	**1.42**	**1.53**	**1.65**	**0.24**	**0.69**
CV	**23.62**	**34.48**	**23.87**	**33.49**	**6.95**	**9.82**
P	**0.004**	**0.003**	**0.030**	**0.056**	**0.000**	**0.002**
P	**	**	*	+	***	**
Min	**2.07**	**1.86**	**2.62**	**1.61**	**2.17**	**6.18**
Max	**6.17**	**5.51**	**7.34**	**5.82**	**9.73**	**10.32**

3.2 Discussion

The testcrosses performed differently across the three locations due to G x E interactions.

Kakamega

The highest yielding cross in Kakamega was Tester A x L46 with a yield of 6.17t/ha. The second highest yielding was Tester A x L62 yielding 6.1t/ha. The highest yielding cross with Tester B was Tester B x L81. Overall performance of the crosses with tester A was higher than the crosses with tester B.

The highest yielding crosses with tester A yielded 6.17t/ha while the lowest with tester A yielded 2.07t/ha. The highest yielding cross with tester B yielded 5.51t/ha while the lowest yielded 1.86t/ha.

Embu

The highest yielding crosses with tester A in Embu yielded 7.34t/ha while the lowest had a yield of 2.62t/ha. The highest yielding cross with tester B had a yield of 5.82t/ha while the lowest had a yield of 1.61t/ha.

The top 10 highest yielding crosses in Embu were;

Tester A/Line 74- 7.34t/ha, Tester/line 12- 6.93t/ha, Tester/Line 27- 6.89t/ha, Tester/Line 45- 6.66t/ha, Tester/Line 75- 6.6t/ha, Tester A/Line 50- 6.37t/ha, Tester A/Line 81- 6.29t/ha, Tester A/Line 18- 6.14t/ha, Tester A/Line 62- 6.11t/ha and Tester A/Line 2- 6.08t/ha.

All the top best performing crosses were crosses with tester A.

Muranga

This region recorded the highest yield performance compared to Kakamega and Embu. The highest performing cross recorded a yield of 10.32t/ha. The lowest yielder for Muranga had a yield of 2.17t/ha. For the crosses with tester A, the highest yield was 9.73t/ha while the lowest was 2.17t/ha. For the tester B crosses, the highest yield recorded was 10.32t/ha while the lowest was 6.18t/ha.

While in the other regions tester A crosses were performing better, in Muranga the crosses with tester B were leading.

The top best performing crosses in Muranga were;

Tester B/Line 19- 10.32t/ha, Tester B/Line 1- 10.25t/ha, Tester B/Line 73- 10.13t/ha, Tester A/Line 73- 9.73t/ha, Tester B/Line 75- 9.5t/ha, Tester B/Line 74- 9.47t/ha, Tester A/Line 79- 9.33t/ha, Tester A/Line 45- 9.31t/ha, Tester A/Line 9- 9.21t/ha, Tester B/Line 76- 9.07t/ha, Tester B/Line 61- 9.02t/ha and Tester B/Line 63-9t/ha.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusion

The maize crosses exhibited different yield performance across the three locations even under similar agronomic management practices. Testcrosses developed with Tester A recorded higher yields in Kakamega and Embu while in Muranga the crosses developed from Tester B recorded higher average yields. According to Fageria *et al.* (2006), yield can be considered as a result of interaction between genotype, agronomic management and the environment.

4.2 Recommendations

The top performing crosses could hence be subjected to further trials hence recommended for high yielding varieties in best suited regions in the country. The lines could further be developed to breed for high performing hybrids that would be best suited for different agro-ecological zones across the country in different combinations. Trethowan *et al*. (2001) recorded that plant breeders would need to understand the relationship between the yield testing environments in order to concentrate on germplasm that is well adapted to different production environments.

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