Research to Nourish Africa

Evaluation of *striga*-resistant early maize hybrids and test locations under *striga*-infested and *striga*-free environments

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Introduction

The usefulness of a test environment is determined by its ability to discriminate sufficiently among genotypes and its genetic correlation with target environments. Yan and Holland (2010) reported that the most appropriate GGE biplot scaling method for simultaneous evaluation of genotype as well as test environment is the heritability-adjusted (HA) GGE biplot. Badu-Apraku and Akinwale (2011) also employed genotype-by trait biplot analysis to identify superior and maize cultivars based on multiple *Striga*-adaptive traits. The objectives of the present study were to (i) evaluate selected *Striga*-resistant hybrids for grain yield performance and stability based on multiple traits and HA-GGE biplot under *Striga*-infested and *Striga*-free conditions; and (ii) assess the discriminating ability and representativeness of the test locations used for evaluating genotypes for *Striga* resistance by the IITA maize program.

Materials and Methods

Thirty *Striga*-resistant single–cross hybrids plus two checks were evaluated under artificial *Striga* infestation and *Striga*-free conditions at 2 locations in Nigeria in 2008 and 2009. The hybrids were selected from 378 diallel crosses among 28 parent inbreds based on superior performance under *Striga* infestation. The trial was laid out as pair experiment using randomized incomplete block design with two replicates under artificial *Striga* infestation and *Striga*-free conditions at Mokwa and Abuja. Data on grain yield and other important agronomic traits were collected and subjected to analysis of variance, genotype-by-trait biplot and HA-GGE biplot analysis.

Results

- Significant location effects under the two research conditions indicated that the locations were distinct from each other (Table 1).
- The HA-GGE biplot revealed that TZEI 11/TZEI 25 (H27) was the best (vertex genotype) under *Striga* infestation at both Abuja (ABS) and Mokwa (MKS) whereas under *Striga*-free conditions, TZEI 12/TZEI 25 (H28) was the best at Mokwa (MKN) and TZEI 106/TZEI 87 (H16) at Abuja (ABN) (Fig. 1).
- The two test locations possessed high discriminating ability (long vectors), indicating that both were important in the evaluation of the hybrids and that neither of them could be considered as redundant when screening genotypes for *Striga* resistance and yield potential (Fig. 2).
- More promising genotypes (entries that fell inside the innermost concentric circle in Figs 3and 4) were identified using multiple traits under *Striga* infestation than selection based on yield performance only, suggesting that grain yield alone may not suffice as a precise predictor of *Striga* resistance (Fig. 3 and 4).
- Based on both HA-GGE and GT biplot analyses, TZEI 12/TZEI 25 was identified for its outstanding performance under *Striga*-infested and *Striga*-free conditions. Furthermore, TZEI 11/TZEI 127 and TZEI 80/TZEI 2B were identified as promising under *Striga*-infested conditions and TZEI 60/TZEI 87 under *Striga*-free environments by the two biplot methods.

Table 1. Mean squares of grain yield and other agronomic traits of early maize hybrids with checks derived from ANOVA combined across *Striga*-infested and *Striga*-free conditions at Mokwa and Abuja, Nigeria in 2008 and 2009.

Source	DF	Grain yield, kg ha^{-1}	Ears per plant	ASI	Plant height, cm	Stalk lodging, %	Ear aspect
LOC	1	76769335**	0.03ns	0.2ns	62260**	132.0**	10.23**
YEAR	1	230322680**	0.36**	42.8**	30074**	321.9**	100.96**
REP(LOC*YEAR)	4	6732312**	0.10**	1.1ns	673*	5.1ns	1.57
STRT#	1	487449204**	4.11**	87.8**	118889**	461.3**	52.87*
ENTRY	31	5610312**	0.18**	7.1**	2221**	3.0ns	3.04**
LOC*YEAR	1	164075840**	0.05	21.16**	11381.63	7.0	21.81ns
LOC*ENTRY	31	1150769ns	0.03ns	3.0**	581**	4.7ns	0.58ns
YEAR*ENTRY	31	1283238ns	0.03ns	3.8**	429*	2.5ns	0.72ns
STRT*ENTRY	31	2906526**	0.08**	1.8ns	522**	1.9ns	0.94**
LOC*YEAR*ENTRY	31	1093478ns	0.02ns	3.1**	361ns	4.3ns	0.67*
ERROR	348	1174426	0.03	1.8	287	3.6	0.60ns

*,**, Significant F-test at 0.05 and 0.01 levels of probability, respectively. #STRT = *Striga* infestation treatment

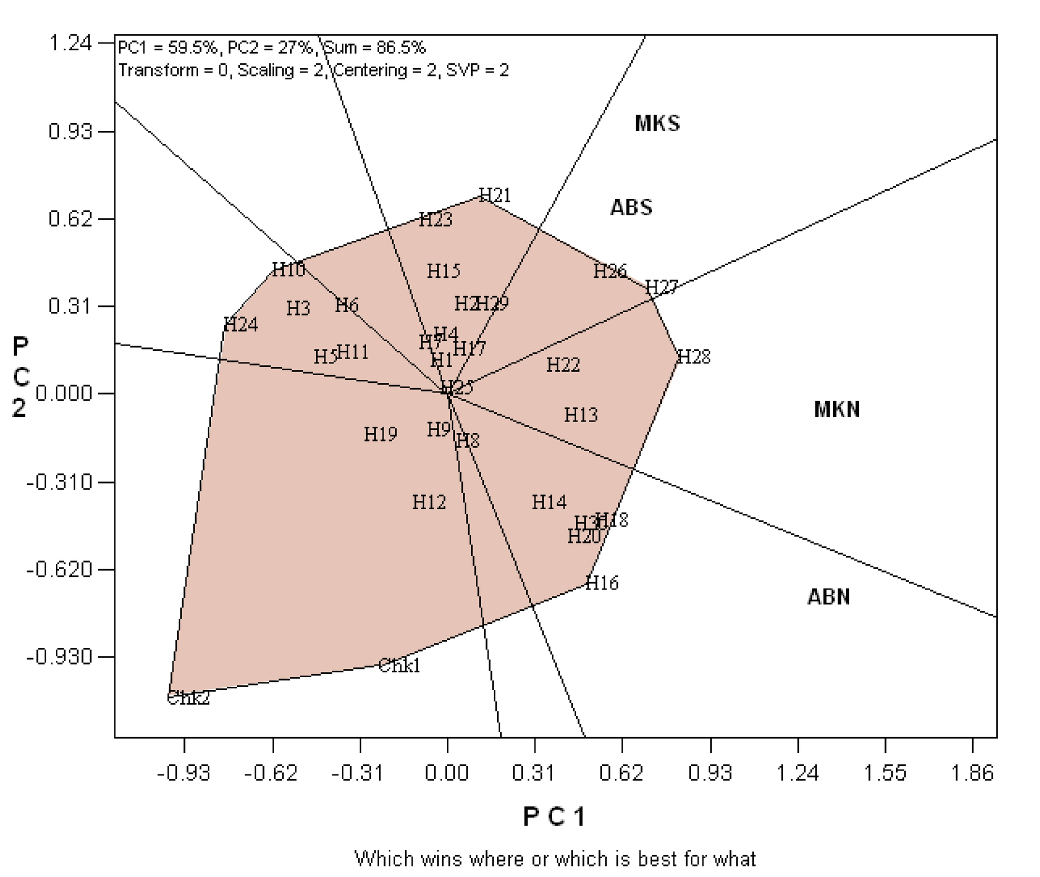

Figure 1. Polygon view of heritability-adjusted GGE biplot showing which genotype is best for which environment. Hybrid codes: H1 = TZEI 2 x TZEI 83; H2= TZEI 2B x TZEI 60; H3= TZEI 11 x TZEI 12; H4= TZEI 11 x TZEI 14; H5= TZEI 11 x TZEI 23; H6= TZEI 12 x TZEI 14; H7= TZEI 12 x TZEI 23; H8= TZEI 14 x TZEI 23; H9= TZEI 2 x TZEI 80; H10= TZEI 188 x TZEI 2B ;H11= TZEI 2 x TZEI 21; H12= TZEI 2 x TZEI 2B; H13= TZEI 83 x TZEI 2B; H14= TZEI 128 x TZEI 14; H15= TZEI 7 x TZEI 2B; H16= TZEI 106 x TZEI 2B; H17= TZEI 188 x TZEI 98; H18= TZEI 2 x TZEI 81; H19= TZEI 2 x TZEI 98; H20= TZEI 106 x TZEI 87; H21= TZEI 80 x TZEI 2B; H22= TZEI 136 x TZEI 11; H23= TZEI 136 x TZEI 12; H24= TZEI 136 x TZEI 14; H25= TZEI 136 x TZEI 23; H26= TZEI 11 x TZEI 127 H27= TZEI 11 x TZEI 25; H28 = TZEI 12 x TZEI 25 H29 = TZEI 23 x TZEI 25; H30= TZEI 60 x TZEI 87; CHK1= TZE COMP4C3 (Resistant OPV); CHK2=8338-1 (Susceptible).

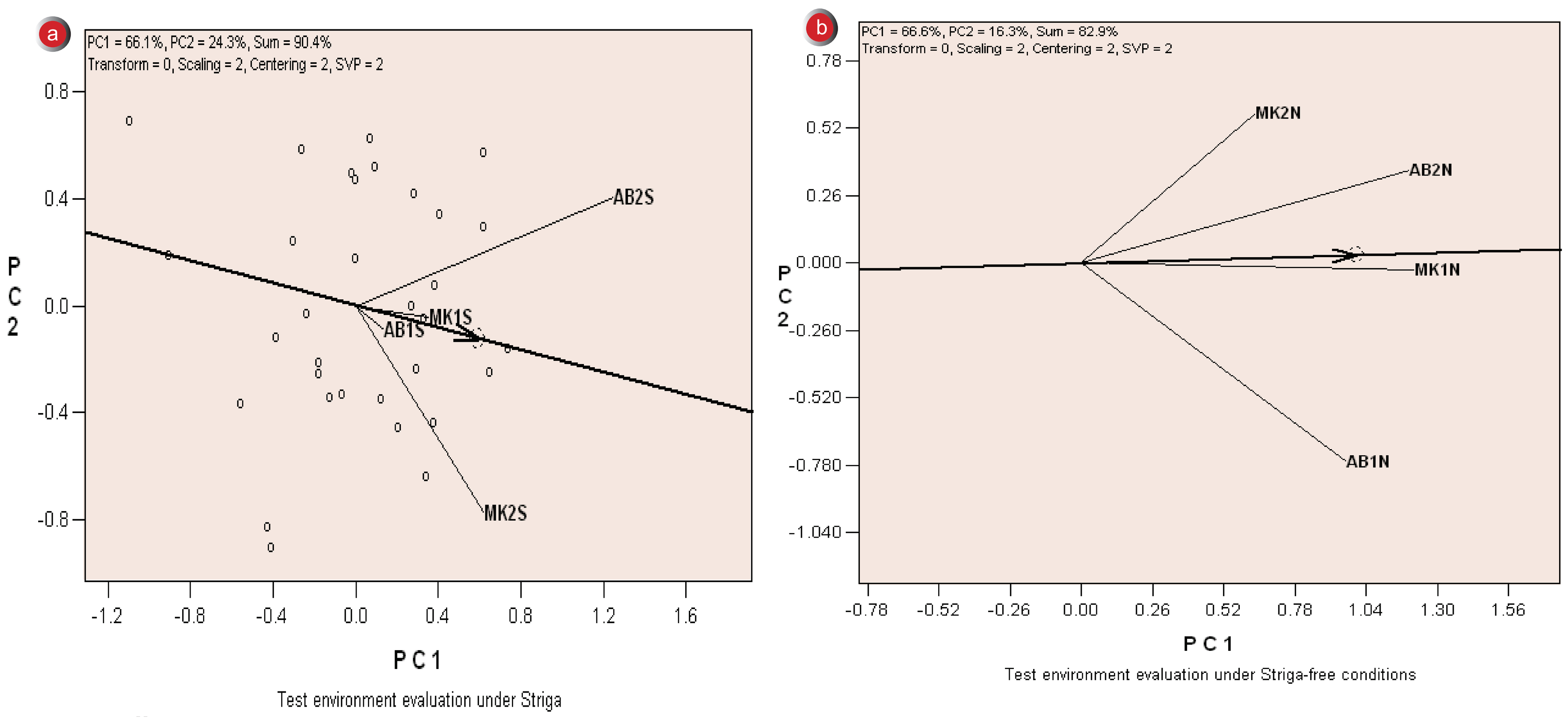

Figure 2. Average tester coordination view of the GGE biplot showing the discriminativeness and representativeness of the test environment (a) under *Striga* infestation; (b) *Striga*-free conditions. Abbreviations; MKS for Mokwa under *Striga* infestation, ABS for Abuja under *Striga* infestation, MKN for Mokwa under *Striga*-free conditions, ABN for Abuja under *Striga*-free conditions, 1 stands for year 2008 and 2 for year 2009.

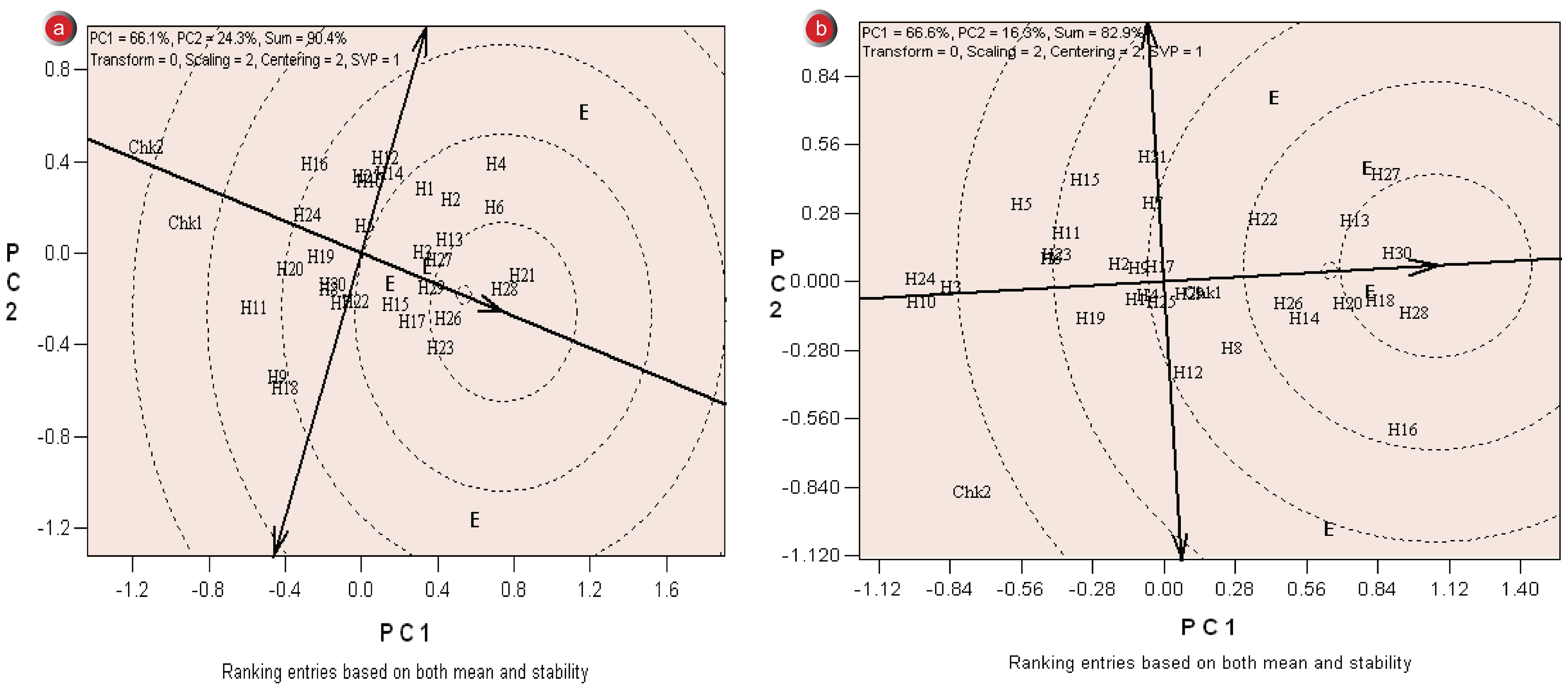

Figure 3. Average tester coordination view of HA-GGE biplot showing the ranking of hybrids based on yield performance (a) under *Striga* infestation; (b) under *Striga*-free conditions. 'E' marked the exact position of the environments used for the ranking of the genotypes. See Fig 1 for codes of hybrids.

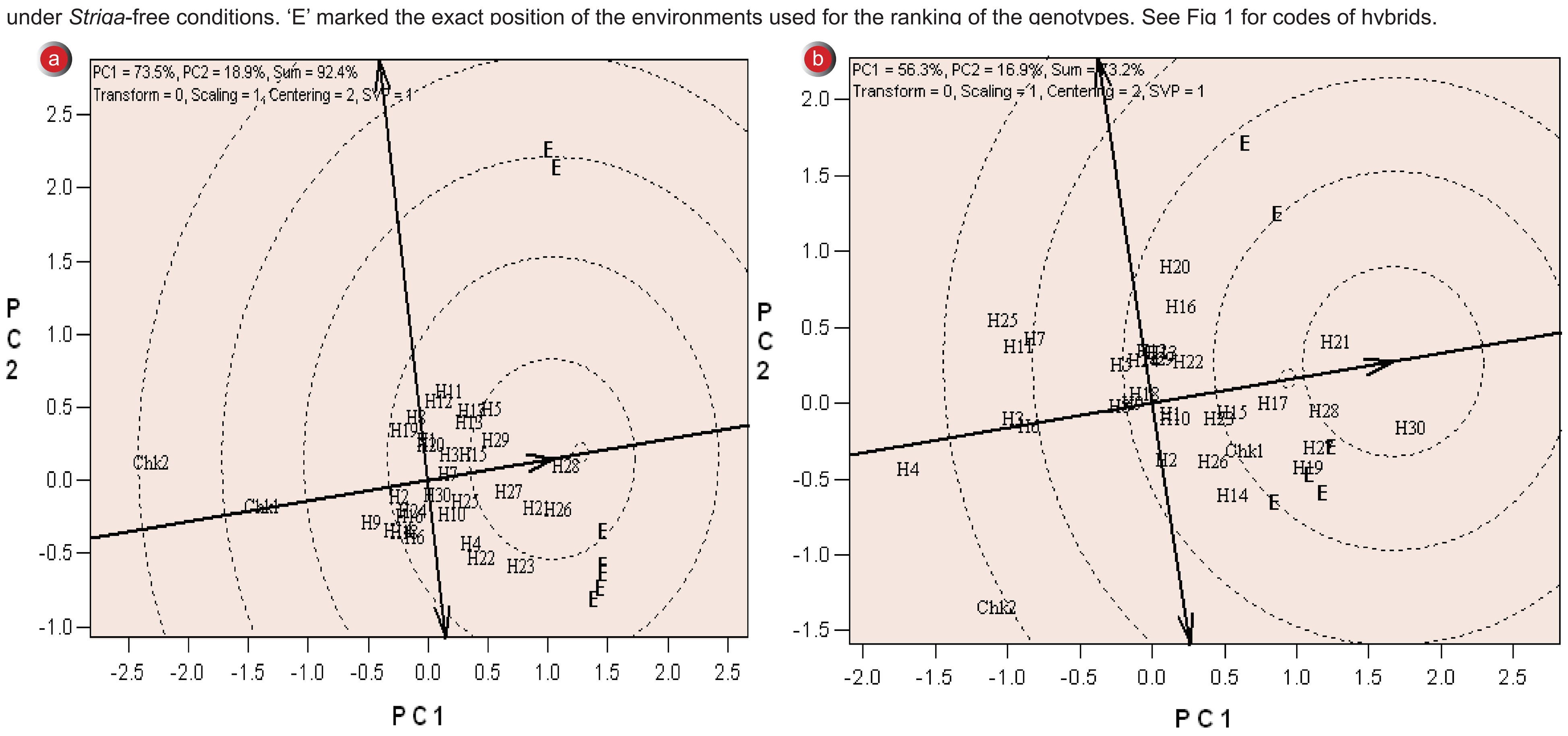

Figure 4. Ranking of hybrids based on multiple traits (a) under *Striga* infestation (b) under *Striga*-free environments. Ideal genotypes are located inside the innermost concentric circle. 'E' marked the exact position of the traits used for the ranking. See Fig. 1 for hybrid codes.

Picture of a resistant maize hybrid in *Striga* infested plot

Picture of *Striga* plant on susceptible maize hybrid.

Conclusions

The two test locations used by IITA for screening genotypes for *Striga* tolerance or resistance are unique and non-redundant in their evaluation of the genotypes. The hybrids TZEI 12/TZEI 25, TZEI 11/TZEI 127, TZEI 80/TZEI 2B, and TZEI 60/TZEI 87 showed outstanding performance and should be promoted for extensive testing in the regional hybrid trials and subsequent release for commercial production.

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References

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