Australian Journal of Crop Science AJCS

AJCS 14(02):259-262 (2020) ISSN:1835-2707
doi: 10.21475/ajcs.20.14.02.p2112

Genotype by environment analysis of rice (*Oryza sativa* L.) populations under drought stressed and well-watered environments

Lourine Chebet Bii , Kahiu Ngugi, John M. Kimani and George N. Chemining'wa

Supplementary Table 1: 19 generation of crosses in the F_3 population, 6 parental and 5 check varieties selected for evaluation.

Genotype/ generation of cross	Generation	Description	Origin
NERICA.1 XNERICA.2	F_3 population	Generation of crosses	KALRO-Mwea
NERICA1XNERICA11	F_3 population	Generation of crosses	KALRO-Mwea
NERICA1XNERICA15	F_3 population	Generation of crosses	KALRO-Mwea
NERICA1XSARO5	F_3 population	Generation of crosses	KALRO-Mwea
NERICA2XNERICA1	F_3 population	Generation of crosses	KALRO-Mwea
NERICA2XNERICA11	F_3 population	Generation of crosses	KALRO-Mwea
NERICA2XKomboka	F_3 population	Generation of crosses	KALRO-Mwea
NERICA2XSARO5	F_3 population	Generation of crosses	KALRO-Mwea
NERICA11XNERICA2	F_3 population	Generation of crosses	KALRO-Mwea
NERICA11XNERICA15	F_3 population	Generation of crosses	KALRO-Mwea
NERICA15XNERICA2	F_3 population	Generation of crosses	KALRO-Mwea
NERICA15XNERICA11	F_3 population	Generation of crosses	KALRO-Mwea
NERICA15XSARO5	F_3 population	Generation of crosses	KALRO-Mwea
KombokaXNERICA11	F_3 population	Generation of crosses	KALRO-Mwea

KombokaXNERICA15	F_3 population	Generation of crosses	KALRO-Mwea
SARO5XNERICA1	F_3 population	Generation of crosses	KALRO-Mwea
SARO5XNERICA11	F_3 population	Generation of crosses	KALRO-Mwea
SARO 5XNERICA15	F_3 population	Generation of crosses	KALRO-Mwea
SARO5XKomboka	F_3 population	Generation of crosses	KALRO-Mwea
NERICA 1(Parent)	Pure line	Aromatic, Blast tolerant, Long grains, Susceptible to drought.	KALRO-Mwea
NERICA 2(Parent)	Pure line	Non-aromatic and Drought tolerant	KALRO-Mwea
NERICA 11(Parent)	Pure line	Non-aromatic, Long grains, Tolerance to blast and susceptible to drought.	KALRO-Mwea
NERICA 15(Parent)	Pure line	Drought tolerant and Non-aromatic,	KALRO-Mwea
Komboka (Parent)	Pure line	High yielding, mild aroma, tolerant to most diseases, good grain quality and drought tolerant.	KALRO-Mwea
SARO5(Parent)	Pure line	Aromatic, high yield, Susceptible to drought	KALRO-Mwea
NERICA 4(Check)	Pure line	Drought susceptible	KALRO-Mwea
NERICA 10(Check)	Pure line	Drought susceptible	KALRO-Mwea
Duorado precoce (Check)	Pure line	Drought tolerant	KALRO-Mwea
IRAT 109(Check)	Pure line	Drought susceptible	KALRO-Mwea
MWUR 4(Check)	Pure line	Drought tolerant	KALRO-Mwea

Source: National crop variety list (KEPHIS, 2015). The generation of crosses were obtained from a student who developed crosses and evaluated them up to F_3 seed.

Note. KALRO: Kenya Agricultural Livestock and Research Organization.

Source: National crop variety list (KEPHIS, 2015).

Supplementary Table 2. ANOVA for AMMI and IPCA analysis for grain yield in tha-1 of the 30 rice lines in drought stressed and well-watered environments through two seasons in 2016/2017 at KALRO-Mwea.

Source of variation	Df	SS	%SS	MS	GEI SS%
Treatments	119	1894.1		15.92***	
Genotypes	29	363.2	18.2	12.52***	
Environments	3	1277.2	64.12	425.75***	
Block	8	6.2		0.78*	
Interactions (GEI)	87	253.7	12.73	2.92***	
IPCA1	31	229.2		7.39***	90.34
IPCA2	29	16.8		0.58ns	9.66
Residuals (noise)	27	7.8		0.29ns	
Error	232	91.4		0.39	
Total	359	1991.8		5.55	

Key: ***= very highly significant, **= highly significant, *= significant and ns=not significant. GEI=Genotype by Environment Interaction.

Supplementary Table 3. IPCA scores, ASV (AMMI Stability Variance) and mean performance in tons per hectare of the 30 rice lines grown under well-watered and drought stressed environment through two seasons in 2016/ 2017 at KALRO-Mwea.

Ser. No.	Genotypes	MEANS					IPCA Score		ASV
		Drought1	Drought2	WW1	WW2	GM	IPCA1	IPCA2	
1	NERICA.1 XNERICA.2	1.6	1.2	3.4	3.5	2.4	0.58217	0.03476	7.9
2	NERICA1XNERICA11	1.0	1.1	7.1	7.4	4.2	-0.82146	-0.00619	11.2
3	NERICA1XNERICA15	1.9	1.5	6.4	6.5	4.1	-0.31239	0.18865	4.3
4	NERICA1XSARO5	1.8	2.6	7.4	7.7	4.9	-0.55842	-0.35142	7.6
5	NERICA2XNERICA1	1.2	1.5	2.3	2.5	1.9	0.91225	-0.34524	12.5
6	NERICA2XNERICA11	1.4	1.2	4.7	4.9	3.0	0.09969	0.00107	1.4
7	NERICA2XKomboka	1.2	3.0	6.8	7.3	4.6	-0.43041	-0.85482	5.9
8	NERICA2XSARO5	1.1	2.2	8.6	9.1	5.3	-1.18555	-0.39368	16.2
9	NERICA11XNERICA2	2.2	1.8	5.9	6.1	3.9	-0.07967	0.13272	1.1
10	NERICA11XNERICA15	1.5	1.3	3.2	3.3	2.3	0.65798	-0.05108	8.9
11	NERICA15XNERICA2	1.5	1.4	2.9	3.1	2.3	0.74355	-0.11801	10.1
12	NERICA15XNERICA11	2.3	1.5	7.5	7.7	4.7	-0.63006	0.36190	8.6
13	NERICA15XSARO5	2.8	1.9	7.9	8.2	5.2	-0.65580	0.43780	8.9
14	KombokaXNERICA11	1.5	1.9	6.9	7.2	4.4	-0.52526	-0.18088	7.2
15	KombokaXNERICA15	1.5	1.4	2.9	3.0	2.2	0.75454	-0.15250	10.3
16	SARO5XNERICA1	1.8	1.8	6.3	6.5	4.1	-0.27617	0.01432	3.88
17	SARO5XNERICA11	2.8	2.1	8.2	8.5	5.4	-0.70676	0.36049	9.6
18	SARO 5XNERICA15	2.5	1.1	5.1	5.1	3.5	0.17252	0.53777	2.4

19	SARO5XKomboka	1.7	1.5	5.0	5.2	3.4	0.09165	-0.00372	1.3
20	NERICA 1(Parent)	1.4	0.6	3.5	3.6	2.3	0.42588	0.22999	5.8
21	NERICA 2(Parent)	1.2	0.4	3.1	3.1	1.9	0.53135	0.18492	7.3
22	NERICA 11(Parent)	1.8	2.4	4.8	5.0	3.5	0.30398	-0.35306	4.2
23	NERICA 15(Parent)	1.7	1.3	5.2	5.3	3.4	0.01635	0.12664	0.3
24	Komboka(Parent)	1.9	1.6	4.1	4.2	2.9	0.46567	0.01530	6.4
25	SARO5(Parent)	1.4	1.4	5.8	6.0	3.7	-0.24637	-0.04913	3.4
26	NERICA 4(Check)	2.7	1.8	4.5	4.6	3.4	0.51947	0.23436	7.1
27	NERICA 10(Check)	1.2	1.3	6.4	6.6	3.9	-0.49632	-0.02067	6.7
28	Duorado precoce(Check)	1.5	0.8	5.1	5.2	3.2	-0.05987	0.23092	0.8
29	IRAT 109(Check)	1.2	1.1	3.9	4.1	2.6	0.32593	-0.05774	4.4
30	MWUR 4(Check)	1.8	1.9	4.4	4.5	3.2	0.38155	-0.15345	5.2
	Mean	1.7	1.6	5.3	5.5	3.5			7.9

Key: Drought 1 and Drought 2= drought season 1 and drought season 2 respectively, WW1 and WW2=well-watered season 1 and well-watered season 2 respectively. GM= General mean, IPCA= Interaction Principal Component Analysis, ASV=AMMI stability variance.

Supplementary Table 4: List of 19 generation of crosses in the F_3 population, 6 parental and 5 check varieties. This is a guide for the GGE biplots.

Code	Germplasm	Code	Germplasm	Code	Germplasm
1	Nerica 1 x Nerica 2	11	Nerica 15 x Nerica 2	21	Nerica 2
2	Nerica 1 x Nerica 11	12	Nerica 15 x Nerica11	22	Nerica 11
3	Nerica 1x Nerica 15	13	Nerica 15 x SARO 5	23	Nerica 15
4	Nerica 1 x SARO 5	14	Komboka x Nerica11	24	Komboka
5	Nerica 2 x Nerica 1	15	Komboka x Nerica15	25	SARO 5
6	Nerica 2 x Nerica 11	16	SARO5 x Nerica 1	26	Nerica 4(check)
7	Nerica 2 x Komboka	17	SARO5 x Nerica 11	27	Nerica 10(check)
8	Nerica 2 x SARO 5	18	SARO5 x Nerica 15	28	Durado precoce(check)
9	Nerica 11 x Nerica 2	19	SARO 5 x Komboka	29	IRAT 109(check)
10	Nerica 11 x Nerica15	20	Nerica 1	30	MWUR 4(check)

GGE Biplots

The goodness of fit of GGE biplot is 100% with PC1 accounting for 96.44% and PC2 accounting for 3.56% (Figure 1).

For guide of numbers in figures 2 to 5 refer to table 4.

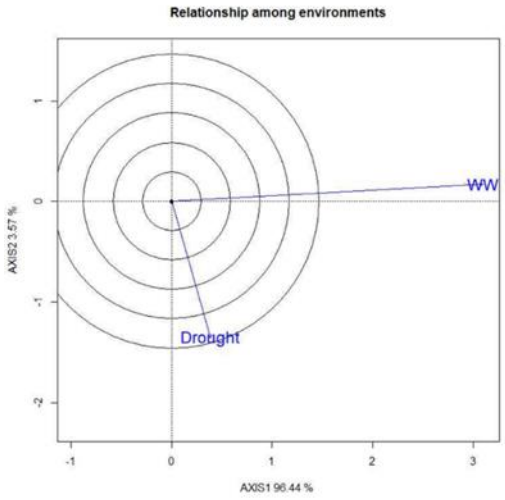

Figure 1

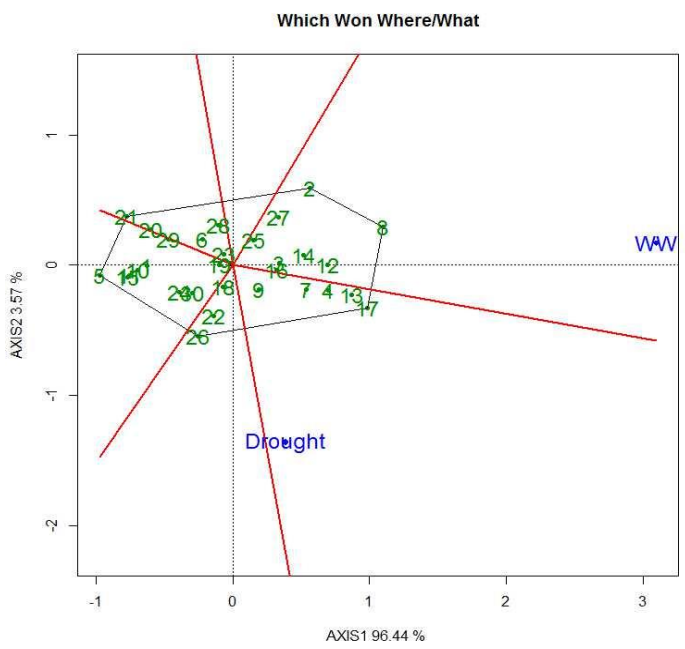

Figure 2

Figure 1: Relationship among the environments. It shows the angle between well-watered and drought stressed environment is an acute angle showing positive correlations between the two environments. **Figure 2: Polygon view of GGE biplot based on symmetrical scaling.** The Which-Won-Where view of GGE biplot aided in visualizing mega-environments. Ray 1 is perpendicular to the sides that connected number 2 and 8. In the well-watered environment, 2and 8 (NERICA 1 x NERICA 11and NERICA 2 x SARO5 respectively) were the winning lines while in the drought stressed environment 17 (SARO5 x NERICA 11) was the winning line.

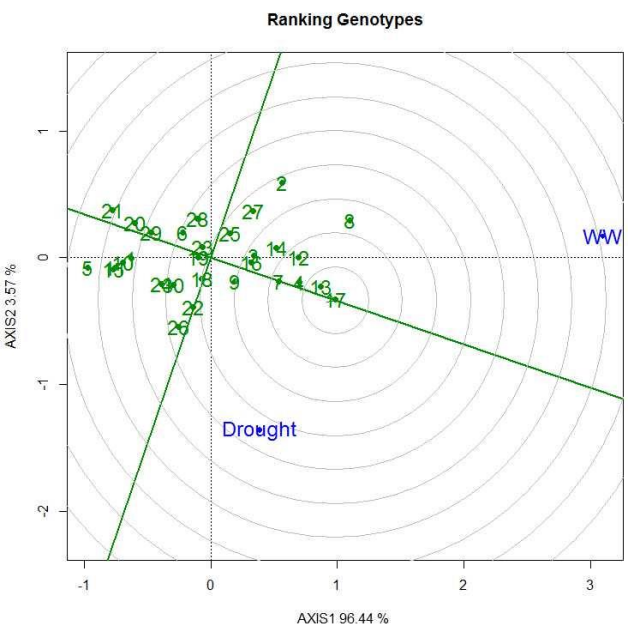

Figure 3

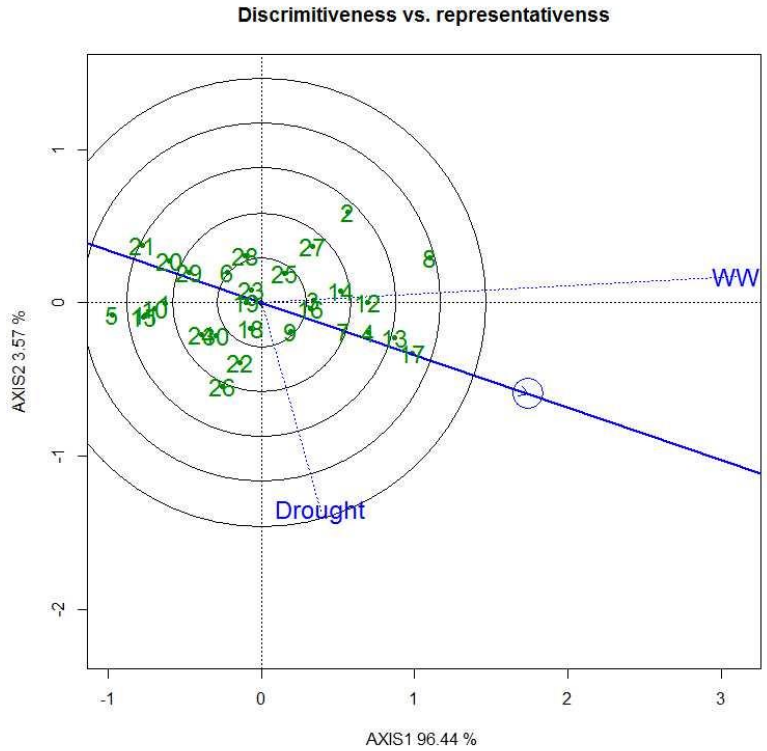

Figure 4

Figure 3: GGE-biplot based on genotype-focused scaling for comparison the genotypes with ideal genotypes. Concentric lines are drawn to help visualize the distance between each genotype and the ideal genotype. From Figure 3, generation of crosses, SARO5 x NERICA 11(17) and NERICA 15 x SARO 5 (13) fell within the innermost concentric circles and therefore ranked as the best in terms of yield and stability in both environments. **Figure 4: The discriminating and representative view showing the discriminating ability and representativeness of the test environments.** The well-watered environment had a longer vector and therefore it discriminated the rice lines the most but it was non-representative. The drought stressed environment had a shorter vector meaning all genotypes performed similarly in the environment and therefore it provided less information on the differences among the lines.

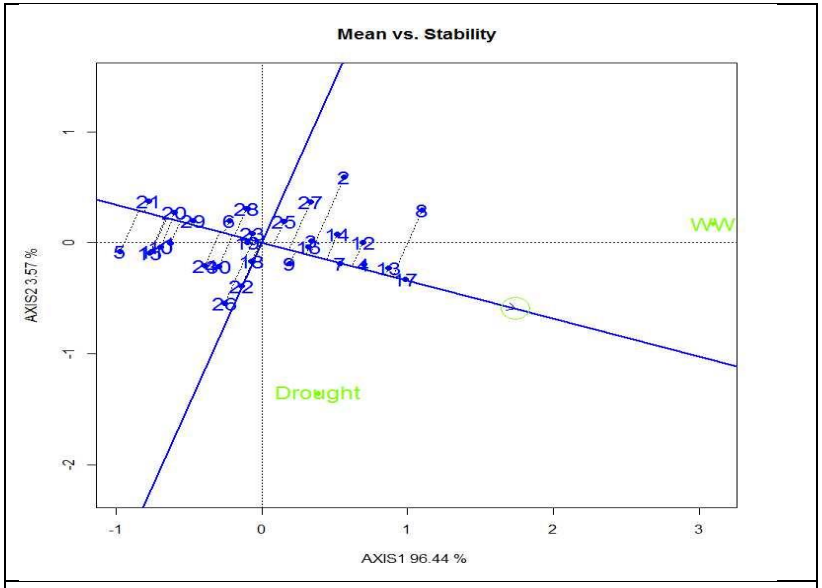

Figure 5

Figure 5: GGE biplot based on genotype focused singular value partitioning for comparison of the genotypes with the ideal genotype. The mean vs. stability biplot was used to identify an ideal genotype which is characterized by both high mean performance and high stability. This figure shows the performance of the lines were ranked as follows in this biplot 17>8>13>4>12>7>14>2>16>3>9>27>25 (Table 4) to be above average means. Lines 2 and 26 were least stable as they had long projections from the AEA (Figure 5).