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Stability Analysis for Yield and some Other Traits in Grain Sorghum Using Tai's Stability Method

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ABSTRACT

Ten sorghum genotypes (*Sorghum bicolor* L. Moench) were evaluated at three locations namely; Arab El-Awamer, Shandweel, and El-Fayoum Agric. Res. Stations in 2018 and 2019 growing seasons. Planting time at the three locations during the two years were during the 1st week of July. The objectives of this study were to determine the performance and stability of ten sorghum across different locations of Egypt. The study was conducted using a randomized complete block design with four replications. Stability analysis for grain yield, 1000-grain weigh, plant height and days to 50% flowering were estimated using Tai's statistical method. A combined analysis of variance emphasized the significant effect of genotypes and locations for all studied traits. There was nonsignificant effect of year for all studied traits, except for 1000-grain weight. The effect of location on Sorghum grain yield and the other studied traits was greater than the effect of year. Hence, testing genotypes under many locations should be done rather than years. Significant effect of genotype x location interaction, suggesting that each genotype differentially responded to the change in the investigated locations. Based on Tai's stability analysis, 3 out of 10 tested sorghum genotypes i.e., (ASH-8 x ICSR-93002), (ASH-9 x ICSR-93002), and (ASH-12 x ICSR-93002) showed average stability and gave high yielding compared to the general mean and are thus the most stable grain sorghum genotypes for grain yield. Generally, Tai's stability method was facilitated the visual comparison and identification of superior genotypes, thereby supporting decisions grain sorghum genotypes for different environments.

Keywords: Sorghum, Grain yield, Stability, GxE interaction

INTRODUCTION

Grain sorghum (*Sorghum bicolor* L. Moench) is one of the major cereal crops in Egypt, as the cultivated grain sorghum area about 147.961 hectares produced about 727648 tons (FAO 2017). It has a remarkable ability to produce a crop under a biotic stress conditions, such as heat, drought and salinity.

Seventy percent of cultivated areas concentrated in Upper Egypt. Also, the El-Fayoum province has a large cultivated area due to soil problems such as salt, drought and low fertility in addition to heat stress which prevent the cultivation of other crops.

The performance of plants changes in response to the differences of the environments, so developed cultivars with stability seems necessary for yield. The difference in genotype stability may be due to the interaction effect of genotype and environment, therefore, changes in their rank are different in various environmental conditions. (Shahryarinasab and Chogan, 2015)

Stability of yield defined as the ability of genotypes to avoid substantial fluctuations in yield across a range of environments. Genotype x environmental interaction (GEI) is an important consideration in plant breeding programs because it reduces the progress from the selection at one environment (Hill,1975). Significant GEI results from the change in the magnitude difference between genotypes in different environments or changes in the relative ranking of the genotypes. Consistent performances across different locations and/or years are referred to stability. Partitioning GEI into stability statistics assignable to each genotype evaluated across a range of environments is useful in selecting stable genotypes.

Different stability estimates are proposed to measure the stability of genotypes tested under a wide range of environments (Fernandez et al., 1989; Hill 1975; Pritts and Luby 1990). The most popular methods (Eberhart and Russell, 1966; Finlay and Wilkinson, 1963) have used analysis of variance combined with joint regression analysis to determine whether GEI is a linear function of the additive environment.

One of the essential features in developing this regression technique was the estimation of the environmental index (Env. Index), as an independent variable, which is obtained by subtracting the environmental mean from the grand mean.

Tai (1971) proposed partitioning the GEI effect of the ith genotype into two stability statistics αi and λi, based on the principles of structural relationship analysis. The αi measures the linear response of the environmental effect, and λi measures the deviation from the linear response in terms of the magnitude of the error variance. A genotype having $\alpha i = 0$ and $\lambda i = 1$ is considered of average stability. Approximate procedures for testing the hypotheses $\alpha i = 0$ and $\lambda i = 1$ were given, and a method of obtaining the prediction interval for $\alpha i = 0$ and a confidence interval for λi values so that genotypes can be distributed in different stability regions were also suggested (Tai, 1971). The objectives of this study are: (1) to evaluate 10 sorghum genotypes adapted to different environments of Egypt

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for grain yield and some other traits, and (2) to identify stable high-yielding sorghum genotypes in different environments.

MATERIALS AND METHODS

Ten grain sorghum genotypes were developed by National Sorghum Research Program at Shandaweel Agric. Res. Station, Sohag province. Nine crosses were produced from nine cytoplasmic male sterile lines (CMS-Lines) (A-lines) with the restorer line (ICSR-93002). In 2017 growing season the pollen from the restorer line ICSR-93002 (R-line) was collected to pollinate the nine male sterile lines for producing the nine cross seeds. The resultant nine grain sorghum crosses, along with commercial hybrid i.e., H-305 were planted during the 1st week of July in 2018 and 2019 growing seasons across three locations i.e., Shandweel , El-Fayoum Agric. Res. Stations and other one was in a new reclaimed land namely, Arab El-Awamer Agric. Res. Station at Assiut Province.

The pedigree of the ten sorghum crosses which investigated in this study are presented in Table 1. At each location, a randomized complete block design with four replications was used. Plot size was 9.6 m2 (4 rows, 4m long and 60-cm row spacing and 20 cm between hills). Data for grain yield and the other studied traits were subjected to analysis of variance using the SAS statistical package. Error homogeneity was tested and combined analysis of variance across all environments was performed according to (Gomez and Gomez, 1984) using the general linear model (Proc GLM) procedures. All recommended agricultural practices were applied. Data were recorded on 1000- grain weight (g), days to 50 % flowering, Plant height (cm) and Grain yield which was measured per plot and converted to ardab faddan-1. (faddan=4200 m2, ardab= 140 kg).

The linear regression concept of Tai (1971) was used in this study, a hybrid with average stability will have $\alpha = 0$ and $\lambda = 1$. Furthermore, a perfectly stable hybrid will have $\alpha = -1$ and $\lambda = 1$. The two stability linear regression parameters can be represented in two orthogonal axes α (on the y-axis) versus λ (on the x-axis) formatting a hyperbola with the first two vertical lines delineating the limiting of 95% confidence interval for $\lambda = 1$. Also, the two vertical lines and the hyperbola marked two regions, region A (within the hyperbola) for hybrids that do not significantly differ from average stability and region B (outside the hyperbola) for hybrids with stability significantly above average.

Table 1. Pedigree of the 10 grain sorghum genotypes evaluated in 6 environments.

Genotype No.	Pedigree
1	A SH-8 × ICSR- 93002
2	A SH-9 × ICSR-93002
3	A SH-10 × ICSR- 93002
4	A SH-12 × ICSR- 93002
5	A SH-14 × ICSR- 93002
6	A SH-16 × ICSR- 93002
7	A SH-18 × ICSR-93002
8	A SH-21 × ICSR-93002
9	A SH-30- × ICSR-93002
10	H-305 (commercial hybrid)

Abbreviations: A= cytoplasmic male sterility line (CMS lines)
SH= Shandweel Agri. Res. Station, Egypt.

RESULTS AND DISCUSSION

1. Analysis of Variance

Results of the combined analysis of variance (Table 2) showing the significant effect of genotypes and locations for all studied traits. There was nonsignificant effect of year for all studied traits, except for 1000-grain weight. The effect of location on Sorghum grain yield and the other studied traits was greater than the effect of year. Hence, testing at more locations should be done rather than testing in more years. Matos et al. (2007) and Torga et al. (2013) found that the line x location interaction was greater than or equal to the line x year interaction. Saeed et al. (1984), Ali, (2000) and Ezat et al. (2010) reported that interaction genotype with locations was more important than that with years for sorghum grain yield, plant height, days to 50% blooming and 1000-grain weight. However, Silva et al. (2011) and Ricardo et al. (2015) observed that the line x location interaction contributed less than the line x year interaction. Laidig et al. (2008) and Meyer et al. (2011) working with cultivars from 30 different crops reported that the contribution of Genotype x Year and Genotype x Environment interaction varies among the crops.

Table 2. Mean squares obtained from combined analysis of variance for grain yield, 1000-Grain weight, days to 50% flowering and plant height recorded in three locations and two years.

S. O. V	df	Grain yield (ardab fad^{-1})	1000-grain weight (g)	Plant height (cm)	Days to 50% flowering
Location	2	1309.19**	2427.19**	2274.61**	3161.31**
Year	1	0.040 NS	566.48**	44.78 NS	12.76 NS
Year x location	2	1.17 NS	203.52**	318.38*	20.92 NS
Year x location x rep	18	2.11 NS	11.71**	63.05 NS	10.76 NS
Genotype	9	62.15**	76.08**	509.42**	67.10**
Genotype x location	18	22.93**	21.06**	179.72**	95.94**
Genotype x year	9	2.17 NS	21.41**	72.24 NS	15.58 NS
Genotype x location x year	18	4.18 NS	9.65**	49.36 NS	18.80*
Error	162	2.83	2.73	67.94	10.69

NS'*' Nonsignificant, significant and highly significant at 0.05 and 0.01 levels of probability, respectively.**

Significant effect of genotype x location interaction, suggesting that each genotype differentially responded to the change in the investigated locations. This significant interaction encourages sorghum breeders to develop high yielding and more uniform crosses under different environmental conditions. No significant effect was detected of genotype x year interaction, indicating that the trend of genotype changes for studied traits was similar, except for 1000- grain weight in the two investigated years (Table 2). In addition, no significant effect of genotype x location x year for grain yield and plant height. whereas, a significant effect of genotype x location x year interaction was observed for 1000-grain weight and days to 50% flowering, suggesting that sorghum genotypes fluctuated in the different environments. making focus at the previous interaction effects, finding adapted sorghum genotypes to different environments condition strongly recommendation stability analysis should be done.

2. Mean Performance and Environmental index (Env. Index)

Mean performance and environmental index for grain yield and other studied traits are presented in Tables 3 and 4. The environmental index is computed as the difference between each environment mean and the mean of overall environments. Hence, it is directly reflecting the rich or poor environment in terms of positive and negative, respectively. Therefore, the most favorable environments were E2 and E5 (Shandweel Agric. Res. Station) for grain yield and the other studied traits. Also, E3 was rich for plant height. On the other side, the poorest environment was E1 and E4 (Arab El-Awamer Agric Res. Station) for grain yield and other studied traits whereas gave negative environmental index. This is may be due to that a newly reclaimed soil is poor in minerals and have some abiotic stress.

Table 3. Mean performance of grain yield and 1000-Grain weight for 10 grain sorghum genotypes evaluated in 6 environments (two years and three locations) during 2018 and 2019 growing seasons.

Genotype	Grain yield (ardab fad^{-1})							1000-Grain weight (g)						
	E1	E2	E3	E4	E5	E6	Mean	E1	E2	E3	E4	E5	E6	Mean
G1	13.05	23.70	16.87	14.57	23.30	16.95	18.07	16.53	26.43	14.88	16.30	31.30	23.37	21.46
G2	12.73	20.85	15.75	13.02	20.40	17.35	16.68	18.00	27.25	20.55	15.90	31.95	22.33	22.66
G3	17.50	22.55	16.23	18.15	21.07	15.20	18.45	22.25	28.58	20.45	21.58	32.30	24.58	24.95
G4	14.02	22.57	14.25	13.3	23.67	16.75	17.43	20.40	32.08	20.45	19.35	33.45	25.58	25.26
G5	12.22	23.75	15.60	11.34	24.60	15.02	17.09	17.60	30.35	19.55	18.18	31.45	22.92	23.34
G6	17.55	24.37	14.53	15.92	24.90	16.00	18.88	24.15	30.83	19.40	21.63	31.28	26.32	25.60
G7	11.72	19.57	16.65	14.87	18.25	16.92	16.33	18.50	28.50	21.80	22.25	32.75	27.88	25.28
G8	14.75	17.60	14.57	12.1	18.20	15.20	15.40	25.53	28.65	19.65	26.43	33.85	33.30	27.90
G9	10.90	18.28	14.13	11.15	17.00	12.57	14.01	21.93	32.43	17.98	19.38	33.73	22.87	24.71
G10	10.96	20.60	13.05	11.37	20.20	12.25	14.74	20.53	29.60	18.50	24.30	31.35	27.65	25.32
Mean	13.54 c	21.38 a	15.16 b	13.58 c	21.16 a	15.42 b	16.71	20.54 d	29.47 b	19.32 d	20.53 d	32.34 a	25.68 c	24.65
Env. Index	-3.17	4.76	-1.55	-3.13	4.45	-1.29	--	-4.11	4.82	-5.33	-4.12	7.69	1.03	--
CV (%)	11.48	6.37	10.63	10.46	5.60	16.79	10.07	9.90	8.01	6.93	5.71	5.66	5.77	6.70
R. LSD*	2.14	1.85	2.34	1.95	1.35	3.76	0.86	2.83	3.42	1.87	1.51	-	1.99	0.82

E1: Arab El-Awamer (Assiut) 2018; E2: Shandweel 2018; E3: El-Fayoum 2018; E4: Arab El-Awamer (Assiut) 2019; E5: Shandweel 2019; E6: El-Fayoum 2019

*** Revised Least Significant Difference**

Table 4. Mean performance of plant height and days to 50% flowering for 10 grain sorghum genotypes evaluated in 6 environments (two years and three locations) during 2018 and 2019 growing seasons.

Genotype	Plant height (cm)							Days to 50% flowering						
	E1	E2	E3	E4	E5	E6	Mean	E1	E2	E3	E4	E5	E6	Mean
G1	170	182	168	169	186	170	174.17	87.00	72.00	72.00	84.58	70.25	79.00	77.47
G2	163	187	176	163	188	166	173.83	80.50	63.75	78.00	82.25	66.75	80.00	75.21
G3	169	184	179	174	185	182	178.83	79.25	68.75	77.00	76.25	67.50	79.50	74.71
G4	188	187	184	179	187	181	184.33	77.75	63.25	83.00	77.00	67.25	84.00	75.38
G5	163	178	183	176	186	186	178.76	83.50	70.00	85.00	85.67	68.50	82.25	79.15
G6	168	177	185	171	183	178	177.00	74.00	67.50	83.00	79.42	68.50	83.50	75.99
G7	172	176	196	181	188	184	182.83	73.25	73.75	79.50	74.00	68.25	79.50	74.71
G8	181	183	186	178	185	182	182.50	79.50	71.75	80.75	85.75	72.50	81.25	78.58
G9	173	174	174	171	179	175	174.33	73.50	72.50	81.00	72.25	68.50	81.50	74.88
G10	161	174	177	165	177	168	170.33	79.75	71.25	81.75	83.92	69.75	78.00	77.40
Mean	171 c	180 b	181 b	173 c	184 a	177 b	177.68	78.80 b	69.45 c	80.10 ab	80.11 ab	68.78 c	80.85 a	76.35
Env. Index	-6.68	2.32	3.32	-4.68	6.32	-0.68	-	2.45	-6.90	3.75	3.76	-7.57	4.5	--
CV (%)	3.36	4.94	3.96	3.37	5.63	5.65	4.63	4.29	3.83	3.86	5.63	4.72	2.81	4.28
R. LSD*	7.99	--	10.52	8.74	--	--	4.42	4.78	3.74	4.45	6.61	--	3.53	1.79

E1: Arab El-Awamer (Assiut) 2018; E2: Shandweel 2018; E3: El-Fayoum 2018; E4: Arab El-Awamer (Assiut) 2019; E5: Shandweel 2019; E6: El-Fayoum 2019

*** Revised Least Significant Difference**

Concerning grain yield, data in Table 3 showed that the mean grain yield of each environment and the overall grain yield across environments. Grain yield across all environments ranged from 14.01 for ASH-30 x ICSR-93002 to 18.88 for ASH-16 x ICSR-93002. The mean of environments ranged from 13.54 for E1 to 21.38 for E2. The interaction between crosses and environments was highly significant and the crosses ASH-16 x ICSR-93002 (24.90) and ASH-14 x ICSR-93002 (24.60) under E5 gave the highest values of grain yield, respectively. On the other hand, the lowest values of grain yield were detected from H-305 (10.96) and ASH-30 x ICSR-93002 (10.90) under E1. In a closer look at data for E1 finding that ASH-10 x ICSR-93002 (17.50, 18.15) and ASH-16 x ICSR-93002 (17.55, 15.92) gave the highest yielding in the two evaluation years, respectively and may be more adaptable for new reclaimed soil than the other investigated materials. The overall grain yield performance across environments indicates that the highest-yielding crosses were ASH-16 x ICSR-93002 (18.88), ASH-10 x ICSR-93002 (18.45) and ASH-8 x ICSR-93002 (18.07), respectively. These crosses produced grain yield more than the commercial hybrid H-305 (14.74) by 4.14, 3.71 and 3.33 ardeb fad^{-1} and are considering as a promising cross and may be released as a new sorghum hybrid after further wide of evaluation.

Regarding 1000-grain weight, data in Table 3 showed that means overall environments ranged from 21.46 for ASH-8 x ICSR-93002 to 27.90g for ASH- 21 x ICSR-93002. Also, means of environments ranged from 19.32 under E3 to 32.34g under E5. The highest values were detected from ASH-21 x ICSR-93002 (33.85g), ASH-30 x ICSR-93002 (33.73g) and ASH-12 x ICSR-93002 (33.45g) under E5. On the other side, the lowest values of grain weight were shown at E3 for ASH-8 x ICSR-93002 (14.88g) and E4 for ASH-9 x ICSR-93002 (15.90g).

For plant height, the average performance for 10 sorghum genotypes in each environment and overall environments are presented in Table 4. The overall plant height of the 10 investigated sorghum across the 6 environments ranged from 170.33 for H-305 to 184.33cm for ASH-12 x ICSR-93002. Also, environments mean overall crosses varied from 171 for E1 to 184 cm for E5. The interaction between location and crosses was highly significant and A SH-18 x ICSR-93002 (196 cm) under E3 had the tallest plants while the shortest plants detected from H-305 (161), ASH-9 x ICSR-93002 (163) and ASH-14 x ICSR-93002 (163 cm) under E1. Significant differences were observed between E5 (Shandweel 2019) and other 5 environments for plant height. This may be due to the environmental conditions at Shandweel were good for sorghum growth.

Concerning days to 50% flowering, data in Table 4 showed that the overall days to 50% flowering across environments varied from 74.71 for ASH-10 x ICSR-93002 and ASH-18 x ICSR-93002 to 79.15 days for ASH-14 x ICSR-93002. Also, we can notice that the environments mean ranged from 68.78 under E5 to 80.85 days under E6. The earliest genotype is ASH-9 x ICSR-93002 under E2 with a value of 63.75 days, while ASH-8 x ICSR-93002 under E1 is the latest one. Generally, we can notice that increasing the days to 50% Flowering at Arab El-Awamer (E1 and E4) and El-Fayoum (E3 and E6) Agric. Res. Stations in the two investigated years compared by Shandweel Agric Res. Stations (E2 and E5). These results may be due to a biotic stress in these two locations. The same results were obtained by Abo-Zaid (2007), Hovny and El-Dsouky (2007) and El-Sagheer and Mohamed (2017).

3- Linear Regression for Stability

Tai (1971) stability concept partitions the GEI effect into two components, α that measures the linear response to environmental effects and λ that measures deviation from the linear response. The two stability linear regression parameters can be represented in two orthogonal axes α (on the y-axis) versus λ (on the x-axis) formatting a hyperbola with the first two vertical lines delineating the limiting of 95% confidence interval for λ = 1. The area within the hyperbola and the two vertical lines define the region as having average stability, whereas the area between the two vertical lines but outside the hyperbola define the area as having "above average stability".

Also, the two vertical lines and the hyperbola marked two regions, region A (within the hyperbola) for hybrids that do not significantly differ from average stability and region B (outside the hyperbola) for hybrids with stability significantly above average. Stability parameters for grain yield, 1000-grain weight, Plant height and days to 50% flowering are presented in Table 5.

Table 5. Stability parameters of grain yield, 1000-Grain weight, plant height and days to 50% flowering for 10 grain sorghum genotypes evaluated in 6 environments.

Genotype	Grain yield (ardab fad^{-1})			1000-grain weight (g)			Plant height (cm)			Days to 50% flowering		
	Mean	α	λ	Mean	α	λ	Mean	α	λ	Mean	α	λ
G1	18.07	0.22	0.66^{NS}	21.46	0.23	0.45^{NS}	174.17	0.05	2.19^{NS}	77.47	-0.19	12.59**
G2	16.68	-0.08	1.70^{NS}	22.66	0.04	7.16**	173.83	1.08	1.69^{NS}	75.21	0.35	1.84^{NS}
G3	18.45	-0.35	3.92**	24.95	-0.16	1.01^{NS}	178.83	0.13	0.42^{NS}	74.71	-0.11	0.90^{NS}
G4	17.43	0.24	1.14^{NS}	25.26	0.14	1.80^{NS}	184.33	-0.86	0.84^{NS}	75.38	0.41	3.11*
G5	17.09	0.57	0.69^{NS}	23.34	0.10	3.83**	178.76	0.36	1.90^{NS}	79.15	0.35	1.05^{NS}
G6	18.88	0.17	4.67**	25.60	-0.14	3.00*	177.00	0.20	0.53^{NS}	75.99	0.15	3.19**
G7	16.33	-0.37	3.56**	25.28	-0.08	5.17**	182.83	0.07	2.92*	74.71	-0.45	3.44**
G8	15.40	-0.44	1.28^{NS}	27.90	-0.21	16.39**	182.50	-0.59	0.12^{NS}	78.58	-0.11	1.68^{NS}
G9	14.01	-0.18	0.94^{NS}	24.71	0.20	5.94**	174.33	-0.67	0.10^{NS}	74.88	-0.35	5.67**
G10	14.74	0.22	0.34^{NS}	25.32	-0.11	4.96**	170.33	0.23	0.17^{NS}	77.40	-0.06	1.93^{NS}

NS'*' Nonsignificant, significant and highly significant at 0.05 and 0.01 levels of probability, respectively.**

Concerning grain yield, when parameters from Tai's model are plotted for the 10 sorghum genotypes overall 6 environments, Fig 1 shows 3 sorghum crosses namely, ASH-8 x ICSR-93002, ASH-9 x ICSR-93002 and ASH-12 x ICSR-93002 as being within the average stability area and shows high-yielding compared to general mean and are thus the most stable sorghum genotypes for grain yield, while ASH-21 x ICSR-93002 and H-305 as being inside the two vertical lines but outside the average stability zone. On the other hand, the ASH-10 x ICSR-93002, ASH-16 X ICSR-93002, and ASH-18 x ICSR-93002 are far from the acceptability area and are considering the most unstable sorghum genotypes for grain yield.

Regarding 1000-grain weight (Fig 2) 2 out of 10 grain sorghum genotypes namely, ASH-10 x ICSR-93002 and ASH-12 x ICSR-93002 fall within the average stability area and are considering the most stable sorghum genotypes of the investigated materials. Also, ASH-8 x ICSR-93002 is being inside the vertical line but outside the average stability zone. The most unstable grain sorghum genotype is ASH-21 x ICSR-93002 whereas falls far from the acceptable area.

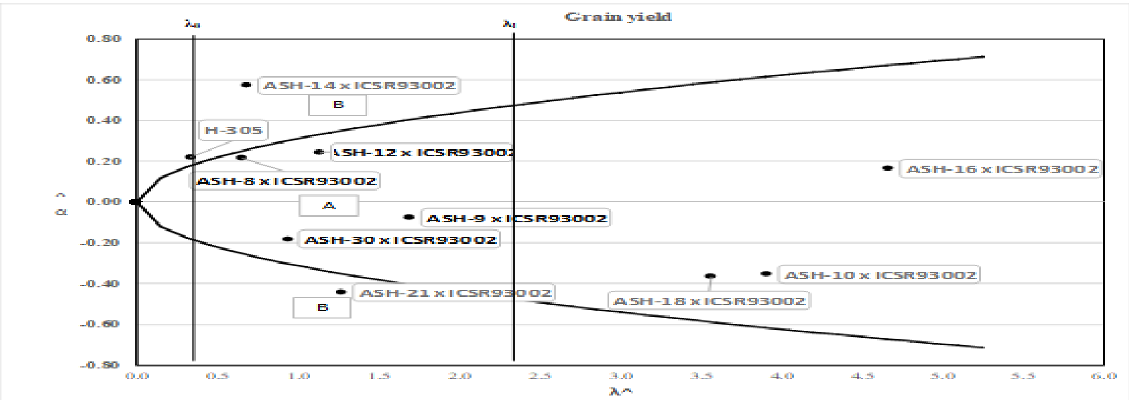

Fig. 1. Plot of parameters α and λ for Tai's stability method for 10 grain sorghum genotypes.

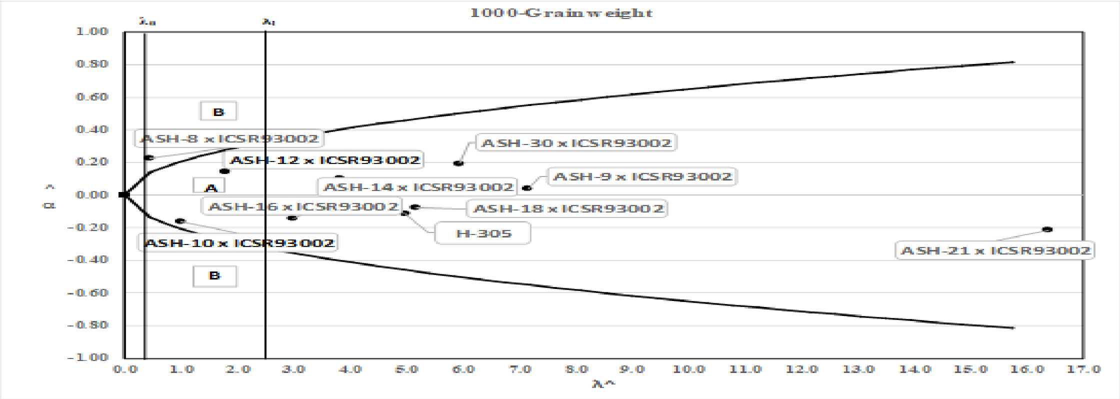

Fig. 2. Plot of parameters α and λ for Tai's stability method for 10 grain sorghum genotypes.

Concerning plant height, (Fig 3) five grain sorghum genotypes namely; ASH-8 x ICSR-93002, ASH-9 x ICSR-93002, ASH-12 x ICSR-93002, ASH-14 x ICSR-93002 and ASH-16 x ICSR-93002 as being in the average stability and are thus the most stable genotypes for plant height. The most unstable grain sorghum genotype is ASH-18 x ICSR-93002 whereas falls far from the acceptable area.

Regarding days to 50% flowering (Fig 4) 5 out of 10 grain sorghum genotypes namely; ASH-9 x ICSR-93002, ASH-10 x ICSR-93002, ASH-14 x ICSR-93002, ASH-21 x ICSR-93002, and H-305 fall within the average stability area and are considering the most stable grain sorghum genotypes. On the other hand, ASH-8 x ICSR-93002 and ASH-30 X ICSR-93002 are being the most unstable grain sorghum genotypes whereas fall far from the acceptable area.

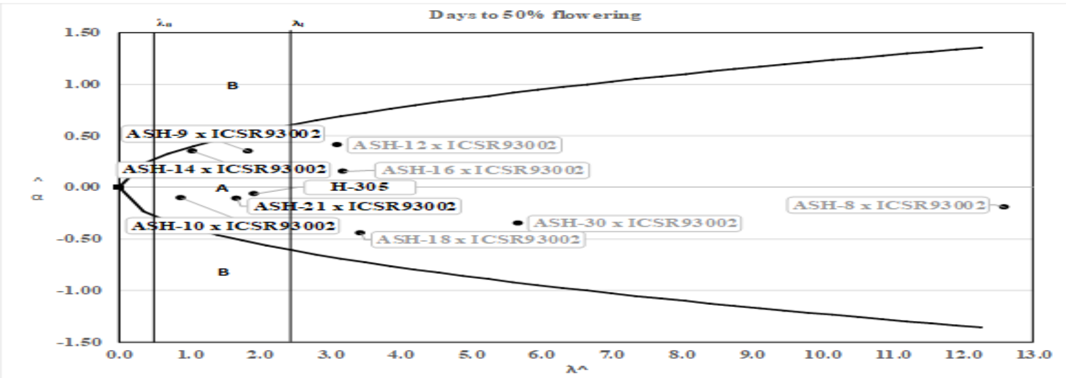

Fig. 3. Plot of parameters α and λ for Tai's stability method for 10 grain sorghum genotypes.

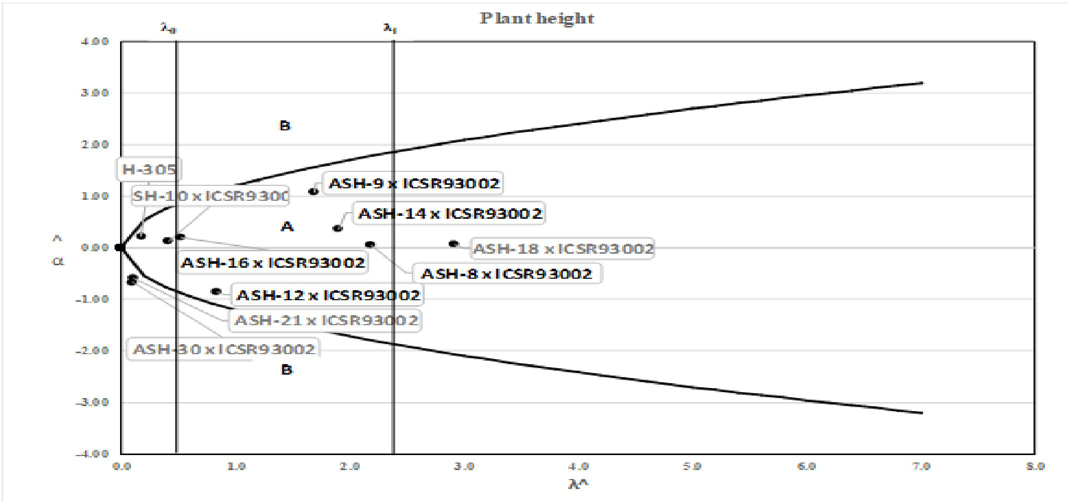

Fig. 4. Plot of parameters α and λ for Tai's stability method for 10 grain sorghum genotypes.

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تحليل الثبات فى محصول الحبوب وبعض الصفات الأخرى فى الذرة الرفيعة باستخدام طريقة تاى

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تم تقييم عشرة تراكيب وراثية من الذرة الرفيعة فى ثلاثة مواقع مختلفة وهى محطات البحوث الزراعية بعرب العوامر (أسيوط) وشندويل (سوهاج) والفيوم وذلك لمدة موسمين زراعيين وهما 2018 و 2019. تمت الزراعة فى كل المواقع والسنين فى الاسبوع الأول من شهر يوليو. كان الهدف من هذه الدراسة هو تقييم اداء وثبات التراكيب الوراثية فى مواقع مختلفة من جمهورية مصر العربية. تم زراعة جميع التجارب فى تصميم القطاعات كاملة العشوائية مع استخدام اربع مكررات. تم تقدير الثبات فى محصول الحبوب، وزن 1000- حبة ، ارتفاع النبات و عدد الأيام حتى تزهير 50% من النباتات باستخدام طريقة Tai . اظهر التحليل المشترك اختلافات معنوية بين التراكيب الوراثية وايضا المواقع لجميع الصفات محل الدراسة ، كما أظهر ايضا عدم وجود تأثير أو اختلاف معنوى بين السنوات لجميع الصفات المدروسة باستثناء وزن 1000-حبة. كان تاثير المواقع بالنسبة لصفة المحصول والصفات الأخرى محل الدراسة أكبر من تأثير السنوات مما يشير الى ان اجراء اختبار الثبات فى مواقع مختلفة عديدة اكثراهمية من اختباره لعدة سنوات. اظهر التفاعل بين التراكيب الوراثية والمواقع اختلافات معنوية مما يشير الى اختلاف استجابة التراكيب الوراثية المختبرة من الذرة الرفيعة للظروف البيئية من موقع لآخر. استنادا الى تحليل الثبات بطريقة Tai نجد أن هناك ثلاث تراكيب وراثية وهى (ASH-8 x ICSR-93002)، (ASH-9 x ICSR-93002) و (ASH-12 x ICSR-93002) كانت الاكثر ثباتا بالاضافة لاعطاء محصول عالى من الحبوب مقارنة بالمتوسط العام للعشرة تراكيب وراثية المختبرة فى هذه الدراسة. وبشكل عام فان طريقة Tai تساعد بسهولة فى التعرف على التراكيب الوراثية المتفوقة والأكثر ثباتا مما يساعد على دعم اتخاذ القرار فى اختيار التراكيب الوراثية من الذرة الرفيعة عند تقييمها فى بيئات مختلفة.