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Stability analysis for seed yield and its component characters in groundnut (*Arachis hypogaea* L.)

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Abstract
Nine advance breeding lines of groundnut developed at agricultural research station, Kadiri were evaluated along with six agronomically adopted varieties dharani, k-6, k-9, Kadiri Amaravathi, Kadiri Anantha, Kadiri Harithandra in randomized block design with three replications to study the Genotype x environment interaction for grain yield and their component characters under three environments during *kharif* 2017, *kharif* 2018 and *kharif* 2019. The environment + (genotype x environment) was significant for all the characters indicating distinct nature of environments genotype x environment interactions in phenotypic expression. The genotype x environment (linear) interaction component showed significance for all the characters studied except days to 50% flowering and dry haulm weight. This indicated significant differences among the genotypes for linear response to environments (b_i) behaviour of the genotypes could be predicted over environments more precisely and GXE interaction was outcome of the linear function of environmental components. Based on stability parameters and over all mean, two genotypes *viz.,* K2348 and K2353 were stable in performance for yield and yield parameters over the environments.

Keywords: Stability analysis, genotype x environment interaction and groundnut

Introduction

Groundnut is the second most important edible oil seed crop after rice in Andhra Pradesh in terms of acreage and economy. It is being cultivated in 8.74 lakh ha with a production of 4.93 lakh tonnes. However, there are great fluctuations in its annual production both the regions and years. One of the reasons for this seems to be the sensitive behaviour of the available varieties to variable environmental growing conditions. Thus, there is an urgent need to breed varieties which perform consistently over environments and possess high level of kernel and pod yield. Yield is a complex quantitative character and is greatly influenced by environmental fluctuations; hence, the selection for superior genotypes based on yield *per se* at a single location in a year may not be very effective. Thus, evaluation of genotypes for stability of performance under varying environmental conditions for yield has become an essential part of any breeding programme. An understanding of the causes of genotype x environment interaction can help in identifying traits and environments for better cultivar evaluation.

Finlay and Wilkinson (1963) [6] suggested linear regression as a measure of stability. Eberhart and Russell (1966) [5] emphasised that both linear (b,) and non-linear (S^2_{di}) components of the genotype-environment interaction should be considered while judging the phenotypic stability of a genotype. They further suggested that an ideal variety should have high mean, linear regression and a S^2_d as small as possible. Paroda and Hayes (1971) [9] observed that the linear regression should simply be considered as a measure of response of a genotype, whereas, the deviations around the regression line is a measure of stability. They also pointed out that a genotype with the lowest deviation may be the most stable and *viceversa.*

In the present investigation, an attempt has been made to evaluate Nine advance breeding lines of groundnut along with six agronomically adopted varieties dharani, k-6, k-9, kadiri Amaravathi, Kadiri Anantha, Kadiri Harithandra for their level and stability of performance for pod and kernel yield at Agricultural Research Station, Kadiri by using Eberhart and Russell model.

Materials and Methods

The experimental material for the present investigation consisted of Nine advance breeding lines of groundnut *viz.,* K2346, K2347, K2348, K2349, K2350, K2351, K2352, K2353, K2354with six agronomically adopted varieties dharani, k-6, k-9, Kadiri amaravathi, Kadiri

Anantha, Kadiri Harithandra. At each environment these materials were evaluated in randomized block design with three replications during *kharif* 2017 (E1), *kharif* 2018 (E2) and *kharif* 2019(E3).The material was sown in a plot size consisted of 7 rows of 5m length with a spacing of 30 × 10cm. The observations were recorded for days to 50% flowering, shelling %, dry pod yield, kernel yield, 100 kernel weight, sound mature kernel % and dry haulm weight. Analysis of variance was carried out as per the method suggested by Panse and Sukhatme (1979). Statistical constants of mean for all the characters were estimated by Eberhart and Russell (1966) [5] model.

Results and Discussion

Pooled analysis of variance (Table1) showed that Mean squares due to environment (linear) was found significant for most of the characters, indicating differences between environments and their influence on genotypes for expression of these characters. The environment + (genotype x environment) was significant for all the characters indicating distinct nature of environments and genotype x environment interactions in phenotypic expression. The genotype x environment (linear) interaction component showed significance for all the characters studied except days to 50% flowering and dry haulm weight. This indicated significant differences among the genotypes for linear response to environments ($b_{i)}$ behaviour of the genotypes could be predicted over environments more precisely and G X E interaction was outcome of the linear function of environmental components. Hence, prediction of performance of genotypes based on stability parameters would be feasible and reliable. The existence of G x E interaction for pod yield and its component characters have also been reported by Bentur *et al.* (2004) [1] and Prakash Kumar *et al.* (1984) [10] and Deshmukh (2007) for shelling percentage.

Eberhart and Russell (1966) [5] defined a stable genotype as the one which showed high mean yield, regression co-efficient (b_i) around unity and deviation from regression near to zero. Based on this model the phenotypic stability of the genotypes was measured by three parameters, viz., mean performance over environments, the linear regression, and the deviations from regression function.

Accordingly, the mean (table 2) and deviation from regression (table 3) of each genotype were considered for stability and linear regression was used for testing the varietal response. Genotypes with high mean, $b_i = 1$ with non significant S^2d are suitable for general adaptation, *i.e.*, suitable over all environmental conditions and they are considered as stable genotypes. Genotypes with high mean, $b_i > 1$ with non significant S^2d are considered as below average in stability. Such genotypes tend to respond favorably to better environments but give poor yield in un favourable environments. Hence, they are suitable for favourable environments. Genotypes with low mean, $b_i < 1$ with non significant S^2d do not respond favourably to improved environmental conditions and hence, it could be regarded as specifically adapted to poor environments. Genotypes with any b_i value with significant S^2d are unstable

Out of the Fifteen genotypes under study varieties dharani, k-6 for days to 50% flowering; K2348 for shelling %; K2347 and K2352 for dry haulm weight; K2349 for sound mature kernel %; K2348 and K2353 for dry pod yield had values near to unit regression (Table 3). Hence, these genotypes are suitable for overall environmental conditions and they are considered as stable genotypes. Therefore, these genotypes were stable for grain yield in all the Chavan *et al.* (2009) [2].

The development varieties having high yield, stability and average response is of immense value. A perusal of stability parameters for dry pod yield indicated that out of nine genotypes, K2348 and K2353 registered higher grain yield and showed significant bi value. Therefore, these genotypes were stable for grain yield in all the environments. Similar findings were reported by Chavan *et al.* (2009) [2].

The genotypes K2354 for days to 50% flowering; K2349 for shelling %; K2349 and K2354 for dry haulm weight; dharani for sound mature kernel %; K2351 for 100 kernel weight; K2347, K2351and K2351for dry pod yield; K2353 for kernel yield had the regression value significantly more than one ($b_i > 1$) and showed non-significant deviation from regression (Table 3). Hence, these genotypes were found to be suitable for favourable environments and there is yield reduction in the unfavourable environments. Similar results were observed by Viswanathan *et al.*, (2008).

The genotypes K2353 for dry haulm weight; K2351 for sound mature kernel %; K2352 for100 kernel weight; K2349 for dry pod yield;K2348, K2349 for kernel yield had the regression value below one ($b_i < 1$) and were found to be suited for unfavourable / poor environments. These results were in accordance with by Bhakta and Das (2008) [3]

It is concluded from the present study that Based on stability parameters and over all mean, two genotypes *viz.*, K2348 and K2353 were stable in performance for yield and yield parameters over the environments.

Table 1: ANOVA for stability (Eberhart and Russell model) for different quantitative characters.

Source of variation	d.f	Mean sum of square						
		DFF	**S%**	**100 KW**	**SMK**	**PY**	**KY**	**DHW**
Rep within Env.	6	4.11**	5.16**	6.21**	4.23**	25904.21**	3935.23**	12874.05**
Genotype	14	9.50**	24.28**	101.32**	6.79**	315599.63**	177275.99**	493171.90**
Environment+ (G x E)	30	5.36**	2.67**	12.66**	2.05**	25803.86**	17155.97**	61177.65**
Environments	2	60.95**	9.25**	18.19**	2.83**	164868.92**	46921.06**	110945.90**
Var.* Env.	28	1.39**	2.20**	12.27**	2.00**	15870.64**	15029.90**	57622.78**
Environment (linear)	1	121.91**	18.50**	36.39**	5.66**	329737.84**	93842.12**	221891.81**
Genotype x Envt. (linear)	14	1.68	3.54**	18.48**	2.22**	20844.21**	23693.94**	69274.61
Pooled deviation (non linear)	15	1.03**	0.80**	5.65**	1.66**	10170.60**	5941.46**	42906.21**
Pooled Error	84	0.19**	0.91**	3.24**	1.14**	8881.98**	2573.48**	6164.26**
Total	44	6.68	9.55	40.87	3.56	1180.00	68103.25	198630.37

* Significant at 5% level ** Significant at 1% level

Table 2: Mean performance of Grain yield along with stability parameters in advance breeding lines of Groundnut.

Genotype	Mean Pod yield			
	kharif 2017	*kharif* 2018	*kharif* 2019	Pooled Mean
K2346	962	1493	1450	1302
K2347	1562	1720	1667	1650
K2348	1827	1877	2067	1924
K2349	1553	1726	1917	1732
K2350	1803	1777	1550	1710
K2351	1677	1723	1733	1711
K2352	1813	1737	1900	1817
K2353	1450	1643	1600	1564
K2354	1150	1480	1517	1382
Dharani	822	1267	1333	1141
K-6	730	767	1017	838
K-9	1455	1487	1540	1494
Amaravathi	1180	1207	1500	1296
Anantha	905	905	1200	1003
Harithandra	1070	1153	1070	1098
Mean	1330.6	1464.133	1537.4	1444.133

Table 3: Mean and Stability Parameters of advance breeding lines of groundnut

Genotypes	DF			S%			100 KW			SMK			PY			KY			DHW		
	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d	Mean (μ)	βi	S^2d
K2346	32.222	1.19	4.19	72.667	0.70	-0.91	36.556	0.35	-3.44	93.111	3.03	-1.18	1301	2.56	20255	898.222	2.81	4213.25	1331.778	0.44	-2767
K2347	32.889	1.15	-0.25	74.889	3.03	-0.93	39.111	2.21	-1.86	92.222	2.33	-1.32	1649	0.59	-4701	1212.222	-0.37	-1330	2201.667	-0.88	72232
K2348	33.889	1.31	-0.14	74.778	0.90	-0.14	53.667	-0.27	-3.41	93.333	2.10	1.65	1923	1.07	-2968	1427.556	1.96	5922	2164.444	5.43	4084
K2349	33.889	1.31	-0.14	75.222	0.84	-1.10	47.000	-0.19	-1.98	93.889	1.23	-0.96	1731	1.70	-7507	1282.000	1.89	-2242	1877.667	0.52	26752
K2350	34.444	0.53	-0.41	71.444	4.75	-0.26	57.444	-3.75	19.53	91.778	1.63	4.38	1710	-1.10	2130	1248.222	-3.37	-1004	1940.222	2.96	9463
K2351	33.667	1.24	-0.31	72.778	-0.80	-0.59	53.667	0.25	-3.37	94.222	1.33	0.73	1711	0.28	-9951	1264.000	-0.11	-2540	2084.444	2.89	54921
K2352	32.778	0.85	-0.46	70.667	1.74	0.61	47.667	-1.54	23.48	90.000	-1.96	-1.25	1816	0.30	1386	1229.778	-1.55	-2447	2194.000	1.06	49717
K2353	32.556	0.78	-0.42	69.778	-0.14	-1.15	41.000	1.90	9.39	90.111	4.75	-0.03	1564	0.81	-4021	1106.333	0.36	15770	1989.667	1.67	-3855
K2354	30.778	0.58	-0.40	70.000	0.77	-1.04	47.889	2.13	-2.42	92.111	-3.90	6.32	1382	1.86	-4374	942.222	2.37	6019	1858.333	0.48	112063
Dharani	29.556	0.89	-0.16	78.444	-1.04	4.87	42.333	1.73	0.18	94.444	-0.70	-1.01	1140	2.58	-1489	885.222	3.78	-230.20	1177.667	0.00	8325
k-6	30.333	0.93	0.70	75.444	2.41	-0.71	44.111	-1.34	-2.15	94.556	3.66	1.00	837	1.25	4260.71	569.333	1.71	752.19	1165.444	-0.15	-4494
k-9	31.000	1.70	4.63	79.111	2.83	-1.20	42.667	1.02	-3.06	94.889	-1.50	-1.23	1493.889	0.39	-9668	1163.444	0.52	5917	1534.889	3.93	-6189
Amaravathi	31.000	1.80	1.38	70.889	0.84	-1.10	47.667	2.17	8.01	92.333	-1.29	0.02	1295.556	1.38	10970	912.222	3.34	9281.61	2125.889	-3.53	220142
Anantha	29.889	0.67	-0.43	74.000	-1.08	-1.09	42.000	8.90	-2.82	93.222	3.52	-1.08	1003.333	1.25	13498	735.667	2.05	-589.03	1180.000	0.64	-3120
Harithandra	28.778	0.08	0.90	74.333	-0.73	-1.20	42.889	1.45	-2.89	92.000	0.77	-1.35	1097.778	0.08	-5514	803.333	-0.42	1665.77	1377.778	-0.46	7146
Population Mean	31.844			73.630			45.711			92.815			1443.978			1045.318			1746.926		

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