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Selection of Stable Groundnut Genotypes (*Arachis hypogaea*) for Manipur Valley Condition

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A B S T R A C T

Stability analysis in groundnut (*Arachis hypogaea*) for thirteen promising genotypes was conducted during *kharif* 2009-10 for estimation of stability parameters with respect to pod yield and its components in five different environments of Manipur valley. Analysis of variance revealed that there were significant differences among the genotypes for all the characters under study. The study of stability parameters in the present investigation revealed that among the environments, the E-1 (Thamnapokpi) was the best yield and its components while the E-5 environment (Iroisemba) was the lowest for yield and its component. The better genotype for the phenotypic stability of pod yield and its component were found to be M 335(NC) and it could be recommended for general cultivation over a wide environmental condition in Manipur valley. The better genotypes under favourable environments for yield and its components were found to be Kaushal and CSMG 03-07 and they could be recommended for cultivation under suitable soil condition and high input management. Under unfavourable environment, the better performing genotype was found to be HNG 123 and ICGS 76 and therefore, it could be recommended for cultivation under poor/low management conditions.

Introduction

Groundnut (*Arachis hypogaea*, 2n = 40) is an annual, soil-enriching, nitrogen-fixing legume, adapted to a wide diversity of soils and temperature around the world. Every part of the plant is used for food, feed or agribusiness. Groundnut is a very recent introduction in the North Eastern region. This crop has the potential for expansion of area about 65,000 ha in major states of the North Eastern region. Groundnut rank's 1st among the oilseed crop of India constituting about 59% of the total oilseed production. In India, about 80% (6 million ha) of total groundnut area is confined to Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka, and Maharashtra with 84% (6 million tonnes) of total production (Anonymous, 2008). It is largely grown in rainfed marginal lands which are inferior in quality and fertility. The irrigation facilities are available to about 20% of the area under this crop. The average yield is about one ton/ha which is very low as compared with a much higher yield in other countries. Thus the most important goals of crop improvement

programme not only a high yield, biotic and abiotic stress tolerant cultivars, but also wide adaptability and stability (Hamdi *et al.,* 2002; Dehghani *et al.*, 2008; Gautam *et al.,* 1984) also suggested that the selection of stable genotype was the most popular approach to minimize G X E interactions. Stability of crops reflects the suitability of a variety for general cultivation over a wide range of environments or location specific environments or location specific environments. The development of genotypes, which can be adapted to a wide range of diversified environment, is the ultimate goal of plant breeders in a crop improvement programme.

Materials and Methods

In the present experiment thirteen (13) Virginia genotypes of groundnut viz., JSP 45, JSP 46, CSMG 03-07, K 1340-1, K 1341-1, AK 302, RG 430, RG 411, HNG 123, Kaushal (National Check), M 335 (National Check), ICGS 76 (Zonal Check), BAU 13 (Zonal Check) were conducted in a randomized block design with three replications in five different locations *viz*., Thamnapokpi (E-1), Lamsang (E-2), Andro (E-3), Kongpal Top Khongkhong (E-4) and Iroisemba (E-5). Each genotype was grown in a raised bed plot having4 rows of 3 m length with a spacing of 45 cm row to row and 15 cm plant to plant. The recommended package of practices was followed with the application @ 20 kg N, 60 kg P and 40 kg K per hectare at the time of field preparation. The lime application at the recommended dose of 300 kg/ha was also applied as side placement at the time of pegging (35-40 days after sowing) due to acidic nature of the soil. Five competitive plants at random were taken from each plot in each replication under each environment to record the data/observations on 11 characters *viz.* Days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, number of secondary branches per plant, number of mature pods per plant, pod yield per plant (g), 100 kernel weight (g), shelling (%), oil (%) and harvest index. The days of 50% flowering and days to maturity were recorded on plot basis by visual observations. Oil content in seed was determined by Soxhlet extraction methods as described by AOAC (1980).

$$\text{Oil percent} = \frac{W_2 - W_1}{X} \times 100$$

Where,

W_1 = weight of the empty flask
W_2 = weight of the flask + weight of oil
X = weight of the sample taken for extraction

The root sample and above ground samples were oven dried at 80^0 C until constant weight is reached. After oven drying, root dry weight and shoot dry weight were recorded. Harvest index was calculated using the following relationship (Wright and Nageswara Rao, 1994).

$$\text{Harvest Index} = \frac{Podyield}{Podyield + s\square ootandrootdryweig\square t}$$

The mean values for the different characters were used for statistical analysis. After testing the homogeneity of the error variances by using Barlett's test (Gomez and Gomez, 1984) and having satisfied the homogeneity of variance for all the environments were performed.

After obtaining significance of variance ratio due to GXE interaction, the data were analysed according to the stability model as suggested by Eberhart and Russell (1966). In this model, the regression coefficient, bi and the deviation from the regression mean squares (S^2di) were considered as parameters of response and stability, respectively.

According to Eberhart and Russell the analysis of variance for the stability model was as follows:

Results and Discussion

Environment wise analysis of variance

The environment wise analysis of variance for different characters was presented in Table 1. It was evident from the environment wise analysis of variance that the variance ratios due to all genotype for all the characters in all the environments were highly significant. Barlett's test of homogeneity of variances of all environments for all the characters revealed the homogeneity of error variances.

Pooled analysis of variance

Character-wise pooled analysis of variance was presented in Table 2. The character wise pooled analysis of variance revealed that variance ratios due to genotypes for all the characters were found to be significant. Variance ratios due to genotype x environment interaction for all the characters, except plant height and harvest index were significant.

Analysis of variance for stability

Pooled ANOVA for the stability of different characters (Eberhart and Russell, 1966) are given in Table 3. Both genotypic differences pooled over environments were significant for most of the characters except harvest index. Similarly, environment linear component was also significant for all the traits except harvest index. Both G x E (linear and tested against pooled deviation) and pooled deviation (nonlinear portion of variance and tested against pooled error) was significant for all the characters except days to 50% flowering, days to maturity, primary branches per plant and harvest index whereas oil (%) showed significant interaction only for G x E (linear). Almost all the thirteen genotypes except few as subcomponent of pooled deviation tested against pooled error were significant for the entire component except for days to 50% flowering, days to maturity, primary branches per plant, harvest index and oil (%).

Analysis of variance

The environment wise analysis of variance revealed that there were significant differences among genotypes for all the characters in all the environments. The significance of variance due to genotypes indicated that the performances of genotypes for all the characters studied were different from one another. The homogeneity of variances for different experiments further permitted pooled analysis of variance over environments. It was evident from the pooled that there were significant mean sums of squares due to genotypes for all the characters indicating that there were real differences all the characters among the 13 genotypes tested. Highly significant mean sums of squares due to the environment in the pooled analysis of variance indicated that there was a real difference between the environments. The significance of genotype x environment interaction for all the characters except plant height and harvest index also proved that existence of genotype and environment differences governing the expression of these traits and the significant contribution of G x E interaction in influencing the performance of genotypes. Significant variances due to genotype x environment interaction either for pod yield or along with its important components were also observed by Reddy *et al.*, (1995), Chuni Lal *et al.*, (1998), Venkataraman *et al.*, (2000) and Mothilal *et al.*, (2010) in groundnut. The non-significance of genotype x environment interaction for pod yield per plant, days to 50% flowering, days to maturity indicated that the environments had no influence on the performance of these characters.

Analysis of variance for phenotypic stability

The pooled analysis of variance indicated significant variation due to the environment (linear) for all the characters except harvest index revealing considerable additive environment variance. Further, the significance of G x E (linear) component and pooled deviation was significant for plant height, secondary branches per plant, number of mature pods per plant, pod yield per plant, 100 kernel weight and shelling percentage indicating that some genotypes showed linear effects over environments, while others showed significant deviation from linear relationship. The significance of both G x E (linear) and non-linear component was also observed for secondary branches per plant and pod yield per plant by Moinuddin *et al.*, (1998) and for pod yield per plant by Kadam *et al.*, (2001). It was further revealed that the prediction of stability would be difficult for those characters having non-significant G x E (linear). Therefore, the prediction of stability for days to 50% flowering, days to maturity, primary branches per plant and harvest index were difficult. However, even for the unpredictable factors, prediction can be made if one considers the stability performance of individual genotype.

Phenotypic stability for different characters in groundnut

The mechanism behind the phenotypic stability of genotypes is homeostasis. Two kinds of homeostasis mechanism have been assumed:

Developmental homeostasis and
Genetic homeostasis

Source	d.f.	SS	MS
Total	Nv-1	$\sum_i \sum_j Yij2 - C.F.$	
Varieties (V)	v-1	$\frac{1}{2} \sum_i Yi2 - C.F$	
Environment (Env) + V x Env	v (n-1)	$\sum_i \sum_j Yij2 - \sum Yi2/n$	
Env (linear)	1	$1/v [\sum_j Y.jIj]2/\sum_j Ij2$	
V x Env (linear)	v-1	$\sum_i [(\sum_j YijIj)2/\sum_j I2] - Env (linear)SS$	
Pooled deviation	V (n-2)	$\sum_i \sum_j \delta ij2$	
Variety 1	n-2	$[\sum_j Y1j2 - Y12/n] - (\sum_j Y1j Ij)2/\sum_j Ij2$	
Variety v	n-2	$[\sum_j Yvj2 - Yv2/n] - (\sum_j YvjIj)2/\sum_j Ij2/\sum_i Ij2 = \sum_j \delta vj2$	
Pooled error	n (r-1) (v-1)		

In this model the significance of differences among variety means
H_0: $\mu_1 = \mu_2 = \ldots\ldots\ldots = \mu_V$ - can be tested approximately by F test,

Table.1 Analysis of variance (mean squares) for different characters in five different environments

Source of variation	d.f.	50% flowering	Days to maturity	Plant height	Primary branches	Secondary branches	No. of mature pods per plant	Pod yield per plant	100 kernel weight	Oil (%)	Shelling %	Harvest index
E-1												
Replication	2	0.53	8.61	12.82	0.39	13.43	5.51	11.76	3.42	6.01	6.92	0.0014
Genotypes	12	10.84	20.65	37.21	2.43	35.34	31.44	71.83	63.48	24.44	82.69	0.0039
Error	24	0.64	3.00	5.19	1.40	8.17	6.13	9.84	5.05	3.39	4.39	0.0012
E-2												
Replication	2	0.02	6.64	60.77	1.62	8.98	19.57	28.39	5.34	2.49	2.41	0.0012
Genotypes	12	9.03	43.75	71.77	2.99	21.06	30.69	46.02	187.35	16.37	66.23	0.0027
Error	24	0.55	3.72	6.65	0.99	4.47	2.98	9.47	2.89	4.87	5.77	0.0017
E-3												
Replication	2	0.07	1.00	5.32	0.13	0.21	1.83	42.02	22.81	0.12	7.61	0.0026
Genotypes	12	5.92	42.23	51.86	1.83	6.67	3.55	18.10	109.45	17.19	60.89	0.0044
Error	24	0.49	5.33	4.82	0.83	1.17	0.98	2.69	6.44	7.70	4.08	0.0010
E-4												
Replication	2	26.38	10.33	57.52	0.54	11.19	11.15	5.68	8.62	2.78	1.92	0.0007
Genotypes	12	5.02	17.52	62.92	2.82	24.51	27.31	122.05	158.17	16.51	137.93	0.0145
Error	24	0.85	4.02	8.61	0.45	2.36	1.47	10.72	4.45	5.49	7.18	0.0007
E-5												
Replication	2	0.23	1.94	2.00	0.21	4.56	1.84	34.68	0.52	34.40	9.45	0.0011
Genotypes	12	11.61	25.73	106.39	1.16	20.74	19.76	99.81	123.13	23.67	79.38	0.0155
Error	24	0.53	0.69	4.73	0.57	2.64	2.30	8.16	5.77	3.33	5.19	0.0007

Table.2 Character-wise pooled analysis of variance (mean squares) over all the environments for different characters in Groundnut

Source of variation	d.f.	50% flowering	Days to maturity	Plant height	Primary branches	Secondary branches	No. of mature pods per plant	Pod yield per plant	100 kernel weight	Oil (%)	Shelling %	Harvest index
Genotype (G)	12	27.53	114.40	82.35	6.22	47.77	39.34	49.77	397.92	75.42	254.63	0.01
Environment (Env.)	4	30.20	23.45	6610.30	12.32	654.15	415.86	1047.56	413.26	57.91	26.58	0.02
G x Env.	48	3.72	8.87	61.95	1.25	15.28	18.36	77.01	60.96	5.69	43.12	0.007
Pooled error	130	0.98	3.53	7.67	0.83	4.06	3.17	9.43	5.17	5.28	5.34	0.001

Table.3 Analysis of variance (mean squares) for different characters in groundnut (Eberhart and Russell, 1966)

Source of variation	d.f.	Days to 50% flowering	Days to maturity	Plant height	Primary branches per plant	Secondary branches per plant	No. of mature pods per plant	Pod yield per plant	100 kernel weight	Oil (%)	Shelling (%)	Harvest index
Genotypes	12	9.17**	38.13**	27.45**	2.07*	15.92**	13.11**	16.59**	132.64**	25.14**	84.87**	0.004
Env. +(G x E)	52	1.92*	3.33**	188.55**	0.70	21.47**	16.31**	50.55**	29.35**	3.23**	13.95**	0.002
Env. (linear)	1	40.27**	31.27**	8813.74**	16.42**	872.21**	554.48**	1396.75**	551.02**	77.22**	35.44**	0.026
G x E (linear)	12	0.78	3.87	25.92**	0.39	7.52**	1.95*	8.67**	11.83**	4.05**	9.71**	0.004
Pooled deviation	39	1.28	2.44	17.43**	0.39	3.95**	6.93**	28.92**	21.37**	1.08	14.70**	0.001
Genotype 1 (JSP 45)	3	0.49	1.51	16.70**	0.43	4.76**	9.78**	39.20**	74.71**	1.71*	23.73**	0.003
Genotype 2 (JSP 46)	3	0.19	6.39**	25.07**	0.58	0.47	2.25*	5.29**	8.50**	1.29	32.28**	0.0006
Genotype 3 (CSMG 03-07)	3	1.47	3.72**	45.90**	0.09	3.13**	6.42**	21.87**	10.25**	0.39	4.75**	0.001
Genotype 4 (K 1340-1)	3	1.44	1.58	13.10**	0.04	1.08	2.06*	82.55**	3.84**	0.75	4.62**	0.001
Genotype 5 (K 1341-1)	3	0.67	2.66**	6.21**	0.43	1.19	1.34	20.59**	15.72**	1.48	7.11**	0.002
Genotype 6 (AK 302)	3	0.58	0.90	1.11	0.83	1.80*	1.26	52.80**	0.55	1.92*	39.89**	0.002
Genotype 7 (RG 430)	3	2.22*	3.41**	10.92**	0.05	9.11**	14.07**	2.88**	15.03**	0.49	8.02**	0.0007
Genotype 8 (RG 411)	3	0.70	2.33*	15.39**	0.05	1.03	19.73**	11.33**	5.69**	1.41	4.91**	0.0002
Genotype 9 (HNG 123)	3	0.60	2.46**	20.53**	0.17	4.06**	6.35**	14.08**	14.74**	0.43	5.56**	0.002
Genotype10 (Kaushal) #	3	2.47**	0.43	18.63**	0.55	5.84**	4.40**	23.74**	1.24	0.51	5.48**	0.002
Genotype11 (M 335)#	3	2.09*	1.22	26.05**	0.88	0.76	1.09	50.13**	47.38**	0.06	41.41**	0.002
Genotype12 (ICGS 76)#	3	1.23	4.94**	5.67**	0.82	13.20**	3.86**	27.19**	9.49**	1.98*	6.24**	0.0001
Genotype 13 (BAU 13)#	3	2.60**	0.19	21.37**	0.16	4.94**	17.16**	24.32**	70.64**	0.63	7.07**	0.001
Pooled error	130	0.32	1.17	2.55	0.27	1.35	1.05	3.14	1.72	1.76	1.78	0.0004

*, ** bi and S^2di values significantly deviated from 0 at 5% and 1% levels respectively.

Developmental homeostasis and genetic homeostasis are also referred to as individual buffering and population buffering respectively (Allard and Bradshaw, 1964).

The stability present in the present genotypes may be due to the developmental homeostasis, as groundnut is a self-pollinated crop. Any generalization regarding the stability of a cultivar for all the characters is too difficult (Singh and Singh, 1980). Although there are a number of models available to characterize the genotypes for their G x E interactions, but Eberhart and Russell (1966) model is widely used for its simplicity and reliability. An ideal genotype is defined as the one possessing high mean performance, with a regression coefficient around unity (bi =1) and deviation from regression (S^2di) close to zero. The linear regression is regarded as the measure of the linear response of a particular genotype to the changing environment. If the regression coefficient (bi) is greater than unity, the genotype is said to be highly sensitive to environmental fluctuations but adapted to high yielding environments. If the regression coefficient (bi) is equal to unity, it indicates the average sensitivity to environmental fluctuations and adaptable to all environments.

If the regression coefficient (bi) is less than unity, it indicates less sensitivity to environmental changes and if this is accomplished by a high mean value, then the genotype is said to be better adapted for poor conditions.

In the present study stability parameters such as mean (x), regression coefficient (bi) and deviation from regression (S^2di), as suggested by Eberhart and Russell (1966) were considered to explain and discuss the stability of different genotypes for various characters under consideration.

The significant differences between genotypes in environment wise analysis of variance for all the characters showed the existence of variability among the genotypes under study. Significant genotypic mean sums of squares in environment wise analysis of variance permitted to test the homogeneity of error variance by using Barlett's test of homogeneity. The homogeneity test also permitted to carry out a pooled analysis of variance over all the environments. The significance of genotype x environment interaction for all the characters except plant height and harvest index suggesting that genotypes interacted significantly with the environments. Further, the significance of G x E (linear) component and pooled deviation was significant for plant height, secondary branches per plant, number of mature pods per plant, pod yield per plant, 100 kernel weight and shelling percentage indicating that some genotypes showed linear effects over environments, while others showed significant deviation from linear relationship.

Among the environments, the E-1 (Thamnapokpi, Imphal West) was the best for yield and its components while the E-5 was poor for yield and its component. On the basis of stability parameters for individual genotypes, the most stable genotype for different characters were K 1340-1 for days to 50% flowering; JSP-45 and CSMG 03-07 for days to pod maturity; M 335 for primary branches per plant; RG-430 and JSP-45 for number of mature pods per plant; M 335 for pod yield per plant; ICGS 76 for oil percentage; Kaushal and ICGS 76 for shelling percentage, and HNG 123 and M 335 for harvest index. None of the genotypes was found stable for short plant height, secondary branches per plant and 100 kernel weight. The genotype M 335 was found to be stable across the environments pod yield per plant along with for primary branches per plant and harvest index, while ICGS 76 was also found

to be stable for high oil content and shelling percentage. Among the genotypes studied, the best performing genotypes under favourable environments were Kaushal and CSMG 03-07, while HNG 123 and ICGS 76 could be considered as better performing genotype under unfavourable environments.

However, a rigorous testing under varying environments/locations is further needed to generate more information on this aspect before a genotype is recommended for its commercial cultivation. After thorough and multilocation testing, they may be used as commercial variety as such or may be taken to breeding programme aiming towards developing suitable breeding materials with better stability.

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