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Stability Analysis in Green gram (*Vigna radiata* (L.) Wilczek) for Agro-morphological traits

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Abstract: Twenty-five genotypes of green gram (*Vigna radiata*) representing diversity in adaptability and variability in characters were assessedwith 3 replicationsin Randomized Block Design (RBD). Environment wise data on each character for all the genotypes had been subjected pooled analysis of variance and stability of genotype had been evaluatedby virtue of mean (x), regression coefficient (b) and deviation from the regression (S^2d). The pooled analysis of variance (ANOVA) showed significant differences among genotypes for the agro-morphological characters. Varieties *viz*., ML 24-59,PUSA M-1972 had low mean,regression coefficient (b_i) close to 1 and lowest deviations from regression (S^2d_i) andgenotypes *viz*., JLPM 504-20, DGGV 80, IGKM 05-18-02 were suitable for better environment and genotypes, *viz*., IPM 02-03, MH 1703, ML 2482, Pusa-BM-5 and PUSA M-1971 were suitable for poor environment for days to 50% flowering.For days to maturity,varieties *viz*.,IPM 312-394-1, DGGV 80, VGG 17-04, MH 1421 were most stable performer andPusa-BM-5, MH 2-15, BGG 17-043 were suitable for better environment.Varieties *viz*., PUSA M-197, PM 16-23, IPM 02-03, IPM 312-394-1, PM 1618, IGKM 06-10-7 were most stable.PUSA M-1971,MGG 389 weresuitable for better environment and IPMD 14-10, VGG 17-04 were suitable for poor environment for plant height.For number of branches varieties *viz*., MGG 389, NDMK 17-07, IGKM 06-10-7, PM 1618,ML 24-59, ML 2482, DGGV 80 were most stable andIPM 312-394-1,JLPM 504-20 weresuitable for better environment andIPM 14-49-5,OBGG 103were suitable for poor environment.

Keywords*:* Green gram, stability, ANOVA, agro-morphological traits, environment

INTRODUCTION

Green gram (*Vigna radiata* (L.) Wilczek), a self-pollinating crop with a chromosome number 2n=2x=22, belongs to family *Leguminaceae,* subfamily *Papilionoideae* and native to India. It is also called as, mung, moong and mung bean in India (Morton *et al*., 1982). Green gram grown round the year in multiple cropping systems because ofbroader adaptability and small duration. Green gram is an important legume crop due to its small growth period, little water demand and soil fertility and it is advised for consumption due to its easy digestibility (Shil and Bandopadhya, 2007).

Green gramis good source of antioxidants like phenolic acids, flavonoids, caffeic acid, cinnamic acid, etc. which lessen risk of incurable diseases, cancers, heart disease and diabetes (Baraki*et al*., 2020).Green gramcould be eaten as whole seed or converted into flours, soup material, snacks base, noodles as well as ice cream. Split seeds can be changed into dal and sprouted seeds are enjoyed raw and cooked. Sometimes green gram grown for fodder and straw also. India is major country in green gram cultivation up to 50% of total world production and 60% of total world acreage (Rishi, 2009 and Singh *et al*., 2013).

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Because of the occurrence of genotype x environment interaction (GEI), identification of stable and high yielding varieties of green gram is difficult under different environments. Occurrence of significant GEI is greatly possible in such widely variable environments. Occurrence of such significant genotype x environment interaction in plant breeding is an opportunity as well asconfront for plant breeding community (Baraki*et al*., 2014). Stability analysis has enough utility in identification of adaptable genotypes and in forecasting the responses of genotypes over variable environments to select genotypes suitable for better or poor environment.

MATERIAL AND METHODS

The experimental material for study comprises of twenty-five genotypes of green gram (*Vigna radiata*) representing diversity in adaptability and variability in characters. The experiment was conducted during the *kharif*, 2020 in three environments (E_1, E_2 and E_3) by keeping 15 days intervals between the dates of sowing. Each genotype was planted in a plot size of 3.0 x 0.3m^2 in each environment and each replication.The spacing was maintained as 30 cm between row to row and 10 cm between plant to plant. The field experiment was carried out in Randomized Block Design with three replications at the Research Farm, S. K. N. College of Agriculture, Jobner, Jaipur. Observations were recorded on agro-morphological characters *viz*., days to 50% flowering, days to maturity, plant height (cm), branches per plant. The environment wise data on each character for all the genotypes had been subjected pooled analysis of variance (Singh and Choudhary, 1985).The data had also been subjected to the stability of genotype had been judged on the basis of mean (x), regression coefficient (b) and deviation from the regression (S^2d) Eberhart and Russell (1966) model.

RESULTS AND DISCUSSION

The pooled analysis of variance showed highly significant differences among genotypes for all the agro-morphological characters *viz*., days to 50% flowering, days to maturity, plant height (cm), branches per plant. The environmental effects were highly significant as well Genotype x environment (G x E) interactions were significant for all the agro-morphological characters. Several earlier workers have also reported similar results *viz*., Sultana *et al*. 2001; Dhuppe *et al*. 2005 and Thippani *et al*. 2013. It specifies the differential influence of environment on the genotypes in respect of all the agro-morphological characters (Table 1).

Stability Analysis

The stability parameters of different genotypes were calculated for different traits. Days to 50% flowering is the character for which a variety which flower earlier is desirable. After analyzing mean value and stability parameters it has been found that varieties *viz*., ML 24-59($\bar{x}$ =40.33, b_i=0.98 and S^2_{di}= -0.96), PUSA M-1972 ($\bar{x}$=40.00, b_i=1.13 and S^2_{di}= -0.17) had low mean (flower early), regression coefficient (b_i) close to 1 and lowest and non-significant deviations from regression (S^2d_i) which indicates that these genotypes weremost stable in their performance over environments for days to 50 per cent flowering.

On the other hand, genotypes *viz*., JLPM 504-20 ($\bar{x}$=40.44, bi=1.40 and S^2_{di}= -0.80), DGGV 80 ($\bar{x}$=40.44, b_i=1.70 and S^2_{di}= 1.26), IGKM 05-18-02 ($\bar{x}$=40.44, b_i=1.73 and S^2_{di}= 1.05) were suitable for better environment as these varieties has low mean and high regression coefficient andlow deviation from regression, thus exhibiting below average stability. In contrary, genotypes, *viz*., IPM 02-03 ($\bar{x}$=40.78, b_i=0.71 and S^2_{di}= -0.44), MH 1703 ($\bar{x}$=39.44, b_i=0.57 and S^2_{di}= -0.66), ML 2482 ($\bar{x}$=40.56, b_i=0.79 and S^2_{di}= -0.56), Pusa-BM-5 ($\bar{x}$ =39.22, b_i=0.79 and S^2_{di}= -0.56) and PUSA M-1971 ($\bar{x}$=40.33, b_i=0.78 and S^2_{di}= -0.91), were suitable for poor environment as these had low mean, low regression coefficient and low deviation from regression thus exhibiting above average stability (Table 2).

For days to maturity,after analyzing mean value and stability parameters it has been found that varieties *viz*.,IPM 312-394-1 ($\bar{x}$=61.67, b_i =0.94 and S^2_{di}= -2.17), DGGV 80 ($\bar{x}$=60.89, b_i=1.14 and S^2_{di}= -2.32), VGG 17-04 ($\bar{x}$=60.56, b_i=1.23 and S^2_{di}= -0.73), MH 1421 ($\bar{x}$=58.33, b_i=.91 and S^2_{di}= -2.33), were most stable performer and desirable varieties because of low mean, b_i close to 1 and non-significant deviation from regression. On the other hand, Pusa-BM-5 ($\bar{X}$ = 63.00, b_i=1.35 and S^2_{di}= -0.83), MH 2-15 ($\bar{X}$=63.89, b_i=1.59 and S^2_{di}= -1.01), BGG 17-043 ($\bar{X}$ = 62.56, b_i=1.72 and S^2_{di}= -2.18), were suitable for better environment as these varieties has low mean and high regression coefficient and low deviation from regression, thus exhibiting below average stability. For, days to maturity done of the varieties showed low mean, regression coefficient (b_i) less than unity and low and non-significant deviation from regression combination indicates none of them were suitable for poor environment for days to maturity. Therefore, genotypes suitable for poor environment and could not be identified (Table 2).

Since large plant height is positively correlated with yield in green gram, thereby it has been found that varieties *viz*.,PUSA M-1972 ($\bar{X}$=46.72, b_i=1.26 and S^2_{di}= 0.16), PM 16-23 ($\bar{X}$ = 42.81, b_i = 1.21 and S^2_{di}= -2.67), IPM 02-03 ($\bar{X}$ =40.17, b_i = 1.21 and S^2_{di}= 1.48), IPM 312-394-1 ($\bar{X}$ =42.73, b_i=1.18 and S^2_{di}= 2.88), PM 1618 ($\bar{X}$=41.91, b_i=1.16 and S^2_{di}= 2.77) and IGKM 06-10-7 ($\bar{X}$ =41.23, b_i=1.29 and S^2_{di}= -1.38), were most stable because of high mean for the character, b_i close to 1 and lowest and non-significant deviation from regression which is desirable in green gram.On the other side, PUSA M-1971 ($\bar{X}$=44.99, b_i=1.72 and S^2_{di}= 1.28),MGG 389 ($\bar{X}$=44.42, b_i=1.88 and S^2_{di}= -2.49), was suitable for better environment because of its higher mean and high regression coefficient and low deviation from regression, thus exhibiting below average stability. Adversely, IPMD 14-10 ($\bar{X}$=40.29, b_i=0.81 and S^2_{di}= -2.03), VGG 17-04 ($\bar{X}$=39.02, b_i=0.88 and S^2_{di}= 1), were suitable for poor environment because of its higher mean, low regression coefficient and low deviation from regression thus exhibiting above average stability (Table 3).

More number of branches bears a greater number of clusters, pods and seeds per plant which in turn increases the yield. Therefore, branches per plant are positively correlated with yield and desirable. After analyzing mean value and stability parameters it has been found that varieties *viz.*, MGG 389 ($\bar{X}$=3.63, b_i=1.17 and S^2_{di}= 0.13), NDMK 17-07 ($\bar{X}$ =3.70, b_i=1.11 and S^2_{di}= 0.57), IGKM 06-10-7 ($\bar{X}$=3.36, b_i=1.00 and S^2_{di}= -0.09), PM 1618 ($\bar{X}$=3.43, b_i=0.99 and S^2_{di}= -0.08), ML 24-59 ($\bar{X}$=3.36, b_i=1.02 and S^2_{di}= -0.10), ML 2482 ($\bar{X}$=3.41, b_i=1.04 and S^2_{di}= -0.03), DGGV 80 ($\bar{X}$=3.33, b_i=0.99 and S^2_{di}= -0.10), were most stable because of highmean, b_i close to 1 and lowest deviation from regression. Whereas, IPM 312-394-1 ($\bar{X}$=3.70, b_i=1.31 and S^2_{di}= -0.11), JLPM 504-20 ($\bar{X}$=3.65, b_i=1.23 S^2_{di}= -0.11) weresuitable for better environment as these varieties has high mean and high regression coefficient and low and non- significant deviation from regression, thus exhibiting below average stability. Adversely, IPM 14-49-5 ($\bar{X}$=4.11, b_i=0.87 and S^2_{di}= -0.10), OBGG 103 ($\bar{X}$=3.29, b_i=0.81 S^2_{di}= -0.11), were suitable for poor environment as these had high mean, low regression coefficient than unity and low deviation from regression thus exhibiting above average stability (Table 3). Several earlier workers have also reported similar results *viz*., Sultana *et al*. 2001; Dhuppe *et al*. 2005 and Thippani *et al.* 2013

Table 1: Pooled analysis of variance for Agro-morphological traits in green gram

Source	*d.f.*	*DFF*	*DM*	*PH*	*BPP*
Genotypes	24	14.81**	26.84**	75.09**	0.56**
Environments	2	374.61**	192.46**	1615.08**	65.00**
Rep. in Environment	6	7.80	22.27	5.45	0.51
G X E Interaction	48	9.86**	11.79**	25.13**	0.41**
Pooled Error	144	3.03	7.01	8.11	0.32

*, **: Significant at 5% and 1% levels, respectively

DFF Days to 50% flowering

DM Days to maturity

PH Plant height (cm)

BPP Branches per plant

Table 2: Mean values and stability parameters (b_i and S^2_{di}) of the green gram genotypes for days to 50% flowering and days to maturity

Genotypes	*Days to 50% flowering*			*Days to maturity*		
	Mean	*bi*	*S²di*	*Mean*	*bi*	*S²di*
ML 24-59	40.33	0.98**	-0.96	60.89	1.07	0.09
IGKM 06-10-7	39.89	2.47**	1.40	62.78	1.37	3.50
PM 1618	40.89	2.07**	-0.99	58.89	0.70	-0.33
JLPM 504-20	40.44	1.40**	-0.80	61.44	1.31	-0.14
DGGV 80	40.44	1.70**	1.26	60.89	1.14**	-2.32
MH 1703	39.44	0.57**	-0.66	59.11	0.48**	-2.31
MH 1421	37.00	0.38	0.18	58.33	0.91**	-2.33
ML 818	42.00	0.82	0.90	62.78	0.19	0.66
Pusa-BM-5	39.22	0.79**	-0.56	63.00	1.35*	-0.83
MH 2-15	39.00	1.06	4.64	63.89	1.59**	-1.01
PUSA M-1972	40.00	1.13**	-0.17	58.67	0.21	3.66
VGG 17-04	38.67	0.49**	-0.75	60.56	1.23*	-0.73
ML 2482	40.56	0.79**	-0.56	62.89	0.54	-1.07
IPM 312-394-1	39.33	0.21	2.79	61.67	0.94**	-2.17
PUSA M 1971	40.33	0.78**	-0.91	59.00	-0.31	1.83
IPM 02-03	40.78	0.71**	-0.44	62.33	1.35*	-0.83
IGKM 05-18-02	40.44	1.73**	1.05	61.89	-0.13	6.98
OBGG 103	39.89	0.36**	-0.87	61.22	0.51	0.20
BGG 17-043	39.44	0.85	3.39	62.56	1.72**	-2.18
MGG 389	40.56	1.08	3.45	64.11	2.33	8.51
VGG 17-038	38.00	0.35	2.42	62.00	1.95**	-1.58
PM 16-23	42.22	2.59**	4.22	61.89	-0.64	25.44
IPM 14-49-5	37.89	1.05	3.31	62.11	2.59**	-0.61
NDMK 17-07	37.56	0.56	1.46	64.44	0.82	3.21
IPMD 14-10	38.67	0.06	3.18	62.89	1.80	17.19
SE	**1.01**	**0.45**		1.49	0.93	
Pop. Mean	39.72	1.00		61.61	1.00	

*, **: Significant at 5% and 1% levels, respectively

Table 3: Mean values and stability parameters (b_i and S^2_{di}) of the green gram genotypes for plant height (cm) and branches per plant

Genotypes	*Plant height (cm)*			*Branches per plant*		
	Mean	*bi*	*S²di*	*Mean*	*bi*	*S²di*
ML 24-59	**43.88**	**0.38****	**-2.67**	3.36	1.02**	-0.10
IGKM 06-10-7	41.23	1.29**	-1.38	3.36	1.00**	-0.09
PM 1618	41.91	1.16**	2.77	3.43	0.99**	-0.08
JLPM 504-20	42.18	0.81	17.4	3.65	1.23**	-0.11
DGGV 80	40.89	0.76	3.61	3.33	0.99**	-0.10
MH 1703	39.51	0.47	10.75	2.99	0.89**	0.15
MH 1421	40.79	0.94	7.07	3.65	1.59**	-0.06
ML 818	47.24	2.03**	17.98	3.57	0.33**	-0.11
Pusa-BM-5	50.25	1.14	38.29	3.37	1.38*	0.41
MH 2-15	44.77	0.44*	-1.37	3.50	0.59**	-0.11
PUSA M-1972	46.72	1.26**	0.16	3.29	0.77**	-0.11
VGG 17-04	39.02	0.88**	1	3.51	0.63**	-0.10

Genotypes	*Plant height (cm)*			*Branches per plant*		
	Mean	*bi*	S^2di	*Mean*	*bi*	S^2di
ML 2482	43.13	1.24*	7.05	3.41	1.04**	-0.03
IPM 312-394-1	42.73	1.18**	2.88	3.70	1.31**	-0.11
PUSA M-1971	44.99	1.72**	1.28	3.55	1.36**	0.07
IPM 02-03	40.17	1.21**	1.48	3.16	0.69**	-0.11
IGKM 05-18-02	41.24	0.67**	-1.37	3.26	1.09**	0.07
OBGG 103	40.23	0.72**	-2.49	3.29	0.81**	-0.11
BGG 17-043	38.81	0.23	12.97	3.94	1.25*	-0.01
MGG 389	44.42	1.88**	-2.49	3.63	1.17**	0.13
VGG 17-038	38.17	1.05*	5.33	3.18	1.03**	-0.10
PM 16-23	42.81	1.21**	-2.67	3.70	1.24*	0.44
IPM 14-49-5	40.96	1.07	9.78	4.11	0.87**	-0.10
NDMK 17-07	40.72	0.44**	-2.59	3.70	1.11	0.57
IPMD 14-10	40.29	0.81**	-2.03	3.28	0.64	0.06
SE	**1.94**	**0.42**		**0.25**	**0.26**	
Pop. Mean	**42.28**	**1.00**		**3.48**	**1.00**	

*, **: Significant at 5% and 1% levels, respectively

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