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Research Article

Stability analysis of yield and yield attributing traits in advanced breeding lines of cowpea [*Vigna unguiculata*(L.) Walp.]

Manish Sharma*, M. P. Patel, P. J. Patel and P. R. Patel

Pulses Research Station, SDAU, SK Nagar, Gujarat
***E-Mail**: manisharmagpb@sdau.edu.in

Abstract
In the present investigation, 14 cowpea genotypes including four checks were evaluated for yield and yield attributing traits in six different locations. Pooled analysis of variance revealed that the mean sum of squares due to genotypes (G) and environments (E) were significant for all the characters studied which provided the sound evidence for the validity of the experiments. The genotype GC 1602 had desirable stability parameters for both days to 50% flowering and days to 80% maturity and identified as an early maturing genotype, the genotypes namely GC 1805, GC 1906, GC 1903 and GC 1802 were found to be high yielding and stable in all environments for seed yield and GC 1805 and GC 1906 for pod length and the number of pods per plant. The stable cowpea genotypes identified in the present study can be recommended for commercial cultivation in a wider range of environments.

Keywords: Cowpea, genotypes, environments, stability.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important grain and forage legumes in the semi-arid tropics in parts of Asia, Africa, Southern Europe, Southern United States and Central and South America. It is an African origin crop, with high genetic variability, which allows this multipurpose crop to adapt in different climatic conditions. It not only provides food for man and livestock but also serves as a valuable and dependable revenue-generating commodity for farmers especially under stressed environments. It is a major staple component of the human diet in many developing countries, nutritionally on average seeds of cowpea contain about 25 per cent protein, making it enormously valuable in areas where many people cannot afford proteinaceous foods like fish and meat (Lephale *et al*., 2012) hence, it is often regarded as vegetable meat and poor man's meat. Cowpea has recently gained more attention due to qualities such as drought tolerance, nitrogen fixation and mixed cropping potential. Like most other pulses it also has the unique ability to fix atmospheric nitrogen through its nodules and thus it can yield substantially in poor soils too (Kumar and Singh, 2004). Coupled with these attributes, its quick growth and rapid ground cover, checks soil erosion and nitrogen-rich residue improves soil fertility and structure.

Cowpea is a self-pollinating legume and varieties to be developed are pure lines, most cowpea breeders employ backcross or pedigree methods to handle segregating populations aiming for higher grain yields and improved grain quality. But with the advent of climate change and cowpea being grown in the harsh environments, breeding programs have to focus on developing a range of high yielding cowpea varieties adapted to different agro ecological zones that possess regionally preferred traits for plant type, growth habit, days to maturity, seed type and resistance to biotic and abiotic stresses (Yousaf and

Sarwar, 2008). The performance of genotypes exhibits a wide range of variation within and between environments due to genotype × environment (G x E) interaction which refers to the differential response of the genotypes to different environmental conditions which affects the selection of cultivars with wider adaptability (Banik *et al*., 2021). This differential response decreases the correlation between the phenotype and genotype values, hampering the selection and suggestion of superior genotypes (Yan and Holland. 2010). It is important for cowpea breeders to identify specific genotypes adapted or stable to different environment(s), thereby achieving rapid genetic gain through screening of genotypes for wider adaptation and stability under varying environmental conditions prior to their release as cultivars. To breed a stable variety, it is necessary to get information on the extent of genotype x environment interaction for yield and its component characters. Therefore an attempt has been made in the present study to evaluate different genotypes of cowpea across the locations to understand the role of genotype x environment interaction and also to analyze the stability of genotypes for different traits using Eberhart and Russell's (1966) model of stability analysis.

MATERIALS AND METHODS

The study comprised of fourteen cowpea genotypes/ lines including four checks (**Table 1**) developed at Pulses Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India. The purelines were mainly obtained by hybridization followed by the pedigree method of selection. The advanced strains selection was performed, focusing on the productivity of the grains, earliness, architecture of the plants, quality of the grains, and resistance to diseases and pests. The experiment was conducted at six locations *viz*., Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE) in the Banaskantha, Sabarkantha, Patan and Mehsana districts of Gujarat State.

The experiment was laid out in a randomized complete block design with three replications during *kharif,* 2020 in all the environments. Each entry was raised in six rows of four meter length with a spacing of 45 cm between the rows and 10 cm between the plants. All the plant protection measures were attended to as and when required for raising a good crop. The plants were planted under rainfed conditions and only life saving irrigation was given to avoid wilting. The observations were recorded on five randomly selected plants on each replication in each environment for days to 50% flowering, days to 80% maturity, pod length, the number of pods per plant and seed yield at harvest. The seed yield harvested from the net plot area of each genotype was added with the yield obtained from five tagged plants and was recorded (kg) per plot and finally expressed in kilograms per hectare (kg/ha).

A two way analysis of variance was performed and the stability parameters are computed following the model proposed by Eberhart and Russell (1966). In this model, stability is decided on regression coefficient (bi), mean values and deviation from the regression line. If bi is equal to unity a genotype is considered to have average stability i.e. same performance in all the environments, if bi is greater than one it is suggested to have less than average stability i.e good performance in favorable environments meaning it can utilize the resources to a greater extent than those of stable ones. Thus, this model defines stable variety as one with a regression coefficient of unity (bi=1) and minimum deviation from the regression line ($s^2d=0$).

RESULTS AND DISCUSSION

Pooled analysis of variance (**Table 2**) revealed that the mean sum of squares due to genotypes (G) and environments (E) were significant for all the characters studied indicating the presence of a sufficient amount of variability in the material chosen for the study and environments were different from each other, which

Table 1. List of cowpea genotypes and their parents

S.No.	Genotypes	Parentage
1	GC 1802	GC 2 x GC 0723
2	GC 6 (Check)	TC-2004 x GC-4
3	GC 1906	GC 502 x GC 203
4	GC 1805	GC 5 x PGCP 12
5	GC 3 (Check)	V-16 X Black eye 7-31
6	GC 1602	GC 2 x PGCP II
7	GC 1910	Selection from GDVC 2
8	GC 5 (Check)	GC 2 X GC 8963
9	GC 1801	GC-2 x PGCP-1 (I)
10	GC 1907	GC 2 x GC 203
11	GC 4 (Check)	Dholar X GC 2
12	GC 1903	GC 203 x Pant Lobia 1
13	GC 1601	GC 2 x PGCP I
14	GC 1603	GC 2 x GC 0723 (I)

Table 2. Pooled analysis of variance for stability parameters associated with yield and yield attributes for 14 cowpea genotypes

Source of Variations	df	Days to 50% flowering	Days to 80% maturity	Pod length	Pods per plant	Yield
Rep within Env.	12	0.57143	1.87566	0.35416	9.67978	4252.49031
Varieties	13	10.97202*	3.27116*	1.99307**	20.11989**	62635.68687**
Env. + (Var.* Env.)	70	14.87593**	45.49868**	1.1912	36.67251**	108837.3339**
Environments	5	128.9569**	574.42468**	5.83521**	416.03499**	1180171.517**
Var.* Env.	65	6.10047	4.81206	0.83397	7.49078	26427.01214
Environments (Lin.)	1	644.78449**	2872.12341**	29.17603**	2080.17497**	5900857.584**
Var.* Env.(Lin.)	13	1.97887	4.73457	0.8053	7.47245	23688.46195
Pooled Deviation	56	6.62152**	4.48633**	0.78106**	6.95998**	25175.10329**
Pooled Error	156	0.63126	0.90415	0.12779	1.89623	2204.37402
Total	83	14.26447	38.88473	1.3168	34.07993	101600.9314

* &** Significant at 5 and 1 per cent level

provided the sound evidence for the validity of the experiments. The non-linear component of G × E interaction (pooled deviations) was found to be significant against pooled error for all the traits which indicated the role of an unpredictable portion of environments influencing these traits. The results obtained in the present study are in agreement with earlier findings of El-Shaieny *et al*. (2015), Singh *et al*. (2018) and Manivannan *et al*. (2019) for the presence of a substantial amount of genotype × environment interaction. To verify the presence of variance due to components of G × E interaction, stability analysis was carried out as per Eberhart and Russell's (1966) model for all the characters taken for study. In this model three stability parameters *viz.,* mean (x), regression coefficient (bi) and deviation from regression (S^2di) were estimated. Earliness measured in terms of days to 50% flowering (**Table 3**) and 80% maturity (**Table 4**) is a desirable character when cowpea is grown in adverse environments. The ideal stability parameters for earliness are different from that of yield as here the genotypes with low mean, bi and S^2di minimum possible were selected. The genotypes namely, GC 1603, GC 1602, GC 4 and GC 1801 were found to be early for days to 50% flowering, while the genotype GC 1602 was adjudged as the best one for earliness as its bi (linear response) was significantly lower than 1.0 with least deviation from regression (**Fig. 1**). In case of days to 80% maturity again GC 1603 was found to mature early as compared to check and other test genotypes but it was not stable. Whereas GC 1601and GC 1602 were the most desired genotypes for earliness (**Fig. 2**) showing the least regression coefficient (bi) and deviation from regression (S^2di). Similar results were reported earlier by Adewale *et al*. (2010 and Patel and Jain (2012).

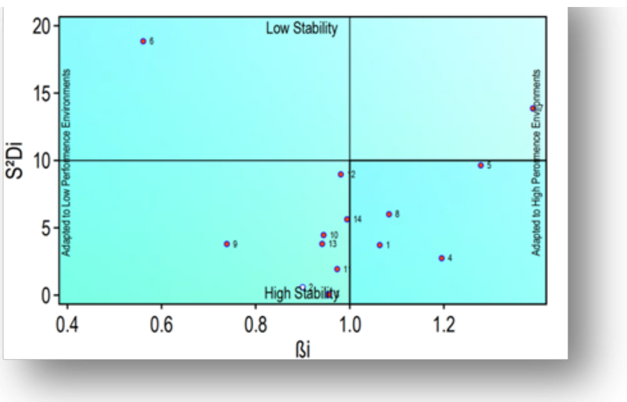

Fig. 1. Stability based on regression coefficient and mean square deviation from regression for days to 50% flowering.

Table 3. Stability parameters for 14 cowpea genotypes for days to 50% flowering in six environments

Variety	SKN	BHIL	LAD	RADH	TAR	DEE	Grand mean	S^2D_i	Rank	b_i	Rank
GC 1802	39.00	34.00	43.67	41.00	40.67	44.33	40.44	3.72	5	1.06	7
GC 6 (C)	39.33	34.67	41.33	40.67	42.67	42.00	40.11	0.59	2	0.90	9
GC 1906	40.67	34.67	41.00	40.33	42.00	43.33	40.33	-0.03	1	0.96	4
GC 1805	43.00	34.00	42.67	40.33	44.67	44.33	41.50	2.74	4	1.20	10
GC 3 (C)	41.67	35.00	43.33	50.00	44.00	43.67	42.94	9.63	12	1.28	12
GC 1602	42.00	35.00	43.33	35.33	35.33	43.67	39.11	18.84	14	0.56	14
GC 1910	43.00	34.00	37.67	49.67	42.67	44.00	41.83	13.86	13	1.39	13
GC 5 (C)	42.00	34.00	36.00	40.67	44.33	42.33	39.89	6.01	10	1.08	8
GC 1801	39.00	34.67	42.67	38.00	40.33	42.00	39.44	3.79	6	0.74	11
GC 1907	42.33	34.67	36.33	39.67	42.33	43.00	39.72	4.46	8	0.94	5
GC 4 (C)	39.00	34.33	37.00	41.00	43.00	42.00	39.39	1.93	3	0.97	3
GC 1903	43.33	37.67	38.67	48.33	42.33	45.67	42.67	8.96	11	0.98	2
GC 1601	39.33	35.67	40.00	38.67	43.67	45.00	40.39	3.80	7	0.94	6
GC 1603	34.33	32.67	40.67	41.00	40.00	41.00	38.28	5.62	9	0.99	1
Environmental Index	0.14	-5.79	-0.12	1.33	1.57	2.88					
Mean	40.57	34.64	40.31	41.76	42.00	43.31					
C. V.	2.45	1.29	1.14	6.89	2.37	1.94					
SE of Difference	0.81	0.37	0.38	2.35	0.81	0.69					
CD 95%	1.67	0.75	0.77	4.83	1.67	1.41					
CD 99%	2.25	1.01	1.04	6.53	2.25	1.91					

bi -Regression coefficient S²di - Mean square deviation from regression
Locations: Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE)

Table 4. Stability parameters for 14 cowpea genotypes for days to 80% flowering in six environments

Variety	SKN	BHIL	LAD	RADH	TAR	DEE	Grand mean	S^2D_i	Rank	b_i	Rank
GC 1802	59.00	78.67	76.00	67.00	71.33	64.00	69.33	1.64	6	1.14	10
GC 6 (C)	59.33	78.33	75.33	70.33	72.67	65.00	70.17	-0.46	3	1.09	6
GC 1906	60.00	78.33	75.00	72.67	75.67	64.33	71.00	2.30	7	1.10	8
GC 1805	64.00	79.33	75.33	68.67	70.33	64.67	70.39	2.93	8	0.90	9
GC 3 (C)	58.00	77.67	76.00	73.33	69.33	65.67	70.00	4.79	11	1.10	7
GC 1602	62.67	78.00	75.67	68.00	70.67	64.67	69.94	1.54	5	0.92	5
GC 1910	58.00	76.33	74.33	75.33	71.33	65.33	70.11	7.75	13	1.04	2
GC 5 (C)	64.00	77.00	74.00	72.00	71.33	65.00	70.56	-0.03	1	0.78	12
GC 1801	60.67	77.00	75.33	69.00	72.33	63.67	69.67	-0.30	2	1.01	1
GC 1907	62.67	78.00	74.00	65.33	73.33	63.33	69.44	6.82	12	0.93	4
GC 4 (C)	58.00	77.00	74.33	71.33	71.67	65.00	69.56	0.96	4	1.06	3
GC 1903	67.00	80.33	74.67	71.00	71.00	65.67	71.61	4.55	10	0.77	13
GC 1601	63.00	76.33	74.67	66.33	71.33	63.33	69.17	3.14	9	0.86	11
GC 1603	54.00	75.33	75.00	75.33	72.67	61.00	68.89	13.56	14	1.33	14
Environmental Index	-9.25	7.70	4.99	0.42	1.80	-5.66					
Mean	60.74	77.69	74.98	70.41	71.79	64.33					
C. V.	1.86	1.15	0.83	5.01	1.05	1.38					
SE of Difference	0.93	0.73	0.51	2.88	0.61	0.73					
CD 95%	1.90	1.50	1.05	5.92	1.26	1.49					
CD 99%	2.57	2.03	1.42	8.01	1.70	2.02					

bi -Regression coefficient, S²di - Mean square deviation from regression
Locations: Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE)

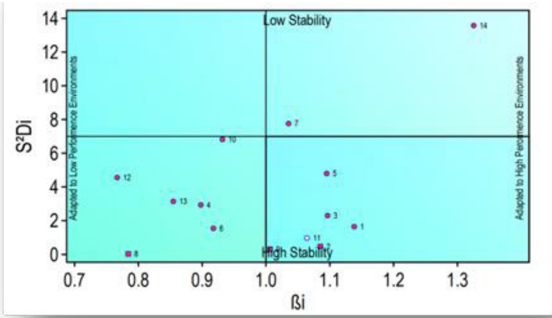

Fig. 2. Stability based on regression coefficient and mean square deviation from regression for days to 80% flowering.

The stability parameters for pod length are illustrated in **Table 5 and Fig. 3**. Among the genotypes tested, four genotypes had longer pods than the population mean (12.03) with the longest pod observed in the genotype GC 1910 followed by the check GC 3. The regression coefficient (bi) was found near unity for GC 1903, GC 1910 and GC 1603 whereas, the least deviation from regression (S^2di) was found in GC 5 followed by GC 1801. The genotypes *viz*., GC 1805 and GC 1906 exhibited above average stability and were adaptable to high performance environments as indicated by low deviation from regression and high regression coefficient. However, the genotypes GC 1601 exhibited above average stability and adaptation to a poor environment (**Fig. 3**). Havaraddi and Deshpande (2018) also reported similar findings.

The stability parameters for the number of pods per plant are illustrated in **Table 6**. The maximum number of pods across six environments was counted in GC 1602 followed by GC 1906 and GC 1802. The genotypes GC5 and GC 1910 had regression coefficient near to unity, while the least deviation from regression was observed in GC 1802. Similar results were also obtained earlier by Patel and Jain (2012) and Singh *et al.* (2018). It is evident that

Table 5. Stability parameters for 14 cowpea genotypes for number of pod length in six environments

Variety	SKN	BHIL	LAD	RADH	TAR	DEE	Grand mean	S^2D_i	Rank	b_i	Rank
GC 1802	10.90	11.13	13.93	11.30	10.93	11.83	11.67	0.79	9	1.19	4
GC 6 (C)	12.07	11.57	12.47	12.13	10.67	12.15	11.84	0.14	3	0.67	6
GC 1906	12.17	10.93	14.17	10.43	10.70	11.19	11.60	0.43	5	1.89	11
GC 1805	12.53	10.50	14.43	11.47	10.33	12.18	11.91	0.37	4	2.13	14
GC 3 (C)	13.61	13.33	11.63	12.20	12.47	13.97	12.87	0.88	10	0.08	12
GC 1602	11.49	11.93	14.63	10.83	11.40	11.50	11.96	1.12	13	1.40	9
GC 1910	14.63	11.97	13.43	12.87	13.30	14.78	13.50	0.70	8	1.05	2
GC 5 (C)	12.44	11.13	11.80	10.97	11.43	11.55	11.55	-0.01	1	0.63	8
GC 1801	11.60	11.20	12.83	10.33	10.30	11.69	11.33	0.02	2	1.36	7
GC 1907	12.00	9.57	13.17	11.67	11.93	12.58	11.82	0.96	11	1.23	5
GC 4 (C)	13.46	13.17	11.53	12.47	10.77	12.50	12.32	1.11	12	0.21	10
GC 1903	13.08	10.53	11.80	11.83	10.77	12.35	11.73	0.50	6	0.98	1
GC 1601	12.07	12.60	12.27	10.83	12.47	11.10	11.89	0.54	7	0.07	13
GC 1603	13.77	12.30	12.10	10.13	12.50	13.58	12.40	1.36	14	1.10	3
Environmental Index	0.53	-0.47	0.85	-0.64	-0.60	0.33					
Mean	12.56	11.56	12.87	11.39	11.43	12.35					
C. V.	4.89	2.88	6.13	4.44	7.20	4.10					
SE of Difference	0.50	0.27	0.64	0.41	0.67	0.41					
CD 95%	1.03	0.56	1.32	0.85	1.38	0.85					
CD 99%	1.39	0.76	1.79	1.15	1.87	1.15					

bi -Regression coefficient, S^2di - Mean square deviation from regression
Locations: Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE)

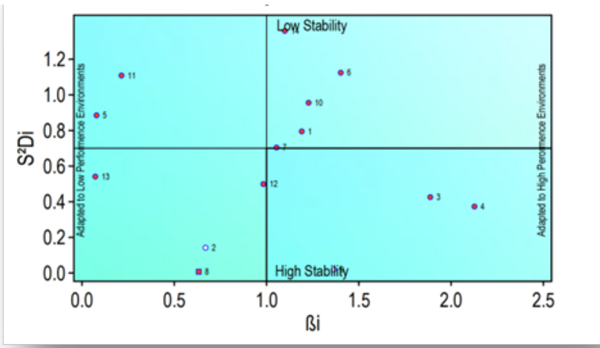

Fig. 3. Stability based on regression coefficient and mean square deviation from regression for pod length

Table 6. Stability parameters for 14 cowpea genotypes for number of pods per plant in six environments

Variety	SKN	BHIL	LAD	RADH	TAR	DEE	Grand mean	S^2D_i	Rank	b_i	Rank
GC 1802	14.80	15.00	25.40	8.87	14.57	26.13	17.46	-0.35	1	1.23	10
GC 6 (C)	17.80	16.00	22.67	9.07	11.00	19.33	15.98	5.39	9	0.82	5
GC 1906	13.47	16.00	25.93	13.40	15.33	21.27	17.57	0.84	3	0.87	3
GC 1805	12.00	9.00	26.20	11.67	11.43	23.33	15.61	3.02	7	1.27	12
GC 3 (C)	15.07	18.00	19.87	13.40	9.67	25.60	16.93	10.93	13	0.82	7
GC 1602	15.87	21.33	27.33	10.33	12.53	26.67	19.01	7.70	11	1.22	8
GC 1910	8.00	8.67	25.13	5.93	10.67	14.27	12.11	11.19	14	1.13	2
GC 5 (C)	11.60	14.33	21.33	10.33	8.53	24.87	15.17	4.34	8	1.12	1
GC 1801	15.67	10.33	23.13	6.87	13.67	26.87	16.09	5.96	10	1.31	13
GC 1907	11.93	8.00	23.73	11.07	10.23	22.33	14.55	2.81	6	1.17	4
GC 4 (C)	14.20	9.00	19.47	9.27	9.33	18.20	13.24	0.81	2	0.82	6
GC 1903	12.13	12.33	20.07	11.47	10.23	17.20	13.91	-1.04	4	0.68	14
GC 1601	12.47	12.67	22.13	13.73	15.33	22.27	16.43	1.11	5	0.78	9
GC 1603	14.87	12.00	21.73	7.47	18.47	19.00	15.59	10.41	12	0.76	11
Environmental Index	-2.13	-2.64	7.46	-5.48	-3.48	6.26					
Mean	13.56	13.05	23.15	10.21	12.21	21.95					
C. V.	14.78	8.78	11.22	12.43	23.16	16.07					
SE of Difference	1.64	0.94	2.12	1.04	2.31	2.88					
CD 95%	3.36	1.92	4.36	2.13	4.75	5.92					
CD 99%	4.55	2.60	5.90	2.88	6.42	8.00					

bi -Regression coefficient, S^2di - Mean square deviation from regression
Locations: Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE)

GC 1801 and GC 1805 had above average stability and can be explored for rich environments, while genotypes GC 1903 was adapted to low performance environments (**Fig. 4**). Across the environments, the genotype GC 1906 was found to be suitable for a general recommendation, i.e. suitable for all environmental conditions as its bi (linear response) was around 1.0 with least deviation from regression and high mean for this trait.

The mean seed yield was ranged from 506.40 (GC 4) to 807.56 kg/ha (GC 1601). The genotypes *viz*., GC 1601, GC 1602, GC 1603, GC 1802, GC 1906, GC 1801 and GC 1805 were recorded higher seed yield (**Table 7, Fig. 5**) than the check variety GC 5 (652.24 kg/ha). Considering all the stability parameters *i.e*., high mean, bi near to one and S^2di close to zero, four genotypes *viz*., GC 1805, GC 1906, GC 1903 and GC 1802 were found to be superior and stable across environments (**Fig. 6**). Genotypes *viz*., GC 1602 and GC 1801 had significantly higher mean than check variety, regression coefficient more than unity hence, these genotypes were suited for exploiting better environmental condition. Genotype GC 1910 and check variety GC 3 recorded more pod yield per plant and bi value less than one, which will be superior in poor environments (unfavourable). The results are concomitant with earlier reports by Cholin *et al*. (2010), El-Shaieny *et al*. (2015) and Havaraddi and Deshpande (2018).

The present study aimed on the evaluation of genotypic and environmental performance of 14 cowpea genotypes across six locations. Significant differences among the genotypes and environment recorded for yield traits

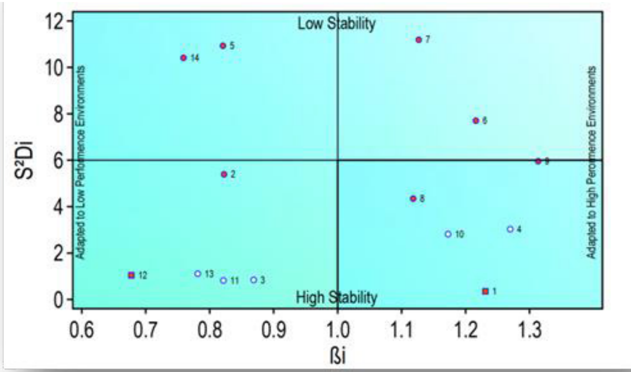

Fig. 4. Stability based on regression coefficient and mean square deviation from regression for pods per plant

Table 7. Stability parameters for 14 cowpea genotypes for yield in six environments

Variety	SKN	BHIL	LAD	RADH	TAR	DEE	Grand mean	S^2D_i	Rank	b_i	Rank
GC 1802	1145.37	526.62	908.10	214.82	681.25	1020.14	749.38	3935.46	1	1.16	8
GC 6 (C)	762.96	349.54	785.19	212.50	275.00	693.52	513.12	6538.32	4	0.85	7
GC 1906	1137.73	692.13	918.98	324.07	328.94	958.10	726.66	13374.76	7	1.11	4
GC 1805	902.32	622.69	960.88	281.48	465.97	925.00	693.06	7077.40	5	0.92	2
GC 3 (C)	813.43	467.59	671.30	249.54	896.99	693.06	631.98	39952.99	12	0.52	14
GC 1602	1254.40	695.60	996.30	202.32	436.81	955.56	756.83	8507.81	6	1.30	11
GC 1910	453.24	376.16	874.54	79.17	594.21	824.77	533.68	57118.28	13	0.70	12
GC 5 (C)	958.57	609.95	712.96	214.35	340.51	1077.08	652.24	14633.98	8	1.09	3
GC 1801	1237.96	525.46	803.24	278.70	404.63	1062.73	718.79	6199.36	3	1.28	10
GC 1907	1179.63	262.73	821.76	242.59	276.62	866.44	608.30	18589.27	10	1.31	13
GC 4 (C)	715.97	324.07	652.78	206.71	300.93	837.96	506.40	5587.10	2	0.86	6
GC 1903	1003.01	454.86	685.19	262.50	170.60	705.32	546.91	17417.94	9	0.98	1
GC 1601	1302.08	773.15	766.20	441.67	421.07	1141.20	807.56	27715.22	11	1.11	5
GC 1603	1138.66	493.06	726.85	217.59	1137.27	853.47	761.15	92894.20	14	0.82	9
Environmental Index	342.81	-145.18	148.44	-412.72	-176.81	243.45					
Mean	1000.38	512.40	806.02	244.86	480.77	901.03					
C. V.	9.87	13.57	9.38	17.00	13.06	12.99					
SE of Difference	80.60	56.79	61.74	33.98	51.28	95.58					
CD 95%	165.67	116.74	126.90	69.86	105.40	196.47					
CD 99%	223.96	157.81	171.54	94.43	142.48	265.60					

bi -Regression coefficient, S^2di - Mean square deviation from regression
Locations: Sardarkrushinagar (SKN), Bhiloda (BHIL), Ladol (LAD), Radhanpur (RADH), Targadhiya (TAR) and Deesa (DEE)

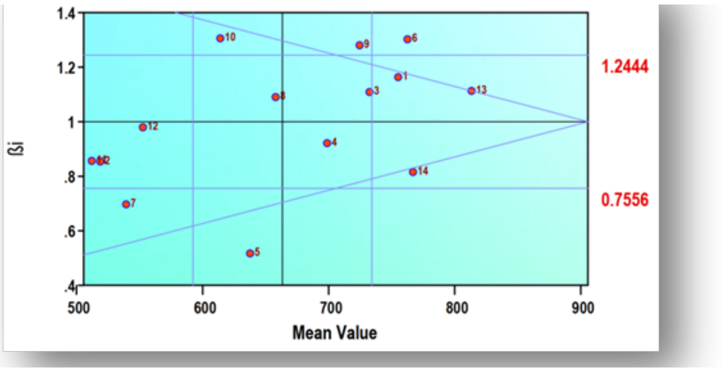

Fig. 5. Stability based on regression coefficient and mean value for yield

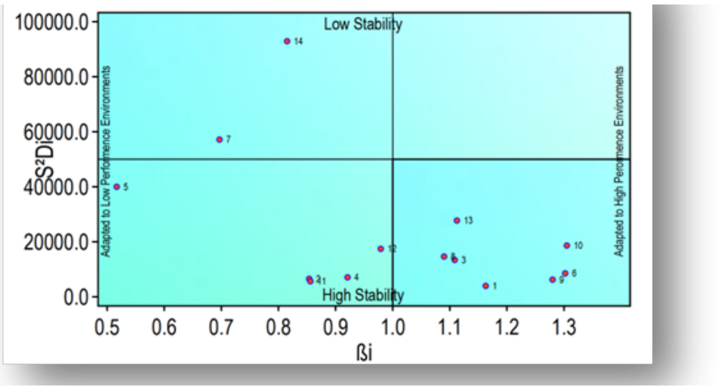

Fig. 6. Stability based on regression coefficient and mean square deviation from regression for yield

suggested the presence of wide variability. Significant pooled deviations observed for yield traits, suggested that there are considerable genotypic differences. Based on the stability parameters, GC 1602 was found to be early and suitable for cultivation across the environments based on days to 50% flowering and days to 80% maturity. For pod length genotypes GC 1805 and GC 1906 exhibited above average stability and adaptability to high performance environments while genotypes GC 1601 will be suitable for poor environments. With regard to the number of pods per plant, the genotype GC 1906 was stable with more the number of pods per plant. Considering all parameters of Eberhart and Russell's (1966) model, the genotypes GC 1805 and GC 1906 were found to be superior and stable across environments for yield and yield attributing characters.

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