



Stability Analysis in Pigeonpea [*Cajanus cajan* (L.) Millsp.] at Multiple Environments

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ABSTRACT: Stability analysis of the twenty genotypes of pigeonpea was accessed for eight characters in a randomized complete block design (RCBD) with two replications at three locations viz., Research Cum Instructional Farm College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Sant Kabir College of Agriculture and Research Station, Kabirdham and Shaheed Gundadhar College of Agriculture and Research station, Jagdalpur during kharif 2022-2023. The analysis of variance for stability showed significant mean sum of squares for the genotypes for eight traits viz., days to 50% flowering, days to maturity, plant height, number of branches, number of pods per plant, number of seeds per pod, 100 seed weight, seed yield per plant. For each character, the (linear) mean sum of squares for their environment was significant. During the kharif of 2022–2023, stability analysis of the 20 pigeonpea genotypes was obtained for eight characters in a randomized complete block design (RCBD) with two replications at three locations: Shaheed Gundadhar College of Agriculture and Research station, Jagdalpur; Sant Kabir College of Agriculture and Research Station, Kabirdham; and College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Significant mean sum of squares for the genotypes for eight traits—days to 50% flowering, days to maturity, plant height, number of branches, number of pods per plant, number of seeds per pod, 100 seed weight, and seed yield per plant—were revealed by the stability analysis of variance. The (linear) mean sum of squares for each character's surroundings was noteworthy. In terms of seed yield per plant, stability analysis also supports the aforementioned findings and showed that the genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32, and BDN 716 were stable. Regression values greater than one for genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32, and BDN 716 showed greater stability for the number of tillers per plant under particular conditions. Regression values smaller than one indicate that the genotypes RPS 2014-1, RPS 2014-19, RPS 2014-6, RPS 2014-03, RPS 2014-31, RPS 2014-34, C.G. Arhar-1, and RP7373 are generally stable over a range of environments. If the regression value is more than one, then highly stable cultivars may be recommended for extremely favourable conditions.

Keywords: Stability, genotype, pigeonpea, Multiple Environments.

INTRODUCTION

Pigeon peas (*Cajanus cajan* L. Millsp.) are the most significant pulse crop that grows in tropical and subtropical regions. Sarkar *et al.* (2020) India is the world's largest producer of pigeon peas, accounting for 75–80% of total production. With a production of 960 kg/ha, it yields 4.25 MT total when planted over an area of 4.43 MHA in India. With a yield of 4.9 thousand tonnes, the area in Assam is 6,000 hectares and the productivity is 833 kg/ha. (2018, Agricultural Statistics). The pigeon pea, also known as "arhar, tur," or "red gramme," is a forage or cover crop as well as a food crop (dry peas, flour, or green vegetable peas). It is known to be a good source of vegetarian protein, especially in underdeveloped nations like India. The vast majority of people rely on inexpensive vegetarian meals (Gupta *et al.*, 2024). It can repair the nitrogen in the atmosphere. Among its many benefits are seeds with a high protein content (21–25%), fuel, fodder, and

the ability to prevent erosion. Most often, it is grown as a solitary crop, a kharif crop, or a mixed crop. In Assam, black gramme, green gramme, and sesame are interplanted. Traditional pigeon pea varieties are incompatible with other crop systems because they are long-duration varieties that take more than 10 months to mature (Borah *et al.*, 2020). Over time, a gap between supply and demand has arisen as a result of pigeon pea yield stagnating due to a lack of diversity and photosensitivity (Sameerkumar *et al.*, 2016). Twenty pigeonpea genotypes were selected for the current study in order to examine the genotypes' differences in seed yield and seven yield-related variables, as well as their stability under three different environmental conditions.

MATERIAL AND METHODS

The experimental material for this study consisted of 20 pigeonpea genotypes, including two checks (BDN-716 & Chhattisgarh Arhar-1). Table 1 of the study's materials was supplied by the Department of Genetics

and Plant Breeding College of Agriculture, Raipur's AICRP pigeonpea department. At each site, two replications were set up using a Randomised Block Design. The current study was conducted in three different settings: Shaheed Gundadhar College of Agriculture and Research Station, Jagdalpur; Sant Kabir College of Agriculture and Research Station, Kabirdham; and College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur. Each genotype was planted in a single plot that had six rows, each measuring 4 by 3.6 meters, with an interrow spacing of 60 cm and an intrarow spacing of 20 cm. To improve the uniform crop stand, suggested agronomic techniques and plant protection measures were implemented. Five competitive plants were randomly chosen from each genotype and replication at each site, and observations were made on eight distinct morphological characteristics: days to 50% flowering, days to maturity, plant height (cm), number of branches/plant, number of pods/plant, number of seeds/pod, 100 seed weight (g), and seed yield/plant (g). Mean values from pooled data were used to study variability. Homogeneity of variance was tested using Bartlett's test. To ascertain stability regression coefficients and regression deviations, stability analysis was performed. Using the proper test recommended by Ebehart and Russell (1966), the mean square for regression deviations was compared to the residual mean square.

RESULTS AND DISCUSSION

The current study's findings are being examined in relation to the genotypes' variability;

Stability Analysis. Result of stability analysis has been presented in table 5. The analysis of variance for stability showed significant mean sum of squares for

the genotypes for eight traits viz., days to 50% flowering, days to maturity, plant height, number of branches, number of pods per plant, number of seeds per pod, 100 seed weight, seed yield per plant. For each character, the (linear) mean sum of squares for their environment was significant. Stability analysis also confirms the above findings and exhibited stability of genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32, and BDN 716 for seed yield per plant. Genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32, and BDN 716 exhibited regression value more than one, indicated better stability of these genotypes for number of seed yield per plant in specific environments. Genotypes RPS 2014-1, RPS 2014-19, RPS 2014-6, RPS 2014-03, RPS 2014-31, RPS 2014-34, C.G. Arhar-1 and RP7373 have regression value less than one which showed average stability of this genotypes over a range of environment. There are highly stable varieties that can be suggested for highly favourable environments if the regression value is greater than one. Present result supports the earlier findings of Kuchanur *et al.* (2008); Sawargaonkar *et al.* (2011); Sreelakshmi *et al.* (2013); Kumara *et al.* (2016); Singh *et al.* (2016); Ramesh *et al.* (2017); Yohane *et al.* (2020); Pal *et al.* (2020); Chauhan *et al.* (2021); Patel *et al.*, (2022); Dhanushasree and Hemavathy (2022) Jatav and Sahu (2025).

Stability analysis confirms that Genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32 and BDN 716 were found to have better combination of above mentioned characters and also contributing maximum to yield even in odd climatic conditions of Chhattisgarh. These genotypes have the maturity duration between 177 – 180 days.

Table 1: List of genotypes/entries and pedigree.

Sr. No.	Genotype	Pedigree	Sr. No.	Genotype	Pedigree
1.	RP-3	Germplasm	11.	*RPS-2014-6	ICP7373 × ICPL 87119
2.	RP-5	Germplasm	12.	*RPS-2014-29	ICP 7393 × ICP 87
3.	RP-2	Germplasm	13.	*RPS-2014-03	ICP 7004 × UPAS 120
4.	ICP-7379	ICRISAT	14.	*RPS-2014-31	ICP 7406 × ICPL 87119
5.	ICP-6994	ICRISAT	15.	*RPS-2014-34	ICP 7406 × ICPL 87
6.	ICP-7005	ICRISAT	16.	*RPS-2014-32	ICP 7406 × BDN 2
7.	*RPS-2014-1	ICP 7004 × ICPL 87119	17.	C.G. Arhar-1	Selection for ICP 7366
8.	*RPS-2014-11	ICP 7376 × ICPL 87119	18.	BDN-716	BSMR 736 × BSMR 198
9.	*RPS-2014-21	ICP 7391 × ICP 87119	19.	RP-7	Germplasm
10.	*RPS-2014-19	ICP 7382 × ICPL 87	20.	RP-7373	Germplasm

*F₇ generation

Source: AICRP on Pigeonpea, Dept. of G&PB, Raipur

Table 2: Analysis of variance for stability of different characters in pigeonpea.

	DF	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Seed yield per plant (g)
Rep within Env.	3	2.621	2.842	53.364	0.771	147.093	0.028	0.478	11.366
Varieties	19	3.441	2.569	151.629	2.006	536.437	0.032	0.527	15.085
Env.+ (Var.* Env.)	40	164.229 **	17.554 **	248.988 *	5.218 **	2748.296 **	0.097	1.760 **	89.867 **
Environments	2	3204.754 **	283.054 **	3563.129 **	79.261 **	46071.950 **	0.952 **	20.425 **	1527.766 **
Var.* Env.	38	4.202	3.58	74.559	1.321	468.104	0.052	0.777	14.188
Environments (Lin.)	1	6409.507 **	566.108 **	7126.258 **	158.521 **	92143.890 **	1.904 **	40.851 **	3055.532 **
Var.* Env.(Lin.)	19	4.315	2.722	47.269	1.344	549.053	0.039	1.094 *	13.458
Pooled Deviation	20	3.884 **	4.217 **	96.758 **	1.233 **	367.797 **	0.061 **	0.437 **	14.172 **
Pooled Error	57	1.042	0.921	30.621	0.39	81.532	0.014	0.19	3.784
Total	59	112.45	12.729	217.635	4.184	2036.002	0.076	1.363	65.785

*, **, significant at 5%, 1% level respectively

Table 3: Mean values for yield and its component traits in 20 genotypes of Pigeonpea.

Sr. No.	Genotypes	Days to 50% flowering			Days to maturity			Plant height (cm)			Number of branches			Number of pods per plant			Number of seeds per pod			100 seed weight (g)			Seed yield per plant (g)		
		Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)	Mean	(bi)	(S'di)
1.	RP-3	125.30	1.12	29.99**	178.20	0.91	1.81	187.00	0.63	123.46*	11.03	0.68	-0.41	139.90	1.61	52.88	3.60	1.816	0.051*	9.82	1.71	-0.20	23.06	1.18	75.54**
2.	RP-5	122.80	1.19	3.74*	180.20	1.73	17.74**	195.80	1.02	-30.39	11.27	0.97	-0.25	140.20	1.08	-29.87	3.43	0.928	0.0098	10.20	1.47	-0.20	24.57	1.19	69.48**
3.	RP-2	124.70	1.00	-1.12	179.70	0.97	7.19**	192.70	0.93	29.01	9.07	0.42	0.07	134.00	0.69	1476.10**	3.60	1.624	-0.002	9.73	1.66	0.96*	24.22	1.34	-4.10
4.	ICP-7379	122.70	1.00	1.09	180.20	0.91	1.8	194.90	0.55	-26.33	11.50	1.41	6.67**	162.30	1.96	567.82**	3.64	1.143	0.029	10.42	1.68	0.19	23.41	1.21	6.45
5.	ICP-6994	123.70	1.14	-1.11	177.30	1.49	2.50	184.80	0.86	96.83*	9.30	0.25	-0.11	150.90	1.22	1148.66**	3.80	1.149	0.0015	9.51	1.07	1.18	26.45	1.74	6.78
6.	ICP-7005	123.30	0.98	-0.52	178.30	1.04	5.33*	193.40	0.97	183.45*	10.57	0.44	1.92*	165.10	0.99	-82.30	3.73	-0.02	0.091**	9.91	2.04	-0.04	26.89	1.09	-1.26
7.	RPS-2014-1	125.00	0.99	-0.94	179.50	1.15	-0.16	186.60	1.48	366.50**	10.90	0.95	0.94	128.90	0.75	334.25*	3.53	0.215	0.0273	10.03	1.22	-0.20	21.06	0.87	5.96
8.	RPS-2014-11	124.80	1.05	0.68	179.30	0.65	-0.69	184.20	1.06	10.33	11.80	1.16	-0.13	141.50	1.23	205.79	3.57	1.805	0.161**	10.47	0.33	-0.20	21.52	0.82	14.75*
9.	RPS-2014-21	122.70	0.90	2.23	179.00	1.01	12.33**	189.60	1.44	-28.83	11.33	0.82	3.73**	166.40	0.90	43.06	3.57	0.905	0.0137	10.06	0.40	-0.01	27.80	1.09	24.56*
10.	RPS-2014-13	124.20	0.94	1.07	178.80	1.07	-0.589	184.00	0.70	23.19	11.70	1.65	1.25*	170.00	0.79	1093.50**	3.80	0.204	0.121**	9.46	0.82	1.28**	27.69	0.69	-1.70
11.	RPS-2014-6	125.30	0.95	1.77	180.00	0.74	-0.857	179.30	1.27	29.95	11.80	1.37	-0.40	143.40	0.60	-78.23	3.57	0.017	-0.0079	10.34	-0.10	0.06	22.74	0.74	2.17
12.	RPS-2015-28	125.80	0.95	1.77	179.80	0.94	-0.793	189.10	1.29	-25.96	11.67	1.03	-0.37	143.10	0.72	427.28*	3.53	1.624	0.060*	10.04	-0.71	0.28	24.65	1.12	-3.00
13.	RPS-2014-03	124.70	0.97	-0.14	179.50	0.64	-0.203	188.50	1.79	10.32	10.60	0.49	-0.38	157.20	0.82	-46.04	3.70	1.386*	-0.0149	9.07	1.32	-0.16	25.97	0.76	-2.07
14.	RPS-2014-31	124.30	0.95	-0.94	177.70	0.77	5.50*	180.10	0.73	35.64	10.43	0.7	-0.29	153.70	1.38	-7.47	3.53	0.69	-0.0136	9.49	0.92	-0.16	23.47	0.63	-4.08
15.	RPS2014-34	126.20	0.73	-0.55	181.00	0.40	8.53**	171.00	0.56	325.31**	10.90	1.12	4.23**	150.20	0.72	-78.59	3.77	0.226	-0.0131	10.01	0.77	-0.18	24.91	0.71	1.68
16.	RPS-2014-32	124.80	0.91	-0.53	180.50	1.12	-0.13	177.60	0.42	5.12	11.30	1.44	0.11	164.00	0.89	-60.76	3.67	1.16	0.0237	10.77	-0.06	0.06	29.21	1.01	-4.10
17.	G. Arhar-1	125.80	1.12	3.05	178.80	1.22	0.05	197.60	1.45	26.73	11.73	1.48	0.01	153.70	0.84	120.44	3.47	1.618	0.0225	9.91	1.61	2.52**	26.57	0.61	-0.45
18.	BDN 716	124.20	1.24	1.70	179.30	0.78	-0.87	175.50	0.89	-27.53	10.67	0.88	-0.17	126.20	0.76	95.47	3.60	0.475	0.0436	10.49	0.91	-0.19	26.74	1.43	-1.66
19.	RP-7	123.30	0.95	14.52**	179.50	1.38	0.68	180.80	0.86	126.52*	12.00	1.28	0.45	166.00	0.85	-75.79	3.67	1.177	0.179**	9.95	1.05	0.58	26.96	0.88	16.12*
20.	RP-7373	125.20	0.94	-0.52	179.70	1.12	4.80*	184.20	1.13	46.65	12.07	1.48	-0.41	164.60	1.18	553.49**	3.63	1.861	0.141**	9.57	1.89	0.09	27.44	0.91	-0.90

*, **, significant at 5%, 1% level respectively

CONCLUSIONS

Stability analysis confirms that Genotypes RP 2, ICP 7379, ICP 6994, ICP 7005, RPS 2015-29, RPS 2014-32 and BDN 716 were found to have better combination of above mentioned characters and also contributing maximum to yield even in odd climatic conditions of Chhattisgarh. These genotypes have the maturity duration between 177 – 180 days.

FUTURE SCOPE

A thorough investigation of pigeonpea stability can increase adaptability and output in the event of rains. Finally, the effect of climate change can be reduced through the choice of stable genotypes that are able to perform better during irregular precipitation patterns. Research on the conservation of soil and water increases the stability of cultivation in the areas for pigeonpea. Stability analysis can support decision makers in recommending flexible crops and better seed distribution strategies. All things were considered, this development would support permanent agriculture and food security.

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