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GENOTYPE x ENVIRONMENT INTERACTION AND STABILITY ANALYSIS FOR NUMBER OF PODS PLANT^{-1} AND GRAIN YIELD PLANT^{-1} IN PIGEONPEA [*Cajanus cajan* (L.) Millspaugh]

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ABSTRACT

The occurance of genotype x environment interaction has posed a major challenge for complete understanding of the genetic control of variability. A detailed study of genotype x environment interaction is of a great importance not only for evolutionary trends but also for the variety development process in economic crops. In this case we tried to evaluate the thirty –two pigeonpea hybrids at three locations i.e. Parbhani, Nanded, and Badnapur during *kharif* 2012 to test whether there is any environmental effect on the performance of these hybrids. The pooled analysis of variance for stability of number of pods plant^{-1} and grain yield showed significant differences among the genotypes. The interaction between genotype and environment including linear was highly significant for both the characters. A significant pooled deviation indicated that genotypes differed considerably with respect to their stability for grain yield plant $^{-1}$. Parental lines ICPA-2043 and ICPA-2047 had higher mean and bi value less than unity indicating above average stability. ICPA-2047 X BSMR-175 was the only cross with high mean and regression coefficient closure to unity which indicated that the cross was stable and widely adapted to all over environments. Crosses ICPA-2043 X ICPR-2671 and ICPA-2092 X ICPL-20181 were stable and specifically adapted to poor environments

(Key words: *Cajanus cajan*, genotype × environment, stability)

INTRODUCTION

Pigeonpea is the important grain legume. It is cultivated in varied agro climatic conditions ranging from moisture stress and input starved conditions to irrigated conditions. Selection and yield testing are the two major phases of varietal development and the later one is highly influenced by the locations. Yield is a complex quantitative character governed by polygenes and is greatly influenced by diverse agroclimatic condition. It is fact that the phenotypic performance of a genotype may not necessarily the same level of phenotypic expression under diverse environmental conditions. In this situation a phenomenon “genotype x environment interaction “is responsible. In any breeding programme, emphasis is usually placed on developing the varieties which could perform fairly well under varying environmental conditions. For achieving this objective, it becomes imperative to have the basic information on the extent of genotype x environment interactions for yield and its component characters. Genotype x environment interactions are of major importance to the plant breeder in developing stable genotypes that interact less with the environment in which they are to be grown. If stability performance or the ability to show a minimum interaction with the environment is a genetic characteristic, then preliminary evaluation could be planned to identify the stable genotypes. Stability is the ability to show a minimum interaction with the environments (Eberhart and Russel, 1966). Hence, the stability of genotype performance is directly related to the effect of G X E (Campbell and Jones, 2005). The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is tested (Finlay and Wilkinson, 1963). A genotype is considered to be more adaptive/stable one, if it has high mean yield but a low degree of fluctuation in yielding ability when grown over diverse environments and different genotypes respond differently to specific location (Sawargaokar *et al*., 2011). Therefore, knowledge of G X E interaction and yield stability are important for breeding new cultivars with improved adaption to environmental constraints prevailing in the target environments. The present research study was conducted to identify stable and high yielding pigeonpea genotypes under changing environments.

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MATERIALS AND METHODS

A line x tester mating design was used to develop 32 F_1 hybrids using four CGMS lines ICPA-2043, ICPA-2047, ICPA-2092 with A_4 cytoplasm, derived from *C.cajanifolius* (Saxena *et al*. 2005b) developed at ICRISAT and BSMR-736A with A_2 cytoplasm, derived from *C.scarabaeoides* (Tikka *et al*., 1997; Saxena and Kumar , 2003) from Agricultural Research Station, Badnapur ,V.N.M.A.U., Parbhani. The tester materials comprised of 2 genotypes (ICPR-2671, ICPL-20181) obtained from International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru (Andhra Pradesh), 5 genotypes (BSMR-79, BSMR-175, BSMR-316, BSMR-528 and BSMR-253) from Agricultural Research Station, Badnapur, V.N.M.A.U., Parbhani. RVSA-0722 selected from local germplasm. All these materials were evaluated at three selected environments viz., Parbhani (E_1), Nanded (E_2) and Badnapur (E_3). All these 32 cross combinations were made during *kharif* 2012 in a line (4) x tester (8) mating design and sufficient number of hand pollinated seeds were produced during 2012 rainy season at the Department of Agricultural Botany, Vasantrao Naik Marathwada Agricultural University, Parbhani. The 32 F_1s and 12 parents in all the three environments were planted with two replications. The inter and intra row spacing was kept at 90 cm and 30 cm, respectively. Observations on five randomly selected competitive plants in all the environments were recorded for number of pods plant^{-1} and grain yield plant^{-1} (g). Statistical analysis was performed using SAS software available at ICRISAT, Patancheru.

RESULTS AND DISCUSSION

Stable genotypes are usually sought for commercial production of crop plants. In any breeding program it is necessary to screen and identify stable genotypes, which could perform more or less uniformly under different environmental conditions. Considering this fact in mind the present investigation was carried out to collect information on genotypes of pigeonpea which may be of great use in launching a dynamic and efficient breeding programme. The pooled analysis of variance for stability of grain yield and number of pods plant $^{-1}$ showed significant differences among the genotypes under study (Table1). The genotypes x environment interactions were significant for number of pods plant^{-1} and grain yield plant $^{-1}$ (g). This indicates that these characters were unstable and can fluctuate in their expression with change in environments. The interaction between genotype and environment including linear was highly significant for number of pods plant^{-1} and grain yield plant^{-1} (g). This indicates that for these characters the genotypes differed from each other with respect to their linear response. In accordance to this result Idhole *et al.* (2016) also reported in Soybean the magnitude of linear component i.e. environment (linear) was many times higher than the non-linear component (pooled deviation) for both the characters indicating that the prediction of stability could be reliable though it may get affected to some extent . The non-linear component was significant for both the characters which exhibited genotype x environment interaction. It suggests that a large portion of genotype x environment interaction was accounted by non linear function. A significant pooled deviation indicated that genotypes differed considerably with respect to their stability for grain yield and number of pods plant^{-1}. Phad *et al*. (2005) reported significant differences for the stability of the crosses evaluated over four environments.

Genotypes with unit regression coefficient and non-significant or least deviation (s^2di) are considered as average stable. When this is associated with high mean, genotypes have general adaptability, but when the mean is low, genotypes have poor adaptability in all of the environments (Fig. 1 and Fig. 2). Regression values increasing above unity (bi >1.0) reflects increasing sensitivity of the genotypes to environmental change (below average stability) and greater stability of adaptation to favourable environments. Regression coefficient decreasing below unity (bi<1.0) indicate greater resistance to environmental change (above average stability) and therefore increasing specificity to poor environments. Male parents ICPR-2671 and BSMR-79 recorded comparable means but recorded highest deviation from regression indicating sensitivity of above parents to environmental fluctuation (Table 2). Crosses ICPA-2047 X BSMR-175, ICPA-2047 X ICPR-2671 and ICPA-2043 X ICPR-2671 were stable and specifically adapted to favourable or rich environment for number of pods. In accordance to this result Solanki *et al.* (2014) also identified stable genotypes for number of pods plant $^{-1}$ in soybean. Parents ICPA – 2043 and ICPA – 2047 were stable and indicated greater resistance to environmental change (above average stability) and therefore increasing specificity to poor environments and cross combination ICPA – 2047 x BSMR –175 was the only cross with high mean and regression coefficient nearer to unity which indicated that, this cross was stable and widely adapted to all over environments. Crosses ICPA – 2043 x ICPR – 2671 and ICPA – 2092 x ICPL – 20181were stable and specifically adapted to poor environments for grain yield plant^{-1} (Fig. 2). This is in support with the results of Ghodke *et al*.(1992), Khapre *et al*. (1996) and Manivel *et al*. (1998), who also identified the stable genotype on the basis of high mean, regression coefficient not deviating from unity and non-significant minimum deviation from regression in pigeonpea. Phad *et al*. (2005) and Muthiah and Kalaimagal (2005) reported stability of experimental hybrids under stress environments and also found that only few hybrids performed better only under favourable environments.

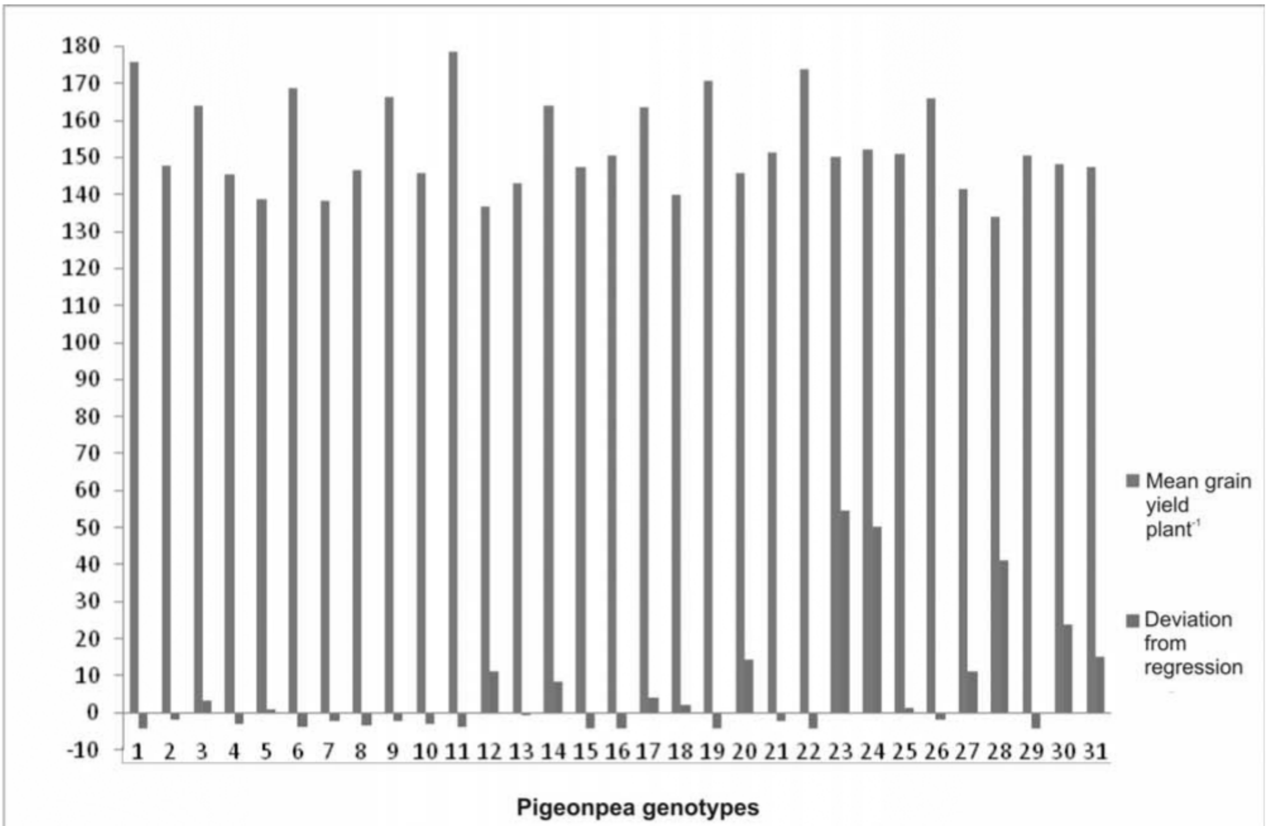


Fig. Stability parameters of crosses (mean performance and deviation from regression) for grain yield plant^{-1}

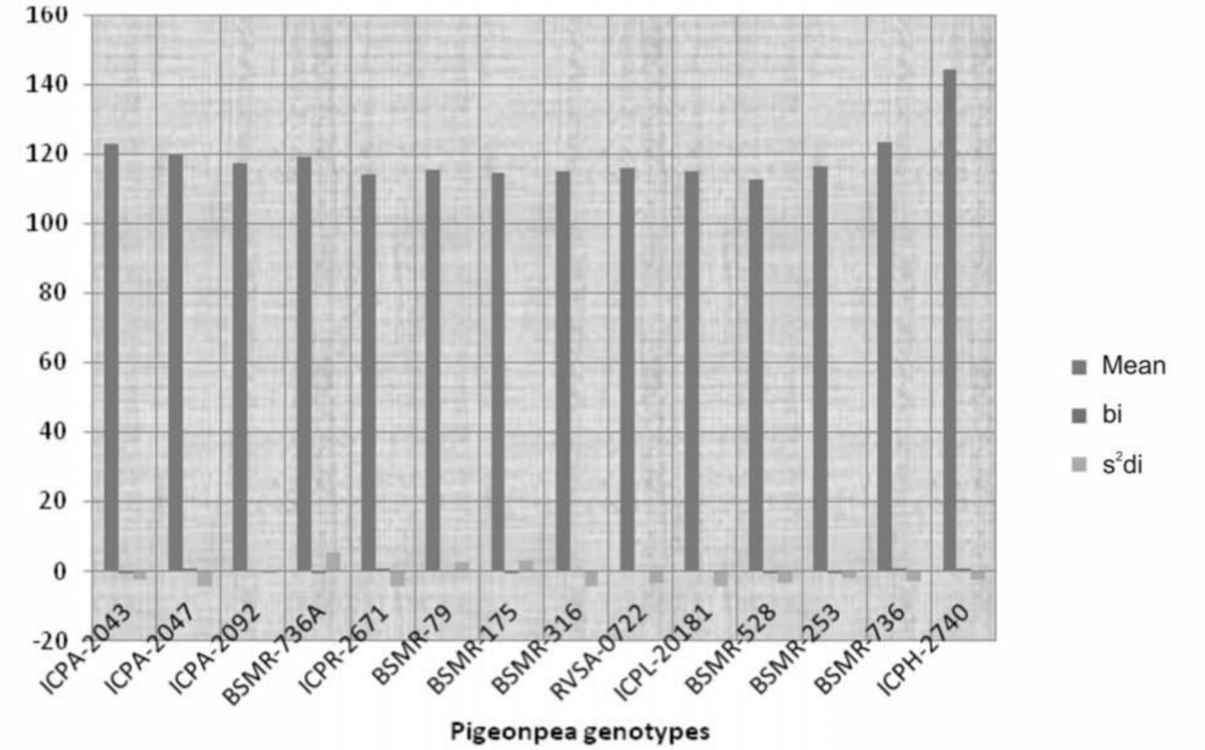


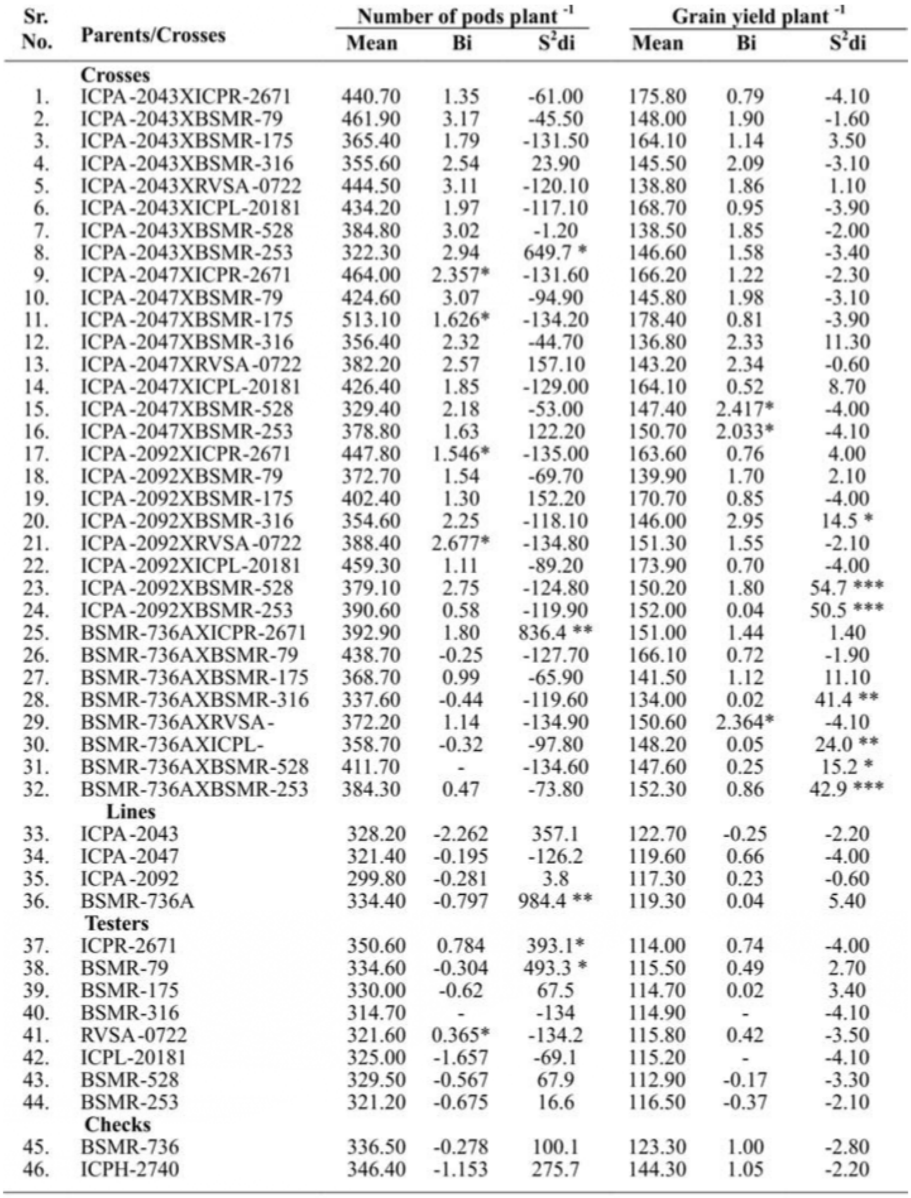
Fig.2. Stability parameters of parents (mean performance regression coefficient and deviation from regression) for grain yield plant^{-1}

Table 1. Analysis of variance for stability parameters of genotypes over three environments

Source of variation	D.F.	Mean sum of squares	
		Number of pods plant^{-1}	Grain yield plant $^{-1}$ (g)
		6	9
Rep within	3	951.83	4.91
Varieties	45	7492.88**	1115.92**
Env.+ (Var.* Env.)	92	587.99**	31.58**
Environments	2	7625.60**	713.67**
Var.* Env.	90	431.60**	16.42**
Environments (Lin.)	1	15251.21**	1427.34**
Var.*	45	689.22**	23.91**
Pooled	46	170.20*	8.73**
Pooled Error	135	116.65	4.10

***, ** Significant at 5 per cent and 1 per cent level, respectively at pooled deviation**

Table 2. Estimates of stability parameters for number of pods plant^{-1} and grain yield plant $^{-1}$ (g) in pigeonpea.



Sr. No.	Parents/Crosses	Number of pods plant $^{-1}$			Grain yield plant $^{-1}$		
		Mean	Bi	S^{2}di	Mean	Bi	S^{2}di
	Crosses						
1.	ICPA-2043XICPR-2671	440.70	1.35	-61.00	175.80	0.79	-4.10
2.	ICPA-2043XBSMR-79	461.90	3.17	-45.50	148.00	1.90	-1.60
3.	ICPA-2043XBSMR-175	365.40	1.79	-131.50	164.10	1.14	3.50
4.	ICPA-2043XBSMR-316	355.60	2.54	23.90	145.50	2.09	-3.10
5.	ICPA-2043XRVSA-0722	444.50	3.11	-120.10	138.80	1.86	1.10
6.	ICPA-2043XICPL-20181	434.20	1.97	-117.10	168.70	0.95	-3.90
7.	ICPA-2043XBSMR-528	384.80	3.02	-1.20	138.50	1.85	-2.00
8.	ICPA-2043XBSMR-253	322.30	2.94	649.7 *	146.60	1.58	-3.40
9.	ICPA-2047XICPR-2671	464.00	2.357*	-131.60	166.20	1.22	-2.30
10.	ICPA-2047XBSMR-79	424.60	3.07	-94.90	145.80	1.98	-3.10
11.	ICPA-2047XBSMR-175	513.10	1.626*	-134.20	178.40	0.81	-3.90
12.	ICPA-2047XBSMR-316	356.40	2.32	-44.70	136.80	2.33	11.30
13.	ICPA-2047XRVSA-0722	382.20	2.57	157.10	143.20	2.34	-0.60
14.	ICPA-2047XICPL-20181	426.40	1.85	-129.00	164.10	0.52	8.70
15.	ICPA-2047XBSMR-528	329.40	2.18	-53.00	147.40	2.417*	-4.00
16.	ICPA-2047XBSMR-253	378.80	1.63	122.20	150.70	2.033*	-4.10
17.	ICPA-2092XICPR-2671	447.80	1.546*	-135.00	163.60	0.76	4.00
18.	ICPA-2092XBSMR-79	372.70	1.54	-69.70	139.90	1.70	2.10
19.	ICPA-2092XBSMR-175	402.40	1.30	152.20	170.70	0.85	-4.00
20.	ICPA-2092XBSMR-316	354.60	2.25	-118.10	146.00	2.95	14.5 *
21.	ICPA-2092XRVSA-0722	388.40	2.677*	-134.80	151.30	1.55	-2.10
22.	ICPA-2092XICPL-20181	459.30	1.11	-89.20	173.90	0.70	-4.00
23.	ICPA-2092XBSMR-528	379.10	2.75	-124.80	150.20	1.80	54.7 ***
24.	ICPA-2092XBSMR-253	390.60	0.58	-119.90	152.00	0.04	50.5 ***
25.	BSMR-736AXICPR-2671	392.90	1.80	836.4 **	151.00	1.44	1.40
26.	BSMR-736AXBSMR-79	438.70	-0.25	-127.70	166.10	0.72	-1.90
27.	BSMR-736AXBSMR-175	368.70	0.99	-65.90	141.50	1.12	11.10
28.	BSMR-736AXBSMR-316	337.60	-0.44	-119.60	134.00	0.02	41.4 **
29.	BSMR-736AXRVSA-	372.20	1.14	-134.90	150.60	2.364*	-4.10
30.	BSMR-736AXICPL-	358.70	-0.32	-97.80	148.20	0.05	24.0 **
31.	BSMR-736AXBSMR-528	411.70	-	-134.60	147.60	0.25	15.2 *
32.	BSMR-736AXBSMR-253	384.30	0.47	-73.80	152.30	0.86	42.9 ***
	Lines						
33.	ICPA-2043	328.20	-2.262	357.1	122.70	-0.25	-2.20
34.	ICPA-2047	321.40	-0.195	-126.2	119.60	0.66	-4.00
35.	ICPA-2092	299.80	-0.281	3.8	117.30	0.23	-0.60
36.	BSMR-736A	334.40	-0.797	984.4 **	119.30	0.04	5.40
	Testers						
37.	ICPR-2671	350.60	0.784	393.1*	114.00	0.74	-4.00
38.	BSMR-79	334.60	-0.304	493.3 *	115.50	0.49	2.70
39.	BSMR-175	330.00	-0.62	67.5	114.70	0.02	3.40
40.	BSMR-316	314.70	-	-134	114.90	-	-4.10
41.	RVSA-0722	321.60	0.365*	-134.2	115.80	0.42	-3.50
42.	ICPL-20181	325.00	-1.657	-69.1	115.20	-	-4.10
43.	BSMR-528	329.50	-0.567	67.9	112.90	-0.17	-3.30
44.	BSMR-253	321.20	-0.675	16.6	116.50	-0.37	-2.10
	Checks						
45.	BSMR-736	336.50	-0.278	100.1	123.30	1.00	-2.80
46.	ICPH-2740	346.40	-1.153	275.7	144.30	1.05	-2.20

It was concluded from this studies that none of the genotypes studied was found superior for yield in all the environments. Parent ICPA-2043 was stable and indicated greater resistance to environmental change and therefore increasing specificity to poor environments. ICPA-2047 X BSMR-175 was the only cross with high mean and regression coefficient near to unity, and therefore is stable and widely adapted to all the environments. The stable genotypes identified could be used as parents in future breeding programme for developing suitable genotypes with wider adaptability.

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