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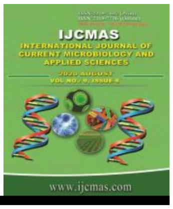

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Stability Analysis of Pistillate x Pistillate based Hybrids and their Parents for Seed Yield in Castor (*Ricinus communis* L.)

A. R. Aher*, M. S. Kamble, M. S. Mote, A. G. Bhoite and S. R. Shinde

Agricultural Botany Division, RCSM College of Agriculture, Kolhapur 416004
(University: Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra), India

**Corresponding author*

ABSTRACT

Thirty six pistillate x pistillate base hybrids, nine parents and one commercial check were evaluated under three environments in randomized complete block design with three replications. Significant differences were observed for genotype, environments and genotype x environment interaction. Stability analysis revealed that none of the genotypes was found consistently stable for all five characters in any environment. Base on mean, regression coefficient (bi) and deviation from regression (S^2di) the parent ANDCP-06-07 as well as hybrids ANDCP-08-01 x JP-65, ANDCP-06-07 x ACP-1-06-07, ANDCP-06-07 x DPC-9, VP-1 x DPC-9 and DPC-9 x ANDCP-06-07-1 had average stability and wider adaptability; whereas, parents ACP-1-06-07, SKP-84, ANDCP-06-07-1 and hybrid ACP-1-06-07 x JP-65 had above average stability and well adapted to poor environment, similarly hybrids ANDCP-08-01 x ANDCP-06-07-1, ACP-06-07-1 x DPC-9, GCH-7 (Check) had below average stability and specifically adapted to favorable environment for seed yield per plant.

Keywords

Ricinus communis L., Pistillate x pistillate G x E interaction, Stability

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Introduction

Castor is grown in tropical, sub-tropical and temperate regions of the world. It is cultivated in about 30 countries on commercial scale. Among those, India, Brazil, China, Russia, Thailand and Philippines are the principal castor growing countries. Being the largest producer, India is also largest exporter of castor seed oil and exports 80% of its total castor oil to China, which is the world's largest importer of castor oil followed by US, Japan, Thailand and other European countries. Gujarat is leading castor growing state, where the crop was grown in around 8.72 lakh ha. with 17.88 lakh tonnes production and productivity of 2050 kg/ha (Anno, 2019).

Development and adaption of high yielding genotypes under wider range of diversified environments is one of the major goals for the plant breeders in castor improvement programme. Therefore, the present study of the genotype x environment interaction is important in F_1 generation is that the F_1S, which are stable in varied environments, are likely to produce stable segregants in succeeding generations, and those may be looked for selection of desirable genotypes. Generally multilocation trials are conducted for the several years to find out stability. However, economy could be exercised by manipulating agronomic differentials like sowing dates, plant geometry, doses of fertilizer, irrigations, spacing etc. at a single sowing location and season. In order to minimize genotypes x environments interactions, and to increase precision in selection, stratification of environments has been employed; however, even with refinement of technique, an interaction of genotypes with environments within same year remains very large (Allard and Bradshaw, 1964).

The testing of genotypes over environments proves an opportunity to study the adaptability of a genotype to a particular environment and also the stability of a genotype over different environments. Precise knowledge on the nature and magnitude of genotype x environment interactions is important in understanding the stability in yield of a particular variety or hybrid before it is being recommended for a given situation. The present study was undertaken to identify stable pistillate x pistillate hybrids and their parents for seed yield and four component characters.

Materials and Methods

The experimental material consisted of nine genetically diverse pistillate lines *viz.* ANDCP-08-01, ANDCP-06-07, ACP-1-06-07, SKP-84, VP-1, DPC-9, JP-65, ANDCP-06-07-1 and ANDCP-06-07-2 were crossed in half diallel mating fashion. The resulting 46 genotypes (36 hybrids + 9 parents + GCH-7 as commercial check) were grown in Randomized Complete Block Design with three replications in three environments *viz.*, E1 (Late *kharif* – Second week of September; 120 x 60 cm^2), E2 (*Autumn* - Second week of October; 90 x 60 cm^2) and E3 (*Rabi*- First week of November; 90 x 45 cm^2). The investigation was carried out at Regional Research Station, Anand Agricultural University, Anand. All recommended package of practices were followed for good crop stand and growth. Five competitive plants in each replication were randomly selected for recording seed yield per plant, plant height up to base of primary raceme and number of nodes up to base of primary raceme. Whereas, data on days to 50 % flowering of primary raceme and days to 50 % maturity of primary raceme were recorded on plot basis. The genotype x environment interaction and stability parameters were estimated as per the model of Eberhart and Russell (1966).

Results and Discussion

The results of the combined analysis of variance as per Eberhart and Russell model for seed yield per plant, plant height up to base of primary raceme, number of nodes up to base of primary raceme, days to 50 % flowering of primary raceme and days to 50 % maturity of primary raceme are presented in table 1. The highly significant values of mean square due to genotypes, genotype x environment and environments (linear) for all the characters indicated that environments differed considerably among different sowing dates. This suggesting the existence of considerable variation among the genotypes as well as created environment. Similar finding were also reported by Solanki and Joshi (2003) and Patel (2009). The mean square values due to G X E (linear) and pooled deviation were found to be significant for the all the characters. Significant G x E interactions (linear) for seed yield per plant were earlier reported by Solanki and Joshi (2003), Sasidharan (2005), Chaudhari (2006) and Patel (2009). An evaluation of genotype environment interaction gives an idea of the buffering capacity of the genotypes under study; the low magnitude of genotype environment interactions indicates consistent performance of genotypes over environments for particular characters. Both relative magnitude of linear and non-linear components of G X E interaction would decide, whether the performance of a genotype for the character under consideration would be predictable or not. Since, when both linear and non-linear (pooled deviation) components of G X E interaction are significant, the magnitude of both the components need to be considered, and greater magnitude of linear component suggests possibility for prediction of performance of genotypes over environments.

Environmental index directly reflects the poor or rich environment in terms of negative and positive index, respectively. The higher seed yield per plant was obtained under *Autumn* season (Better environment); whereas, lower seed yield per plant was obtained under late *Kharif* and *Rabi* seasons, which were considered as poor environments. For plant height up to base of primary raceme, days to 50 % flowering of primary raceme and days to 50 % maturity of primary raceme the *rabi* season was considered as better environment and *Autumn* and late *Kharif* season was considered as poor environment. Likewise, for number of nodes up to base of primary raceme the late *Kharif* season was considered as better environment and *Autumn* and *rabi* season was considered as poor environment. None of the environment was found consistently better for all the characters (Table 2).

The estimate of mean performance (x), regression coefficient (bi) and deviation from regression (S^2di) presented in Table 3 to 5. The stability parameters employed for identification of stable genotypes were high or low mean values than population mean as the character has economic importance, a regression coefficient (bi) equals to unity and a mean square deviation from linear regression coefficient statistically equal to zero (S^2d_i). For seed cotton yield per plant 13 genotypes were identified as well adapted to different environments. Among the parental genotypes, parent ANDCP-06-07 had average stability (Mean<parental mean; b_i=0 significant and b_i=1 NS; S^2d_i=0 NS), suggesting it as widely adapted to all the environments. Parents ACP-1-06-07, SKP-84 and ANDCP-06-07-1 had above average stability (Mean>parental mean; b_i=0 significant; b_i=1 significant and b_i<1.00; S^2d_i=0 NS), thereby specifically adapted to poor environment. Among the hybrids, hybridsANDCP-08-01 x JP-65, ANDCP-06-07 x ACP-1-06-07, ANDCP-06-07 x DPC-9, VP-1 x DPC-9 and DPC-9 x ANDCP-06-07-1 were found stable and widely adapted to all the environments (Mean>hybrids mean; b_i=0 significant and b_i=1 non significant; S^2d_i=0 NS), while hybrids ANDCP-08-01 x ANDCP-06-07-1,ACP-06-07-1 x DPC-9, and GCH-7 (Check) had below average stability (Mean>hybrids mean; b_i=0 significant; b_i=1 significant and b_i>1.00; S^2d_i=0 NS), thereby well adapted to favorable environment. On the other hand, hybrid ACP-1-06-07 x JP-65 had above average stability (Mean>hybrids mean; b_i=0 significant; b_i=1 Significant and b_i<1.00; S^2d_i=0 NS), and specifically adapted to unfavorable or poor environment.

For pistillate parent dwarf plant stature is desirable. The parental mean and hybrids mean were 53.55 and 63.22 cm, respectively.

The results revealed that pistillate parent SKP-84 had average stability; whereas, two pistillate parents VP-1 and ANDCP-06-07-1 had above average stability, revealing them specifically adapted to poor environment. Among the hybrids, ANDCP-06-07 x SKP-84 and SKP-84 x ANDCP-06-07-2 had average stability; whereas, four hybrids ANDCP-08-01 x ACP-1-06-07, ANDCP-06-07 xANDCP-06-07-2, ANDCP-06-07 x ANDCP-06-07-2 and SKP-84 x ANDCP-06-07-1 had below average stability, and well adapted to favorable environment, while four hybrids ANDCP-06-07 x ACP-1-06-07, ACP-1-06-07 x ANDCP-06-07-1, ACP-1-06-07 x ANDCP-06-07-2, and VP-1 x ANDCP-06-07-2 had above average stability, thereby specifically adapted to poor environment.

The character number of nodes up to base of primary raceme is positively correlated with plant height, and for pistillate parent requirement is for dwarf plant stature, hence genotypes with minimum number of nodes up to base of primary raceme are favoured. The pistillate parent ANDCP-06-07-1 and hybrids ANDCP-08-01 x VP-1, ANDCP-08-01 x ANDCP-06-07-1, ANDCP-06-07 x ANDCP-06-07-1, ACP-1-06-07 x DPC-9 and VP-1 x JP-65 had average stability. Whereas two hybrids VP-1 x ANDCP-06-07-1 and VP-1 x ANDCP-06-07-2 had below average stability; hence, specifically adapted to favorable environment, and four hybrids ANDCP-08-01 x SKP-84, ANDCP-08-01 x JP-65, ANDCP-06-07 x JP-65 and DPC-9 x ANDCP-06-07-1 had above average stability, thereby specifically adapted to poor environment.

Earliness is prerequisite for any crop species in climate change, hence minimum days to 50% flowering and maturity of primary raceme are desirable. For days to 50% flowering of primary raceme the parental genotypes, ANDCP-06-07, SKP-84 and ANDCP-06-07-2 had average stability, whereas parents VP-1 and ANDCP-06-07-1 had above average stability specifically adapted to poor environment. Among hybrids, nine hybrids ANDCP-08-01 x ANDCP-06-07,ANDCP-08-01 x SKP-84, ANDCP-08-01 x DPC-9, ANDCP-06-07 x DPC-9, ANDCP-06-07 x JP-65, ANDCP-06-07 x ANDCP-06-07-1, ACP-1-06-07 x VP-1, SKP-84x ANDCP-06-07-1, SKP-84 x ANDCP-06-07-2 and GCH-7 (Check) had average stability; while two hybrids ANDCP-06-07 x ANDCP-06-07-2 and SKP-84 x DPC-9 had below average stability; whereas, six hybrids ANDCP-08-01 x ACP-1-06-07, ANDCP-08-01 x JP-65, ANDCP-06-07 x VP-1, ACP-1-06-07 x DPC-9, VP-1 x ANDCP-06-07-1 and VP-1 x ANDCP-06-07-2 had above average stability, thereby specifically adapted to poor environment.

For days to 50% maturity of primary raceme the pistillate parents, parents ANDCP-06-07, DPC-9 and ANDCP-06-07-1 had below average stability, thereby adapted to better environment. Whereas, two pistillate parents SKP-84 and VP-1 had above average stability, hence specifically adapted to poor environment. Among the hybrids, hybrids ANDCP-06-07 x ANDCP-06-07-2, ACP-1-06-07 x DPC-9, SKP-84 x DPC-9, SKP-84 x ANDCP-06-07-1, SKP-84x ANDCP-06-07-2, VP-1 x ANDCP-06-07-1 and VP-1 x ANDCP-06-07-2 had average stability, and these hybrids would have wide adaptation; whereas, hybrids ANDCP-08-01 x DPC-9, ANDCP-06-07 x VP-1, VP-1 xJP-65 and ANDCP-06-07-1 x ANDCP-06-07-2had below average stability and hybrids ANDCP-08-01 x ANDCP-06-07, ANDCP-08-01 x SKP-84, ACP-1-06-07 x VP-1, and DPC-9 x ANDCP-06-07-2 had above average stability (Mean<hybrids mean; $b_i=0$ significant; $b_i=1$ significant and $b_i<1.00$; $S^2d_i=0$ NS); thereby specifically adapted to poor environment.

Table.1 Analysis of variance for phenotypic stability for different characters in castor

Source	df	Seed yield per plant		Plant height up to base of primary raceme		Number of nodes up to base of primary raceme	
Rep. within Env.	6	497.994		32.25	*	3.086	# **
Genotypes	45	16320.820	@@ ## **	1965.236	@@ ## **	8.231	@@ ## **
Environments	2	219969.500	@@ ## **	503.359	@@ ## **	112.176	@@ ## **
Geno. x Env.	90	4846.68	**	53.585	**	1.688	# **
Env. + (Geno. x Env.)	92	9523.264	## **	63.363	# **	4.090	## **
Environments (Lin.)	1	439939.100	## **	1006.717	## **	224.351	## **
Geno. x Env. (Lin.)	45	6019.572	# **	68.470	# **	2.296	## **
Pooled deviation	46	3593.923	**	37.860	**	1.057	**
Pooled error	270	457.154		12.227		0.545	
Total		11756.04		688.066		5.45	

Source	df	Days to 50 % flowering of primary raceme		Days to 50 % maturity of primary raceme	
Rep. within Env.	6	49.225	@@ ## **	23.589	**
Genotypes	45	58.698	@@ ## **	133.981	@@ ## **
Environments	2	5615.406	@@ ## **	4527.781	@@ ## **
Geno. x Env.	90	10.897	**	20.000	**
Env. + (Geno. x Env.)	92	132.734	## **	117.995	## **
Environments (Lin.)	1	11230.810	## **	9055.562	## **
Geno. x Env. (Lin.)	45	13.866	# **	23.817	**
Pooled deviation	46	7.756	**	15.831	**
Pooled error	270	4.644		6.561	
Total		108.416		123.246	

@, @@ Significant tested against genotypes x environments (G x E) at 0.05 and 0.01 levels of probability, respectively
Significant tested against pooled deviation at 0.05 and 0.01 levels of probability, respectively
*, ** Significant tested against pooled error at 0.05 and 0.01 levels of probability, respectively

Table.2 Environmental index (I) for different quantitative characters

SN	Characters	I_1	I_2	I_3
1.	Seed yield per plant	-38.799	79.839	-41.040
2.	Plant height up to primary raceme	-1.461	-2.326	3.787
3.	Number of nodes up to primary raceme	1.802	-0.947	-0.856
4.	Days to 50 % flowering of primary raceme	-8.328	-4.205	12.534
5.	Days to 50 % maturity of primary raceme	-7.614	-3.606	11.220

I_1, I_2 and I_3 environmental index for environments E_1, E_2 and E_3, respectively.

Table.3 Stability parameters for seed yield per plant

S.No	Parents / Crosses	Code	Seed yield per plant				
			Mean	b_i		S^2d_i	
1	ANDCP-08-01	P1	116.79	0.84	**@	-410.73	
2	ANDCP-06-07	P2	174.98	0.23	**	167.80	
3	ACP-1-06-07	P3	169.62	0.51	**@@	-194.79	
4	SKP-84	P4	195.21	0.78	**@@	-436.59	
5	VP-1	P5	196.18	1.27	*	2384.78	#

6	DPC-9	P6	128.72	-0.04		5944.63	#
7	JP-65	P7	135.49	-0.53		25133.88	#
8	ANDCP-06-07-1	P8	193.29	0.71	**@	-320.66	
9	ANDCP-06-07-2	P9	167.75	0.53		3412.96	#
	Parental Mean		**164.22**				
10	ANDCP-08-01 **x** ANDCP-06-07	P1 x P2	211.90	1.09	*	2123.99	#
11	ANDCP-08-01 **x** ACP-1-06-07	P1 x P3	208.51	0.38	@	319.31	
12	ANDCP-08-01 **x** SKP-84	P1 x P4	197.41	0.08		5723.93	#
13	ANDCP-08-01 **x** VP-1	P1 x P5	203.90	-0.06		4967.29	#
14	ANDCP-08-01 **x** DPC-9	P1 x P6	223.87	1.38		5516.22	#
15	ANDCP-08-01 **x** JP-65	P1 x P7	366.42	0.93	**	-335.58	
16	ANDCP-08-01 **x** ANDCP-06-07-1	P1 x P8	262.16	2.10	**@@	365.54	
17	ANDCP-08-01 **x** ANDCP-06-07-2	P1 x P9	221.82	1.36		5928.43	#
18	ANDCP-06-07 **x** ACP-1-06-07	P2 x P3	264.05	0.95	**	-435.09	
19	ANDCP-06-07 **x** SKP-84	P2 x P4	210.51	0.13	@@	570.35	
20	ANDCP-06-07 **x** VP-1	P2 x P5	172.55	0.11	@	1040.92	
21	ANDCP-06-07 **x** DPC-9	P2 x P6	308.72	1.51	**	319.95	
22	ANDCP-06-07 **x** JP-65	P2 x P7	371.17	1.32		4116.71	#
23	ANDCP-06-07 **x** ANDCP-06-07-1	P2 x P8	128.64	0.22	*@@	-338.168	
24	ANDCP-06-07 **x** ANDCP-06-07-2	P2 x P9	172.32	0.69		1003.87	
25	ACP-1-06-07 **x** SKP-84	P3 x P4	211.85	0.17		11997.35	#
26	ACP-1-06-07 **x** VP-1	P3 x P5	209.41	1.25	**	455.32	
27	ACP-1-06-07 **x** DPC-9	P3 x P6	329.93	2.14	**@@	-381.82	
28	ACP-1-06-07 **x** JP-65	P3 x P7	297.50	0.29	@@	-230.42	
29	ACP-1-06-07 **x** ANDCP-06-07-1	P3 x P8	240.61	1.78	**@@	-444.48	
30	ACP-1-06-07 **x** ANDCP-06-07-2	P3 x P9	172.29	0.82	**	-353.26	
31	SKP-84 **x** VP-1	P4 x P5	204.30	1.10	**	552.41	
32	SKP-84 **x** DPC-9	P4 x P6	355.28	0.69		5058.24	#
33	SKP-84 **x** JP-65	P4 x P7	410.35	2.19	*	8714.75	#
34	SKP-84 **x** ANDCP-06-07-1	P4 x P8	231.31	1.57	**@@	-216.99	
35	SKP-84 **x** ANDCP-06-07-2	P4 x P9	245.62	1.51	**@@	-156.38	
36	VP-1 **x** DPC-9	P5 x P6	305.38	1.32	**	276.35	
37	VP-1 **x** JP-65	P5 x P7	317.71	2.07	**	3304.86	#
38	VP-1 **x** ANDCP-06-07-1	P5 x P8	219.79	0.46		3580.15	#
39	VP-1 **x** ANDCP-06-07-2	P5 x P9	182.96	0.63	**@@	-264.62	
40	DPC-9 **x** JP-65	P6 x P7	234.49	0.64		22812.66	#
41	DPC-9 **x** ANDCP-06-07-1	P6 x P8	302.89	1.23	**	618.40	
42	DPC-9 **x** ANDCP-06-07-2	P6 x P9	291.65	2.22	**	5699.24	#
43	JP-65 **x** ANDCP-06-07-1	P7 x P8	368.75	2.52	**	7211.79	#
44	JP-65 **x** ANDCP-06-07-2	P7 x P9	319.18	1.74	**	3020.55	#
45	ANDCP-06-07-1 **x** ANDCP-06-07-2	P8 x P9	238.05	0.04		6236.23	#
46	GCH-7	Check	358.64	3.16	**@@	234.71	
	Hybrids Mean		**258.70**				

*, ** Significant at 0.05 and 0.01 percent level, respectively when H_0: b=0

@, @@ Significant at 0.05 and 0.01 percent level respectively, when H_0: b=1

Significant at 0.05 percent level

Table.4 Stability parameters for plant height up to base of primary raceme and number of nodes up to base of primary raceme

SN	Parents / Crosses	Code	Plant height up to base of primary raceme					Number of nodes up to primary raceme				
			Mean	b_i		S^2d_i		Mean	b_i		S^2d_i	
1	ANDCP-08-01	P1	26.73	0.85		-6.35		14.96	0.45		1.79	#
2	ANDCP-06-07	P2	44.29	0.87		-4.78		16.02	0.41		0.30	
3	ACP-1-06-07	P3	57.44	-2.15		70.33	#	20.33	2.38	**	3.06	#
4	SKP-84	P4	46.20	0.97	**	-9.52		18.04	1.47	**	0.17	
5	VP-1	P5	35.27	-1.18	**@@	-8.48		12.78	2.13	*	5.00	#
6	DPC-9	P6	73.87	1.61	**	-9.62		14.84	-0.15	@@	0.24	
7	JP-65	P7	109.47	0.47	**@@	-12.12		18.04	1.11	**	-1.20	
8	ANDCP-06-07-1	P8	45.67	-2.11	**@@	-12.21		15.16	1.46	**	0.10	
9	ANDCP-06-07-2	P9	43.02	0.85		27.82		16.56	0.44		0.05	
	Parental Mean		**53.55**					**16.30**				
10	ANDCP-08-01 **x** ANDCP-06-07	P1 x P2	33.16	1.25		2.18		14.18	0.92		1.17	
11	ANDCP-08-01 **x** ACP-1-06-07	P1 x P3	36.51	2.28	**@@	-8.36		14.67	1.31		1.70	#
12	ANDCP-08-01 **x** SKP-84	P1 x P4	36.20	0.23		1.54		14.42	0.22	@@	-0.29	
13	ANDCP-08-01 **x** VP-1	P1 x P5	34.87	1.30		-4.04		14.40	1.31	**	0.11	
14	ANDCP-08-01 **x** DPC-9	P1 x P6	75.51	0.38		-7.44		13.51	0.47		1.83	#
15	ANDCP-08-01 **x** JP-65	P1 x P7	76.42	0.96		43.86	#	15.11	0.64	**@@	-0.53	
16	ANDCP-08-01 **x** ANDCP-06-07-1	P1 x P8	36.42	1.87		14.53		14.87	1.43	**	0.10	
17	ANDCP-08-01 **x** ANDCP-06-07-2	P1 x P9	40.42	0.78		20.96		15.78	1.09	**	-0.30	
18	ANDCP-06-07 **x** ACP-1-06-07	P2 x P3	51.58	-1.05	**@@	-11.86		17.29	2.13	**@@	-0.33	
19	ANDCP-06-07 **x** SKP-84	P2 x P4	38.60	1.87	*	7.22		16.13	0.53		1.11	
20	ANDCP-06-07 **x** VP-1	P2 x P5	31.36	0.93		14.10		13.51	1.84	*	2.26	#
21	ANDCP-06-07 **x** DPC-9	P2 x P6	90.22	3.00	**@@	-12.17		14.53	0.15	@@	-0.51	
22	ANDCP-06-07 **x** JP-65	P2 x P7	78.78	5.06	**@@	12.03		15.22	0.66	**@@	-0.51	
23	ANDCP-06-07 **x** ANDCP-06-07-1	P2 x P8	46.80	2.14	**@@	-11.44		15.49	1.25	**	-0.03	
24	ANDCP-06-07 **x** ANDCP-06-07-2	P2 x P9	48.80	2.28	**@@	-12.03		15.93	0.61	@@	0.05	
25	ACP-1-06-07 **x** SKP-84	P3 x P4	60.42	-0.70		58.69	#	19.84	2.89	**@@	-0.44	
26	ACP-1-06-07 **x** VP-1	P3 x P5	50.22	0.57		-8.53		17.00	1.59	**	-0.43	
27	ACP-1-06-07 **x** DPC-9	P3 x P6	82.09	1.08		60.20	#	15.11	0.82	**	-0.22	
28	ACP-1-06-07 **x** JP-65	P3 x P7	122.71	4.41	**@@	17.74		16.98	0.72	**	-0.44	
29	ACP-1-06-07 **x** ANDCP-06-07-1	P3 x P8	59.11	0.49	**@@	-12.16		17.76	1.03	**	-0.42	
30	ACP-1-06-07 **x** ANDCP-06-07-2	P3 x P9	50.47	-1.49	**@@	-12.12		19.16	1.72	**@@	-3.31	
31	SKP-84 **x** VP-1	P4 x P5	39.82	0.95		20.17		16.71	0.99	**	0.15	
32	SKP-84 **x** DPC-9	P4 x P6	65.76	1.98		94.57	#	14.91	0.59		3.60	#
33	SKP-84 **x** JP-65	P4 x P7	103.51	3.85	**@	30.78		17.96	0.87	**	-0.51	
34	SKP-84 **x** ANDCP-06-07-1	P4 x P8	47.82	2.52	**@@	-12.03		16.69	1.25	*	-0.52	
35	SKP-84 **x** ANDCP-06-07-2	P4 x P9	48.02	2.16	*	0.85		16.11	1.29	*	0.87	
36	VP-1 **x** DPC-9	P5 x P6	93.20	-3.11		600.66	#	15.67	-0.24	@	0.70	
37	VP-1 **x** JP-65	P5 x P7	84.04	5.52	**@@	19.95		14.11	1.02	**	-0.38	
38	VP-1 **x** ANDCP-06-07-1	P5 x P8	36.71	-0.60		25.25		13.11	2.04	**@@	-0.44	
39	VP-1 **x** ANDCP-06-07-2	P5 x P9	34.80	-0.91	**@@	-12.09		13.93	1.85	**@@	-0.52	
40	DPC-9 **x** JP-65	P6 x P7	98.07	1.26	**	-9.88		15.22	0.45		2.08	#
41	DPC-9 **x** ANDCP-06-07-1	P6 x P8	88.76	0.04		104.82	#	15.58	0.42	**@@	-0.52	
42	DPC-9 **x** ANDCP-06-07-2	P6 x P9	80.96	0.91		-6.31		14.91	0.32	**	4.25	#
43	JP-65 **x** ANDCP-06-07-1	P7 x P8	106.71	0.11		20.02		16.07	0.38	@	-0.14	
44	JP-65 **x** ANDCP-06-07-2	P7 x P9	100.00	0.81		36.26	#	16.20	0.11	@@	-0.53	
45	ANDCP-06-07-1 **x** ANDCP-06-07-2	P8 x P9	45.36	-0.12		48.17	#	16.18	0.65		0.45	
46	GCH-7	Check	85.04	2.82	**	19.95		15.98	1.00	*	0.47	
	Hybrids Mean		**63.22**					**15.68**				

*, ** Significant at 0.05 and 0.01 percent level, respectively when H_0: b=0

@, @@ Significant at 0.05 and 0.01 percent level respectively, when H_0: b=1

Significant at 0.05 percent level

Table.5 Stability parameters for days to 50 % flowering of primary raceme and days to 50 % maturity of primary raceme

SN	Parents / Crosses	Code	Days to 50 % flowering of primary raceme					Days to 50 % maturity of primary raceme				
			Mean	b_i		S^2d_i		Mean	b_i		S^2d_i	
1	ANDCP-08-01	P1	64.00	1.17	**	35.95	#	141.44	0.61	**@	-0.41	
2	ANDCP-06-07	P2	65.56	1.17	**	1099		136.67	1.51	**@@	-6.47	
3	ACP-1-06-07	P3	78.33	1.23	**	29.19	#	148.78	0.83		38.86	
4	SKP-84	P4	67.00	1.05	**	-4.11		138.11	0.42	**@@	-5.10	
5	VP-1	P5	60.56	0.40	**@@	-4.15		128.44	0.74	**@	-4.52	
6	DPC-9	P6	70.44	1.30	**	18.22	#	134.56	1.51	**@@	-5.21	
7	JP-65	P7	73.22	1.41	**@	4.25		156.44	0.94	**	-2.20	
8	ANDCP-06-07-1	P8	59.33	0.64	**@@	-0.08		128.00	1.38	**	2.66	
9	ANDCP-06-07-2	P9	65.67	1.15	**	-2.39		142.67	1.06	*	38.05	#
	Parental Mean		**67.12**					**139.46**				
10	ANDCP-08-01 **x** ANDCP-06-07	P1 x P2	56.67	0.91	**	-0.76		128.67	0.79	**@@	-5.40	
11	ANDCP-08-01 **x** ACP-1-06-07	P1 x P3	62.67	0.61	**@@	-0.53		135.00	0.85	**	-4.64	
12	ANDCP-08-01 **x** SKP-84	P1 x P4	63.00	0.94	**	-3.99		128.11	0.90	**@	-6.08	
13	ANDCP-08-01 **x** VP-1	P1 x P5	64.78	1.01	**	-4.28		136.44	0.91	*	32.64	#
14	ANDCP-08-01 **x** DPC-9	P1 x P6	59.56	0.87	**	2.69		130.67	1.60	**@@	-4.58	
15	ANDCP-08-01 **x** JP-65	P1 x P7	58.78	0.63	**@@	-0.73		134.44	0.97	*	30.61	#
16	ANDCP-08-01 **x** ANDCP-06-07-1	P1 x P8	60.33	0.91	**	20.08	#	126.89	0.49		9.85	
17	ANDCP-08-01 **x** ANDCP-06-07-2	P1 x P9	64.67	1.23	**@@	-4.20		139.33	1.04	**	-1.37	
18	ANDCP-06-07 **x** ACP-1-06-07	P2 x P3	66.22	1.00	**	10.74		135.33	1.02	*	46.57	#
19	ANDCP-06-07 **x** SKP-84	P2 x P4	65.00	1.09	**	1.66		131.67	1.29	**	20.26	#
20	ANDCP-06-07 **x** VP-1	P2 x P5	59.33	0.85	**@@	-4.63		131.00	1.39	**@	0.07	
21	ANDCP-06-07 **x** DPC-9	P2 x P6	61.44	0.99	**	-4.03		142.56	0.71		47.12	#
22	ANDCP-06-07 **x** JP-65	P2 x P7	62.78	1.01	**	-2.22		139.78	0.92	**	-0.78	
23	ANDCP-06-07 **x** ANDCP-06-07-1	P2 x P8	62.22	0.93	**	-3.94		132.67	0.74		60.06	#
24	ANDCP-06-07 **x** ANDCP-06-07-2	P2 x P9	63.11	1.21	**@@	-4.64		131.33	0.98	**	-1.07	
25	ACP-1-06-07 **x** SKP-84	P3 x P4	72.44	0.53	*@	9.30		144.33	0.82	**	2.96	
26	ACP-1-06-07 **x** VP-1	P3 x P5	63.89	0.98	**	5.29		131.11	0.63	**@@	-5.36	
27	ACP-1-06-07 **x** DPC-9	P3 x P6	61.89	0.68	**@@	-3.92		127.11	0.93	**	-5.56	
28	ACP-1-06-07 **x** JP-65	P3 x P7	67.00	1.19	**	7.19		143.89	0.94	**	3.75	
29	ACP-1-06-07 **x** ANDCP-06-07-1	P3 x P8	67.00	1.09	**@@	-4.63		142.33	0.39		30.67	#
30	ACP-1-06-07 **x** ANDCP-06-07-2	P3 x P9	74.33	1.02	**	11.14		144.78	0.64	**@@	-6.52	
31	SKP-84 **x** VP-1	P4 x P5	65.89	1.03	**	2.72		135.00	0.48	**@@	-6.56	
32	SKP-84 **x** DPC-9	P4 x P6	62.67	1.12	**@@	-4.39		128.78	1.13	**	-0.21	
33	SKP-84 **x** JP-65	P4 x P7	66.89	1.17	**@@	-3.95		137.33	0.85	**	-4.64	
34	SKP-84 **x** ANDCP-06-07-1	P4 x P8	62.22	1.15	**	0.28		130.33	1.08	**	-4.49	
35	SKP-84 **x** ANDCP-06-07-2	P4 x P9	63.44	1.01	**	-2.22		127.22	1.16	**	0.38	
36	VP-1 **x** DPC-9	P5 x P6	63.67	0.96	**@@	-4.64		135.56	0.76		32.36	#
37	VP-1 **x** JP-65	P5 x P7	60.33	0.93	**	15.06	#	131.67	1.80	**@@	1.31	
38	VP-1 **x** ANDCP-06-07-1	P5 x P8	55.56	0.66	**@@	-3.64		122.67	1.05	**	-4.05	
39	VP-1 **x** ANDCP-06-07-2	P5 x P9	59.89	0.67	**@@	-2.02		128.33	1.03	**	15.23	
40	DPC-9 **x** JP-65	P6 x P7	64.33	1.12	**	-0.16		139.11	1.37	**	3.96	
41	DPC-9 **x** ANDCP-06-07-1	P6 x P8	65.00	1.21	**@@	-3.23		132.67	0.91	*	24.14	#
42	DPC-9 **x** ANDCP-06-07-2	P6 x P9	62.00	0.95	**	26.62	#	126.89	0.68	**@	1.61	
43	JP-65 **x** ANDCP-06-07-1	P7 x P8	66.22	1.42	**	13.12		136.11	1.37	**	17.87	
44	JP-65 **x** ANDCP-06-07-2	P7 x P9	67.22	1.47	**@@	-0.18		138.11	1.63	**@	7.51	
45	ANDCP-06-07-1 **x** ANDCP-06-07-2	P8 x P9	66.22	1.17	**	-2.87		133.67	1.75	**@	12.26	
46	GCH-7	Check	63.00	0.77	**	-0.50		132.22	1.02	*	31.74	#
	Hybrids Mean		**63.56**					**133.87**				

*, ** Significant at 0.05 and 0.01 percent level, respectively when H_0: b=0
@, @@ Significant at 0.05 and 0.01 percent level respectively, when H_0: b=1
Significant at 0.05 percent level

From present study, it was revealed that none of the crosses was found consistent for its performance over environments for all the attributes, which might be because of sensitivity of parental genes to environmental differences. Such interaction result in change of relative ranking of different genotypes and also alters magnitude of difference between genotypes, which create problem for plant breeders in making proper assessment of genotypes, when the same are tested over varied environments (Comstock and Moll, 1963). Therefore, more vigours testing/ evaluation of the crosses in an array of environments is suggested, environmental specific crosses has been identified with high heterotic and sca effects, and available gene pool may be strengthened with the inclusion of more diverse source of parental genotypes.

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