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Stability analysis in chilli (*Capsicum annuum* L.)*

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Abstract

Twenty cytoplasmic genetic male sterility (CGMS) based F_1 hybrids, three promising genotypes and a check were evaluated in three different environments for stability analysis. The correlation and path coefficient analysis were studied in 75 genotypes for 18 and 12 different quantitative characters, respectively. Variance due to genotypes × environment interactions were significant for all the characters except number of fruits plant^{-1} and fresh fruit weight plant^{-1}. Considering all the stability parameters, JCH-47, BCH-24 and BVC-37 exhibited wider stability for dry fruit yield plant^{-1}, JCH-01 had stability for favourable environment and JCH-05, JCH-14, JCH-23, JCH-24, JCH-54 and RCH-23 showed below average stability. Highest performing F_1 hybrid JCH-54 was identified as stable performer under unfavourable environment for dry fruit yield. The highest correlations were found with dry fruit weight plant^{-1} and fresh fruit weight plant^{-1} (r=1.00), number of fruits plant^{-1} (r=0.63), dry fruit weight fruit^{-1} (r=0.44), number of seeds fruit^{-1} (r=0.35), fresh fruit weight fruit^{-1} (r=0.32) and fruit length (r=0.28). Path analysis indicated that the number of fruits plant^{-1} and fresh fruit weight fruit^{-1} were the two factors that exerted the greatest influence both directly and indirectly upon the dry fruit yield. These two traits were the most important components that involved dry fruit yield plant^{-1}.

Keywords: *Capsicum annuum*, chilli, correlation, genotype × environments, path analysis, stability

Introduction

Chilli (*Capsicum annuum* L.), vegetable-cum-spice is one of the most important commercial crops of India, valued for its industrial (oleoresin extraction) purposes. Chilli has its unique place in Asian diet as a spice as well as vegetable. It is also a high value crop grown commercially in almost all parts of the world. Dry chilli production in world is 2.80 mt with a productivity of 1584 kg ha^{-1} from an area of 1.77 mha. The production in India is estimated to be 1.30 mt in dry weight with a productivity of 1611 kg ha^{-1} from an area of 0.81 mha which makes India the largest producer of chilli in the world (Anonymous 2009). Phenotypic expression of the genotype is variable when grown in different environments. It is observed that G × E interaction is widely present and

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contributes substantially to the non-realization of expected gain from the selection (Comstock & Moll 1963). Stable genotypes are particularly of great importance in the country like India, where the crops are grown in varied environmental conditions. Stability parameters along with the knowledge of interrelationship of plant characters with dry fruit yield plays significant role for improvement of yield for which direct selection is not much effective. Present investigation was carried out to identify stable and high yielding genotypes of chilli for cultivation in Kymore Plateau and Satpura Hill region of Madhya Pradesh through stability analysis and to understand the type of association among characters and the extent and nature of direct and indirect effect of component traits on dry fruit yield.

Materials and methods

Twenty cytoplasmic genetic male sterility based F_1 hybrids, three promising genotypes and a check *viz*., JCH-01, JCH-05, JCH-14, JCH-23, JCH-24, JCH-31, JCH-40, JCH-41, JCH-47, JCH-54, BCH-05, BCH-14, BCH-23, BCH-24, BCH-40, BCH-54, RCH-05, RCH-12, RCH-14, RCH-23, 9608U GUK2-1 BVC-37 and VNR-332 were evaluated in three macro environments by transplanting the seedlings on different dates *viz*., 17th June, 2009 (E1), 3rd August, 2009 (E2) and 20th August, 2009 (E3) for stability analysis during *kharif* season of 2009-2010. The correlation and path coefficient analysis were studied in 75 genotypes *viz*., JCH-06, JCH-O8, JCH-09, JCH-10, JCH-11, JCH-12, JCH-39, BCH-1, BCH-06, BCH-08, BCH-09, BCH-10, BCH-11, BCH-12, BCH-31, BCH-39, BCH-41, BCH-47, RCH-01, RCH-06, RCH-08, RCH-09, RCH-10, RCH-11, RCH-24, RCH-31, RCH-39, RCH-40, RCH-41, RCH-47, RCH-54, JNB-1, ACB-1, ACB-2, UJALA, AMULYA, P.HOT, SNK, PANTC-1, G-4, K1-4C, BVC-1, GUK-1, GUK-2, LCA-334, LCA-960, KDSC-210-10-4, P.JWALA, KA-2, K1-4D, P.SADABAHAR (including the promising genotypes used for stability analysis). The 18 different characters *viz*., days to first flower initiation, days to 50% flowering, days to first fruit ripening, days to first harvest, number of pickings, number of fruits plant^{-1}, fresh fruit weight fruit^{-1} (g), dry fruit weight fruit^{-1} (g), fruit length (cm), fruit diameter (cm), pedicel length (cm), petiole length (cm), number of primary branches, plant height (cm), number of seeds fruit^{-1}, 1000 seed weight (g), fresh fruit weight plant^{-1} (kg) and dry fruit weight plant^{-1} (kg) were used for correlation studies. However, 12 characters which showed positive correlations with fruit weight plant^{-1} *viz*., number of pickings, number of fruits plant^{-1}, fresh fruit weight fruit^{-1} (g), dry fruit weight fruit^{-1} (g), fruit length (cm), fruit diameter (cm), pedicel length (cm), number of primary branches, plant height (cm), number of seeds fruit^{-1}, 1000 seed weight (g) and dry fruit weight plant^{-1} (kg) were selected for path analysis. The 12 characters studied for stability analysis were days to 50% flowering, number of fruits plant^{-1}, dry fruit weight fruit^{-1}, fruit length (cm), fruit diameter (cm), number of primary branches, plant height (cm), number of seeds fruit^{-1}, 1000 seed weight (g), fresh fruit weight plant^{-1} (g), dry fruit weight plant^{-1} (g) and net plot yield (kg).

The experiment was laid out in Randomized Complete Block Design (RCBD) having two replications at Department of Horticulture, Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur during *kharif* 2009–2010 (at 23.9^{o}N latitude, 79.58^{o}E longitude and 411.78 m MSL). The soil of the experimental area was clay loam with uniform topography. The plot size for each accession was 6 m × 1.2 m where in row-to-row and plant-to-plant spacing of 60 cm × 60 cm respectively. The crop was raised as per the standard practice. Observations on 12 and 18 quantitative characters were recorded on five randomly selected plants in each plot for stability and path analysis, and correlation studies respectively. For days to 50% flowering, data were recorded on plot basis. The mean data were subjected to stability analysis as per the model proposed by Eberhart & Russell (1966). Correlation coefficients were computed using the method of Al-jibouri *et al.* (1958). The direct and indirect effects of component characters on yield were established through path analysis technique (Wright 1921).

Results and discussion

Analysis of variance over three environments (Table 1) showed that genotypic variances

Table 1. Analysis of variance for stability in three environments

Characters	Genotypes (G)	Environment (E)	G × E	E + (G× E)	E. (Linear)	G × E (Linear)	Pooled deviation	Pooled error
	Mean sum of square							
D.F.	23	2	46	48	1	23	24	69
Days to 50% flowering	33.49++ ^{aa}	1287.60++	9.35**	60.70 ^{aa}	2575.2^{aa}	13.875^{aa}	0.80400	0.64700
Number of fruits plant^{-1}	49569.9++ ^{aa}	19083.07++	180.42	968.03 ^{aa}	38166.13 ^{aa}	282.06 ^{a}	75.5000	1338.64
Dry fruit weight fruit^{-1}	0.415 ^{aa}	0.01280	0.307**	0.00004 ^{aa}	0.4158 ^{aa}	0.00007 ^{a}	0.00002	0.00004
Fruit length	28.16++ ^{aa}	0.49100	11.767**	0.00154	23.53 ^{aa}	0.00090	0.0021**	0.00548
Fruit diameter	0.408++ ^{aa}	0.00718	0.157**	0.00064	0.315 ^{aa}	0.00006	0.00116	0.00071
No. of primary branches	2.65400	0.19200	4.625**	0.0000	9.25 ^{aa}	0.00000	0.00000	0.00000
Plant height	238.115 ^{aa}	19.0500	321.78**	5.89 ^{aa}	643.56 ^{aa}	8.27500	3.37200	26.4240
Number of seeds fruit^{-1}	1606.35++ ^{aa}	28.2150	566.00**	4.833 ^{aa}	1132.00 ^{aa}	7.02100	2.53400	10.9000
1000 seed weight	1.36100	0.23600	5.664**	0.0000	11.32 ^{aa}	0.00000	0.00000	0.00000
Fresh fruit weight plant^{-1}	0.3549++ ^{aa}	0.655++	0.0047	0.0318 ^{aa}	1.311 ^{aa}	0.0076 ^{a}	0.00180	0.00950
Dry fruit weight plant^{-1}	0.0221 ^{aa}	0.00200	0.0419**	0.00029 ^{aa}	0.0838 ^{aa}	0.00046 ^{a}	0.00011	0.00061
Net plot yield	1.756 ^{aa}	0.15700	3.241*	0.023 ^{aa}	6.482 ^{aa}	0.0372 ^{a}	0.00930	0.04680

+, ++ Significant at P<0.05 and 0.01, respectively when tested against G × E.
^{a}, ^{aa} Significant at P<0.05 and 0.01, respectively when tested against pooled deviation.
*,**Significant at P<0.05 and 0.01, respectively when tested against pooled error.

when tested against G × E were statistically significant for most of the characters except dry fruit weight fruit^{-1}, number of primary branches plant^{-1}, plant height, 1000 seed weight, dry fruit weight plant^{-1}, and net plot yield and except number of primary branches plant^{-1}, and 1000 seed weight when tested against pooled deviation. Environmental variances were significant for days to 50% flowering, number of fruits plant^{-1} and fresh fruit weight plant^{-1} when tested against G × E.

The data in (Table 1) revealed significance of G × E interaction for all the characters except number of fruits plant^{-1} and fresh fruit weight plant^{-1}, which suggested differential responses of genotypes in different environments. The partitioning of G × E interaction showed that G × E (linear) effects were significant for days to 50% flowering, dry fruit weight fruit^{-1}, fresh fruit weight plant^{-1}, dry fruit weight plant^{-1} and net plot yield. However, environment (linear) effects were significant for all the characters when tested against pooled deviation. Pooled deviation effects were significant for days to first fruit ripening and fruit length when tested against effective pooled error. The magnitudes of linear components were more than non linear components for all the characters suggesting that prediction across the environments is possible for these characters.

Environmental indices

The estimates of environmental indices (I_j) (Table 2) indicated that transplanting on 17th June 2009 (E1) was highly favourable for days to first flower initiation, days to 50% flowering, days to first fruit ripening and days to first harvest. However, 20th August 2009 (E3) was favourable for all the characters except days to first flower initiation, days to 50% flowering, days to first fruit ripening and days to first harvest. Though plant is a single developmental unit, but different traits get expressed in different phases. In chilli, temperature, relative humidity, total rainfall and total sunshine hours affect the traits differently at the beginning or middle or end of the crop season. In the month of June, the highest (41.7^{o}C) and lowest (27.3^{o}C) temperatures were recorded

Table 2. Estimates of environmental indices (I_j) for each character under different environments

Sl. No.	Characters	Environments			
		17th June (E1)	3rd August (E2)	20th August (E3)	CD (5%)
1	Days to first flower initiation	8.069	-3.389	-4.681	1.221
2	Days to 50% flowering	8.361	-3.076	-5.285	1.511
3	Days to first fruit ripening	4.007	-1.993	-2.014	2.502
4	Days to first harvest	3.319	0.215	-3.535	00.976
5	Number of pickings	-0.049	-0.069	0.118	0.1241
6	Number of fruits plant^{-1}	-28.632	0.889	27.74	14.643
7	Fresh fruit weight fruit^{-1} (g)	-0.275	-0.026	0.302	0.0012
8	Dry fruit weight fruit^{-1} (g)	-0.117	0.009	0.109	0.0067
9	Fruit length (cm)	-0.359	-0.077	0.735	0.0772
10	Fruit diameter (cm)	-0.024	-0.067	0.090	0.0575
11	Pedicel length (cm)	-0.508	0.075	0.433	00.056
12	Petiole length (cm)	-0.159	0.066	0.093	0.0032
13	No. of primary branches	-0.417	-0.042	0.458	00.00
14	Plant height (cm)	-3.542	-0.229	3.771	3.0945
15	Number of seeds fruit^{-1}	-5.33	1.167	4.167	2.6829
16	1000 seed weight (g)	-0.377	-0.172	0.548	00.00
17	Fresh fruit weight plant^{-1} (kg)	-0.169	0.007	0.162	0.0719
18	Dry fruit weight plant^{-1} (kg)	-0.043	0.001	0.041	0.0177

followed by heavy rainfall (1123.1 mm) with lowest total sunshine hours (233.7 hrs) during flowering and fruiting (June to August), which affected the crop forcing early maturity and reduced yield. However, during August 2009 to October 2009, favourable temperature (16.7–32.2°C) coupled with high relative humidity (89.6%) and sunshine hours (539.7) helped the crop to boost the fruit yield.

Stability parameters

The genotypes, JCH-47, BCH-24, BCH-54 and BVC-37 were found to be stable, as regression coefficient (bi)H~1, non significant deviations from regression (s^2di) and the highest mean performance than population mean for fruit yield while, genotype JCH-40 was found to be suitable for favourable environmental condition as it recorded bi>1 and JCH-05, JCH-14, JCH-23, JCH-24, JCH-54 and RCH-23 for unfavourable environments as they recorded bi<1, with non significant s^2di and higher mean performance than population mean. Chowdhury *et al.* (2001), Senapati & Sarkar (2002) and Nehru *et al.* (2003) also obtained similar results. JCH-47 and BVC-37 proved to be the best yielding genotypes, having higher yield level than the check and were stable for almost all the characters as evident from their non-significant s^2di values (Table 3).

In case of 50% flowering, hybrids JCH-05, JCH-47 and BCH-05 were found to be highly stable when lateness is desirable while JCH-23, BCH-23 and BCH-24 for earliness. Chowdhury *et al.* (2001) also observed stability for 50% flowering in chilli. JCH-47 exhibited high stability for number of fruits plant^{-1}. Similar results were reported earlier by Chowdhury *et al.* (2001), Senapati & Sarkar (2002) and Lohithaswa *et al.* (2001). JCH-01, JCH-05, JCH-14, JCH-24, JCH-31, JCH-54, BVC-37, and VNR-332 had high stability for dry fruit weight. JCH-01, JCH-05, JCH-14, JCH-31, JCH-40, JCH-41, JCH-47, JCH-54, BVC-37 and VNR-332 were found to be highly stable genotypes for fruit length. High stability was exhibited by JCH-24 and JCH-54 for fruit diameter while JCH-05, JCH-14, JCH-23, JCH-31,

Table 3. Stability parameters for 12 quantitative characters in chilli

Geno-types	Days to 50% flowering			Number of fruits $plant^{-1}$			Dry fruit weight $plant^{-1}$ (g)			Fruit length (cm)			Fruit diameter (cm)			No. of primary branches		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
JCH-01	45.67	0.47	0.46	279.67	2.12	-645.17	1.41	1.04	-0.02	17.52	1.01	-0.01	1.11	0.90	0.00	4.79	1.00	-0.09
JCH-05	39.17	1.11	-0.52	381.33	0.42	-1253.61	1.16	1.00	-0.02	11.08	1.06	-0.01	1.00	1.03	-0.01	5.79	1.00	-0.09
JCH-14	37.17	1.57	2.48*	380.33	0.76	-1302.44	1.50	1.09	-0.02	12.98	1.06	-0.01	1.03	1.17	-0.01	5.79	1.00	-0.09
JCH-23	38.67	1.16	-0.04	433.00	0.63	-1259.48	0.77	0.97	-0.02	8.74	0.99	-0.02	0.80	1.03	-0.01	5.59	1.00	-0.09
JCH-24	37.33	0.85	-0.55	308.17	0.68	-1283.07	1.08	1.00	-0.02	8.26	0.99	-0.02	1.96	1.03	-0.01	4.79	1.00	-0.09
JCH-31	36.33	1.32	0.40	235.67	0.99	-1302.59	1.09	1.04	-0.02	11.70	0.99	-0.02	0.94	1.03	-0.01	6.79	1.00	-0.09
JCH-40	38.00	1.37	-0.48	255.83	1.56	-1058.89	0.89	0.95	-0.02	10.93	0.99	-0.02	1.00	1.03	-0.01	5.69	1.00	-0.09
JCH-41	38.17	1.35	-0.14	252.67	0.88	-1286.08	0.83	1.00	-0.02	13.31	0.99	-0.02	1.19	1.00	-0.01	4.79	1.00	-0.09
JCH-47	42.17	1.00	-0.31	552.50	1.06	-1302.63	0.95	1.00	-0.02	9.69	0.99	-0.02	0.94	1.00	-0.01	4.79	1.00	-0.09
JCH-54	38.17	0.53	-0.27	409.67	0.50	-1293.71	1.39	1.09	-0.02	11.97	0.99	-0.02	1.39	1.00	-0.01	5.79	1.00	-0.09
BCH-05	40.00	1.07	-0.56	565.17	1.73	-1244.55	0.52	0.93	-0.02	4.85	1.00	-0.02	0.99	0.96	-0.01	4.59	1.00	-0.09
BCH-14	35.33	1.32	0.40	451.00	0.80	-1299.59	0.69	0.95	-0.02	6.91	1.00	-0.02	1.29	0.96	-0.01	3.99	1.00	-0.09
BCH-23	38.33	1.16	-0.53	548.50	1.14	-1087.23	0.61	0.95	-0.02	7.31	1.00	-0.02	0.92	0.96	-0.01	7.89	1.00	-0.09
BCH-24	38.67	1.06	-0.61	482.67	1.18	-1296.61	0.75	0.97	-0.02	7.33	1.02	-0.01	1.17	0.96	-0.01	5.59	1.00	-0.09
BCH-40	37.00	1.25*	-0.59	241.00	1.15	-1297.82	0.70	0.97	-0.02	7.50	1.05	-0.02	0.94	0.96	-0.01	5.09	1.00	-0.09
BCH-54	39.00	0.90	-0.49	380.17	1.21	-1225.26	1.12	1.04	-0.02	9.41	1.05	-0.02	1.39	0.96	-0.01	6.09	1.00	-0.09
RCH-05	37.67	1.46	0.15	505.00	1.47	-1246.37	0.83	0.97	-0.02	8.03	0.96	-0.02	0.99	1.07	-0.01	4.09	1.00	-0.09
RCH-12	37.67	1.29	-0.56	215.00	0.54	-1219.91	1.00	0.93	-0.02	7.99	0.96	-0.02	1.09	1.00	-0.01	6.99	1.00	-0.09
RCH-14	36.17	0.71	-0.18	446.33	0.86	-1228.28	0.87	1.04	-0.02	6.39	0.96	-0.02	1.10	1.07	-0.01	5.89	1.00	-0.09
RCH-23	36.83	0.81	0.13	489.00	0.88	-1283.23	0.72	0.97	-0.02	8.81	0.96	-0.02	0.98	1.07	-0.01	4.09	1.00	-0.09
9608U	44.17	0.42	1.57	144.67	1.34	-1252.41	0.96	1.00	-0.02	7.90	0.96	-0.02	1.34	0.91	0.00	5.79	1.00	-0.09
GUK2-1	40.33	0.75	-0.25	243.50	0.67	-1300.14	0.98	1.00	-0.02	6.14	0.96	-0.02	2.24	0.91	0.00	4.79	1.00	-0.09
BVC-37	48.33	0.17	4.35**	193.00	0.55	-1285.73	1.92	1.00	-0.02	13.80	1.01	-0.01	1.99	0.90	0.00	5.29	1.00	-0.09
VNR-332 (C)	33.00	0.88	0.45	226.33	0.86	-1228.28	1.94	1.13	-0.02	13.92	0.98	-0.02	1.07	1.07	-0.01	4.99	1.00	-0.09
Population mean	38.88			359.2			1.03			9.68			1.20			5.41		

** $P<0.05$; *$P<0.01$; bi=regression coefficient; s^2di=deviation from regression coefficient

Table 3. Cont.

Geno-types	Plant height (cm)			Number of seeds $fruit^{-1}$			1000 seed weight (g)			Fresh fruit weight $plant^{-1}$ (g)			Dry fruit weight $plant^{-1}$ (g)			Net plot yield (kg)		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
JCH-01	81.17	1.02	-27.54	113.50	1.38	-8.73	6.53	1.00	-0.03	1.61	2.25	0.01	0.40	2.23	0.00	3.57	2.25	0.05
JCH-05	64.83	0.96	-27.53	89.50	1.38	-8.73	5.28	1.00	-0.03	1.92	0.49	-0.01	0.48	0.48	0.00	4.26	0.52	-0.04
JCH-14	68.50	0.69	-26.49	113.50	1.38	-8.73	5.77	1.00	-0.03	1.78	0.88	-0.01	0.45	0.84	0.00	3.96	0.87	-0.05
JCH-23	71.83	2.35	-6.91	73.50	1.38	-8.73	4.95	1.00	-0.03	1.91	0.78	-0.01	0.48	0.72	0.00	4.25	0.77	-0.04
JCH-24	64.50	1.69	-22.20	87.50	1.38	-8.73	5.60	1.00	-0.03	1.90	0.91	-0.01	0.47	0.96	0.00	4.23	0.92	-0.04
JCH-31	63.17	1.82	-19.93	111.00	1.38	-8.73	4.41	1.00	-0.03	1.37	1.14	-0.01	0.34	1.14*	0.00	3.05	1.14	-0.05
JCH-40	52.83	0.96	-27.53	59.00	1.38	-8.73	5.32	1.00	-0.03	1.57	1.81	0.00	0.39	1.75	0.00	3.48	1.80	0.00
JCH-41	77.83	0.56	-25.37	98.50	1.38	-8.73	6.23	1.00	-0.03	1.47	1.04	-0.01	0.37	1.07	0.00	3.27	1.04	-0.04
JCH-47	74.17	0.43	-23.85	82.00	1.38	-8.73	5.44	1.00	-0.03	1.88	0.98	-0.01	0.47	1.02	0.00	4.17	0.99	-0.05
JCH-54	78.17	1.82	-19.93	124.50	1.38	-8.73	5.42	1.00	-0.03	2.27	0.75	-0.01	0.57	0.78	0.00	5.04	0.76	-0.04
BCH-05	59.17	1.02	-27.54	49.33	1.03	-10.20	5.38	1.00	-0.03	1.28	1.05	-0.01	0.32	1.02	0.00	2.85	1.04	-0.04
BCH-14	54.83	0.96	-27.53	55.83	1.03	-10.20	4.72	1.00	-0.03	1.28	0.70	-0.01	0.32	0.72	0.00	2.83	0.69	-0.05
BCH-23	73.17	0.63	-25.98	64.33	1.03	-10.20	4.85	1.00	-0.03	1.21	0.80	-0.01	0.30	0.83	0.00	2.68	0.80	-0.04
BCH-24	58.83	0.76	-26.90	72.83	1.03	-10.20	5.13	1.00	-0.03	1.63	1.01	-0.01	0.41	1.02	0.00	3.62	1.01	-0.05
BCH-40	59.83	0.96	-27.53	69.83	0.63	-7.46	5.55	1.00	-0.03	1.14	1.09	-0.01	0.29	1.08	0.00	2.53	1.09	-0.05
BCH-54	54.50	1.29	-26.60	92.83	0.63	-7.46	6.23	1.00	-0.03	1.54	1.10	-0.01	0.38	1.07	0.00	3.43	1.09	-0.04
RCH-05	59.50	0.89	-27.42	69.33	0.40	-3.08	6.49	1.00	-0.03	1.27	0.97	-0.01	0.32	0.96	0.00	2.81	0.98	-0.04
RCH-12	67.50	0.69	-26.49	43.00	0.55	-5.21	6.58	1.00	-0.03	1.03	0.60	-0.01	0.26	0.59	0.00	2.30	0.59	-0.04
RCH-14	58.83	1.16	-27.27	89.50	0.38	-6.84	4.30	1.00	-0.03	1.50	0.80	-0.01	0.38	0.84	0.00	3.34	0.80	-0.04
RCH-23	62.83	0.76	-26.90	71.33	0.40	-3.08	5.23	1.00	-0.03	1.59	0.82	-0.01	0.40	0.84	0.00	3.54	0.81	-0.04
9608U	64.50	0.89	-27.42	84.33	0.63	-7.46	4.21	1.00	-0.03	0.79	1.34	-0.01	0.20	1.31	0.00	1.75	1.35	-0.04
GUK2-1	52.50	-0.49	-2.10	82.83	0.90	-10.63	4.97	1.00	-0.03	1.17	0.72	-0.01	0.30	0.72	0.00	2.61	0.72	-0.05
BVC-37	81.83	1.35	-26.11	88.50	1.08	-9.76	5.46	1.00	-0.03	1.81	0.99	-0.01	0.45	1.07	0.00	4.02	1.01	-0.04
VNR-332 (C)	59.17	0.83	-27.21	132.17	0.49	-5.79	5.74	1.00	-0.03	1.27	0.99	-0.01	0.32	0.95	0.00	2.81	0.98	-0.03
Population mean	65.17			84.10			5.41			1.51			0.38			3.35		

** $P<0.05$; * $P<0.01$; bi=regression coefficient; s^2di=deviation from regression coefficient

JCH-40, JCH-54, BCH-23, BCH-24, BCH-54, RCH-12, RCH-14, 9608U for primary branches plant^{-1} and JCH01 stable for plant height. JCH-01, JCH-14, JCH-24, JCH-41, BCH-40, BCH-54, RCH-05, RCH-12 and VNR-332 were stable genotypes for 1000 seed weight while JCH-41 for fresh fruit weight plant^{-1}.

The genotypic correlations were higher than the phenotypic correlations (Table 4) indicating the high heritable nature of all the characters. Similar observations were made by Choudhary *et al.* (1985), and Ajjapplavara *et al.* (2005). The genotypic correlation of dry fruit weight plant^{-1} was positive with all other traits except the traits for earliness *viz*., days to first flower initiation, days 50% flowering, days to first fruit ripening and days to first fruit harvesting. Hence, dry fruit yield plant^{-1} can be improved by selecting the lines with these desirable characters. The high correlation between fruit yield plant^{-1} and related component characters have also been reported by Hiremath (1997) and Ajjapplavara *et al*. (2005).

In the present investigation, the direct effects of genotypic path were slightly higher in magnitude than phenotypic path (Table 5) for the characters *viz*., number of pickings, fruit length, fruit diameter, plant height and 1000 seed weight. An examination of the path analysis revealed that the direct effects, through number of fruits plant^{-1} and fresh fruit weight were very strong. Farhad *et al. (*2008) and Pandit *et al.* (2009) registered similar findings showing direct positive effect for number of fruits plant^{-1} with fruit yield. However, direct influence through number of pickings, dry fruit weight fruit^{-1}**,** fruit length, fruit diameter, number of primary branches and plant height were low. Although petiole length and number of seeds fruit^{-1} were positively correlated with dry fruit yield plant^{-1}, path coefficient analysis revealed that petiole length and 1000 seed weight exhibited negative direct effect on dry fruit yield plant^{-1}.

It is concluded that, the genotypes, JCH-47, BCH-24, BCH-54 and BVC-37 exhibited good stability over all environments, whereas, JCH-40 registered above average stability and JCH-05, JCH-14, JCH-23, JCH-24, JCH-54 and RCH-23 recorded below average stability for dry fruit yield. The high yielding F_1 hybrid, JCH-54 was suitable in unfavourable environment for early flowering, number of fruits plant^{-1}, fresh and dry fruit weight plant^{-1} and net plot yield, whereas it exhibited good stability for dry fruit weight fruit^{-1}, fruit length, fruit diameter, number of primary branches and 1000 seed weight and suitable for favorable environment with respect to the characters *viz*., number of pickings, plant height and number of seeds.

Use of the F_1 hybrids such as JCH-47, BCH-24, BCH-54 and genotype, BVC-37 with good stability for the development of new hybrids and variety, respectively with desired nature of stability is suggested. The F_1 hybrids JCH-40 and JCH-05, JCH-14, JCH-23, JCH-24, JCH-54, RCH-23 can be utilized as the CMS based new hybrids in favourable and unfavourable environments. Number of fruits plant^{-1} and fresh fruit weight fruit^{-1} were the two factors that exerted the greatest influence both directly and indirectly on the dry fruit yield. These two traits were important components that involved dry fruit yield plant^{-1}, whereas pedicel length and 1000 seed weight were relatively unimportant.

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Table 4. Estimate of genotypic and phenotypic correlation coefficient between fruit yield and its components in chilli during 2009–2010 (pooled)

Characters		DFF	DFR	DFH	NOP	NFP	FFW	DFW	FL	FD	PL	PTL	NPB	PH	NS	SW	FFWP	DFWP
DFI	G	0.99**	0.70**	0.46**	-0.44**	-0.30**	0.23*	-0.02	0.10	0.31**	0.18	-0.09	-0.26*	0.25*	-0.10	0.01	-0.22	-0.22
	P	0.95**	0.14	0.31**	-0.08	-0.20	0.15	-0.01	0.07	0.24*	0.12	-0.06	-0.18	0.18	-0.07	0.00	-0.13	-0.13
DFF	G		0.68**	0.44**	-0.49**	-0.35**	0.26*	0.04	0.14	0.32**	0.20	-0.09	-0.23*	0.25*	-0.04	-0.01	-0.23*	-0.23*
	P		0.14	0.30**	-0.09	-0.24*	0.18	0.03	0.10	0.25*	0.14	-0.07	-0.16	0.19	-0.03	0.00	-0.15	-0.15
DFR	G			1.00**	-0.76**	-0.47**	0.16	0.04	0.87**	-0.09	0.46**	-0.12	-0.35**	0.64**	0.07	-0.07	-0.44**	-0.44**
	P			0.26*	-0.17	-0.09	0.03	0.01	0.18	-0.01	0.08	-0.02	-0.07	0.10	0.00	-0.01	-0.08	-0.08
DFH	G				-0.09	-0.22*	-0.02	-0.21	-0.02	0.14	0.08	0.12	0.03	0.06	-0.14	0.01	-0.28*	-0.27*
	P				-0.07	-0.21	-0.01	-0.20	-0.02	0.13	0.07	0.11	0.03	0.03	-0.13	0.01	-0.26*	-0.26*
NOP	G					0.42**	-0.01	-0.05	-0.27*	-0.12	-0.12	0.06	0.20	-0.20	0.02	0.06	0.36**	0.36**
	P					0.24*	0.00	-0.03	-0.16	-0.08	-0.05	0.04	0.11	-0.06	0.03	0.04	0.21	0.21
NFP	G						-0.43**	-0.14	-0.22*	-0.33**	-0.17	-0.06	0.24*	0.17	-0.11	-0.01	0.62**	0.62**
	P						-0.42	-0.14	-0.21	-0.32**	-0.16	-0.05	0.24*	0.14	-0.11	-0.01	0.63**	0.63**
FFW	G							0.73**	0.55**	0.52	0.47**	-0.05	-0.13	0.28*	0.57**	0.25*	0.33**	0.33**
	P							0.73**	0.55**	0.52**	0.47**	-0.04	-0.13	0.25*	0.56	0.25*	0.32**	0.32**
DFW	G								0.55**	0.41	0.41**	-0.13	-0.06	0.32**	0.73**	0.38**	0.45**	0.45**
	P								0.55**	0.41**	0.41**	-0.13	-0.06	0.28*	0.72	0.38**	0.44**	0.44**
FL	G									0.02	0.51**	0.04	0.08	0.48**	0.54**	0.13	0.28**	0.29**
	P									0.02	0.51**	0.04	0.08	0.42**	0.53	0.13	0.28**	0.28*
FD	G										0.15	-0.20	-0.28*	-0.02	0.27*	0.16	0.10	0.10

Table 4. Cont.

Characters		DFF	DFR	DFH	NOP	NFP	FFW	DFW	FL	FD	PL	PTL	NPB	PH	NS	SW	FFWP	DFWP
	P										0.15	-0.19	-0.27	-0.01	0.26	0.16	0.10	0.10
PL	G											-0.08	-0.04	0.30**	0.37**	0.01	0.20	0.20
	P											-0.08	-0.04	0.27*	0.37	0.01	0.19	0.19
PTL	G												0.29**	0.00	-0.13	0.12	-0.06	-0.06
	P												0.29**	0.01	-0.13	0.12	-0.05	-0.05
NPB	G													0.09	0.02	-0.15	0.19	0.19
	P													0.08	0.02	-0.15	0.19	0.19
PH	G														0.32**	0.01	0.43**	0.43**
	P														0.28	0.01	0.37**	0.37**
NS	G															0.09	0.37**	0.37**
	P															0.09	0.35**	0.35**
SW	G																0.15	0.16
	P																0.15	0.15
FFWP	G																	1.00**
	P																	1.00**

*, **Significant at $P<0.05$ and 0.01, respectively

DFI=Days to first flower initiation;
DFF=Days to 50% flowering;
DFR=Days to first fruit ripening;
DFH=Days to first harvest;
NOP=Number of pickings;
NFP=Number of fruits plant^{-1};
FFW=Fresh fruit weight fruit^{-1} (g);
DFW=Dry fruit weight fruit^{-1} (g);
FL=Fruit length (cm);
FD=Fruit diameter (cm);
PL=Pedicel length (cm);
PTL=Petiole length (cm);
NPB=Number of primary branches;
PH=Plant height (cm);
NS=Number of seeds fruit^{-1};
TSW=1000 seed weight (g);
FFWP=Fresh fruit weight plant^{-1} (kg);
DFWP=Dry fruit weight plant^{-1} (kg).

Table 5. Genotypic and phenotypic path coefficients of the characters affecting dry fruit yield plant^{-1}

		Number of pickings	Number of fruits	Fresh fruit weight	Dry fruit weight	Fruit length	Fruit dia-meter	Pedicel length	Number of branches	Plant height	Number of seeds	1000 seed weight
No. of pickings	G	**0.049**	0.021	-0.000	-0.002	-0.013	-0.006	-0.006	0.010	-0.010	0.001	0.003
	P	**0.015**	0.004	-0.000	-0.000	-0.002	-0.001	-0.001	0.002	-0.001	0.000	0.001
Number of fruits	G	0.369	**0.878**	-0.379	-0.127	-0.190	-0.294	-0.149	0.214	0.147	-0.098	-0.010
	P	0.219	**0.897**	-0.379	-0.127	-0.189	-0.291	-0.147	0.214	0.127	-0.098	-0.010
Fresh fruit weight	G	-0.020	-0.224	**0.519**	0.382	0.287	0.272	0.244	-0.070	0.143	0.294	0.130
	P	-0.002	-0.228	**0.540**	0.396	0.298	0.279	0.252	-0.072	0.133	0.300	0.135
Dry fruit weight	G	-0.004	-0.012	0.061	**0.083**	0.045	0.034	0.034	-0.005	0.026	0.061	0.031
	P	-0.002	-0.011	0.054	**0.074**	0.040	0.030	0.030	-0.004	0.021	0.054	0.028
Fruit length	G	-0.039	-0.031	0.080	0.079	**0.145**	0.003	0.074	0.012	0.069	0.078	0.019
	P	-0.020	-0.027	0.069	0.069	**0.126**	0.003	0.064	0.010	0.053	0.067	0.017
Fruit diameter	G	-0.015	-0.040	0.063	0.050	0.003	**0.121**	0.019	-0.034	-0.002	0.032	0.019
	P	-0.008	-0.034	0.054	0.042	0.002	**0.104**	0.016	-0.029	-0.001	0.027	0.017
Petiole length	G	0.004	0.005	-0.015	-0.013	-0.016	-0.005	**-0.031**	0.001	-0.009	-0.012	-0.000
	P	0.002	0.005	-0.014	-0.012	-0.015	-0.004	**-0.029**	0.001	-0.008	-0.011	-0.000
Number of branches	G	0.011	0.013	-0.007	-0.003	0.004	-0.015	-0.002	**0.054**	0.005	0.001	-0.008
	P	0.007	0.014	-0.008	-0.003	0.005	-0.016	-0.003	**0.060**	0.005	0.001	-0.009
Plant height	G	-0.012	0.010	0.016	0.019	0.028	-0.001	0.018	0.005	**0.059**	0.019	0.000
	P	-0.003	0.006	0.010	0.011	0.020	-0.000	0.011	0.003	**0.040**	0.011	0.000
Number of seeds	G	-0.000	0.001	-0.004	-0.005	-0.004	-0.002	-0.003	-0.000	-0.002	**-0.007**	-0.001
	P	0.000	-0.000	0.002	0.003	0.002	0.001	0.001	0.000	0.001	**0.004**	0.000
1000 seed weight	G	-0.002	0.000	-0.007	-0.011	-0.004	-0.005	-0.000	0.005	-0.000	-0.003	**-0.031**
	P	-0.001	0.000	-0.007	-0.010	-0.003	-0.004	-0.000	0.004	-0.000	-0.002	**-0.030**
Correlation with fruit	G	0.357**	0.620**	0.327**	0.450**	0.285**	0.103	0.198	0.192	0.425**	0.367**	0.156
weight plant^{-1}	P	0.207	0.626**	0.322**	0.442**	0.280*	0.099	0.195	0.189	0.369**	0.352**	0.153

P=Phenotypic path coefficient; G=Genotypic path coefficient

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