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Genetic Variability, Heritablity, Correlation and Path Analysis in Chilli (*Capsicum annuum* L.)

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ABSTRACT

A field experiment was conducted to study the genetic variability, heritablity, correlation and path analysis of 63 chilli genotypes with two replications at Kittur Rani Channamma College of Horticulture, Arabhavi which falls under Northern dry zone of Karnataka. Study revealed that, highly significant difference among the accessions for all the characters studied. Environmental influence was very less on expression of characters as it was evident by narrow gap between genotypic and phenotypic coefficients of variation. Genotypic and phenotypic coefficients of variation were moderate to high for all the characters studied except green and dry fruit weight. High heritability was observed for all characters, except 1000-seed weight and high genetic advance as per cent mean indicating that simple selection would be sufficient for these traits to bring genetic improvement. Fruit yield had positive and highly significant association with number of fruits per plant and fruit set percentage. Strong association of these traits revealed that selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of genotypes possessing combination of such characters is most useful for obtaining desirable high yielding segregants. Path-coefficient analysis revealed that fruit set percentage and fruit weight had the highest positive direct effect on fruit yield both at genotypic and phenotypic levels and most of the fruit related traits contributed to fruit yield mainly through fruit girth and fruit weight. Hence, it would be rewarding to lay stress on these characters in selection programmes for increasing yield.

Key words: *GCA, PCA, GA, Correlation and Path analysis*

INTRODUCTION

Chilli (*Capsicum annuum* L.) is a spice cum vegetable crop belonging to the family Solanaceae with chromosome number is 2n = 24. It is a native of Mexico, which was brought into India from Brazil by Portuguese prior to 1785 AD. It can be regarded as universal spice of India. Crop improvement in chilli has so far been achieved by exploiting the available sources of the variability.

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Naturally, the genetic variation or diversity for most of the yield attributes is considerably high in chilli. There is a need to seek improvement in complex quantitative trait such as yield. As a result of free exchange of chilli germplasm and lot of introgression of characters has taken place in many local chilli cultivars resulting in enhancement of variability and new genetic combinations.

To know the extent of variability present in a population, evaluation of large number of germplasm lines is the first step. This improvement in any crop is based on the extent of genetic variation and magnitude of available beneficial genetic variability. The proportion of genotypic, environmental variance and their interaction (G × E), can be determined by employing useful biometrical and genetical methods. Some of these parameters include genotypic (GCV) and phenotypic (PCV) coefficients of variation. Another indicator of variability is heritability, which is the ratio of genetic variance to total variance. Genotypic and phenotypic correlations reveal the degree of association between different characters[6]. The other genetic parameter commonly used is the path analysis as given by Dewey and Lu[5]. Path analysis gives the cause and effect relationship. It critically breaks up different direct effect and indirect effect which finally makes up correlation coefficient. In this study genotypic and phenotypic path for yield per plant was analysed by selecting most influencing independent variables.

Importance of genetic variability in any breeding material is a pre-requisite as it provides not only a basis for selection but also some valuable information regarding selection of diverse parents for use in hybridization programme. The plant breeder has to identify the sources of favourable genes, incorporate them in breeding populations and aim for isolation of productive genotypes and cultivars. Thus, improvement in any crop is based on the extent of genetic variation and the degree of improvement depends upon the magnitude of available beneficial genetic variability. Hence, the present study was undertaken to analyse the extent of variability present in sixty-three germplasm lines of chilli in respect of traits contributing to yield and quality of chilli fruits.

MATERIALS AND METHODS

The experiment was conducted in field of department of Crop improvement and biotechnology of Kittur Rani Channamma College of Horticulture, Arabhavi, which is located at Zone-3 of Karnataka**.** Germplasm were collected from HRS (Horticulture Research Station), Devihosur along with two established popular local cultivars Byadagi Kaddi and Byadagi Dabbi and some other were from local farmers. The accession numbers of the genotypes with codes are given in Table 1. The germplasm accessions raised were raised in the main field in randomized block design with two replications consisting of one row of 15 plants for each entry. A spacing of 60 cm × 60 cm was followed and the crop was raised as per the recommended package of practices. Five random competitive plants per treatment/genotypes were selected, tagged and observations were recorded on these plants for different characters like, growth, earliness, fruit, yield, seed and quality parameters.

Average of values of each parameter or characters were used for analysis. Statistical analysis of the data was carried out by using Statistical Package for Agricultural Research (SPAR) and Indostat.

RESULTS AND DISCUSSION

Under present study we report the variability parameters of 63 genotypes under study which could be worthwhile for selection of desirable genotypes in hybridization programmes

Genetic variability, heritability and genetic advance

Plant growth characters: In the present study low GCV and PCV were observed for number of secondary branches, plant spread in EW and NS and stem diameter (Table 2). These, results are in agreement with Ajjappalavara and Channagoudra[1], Suryakumari *et al*[16]., Kulkarni *et al*[10]., and Berhanu *et al*[3]. Narrow difference between GCV and PCV indicated that little environmental effect and may be governed by non-additive genes. However, plant height showed moderate GCV and PCV which the result is in agreement with those of Kulkarni *et al*[10]., Suryakumari *et al*[16]., and Berhanu *et al*[3]. High heritability and GAM (Table 2) were observed for plant height, plant spread in EW and NS direction and stem diameter, which the results are in line with the Suryakumari *et al*[16]., and Berhanu *et al*[3]. The high heritability with high GAM estimates for these traits indicated the role of additive genes in governing their expression. Hence, selection on phenotype would be rewarding in improvement of these traits.

Earliness characters: Days to first flowering and days to 50% flowering had low GCV, PCV and GAM but high heritability (Table 2). These results are in accordance with Gogoi *et al*[7]., Chattopadhaya *et al*[4]. This indicated that simple selection for improvement of these traits may be helpful.

Fruit characters: Green fruit girth and green fruit length had moderate GCV and PCV with high heritability and GAM (Table 2). These results are in line with, Kulkarni *et al*[10]., Suryakumari *et al*[16]., and Berhanu *et al*[3]. However, in contrast low GCV and PCV with high heritability and moderate GAM was observed for green fruit weight but narrow difference between GCV and PCV indicated that little environmental effect and may be governed by non-additive genes. This indicated that simple selection will be helpful in improvement of these traits. High GCV, PCV, heritability and GAM was observed for number of green fruits per plant, dry fruit girth and dry fruit length (Table 2). These results are in accordance with Suryakumari *et al*[16]., Kulkarni *et al*[10]., and Berhanu *et al*[3]. However low GCV, PCV with high heritability and moderate GAM for dry fruit weight indicated the predominance of additive gene effect in expression of these characters. Thus, selection on phenotype would be rewarding in improvement of the traits.

Yield parameters: High GCV, PCV, heritability and GAM was observed for green and dry fruit yield per plant, green and dry fruit yield per plot, green and dry fruit yield per hectare (Table 2). These results are in accordance with Ajjappalavara and Channagoudra[1], Kulkarni *et al*[10]., and Sharma *et al*[15]., Chattopadhaya *et al*[4]. This indicated presence of additive gene effect for these traits, thus simple selection will be helpful. However, yield is a complex character which cannot lead success in direct selection based on it. So characters associated and contributable for this character must be studied after which selection will be promising.

Seed parameters: High GCV, PCV, heritability and GAM was observed for number of seeds per fruit (Table 2) where the results are in compliance with Sharma *et al*[15]., Chattopadhaya *et al*[4]. This indicated that preponderance of additive gene action for the control of these traits. Thus, selection based on these characters would be effective. However low GCV, heritability, GAM but high PCV was observed for 1000-seed weight (Table 2). This was in contrast with earlier worker Manju and Sreelathakumari[11]. This might be due to different genotypes used in the study and locations of experiment conducted are different. This indicated that selection might not work out for improvement of this trait.

Quality parameters: High estimates of GCV, PCV, heritability and GAM were observed for ascorbic acid content (Table 2). This result is compliance with earlier worker Wasule *et al*[17]. This suggested that simple selection might improve the trait but Jagadeesha *et al*[8]., reported that ascorbic acid content is highly

variable and selection on this trait might not be proper. Capsaicin content recorded moderate GCV but high PCV, heritability and GAM. This result was in line with values obtained by earlier worker Wasule *et al*[17]. This suggests that preponderance of additive gene, so selection will be rewarding for improvement of this trait.

Correlation analysis

A narrow difference between the genotypic and phenotypic correlation coefficients was observed (Table 2) for various traits in the present finding and this indicates the lesser influence of environment in the expression of these traits and presence of strong inherent association among the traits. Therefore, in the present study, though the genotypic and phenotypic correlation coefficients were worked out for growth, yield and quality components in chilli, only the heritable genotypic association has been discussed.

Among the growth parameters (plant height, number of primary and secondary branches, plant spread in EW and NS direction) non-significant association of green chilli yield per plant was observed (Table 3 and 4). These results are in conformity with those of Kannan *et al*[9]., and Chattopadhyay *et al*[4]. However, results are in contrast with Ajjappalavara *et al*[2]. This may be because, since genetic potential of plant remain constant, when it contributes more to vegetative growth, yield will be reduced. Therefore, it is logical that not to attempt for selecting genotypes performing well in vegetative growth, which would simultaneously help in reduction in yield. Among the fruit characters, fruit length (0.354), green fruit weight (0.329) and number of green fruits per plant (0.874) had significant positive association with the yield (Table 3 and 4). Applying selection pressure on these traits would be rewarding for improvement in the total yield. Earlier Satish[14] and Kannan *et al*[9]., for number of fruits per plant, Kannan *et al*[9]., and Chattopadhyay *et al*[4]. for fruit length also reported positive association with total yield. These results indicated that selection for higher number of fruits and longer fruited plants would simultaneously result in selection for higher total fruit yield. Fruit set percentage (0.914) had highly significant and positive correlation with green fruit yield per plant (Table 3 and 4). This result is compliance with the results of earlier workers Ajjappalavara and Channagoudra[1], Kulkarni *et al*[10]., and Sharma *et al*[15]., Chattopadhaya *et al*[4]. This suggests that selection based on fruit set percentage will definitely bring improvement in yield. Highly significant and negative correlation was obtained by 1000-seed weight with green fruit yield per plant (Table 3 and 4). This result is in line with Sharma *et al*[15]., Chattopadhaya *et al*[4]. Therefore, selection based on this trait may not bring improvement in yield.

Path coefficient analysis

Path-coefficient analysis revealed that green fruit yield per plant was directly influenced by plant spread in E-W direction, days to 50% flowering, fruit set percentage and fruit weight. So, selection for any of these independent traits leads to improving the genotypes for green fruit yield per plant (Table 5). The importance of fruit set percentage and fruit weight has been highlighted by Prabhudeva[13], Sharma *et al*[15]., and Chattopadhaya *et al*[4]. The path analysis confirms the earlier studies that days to 50% flowering, fruit set percentage and fruit weight are important traits that contribute to fruit yield. Plant height, number of secondary branches per plant, stem girth, fruit girth and fruit length had negative direct effect on green fruit yield per plant (Table 5). These results were in line with the results of Patel *et al*[12]., and Chattopadhaya *et al*[4]. From the present path analysis study in chilli, it may be concluded that improvement in green fruit yield per plant could be brought by selection for component characters like plant spread in E-W direction, days to 50% flowering, fruit set percentage and fruit weight.

Table 1: List of 63 genotypes used for the diversity study

Sl. No.	Lines	Sl. No.	Lines	Sl. No.	Lines
1	Samriddhi	22	V-20	43	G22
2	Gadag Local	23	V-22	44	G23
3	V-1	24	V-23	45	G24
4	V-2	25	VN2	46	G176
5	V-3	26	G1	47	G178
6	V-4	27	G2	48	G179
7	V-5	28	G4	49	G180
8	V-6	29	G5	50	G181
9	V-7	30	G6	51	G189
10	V-8	31	G9	52	G190
11	V-9	32	G11	53	G191
12	V-10	33	G12	54	G192
13	V-11	34	G13	55	G194
14	V-12	35	G14	56	G197
15	V-13	36	G15	57	G198
16	V-14	37	G16	58	G199
17	V-15	38	G17	59	G201
18	V-16	39	G18	60	Byadagi Kaddi
19	V-17	40	G19	61	Byadagi Dabbi
20	V-18	41	G20	62	Arka Lohit
21	V-19	42	G21	63	Pusa Jwala

Table 2: Different genetic parameters for quantitative and qualitative traits in chilli germplasm

Sl. No.	Characters	Mean	Range	Genotypic variance	Phenotypic variance	Genotypic coefficient of variance (GCV in %)	Phenotypic coefficient of variance (PCV in %)	Heritability (h^2 in %)	Genetic Advance (GA) at 5%	Genetic Advance as Percent mean (GAM %) at 5%
1	Plant height (cm)	104.64	59.8-129.60	164.55	178.64	12	13	92	32.5	31.06
2	No. of primary branches	4.03	3.1-5.30	0.09	0.2	8	11	46	0.54	13.47
3	No. of secondary branches	9.49	7.8-12.16	0.7	0.77	9	9	91	2.1	22.13
4	East West (cm)	77.89	51.6-96.70	27.74	43.56	7	8	64	11.09	14.24
5	North South (cm)	77.28	56.6-105.80	51.45	54.42	9	10	95	18.41	23.82
6	Stem girth (cm)	1.79	1.44-2.30	0.03	0.03	9	10	78	0.38	21.1
7	Days to first flowering	58.06	49-69	7.35	20.28	5	8	36	4.31	7.42
8	Days to 50% flowering	67.79	58.5-78.00	7.59	19.8	4	7	38	4.5	6.64
9	Fruit set %	48.59	26-61.00	61.18	67.63	16	17	90	19.64	40.42
10	Fruit girth (cm)	1.22	0.76-1.73	0.05	0.06	18	19	92	0.57	46.37
11	Fruit length (cm)	9.9	6.74-15.54	3.2	3.37	18	19	95	4.61	46.53
12	Green Fruit weight in (g)	44.8	38.38-49.49	4.13	4.17	5	5	99	5.34	11.92
13	Number of green fruits/plant	114.63	22.3-106.9	1483.16	1501.16	34	34	99	101.06	88.16
14	Green fruit yield /plant (kg)	0.52	0.17-0.95	0.031	0.032	35	35	99	0.47	90.63
15	Green fruit yield /plot (kg)	7.73	2.57-14.22	7.08	7.16	34	35	99	6.99	90.4
16	Green fruit yield /ha (t)	14.31	4.75-26.34	24.28	24.56	34	35	99	12.93	90.38
17	Dry fruit girth (cm)	1.1	0.64-1.61	0.05	0.06	20	21	92	0.57	51.43
18	Dry fruit length (cm)	8.31	5.14-13.95	3.2	3.36	22	22	95	4.6	55.4
19	Dry fruit weight in (g)	11.2	9.59-12.37	0.26	0.26	5	5	99	1.34	11.93
20	Dry fruit yield /plant (kg)	106.55	35.44-196.12	1346.46	1361.65	34	35	99	96.33	90.4
21	Dry fruit yield /plot (kg)	1.6	0.53-2.94	0.3	0.31	34	35	99	1.45	90.4
22	Dry fruit yield /ha (t)	2.96	0.98-5.45	1.04	1.05	34	35	99	2.68	90.38
23	Number of seeds per fruit	49.83	27.2-122.80	216.49	246.31	30	31	88	36.42	73.08
24	1000 seed weight	4.09	0.25-1.72	0.08	3.3	7	44	2	0.11	2.78
25	Ascorbic acid content (mg/100 g)	165.61	73.80-290.48	2543.39	2563.22	30	31	99	132.62	80.08
26	Capsaicin content (%)	2.56	1.11-3.97	0.24	0.35	19	23	70	1.08	42.4

Table 3: Phenotypic correlation coefficents among growth, earliness, yield and quality parameters in green chilli

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-0.028	0.035	0.318**	0.355**	0.301**	0.203*	0.192*	-0.096	0.12	0.193*	0.257**	-0.097	0.175	0.148	-0.024	-0.107	-0.059
	1	0.339**	-0.143	-0.015	0.117	0.071	0.072	0.005	-0.127	-0.126	-0.14	-0.006	-0.035	0.08	0.035	0.115	-0.031
		1	-0.137	-0.101	0.022	0.054	0.141	-0.13	-0.238**	0.206**	-0.139	-0.206*	-0.069	-0.052	0.295**	-0.025	-0.228**
			1	0.605**	0.252**	-0.016	-0.05	-0.06	0.223*	0.139	0.143	-0.123	0.067	0.03	-0.07	-0.193*	-0.093
				1	0.311**	-0.037	-0.074	0.043	0.179*	0.191*	0.062	-0.033	0.056	-0.041	-0.032	-0.164	-0.019
					1	0.115	0.111	0.074	0.114	-0.027	-0.018	-0.011	0.348**	0.001	-0.168	0.014	-0.012
						1	0.902**	0.026	0.197*	0.196*	0.103	0.114	0.065	0.015	0.107	-0.18	0.123
							1	-0.033	0.123	0.248**	0.01	0.064	0.027	-0.004	0.099	-0.211*	0.064
								1	0.297**	-0.01	0.256**	0.859**	0.119	-0.085	-0.127	0.122	0.858**
									1	0.177*	0.357**	0.307**	0.257**	0.047	0.129	-0.151	0.34**
										1	0.145	-0.023	-0.112	-0.101	0.302**	-0.273**	-0.003
											1	0.197*	0.29**	0.028	-0.158	-0.012	0.322**
												1	0.073	-0.07	-0.063	0.076	0.99**
													1	0.053	-0.083	0.002	0.106
														1	-0.052	-0.036	-0.066
															1	-0.112	-0.089
																1	0.073
																	1

Table 4: Genotypic correlation coefficients among growth, earliness, yield and quality parameters in green chilli

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-0.087	0.024	0.409**	0.395**	0.34**	0.494**	0.483**	-0.081	0.159	0.197*	0.287**	-0.091	0.227*	0.333**	-0.021	-0.184*	-0.05
	1	0.494**	-0.147	-0.057	0.269**	-0.471**	-0.362**	0.147	-0.354*	-0.221*	-0.253*	-0.035	0.057	-0.835**	0.042	0.376*	-0.078
		1	-0.239**	-0.087	-0.05	0.065	0.263**	-0.184*	-0.274**	0.235**	-0.137	-0.249**	-0.063	-0.314**	0.329**	-0.065	-0.27
			1	0.883**	0.283**	0.259**	0.044	-0.092	0.449**	0.189*	0.18*	-0.16	0.091	0.031	-0.098	-0.219*	-0.12
				1	0.416**	0.049	-0.079	0.066	0.203*	0.214*	0.06	-0.029	0.07	0.252**	-0.03	-0.283**	-0.014
					1	0.27**	0.06	0.061	0.137	-0.027	0.003	-0.009	0.46**	-0.073	-0.221*	0.089	-0.01
						1	0.986**	-0.086	0.449**	0.589**	0.241**	0.137	0.191*	-0.736**	0.16	-0.427**	0.163
							1	-0.233**	0.307**	0.65	0.031	0.043	0.032	-0.81**	0.172	-0.529**	0.049
								1	0.305**	-0.006	0.295**	0.914**	0.13	-0.131	-0.14	0.139	0.914**
									1	0.152	0.406**	0.315**	0.305**	0.901**	0.138	-0.214**	0.354**
										1	0.155	-0.022	-0.17	-0.874**	0.328**	-0.372**	0.004
											1	0.204*	0.346**	0.341**	-0.16	-0.012	0.329**
												1	0.076	-0.537**	-0.066	0.088	0.874**
													1	0.596**	-0.094	0.064	0.116
														1	-0.558**	0.913**	-0.518**
															1	-0.139	-0.092
																1	0.082
																	1

Critical r Value=0.1765 at 5 per cent and 0.2315 at 1 per cent
* and ** indicate significant at 5 and 1 percent probability level, respectively

1 Plant height (cm)
2 Number of primary branches
3 Number of secondary branches
4 Plant spread in EW direction (cm)
5 Plant spread in NS direction (cm)
6 Stem girth (cm)
7 Days to first flowering
8 Days to 50% flowering
9 Fruit set (%)
10 Fruit girth (cm)
11 Fruit length (cm)
12 Green fruit weight (g)
13 Number of green fruits per plant
14 Number of seeds per fruit
15 1000 seed weight (g)
16 Ascorbic acid content (mg/100 g)
17 Capsaicin content (%)
18 Green fruit yield/plant (kg)

Table 5: Phenotypic and genotypic path for selected characters

Characters		Plant height (cm)	No. of primary branches	Plant spread in East-West (cm)	Stem girth (cm)	Days to 50% flowering	Fruit set %	Fruit girth (cm)	Fruit length (cm)	Fruit weight (g)
Plant height (cm)	**P**	**0.0225**	0.0008	0.0071	0.0068	0.0043	-0.0022	0.0027	0.0043	0.0058
	G	**-0.7699**	-0.0188	-0.3149	-0.2619	-0.3716	0.0627	-0.1224	-0.152	-0.2209
No. of primary branches	**P**	-0.0041	**-0.1177**	0.0162	-0.0025	-0.0165	0.0153	0.028	-0.0243	0.0163
	G	-0.0053	**-0.216**	0.0515	0.0109	-0.0567	0.0396	0.0592	-0.0508	0.0297
Plant spread in East-West (cm)	**P**	-0.0204	0.0088	**-0.0642**	-0.0162	0.0032	0.0039	-0.0143	-0.0089	-0.0092
	G	0.2716	-0.1584	**0.6642**	0.1879	0.0293	-0.0611	0.2979	0.1257	0.1193
Stem girth (cm)	**P**	-0.023	-0.0017	-0.0193	**-0.0766**	-0.0085	-0.0057	-0.0087	0.0021	0.0014
	G	-0.0125	0.0018	-0.0104	**-0.0367**	-0.0022	-0.0022	-0.005	0.001	0.001
Days to 50% flowering	**P**	0.0201	0.0147	-0.0053	0.0116	**0.1046**	-0.0034	0.0129	0.0259	0.001
	G	0.7597	0.4134	0.0694	0.095	**0.5742**	-0.3661	0.4828	1.0233	0.0481
Fruit set %	**P**	-0.0783	-0.106	-0.0492	0.0602	-0.0267	**0.8137**	0.2417	-0.0081	0.2083
	G	-0.1106	-0.2495	-0.1251	0.0827	-0.3161	**0.3593**	0.4145	-0.0084	0.4013
Fruit girth (cm)	**P**	0.0061	-0.0122	0.0115	0.0058	0.0063	0.0152	**0.0513**	0.0091	0.0183
	G	-0.1285	0.2215	-0.3627	-0.1111	-0.248	-0.2466	**-0.8087**	-0.1227	-0.3284
Fruit length (cm)	**P**	-0.0029	-0.0031	-0.0021	0.0004	-0.0037	0.0001	-0.0026	**-0.015**	-0.0022
	G	-0.1738	-0.207	-0.1666	0.0235	-0.5725	0.0055	-0.1336	**-0.8807**	-0.1364
Fruit weight (g)	**P**	0.0212	-0.0115	0.0118	-0.0015	0.0008	0.0211	0.0295	0.012	**0.0826**
	G	0.1195	-0.0573	0.0748	0.001	0.0127	0.123	0.1692	0.0645	**0.4165**
Green fruit yield per plant (kg)	**P**	-0.0587	-0.2277	-0.0934	-0.0119	0.0638	0.8581	0.3404	-0.0029	0.3224
	G	-0.0498	-0.2702	-0.1198	-0.0097	0.0491	0.9141	0.3537	-0.0002	0.3292
Partial R^2	**P**	-0.0013	0.0268	0.006	0.0009	0.0067	0.6983	0.0175	0	0.0266
	G	0.0384	0.0584	-0.0796	0.0004	0.0773	1.2425	-0.2861	0.0002	0.1371

CONCLUSION

Analysis of variance revealed highly significant difference among the accessions for all the characters studied. Environmental influence was very less on expression of these characters as it was evident by narrow gap between genotypic and phenotypic coefficients of variation. Genotypic and phenotypic coefficients of variation were moderate to high for all the characters studied except green and dry fruit weight. High heritability was observed for all characters, except 1000-seed weight and high genetic advance as per cent mean indicating that simple selection would be sufficient for these traits to bring genetic improvement. Fruit yield had positive and highly significant association with number of fruits per plant and fruit set percentage. Strong association of these traits revealed that selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of genotypes possessing combination of such characters is most useful for obtaining desirable high yielding segregants. Path-coefficient analysis revealed that fruit set percentage and fruit weight had the highest positive direct effect on fruit yield both at genotypic and phenotypic levels and most of the fruit related traits contributed to fruit yield mainly through fruit girth and fruit weight. Hence, it would be rewarding to lay stress on these characters in selection programmes for increasing yield.

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