

## SELECTION PARAMETERS FOR FRUIT YIELD AND RELATED TRAITS IN CHILLI (*CAPSICUM ANNUUM* L.)

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### Abstract

Thirty genotypes of chilli were evaluated in RBD with three replications at vegetable research farm, CHF, CAU, Pasighat, Arunachal Pradesh, India during *kharif*, 2011. Variability, correlation and path analysis were carried out to study the character association and contribution, respectively. Analysis of variance revealed significant differences among the genotypes for all traits. High PCV and GCV, heritability, genetic advance were observed for days to first flowering, plant height, number of seed per fruit, number of fruit per plant, ascorbic acid and fruit yield per plant. Correlation indicated that fruit yield per plant was positively and significantly correlated with number of branch per plant, number of fruit per plant and chlorophyll content while negative and significant association was established with ascorbic acid content. Maximum positive direct effect on fruit yield per plant was imposed by fruit weight, number of fruit per plant, number of seed per fruit and capsaicin content.

### Introduction

Chilli (*Capsicum annuum* L., Solanaceae), native the new world tropics are now widely cultivated for uses as species or vegetables in the temperate zone as well as in the tropics. It is an important constituent of many food adding. However, colour, vitamin and pungency and therefore indispensable to the United States and World food Industries (Green leaf 1986). A wide variability in chilli fruit morphology, pungency, bearing habit and crop duration is found throughout India (Asati and Yadav 2004). The production and consumption of chilli in North eastern region of India has immense potential considering its congenial agro-climatic conditions. A large number of chilli accessions are cultivated in the region but no serious attempts have been made to improve them for higher productivity and acceptability. It is, therefore essential to assess the quantum of genetic variability, nature of character association with respect to different characters, which would help breeders in planning a successful breeding programme. Although the correlation coefficient analysis is useful in determining the relative influence of the various characters on yield, it does not provide an exact picture of the relative importance of each of the characters towards the yield. Path coefficient analysis proves helpful in partitioning the correlation coefficient into direct and indirect effects. It provides realistic basis for allocation of appropriate weightage to various yield components. Therefore, 30 chilli genotypes were collected from different parts of the country and an attempt was made to study the genetic variability, interrelationships among important characters and their direct and indirect effects on fruit yield by path coefficient analysis.

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## Materials and Methods

The present research was carried out in vegetable research farm, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India (altitude 153 m above mean sea level, and 28°04'N and 95°22'E). The soil is sandy loam with pH 6.7. The experimental material for the present study was comprised of 30 genotypes of chilli. The experiment was laid out in RCBD with three replications. The spacing between row to row 60.0 cm and plant to plant 45.0 cm was maintained with accommodating 58 number of plant in each plot of 3.5 × 4.5 m. About 20 metric tonne (mt) of well decomposed cow-dung manure was mixed in the soil at field preparation. Fertilizer was applied @ 90 kg N, 60 kg P<sub>2</sub>O<sub>5</sub> and 60 kg K<sub>2</sub>O per hectare. The standard cultural operations were adopted whenever needed. The observations were recorded on five randomly selected plants of each genotype in accordance with the descriptor list of International Plant Genetic Research Institute, Rome, Italy on plant height (cm), number of primary branch per plant, days to first flowering, fruit length (cm), fruit diameter (cm), number of fruit per plant, average fruit weight (g), green fruit yield per plant (g), number of seed per fruit, ascorbic acid (mg/100 g), capsaicin content (%) and chlorophyll content (mg/g). Ascorbic acid content was determined by the method as described by Jagota and Dani (1982). Capsaicin content (%) was determined by the method as described by Balasubramaniam *et al.* (1982) and chlorophyll content (mg/g) was estimated by the method as suggested by Arnon (1949) and illustrated by Witham *et al.* (1971). Analysis of variance was calculated according to Singh and Chaudhary (1985). Traits that differed significantly were further utilized for estimation of the genetic parameters. The phenotypic and genotypic coefficient of variability and heritability (bs) was calculated as per formula given by Burton and de Vane (1953). The expected genetic advance resulted from selection of 5 per cent superior individuals were worked out as suggested by Johnson *et al.* (1955). Genotypic and phenotypic correlation coefficients were estimated according to the formulae given by Al-Jibouri *et al.* (1958). The direct and indirect effects were calculated by solving the following set of simultaneous equations proposed by Dewey and Lu (1959).

## Results and Discussion

Analysis of variance indicated significant differences among genotypes for all the traits (Table 1). Sufficient genetic variability for many traits had also been reported by Smitha and Basavaraj (2006). The genotype CHFC-16 was earliest in first flowering (33.93 days). The genotype CHFC-27 took the longest time to first flowering (61.27 days). Green fruit yield per plant varied between 73.02 and 531.38 g. The genotype CHFC-26 had higher fruit yield (531.38 g). Genotype CHFC-27 had the highest capsaicin content (2.07%). However, minimum value was recorded in CHFC-3 (0.24%). High ascorbic acid content was found in genotype CHFC-15 (370.33 mg/100 g). However, minimum value was recorded in CHFC-2 (135 mg/100 g). The maximum chlorophyll content was observed in genotype CHFC-13 (0.77 mg/g). However, minimum value was recorded in CHFC-11 (0.16 mg/g) (Table 2). Phenotypic and genotypic variances were highest 14424.88 and 11928.77, respectively for green fruit yield per plant and lowest 0.02 and 0.02, respectively for chlorophyll content (Table 3). The highest estimates of phenotypic (PCV) and genotypic (GCV) coefficient of variation were observed for capsaicin content (72.19, 71.63%). However, the lowest estimates of PCV and GCV were recorded in plant height (18.81, 15.76%). High heritability estimates was recorded for all the characters which ranged between 68.47 and 98.44%. These results were in agreement with Chattopadhyay *et al.* (2011). Genetic advance was high for capsaicin content (146.39%). However, low value was observed for plant height (27.22%). This was in conformity with Datta and Jana (2010). From the above study on mean performance and other genetic parameters of different characters, it was revealed that the characters *viz.*, number of

Table1. Analysis of variance, mean, coefficient of variation and least significant differences for studied traits in chilli genotypes.

S O V	df	Plant height (cm)	No. of primary branch/plant	Days to first flowering	Fruit length (cm)	Fruit diam. (cm)	Mean of square					Green fruit yield/ plant (g)
							No. of fruit /plant	Av. fruit weight (g)	Capsaicin content (%)	Ascorbic acid (mg/100g)	Chlorophyll content (mg/g)	
Replication	2	5.769 <sup>ns</sup>	0.007 <sup>ns</sup>	0.806 <sup>ns</sup>	0.099 <sup>ns</sup>	0.017 <sup>ns</sup>	3.729 <sup>ns</sup>	0.001 <sup>ns</sup>	0.003 <sup>ns</sup>	54.652 <sup>ns</sup>	0.001 <sup>ns</sup>	118.925 <sup>ns</sup>
Genotype	29	307.401 <sup>**</sup>	3.441 <sup>**</sup>	252.467 <sup>**</sup>	4.659 <sup>**</sup>	0.483 <sup>**</sup>	322.477 <sup>**</sup>	0.514 <sup>**</sup>	0.819 <sup>**</sup>	11421.668 <sup>**</sup>	0.053 <sup>**</sup>	38282.418 <sup>**</sup>
Error	58	38.026	0.458	24.357	0.449	0.042	38.524	0.009	0.004	268.596	0.001	2496.103
Mean		60.12	4.55	44.32	4.26	1.01	40.54	1.22	0.73	278.93	0.49	189.67
CV %		10.26	14.86	11.13	15.73	20.25	15.31	7.77	9.03	5.88	8.34	26.34
CD (5%)		10.08	1.11	8.07	1.09	0.33	10.14	0.15	0.11	26.79	0.07	81.66

\* \*\*, and ns significant at  $p < 0.05$ ,  $p < 0.01$  and non significant, respectively.

Table 2. Mean performance of chilli genotypes for yield and yield attributing characters.

Genotypes	Plant height (cm)	Number of primary branch/plant	Days to first flowering	Fruit length (cm)	Fruit diameter (cm)	Number of seed per fruit	Number of fruit per plant	Av. fruit weight (g)	Capsaicin content (%)	Ascorbic acid (mg/100g)	Chlorophyll content (mg/g)	Green fruit yield/plant (g)
CHFC-1	63.47	3.70	34.60	5.80	0.73	45.28	425.88	1.07	0.27	221.43	0.48	455.64
CHFC-2	58.39	6.37	45.07	2.60	1.35	63.51	226.28	1.15	0.59	135.31	0.46	263.45
CHFC-3	51.20	3.50	34.53	3.30	0.97	43.61	80.63	1.11	0.24	174.17	0.55	91.48
CHFC-4	66.67	3.07	37.00	5.89	0.85	55.43	72.52	1.13	0.76	324.27	0.44	82.32
CHFC-5	57.86	5.50	39.87	3.97	0.68	48.45	217.52	1.03	0.40	210.68	0.42	226.34
CHFC-6	63.53	5.53	49.80	2.49	0.46	15.47	195.13	0.48	0.88	314.88	0.54	94.85
CHFC-7	68.31	4.10	56.40	3.14	1.57	41.49	224.53	1.22	1.60	290.20	0.42	278.14
CHFC-8	73.59	4.50	56.20	3.50	0.52	24.78	223.81	0.66	0.85	353.42	0.60	148.40
CHFC-9	45.24	4.50	36.20	4.67	0.83	54.60	96.55	1.14	0.41	344.08	0.45	111.67
CHFC-10	46.08	3.83	35.47	6.15	0.77	42.36	77.17	1.06	0.31	335.79	0.33	81.97
CHFC-11	57.77	4.10	47.07	4.75	0.85	31.48	131.72	1.01	0.42	328.26	0.16	134.81
CHFC-12	72.26	2.13	35.47	6.13	0.95	39.69	72.45	1.18	0.35	259.98	0.47	86.32
CHFC-13	31.52	3.13	57.27	2.73	1.89	23.27	189.15	1.43	1.65	296.91	0.77	272.62
CHFC-14	65.07	5.50	35.40	6.58	1.10	45.83	219.98	1.71	0.52	314.73	0.60	377.64
CHFC-15	51.73	4.33	35.00	3.41	0.78	42.56	120.15	1.12	0.44	370.33	0.69	135.71
CHFC-16	47.14	4.00	33.93	3.96	0.99	41.29	77.74	1.07	0.65	357.29	0.48	84.52
CHFC-17	55.36	5.20	44.80	4.81	0.77	37.84	149.72	1.28	0.50	312.85	0.55	194.55
CHFC-18	40.85	4.03	44.47	3.07	0.92	39.21	203.78	1.13	0.30	296.16	0.69	232.12
CHFC-19	62.45	5.03	41.07	2.95	1.10	36.51	217.83	1.13	0.31	308.89	0.42	247.65
CHFC-20	63.53	5.50	59.73	5.16	1.88	34.53	46.86	2.32	2.05	275.16	0.44	108.29
CHFC-21	72.57	5.27	35.53	5.18	0.86	35.60	186.51	1.17	0.50	274.33	0.58	219.32
CHFC-22	62.99	3.40	35.53	2.93	1.03	45.73	116.63	1.10	0.60	266.07	0.67	129.43
CHFC-23	53.60	7.10	53.67	5.21	0.76	39.63	208.94	1.13	0.59	197.00	0.56	237.83
CHFC-24	58.43	4.13	57.93	3.10	0.55	22.61	164.29	0.78	0.87	340.54	0.59	128.72
CHFC-25	75.71	4.17	56.80	2.83	1.47	34.74	117.28	1.94	1.62	279.79	0.45	226.85
CHFC-26	71.68	6.23	36.07	5.12	0.88	39.04	472.95	1.12	0.62	175.23	0.59	531.38
CHFC-27	70.79	5.33	61.27	5.17	2.05	40.19	41.61	2.48	2.07	208.87	0.42	103.79
CHFC-28	55.25	4.47	44.27	4.66	0.77	51.00	182.77	1.09	0.52	294.46	0.22	202.05
CHFC-29	62.50	4.70	44.33	3.18	1.09	47.64	117.59	1.09	0.41	304.43	0.42	129.11
CHFC-30	68.00	4.27	45.00	5.38	0.83	52.75	56.84	1.28	0.52	202.51	0.38	73.02
Mean	60.12	4.55	44.32	4.26	1.01	40.54	164.49	1.22	0.73	278.93	0.49	189.67
CV	10.26	14.86	11.13	15.73	20.25	15.31	20.06	7.77	9.03	5.88	8.34	26.34
S.E.M±	3.56	0.39	2.85	0.39	3.58	3.58	19.05	0.05	0.04	9.46	0.02	28.85
C.D.5%	10.08	1.11	8.07	1.09	10.14	10.14	53.92	0.15	0.11	26.79	0.07	81.66

\*Data are average of 3 replications.

Table 3. Genetic parameters of yield and its components characters in chilli.

Character	Mean ± SE (m)	Range		Variance		Coefficient of variability (%)		Herita- bility (%)	Genetic advance	Genetic advance as % of mean
		Min.	Max.	Phenotypic	Genotypic	PCV	GCV			
Plant height	60.12±3.56	31.52	75.71	127.82	89.79	18.81	15.76	70.25	16.36	27.22
Number of primary branches/plant	4.55±0.39	2.13	7.10	1.45	0.99	26.46	21.89	68.47	1.70	37.32
Days to first flowering	44.32±2.85	33.93	61.27	100.39	76.04	22.61	19.67	75.74	15.63	35.27
Fruit length	4.26±0.39	2.49	6.58	1.85	1.40	31.95	27.80	75.75	2.12	49.85
Fruit diameter	1.01±0.12	0.46	1.89	0.19	0.15	43.03	37.97	77.84	0.69	69.03
Number of seed per fruit	40.54±3.58	15.47	55.43	133.18	94.65	28.47	24.00	71.07	16.89	41.68
Number of fruit per plant	164.49±19.05	41.61	425.88	10493.27	9404.79	62.27	58.96	89.63	189.13	114.98
Average fruit weight	1.22±0.05	0.48	2.48	0.18	0.17	34.47	33.58	94.92	0.82	67.40
Capsaicin content	0.73±0.04	0.24	2.07	0.28	0.272	72.19	71.63	98.44	1.07	146.39
Ascorbic acid	278.93±9.46	135.31	370.33	3986.29	3717.69	22.64	21.85	93.26	121.29	43.49
Chlorophyll content	0.49±0.02	0.16	0.77	0.02	0.02	27.74	26.45	90.96	0.26	51.97
Green fruit yield per plant	189.67±28.85	73.02	531.38	14424.88	11928.77	63.32	57.59	82.70	204.60	107.87

Table 4. Phenotypic (P) and genotypic (G) correlation coefficients among twelve characters in chili.

Character	1	2	3	4	5	6	7	8	9	10	11	12
Plant height	P	1.000	0.100	0.081	0.189	-0.002	0.017	0.121	0.155	0.167	-0.194	0.113
	G	1.000	0.165	0.152	0.198	0.006	-0.044	0.160	0.197	0.189	-0.243**	0.152
Number of primary branch/plant primary	P	1.000	0.179	0.011	0.016	0.016	0.016	0.318**	0.118	0.069	-0.321*	0.306**
branch/plant	G	1.000	0.252*	-0.013	-0.005	0.049	0.372**	0.137	0.084	0.084	-0.384**	0.389**
Days to first flowering	P		1.000	-0.326**	0.391**	-0.425**	-0.109	0.326**	0.710**	-0.014	-0.015	-0.095
	G		1.000	-0.327**	0.526**	-0.537**	-0.123	0.376**	0.831**	-0.001	-0.021	-0.102
Fruit length	P			1.000	-0.081	0.230*	-0.019	0.236*	-0.136	-0.056	-0.280*	0.086
	G			1.000	-0.119	0.330**	-0.044	0.290**	-0.167	-0.076	-0.319*	0.089
Fruit diameter	P				1.000	0.040	-0.212*	0.747**	0.721*	-0.208*	0.017	0.053
	G				1.000	0.031	-0.253*	0.872**	-0.812**	-0.239*	0.019	0.061
Number of seed/fruit	P					1.000	-0.076	0.134	-0.304**	-0.326**	-0.289*	0.053
	G					1.000	-0.102	0.131	-0.359	-0.394**	-0.319**	0.038
Number of fruit/plant	P						1.000	-0.271**	-0.202	-0.266*	0.199	0.909**
	G						1.000	-0.337**	-0.214*	-0.304**	0.250*	0.907**
Average fruit weight	P							1.000	0.659**	-0.207	-0.079	0.075
	G							1.000	0.679**	-0.232*	-0.069	0.012
Capsaicin content	P								1.000	-0.015	0.052	-0.053
	G								1.000	-0.020	0.055	-0.062
Ascorbic acid	P									1.000	0.016	-0.314**
	G									1.000	0.037	-0.375**
Chlorophyll content	P										1.000	0.201
	G										1.000	0.262*
Green fruit yield/plant	P											1.000
	G											1.000

\*, \*\* indicate significant at 5.0 and 1.0% level of probability, respectively. 1. Plant height, 2. Number of primary branch per plant, 3. Days to first flowering, 4. Fruit length, 5. Fruit diameter, 6. Number of seed per fruit, 7. Number of fruit per plant, 8. Average fruit weight, 9. Capsaicin content, 10. Ascorbic acid, 11. Chlorophyll content, 12. Green fruit yield per plant.

Table 5. Genotypic (G) and Phenotypic (P) path coefficients for fruit yield and its components in chili.

Characters	1	2	3	4	5	6	7	8	9	10	11	Correlation with yield
1. P	-0.028	-0.003	-0.002	-0.005	0.000	-0.001	-0.003	-0.004	-0.005	0.005	0.005	0.113
G	-0.236	-0.039	-0.036	-0.047	-0.001	0.010	-0.038	-0.047	-0.045	0.058	0.042	0.152
2. P	-0.004	-0.038	-0.007	-0.000	-0.001	-0.001	-0.012	-0.005	-0.003	0.012	-0.000	0.306
G	-0.050	-0.303	-0.076	0.004	0.001	-0.015	-0.113	-0.042	-0.026	0.116	0.001	0.389
3. P	-0.001	-0.002	-0.010	0.003	-0.004	0.004	0.001	-0.003	-0.007	0.000	0.000	-0.095
G	0.010	0.017	0.066	-0.021	0.035	-0.035	-0.008	0.025	0.054	-0.000	-0.001	-0.102
4. P	0.001	0.000	-0.002	0.005	-0.000	0.001	-0.000	0.001	-0.001	-0.000	-0.001	0.086
G	0.075	0.005	0.124	-0.379	0.045	-0.125	0.017	-0.109	0.063	0.029	0.121	0.089
5. P	-0.000	0.001	0.035	-0.007	0.090	0.004	-0.019	0.067	0.065	-0.019	0.002	0.053
G	-0.006	0.005	-0.523	0.119	-0.994	-0.031	0.252	-0.868	-0.807	0.239	-0.019	0.061
6. P	0.001	0.001	-0.026	0.014	0.003	0.062	-0.005	0.008	-0.019	0.020	-0.018	0.053
G	-0.009	0.010	-0.112	0.069	0.006	0.208	-0.021	0.027	-0.075	-0.082	-0.066	0.036
7. P	0.125	0.328	-0.113	-0.019	-0.219	-0.079	1.034	-0.280	-0.209	-0.275	0.206	0.909
G	0.212	0.493	-0.163	-0.058	-0.335	-0.135	1.324	-0.446	-0.283	-0.403	0.332	0.907
8. P	0.062	0.047	0.130	0.094	0.298	0.053	-0.108	0.399	0.263	-0.083	-0.032	0.075
G	0.273	0.190	0.522	0.403	1.211	0.182	-0.468	1.389	0.944	-0.322	-0.096	0.012
9. P	-0.023	-0.009	-0.099	0.019	-0.101	0.042	0.028	-0.091	-0.139	0.002	-0.007	-0.053
G	0.022	0.009	0.095	-0.019	0.093	-0.041	-0.025	0.078	0.115	-0.002	0.006	-0.062
10. P	-0.012	-0.020	-0.001	-0.004	-0.013	-0.020	-0.017	-0.013	-0.001	0.063	0.001	-0.314
G	0.001	0.002	0.000	0.000	0.001	0.002	0.002	0.001	0.000	-0.005	-0.000	-0.375
11. P	-0.007	0.000	-0.001	-0.013	0.000	-0.013	0.009	-0.004	0.002	0.001	0.046	0.201
G	0.010	0.000	0.001	0.018	-0.001	0.018	-0.014	0.004	-0.003	-0.002	-0.057	0.262

Residual effect (G) = 0.221, Direct effect values are shown as underline and bold.

1. Plant height, 2. Number of primary branch per plant, 3. Days to first flowering, 4. Fruit length, 5. Fruit diameter, 6. Number of seed per fruit, 7. Number of fruit per plant, 8. Average fruit weight, 9. Capsaicin content, 10. Ascorbic acid, 11. Chlorophyll content.

fruit per plant, fruit length, fruit diameter and fruit weight were the most important traits for improving the genotypes for higher fruit yield and may be applied for selection in chilli. In general, genotypic correlation was higher than phenotypic correlation, indicated low influence due to environment and the expression of characters being mainly due to genetic factors (Table 4). Correlation studies revealed that characters like number of primary branch per plant, number of fruit per plant and chlorophyll content had significant positive correlation with fruit yield per plant both at genotypic and phenotypic level. Similar result was also reported by Datta and Jana (2010) in their experiment. Chlorophyll content had positive and significant correlation with fruit yield per plant. This result was corresponding with the observation of Mathew *et al.* (2004). However, negative and significant association of green fruit yield per plant was illustrious with ascorbic acid content both at genotypic and phenotypic level, indicated that green fruit yield and ascorbic acid content could not be improved simultaneously through selection and it is strongly suggested that this character should not be emphasized for direct selection of high yielding genotype. Path coefficient analysis is one such method which partition correlation into direct and indirect effects. In the present investigation, green fruit yield per plant was taken as dependent variable and other 11 traits were considered as causal variables (Table 5). Fruit weight had maximum positive direct effect on fruit yield per plant and indicated that this was the real independent characters and has maximum contribution towards increase in fruit yield per plant. These observations were in agreement with Datta and Jana (2010). Path coefficient analysis revealed that number of fruit per plant, fruit weight and number of seed per fruit were the most important traits affecting fruit yield per plant. However, relative importance of days to first flowering and capsaicin content cannot be ignored when selection is practiced for improving the green fruit yield per plant in chilli. The residual factor determines how best the causal factors account for the variability of the dependant factors, the fruit yield per plant in this case. The residual effect at genotypic level (0.221) was of moderate and negligible in magnitude. The variables studied explain about 77.9% of the variability. It indicates that some characters which have not been studied here need to be included in this analysis to account fully for the variation in fruit yield per plant. In conclusion, the correlation coefficient analysis revealed that fruit yield per plant had significantly positive genotypic correlation with number of fruit per plant, weight of fruit, length of fruit and chlorophyll content. Path analysis revealed that number of fruit per plant and average fruit weight had strong influence on fruit yield and the main determiners of fruit yield per plant. Therefore, improvement in yield can be achieved by selecting the genotypes which have more number of fruit per plant with more fruit weight.

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