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DIVERSITY OF GENETIC RESOURCES AND GENETIC ASSOCIATION ANALYSES OF GREEN AND DRY CHILLIES OF EASTERN INDIA

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Chilli (*Capsicum annuum* L.) is regarded as one of the main commercial vegetable and spice crops at the global level. Maximum diversity can be noted among the cultivars/landraces available in India with respect to shape, size, yield, quality, and other traits. The present experiment was conducted to identify the most promising chilli variety suited for green and dry purposes, to study the genetic variability for different traits and to assess the association of different yield attributing traits with the green and dry yield of chilli. Thirty four genotypes were characterized during a 2-yr period. Most of the genotypes possessed the character constellation of *C. annuum*. Two genotypes, 'Chaitali Pointed' and 'BC CH Sel-4' were found most promising with respect to green fruit yield (272.79 g, 221.10 g per plant) and dry fruit yield (54.56 g, 44.44 g per plant). Phenotypic and Genotypic Coefficient of Variation values for green fruit weight (119.95%, 111.26%), green fruit girth (89.76%, 48.93%), weight of red ripe fruit (112.02%, 111.93%), weight of dry fruit (111.63%, 110.97%) and number of fruits per plant (86.05%, 85.02%) were recorded to be high. Green fruit yield per plant, ascorbic acid content, and number of fruits per plant also showed very high broad-sense heritability and genetic advance. From the study of correlation and path coefficient analyses, the number of fruits per plant, green fruit length for green chilli, weight of dry fruit and the number of fruits per plant for dry chilli were found to the most important selection indices.

Key words: Quantitative traits, qualitative traits, genetic variability, heritability, selection index, *Capsicum annuum*.

India is one of the leading chilli (*Capsicum annuum* L.) producing countries of the world. It is grown for for use as a vegetable (green chilli), spice (dry chilli), condiment, sauce and pickle under tropical, sub-tropical and temperate climates (Hazra *et al*., 2011). Chilli, both in the green and ripe stages, is an important condiment used for imparting pungency, which is due to an active principle 'capsaicin', an alkaloid present in the placenta, which can directly scavenge various free radicals (Reddy and Lokesh, 1992; Kogure *et al*., 2002; Bhattacharya *et al*., 2010). Chilli is considered a good source of vitamin C (ascorbic acid) in food and beverage industries (Bosland and Votava, 1999). It has also acquired a great importance because of the presence of 'oleoresin', which permits better distribution of color and flavor in foods.

Though India stands first in chilli cultivation, representing 45% of the world acreage, its productivity is quite low (1 t ha^{-1} dry chilli) as compared to USA, China, South Korea, Taiwan, etc. (3-4 t ha^{-1} dry chilli) as reported by Reddy *et al*. (2002). The main reason for low productivity in India is the use of open pollinated varieties, with only 2.6% of cultivated areas using hybrid varieties (Hundal, 2000).

In spite of tremendous potential use, good scope for export as a spice, high nutritive value, good acceptability among the average Indian farmer and consumer, and a wide range of available genetic variability, India is still far behind in attaining the required optimum productivity in chilli. Moreover, all the available information regarding the quality parameters has been confined to a few genotypes with very scanty data available for parameters like capsaicin, ascorbic acid, and oleoresin contents. Therefore, concentrated efforts are necessary to improve yield and yield components. Hence, evaluation of the potential of existing genetic resources in eastern India is essential because improvement programs depend on the genetic diversity of the crop. The magnitude of heritable, and more particularly genetic components, is clearly the most important aspect of the genetic constitution of the breeding material, which has a close bearing on its response to selection. Selection of one trait invariably affects a number of associated traits, which evokes the necessity to determine the interrelationship of various yield components, both among themselves and with yield. Keeping in view the above facts, the present experiment was undertaken with the following two objectives: To evaluate and characterize different qualitative and quantitative characters of chilli genotypes grown in Eastern India; and to study character inter-relationships

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and their direct and indirect effects on green and dry chilli fruit yield.

MATERIALS AND METHODS

Plant material

The present investigation was undertaken during the autumn-winter season of two consecutive years (2008-2009 and 2009-2010) at "C" Block Farm at the research field of the All India Coordinated Research Project on Vegetable Crops, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India. This site (22°56' N, 88°32' E, 9.75 m.a.s.l.) is situated in a humid sub-tropical region with an average temperature range of 11.25 to 29.25 °C during the autumn-winter months (September-March). The soil of the experimental field was sandy loam in texture, with good drainage and medium soil fertility. Thirty-four genotypes collected from different parts of Eastern States (West Bengal, Assam, Tripura, Bihar, Orissa, and Eastern UP) of India were evaluated following a randomized complete block design with three replicates. The seedlings of each genotype were raised under low cost poly tunnel. Nursery beds were covered with 200 µm ultraviolet (UV)-stabilized film supported by bamboo poles with open sides to protect seedlings from rain and direct sunlight. The sides of the nursery structure were covered with a 50 mesh nylon net to prevent the attack of whitefly (*Bemisia tabaci*). Seedlings were hardened by withholding water 4 d before transplanting. Twenty-five-day-old, seedlings, at least 15 cm in height with 3-4 leaves, were used for transplanting in the main field, at a spacing of 50 cm both ways in a plot size of 9 m^2. The crop was fertilized with 15 t farmyard manure, along with 120 kg N ha^{-1} (Urea), 60 kg P_2O_5 ha^{-1} (Single super phosphate) and 60 kg K_2O ha^{-1} (potassium chloride). 1/3 amount of N and full doses of P and K were applied at planting. The remaining amount of N was top-dressed at 30 d after planting (DAP) and 60 DAP in equal amounts. The cultural practices were followed in accordance with Bose *et al*. (2003).

Physical-chemical characteristics

Each genotype was characterized regarding 16 morphological characters in accordance with the descritptor list of the International Plant Genetic Resources Institute in Rome. Ten randomly selected plants from each replicate were taken to record ten quantitative and three qualitative traits. One plant out of each genotype was kept for selfing to collect selfed seeds for the next generation. Selfing was done by covering the plant with a cage of mesh size 20 × 16 holes per 2.5 m^2 (Bosland and Votava, 1999) to prevent insect pollination. Vitamin C content was determined by the dichlorophenol indophenol titration procedure (Casanas *et al*., 2002). For analysis of capsaicin, 0.5 g of dry chilli powder was extracted with 10 mL dry acetone (acetone free from water obtained after treatment with anhydrous Na_2SO_4) by shaking for 3 h in a mechanical shaker, the contents centrifuged at 10 000 g for 10 min, and the supernatant evaporated to dryness in a hot water bath. The residue was re-dissolved in 5 mL 0.4% sodium hydroxide solution and 3 mL 3% phosphomolybdic acid solution. The contents were shaken by hand and kept aside for 1 h and then centrifuged at 5000 g for 15 min and the absorbance of the blue color supernatant measured at 650 nm against a reagent blank. The content of capsaicin was calculated using a calibration curve against a high purity capsaicin (Sadasivam and Manickam, 1992). The oleoresin content of ripe red fruits was estimated in accordance with the method of Ranganna (1986).

Statistical analysis

The mean data obtained were used to determine a genotypic coefficient of variation and a phenotype coefficient of variation (Burton, 1952), broad-sense heritability (Hanson *et al*., 1956), and the expected genetic advance (Johnson *et al*., 1955). The correlation coefficients at the genotypic and phenotypic levels were calculated in accordance with the method given by Johnson *et al*. (1955). The path coefficient analysis was done in accordance with Dewey and Lu (1959). All statistical analyses were done using SPSS Professional Statistics version 7.5 (SPSS Inc., Chicago, Illinois, USA).

RESULTS AND DISCUSSION

Characterization of chilli genotypes

Sixteen morphological characters were recorded in accordance with the descriptors and their frequency distribution patterns as shown in Table 1. The genotypes showed three plant growth habits. It was observed that 53% of the genotypes showed intermediate plant growth habit, 38% showed erect habit and only 9% had spreading habit. The predominant branching habits were dense, sparse and intermediate with 41%, 32% and 27% of genotypes, respectively. Maximum genotypes (74%) had medium-sized leaves and the rest had small to large leaves. The pigmentation at nodes was mostly present (88%) in the genotypes. Most of the genotypes (82%) had lanceolate shaped-leaves. The predominant leaf color was green (77%). All the genotypes had only one flower per axil, except one that had more than two flowers per axil. The predominant anther color was blue (32%), followed by purple (26%), bluish yellow, and pale blue. Entire and intermediate type calyx margins were observed in equal proportion (38%), followed by a dentate type (24%). Most of the genotypes (80%) had long fruit shape, followed by conical and very long. Maximum genotypes (91%) showed pendant fruit position and the remaining were in erect position. The fruit shape of most of the genotypes at blossom-end was pointed (65%) and the remaining ones showed a blunt-type fruit shape. The

Table 1. Frequency distribution pattern for morphological characters in chilli genotypes.

Characters	Specification	N° of genotypes	% of genotypes
Plant growth habit	Intermediate	18	52.94
	Spreading	3	8.83
	Erect	13	38.23
Branching habit	Dense	14	41.17
	Sparse	11	32.36
	Intermediate	9	26.47
Leaf size	Small	2	5.89
	Medium	25	73.52
	Large	7	20.59
Leaf shape	Ovate	6	17.65
	Lanceolate	28	82.35
Leaf color	Green	26	76.48
	Dark green	4	11.76
	Light green	4	11.76
Pigment at node	Absent	4	11.76
	Present	30	88.24
N° of flowers per axil	More than two	1	2.95
	One	33	97.05
Fruit surface	Smooth	5	14.70
	Wrinkled	29	85.30
Fruit shape at pedicel attachment	Acute	1	2.94
	Obtuse	29	85.30
	Truncate	4	11.76
Anther color	Bluish yellow	7	20.59
	Pale blue	7	20.59
	Blue	11	32.36
	Purple	9	26.46
Calyx margin	Intermediate	13	38.23
		8	23.54
	Entire	13	38.23
Immature fruit color	Green	29	85.30
	Light green	3	8.83
	Dark green	2	5.87
Ripe fruit color	Dark red	4	11.76
	Red	21	61.75
	Light red	1	2.95
	Orange	4	11.76
	Pale orange	1	2.95
	Brown	3	8.83
Fruit position	Pendant	31	91.17
	Erect	3	8.83
Fruit shape	Conical	4	11.76
	Long	27	79.41
	Very long	3	8.83
Blossom end fruit shape	Pointed	22	64.70
	Blunt	12	35.30

predominant immature fruit color was green (85%) and ripe fruit color was red (62%). Most of the genotypes (85%) had an obtuse fruit shape at the pedicel attachment. From the morphological study, it is established that most of the genotypes possess the character constellation of *C. annuum* and only one genotype (Ganga Kaveri-1) belongs to *C. frutescens*.

The genotypes showed a wide range of variation in different yield component traits (Table 2). The earliest 50% flowering was noted in genotype Cob chilli-10 (30.33 d) followed by 'Cob chilli-3' (30.67 d), 'HP-30' and 'HP-33' (31.00 d). However, very late flowering was observed in chilli-335 (109.00 d). The green fruit weight of the genotypes varied between 1.60 g and 23.00 g, the maximum being in HP-30 followed by genotypes HP-25 (20.67 g). Green fruit length was the maximum in 'HP-25' (14.97 cm) and the minimum in 'chilli-335' (2.93 cm). The range of values was comparable to observations of Rani (2001). The green fruit girth varied from 0.53 to 2.77 cm. The results are in line with those observed by Chandra *et al*. (1990). The weight of red ripe fruit weight varied considerably, ranging from 1.07 to 19.87 g. The maximum weight of dry fruit was found in 'HP-30' (4.60 g) and the minimum in 'Beldanga' (0.20 g). The number of fruits per plant ranged from 5.6 to 134.0. The maximum number of fruits per plant was recorded in 'BC Ch Sel-4' and the minimum in 'HP-30'. The number of seeds per fruit varied from 43.33 to 117. The green fruit yield per plant varied considerably, ranging from 41.80 to 272.79 g. The maximum green fruit yield per plant was obtained in 'Chaitali pointed' followed by 'BC Ch Sel-4'. The range of values was in agreement with the observations of previous works (Chandra *et al*., 1990; Singh *et al*., 2005; Tembhurne *et al*., 2008). The mean ratio of green fruit yield to dry fruit yield per plant was 4.87:1. The results corroborate the earlier findings of Sheela *et al*. (2004), who observed 20.25 to 25.61% recovery of dry chilli from the green ones. The maximum dry fruit yield per plant was noted in 'Chaitali pointed' (54.56 g) and the minimum was recorded in 'Cob chilli-8' (8.36 g). The same trend of results were obtained by earlier works (Rani, 2001; Singh *et al*., 2005).

The quality characters of different chilli genotypes are shown in Table 3. The range of ascorbic acid content in green fruit, which agrees with Khadi *et al*. (1987), was highest for the genotype BCC-1 (221.18 mg 100 g^{-1}) and the lowest for the genotype Cob chilli-8 (9.93 mg 100 g^{-1}). The capsaicin content of ripe fruit was estimated to be high in 'BCC-12' (0.37%), followed by 'BCC-1' (0.31%) and 'BCC-62' (0.26%), with a mean value of 0.15%, which agrees well with the observations of Gomez-Fuentes and Canessa (1988). The oleoresin content of ripe fruit varied from 8.89% to 37.00%, the maximum being in 'AC-588' and the minimum in 'BCC-12'.

Assessment of genetic variability and heritability

The ANOVA for the different yield component characters revealed that the mean square due to genotypes was highly significant. The phenotypic coefficient of variance (PCV) agreed closely with the values of the genotypic coefficient of variance (GCV). However, the value of the PCV is slightly greater than that of the GCV for all the characters (Table 4). The results obtained by Bandale *et al*. (2006) follow the same trends. The PCV and GCV values for green fruit weight, green fruit girth, weight of red ripe fruit, weight of dry fruit, and number of fruits per plant were high and the broad-sense heritability value of most of the characters was high (96.5 to 99.80%). This trend is in line with values obtained by Khurana *et al*. (2003). The genetic advance (GA), which is expressed as a percentage of mean was very high for characters like green fruit yield per plant (122.97), ascorbic acid content (102.60), and number of fruits per plant (74.75), which had high value of broad-sense heritability, indicating

Table 2. Yield component characters of 34 chilli genotypes.

Genotypes	Days to 50% flowering	Green fruit weight	Green fruit length	Green fruit girth	Weight of ripe fruit	Weight of dry fruit	Number of fruits per plant	Number of seeds per fruit	Green fruit yield per plant	Dry fruit yield per plant
		g	cm		g				g	
BCC-1	88.00	2.90	4.76	1.12	1.32	0.27	65.25	64.00	189.00	37.80
BC Ch Sel-4	62.00	1.63	6.23	1.20	1.39	0.33	134.00	74.00	221.10	44.22
BCC-12	40.00	2.27	5.47	1.10	1.18	0.26	53.33	69.33	75.27	15.05
BCC-62	45.00	1.60	9.20	1.10	1.39	0.32	90.67	116.33	147.92	29.58
BCC-30	75.00	1.67	7.39	0.87	1.27	0.25	80.24	57.00	131.00	26.20
AC-575	71.00	1.72	6.63	0.90	1.62	0.35	69.07	59.33	124.26	24.85
AC-576	38.00	7.47	6.63	1.30	6.67	1.49	11.00	60.67	87.18	17.44
AC-585	43.00	1.80	5.20	0.33	1.23	0.36	63.67	54.00	116.90	23.38
AC-588	44.00	2.76	8.07	0.83	2.57	0.55	19.00	63.33	59.88	11.98
AC-615	39.00	3.43	6.23	0.60	2.53	0.69	36.67	74.67	133.26	26.65
HP-25	40.00	20.67	14.97	1.87	17.53	4.12	6.47	83.00	137.42	27.48
HP-26	44.00	6.63	9.87	1.17	5.23	1.33	27.67	43.33	189.81	37.96
HP-27	32.00	12.87	11.17	2.13	11.77	2.57	6.77	112.67	89.10	17.82
HP-30	31.00	23.00	11.47	2.77	19.87	4.60	5.60	22.67	129.56	25.91
HP-33	31.00	8.20	11.27	1.40	5.17	1.64	19.33	94.33	128.83	25.77
Chaitali pointed	56.00	2.22	6.30	1.20	1.97	0.44	114.40	79.00	272.79	54.56
Chaitali Blunt	85.00	2.00	3.53	0.92	1.12	0.22	55.30	65.40	110.00	22.45
Beldanga	86.00	1.60	7.76	0.84	1.07	0.20	56.20	55.80	83.00	16.80
Mukta	76.00	1.67	7.78	0.83	1.24	0.24	90.00	77.60	148.60	29.70
J. Mukta	57.00	1.70	8.03	0.90	1.64	0.34	89.00	94.00	171.49	34.30
Chandramukhi	77.00	3.30	6.87	0.89	2.68	0.53	23.00	56.00	75.47	15.07
Ganga Kaveri-1	52.00	2.10	6.53	0.90	1.82	0.43	76.67	84.00	172.41	34.48
Aismali	42.00	2.12	4.53	0.53	1.84	0.42	59.67	52.67	129.99	26.00
Sel-14	90.00	1.67	4.73	0.63	1.35	0.30	91.00	73.00	152.00	38.00
Barshali	46.00	2.00	2.93	0.95	1.65	0.41	32.00	56.00	65.00	17.20
Chilli-335	109.00	1.67	2.93	0.93	1.65	0.41	32.00	56.00	65.00	17.20
Chilli-353	75.33	2.43	6.16	0.82	1.25	0.31	42.03	55.50	103.00	25.75
Cob chilli-1	55.67	2.87	7.03	1.43	2.74	0.57	62.00	54.67	190.95	38.19
Cob chilli-2	71.67	1.81	7.00	0.63	1.66	0.37	72.67	72.67	133.58	26.71
Cob chilli-3	30.67	2.27	4.23	0.63	2.04	0.45	22.00	52.67	57.48	11.50
Cob chilli-6	54.67	1.83	12.00	1.20	1.70	0.40	25.80	47.67	47.21	9.40
Cob chilli-8	31.67	2.07	3.27	1.30	2.08	0.41	18.67	73.67	41.80	8.36
Cob chilli-10	30.33	2.48	4.63	1.10	2.38	0.50	17.00	86.00	42.16	8.43
Cob chilli-11	41.33	2.12	4.33	1.13	2.01	0.43	26.00	117.00	63.88	12.78
Average	55.60	4.07	6.91	1.07	3.80	0.87	49.18	69.35	120.18	24.67
LSD (P = 0.05)	4.80	1.41	0.40	0.22	0.44	0.28	11.54	6.27	12.17	2.44
CV, %	5.24	12.39	2.69	9.06	4.44	12.12	13.28	4.17	5.10	5.10

CV: coefficient of variation (ratio of the standard deviation to the mean).

a preponderance of additive gene action for the control of these traits. Thus, selection based on these characters would be effective. These observations are supported by earlier workers (Bhagyalakshmi *et al*., 1990; Rani *et al*., 1996; Gogoi and Gautam, 2002; Das and Maurya, 2004; Prabhakaran *et al*., 2004; Varkey *et al*., 2005; Wasule *et al*., 2007; Patel *et al*., 2009).

Correlation coefficient

Association analysis of different morphological characters with green and dry fruit yield of chilli and their inter-relationships were investigated through the study of both phenotypic and genotypic correlation coefficient. In the present study, eight characters including growth and reproductive characters were recorded and their genotypic and phenotypic correlation coefficients were analyzed for green chilli (Table 5) and seven characters were analyzed for dry chilli (Table 6). For both green and dry chillies, the phenotypic and genotypic correlation coefficient, in general, agreed very closely.

Three characters, namely days to 50% flowering, number of fruits per plant, and ascorbic acid content, exhibited significantly positive correlation coefficients with green fruit yield per plant. Hence selection based on these characters would be rewarding. These findings corroborate the earlier observations of Bhagyalakshmi *et al*. (1990); Rani (1997); Devi and Aramugam (1999); Kumar *et al*. (2003); Nandadevi and Hosamani (2003); Tembhurne *et al*. (2008). However, green fruit weight, green fruit girth, and number of seeds per fruit exhibited negative correlations with green fruit yield per plant. The correlation between green fruit yield and green fruit length was non-significant, although positive, indicating its limited contribution towards green fruit yield per plant.

However, two characters days to 50% flowering and number of fruits per plant exhibited significantly positive correlation coefficient with dry fruit yield per plant. The other characters exhibited negative correlations with dry fruit yield per plant.

Path coefficient analysis

In the present study, the phenotypic correlation was partitioned into direct and indirect effects to identify the relative importance of yield components towards green and dry fruit yield of chilli genotypes (Tables 5 and 6).

Among the seven yield attributing characters, number

Table 3. Quality characters of 34 chilli genotypes.

Genotypes	Ascorbic acid content of green fruit	Capsaicin content of ripe fruit	Oleoresin content of ripe fruits
	mg 100 g^{-1}	%	
BCC-1	221.18	0.31	22.25
BC Ch Sel-4	131.32	0.12	31.00
BCC-12	21.38	0.37	8.89
BCC-62	128.36	0.26	10.83
BCC-30	89.25	0.17	17.26
AC-575	52.81	0.14	31.00
AC-576	55.22	0.16	20.22
AC-585	32.65	0.11	22.00
AC-588	130.08	0.10	37.00
AC-615	150.02	0.12	10.83
HP-25	123.29	0.20	30.67
HP-26	108.43	0.21	26.00
HP-27	79.41	0.11	11.83
HP-30	125.92	0.20	31.00
HP-33	17.47	0.20	22.00
Chaitali pointed	132.74	0.13	11.67
Chaitali Blunt	105.32	0.11	12.00
Beldanga	115.40	0.15	18.26
Mukta	146.32	0.15	12.42
J. Mukta	168.10	0.13	11.33
Chandramukhi	48.26	0.11	9.53
Ganga Kaveri-1	97.66	0.10	11.00
Aismali	53.25	0.11	29.17
Sel-14	128.20	0.11	27.00
Barshali	27.24	0.10	12.24
Chilli-335	34.56	0.10	12.24
Chilli-353	32.00	0.10	23.50
Cob chilli-1	20.86	0.13	11.17
Cob chilli-2	68.64	0.13	24.93
Cob chilli-3	67.34	0.08	24.67
Cob chilli-6	35.67	0.11	18.00
Cob chilli-8	9.93	0.13	31.15
Cob chilli-10	55.28	0.16	23.33
Cob chilli-11	32.75	0.24	12.80
Average	83.71	0.15	19.68
LSD (P = 0.05)	0.90	0.02	2.06
CV, %	0.56	5.66	4.81

CV: coefficient of variation (ratio of the standard deviation to the mean).

of fruits per plant and green fruit length showed highly positive direct effects on green fruit yield per plant, as observed by Kataria *et al*. (1997), Devi and Aramugam (1999), Nandadevi and Hosamani (2003), Patel *et al*. (2009). The direct effects of other characters were negligible. The residual effect of the path analysis was low (0.2274), suggesting inclusion of maximum green fruit yield among influencing characters in the present analysis.

Table 4. Estimates of genetic variability of 13 characters of chilli genotypes.

Characters	PCV	GCV	Heritability (bs)	Genetic advance as percentage of mean
	%			%
Days to 50% flowering	27.97	27.47	96.50	25.33
Green fruit weight, g	111.95	111.26	98.80	12.88
Green fruit length, cm	38.85	38.75	99.50	6.05
Green fruit girth, cm	89.76	48.93	96.70	1.18
Weight of red ripe fruit, g	112.02	111.93	99.80	11.31
Weight of dry fruit, g	111.63	110.97	98.80	2.57
Number of fruits per plant	86.05	85.02	97.60	74.75
Number of seeds per fruit	35.18	34.93	98.60	53.43
Green fruit yield per plant, g	50.87	50.58	99.00	122.97
Dry fruit yield per plant, g	50.87	50.60	99.00	24.59
Ascorbic acid content, mg 100 g^{-1}	61.79	61.70	99.00	102.60
Oleoresin content, %	40.57	40.29	98.60	17.55
Capsaicin content, %	46.32	45.97	98.50	0.15

PCV: Phenotypic coefficient of variation; GCV: Genotypic coefficient of variation.

Table 5. Genotypic and phenotypic correlations and direct effects of seven characters on green fruit yield per plant.

Characters	rg with yield per plant	rp with yield per plant	Direct effect on yield per plant
Days to 50% flowering	0.459	0.462**	0.001
Green fruit weight, g	-0.112	-0.114	-0.182
Green fruit length, cm	0.121	0.123	0.472
Green fruit girth, cm	-0.042	-0.041	0.249
Number of fruits per plant	0.741	0.750**	0.979
Number of seeds per fruit	-0.102	-0.104	-0.249
Ascorbic acid content, mg100 g^{-1}	0.399	0.401**	0.064

*Significant at 5% level; ** Significant at 1% level.
rg: Genotypic correlation coefficient; rp: phenotypic correlation coefficient; Residual effect: 0.2274.

Table 6. Genotypic and phenotypic correlations and direct effects of seven characters on dry fruit yield per plant.

Characters	rg with yield per plant	rp with yield per plant	Direct effect on yield per plant
Days to 50% flowering	0.459	0.462**	-0.070
Weight of red ripe fruit, g	-0.133	-0.134	-1.528
Weight of dry fruit, g	-0.113	-0.115	1.939
Number of fruits per plant	0.741	0.750**	0.860
Number of seeds per fruit	-0.102	-0.104	-0.165
Oleoresin content	-0.230	-0.232	-0.181
Capsaicin content	-0.189	-0.190	-0.124

*Significant at 5% level; **Significant at 1% level.
rg: Genotypic correlation coefficient; rp: Phenotypic correlation coefficient; Residual effect: 0.246.

Regarding dry fruit yield per plant, there were highly positive direct effects on this trait shown by the characters viz. weight of dry fruit and number of fruits per plant, as observed by Natarajan *et al*. (1993), Devi and Aramugam (1999), Singh and Singh (2004). Low residual effect (0.2464) of the path analysis suggested inclusion of maximum dry fruit yield as an influencing character in the present analysis.

Although days to 50% flowering showed a positive significant correlation, the direct effect on green and dry fruit yield per plant was negligible. Thus, this trait may not be considered a reliable selection index. On the other hand, although green fruit length and weight of dry fruit showed negative associations with green and dry fruit yield of chillies, respectively, their direct effects were highly positive. Selection based on these characters could be beneficial for yield improvement of both green and dry chillies.

CONCLUSION

Wide variability has been found in different quantitative and qualitative traits of chilli grown in Eastern India. Most of the genotypes under study belong to *Capsicum annuum*. Some of the genotypes ('Chaitali Pointed' and 'BC CH Sel-4') possess high yield, with qualities suitable for use as both green and dry chilli. This information will provide breeders with the ability to develop desirable types having high yield and better nutritional profiles. From the combing study of GCV, PCV, heritability, genetic advance, correlation and path coefficient, two

characters, namely number of fruits/plant and green fruit length, were found to be the most important selection indices of green chilli, whereas weight of dry fruit and number of fruits/plant were identified as most important selection indices of dry chilli.

Diversidad de recursos genéticos y análisis de asociación genética de ajíes verdes y secos del Este de India. El ají (*Capsicum annuum* L.) es considerado como uno de los principales cultivos comerciales de vegetales y especias a nivel mundial. La máxima diversidad puede ser observada entre los cultivares y razas disponibles en India con respecto a forma, tamaño, producción, calidad, y otros rasgos. Este experimento se realizó para identificar la variedad de ají más promisoria y apropiada para fruto verde y seco, para estudiar la variabilidad genética para diferentes rasgos y evaluar la asociación de diferentes rasgos productivos con el rendimiento de ají verde y seco. Treinta y cuatro genotipos se caracterizaron durante un período de 2 años. La mayoría de los genotipos poseía constelación de caracteres de *C. annuum*. Dos genotipos, 'Chaitali Pointed' y 'BC CH Sel-4' fueron los más promisorios para rendimiento de fruto verde (272,79 g, 221,10 g por planta) y de fruto seco (54,56 g, 44,44 g por planta). Los valores de coeficiente de variación fenotípica y genotípica se consideraron altos para peso de fruto verde (119,95%, 111,26%), circunferencia fruto verde (89,76%, 48,93%), peso de fruto maduro rojo (112,02%, 111,93%), peso de fruto seco (111,63%, 110,97%) y número de frutos por planta (86,05%, 85,02%). Rendimiento de fruto verde, contenido de ácido ascórbico, y número de frutos por planta también mostraron heredabilidad en sentido amplio y avance genético altos. Para el estudio de correlación y análisis de coeficientes, los índices de selección más importantes fueron número de frutos por planta y longitud de fruto verde para ají verde, y peso de fruto seco y número de frutos por planta para ají seco.

Palabras clave: rasgos cuantitativos, rasgos cualitativos, variabilidad genética, heredabilidad, índice de selección, *Capsicum annuum*.

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