ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 45(3): 335-348, September 2020

EVALUATION OF CHILLI GENOTYPES FOR EARLINESS, YIELD AND OTHER CHARACTERS IN WINTER SEASON

M. I. HAQUE[1], S. ISHTIAQUE[2], M. M. ISLAM[3] AND M. A. RAHIM[4]

Abstract

Thirty-six genotypes of chilli (*Capsicum* spp.) from diverse sources were evaluated at the Regional Spices Research Station, BARI, Gazipur during February 2017 to November 2018 to select the promising genotype(s) for breeding. Distinct variation among the genotypes was observed in all the qualitative parameters except seed colour and fruiting behavior. The genotype CO 525 and CO 634 took minimum days for 1st flowering (50 days) and first fruit set (59 days), while the genotype CO 633 took the maximum for 1st flowering and first fruit set (125 and 141 days). Plant height ranged from 46 cm (CO 610) to 119cm (CO613). Single fruit weight ranged from 0.72 g (CO629) to 7.81g (CO642), while fruit length ranged from 2.90cm (CO645) to 12.68 cm (CO631). Pedicel length was maximum in CO643 (5.52 cm) and minimum in CO639 (1.50 cm). The genotype CO 611-2 had the maximum number of fruits/plant (342) whereas the genotype CO640 had the minimum no. of fruits/plant (41.33). The genotype CO631 produced the maximum weight of fruits/plant (628.33g). The maximum number of fresh seeds was obtained from CO635 (93.20/fruit) and it was the lowest in C0645 (18). The highest weight of fresh seeds/fruit was obtained from CO525 (0.61 g) and the lowest from CO 639 (0.13 g). The maximum fruit yield was recorded from CO 631 (23.88 t/ha) closely followed by CO635 (19.21 t/ha) and CO 637 (19.12 t/ha). Results revealed that the genotypes differed significantly in most of the parameters and offer a good scope for selection of better genotypes as parents for the desired traits.

Keywords: Chilli genotypes, winter season, selection, yield.

Introduction

Chilli (*Capsicum* sp) is an economically important spice crop in Bangladesh belonging to the family Solanaceae, originated from South and Central America (Pickersgill, 1997). The major centre of diversity of the crop is Brazil where representatives at all cited levels are found (Costa *et al.*, 2009). Chilli is considered as the first spice to have been used by humans and there is archaeological evidence of chilli along with other fossil foods from as early as 6000 years ago (Hill *et al.*, 2013). The genus *Capsicum* has five domesticated species (*C. annuum, C. frutescens, C. chinense, C. pubescens and C. baccatum*)

---

[1]Senior Scientific Officer, Regional Spices Research Station, Bangladesh Agricultural Research Institute (BARI), Gazipur; [2]Scientific Officer, On-Farm Research Division, BARI, Gazipur; [3]Senior Scientific Officer, Plant Pathology Division, BARI, Gazipur and [4]Professor, Department of Horticulture, Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh.

of which *C. annuum* is the most widely cultivated species worldwide (Andrews, 1984). Chilli was introduced into Europe by Columbus and other early new explorers in the sixteenth century and later its cultivation spread throughout the world (Greenleaf, 1986). The crop can be distinguished by its pungency which varies with cultivar but generally higher in smaller fruit types than larger thick-fleshed types. Major chilli producing countries include China, Mexico, India, Turkey, which produce about 70% of the total world production (MiDA, 2010). Chilli in Bangladesh is cultivated both in Rabi (winter) and Kharif (summer) season. Total production of chilli in Bangladesh was about 1.30 Lakh Metric tons from 1.02 Lac hectares of land (BBS, 2016). Chilli is a vital commercial crop, cultivated for vegetable, spice, and value-added processed products (Kumar and Rai, 2005) and is an important constituent of many foods, adding flavour, colour, vitamins A and C and pungency and is, therefore, indispensable to world food industries. It can be used medically for the treatment of fevers, colds, indigestion, constipation and pain relief (Dagnoko *et al*., 2013) and also used by the security agencies in the preparation of tear gas. Even though chilli is very popular crop in all the agro-ecological zones of Bangladesh, very little has been achieved in the improvement of the indigenous cultivars probably because of the limited information on the genetic diversity within the species. It has been observed that farmers select and share seeds among themselves which are later cultivated under different local names. These materials are named based on several criteria, such as the origin of the genotype, pungency, uses, size and shape of fruits. This phenomenon has resulted in the treatment of some genotypes as different cultivars in different localities. For this reason, estimation of the genetic diversity among cultivated genotypes has become the fundamental requirement of the crop industry, purposely, for identification and crop improvement (Tam *et al*., 2005). In Bangladesh, the study regarding collection, evaluation, characterization, selection and conservation of genetic resources of chilli is hardly emphasized in the past. Since there are different types of chilli germplasm distributed throughout the country, it is necessary to collect and characterize them with a view to developing new varieties. The main objective of this study was to find out the morphological diversity of some local and exotic chilli germplasm and to select desirable parents for further breeding of this crop.

Materials and Methods

The investigation was carried out at the Regional Spices Research Centre (RSRC). Bangladesh Agricultural Research Institute (BARI), Gazipur from February 2017 to November 2018. The location of the site was 24° North latitude to 90.43° E longitude with an elevation of 8.4 m from sea level. The experimental field was medium high land with sandy loam soil. Thirty-six chilli genotypes of which 21 were indigenous and were collected from different areas of the country and the rest were collected from 15 exotics. Background of the genotypes is presented in Table 1.

The seeds of collected germplasms were soaked in water for 24 hours in order to facilitate germination. They were dried and treated by Autostin @ 2 g/kg of seed minimize the primary seed-borne diseases. The seeds were sown on beds in lines maintaining a depth of one centimeter for easy emergence. Each seed bed was then covered with one layer of newspaper to increase the soil temperature to facilitate germination and prevent evaporation of water. The seeds were nursed in seed boxes on 11 October 2017 using potting mix sterilized by steam sterilization method. The potting mix consisted of two parts of top soil to one part of well decomposed cow dung. Nursery management practices, such as shading, forking, thinning, watering and hardening off, were carried out appropriately to ensure that healthy seedlings were produced.

The field was ploughed and harrowed. After this the trial was laid out and ridged at a spacing of 75 cm between ridges. The experimental design used was the augmented design with single rows of each genotype. The length of each row was 5 m with inter- and intra- row spacing of 75 cm and 50 cm, respectively. The genotypes were randomly assigned to plots by means of drawing lots to avoid bias. Seedling of 35 days old were transplanted on 15 November 2017 for *rabi* in the cooler period of the day (evening) after which watering was done to reduce transplanting shock. The experimental plots were manured and fertilized. Cow dung, Urea, TSP, MoP and Gypsum were used as 10t, 210, 330, 200 and 110 $kgha^{-1}$, respectively. The total amount of Cow dung, TSP, Gypsum and one third of MoP were applied during land preparation. The rest of MoP and Urea were applied at three equal splits after 20, 50 and 70 days of transplanting (Anon. 2012). The fertilizer application method was side placement which was done at about 5 cm away from the plants. Weeds were manually controlled using hand hoe at the second and sixth weeks after transplanting. Reshaping of ridges was carried out at the fourth and eighth weeks after transplanting with hand hoe. Insect, mites and diseases were managed by spraying of Vertimec (Abamectin) 1.8EC @ I ml/L of water, Dithane M-45 (Mencozeb) @ 2g/L of water, Imetaf (Imedacloprid) 20 SL @ 0.5ml/L of water and sex pheromone trap. The data pertaining to the days to first emergence, days to first flower bud open, days to first flowering, days to first fruit set, plant height (cm), number of branches per plant, single fruit weight (g), fruit length (cm), pedicel length (cm) pericarp thickness (cm), weight of pericarp (g), number of fruits per plant, weight of fruit per plant (g), number of seeds per fruit, weight of seed per fruit (g), 1000 seed weight (g) and yield per hectare (ton) were recorded from randomly selected five plants from each plot. The collected data was analyzed using Genstat statistical package (9^{th} edition). Frequency distribution was used to classify the genotype into groups based on the qualitative traits. For the quantitative traits mean, standard deviation, standard error, range and coefficient of variation were calculated using Micosoft Excel version of Statistical Analysis Software (SAS).

Table1: Genotype codes with sources of collection for the 36 chilli genotypes under study

SL. No.	Genotype code	Source	SL. No.	Genotype code	Source
1.	CO 001	SRC, BARI	19.	CO 632	The World Vegetable Centre
2.	CO 002	SRC, BARI	20.	CO 633	The World Vegetable Centre
3.	CO 003	SRC, BARI	21.	CO 634	The World Vegetable Centre
4.	CO 446	SRC, BARI	22.	CO 635	The World Vegetable Centre
5.	CO 446-1	SRC, BARI	23.	CO 636	The World Vegetable Centre
6.	CO 525	SRC, BARI	24.	CO 637	The World Vegetable Centre
7.	CO 525-1	SRC, BARI	25.	CO 638	The World Vegetable Centre
8.	CO 525-2	SRC, BARI	26.	CO 639	The World Vegetable Centre
9.	CO 525-3	SRC, BARI	27.	CO 640	The World Vegetable Centre
10.	CO 610	SRC, BARI	28.	CO 641	The World Vegetable Centre
11.	CO 610-1	SRC, BARI	29.	CO 642	The World Vegetable Centre
12.	CO 611-1	SRC, BARI	30.	CO 643	The World Vegetable Centre
13.	CO 611-2	SRC, BARI	31.	CO 644	The World Vegetable Centre
14.	CO 613	SRC, BARI	32.	CO 645	The World Vegetable Centre
15.	CO 626	SRC, BARI	33.	CO 646	SRC, BARI
16.	CO 629	SRC, BARI	34.	CO 647	SRC, BARI
17.	CO 630	SRC, BARI	35.	CO 648	SRC, BARI
18.	CO 631	The World Vegetable Centre	36.	BARI Chilli-2	Released by SRC, BARI

Results and Discussion

The genotypes of chilli under investigation showed considerable variation for most of the characters studied (Table 2 to 5).

Qualitative characters

A wide range of variation was observed among the genotypes for several morphological characters (Table 2). The genotypes were characterized by green to purple corolla colour and majority of the genotypes showed white colour (91.67 %). This corroborates the results of Quresh *et al.* (2015) who found flower (corolla) colour as white, light green and green. Fruit colour at intermediate stage was found as green (72.22%), deep green (13.90%), light green (5.56%), creamy white (2.78%) and black (5.56%). This is in agreement with the results of Datta and Dus (2015) who found variability in fruit colour at intermediate stage as green -69.81%, purple-3.77% and others- 26.42%. Fruit colour at mature stage varied from light red to dark red and red colour was dominant (72.22%) followed by dark red colour (25.00%). Quresh *et al.* (2015) reported that fruit colour at maturity was purple and dark red. Khan *et al.* (2020) also found variability in fruit colour at maturity as orange- 10.52%, light red-26.31% and dark red – 57.89%. Most of the genotypes produced fruit under pendent (94.44 %), erect (2.78%) and cluster (2.78 %). Similar findings with respect to mature fruit colour were also reported by Datta and Das (2015).

Fruit weight

The maximum fruit weight was in CO 631 (628.33 g/plant) closely followed by that of CO 637 (504.47 g/plant), CO 635 (506.43 g/plant), CO 644 (486.40 g/plant), CO 525 (485.11 g/plant), CO 525-1 (480.33 g/plant), CO 640 (468.39 g/plant), CO 003 (450.84 g/plant), CO-611-1 (441.83 g/plant), CO 525-2 (441.33 g/plant), CO 646 (412.39 g/plant) and CO 626 (407.82 g/plant) and the lowest were in CO 648 (78.74 g/plant) which was statistically similar to CO 633 (124.33 g/plant), CO 002 (152.63 g/plant), CO 525-2 (157.00 g/plant), CO 642 (191.04 g/plant), CO 638 (197.86 g/plant), CO 645 (213.24 g/plant), CO 643 (213.82 g/plant), CO 001 (212.46 g/plant), CO 630(224.37 g/plant, CO 613 (266.56 g/plant), CO 636 (282.10 g/plant), CO 629 (288.43 g/plant) and CO 610 (301.33 g/plant) (Table 4). Rahman *et al.* (2017) obtained fruit yield/plant in the range of 1.09-155.57g from 60 chilli genotypes in Gazipur region. Khan *et al.* (2020) got fruit yield per plant ranging from 175.49 to 780.30 g in Pakistan while in India, Datta and Das (2015) obtained fruit yield/plant in the range of 61.38 g – 196.29 g. The present findings support the results of Khan *et al*. (2020). The difference in weight of fruits/plant might be due to the genotypic difference and ecological variation.

Fruit yield

Chilli genotypes under investigation showed a wide range of variability among themselves in respect of green fruit yield per hectare (Table 4). It ranged from 2.99 to 23.88 t/ha. The maximum fruit yield was obtained from CO 631 (23.88 t/ha) closely followed by CO 635 (19.21 t/ha), CO 637 (19.12 t/ha), CO 525-1 (18.45 t/ha), CO 644 (18.43 t/ha), CO 525 (18.34 t/ha), CO 640 (17.86 t/ha), CO 0033 (17.17 t/ha), CO 611-1 (16.79 t/ha) and CO 525-2 (16.77 t/ha). The lowest fruit yield was found in CO 648 (2.99 t/ha) which was identical with CO 001, CO 002, CO 525-3, CO 613, CO 630, CO 633, CO 638, CO 642, CO 643, CO 645 and CO 648. The moderate fruit yield was produced by CO 646 (15.67 t/ha), CO 626 (15.50 t/ha), CO 611-2 (14.72 t/ha), CO 446-1 (14.35 t/ha) and CO 641 (13.93 t/ha). Bharadwaza *et al*. (2018) reported that 15 genotypes of chilli produced seed yield in the range of

5.16 – 14.86 t/ha in Allahabad during *rabi* season. Kerketta *et al*. (2018) obtained fruit yield of 17 chilli genotypes in the range of 0.36-0.68 t/ha at Allahabad, India during kharif season.

Table 2. Salient morphological characteristics of the 36 chilli genotypes under study.

Sl. No.	Characters	Type	Number of genotypes	Frequency (%)
1.	Flower colour	White	33	91.67
		Purple	3	8.33
2.	Fruit colour at intermediate stage	Green	26	72.22
		Deep green	5	13.89
		Light green	2	5.56
		Creamy white	1	2.78
		Black	2	5.56
3.	Fuit colour at mature stage	Red	26	72.22
		Dark red	9	25
		Light red	1	2.78
4.	Seed colour	Straw	36	100
5.	Position of fruit	Pendant	34	94.44
		Erect	1	2.78
		Cluster	1	2.78
6.	Fruiting behavior	Single	36	100

Significant variation was recorded on the days to flower bud opening from thirty genotypes (Table 3). Among the genotypes, CO525 & CO631took minimum days to flower bud opening (44, 42) days, respectively which was followed by BARI Chilli-2. However, genotypes CO632 & CO633 took maximum days for flower bud opening (77.11 days) (Table 3). First flowering occurred earlier in CO525 and CO634 (50 days) & CO631 (53 days) which was similar to BARI Chilli-2 (32 days). However, CO648 took maximum days (110) for 1st flowering (Table 3).The genotypes CO525, CO634 and CO631 required minimum time (59 and 66 days) for first fruit setting, respectively which was similar to CO002, CO525-3, CO629, CO632 and CO633 (Table 3). The germplasm CO634 also required minimum time (59 days) which was similar to CO525. Besides these, maximum time (103 & 141 days) took regarding with CO632 and CO633.The plant height registered significant variation among the all chilli genotypes (Table 3). The highest plant height (111 cm) was recorded from CO631 while the lowest (41 cm) was found in CO641 which was statistically similar to CO646. Significant variation was recorded in number of branches per plant with studied genotypes (Table 3) and varied from 5.11 to 10.76. However, the maximum number of branches (10.76) was recorded from CO631 while the minimum

(5.11) was recorded from CO003 which was statistically similar to CO644, CO645, CO646 and CO647 (Table 3).

Table 3. Performance of the 36 chilli genotypes under study in winter season

Chilli genotypes	1st emergence (Days)	1st flower bud opening (days)	1st flowering (days)	1st fruit set (days)	Plant height (cm)	No. of branches/plant
CO 001	7.00	51.00	60.00	70.00	80.33	7.44
CO 002	7.00	59.00	69.00	87.00	53.00	6.44
CO 003	7.00	51.00	59.00	75.00	91.33	5.11
CO 446	7.00	46.00	56.00	67.00	84.33	6.86
CO 446-1	7.00	46.00	61.00	69.00	73.00	7.33
CO 525	7.00	44.00	50.00	59.00	96.66	10.55
CO 525-1	7.00	50.00	58.00	70.00	86.66	7.10
CO 525-2	7.00	49.00	59.00	70.00	93.00	7.33
CO 525-3	7.00	51.00	60.00	82.00	104.00	8.00
CO 610	7.00	46.00	57.00	70.00	46.00	10.22
CO 610-1	7.00	49.00	60.00	74.00	75.33	6.11
CO 611-1	7.00	46.00	57.00	69.00	85.00	8.20
CO 611-2	7.00	46.00	56.00	67.00	94.00	8.76
CO 613	7.00	59.00	69.00	77.00	119.00	6.77
CO 626	7.00	51.00	63.00	80.00	92.33	6.20
CO 629	7.00	44.00	77.00	88.00	106.33	6.76
CO 630	7.00	59.00	69.00	77.00	93.66	3.66
CO 631	7.00	42.00	53.00	66.00	111.00	10.76
CO 632	7.00	77.00	69.00	103.00	100.33	7.66
CO 633	7.00	110.00	125.00	141.00	94.66	10.30
CO 634	7.00	40.00	50.00	59.00	101.00	6.53
CO 635	7.00	50.00	59.00	70.00	76.33	8.88
CO 636	7.00	59.00	69.00	77.00	87.00	8.66
CO 637	7.00	49.00	59.00	74.00	86.33	8.55
CO 638	7.00	59.00	67.00	76.00	58.66	7.88
CO 639	7.00	49.00	59.00	67.00	84.00	6.88
CO 640	7.00	51.00	60.00	69.00	106.66	6.77
CO 641	7.00	45.00	59.00	69.00	61.00	5.44
CO 642	7.00	48.00	58.00	70.00	84.66	6.55
CO 643	7.00	46.00	58.00	69.00	70.33	6.55
CO 644	7.00	51.00	60.00	70.00	76.66	6.66
CO 645	7.00	51.00	60.00	72.00	88.66	5.77
CO 646	7.00	59.00	67.00	74.00	61.66	6.00
CO 647	7.00	69.00	56.00	70.00	65.66	6.00
CO 648	7.00	100.00	110.00	13.00	68.66	7.43
BARI Chilli-2	7.00	41.00	52.00	68.00	85.66	6.76
LSD (5%)	-	1.447	1.607	2.069	20.290	1.700
CV(%)	0.00	6.62	7.51	5.64	14.48	14.04

In case of yield parameters**,** single fruit weight varied from 0.72 to 8.48g (Table 4). The highest single fruit weight (8.48g) was recorded from CO631 which was statistically similar to CO642 (7.81g) and CO641 (7.47g). The lowest fruit weight (0.76g) was recorded from CO645. Significant variation was exhibited on the fruit length (Table 4). Among the genotypes, the maximum fruit length (12.68 cm) was recorded from CO631 which was statistically similar to CO642 (11.62 cm) and CO641 (11.02 cm) whereas the minimum was recorded from CO645 (2.90 cm) (Table 4).The pedicel length showed significant difference with the chilli genotypes under study (Table 4).

The genotype CO643 gained maximum pedicel length (5.22 cm) which was statistically similar to CO646 (4.32 cm), whereas the minimum pedicel length (1.50 cm) was observed in CO639 (Table 4). Statistically significant difference was found on the pericarp thickness regarding the genotypes (Table 4). Generally, pericarp addressed to quality of chilli and minimum thickness encourages to high quality of chilli. The lower level of pericarp thickness (0.42 mm) was obtained from CO630 followed by the rest of the studied genotypes, whereas, the higher level of pericarp thickness (3.75 mm) was observed from CO640 which was statistically similar to CO002 (3.45 mm). The weight of pericarp varied from 0.26 to 9.51 g. Among the studied genotypes, the maximum weight (9.51 g) was recorded from CO640 while the lowest was found from CO626 (0.26 g) (Table 4). Number of fruits per plant responded significantly ranged from 41.33 to 342.0. The plants of genotypes CO611-2 produced maximum fruits per plant (342.0) while the lowest (41.33) was found in CO640 (Table 4). The second highest fruits (321.66) per plant was recorded from CO631 which was statistically similar to CO525 (307.30) and 307.66). Highly significant variation was found with regards to weight of fruits per plant in all the genotypes (Table 4). The highest weight of fruits was recorded from CO631 (628.33 g) which was followed by CO635, CO637, CO525, CO-525-1 & CO640 whereas, the lowest was found in CO648 (78.74 g) (Table 4). All the characters showed significant variation in respect of all the genotypes (Table 4). The maximum seeds per fruit were recorded from CO635 (92.20) which were statically similar to CO640 (88.83) whereas, the minimum (18.60) was recorded from CO645 (18.60) that was identical (Table 4).Weight of seeds per fruit varied from 0.13 to 0.61 g. However, the maximum quantity of seeds was obtained from CO525 (0.61 g) while the minimum was from CO639 (0.13 g) that was statistically similar to CO644 (15), CO645 (15), CO638 (16) and CO525-3 (16) (Table 4). Similar trend was obtained in thousand seed weight in all chilli genotypes (Table 4). Nevertheless, maximum thousand fresh seed weight (5.20g) was recorded from CO525 and CO525-2 while the lowest was found in CO647 (2.20g). The highest yield of green chilli was obtained from the genotypes CO631 (23.88 t ha-1) followed by CO525 (18. 34t ha^{-1}), CO 525-1 (18.45 t ha^{-1}), CO640 (17.86t ha^{-1}) and CO003 (17.17t ha^{-1}), respectively whereas the lowest yield was recorded from the genotype CO648 (2.99 t ha^{-1}) (Table 4).

Table 4. Performance of the 36 chilli genotypes for yield and yield contributing characters in the winter season.

Chilli genotypes	Single fruit weight (g)	Fruit length (cm)	Pedicel length (cm)	Pericarp thickness (mm)	Wt. of pericarp (g)	No. of fruits/plant	Wt. of fruits/ plant (g)	No. of fresh seeds/ fruit	Weight of fresh seeds/fruit (g)	1000 fresh seed weight (g)	Green fruit yield (t/ha)
CO 001	1.37	5.86	2.88	1.43	0.96	158.00	212.46	31.46	0.22	4.00	8.07
CO 002	1.37	10.52	3.57	3.45	5.05	43.00	152.63	52.80	0.44	3.40	5.80
CO 003	2.16	5.10	2.66	1.57	1.05	273.00	450.84	53.06	0.29	4.20	17.17
CO 446	1.89	5.26	3.14	1.44	0.49	250.00	311.28	31.60	0.33	4.56	11.83
CO 446-1	2.24	6.19	3.52	1.59	0.91	164.00	377.71	58.46	0.23	4.80	14.35
CO 525	3.20	5.92	3.09	0.90	0.85	290.00	485.11	77.73	0.61	5.20	18.34
CO 525-1	2.00	5.74	2.64	1.23	0.44	307.33	480.33	28.00	0.17	4.68	18.45
CO 525-2	3.31	8.91	3.30	1.42	1.12	254.66	441.33	52.53	0.24	5.20	16.77
CO 525-3	1.42	5.16	2.42	1.31	0.90	136.33	157.00	23.73	0.16	3.10	5.97
CO 610	2.72	5.90	3.45	0.93	0.45	206.33	304.33	36.86	0.19	5.10	11.56
CO 610-1	2.57	6.25	2.62	0.88	0.51	194.33	331.32	65.06	0.23	4.72	12.59
CO 611-1	2.49	7.10	3.74	1.34	0.87	305.33	441.83	27.00	0.20	4.12	16.79
CO 611-2	2.55	5.93	3.97	1.22	0.64	342.00	387.25	62.13	0.26	4.32	14.72
CO 613	1.34	3.34	1.75	0.77	0.53	191.66	266.56	42.33	0.23	3.00	10.13
CO 626	2.00	5.08	3.58	1.54	0.26	246.66	407.82	52.93	0.28	4.90	15.50
CO 629	0.72	3.79	2.83	1.20	0.36	307.66	288.43	34.13	0.21	3.00	10.96
CO 630	1.69	4.02	2.28	0.42	0.88	101.66	224.37	30.46	0.38	3.26	8.53
CO 631	8.48	12.68	3.51	1.34	0.84	321.66	628.33	68.80	0.45	4.84	23.88
CO 632	1.98	5.64	3.31	1.47	0.69	255.00	340.88	65.33	0.27	3.86	12.95

Table 4. Continued

Chilli genotypes	Single fruit weight (g)	Fruit length (cm)	Pedicel length (cm)	Pericarp thickness (mm)	Wt. of pericarp (g)	No. of fruits/plant	Wt. of fruits/ plant (g)	No. of fresh seeds/ fruit	Weight of fresh seeds/fruit (g)	1000 fresh seed weight (g)	Green fruit yield (t/ha)
CO 633	1.79	5.10	2.99	0.95	0.44	68.00	124.43	52.33	0.22	4.36	4.73
CO 634	4.16	6.80	3.25	2.05	2.00	123.66	326.79	42.60	0.32	3.39	12.42
CO 635	5.29	9.22	2.66	0.77	1.86	127.33	506.43	92.20	0.34	4.18	19.21
CO 636	3.14	8.14	3.51	3.23	2.72	153.00	282.10	61.00	0.30	3.50	10.72
CO 637	4.53	6.20	2.57	1.79	1.63	144.00	504.47	74.66	0.35	4.10	19.12
CO 638	2.44	9.46	2.29	1.86	0.83	102.00	197.86	42.26	0.16	3.67	7.52
CO 639	6.62	9.42	1.50	2.73	2.57	84.66	310.33	25.00	0.13	4.17	11.79
CO 640	2.35	5.81	3.21	3.75	9.51	41.33	468.39	88.73	0.38	4.50	17.86
CO 641	7.47	11.02	3.14	2.84	5.16	47.00	366.62	45.40	0.35	4.44	13.93
CO 642	7.81	11.62	3.96	2.45	2.74	50.66	191.04	50.20	0.26	423	7.26
CO 643	5.80	10.56	5.22	1.87	0.89	48.33	213.82	30.53	0.19	4.16	8.13
CO 644	1.51	5.43	2.93	1.04	0.20	301.33	486.40	34.80	0.15	3.00	18.43
CO 645	0.76	2.90	2.66	0.69	0.81	126.00	213.24	18.60	0.15	3.42	8.10
CO 646	3.18	6.82	4.32	0.98	0.69	216.66	412.39	55.86	0.30	3.10	15.67
CO 647	1.50	3.94	3.36	1.42	0.76	231.33	307.65	51.86	0.20	2.20	11.69
CO 648	2.94	3.05	2.76	1.61	0.66	49.00	78.74	47.86	0.24	4.00	2.99
BARI Chilli-2	3.86	7.55	3.70	1.41	0.57	251.33	293.98	30.66	0.21	5.10	11.17
LSD (5%)	0.989	1.333	0.571	0.644	1.079	143.00	228.30	15.680	0.014	0.387	7.21
CV (%)	19.39	11.99	11.14	14.56	15.11	17.66	21.40	19.19	14.35	8.80	11.43

From the study it was revealed that growth parameters showed significant variation in the studied genotypes except 1st emergence days. Among the 36 genotypes, CO525 and CO631 responded positive effect in respect of 1st flowering bud open days, 1st flowering days, 1st fruit set days, number of branch/plant. The rest of the genotypes addressed to late appearance through 1st flowering bud open days, 1st flowering days which lead to late fruit setting. It might be due to inherent characters. The critical observation of the data in the present investigation showed a wide variation in physical characteristics such as plant height. This may be due to differences in germplasm used in the study, environmental conditions and management practices. The increasing plant height might be mainly due to better availability of soil nutrients in the growing areas, especially nitrogen and phosphorus might have been enhanced vegetative growth of plants through increasing cell division and elongation and also due to the varietal variability to absorb the nutrients from the soil (Vos, 2008) and El-Tohamy *et al.,* 2006). Hence, germplasm with wider canopy diameter might be produced more fruit or pods and varieties with narrow canopy due to increasing number of secondary and tertiary branches which were the locations for fruit bud formation. The number of days to fifty percent flowering showed highly significant difference and as investigation comprised of 36 germplasm of chilli. This study revealed significant differences among genotypes for traits that define earliness (days to 50% flowering and fruit maturity). This variation for these traits can be largely attributed to their inherent genetic constitution. Earliness or lateness in the days to 50% flowering might have been due to their inherent characteristics, early acclimatization to the growing area to enhance their growth and developments. The results regarding the branches were generally, the differences observed in branching of chilli plants might have been due to genetic variations existed between genotypes and or due to favorable influence of organic and inorganic nutrients present in the soils or the growing environment which correlates with the findings of El-Tohamy *et al.* (2006) that stated the presence of adequate amount of organic nutrients in the soil improves growth of pepper plants. Earliness among growth traits is an important trait in chilli because early maturing genotypes can be grown in short rainy seasons and easily create land for other crops.

Yield parameters also showed significant variation among thirty-six genotypes in winter season. CO525 and CO631germplasm responded in positive effect on the yield parameters (single fruit weight, number of fruit/plant, weight of fruit/plant, number of seed /fruit, weight of seed/fruit, thousand seed weight and yield). The highest fruit length attained only from CO631, CO641 and CO642. There was no effect of pedicel length, pericarp thickness, weight of pericarp on yield. Fruit and seed yield traits are very important for the farmers, processor and seed industry. Highly significant genotypic differences were observed in all yield traits in growing seasons. Results on number of fruits per plant are consistent with the findings of Sermenli and Mavi (2010) who found a range of 30-79, 13.1-66.4 and

21.33-76.33 fruits, respectively. The average 1000-seed weight per genotype varied from 2.20 to 5.20 g among the genotypes. The maximum average 1000-seeds weight (5.20 g) was attained from BARI Chilli-2 followed by 5.10g, 525-1 (5.00), 525-2 (5.00 g), 610 (5.00 g), 634 (5.00g) and 643 (5.00 g) respectively. CO525and the lowest average 1000-seeds weight (1.50 g) were recorded from CO647. This might be attributed to the genetic makeup of and/or the agro ecological factors including, soil type and its nutrient contents, temperature, availability of irrigation or rain water in the growing area based on the study period. Because, pods with higher seed weight can be considered as those receiving higher percentage of assimilate, which also indicate that a good combination of number of seeds and seed weight per pod could improve pod quality through increase of seed weight and pod size. The recorded variations among the genotypes regarding in yield might be due to their differences in genetic make-up and/or agro ecological adaptations compared to the locations in which they had evaluated, which agreement with the findings of Fekadu and Dandena (2009) who reported that the magnitude of genetic variability and heritability are necessary in systematic improvement of hot pepper for fruit yield and related traits. Therefore, it is clear that these traits are less influenced by environmental changes and improvement in these traits would be more effective through selection owing to their additive gene effects. There is a great variation in the fruit components mainly due to cultivars and climatic conditions. Fruit size and thickness are some important qualitative characteristics for consumer acceptability on the market. The average length of chilli fruits varied from 2.90 cm to 11.62cm among the chilli genotypes. The result agrees with that of MARC (2005) which reported that the long fruit length of (15 cm) and the short fruit length with (7 cm) at similar variety trial. Nevertheless, these differences among investigations were because of their different genetic characteristics. On the other hand, the increase of total pod yield might be due to the variation in plant height, as well as formation of more primary, secondary and tertiary branches that increase potential of pod bearing buds and also leaf area that maximizes photosynthetic capacity and assimilate partitioning to the pods. This result is further consolidated by the findings with Sam-Aggrey and Bereke-Tsehai (1985) who reported that positive impact of vegetative growth up on yield and yield components of hot pepper. The study revealed exist enough genetic variability among the genotypes at morphological levels. Substantial variation existed among the accessions especially in fruit traits (colour, weight, length, thousand seed weight and pericarp weight and width). The first four principal components accounted for 72.44% of the total genetic variance among the accessions. The larger part of variance was accounted for by plant height, single fruit weight, number of fruit per plant and fruit length. Morphological cluster analysis revealed genetic dissimilarity of 0.88-0.99. C0003 and C0525-1 showed the widest diversity while the highest degree of similarity existed between C0610-1 and C0632. The introduced chilli genotypes out-performed local genotypes in flowering and maturity periods, bigger fruits and total marketable fruit yields.

Local genotypes is, however, better in number of fruits produced per plant and seeds per fruit, plant height and width. Genotypes are most stable for average fruit weight, fruit length, fruit width, seed weight and days to fruit 50% maturity, canopy and number of seeds. The genotypes CO631, CO635, CO637, CO525-1, C0644 and C0525 produced high in yield across the seasons performing better than all genotypes in all traits with the BARI Chilli-2 as a check. The three commercial genotypes perform better than all the local genotypes and most of the genotypes in terms of fruit yield and maturity periods and perhaps this are why they are popular among the farmers. The genotype C0634 though medium yielder is the earliest-maturing variety among all genotypes. Its genes can be used for early yield improvement in chilli pepper. It can be concluded from the present results that based on yield and yield attributes, the genotypes C0631, C0635, C0637, C0525-1 and C0644 were promising under the agro-ecological condition of Bangladesh for breeding higher yielding varieties. Genotypes C0446, C0001 and C0613 may be considered for developing early varieties. The present result provides the basic information to the breeders or researchers for selecting parents' in future breeding programmes.

References

Andrews, J. 1984. Peppers: The domesticated Capsicums. Austin: University of Texas Press. pp. 125.

Anonymous. 2012. Fertilizer Recommendation Guide (FRG), Bangladesh Agricultural Research Council, Farmgate, Dhaka. Pp.70-71.

BBS. 2016. Bangladesh Bureau of Statistics. Statistics and Information Division. Ministry of Planning. Government of the People's of Bangladesh. www.bbs.gov.bd.

Bharadwaza, R.K., V.M. Prasad, M. Adinarayan and G.N. Swamy. 2018. Evaluation of chilli (*Capsicum annum* L.) genotypes for yield and yield attributes in Allahabad Agro-Climatic Conditions. Int. J. Curr. Microbiol. App. Sci. 7: 773-776. https://www. Ijcmas. Com/special/7R.% 20Katheek%20Bharadwaz2,%20et%20al.pdf.

Costa, L.V., R. Lopes, M.T.G. Lopes, A. F. D. Figueiredo, W.S. Barros and S.R.M. Alves. 2009. Cross compatibility of domesticated hot pepper and cultivated sweet pepper. *Crop Breeding and Applied Biotechnology*, **9:** 37-44.

Dagnoko, S, N. Yaro-Diarisso, P.N. Sanogo, O. Adetula, A. Dolo-Nantoume, K. Gamby-Toure, A. Traore-Thera, S. Katile and D. Diallo-Ba. 2013. Overview of pepper (*Capsicum* spp.) breeding in West Africa. *African Journal of Agricultural Research* **83:** 1108-1114.

Datta, S. and L. Das. 2015. Characterization and genetic variability analysis in *Capsicum annum* L. germplasm. SAARC J. Agri., 11(1): 91-103. https://pdfs. Semanticscholar.org./9f3e/1031 c0e4f647af18e1eae8e29076f600abb3.pdf.

EL-Tohamy, W. A., A.A. Ghoname and S.D. Hossain. 2006. Improvement of pepper growth and productivity in sandy soil by different fertilization treatment under protected cultivation. *Journal of applied Science Research*. **2:** 8-12.

Fekadu , M. and. G. Dandena. Status of Vegetable Crops in Ethiopia//scrib. asterpix. Com/cy/2437661/= accessed on 12/29/2009. *Uganda Journal of Agricultural* **12:** 26-30.

Greenleaf, W. H. 1986: Pepper Breeding. In: Breeding Vegetable Crops, Bassett M.J. (Editors.). AVI Publishing Co INC, United States of America (USA). pp. 67-134.

Hill, T.A., H. Ashrafi, S. Reyes-Chin-Wo, J. Yao, K. Stoffel, M. A. A. Truco, Kozik, R.W. Michelmore and A.V. Deynze. 2013. Characterization of *Capsicum annuum* genetic diversity and population structure based on parallel polymorphism discovery with a 30K Unigene Pepper Gene Chip. *Plos One* **8:** 1-16.

Khan, N., M.J. Ahmed, S.J.A. Shah, T. Shehzad, M.Ahmed, S. Bashir and A. Hamid. 2020. Morphological and agronomic characterization of (*Capsicum annum* L.) germplasm in Pakistan. Pure and Applied Biology. 9(2): 1603-1612.

Kerketta, A., J.P. Collis, M. Tirkey, R. Lal and N.V. Singh. 2018. Evaluation of chilli (*Capsicum annum* L) genotypes for growth, yield and quality characters under Allahabad Agro Climatic Conditions, Int. J. Pure App. Biosci. 6(4): 451-455(2018). Doi: http://dx.doi.org/10. 18782/ 2320-7051. 5367.

Kumar, S. and M. Rai 2005: Chile in India. Chile Pepper Institute Newsletter (XXII), pp. 1-3.

MARC, (Melkasa Agricultural Research Center) 2005: Progress Report on Completed Activities. Addis Ababa, Ethiopia. pp. 14.

Millennium Development Authority (MiDA), 2010: Investment Opportunity in Ghana Chili Pepper Production. www.mida.gov.gh

Pickersgill, B. 1997. Genetic resources and breeding of Capsicum spp. *Euphytica*. **96:** 129-133.

Quresh, W., M. Alam, H. Ullah, S.A. Jatoi and W.U. Khan. 2015. Evaluation and characterization of Chilli (*Capsicum annum* L.) germplasm for some morphological and yield characters. Pure and Applied Biology. **4(4):** 628-635.

Rahman, S., M.A. Hossain and R. Afroz. 2017. Morphological characterization of chilli germplasm in Bangladesh. Bangladesh J. Agril. Res. **42(2):** 207-219.

Sam-Aggery, W.G. and T. T. Bereke. 1985. Proceedings of the 1st Ethiopian Horticultural workshop. 20-22 February. IAR Addis Ababa.pp.212.

Sermenli, T. and K. Mavi. 2010. Determining the yield and several quality parameters of Jalapeno in comparison to `Pical' and `GeikBoynuzu' pepper cultivars under Mediterranean conditions. *Africa Journal of Agricultural Research.* G5 2825-2828.

Tam, S. M., C.Mhiri, A.Vogelaar, M. Kerkveld, R. S. Pearce and M. A. Grandbastien. 2005. Comparative analyses of genetic diversities within tomato and pepper collections detected by retrotransposon-based SSAP, AFLP and SSR. *Theoretical and Applied Genetics.* **110:** 819-831.

Vos, J.G.M. and H.D. Friking. 2008. Nitrogen fertilization as a component of integrated crop management of hot pepper (*Capsicum species*) under tropical lowland conditions. *International Journal of Pest Management.* **43:** 1-10.