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Morphological characterization in Chilli

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Abstract
Morphological characterization is necessary to characterize a genotype as distinct, uniform and stable over the one that is being commercially grown. Characterization helps in identification of genotypes, classification of cultivars/genotypes into different groups and for registration and protection of a plant variety. In chilli, wide variation has been observed among genotypes. This variation is useful in identification of superior genotypes for inclusion in breeding programmes or direct use as a cultivar. In the present study it indicates the phenotypic diversity among different accessions taken into consideration. Morphological characterization for nearly 48 phenotypic attributes based on IPGRI descriptors was carried out resulted in the development of a comprehensive data set in respect of 20 genotypes of chilli, In addition, significant differences were observed for several yield contributing traits.

Keywords: Morphological characterization**,** *IPGRI* descriptor

Introduction
Chilli (*Capsicum annuum* L.) has a unique place in the diet as a vegetable and spice crop due to its pungency, taste, colour, and flavour. Chilli fruits are very rich source of health promoting bioactive compounds, the antioxidants of pepper belong to a wide range of different phytochemicals, both hydrophilic (ascorbic acid and water-soluble phenols) and lipophilic (carotenoids, capsaicinoids and tocopherols) (Bae *et al.*, 2012) [3]. The pungency of peppers is due to the presence of a group of compounds called capsaicinoids of which capsaicin is the predominant compound, and colour is due to capsanthin and capsorubin. Pepper fruits can supply above 100% α-tocopherol RDI per 100 g serving depending on the cultivar (Yuni *et al.*, 2013) [6] and rich in Ascorbic acid content ranging from 44.3mg to 280mg/100g FW (Martinez *et al.*, 2005) [5]. Portuguese introduced chilli or hot pepper into Southern parts of India. It spread throughout the country by the end of the 19th century. This long history of cultivation and selection resulted into generation of sufficient genetic variability in chilli within the Indian subcontinent.
Chilli is one of the most important cash crops of India grown in an area of 366 thousand ha with an annual production of 3.7 million tonnes and the productivity of 10.21 t/ha (Anonymous, 2019) [2]. India is the largest producer and exporter of chilli in the world. Indian chilli reaches over 90 countries in the world. Sri Lanka, USA, UAE, Pakistan, Bangladesh, Saudi Arabia, and Malaysia are the important markets for Indian chillies. Chilli grows in almost all the states of India. In Himachal Pradesh, green chillies are cultivated over an area of 1.22 thousand ha with annual production of 14.52 thousand tonnes (Anonymous, 2019) [2].
Morphological traits are effective tools in studying genetic diversity in *Capsicum* species (Agyare *et al.*, 2016) [1]. A wide variability with respect to yield attributing characters such as fruit weight, fruit length, fruit wall thickness information can help the farmers in deciding a variety suitable for a particular market type. Flower descriptors will helps in identifying the male sterile lines and mode of pollination of the crop, Seed descriptor such as 1000 seed weight is essential in calculating the seed rate.

Materials and Methods
The study was carried out during 2019 at vegetable research farm of Department of Vegetable Science, College of Horticulture, University of Horticultural Sciences and Forestry, Nauni, Solan, Himachal Pradesh.The experimental material comprised of 20 diverse genotypes of chilli including 1 check variety *i.e.* DKC-8. 30 days old seedlings were transplanted in main field following a RBD design in 3 replications. To assess the morphological characteristics, the observations were recorded according to the Descriptors for *Capsicum* (IPGRI, 1995) [3].

Results and Discussion

Table 1: Morphological descriptors that are considered and the accessions that fall under respective traits.

Sl. No.	Traits	Categories/type	No. of accessions	Accessions
1.	Hypocotyl colour	1. White 2. Green	6 14	White: UHF-CHI-4, UHF-CHI-5, UHF-CHI-7, DKC-8, Anugraha and Ujwala
2.	Hypocotyl pubescence	3. Sparse	20	-
3.	Cotyledonous leaf colour	2. Green 3. Dark green	14 6	Dark green: UHF-CHI-5, UHF-CHI-8, UHF-CHI-10, UHF-CHI-16, G-1-1 and Ujwala
4.	Cotyledonous leaf shape	3. Lanceolate 4. Elong-deltoid	16 4	Elong-deltoid: UHF-CHI-7, UHF-CHI-13, G-1 and Gundu-2
5.	Stem colour	1. Green 2. Green with purple stripes	4 16	Green: 4genotypesUHF-CHI-4, UHF-CHI-10, Gundu -2 and Anugraha
6.	Stem pubescence	3. Sparse 5.Intermediate 7.Dense	15 4 1	Intermediate: UHF-CHI-8, UHF-CHI-11, UHF-CHI-18 and G-1-1 Dense: UH-CHI-4
7.	Nodal anthocyanin (whole plant)	1. Green 5. Purple 7. Dark purple	2 3 15	Green: DKC-8 and Gundu- 2 Purple: UHF-CHI-4, UHF-CHI-12 and UHF-CHI-16
8.	Stem shape	1-Cylindrical	20	-
9.	Plant height [cm]	4. 66-85 5.>85	9 11	66-85 cm: UHF-CHI-4, UHF-CHI-5, UHF-CHI-12, UHF-CHI-13, UHF-CHI-19, DKC-8, Gundu-2, Anugraha, and Ujwala
10.	Plant growth habit	5. Intermediate (compact) 7. Erect	15 5	Intermediate: UHF-CHI-12, UHF-CHI-13, UHF-CHI-16, DKC-8 and Ujwala
11.	Branching habit	5. Intermediate 7. Dense	13 7	Dense: UHF-CHI-5, UH-CHI-8, UHF-CHI-10, UHF-CHI-12, UHF Sel-4, DKC-8 and Anugraha
12.	Tillering	3. Sparse 5. Intermediate 7. Dense	2 4 14	Sparse: UHF-CHI-13 and UHF-CHI-14 Intermediate: UHF-CHI-5, UHF-CHI-12, UHF Sel-4 and DKC-8
13.	Leaf density	3. Sparse 5. Intermediate 7. Dense	2 12 6	Sparse: UHF-CHI-11 and G-1-1 Dense: UHF-CHI-5, G-1, UHF Sel-4, DKC-8, Gundu-2, and Anugraha
14.	Leaf colour	2.Light green 3.Green 4.Dark green	1 16 3	Light green: UHF-CHI-12 Dark green: UHF-CHI-10, UHF-CHI-11 and DKC-8
15.	Leaf shape	2.Ovate 3. Lanceolate.	7 13	Ovate: UHF-CHI-12, UHF-CHI-13, UHF-CHI-14, UHF-CHI-16, UHF-CHI-18, UHF-CHI-19 and G-1
16.	Lamina margin	1.Entire	20	-
17.	Leaf pubescence	3.Sparse	20	-
18.	Number of flowers per axil	1. One 2. Two 3. Three 4. Many flowers in bunches but each in individual axil.	16 1 2 1	Two: UHF-CHI-7 Three: UHF-CHI-11 and UHF-CHI-15 Many flowers in bunches but each in individual axil: DKC-8
19.	Flower position	3.Pendant 5.Intermediate	18 2	Intermediate: UHF CHI-12and UHF-CHI-15
20.	Corolla colour	1.White	20	-
21.	Corolla spot colour	1.White	20	-
22.	Corolla shape	1.Rotate	20	-
23.	Corolla length [cm]	1.<1.5	20	-

24.	Anther colour	5.Purple	20	-
25.	Filament colour	1.White	20	-
26.	Stigma exertion	7.Exerted	20	-
27.	Male sterility	0.Absent	20	-
28.	Calyx Pigmentation	0.Absent	20	-
29.	Calyx margin	2.Intermediate 3.Dentate	9 11	Intermediate: Gundu-2, G-1-1, UHF-CHI- 9, UHF-CHI-12, UHF-CHI-16, UHF-CHI-8, UHF-CHI-5 and UHF-CHI-15
30.	Calyx annular constriction	1.Present 0.Absent	2 18	Present: G-1 and Gundu-2
31.	Anthocyanin spots or stripes	1.Present 0.Absent	2 18	Present: G-1 and Gundu-2
32.	Fruit colour at intermediate stage	4.Orange	20	-
33.	Fruit set	5.Intermediate 7.High	15 5	High: UHF-CHI-12, UHF-CHI-14, UHF-CHI-16, UHF Sel-4 and DKC-8
34.	Fruit colour at mature stage	7.Light red 8.Red	1 19	Light red: UHF-CHI-13
35.	Fruit shape	1.Elongate 5.Blocky	19 1	Blocky: Gundu - 2
36.	Fruit shape at pedicel attachment	2-.Obtuse 3.Truncate 4.Cordate	17 1 2	Truncate: G-1-1 Cordate: G-1 and Gundu-2
37.	Neck at base of fruit	0.Absent 1.Present	5 15	Absent: UHF-CHI-8, UHF-CHI-10, UHF-CHI-16, DKC-8 and Gundu-2
38.	Fruit shape at blossom end	1.Pointed 2.Blunt 3.Sunken	14 3 3	Blunt: UHF-CHI-14, UHF-CHI-18 and UHF-CHI-19 Sunken: UHF-CHI-4, G-1and Gundu-2
39.	Fruit blossom end appendage	0.Absent 1.Present	18 2	Present: UHF-CHI-4 and G-1
40.	Fruit cross-sectional corrugation	3.Slightly corrugated	20	-
41.	Fruit surface	1.Smooth 2.Semiwrinkled 3.Wrinkled	3 16 1	Smooth: UHF-CHI-10, DKC-8 and Gundu-2 Wrinkled: UHF Sel-4
42.	Pedicel with fruit	5.Intermediate 7.Persistent	1 19	Intermediate: UHF Sel-4
43.	Pedicel with stem	3.Slight 5.Intermediate 7.Persistent	5 11 4	Slight: UHF-CHI-4, UHF-CHI-5, UHF-CHI-10, UHF-CHI-18 and UHF Sel-4 Persistent: UHF-CHI-13, UHF-CHI-16, DKC-8 andUjwala
44.	Placenta length	2.1/4-1/2 of fruit length 3.>1/2 of fruit length	2 18	1/4-1/2 of fruit length: G-1and Gundu-2
45.	Seed colour	1.Straw (deep yellow)	20	-
46.	Seed surface	2.Rough	20	-
47.	Seed size	3.Small 5.Intermediate	3 17	Small: UHF-CHI-12, UHF-CHI-13 and Ujwala
48.	No. of seeds per fruit	3.>50	20	-

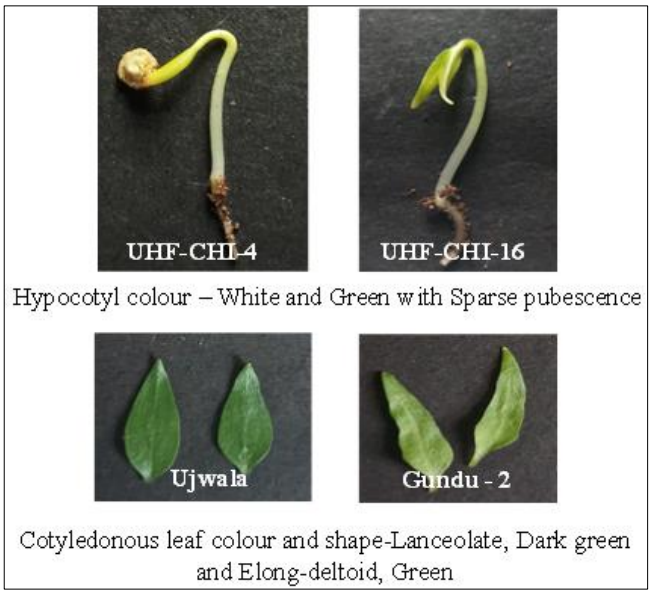

Plate 1: Seeding descriptors.

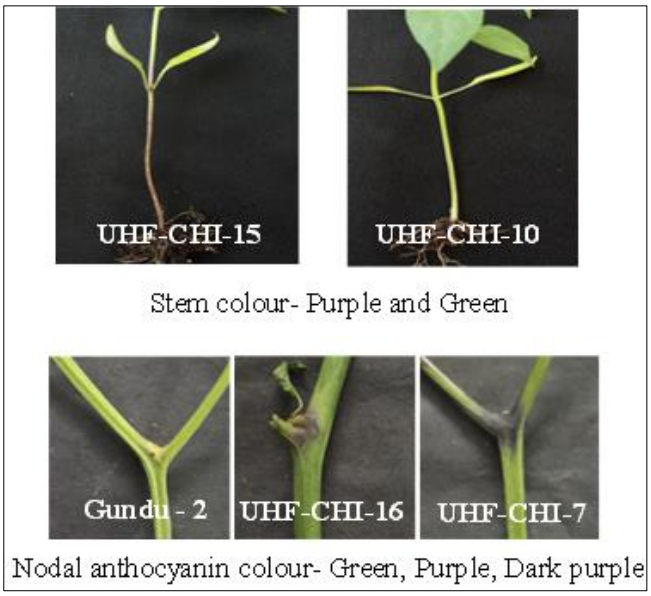

Plate 2: Plant descriptors.

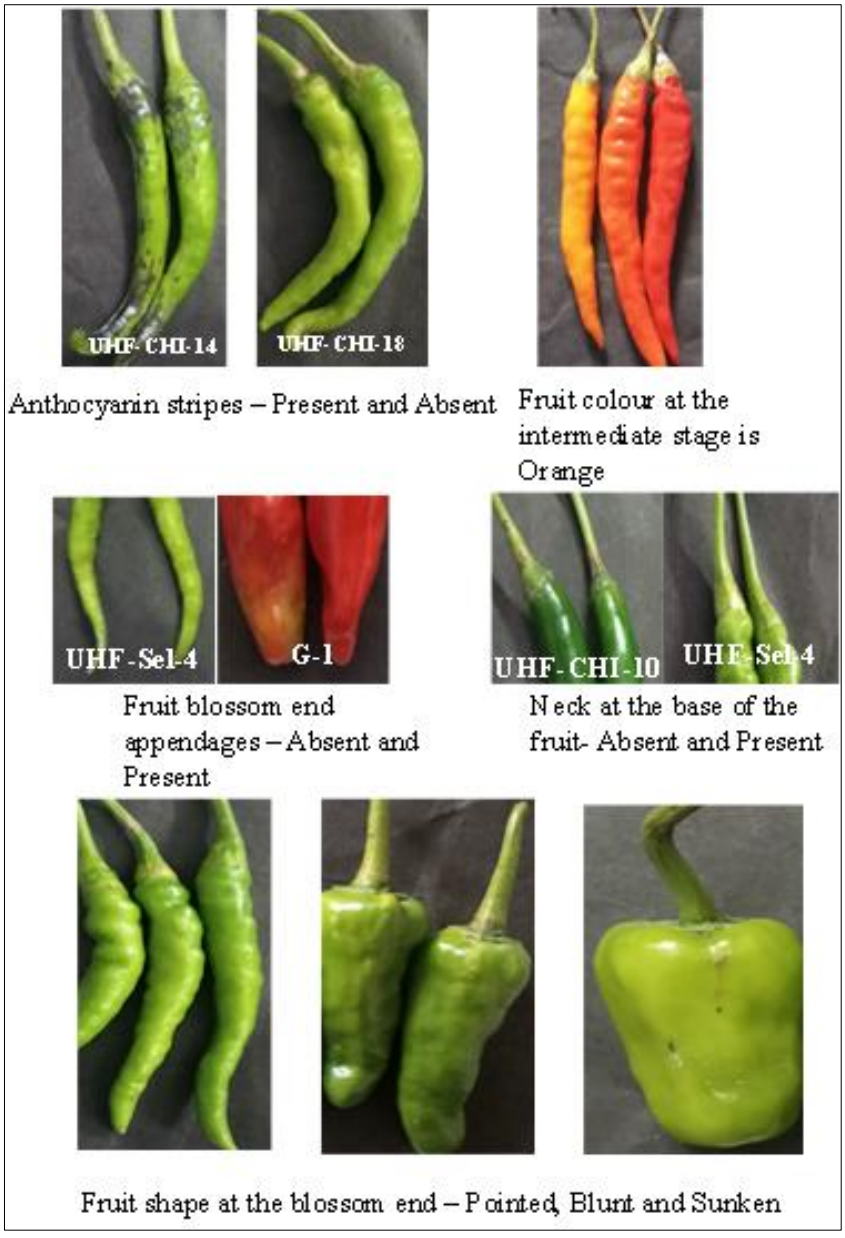

Plate 3: Fruited descriptors.

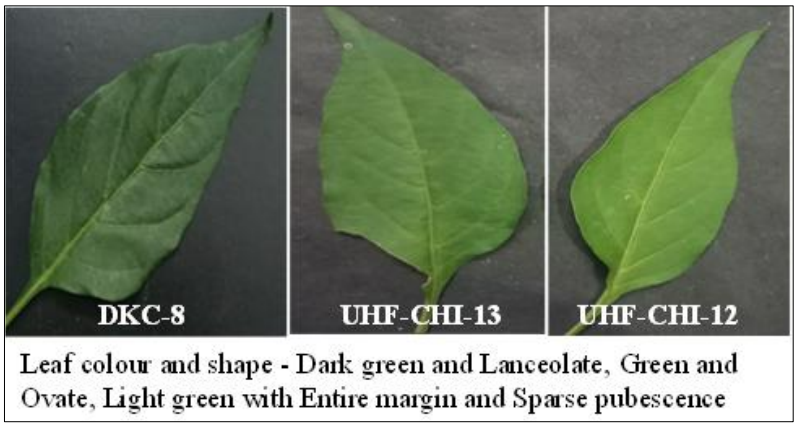

Plate 4: Leaf descriptors.

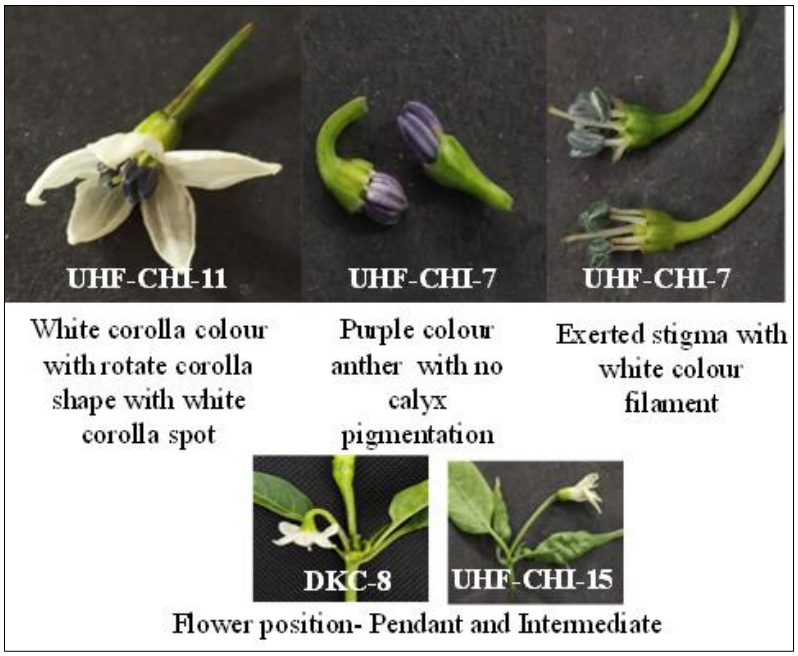

Plate 5: Flower descriptors.

Table 2: Mean performance of chilli genotypes for different quantitative traits

Sl. No.	Genotypes	Plant heights (cm)	Canopy Width (cm)	Stem Length (cm)	Stem Diameter (cm)	Leaf Length (cm)	Leaf Width (cm)	Days to flowering
1	UHF-CHI-4	65.76	41.0	16.4	179.1	9.32	4.12	27.63
2	UHF-CHI-5	69.23	59.0	19.8	182.8	9.80	3.66	22.50
3	UHF-CHI-7	89.0	51.7	17.2	178.3	9.35	3.71	22.92
4	UHF-CHI-8	90.56	52.1	19.5	177.6	9.31	3.26	23.00
5	UHF-CHI-10	84.9	51.0	16.3	179.2	8.39	3.86	18.55
6	UHF-CHI-11	82.6	48.0	18	181.7	8.85	3.29	26.40
7	UHF-CHI-12	71.8	48.2	18.1	185.5	8.62	4.08	27.32
8	UHF-CHI-13	74.5	40.3	18.6	177.7	8.43	4.14	25.13
9	UHF-CHI-14	85.8	46.4	22.3	179.9	9.90	4.36	21.37
10	UHF-CHI-15	89.86	59.0	16.6	178.9	9.55	3.72	23.10
11	UHF-CHI-16	90.53	49.9	16.4	179.6	10.60	4.22	18.85
12	UHF-CHI-18	94.33	57.3	15.6	180.5	10.42	4.11	23.08
13	UHF-CHI-19	75.66	55.3	17.4	180.4	9.70	4.48	28.60
14	G-1	77.0	50.6	15.5	181.1	11.75	5.21	26.10
15	G-1-1	70.13	55.5	14.3	180.6	8.79	3.61	27.39
16	UHF Sel-4	89.10	52.6	16.0	178.3	9.68	3.51	22.71
17	DKC-8	77.3	59.2	11.1	194.6	10.48	4.06	28.13
18	Gundu-2	75.06	58.5	12.6	180.1	8.70	3.42	23.20
19	Anugraha	72.16	57.7	15.3	184.5	8.83	3.76	24.43
20	Ujwala	74.63	38.6	13.0	174.6	8.73	3.60	23.63
C.D.(0.05)		1.79	5.96	1.93	2.55	1.01	0.61	2.59

Table 3: Mean performance of chilli genotypes for fruit traits

Sl. No.	Genotypes	No. of Fruits per plant	Fruit yield per plant (g)	Fruit Length (cm)	Fruit Width (cm)	Fruit weight (g)	Fruit Pedicel length (cm)	1000 Seed Weight (g)
1	UHF-CHI-4	72.56	132.90	8.67	1.14	5.37	3.50	4.43
2	UHF-CHI-5	70.76	173.68	8.18	1.59	5.07	4.29	4.47
3	UHF-CHI-7	87.15	235.95	9.55	1.13	4.50	3.50	4.70
4	UHF-CHI-8	61.24	180.81	9.52	0.68	2.54	4.00	4.98
5	UHF-CHI-10	75.19	281.09	9.30	1.77	5.62	3.750	4.72
6	UHF-CHI-11	129.13	234.57	6.88	1.34	3.21	3.42	3.78
7	UHF-CHI-12	22.25	102.68	5.86	1.52	1.87	3.05	3.20
8	UHF-CHI-13	67.12	183.34	5.43	0.72	1.67	2.85	3.23
9	UHF-CHI-14	116.30	248.25	10.49	0.99	5.40	4.18	4.4
10	UHF-CHI-15	82.70	214.24	6.10	0.85	3.43	3.99	4.63
11	UHF-CHI-16	42.26	92.85	8.20	1.73	5.51	3.23	5.73
12	UHF-CHI-18	46.39	97.16	8.20	0.82	3.88	3.63	4.73
13	UHF-CHI-19	194.52	338.09	7.31	1.90	4.24	3.04	5.47
14	G-1	98.99	271.71	5.0	1.63	6.73	3.61	4.30
15	G-1-1	94.73	223.60	5.22	1.59	4.57	3.58	4.65
16	UHF Sel-4	68.06	148.48	9.83	1.82	3.17	3.73	5.29
17	DKC-8	77.39	173.98	4.83	1.04	2.80	3.03	4.79
18	Gundu-2	66.66	128.10	2.89	2.07	6.17	2.95	4.66
19	Anugraha	67.77	122.72	9.07	1.71	3.39	3.89	4.10
20	Ujwala	86.47	115.94	6.82	1.70	2.03	3.67	2.90
C.D. (0.05)		2.57	4.37	0.95	0.33	0.88	0.17	0.39

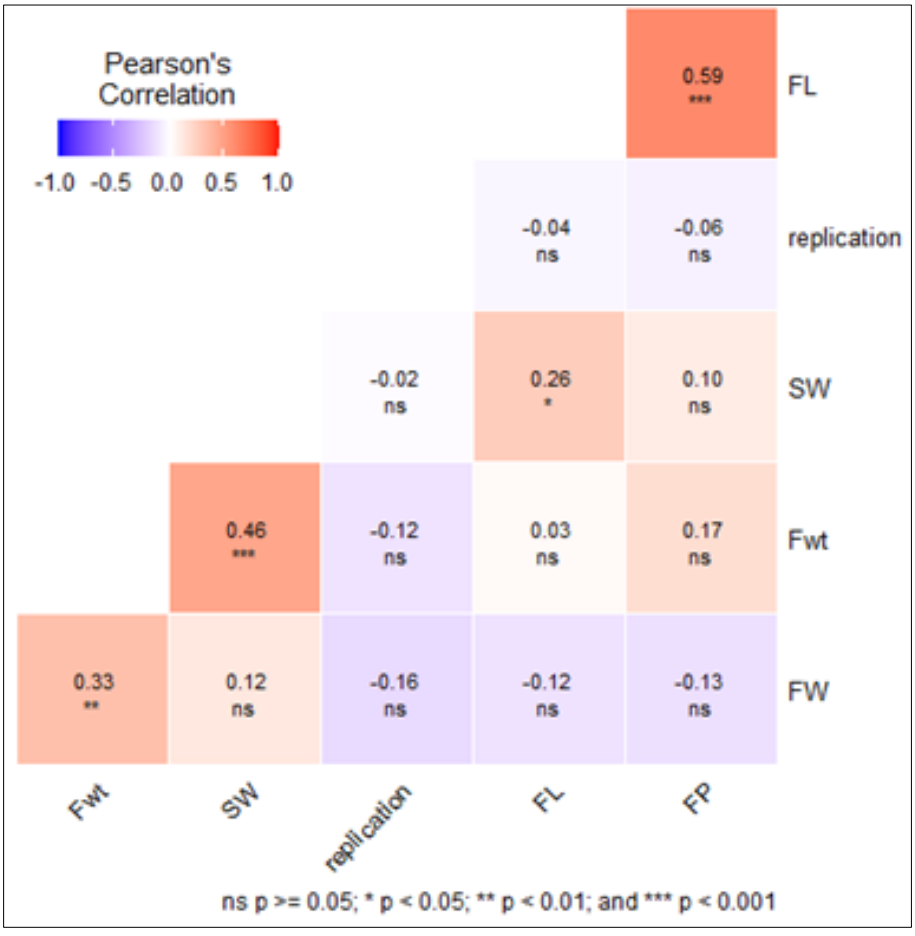

Fig 1: FL (Fruit length), FWt (Fruit weight), FP (Fruit pedicel length, FW (Fruit width), SW (Seed weight)

The figure suggests that the fruit length and fruit weight make a significant difference with respect to seed weight and fruit width and fruit weight parameters are correlated.

Conclusion

Predominance of single descriptor state was seen in morphological characters such as hypocotyl pubescence, stem shape, lamina margin, leaf pubescence, corolla colour, corolla shape, corolla length, anther colour, filament colour, stigma exertion, male sterility, calyx pigmentation, fruit colour at intermediate stage, fruit cross sectional corrugation, seed colour, seed surface, No. of seeds per fruit where the frequency

of the occurrence remained 100%. The unique traits reported in very minimal such as presence of blossom end appendage, wrinkled fruit surface, sunken fruit shape at blossom end, blocky fruit shape, high fruit set, presence of anthocyanin stripes on fruits would be considered as important morphological breeding traits for the development of diverse chilli varieties with special identity. These findings will help to identify the genetically pure traits linked with the chilli genotypes during maintenance breeding programme. Yield attributing traits such as fruit length, fruit width, and fruit weight, no. of fruits per plant and fruit yield per plant showed moderate to high variation indicating a better scope for crop improvement through selection.

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