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Morphological Characterization of Chilli (*Capsicum annuum* L.) Germplasm

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ABSTRACT: The genetic variability is plinth for any breeding program. Characterization of germplasm is highly essential as it helps in identification of the varieties. In the present investigation, 35 genotypes of chilli were characterized using 10 qualitative traits *viz.* life cycle, stem colour, plant growth habit, leaf pubescence, leaf colour, leaf shape, leaf margin, corolla colour, fruit position and fruit surface. Wide variations were observed among the 35 genotypes for the qualitative traits especially in leaf pubescence, leaf shape, fruit position and fruit surface. Morphological markers enable the detection of genetic variation based on individual phenotypic variations. These qualitative traits which exhibited high phenotypic variability will be useful as morphological markers in selection of segregating populations. Therefore, it is necessary to lay attention on these traits in crop improvement programme. This study significantly contributes to the knowledge of conservation of genetic resources, breeding of chilli and will useful for selection of traits.

Keywords: chilli, genotypes, morphological markers, variability.

INTRODUCTION

Chilli (*Capsicum annuum* L.) originated from tropical and humid zone of Central and Southern America and belongs to the Solanaceae family with diploid chromosome number 2n = 2x = 24 (Saisupriya *et al.*, 2020). It is one of the important commercial vegetable. Unripe green fruits are used as vegetable whereas ripe red fruits are used as spice after drying. The major constituents such as carbohydrates, volatile oil, fixed oil, protein, tannin, resins, pigments and minerals are present in the dry weight of spices (Subbalaxmi and Naik, 2002). Chilli, one of the most widely used condiment as flavouring and colouring in virtually indispensable in Asian cuisines (Jitbunjerdkul and Kijroongrojana, 2007; Toontom *et al.*, 2010). Chilli is in high demand food and pharmaceutical industries. Capsaicin is the secondary metabolite responsible for pungency in chilli is used in various pharmaceutical preparations.

In germplasm management and crop improvement, both morphological traits and molecular markers have their own implication and validity and none is superior (Parthsinh *et al.*, 2019). Genetic diversity can be measured using morphological, biochemical characterization and evaluation (Mondini *et al.*, 2009). Conventionally morphological markers known as descriptors were used to identify varieties and helps in analysis of genetic diversity (Dhaliwal *et al.*, 2014). Morphological characterization is intended to protect the genetic resources that are usually lost by in the crop mismanagement either by replacing varieties originating of a region by improving varieties or destruction of mountain vegetation (IBPGR Annual Report, 1974). Characterization includes recording those characters which are highly heritable, can be easily distinguished by naked eye and are expressed in all environments. The morphological markers facilitate assessment of visually detectable variability based on individual phenotypic difference such as morphology and structure of plants. It is evident that plant morphology would contribute to plant genetics in the characterization of the phenotype (Atnafua and Endashaw, 2014). To be more effective, the methodology needs to correctly describe each accession in order to differentiate between the accessions in the same collection (Anuradha *et al.*, 2018). They are useful to differentiate between accessions in the same collection lot. Morphological characterization is carried out on a representative population of an accession using a list of descriptors for the species (Benjamin *et al.*, 2008).

Morphological characterization is challenging and time consuming as it demands extensive collection of data. However, study on phenotypic attributes is needed, because those parameters have been widely used for the assessment of genetic diversity, breeding value and yield potential of the crop (Agong *et al*., 2001; Dharmatti *et al*., 2001; Mohanty *et al.*, 2001; Parthasarathy *et al.*, 2002; Naveen *et al.*, 2018; Saidaiah *et al.,* 2019). In this regard, the present investigation was carried out to assess the morphological characterisation in 35 chilli genotypes using ten minimal descriptors.

MATERIAL AND METHODS

Thirty five genotypes of chilli which includes homozygous accessions obtained from NBPGR Regional Station, Rajendranagar, Hyderabad and one variety released from IARI, New Delhi and two released varieties from RARS, Lam, Guntur, Andhra Pradesh were evaluated in Randomized block design with three replications in field conditions. The data on ten qualitative characters was recorded in each genotype as per minimal descriptors of NBPGR (Srivastava *et al.*, 2001). The details of trait, classification and stage of scoring are presented in Table 1.

Table 1: Classification and stage of scoring of 10 qualitative traits in 35 chilli genotypes as per NBPGR descriptors.

Sr. No.	Qualitative trait	Stage of scoring	Classification	No. of Accessions	Frequency
1.	Life cycle	Mature fruit harvesting stage	Annual	35	100
			Biennial	-	
			Perennial	-	
2.	Stem colour	Full foliage stage	Green	-	
			Green with purple stripes	35	100
			Purple	-	
3.	Plant growth habit	Mature fruit stage	Prostrate	-	
			Intermediate	2	5.7
			Erect	33	94.3
4.	Leaf pubescence	Youngest mature leaf	Absent	-	
			Sparse	29	82.9
			Intermediate	4	11.4
			Dense	2	5.7
5.	Leaf colour	Full foliage stage	Green	1	2.9
			Dark green	34	97.1
			Purple	-	
6.	Leaf shape	Full foliage stage	Deltoid	-	
			Ovate	18	51.4
			Lanceolate	17	48.6
7.	Leaf margin	Full foliage stage	Entire	-	
			Undulate	35	100
			Ciliate	-	
8.	Corolla colour	Immediately after blooming	White	34	97.1
			Yellow	-	
			Purple	1	2.9
9.	Fruit position	Mature fruit stage	Pendent	28	80.0
			Semi pendent	6	17.1
			Erect	1	2.9
10.	Fruit surface	Mature fruit stage	Smooth	-	
			Semi wrinkled	18	51.4
			Wrinkled	17	48.6

RESULTS AND DISCUSSION

Thirty five genotypes of chilli germplasm under present investigation were characterized based on 10 qualitative traits (Table 2).

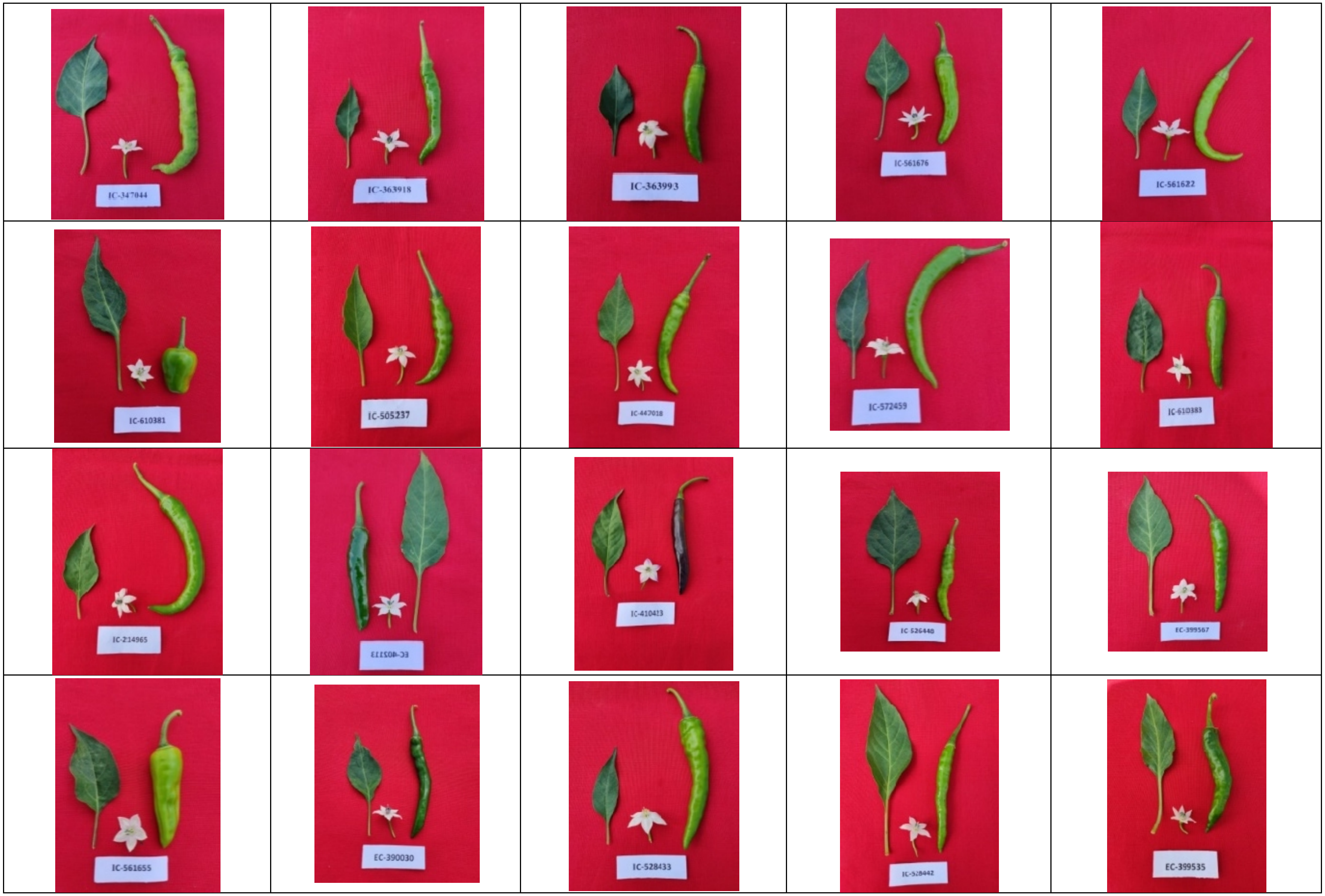
The observations on life cycle revealed that all the 35 genotypes of chilli under study are annuals completing their life cycle in one season. With respect to stem colour, the observations revealed that stem colour of all the 35 genotypes investigated was green with purple stripes. The observations on plant growth habit showed that 33 genotypes are erect and the rest 2 genotypes *viz.*, IC-347044 and IC-528433 are having intermediate growth habit.

The observations noted regarding leaf pubescence of the 35 genotypes of chilli under investigation showed that 29 genotypes have sparse leaf pubescence, 4 genotypes *viz.*, IC-561622, IC-447018, IC-526448 and IC-526737 showed intermedaiate leaf pubescence and the rest 2 genotypes *viz.*, IC-363918 and IC-214965 have dense leaf pubescence. For leaf colour 34 genotypes showed dark green leaves and one genotype *viz.*, IC-561648 showed green coloured leaves. The dark green colour of leaves is generally due to presence of high chlorophyll content which ultimately leads to the increased yield hence, it becomes a good criterion for selection of elite cultivars (Andrade *et al.*, 2020).

The observations analysed about the 35 genotypes for leaf shape showed that 18 among these have ovate-lanceolate shaped leaves and 17 genotypes have lanceolate shaped leaves. The observations on leaf margin revealed that all the 35 genotypes of chilli under study are with undulate leaf margin.

Table 2: Qualitative traits of 35 chilli genotypes.

Genotype	Life cycle	Stem colour	Plant growth habit	Leaf pubescence	Leaf colour	Leaf shape	Leaf margin	Corolla colour	Fruit position	Fruit surface
IC-347044	Annual	Green with purple stripes	Intermediate	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-363918	Annual	Green with purple stripes	Erect	Dense	Dark green	Lanceolate	Undulate	White	Erect	Semi wrinkled
IC-363993	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
IC-561676	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
IC-561622	Annual	Green with purple stripes	Erect	Intermediate	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-610381	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Erect	Semi wrinkled
IC-505237	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
IC-447018	Annual	Green with purple stripes	Erect	Intermediate	Dark green	Ovate-Lanceolate	Undulate	White	Semi pendent	Wrinkled
IC-572459	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-610383	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-214965	Annual	Green with purple stripes	Erect	Dense	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
EC-402113	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-410423	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White with purple stripes	Erect	Wrinkled
IC-526448	Annual	Green with purple stripes	Erect	Intermediate	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
EC-399567	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
IC-561655	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
EC-390030	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-528433	Annual	Green with purple stripes	Intermediate	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
IC-528442	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Erect	Wrinkled
EC-399535	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
EC-378632	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-215012	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
EC-378688	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-214966	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Semi wrinkled
IC-319335	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Erect	Wrinkled
IC-394819	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
IC-572498	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
EC-399581	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
IC-526737	Annual	Green with purple stripes	Erect	Intermediate	Dark green	Lanceolate	Undulate	White	Erect	Semi wrinkled
IC-570408	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
IC-561648	Annual	Green with purple stripes	Erect	Sparse	Green	Ovate-Lanceolate	Undulate	White	Pendent	Wrinkled
IC-334383	Annual	Green with purple stripes	Erect	Sparse	Dark green	Lanceolate	Undulate	White	Pendent	Wrinkled
SINDHUR[c]	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
LCA-625[c]	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled
PUSA JWALA[c]	Annual	Green with purple stripes	Erect	Sparse	Dark green	Ovate-Lanceolate	Undulate	White	Pendent	Semi wrinkled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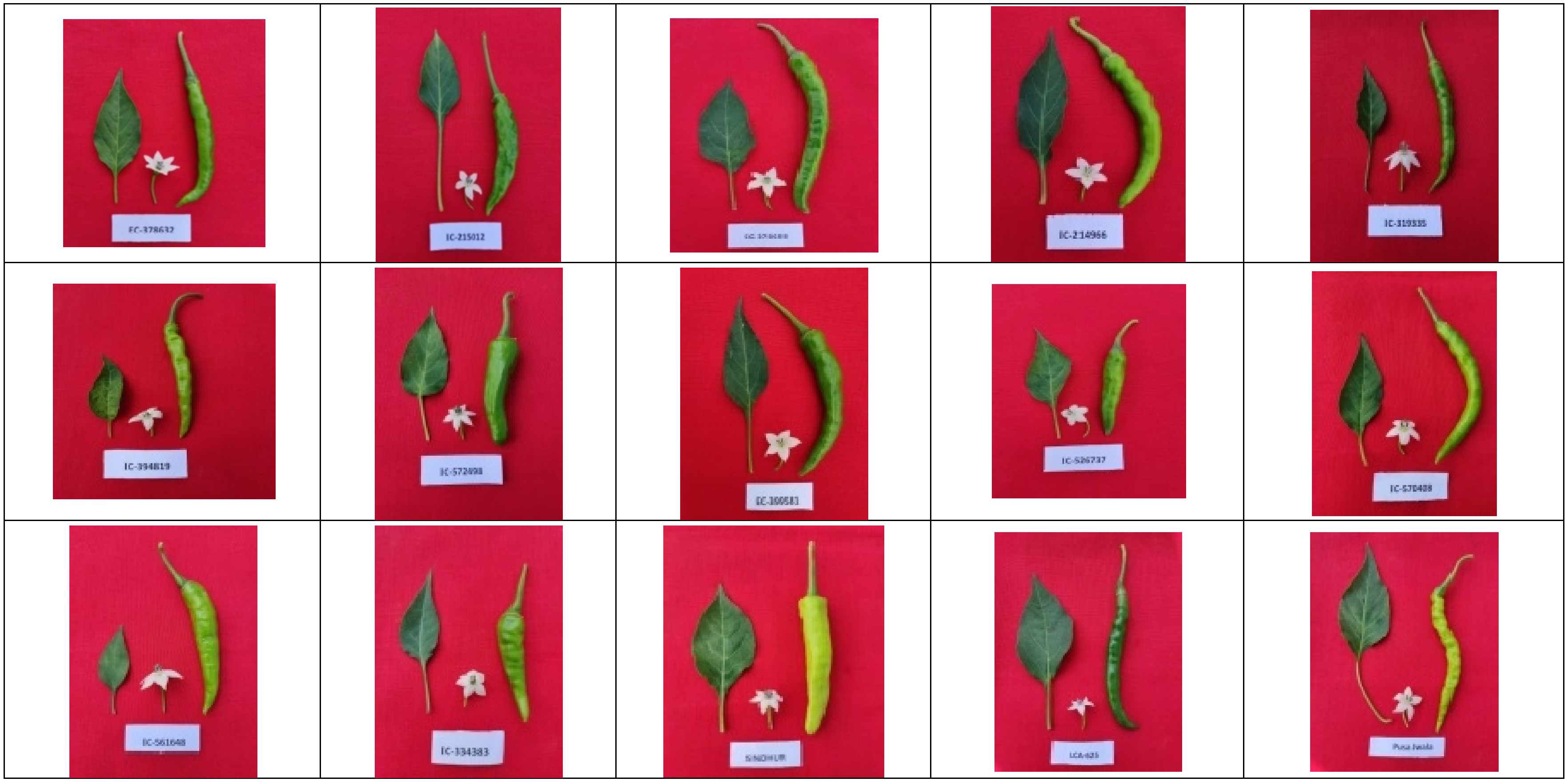

Fig. 1. Phenotypic diversity of 35 chilli genotypes.

The corolla colour showed that 34 genotypes have white colour corolla and one genotype IC-410423 have white colour corolla with purple stripes. The observations noted on fruit position showed that 28 genotypes have pendent fruits, six of them have erect fruits (IC-363918, IC-610381, IC-410423, IC-528442, IC-319335 and IC-526737) and one genotype have semi-pendent fruits (IC-447018). The observations on fruit surface disclosed that 18 genotypes have semi wrinkled fruit surface and 17 genotypes are with wrinkled fruit surface. Similarly maximum morphological variation was observed for fruit traits of two distinct chilli cultivars from North Eastern India by Colney *et al.,* (2018).

Among the different traits assessed, annual life cycle, green stem colour with purple stripes, undulate leaf margin showed 100% frequency; a higher frequency was also observed for erect plant growth (94.3%), sparse leaf pubescence (82.9%), dark green leaf colour (97.1%), white corolla colour (97.1%) and pendent fruit position (80.0%). For the trait white corolla colour, Joshia *et al.,* (2020) also reported the higher frequency which were in confirmation with the results obtained in this study.

Wide variations among the qualitative characters of the 35 genotypes were recorded. Intermediate growth habit was observed in IC-347044 and IC-528433, intermediate leaf pubescence was recorded in IC-561622, IC-447018, IC-526448 and IC-526737, dense leaf pubescence was recorded in IC-363918 and IC-214965, green leaf colour was recorded in IC-561648, white colour corolla with purple stripes was recorded in IC-410423, 6 genotypes have erect fruits (IC-363918, IC-610381, IC-410423, IC-528442, IC-319335 and IC-526737) and one genotype have semi pendent fruits (IC-447018). One genotype IC-610381 can be exploited as ornamental plant because it has peculiar fruit characters as recorded in the above parameters. This is in confirmation with the results of Erika *et al*., 2020 whose study reported that chilli peppers are suitable germplasm for cultivation and distribution as ornamental plants.

Similar studies on stem colour, leaf size, leaf pubescence and leaf colour are conducted by Gaddagimath, (1992), Padma *et al*., (2017) in chilli. Horacio *et al.,* (2013) also studied about the descriptors leaf size, leaf pubescence and fruit surface in chilli. A similar kind of study was conducted by Zhani *et al.,* (2015) on characters like leaf colour, fruit position and fruit surface. Genetic variability of chilli peppers based on phenotypic and molecular descriptors have been studied by Bozokalfa *et al.,* (2009); Dias *et al.,* (2013); Moreira *et al.,* (2018).

CONCLUSION

The present study analysed the genetic similarities and variability between the thirty five chilli accessions using morphological markers. Results indicated that there is variability for most of the traits in chilli germplasm. Genotypes differed significantly in traits explaining uniqueness of characters. Understanding the extent of genetic variability within a species through the use of morphological marker is of critical importance for estimation of possible loss of genetic variation as well as to develop the strategies for germplasm conservation (Agyare *et al.,* 2016). These qualitative traits which showed high variation will be useful as morphological markers as they enable the detection of genetic variation based on individual phenotypic variations and also useful for identification of varieties in DUS testing. Hence selection based on these qualitative traits will be effective. These traits are useful in quick characterization of germplasm and may be utilized in further crop improvement studies.

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Conflicts of Interest. None.

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