Evaluation of local types of bird's eye chilli (*Capsicum frutescens* L.) for plant and fruit morphological characters.

Abstract

Chilli is an important commercial crop grown for its pungency. *Capsicum frutescens* L. is one of the five cultivated species in the genus Capsicum. These are widely used as spice throughout the world due to characteristic pungency and also have applications in pharmaceutical industry. *Capsicum frutescens* L. exhibits large variation in plant and fruit characters. The present study was conducted to evaluate bird's eye chilli genotypes and identify the variation for some plant physical characters and fruit morphological traits (qualitative and quantitative). A total of thirty-three genotypes including a check variety*viz.*, Vellayani Samruddhi (*C. frutescens* L.)were used in the study. Field evaluation was carried out and observations such as leaf shape, leaf pubescence, flowers per axil, fruit orientation (plant physical traits) and fruit shape, fruit curvature, fruit colour, fruit glossiness and seed colour (fruit morphological characters) were recorded. The results on morphological evaluation revealed that most of the genotypes (26) possess ovate shaped leaves with pubescence. Flowers were erect being one to three per axil. All the genotypes had moderately triangular fruit shape with no curvature. The colour of seeds varied among the genotypes including light yellow (UASBCF-19, UASBCF-29 and Vellayani Samruddhi) and rest of the genotypes being orange yellow. The average values for quantitative traits such as fruit length, width, number of locules, pericarp thickness and fruit stalk length were observed to be 1.99 cm, 0.66 cm, 2.00, 0.29 mm and 2.23 cm respectively. This variations in qualitative characters of the fruit can be utilized in crop improvement programme.

Keywords: Chilli,*Capsicum frutescens*, qualitative and quantitative characterization, fruit morphology

Introduction

Chilli (*Capsicum annuum* L. 2n=24) is a unique and popular Solanaceous crop cultivated for its pungency. It is invariably used to add hotness and unique flavour to food across the globe. Chilli is an often-cross pollinated crop where the extent of cross pollination is about 7 to 36 per cent (Sunil and Rasheed, 1998).Though chilli is native to North America, India has plethora ofvariability in the crop and thus regarded as secondary centre of diversity especially

for *Capsicumannum* (Thakur *et al.,* 2019). Chilli can be grown both as *Kharif* and *Rabi* crop. (Anon., 2019).Indian chilli is considered to be famous globally for two important commercial qualities, *viz.,* colour and pungency (Madhu *et al.,* 2009).With greater diversity, types of chillies cultivated around the world comprise of *Capsicum annuum, Capsicum baccatum, Capsicum pubescens, Capsicum chinense*and*Capsicum frutescens* of which *C. annuum* and *C. frutescens* are mostly found in India (Mnahoncakova*et al.,* 2020).

***Capsicum frutescens* L.(bird's eye chilli)** is a wild chilli having genetic proximity to one of the cultivated chillies, *Capsicum chinense*. Chilli cultivars of *C. frutescens* can be annual or short-lived perennial plants and grow three to eight years (Wikipedia, 2023). It is a shade loving plant and needs regular supply of water. The plant is characterized by spreading architecture with hard stem and slender branches.*Capsicum frutescens*L.plants have smooth, medium-sized, elliptical leaves and a greater number of primary and secondary branches compared to *C. annum* species (Gurung *et al.,* 2020).Flowers are solitary or several in each axil, stalked, pale green or yellowish-green (Bedjaoui *et. al.,* 2022). The plants attain their full size in a hot and humid climate. Fruits are erect and exhibit less variation in colour, shape and size (Paredes *et al.,* 2020)than do *Capsicum annuum, C. chinense, and C. baccatum.*

However, the use of these chillies is limited due to difficulty in crop establishment, low adaptability in hot and dry climates, poor yield and seed dormancy problems (Barchenger and Bosland, 2016). There is no doubt if prompt efforts are made to improve the crop and made available to the farming community, it will become a potential foreign exchange earner of the country. But there is no known desirable cultivar in the country. So, it has now become essential to evaluate the available collections in bird's eye chilli and to recommend the best cultivar(s) to the farmers. Improvements are needed fruit quality and therefore its characterization is very important.In the present study, it is therefore aimed at characterization of local bird's eye chilli genotypes for fruit morphologicaltraits.

Table 1. List of genotypes and their place of collection

Sl. no	Genotype	Place of collection
1	UASBCF-1	Ponnampet, Kodagu, Karnataka
2	UASBCF-2	Alur, Hassan, Karnataka
3	UASBCF-3	Alur, Hassan, Karnataka
4	UASBCF-4	Alur, Hassan, Karnataka

5	UASBCF-5	Malappuram, Kerala
6	UASBCF-6	Alur, Hassan, Karnataka
7	UASBCF-7	Belur, Hassan, Karnataka
8	UASBCF-8	Ponnampet, Kodagu, Karnataka
9	UASBCF-9	Hassan, Karnataka
10	UASBCF-10	Mudigere, Chikkamagaluru, Karnataka
11	UASBCF-11	Mudigere, Chikkamagaluru, Karnataka
12	UASBCF-12	Mudigere, Chikkamagaluru, Karnataka
13	UASBCF-13	Mudigere, Chikkamagaluru, Karnataka
14	UASBCF-14	Mudigere, Chikkamagaluru, Karnataka
15	UASBCF-15	Ponnampet, Kodagu, Karnataka
16	UASBCF-16	Ponnampet, Kodagu, Karnataka
17	UASBCF-17	Ponnampet, Kodagu, Karnataka
18	UASBCF-18	Ponnampet, Kodagu, Karnataka
19	UASBCF-19	Ponnampet, Kodagu, Karnataka
20	UASBCF-20	Ponnampet, Kodagu, Karnataka
21	UASBCF-21	Maddur, Mandya, Karnataka
22	UASBCF-22	Virajpet, Kodagu, Karnataka
23	UASBCF-23	Virajpet, Kodagu, Karnataka
24	UASBCF-24	Sirsi, Uttara Kannada, Karnataka
25	UASBCF-25	Kollam, Kerala
26	UASBCF-26	Tiruvanathapuram, Kerala
27	UASBCF-27	Tiruvanathapuram, Kerala
28	UASBCF-28	Tiruvanathapuram, Kerala
29	UASBCF-29	Malappuram, Kerala
30	UASBCF-30	Kollam, Kerala
31	UASBCF-31	Wayanad, Kerala
32	UASBCF-32	Koppa, Chikkamagaluru, Karnataka
33	Vellayani Samruddhi (C)	Kerala Agricultural University, Kerala

Material and methods

The current study was carried out in the experimental plots of 'K' block, Department of Plant Biotechnology, College of Agriculture, GKVK, Bengaluru, situated at an altitude of 930 meters above mean sea level (MSL), 12º58' North latitude and 77º35' East longitude. This region corresponds to the Eastern Dry Agro-climatic Zone (Zone V) of Karnataka.

A total of 33 genotypes including thirty-two local types of bird eye chilli collected from various parts of Karnataka and Kerala and a check variety*viz.*, "Vellayani Samruddhi"were used in the study. For convenience, these local types of bird eye chilli collected were renamed

as UASBCF (1-32) (UAS, Bangalore, *Capsicum frutescens*).The details of experimental material and their place of collection are presented in Table 1.

The experimental plot consisting of red laterite soil was ploughed and brought to fine tilth to make ridges. Weeds, stubbles, stones were removed and well decomposed farmyardmanurewasappliedandmixedwell.Plots were drenched with Bavistin @ 2 g/ml before sowing to avoid soil borne diseases. Healthy and uniform seedlings of six weeks old were transplanted in the experimentalplotsineachreplicationduringthemonth ofJanuary 2023. Aftertransplantingonelightirrigationwas given for quick establishment of seedlings. Recommended dose of fertilizers N, P and K @ 150: 75: 75 NPK kg/ ha were applied as per the recommended package of practice in the form of urea, diammonium phosphate and muriate of potash, respectively. Fifty per cent of nitrogen and full dose of phosphorus and potash were applied as basal dose and the remaining fifty per cent of nitrogen was applied 45 days after transplanting.The field was kept free from weeds by hand weeding at 15 days interval.Theplotswereirrigatedatanintervalofonedayininitialgrowthperiod. Latertheirrigationintervalincreasedtooncein2-3daysdepending on the soil moisture conditions. Detailsof design and layout of experimental block is given in Table 2.

Observations on plant and fruit morphological parameters (qualitative and quantitative) were recorded from plants in the field based on DUS guidelines, chilli (PPV&FRA). Observations on plant physical traitssuch as leaf shape, leaf pubescence, flowers per axil, fruit orientation (Fig. 1a),fruit qualitative characters such as fruit shape (Fig. 1b), fruit curvature (Fig. 1c), fruit colour, fruit glossiness and seed colour and quantitative traits *viz.*,fruit length, fruit width, number of locules, pericarp thickness and fruit stalk length were recorded.

Table 2. Designandlayoutofexperiment.

Plant material	Local genotypes of bird’s eye chilli collected from Western ghats of Karnataka and Kerala

Number of genotypes used	32 genotypes and check varieties (Vellayani Samrudhi)
Experimental Design	RCBD
Number of Replications	Two
Location	Department of Biotechnology, College of Agriculture, GKVK, Bangalore
Plot Size	Row to row- 1 meter and plant to plant spacing- 1 meter

Results and Discussion

The genotypes were subjected to visual observation ofplant physical traits *viz*., leaf shape, leaf pubescence, flowers per axil, fruit orientation, fruit bearing habit and fruit qualitative traits *viz*., fruit shape, curvature, colour, glossiness andseed colour. Also, the fruits were recorded for quantitative traits such as fruit length, fruit width, number of locules, pericarp thickness and fruit stalk length. The results on evaluation of bird's eye chilli genotypes for plant and fruit characters (qualitative) are presented in Table 3.

The shape among bird's eye chilli genotypes varied with four genotypes being lanceolate, twenty-six being ovate (including Vellayani Samruddhi)and two broad-elliptic (Plate 1).Sahid *et al.* (2022) identified both ovate and lanceolate shape of leaves in *C. frutscens*. Most of our*C. frutscens* genotypes studied possessed ovate shape. For all the genotypes under study, the leaf pubescence was present. Results found by Saisupriya *et al.* (2021) on evaluation of chilli genotypes for leaf pubescence showed that it was present in all genotypes. Eleven genotypes were found have one flower per axil whereas seventeen genotypes had two flowers and five genotypes had three flowers per axil. Bird's eye chilli is mostly found to have two tothree flowers per axil. Similar results were observed by Padma *et al.* (2017) in which all eleven genotypes had two to three flowers per axil. All the bird eye chilli genotypes had erect fruits including the check variety "Vellayani Samruddhi". Jarret *et al.* (2007) have also reported pendent larger fruited cultivated from upright small fruited primitive and semi-pendent transitional form in case of *C. frutscens*. Thus, in the present study maximum number were upright small fruited primitive types.

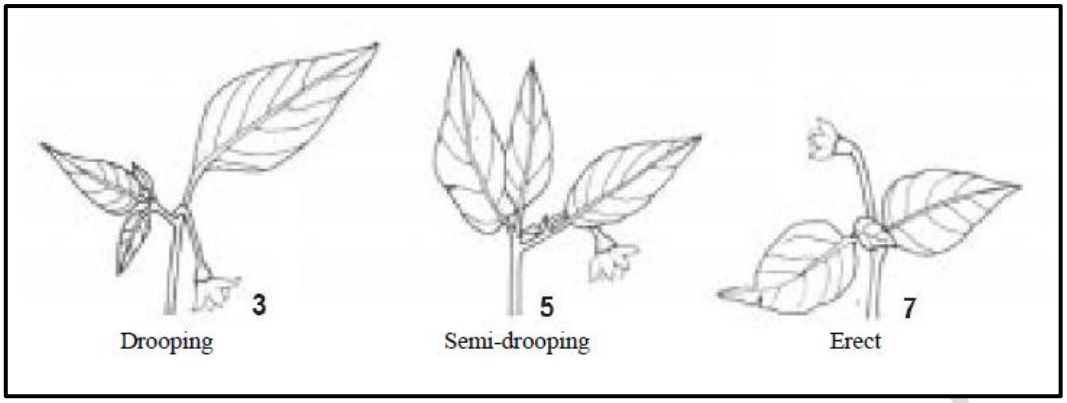

Fig. 1a. Different flower/ fruit orientation observed in chilli

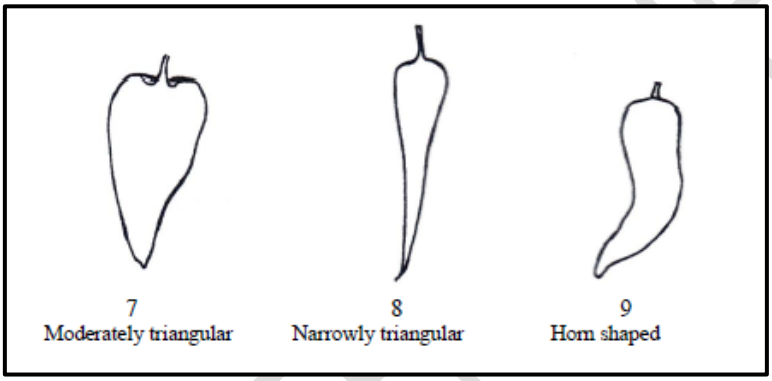

Fig. 1b. Different fruit shapes found in chilli

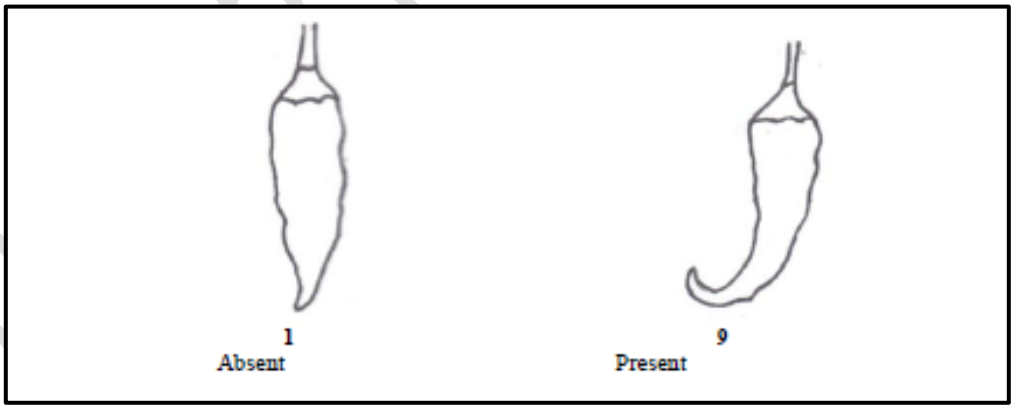

Fig. 1c.Fruit curvature

Table 3. Plant and fruit characteristics of bird eye chilli genotypes in the study

Genotype	Leaf shape	Leaf pubescence	Flowers per axil	Fruit orientation	Fruit curvature	Fruit shape	Fruit colour	Fruit glossiness	Seed colour
UASBCF-1	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-2	Ovate	Present	3	Erect	Absent	Moderately triangular	Light brown	Weak	Orange Yellow
UASBCF-3	Ovate	Present	2	Erect	Absent	Moderately triangular	Light orange	Medium	Orange Yellow
UASBCF-4	Ovate	Present	1	Erect	Absent	Moderately triangular	Light brown	Weak	Orange Yellow
UASBCF-5	Lanceolate	Present	2	Erect	Absent	Moderately triangular	Medium red	Medium	Orange Yellow
UASBCF-6	Ovate	Present	2	Erect	Absent	Moderately	Light red	Weak	Orange

						triangular			Yellow
UASBCF-7	Lanceolate	Present	1	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-8	Ovate	Present	3	Erect	Absent	Moderately triangular	Light orange	Weak	Orange Yellow
UASBCF-9	Ovate	Present	3	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-10	Ovate	Present	2	Erect	Absent	Moderately triangular	Medium red	Medium	Orange Yellow
UASBCF-11	Ovate	Present	2	Erect	Absent	Moderately triangular	Medium orange	Medium	Orange Yellow
UASBCF-12	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow

UASBCF-13	Ovate	Present	2	Erect	Absent	Moderately triangular	Light orange	Medium	Orange Yellow
UASBCF-14	Ovate	Present	3	Erect	Absent	Moderately triangular	Light orange	Weak	Orange Yellow
UASBCF-15	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-16	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-17	Ovate	Present	3	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
Genotype	**Leaf shape**	**Leaf pubescence**	**Flowers per axil**	**Fruit orientation**	**Fruit curvature**	**Fruit shape**	**Fruit colour**	**Fruit glossiness**	**Seed colour**
UASBCF-18	Ovate	Present	1	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow

UASBCF-19	Lanceolate	Present	1	Erect	Absent	Moderately triangular	Medium orange	Weak	Light Yellow
UASBCF-20	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-21	Ovate	Present	2	Erect	Absent	Moderately triangular	Medium red	Weak	Orange Yellow
UASBCF-22	Ovate	Present	2	Erect	Absent	Moderately triangular	Light orange	Weak	Orange Yellow
UASBCF-23	Ovate	Present	2	Erect	Absent	Moderately triangular	Light yellow	Weak	Orange Yellow
UASBCF-24	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-25	Ovate	Present	1	Erect	Absent	Moderately triangular	Medium red	Strong	Orange Yellow

UASBCF-26	Broad elliptic	Present	1	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-27	Broad elliptic	Present	1	Erect	Absent	Moderately triangular	Medium red	Weak	Orange Yellow
UASBCF-28	Broad elliptic	Present	1	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-29	Lanceolate	Present	1	Erect	Absent	Moderately triangular	Light yellow	Weak	Light Yellow
UASBCF-30	Ovate	Present	2	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow
UASBCF-31	Ovate	Present	2	Erect	Absent	Moderately triangular	Medium red	Medium	Orange Yellow
UASBCF-32	Ovate	Present	1	Erect	Absent	Moderately triangular	Light red	Weak	Orange Yellow

Vellayani Samruddhi (C)	Ovate	Present	1	Erect	Absent	Moderately triangular	Light yellow	Medium	Light Yellow

Plate 1. Different leaf shapes observed in chilli genotypes. Note: 1= Lanceolate, 2= Ovate and 3= Broad-elliptic.

For all the genotypes under study, the fruit shape was found to be moderately triangular. Sahid *et al.* (2022) identified both narrowly triangular and moderately triangular fruits in that *C. frutscens.*Fruit curvature was absent for all the bird's eye chilli genotypes including the check variety "Vellayani Samruddhi". Fruit curvature was absent for all the bird's eye chilli genotypes including the check variety "Vellayani Samruddhi". Fruits of twenty-five genotypes were observed to be weak (non-glossy), seven having medium glossiness (including the check variety "Vellayani Samruddhi") and only one genotype was found to have high glossiness (UASBCF-25) among the genotypes collected in bird's eye chilli.Sahid *et al.* (2022) reported in a study that most of the *C. frutescens* genotypes had weak and medium glossiness. The colour of seeds varied among the genotypes including light yellow (UASBCF-19, UASBCF-29 and Vellayani Samruddhi) and rest of the genotypes being orange yellow.

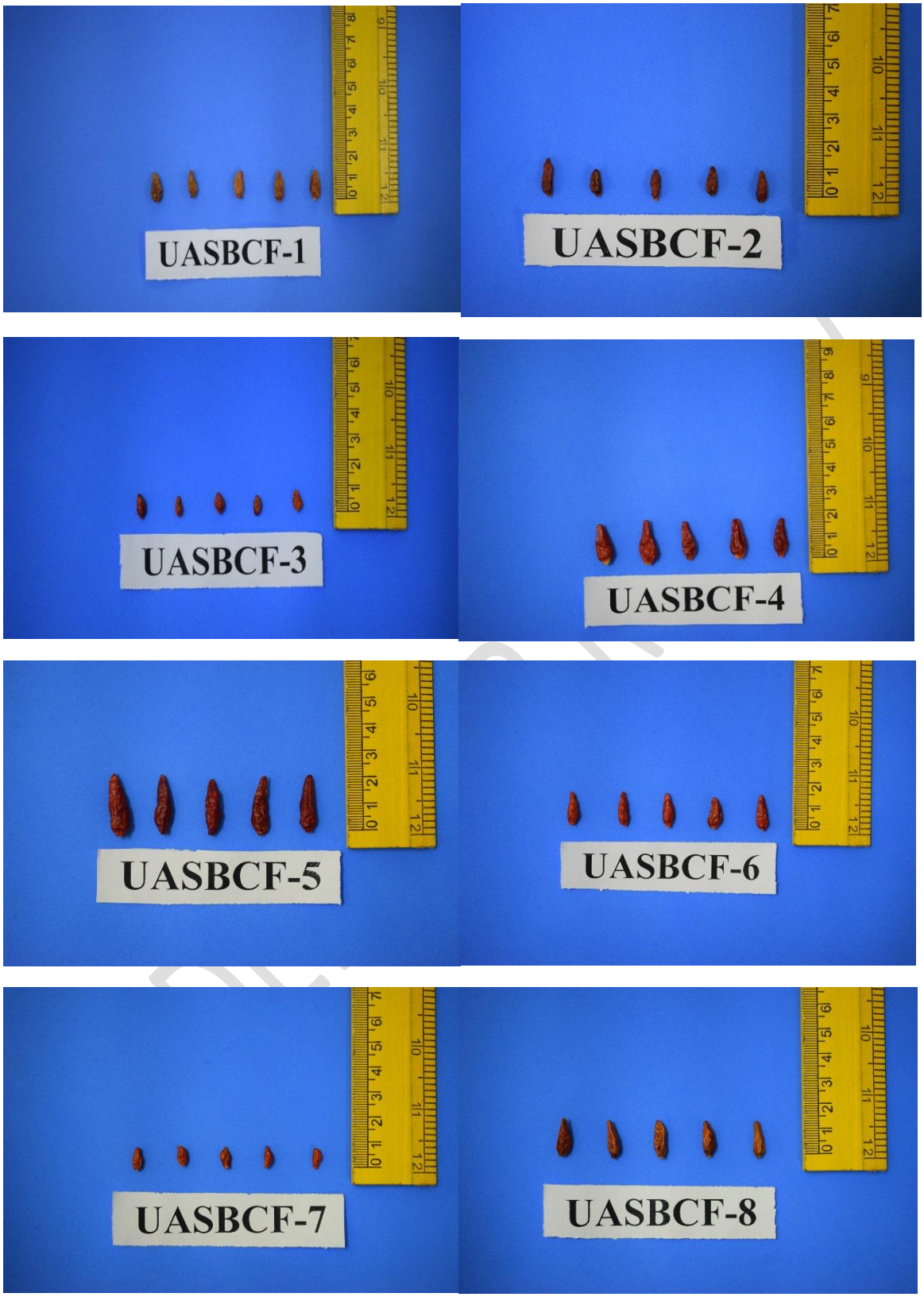

Plate 2a. Bird's eye chilli genotypes used in the study (UASBCF-1 to UASBCF-8)

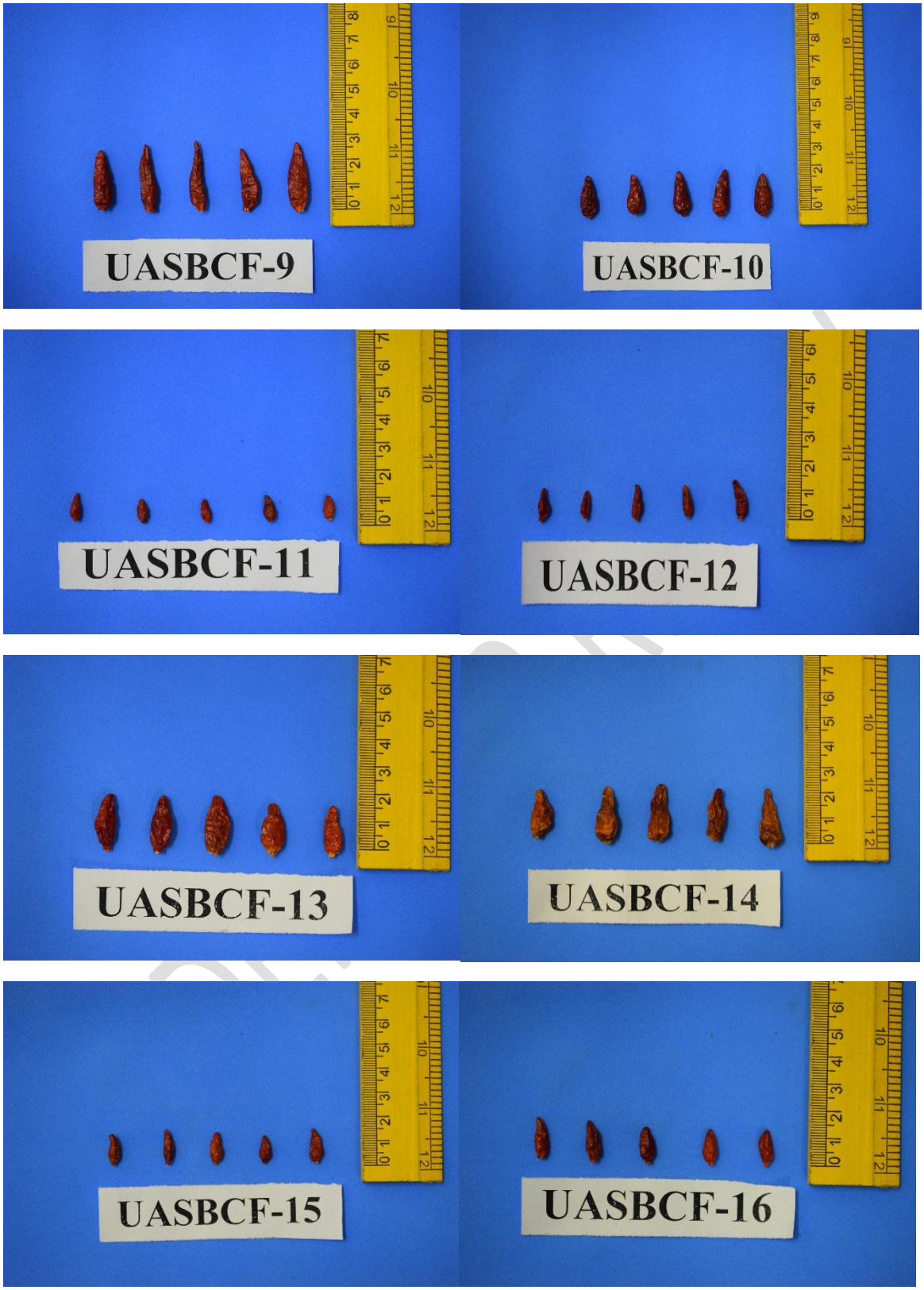

Plate 2b. Bird's eye chilli genotypes used in the study (UASBCF-9 to UASBCF-16)

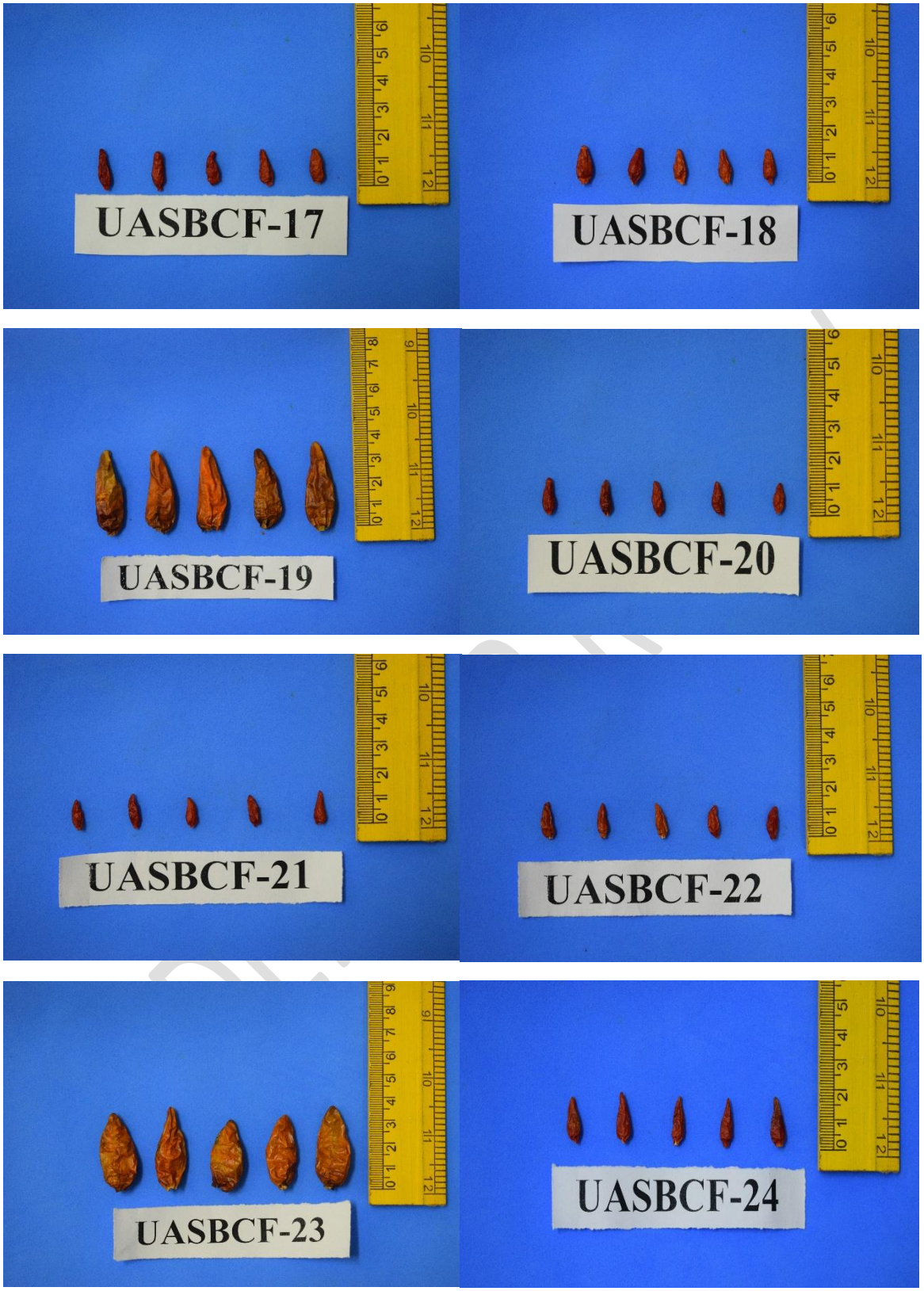

Plate 2c. Bird's eye chilli genotypes used in the study (UASBCF-17 to UASBCF-24)

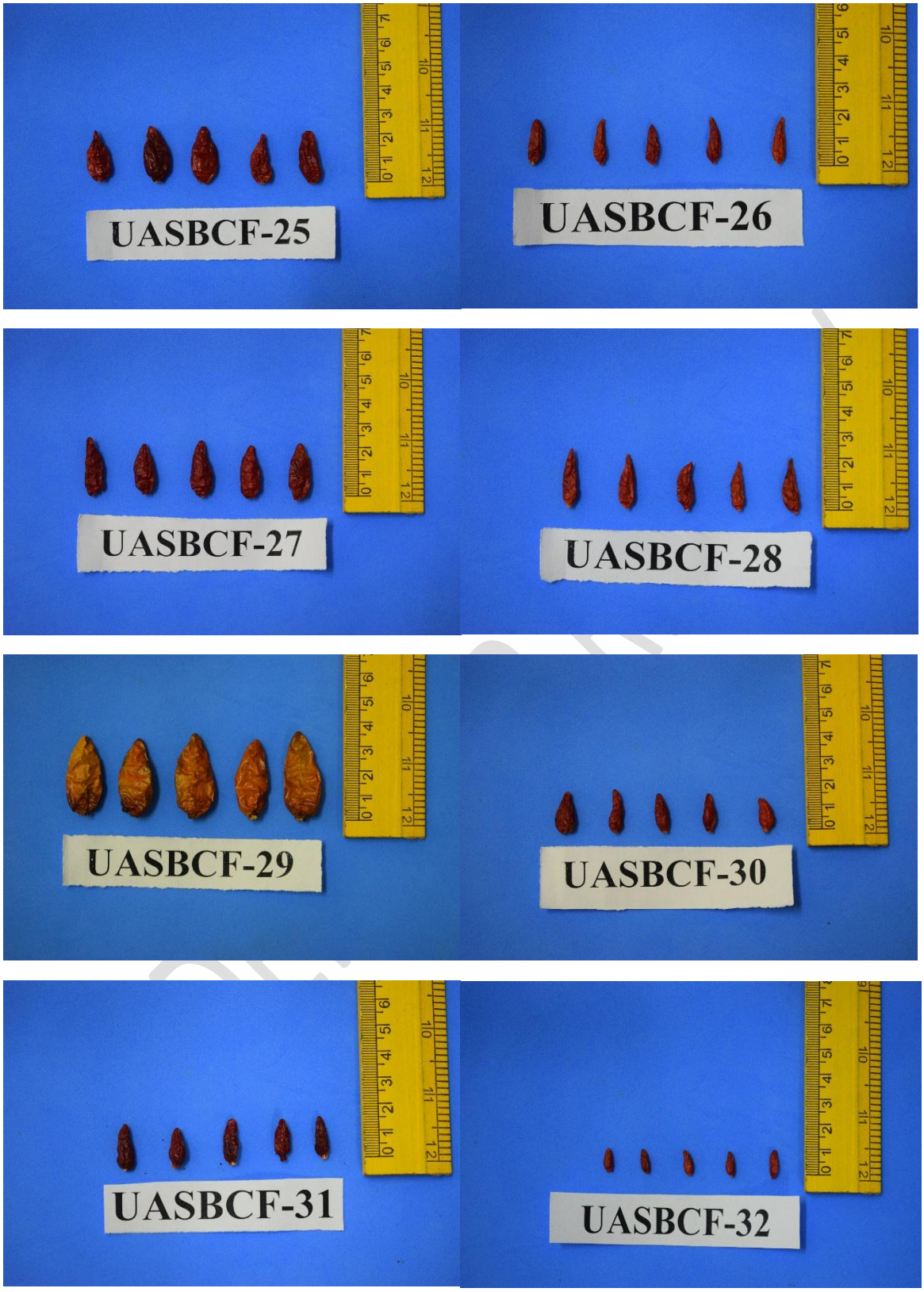

Plate 2d. Bird's eye chilli genotypes used in the study (UASBCF-25 to UASBCF-32)

Plate 2e. Check variety used in the study (Vellayani Samruddhi)

The observations recorded for fruit quantitative traits are presented in Table 4.The average fruit length was found to be 1.91 cm. The highest fruit length was in UASBCF-19 (4.05 cm) and UASBCF-29 (3.95) was on par with each other. The lowest fruit length was observed in UASBCF-4 (0.85 cm). The fruit length of check variety "Vellayani Samruddhi" was observed to be 3.55 cm. Similarly, Carvalho *et al.* (2017) have reported a mean fruit length of 0.6 to 4.6 cm in *C. frutescens* genotypes evaluated by them. The significantly high fruit width was found to be 1.35 cm (UASBCF-29) followed by UASBCF-19 (1.25 cm). Both were found to be on par with each other the lowest fruit width was found to be 0.25 cm (UASBCF-2). The mean value for fruit width was 0.66 cm. The fruit width of check variety "Vellayani Samruddhi" was observed to be 1.05 cm. Jarret and Berke (2008) have reported a mean fruit width of 2.11 cm in *C. frutescens* accessions followed by Roy *et al.* (2018). For all the genotypes under investigation, only two locules were recorded. Findings of Sahid *et al.* (2022) revealed that the number of locules present in chilli were predominantly two followed by three locules. The pericarp thickness in the present accessions ranged from 0.15 to 0.55 mm. It was low (0.15 mm) in eight genotypes, medium (0.45 mm) in seven genotypes and high (0.55 mm) in UASBCF-31. The average value of 0.29 mm was recorded. The pericarp thickness of check variety "Vellayani Samruddhi" was observed to be 0.45 mm. Similar variations in *C. frutescens* pericarp thickness or fruit thickness in the range of 0.25 mm to 1.5 mm has been reported by Carvalho *et al.* (2017). The results revealed that average length of fruit stalk was 2.23 cm with a lowest value of 1.75 cm (UASBCF-6) and highest value of 2.55 cm (UASBCF-3). The fruit stalk length of check variety "Vellayani Samruddhi" was observed to be 2.30 cm. Similar variations in *C. frutescens* fruit stalk length in the range of 2.63 cm to 6.00 cm has been reported by Sahid *et al.* (2022).

Table 4. Fruit morphological traits of bird eye chilli (*C. frutescens*) germplasm collection

Genotype	Fruit length (cm)	Fruit width (cm)	Number of locules	Pericarp thickness (mm)	Fruit stalk length (cm)
UASBCF-1	1.15	0.55	2	0.45	2.35
UASBCF-2	1.20	0.25	2	0.45	2.05
UASBCF-3	1.85	0.55	2	0.45	2.55
UASBCF-4	0.85	0.45	2	0.40	2.20
UASBCF-5	2.50	0.79	2	0.35	1.90
UASBCF-6	1.25	0.61	2	0.25	1.75
UASBCF-7	1.05	0.42	2	0.25	2.35
UASBCF-8	1.50	0.61	2	0.40	2.00
UASBCF-9	3.10	0.81	2	0.45	2.40
UASBCF-10	2.15	0.93	2	0.15	3.10
UASBCF-11	1.15	0.46	2	0.25	2.40
UASBCF-12	1.20	0.32	2	0.25	2.40
UASBCF-13	1.95	0.60	2	0.15	2.25
UASBCF-14	2.20	0.88	2	0.15	2.20
UASBCF-15	1.65	0.58	2	0.15	1.85
UASBCF-16	1.75	0.53	2	0.35	2.25
UASBCF-17	1.55	0.45	2	0.25	2.45
UASBCF-18	1.45	0.56	2	0.15	2.00
UASBCF-19	4.05	1.25	2	0.25	2.25
UASBCF-20	1.15	0.45	2	0.25	2.45
UASBCF-21	1.45	0.35	2	0.15	2.15
UASBCF-22	1.55	0.60	2	0.25	2.30
UASBCF-23	3.65	1.15	2	0.25	2.25
UASBCF-24	2.15	0.55	2	0.40	1.95

UASBCF-25	2.35	1.10	2	0.15	2.20
UASBCF-26	2.25	0.55	2	0.30	2.10
UASBCF-27	2.45	0.95	2	0.50	2.40
UASBCF-28	2.25	0.75	2	0.20	2.05
UASBCF-29	3.95	1.35	2	0.15	2.20
UASBCF-30	1.95	0.50	2	0.30	2.25
UASBCF-31	2.10	0.55	2	0.55	2.35
UASBCF-32	1.25	0.35	2	0.20	1.95
Vellayani Samruddhi	3.55	1.05	2	0.45	2.30
Mean	**1.99**	**0.66**	**2**	**0.29**	**2.23**
C.V.	4.19	8.64	0	18.87	4.69
C.D. 5%	0.16	0.10	-	0.09	0.17

Conclusion

The bird's eye chilli genotypes were collected from various regions of Karnataka and Kerala (India) and subjected to evaluation for plant and fruit characters.Different leaf shapes *viz.*, lanceolate, ovate and broad elliptic were observed. All the bird's eye chilli genotypes had pubescent leaves.Twelve genotypes were found have one flower per axil, seventeen genotypes had two flowers and five genotypes had three flowers per axil. Fruit of all the bird's eye chilli genotypes were erect. For all the genotypes under study, the shape was found to be moderately triangular. Fruit curvature was absent for all the bird eye chilli genotypes. The colour of fruits varied among the genotypes including light red, light orange, medium red, medium orange, light brown, light yellow and dark red. Fruits of twenty-seven genotypes were observed to be weak (non-glossy), seven having medium glossiness and only one genotype was found to have high glossiness.

Fruit size of bird's eye chilli genotypes was very small. There was no difference in number of locules and very less difference in pericarp thickness between bird's eye chilli genotypes and the check variety.These genotypes exhibiting variation for qualitative and quantitative traits can be effectively utilized in crop improvement programme.

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