

## Screening of bird's eye chilli (*Capsicum frutescens* L.) landraces for growth, floral, yield and quality traits in coastal region of Tamil Nadu, India

### Abstract

The present study aims to observe the performance of ten landraces of bird's eye chilli for various traits and to screen the best performing landrace for utilization in further breeding program. This investigation was carried out at the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar, during the year 2022-2023. The experiment was conducted in Completely Randomized Design (CRD) with three replications and ten different landraces of bird's eye chilli. Significant variation was observed among the landraces for all the characters. Among the ten landraces, LR-1 (Green bird's eye chilli) recorded the highest values for the growth characters viz., germination percentage (89.19%), seedling vigour index (993.57), plant height (63.02 cm) and number of primary branches plant<sup>-1</sup> (16.01). The minimum number of days taken for 50% flowering (88.84 days) was registered in LR-10 (Suryamukhi). For the floral characters, the peak period of anthesis and anther dehiscence was recorded between time periods 6:00 to 7:00 a.m. and 9:00 to 10:00 a.m., respectively. However, the maximum pollen viability (83.59%) was observed in the landrace LR-6 (Purple bird's eye chilli). The maximum value for the yield characters viz., number of flowers plant<sup>-1</sup> (74.86), number of fruits plant<sup>-1</sup> (53.64) and fruit set percentage (71.65%) was recorded in the landrace LR-1 (Green bird's eye chilli). The landrace LR-10 (Suryamukhi) recorded the maximum fruit length (5.54 cm), fruit girth (2.69 cm), average fruit weight (3.75 g) and number of seeds fruit<sup>-1</sup> (23.77). Regarding the quality characters, the maximum ascorbic acid (141.08 mg 100 g<sup>-1</sup>) and capsaicin content (1.43%) were recorded in the landrace LR-8 (Thai bird's eye chilli). Based on the overall performance of the landraces under study, the landraces LR-1 and LR-10 were found to be best with respect to yield indicating that these landraces can be considered for further improvement.

**Keywords:** *Capsicum frutescens*, anthesis, anther dehiscence, quality, capsaicin.

### Introduction

Chilli is one of the most commercially important vegetable and spice crops in the world. A wide variability in chilli fruit morphology, pungency, bearing habit and crop duration is found throughout India. The genus *Capsicum* consists of approximately 27 species including 22 wild species and 5 domesticated species. (Singh *et al.* 2023). The domesticated chilli species include *Capsicum annuum* L., *Capsicum frutescens* L., *Capsicum chinense* Jacq., *Capsicum pubescens* Ruiz & Pav., and *Capsicum baccatum* L. which have been largely cultivated in the world because of their high economic value (Herath *et al.* 2020).

Bird's eye chilli (*Capsicum frutescens* L.) is a tropical berry belonging to the family Solanaceae. It is one among the ten hottest chillies in the world. In India, bird's eye chillies are widely distributed in almost all parts of the tropical and sub-tropical regions and still grows wild today. The North-Eastern Hill (NEH) region, being one of the hot-spots of biodiversity in the Indian gene centre, is also known for its

richness in ethnic diversity and traditional culture (Ralte and Ekhe,2022).

The plants of bird's eye chilli (*Capsicum frutescens* L.) are slow growing, typically upright perennial bushes growing as tall as 2 m and may survive up to 10 years with one or sometimes two flowers per node. The fruits are 12 to 25 mm long and up to 7 mm wide being oblong-conical in shape. Fruits are small sized, highly pungent, green to yellow when immature and dark red when mature. The fruit is made up of two cells separated by a membranous dissepiment to which the seeds (around 15-20 in number) are attached (Muthuswamy *et al.*,2021).

*Capsicum frutescens* L. has seven alkaloid related compounds which are associated with burning, scathing and spiciness characteristics (Kishore *et al.*,2021). Among these, capsaicinoids are usually found in seeds and are responsible for 90% of the pungency. Capsaicin (8-methyl-N-vanillyl-trans-6-nonenamide) is a colourless, crystalline pungent alkaloid that is thermolabile, often soluble in oils and alcohols. Capsaicin and di-hydro capsaicin (DHC) are major contributors to pungency and form about one-third (69%) of the total capsaicin. The capsaicin content ranges from 0.26 to 1.21% w/w or 1,00,000 to 1,50,000 Scoville Heat Units (SHU). Apart from this, 100g edible portion of fruits contains 86.0g of water, 1.9g of protein, 9.2g of carbohydrates, 1.2mg of iron, 14.4mg of calcium, 700-21600 IU of Vitamin-A, 242.0mg of Vitamin-C and 257.0kJ of energy value (Vaishnavi *et al.*,2017). Besides being used as spice and vegetable, they are also used as a very good source of ethno-medicines for a number of diseases by the traditional healers.

A wider range of variability in chilli is available which provides a great scope for improving different traits of chilli through a systematic and planned selection programme. The success of the fruit formation depends on the anthesis, anther dehiscence, pollen viability and the successful transfer of viable pollen from the anther to a receptive stigma of a flower. Thus, the knowledge of floral biology is fundamental in obtaining higher fruit and seed set (Peña-Yam *et al.* 2019). In view of the above facts, the present study was undertaken to observe the performance of different landraces for various traits and to screen the best performing landrace for utilization in further breeding program.

## Materials and Methods

The basic material for the study included ten landraces of bird's eye chilli (*Capsicum frutescens* L.) collected from the diverse origins, which showed diverse fruit and other economic characters. The experiment with ten landraces of bird's eye chilli was conducted in a Completely Randomized Design (CRD) with three replications. For the purpose of raising seedlings, the pot trays were taken and filled with suitable soil mixture. The sowing of all the landraces were done in the pot trays and forty-five-day old seedlings of uniform size and growth were transplanted. Recommended dose of balanced inorganic fertilizers at 100:50:50 kg NPK ha<sup>-1</sup> were applied to the crop. Irrigation was given at frequent intervals for the good growth and development of the crop. Intercultural operations which include weeding, hoeing and earthing up, were done regularly as when required to the crop. Plant growth regulators like NAA was sprayed to reduce the flower drop and increase the fruit set. Plant protection measures were carried out to maintain the plants free from pests and disease causing pathogens. The experimental data recorded on various characteristics during the investigation were statistically analysed as applicable to a Completely Randomized Design (CRD) by Fisher and Yates (1957).

**Table 1. List of ten landraces of *Capsicum frutescens***

S.No.	Identity	Landraces	Source of seeds
1	LR-1	Green bird's eye chilli	Local Nursery, Thanjavur
2	LR-2	Orange bird's eye chilli	PDK Gardens, Trichy
3	LR-3	Cream bird's eye chilli	PDK Gardens, Trichy
4	LR-4	Giant bird's eye chilli	Kerala
5	LR-5	Black bird's eye chilli	Kerala
6	LR-6	Purple bird's eye chilli	Kodaikanal
7	LR-7	White bird's eye chilli	Kerala
8	LR-8	Thai bird's eye chilli	Pondicherry
9	LR-9	Double shade bird's eye chilli	PDK Gardens, Trichy
10	LR-10	Suryamukhi	Sardar Grow Seeds Company (P) Ltd.

## Results and Discussion

Significant differences were observed among the landraces for all the characters under study indicating the presence of wide genetic variability and considerable scope among the landraces for their improvement in the further breeding program.

**Table 2. Mean performance among the landraces of bird's eye chilli (*C. frutescens* L.) for growth characters**

S.No	Identity	Germination percentage (%)	Seedling vigour index	Plant height (cm)			No. of branches plant <sup>-1</sup>	Days to 50% flowering (days)
				30 DAT	60 DAT	90 DAT		
1	LR-1	89.19	993.57	29.02	44.34	63.02	16.01	91.58
2	LR-2	60.96	291.38	18.99	30.40	46.07	8.03	105.21
3	LR-3	64.18	343.36	20.27	32.35	48.23	9.77	109.63
4	LR-4	67.29	398.35	25.34	39.50	56.76	11.57	102.84
5	LR-5	70.47	473.55	21.61	34.24	50.37	8.89	98.66
6	LR-6	80.48	592.33	26.57	41.23	58.89	15.13	107.49
7	LR-7	77.51	748.74	24.18	37.82	54.64	13.34	96.40
8	LR-8	83.59	879.36	27.75	42.71	60.96	14.25	93.92
9	LR-9	73.98	656.94	22.87	36.07	52.53	12.46	100.85
10	LR-10	86.44	699.29	17.32	28.32	43.98	10.66	88.84
General mean		75.40	608.10	23.39	36.69	53.54	12.01	99.64
S.Ed.		1.23	19.80	0.43	0.62	0.97	0.40	0.89
CD ( <i>P</i> = .05)		2.59	41.60	0.91	1.31	2.04	0.84	1.87

In the present study, the germination percentage ranged from 60.96 to 89.19% with a general mean of 75.40%. The highest germination percentage (89.29%) was recorded in landrace LR-1, while the lowest was recorded in LR-2 (60.92%). The differential response of these seedlot to germination percentage might be due to the variable genetic makeup of the landraces. The results also correlate with the findings of Kumar *et al.* (2018) and Hameedi *et al.* (2023).

These seedling vigour index is helpful in monitoring and ensuring the survival and growth of seedlings after germination. The maximum seedling vigour index was exhibited in the landrace LR-1 (993.57), while the minimum value was recorded in LR-2 (291.38). These seedling root and shoot lengths, influence these seedling characters that can be attributed to the inh

erent genotypic capacity and differential response for seedling vigour indices. These results were in conformity with the findings of Kumara *et al.* (2018) and Verma *et al.* (2018)

The plant height represents the extension of primary growth and is a good predictor of growth and development. The landraces under study possessed a large amount of variability for this character. The maximum plant height was attained by LR-1 (63.02 cm) and minimum height was attained by LR-10 (43.98 cm). This variation in plant height might be due to specific genetic makeup, inherent properties, hormonal factor, vigour of the crop and nutrient utilization. These results are in accordance with the finding of Satam *et al.* (2020), Molonaro *et al.* (2022) and Arain and Sial (2022).

Number of branches ranged from 8.03 to 16.01 with an average mean of 12.01. The maximum number of branches was observed in LR-1 (16.01) and minimum number of branches was observed in LR-2 (8.03). The greater number of branches in LR-1 can be justified by the proper recommended dose of NPK which might have helped the plant to have a good vegetative growth. These findings are in close conformity with the results reported by Nivedha *et al.* (2019), Awasthi *et al.* (2021) and Indrabi *et al.* (2022).

Day to 50 percent plant flowering indicates the earliness of crop which differed significantly. Earliest 50% flowering was recorded in LR-10 (88.84 days) and delayed 50% flowering was recorded in LR-3 (109.63 days). Early and late flowering may be attributed purely to genetic variation of landrace and less influence of environment and soil type. Similar results were also reported by Dhuma *et al.* (2020) and Molonaro *et al.* (2022).

**Table 3. Mean performance among the landraces of bird's eye chilli (*C. frutescens* L.) for floral characters**

S.No	Identity	Anthesis					Anther dehiscence					Pollen viability (%)
		5hrs	6hrs	7hrs	8hrs	9hrs	6hrs	7hrs	8hrs	9hrs	10hrs	
1	LR-1	15.19	50.89	52.97	26.18	14.12	1.27	6.71	25.63	49.65	46.72	78.76
2	LR-2	7.11	25.44	26.51	16.38	6.18	0.00	0.04	4.38	30.47	17.32	60.41
3	LR-3	6.54	27.26	29.62	12.65	4.60	0.00	1.15	6.03	25.99	22.53	67.23
4	LR-4	8.36	35.31	38.16	23.74	3.21	0.00	1.27	5.95	29.83	33.59	62.77
5	LR-5	7.73	37.03	37.58	17.00	5.54	0.00	3.69	8.17	34.36	26.47	69.62
6	LR-6	11.28	41.63	43.79	18.93	3.92	0.00	2.00	8.54	43.48	37.28	83.59
7	LR-7	10.94	44.18	46.83	14.48	4.76	0.00	4.32	14.59	38.70	28.14	65.00
8	LR-8	13.45	47.75	48.34	21.27	2.19	0.52	5.83	21.54	47.31	43.10	81.23
9	LR-9	9.00	33.80	35.27	15.31	2.01	0.00	3.01	11.33	32.18	35.37	74.98
10	LR-10	9.87	39.52	39.98	22.49	1.15	0.00	2.76	16.82	40.24	39.81	72.28
General mean		9.95	38.29	39.90	18.84	4.78	0.17	3.08	12.28	37.22	33.03	71.58
S.Ed.		0.38	1.02	1.25	0.72	0.28	0.02	0.14	0.52	0.99	1.91	1.03
CD ( $P= .05$ )		0.813	2.14	2.64	1.51	0.60	0.03	0.29	1.09	2.10	0.91	2.17

According to the observations carried out, the highest number of flowers in anthesis and anther dehiscence were registered at 7:00 a.m. and 9:00 a.m. in LR-1 respectively. The anther dehiscence is an important step in pollination, which started at 6:00 a.m. in two landraces viz., LR-1 and LR-8. However, the peak period for the dehiscence was from 9:00 to 10:00 a.m., which indicated the need for the fresh pollen to be collected. The results are consistent with the findings of Dhalla *et al.* (2011) and Vinodhini *et al.* (2019).

Pollen viability is one of the important characters in the cultivated plants. In the present investigation, the pollen viability ranged from 60.41 to 83.59% with a general mean of 71.58%. The highest and lowest pollen viability was recorded in the landrace LR-6 (83.59%) and LR-2 (60.41%) respectively. This was in support with the findings of Vinothini *et al.* (2019) and Hazarika *et al.* (2023).

**Table 4. Mean performance among the landraces of bird's eye chilli (*C. frutescens* L.) for yield characters**

S.No	Identity	No. of flowers plant <sup>-1</sup>	No. of fruits plant <sup>-1</sup>	Fruit set percentage (%)	Fruit length (cm)	Fruit girth (cm)	Average fruit weight (g)	No. of seeds fruit <sup>-1</sup>	Fruit yield plant <sup>-1</sup> (g)
1	LR-1	74.86	53.64	71.65	4.83	2.35	3.16	20.40	303.13
2	LR-2	56.47	27.19	48.14	3.31	1.58	1.05	10.98	217.04
3	LR-3	54.12	24.34	44.97	2.49	1.32	1.64	9.56	249.62
4	LR-4	61.08	31.01	50.76	4.10	1.95	2.55	15.61	204.55
5	LR-5	58.75	33.48	56.98	2.22	1.20	1.33	12.47	232.73
6	LR-6	70.27	44.84	63.81	3.79	1.73	2.24	18.78	185.90
7	LR-7	67.98	36.11	53.11	4.42	2.08	2.87	17.14	177.34
8	LR-8	72.58	50.04	68.94	5.16	2.57	3.46	22.09	294.18
9	LR-9	63.37	41.99	66.26	2.87	1.44	1.93	13.98	196.46
10	LR-10	65.66	38.95	59.32	5.54	2.69	3.75	23.77	261.28
General mean		64.51	38.15	58.39	3.87	1.89	2.39	16.47	232.22
S.Ed.		1.09	1.02	1.11	0.11	0.05	0.13	0.66	3.58
CD (P= .05)		2.07	2.16	2.34	0.24	0.11	0.27	1.39	7.53

Number of flowers plant<sup>-1</sup> is the most vital character, as ultimately it is the flower which bears the fruit that leads to yield. This character showed considerable variation from 54.12 to 74.86. with an overall mean of 64.51. The maximum number of flowers was observed for LR -1 (74.86) and minimum number of flowers was found in LR-3 (54.12). These results are consistent with the findings of Parulekar *et al.* (2020), Jayanthi *et al.* (2023) and Meghana *et al.* (2023).

Number of fruit plant<sup>-1</sup> ranged 24.34 to 53.64 with an overall mean of 38.15. LR-1 recorded the maximum (53.64) and LR-3 recorded the minimum (24.34) number of fruits plant<sup>-1</sup>. The higher number of fruits plant<sup>-1</sup> in the landrace LR-1 can be justified by its higher assimilatory surface area due to the maximum plant height and a greater number of primary branches which in turn altered the canopy. Similar findings were also reported by Purad *et al.* (2019), Lakshmidamma *et al.* (2021) and Molonaro *et al.* (2022).

The percentage of fruit set varied significantly from 44.97 to 71.65%, with the highest being recorded in the landrace LR-1 (71.65%) and lowest in LR-3 (44.97%). The higher fruit set in LR-1 may be due to more convenient condition for pollination, higher rate of anther dehiscence and higher pollen viability. These results are in conformity with the findings of Pujar *et al.* (2017) and Dhaliwal *et al.* (2020).

The length and girth of fruit is one of the major factors for deciding the yield of the crop. The maximum value for fruit length was recorded for LR-10 (5.54 cm) and minimum value in LR-5 (2.22 cm), while the maximum value for fruit girth was registered in LR-10 (2.69 cm) and minimum value in LR-5 (1.20). This variation is closely correlated with the quantity of nutrients consumed and the plant's vegetative state. These outcomes are consistent with those of Katheek *et al.* (2018) and Jeevitha *et al.* (2021) who noted variance in fruit length among several cultivars in their studies.

The genotypes under study possessed a large amount of variability for average fruit weight. Average fruit weight of landraces ranged from 1.05 to 3.75 g with an average of 2.39 g. The maximum value was recorded for LR-10 (3.75 g) and minimum value was recorded in LR-2 (1.05 g). The landrace LR-10 recorded the highest average fruit weight that might have been contributed by the flesh thickness. These results align with those reported by Awasthi *et al.* (2021), Arain and Sial (2022) and Sharath *et al.* (2023).

Number of seeds fruit<sup>-1</sup> exhibited significant variation ranging from 9.56 to 23.77 with a general mean of 16.47. The maximum number of seeds fruit<sup>-1</sup> was recorded in LR-10 (23.77) and the minimum value was recorded in LR-3 (9.56). The result was most likely due to the variation of genetic materials in chilli. These findings are in close conformity with the results reported by Pawar *et al.* (2022) and Aimole *et al.* (2023).

Fruit yield plant<sup>-1</sup> ranged from 177.34 to 303.13 g with a general mean of 232.22 g. The maximum yield plant<sup>-1</sup> was observed in LR-1 (303.13 g) and the lowest yield was found in LR-7 (177.34 g). The maximum fruit yield may be due to the higher number of fruits as well as greater canopy size which is associated with more number of branches. The similar results were also reported by Vaishnavi *et al.* (2017) and Santhosha *et al.* (2020).

**Table 5. Mean performance among the landraces of bird's eye chilli (*C. frutescens* L.) for quality characters**

S.No	Identity	Ascorbic acid content (mg 100g <sup>-1</sup> )	Capsaicin content (%)
1	LR-1	119.93	1.35
2	LR-2	95.45	0.63
3	LR-3	108.01	0.75
4	LR-4	114.15	0.93
5	LR-5	90.06	1.01
6	LR-6	135.76	1.10
7	LR-7	130.60	1.18
8	LR-8	141.08	1.43
9	LR-9	125.17	0.87
10	LR-10	102.21	1.26
General mean		116.24	1.04
S.Ed.		2.37	0.03
CD ( <i>P</i> = .05)		4.97	0.07

The nutritive value of chilli is largely determined by the content of ascorbic acid. Ascorbic acid content ranged from 90.06 to 141.08 mg 100g<sup>-1</sup> with an average mean of 116.24 mg 100g<sup>-1</sup>. The maximum ascorbic acid content was recorded in LR-8 (141.08 mg 100g<sup>-1</sup>) and LR-5 showed minimum ascorbic acid content (90.06 mg 100g<sup>-1</sup>). Also, capsaicin, the pungent principle of chilli, was found to vary from 0.63 to 1.43%, with the highest being recorded in LR-8 (1.43%) and lowest in LR-2 (0.63%). This difference in ascorbic acid and capsaicin content might be attributed to the fruit size and genetic makeup. These similar results were also reported by Kopta *et al.* (2020) and Phairon *et al.* (2020).

## Conclusion

In this study, overall performance of the ten landraces revealed that there exist a wider range of variability for most of the characters. However, landraces LR-1 and LR-10 exhibited superior performance with respect to growth and yield attributes. Thus, these landraces can be either

directly used for commercial cultivation or utilized in further improvement.

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