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Nagma
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Jitendra Trivedi
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Dhananjay Sharma
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Shaurya Parganiha
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Tulsi Dansena
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Corresponding Author:
Nagma
Department of Vegetable Science,
Faculty of Horticulture, College of
Agriculture, Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Evaluation of F₁ chilli hybrids (*Capsicum annuum* L.) for fruit yield and quality parameter under Chhattisgarh plain

Nagma, Jitendra Trivedi, Dhananjay Sharma, Shaurya Parganiha and Tulsi Dansena

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Abstract

The present study evaluated the performance of 23 chilli genotypes at Horticultural Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh. The genotypes included hybrids developed in 2022, 2021 and 2023. The experiment was laid out in a randomized block design with three replications. Plots of size 3.6m x 3m were maintained with a spacing of 60 cm x 50 cm. Observations were recorded on growth, yield and quality traits from five randomly selected plants in each plot. The genotype 2021/CHIHBY-7 demonstrated superior performance in traits such as fruit girth, fruit weight, dry weight of fruit, fruit weight per plant, and fruit yield per plot and hectare, making it the top-performing genotype overall. However, for early flowering traits like days to first flowering and 50% flowering, genotypes 2023/CHIHBY-4 and 2023/CHIHBY-1 exhibited earlier flowering.

Keywords: Chilli, *Capsicum annuum*, genotype evaluation, agro-morphological characters, earliness, promising genotypes, varietal development, genetic variability, breeding

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important vegetable cum spice crops belonging to the family Solanaceae with chromosome number 2n=24. Chilli originated from Tropical America, where it was domesticated around 5000 BC. Chilli has attained a status of high value crop in India and occupies a unique place among vegetables in Indian cuisine because of its delicate taste and pleasant flavor coupled with rich content of ascorbic acid and other vitamins and minerals. Chilli is grown for export as well as for domestic market. Chilli contributes about 33% of total spice export from India and share about 16% of the world trade.

There are more than 400 different varieties of chillies found all over the world. The genus *Capsicum* has five domesticated species namely *C. annuum*, *C. frutescens*, *C. chinense*, *C. pubescens*, *C. baccatum*, of which *C. annuum* is the most widely cultivated species over worldwide. Pepper was introduced into Europe by Columbus and other early new explorers in the sixteenth century and cultivation spread throughout the world. The world's hottest chilli "Naga Jolokia / Bhoot Jolokia" is cultivated in hilly terrain of Assam in a small town Tezpur, India. Different varieties are grown for vegetables, spices, condiments, sauces and pickles (<https://agmarknet.gov.in>). Chilli is a branched herbaceous annuals or perennials. They are predominately single flower & off-white in colour. The fruit are berries that may be green, yellow, orange or red when ripe.

Materials and Methods

The field experiment was conducted during the *rabi* season of 2023 at the Horticultural Research cum instructional farm, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experiment was laid out in a Randomized Block Design (RBD) with three replications. The plot size was 3.6 m x 3 m with row and plant spacing of 60 cm and 50 cm respectively. Seeds were sown on second week of September 2023 in a nursery. Twenty-five days old seedlings were transplanted on second week October of 2023 with

recommended package of practices. Observations were recorded on five competitive plants from each plot for various traits and mean values were calculated.

Plant height was measured from the ground to the topmost leaf, expressed in centimeters. Plant girth was recorded from five randomly selected plants per genotype, measuring at the stem's center. The number of primary branches emerging from the main stem and secondary branches on those primaries were counted. Days to flowering were tracked from transplanting to the first flower and separately when 50% of the plants bloomed. Days to the first and last fruit picking were noted, recording marketable green fruits along with the total number of pickings were calculated. Fruit length and girth were measured from five randomly selected fruits per genotype. The average fruit weight and the number of fruits per plant were recorded from selected plants, and dry fruit weight was calculated similarly. Fruit yield per plot was recorded, with the total yield worked out in kilograms per hectare based on cumulative pickings using a specified formula.

Results and Discussion

The study collected data on fruit yield and contributing traits from a randomized sample of plants for each chili genotype. The randomized sampling and replication-wise averaging approach enabled reliable estimation of genotype performance for yield and associated attributes. The mean performance of fruit yield and its contributing characters and 18 quantitative parameters are presented in Table 1 and Table 2.

Significantly wide range of plant height (cm) was observed from 49.88 cm (2022/CHIHBY-1) to 76.61 cm (2021/CHIHBY-6) with the mean of 57.73 cm. The genotype (2021/CHIHBY-6) recorded the highest plant height of 76.61 cm, which was followed by with the genotype (2021/CHIHBY-1) (68.14 cm), (2021/CHIHBY-2) (66.38 cm) and (2021/CHIHBY-7) (65.68 cm), (2023/CHIHBY-2) (65.48 cm). The lowest plant height was observed in genotype (2022/CHIHBY-3) (51.48 cm) and (2023/CHIHBY-1) (51.78 cm).

Plant girth (cm) recorded from 2.65 cm (2023/CHIHBY-1) to 4.87 cm (2021/CHIHBY-3) with the mean of 3.99 cm. The genotype (2021/CHIHBY-3) recorded the highest plant girth of 4.87 cm, which was at par with the genotype (2021/CHIHBY-5) 4.83 cm), (2023/CHIHBY-6) (4.77 cm) (2021/CHIHBY-7), (4.73 cm), (2023/CHIHBY-2) (65.48 cm) and (2022/CHIHBY-5) (4.68 cm). The lowest plant girth (cm) was observed in genotype (2022/CHIHBY-4) (2.84 cm) and (2023/CHIHBY-1) (2.65 cm).

Number of primary branches recorded from 5.53 (2022/CHIHBY-2) to 8.17 (2021/CHIHBY-1) with the mean of 7.08. The genotype (2021/CHIHBY-1) observed the maximum number of primary branches of 8.17, which was at par with the genotype (2021/CHIHBY-8) (8.10), (2023/CHIHBY-5) (8.00), (2021/CHIHBY-2) (8.00) and (2023/CHIHBY-7) (7.90). The minimum number of primary branches was observed in genotype (2022/CHIHBY-3) (5.77) and (2022/CHIHBY-2) (5.53).

Number of secondary branches varied from 11.25 (2022/CHIHBY-1) to 15.68 (2023/CHIHBY-8) with the mean of 13.82. The genotype (2023/CHIHBY-8) noted the maximum number of secondary branches of 15.68, which was at par with the genotype (2021/CHIHBY-8) (15.48), (2022/CHIHBY-7) (14.91), (2022/CHIHBY-4) (14.71) and (2023/CHIHBY-2) (14.61). The minimum number of secondary branches was observed in genotype (2022/CHIHBY-1) (11.25) and (2023/CHIHBY-5) (12.75).

Days to first flowering was range from 26.25 (2023/CHIHBY-4) to 33.59 (2022/CHIHBY-2) with the mean of 29.50. The genotype (2023/CHIHBY-4) recorded the early days to first flowering of 26.25 days, which was at par with the genotype (2023/CHIHBY-4) (26.25), (2021/CHIHBY-2) (27.59) and (2023/CHIHBY-6) (27.59). The late days to first flowering was observed in genotype (2022/CHIHBY-2) (33.59) and (2021/CHIHBY-6) (32.59).

Days to 50 percent flowering was range from 37.60 (2023/CHIHBY-1) to 45.26 (2022/CHIHBY-2) with the mean of 29.50. The genotype (2023/CHIHBY-1) recorded the minimum days to 50 percent flowering of 37.60 day after transplanting, which was at par with the genotype (2023/CHIHBY-4) (37.61), (2021/CHIHBY-8) (39.92) and (2023/CHIHBY-3) (39.93). The maximum days to 50 percent flowering was observed in genotype (2022/CHIHBY-2) (45.26).

Days to first picking was range from 49.43 (2021/CHIHBY-5) to 62.01 (2023/CHIHBY-1) with the mean of 41.74. The genotype (2021/CHIHBY-5) observed the minimum days to first picking of 49.43 days, which was at par with the genotype (2021/CHIHBY-1) (51.62), (2021/CHIHBY-4) (52.69) and (2021/CHIHBY-8) (52.73). The maximum days to first picking was observed in genotype (2021/CHIHBY-5) (62.01).

Days to last picking was range from 154.97 (2022/CHIHBY-2) to 193.05 (2021/CHIHBY-4) with the mean of 170.82. The genotype (2021/CHIHBY-5) recorded the minimum days to last picking of 154.97 days to transplanting, which was at par with the genotype (2023/CHIHBY-4) (160.55). The maximum days to last picking was observed in genotype (2021/CHIHBY-5) (193.05).

Total picking was range from 13.99 (2022/CHIHBY-2) to 20.05 (2021/CHIHBY-4) with the mean of 16.44. The genotype (2021/CHIHBY-4) recorded the maximum total picking of 20.05, which was at par with the genotype (2023/CHIHBY-5) (18.59), (2023/CHIHBY-2) (17.64) and (2022/CHIHBY-1) (17.42). The minimum total picking was observed in genotype (2022/CHIHBY-2) (13.99).

Fruit length (cm) was range from 6.51 cm (2022/CHIHBY-1) to 12.41 cm (2023/CHIHBY-4) with the mean of 8.92 cm. The genotype (2023/CHIHBY-4) recorded the maximum fruit length (cm) of 12.41, which was followed by the genotype (2020/CHIHBY-7) (11.04), (2021/CHIHBY-1) (10.41) and (2021/CHIHBY-2) (10.31). The minimum fruit length (cm) was observed in genotype (2022/CHIHBY-1) (6.51 cm).

Fruit girth (cm) was range from 2.83 cm (2020/CHIHBY-1) to 6.26 cm (2021/CHIHBY-5) with the mean of 8.92 cm. The genotype (2021/CHIHBY-5) recorded the maximum fruit girth (cm) of 6.26, which was at par with the genotype (2021/CHIHBY-7) (5.96) and (2020/CHIHBY-6) (5.93). The minimum fruit girth (cm) was observed in genotype (2020/CHIHBY-1) (2.83 cm).

Fruit weight (g) was range from 2.77 g (2022/CHIHBY-4) to 7.01 g (2020/CHIHBY-3) with the mean of 4.62 g. The genotype (2021/CHIHBY-5) observed the maximum fruit weight (g) of 7.01 g, which was at par with the genotype (2021/CHIHBY-7) (6.57 g). The minimum fruit weight (g) was observed in genotype (2020/CHIHBY-1) (2.77 g).

Number of fruits per plant was range from 73.89 (2020/CHIHBY-1) to 257.59 (2021/CHIHBY-5) with the mean of 155.04. The genotype (2021/CHIHBY-5) noted the maximum number of fruits per plant of 257.59, which was at par with the genotype (2020/CHIHBY-6) (255.19) and (2020/CHIHBY-3) (233.19). The minimum number of fruits per plant was observed in genotype (2020/CHIHBY-1) (73.89).

Dry weight of fruit (g) was range from 0.30 (2022/CHIHBY-1) to 1.22 (2021/CHIHBY-7) with the mean of 0.63. The genotype (2021/CHIHBY-7) observed the maximum dry weight of fruit (g) of 1.22, which was at par with the genotype (2021/CHIHBY-1) (1.19). The minimum dry weight of fruit (g) was observed in genotype (2022/CHIHBY-1) (0.30).

Average fruit weight (g) was range from 0.68 (2020/CHIHBY-6) to 3.16 (2020/CHIHBY-1) with the mean of 1.97. The genotype (2020/CHIHBY-1) observed the maximum average fruit weight (g) of 3.16, which was at par with the genotype (2021/CHIHBY-8) (2.89), (2021/CHIHBY-2) (2.86) and (2021/CHIHBY-1) (2.58). The minimum average fruit weight (g) was observed in genotype (2020/CHIHBY-6) (0.68).

Fruit weight per plant (g) range was from 173.29 (2020/CHIHBY-6) to 391.69 gram (2021/CHIHBY-7) with the mean of 274.66. The genotype (2021/CHIHBY-7) noted the maximum average fruit weight (g) of 391.69, which was at par with the genotype (2021/CHIHBY-5) (372.66), (2022/CHIHBY-6) (368.37) and (2021/CHIHBY-6) (358.95). The minimum average fruit weight (g) was observed in genotype (2020/CHIHBY-6) (173.29).

Fruit yield per plot (kg) was range from 6.23 (2020/CHIHBY-6) to 14.09 (2021/CHIHBY-7) with the mean of 9.88. The genotype (2021/CHIHBY-7) observed the maximum fruit yield per plot (kg) of 391.69, which was at par with the genotype (2021/CHIHBY-5) (13.40), (2022/CHIHBY-6) (13.25) and (2021/CHIHBY-6) (12.91). The minimum fruit yield per plot (kg) was observed in genotype (2020/CHIHBY-6) (173.29).

Fruit yield per hectare (q/ha) was range from 57.76 (2020/CHIHBY-6) to 130.56 (2021/CHIHBY-7) with the mean of 91.55. The genotype (2021/CHIHBY-7) recorded the maximum fruit yield per hectare (q/ha) of 130.56, which was at par with the genotype (2021/CHIHBY-5) (124.22), (2022/CHIHBY-6) (122.79) and (2021/CHIHBY-6) (119.65).

The minimum fruit yield per hectare (q/ha) was observed in genotype (2020/CHIHBY-6) (57.76).

The results for the mean performance of 18 quantitative parameters across 18 chili genotypes showed wide variations among the genotypes. Most traits, including plant height, number of primary and secondary branches, fruit length and girth, number of fruits per plant, fruit weight, dry weight, average fruit weight, fruit weight per plant, fruit yield per plot and hectare exhibited significant differences among the genotypes. Specifically, the genotype 2021/CHIHBY-7 performed best for fruit girth, fruit weight, dry weight of fruit, fruit weight per plant, fruit yield per plot and hectare, indicating its overall superior performance compared to other genotypes. However, for traits like days to first flowering and 50% flowering, some other genotypes like 2023/CHIHBY-4 and 2023/CHIHBY-1 showed early flowering. The varying performance of genotypes for different traits suggests opportunities for selection and use of best genotypes with desirable agronomic and yield contributing traits in chili breeding programs.

These findings are in close proximity with the results of Parulekar *et al.* (2020) ^[17] for plant height, Molonaro *et al.* (2022) ^[13] for plant girth, Tirupathamma *et al.* (2021) for number of primary branches, for number of secondary branches, Vidya *et al.* (2018) ^[25] for days to first flowering, Chavan *et al.* (2021) for days to 50% flowering, Jogi *et al.* (2015) ^[9] for days to first picking, Nagargoje *et al.* (2023) ^[14] for days to last picking, Vidya *et al.* (2018) ^[25] for total picking, Negi and Sharma (2019) ^[15] for fruit length, Shrestha *et al.* (2010) ^[20] for fruit girth, Bharadwaza *et al.* (2018) ^[3] for no. of fruits per plant, Chattopadhyay *et al.* (2011) ^[5] for dry weight of fruit, Singh *et al.* (2024c) ^[22] for average fruit weight, Rosmania *et al.* (2016) for fruit weight per plant, Kumari *et al.* (2017) ^[11] for fruit yield per plot (kg), Kumar *et al.* (2020) ^[10] for fruit yield per hectare.

Table 1: Mean performance of fruit yield and yield attributing traits in chilli.

Tr. no	Genotypes	Plant height (cm)	Plant girth (cm)	No. of primary branches	No. of secondary branches	Days to first flowering	Days to 50% flowering	Days to first picking	Days to last picking	Total picking
T ₁	2022/CHIHBY-1	49.88	3.29	6.30	11.25	31.25	44.92	59.84	181.78	17.42
T ₂	2022/CHIHBY-2	54.18	2.93	5.53	14.58	33.59	45.26	57.07	154.97	13.99
T ₃	2022/CHIHBY-3	51.48	3.13	5.77	14.15	30.25	43.60	60.40	169.23	15.55
T ₄	2022/CHIHBY-4	54.71	2.84	7.27	14.71	30.25	43.92	55.48	172.23	16.68
T ₅	2022/CHIHBY-5	54.64	4.68	6.60	13.95	30.25	42.92	60.41	181.74	17.33
T ₆	2022/CHIHBY-6	52.24	3.62	6.20	13.08	30.25	42.93	53.77	170.16	16.63
T ₇	2022/CHIHBY-7	53.94	3.78	7.70	14.91	31.93	44.59	57.10	174.29	16.74
T ₈	2021/CHIHBY-1	68.14	4.52	8.17	13.31	28.92	40.94	51.62	164.45	16.12
T ₉	2021/CHIHBY-2	66.38	3.94	8.00	13.91	27.59	39.59	54.90	167.25	16.05
T ₁₀	2021/CHIHBY-3	57.48	4.87	7.13	12.81	31.25	42.58	55.44	164.38	15.56
T ₁₁	2021/CHIHBY-4	54.71	4.61	6.37	14.48	29.93	42.59	52.69	193.05	20.05
T ₁₂	2021/CHIHBY-5	57.64	4.83	7.00	12.88	29.25	41.60	49.43	179.57	18.59
T ₁₃	2021/CHIHBY-6	76.61	3.98	6.87	13.25	32.59	44.93	53.58	174.36	17.25
T ₁₄	2021/CHIHBY-7	65.68	4.73	7.53	14.55	30.93	43.26	54.92	163.37	15.49
T ₁₅	2021/CHIHBY-8	63.71	4.34	8.10	15.48	28.93	39.92	52.73	172.25	17.07
T ₁₆	2023/CHIHBY-1	51.78	2.65	6.63	14.25	26.25	37.60	62.01	173.20	15.88
T ₁₇	2023/CHIHBY-2	65.48	4.09	7.07	14.61	27.93	39.94	57.12	180.60	17.64
T ₁₈	2023/CHIHBY-3	53.58	3.83	7.37	13.31	27.59	39.93	55.96	167.32	15.91
T ₁₉	2023/CHIHBY-4	58.71	4.21	6.80	13.68	26.25	37.61	55.98	160.55	14.94
T ₂₀	2023/CHIHBY-5	52.34	4.14	8.00	12.75	27.93	39.95	55.97	166.19	15.74
T ₂₁	2023/CHIHBY-6	57.11	4.77	7.73	13.61	27.59	40.27	52.15	162.45	15.76
T ₂₂	2023/CHIHBY-7	52.54	4.46	7.90	12.75	28.59	39.94	56.05	167.26	15.89
T ₂₃	2023/CHIHBY-8	54.84	3.53	6.77	15.68	29.25	41.27	55.99	168.27	16.04
Sem (±)		2.10	0.15	0.40	0.49	1.012	1.34	1.88	6.30	0.92
CD (5%)		5.99	0.43	1.14	1.39	2.88	3.83	5.38	17.96	2.64
CV (%)		6.31	6.59	9.79	6.11	5.94	5.58	5.87	6.39	9.76

Table 2: Mean performance of fruit yield and yield attributing traits in chilli.

Tr. no	Genotypes	Fruit length (cm)	Fruit girth (cm)	Fruit weight (g)	No. of fruits per plant	Dry weight of fruit (g)	Average Fruit Weight (g)	Fruit weight per plant (g)	Fruit yield per plot (kg)	Fruit yield per hectare (q/ha)
T ₁	2022/CHIHBY-1	6.51	3.06	3.61	146.69	0.30	2.52	357.25	12.85	119.08
T ₂	2022/CHIHBY-2	6.71	3.96	4.64	113.49	0.38	2.16	245.23	8.82	81.74
T ₃	2022/CHIHBY-3	8.21	3.60	4.54	101.69	0.39	1.98	199.34	7.17	66.45
T ₄	2022/CHIHBY-4	8.27	3.46	2.77	127.89	0.42	1.86	234.46	8.43	78.15
T ₅	2022/CHIHBY-5	8.37	5.20	6.41	227.69	0.47	1.34	303.95	10.93	101.32
T ₆	2022/CHIHBY-6	8.67	3.70	3.87	163.89	0.49	2.34	368.37	13.25	122.79
T ₇	2022/CHIHBY-7	8.17	3.46	3.14	104.49	0.58	2.77	287.40	10.34	95.80
T ₈	2021/CHIHBY-1	10.41	4.56	6.17	107.99	1.19	2.58	277.86	9.99	92.62
T ₉	2021/CHIHBY-2	10.31	3.46	3.61	113.09	0.79	2.86	322.91	11.61	107.63
T ₁₀	2021/CHIHBY-3	9.41	5.10	6.11	154.49	1.02	1.90	293.93	10.57	97.98
T ₁₁	2021/CHIHBY-4	9.41	4.53	4.07	210.19	0.63	1.47	306.65	11.03	102.21
T ₁₂	2021/CHIHBY-5	8.64	6.26	5.67	257.59	0.54	1.45	372.66	13.40	124.22
T ₁₃	2021/CHIHBY-6	9.44	3.33	3.27	166.09	0.50	2.20	358.95	12.91	119.65
T ₁₄	2021/CHIHBY-7	10.17	5.96	5.51	166.79	1.22	2.37	391.69	14.09	130.56
T ₁₅	2021/CHIHBY-8	8.71	4.36	4.57	104.59	1.08	2.89	298.53	10.74	99.51
T ₁₆	2023/CHIHBY-1	7.44	2.83	3.34	73.89	0.47	3.16	224.40	8.07	74.80
T ₁₇	2023/CHIHBY-2	9.21	4.10	5.27	128.09	0.78	1.83	233.13	8.38	77.71
T ₁₈	2023/CHIHBY-3	9.27	4.20	7.01	233.19	0.46	0.95	221.50	7.97	73.83
T ₁₉	2023/CHIHBY-4	12.41	3.90	4.11	213.49	0.66	0.86	181.50	6.53	60.50
T ₂₀	2023/CHIHBY-5	8.24	3.93	4.01	149.09	0.49	1.50	218.62	7.86	72.87
T ₂₁	2023/CHIHBY-6	7.31	5.93	3.57	255.19	0.42	0.68	173.29	6.23	57.76
T ₂₂	2023/CHIHBY-7	11.04	4.26	6.57	129.09	0.77	1.99	255.64	9.19	85.21
T ₂₃	2023/CHIHBY-8	8.81	3.86	4.47	117.29	0.44	1.65	190.03	6.83	63.34
Sem (±)		2.10	0.19	0.19	9.328	0.023	0.240	19.715	0.709	6.572
CD (5%)		5.99	0.53	0.54	26.59	0.07	0.69	56.19	2.02	18.73
CV (%)		6.31	7.67	7.12	10.42	6.32	11.15	12.43	12.43	12.43

Conclusion

The study evaluated 23 chilli genotypes and identified five top performing hybrids with superior yield and other agronomic traits. Genotype evaluation revealed significant genetic variability among the genotypes for all studied parameters. The superior performance of genotype 2021/CHIHBY-7 across multiple traits, including fruit girth, fruit weight, dry weight of fruit, fruit weight per plant, and overall fruit yield, marks it as the most promising genotype in this study. It consistently outperformed other genotypes, particularly in key yield-contributing parameters, demonstrating its potential for use in chili breeding programs aimed at improving fruit yield and quality. However, early flowering traits such as days to first flowering and 50% flowering were more prominent in genotypes 2023/CHIHBY-4 and 2023/CHIHBY-1, indicating that these genotypes may be more suited for breeding programs focused on early maturation.

Suggestions for Future Research Work

1. **Select High-Yielding Genotypes:** Breeding programs should focus on genotypes like 2021/CHIHBY-7, which showed excellent fruit yield and quality. Using this genotype in hybrid development can improve productivity and fruit characteristics.
2. **Develop Early Flowering Varieties:** Genotypes such as 2023/CHIHBY-4 and 2023/CHIHBY-1, which flower earlier, can be valuable for regions with shorter growing seasons, helping farmers maximize yield in less time.
3. **Study Genotype-Environment Interaction:** Further research on how different genotypes perform under various environmental conditions can help optimize growing practices and improve yield consistency across diverse regions.

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