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Evaluation of chilli genotypes for yield, quality traits and tolerance to thrips in Western Ghats agro-climatic region

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Abstract
Twenty-three chilli genotypes were evaluated during rabi season of year 2022-23 in a Randomized Block Design for yield traits and tolerance to thrips. The chilli accessions differed significantly for all the traits evaluated. The lowest thrips population recorded in the genotypes Seln-BBL and Seln-14 throughout the cropping period, whereas Percent leaf curl index was lowest in Seln-BLG-1(15%) and Seln-BBL-1 (18%) while the susceptible lines showed 100% leaf curling. Maximum number of fruits per plant were recorded in Seln-BBL-1(252.82) followed by Seln-14 (205.91). However, maximum yield/plant (556.57 g) and total yield (20.61 t/ha) was recorded in Seln-14 due to larger individual fruit size. It was interesting to note that yield of 20 t/ha recorded in Seln-14 was much higher the national average of 7-10 t//h. The ascorbic acid content was maximum in Seln-43 (176.67 mg/100 g) and maximum Total Soluble Solids recorded in genotype EC787067 (11.57 ^{o}Brix). The study identified the chilli lines Seln-14, Seln-BBL-1, Seln-BLG-1 and Seln-43 as the promising selections for different traits under Western Ghats agro-climatic region. Hence, they may be used in future breeding programmes.

Keywords: Chilli, yield, thrips, leaf curl index, ascorbic acid

Introduction
India is the major producer, consumer and exporter of chilli. Chilli contributes 42% of the total quantity of spice exported from the country, predominantly to countries like China, Vietnam, Thailand, Sri Lanka, Indonesia and Malaysia. Indian chillies are world-famous for qualities such as colour and pungency level. Chilli grown in about 4.18 lakh hectares in India with production of 45.05 lakh tonnes of green chillies (Anonymous, 2022) [1]. India contributes about 43% for world's chilli production. Chilli is consumed both as green fruits and as dried red fruits and is one of the major component in Indian culinary as a spice for imparting pungency as well as colouring agent in food preparation. Besides being a vital ingredient of Indian food, it occupies an important share in Indian economy. Chillies accounted for over 130 billion Indian rupees in the Indian economy in fiscal year 2020 (https://www.statista.com/statistics) [6].

In Maharashtra state chilli mainly grown in districts Dhule, Jalgaon, Pune, Satara, Nagpur, Kolhapur, Yavatmal, Aurangabad and Sangli. Climate change effect, insect pests and diseases are the major productivity limiting factors. Huge losses ranging around 50-90% incurred due to insect-pest damage and among them thrips (*Scirtothrips dorsalis* and *Thrips parvispinus*) contribution is 30-50%. These sucking pests cause serious damage to the chilli crop by direct feeding (Reddy and Reddy, 1999) [15] leading to poor crop production and economic losses to farmers. Both adult thrips and nymphs suck the sap from tender leaves and growing shoot leading to upward curling of leaves. Continuous application of chemical pesticides for controlling the pests results in pesticide resistance development in target pests. To overcome thrips menace, host plant resistance can play a key role in formulating pest management strategies. Therefore, environmental friendly solution is to develop thrips tolerant/resistant varieties/hybrids with better quantitative and qualitative attributes. The objective of this study is to evaluate chilli genotypes in Pune condition, which lies in Western Ghats agro-climatic region for excellent quality, growth, and yield and thrips tolerance.

Materials and Methods
Twenty-three chilli lines evaluated at research farm of IARI, Regional Station, Pune (18° 3' N, 73° 51'E) during 2022-2023.

The accessions EC783760, EC777201, EC787067 and IC326912 collected from NBPGR, New Delhi; Kashi Anmol from IIVR, Varanasi and Black chilli "Assam Black" collected from Assam. All other lines were the variants selected from above accessions. Seedlings of all chilli genotypes were raised in plug trays in insect proof net house and thirty-five days old seedlings were transplanted to the experimental field. The experiment was laid out in a completely randomised block design with three replication and spacing of 60*30 cm. Crop was gown in the filed by following all the recommended package of practices but without insecticide application. From each replication, ten chilli plants selected and tagged for recording population of thrips and whiteflies. The thrips population estimated by beat cup method, which involved gently beating of plants against thermocol cup and counting their numbers (Chavan *et al*. 2015) [2]. The leaves upward curling symptoms caused by thrips recorded based on visual rating scale of 0-4 at 60, days after transplantation (Kaur *et al*. 2010) [8] and the percent leaf curl index (PLI) was calculated for each accession as per the formula given by Niles (1980, Table 2) [11]. Based on the PLI, the accessions were classified into 6 categories on 0-100 scale as described by Niles (1980, Table 1) [11].

Table 1: Scales used for scoring thrips damage

Damage Score	Extent of damage
0	Healthy foliage
1	<25% foliage showing thrips curling symptoms
2	26 to 50% foliage showing thrips curling symptoms
3	50 to 75% foliage showing thrips curling symptoms
4	>75% foliage showing thrips curling symptoms

Table 2: Scales used for scoring Percent Leaf curling Index

PLI	Category
0	Highly resistant
1-10	Resistant
11-20	Moderately resistant
21-30	Moderately susceptible
31-50	Susceptible
51-100	Highly susceptible

Percent Leaf curl Index (PLI) = (Sum of scores of all plants/Total no. of plants * No. of score category)*100 (Niles, 1980) [11].

Whiteflies incidence estimated by counting number of whiteflies per leaf selected at bottom, middle and top portion of tagged plants selected randomly. Tagged plants were also used for recording observation on characters *viz*., Plant height (cm) at 90 DAT, Number of fruits/plant, yield/plant(kg), fruit yield (t/ha), Total soluble solid (°Brix) of fruits and ascorbic acid (mg/100 g) of fruit juice. Total Soluble Solids (TSS) was measured by hand-held digital refractometer and ascorbic acid content in fruits was estimated using 2, 6-dichlorophenol indophenol visual titration method (Ranganna, 2001) [14]. Data analysed statistically and parameters interpreted with help of F test and CD values.

Results and Discussion

Growth, Yield and Quality Parameters

The plant growth, yield and yield contributing characters as well as quality showed significant differences among all the genotypes (Table 3). Plant height is an important growth character in chilli, which directly influences crop yield. Seln-52 recorded maximum plant height (72.08 cm) at 90 DAPS followed by Assam Black (71.47cm) while Kashi Anmol recorded minimum height (47.33 cm). The variation in plant height of different chilli genotypes has been reported (Sreelathakumary and Rajamony 2004 [20] Dhaliwal *et al*. [3] 2015; Dhumal *et al*. 2020) [4]. The genetic potential, environmental factors, especially optimum temperature for good vegetative growth, thereby leading to differences in plant height. The highest number of fruits per plant were recorded in Seln-BBL-1(252.82) which was at par with Seln-14 (205.91) compared to check Kashi Anmol (83.09). Lowest number of fruits per plant was observed in EC777201 (19.74). The number of fruits per plant was appreciably high for certain lines and thus provides good scope for selection of these genotypes for improvement in chilli for yield characters. The variation in fruit number may be due to the difference in percentage fruit set, genetical and environmental factors. The results obtained are in accordance with Janaki *et al.* (2015) [7], Nivedha *et al*. (2019) [12] and Dhumal *et al*. (2020) [4]. The yield per plant was significantly and positively associated with both genotypic and phenotypic levels (Farhad *et al*., 2008) [5]. Maximum yield/plant and total yield was recorded in Seln-14 (556.57 g; 20.61 t/ha) followed by IC326912 (533.00 g; 19.74 t/ha) and Seln-BBL-1 (508.31 g; 18.83 t/ha). Variation in fruit yield among chilli genotypes was also reported by several studies (Smitha and Basavaraja 2006 [19]; Yatagiri *et al*. 2017 [21]; Nivedha *et al*. 2019) [12]. Ascorbic acid content also varied among chilli genotypes with was highest in genotype Seln-43 (176.67 mg/100 g) and lowest in Seln-37-2 (71.60 mg/100 g). Similar observation of variation in ascorbic acid is reported (Kumar *et al*. 2012 [10]; Kerketta *et al*. 2018) [9]. Total soluble solids (TSS) ranged between 5.03-11.57°Brix among genotypes and it was highest in genotype EC787067 (11.57 °Brix). The TSS and Ascorbic acid content likely to be associated with local conditions, genetic characters and higher nutrients utilization efficiency.

Reaction of chilli genotypes to thrips and whiteflies

Chilli genotypes assessed for thrips and whiteflies tolerance (Fig 1.). Thrips count recorded from the tagged plants at 30, 45, 60 and 90 DAT. All the genotypes of chilli showed infestation of thrips. In the first count, there was no infestation of thrips in genotypes Seln-BGR, Seln-BGL, Seln-BBL-1, Seln-BLG-1, Seln- 37-3, Seln-37-5, EC787067, Seln-43 and Seln-52-2. In Seln-BGL, Seln- 37-3 and Seln-37-5 thrips infestation was observed during 3rd and 4th count. Lowest thrips population recorded in the genotypes Seln-BBL and Seln-14 throughout the cropping period. IC326912 recorded maximum number of thrips/sample (5.8) followed by Seln-BGL (5.2). Percent leaf curl index was lowest in Seln-BLG-1(15%) and Seln-BBL-1 (18%). Out of twenty three genotypes, two were categorised as moderately resistance, two susceptible and rest are highly susceptible. Seln-BBR, Seln-BGR, Seln-BBL, Seln-BBL-1 and Seln-BLG-1 were the selections obtained from the parent Assam Black. The two selections from Assam Black namely Seln-BBL-1 and Seln-BLG-

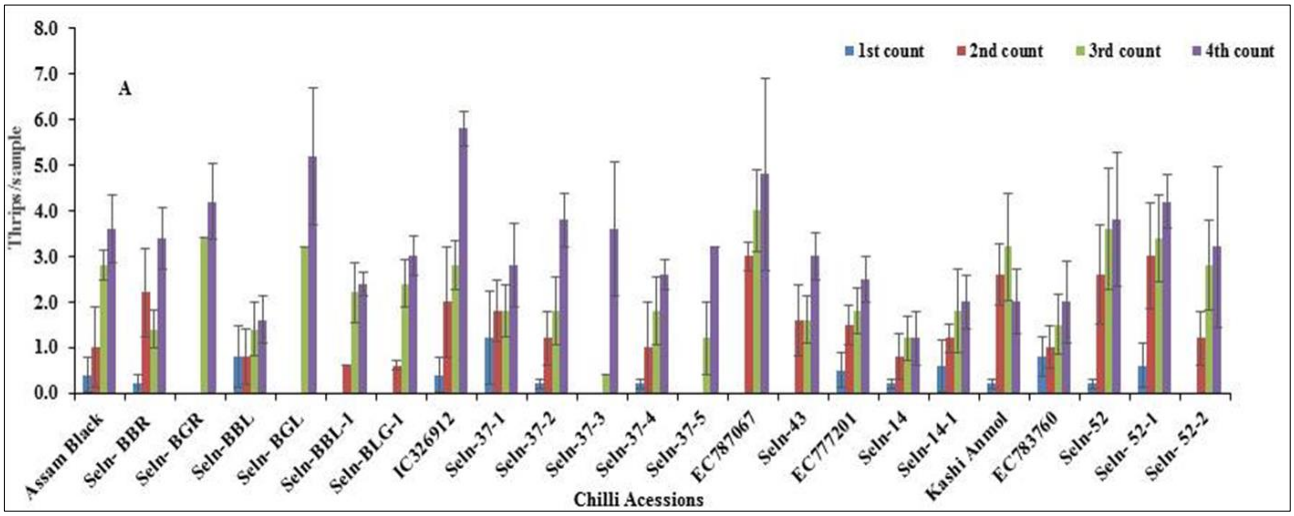
Table 3: Mean performance of chilli genotypes for different characters like growth and quality parameters.

S. No	Accessions	Plant height (cm)	No. of fruits/plant	Yield/plant (gm)	Yield (t/ha)	Vitamin C (mg/100 gm FW)	TSS (°Brix)
1.	Assam Black	71.47	50.11	85.66	3.17	79.87	6.62
2.	Seln- BBR	60.27	81.12	205.35	7.61	79.50	8.50
3.	Seln- BGR	49.67	77.58	226.14	8.38	154.00	9.00
4.	Seln-BBL	61.47	97.68	189.80	7.03	76.05	6.27
5.	Seln- BGL	61.17	142.47	333.60	12.36	104.33	8.53
6.	Seln-BBL-1	55.21	252.82	508.31	18.83	104.33	7.67
7.	Seln-BLG-1	57.67	79.93	414.03	15.34	96.28	6.63
8.	IC326912	58.87	128.55	533.00	19.74	83.74	5.87
9.	Seln-37-1	59.53	82.44	313.17	11.6	118.17	7.20
10.	Seln-37-2	51.00	104.42	230.27	8.53	71.60	7.33
11.	Seln-37-3	59.00	78.27	229.08	8.48	71.63	7.40
12.	Seln-37-4	62.60	71.29	158.56	5.87	120.68	6.37
13.	Seln-37-5	51.17	64.64	152.02	5.63	113.67	7.60
14.	EC787067	64.33	153.65	203.66	7.54	78.65	11.57
15.	Seln-43	67.00	70.69	321.02	11.89	176.67	9.03
16.	EC777201	69.00	19.74	300.68	11.14	148.59	8.77
17.	Seln-14	60.07	205.91	556.57	20.61	88.00	5.17
18.	Seln-14-1	69.07	38.05	427.03	15.82	74.03	5.53
19.	Kashi Anmol	47.33	83.09	259.55	9.61	94.267	9.53
20.	EC783760	47.98	27.75	250.38	9.27	101.15	5.03
21.	Seln-52	72.08	35.50	113.22	4.19	99.67	5.47
22.	Seln- 52-1	61.33	115.74	393.98	14.59	73.33	7.00
23.	Seln- 52-2	59.63	41.50	155.45	5.76	110.41	7.20
	CD	5.95	4.90	6.13	0.22	7.42	0.56
	CV	6.04	3.27	1.30	1.38	4.47	4.69

Table 4: Percent leaf index of different chilli lines

S. No.	Genotypes	PLI	Category	S. No.	Genotypes	PLI	Category
1.	Assam Black	100.00	HS	13.	Seln-37-5	49.00	S
2.	Seln- BBR	100.00	HS	14.	EC787067	77.78	HS
3.	Seln- BGR	57.00	HS	15.	Seln-43	63.00	HS
4.	Seln-BBL	66.67	HS	16.	EC777201	77.00	HS
5.	Seln- BGL	77.27	HS	17.	Seln-14	75.00	HS
6.	Seln-BBL-1	18.00	MR	18.	Seln-14-1	66.00	HS
7.	Seln-BLG-1	15.00	MR	19.	Kashi Anmol	78.13	HS
8.	IC326912	73.00	HS	20.	EC783760	56.00	HS
9.	Seln-37-1	91.18	HS	21.	Seln-52	63.00	HS
10.	Seln-37-2	55.56	HS	22.	Seln- 52-1	69.00	HS
11.	Seln-37-3	50.00	S	23.	Seln- 52-2	81.82	HS
12.	Seln-37-4	83.33	HS				

1were found moderately resistant as per the percent leaf index. Similar findings were reported by Singh *et al*. (1998) [18] and Samota *et al*. (2018) [17]. Whiteflies numbers recorded at 30 and 90 DAT. Most of the chilli lines showed good infested of whiteflies except Seln-37-3. Seln-37-3 is a selection from IC326912 which showed no whiteflies/leaf in all the counts while parent recorded up to 1.4 whiteflies/leaf. Similarly, Seln-BLG-1 recorded very less whiteflies during first and second count (0 & 0.2 whiteflies/leaf) in comparison to its parent Assam Black (1 & 1.6 whiteflies/leaf). The highest population (2.5whiteflies/leaf) observed in EC783760. Similar variation in whitefly population amongst genotypes also reported by Priyadarshini *et al*. (2019) [13].



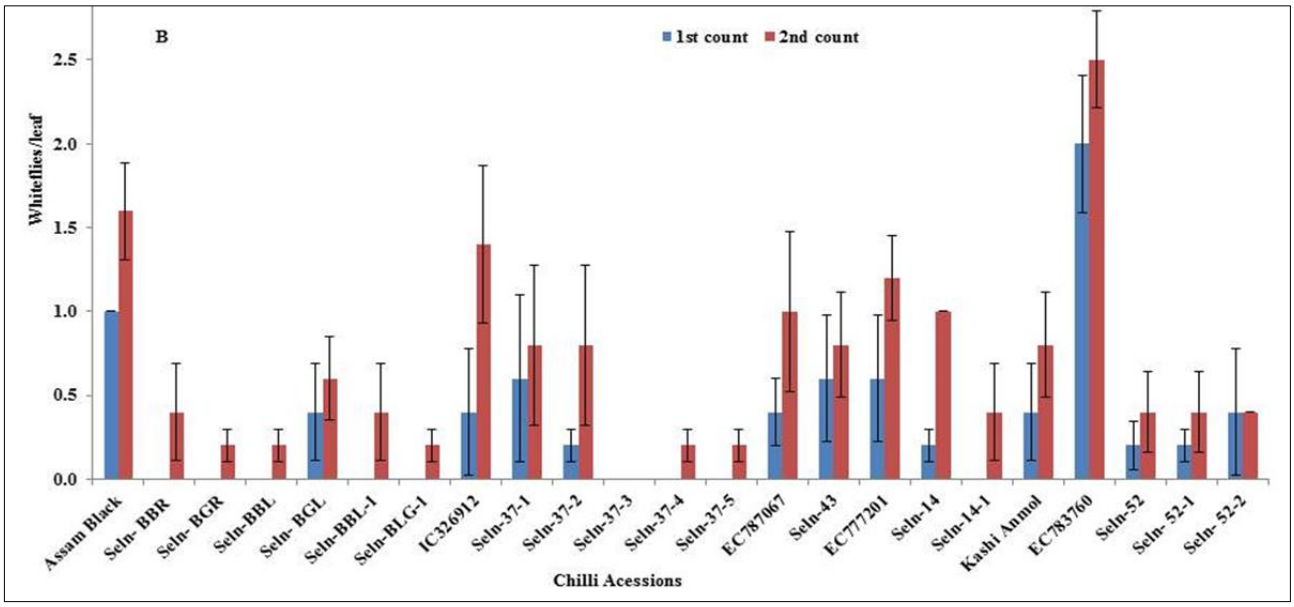


Fig 1: Tolerance of chilli genotypes for (A) thrips and (B) whiteflies tolerance

Conclusion

The present investigation reports the chilli genotypes Seln-14, Seln-BBL-1, Seln-43 Seln-BLG-1 as promising in terms of growth, yield and quality under Western Ghats agro-climatic region. These lines may be utilised for breeding purpose.

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