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Evaluation of cucumber (*Cucumis sativus* L) germplasm for resistance to downy mildew

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Abstract

Downy mildew is one of the most common types of destructive foliar disease of cucumber, Oomycete pathogen *Pseudoperonospora cubensis* is responsible for this in cucumber, moderately resistant Hybrids and open pollinated varieties are available, but without the use of fungicides, yield losses are enormous. The development and utilization of resistant cultivars is economically and ecologically considered to be the best approach to control downy mildew. The Wild cucumber (*C. sativus* var. *hardwickii*) originated in India and served as a source of resistance to a number of diseases, including downy mildew however, recently it has shown a susceptible reaction. The current research aimed to find the lines that are resistant among the 34 screened lines the 3 USDA accessions PI-330628, PI-250147, and PI-197085 displayed resistance to downy mildew. These lines can be more thoroughly used for resistant lines or hybrid development.

Keywords: Downy mildew, *C. sativus* var. *hardwickii*, susceptible, resistant

1. Introduction

Cucumber (*Cucumis sativa* L.) is a popular fresh market vegetable grown extensively in tropical and sub-tropical parts of the world. It is a valuable vegetable crop primarily cultivated for its young, undeveloped fruits. Ranking third in cultivation after tomatoes and onions (Global Production of vegetables, 2022) [4]. Cucumbers have found diverse uses, being incorporated into salads, pickles, and an array of culinary and non-culinary applications. Raw cucumber is composed of about 95% water, 4% carbohydrates, and 1% protein. It's a low-calorie option, providing only around 16 kilocalories per 100-gram serving (USDA Food Data Central Search, 2019) [17].

In India, Cucumbers are cultivated in an area of 113000 hectares with a production of 1638000 metric tonnes (Horticultural Crops, 2021-22) [6]. The cucumber crop is vulnerable to a number of stresses, both biotic and abiotic in nature. Angular leaf spot, Anthracnose, Downy mildew, Powdery mildew, Bacterial wilt, and Cucumber mosaic virus are the major biotic stresses affecting the crop, considering these diseases, downy mildew and virus diseases cause heavy losses, particularly during the hot and humid season. Downy mildew caused by *Pseudoperonospora cubensis* (Berk. & Curt.) Rostov] is one of the most significant cucurbit foliar diseases, leading to significant yield losses not only in India but also in the USA, Europe, China, and Israel (Pragya R, 2014) [10], causing both yield and quality losses.

Despite the availability of fungicides for disease control, genetic resistance is a more sustainable and environmentally friendly approach (Urban J & Lebeda A, 2006) [16]. The primary requirement for disease resistance breeding is a resistant source and a comprehensive understanding of the genetic diversity within cucumber germplasm. Thus, the identification of resistance sources for downy mildew is a crucial initial step to achieve a valuable increase in the overall crop yield and quality. Keeping this in view, the current study was carried out to evaluate and screening of 38 cucumber germplasm lines.

2. Materials and Methods

The study material comprised 11 USDA accessions PI-215589, PI-109484, PI-175111, PI-197085, PI-197087, PI-197088, PI-200818, PI-220860, PI-234517, PI-250147, PI-330628, 23 internal pure lines (NCU-01 to NCU-23) and 4 checks *Cucumis Sativus* *hardwickii*, Pusa Uday, Pusa Bharka and Pusa long green.

The current research was conducted at the research farm of seed company NOBLE SEEDS PVT LTD, Thondebavi, Gauribidanur taluk, Chikkaballapura district, Karnataka situated at 13.4948° N latitude and 77.5290° E longitude with an altitude of 684 meters above mean sea level.

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The experiment was conducted during Kharif 2023, due to the availability of a limited number of seeds of the germplasm under study the experiment was laid out in augmented design and followed the spreader row technique for downy mildew screening in open field natural conditions. The susceptible lines were planted a month earlier than the planting of the main screening material. The soil is red sandy loam, and the crop was raised in well-prepared raised beds, with a spacing of 90 cm between rows and 60 cm between plants. The suggested fertilizer dosage and agronomic procedures were followed to raise a successful crop.

Cucumber accessions were screened for the pathogen that causes downy mildew (DM) disease. Utilizing the method described by Reuveni (1983) [11], 0 to 4 scale the descriptions are given in Table 1. The disease was scored at 15-day intervals. Each accession's PDI was determined after scoring. Based on PDI, the lines were grouped into four categories: 0-25, resistant (R); 25-50, moderately resistant (MR); 50-75, moderately susceptible (MS); >75 susceptible (S) (Reuveni, 1983) [11].

Percent disease index (PDI) was calculated by applying the formula given by Wheeler (1969) [19].

$$\text{PDI} = \frac{\text{The sum of numerical values}}{\text{Number of plants graded} \times \text{Maximum ratings}} \times 100.$$

Table 1: The disease reaction is categorized into different descriptions and disease ratings (Reuveni, 1983) [11].

Diseases rating	Description	Disease reaction
0	No symptoms	Immune
1	1-10 scattered small lesions per leaf, with less than 25% of the leaf area turning yellowish.	Resistant
2	11-20 scattered small lesions per leaf, with yellowing covering between 25% and 50% of the leaf area.	Moderate Resistant
3	21-40 scattered or coalesced lesions per leaf, with yellowing covering more than 50% of the leaf area.	Moderate Susceptible
4	More than 40 coalesced lesions per leaf, resulting in the infected area turning brown and dying, with yellowing covering over 75% of the leaf area.	Susceptible

3. Results and Discussion

Screening for Disease Resistance:

In order to identify the resistant donors for cucumber Downy mildew line development programs a total of 38 cucumber lines including checks were screened in the natural open field condition. Among the 4 checks, *Cucumis Sativus hardwickii* showed a Moderately Susceptible reaction with a PDI of 75, whereas the other 3 checks Pusa Uday, Pusa Bharka, and Pusa long green exhibited a Susceptible Reaction to downy mildew. Out of 34 lines Screened for Disease resistance only 3 accessions from USDA collection i.e PI-330628, PI-250147, PI-197085 showed resistance which showed only mild symptoms on lower leaves of the plant whose PDI ranged from 10 to 20, 16 lines exhibited Moderately resistant reaction, 12 lines showed Moderately susceptible reaction and remaining 3 lines demonstrated susceptible reaction with PDI of > 75. The data of PDI and disease reaction for all the lines screened is presented in Table 2.

Table 2: The PDI scoring at 15-day intervals and Disease reaction details for all the lines screened.

S. No.	Accessions	PDI at 15 days Interval				Disease reaction
		1	2	3	4	
1	PI-215589	20	30	45	45	MR
2	PI-109484	20	25	60	60	MS
3	PI-175111	20	25	40	40	MR
4	PI-197085	20	40	45	45	MR
5	PI-197087	20	45	50	50	MR
6	PI-197088	0	10	20	20	R
7	PI-200818	20	30	90	90	S
8	PI-220860	20	45	45	45	MR
9	PI-234517	20	55	85	85	S
10	PI-250147	0	10	10	15	R
11	PI-330628	0	10	10	10	R
12	NCU-01	20	35	75	75	MS
13	NCU-02	20	30	30	45	MR
14	NCU-03	20	30	55	55	MS
15	NCU-04	20	50	55	55	MS
16	NCU-05	20	25	35	45	MR
17	NCU-06	20	30	35	45	MR
18	NCU-07	20	30	50	50	MR
19	NCU-08	20	45	55	55	MS
20	NCU-09	20	65	80	80	S
21	NCU-10	20	45	45	60	MS
22	NCU-11	20	35	35	55	MS
23	NCU-12	20	40	45	60	MS
24	NCU-13	20	35	40	40	MR
25	NCU-14	20	25	30	30	MR
26	NCU-15	20	45	50	50	MR
27	NCU-16	20	40	45	45	MR
28	NCU-17	20	45	60	60	MS
29	NCU-18	20	40	60	60	MS
30	NCU-19	20	40	65	65	MS
31	NCU-20	20	25	35	35	MR
32	NCU-21	20	25	25	25	R
33	NCU-22	20	25	40	40	MR
34	NCU-23	20	40	75	75	MS
35	<i>C.S hardwickii</i>	20	40	75	75	MS
36	Pusa Uday	20	35	85	85	S
37	Pusa Long Green	20	60	95	95	S
38	Pusa Bharka	20	55	90	90	S

*R- Resistant, MR- Moderately resistant, MS- Moderately susceptible, S-Susceptible.

Call AD (2012) [2] tested 1300 cultigens across the years and over locations and identified 3 PI 605996, PI 330628, and PI 197088 most resistant cultigens over all environments. The cultigens were also discovered to significantly outperform checks in all resistance traits. Wang Y (2016) [18] identified the presence of two novel QTLs *dm 4.1* and *dm 5.1* for DM resistance in the accession PI 330628 which conferred resistance in multiple countries.

4. Conclusion

The present study resulted in identifying 3 DM resistant accessions PI-330628, PI-250147, and PI-197085 from USDA entries that can be further used in Downy mildew resistance breeding programs. And their Resistance can be further confirmed by further screening and QTL analysis.

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