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Validation of downy mildew resistance in cucumber germplasm through artificial screening

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Abstract

The present study was conducted to validate downy mildew resistance in three promising cucumber accessions, IC527431, IC527400, and IC572024, through artificial inoculation at the greenhouse facility of ICAR-IIHR, Bengaluru, during 2024–25. These lines were previously identified through a multi-location trial conducted at New Delhi, Varanasi, and Bengaluru, India, from 2022–24. Three check varieties, Pusa Uday, Pusa Barkha, and Arka Veera were included to compare the performance of the selected genotypes. Thirty-five days after inoculation, the check varieties Pusa Uday (77.78% PDI) and Pusa Barkha (51.85% PDI) exhibited highly susceptible reactions. In contrast, only mild symptoms were observed on the leaves of IC572024, IC527431, and IC527400, with average Per cent Disease Index (PDI) values of 12.96, 15.74, and 29.63, respectively indicating resistant to moderately resistant responses. These germplasm lines appear promising as sources of resistance to downy mildew in cucumber and hold potential for use in the development of resistant cultivars.

Key words: Cucumber, Downy mildew, Challenged inoculation, Artificial screening, Resistant source

Cucumber (*Cucumis sativus* L.) is an important salad vegetable valued for its flavour and nutritional benefits. Downy mildew, caused by *Pseudoperonospora cubensis* [(Berkeley & M.A. Curtis) Rostovzev], is the most prevalent foliar disease affecting cucumber and other cucurbit crops worldwide. Under favourable environmental conditions, the disease spreads rapidly and can devastate the crop, leading to yield losses of up to 100% (Núñez-Palenius *et al.*, 2022). It significantly reduces both the quality and productivity of the cucumber, resulting in significant economic losses for growers. Although downy mildew can be managed through fungicides, the extensive use of pesticides raises serious concerns regarding human health and environmental safety.

Therefore, the development and deployment of resistant cultivars remain the most effective and sustainable strategy for managing diseases and pests in cucumber. Globally, several downy mildew-resistant cucumber cultivars have been developed using Indian-origin genotypes PI 197086, PI 197087, and PI 197088 as sources of resistance. In India, over the past five decades, a total of 587 vegetable varieties across 28 crops have been recommended for cultivation in various agroclimatic zones of India, including 54 varieties resistant to different biotic and abiotic stresses (Pandey *et al.*, 2024). However, to date, no indigenous cucumber cultivar with resistance to downy mildew has been reported in India. To address this gap, the present study was undertaken to identify a new source of resistance to downy mildew in cucumber.

Three cucumber accessions (IC572024, IC527400 and IC527431) identified through multi-location evaluation were validated through challenged inoculation conducted under greenhouse at ICAR-IIHR Bengaluru during 2024-25. Three checks were used to compare the performance of selected genotypes. Diseased cucumber plants maintained in greenhouse conditions were used to extract the source of inoculum and 20 to 25 -old seedlings were inoculated with a sporangium suspension containing 10,000/ml sporangia using hand sprayer.

After inoculation, plants were kept in the dark at 100% relative humidity (RH) for 24 h, followed by 7 to 10 days at 80/100% RH by day/night at a temperature of 20 to 23°C. Disease scoring was carried out on the basis of per cent leaf area infected by the downy mildew lesions and 0-9 rating scale was adopted for disease ratings. Genotypes were screened on 0 to 9 scale (Jenkins and Wehner, 1983) based on the percentage of symptomatic leaf area (0=0%, 1 =1–5%, 2 = 6–10%, 3 = 11–20%, 4 = 21–30%, 5 = 31–50%, 6 = 51–65%, 7 = 66–80%, 8 = 81–99%, and 9 = 100%). The per cent disease index (PDI) was calculated by the following formula given by Wheeler (1969).

$$PDI = \frac{N_1 \times 1 + N_2 \times 2 + N_3 \times 3 + N_4 \times 4 + N_5 \times 5 + N_6 \times 6 + N_7 \times 7 + N_8 \times 8 + N_9 \times 9}{\text{Total number of observed leaves} \times \text{Maximum grade}} \times 100$$

Where N_1 to N_9 represents total number of leaves falling under 1–9 scales, respectively.

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Based on PDI the disease reaction of genotype was classified into four groups namely resistant (0–20%), moderately resistant (21–40%), susceptible (41–60%) and highly susceptible (> 60%) based on the average PDI (Reddy, 2002). The differences among genotypes for PDI value was analyzed through open source statistical software 'R'. Artificial inoculation of the pathogen on cucumber revealed that disease initiation occurred on the fourth day post-inoculation. Symptom scoring began on the tenth day and was conducted weekly thereafter. Disease symptoms appeared 3–6 days post-inoculation in the check varieties and progressed gradually over time (Fig. 1).

In contrast, the accessions IC572024, IC527431, and IC527400 showed no signs of infection until 14 days post-inoculation, and only mild symptoms were observed even after 35 days. At 35 days post-inoculation, Percent Disease Index (PDI) values ranged from 12.96 to 77.78 (Table 1), indicating varying levels of resistance among the tested genotypes. At 35 days post-inoculation, the check varieties Pusa Uday and Pusa Barkha exhibited highly susceptible and susceptible reactions, respectively. In contrast, only mild symptoms were observed on the leaves of IC572024, IC527431, and IC527400, with average PDI values of 12.96, 15.74, and 29.63, respectively. These results indicate that IC572024 and IC527431 are resistant, while IC527400 shows a moderately resistant reaction. Notably, all three germplasms performed better than the moderately resistant check Arka Veera, which recorded a PDI of 33.33.

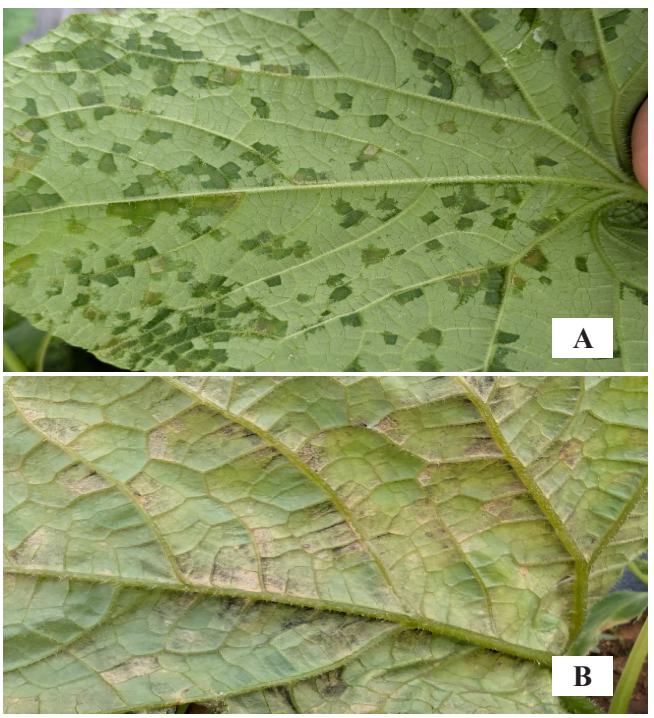

Fig 1. (a) Symptoms of Downy mildew after 20 days and 30 days after sowing on susceptible genotype Pusa Uday under artificial screening.

Table 1. Disease reaction of cucumber genotypes and checks against downy mildew incidence under artificial epiphytotic conditions

Genotype	Severity (Per cent disease Index – PDI*) Mean ± S.E.
IC527431	15.74±0.93 (23.35±0.74)
IC572024	12.96±0.93 (21.07±0.80)
IC527400	29.63±3.70 (32.87±2.38)
Pusa Uday	77.78±1.60 (61.88±1.11)
Pusa Bharka	51.85±1.85 (46.05±1.06)
Arka Veera	33.33±0.00 (35.25±0.00)
C.D.@1%	3.86
SE(m)	1.24
SE(d)	1.75
C.V.	5.84

*Values in parentheses are arc sine transformed values of PDI

Protocols for artificial screening in cucumber are well established and widely employed for evaluating downy mildew (DM) resistance across large germplasm collections (Criswell, 2008). Artificial screening of Indian cucumber lines for DM resistance was previously reported by Pitchaimuthu *et al.* (2024). Several genetic resources from the Indian gene centre including PI 197085, PI 197086, PI 197087, and PI 197088 have been documented to possess resistance to downy mildew (Call *et al.*, 2012; Barnes and Epps, 1954), and are globally utilized as sources of resistance. However, the emergence of new races and pathotypes due to changing climatic conditions necessitates the continuous identification of novel resistance sources. Indian researchers have reported various cucumber accessions exhibiting resistance to DM (Ranjan *et al.*, 2015; Bhutia *et al.*, 2015; Gautam *et al.*, 2020; Reddy *et al.*, 2022). Yet, many of these accessions have not undergone multi-location testing, limiting their applicability to specific agro-climatic zones. The lines identified in the present study IC572024, IC527431, and IC527400 demonstrated promising resistance and represent potential novel sources for breeding. These germplasms should be prioritized in cucumber improvement programs aimed at developing cultivars with durable resistance to downy mildew in India.

CONCLUSION

The validation of downy mildew resistance in cucumber accessions IC572024, IC527431, and IC527400 under greenhouse conditions confirms their potential as resistant genetic resources. The markedly lower PDI

values observed in these lines, compared to the susceptible check varieties, underscore their robustness against downy mildew infection. These results are consistent with previous multi-location trials, reinforcing the reliability of their resistance across environments.

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