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SCREENING OF CLUSTERBEAN GENOTYPES (*CYAMOPSIS TETRAGONOLOBA* L. TAUB.) FOR POWDERY MILDEW (*LEVEILLULA TAURICA*) DISEASE RESISTANCE

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ABSTRACT

Powdery mildew, caused by *Leveillula taurica*, is one of the most damaging foliar diseases affecting cluster bean, leading to significant economic losses. It predominantly targets the leaves and pods, resulting in heavy defoliation and weakening of the plants due to premature drying and death of the infected foliage. In the present study, 40 cluster bean genotypes were evaluated for their response to powdery mildew under both natural and artificially induced conditions. None of the genotypes exhibited complete resistance or immunity to the disease both in natural and artificial inoculation conditions. Under natural field conditions, five genotypes GP-11, GP-18, GP-17, RGC-12-1 and Bagalkot Local-5 demonstrated moderate resistance to powdery mildew. However, when tested under artificial inoculation, GP-18 and Bagalkot Local-5 showed moderate susceptibility. This inconsistency in response may be attributed to lower or uneven disease pressure in natural environments or possible disease escape mechanisms that can sometimes conceal the true susceptibility of a genotype.
Keywords **:** Cluster bean, Powdery mildew, Screening, Disease rating scale

Introduction

Cluster bean (*Cyamopsis tetragonoloba*), an annual legume from the Fabaceae family, commonly known as guar in hindi, it is valued for its ability to thrive in drought-prone, high-temperature regions (Kumar and Rodge, 2012). Cluster bean is especially important for its gum-producing potential and suitability to arid and semi-arid climates. It prefers well-drained, medium to light soils with a pH of 7.0–8.5 and can grow in low-fertility soils, making it useful as a green manure crop. Pest and diseases are the major problems of every crop, like that Powdery mildew, caused by *Leveillula taurica*, is a major foliar disease of cluster bean, usually appearing around 30 days after sowing, starting on lower leaves and spreading as white mycelial growth (Vijaykumar *et al*., 2021) and capable of reducing yields by up to 50–55%. The disease is more severe in regions with extended cropping seasons and thrives under warm temperatures above 33°C, high humidity over 80 per cent and bright sunlight (Channamma *et al*., 2015). Many fungicides are available to control the powdery mildew disease, but they are expensive and environmentally harmful. The best, alternate and sustainable approach to manage powdery mildew disease is evaluation and development of new resistant varieties in cluster bean.

Material and Methods

Fourty cluster bean genotypes were collected from the different sources and were evaluated. Four susceptible popular varieties *viz.*, Pusa Navbahar, NCB-115, Amrit-11 and RGC-936 were used as check (Table 1).

Table 1 : List of cluster bean genotypes evaluated against powdery mildew disease

Sl. No	Code	Genotypes	Location
1	G1	VRCB-87	IIVR Varanasi, Uttar Pradesh
2	G2	GP-3	RARI Durgapur, Rajastan
3	G3	VRCB-88	IIVR Varanasi, Uttar Pradesh
4	G4	RGC-1066	RARI Durgapur, Rajastan
5	G5	VRCB-139	IIVR Varanasi, Uttar Pradesh
6	G6	RGC-1033	RARI Durgapur, Rajastan
7	G7	GP-4	RARI Durgapur, Rajastan
8	G8	GP-20	RARI Durgapur, Rajastan
9	G9	GP-18	RARI Durgapur, Rajastan
10	G10	GP-12	RARI Durgapur, Rajastan
11	G11	GP-14	RARI Durgapur, Rajastan
12	G12	VRCB-10	IIVR Varanasi, Uttar Pradesh
13	G13	GP-19	RARI Durgapur, Rajastan
14	G14	GP-11	RARI Durgapur, Rajastan
15	G15	GP-17	RARI Durgapur, Rajastan
16	G16	RGC-12-1	RARI Durgapur, Rajastan
17	G17	RGC-1030	RARI Durgapur, Rajastan
18	G18	GP-8	RARI Durgapur, Rajastan
19	G19	VRCB-127	IIVR Varanasi, Uttar Pradesh
20	G20	RGC-986	RARI Durgapur, Rajastan
21	G21	Gokak Local-1	Gokak
22	G22	Gokak Local-2	Gokak
23	G23	VRCB-124	IIVR Varanasi, Uttar Pradesh
24	G24	Bagalkot Local-1	Bagalkot
25	G25	Bagalkot Local-2	Bagalkot
26	G26	Bagalkot Local-3	Bagalkot
27	G27	Bagalkot Local-4	Bagalkot
28	G28	Bagalkot Local-5	Bagalkot
29	G29	Bagalkot Local-6	Bagalkot
30	G30	Davangere Local	Davangere
31	G31	Gokak Local	Gokak
32	G32	Gokak Local-3	Gokak
33	G33	Bagalkot Local-7	Bagalkot
34	G34	Ghataprabha Local	Ghataprabha
35	G35	Bagalkot Local-8	Bagalkot
36	G36	GP-18″	RARI Durgapur, Rajastan
37	G37	Pusa Navabahar (Check -1)	IARI, New Delhi
38	G38	NCB-115 (Check -2)	Nirmal Seeds Pvt. Ltd.
39	G39	Amrit-11 (Check-3)	Avatar Quality Seeds
40	G40	RGC – 936 (Check-4)	RARI Durgapur, Rajastan

Experimental location

The present field evaluation experiment was undertaken at open field at sector No.1, Seed Unit, UHS Bagalkot with 16º 10' N latitude and 72 º 42' E longitudes with an elevation of 542 meters above mean sea level. The artificial screening experiment was conducted in poly house at main campus, UHS, Bagalkot.

Natural screening

The experiment was conducted during the *rabi*-2024 season at Sector No. 1, Seed Unit, University of Horticultural Sciences (UHS), Bagalkot. Seeds were sown in an open field using a Randomized Complete Block Design (RCBD) with two replications. Each plot measured 3.75 meters by 0.6 meters and the spacing between plants was maintained at 45 cm × 20 cm to ensure proper plant growth and development. Observations were recorded on five randomly selected plants at 90 days after sowing and disease reactions were classified based on a 0.0–9.0 scale as immune, resistant, moderately resistant, moderately susceptible, susceptible or highly susceptible and disease reaction was given based on the maximum grade obtained by particular genotype (Mayee and Datar, 1986).

Artificial screening

Raising of seedlings

The seeds were sown in the polybag of size 4.5x3 inch containing an equal mixture of soil, sand and farmyard manure (1:1:1). The seeds of each genotype sown separately and ten replications were maintained in each variety. The seedlings were maintained in polyhouse with 28 ± 2^0C and RH of 75±5%. The seedlings were maintained by regular watering and application nutrients.

Inoculation

The 35 days old seedlings were used for the inoculation. The inoculums are collected from the infected leaves of cluster bean at a distant place in the sterile polybags and brought to the inoculation area. The collected infected leaves were sticked with cellophane tape and then transferred the sticked cellophane tape to healthy leaves. Two leaves per seedling were stapled (Fig. 1). The artificial inoculation of powdery mildew was performed to assess the resistance levels of the various cluster bean genotypes, providing insights into potential source of resistance against this prevalent disease.

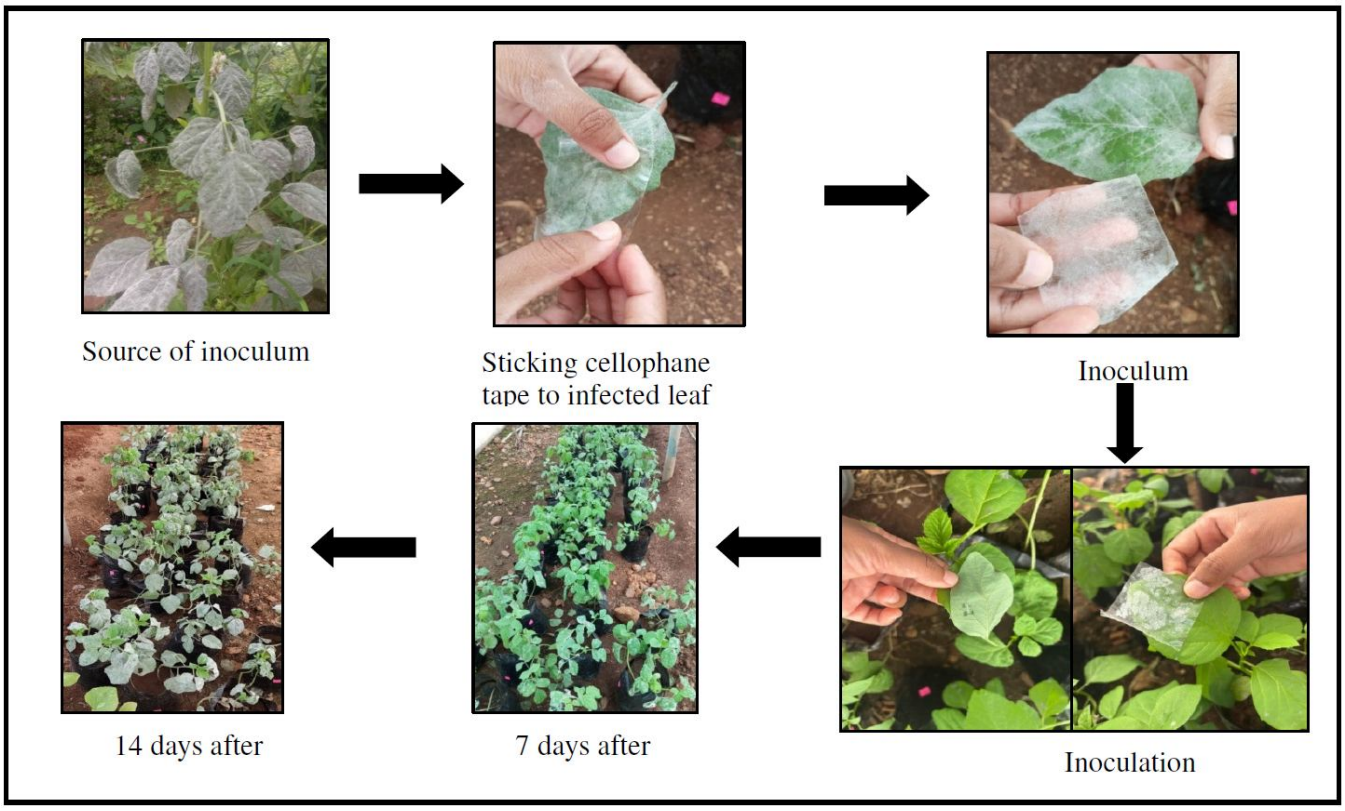

Fig.1 : Steps followed in artificial inoculation

Disease scoring

The disease severity was scored using 0 to 9 scale (Mayee and Datar, 1986). Wherein 0- No symptoms of powdery mildew on leaves (Immune reaction), 1-Small powdery specks covering 1 per cent or less leaf area (Resistant reaction), 3-Powdery lesions small (up to 5 mm in size) covering 1-10 per cent of leaf area (Moderately resistant reaction), 5- Powdery lesions enlarging 11-25 per cent of leaf area. (Moderately susceptible), 7-Powdery lesions coalesce to form big patches covering 26-50 per cent of leaf are (Susceptible), and 9-Big powdery patches covering 51 per cent or more of leaf area and defoliation occur (Highly susceptible) (Fig. 2).

Result and Discussion

Disease screening is a critical part of crop improvement and plant breeding programs. It involves identifying plants that can resist or tolerate diseases caused by fungi, bacteria, viruses or other pathogens. Diseases are one of the major limiting factors in crop production, causing significant yield losses and reducing quality. By screening plants for disease resistance, breeders can identify healthy and resistant genotypes, which can be used either directly as varieties or as parents in hybrid development. Disease-resistant varieties reduce the dependency on chemical pesticides, making farming more sustainable and environmentally friendly.

Natural screening

Natural disease screening is an important method used in plant breeding to evaluate how different genotypes perform under real field conditions where disease outbreaks occur naturally. Unlike artificial screening, where pathogens are deliberately introduced under controlled conditions, natural screening relies on the presence and natural spread of diseases in environments known to have regular disease pressure. This approach plays a significant role in identifying durable and field-effective disease resistance.

In the natural screening study, none of the genotypes were found to be completely immune or resistant to the disease. However five genotypes namely GP-11, GP-18, GP-17, RGC-12-1 and Bagalkot local-5 demonstrated moderate level of resistance, with disease rating scale of 3 at 90 days after sowing suggests their potential as valuable sources for breeding powdery mildew-resistant cluster bean varieties. Their low disease rating indicates effective defence against the pathogen under natural conditions. This resistance may be attributed to genetic factors that enable these genotypes to restrict pathogen growth and symptom expression. Similarly, seven genotypes *i.e.* GP-20, GP-12, GP-14, VRCB-10, GP-

19, Bagalkot Local-3 and Davangere Local showed moderate susceptibility (Table 2). This moderate susceptibility may be due to the presence of partial resistance genes that limit but do not completely prevent disease development. Their intermediate disease response indicates partial resistance but also highlights the need for further improvement. Out of all the genotypes screened, 10 were found to be susceptible and 18 showed high susceptibility to powdery mildew, exhibiting prominent disease symptoms and elevated disease rating scores (Table 3). Similar results were also reported by Zhou *et al*., 2010; Iqbal *et al*., 2017; Singh *et al*., 2020; Vijaykumar *et al*., 2021 in cluster bean. These genotypes lacked effective resistance mechanisms, making them vulnerable to infection under natural conditions. Their poor performance under disease pressure suggests limited potential for direct cultivation in disease prone areas. But, they may still hold value in breeding programs if combined with resistant lines to improve disease tolerance. These results emphasize the need to determine the particular pathogen races occurring in these areas to gain deeper insight into the differences in host reactions and to inform targeted breeding strategies for resistance.

Table 2 : Reaction of cluster bean genotypes to powdery mildew under natural screening

Sl. No.	Genotype	Maximum grade observed	Disease Reaction
1	VRCB-87	9	HS
2	GP-3	9	HS
3	VRCB-88	7	S
4	RGC-1066	7	S
5	VRCB-139	9	HS
6	RGC-1033	9	HS
7	GP-4	7	S
8	GP-20	5	MS
9	GP-18	3	MR
10	GP-12	5	MS
11	GP-14	5	MS
12	VRCB-10	5	MS
13	GP-19	5	MS
14	GP-11	3	MR
15	GP-17	3	MR
16	RGC-12-1	3	MR
17	RGC-1030	9	HS
18	GP-8	9	HS
19	VRCB-127	9	HS
20	RGC-986	9	HS
21	Gokak Local-1	7	S
22	Gokak Local-2	7	S
23	VRCB-124	7	S
24	Bagalkot Local-1	9	HS
25	Bagalkot Local-2	7	S
26	Bagalkot Local-3	5	MS
27	Bagalkot Local-4	9	HS
28	Bagalkot Local-5	3	MR
29	Bagalkot Local-6	9	HS
30	Davangere Local	5	MS
31	Gokak Local	7	S
32	Gokak Local-3	9	HS
33	Bagalkot Local-7	9	HS
34	Ghataprabha local	7	S
35	Bagalkot Local-8	9	HS
36	GP-18″	9	HS
37	Check-1 (Pusa Navabahar)	7	S
38	Check-2 (NCB-115)	9	HS
39	Check-3 (Amrit-11)	9	HS
40	Check-4 (RGC-936)	9	HS

Table 3 : Grouping of cluster bean genotypes based on reaction to powdery mildew under natural screening

Grade	Reaction	No. of genotypes	Details of genotypes
0	I	-	
1	R	-	
3	MR	5	GP-11, GP-18, GP-17, RGC-12-1, Bagalkot Local-5
5	MS	7	GP-20, GP-12, GP-14, VRCB-10, GP-19, Bagalkot Local-3, Davangere Local
7	S	10	VRCB-88, RGC-1066, GP-4, Gokak Local-1, Gokak Local-2, VRCB-124, Bagalkot Local-2, Gokak Local, Ghataprabha Local, Pusa Navabahar
9	HS	18	VRCB-87, GP-3, VRCB-139, RGC-1033, GP-8, VRCB-127, RGC-986, RGC-1030, Bagalkot Local-1, Bagalkot Local-4, Bagalkot Local-6, Gokak Local-3, Bagalkot Local-7, Bagalkot Local-8, GP-18″, NCB-115, Amrit-11, RGC-936

Artificial screening

Artificial disease screening is a method where plants are intentionally exposed to a specific pathogen under controlled conditions. This allows breeders to observe how each genotype responds to infection in a uniform and timely manner. It is especially valuable because it ensures that all plants face the same level of disease pressure, which improves the accuracy of selection. It also speeds up the breeding process, as resistant plants can be identified early and used in crossing programs to develop hybrids or improved varieties. Additionally, artificial screening helps in testing for multiple diseases across different growth stages, which may not be possible under natural conditions.

In artificial screening none of the genotypes displayed complete immune or resistance to the powdery mildew infection. However, two genotypes GP-18 and Bagalkot Local-5 showed moderate susceptibility (Table 4 and Fig. 3) even though they exhibited moderately resistant under natural condition. This variation may be due to lower or uneven disease pressure under natural conditions or also due to some disease escaping mechanism which can sometimes mask true susceptibility, whereas artificial inoculation ensures uniform exposure and reveals the actual resistance level. Notably, Bagalkot Local-5 is locally cultivated, suggests that fragile resistance traits may be common in locally grown varieties. Hence, understanding the inheritance patterns of resistance in these genotypes is essential for effective breeding (Rana *et al*., 2013; Deng *et al*., 2022; Venkatr *et al*., 2024) (Table 5).

Table 4 : Reaction of cluster bean genotypes to powdery mildew under artificial screening

Sl. No.	Genotype	Maximum grade observed 7 DAI	Maximum grade observed 14 DAI	Disease Reaction
1	VRCB-87	9	9	HS
2	GP-3	9	9	HS
3	VRCB-88	5	7	S
4	RGC-1066	7	9	HS
5	VRCB-139	9	9	HS
6	RGC-1033	9	9	HS
7	GP-4	5	7	S
8	GP-20	7	9	HS
9	GP-18	3	5	MS
10	GP-12	7	9	HS
11	GP-14	7	7	S
12	VRCB-10	9	9	HS
13	GP-19	7	9	HS
14	GP-11	7	9	HS
15	GP-17	5	7	S
16	RGC-12-1	5	7	S
17	RGC-1030	5	7	S
18	GP-8	9	9	HS
19	VRCB-127	7	9	HS
20	RGC-986	7	9	HS
21	Gokak Local-1	5	9	HS
22	Gokak Local-2	9	9	HS
23	VRCB-124	9	9	HS
24	Bagalkot Local-1	3	9	HS
25	Bagalkot Local-2	7	9	HS
26	Bagalkot Local-3	9	9	HS
27	Bagalkot Local-4	3	7	S
28	Bagalkot Local-5	3	5	MS
29	Bagalkot Local-6	7	9	HS
30	Davangere Local	7	7	S
31	Gokak Local	9	9	HS
32	Gokak Local-3	5	9	HS
33	Bagalkot Local-7	9	9	HS
34	Ghataprabha Local	5	7	S
35	Bagalkot local-8	9	9	HS
36	GP-18″	9	9	HS
37	Check-1 (Pusa Navabahar)	7	9	HS
38	Check-2 (NCB-115)	9	9	HS
39	Check-3 (Amrit-11)	5	9	HS
40	Check-4 (RGC-936)	9	9	HS

Table 5: Grouping of cluster bean genotypes based on reaction to powdery mildew under artificial screening

Grade	Reaction	No. of genotypes	Details of genotypes
0	I	-	
1	R	-	
3	MR	-	
5	MS	2	GP-18, Bagalkot Local-5
7	S	9	VRCB-88, GP-4, GP-14, GP-17, RGC-12-1, RGC-1030, Bagalkot Local-4, Davangere Local, Ghataprabha Local
9	HS	29	VRCB-87, GP-3, RGC-1066, VRCB-139, RGC-1033, GP-20, GP-18, GP-12, VRCB-10, GP-19, GP-11, GP-8, VRCB-127, RGC-986, Gokak Local-1, Gokak Local-2, VRCB-124, Bagalkot Local-1, Bagalkot Local-2, Bagalkot Local-3, Bagalkot Local-6, Gokak Local, Gokak Local-3, Bagalkot Local-7, Bagalkot Local-8, GP-18″, Pusa Navabahar, NCB-115, Amrit-11, RGC-936

I-Immune, R- Resistant, MR – Moderately Resistant,
MS- Moderate Susceptible, S- Susceptible, HS- Highly Susceptible

Powdery mildew disease ratings in cluster bean genotypes showed significant differences between natural and artificial screening methods. Under artificial screening, most genotypes recorded higher disease ratings, as they were intentionally inoculated with powdery mildew spores under conditions that favoured pathogen development and spread. This approach ensures a consistent and accurate evaluation of resistance under controlled conditions. In contrast, natural screening generally showed lower disease severity, which may be attributed to disease escape where plants avoid infection not due to genetic resistance, but because environmental or physical factors limit their exposure to the pathogen. This highlights a key limitation of natural screening methods.

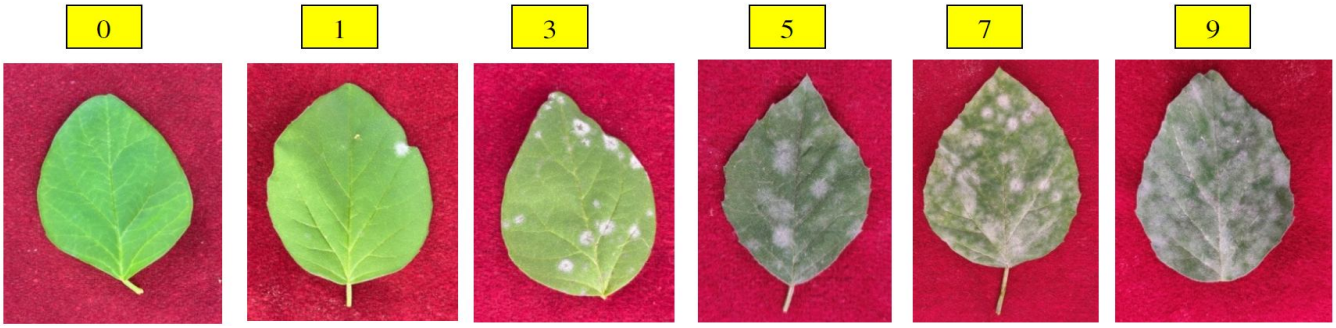

Fig. 2 : Disease rating scale

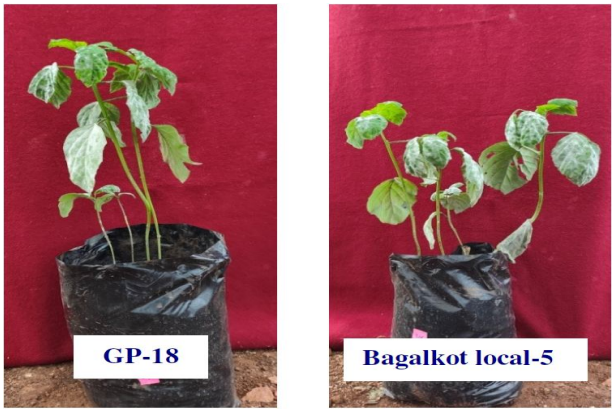

Fig. 3 : Moderately susceptible genotypes

The correlation between natural and in vitro powdery mildew disease screening lies in their complementary roles. Natural screening helps identify resistant plant lines in real-world conditions, while in vitro screening validates and studies those resistance traits in a controlled setting. For example, a plant genotype found to be resistant in natural screening can be further tested in vitro to determine whether the resistance is consistent across environments and to investigate the underlying mechanisms. Similarly, findings from in vitro experiments can be used to guide natural screening by identifying markers or traits to look for in field populations.

Conclusion

The study on evaluation of cluster bean genotypes against powdery mildew disease under natural conditions, identified five moderately resistant genotypes namely GP-11, GP-18, GP-17, RGC-12-1 and Bagalkot local-5 and seven genotypes including GP-20, GP-12, GP-14, VRCB-10, GP-19, Bagalkot local-3 and Davangere local exhibited moderately susceptible reaction to the powdery mildew at 90 days after sowing. However, in artificial inoculation method none was found with moderate resistance. While two genotypes GP-18 and Bagalkot Local-5 were identified as moderately susceptible. So considering both natural and artificial evaluation GP-18 and Bagalkot Local-5 were somewhat less affected by powdery mildew disease compared to others.

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