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Assessment of Rajmash (*Phaseolus vulgaris* L.) Germplasm Against *Colletotrichum lindemuthianum* inciting Bean Anthracnose

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ABSTRACT: The common bean (*Phaseolus vulgaris* L.) is the world's most widely grown and consumed grain legume. It has more fiber, vitamins, minerals, and proteins than usual. *Colletotrichum lindemuthianum* is the agent of the most damaging bean disease, anthracnose. The current study was conducted at the Research Farm of the School of Agriculture, Abhilashi University, Mandi (H.P.) during the kharif season of 2022 to assess 30 common bean genotypes obtained from NBPGR regional station Shimla and 10 local cultivars gathered from a separate area of the Mandi district to determine the source of resistance against virulence of *Colletotrichum lindemuthianum.* Screening of genotypes for anthracnose resistance aids in the identification of 3 highly resistant genotypes (IC-328492, EC-500200 and IC-329497), 29 moderately resistant genotypes (MR-EC-500262, EC-530916, EC-500250, EC-271523, EC-500210, EC-500206, EC-500307, EC-5309132, EC-500189, EC-44624,EC-500237, IC-328404, IC-329389, IC-328653, IC-328847, IC-328449,IC-328537, IC-328411, IC-328626, IC-329462, IC-328398, IC-328397,Barot-1, Barot-2, Barot-3, Barot-4, Janjehli-1, Karsog-1, Karsog-2) and 8 moderately susceptible genotypes (EC- 500337, EC- 405230, EC- 530936, IC- 328639, IC- 328396, Rampur-1, Nihri-1 and Nihri-2). The resistance genotypes that have been identified can either be subjected to a varietal development selection procedure for direct use by farmers, or they can be used as potential donors of resistant genes in breeding programs to develop cultivars with broad and long-lasting resistance to anthracnose.

Keywords: Screening, *Colletotrichum lindemuthianum*, Anthracnose disease, Common bean, Resistance.

INTRODUCTION

Common bean is an annual legume crop of *Fabaceae* (Coelho *et al.*, 2009). It originated in southern Mexico and Central America (Vavilov, 1951) and in addition to having some therapeutic benefits, it has grown in popularity because of its high-quality protein and balanced nutrition. This crop has become the third most important food legume and is also the most utilized crop for direct consumption in the world (Broughton *et al.*, 2003). According to FAO (Food and Agriculture Organization), global production and productivity of dry bean and green bean in the 2021 cropping session was about 420 and 2900 thousand tonnes and 2.8 and 0.32 tonnes/ha, respectively. In India, dry beans and green beans are cultivated in an area of 150 and 9000 thousand tonnes, respectively (Hamid and Rasool 2021). India alone produced dry beans with a productivity of 10 to 12 quintals /hectare (Anonymous, 2021). Himachal Pradesh along with other states is one of the important Rajmash growing areas, with an area of 16.46 thousand hectares with an annual production of 14.20 thousand tonnes, and a productivity of 862 kg/ha (Anonymous, 2021).

Bean crop suffers from several fungal and bacterial disease (Genchev *et al.*, 2010). Anthracnose, caused by *Colletotrichum lindemuthianum,* is a major disease that causes massive yield losses year after year in these beans (Junaid *et al.*, 2014).

With a 100% yearly loss Common bean anthracnose is a devastating disease. Typically, contaminated seeds are used to spread it. The illness is more common in areas with temperate to subtropical climates (Pastor *et al.*, 1989). An abundance of humidity combined with a moderate temperature encouraged the growth of diseases that led to crop failure (Tu, 1981). Anthracnose

symptoms can be seen across a variety of plant parts, including leaves, stamens, and pods(Agrios, 2005). The most noticeable signs are flesh-colored spores that emerge on pods and black, shrunken lesions. Brick-red to purple spots start to appear on the leaf's lower surface along with the veins.

The current study was conducted to assess common bean genotypes resistance to anthracnose disease under natural conditions because host resistance is the most economical method of reducing anthracnose in beans, given the significance of this crop in HP (Kelly and Vallejo 2004; Mahuku *et al.,* 2004).

MATERIAL AND METHOD

The experiment was conducted at the Research Farm of the School of Agriculture, Abhilashi University Mandi during *Kharif*, 2022. The Experimental Farm is situated at 31.5591555 latitudes and 77.009466 longitudes at an elevation of 2065 m. Agroclimatically, the location is in Himachal Pradesh's mid-hill zone (Zone II), which has a humid sub-temperate climate with a high mean annual rainfall (1876mm). The soil is acidic in nature, with a pH ranging from 5.0 to 5.6 and a silty clay loam texture. In total 40 genotypes which included 15 IC collections and 15 EC collections along with 10 local landraces were evaluated in RBD design with three replications. The source of germplasms is given in (Table 1). Morphological characteristics of the germplasm are given in (Table 2). The cultivar was classified based on their PDI values as given in Table 4 (Maibam *et al*., 2015) from which the percent disease severity was calculated (Sharma *et al*., 2015).

Number of genotypes	40
Design	RBD (Randomized Block Design)
Replications	03
Spacing	30×10cm
Plot size	1.0×1.0m (2 rows per plot)
Seed rate	100-125 kg/ha
Date of sowing	28-05-2022
Date of harvesting	30-09-2022

Table 1: Source of germplasm.

Germplasm	Location
IC-328537, IC-328398, IC-328397, IC-328492, IC-328404, IC-328639, IC-329462, IC-328626, IC-328847, IC-328449, IC-328411, IC-329497, IC-328396, IC-329389, IC-328653	NBPGR regional station Shimla
EC-500189, EC-530916, EC-530913, EC-500237, EC-500206, EC-500250, EC-500262, EC-530936, EC-500210, EC-500200, EC-405230, EC-271523, EC-500307, EC-44624, EC-500337	NBPGR regional station Shimla
Barot-1, Barot-2, Barot-3, Barot-4	Barot, Mandi Himachal Pradesh
Nihri-1, Nihri-2	Nihri, Mandi Himachal Pradesh
Janjehli-1	Janjehli, Mandi Himachal Pradesh
Rampur-1	Rampur, Mandi Himachal Pradesh
Karog-1, Karsog-2	Karsog, Mandi Himachal Pradesh

Table 2: Morphological characteristics of different genotypes.

Genotypes	Growth habit	Flower colour	Seed colour	Seed shape
IC-328537	P	Pink	Brown	Kidney
IC-328398	SP	Yellow	Cream	Oval
IC-328397	B/SP	White	Marron	Kidney
IC-328492	B	Pink	Black	Kidney
IC-328404	B/SP	White	Cream	Kidney
IC-328639	B	White	White	Oval
IC-329462	B/SP	Purple	Cream	Kidney
IC-328626	B	Pink	Cream	Kidney
IC-328847	B/SP	White	Marron	Kidney
IC-328449	P	Purple	Marron	Kidney
IC-328411	P	Purple	Brown and variegated	Kidney
IC-329497	P	Purple	Cream	Kidney
IC-328396	B	Pink	Light brown	Kidney
IC-329389	P	Pink	Red	Oval
IC-328653	P	Pink	Red	Kidney
EC-500189	SP	Purple	Brown and variegated	Oval
EC-530916	B/SP	White	Marron	Kidney
EC-530913	B/SP	White	Marron	Cuboid
EC-500237	P	White	Cream	Cuboid
EC-500206	SP	White	Red	Kidney
EC-500250	SP	Purple	Black	Kidney
EC-500262	SP	Pink	Black	Kidney
EC-530936	SP/B	White	Marron	Kidney
EC-500210	SP	Purple	Black	Cuboid
EC-500200	SP	White	Yellowish orange	Kidney
EC-405230	SP	White	Marron	Cuboid

EC-271523	SP	Purple	White	Oval
EC-500307	SP	White	Cream	Kidney
EC-44624	P/SP	White	Brown	Kidney
EC-500337	P	White	Charcoal	Kidney
Nihri-1	SP	Yellow	Brown and variegated	Kidney
Nihri-2	SP	White	Brown and variegated	Kidney
Barot-1	P	White	Marron	cuboid
Barot-2	P	White	Yellow	Cuboid
Barot-3	P	White	Cream/beige	Kidney
Barot-4	P	Yellow	Brown and variegated	Kidney
Rampur-1	SP	White	Burgundy	Kidney
jJanjehli-1	SP	White	Cream/beige	Cuboid
Karsog-1	B	yellow	Burgundy	Cuboid
Karsog-2	B	White	Yellow	Cuboid

Table 3: The disease reaction was scored using a 0-3 scale (Inglis *et al.*, 1988).

Scale	Plant parts affected
0	No disease
1	1-10% veins with lesions
2	11-25% veins and veinlets with lesions
3	26% or more veins and veinlets with lesions

The disease reaction was scored according to the scoring given by Inglis *et al.* (1988) (Table 3). The experiment was conducted within a natural infestation. The cultivars were classified into different categories based on their PDI value.

Table 4: Classification of cultivars into different categories based on percent disease index (PDI).

PDI (%)	Categories
0	Resistant (AR)
0.01	Highly resistant (HR)
12.22-33.33	Moderately resistant (MR)
34.44-55.55	Moderately susceptible (MS)
56.66-77.77	Susceptible (S)
78.88-100	Highly susceptible (HS)

Table 5: Screening of genotypes for anthracnose resistance.

Genotype	Percent disease index	Disease reaction
IC-328537	26.66	MR
IC-328398	33.33	MR
IC-328397	33.33	MR
IC-328492	6.66	HR
IC-328404	20	MR
IC-328639	26.66	MS
IC-329462	13.33	MR
IC-328626	13.33	MR
IC-328847	20	MR
IC-328449	20	MR
IC-328411	26.66	MR
IC-329497	13.33	MR
IC-328396	53.33	MS
IC-329389	26.66	MR
IC-328653	20	MR
EC-500189	33.33	MR
EC-530916	26.66	MR
EC-530913	33.33	MR
EC-500237	26.66	MR
EC-500206	26.66	MR
EC-500250	33.33	MR
EC-500262	33.33	MR
EC-530936	46.66	MS
EC-500210	33.33	MR
EC-500200	20	MR
EC-405230	46.66	MS
EC-271523	26.66	MR
EC-500307	33.33	MR

EC-44624	33.33	MR
EC-500337	53.33	MS
Nihri-1	30.58	MR
Nihri-2	33.33	MR
Barot-1	13.88	MR
Barot-2	21.36	MR
Barot-3	33.33	MR
Barot-4	55.55	MS
Rampur-1	41.66	MS
jJanjehli-1	55.55	MS
Karsog-1	20	MR
Karsog-2	20	MR

HR: highly resistant; MS: moderately resistant; MS: moderately susceptible

Diversity in germplasm:

RESULTS AND DISCUSSION

The use of anthracnose-resistant cultivars is the most successful, efficient, and safe method of managing anthracnose in common beans, and it is simple to implement for farmers (Kelly and Vallejo 2004; Meziadi *et al.*, 2016; Singh and Schwartz 2010). In the present investigation, 40 common bean genotypes were screened for anthracnose resistance under natural conditions during *Kharif* 2022. The screening of genotypes was done according to a 0-3 scale (Inglis *et al.*, 1988) and the severity of disease was calculated by PDI (Table 5).

The severity of the disease varied among genotypes ranging from 6.66% to 53.33%. Based on the percent disease index the genotypes under study were divided into three reaction groups *viz*. highly resistant, moderately resistant and moderately susceptible. Three genotypes i.e., (IC-328492, EC-500200, and IC-329497) were found to be highly resistant. GenotypesEC-500262, EC-530916, EC-500250, EC-271523, EC-500210, EC-500206, EC-500307, EC-5309132, EC-500189, EC-44624, EC-500237, IC-328404, IC-329389, IC-328653, IC-328847, IC-328449, IC-328537, IC-328411, IC-328626, IC-329462, IC-328398, IC-328397, Barot-1, Barot-2, Barot-3, Barot-4, Janjehli-1, Karsog-1 and Karsog-2 were moderately resistant and EC- 500337, EC-405230, EC- 530936, IC- 328639, IC- 328396, Rampur-1, Nihri-1 and Nihri-2 were found to be moderately susceptible.

Crop breeding programs' primary goal is to screen and identify bean genotypes with anthracnose resistance. The current study will help to develop a cultivar with broad and long-lasting anthracnose resistance. Resistance to different races of the pathogen has also been reported in Himachal Pradesh in both indigenous and exotic accessions (Pathania *et al.*, 2006). G 2333, Widusa, Cornell 49292, TO, Perry Marrow, PI 207262, Mexique 222 and Kaboon, KRC- 5 is some of them (Zaumeyer and Thomas 1957). In another study, 10

lines (IC- 328537, IC- 328538, IC- 448888, IC-313294, IC- 278723, IC- 339645, IC- 341862, EC-169813, EC- 398530 and EC- 500226) were identified (Sharma *et al.*, 2012; Salgotra *et al.*, 2022; Sujata *et al.*, 2021). The identified resistance genotypes can be used as potential donors of resistant genes in breeding programs to develop cultivars with broad and long-lasting anthracnose resistance.

CONCLUSIONS

The screening of genotypes for anthracnose resistance was done according to a 0-3 scale (Inglis *et al*., 1988) and the severity of the disease ranged from 6.66% to 53.33% based on the percent disease index (PDI) genotypes under study was divided into three reaction groups viz. highly resistant (3), moderately resistant (29) and moderately susceptible (8). The resistant cultivar can be used in further breeding programs.

FUTURE SCOPE

The promising hybrids identified in this study can act as potential donors of resistant genes in breeding programs to develop cultivars with broad and durable resistance to anthracnose.

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Conflict of Interest. None.

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