



## Research Article

# EVALUATION OF RAJMASH (*Phaseolus vulgaris* L.) GERMPLASM FOR RESISTANCE TO VARIOUS DISEASES

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**Abstract:** Sixty Rajma landraces and four local checks collected from different regions of the India were evaluated at Bioversity International, Bengaluru against major diseases namely angular leaf spot, rust, powdery mildew, Bean Yellow Mosaic Virus (BYMV) and Common Bean Mosaic Virus (CBMV) diseases under field condition. The results indicated that there is a significant genetic variability in the landraces collected against major diseases and showed varied degree of resistance to different pathogens. BFB-23 showed immune reaction to all the five major diseases. BFB-14 recorded immune reaction to rust, powdery mildew, BYMV and CBMV. BFB-38 exhibited immune reaction to Rust, BYMV and CBMV. Other landraces showed varied range of disease reaction from resistance to highly susceptible. Sources of resistance identified from this study will be utilized in crossing programme and incorporation of the desirable traits for developing resistant varieties in future breeding programs.

**Keywords:** Rajma, Landraces, Leaf spot, Rust, Powdery Mildew and Viral disease

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## Introduction

Rajmash or Rajma (*Phaseolus vulgaris* L.) is a leguminous plant also known as red kidney bean, common bean or haricot bean or dry bean or snap bean. It is highly nutritious, an important source of protein and calories in human diets [1,2]. The set of essential amino acids present in Rajma is complementary to the grains of cereals such as rice (*Oryza sativa* L.) hence, rajma and rice are regularly consumed together in most of the North Indian States [3,4]. Rajma cultivars were grown and consumed an approximately 33.06 million hectares in about 120 countries with a production of 28.90 million tonnes. Asian countries share the major common bean production areas (49.7%) followed by the America's (24.4%) and Africa's (24.4%) [5].

In India, the Rajma crop is largely grown in Himachal Pradesh, Jammu and Kashmir, Uttarakhand, and North Eastern Hill Region having mild climate with humid environmental conditions [6]. Rajma production is however constrained by several fungal diseases like angular leaf spot caused by *Phaeoisariopsis griseola* (Sacc.), rust caused by *Uromyces appendiculatus* and powdery mildew caused by *Erysiphe polygoni* and viral diseases namely Bean Yellow Mosaic Virus (BYMV) and Common Bean Mosaic Virus (CBMV).

Number of high yielding genotypes of Rajma were identified in the past and made available to the farmers in Northern part of India but systematic evaluation of Rajma genotypes was not carried out in south Indian states hence this experiment was planned to evaluate north Indian landraces at Bangalore location to screen against various diseases under natural field condition. The major fungal and viral diseases in Rajma affects the foliage and pods throughout the growing season. Development of resistant cultivars against above diseases is the productive method of disease management compared to chemical management [7].

## Materials and Methods

Field experiment was conducted at Bioversity International farm situated at College of Horticulture Bengaluru during Kharif 2019. The landraces and local varieties collected from different states of North India namely Jammu and Kashmir, Uttarakhand, Chhattisgarh, and North Eastern region of India were sown along with standard checks namely Arka Suvida, Arka Arjun, Arka Komal and Arka Anoop. The Experiment was laid out in Latin Square Design (LSD) and in each replication the sixty-four genotypes were grown in 5 rows of 1.5 meter long with spacing of 30 x 15 cm for row to row and plant to plant respectively. Within a row, seeds were dibbled 15 cm apart. General cultural practices were adopted to maintain the experiment except spraying of plant protections chemicals in order to encourage disease for effective screening.

The observations were recorded from randomly selected ten plants in each germplasm using disease incidence rating for angular leaf spot was based on a 1-9 arbitrary scale [as suggested by CIAT, 1987[8]]. Disease incidence rating for rust was based on 0-9 points rating scale as suggested by CIAT, 1987[8]. Disease incidence rating for powdery mildew was based on 0-5 points rating scale as adopted from ICARDA International Nursery Guideline described for small grain legumes [9]. For viral diseases percentage of plants affected by virus was recorded by observing number of plants affected by virus to the total number of plants of each treatment.

These values were converted into Percent Disease Index (PDI) by using Wheeler, 1969[10].

Percent disease index PDI = [(Sum of individual disease ratings) / (Total no. of leaves observed x Maximum disease score)] X 100

# Evaluation of Rajmash (*Phaseolus vulgaris* L.) Germplasm for Resistance to Various Diseases

Table-1 Evaluation of French bean accessions against Angular leaf Spot, Rust, PM, BYMV and CBMV

SN	Name of the genotype	Angular leaf spot		Rust		Powdery mildew		Percent intensity of BYMV	Percent intensity CBMV
		PDI	Disease reaction	PDI	Disease reaction	PDI	Disease reaction		
1	BFB-1	58.73	HS	34.92	S	53.57	HS	0.00	0.00
2	BFB-2	65.08	HS	0.00	I	75.00	HS	0.00	11.67
3	BFB-3	61.90	HS	26.98	MS	0.00	I	0.00	8.33
4	BFB-4	58.73	HS	58.73	HS	7.14	R	23.08	0.00
5	BFB-5	58.73	HS	34.92	S	0.00	I	0.00	12.90
6	BFB-6	46.03	S	34.92	S	53.57	HS	0.00	13.46
7	BFB-7	68.25	HS	26.98	MS	85.71	HS	0.00	0.00
8	BFB-8	55.56	HS	14.29	MR	35.71	S	0.00	0.00
9	BFB-9	42.86	S	49.21	S	0.00	I	0.00	0.00
10	BFB-10	55.56	HS	31.75	S	60.71	HS	0.00	0.00
11	BFB-11	52.38	HS	22.22	MS	60.71	HS	0.00	0.00
12	BFB-12	39.68	S	14.29	MR	17.86	MR	33.33	23.33
13	BFB-13	61.90	HS	71.43	HS	0.00	I	0.00	0.00
14	BFB-14	65.08	HS	0.00	I	0.00	I	0.00	0.00
15	BFB-15	80.95	HS	74.60	HS	3.57	R	0.00	0.00
16	BFB-16	52.38	HS	49.21	S	50.00	HS	0.00	0.00
17	BFB-17	25.40	MS	41.27	S	0.00	I	0.00	0.00
18	BFB-18	41.27	S	71.43	HS	10.71	MR	0.00	0.00
19	BFB-19	46.03	S	44.44	S	0.00	I	0.00	16.95
20	BFB-20	49.21	S	28.57	MS	0.00	I	0.00	0.00
21	BFB-21	65.08	HS	30.16	S	57.14	HS	0.00	11.86
22	BFB-22	55.56	HS	33.33	S	50.00	S	0.00	0.00
23	BFB-23	0.00	I	0.00	I	0.00	I	0.00	0.00
24	BFB-24	55.56	HS	39.68	S	89.29	HS	0.00	10.53
25	BFB-25	42.86	S	15.87	MR	0.00	I	0.00	0.00
26	BFB-26	46.03	S	44.44	S	42.86	S	0.00	0.00
27	BFB-27	49.21	S	84.13	HS	0.00	I	9.52	19.05
28	BFB-28	47.62	S	19.05	MR	60.71	HS	0.00	0.00
29	BFB-29	47.62	S	19.05	MR	0.00	I	0.00	0.00
30	BFB-30	58.73	HS	0.00	I	71.43	HS	0.00	7.27
31	BFB-31	55.56	HS	23.81	MS	32.14	S	18.42	13.16
32	BFB-32	49.21	S	58.73	HS	0.00	I	0.00	0.00
33	BFB-33	33.33	S	11.11	MR	0.00	I	0.00	0.00
34	BFB-34	61.90	HS	39.68	S	25.00	MS	0.00	4.83
35	BFB-35	65.08	HS	30.16	S	42.86	S	0.00	13.79
36	BFB-36	55.56	HS	23.81	MS	64.29	HS	0.00	0.00
37	BFB-37	46.03	S	25.40	MS	0.00	I	5.77	5.76
38	BFB-38	34.92	S	0.00	I	67.86	HS	0.00	5.12
39	BFB-39	52.38	HS	23.81	MS	0.00	I	0.00	17.86
40	BFB-40	46.03	S	25.40	MS	71.43	HS	0.00	10.00
41	BFB-41	33.33	S	19.05	MR	78.57	HS	0.00	8.33
42	BFB-42	55.56	HS	33.33	MS	71.43	HS	0.00	0.00
43	BFB-43	52.38	HS	17.46	MR	50.00	S	0.00	4.08
44	BFB-44	49.21	S	19.05	MR	60.71	HS	0.00	5.00
45	BFB-45	49.21	S	60.32	HS	67.86	HS	7.14	7.14
46	BFB-46	46.03	S	55.56	HS	46.43	S	0.00	0.00
47	BFB-47	39.68	S	14.29	MR	35.71	S	9.68	0.00
48	BFB-48	49.21	S	19.05	MR	78.57	HS	0.00	4.00
49	BFB-49	36.51	S	1.59	R	0.00	I	0.00	5.76
50	BFB-50	46.03	S	30.16	S	78.57	HS	0.00	0.00
51	BFB-51	41.27	S	36.51	S	50.00	S	0.00	0.00
52	BFB-52	68.25	HS	60.32	HS	82.14	HS	0.00	15.38
53	BFB-53	36.51	S	22.22	MR	0.00	I	14.29	23.81
54	BFB-54	58.73	HS	65.08	HS	67.86	HS	27.78	13.89
55	BFB-55	36.51	S	15.87	MR	35.71	S	0.00	0.00
56	BFB-56	52.38	HS	19.05	MR	0.00	I	0.00	0.00
57	BFB-57	55.56	HS	44.44	S	0.00	I	0.00	46.67
58	BFB-58	46.03	S	19.05	MR	0.00	I	0.00	0.00
59	BFB-59	36.51	S	22.22	MS	0.00	I	17.31	11.54
60	BFB-60	41.27	S	39.68	S	78.57	HS	0.00	10.64
61	Check 1	39.68	S	0.00	I	3.57	R	0.00	0.00
62	Check 2	41.27	S	31.75	S	32.14	S	0.00	0.00
63	Check 3	36.51	S	31.75	S	35.71	S	0.00	0.00
64	Check 4	65.08	HS	0.00	I	0.00	I	0.00	0.00

Table-2 Classification of genotypes based on the infection rating of *Alternaria* leaf spot

Alternaria leaf spot Infection Rating	Immune	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible	Highly Susceptible
Genotypes Reaction	BFB-23			BFB-17	BFF6,9,12,18,19,20,25,26,27,28,29,32,33,37,38,40,41,44,45,46,47,48,49,50,51,53,55,58,59,60	1,2,3,4,5,7,8,10,11,13,14,15,16,21,22,24,30,31,34,35,36,39,42,43,52,54,56,57

Table-3 Classification of genotypes based on the infection rating of Rust

Rust Infection Rating	Immune	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible	Highly Susceptible
Genotypes Reaction	BFB-2, 14, 23, 30, 38,	BFB-49,	BFF 8,12,25,28,29,33,41, 43,44,47,48,53,55,56,58	BFF3,7,11,20,31,36,37,39,40,42 ,59	BFF5,6,9,10,16,17,19,21,22 ,24,26,34,35,50,51,57,60	BFF13,15,18,27,32, 45,46,52,54,

Table-4 Classification of genotypes based on the infection rating of Powdery mildew

Powdery mildew Infection Rating	Immune	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible	Highly Susceptible
Genotypes Reaction	BFB-3, 5, 9, 13, 14, 17, 19, 20, 23, 25, 27, 29, 32, 33, 37, 39, 49, 53, 56, 57, 58, 59	BFF 4 and 15	BFF-12 and 18	BFF- 34	BFF- 8,22,26,31,35	1,2,6,7,10,11,16,21,24,28,30,36,38, 40,41,42,44,45,48,50,52,54,60

Table-5 Germplasms were further grouped into the following categories based on the PDI value.

Disease reactions	PDI range
Immune	0
Resistant	1-10
Moderately resistant	11-20
Moderately Susceptible	21-30
Susceptible	31-50
Highly susceptible	51-100

## Results and Discussion

The results indicated that there is considerable variability among the germplasms for resistance. The reaction of rajma germplasm against Angular leaf spot, Rust, Powdery mildew, Common bean mosaic virus and Golden Yellow Mosaic Virus are presented in [Table-1]. The maximum Percent Disease Incidence (PDI) of 89.29 was recorded for powdery mildew and the minimum 0.00 in case of few landraces for all five diseases studied. Promising germplasm identified against important biotic stresses are listed in [Table-2, 3 and 4]. The reaction of Rajma germplasm against each of the diseases is summarized here under.



Fig-1 BFB-23 immune reaction to Angular leaf Spot, Rust, and Powdery Mildew

## Disease reaction of germplasm against biotic stresses

### Angular leaf spot

It is an important worldwide occurring disease of Rajma particularly in mid-hill conditions where moderate temperatures with high humidity conditions favour the development of this disease [11]. In India, the total loss including damaged and unmarketable pods have been estimated to be about 40–70% due to this disease [12] whereas up to 20-25% loss in grain yield every year has been recorded in Sikkam[13]. With respect to this disease, landrace BFB-23 showed immune reaction and totally free from the disease. PDI ranged from 0.00 per cent to 80.95 per cent. None of the accessions showed resistance reaction while one landrace showed moderately susceptible and thirty landraces showed susceptible reaction and remaining twenty-eight landraces showed highly susceptible reaction. All the checks included in the study also revealed susceptible reaction with the PDI ranging from 36.51 to 65.08 per cent [Table-5].

### Screening for rust resistance

Rust disease has been reported from the entire bean growing areas of the world and it was first described from Germany in 1795[14]. In India, losses in green pod yield due to this disease ranged in between 4.7% and 69.0% [15]. The rust incidence was recorded at physiological maturity of the genotype and the results are presented in [Table-1]. Reactions of 60 genotypes to rust revealed that, five accessions namely BFB-2, BFB-14, BFB-23, BFB-30 and BFB-38 showed immune reaction and totally free from the diseases.

PDI ranged from 0.00 per cent to 84.13 per cent, BFB-27 (84.13) showed maximum PDI and was highly susceptible [Table-5]. Five accessions exhibited immune reaction, one accession showed resistance reaction and fourteen accessions showed moderate resistance. While, nineteen accessions showed moderate susceptibility and ten accessions showed highly susceptible reaction. Out of 4 checks, two checks were immune to rust and while other two checks showed susceptibility reaction[Table-1].

### Powdery mildew

Out of 60 accessions screened for powdery mildew, 22 accessions showed immune reaction and these accessions are totally free from the disease. Two accessions showed moderate resistance. While, eleven genotypes showed moderate susceptibility and twenty-two accessions showed highly susceptible reaction. PDI ranged from 0.00 to 89.29 per cent, the accession BFB-24 (89.29) showed maximum PDI followed by BFB-7 (85.71), BFB-52 (82.14), BFB-60 (78.57) and were highly susceptible [Table-5].

### Screening for Bean Yellow Mosaic Virus and Common Bean Mosaic Virus

With respect to Yellow Mosaic Virus, out of 60 accessions, 10 accessions showed range of reaction to Bean Yellow Mosaic Virus (BYMV). Percent of incidence ranged from 5.77 to 33.33 per cent. Maximum percent of incidence observed in BFB-12 (33.33) followed by BFB-54 (27.78), BFB-4 (23.08), BFB-31 (18.42) and BFB-59 (17.31). Other fifty accessions not showed any symptoms pertaining to this virus. None of the checks showed any symptoms to this virus. With respect to CBMV, twenty-nine accessions showed varied percent of incidence ranging from 4.00 to 46.67. Maximum percent of incidence observed in BFB-17 (46.67) followed by BFB-53 (23.81), BFB-4 (23.33), BFB-27 (19.05) and BFB-59 (17.86). Other thirty-one accessions not showed any symptoms pertaining to this virus. None of the checks showed any symptoms to this virus.

The Rajma germplasm was grouped based on the mean PDI in to different categories viz., Immune (0) resistant (1-10); moderately resistant (11-20); moderately susceptible (21-30); susceptible (31-50) and highly susceptible (51-100) [Table-5]. Based on this scale genotype BFB-23 showed immune reaction to all the five diseases studied [Table-3, 4 and 5]. BFB-14 and BFB-23 recorded immune reaction to all four diseases except Angular leaf spot [Table-3, 4 and 5]. BFB-38 exhibited immune reaction to three diseases studied except Angular leaf spot and Powdery mildew disease. Other genotypes showed range of disease reaction from resistance to highly susceptible reaction.

### Conclusion

Even though there are several methods to combat the diseases such as cultural, physical, biological, chemical means but the host plant resistance is paramount because of its eco-friendly nature and cost effectiveness. One of the easiest and cheapest method to manage these diseases is to select the resistant genotypes against above studied diseases. The present study indicated that there is significant genetic variability in the overall Rajma germplasm collections for degree of resistance to different pathogens. Accession BFB-23 showed immune reaction to all the five diseases studied, BFB-14 and BFB-23 recorded immune reaction to four diseases except Angular leaf spot and BFB-38 exhibited immune reaction to three diseases studied except Angular leaf spot and Powdery mildew disease. Significant sources of resistance identified for Angular leaf spot, rust and powdery mildew will be utilized in crossing programme and incorporation of the resistance in to desirable backgrounds for developing resistant pure line/ varieties in future breeding programs.

It was also observed that the manifestation and degree of disease incidence was very low in case of Bean Yellow Mosaic Virus (BYNV) and Common Bean Mosaic Virus (CBNV) for drawing meaningful conclusions.

**Application of research:** Identified tolerant genotypes for various diseases of Rajma would help for future breeding programmes for transferring the trait of interest.

**Research Category:** Genetics & Plant Breeding

**Abbreviations:** BYMV-Bean Yellow Mosaic Virus

CBMV-Common Bean Mosaic Virus

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**Author Contributions:** All authors equally contributed

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**Study area / Sample Collection:** College of Horticulture, Bengaluru

**Cultivar / Variety / Breed name:** Rajma (*Phaseolus vulgaris* L.)

**Conflict of Interest:** None declared

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