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Resistant resources and transmission of bacterial blight of common beans (*Phaseolus vulgaris* L.)

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Abstract
The present investigations regarding the identification of resistance resources of bacterial blight in common bean were conducted in the SKUAST-K during 2009 to 2010. Study showed that the infected seeds harbour the pathogen beyond the next sowing season. The viability of pathogen on infected seeds decreased with time. Out of forty one bean genotypes screened against the pathogen under conditions of artificial inoculation, 2 were categorised as resistant, 2 as moderately resistant, 21 as moderately susceptible, whereas 13 genotypes were found susceptible and only three genotypes were highly susceptible.

Keywords: resistance, screening, bean, bacterial blights, transmission

1. Introduction
Common bean (*Phaseolus vulgaris* L.) locally known as Rajmash or Rajma, is one of the major legumes cultivated throughout the world. In India, its cultivation is spread over about 8.0 million hectares with an annual production of 3.2 million tons [1]. It is a green legume of worldwide significance for direct human consumption and a dietary supplement rich in proteins, vitamins and minerals such as calcium, phosphorus, iron and zinc [2]. It is the premier green legume crop of Jammu and Kashmir where its cultivation is mainly confined to rainfed and *Karewa* areas covering an area of about 26.75 thousand hectares with an annual production of 14.2 thousand metric tons [3]. Kashmiri Rajma is a prized commodity throughout northern India and is valued as *Dal* for its taste and colour. As vegetable crop, French bean is grown in Kashmir over an area of 2000 ha with an annual production of 400 metric tonnes [4].
Nutritionally, legumes play an important role in human diet and edible bean (*Phaseolus vulgaris* L.) is one of the most important legume crops in the world owing to its high commercial value, extensive production, consumer use and nutrients like carbohydrates, proteins, minerals and vitamins. It is traditionally a basic food crop in many developing countries, and serves as a major plant protein source for rural and urban areas [5]. Beans are a key source of proteins, with high contents of lysine and methionine, the dry pulse bean has 22% protein, while the green snap bean has 6.1% protein, and are increasingly being consumed as an alternative to animal protein by low income families in developing countries as immature green pods or as dry pulses [6].

Materials and Methods
Transmission of disease
Survival on seed
Survival of the pathogen was studied on naturally infected and artificially inoculated bean seeds. Naturally infected seeds were obtained after harvesting, from mature pods severely infected with common bacterial blight disease.

Artificial inoculation of seeds
Healthy bean seeds were collected soon after harvesting of bean crop and artificially inoculated with *Xanthomonas campestris* pv. *Phaseoli* was done as per the method described by Leben [7]. Bacterial cells from 48 hours old culture of the pathogen were suspended in sterile distilled water and adjusted to an optical density of 0.2 (equalling 10^8cfu/ ml). Bean seeds were dipped in the suspension for 2 hours, dried in thin layers of paper for 2 days and stored in laboratory for periodical assays.
Seeds were sown twice in the month of March and May to detect presence of the pathogen in both naturally infected and artificially inoculated seed.

Role of seed
Naturally infected and artificially inoculated seeds were sown in pots containing sterilized soil in the months of March and May. Observations on seed germination (%) and plant stand (%) were made on the basis of number of seeds germinated out of total seeds sown and number of plants surviving at true leaf stage, respectively. Seedlings were regularly observed for presence of common bacterial blight symptoms. Disease incidence was recorded on the basis of number of seedlings expressing disease symptoms out of total number of seedlings emerged in each case.

Management of disease through resistance
Seeds of 41 different bean varieties/lines were obtained from Department of Plant Breeding and Genetics Faculty of Agriculture Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, Wadura Sopore (J&K) to evaluate for susceptibility/ tolerance against the pathogen *Xanthomonas campestris* pv. *Phaseoli* under conditions of artificial inoculation. Pots were arranged in a greenhouse and the temperature was maintained at 25 ± 2^0C. The bacterial suspension adjusted to optical density of 0.2 (equaling to10^8 cfu/ml) in sterile distilled water was sprayed on fully expanded trifoliate leaves of the plants. One set of plants was given smaller injuries on leaves, using entomological pins embedded in lac mounted on a wooden rod, prior to spray inoculation.

Sowing of seed
Seeds were sown in sterilized soil filled in polybags. Three replications of five poly bags each were maintained in case of each variety / line and four seeds were planted per polybag.

Preparation of inoculums
A virulent isolate of *Xanthomonas campestris* pv. *Phaseoli* was mass multiplied in nutrient broth. Eighty four hours old culture was diluted with sterile distilled water to adjust its optical density to 0.2 (equalling 10^8cfu/ ml).

Inoculation of plants
Plants were inoculated at the age of 4 weeks by the method described by Mkandawire *et al.,* [8]. Plants were regularly irrigated in green house for next month and observations on disease incidence and intensity were recorded after 21 days of inoculation.

Disease incidence
Disease incidence was calculated on the basis of number of plants showing disease symptoms out of total number of plants raised in case of each variety / line.

Disease intensity
Disease intensity in case of each variety / line was calculated according to the method mentioned by Souza *et al.,* [9] by which different varieties/lines were classified according to the extent of disease intensity into following groups

S. No.	Category	Per cent disease intensity
1.	Resistant (R)	(0 to 5% PDI)
2.	Moderately tolerant	(MT) (5.1 to 10% PDI)
3.	Moderately susceptible	(MS) (10.1 to 25% PDI)
4.	Susceptible (S)	(25.1 to 50% PDI)
5.	Highly susceptible	(HS) (>50% PDI).

Results and Discussion
Studies were carried out on the transmission of disease through naturally infected and artificially inoculated seeds. Results reveal that bacterium *Xanthomonas campestri* spv. *Phaseoli* inciting common bacterial blight survived on both naturally infected as well as artificially inoculated seed from harvesting up to next sowing time. It was observed that there was slight variation in germination percentage and per cent plant stand of naturally infected and artificially inoculated seeds when sown in the months of March or in May. Disease incidence was lesser (68.05% ; 65.67%) on plants sown in March but it increased to 78.35% and 72.87% in the month of May in case of naturally infected and artificially inoculated seeds respectively. This increased incidence may be attributed to increase in temperature regime from March to May. Opio *et al.,* [10] reported that warmer temperatures with high relative humidity favours the disease. This is in confirmation with present studies. The results are also substantiated by the findings of [11, 12]. These studies confirm the seed borne nature of the pathogen, which has already been reported by many workers [10, 13, 14, 15, 16].

Table 1: Infectivity of *Xanthomonas campestris* pv. *Phaseoli* incitant of common bacterial blight of beans by naturally infected seeds

Observation	Sowing time		Average
	March	May	
Germination percentage	76.00	79.00	77.5
Plant stand (%)	100	92.00	96.00
Disease incidence (%)	68.05	78.35	73.2

Table 2: Infectivity of *Xanthomonas campestris* pv. *Phaseoli* incitant of common bacterial blight of beans by artificially inoculated seeds

Observation	Sowing time		Average
	March	May	
Germination percentage	78.00	82.00	80.00
Plant stand (%)	100	100	100
Disease incidence (%)	65.67	72.87	69.27

There is a global concern over the excessive use of pesticides in agro ecosystem. Efforts to manage diseases and pests of plants through eco-friendly practices are given priority. The host resistance is considered as a cost effective and eco-friendly method of disease management. Efforts were therefore made during the present study to explore the possibility of disease management through screening of available germplasm for utilization of resistant ones in hybridization programme so as to minimize chemical usage.
Present observations regarding the reaction of 41 genotypes of beans to *Xanthomonas campestris* pv. *Phaseoli* (common bacterial blight) revealed that the test genotypes showed significantly varying response to the pathogen under greenhouse conditions. The tested genotypes were categorized into various reaction groups on the basis of mean per cent disease intensity. Two genotypes found resistant to the pathogen are WB- 249 and WB- 22. Mean disease intensity in test genotypes varied between a range of 7.86 per cent in case of genotype Red Dowry and 53.54 per cent in case of highly susceptible genotype French Yellow. On the basis of degree of variability in disease reaction, two genotypes *viz.,* (Red Dowry and Gurez) were categorized as moderately tolerant 21 as moderately susceptible, 13 as susceptible and only three genotypes (SKUA-RB-8, Master Bean and French Yellow) as highly susceptible. Numerous workers have also recorded varying degree of susceptibility/ tolerance in various bean genotypes against *Xanthomonas campestris* Pv. *phaseoli*

under greenhouse conditions. The present observations are in agreement with the findings of [5, 17, 18, 19, 20, 21]

It is evident from the present investigation on existing available germplasm that there exists a great scope for developing tolerant/ resistant cultivars with acceptable varietal characters.

Table 3: Screening of various bean genotypes against common bacterial blight

Genotypes	Disease incidence* (%)	Disease intensity* (%)	Reaction **
WB-249	0(1)	0(1)	R
WB-22	0(1)	0(1)	R
Red Dowry	14.98 (3.99)	7.86(2.97)	MR
Gurez	17.49 (4.30)	8.69 (3.11)	MR
SKUA-RB-3	21.15 (4.70)	10.04 (3.32)	MS
RB-7	21.30 (4.72)	10.07 (3.33)	MS
WB-55	22.64 (4.86)	11.35 (3.51)	MS
WB-235	23.30(4.92)	12.40 (3.66)	MS
RB-8	25.11 (5.10)	12.45 (3.67)	MS
SKUA-RB-7	26.27 (5.22)	13.12 (3.75)	MS
WB-245	26.56 (5.24)	13.27 (3.77)	MS
WB-117	27.52 (5.34)	13.57 (3.81)	MS
WB-223	32.34 (5.77)	16.17 (4.14)	MS
WB-232	32.89 (5.82)	16.42 (4.17)	MS
RB-10	36.96(6.16)	16.94 (4.23)	MS
RB-18	37.22 (6.18)	17.09 (4.25)	MS
WB-246	37.51 (6.20)	18.75 (4.44)	MS
SKUA-RH-91	42.61 (6.60)	20.22 (4.60)	MS
SKUA-RB-47	43.46 (6.66)	20.89(4.67)	MS
WB-115	43.89(6.70)	21.29(4.72)	MS
WB-192	44.15(6.71)	21.93(4.78)	MS
SKUA-RB-39	46.16(6.86)	22.14(4.82)	MS
WB-241	46.33 (6.87)	23.12 (4.91)	MS
SKUA-RB-51	46.43 (6.89)	23.38 (4.93)	MS
WB-242	47.03 (6.93)	23.98 (4.99)	MS
WB-237	51.23 (7.22)	25.58 (5.15)	S
SKUA-RB-18	52.19 (7.29)	25.63 (5.16)	S
SKUA-RB-109	52.48(7.31)	25.70 (5.17)	S
Local Red	54.83 (7.47)	25.78 (5.18)	S
WB-244	56.26 (7.56)	27.94 (5.37)	S
SKUA-RB-40	57.62 (7.65)	28.34 (5.41)	S
SKUA-RB-17	61.86 (7.92)	30.38 (5.60)	S
WB-230	62.03 (7.93)	30.75 (5.63)	S
WB-199	64.05 (8.00)	34.55(5.96)	S
WB-211	65.75 (8.17)	35.46 (6.03)	S
SKUA-RB-22	70.76 (8.47)	38.44 (6.28)	S
SKUA-RB-19	72.73 (8.58)	41.30 (6.50)	S
SKUA-R-103	74.03(8.66)	44.37(6.73)	S
SKUA-RB-8	84.35 (9.23)	51.30 (7.23)	HS
Master Bean	87.74 (9.42)	53.30(7.36)	HS
French Yellow	88.12(9.44)	53.54 (7.38)	HS

*Based on the Tukey's Test i.e. modified Dunkan's Multiple Range Test (DMRT) varieties was found statistically significant at 5% level of significance and were categorised into different levels. Data is mean of 3 replications, following the ANOVA in one way, with figures in the parentheses as transformed values. **Categorised as R-resistant (0- 5 % PDI), MR-moderately resistant (5.1-10 % PDI), MS-susceptible (10.1-25 % PDI), S-susceptible (25.1-50 % PDI) and HS-highly susceptible (>50 % PDI).

Summery and conclusion

During the present investigations the resistance reaction of 41 genotypes of beans to *Xanthomonas campestris* pv. *Phaseoli* (common bacterial blight), the test genotypes showed significantly varying response to the pathogen under controlled environment. The genotypes were categorized into various reaction groups on the basis of mean per cent disease intensity. Mean disease intensity in test genotypes varied between a range of 7.86 per cent in case of genotype Red Dowry and 53.54 per cent in case of highly susceptible genotype French Yellow.

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