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Evaluation of Common Bean (*Phaseolus vulgaris* L.) Germplasm for Resistance to Angular Leaf Spot Disease [*Phaeoisariopsis griseola* (Sacc.) Ferraris] under Cold Arid Conditions of Ladakh

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ABSTRACT

An experiment was conducted to identify promising accessions suited for cultivation under cold arid conditions of Leh, Ladakh. Twenty two accessions of French bean were screened for resistance to angular leaf spot disease during the spring seasons of 2016 and 2017 in the Experimental field of High Mountain Arid Agriculture Research Institute (HMAARI) Leh, Ladakh, Sheri Kashmir University of Agricultural Sciences and Technology of Kashmir. The study revealed that under natural epiphytotic conditions none of the accessions was resistant in reaction. Eight accessions *viz*., Acc-WB22, Acc-1643, Acc-1690, Acc-811, Acc-4564, WB-1247, WB-185 and Acc-252 were moderately susceptible. All other fourteen accessions *viz*., Acc-966, Acc-335, Acc-1129, Acc-21529, Acc-WB216, Acc-719, WB-956, Acc-622, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local exhibited susceptible reaction.

Key words: Accessions, Angular leaf spot, Evaluation, French bean, Screening.

INTRODUCTION

Common beans (*Phasolus vulgaris* L.) also called as Rajmash or Rajma (Hindi) or haricot bean or kidney bean or common bean or snap bean or french bean, occupies premier place among grain legumes in number of countries including India. Legumes constitute the third largest family of higher plants, with 20,000 species and second in agricultural importance based on area and total production (Razvi *et al.* 2018). Among grain crops, pulses (food legumes) rank third after cereals and oilseeds in terms of total world production. Pulses are rich in proteins and represent an important source of dietary protein for humans and animals. The proteins are generally composed of high amount of lysine, while the amount of methionine and cysteine is less. However, consumption of legumes and cereals results in a balanced diet of energy and protein. Common bean is an important legume crop in the daily diet of more than 300 million people of the world's population (Hadi *et al.* 2006; Meziadi *et al.* 2016). In particular, in developing countries, the importance of common bean is beyond limit as a source of cash and full food nutrients (Popelka *et al*. 2004; Hadi *et al*. 2006; Akhavan *et al.* 2013; Meziadi *et al.* 2016). Legumes are also an important source of some essential minerals (Grusak, 2002). The legumes have been observed to reduce blood cholesterol levels (Andersen *et al*., 1984). It is consumed in different forms including the leafy vegetable, pods, green grains and as dry beans (Katungi *et al.* 2009). It is a source of vitamin-B, calcium, iron, phosphorus and zinc which are essential for human growth, health and development. According to Rusuku *et al.* (1997), in the developing world, this leguminous crop is produced subsistantly by women farmers' who market approximately 40% of their produce estimated at US $452 million, while the rest of the crop is used for home consumption.

It is largely grown in Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, North Eastern Hills, Darjeeling, South plateau Hills (Nilgiri and Palni hills) Mahabaleshwar, Ratnagiri (Maharastra) and Chickmanglore (Karnataka) having mild climate with humid environmental conditions (Amit Koul *et al.* 2018). Although there has been increase in bean production due to expansion into marginal

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agricultural lands, productivity has not shown any encouraging improvements. Typical bean yields obtained on farmers fields are only 20% to 30% of the genetic potential of improved varieties (Wortman *et al*.1998). One of the reasons for low productivity is lack of effective disease management practices including lack of disease resistant cultivars. The development of cultivars with improved resistance to biotic and abiotic stresses has long been a primary goal for many bean breeding programs (Miklas *et al.* 2006). Among the diseases Angular leaf spot (ALS) of common bean caused by the imperfect fungus *Phaeoisariopsis griseola* (Sacc.) Ferraris, is one of the most damaging and widely distributed disease. This disease mainly infects leaves and pods, inducing premature leaf dropping and consequently reduction in grain quality (Mahuku *et al.* 2009). Losses in grain yield caused by ALS can reach 80% (Singh and Schwartz, 2010). Use of resistant varieties combined with other disease management practices is regarded as the most practical approach to disease control at the farm level. The greatest setback to this strategy is the high pathogenic variability occurring on *Phaeoisariopsis griseola* (Sacc.) that renders bean varieties that are resistant in one location or year susceptible in another and also its incidence and severity has increased in the areas of common bean production (Stenglein *et al.* 2003). It is considered that the use of resistant cultivars is an efficient, safe and in expensive technique accessible for bean growers (Ferreira *et al*. 2000). In fact, this strategy is the most effective and sustainable method for controlling bean diseases (Oliveira *et al.* 2008). An important step towards achieving this goal involves testing of the available germplasm to identify potential doners for resistance. Although currently there are no well adapted parents available for breeding, hence to draw genes from both local and conserved material, this study was undertaken to identify potential sources of resistance to angular leaf spot from the accessions maintained and collected from major bean growing regions of the state. Common bean has a great scope in Ladakh as the road remains closed for almost six months during winters and no fresh vegetable is available during that season.

MATERIALS AND METHODS

Twenty two common bean accessions (Table 2) selected from germplasm collection maintained at dry land agriculture research station K. D. Farm, Old Air Field, Rangreth, Srinagar, India were screened against the angular leaf spot disease under natural conditions at High Mountain Arid Agriculture Research Institute Leh, Ladakh SKUAST-K during 2016 and 2017. The experiment was laid out in a complete randomized block design with three replications in each year. Recommended agronomic practices were followed to raise a good crop. From each representative collection, 10 plants were selected randomly, kept unsprayed throughout the season and were tagged for the assessment of the disease. All the leaves of the ten plants were counted and then grouped as healthy and diseased. The disease incidence and intensity was assessed in the month of September. Per cent disease incidence was worked out as per the following formula given by (James,1974):

Percent disease incidence =

$$\frac{\text{No. of diseased leaves}}{\text{Total no. of leaves examined}} \times 100$$

For assessment of disease intensity, Twenty two accessions of common bean were screened at flowering stage of crop. Observation on angular leaf spot was recorded from flowering till maturity of the crop using Centro International de Agricultura Tropical (CIAT) 1-9 scale adapted from (Inglis *et al.* 1988) and (Razvi *et al*. 2017) which is given in Table 1.

Table 1: Evaluation scale for screening for angular leaf spot reaction.

Scale	% leaflet area with lesions
1	1-10
3	11-25
5	26-50
7	>50
9	Defoliation

Where

1 = plants with no symptoms,

3 = plants with 5-10% of the leaf area with lesions,

5 = plants with 20% leaf area infected and sporulation,

7 = plants with upto 60% of the leaf area with lesions and sporulation association with hlorosis and necrosis,

9 = 90% of the leaf area with lesions frequently associated with early defoliation and plant death.

Plants with scores less than 3 were considered resistant. Per cent disease intensity (PDI) was calculated as per the following formula given by FAO (Anonymous, 1967):

$$\text{PDI} = \frac{\Sigma\ (\text{NxV}) \text{ x } 100}{\text{N x S}}$$

Where,

Σ= summation

N= no. of leaves in each category

V= numerical value of leaves observed

S= maximum numerical value/grade.

RESULTS AND DISCUSSION

The evaluation study of 22 common bean accessions conducted during the year 2008 and 2009 under natural epiphytotic conditions against angular leaf spot (*Phaeoisariopsis griseola* (sacc. Ferr.) indicated that disease occurred in variable proportion on all the tested cultivars during both years (Tables 2 and 3). However, analysis of data showed a differential response among the accessions with regard to incidence as well as intensity.

Disease incidence

The results revealed that disease incidence was significantly different for two years and minimum of 43.61 per cent was

Table 2: Field reaction of common bean accessions against angular leaf spot disease incidence (%) during 2016 and 2017.

Accessions	Disease incidence (%)		Polled
	2016	2017	data
Acc-966	50.53	52.84	51.68
Acc-335	56.53	57.62	57.07
Acc-1129	58.62	60.69	59.65
Acc-21529	59.91	61.59	60.75
Ac-WB216	46.50	48.23	47.36
Acc-719	60.09	63.51	61.80
Acc-WB22	20.41	23.14	21.77
Acc-1643	22.97	24.15	23.56
Acc-1690	26.99	26.33	26.66
Acc-811	27.74	29.95	28.84
Acc-4564	29.01	31.77	30.39
WB-1247	33.99	35.62	34.80
WB-185	28.35	31.05	29.70
WB-956	63.77	63.27	63.52
Acc-662	59.33	59.06	59.19
Acc-252	28.18	31.04	29.61
Acc-1492	63.47	63.87	63.67
Acc-195	35.21	36.90	36.05
Anupuma	34.14	36.14	35.14
WB-6	50.52	51.10	50.81
WB-257	36.87	36.28	36.57
Local	66.47	66.17	66.32
Overall Mean	43.61	45.01	44.31
CD	2.51	2.91	2.71
CV	3.38	4.03	3.70

*Mean of three replications.

recorded in the year 2016 and maximum of 45.01 per cent in 2017. The disease incidence among the accessions ranged between 20.41 to 66.47 percent during the year 2016 as against 23.14 to 66.17 per cent in 2017. The analysis of the pooled data for two years indicated that most of the accessions evaluated were susceptible to the disease but there existed a significant difference in the disease incidence among different accessions. Maximum disease incidence (66.32%) was recorded in the accession local (local rajma) which was statistically at par with Acc-1492, WB-956, Acc-719, Acc-21529, Acc-1129 and Acc-662 with average incidence of 63.67, 63.52, 61.80, 60.75, 59.65 and 59.19 respectively. The minimum disease incidence was recorded in genotype WB-22 which was statistically at par with Acc-1643 with average incidence of 21.77 and 23.56 per cent respectively. Rest of the accessions observed have significant differential response to the maximum and minimum disease incidence.

Disease intensity

The disease intensity was significantly different for two years and minimum of 29.73 per cent was recorded in the year 2016 and maximum of 33.16 per cent in 2017. The disease intensity among the accessions ranged between 11.63 to 45.78 per cent during the year 2016 as against 15.44 to 48.82 per cent in 2017 (Table 3). The analysis of pooled data for two years indicated that most of the accessions evaluated were susceptible to the disease but there existed a significant difference in disease intensity among different accessions. Maximum disease intensity was recorded in the genotype local rajma which was statistically at par with Acc-21529, WB-956, Acc-1129, Acc-1492 and Acc-719 with average intensity of 47.30, 44.99, 44.21, 44.13, 44.04 and 43.33 respectively. The disease intensity of 41.84 per cent was recorded in Acc-662 which was statistically at par with Acc-335 (41.83%). The least disease intensity was recorded in Acc-WB22, which was statistically at par with Acc-1643, with average intensity of 13.53 and 16.61 per cent, respectively. Among 22 common bean accessions screened none of the accessions exhibited resistance reaction to the disease (rating between 0-10% PDI), eight accessions *viz.,* Acc-WB22, Acc-1643, Acc-1690, Acc-811, Acc-4564, WB-1247, WB-185 and Acc-252 were moderately susceptible (rating between 10.1-25% PDI). Rest of the fourteen accessions *viz*., Acc-966, Acc-335, Acc-1129, Acc-21529, Acc-WB216, Acc-719, WB-956, Acc-622, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local accessions were

Table 3: Field reaction of common bean accessions against angular leaf spot disease intensity (%) during 2016 and 2017 under natural field conditions.

Accessions	Disease intensity (%)		Pooled
	2016	2017	Mean
Acc-966	36.63	40.04	38.33
Acc-335	40.56	43.11	41.83
Acc-1129	42.16	46.11	44.13
Acc-21529	42.95	47.03	44.99
Ac-WB216	31.30	33.02	32.16
Acc-719	41.43	45.23	43.33
Acc-WB22	11.63	15.44	13.53
Acc-1643	14.74	17.62	16.61
Acc-1690	14.58	19.63	17.10
Acc-811	17.17	23.23	20.0
Acc-4564	18.39	24.48	21.43
WB-1247	22.33	25.41	23.87
WB-185	20.01	22.47	21.24
WB-956	43.18	45.25	44.21
Acc-662	37.44	46.25	41.84
Acc-252	19.29	23.18	21.23
Acc-1492	42.80	45.29	44.04
Acc-195	24.74	27.37	26.05
Anupuma	27.18	27.70	27.44
WB-6	32.61	34.00	33.30
WB-257	27.32	29.02	28.17
Local	45.78	48.82	47.30
Overall mean	29.73	33.16	31.46
CD (p=0.05)	2.23	2.43	2.33
CV	4.30	4.67	4.48

*Mean of three Replications.

Table 4: Grouping of common bean accessions for angular leaf spot reaction based on per cent disease intensity.

Reaction/Category	Per cent disease intensity	Accessions
Resistant (R)	0-10	-
Moderate susceptible (MS)	10.1-25	Acc-WB22, Acc-1643, Acc-1690, Acc-811, Acc-4564, WB-1247, WB-185, Acc-252
Susceptible(S)	25.1-50	Acc-966, Acc-335, Acc-1129, Acc-21529, Acc-WB216, Acc-719, WB-956, Acc-622, Acc-1492, Acc-195, Anupama, WB-6, WB-257, Local
Highly susceptible (HS)	50.1 and above	-

susceptible. The development of ALS resistance genotypes can be expected to increase profitability by reducing the amount of fungicides used to produce a crop. Plant species have a defense mechanism to avoid and resist pathogens and pests. Identification and utilization of common bean resistant sources to *P. griseola* contributes greatly to management of the disease, since resistant varieties are the most practical and easily adapted strategy. However breeding for resistant varieties has been made difficult by the high pathogenic variability of *P. griseola.* An effective way of breeding for durable resistance to the highly variable pathogen is by use of minor genes. The advantage of the host resistance is that once the technology has been developed, it is packaged in seed which is easy to disseminate and does not require any additional handling by the farmers, other than the normal crop production practices. Several common bean lines with good levels of resistance to different isolates of *P. griseola* were identified (Pastor-Corrales *et al.*1998; Mahuku *et al.* 2003). Genotypes AND 277, MAR-2, Mexico 54, BAT 332 and Cornell 49249 were identified as potential sources of resistance having dominant genes that govern plant resistance to certain races of *P. griseola* (Nietsche *et al.* 2000; Sartorato *et al.* 2000; Aggarwal *et al*. 2004; Caixeta *et al*. 2005: Pereira *et al.* 2015). Genotype Ouro Negro was reported to have dominant gene that controlled resistance to *P. griseola* races 63-39 and 31-32 (Sanglard *et al*. 2013). The common bean genotypes G10474 and G1090 were reported to have a single dominant gene conditioning resistance to two *P. griseola* pathotypes (Mahuku *et al.* 2004 and 2011). Studies by Mahuku and Iglesias (2009), revealed that common bean conditioning resistance to *P. griseola* race 31-0. Resistance to ALS disease has been shown to be inherited quantitatively. Oblessuc *et al.* (2012) showed the existence of seven QTL's that had variable magnitudes of phenotypic effects under different environments. Kimno *et al.* (2016) reported that only one out of the 34 entries studied showed field resistance to ALS and further revealed that there remains a need to identify further donors of resistance. Hence the moderately susceptible accessions identified during the present investigation (Table 4) can be screened at different stages over locations and years to confirm their reaction to angular leaf spot so that promising accessions/resistant donors can be identified and used in future breeding programs for the development ALS resistant varieties.

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