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-822, 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 (Phaseolus 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 (Popek 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 (Gruskak, 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 (Maharashtra) 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 donors 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):

\[
\text{Percent disease incidence} = \frac{\text{No. of diseased leaves}}{\text{Total no. of leaves examined}} \times 100
\]

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):

\[ PDI = \frac{\Sigma (N \times V)}{N \times S} \times 100 \]

Where,

\[ \Sigma \] = 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
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 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-1643, 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-WB22, Acc-719, WB-956, Acc-662, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local accessions were susceptible 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-WB22, Acc-719, WB-956, Acc-662, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local accessions were susceptible to the disease.

### 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

Maximum disease intensity was recorded in the genotype local rajma which was statistically at par with Acc-1643, 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-WB22, Acc-719, WB-956, Acc-662, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local accessions were susceptible to the disease.

### Minimum disease incidence

### Maximum disease intensity

Maximum disease intensity was recorded in the genotype local rajma which was statistically at par with Acc-1643, WB-956, Acc-1129, Acc-1492 and Acc-662 with average intensity of 63.67, 63.52, 61.80, 60.75, 59.65 and 59.19 respectively. The minimum disease incidence 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-1643, 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-WB22, Acc-719, WB-956, Acc-662, Acc-1492, Acc-195, Anupama, WB-6, WB-257 and Local accessions were susceptible to the disease.

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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.2003; Mahuku et al.2005). 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.

### 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 WB-956, Acc-622, Acc-1492, Acc-195, Anupama, WB-6, WB-257, Local |
| Highly susceptible(HS) | 50.1 and above              | -          |

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