LR- 4283
[1-6]



# Evaluation of Bush Type Common Bean (*Phaseolus vulgaris* L.) Genotypes for Morphological Characters and Anthracnose under Cold Arid Ladakh Conditions

S.A. Ganie[1], B.A. Wani[2]

10.18805/LR-4283


## ABSTRACT

In the present study 25 bush type common bean genotypes were evaluated for their adaptability, performance of yield, maturity and anthracnose disease. Among 25 genotypes, ten were red in colour, five were brown in colour, four genotypes were white, two purple and one each was black, pink, yellow and chocolate in colour. For seed shape, 16 genotypes were kidney shaped, 3 were oval, cylindrical and cuboidal. For seed coat pattern, 19 genotypes were plain and 6 were mottled. Seed size revealed that out of 25 genotypes, 6 were large, 17 were medium and two were small. Out of 25 genotypes, 14 were having green colour pods, 10 were yellow and one light green in colour. The pod curvature revealed that 15 genotypes were having medium pod curvature, 7 were curved and 3 genotypes were having straight pod curvature. WB-185 was earliest to flower, whereas WB-956 was earliest to maturity. Highest pod length was recorded in WB-185where as lowest was recorded in local Ladakh and WB-257. Maximum seeds per pod were recorded in genotype WB-185 whereas minimum seeds per pods were recorded in WB-956. Highest plant height was recorded in genotype WB-1690. Highest value for 100 seed weight was recorded in WB-966 and lowest value was recorded in WB-6. Highest yield per plant was recorded in WB-185 and lowest yield per plant was recorded in WB-1129. Analysis of variance revealed that the genotypes exhibited significant variability for all the traits. Screening of genotypes against anthracnose revealed that maximum disease incidence was shown by WB-1690 followed by WB-257, WB-1643, WB-956 and WB-1129. Maximum disease intensity was shown by WB-1690 while lowest disease intensity was recorded in WB-719.


**Key words:** Anthracnose, Common bean, Maturity, Screening, Yield.

## INTRODUCTION

Ladakh which is wide spread over 80,000 square kilometres being the cold arid, high altitude region of India has a very harsh climate and a short agriculture season. Nearly 89% of people live in rural areas. The villages are remote, unconnected and inaccessible. Agriculture in this region is different from that in other rural areas of India, since farming can be done only for four to five months. Further, the soil suffers from moisture stress. There are socio-economic constraints as well- small land holdings, low productivity, labour shortage, poor post-harvest management and marketing of produce. The region remains landlocked for over six months in a year due to heavy snow fall. Most of the population (>70%) of the region belongs to schedule tribe and are left with a limited period of a year to earn their livelihood. Availability of locally grown fresh vegetables is restricted to summer months and therefore, there are seasonal differences in dietary intake of food. The availability of fresh vegetable decreases significantly during the winter months, so here is great scope of pulses during harsh winter months. In winter when no fresh vegetables are available in Ladakh, Common bean can be used in diet. Wheat and alfalfa are major crops of the Ladakh region and pulses are grown on just 300 hectares with a meagre productivity of 585 kgs/ha (CRIDA, 2012). Common bean is regarded as a nearly perfect food as it contains balanced mixture of different nutrients that promote better health and fight certain diseases. However, due to disappointingly low yield of pulses, they have become less competitive and people mostly prefer wheat and other crops. Therefore, in order to diversify the farming system, it is essential to identify high yielding varieties of common bean that can perform better under Ladakh conditions. This would require characterisation of germplasm for its adaptability and yielding ability in Ladakh.

Common bean (*Phaseolus vulgaris* L.) also known as Rajmash or Rajma (Hindi) or haricot bean or kidney bean or Common bean or snap bean is an important grain legume

[1]High Mountain Arid Agriculture Research Institute, Leh-194 104, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, Jammu and Kashmir, India.
[2]Department of Seed Technology, Govt. Degree College, Anantnag-192 101, Kashmir, Jammu and Kashmir, India.

**Corresponding Author:** S.A. Ganie, High Mountain Arid Agriculture Research Institute, Leh-194 104, Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, Jammu and Kashmir, India. Email: shabeer.ganie@gmail.com

**How to cite this article:** Ganie, S.A. and Wani, B.A. (). Evaluation of Bush Type Common Bean (*Phaseolus vulgaris* L.) Genotypes for Morphological Characters and Anthracnose under Cold Arid Ladakh Conditions. Legume Research. ():

**Submitted:** 15-11-2019 **Accepted:** 05-05-2020 **Published**:

in human consumption in the whole world. Due to its importance, researchers around the world for many years have been developing new improved varieties from the many useful landraces present (Broughton *et al*. 2003; Munda, 2009). Common bean have growth habits which vary from determinate dwarf or bush types to indeterminate climbing (Kelly, 2010) and can be grown as a vegetable crop for fresh pods and leaves, or for dry seed. Furthermore, Common bean is important because it plays a role in improving soil fertility through nitrogen fixation. When used in crop rotation or intercropped with cereals it disrupts the life cycle of soil pathogens in an event were soil pathogens are present and supplies nitrogen to the cereal crop (Akibode and Maredia, 2011). Although there has been increase in bean production due to expansion into marginal 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 constraints, bean anthracnose disease caused by *Colletotrichum lindemuthianum* (Sacc. and Magnus) Briosi and Cavara is one of the most devastating seed-borne diseases of Common bean. Since this pathogen overwinters inside bean seeds hence the losses can be 100% when badly contaminated seed is planted under conditions favourable for disease development (cool and wet weather) (Sharma *et al*. 1994). Under favourable conditions during the growing season, infected seeds become discoloured, shrivelled and dark acervuli are prominent on the lesions (Gonzalez *et al.* 1998). Common bean cultivation for green pod has potential to improve the economic conditions of tribal farmers in this Ladakh region. Therefore, the present investigation was done for identification of different resistant genotypes of Common bean.

## MATERIALS AND METHODS

The present study was carried out during *kharif* 2018 at the research farm of High Mountain Arid Agriculture Research Institute Leh, SKUAST-K which is situated between 32°N to 36°N latitude and 75°E to 80°E longitude at an altitude of 3319 metres above sea level. 24 bush type genotypes of Common bean belonging to diverse maturity and market classes (comprising local landraces a well as accessions procured from national and international gene banks including a check variety Arka anup were evaluated in the present study. The experiment was conducted in randomized complete block design (RCBD) with three replications. Each genotype was represented by a plot size of 2 x 2 meter dimensions with 5 lines. Observations were recorded on plant height, days to flowering, days to maturity, pod length, seeds per pod, 100-seed weight, pods per plant and yield per plant. Days to flowering and days to maturity were measured on plot basis whereas above ground biomass and seed yield was measured on five competitive plants from each replication. Data was analysed for ANOVA using OPSTAT-1 (CCS HAU, Hisar).

Screening of 25 Common bean genotypes including popular local land races and released variety was done against anthracnose. The sowing was done on 5$^{th}$ of May in randomized complete block design (RCBD) with three replications. Recommended agronomic practices were followed to raise a good crop. No disease protection measures were adopted. 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 pods 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):

Per cent disease incidence =

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

The severity of the disease was recorded on the basis of 1 to 9 scales (CIAT 1987). The description of the scale is given below in Table 1.

Per cent Disease Index (PDI) was calculated on the basis of rating scale using the following formula,

Per cent disease incidence =

$$\frac{\text{Sum of all numerical rating}}{\text{No. of pods x maximum score in scale}} \times 100$$

On the basis of PDI, genotypes were classified into different categories (Table 2).

## RESULTS AND DISCUSSION

The general descriptive features of 25 genotypes used in the study are presented in Table 3. The growth habit of all the genotypes was bush type. Out of 25 genotypes 12 were exotic (procured from NBPGR, CIAT Columbia and IPK Germany) and 12 were local land races and arka anup was used as check. Seed colour revealed that out of 25 genotypes ten were red in colour, five were brown in colour and four genotypes were white, two purple and one each was black, pink, yellow and chocolate in colour. For seed shape, 16 genotypes were Kidney shaped, 3 each were cylindrical, cuboidal and oval. Seed coat pattern revealed that 19 genotypes were having plain seed coat pattern and 6 had mottling of variable colours and intensities. Seed size revealed that out of 25 genotypes, six were large, 17 were medium and two were small. For pod colour 14 genotypes were having green colour pods, ten were yellow and one light green in colour. The pod curvature revealed that 15 genotypes were having medium pod curvature, 7 were curved and 3 genotypes were having straight pod curvature. The results indicated diversity of market classes in the material evaluated in terms of seed size, shape and colour and pod colour and curvature.

Mean performance of genotypes for morphological and yield traits revealed that WB-185 was earliest to flower (65.333) followed by WB-252 (65.667), WB-1435 (66.333), WB-195 (66.667) and WB-811 (67.333) whereas WB-1690 (85.333) took the highest number of days to flower (Table 4). For days to maturity, results showed that WB-956 (106.667) matured earlier which was followed by WB-252 (109.333), WB-811 (109.333), WB-195 (110.000) and WB-185 (110.000) whereas WB-1690 (132.667) was late maturing. Highest pod length was recorded in case of WB-185 (11.667cm) followed by WB-216 (10.933cm), WB-1492 (10.867cm), WB-1129 (10.833cm) and Arka anup (10.700cm) whereas lowest pod length was recorded in case of WB- 6(8.833cm) and local Ladakh (8.833cm). Seeds per pod was recorded highest in genotype WB-185 (5.700) followed by WB-1129 (5.500), WB-6 (5.333), WB-1492 (5.300), WB- 1690 (5.067) and WB-1643 (5.000) whereas lowest seeds per pod was recorded in WB-956 (3.200). Plant height was recorded highest in genotype WB-1690 (42.033cm) which was followed by WB-216 (38.333cm) and Arka anup (37.800cm). The lowest plant height was recorded in genotype WB-662 (23.967cm).

The highest value for 100-seed weight was recorded in genotype WB-966 (50.100g), followed by WB-216 (43.767g) and WB-22 (43.333g) and lowest value was recorded for WB-6 (22.400g). Seed yield measured on per plant basis was recorded highest in case of WB-185 (12.733g) followed by SKUAWB-5001 (9.033g) and lowest in case of WB-1129 (5.100g). For pods per plant maximum number of pods per plant were recorded in WB-185 (9.667) followed by WB-1643 (9.633), WB-216 (9.367), WB-719 (9.333) and WB-22

**Table 1:** Description scale for rating against anthracnose.

| Rating scale | Per cent Infection |
|---|---|
| 1 | No infection |
| 3 | Upto 1% of pod surface area |
| 5 | Up to 5% of surface area |
| 7 | Upto 10% of surface area |
| 9 | More than 25% pod surface area |

**Table 2:** Reaction of different genotypes of Common bean against *Colletotrichum lindemuthianum.*

| PDI | Categories |
|---|---|
| 0 | Absolutely 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) |
| 78.88-100.00 | Highly susceptible (HS) |

**Table 3:** General description of 25 Common bean genotypes used in the study.

| Genotype | Origin | Growth habit | Seed colour | Seed shape | Seed coat pattern | Seed size | Pod colour | Pod curvature |
|---|---|---|---|---|---|---|---|---|
| WB-966 | Exotic | Bush | Red | Kidney | Mottled | Large | Green | Medium |
| WB-335 | Exotic | Bush | White | Oval | Plain | Medium | Green | Medium |
| WB-1129 | Local | Bush | Brown | Cylindrical | Plain | Medium | Green | Medium |
| WB-1435 | Exotic | Bush | Black | Oval | Plain | Medium | Light green | Curved |
| WB-216 | Exotic | Bush | Pink | Kidney | Plain | Large | Yellow | Medium |
| WB-719 | Exotic | Bush | Red | Cuboidal | Plain | Medium | Green | Medium |
| WB-22 | Exotic | Bush | Purple | Cylindrical | Plain | Large | Green | Medium |
| WB-1643 | Exotic | Bush | Brown | Cuboidal | Mottled | Medium | Green | Curved |
| WB-1690 | Local | Bush | Brown | Cylindrical | Plain | Small | Yellow | Straight |
| WB-811 | Local | Bush | Brown | Kidney | Mottled | Medium | Yellow | Medium |
| WB-1441 | Exotic | Bush | White | Kidney | Mottled | Medium | Yellow | Straight |
| WB-1247 | Local | Bush | Red | Cuboidal | Plain | Medium | Green | Straight |
| WB-185 | Exotic | Bush | Red | Kidney | Plain | Large | Yellow | Medium |
| WB-956 | Exotic | Bush | White | Kidney | Mottled | Medium | Yellow | Medium |
| WB-662 | Local | Bush | Yellow | Kidney | Plain | Medium | Yellow | Medium |
| WB-252 | Local | Bush | Brown | Kidney | Plain | Medium | Green | Curved |
| WB-1492 | Exotic | Bush | Purple | Kidney | Mottled | Medium | Green | Curved |
| WB-195 | Local | Bush | Chocolate | Kidney | Plain | Medium | Green | Medium |
| WB-6 | Exotic | Bush | Red | Oval | Plain | Large | Green | Curved |
| WB-257 | Local | Bush | Red | Kidney | Plain | Large | Green | Curved |
| Arka Anup | Check | Bush | White | Kidney | Plain | Small | Green | Curved |
| Local Ladakh | Local | Bush | Red | Kidney | Plain | Medium | Green | Medium |
| SKUAWB-5000 | Local | Bush | Red | Kidney | Plain | Medium | Yellow | Medium |
| SKUAWB-5001 | Local | Bush | Red | Kidney | Plain | Medium | Yellow | Medium |
| SKUAWB-5002 | Local | Bush | Red | Kidney | Plain | Medium | Yellow | Medium |

**Table 4:** Performance of 25 Common bean genotypes for morphological and yield parameters.

| Genotype | DF | DM | PL (cm) | Seeds/pod | PH (cm) | 100-SW(g) | Yield/plant (g) | Pods/plant |
|---|---|---|---|---|---|---|---|---|
| WB-966 | 75.66 | 122.33 | 9.50 | 3.50 | 26.83 | 50.10 | 7.70 | 8.46 |
| WB-335 | 74.66 | 121.66 | 9.16 | 4.73 | 25.76 | 37.00 | 6.46 | 6.13 |
| WB-1129 | 73.00 | 123.66 | 10.83 | 5.50 | 24.76 | 27.93 | 5.10 | 7.50 |
| WB-1435 | 66.33 | 112.33 | 9.83 | 4.03 | 30.40 | 36.60 | 8.43 | 7.66 |
| WB-216 | 74.33 | 122.66 | 10.93 | 3.86 | 38.33 | 43.76 | 6.40 | 9.36 |
| WB-719 | 72.33 | 120.66 | 9.83 | 4.16 | 28.56 | 32.66 | 6.43 | 9.33 |
| WB-22 | 75.66 | 119.66 | 9.50 | 4.46 | 28.00 | 43.33 | 8.40 | 9.33 |
| WB-1643 | 71.66 | 111.00 | 10.03 | 5.00 | 27.90 | 32.75 | 9.16 | 9.63 |
| WB-1690 | 85.33 | 132.66 | 9.50 | 5.06 | 42.03 | 22.86 | 5.82 | 8.00 |
| WB-811 | 67.33 | 109.33 | 10.50 | 4.86 | 30.93 | 36.90 | 8.43 | 7.83 |
| WB-1441 | 72.00 | 113.66 | 9.93 | 4.20 | 29.40 | 37.56 | 6.50 | 6.66 |
| WB-1247 | 70.33 | 115.00 | 10.30 | 4.13 | 30.83 | 33.56 | 6.66 | 6.00 |
| WB-185 | 65.33 | 110.00 | 11.66 | 5.70 | 31.40 | 40.56 | 12.73 | 9.66 |
| WB-956 | 67.00 | 106.66 | 10.30 | 3.20 | 30.63 | 37.76 | 7.36 | 5.50 |
| WB-662 | 72.66 | 111.00 | 10.30 | 3.53 | 23.96 | 29.63 | 5.80 | 4.36 |
| WB-252 | 65.66 | 109.33 | 10.16 | 4.53 | 26.50 | 27.61 | 6.76 | 5.66 |
| WB-1492 | 72.00 | 111.66 | 10.86 | 5.30 | 35.40 | 29.63 | 8.66 | 6.33 |
| WB-195 | 66.66 | 110.00 | 10.23 | 4.73 | 28.00 | 32.67 | 5.63 | 6.83 |
| WB-6 | 70.66 | 123.00 | 10.50 | 5.33 | 24.43 | 22.40 | 5.60 | 5.16 |
| WB-257 | 71.00 | 123.66 | 8.83 | 3.73 | 30.30 | 40.36 | 5.70 | 5.50 |
| Arka Anup | 72.66 | 111.66 | 10.70 | 4.66 | 37.80 | 39.96 | 6.56 | 6.13 |
| Local Ladakh | 74.66 | 124.33 | 8.83 | 3.50 | 25.20 | 24.76 | 7.53 | 4.16 |
| SKUAWB-5000 | 74.00 | 125.00 | 10.50 | 4.53 | 31.40 | 28.66 | 8.36 | 5.50 |
| SKUAWB-5001 | 72.00 | 121.33 | 10.66 | 4.40 | 35.30 | 29.66 | 9.03 | 6.10 |
| SKUAWB-5002 | 70.00 | 120.66 | 9.46 | 4.63 | 30.83 | 28.43 | 8.43 | 6.66 |
| CD | 1.61 | 1.99 | 0.91 | 0.64 | 1.99 | 0.98 | 0.51 | 0.58 |
| CV | 1.37 | 1.03 | 5.49 | 8.80 | 4.01 | 1.76 | 4.25 | 5.12 |

**Table 5:** Analysis of variance for morphological, maturity, yield and yield component traits of the Common bean (*Phaseolus vulgaris* L.) genotypes.

| Source of variation | DF | DF | DM | PL(cm) | Seeds/pod | PH(cm) | 100-SW(g) | Yield/plant(g) | Pods/plant |
|---|---|---|---|---|---|---|---|---|---|
| Replication | 2 | 1.48 | 2.68** | 0.33 | 0.12 | 2.84** | 0.28 | 0.66 | 1.28 |
| Genotypes | 24 | 53.74* | 138.60** | 1.41** | 1.34** | 63.88** | 144.34** | 8.23** | 8.23** |
| Error | 48 | 0.97 | 1.47 | 0.31 | 0.15 | 1.47 | 0.36 | 0.10 | 0.13 |

(9.333). The lowest pods per plant were recorded in WB-662 (4.367). Based on CD values, it could be safely concluded that the lines were significantly different from each other for various traits studied. Sofi *et al* (2014), Razvi *et al.* (2018) and Iram Saba *et al* (2017) have also reported significant variability for morphological and yield traits in Common bean germplasm tested under Kashmir valley condition. The results were also in agreement with Singh *et al*. (2009). Analysis of variance (Table 5) for the traits studied revealed that mean squares due to genotypes were significant for all the traits studied indicating presence of substantial variability in the lines evaluated that can be used to develop high yielding common bean genotypes for Ladakh region.

### Screening of genotypes

The evaluation study of 25 Common bean accessions conducted during the year 2018 under natural epiphytotic conditions against anthracnose indicated that disease occurred in variable proportion on all the tested cultivars during both years (Table 6). However, analysis of data showed a differential response among the accessions with regard to incidence as well as intensity.

### Disease incidence

The disease incidence among the genotypes ranged between 10.53 to 68.63 percent. Maximum disease incidence (68.63%) was recorded in genotype WB-1690, which was statistically at par with WB-257 and WB-1643 with average disease incidence of 64.50% and 64.36% respectively. The minimum disease incidence was recorded in genotype WB-719 (10.53%) which was statistically at par with genotype WB-22 (11.66%).Rest of the accessions observed have significant differential response to the maximum and minimum disease incidence.

### Disease intensity

The disease intensity among the genotypes ranged between 5.83 to 36.00 percent. Maximum disease incidence (36.00%) was recorded in genotype WB-1690, which was statistically at par with WB-257 and WB-1643 with average disease intensity of 33.50% and 33.30% respectively. The minimum disease intensity was recorded in genotype WB-719 (5.83%) which was statistically at par with genotype WB-22 (6.36%) and WB-1435 (6.96%). Among 25 Common bean accessions screened nine of the accessions viz., WB-1435, WB-719, WB-22, WB-811, WB-4564, WB-662, WB-6, Local Ladakh and SKUAWB-5002 exhibited highly resistant reaction to the disease (rating between 0.01-12.21% PDI), fourteen accessions *viz.,* WB-966,WB-335, WB-1129, WB-216, WB-1643, WB-1247, WB-185, WB-956,WB-252, WB-1492, WB-195, Arka Anup, SKUAWB-5000 and SKUAWB-5001 were moderately resistant (rating between 12.22-33.33% PDI). Rest of the two accessions *viz*., WB-1690 and WB-257 were moderately susceptible. The development of anthracnose 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 (Parlevlite, 2002). Similar findings were reported by Maibam Nirmala *et al*. (2015).

**Table 6:** Field reaction of Common bean genotypes against anthracnose.

| Genotype | Disease incidence | Disease intensity |
|---|---|---|
| WB -966 | 48.76 | 25.03 |
| WB -335 | 44.96 | 22.76 |
| WB -1129 | 56.33 | 28.33 |
| WB-1435 | 13.93 | 6.96 |
| WB-216 | 28.53 | 14.83 |
| WB -719 | 10.53 | 5.83 |
| WB-22 | 11.66 | 6.36 |
| WB -1643 | 64.36 | 33.30 |
| WB -1690 | 68.63 | 36.00 |
| WB -811 | 16.73 | 9.40 |
| WB -4564 | 18.26 | 9.30 |
| WB-1247 | 50.56 | 25.90 |
| WB-185 | 40.00 | 19.90 |
| WB-956 | 60.90 | 30.06 |
| WB -662 | 17.80 | 10.06 |
| WB -252 | 44.96 | 22.63 |
| WB -1492 | 30.93 | 15.30 |
| WB-195 | 18.36 | 10.70 |
| Anupma | 35.90 | 18.36 |
| WB-6 | 16.40 | 8.70 |
| WB-257 | 64.50 | 33.50 |
| Local (Ladakh) | 21.26 | 11.83 |
| SKUA WB -5000 | 23.60 | 12.40 |
| SKUA WB- 5001 | 36.36 | 18.36 |
| SKUAWB-5002 | 17.96 | 8.73 |
| CD | 4.72 | 2.91 |
| CV | 8.31 | 9.95 |

Screening is one of the important processes involved in breeding programmes and it ensures that cultivars chosen exhibits increased resistance to a wide range of diseases and insects, better tolerance to environmental stress, better seed quality and improved efficiency in the utilization of limited soil nutrients. Many workers have conducted screening and reported varying degree of resistance to anthracnose in local land races and exotic Common bean genotypes (Pathania *et al.* 2006, Kour *et al.* 2012). More than 10 different anthracnose resistance genes have been identified in a number of bean varieties (Kelly and Vallejo 2004). According to Mahuku and Riascos (2004), the best strategy to manage this disease is planting resistant cultivars, which is most effective, least expensive and easiest for farmers to adopt.

Hence the moderately resistant and moderately susceptible accessions identified during the present investigation (Table 7) can be screened at different stages over locations and years to confirm their reaction to anthracnose so that promising accessions/resistant donors can be identified and used in future breeding programs for the development of anthracnose resistant varieties.

## CONCLUSION

Out of 25 genotypes screened, nine genotypes *viz*., WB-1435, WB-719, WB-22, WB-811, WB-4564, WB-662, WB-6, Local Ladakh and SKUAWB-5002 were found highly resistant, fourteen genotypes *viz*., WB-966,WB-335, WB-1129, WB-216, WB-1643, WB-1247, WB-185, WB-956,WB-

**Table 7:** Grouping of Common bean accessions for anthracnose reaction based on per cent disease intensity.

| Reaction/Category | Per cent disease intensity | Accessions |
|---|---|---|
| Assolutely Resistant(AR) | 0 | - |
| Highly Resistant (HR) | 0.01 | WB-1435, WB-719, WB-22, WB-811, WB-4564, WB-662, WB-6, Local Ladakh, SKUAWB-5002 |
| Moderately Resistant (MR) | 12.22-33.33 | WB-966,WB-335, WB-1129, WB-216, WB-1643, WB-1247, WB-185, WB-956,WB-252, WB-1492, WB-195, Arka Anup, SKUAWB-5000, SKUAWB-5001 |
| Moderate susceptible(MS) | 34.44-55.55 | WB-1690, WB-257 |
| Susceptible(S) | 56.66-77.77 | |
| Highly susceptible(HS) | 78.88-100.00 | - |

252, WB-1492, WB-195, Arka Anup, SKUAWB-5000 and SKUAWB-5001 were moderately resistant, whereas other two genotypes were categorized as moderately susceptible. None of the genotypes was found highly susceptible to anthracnose disease.

## REFERENCES


Akibode, S. and Maredia, M. (2011). Trends in the production, trade and consumption of food-legume crops in Sub-Saharan Africa. Report submitted to SPIA. Department of Agricultural, Food and Resource Economics. Michigan State University. USA.

Broughton, W.J., Hern´andez, G., Blair, M., Beebe, S., Gepts, P. and Vanderleyden, J. (2003). Beans (*Phaseolus* spp.) model food legumes. Plant and Soil. 252: 55–128.

CIAT (1987). Standard evaluation system for the bean germplasm. Cali, Colombia.

CRIDA (2012). District wise Contingence plans. http://www.crida.in/CP-2012/index.html.

Gonzalez, M., Rodriguez, R., Zavala, M., Jacobo, J., Hernandez, F., Acosta, J., Martinez and Simpson, J. (1998). Characteri--zation of Mexican isolates of *Colletotrichum lindemuthianum* by using differential cultivars and molecular markers. Phytopathology. 88: 292-299.

Iram Saba, Parvaze A. Sofi, Zeerak, N.A., Mir, R.R. and Musharib Gull. (2017). Using augmented design for evaluation of common bean (*Phaseolus vulgaris* L.) germplasm. International Journal Current Microbiology Applied Sciences. 6 (7): 246-254.

James, W.C. (1974). Assessment of plant diseases and looses. Annual Review of Phytopathology. 12: 27-48.

Kelly, J.D. and Vallejo, V.A. (2004). A comprehensive review of the major genes conditioning resistance to anthracnose in common bean. Horticulture Science. 39: 1196-207.

Kelly, J. D. (2010). The Story of Bean Breeding. Michigan University. USA. pp 1-3.

Kour, B., Kour, G., Kaul, S. and Dhar, M.K. (2012). Screening of *Phaseolus vulgaris* cultivars growing in various areas of Jammu and Kashmir for anthracnose. International Journal of Science and Research. Pub 2: 1-8

Mahuku, G.S. and Riascos, J.J. (2004). Virulence and molecular diversity within *Colletotrichum lindemuthianum* isolates from Andean and Messoamerican bean varieties and regions. Europian Journal of Plant Pathology. 110: 253-263.

Miklas, P.N., Kelly, J.D., Beebe, S.E., Blair, M. (2006). Common bean breeding for the resistance against biotic and abiotic stresses: From classical to marker assisted selection breeding. Euphytica. 147:105-131.

Munda, A., Radisek, S., Šuštar-Vozli, J. and Javornik, B. (2009). Genetic variability of *Colletotrichum lindemuthianum* isolates from Slovenia and resistance of local *Phaseolus vulgaris* germplasm. Journal of Plant Disease Protection. 116: 23–29.

Nirmala Maibam, Satish Chandra, Pankaj Baiswar, Majumder, D., Kanchan Saikia. (2015). Host Plant Resistance and Yield Loss due to Anthracnose caused by *Colletotrichum lindemuthianum* in French bean (*Phaseolus vulgaris*). *Indian Journal of Hill Farming*. 28(1): 14-18.

Parlevliet JE 2002. Durability of resistance against fungal, bacterial and viral pathogens; present situation. Euphytica. 124: 147- 156.

Pathania Anju, Sharma, P.N., Sharma, O.P., Chahota, R.K., Bilal Ahmad and Sharma, P. (2006). Evaluation of resistance sources and inheritance of resistance in kidney bean to Indian virulences of *Colletotrichum lindemuthianum*: Evaluation of resistance in bean to anthracnose. Euphytica. 149: 97–103.

Razvi, S.M., Khan,M.N., Ashraf Bhat, M., Mushtaq Ahmad, Ganaie, S.A., Sheikh,F.A., Najeeb S. and Parry, F.A. (2018). Morphological variability and phylogenetic analysis in common bean (*Phaseolus vulgaris* L.). Legume Research. 41(2): 208-212.

Sharma, P.N., Sugha, S.K., Panwar, K.S. and Sagwal, J.C. (1994). Reaction of land races and exotic collection of kidney bean (*Phaseolus vulgaris*) to anthracnose (*Colletotrichum lindemuthianum*). Indian Journal of Agricultural Sciences. 63: 456-457.

Singh, A.K., Singh, A.P., Singh, S.B. and Singh, V. (2009). Relation--ship and path analysis for green pod yield and its contributing characters over environments in French bean (*Phaseolus vulgaris* L.). Legume Research. 32: 270-273.

Sofi, P.A., Rana, J.C. and Bhat, N.A. (2014). Pattern of variation in common bean (*Phaseolus vulgaris* L) genetic resources of Jammu and Kashmir. Journal of Food Legumes. 27: 197-201.

Wortmann, C.S., Kirkby, R.A., Elude, C.A., Allen, D.J. (1998). Atlas of common bean (*Phaseolus vulgaris* L.) production in Africa. CIAT, Cali, Colombia.