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Identification of resistant sources in soybean germplasm against major diseases under the Mid-Himalayan region of India

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Abstract

In the present study, 178 soybean germplasm lines along with eight checks were screened at Palampur during the *kharif*, 2023 and 2024, to identify resistant sources against pod blight, brown spot and bacterial pustules. PDI for pod blight varied from 0.0 to 78.52% with absolute resistance by line 'IC0118611' and that of 0.0 to 68.89% with absolute resistance in line 'EC287456' and Himso 1685 for brown spot. Similarly, 10 germplasm lines along with Himso 1685 showed immune response to bacterial pustules with PDI between 0.0 to 59.44%. Overall, highly resistance reaction exhibited by 15 germplasm lines for brown spot and bacterial pustules, 14 for pod blight and bacterial pustules, six lines for pod blight and brown spot, and that of five lines *viz*., EC287456, IC0501258, EC0039755, IC24060 and IC0118562 for pod blight, brown spot and bacterial pustules, highlighting their potential for developing varieties with stable resistance to these diseases.

Key words: Soybean, Pod blight, Brown spot, Bacterial pustules, Resistance

Soybean [*Glycine max* (L.) Merrill] is one of the most economically valuable leguminous crops in the world, a primary source of oil and protein for human consumption and animal nutrition (Delele 2021). Soybean originated in East Asia but has been cultivated globally, making it a pillar of world agriculture and food security (Wilson 2021). It is a nutritionally superior legume crop containing up to 40% protein, 20% oil, higher unsaturated fatty acid content [62% polyunsaturated fatty acids (54% linoleic and 8% linolenic), 23% monounsaturated fatty acid (23% oleic)] including omega-6 and omega-3 fatty acids, as well as essential minerals and vitamins and significantly contributes to the global protein nutrition (Kumar *et al*. 2022). In addition to its nutritional content, soybean plays a substantial role in sustainable agriculture in biological nitrogen fixation, which eliminates the use of synthetic nitrogen fertilizers and improves soil health (Singh and Sharma 2023).

In India, soybean was commercially introduced in the 1970s (Singh 2006). Today it covers around 12 million hectares of the nation's area, with major production in the northern and central parts of the country (ICAR-IISR, 2023). Himachal Pradesh, with its diverse agro-ecological regions varying from sub-tropical to temperate, offers distinctive possibilities and challenges to grow soybean. Although it is an important agricultural crop, soybean production is constrained by several biotic stresses, of which fungal and bacterial diseases are the most important yield-limiting factors. In Himachal Pradesh, some diseases have proven to be of special concern, such as frogeye leaf spot, pod blight, brown spot and bacterial blight. These together can cause yield reductions of 30-50% under the favourable conditions for disease development (Sharma and Gupta 2022). The ability to properly discriminate between varieties is important for maintaining the seed yield and identity of the variety throughout the seed multiplication program (Singh *et al*. 2021). After DUS characterization, disease identification is one of the most effective, quick and cheaper way of doing so.

Pod blight, which is caused by *Colletotrichum truncatum*, infects the entire aerial portion of the plant

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but most devastating when it infects the pods, resulting in deterioration of the seed and massive quality losses. The disease occurs commonly in the hot, wet climate of lower Himachal Pradesh and can cause yield losses of 20-40% in the susceptible varieties (Sharma *et al*. 2022). Brown spot, caused by *Septoria glycines* Hemmi, is characterised by irregular brown patches that first occur on lower leaves and then move up. The disease is very acute under conditions of high rainfall conditions and temperature ranging from 25-30°C, which is the usual situation prevailing in most of the soybean-growing tracts in Himachal Pradesh (Verma *et al*. 2023). Yield loss due to Brown spot may vary from 8-15% in fields affected moderately to more than 30% during severe infection (Kumar and Thakur 2022). Bacterial blight, which is caused by *Pseudomonas syring aepv. glycinea*, occurs as angular, water-soaked lesions that subsequently become brown with a yellow halo. It is seed-borne and is favored by cool wet weather and is thus most troublesome in Himachal Pradesh's higher elevation regions (Chauhan *et al*. 2024). The pathogen's capacity for survival in crop residues aids its continuity in regions where soybeans are being grown.

Chemical control methods, although efficient in the management of diseases, are economically and environmentally unsustainable, leading to residue buildup and resistance development in the pathogens. Moreover, the management of disease through fungicides has severe consequences on human health besides environment. Therefore, genetic resistance is economical, ideal, environmentally sustainable, and durable management strategy (Joshi and Chauhan 2023; Sharma *et al*., 2025). Yet, resistant variety development involves extensive screening of diverse germplasm to determine resistance sources that can be integrated into breeding programs. Germplasm screening in epidemic and natural epidemic conditions helps determine resistant sources that can be used as donors in breeding for resistance (Singh and Kumar 2021). Since soybean cultivation in Himachal Pradesh cuts across diverse agro-ecological environments, systematic germplasm screening for major diseases in the state will be needed for the identification and development of disease-resistant and locally adapted varieties. In this background, thorough screening of soybean germplasm against major diseases such as pod blight, brown spot and bacterial blight in the regional agro-ecological situation of Himachal Pradesh is imperative. This would not only help to identify new sources of resistance but also allow for the development of varieties with stable resistance to these diseases, enhancing the sustainability and productivity of soybean production in the state. Therefore, the present study was undertaken to identify the resistant sources in soybean germplasm against major diseases under the Mid-Himalayan region of India.

Materials and methods

Plant material

The experimental material for the present investigation consists of one hundred seventy-eight diverse soybean germplasm lines of Indian and exotic collections received from NSRI, Indore. These germplasm lines along with eight check varieties *viz*., VLS-59, VLS-63, VLS-89, VLS-99, Palam Early Soya-1, Himso-1685, Hara Soya and PS 1556 were evaluated in an augmented RBD design with five blocks and replicated in two sets. The genotypes were evaluated during two seasons *viz*., *kharif*, 2023 and 2024 in a row length of 0.5m with row-to-row and plant-to-plant spacing of 45 cm and 10 cm, respectively at the Experimental Farm of Department of Genetics and Plant Breeding, CSK HPKV, Palampur (HP). Recommended package of practices were followed to raise the soybean crop.

Growing conditions

Mid-hill zone of Palampur is recognized as a hot spot for these diseases since they appear in severe to moderate epiphytotic form under natural climatic conditions. Agro-climatically Palampur falls under sub-temperate humid zone of Himachal Pradesh. The annual rainfall in Palampur vary from 1500 to 2500mm of which 80% is received during June to September creating warm and humid conditions throughout *kharif* season which are very much favourable for the disease development. The average temperature from June to October season varied from 16.92 (°C) to 27.00 (°C) with the average rainfall of 48.31cm and 83.45% relative humidity whereas during *kharif*, 2024, the temperature ranged between 20.22 (°C) to 25.72 (°C) with the average rainfall of 113.46 cm and 73.64% relative humidity. The data on weather

parameters were received from AICRPAM, Department of Agronomy, CSK HPKV Palampur.

Screening system

The genotypes were screened for reaction to prevailing diseases *viz*., pod blight (*Colletotrichum truncatum*), brown spot (*Septoria glycines*) and bacterial pustules *(Xanthomonas axonopodis* pv. *glycines*) under natural epiphytotic field conditions at the Experimental Farm of Department of Genetics and Plant Breeding, CSK HPKV, Palampur (HP) during the *kharif,* 2023 and *kharif,* 2024. Soybean lines were critically observed throughout the seasons for the occurrence of disease. Uniform method of disease rating was followed and disease scoring was taken two times, 1st during the full bloom (R_2 reproductive stage) and 2nd during the full size (R_6 reproductive stage) during the growing season to confirm the data. Data on disease severity was recorded during *kharif,* 2023 and *kharif,* 2024 on 0-9 scale given by Stonehouse (1994) and AICRP (2022) (Table 1a.).

The percent disease index (PDI) was also calculated with the following formula:

$$PDI = \frac{\text{Sum of all the ratings}}{\text{Total number of observations} \times \text{maximu disease score}} \times 100$$

The screened lines were categorized into different resistant and susceptible categories by adopting the following PDI and grade description (Table 1b). Further, the PDI data of two years, i.e., *kharif,* 2023 and 2024 were pooled to obtain the pooled PDI value of a genotype.

Results and discussions

Symptoms for all these diseases started appearing in the first week of August and became severe in the month of September. Pooled PDI reaction for pod blight disease varied from 0.0 to 78.52 percent (Supplementary Table 1.). Among all the genotypes, only one line, IC0118611 exhibited absolute resistance reaction/immune response whereas 38 genotypes i.e. EC287456, IC0501258, EC172654, IC0118085, IC0128999, EC76757, EC0341825, EC0061398, IC26178, IC0296199, IC0018646, IC0501200, EC0093747, IC0501208, IC100338, IC243794, IC0243688, IC0243043, EC0039755, IC24069, IC24060, IC0501789, IC0501438, IC0567504, IC118480, IC0118562, IC25764, IC0501885, IC0501876, IC128933, IC0049863, IC0118490, IC0016833, IC0391584, IC0243065, IC0501804, EC0076754 and VLGSDL-36 along with Himso 1685 (Check) were highly resistant making 20.97% of the

Table 1a. Scale (0-9) used to evaluate soybean genotypes for reaction to different diseases under field conditions given by Stonehouse (1994) and AICRP (2022)

Scale(0-9)	Grade(%)	Description	Reaction category
0	0	No (lesions/spots/discolouration)	Highly Resistant (HR)
1	<1	Lesions/spots/discoloration covering less than 1% of leaf/pod	Resistant (R)
3	1-10	Lesions/brown, sunken spots covering 1.1-10% of leaf/pod area	Moderate Resistant (MR)
5	10.1-25	Brown spots enlarging to form circular spots covering 10.1-25% of leaf/pod area	Moderate Susceptible (MS)
7	25.1-50	Circular brown, sunken spots covering 25.1-50% of leaf/pod area	Susceptible (S)
9	>50	Circular to irregular, brown spots covering more than 50 % area of leaf/pod	Highly susceptible (HS)

Table 1b. PDI and grade description

PDI	Categories	Disease grade
0.0	Absolute Resistance /Immune (AR)	0
0.0-11.11	Highly Resistance (HR)	1
11.12-33.33	Moderately Resistance (MR)	3
33.34-55.55	Moderately Susceptible (MS)	5
55.56-77.77	Susceptible (S)	7
77.78-100.00	Highly Susceptible (HS)	9

total germplasm lines (Figure 1.). Furthermore, 36.56% of the genotypes exhibited moderately resistant reaction comprising 68 genotypes while 29.57% were moderately susceptible having 55 genotypes. Among the remaining, 20 were susceptible making 10.75% of the total genotypes and only three lines were highly susceptible (Table 2.).

For the brown spot disease, the pooled PDI reaction ranged between 0.0 to 68.89 percent. Only one germplasm line *viz.,* EC287456 along with Himso 1685 (Check) exhibited absolute resistant reaction while 10.75 % of the genotypes *i.e.* IC0015974, IC0100324, IC0243754, IC118593, IC0243588, EC0039755, IC050182, IC0129025, IC0538042, EC76755, IC24060, IC0128949, IC128935, IC0501438, IC0118562, IC0501967, IC0026932, IC0501815, EC0232044 and EC0528662 were highly resistant. However, 91 genotypes were moderately resistant and 59 were moderately susceptible making 48.92% and 31.72% of the total genotypes, respectively (Table 3.). Only 14 genotypes exhibited susceptible reaction making 7.53% of the total genotypes while none of the genotypes was highly susceptible for the disease (Figure 1.).

Pooled PDI reaction for bacterial pustules varied between 0.0 to 59.44 percent. Here 10 germplasm lines i.e. IC0243726, IC0118611, IC0128949, IC0564120, IC25764, EC0100801, IC0501903, EC172659, IC0501692 and EC0528662 along with Himso 1685 (Check) exhibited absolute resistance whereas 26.34% of the genotypes i.e. EC30208, EC287456, IC0501258, EC0172599, EC0241848, EC251506, EC76757, EC0309534, IC0117914, IC0296199, IC0015974, EC0241809, IC24071, IC0117989, EC0241913, IC0501360, IC0243143, IC0100324, IC0243754, EC0093747, IC0243142, EC62376, IC0501249, IC0243741, IC0243816, IC0243814, IC0243043, EC39502, EC0241773, IC0618728, EC0039755, EC389154, IC0129025, IC0538042, IC24060, IC128935, IC436997, IC0118562, IC0501967, IC0391584, IC0501791, IC0567507, IC0501804, IC0501815, IC0356030, EC0232044,

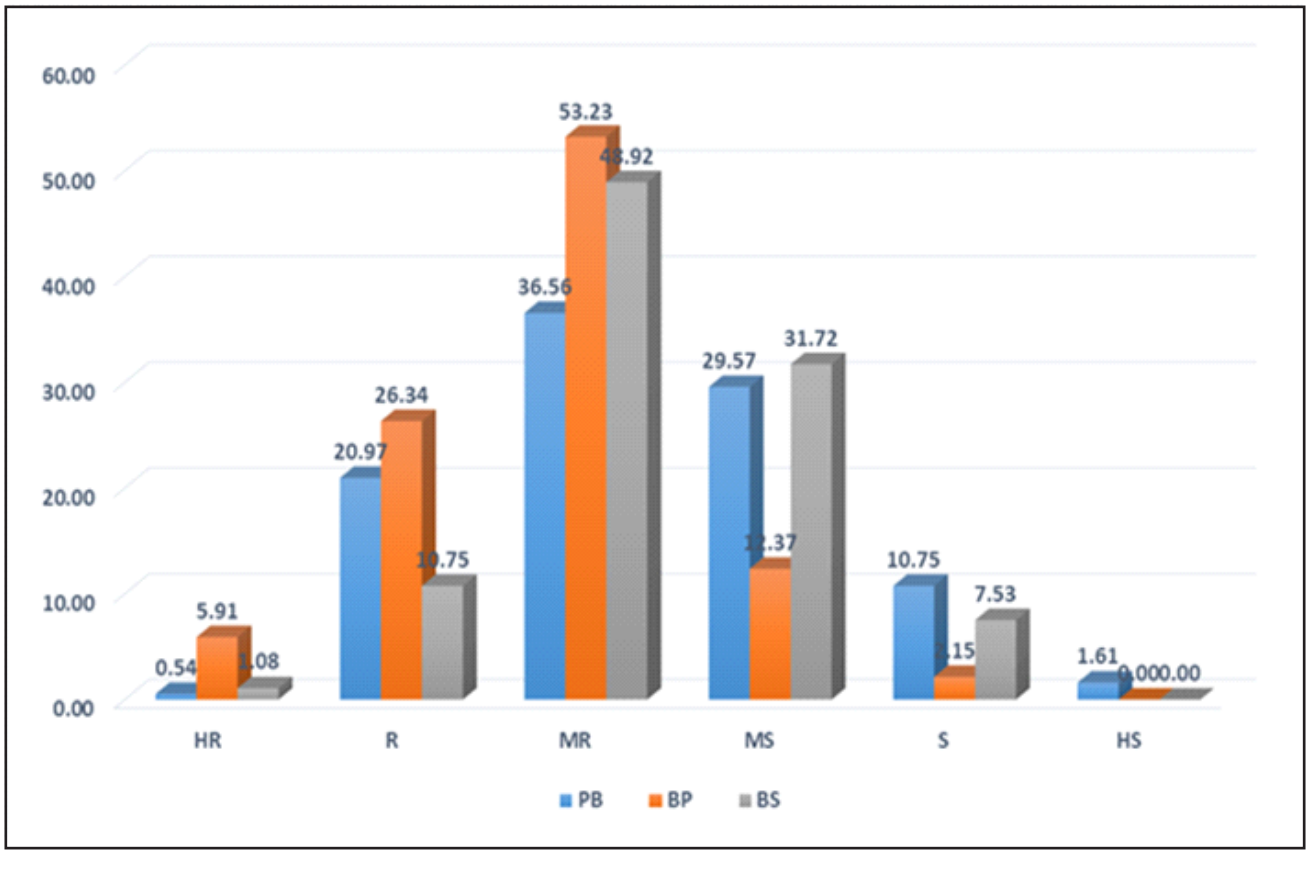

Figure 1. Percentage distribution of disease reaction among different germplasm lines of soybean for pod blight (PB), brown spot (BS) and bacterial pustules (BP)

Table 2. Reaction of different germplasm lines against pod blight disease of soybean

Category	PDI	Germplasm lines	Total
AR	0.0	IC0118611	**1**
HR	0.0-11.11	EC287456, IC0501258, EC172654, IC0118085, IC0128999, EC76757, EC0341825, EC0061398, IC26178, IC0296199, IC0018646, IC0501200, EC0093747, IC0501208, IC100338, IC243794, IC0243688, IC0243043, EC0039755, IC24069, IC24060, IC0501789, IC0501438, IC0567504, IC118480, IC0118562, IC25764, IC0501885, IC0501876, IC128933, IC0049863, IC0118490, IC0016833, IC0391584, IC0243065, IC0501804, EC0076754, VLGSDL-36 and **Himso 1685 (C)**	**39**
MR	11.12-33.33	IC0501670, IC0345660, IC0501663, EC0172599, EC37098, EC0241848, IC0501813, IC0128991, IC0263304, IC0338577, IC0241852, EC57042, IC0117914, IC24071, EC0457236, IC0117989, EC0456537, EC0039730-A, IC0501360, IC0243726, IC0243142, IC0501249, IC0006426, IC118593IC0243816, IC0243662, IC0128982, EC0308281, EC0016729, EC39502, IC0501672, IC0016813, IC0128979, IC328971, IC0009476, IC0243034, EC0241706, IC501603, IC038477, IC21747, IC050182, EC76755, IC0128949, IC0026133, IC0391452, IC436997, IC0501962, IC0042150, IC0419771, IC0501967, IC0118335, IC202, EC0456620, IC0096352, IC0501791, IC0567507, EC0251372, IC0118314, IC13056, EC0026691, IC0026932, EC69729, EC18645, IC0356030, EC0528662, VLGSDL-27, VLGSDL-17 and **VLS-99 (C)**	**68**
MS	33.34-55.55	IC501585, IC0501775, EC30208, IC296874, EC0241902-X, EC0241924, EC99991, IC128960, IC0501755, EC251506, IC501469, EC62386, IC0501699, IC0501416, EC34500, EC0309534, IC0316163, IC0501627, EC0241809, IC0024055, EC0241920, EC0241913, IC0243143, IC0243754, IC501548, EC62376, IC0501267, IC0243741, IC0501196, IC0243814, EC0095794, IC501585, EC0241773, IC0618728, EC0039501, IC0501954, EC389154, IC0129025, IC0538042, IC128935, IC0564120, IC444241, IC012937, IC0501972, IC243017, IC0501903, IC0118614, IC0392508, EC104872, IC0501429, EC39088, EC0039498, EC0251439, IC0501815 and **VLS-89 (C)**	**55**
S	55.56-77.77	IC0015974, IC0100324, IC0128933, IC0243565, EC274701, EC2891400, EC0100801, IC0118567, IC009442, IC0355881, IC0113775, IC0081830, IC0501692, IC0501861, EC99551, **VLS-59 (C), VLS-63 (C), PES-1 (C), Hara soya (C) and PS 1556 (C)**	**20**
HS	77.78-100.00	IC0243588, EC172659 and EC0232044	**3**

Table 3. Reaction of genotypes against brown spot disease of soybean

Category	PDI	Genotypes	Total
AR	0.0	EC287456, **Himso 1685 (C)**	**2**
HR	0.0-11.11	IC0015974, IC0100324, IC0243754, IC118593, IC0243588, EC0039755, IC050182, IC0129025, IC0538042, EC76755, IC24060, IC0128949, IC128935, IC0501438, IC0118562, IC0501967, IC0026932, IC0501815, EC0232044 and EC0528662	**20**
MR	11.12-33.33	IC501585, IC0501670, IC0501775, EC30208, IC0501258, IC296874, EC0241902-X, IC0501663, EC0172599, EC172654, IC0118085, EC37098, EC0241848, IC0128991, EC0241924, EC99991, EC251506, EC76757, IC0241852, EC0341825, EC0061398, EC57042, EC0309534, IC26178, IC0117914, IC0296199, IC0501627, IC24071, EC0457236, IC0117989, EC0456537, EC0241920, EC0241913, IC0501360, IC0243143, IC0243726, IC0501200, EC0093747, IC0243142, IC501548, EC62376, IC0501249, IC0243741, IC0243816, IC0243814, IC0501208, IC0243565, IC100338, EC0308281, IC0501672, EC0241773, IC0618728, IC0016813, IC0128979, IC0009476, IC0243034, IC0118611, IC24069, EC389154, IC0501789, IC0026133, IC0564120, IC436997, IC0567504, IC118480, IC25764, IC0501876, IC0419771, EC0100801, IC0118567, IC0118490, IC0391584, EC0456620, IC0501972, IC0501791, IC0118314, IC0501903, EC0026691, EC69729, EC18645, IC0081830, EC39088, EC0251439, EC172659, IC0501692, IC0501861, EC0076754, EC99551, VLG7DL-27, VLG7DL-36 and VLG7DL-17	**91**
MS	33.34-55.55	IC0345660, IC0501813, IC0128999, IC0263304, IC128960, IC0338577, IC0501755, IC501469, EC62386, IC0501699, IC0501416, EC34500, IC0316163, EC0241809, IC0024055, EC0039730-A, IC0018646, IC0501267, IC0006426, IC0501196, IC0128933, IC0243662, EC0095794, IC0128982, IC0243688, IC0243043, EC0016729, EC39502, IC328971, EC0241706, EC0039501, IC038477, IC0501954, EC2891400, IC444241, IC0501962, IC0501885, IC0042150, IC012937, IC128933, IC0049863, IC0118335, IC009442, IC0355881, IC202, IC0096352, IC0567507, EC0251372, IC0243065, IC0501804, IC0113775, IC13056, IC0392508, EC104872, IC0501429, EC0039498, **VL7-59, VL7-89 (C) and Hara Soya (C)**	**59**
S	55.56-77.77	IC243794, IC501585, EC274701, IC501603, IC21747, IC0391452, IC0016833, IC243017, IC0118614IC0356030, **VL7-63 (C), VL7-99 (C), PES-1 (C) and PS 1556 (C)**	**14**
HS	77.78-100.00	-	**0**

EC99551, VLG7DL-27 and VLG7DL-36 were highly resistant. Furthermore, 53.23% of the genotypes were moderately resistant and 12.37% were moderately susceptible having 99 and 23 genotypes, respectively (Figure 1.). Susceptible reaction was reported by only four genotypes whereas none of the genotypes was highly susceptible for this disease (Table 4.).

Only few of the germplasm lines showed resistance against two or three diseases in the evaluation. Fifteen germplasm lines *viz*., EC287456, IC0501258, IC0015974, IC0100324, IC0243754, EC0039755, IC0129025, IC0538042, IC24060, IC0128949, IC128935, IC0501967, IC0501815, EC0232044 and EC0528662 exhibited absolute/highly resistance against brown spot and bacterial pustules while fourteen lines i.e. EC287456, IC0501258, EC76757, IC0296199, EC0093747, IC0243043, IC0118611, EC0039755, IC24060, IC0118562,

Table 4. Reaction of genotypes against bacterial pustulesdisease of soybean

Category	PDI	Genotypes	Total
AR	0.0	IC0243726, IC0118611, IC0128949, IC0564120, IC25764, EC0100801, IC0501903, EC172659, IC0501692, EC0528662 and **Himso 1685 (C)**	**11**
HR	0.0-11.11	EC30208, EC287456, IC0501258, EC0172599, EC0241848, EC251506, EC76757, EC0309534, IC0117914, IC0296199, IC0015974, EC0241809, IC24071, IC0117989, EC0241913, IC0501360, IC0243143, IC0100324, IC0243754, EC0093747, IC0243142, EC62376, IC0501249, IC0243741, IC0243816, IC0243814, IC0243043, EC39502, EC0241773, IC0618728, EC0039755, EC389154, IC0129025, IC0538042, IC24060, IC128935, IC436997, IC0118562, IC0501967, IC0391584, IC0501791, IC0567507, IC0501804, IC0501815, IC0356030, EC0232044, EC99551, VLG7DL-27 and VLG7DL-36	**49**
MR	11.12-33.33	IC501585, IC0501670, IC0501775, IC296874, EC172654, IC0118085, IC0501813, IC0128999, IC0128991, EC0241924, IC0263304, IC0501755, IC501469, EC34500, EC0341825, EC57042, IC26178, IC0316163, IC0501627, IC0024055, EC0457236, EC0456537, EC0241920, EC0039730-A, IC0018646, IC0501200, IC501548, IC0501267, IC0006426, IC118593, IC0501196, IC0128933, IC0243662, IC0501208, IC0243565, IC0243588, EC0095794, IC0128982, IC100338, IC243794, IC501585, EC0308281, IC0501672, IC0016813, IC0128979, IC328971, IC0009476, IC0243034, EC0241706, IC501603, IC038477, IC0501954, IC21747, IC24069, EC2891400, IC050182, EC76755, IC0501789, IC0026133, IC444241, IC0501438, IC0391452, IC0567504, IC118480, IC0501962, IC0501876, IC0419771, IC012937, IC0049863, IC0118567, IC0118490, IC0118335, IC009442, IC202, EC0456620, IC0096352, IC0501972, EC0251372, IC243017, IC0243065, IC0113775, IC0118314, IC0118614, EC0026691, IC0026932, EC69729, EC104872, IC0501429, IC0081830, EC39088, EC0039498, EC0251439, IC0501861, EC0076754, VLG7DL-17, VL7-59 (C), **VLS-59, PES-1 (C), Hara Soya (C) and PS 1556 (C)**	**99**
MS	33.34-55.55	IC0345660, EC0241902-X, IC0501663, EC37098, EC99991, IC128960, EC62386, IC0501699, IC0241852, EC0061398, EC274701, EC0039501, IC0501885, IC0042150, IC128933, IC0016833, IC0355881, IC13056, IC0392508, EC18645, **VL7-63 (C), VL7-89 (C) and VL7-99 (C)**	**23**
S	55.56-77.77	IC0338577, IC0501416, IC0243688 and EC0016729	**4**
HS	77.78-100.00	-	**0**

IC25764, IC0391584, IC0501804 and VLGSDL-36 were absolute/highly resistant for pod blight and bacterial pustules (Table 5.). However, for pod blight and brown spot, only six lines i.e. EC287456, IC0501258, EC0039755, IC24060, IC0501438 and IC01185626 were categorized as absolute/highly resistant. Overall, only five lines *viz*., EC287456, IC0501258, EC0039755, IC24060 and IC0118562 exhibited multiple disease resistance against all three diseases i.e. pod blight, brown spot and bacterial pustules. These germplasm lines can be further utilized for the development of disease-resistant varieties. These findings are essential for improving soybean productivity and sustainability in Himachal Pradesh, contributing to food security and agricultural resilience.

Table 5. Germplasm lines showing multiple resistance against, pod blight, brown spot and bacterial pustules diseases of soybean

Diseases	Absolute resistance/Highly resistant germplasm lines	Total
Brown spot & Bacterial pustules	EC287456, IC0501258, IC0015974, IC0100324, IC0243754, EC0039755, IC0129025, IC0538042, IC24060, IC0128949, IC128935, IC0501967, IC0501815, EC0232044 and EC0528662	**15**
Pod blight & Bacterial pustules	EC287456, IC0501258, EC76757, IC0296199, EC0093747, IC0243043, IC0118611, EC0039755, IC24060, IC0118562, IC25764, IC0391584, IC0501804 and VLGSDL-36	**14**
Pod blight & Brown spot	EC287456, IC0501258, EC0039755, IC24060, IC0501438 and IC0118562	**6**
Pod blight, Brown spot & Bacterial pustules	EC287456, IC0501258, EC0039755, IC24060 and IC0118562	**5**

Work similar to this has also been done by several workers previously. In India several researchers had identified resistant sources of soybean against these diseases under field natural epiphytotic conditions. For pod blight, Prasad *et al*. (2017) identified moderately resistance in JS 97-52 with disease incidence of 22-28%; Kumar and Singh (2019) revealed the lowest disease incidence (15-20%) in VLS-47 and Hara Soya across Palampur and Kangra regions; Singh and Bhardwaj (2024) studied 42 genotypes in western Himalayan regions, identifying three promising sources of resistance (Palam Soya, HPK-14, and PS-1092) with disease incidence below 15% over three consecutive seasons. Amrate *et al*. 2023 evaluated 121 diverse soybean genotypes against pod blight under high disease pressure field condition and observed that soybean genotypes were affected from V_3 to R_7 stages. Five genotypes were highly resistant (HR). Per cent Disease Index (PDI) ranged between 0.00 to 56.20 per cent. For brown spot disease, Sharma *et al*. (2018) identified JS-335 and Palam Soya as moderately resistant (18-24 % disease incidence) in the mid-hill zones of Himachal Pradesh; Kumar and Singh (2020a) found resistance in PS-1092 and HPK-04 across locations with disease incidence below 15%; Thakur *et al*. (2022) revealed the resistance in varieties *viz*., NRC-86, SL-958, and HPK-12 in Palampur region. Similarly for bacterial pustules, Sharma *et al*. (2019) identified moderately resistance in PS-1347 and JS-335 with disease incidence of 15-22%; In a multi-location trial, Kumar and Singh (2020b) reported resistance in HPK-04, NRC-86, and Palam Soya with incidence below 12%; Thakur and Gupta (2021) documented bacterial pustule affecting 28-55% of soybean cultivation in Kangra, Mandi, and Solan districts with disease ratings ranging from 2 to 7; Bhardwaj and Sharma (2023) across five districts of Himachal Pradesh reported disease incidence varying from 20-60% with highest severity (rating 6-8) observed in susceptible cultivars during warm, humid periods. In a recent screening study, Gupta *et al*. (2024) evaluated 47 genotypes under artificial inoculation conditions, identifying four highly promising resistant sources (PS-1569, HPK-14, SL-958, and NRC-132) showing consistent disease ratings of 1-2 with incidence below 10% across multiple seasons. These findings underscore the importance of integrating disease-resistant germplasm into breeding programs to combat major soybean diseases and ensure more robust and productive cultivation in diverse agro-ecological regions.

Conclusion

In the present study, five germplasm lines *viz*., EC287456, IC0501258, EC0039755, IC24060 and IC0118562 exhibited multiple disease resistance against all three diseases i.e. pod blight, brown spot and bacterial pustules can be screened artificially to confirm the resistance and then further utilized for the development of disease-resistant varieties. The study emphasizes the importance of germplasm screening in the identification of valuable genetic resources and these findings are essential for improving soybean productivity and sustainability in the Mid-Himalayan region of India, contributing to food security and agricultural resilience.

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