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# SCREENING OF BRASSICA GERMPLASM FOR RESISTANCE TO MAJOR DISEASES OF RAPESEED-MUSTARD

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**KEYWORDS**
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**ABSTRACT**
In the present investigation 240 Brassica germplasm were screened in infested field against major disease of rapeseed-mustard (Brassica sp.). Out of 240 Brassica germplasm only seven viz. IC-255498, IC-296685, IC-326253, IC-335847, IC-339589, IC-339597 and IC-417020 were found to be multiple disease resistant with 5-25% disease severity against aforesaid diseases except IC-296685, IC-399678 and IC-401570 which showed 0% disease severity against white rust disease whereas IC-296685 showed 0% disease severity against downy mildew disease. The resistant sources will be useful for selecting elite genotypes for disease resistant where rapeseed-mustard is prevalent. In addition, the resistant genotypes can serve as a gene pool used in breeding programmes to develop new resistant genotypes.

## INTRODUCTION

Oilseed Brassica plays vital role in edible oil of Indian economy. In India rapeseed-mustard is grown on an area of 6.51 m ha with production of 7.54 m ton and productivity of 1174 kg/ha. (Agricultural statistics, 2011). Rapeseed and mustard crops have been known to be severely damaged by some of the important plant pathogens such as *Hyaloperonospora parasitica,* (Pers.) Constant, *Albugo candida,* (Pers. Ex Lev.) Kuntze, *Alternaria brassicae* (Berk.) Sacc., *Sclerotinia sclerotiorum* (Lib.) de Bary causing downy mildew, white rust, Alternaria blight and Sclerotinia stem rot diseases respectively. Downy mildew and white rust can occur separately or in association to each other and can cause intensive yield losses in *B. juncea* and *B. rapa* (Kolte 1986). Saharan *et al*. (1984); Bains and Jhooty, (1985); Kolte, (1985a) reported that the mixed infection of white rust and downy mildew in inflorescence of *Brassica* crop is becoming a serious problem causing 37-47 percent loss in pod formation with 17-54.5 percent reduction in grain yield. Saharan (1992) found that 23-55 percent yield loss in *B. juncea* and yield losses due to Alternaria blight are heavier in yellow sarson (38-45%) followed by brown sarson (26%) and mustard (17-18%). In India, Under favourable conditions Sclerotinia stem rot disease causes 40-72 per cent yield losses in mustard (Shivpuri *et al*., 2000; Chattopadhyay *et al*., 2003 and Ghosalia *et al.,* 2004). In the absence of having disease resistant varieties, some selective fungicides are commonly recommended for the management of major diseases of rapeseed-mustard such as seed treatment with metalaxyl 35SD @ 6g/kg seed and foliar spray of mancozeb @ 2gm/l was effective for Alternaria blight (Rai *et al*., 2014); Seed treatment with matalaxyl 35SD @ 0.6% was effective for downy mildew at cotyledon stage (Bhatt *et al*. 2009) and seed treatment with metalaxyl 35SD @ 0.6% and foliar spray with ridomil MZ @ 0.2% was effective for white rust (Bhatt *et al*., 2009). Because of the present public perception on pesticides contamination of food specially the edible oils there is need to find out resistant sources from the Brassica germplasm against major diseases for the development of economic and eco-friendly approaches. Therefore, 240 *Brassica* germplasm have been screened against major diseases of rapeseed-mustard

## MATERIALS AND METHODS

Screening study of Brassica germplasm was carried out at Norman E. Borlaug Crop Research Centre (CRC), G.B. Pant University of Agriculture and Technology, Pantnagar, which is situated between 29º North latitude and 79.73ºEast longitude at an altitude of 243.8 meters above the mean sea level in the humid and subtropical *Tarai* region. The experiments were conducted during the crop season of year 2011-12 to 2013-2014 for screening of major diseases of rapeseed-mustard. Two hundred fourty Brassica juncea accessions were screened in the sick plot of major fungal pathogens. These Brassica juncea accessions were obtained from NBPGR, New Delhi. Irrigation and weeding was done as per the need. All the recommended cultivation practices were followed to raise a good crop. Crop was grown without any application of chemical treatment for control of major diseases *i*.e. Downy mildew, white rust, Alternaria blight, and Sclerotinia stem rot caused by pathogens viz. *Hyaloperonospora parasitica,* (Pers.) Con-

stant, *Albugo candida,* (Pers. Ex Lev.) Kuntze, *Alternaria brassicae* (Berk.) Sacc., *Sclerotinia sclerotiorum* (Lib.) de Bary. These germplasm of rapeseed mustard were used for determining their phenotypic disease reactions against major disease of rapeseed-mustard under artificially inoculated conditions for selection of resistant sources.

**Methods of Artificial Inoculation**

**Downy mildew**

Freshly harvested conidia from artificially infected cotyledonary leaves of susceptible variety (Divya) were used for preparation of conidial suspension in distilled water. Inoculum concentration was adjusted to $10^4$ conidia/ ml using haemocytometer. Prepared conidial suspension of *Hyaloperonospora parasitica* was inoculated directly to test plants at cotyledonary stage (2/3 leaf stage) in the evening (Kolte, 1985b). Proper moisture in field was maintained for 3 days after inoculation. Observations on disease severity on cotyledonary leaves were recorded after 25 days of inoculation i.e. at maximum disease pressure using revised rating scale (0-9) of AICRP Rapeseed-Mustard group. 2011.

**White rust**

Plants were inoculated at 40 DAS. Inoculum was prepared by collecting fresh zoosporangia in sterilized distilled water from naturally infected leaves with *Albugo candida*. Beaker containing zoosporangia suspension was kept at $4^0$C for 2 hrs to facilitate germination of zoosporangia. To assure germination of the sporangia, a drop of sporangial suspension was put on glass slide and examined under microscope. Germinating zoosporangia were emptied and zoospores were visible in the suspension. Zoospores suspension was filtered through double layered muslin cloth. The suspension was further diluted with distilled water to get desired concentration of $10^4$ zoospores /ml. (Trimali, 2012).The suspension was sprayed on leaves of test plants in the evening with the help of small hand sprayer. Observations of disease severity on leaves were recorded 60 days after sowing (DAS) using revised rating scale (0-9) of AICRP Rapeseed-Mustard group. 2011.

**Alternaria blight**

Plants were inoculated at young stage of the plant i.e. 50 DAS

**List of 240 germplasm entries received from NBPGR, New Delhi and five cultivated varieties in India.**

| S. No. | Genotypes | S. No. | Genotypes | S. No. | Genotypes | S. No. | Genotypes |
|---|---|---|---|---|---|---|---|
| 1 | IC-248993 | 41 | IC-399803 | 81 | IC-491044 | 121 | IC-491125 |
| 2 | IC-255498 | 42 | IC-399808 | 82 | IC-491046 | 122 | IC-491127 |
| 3 | IC-257765 | 43 | IC-399814 | 83 | IC-491047 | 123 | IC-491128 |
| 4 | IC-291158 | 44 | IC-399815 | 84 | IC-491048 | 124 | IC-491129 |
| 5 | IC-296685 | 45 | IC-399816 | 85 | IC-491049 | 125 | IC-491130 |
| 6 | IC-296690 | 46 | IC-399824 | 86 | IC-491052 | 126 | IC-491131 |
| 7 | IC-296703 | 47 | IC-399826 | 87 | IC-491053 | 127 | IC-491133 |
| 8 | IC-296705 | 48 | IC-399840 | 88 | IC-491056 | 128 | IC-491136 |
| 9 | IC-310758 | 49 | IC-399853 | 89 | IC-491057 | 129 | IC-491137 |
| 10 | IC-320614 | 50 | IC-399878 | 90 | IC-491058 | 130 | IC-491138 |
| 11 | IC-320648 | 51 | IC-401570 | 91 | IC-491060 | 131 | IC-491139 |
| 12 | IC-320701 | 52 | IC-401574 | 92 | IC-491061 | 132 | IC-491141 |
| 13 | IC-324000 | 53 | IC-417020 | 93 | IC-491063 | 133 | IC-491142 |
| 14 | IC-326253 | 54 | IC-422165 | 94 | IC-491067 | 134 | IC-491143 |
| 15 | IC-329705 | 55 | IC-423195 | 95 | IC-491073 | 135 | IC-491144 |
| 16 | IC-328316 | 56 | IC-426220 | 96 | IC-491074 | 136 | IC-491145 |
| 17 | IC-335847 | 57 | IC-426221 | 97 | IC-491080 | 137 | IC-491149 |
| 18 | IC-335854 | 58 | IC-426346 | 98 | IC-491081 | 138 | IC-491150 |
| 19 | IC-338523 | 59 | IC-426351 | 99 | IC-491082 | 139 | IC-491151 |
| 20 | IC-339589 | 60 | IC-426354 | 100 | IC-491084 | 140 | IC-491152 |
| 21 | IC-339597 | 61 | IC-426357 | 101 | IC-491085 | 141 | IC-491156 |
| 22 | IC-339625 | 62 | IC-426358 | 102 | IC-491086 | 142 | IC-491157 |
| 23 | IC-341457 | 63 | IC-426379 | 103 | IC-491093 | 143 | IC-491158 |
| 24 | IC-347947 | 64 | IC-426395 | 104 | IC-491100 | 144 | IC-491162 |
| 25 | IC-347994 | 65 | IC-426401 | 105 | IC-491101 | 145 | IC-491163 |
| 26 | IC-360723 | 66 | IC-490996 | 106 | IC-491104 | 146 | IC-491165 |
| 27 | IC-360770 | 67 | IC-491004 | 107 | IC-491105 | 147 | IC-491166 |
| 28 | IC-363606 | 68 | IC-491011 | 108 | IC-491106 | 148 | IC-491167 |
| 29 | IC-363737 | 69 | IC-491016 | 109 | IC-491108 | 149 | IC-491170 |
| 30 | IC-366460 | 70 | IC-491024 | 110 | IC-491111 | 150 | IC-491171 |
| 31 | IC-374698 | 71 | IC-491028 | 111 | IC-426347 | 151 | IC-491173 |
| 32 | IC-375924 | 72 | IC-491029 | 112 | IC-491112 | 152 | IC-491175 |
| 33 | IC-375925 | 73 | IC-491031 | 113 | IC-491114 | 153 | IC-491176 |
| 34 | IC-397277 | 74 | IC-491036 | 114 | IC-491116 | 154 | IC-491177 |
| 35 | IC-397537 | 75 | IC-491038 | 115 | IC-491117 | 155 | IC-491180 |
| 36 | IC-399678 | 76 | IC-491039 | 116 | IC-491118 | 156 | IC-491181 |
| 37 | IC-399784 | 77 | IC-491040 | 117 | IC-491119 | 157 | IC-491183 |
| 38 | IC-399788 | 78 | IC-491041 | 118 | IC-491120 | 158 | IC-491184 |
| 39 | IC-399795 | 79 | IC-491042 | 119 | IC-491123 | 159 | IC-491185 |
| 40 | IC-399802 | 80 | IC-491043 | 120 | IC-491124 | 160 | IC-491186 |

**Cont.... List of 240 germplasm entries received from NBPGR, New Delhi and five cultivated varieties in India.**

| S. No. | Genotypes | S. No. | Genotypes | S. No. | Genotypes | S. No. | Genotypes |
|---|---|---|---|---|---|---|---|
| 161 | IC-491187 | 183 | IC-491222 | 205 | IC-491253 | 227 | IC-491307 |
| 162 | IC-491188 | 184 | IC-491224 | 206 | IC-491254 | 228 | IC-491309 |
| 163 | IC-491189 | 185 | IC-491225 | 207 | IC-491255 | 229 | IC-491310 |
| 164 | IC-491190 | 186 | IC-491227 | 208 | IC-491256 | 230 | IC-491312 |
| 165 | IC-491192 | 187 | IC-491229 | 209 | IC-491257 | 231 | IC-491617 |
| 166 | IC-491195 | 188 | IC-491230 | 210 | IC-491262 | 232 | IC-491626 |
| 167 | IC-491198 | 189 | IC-491231 | 211 | IC-491280 | 233 | IC-491628 |
| 168 | IC-491200 | 190 | IC-491232 | 212 | IC-491281 | 234 | IC-491630 |
| 169 | IC-491201 | 191 | IC-491233 | 213 | IC-491282 | 235 | IC-491640 |
| 170 | IC-491202 | 192 | IC-491234 | 214 | IC-491284 | 236 | IC-491645 |
| 171 | IC-491203 | 193 | IC-491235 | 215 | IC-491285 | 237 | IC-491648 |
| 172 | IC-491205 | 194 | IC-491237 | 216 | IC-491286 | 238 | IC-491877 |
| 173 | IC-491206 | 195 | IC-491238 | 217 | IC-491287 | 239 | IC-491756 |
| 172 | IC-491210 | 196 | IC-491240 | 218 | IC-491288 | 240 | IC-491757 |
| 175 | IC-491211 | 197 | IC-491241 | 219 | IC-491290 | 1 | PJ Kisan |
| 176 | IC-491213 | 198 | IC-491242 | 220 | IC-491292 | 2 | Rajat |
| 177 | IC-491214 | 199 | IC-491243 | 221 | IC-491294 | 3 | RH-30 |
| 178 | IC-491215 | 200 | IC-491244 | 222 | IC-491296 | 4 | Varuna |
| 179 | IC-491217 | 201 | IC-491246 | 223 | IC-491298 | 5 | Laxmi |
| 180 | IC-491219 | 202 | IC-491248 | 224 | IC-491299 | | |
| 181 | IC-491220 | 203 | IC-491249 | 225 | IC-491301 | | |
| 182 | IC-491221 | 204 | IC-491251 | 226 | IC-491304 | | |

in the evening with conidial suspension ($10^5$ conidia/ml) of *Alternaria brassicae* (Kolte, 1985b). The concentration was adjusted with the help of haemocytometer. Proper moisture in the field was maintained for 2 days after inoculation. Observations on disease severity were recorded 75 DAS (leaves) and 110 DAS (pods) i.e. at maximum disease pressure using revised rating scale (0-9) of AICRP Rapeseed-Mustard Scientist group. 2011.

**0-9 rating scale for AB, WR and DM**

| Rating score | Leaf area covered (%) | Disease reaction |
|---|---|---|
| 0 | No symptoms | Immune (I) |
| 1 | > 5 | Highly resistant (HR) |
| 3 | 5-10 | Resistant (R) |
| 5 | 11-25 | Moderately Resistant (MR) |
| 7 | 26-50 | Susceptible (S) |
| 9 | < 50 | Highly susceptible (HS) |

Revised rating scale (0-4) of AICRP Rapeseed-Mustard group 2011 for scoring disease reaction of Sclerotinia rot of rapeseed-mustard

| Reaction | Rating | Symptoms |
|---|---|---|
| Immune | 0 | No disease |
| Resistant | 1 | ¼ stem girdled |
| Moderate resistant | 2 | ½stem girdled |
| Moderate susceptible | 3 | ¾ stem girdled |
| Susceptible | 4 | More than ¾ stem girdled and plant dried |

The plants were inoculated with mycelial disc of *S. sclerotiorum* at flowering stage (75 DAS). Ten plants were inoculated in each replication with 7 days old actively growing mycelium culture (disc of 5mm dia. 2 in nos.) of *S. sclerotiorum* grown on PDA. The inoculum was placed on third internodes of plant at flowering stage. Inoculated portion of the stem was covered with wrapped with plastic tape to conserve moisture (Goswami *et al.,* 2008). Observations on disease incidence and severity were recorded 30 days after inoculation *i.e.* at maximum disease pressure using revised rating scale (0-4) of AICRP Rapeseed-Mustard group. 2011.

Revised rating scale (0-9) of AICRP Rapeseed-Mustard group 2011 for scoring disease severity and disease reaction of downy mildew, white rust and Alternaria blight of rapeseed-mustard

**Formula for calculating disease severity**

$$\text{Average severity score} = \frac{(N\text{-}1X0) + (N\text{-}2X1) + (N\text{-}3X3) + (N\text{-}4X5) + (N\text{-}5X7) + (N\text{-}6X9)}{\text{No. of leaf samples}}$$

## RESULTS AND DISCUSSION

Alternaria blight: Screening of *Brassica* germplasm revealed that among 240 Brassica germplasm none was found highly resistant against Alternaria blight only 08 Brassica germplasm viz. IC-255498, IC-296685, IC-326253, IC-335847, IC-339589, IC-339597, IC- 360723, and IC-417020 were found to be moderately resistant with 11-25% disease severity against Alternaria blight, IC-296705, IC-328316 and IC-338523, were susceptible and showed 26-50% disease severity while 234 were found highly susceptible with more than 50% disease severity (Table 1). The present finding is supported by many authors such as Khan *et al*. (1991) who conducted field trial using 100 accessions of sarson for evaluation of resistance to *A. brassicae* by artificial inoculation. They reported 2 resistant, 4 moderately resistant, 16 moderately susceptible, 53 susceptible and 26 highly susceptible against Alternaria blight; Yadav *et al*. (1999) screened 74 Indian mustard (*Brassica juncea*) germplasm lines for resistance to Alternaria blight and found none of the genotype was completely resistant to Alternaria blight disease. PBR-176, PBR-178 and PBR-180 were

**Table 1: Disease reaction of different *Brassica juncea* accessions to Alternaria blight disease under field condition**

| Rating score | Per-cent intensity | Reaction | Number of accessions | Alternaria blight |
|---|---|---|---|---|
| 0 | 00% | Immune | 0 | Nil |
| 111 | 1>5% | Highly resistant | 0 | Nil |
| 3 | 5-10% | Resistant | 0 | Nil |
| 5 | 11-25% | Moderately Resistant | 8 | IC-255498, IC-296685, IC-326253, IC-335847, IC-339589, IC-339597, IC- 360723, IC-417020 |
| 7 | 26-50% | Susceptible | 3 | IC-296705, IC-328316, IC-338523, |
| 9 | <50% | HighlySusceptible | 234 | IC-248993, IC-257765, IC-291158, IC-296690, IC-296703, IC-310758, IC-320614, IC-320648, IC-320701, IC-324000, IC-329705, IC-335854, IC-339625, IC-341457, IC-347947, IC-347994, IC-360770, IC-363606, IC-363737, IC-366460, IC-374698, IC-375924, IC-375925, IC-397277, IC-397537, IC-399678, IC-399784, IC-399788, IC-399795, IC-399802, IC-399803, IC-399808, IC-399814, IC-399815, IC-399816, IC-399840, IC-399853, IC-399878, IC-401570, IC-401574, IC-422165, IC-423195, IC-426220, IC-426221, IC-426346, IC-426351, IC-426354, IC-426357, IC-426358, IC-426379, IC-426395, IC-426401, IC-490996, IC-491004, IC-491011, IC-491016, IC-491024, IC-491028, IC-491029, IC-491031, IC-491036, IC-491038, IC-491039, IC-491040, IC-491041, IC-491042, IC-491043, IC-491044, IC-491046, IC-491047, IC-491048, IC-491049, IC-491052, IC-491053, IC-491056, IC-491057, IC-491058, IC-491060, IC-491061, IC-491063, IC-491067, IC-491073, IC-491074, IC-491080, IC-491081, IC-491082, IC-491084, IC-491085, IC-491086, IC-491093,IC-491100, IC-491101, IC-491104, IC-491105, IC-491106, IC-491108, I C-491111, IC-426347, IC-491112, IC-491114, IC-491116, IC-491117, IC-491118, IC-491119, IC-491120, IC-491123, IC-491124, IC-491125, IC-491127, IC-491128, IC-491129, IC-491130, IC-491131, IC-491133, IC-491136, IC-491137, IC-491138, IC-491139, IC-491141, IC-491142, IC-491143, IC-491144, IC-491145, IC-491149, IC-491150, IC-491151, IC-491152, IC-491156, IC-491157, IC-491158, IC-491162, IC-491163, IC-491165, IC-491166, IC-491167, IC-491170, IC-491171, IC-491173, IC-491175, IC-491176, IC-491177, IC-491180, IC-491181, IC-491183, IC-491184, IC-491185, IC-491186, IC-491187, IC-491188, IC-491189, IC-491190, IC-491192, IC-491195, IC-491198, IC-491200, IC-491201, IC-491202, IC-491203, IC-491205, IC-491206, IC-491210, IC-491211, IC-491213, IC-491214, IC-491215, IC-491217, IC-491219, IC-491220, IC-491221, IC-491222, IC-491224, IC-491225, IC-491227, IC-491229, IC-491230, IC-491231, IC-491232, IC-491233, IC-491234, IC-491235, IC-491237, IC-491238, IC-491240, IC-491241, IC-491242, IC-491243, IC-491244, IC-491246, IC-491248, IC-491249, IC-491251, IC-491253, IC-491254, IC-491255, IC-491256, IC-491257, IC-491262, IC-491280, IC-491281, IC-491282, IC-491284, IC-491285, IC-491286, IC-491287, IC-491288, IC-491290, IC-491292, IC-491294, IC-491296, IC-491298, IC-491299, IC-491301, IC-491304, IC-491307, IC-491309, IC-491310, IC-491312, IC-491617, IC-491626, IC-491628, IC-491630, IC-491640, IC-491645, IC-491648, IC-491757, IC-491877, IC-491756, IC-399824, IC-399826, PJ Kisan, Rajat, RH-30, Varuna, Laxmi, |

**Table 2: Disease reaction of different *Brassica juncea* accessions to white rust disease under field condition**

| Rating score | Per-cent intensity | Reaction | Number of accessions | White rust |
|---|---|---|---|---|
| 0 | 00% | Immune | 03 | IC-296685, IC-399678, IC-401570 |
| 111 | 1>5% | Highly resistant | 0 | Nil |
| 3 | 5-10% | Resistant | 02 | IC-326253, IC-417020 |
| 5 | 11-25% | Moderately Resistant | 05 | IC-255498, IC-335847, IC-339589, IC-339597, IC-399824 |
| 7 | 26-50% | Susceptible | 04 | IC-338523, IC-399784, IC-399788, IC-399826 |
| 9 | <50% | HighlySusceptible | 231 | IC-248993, IC-257765, IC-291158, IC-296690, IC-296703, IC-296705, IC-310758, IC-320614, IC-320648, IC-320701, IC-324000, IC-329705, IC-335854, IC-339625, IC-341457, IC-347947, IC-347994, IC-360770, IC-363606,IC-363737, IC-366460, IC-374698, IC-375924, IC-375925, IC-397277, IC-397537, IC-399795, IC-399802, IC-399803, IC-399808, IC-399814, IC-399815, IC-399816, IC-399840, IC-399853, IC-399878, IC-401574, IC-422165, IC-423195, IC-426220, IC-426221, IC-426346, IC-426351, IC-426354, IC-426357, IC-426358, IC-426379, IC-426395, IC-426401, IC-490996, IC-491004, IC-491011, IC-491016, IC-491024, IC-491028, IC-491029, IC-491031, IC-491036, IC-491038, IC-491039, IC-491040, IC-491041, IC-491042, IC-491043, IC-491044, IC-491046, IC-491047, IC-491048, IC-491049, IC-491052,IC-491053, IC-491056, IC-491057, IC-491058, IC-491060, IC-491061, IC-491063, IC-491067, IC-491073, IC-491074, IC-491080, IC-491081, IC-491082, IC-491084, IC-491085, IC-491086, IC-491093, IC-491100, IC-491101, IC-491104, IC-491105, IC-491106, IC-491108, IC-491111, IC-426347, IC-491112, IC-491114, IC-491116, IC-491117, IC-491118, IC-491119, IC-491120, IC-491123, IC-491124, IC-491125, IC-491127, IC-491128, IC-491129, IC-491130, IC-491131, IC-491133, IC-491136, IC-491137, IC-491138, IC-491139, IC-491141, IC-491142, IC-491143, IC-491144, IC-491145, IC-491149, IC-491150, IC-491151, IC-491152, IC-491156, IC-491157, IC-491158, IC-491162, IC-491163, IC-491165, IC-491166, IC-491167, IC-491170, IC-491171, IC-491173, IC-491175, IC-491176, IC-491177, IC-491180, IC-491181, IC-491183, IC-491184, IC-491185, IC-491186, IC-491187, IC-491188, IC-491189, IC-491190, IC-491192, IC-491195, IC-491198, IC-491200, IC-491201, IC-491202, IC-491203, IC-491205, IC-491206, IC-491210, IC-491211, IC-491213, IC-491214, IC-491215, IC-491217, IC-491219, IC-491220, IC-491221, IC-491222, IC-491224, IC-491225, IC-491227, IC-491229, IC-491230, IC-491231, IC-491232, IC-491233, IC-491234, IC-491235, IC-491237, IC-491238, IC-491240, IC-491241, IC-491242, IC-491243, IC-491244, IC-491246, IC-491248, IC-491249, IC-491251, IC-491253, IC-491254, IC-491255, IC-491256, IC-491257, IC-491262, IC-491280, IC-491281, IC-491282, IC-491284, IC-491285, IC-491286, IC-491287, IC-491288, IC-491290, IC-491292, IC-491294, IC-491296, IC-491298, IC-491299, IC-491301, IC-491304, IC-491307, IC-491309, IC-491310, IC-491312, IC-491617, IC-491626, IC-491628, IC-491630, IC-491640, IC-491645, IC-491648, IC-491757, IC-491877, IC-491756, IC-399824, IC-399826, PJ Kisan, Rajat, RH-30, Varuna, Laxmi, |

**Table 3: Disease reaction of different *Brassica juncea* accessions to downy mildew disease under field condition**

| Rating score | Per-cent intensity | Reaction | Number of accessions | Downy mildew |
|---|---|---|---|---|
| 0 | 00% | Immune | 01 | IC-296685 |
| 111 | 1 > 5% | Highly resistant | 0 | Nil |
| 3 | 5-10% | Resistant | 02 | IC-326253, IC-417020 |
| 5 | 11-25% | Moderately Resistant | 06 | IC-255498, IC-335847, IC-339589, IC-339597, IC-399678, IC-491617 |
| 7 | 26-50% | Susceptible | 42 | IC-248993, IC-257765, IC-296690, IC-310758, IC-320701, IC-338523, IC-339625, IC-363606, IC-374698,IC-397537, IC-399788, IC-399814, IC-399815, IC-399826, IC-426346, IC-426351, IC-426358, IC-490996, IC-491073,IC-491082,IC-491085, IC-491104, IC-426347, IC-491127, IC-491128, IC-491131, IC-491145, IC-491156, IC-491158,IC-491173,IC-491181, IC-491185, IC-491195, IC-491234, IC-491238, IC-491243, IC-491299, IC-491304, IC-491307,IC-491309, IC-491648, IC-491756 |
| 9 | < 50% | HighlySusceptible | 194 | IC-291158, IC-296703, IC-296705, IC-320614, IC-320648, IC-324000, IC-329705, IC-328316, IC-335854,IC-341457,IC-347947, IC-347994, IC-360723, IC-360770, IC-363737, IC-366460, IC-375924, IC-375925, IC-397277,IC-399784,IC-399795, IC-399802, IC-399803, IC-399808, IC-399816, IC-399824, IC-399840, IC-399853, IC-399878,IC-401570,IC-401574, IC-422165, IC-423195, IC-426220, IC-426221, IC-426354, IC-426357, IC-426379, IC-426395,IC-426401,IC-491004, IC-491011, IC-491016, IC-491024, IC-491028, IC-491029, IC-491031, IC-491036, IC-491038,IC-491039,IC-491040, IC-491041, IC-491042, IC-491043, IC-491044, IC-491046, IC-491047, IC-491048, IC-491049,IC-491052,IC-491053, IC-491056, IC-491057, IC-491058, IC-491060, IC-491061, IC-491063, IC-491067, IC-491074,IC-491080,IC-491081, IC-491084, IC-491086, IC-491093, IC-491100, IC-491101, IC-491105, IC-491106, IC-491108,IC-491111,IC-491112, IC-491114, IC-491116, IC-491117, IC-491118 IC-491119, IC-491120, IC-491123, IC-491124,IC-491125,IC-491129, IC-491130, IC-491133, IC-491136, IC-491137, IC-491138, IC-491139, IC-491141, IC-491142,IC-491143,IC-491144, IC-491149, IC-491150, IC-491151, IC-491152, IC-491157, IC-491162, IC-491163, IC-491165,IC-491166,IC-491167, IC-491170, IC-491171, IC-491175, IC-491176, IC-491177, IC-491180, IC-491183, IC-491184,IC-491186,IC-491187, IC-491188, IC-491189, IC-491190, IC-491192, IC-491198, IC-491200, IC-491201, IC-491202,IC-491203,IC-491205, IC-491206, IC-491210, IC-491211, IC-491213, IC-491214, IC-491215, IC-491217, IC-491219,IC-491220,IC-491221, IC-491222, IC-491224, IC-491225, IC-491227, IC-491229, IC-491230, IC-491231, IC-491232,IC-491233,IC-491235, IC-491237, IC-491240, IC-491241, IC-491242, IC-491244, IC-491246, IC-491248, IC-491249,IC-491251,IC-491253, IC-491254, IC-491255, IC-491256, IC-491257, IC-491262, IC-491280, IC-491281, IC-491282,IC-491284,IC-491285, IC-491286, IC-491287, IC-491288, IC-491290, IC-491292, IC-491294, IC-491296, IC-491298,IC-491301,IC-491310, IC-491312, IC-491626, IC-491628, IC-491630, IC-491640, IC-491645, IC-491757, IC-491877,PJ Kisan,Rajat, RH-30, Varuna, Laxmi, |

**Table 4: Disease reaction of different *Brassica juncea* accessions to Sclerotinia stem rot disease under field condition**

| Rating score | Per-cent intensity | Reaction | Number of accessions | Sclerotinia rot |
|---|---|---|---|---|
| 0 | 00% stem girdled | Immune | 0 | Nil |
| 111 | 125% stem girdled | Resistant | 172 | IC-248993, IC-255498, IC-257765, IC-291158, IC-296685, IC-296703, IC-320614, IC-320648, IC-326253, IC-329705,IC-328316, IC-339589, IC-339597, IC-339625, IC-341457, IC-347994, IC-360723, IC-363606, IC-366460, IC-375924,IC-375925, IC-399678, IC-399784, IC-399802, IC-399803, IC-399808, IC-399814, IC-399815, IC-399816, IC-399824,IC-399826, IC-399840, IC-399853, IC-399878, IC-401570, IC-401574, IC-417020, IC-422165, IC-426221, IC-426357, IC-426358, IC-426395, IC-426401, IC-490996, IC-491004, IC-491011, IC-491028, IC-491036, IC-491038, IC-491039, IC-491042, IC-491044, IC-491046, IC-491047, IC-491049, IC-491052, IC-491053, IC-491056, IC-491057, IC-491058, IC-491060, IC-491063, IC-491073, IC-491074, IC-491080, IC-491081, IC-491082, IC-491085, IC-491086, IC-491100, IC-491101, IC-491104, IC-491105, IC-491108, IC-491111, IC-491112, IC-491114, IC-491116, IC-491117, IC-491118, IC-491120, IC-491123, IC-491124, IC-491125, IC-491127, IC-491128, IC-491129, IC-491130, IC-491131, IC-491137, IC-491138, IC-491139, IC-491141, IC-491142, IC-491143, IC-491145, IC-491149, IC-491150, IC-491151, IC-491152, IC-491157, IC-491158, IC-491162, IC-491165, IC-491166, IC-491167, IC-491170, IC-491171, IC-491176, IC-491177, IC-491180, IC-491181, IC-491183, IC-491184, IC-491185, IC-491186, IC-491189, IC-491192, IC-491195, IC-491198, IC-491200, IC-491201, IC-491202, IC-491203, IC-491210, IC-491213, IC-491214, IC-491215, IC-491217, IC-491219, IC-491220, IC-491221, IC-491224, IC-491225, IC-491227, IC-491229, IC-491230, IC-491231, IC-491232, IC-491234, IC-491235, IC-491237, IC-491238, IC-491240, IC-491242, IC-491243, IC-491244, IC-491248, IC-491249, IC-491255, IC-491256, IC-491262, IC-491280, IC-491281, IC-491282, IC-491285, IC-491287, IC-491288, IC-491292, IC-491296, IC-491298, IC-491301, IC-491307, IC-491310, IC-491617, IC-491626, IC-491628, IC-491630, IC-491877, PJ Kisan, RH-30, Laxmi, |
| 2 | 50% stem girdled | Moderate resistant | 67 | IC-296690, IC-296705, IC-310758, IC-320701, IC-324000, IC-335847, IC-335854, IC-347947, IC-360770, IC-363737,IC-374698, IC-399788, IC-423195, IC-426220, IC-426346, IC-426354, IC-426379, IC-491016, IC-491024, IC-491029,IC-491031, IC-491040, IC-491041, IC-491043, IC-491048, IC-491061, IC-491067, IC-491084, IC-491093, IC-491106,IC-426347, IC-491119, IC-491133, IC-491136, IC-491144, IC-491156, IC-491163, IC-491173, IC-491175, IC-491187, IC-491188, IC-491190, IC-491205, IC-491206, IC-491211, IC-491222, IC-491233, IC-491241, IC-491246, IC-491251,IC-491253, IC-491254, IC-491257, IC-491286, IC-491290, IC-491294, IC-491299,IC-491304,IC-491309,IC-491312,IC-491640, IC-491645, IC-491648, IC-491757, IC-491756, Rajat, Varuna, |
| 3 | 75% stem girdled | susceptible | 03 | IC-397537, IC-426351, IC-491284, |
| 4 | <75% stem girdled | Highly Susceptible | 03 | IC-338523, IC-397277, IC-399795, |

found moderately resistant to Alternaria blight, 16 genotypes were highly susceptible to Alternaria blight and 4 were susceptible; Kolte *et al*. (2001) reported that genotypes PR-8988 and PR-9024 showed high degree of resistance to Alternaria blight and genotypes PR-9301 and PR-9650 showed high degree of susceptibility; Prasad *et al*. (2002) screened 71 rapeseed and mustard genotypes for resistance to Alternaria blight disease. They reported that 15 genotypes were moderately resistant to Alternaria blight; DRMR (2011) screened rapeseed-mustard cultivars for resistance to Alternaria blight diseases. None of the genotype showed resistant reaction to Alternaria blight. However, EC 338997, EC 339000, EC 414293, NPJ 154 and RH 345 were found moderately resistant to Alternaria blight and Meena *et al*. (2011) also reported that S. Alba, GSL 1 and T-27 were highly resistant against thirteen *Alternaria brassicae* isolates.

White rust: In the present investigation three germplasm i.e. IC-296685, IC-399678 and IC-401570 were found immune and showed 0% disease severity, IC-326253 and IC-417020 were found to be resistant with 5-10% disease severity, IC-255498, IC-335847, IC-339589, IC-339597 and IC-399824 were moderately resistant and showed 11-25% disease severity, IC-338523, IC-399784, IC-399788 and IC-399826 were susceptible and showed 26-50% disease severity while, 231 were found to be highly susceptible with more than 50% disease severity against white rust (Table 2). This study was supported by Yadav *et al*. (1999). They worked on 74 Indian mustard (*Brassica juncea*) germplasm lines for resistance against White rust diseases. None of the genotype was completely resistant to white rust diseases. PBR-176, PBR-178 and PBR-180 were found susceptible to white rust, 4 genotypes were susceptible. Meena *et al*. (2011) found that PBC 9221, and EC 414299 brassica lines were resistant to white rust. DRMR (2011) screened the rapeseed-mustard cultivars for resistance to white rust diseases and found EC414291, EC 414293, MCB1, DRMR 243, DRMR 261, DRMR 270, NRCDR 705, JMWR 945-2-2-75 Kr , EC 399313, JYM 11 and NDWR 5-1 were found resistant to white rust and Pandey *et al*. (2013) also found that GSL-1, PBC-9221, NDCDR-515 were highly resistant to white rust.

Downy mildew: The present investigation revealed that IC-296685 germplasm was found to be immune with 0% disease severity; IC-326253 and IC-417020 were found resistant with 5-10% disease severity. IC-255498, IC-335847, IC-339589, IC-339597, IC-399678 and IC-491617 germplasm were found moderately resistant and showed 11-25% disease severity, 42 were susceptible and showed 26-50% disease severity while, 194 were found to be highly susceptible with more than 50% disease severity against downy mildew (Table 3). This result supported by Silue *et al*. (1996) screened 60 accessions of different host species against *Paranospora parasitica* and observed that 6 accessions were resistant.

Sclerotinia stem rot: In the Present finding, 172 germplasm were found to be resistant with 1-25% disease severity, 67 were found to be moderately resistant with 26-50% disease severity, 03 were found to be susceptible with 51-75% disease severity while 03 were found to be highly susceptible with 75-100% disease severity (Table 4). This finding was also supported by many authors such as Singh *et al*. (1994) who reported *B. juncea* cv. Rugosa were resistant against Sclerotinia rot in the field as well as in green house conditions. Pathak *et al*. (2002) also supported the present finding. They found that four genotypes viz. PCR 10, RW 8410, RW 9401 and RGH 8006 showed resistance against *S. sclerotium*. DRMR (2011) screened rapeseed and mustard cultivars for resistance to Sclerotinia stem rot diseases and BCS 3, BCS 4, NPC 16, NPC 20 (*B. carinata*), DMH 1(*B. juncea*) NUDB 26-11(*B. napus*) were found moderately resistant to Sclerotinia stem rot. Dalili (2013). Screened 11 Brassica genotypes against Sclerotinia sclerotiorum and found genotypes RASOPT, HAYOLA 401, RGS003, SARIGOL and ZAR401 were resistant against Sclerotinia stem rot.

Present study revealed that the only seven Brassica germplasm *viz.,* IC-255498, IC-296685, IC-326253, IC-335847, IC-339589, IC-339597 and IC-417020 were found to be multiple disease resistance against major pathogens of rapeseed-mustard viz. *Hyaloperonospora parasitica,* (Pers.) Constant, *Albugo candida,* (Pers. Ex Lev.) Kuntze, Alternaria *brassicae* (Berk.) Sacc., *Sclerotinia sclerotiorum* (Lib.) de Bary Our screening study demonstrates that these aforesaid resistant germplasm may be suitable for identification of sources of host resistant and that genotypes would be useful for the incorporation of resistance to major pathogens of rapeseed-mustard and this selection for resistance is the most cost-effective method of delivering control for farmers.

## REFERENCES

**Agricultural statistics at a glance 2011.** Directorate of economics and statistics, *Ministry of Agriculture*, govt. of India (http:// www.dacnet. nic.in/eands)

**AICRIP R&M. Proceeding 2011.** Revised rating scale of major diseases of rapeseed-mustard. Proceedings of 18th annual group meeting of AICRP rapeseed-mustard. *Khanpur campus,* AAU, Guwahati (Assam). p. 1

**Bains, S. S. and Jhooty, J. S. 1985.** Association of *Peronospora parasitica* with *Albugo candida* on *Brassica juncea* leaves. *Phytopathology*. **112:** 28-31.

**Bhatt, R., Awasthi, R. P. and Tewari, A. K. 2009.** Management of downy mildew and white rust diseases of mustard. *Pantnagar J. Research*. **7(1):** 54-58.

**Chattopadhyay, C., Meena, P. D., Kalpana, S. R. and Meena, R. L. 2003.** Relationship among pathological and agronomic attributes for soilborne diseases of three oilseed crops, *Indian J. Plant Protection*. **31**: 127-128.

**Dalili, Alireza. 2013**. Greenhouse and field evaluation of rapeseed cultivars and lines for resistance against *Sclerotinia sclerotiorum* (Lib.) de Bary. *J. Oilseed Brassica*. **4(2):** 61-65.

**DRMR. 2011**. Report of All India co-ordinated research project on rapeseed-mustard. *Sewar, Bharatpur,* Rajasthan. pp. 1-10.

**Ghosalia, R. P., Shivpuri, A. and Bhargava, A. K. 2004.** *Sclerotinia* rot of Indian mustard (*Brassica juncea*) in Rajasthan. *Indian Phytopathology*. **57:** 76-79.

**Goswami, K., Tewari, A. K. and Awasthi, R. P. 2008**. comparative study if inoculation methods in Sclerotinia sclerotiorum in rapeseed-mustard. *J. Mycology and Pant Pathology*. **38(3):** 667-668.

**Khan, M. W., Ansari, N. A. and Muheat, A. 1991.** Response of some accessions of rapeseed, yellow sarson (*Brassica campestris* var. yellow sarson strain) against Alternaria blight. *Inernational J. Tropical Plant Diseases*. **9:** 113-113.

**Kolte, S. J. 1985a.** Disease management strategies for rapeseed mustard crops in India. *Agriculture. Review*. **6:** 81-88.

**Kolte, S. J. 1985b.** Diseases of annual edible oilseed crops. Vol. II. Rapeseed-mustard and seasame diseases. *CRC Press, Boca Raton. Florida.* p.135.

**Kolte, S. J. 1986.** Important diseases of rapeseed and mustard in India: Present research progress and future research needs. In: Proceedings of the 3rd oil crops workshop on oil seed crops: *Niger and rapeseed mustard held in Addis Ababa*, Ethiopia, 6-10 Oct. pp. 91-106.

**Kolte, S. J. 2001.** Progression of Alternaria blight of mustard in relation to components of resistance. *Indian Phytopath*. **54(3):** 329-331.

**Meena, P. D., Awasthi, R. P., Godika, S., Gupta, J. C., Kumar, A., Sandhu, P. S., Sharma, P., Rai, P. K., Singh, Y. P., Rathi, A. S., Prasad, R., Rai, D. and Kolte, S. J. 2011a.** Eco-friendly approaches managing major diseases of Indian mustard. *World Applied Science*. **12(8):** 1192-1195.

**Meena, P. D., Goyal, P. and Sharma, P. 2011b**. Pathogenic variability among Alternaria brassicae population infecting oilseed Brassicas inIndia. *Indian J. Plant Protection*. **39(3):** 212-214.

**Pandey, P., Tewari, A. K. and Awasthi, R. P. 2013.** Morphological and pathogenic variability of Albugo candida isolates causing white rust in rapeseed-mustard. *The Bioscan*,

**8(3):** 835-838.

**Pathak, A. K., Godika, S., Jain, J. P. and Muralia, S. 2002.** Screening of *Brassica* genotypes against stem rot disease of mustard caused by *Sclerotinia sclerotiorum* (Lib.) de Bary. *J. Mycology and Plant. Pathology*. **32:** 111-112

**Rai, D., Mishra, A. K. and Pandey, A. 2014**. Integrated management of Alternaria blight in Indian mustard. *The Bioscan*. **9(3):** 1247-1249.

**Saharan, G. S., Kaushik, C. D., Gupta, P. P. and Tripathi, N. N. 1984.** Assessment of losses and control of white rust of mustard. *Indian Phytopathology*. **37:** 397.

**Saharan, G. S. 1992**. Management of rapeseed and mustard diseases. In: *Advances in oilseeds research* (D.Kumar and M. Rai eds.). *Scientific Publishers, Jodhpur,* India. pp. 152-188.

**Shivpuri, A., Sharma, K. B. and Chippa, H. P. 2000.** Some studies on the stem rot (*Sclerotinia sclerotiorum*) disease of rapeseed mustard in Rajasthan. *J. Mycology and Pant Pathology*. **30:** 268.

**Silue, D., Nashaat, N. I. and Tirilly, Y. 1996.** Differential responses of *Brassica oleracea* and *Brassica rapa* accessions to seven isolates of *Perenospora parasitica* at the cotyledon stage. *Plant Disease*. **80(2):** 142-144.

**Singh, R., Tripathi, N. N., Kaushik, C. D. and Singh, R. 1994.** Management of Sclerotinia rot of Indian mustard [Brassica juncea (L.) Czern and Coss] by fungicides. *Crop Research*. **7:** 276-281.

**Trimali, A. M. and Kolte, S. J. 2012.** Induction of host resistance in mustard with non-conventional chemicals against white rust (Albugo candida). *J. Plant Disease Science*. **7(1):** 27-31.

**Yadav, M. S., Dhillon, S. S., Kaur, S., Brar, K. S. and Singh, K. 1999.** Screening of Indian mustard germplasm for resistance to Alternaria blight and white rust. *Plant Disease Researc.* **14(1):** 70-72.