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Screening of soybean germplasm lines against charcoal rot caused by *Macrophomina phaseolina*

Pankaj Kumar Mishra and Mala Kumari

Abstract
In the present study, soybean germplasms were screened against charcoal rot of soybean under sick pot condition under *Kharif* 2015 and 2016. In first season, 24 entities were moderately resistant with disease incidence 1.1 to 10% and in second season 46 soybean germplasm behaved as moderately resistant (1.1 to 10% mortality). The charcoal rot fungus (*Macrophomina phaseolina*) soil borne and has a wide host range. Practically management of charcoal rot is very difficult until new resistant sources not found. Investigation attempt has been made to find out the resistance sources for charcoal root rot will be useful for manage disease in future.

Keywords: *Macrophomina phaseolina,* germplasm, screening, charcoal rot

Introduction
Soybean [*Glycine max* (L.) Merrill] designated as miracle bean, cheapest source of vegetable oil and protein. It occupies the world's first rank crop as a source of vegetable oil. In oilseed scenario of India it occupies first place and it is cultivated in area of 12.22 m ha, with production potential of 11.99 million tons. Soybean crop can be attacked by more than 100 pathogens (Sinclair and Shurtleff, 1975) [9]. Several soil borne pathogens attack the soybean plant. Among the different soil borne pathogen which infect soybean, *Macrophomina phaseolina* is an important fungus that causes charcoal rot and producing the symptoms of dry root rot, dry weather wilt, ashy stem blight and seedling blight (Su *et al*., 2001) [10]. *M. phaseolina* is capable of infecting soybean at any crop growth stage, but usually, it infects at post flowering stage. The disease cycle of *M. phaseolinia* begins with germination of microsclerotia when temperatures are between 28 °C and 32 °C (Bressano *et al*., 2010; Dhingra and Sinclair 1978) [3, 4]. In adult plants, the pathogen causes red to brown lesions on roots and stems, produces dark mycelia and black microsclerotia. The stem shows longitudinal dark lesions and the plant becomes defoliated and wilted (Abawi and Pastor-Corrales, 1990) [1]. To date, no charcoal rot resistant variety of soybean is available. Development of any resistant variety, evaluation of soybean germplasms under natural condition is very essential for identification of resistance source.

Materials and Methods
The investigations were carried out at the Department of Plant Pathology, Indira Gandhi Krishi Vishwavidyalaya, College of Agriculture, Raipur, (C.G.). All the field experiments were conducted with four replications with 30 cm spacing (3 rows of 3 m length) to know the resistance levels in the germplasms during *kharif* 2015 and 2016 at the soybean experimental field in the research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). Soybean seeds were procured from AICRP (All India Coordinated Research Project) on Soybean. IGKV, Raipur. The severity of charcoal rot was recorded at the R7 stage of the crop using a disease rating scale 0 to 9 (table 1).

Table 1: Disease rating scale of charcoal rot of soybean (Anon., 2012) [2]

Charcoal rot mortality (%)	Category	Rating
0	Absolute resistant	0
1	Highly resistant	1
1.1 -10	Moderately resistant	3
10.1 – 25	Moderately susceptible	5
25.1 - 50	Susceptible	7
> 50	Highly susceptible	9

Table 2: Reaction of soybean genotypes to *M. phaseolina* under natural conditions during *kharif* 2015

S. No.	Grade	Disease reaction	Name of the genotypes
1	0	Absolute Resistant	Nil
2	1	Highly Resistant	Nil
3	3	Moderately Resistant	PK-10-24, JS-15-14, GP-448, JS-80-21, MACS-1336, PK-10-29, SL-599, JS-15-14, PS-564, Seelajit, EC-34117, MAUS-71, MAUS-145, NRC-2008-G-1-12, NRC-2007-A-3-1, NRC-2007-12-7-2, NRC-96-02-02, NRC-95-08-01, AMS-148, EC-125788, EC-232019, EC-391336, Himso-175, JS-20-74
4	5	Moderately Susceptible	JS 335, BRAGG, BIRSA SOYA, MACS-58, NRC-20, PK-472, NRC- 2, JS-97, JS 415, JS-79-263, JS-80-5417, JS- 92-1418, SL-328, MAUS-47, PB-1, PK-12-41, PK-515, JS-128-5, JS-148, SL-518, NRC-57, MACS-756, JS(SH)96-31, PK-317, H6P20, NRC-2006-4-13, NRC-2006-F-2-2, NRC-2006-A-23, NRC-2007-B-1-19, NRC-2007-1-3, NRC-2011-E-2-1-7, NRC-2012-J- 2-2-1, NRC-2011-A-3-7, Delhi-15, Delhi-16, Delhi-17, NRC-2011-H-4-10, NRC-2011- F-1-15, NRC-2011-G-3-13, NRC-2011-E-2-1-9-1, NRC-2011-E-4-11-1-1, JSM-117-4, NRC-2011-C-4- 12, NRC-2012-M-127-1, NRC-2012-M-127-3, NRC- 2012-F-1-18-3, NRC-20-G-1-2-2-5, JS-18-13, HIMSO-15-21, JS-82-180, NRC-37, MAUS-144, MAUS-754, MAUS-61-2, JS-93-05, JS-97-52, JS-20-21, JS-20-25, JS- 20-27, JS-20-30, JS-20-79, JS-20-87, H5P8, NRC-95-05-03, H5P4, NRC-95- 03-03, NRC-95-06-03, NRC-95-03-02, NRC-95-12- 01, NRC-95-03-01, NRC-96-05-03, H6P21, H3P23, Delhi-1, Delhi-2, EC-685243, JS-20-42, JS-20-55, JS-20-71, NRC-2012- A-3-2-1-1, NRC-2012-E-2-6-4-1, PRAB-1, PI- 283327, MAUS-14-2, JS-20-76, RVS-2008-8
5	7	Susceptible	EC-389179, JS-99-76, PS-10-92, PK-416, KB-165, NRC-56, DS- 98-14, PK-13-14, PKS-7, MACS-124, JS/SH/94-21, PK-262, JS-16-40, B-S-97-12, EC- 389392, NRC-2006-C-7, NRC-2007-G-1-15, NRC-2OO8-G-1-12, VS-495, VS- 2004-18, VS-2005-19, Delhi-14, AMS-60-2-34, Cat-2502, Cat-3299, EC-2581, EC-34078, EC-39491, EC-100027, EC-118443, MACS-798, DS-228, MACS-693, MACS-694, JS-98-21, MMSS-36, EC-391181, JS-90-41, NRC-2007-L-1-5, NRC-2007-J-3, NRC-2006-M-6, NRC-2007-B-2-4, NRC-2007-4-1-36, NRC-2007-C-1-5, VS-2004-9, VS-2004-114, VS-2004-18, VS-2004-13, VS-2173, VLS-47, VS-2005-12, VS-2005-21, VS-2005-22, Delhi-3, Delhi-4, Delhi-5, Delhi-7, Delhi-8, Delhi-9, Delhi-10, Delhi- 11, Delhi-12, Delhi-13, Delhi-18, Delhi-19, Delhi-20, Delhi-21, Delhi-22, Delhi-23, Delhi-24, Delhi-25, Delhi-26, AMS-50-B, AMS-MB-5-18, Cat-2722, EC-389148, EC-457161, EC-685250, EC-685255, JS-20-35, JS-20-59, JS-20-72, NRC-96-03-02, NRC-2006-A-4-12, NRC-2006-4-1-2, NRC-2006-I-1, NRC-2006-J-7, NRC-2006-C-7, NRC-2008-B-3-17, NRC- 2007-A-2-3, NRC-2008-G-2-6, NRC-2008-F-6, NRC- 2008-J-8-1-1, NRC-2011-C-5-5, NRC-2011-B-1-8-1- 43,NRC-2011-F-1-23, NRC-2012-B-6-3-1-4-3, NRC-2012-M-127-2-3, NRC-2012-I-1-6, NRC-2012-12-1-9,NRC-2011-C-N-11, VS-2157, VS- 2002-9, VS-2004-19
6	9	Highly Susceptible	VS-2005-28, JS-20-78, JSM-224, MAUS-703, NRC-2012-G-3-14-1, NRC-95-10-03, Delhi-6, Delhi-11, Delhi-26, VLS-2, Cat-2388, PK-12-25, SL-517, NRC-95-02-03, EC-391167, H3P12, JSM-258, PK-327, B-458, RAUS-5, H5P3, GP-393, EC-15966

Table 3: Reaction of soybean genotypes to *M. phaseolina* under natural conditions during *kharif* 2016

S. No.	Grade	Disease reaction	Name of the genotypes
1	0	Absolute Resistant	NIL
2	1	Highly Resistant	NIL
3	3	Moderately Resistant	PK-10-24, JS-15-14, GP-448, JS-80-21, MACS-1336, PK-10-29, SL-599, JS-15-14, PS-564, Seelajit, EC-34117, MAUS-71, MAUS-145, NRC-2008-G-1-12, NRC-2007-A-3-1, NRC-2007-12-7-2, NRC-96-02-02, NRC-95-08-01, AMS-148, EC-125788, EC-232019, EC-391336, Himso-175, JS-20-74, MAUS-47, PB-1, SL-518, H6P20, NRC-2006-F-2-2, Delhi-17, NRC-2012-M-127-3, NRC- 2012-F-1-18-3, JS-97-52, JS-20-21, H5P4, NRC-95-03-01, NRC-2012-E-2-6-4-1, JS-99-76, MACS-124, NRC-2007-G-1-15, AMS-60-2-34, EC-100027, EC-391181, NRC-2007-C-1-5, Cat-2722 and VS-2004-19
4	5	Moderately Susceptible	JS-335, BRAGG, BIRSA SOYA, MACS-58, NRC-20, PK-472, NRC- 2, JS-97, JS 415, JS-79-263, JS-80-5417, JS- 92-1418, SL-328, PK-12-41, PK-515, JS-128-5, JS-148, NRC-57, MACS-756, JS(SH)96-31, PK-317, NRC-2006-4-13, NRC-2006-A-23, NRC-2007-B-1-19, NRC-2007-1-3, NRC-2011-E-2-1-7, NRC-2012-J- 2-2-1, NRC-2011-A-3-7, Delhi-15, Delhi-16, NRC-2011-H-4-10, NRC-2011- F-1-15, NRC-2011-G-3-13, NRC-2011-E-2-1-9-1, NRC-2011-E-4-11-1-1, JSM-117-4, NRC-2011-C-4- 12, NRC-2012-M-127-1, NRC-20-G-1-2-2-5, JS-18-13, HIMSO-15-21, JS-82-180, NRC-37, MAUS-144, MAUS-754, MAUS-61-2, JS-93-05, JS-20-25, JS- 20-27, JS-20-30, JS-20-79, JS-20-87, H5P8, NRC-95-05-03, NRC-95- 03-03, NRC-95-06-03, NRC-95-03-02, NRC-95-12- 01, NRC-96-05-03, H6P21, H3P23, Delhi-1, Delhi-2, EC-685243, JS-20-42, JS-20-55, JS-20-71, NRC-2012- A-3-2-1-1, PRAB-1, PI- 283327, MAUS-14-2, JS-20-76, RVS-2008-8, EC-389179, PS-10-92, PK-416, KB-165, NRC-56, DS-98-14, PK-13-14, PKS-7, JS/SH/94-21, PK-262, JS-16-40, B-S-97-12, EC- 389392, NRC-2006-C-7, NRC-2OO8-G-1-12, VS-495, VS- 2004-18, VS-2005-19, Delhi-14, Cat-2502, Cat-3299, EC-2581, EC-34078, EC-39491, EC-118443, MACS-798, DS-228, MACS-693, MACS-694, JS-98-21, MMSS-36, JS-90-41, NRC-2007-L-1-5, NRC-2007-J-3, NRC-2006-M-6, NRC-2007-B-2-4, NRC-2007-4-1-36, VS-2004-9, VS-2004-114, VS-2004-18, VS-2004-13, VS-2173, VLS-47, VS-2005-12, VS-2005-21, VS-2005-22, Delhi-3, Delhi-4, Delhi-5, Delhi-7, Delhi-8, Delhi-9, Delhi-10, Delhi- 11, Delhi-12, Delhi-13, Delhi-18, Delhi-19, Delhi-20, Delhi-21, Delhi-22, Delhi-23, Delhi-24, Delhi-25, Delhi-26, AMS-50-B, AMS-MB-5-18, EC-389148, EC-457161, EC-685250, EC-685255, JS-20-35, JS-20-59, JS-20-72, NRC-96-03-02, NRC-2006-A-4-12, NRC-2006-4-1-2, NRC-2006-I-1, NRC-2006-J-7, NRC-2006-C-7, NRC-2008-B-3-17, NRC- 2007-A-2-3, NRC-2008-G-2-6, NRC-2008-F-6, NRC- 2008-J-8-1-1, NRC-2011-C-5-5, NRC-2011-B-1-8-143, NRC-2011-F-1-23, NRC-2012-B-6-3-1-4-3, NRC-2012-M-127-2-3, NRC-2012-I-1-6, NRC-2012-12-1-9, NRC-2011-C-N-11, VS-2157, VS- 2002-9, VS-2005-

			28, JS-20-78, JSM-224, MAUS-703, NRC-2012-G-3-14-1, NRC-95-10-03, Delhi-6, Delhi-11, Delhi-26, VLS-2, Cat-2388, PK-12-25, SL-517, NRC-95-02-03, EC-391167, H3P12, JSM-258, PK-327, B-458, RAUS-5, H5P3, GP-393, EC-15966
5	7	Susceptible	NIL
6	9	Highly Susceptible	NIL

Results and Discussion

To find out the source of resistance, soybean germplasm lines were evaluated for their reaction against *M. phaseolina* under natural condition. The reactions of the individual germplasm line are depicted in (table 2 and 3). During the *kharif* 2015 total 237 germplasm lines were evaluated against the charcoal rot of soybean under natural field condition. Twenty four germplasm lines were found to be moderately resistant with disease incidence 1.1 to 10%. Eighty six germplasm lines were found to be moderately susceptible with disease incidence 10.1-25% and maximum number of germplasm lines, 104 fall under the category of susceptible (25.1-50%). Twenty three germplasm lines is highly susceptible (table 2). The location severity index of charcoal rot of soybean was 6.06. Screening of 237 germplasms screened earlier season were also screened during *kharif* season 2016. The data showed that germplasms fall under the two broad categories, moderately resistant and moderately susceptible. No germplasm lines were as absolute resistant, highly resistant, susceptible and highly susceptible. Out of 237 germplasm lines, 46 soybean entities behaved as moderately resistant (1.1 to 10% mortality) and majority 191 germplasm fall in the category of moderately susceptible (10.1 to 25% mortality) table 3. The location severity index of charcoal rot was 4.61. Two year germplasms screening data revealed that significant variation was found in the soybean entities. Twenty four germplasm lines found were moderately resistant against charcoal rot in *kharif* 2015 and *kharif* 2016 (table 2 and 3). This may be due to the weather parameter such as maximum and minimum temperature, rainfall and relative humidity that influenced the disease development. During the *kharif* 2015 state recorded less rainfall and high temperature, seems favourable for the disease development. The mean average temperature recorded during grain filling to pod maturation was 33 °C. Earlier report revealed that dry conditions favour survival of microsclerotia in the soil, but mycelial growth and infection require moist conditions and are favoured by a temperature above 27 °C (Hagedorn 1991) [5]. A high level of root infection can occur before reproductive development if there is a preponderance of hot and dry weather early in the growing season (Olaya and Abawi 1993) [8]. It was also observed that the population density of *M. phaseolina* increased slowly from the V5 to R6 growth stages and then rapidly from the R6 to R7 growth stages (Mengistu *et al.* 2011) [6]. Nagamma *et al.* 2015 [7] screened 192 chickpea genotypes against dry root rot disease Thirteen entries *viz*., GNG 1958 (AVT-2), GNG 1999, CSJ 303, BG 3004, CSJ 753, RSG 888, Phule G 04305, IPCK 07-62, RVSSG 12, HK 08-212, Phule G 09305, AKG 2002-1K and ICCV 08317 showed resistant reactions under field condition.

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