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Screening of soybean genotypes against soybean mosaic virus under natural and glass house conditions

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Abstract
In view to check the infectivity of soybean mosaic virus on soybean plants under natural and glass house conditions 36 genotypes were screened. Field screening of soybean genotypes revealed that out of thirty six genotypes two were resistance (PS-1589 and PS-1587), while seven were moderately resistant (RVS-2009-09, AMS-MB-5-19, SL-1104, MASC-1520, RSC-10-70, SL-1113 and JS-9305) to SMV under field conditions. Glasshouse screening showed that out of nine promising genotypes which showed resistance/escape under field conditions, three showed resistant reaction (PS-1589, PS1587 and SL-1104), one genotype (SL-1113) showed moderately resistant reaction, three genotypes (RVS-2009- 09, RSC-10-70 and JS-9305) were categorized as susceptible while two genotypes (AMS-MB-5-19 and MASC-1520) showed moderately susceptible reaction.

Keywords: Screening, soybean, soybean mosaic virus, resistance

Introduction
Soybean is considered as a 'Golden bean', 'Miracle bean', 'Agriculture‟s Cinderella', 'Wonder crop of the 20th Century', due to its qualities such as good amount of carbohydrates (35%), oil (20%) and 40 percent high quality protein (as against 7.0 percent in rice, 12 percent in wheat, 10 percent in maize and 20-25 percent in other pulses). Soybean protein is rich in valuable amino acid lycine (5%) in which most of the cereals are deficient. In addition, it contains a good amount of minerals, salts and vitamins (thiamine and riboflavin). Soybean mixed with other cereals is capable of increasing Protein Efficiency Ratio (PER), a parameter of protein quality. According to Mehta (1987) [8] the PER of wheat and rice is increased from 1.53 to 2.57 and 2.10 to 2.77 respectively when mixed with soybean.

During 2015-16 area and production of soybean in India was 11.67 in Million Hectares and 8.59 in Million Tonnes resp. In India Madhya Pradesh is on first position and Maharashtra is on second position in terms of soybean area and production. In Maharashtra it has been grown on 3.77 Million Hectares area with production of 2.10 Million Tonnes which is 24.46 percent of total soybean produced in India (Anonymous, 2016) [3]. During recent years, the average per ha yield of soybean in India still remains low. In addition to many other reasons, diseases and pests, which attack crop, are important factors responsible for low production.

The major diseases on soybean generally observed are rust, *Fusarium* wilt, *Sclerotium* wilt, brown leaf spot (*Septoria glycines*) and bacterial blight (*Pseudomonas glycines*), bud blight and over 50 different viruses are known to affect soybean. In India less than 10 viruses are known. The most important are soybean yellow mosaic virus (Lal *et al.*, 2005, Rajkumar *et al.*, 2007) [10], Soybean mosaic virus and GBNV (Bhat *et al.*, 2002, and Lal *et al.*, 2002) [5, 7] causing bud blight of soybean.

Soybean mosaic virus (SMV) is considered to be one of the most significant soybean viruses recurring worldwide (Bos, 1972) [6]. Economic loss caused by SMV typically ranges between 8% - 35% and in severe case may reach up to 100% (Ahangaran *et al.*, 2009) [1]. Various strains and isolates of SMV that cause different symptoms on soybean have been identified worldwide. Common symptoms of infection by SMV on soybean include mosaic and mottling, crinkling of leaves, leaf puckering, dwarfing and top necrosis (Balgude *et al.* 2012) [4].

In Maharashtra soybean crop is found infected with viruses showing symptoms of vein clearing, mosaic, mottling on leaves. These viral diseases are considered most destructive since they can be spread within the crop during cultural operations and also by insect vectors

thereby causing maximum reduction in crop yield. Considering the importance of SMV disease occurring on soybean, In order to find out an effective integrated disease management practice, this investigation was under taken.

Materials and Methods

Screening of soybean cultivars against soybean mosaic virus

Seed of 36 varieties including one susceptible check i.e. JS-335 were procured from Agricultural Research Station (ARS), Kasabe Digraj, Dist- Sangli. Screening of soybean genotypes under field as well as glasshouse conditions etc. were conducted in *Kharif-2016* at experimental field of Post Graduate Institute (PGI) and glasshouse of Department of Plant Pathology and Agricultural Microbiology, PGI, MPKV, Rahuri. Plants were selected from each variety for recording observations on soybean mosaic virus incidence. For evaluation, at maturity of crop i.e. 90 DAS percent disease incidence for each test genotype was calculated by using formulae where ratio of number of plants infected by SMV to the total number of plants in each rows of test genotype is taken and expressed in percent.

$$PDI = \frac{\text{Number of infected plants}}{\text{Total number of plants}} \times 100$$

Disease severity was recorded using a 0-5 point disease rating scale, which had six categories

Table 1: Disease rating scale for soybean mosaic virus disease

Disease grade	% Plant Infection	Grades
0	0	Immune/Disease Free (I)
1	0.1-20.0	Resistant (R)
2	20.1-40.0	Moderately Resistant (MR)
3	40.1-60.0	Moderately Susceptible (MS)
4	60.1-80.0	Susceptible (S)
5	80.1-100	Highly Susceptible (HS)

Glasshouse Screening

Promising genotypes which showed immune, resistant and tolerant reaction under field conditions were selected and further screened artificially against soybean mosaic virus (SMV) under glasshouse conditions.

For glasshouse screening promising soybean genotypes were sowed in pots of standard size filled with pasteurized soil mixture (1:1:1 soil, sand and peat). For each of the genotype five pots were used and in each such pot five plants of each genotype were maintained. Seedlings were inoculated mechanically and observations were recorded on symptoms produced and number of plants infected (Table 2). Prior to sowing, seeds were treated with 0.3 percent Captan (N-trichloromethyl-thio-4-cyclohexene-1, 2, dicarboximide) to prevent rotting. The glasshouse was sprayed with 0.05 percent monocrotophos (Dimethyl-cis-1-methyl-2 methyl carbamoylvinyl phosphate) at regular intervals to keep it free from the insects.

Results and Discussion

Screening under field (natural) condition

The percent disease incidence on individual genotypes, disease grade and reaction recorded under field condition are presented in Table 1. Out of the 36 varietiesevaluated against the virus, two were resistant, seven moderately resistant; twenty moderately susceptible, five susceptible while two varieties recorded highly susceptible reaction to SMV. No genotype however escaped infection under natural conditions and thus no cultivar could be classified as immune.

Table 2: Natural incidence of soybean mosaic virus on different genotypes of soybean under field conditions

Sr. No	Cultivar / Genotype	PDI (SMV) (%)	Disease grade (0-5 scale)	Reaction
1	MACS-1543	52.17	3	MS
2	RVS-2009-09	37.31	2	MR
3	DSB-283	56.95	3	MS
4	VLS-92	45.31	3	MS
5	KDS-344	54.16	3	MS
6	HIMSO-1687	55.22	3	MS
7	AMS-MB-5-19	37.04	2	R
8	KDS-992	71.83	4	S
9	SL-1104	33.84	2	MR
10	MASC-1460	59.70	3	MS
11	MASC-1520	39.10	2	MR
12	PS-1589	16.81	1	R
13	KDS-753	47.94	3	MS
14	DS-3105	59.42	3	MS
15	KDS-999	52.23	3	MS
16	KDS-726	56.06	3	MS
17	RSC-10-70	36.50	2	MR
18	DSB-32	70.58	4	S
19	KDS-921	52.38	3	MS
20	SL-1113	33.54	2	MR
21	JS-21-08	81.15	5	HS
22	KDS-1045	56.33	3	MS
23	MAUS-711	52.23	3	MS
24	JS-9305	39.06	2	MR
25	NRC-126	59.09	3	MS
26	DS-228	68.05	4	S
27	TS-80	49.23	3	MS
28	NSO-626	64.70	4	S
29	KDS-780	73.52	4	S
30	RSC-1046	49.27	3	MS
31	NRC-125	58.20	3	MS
32	DS-3106	54.16	3	MS
33	KDS-1007	57.57	3	MS
34	KDS-869	54.92	3	MS
35	PS-1587	18.33	1	R
36	JS-335	87.33	5	HS

The genotype PS-1589 and PS-1587 were found to be resistant. The genotypes RVS-2009-09, AMS-MB-5-19, SL-1104, MASC-1520, RSC-10-70, SL-1113, and JS-9305 were found to be moderately resistant. Genotypes *viz,* MACS-1543, DSB-283, VLS-92, KDS-344, HIMSO- 1687, MASC-1460, KDS-753, DS-3105, KDS-999, KDS-726, DSB-32, KDS-921, KDS-1045, MAUS-711, NRC-126, TS-80, RSC-1046, NRC-125, DS-3106, KDS-1007 and KDS-869 showed moderately susceptibility. While KDS-992, DSB-32, DS-228, NSO-626 and KDS-780 showed susceptibility while genotype JS-21-08and JS 335 showed highly susceptible reaction under natural conditions.

Screening under glasshouse condition

Nine promising genotypes of soybean which showed 0 to 2 reactions on disease grading scale under field screening were selected and artificially screened the percent disease incidence on individual genotypes, disease grade and reaction recorded under glasshouse condition are presented in Table 2. In the artificial screening tests of soybean genotypes PS-1589, PS-1587, and SL- 1104 were categorized as resistant, genotype SL-1113 showed moderately resistant, RVS-2009-09, RSC-

10-70, JS-9305 were categorized as moderately susceptible while AMS-MB-5-19, MASC-1520 showed susceptible reaction based on the disease grade scale given earlier in Table 1. Thus out of nine genotypes evaluated against the virus, three were resistant, one tolerant, three susceptible while two genotypes recorded moderately susceptible reaction to the virus. No genotype however escaped infection under glasshouse conditions and thus no cultivar could be classified as immune.

Table 3: Artificial screening of soybean genotypes under glasshouse condition for resistance against SMV

Sr. No	Cultivar / Genotype	PDI (SMV) (%)	Disease grade (0-5 scale)	Reaction
1.	PS-1589	16	1	R
2.	PS-1587	12	1	R
3.	RVS-2009-09	56	3	MS
4.	AMS-MB-5-19	64	4	S
5.	SL-1104	20	1	R
6.	MASC-1520	72	4	S
7.	RSC-10-70	52	3	MS
8.	SL-1113	32	2	MR
9.	JS-9305	48	3	MS

Akhtar *et al.* (1992) [2] screened twelve varieties for resistance to SMV. Four varieties (Crow ford, Cico, Zane and 80-B-4007) were found resistant to the virus. Zheng *et al.* (2000) [12] studied 348 soybean accessions which were screened for resistance to soybean mosaic virus (SMV) by inoculation with SMV3, a strongly virulent strain from north east China. The results showed that 113 accessions were highly resistant, 113 were moderately resistant and 122 were susceptible. Zheng *et al.* (2003) [13] found that soybean line 'ICGR95-5383', A newly released germplasm from China, is resistant (R) to soybean mosaic virus (SMV). In under to investigate the inheritance of SMV resistance ICGR95-5383 was crossed to the susceptible (S) cultivars 'HB 1', 'Tiefeng21', 'Amsoy', and 'Williams'. Mohammed *et al.* (2000) [9] noticed that none of the 29 soybean cultivars and 40 germplasm lines tested were found immune to two isolates of soybean mosaic potyvirus (SMV-S1 and SMV-P1). Malakand-96 was the only cultivar found highly resistant to both S1 and P1 isolates. Swat-84, Bryan, Hobbit-87, Kingsay, Lugan, Sherman and Harper-87 were resistant to S1 and P1 whereas Rinconditawas resistant to S1 and moderately resistant to P1 isolate. Shrirao *et al.* (2009) [11] evaluated 16 genotypes and reported that 14 entries were found absolutely resistant against soybean mosaic virus and two showed highly resistant reaction against SMV.

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