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# Identification of Sources of Resistance in Saffron (*Crocus sativus* L.) to *Fusarium oxysporum* Causing Corm Rot Disease

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**A B S T R A C T**

Of the fifty-five saffron genotypes/ lines screened for resistance to *Fusarium oxysporum* during two consecutive years at Dryland Agriculture Research Station in Kashmir, indicated that disease incidence and disease intensity ranged from 2.50 to 81.50 per cent and 0.25 to 72.25 %, respectively. The highest mean disease incidence (81.50%) was recorded in genotype SDM-102 and while lowest mean disease incidence (2.5%) was recorded in genotype 0.75Kr. Among the screened genotypes/lines, 'Highly Resistant' genotypes are 0.5Kr, 0.75Kr, SMD-1, SMD-3 SMD-27, SMD-146, SD-147, SD-224 SD-45, SD-52, SD-68, while 'highly susceptible' genotypes were SMD-102 and SMD-103.

## Introduction

Saffron (*Crocus sativus* L.) world's most sought after and expensive spice is an important spice cash crop of Kashmir. There are more than 2 lakh people who are directly or indirectly involved with the saffron trade. The crop covers an area of 5000 acres (2023 ha) in Jammu and Kashmir. Saffron is especially grown in uplands and karewa areas of Kashmir valley especially Pampore and adjoining areas. The other place where saffron is grown includes Budgam, Pulwama and Anantnag in Kashmir valley and Kishtwar district in Jammu Division. Saffron covers about 4% of total cultivated areas of Kashmir valley and provides about 6% of total agricultural income (Mir, 1992).

The yield of saffron dwindles year after year. The average productivity in J&K reached to 2.7 kg as against 3.29 kg/ha in 1997 (Zargar, 2002). The decline in production continues though the newer areas are being are brought under its cultivation. The intensive cultivation and mono-culturing of saffron in saffron growing belts of valley together with the continual use of diseased material resulted in frequent occurrence of saffron corm rot diseases incited by pathogens like

*Phomacrocrophila*, *Rhizoctonia crocorum* (sheath blight and corm rot), (*Madan et al.*, 1967), *Fusarium moniliforme* var *intermedium*, non sporulating basidiomycetous fungus (Dhar, 1992), *Macrophomina phaseolina* (Thakur *et al.*, 1992), *Fusarium oxysporum*, *F. solani*, *F. pallidoroseum*, *F.equiseti*, *Mucor*spp, *Penicillium* spp (Wani,2004, Ahmed and Sagar, 2006), *Sclerotium rolfsii* (Kalha*et al.*, 2007). Of these diseases, corm rot of saffron caused by *Fusarium oxysporum* and *F. solani* is considered most destructive (Wani, 2004; Ahmed and Sagar, 2007) and takes considerable proportion of the produce every year. Dhar (1992) reported 6.7 to 15.2 per cent corm rot disease incidence and observed that none of the saffron growing areas in Kashmir valley was free from this disease. Thakur (1997), however, reported corm rot incidence to the magnitude of 70 to 85 per cent in saffron growing fields of Kashmir. The review of work done on this aspect suggested that the evaluation of a much broader range of germplasm of saffron is required for corm rot pathogen. Keeping in view the losses inflicted by this diseases and the need to devise its management with emphasis on use of resistant genotypes, in the present study, an attempt was made to identify sources of resistance to the disease in available germplasm under temperate climatic conditions of Kashmir valley.

## Materials and Methods

Fifty-five saffron genotypes/ lines collected from various places were screened against the pathogen under natural epiphytotic conditions at Dryland Agriculture Research Station, SKUAST-K for two consecutive years. Each line was sown with plant to plant distance of 10 cm and row to row distance of 20 cm.The plot was flanked on both sides with double row of a highly susceptible variety 'SMD-102' and each test row was followed by a row of the same susceptible cultivar 'SMD-102'. Three replications were maintained for each genotype. The disease reaction was recorded on by using modified 0-5 scale (Gupta *et al.*, 2000), where 0 denotes completely disease free corms and 5 denotes the extent of infection covering more than 50% corm area. The genotypes were classified into highly resistant (0-5% disease intensity), resistant (5.1-10% disease intensity), moderately resistant (10.1-20.0% disease intensity), susceptible (20.1-50.0% disease intensity) and highly susceptible (more than 50% disease intensity) categories.

## Results and Discussion

The screening of saffron against corm rot disease during first year of experimentation indicated that disease incidence and disease intensity ranged from 2.50 to 85.00 % and 0.25 to 79.50 %, respectively. The highest disease incidence (85.00%) was recorded in genotype SDM-102 while lowest disease incidence (2.5%) was recorded in SDM-1 genotype. Among the screened germplasm, 'Highly Resistant' genotypes were SMD-1, SMD-27, SMD-46, SMD-93, SMD-156, SD-31, SD-45, SD-52, SD-68, SD-81, SD-147, SD-224, and.75Kr, while 'highly susceptible' genotypes were SMD-98, SMD-102, SMD-103, and SMD-207. However, during the second year of experimentation, disease incidence and disease intensity ranged from 2.50 to 78.0 per cent and 0.25 to 64.0 per cent respectively Most of genotypes showed similar trends as in 2009. The highest disease incidence (78.0%) was recorded in genotype SDM-102 while lowest disease incidence (2.5%) was recorded in SDM-1, SD-45 and.7Kr genotype. Among the screened germplasm, 'Highly Resistant' genotypes were 0.5Kr, 0.75Kr, SMD-1, SMD-3 SMD-27, SMD-146, SD-147, SD-224 SD-45, SD-52, SD- 68, while 'highly susceptible' genotypes were SMD-102, SMD-98, SMD-103.

**Table.1** Screening of saffron genotypes/ lines against corm rot pathogen (*Fusarium oxysporum)* during two years of experimentation at DARS, Budgam

| S. No. | Germplasm | Disease incidence (%) | | | Disease intensity (%) | | |
|---|---|---|---|---|---|---|---|
| | | Ist | 2nd | Mean | Ist | 2nd | Mean |
| 1 | SMD-161 | 10.00 | 12.00 | 11.00 | 6.25 | 7.50 | 6.87 |
| 2 | SMD-101 | 42.50 | 45.00 | 43.75 | 35.50 | 17.50 | 26.50 |
| 3 | SMD-87 | 37.50 | 39.00 | 38.25 | 25.5 | 18.20 | 21.85 |
| 4 | SMD-61 | 30.00 | 32.00 | 31.00 | 16.50 | 11.70 | 14.10 |
| 5 | 0.25 Kr | 20.00 | 18.00 | 19.00 | 9.75 | 7.50 | 8.62 |
| 6 | 0.5 Kr | 7.50 | 8.00 | 7.75 | 5.75 | 3.70 | 4.72 |
| 7 | 0.75Kr | 2.50 | 2.50 | 2.50 | 0.25 | 0.20 | 0.22 |
| 8 | 1 Kr | 37.50 | 35.00 | 36.25 | 28.75 | 17.50 | 23.12 |
| 9 | SMD-152 | 12.50 | 15.00 | 13.75 | 9.00 | 7.25 | 8.12 |
| 10 | SMD-133 | 27.50 | 32.00 | 29.75 | 15.00 | 21.70 | 18.35 |
| 11 | SMD-93 | 12.50 | 15.50 | 14.00 | 4.00 | 7.20 | 5.60 |
| 12 | SMD-1 | 2.50 | 2.50 | 2.50 | 0.25 | 0.25 | 0.25 |
| 13 | SMD-102 | 85.00 | 78.00 | 81.50 | 80.50 | 64.00 | 72.25 |
| 14 | SMD-98 | 65.00 | 64.00 | 64.50 | 60.00 | 45.20 | 52.60 |
| 15 | SMD-170 | 32.50 | 37.50 | 35.00 | 25.50 | 27.50 | 26.50 |
| 16 | SMD-80 | 17.50 | 22.50 | 20.00 | 12.50 | 13.00 | 12.75 |
| 17 | SMD-165 | 35.50 | 35.00 | 35.25 | 30.00 | 17.50 | 23.75 |
| 18 | SMD-27 | 5.00 | 7.50 | 6.25 | 3.00 | 3.70 | 3.35 |
| 19 | SMD-13 | 15.00 | 12.50 | 13.75 | 6.75 | 7.50 | 7.12 |
| 20 | SMD-103 | 62.50 | 60.00 | 61.25 | 60.00 | 55.50 | 57.75 |
| 21 | SMD-124 | 35.00 | 40.00 | 37.50 | 30.00 | 33.00 | 31.50 |
| 22 | SMD-157 | 12.50 | 15.50 | 14.00 | 4.50 | 8.00 | 6.25 |
| 23 | SMD-47 | 12.50 | 15.00 | 13.75 | 2.75 | 8.00 | 5.37 |
| 24 | SMD-45 | 40.00 | 35.00 | 37.50 | 27.00 | 17.50 | 22.25 |
| 25 | SMD-3 | 42.50 | 40.00 | 41.25 | 33.00 | 21.70 | 27.35 |
| 26 | SMD-11 | 17.50 | 15.50 | 16.50 | 13.50 | 8.50 | 11.00 |
| 27 | SMD-111 | 60.00 | 65.00 | 62.50 | 49.50 | 30.50 | 40.00 |
| 28 | SMD-146 | 17.50 | 15.00 | 16.25 | 15.75 | 3.70 | 9.72 |
| 29 | SMD-217 | 25.00 | 17.50 | 21.25 | 17.2 | 13.00 | 15.10 |
| 30 | SMD-76 | 35.00 | 40.00 | 37.50 | 17.5 | 10.00 | 13.75 |
| 31 | SMD-68 | 25.00 | 27.50 | 26.25 | 14.5 | 15.50 | 15.00 |
| 32 | SMD-52 | 15.00 | 12.50 | 13.75 | 7.25 | 5.20 | 6.22 |
| 33 | SMD-54 | 40.00 | 42.50 | 41.25 | 33.0 | 30.50 | 31.75 |
| 34 | SD-21 | 12.50 | 17.00 | 14.75 | 7.5 | 8.00 | 7.75 |
| 35 | SD-1 | 25.00 | 22.50 | 23.75 | 18.25 | 9.70 | 13.97 |
| 36 | SD-175 | 32.50 | 35.00 | 33.75 | 11.75 | 16.50 | 14.12 |
| 37 | SMD-202 | 22.50 | 20.00 | 21.25 | 15.00 | 13.00 | 14.00 |
| 38 | SD-35 | 22.50 | 15.50 | 19.00 | 14.25 | 10.00 | 12.12 |
| 39 | SD-81 | 7.50 | 10.00 | 8.75 | 3.0 | 6.20 | 4.60 |
| 40 | SD-13 | 25.00 | 18.00 | 21.50 | 18.25 | 13.00 | 15.62 |
| 41 | SMD-79 | 40.00 | 37.50 | 38.75 | 18.5 | 25.50 | 22.00 |
| 42 | SD-147 | 7.50 | 10.00 | 8.75 | 0.75 | 2.50 | 1.62 |
| 43 | SD-40 | 22.50 | 27.50 | 25.00 | 16.75 | 15.00 | 15.87 |
| 44 | SMD-186 | 30.00 | 32.50 | 31.25 | 21.75 | 18.00 | 19.87 |
| 45 | SMD-207 | 55.00 | 60.00 | 57.50 | 50.25 | 45.20 | 47.72 |
| 46 | SD-80 | 20.00 | 17.50 | 18.75 | 13.00 | 14.20 | 13.60 |
| 47 | SMD-224 | 50.00 | 42.50 | 46.25 | 47.5 | 30.50 | 39.00 |
| 48 | SD-180 | 12.50 | 12.50 | 12.50 | 5.25 | 7.50 | 6.37 |
| 49 | SMD-192 | 15.00 | 17.50 | 16.25 | 8.0 | 7.20 | 7.60 |
| 50 | SD-211 | 60.00 | 62.50 | 61.25 | 21.75 | 18.50 | 20.12 |
| 52 | SD-224 | 7.50 | 5.00 | 6.25 | 1.00 | 0.75 | 0.87 |
| 53 | SD-31 | 7.50 | 12.00 | 9.75 | 3.75 | 5.20 | 4.47 |
| 54 | SD-45 | 5.00 | 2.50 | 3.75 | 3.50 | 2.00 | 2.75 |
| 55 | SD-52 | 7.50 | 5.00 | **6.25** | 3.50 | 2.50 | **3.00** |

**Table.2** Categorization of fifty five saffron genotypes on the basis of disease reaction types on corms at DARS Budgam, during two years

| Category | Disease intensity range (%) | Genotype |
|---|---|---|
| Highly resistant (HR) | 0.5-5.0 | 0.5Kr, 0.75Kr,SMD-1, SMD-3,SMD-27, SMD-146, SD-147, SD-224,SD-45, SD-52, SD- 68 |
| Resistant (R) | 5.1-10.0 | SMD-161,0.25 Kr,SMD-152, SMD-93, SMD-13, SMD-157, SMD-47, SMD-11, SMD-76, SMD-52, SD-21, SD-1, SD-35, SD-81, SD-180, SMD-192, SD-31 |
| Moderately resistant (MR) | 10.1-20.0 | SMD-101, SMD-87, SMD-61, 1Kr, SMD-133, SMD-80, SMD-165 SMD-45, SMD-217, SMD-68, SMD-175, SMD-202, SMD-13, SD-40, SMD-186, SD-211. |
| Susceptible (S) | 20.1-50.0 | SMD-98, SMD-170 SMD-124, SMD-3, SMD-111, SMD-54, SMD-79, SMD-207 SMD- SMD-224. |
| Highly susceptible (HS) | >50 | SMD-102, SMD-103 |

**Fig.1** Screening of saffron genotypes against *Fusarium oxysporum* on the basis of per cent disease incidence

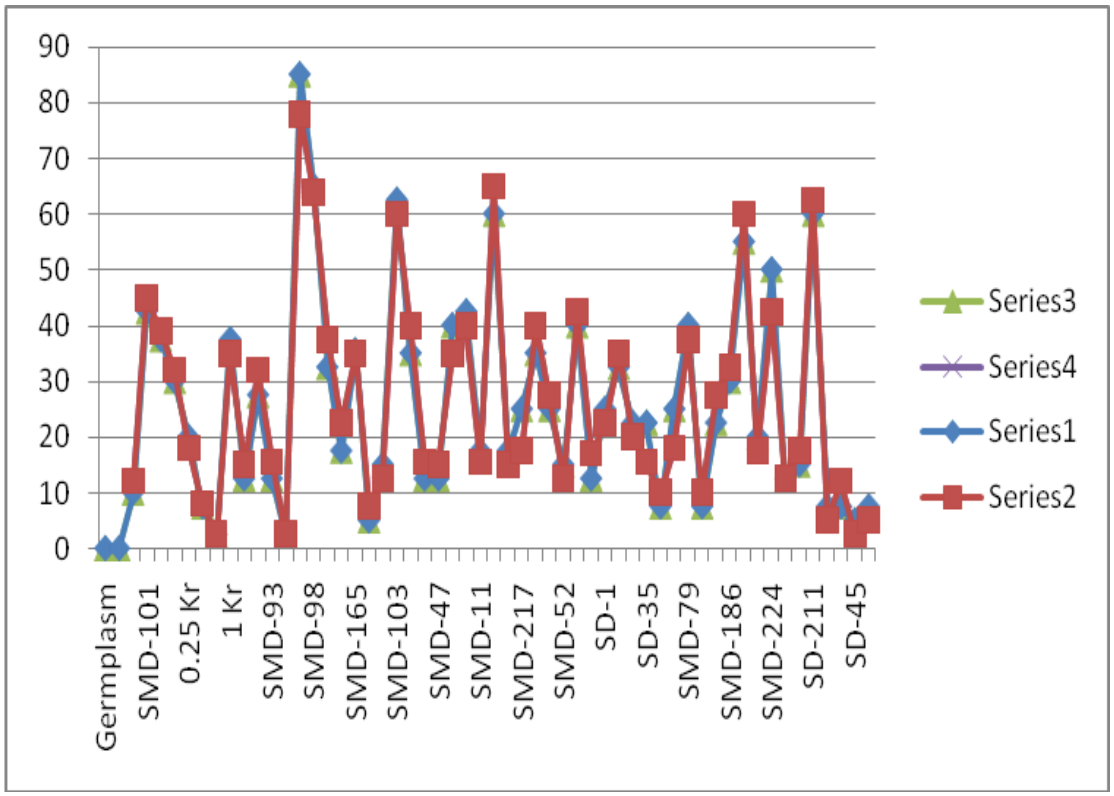
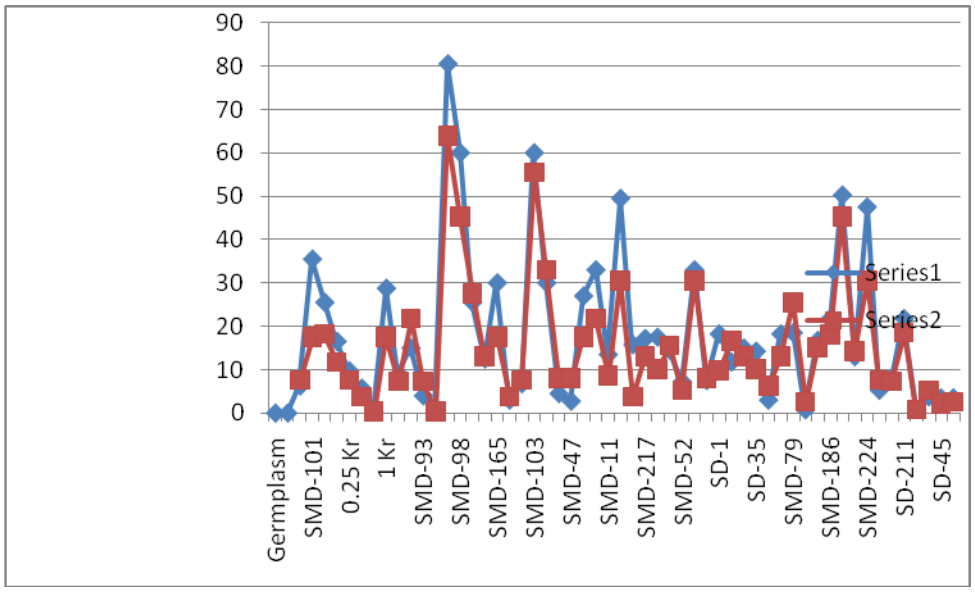


**Fig.2** Screening of saffron genotypes against *Fusarium oxysporum* on the basis of per cent disease intensity




On an overall mean basis of two year data indicated that disease incidence and disease intensity ranged from 2.50 to 81.50 per cent and 0.25 to 72.25 %, respectively (Table 1; Figs. 1 and 2). The highest mean disease incidence (81.50%) was recorded in genotype SDM-102 while lowest mean disease incidence (2.5%) was recorded in 0.75Kr genotype. Among the screened germplasm, 'Highly Resistant' genotypes are 0.5Kr, 0.75Kr, SMD-1, SMD-3 SMD-27, SMD-146, SD-147, SD-224 SD-45, SD-52, SD-68, while 'highly susceptible' genotypes were SMD-102 and SMD-103. In the present investigation, the selection for resistance was based on the reaction of varieties on corms. It is necessary to test the reaction of the varieties at all stage because saffron crop become progressively more susceptible to *Fusarium oxysporum* with increasing age (Thakur, 1997) (Table 2). The difference in behaviour of varieties at different locations may be attributed to prevalence of different weather conditions and existence of different strains of *Fusarium oxysporum* (Singh and Saini, 1980). In the present investigation, the eleven genotypes which showed highly resistant reaction to saffron corm rot pathogen under natural epiphytotic conditions of Kashmir valley could be used as direct introduction or sources of resistance in hybridization programme.

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