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Screening for resistance of sunflower germplasm lines against collar rot disease incited by *Sclerotium rolfsii* Sacc.

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Abstract

The present study was carried out under natural field conditions in the research field of Oilseeds Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar to test resistance/ tolerance of sunflower germplasm lines against *Sclerotium rolfsii*. A total of hundred germplasm lines of sunflower were screened for their relative resistance against collar rot disease in field under natural conditions. Each genotype was planted in single rows with a row length of 3 m and a row spacing of 60 × 30 cm in augmented design and disease incidence were recorded. Among one hundred germplasm line forty-four was showed moderately resistant, thirty-six germplasm lines were showed moderately susceptible reaction, sixteen germplasm lines showed susceptible reaction (40-60%), while four lines were highly susceptible to collar rot disease under natural field conditions.

Keywords: Germplasm, screening, sunflower, *Sclerotium rolfsii* Sacc.

Introduction

The sunflower (*Helianthus annuus* L.) is a member of the *Asteraceae* family. There are 65 species in the *Helianthus* genus (Andrew *et al.*, 2013) ^[1]. *Helianthus* is derived from the Greek words helios (sun) and anthos (flower). The most common sunflower is *Helianthus annuus*, which is an annual sunflower. It is an annual plant with a big inflorescence (flowering head), a rough hairy stem, wide coarsely serrated rough leaves, and round heads. Sunflower is the fourth-largest oil-seed crop and Ukraine is the largest producer of sunflower in the world. Due to the good quality and ample amount of oil in the sunflower seed (48-53%), the oil is used for a variety of cooking purposes (Sharma *et al.*, 2013) ^[14]. It was previously utilized as a decorative plant and in ancient rituals (Harter *et al.*, 2004) ^[6]. In India, sunflower is grown on an area of 2.62 lakh hectare with the production of 2.16 lakh tonnes (Indiastat.com, 2019) ^[7]. Sunflower oil is also widely used in salad dressings and in the manufacturing of margarine, shortening, paints and cosmetics (Kunduraci *et al.*, 2010) ^[10].

The acreage and production of sunflower is very low in India as compared to other developed countries due to several limiting factors such as biotic and abiotic stresses. Susceptibility to diseases is one of the most important biotic factors responsible for limiting crop yields. Sunflowers have been affected by a variety of biotrophic and necrotrophic pathogens, many which have resulted in significant losses (Mehta *et al.*, 2005) ^[11]. Among biotic stresses collar rot incited by *Sclerotium rolfsii* Sacc. is the most damaging soil-borne disease affecting the sunflower. *S. rolfsii* found as the most disturbing plant pathogen, has a wide host range and causes heavy yield losses (Aycok, 1966, Kokub *et al.*, 2007) ^[2, 8]. This disease is of major concern in most areas of India and Pakistan (Gulya *et al.*, 1997) ^[5]. The disease has been reported to cause 10% yield losses under 10-11% disease incidence (Kolte and Tewari, 1977) ^[9]. Sunflower crops need to be grown under warm and humid climatic conditions for luxurious growth and better production efficiency and the pathogen also requires the same condition for the development of the disease (Singh *et al.*, 2022) ^[15]. Clean crop cultivation, pesticides, disease-free planting material, and crop rotation are some of the most frequent management measures used to control the disease.

These strategies all have limitations, and therefore are ineffective as a solitary tactic. Chemical usage is discouraged because of the health risks associated with it. The only practical and feasible strategy to manage this disease is to develop resistant cultivars. Breeding for resistance necessitates the selection of desirable resistant sources against continuous pathogen testing. One of the most crucial aspects of integrated disease management is host resistance. Because of the limited screening of sunflower germplasm under the artificial epiphytotic condition, very little information in the literature is present on the sources of resistance against sunflower collar rot disease (Mullen, 2001)^[12]. Therefore, the present study was carried out with the objective to assess the degree of resistance among the available sunflower germplasm against this pathogen. The resistant cultivars can be used as an important component in integrated disease management programs.

Materials and Methods

The crop was sown during the rabi season on 10th February 2021 and harvested on 11th May 2022 at the Research Field, Oilseeds Section, Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar (29° 10'N latitude, 75° 46'E longitude). Fungus *Sclerotium rolfsii* was isolated from diseased sunflower plants showing typical collar rot symptoms confirmed under *in vitro* conditions. The isolation of pathogen was done on potato dextrose medium using infected sunflower plants that were collected from the field. The pathogen was identified based on morphological characters such as white, dense radiating mycelial growth on PDA (Fig 1). Under natural sick plot conditions, 100 genotypes were tested for their relative resistance to collar rot disease. Due to continuous sunflower cultivation in the same field every year, the soils of experimental plots at Oilseeds Research Area CCSHAU Hisar have become infected with *S. rolfsii*. Each genotype was planted in single rows with a row length of 3 m and a row spacing of 60 × 30 cm in augmented design. Observation of percent disease incidence was recorded 15 days prior to harvest. Disease incidence was calculated by the following formula:

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants}} \times 100$$

Finally, the genotypes were categorized for their relative resistance against *S. rolfsii*.

Results and Discussion

The reaction of sunflower germplasm to *S. rolfsii* is summarized in Table 2. Assessment of cultivars on the basis of disease incidence revealed that none of the germplasm lines was found resistant ($\leq 10\%$ Disease incidence) to collar rot disease. Forty-four germplasm lines viz., CSF-1-5304, R-103, CSF-1-5317, EC-601879, PET-2-7-1-B, EC-601804, EC-601916, P-Population, EC-601937, MSF-6, EC-601957, MSF-1-16, EC-601963, LSF-901, EC-603616, IIOSH-51, EC-623026, HAOL-11, EC623032, HAOL-03, GPB-02, GPB-50, GPB-61, GPB-07, HAOL-06, GMU-935, IHT-222, EC-623028, IIOSH-04-62, EC-623023, CMS-850B, MR-234, EC-601970, MSF-2-16, EC601961, AKSFI-196, EC-601953, EC-601623,, EC-601930, R-101, EARLY-1, RC-10, CGP-17, RC-22 were found moderately resistant

(10-20% disease incidence). Thirty-six germplasm lines showed moderately susceptible reaction (20-40%), sixteen germplasm lines showed susceptible reaction (40-60%), while four lines were highly susceptible to collar rot disease under natural field conditions (Graph 1 a, b, c, d) (Fig 2 & 3).

Because there is a lack of genetic vertical host resistance in sunflower to this necrotic soil borne pathogen, studies on screening sunflower genotypes for relative resistance under epiphytotic conditions in our country suggest that genotypes showing horizontal resistance to this pathogen and multiple resistance to other diseases should be used/exploited for sustainability. Gandhi *et al.*, (2019)^[3] found that the hybrid PSH-1962 showed resistant reactions and twenty-one genotypes of sunflower showed mild resistance to collar rot disease. Datt (2014)^[4] also reported that among forty-one genotypes of sunflower tested for relative resistance to collar rot disease, none of the lines showed resistant reactions, but twenty-seven lines HSFH-1213, HSFH-1540, HSFH-1541, HSFH-1543, HSFH-1545, HSFH-1547, HSFH-1548, HSFH-1549, HSFH-1550, HSFH-1551, HSFH-1552, HSFH-1553, HSFH-848, 91A, CMS-1A, 338 (C)-A), HYD-CMS-1A, CMS-2A, RHA-856, RHA-265, RHA-297, RHA-271, RHA-AK1R, RHA274, RHA-6D-2, P35R, R-17 showed moderate resistance, eleven lines showed moderately susceptible reactions and three lines showed susceptible reactions. The current finding suggests that differences in resistance level exist in genotypes of sunflower. As a result, screening sunflower genotypes for collar rot resistance is essential, and it should be employed in the introduction of unique commercial hybrids with high yield potential and resistance to *S. rolfsii*. As there is a lack of genetic vertical host resistance in sunflower against this devastating soil-borne pathogen, genotypes that demonstrate horizontal resistance to this pathogen as well as multiple resistance to other diseases must be utilised for long-term sustainability.



Fig 1: Pure Culture of *S. rolfsii*

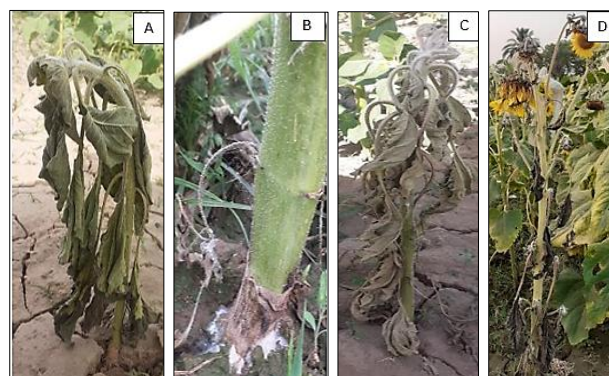


Fig 2: *S. rolfsii* infection in the field

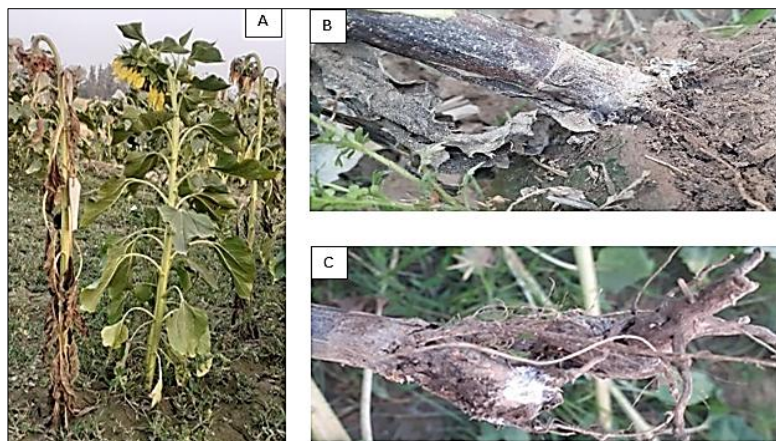


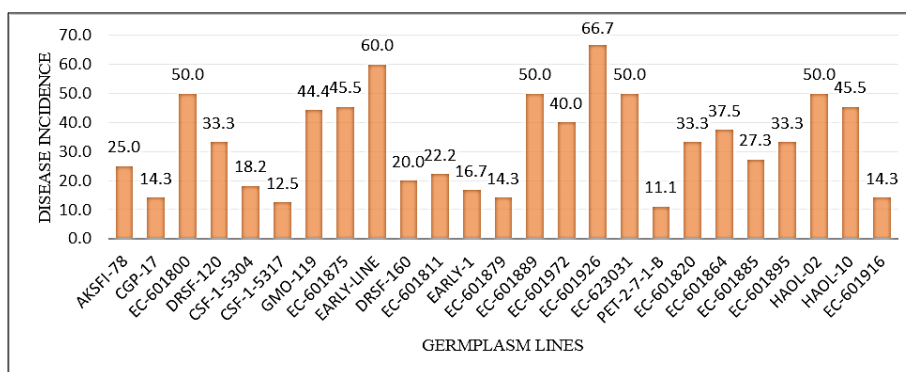
Fig 3: Typical symptoms of collar rot disease after fungal infection

Table 1: Scale used for screening of genotypes for their relative resistance/ tolerance to collar rot disease

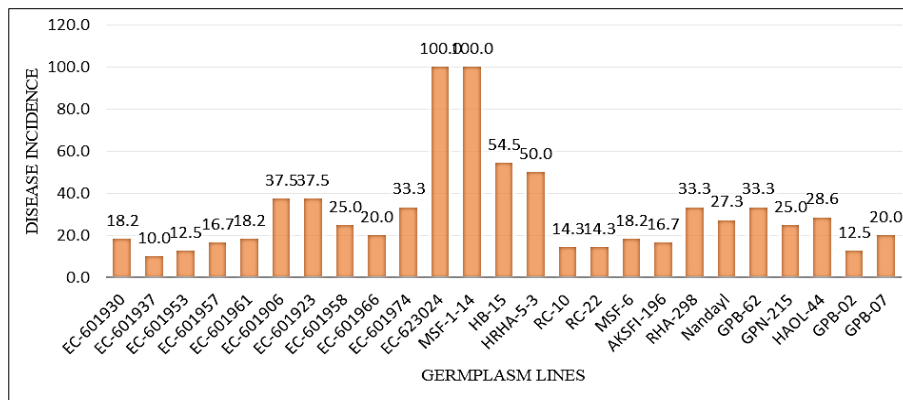
Disease Reaction	Disease Incidence (%)
Resistant	≤10
Moderately Resistant	10-20
Moderately Susceptible	20-40
Susceptible	40-60
Highly Susceptible	≥60

Table 2: Disease reaction of sunflower germplasm lines screened under field conditions

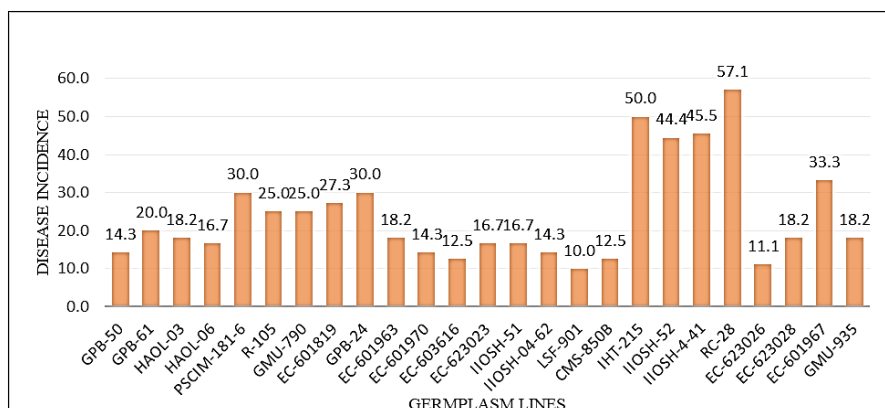
Disease reaction	Disease incidence (%)	
Resistant	≤10	-Nil-
Moderately Resistant	10-20	CGP-17, CSF-1-5304, CSF-1-5317, EARLY-1, EC-601879, PET-2-7-1-B, EC-601916, EC-601930, EC-601937, EC-601953, EC-601957, EC-601961, EC-601963, EC-601970, EC-603616, EC-623023, EC-623026, EC-623028, EC-623032, GMU-935, GPB-02, GPB-07, GPB-50, GPB-61, HAOL-03, HAOL-06, HAOL-11, IHT-222, IIOSH-51, IIOSH-04-62, LSF-901, CMS-850B, MR-234, MSF-1-16, MSF-2-16, MSF-6, AKSFI-196, P-Population, EC-601623, EC-601804, R-101, R-103, RC-10, RC-22
Moderately susceptible	20-40	AKSFI-78, DRSF-120, DRSF-160, EC-601811, EC-601820, EC-601864, EC-601885, EC-601895, EC-601906, EC-601923, EC-601958, EC-601966, EC-601974, EC-623013, EC-623022, EC-623025, EC-623029, GMU-790, EC-601819, GPB-24, GPB-62, GPN-215, HAOL-44, HB-582, IB-102, IB-119, IBN-43, IHT-201, RHA-298, Nandayl, NDLR-02, GP-0672, P-3SRPAU-P ₃ , PSCIM-181-6, R-105, EC-601967
Susceptible	40-60	EC-601800, GMO-119, EC-601875, EC-601889, EC-601972, EC-623031, HAOL-02, HAOL-10, HB-15, HRHA-5-3, IHT-215, IIOSH-52, IIOSH-4-41, RC-28, R-107, RC-02
Highly Susceptible	≥ 60	EARLY-LINE, EC-601926, EC-623024, MSF-1-14



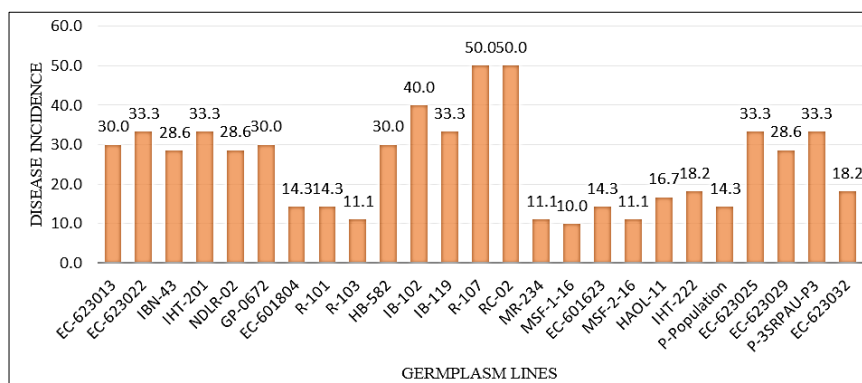
Graph-1a: Evaluation of germplasm lines of sunflower against collar rot disease (*S. rolfsii*) under natural conditions



Graph: 1b



Graph: 1c



Graph: 1d

Conclusion

Use of resistant variety would be the ultimate and most economical means of controlling the collar rot disease of sunflower. Because host resistance is an essential component of an integrated disease management system, a detailed research of host-pathogen responses is required. Research for identifying sources of resistance to collar rot using interspecific hybridization has been conducted throughout the country and around the world, although field resistance among existing genotypes has to be assessed for further use in conventional resistance breeding programmes. Although none of the germplasm lines seem to be resistant to *S. rolfsii*, forty-four lines had a moderately resistant response (10-20% Disease incidence) under natural sick plot environment. These sources of moderate resistant lines must be validated for reliability using artificial inoculation procedures before being used in resistance breeding

programmes to generate at least tolerant varieties of sunflower.

Conflict of Interest

All authors declare that they have no conflict of interest at all.

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