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Pathogenic potential of *Sclerotinia sclerotiorum* isolates collected from different hosts to cause White Mold of tomato

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Abstract
Sclerotinia sclerotiorum is a pathogen which has the ability to cause infection in wide range of plants. The pathogen, being soil borne in nature and with the potential to produce sclerotia is difficult to manage. There are reports of cross infectivity of the pathogen that is the isolate which infects one crop can infect the other crop as well. A study was conducted to observe whether the isolates of the pathogen collected from different hosts can cause White mold disease in tomato plants. The pathogen was isolated from different host crops on the basis of symptoms produced on different hosts. Ten different hosts were taken into consideration *viz*, Chickpea, Gerbera, Summer squash, Cucumber, Capsicum, Pea, Mustard, Okra, Brinjal, and Chilli, and the infectivity of the isolates was tested using Detached leaf method. It was observed that all the isolates were able to produce lesion on healthy tomato leaves. The size of lesion produced by all the isolates varied in size. The lesion of maximum size was produced by Gerbera isolate (30mm) and the smallest lesion formation was observed in case of Brinjal isolate (6mm**).**

Keywords: *Sclerotinia sclerotiorum*, tomato, isolates, detached leaf method

Introduction
Sclerotinia sclerotiorum (Lib.) de Bary is a fungal plant pathogen with a wide host range and is distributed worldwide. It is a soil borne plant pathogen and can survive for long periods (about eight years) in the form of sclerotia in soil (Erental *et al.*, 2008) **[4]**. The fungus belongs to the order Helotiales and family Sclerotiniaceae under the divison Ascomycetes. The fungus is characterized by the formation of hard blackish sclerotia. It is a highly destructive pathogen of many economically important crops. White mould of tomato is one of the most destructive diseases caused by the pathogen in temperate regions. The pathogen is known to infect the flowering parts of the plants thus having a direct impact on the crop production. The pathogen being a necrotroph has a tendency to quickly kill the stems tissues, leading to appearance of bleached areas. White cottony mycelium is observed in the infected areas which later produce black coloured sclerotia. Infected fruits turn gray and rot. Sclerotia are also produced on the infected fruits which fall on the ground and are survival structures of the pathogens.

Economic importance
The pathogen has a wider host range, and has been reported to infect more than 500 species of plants all over the world including various field, fruit, fibre crops, trees, shrubs, ornamentals and many weeds (Garg *et al.*, 2010) [5]. The diseases caused by *Sclerotinia sclerotiorum* in different hosts have been reported to cause losses upto 50 per cent (Young *et al*, 2001). Several crops have suffered huge economic losses in the United States such as lettuce, sunflower, peanut, potato and tomato (Purdy, 1979) [15]. Epidemic outbreaks of Sclerotinia rot have frequently been reported in pea production areas worldwide (Kim *et al*., 2006). The yield and quality of infected crops were reduced by the disease which causes annual loss of millions of dollars (Saharan and Mehta, 2008) [16]. The pathogen causes root, stem, twig and head rots in oilseeds, pulses, vegetables, ornamentals, medicinal and fodder crops, leading to crop failures with 60–80 per cent disease incidence and up to 100 per cent yield loss (Mehta, 2009) [11]. In the United States, the disease caused losses of about 2.8 million tons of soybean between 2010 and 2014, equivalent to 1.2 billion dollars, with a devastating epidemic in 2009 (Allen *et al.*, 2017; Peltier *et al.*, 2012) [2, 14]. Yield losses of oilseed rape due to Sclerotinia stem rot range from 10 to 80 per cent annually in China (Wang *et al*., 2014) [13]. In China, *S. sclerotiorum* was reported to infect a major rapeseed cultivation area causing a loss of almost 4 to 7 million

per ha annually (Ni *et al.*, 2014) [13]. The pathogen is also reported to affect the quality of seed (seed germination, oil and protein content) in soybeans (Mueller *et al.*, 2015) [12]. The annual economic loss caused by the pathogen was around 1.47 billion dollars in Brazil (Lehnar *et al.*, 2016) [8]. Yield losses in different crops were also observed in Canada, India and several European countries (Willbur *et al.*, 2019) [18].

Biology of the pathogen

Sclerotinia produces hard resting structure called sclerotia and no asexual conidia are produced. Long-term survival of the pathogen is mediated through sclerotia. Sclerotia are resistant to chemically and physically adverse conditions and to degradation by microbes (Wu *et al.* 2008) [19] and can survive up to 8 years (Erental *et al.*, 2008) [4]. Sclerotia can undergo two types of germinations depending on the environmental conditions avalailable, either carpogenically to form apothecia which liberates ascospores or myceliogenically to produce hyphae (Aldrich-Wolfe *et al.* 2015) [1]. Carpogenic germination of sclerotia is initiated by presence of cool and moist soil conditions for larger periods. Apothecia are formed on the soil surface from which ascospores are released into the air, from the top surface of these mushroom-like bodies. The release of ascospores is triggered by water such as rainfall, dew, fog or irrigation. Spores can be carried by air currents and wind until they land on plant tissue where they germinate and infect under humid and moist conditions (Bardin & Huang, 2001) [3]. Flower petals are more easily infected than healthy vegetative tissue. Infected flowers lead to infections of developing fruit. Infection in many host plants is mainly by ascospores but direct infection by germinating ascopores in healthy plant tissues is rare (Lumsden, 1976) [9].

Symptoms

The pathogen produces different symptoms in different hosts and affect different plant parts (Kora *et al*., 2003; McLaren *et al*., 2004) [7, 10]. The most common symptoms are water-soaked lesions on leaves, which expand rapidly and move down the petiole into the stem. Development of dark lesions can be seen on stems whereas in some other hosts appearance of water-soaked stem lesions are initial symptoms. Lesions usually develop into necrotic tissues in which patches of fluffy white mycelium can be seen. In the initial stage of lesion development, plants may not appear affected by the disease.

Sclerotinia sclerotiorum has worldwide distribution and the broad host range makes it a more severe pathogen. The pathogen may also increase its host range further affecting more number of crops. The plus point of the pathogen is its ability to survive for longer durations in the form of sclerotia and the soil borne nature of the pathogen makes its management a more difficult task. Also the management seems uneconomical as in many host crops the pathogen attacks at the stage of maturity. All these points indicates towards the need of study to be carried out in different aspects of the pathogen so that losses caused by it can be minimised.

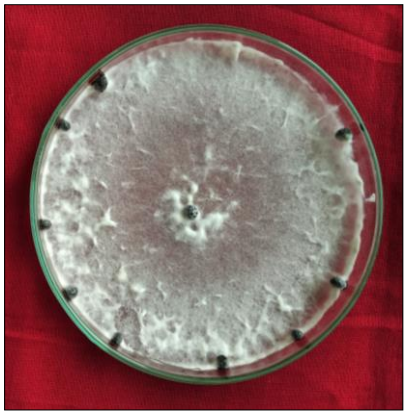
Material and methods

Isolation of the pathogen from different hosts

The isolates of *Sclerotinia sclerotiorum* were collected from different host plants such as Chickpea, Gerbera, Summer squash, Cucumber, Capsicum, Pea, Mustard, Okra, Brinjal, and Chilli. The pathogen was isolated from the infected plant parts of the host or from the sclerotia formed on the host plants. The infected samples were cut into 1-2mm bits, were sterlised with 1 percent sodium hypochloride solution for 30 seconds and then washed twice in sterlised distilled water and blot dried in sterilised blotter papers and then were placed in Petripates poured with autoclaved potato dextrose agar (PDA) media in Laminar air flow. Isolation from some host was done by picking up the white mycelia growth on the surface of the infected tissue with the help of sterilised needle and keeping it in PDA poured plates, in Laminar air flow. Isolation from sclerotia was done by sterilising the sclerotia by dipping them in 1percent sodium hypochloride for 1 minute and dipped twice in sterilised distilled water and then blot dried and kept in PDA poured plate and incubated at 20±2º C in BOD incubator. The culture was purified and transferred to PDA media slants for further use.

a. Symptoms of White mold in Tomato plant

a. Symptom of White mold in Tomato fruit



c. Seven days old culture plate of *Sclerotinia sclerotiorum* with back coloured sclerotia formed at the edge of the plate

Fig 1: Symptoms of White mold of Tomato

Testing the pathogenecity of different isolates on Tomato

The five days old culture of *Sclerotinia sclerotiorum* isolates of all the host crops was taken for testing the pathogenecity on tomato plants. The pathogeecity was tested using Detached leaf methods. The healthy leaves of tomato plants were collected and brought to the laboratory. Three leaves were paced over the three glass slides kept in the petriplates of 20 cm diameter with two layers of steriled blotter papers on the base of each petri plate. The blotter paper was moistened with sterilised distilled water to provide suffient humity for the infection to take place. The leaves were inoculted with 5mm disc of the five days old culture of *Sclerotinia sclerotiorum* of different isolates and the plates were coverd with their lids and incubated at 20±2° C in BOD incubator. The leaves were observed for lesion fomation after 48 hours of innoculation.

Fig 2: Healthy tomato leaves inoculated with mycelia disc of different isolates of *Sclerotinia sclerotiorum*

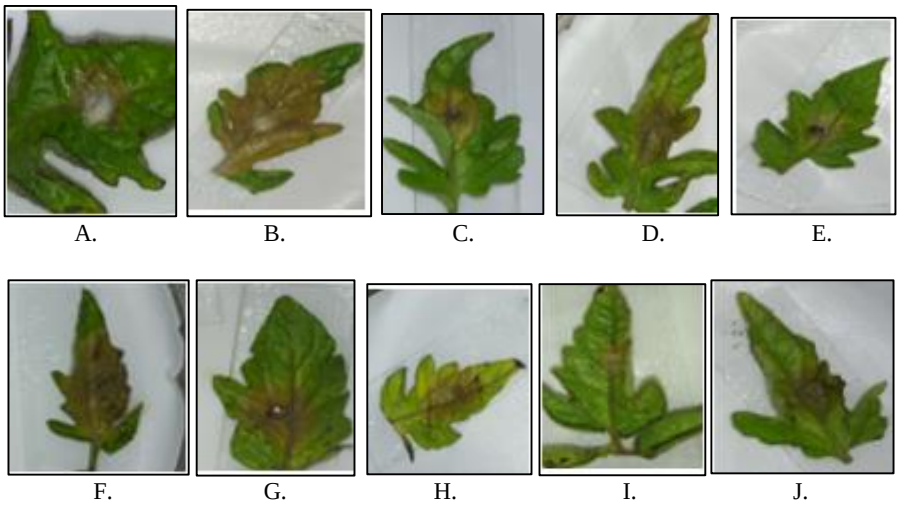


Fig 3: Infection caused by *Sclerotinia sclerotiorum* isolates from a. Chickpea, b. Gerbera, c. Summer squash, d. Cucumber, e. Capsicum, f. Pea, g. Mustard, h. Okra, i. Brinjal, j. Chilli.

Results

Sclerotinia sclerotiorum isolates collected from all the hosts *viz*, Chickpea, Gerbera, Summer squash, Cucumber, Capsicum, Pea, Mustard, Okra, Brinjal, Chilli showed symptoms on the leaves of tomato. The size of the lesion formed by all the isolates was different from each other, showing the difference in the aggressivity of the isolates.

Table 1: List of the isolates of *Sclerotinia sclerotiorum* from different hosts and the lesion size produce by them on the leaves on tomato.

S.no	Isolate collected from host	Lesion size (in mm)
1.	Chickpea	8.0
2.	Gerbera	30.0
3.	Summer squash	9.5
4.	Cucumber	10.2
5.	Capsicum	7.3
6.	Pea	12.6
7.	Mustard	8.7
8.	Okra	8.3
9.	Brinjal	6.0
10.	Chilli	9.0

Maximum lesion size was observed in infection by Gerbera isolate (30mm), followed by Pea isolate (12.6mm) and minimum size of the lesion was observed in case of infection by Brinjal isolate (6mm). The results were in accordance with Tripathi *et al.*, (2016) [17] who studied the cross infectivity on different leguminous hosts *viz*. French bean, dolichos bean, cowpea, sword bean and pea using leaf detachment method and confirmed non host specificity of the tested isolates.

Conclusion

Sclerotinia sclerotiorum being able to infect a large range of host, can come up as the most devastating pathogen as its chances of survival increases with increase in its host range. Also the pathogen produces sclerotia which add up to its survival and viability for longer durations. The pathogen being soil borne in nature is more difficult to manage. Crop rotation with non host crops can be advantageous to prevent the crop losses by the pathogen and for that the knowledge regarding its ability to infect different hosts must be known so that a suitable crop rotation can be followed and the disease incidence by the pathogen can be minimised.

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