Sclerotinia Rot: A Serious Problem of Rapeseed-Mustard in Rajasthan and Haryana
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A Serious Problem of Rapeseed-Mustard in Rajasthan and Haryana

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Oilseed crops have pivotal role in Indian agricultural economy. Because of resilience to grow under diverse agro-climatic conditions and sustainability towards abiotic stresses, rapeseed-mustard has gained premier position among all oilseeds in India. It is estimated that 58 million tons of oilseeds will be required by year 2020 wherein the share of rapeseed-mustard will be around 24.2 million tons. The signing of WTO has necessitated rethinking of the strategies to increase oilseeds production without harming the environment and human health. Rapeseed-mustard group of crops comprise toria, brown sarson, yellow sarson, gobhi sarson, black mustard and taramira. The crops occupy an area of 6.51 million ha, yield 7.67 million tons (2010-11) with average productivity of 1179 kg/ha. Rajasthan ranks first in area whereas Haryana rank first in productivity of rapeseed-mustard. One of the major concerns among biotic stresses in increasing and stabilizing the yield of rapeseed-mustard is the incidence of diseases which, to a large extent, are responsible for low and unstable production of these crops and cause yield losses ranging 10 to 90 per cent. The unfavorable weather and onset of white rust disease brought down the production of rapeseed-mustard to 4.7 million tons in 1997-98. More than twenty diseases have been reported to infect rapeseed-mustard crops in India, however, only few of them are of real economic importance. Among them, *Sclerotinia* rot earlier considered to be a minor problem has become a serious problem in Rajasthan and Haryana. Some times in *Sclerotinia* affected individual plant no grain is formed. At the time of harvesting and threshing sclerotia of the fungus get mixed with seed and this represents as an objectionable seed contaminants for the export.

The publication of the present bulletin "*Sclerotinia* Rot: A Serious Problem of Rapeseed-Mustard in Rajasthan and Haryana" is very timely. It covers the topics right from history of disease to symptomatology, host range; disease cycle, epidemiology; disease loss assessment, sources of resistance,
integrated disease management and future thrust areas. Scientific information presented in the bulletin will be of considerable use of teachers, researchers, extension personnel, farming community as well as others associated with this group of crops in narrowing the gap between production potential and actual realization, thereby boosting the rapeseed-mustard production in the country. Dr. Saroj Singh and her team members Drs M S Yadav, Nasim Ahmad, R B Gaur, Shailesh Godika and D K Yadava deserve all appreciation for bringing out this literature.

July 26, 2012

(Arvind Kumar)
‘Sclerotinia rot’ of rapeseed-mustard earlier considered to be minor problem in India has now become a serious problem in Rajasthan and Haryana. The disease gained importance particularly in raya growing areas, where it led to complete crop failure. Sclerotinia rot in epidemic form are known to cause losses up to 60 per cent leading to the discouragement of growers of the crops. Monocropping of rapeseed-mustard has led to the epidemics of this disease in Rajasthan and Haryana. Fungicides are frequently recommended for disease management that has resulted negative effect on the environment and human health. Moreover, fungicidal control is not effective because of soil borne nature and wide host range of the pathogen. In addition, fungicidal control is not only creating environmental hazards but also developing resistance in the pathogen against fungicides. Therefore, an urgent need was felt to bring out a “Technical Bulletin” that deals particularly with management of Sclerotinia rot of rapeseed-mustard based on our surveillance programme and integrated disease management trials conducted on farmers’ fields at various locations in Rajasthan and Haryana.

This technical bulletin is a comprehensive literature on Sclerotinia rot disease which depicts various topics right from history of the disease; distinguishing symptoms; causal organism; host range; disease cycle; epidemiology; disease loss assessment; sources of resistance; integrated disease management and future thrust areas. This bulletin will serve as a resource document for the farmers’ community across the country to device management strategies to check wide spread of the pathogen. This will also monetarily benefit the farmers who are growing this group of crops.

The authors of the bulletin are highly grateful to Indian Council of Agricultural Research, and to our collaborators Indian Agricultural Research Institute, New Delhi and Swami Keswanand Rajasthan Agricultural University, Bikaner (Rajasthan). Authors are also thankful to all who helped in one way or the other in preparing this bulletin.
# Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>iii</td>
</tr>
<tr>
<td>Preface</td>
<td>v</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>History</td>
<td>1</td>
</tr>
<tr>
<td>Disease Damage</td>
<td>2</td>
</tr>
<tr>
<td>Distribution</td>
<td>3</td>
</tr>
<tr>
<td>Symptoms</td>
<td>4</td>
</tr>
<tr>
<td>Causal Organism</td>
<td>6</td>
</tr>
<tr>
<td>Host Range</td>
<td>6</td>
</tr>
<tr>
<td>Disease Cycle</td>
<td>7</td>
</tr>
<tr>
<td>Epidemiology</td>
<td>9</td>
</tr>
<tr>
<td>Disease Scoring</td>
<td>9</td>
</tr>
<tr>
<td>Integrated Disease Management Practices</td>
<td>10</td>
</tr>
<tr>
<td>A. Disease Monitoring</td>
<td>10</td>
</tr>
<tr>
<td>B. Cultural Control</td>
<td>11</td>
</tr>
<tr>
<td>C. Mechanical Control</td>
<td>11</td>
</tr>
<tr>
<td>D. Biological Control</td>
<td>11</td>
</tr>
<tr>
<td>E. Chemical Control</td>
<td>12</td>
</tr>
<tr>
<td>F. Resistant Varieties</td>
<td>12</td>
</tr>
<tr>
<td>Future Thrust Areas</td>
<td>13</td>
</tr>
<tr>
<td>Selected References</td>
<td>14</td>
</tr>
</tbody>
</table>
INTRODUCTION

Oilseed Brassicas, Rapeseed-mustard are the world’s third most important source of vegetable edible oil. The Rapeseed-Mustard production trends represent fluctuating scenario with an all time high production of 8.13 million tons from 7.28 million hectare acreage with average productivity of 1117 kg/ha during 2005-06. These crops have occupied an area of 6.51 million hectare and production of 7.67 million tons with an average productivity of 1179 kg/ha in India during 2010-11. The destructive diseases of oilseed Brassicas include those caused by fungi, bacteria and viruses. Amongst the fungal diseases, Sclerotinia rot incited by Sclerotinia sclerotiorum (Lib.) de Bary, earlier considered to be a minor problem in India has become a serious problem of rapeseed-mustard over the years in some parts of country like Rajasthan and Haryana. Rajasthan ranks first in area whereas Haryana ranks first in productivity of rapeseed-mustard. The sclerotia that fall in the ground mix up in soil during crop harvest and provide primary inoculums in the following years. Losses due to this disease have been recorded up to 40 per cent in rapeseed-mustard. The Sclerotinia rot is known under a variety of names and the most common of these are cottony rot, white mould or watery soft rot, stem rot, white rot, white blight, stem blight, stalk break, stem break and white canker. Since the pathogen is soil-borne, severity of Sclerotinia rot has been increasing year after year.

The maximum Sclerotinia rot incidence recorded in field of mustard growers of Rajasthan was 90 per cent, whereas in Haryana, the maximum incidence was 30 per cent. At the time of harvesting and threshing sclerotia of the fungus get mixed with seed and this represents as an objectionable seed contaminants for the export.

HISTORY

In India, Sclerotinia stem rot was reported from Pusa (Bihar) in 1915. In 1987 rabi crop season, stem rot appeared in a severe form on mustard crop
in Jodhpur district of Rajasthan. In 1991-92, *Sclerotinia* stem rot of mustard recorded a spectacular height in various districts of Rajasthan (Lodha et al., 1992). Earlier, the disease was also observed in severe form on mustard in Gujarat during 1987-88 and 1988-89 causing losses up to 50 per cent (Dange et al., 1992). Gupta et al. (1994) reported the heavy losses due to *Sclerotinia* rot of Indian mustard (raya) from North-West Haryana. Sharma et al. (2001) conducted the survey of Mohindergarh and Rewari districts of Haryana at post flowering stage. *Sclerotinia* rot has become an economically important yield reducing factor especially in raya (*Brassica juncea*) growing district of Haryana and is causing 40-80 per cent losses in yield (Mehta et al., 2010). The information suggested that the *Sclerotinia* rot is gaining importance which may lead to disastrous crop failure.

**DISEASE DAMAGE**

Field surveys conducted in February-March 2008 by NCIPM in important mustard growing villages of Alwar, Bharatpur, Dausa, Hanumangarh and Sriganganagar districts of Rajasthan revealed that disease is emerging as a serious threat to mustard cultivation (NCIPM Newsletter, 2008). Hot spots were identified in Ramgarh, Mandawar, Rajgarh, Mahawa, Sriganganagar, Padampur and Hanumangarh Tehsil of Rajasthan. In Bharatpur, disease incidence was restricted to only Tehsil- Weir in 2008. It was further spread to new areas of Dig, Kumher, Nagar, Nadbai and Bharatpur Tehsil in 2010 and 2011. During 2010, heavy disease incidence (up to 70%) and severe yield losses (up to 40%) have been recorded (NCIPM Newsletter, 2010),
whereas in 2011, disease incidence increased (up to 90%) and heavy yield losses (up to 60%) have been occurred. Mean incidence and average severity of *Sclerotinia* stem rot ranged from 1.5-37.5 per cent and 0.3-4.0 grades, respectively. Fields village of Srikaranpur, Raisinghnagar, Sriganganagar, Padampur, Pilibanga, Sangariya, Mandawar and Mahawa Tehsil of Rajasthan were identified as hot spots. In Padampur Tehsil alarming situation at farmers’ fields has occurred during 2009 and 2010 and farmers were discouraged for cultivation of mustard. Four years continuous field surveys indicated that *Sclerotinia* stem rot has set its foot in Rajasthan State. *Sclerotinia* stem rot incidence and severity was increasing gradually year after year and emerging as a serious threat to mustard crop and at some places it was in alarming situation. In recent survey by NCIPM in Mohindergarh, Gurgaon and Rohtak districts of Haryana, the incidence range was 1-30 per cent and average severity of grade 3.3 to 4.0 was recorded (Annual Report 2010-11, NCIPM).

**DISTRIBUTION**

*Sclerotinia* rot is a disease that has become significant in recent times in India and elsewhere. *Sclerotinia* stem rot is the most important fungal disease

![Distribution of Sclerotinia stem rot (SSR) from 2008-2011, Rajasthan](image)
of oilseed rape in China (Liu et al., 1991) causes yield losses up to 50 per cent (average 10-20%), a widespread problem in England and Wales (Sansford, 1995). *Sclerotinia* rot is a major cause of losses in Rapeseed-mustard (up to 72% in severe cases) in Uttar Pradesh (Chauhan et al., 1992). The disease appears regularly in mild to severe forms in different Rapeseed-Mustard growing areas of Himachal Pradesh (Kumar and Thakur, 2000). *Sclerotinia* rot has become a widespread and destructive disease (10-74% incidence) in mustard growing parts of India (Saharan et al., 1985; Kang and Chahal, 2000; Sharma et al., 2001; Ghasolia et al., 2004; Yadav et al., 2010). This disease is also reported from the States of Assam, Bihar and Delhi. Distribution and severity of Sclerotinia stem rot of Indian mustard in Rajasthan during 2008-2011 are presented in following figures.

**SYMPTOMS**

Generally, infection and symptoms of *Sclerotinia* rot are visible after flowering. The infection is related to abscised petals of rapeseed-mustard which is the important substrate for germination of ascospores of *Sclerotinia sclerotiorum*, deposited on leaves and leaf nodes and infects the leaves and stem. Generally, lesions on leaves are grayish, irregular in shape and size
and often associated with adhering petals. The lesions on stem are initially soft; watery later converted into a grayish white patch in which soon afterwards develop large compact resting bodies as sclerotia. Stems girdled with lesions are weaker and have a tendency to lodge during or soon after the flowering and later stages of growth and development. The plant with girdled stem ripe prematurely and become conspicuously straw colored in crop which is otherwise green. The girdling stem lesions are located at any point along the stem/branches. Such plant parts ripe prematurely and can be easily
pointed out in the field. At maturity, black pellet-like sclerotia of pathogen can be found inside the infected part of the stem, infected pods and under very humid conditions even on the outside of the infected tissue. In the absence of sclerotia, the pith of the infected stems turns darker in colour as compared to healthy stem. At harvest, the sclerotia are either threshed out with the seed or left in the field along crop residues.

**CAUSAL ORGANISM**

*Sclerotinia sclerotiorum* (Lib.) de Bary. The systematic position of the pathogen is as follows: Kingdom: Fungi, Division: Eumycota, Subdivision: Deuteromycotina, Class: Gonomycetes, Order: Agonomycetales, Family: Mycelia sterilia, Genus: *Sclerotinia*, Species: *sclerotiorum*. However, perfect stage of the pathogen belongs to Ascomycotina, order Helotiales and family Sclerotiniaceae characterized by the formation of hard blackish sclerotia which germinate and produce cup shaped brown coloured apothecia. The family Sclerotiniaceae (under Ascomycotina) was created in 1945 by Whetzel (1945) to accommodate in-operculate discomycetes that produce stromata stipulate, apothecia, ellipsoidal, ascospores and glucose spermatic. There is little or no evidence of physiological specialization. However, *Sclerotinia sclerotiorum* isolates vary in their Pathogenicity.

![Mycelial culture and sclerotia of *Sclerotinia sclerotiorum*](image)

**HOST RANGE**

*Sclerotinia sclerotiorum* (Lib.) de Bary appears to be among the most responsible, omnivorous and damaging plant pathogens. The pathogen is reported to have a wide host range, known to infect about 75 families, 278 genera, 408 plant species and 42 sub-species with most of them present in dicotyledonae subclass of Angiospermae (Boland and Hall, 1994) with no proven source of resistance against disease till date in any of the hosts. It
causes considerable damage in rapeseed-mustard, cauliflower, cabbage, carrot, sunflower, papaya and peas. It is able to form stable heterokaryons and has field populations that are genetically heterogeneous.

### DISEASE CYCLE

The life cycle of *Sclerotinia sclerotiorum* is relatively simple and various sexual and asexual forms help in spread of disease from year after year. Sclerotia forms resting bodies that fall in the ground mix up in soil during crop harvest and provide primary inoculums in the following years. Sclerotia of this polyphagous pathogen, survive with seed as a contaminant.
as well as soil-borne pathogen even under adverse conditions up to 5 years. Seeds also play an important role in survival, perpetuation and transmission of disease from one area to another. When conditions are favourable, these sclerotia germinate to form either a mycelium or apothecia. Mycelium production by sclerotia is negligible unless an exogenous source of energy is supplied and infection of host tissue can only occur if energy is available. Mycelial infection occurs at or below the soil level. Large quantities of ascospores forcibly discharged into the air and are carried by air currents for distances ranging from few centimeters to several kilometers. Ascospores discharged from apothecia at the base of the plants in soil constitute important primary source of infection. When in contact with susceptible healthy host tissue, the ascosporic mycelium processes an appresorium. The ascospores give rise to infection hypha, and the infection within the host takes place; directly by mechanical pressure through the cuticle, or the infection hypha may penetrate already wounded or injured tissue also.

After entering the host plant, the fungus grows through the host tissues causing cell to die in advance of the invading hyphae. Secondary infection results from green tissue coming in contact with an infected area but no secondary infection propagules are produced. The mycelium produces sclerotia externally on affected plant parts and /or internally in stem pith. During harvesting and threshing operations, these sclerotia remain in fields
with the crop debris. Some sclerotia are buried in the soil by subsequent tillage operations. The sclerotia survive in the soil and in the plant debris to complete the disease cycle.

EPIDEMIOLOGY

*Sclerotinia sclerotiorum* primarily survives from one crop period to another in soil through sclerotia. Such sclerotial bodies get mixed with the soil through affected plant debris after the crop is harvested, or when seeds contaminated with the sclerotial bodies are sown in the soil. Infection of above ground plant parts results from ascosporic inoculum whereas soil-borne infection may result either from ascospores or sclerotia. The ascospores can germinate in the presence of a thin layer of water, in less than 24 hr at 5 to 30°C with optimum range being 5 to 10°C. Cool temperatures, prolonged period of high soil moisture level and comparatively high RH are required for apothecial formation. No apothecial initials are produced at either 30 or 5°C. Approximately 48-72h of continuous leaf wetness is required for infection by ascospores. These conditions most commonly occur when soil surface is covered by the crop canopy and these situations are harmonized with flowering and pod formation stages. *Sclerotinia sclerotiorum* infection of Rapeseed-Mustard is primarily through air borne ascospores discharged from apothecia with sudden changes in RH and is dispersed primarily by wind. Since aerial infection, apart from that taking place in the soil, is dependent entirely on continued production and dissemination of ascospores, epidemics are more common in areas of continuously cool moist weather concurrent with susceptible stage of crop, particularly the flowering period. Petals of rapeseed is known to stimulate ascospores germination. Flower petals serve a nutrient source for germination of ascospores and invasion. After abscission infected petals are deposited on leaves, leaf nodes/axils. The infected petals prove a substrate, the fungus invades the leaf or leaf axil tissues and subsequently, the stem is the site of colonization. The epidemiology of *Sclerotinia sclerotiorum* is dependent on several factors viz., soil inoculum; soil type; soil moisture; rainfall; soil and environmental temperature; host susceptibility; plant density and cultural practices adopted.

DISEASE SCORING

The infected plants were those that had stem lesions characteristics of Sclerotinia rot caused *Sclerotinia sclerotiorum*. The plant showing even a minute lesion of stem rot symptom is considered as disease plant. Disease scoring (0-4) scales have been modified by Lesovoi et al. (1987) The scale is 0 = healthy or no visible symptoms; 1 = 0.1-2 cm lesion length on stem; 2 = 2.1-4 cm lesion length on stem; 3 = 4.1-6 cm lesion length on stem and
4 = > 6 cm lesion length on stem or complete dried plant. Sansford (1995) reported assessment scale 0-4 where 0 = no disease, 1 = less than half stem girdled, 2 = more than half stem girdled, 3 = whole stem girdled and 4 = plant dead.

INTEGRATED DISEASE MANAGEMENT PRACTICES

Based upon the available literature and studies carried out under the NCIPM project “Management of Sclerotinia stem rot of Indian mustard following integrated disease management strategies” it is evident that Sclerotinia rot survive as sclerotia in the soil and sclerotia mixed with seed. Being a polyphagous pathogen, once the pathogen established in the field, it is extremely difficult to control. The existing control measure is the application of chemical fungicide which is often cost prohibitive, impractical and hazardous to environment and human health. Therefore, there is a need to develop strong linkage among State Agricultural University, Research Institutes, State Department of Agriculture and farmers to implement integrated disease management (IDM) at village level. Important components of IDM are regular monitoring, cultural, biological, mechanical means of disease management and intelligent usage of fungicides.

A. Disease Monitoring

Monitoring of the disease is an important component of IDM for identifying the hot spots at early stage of infection. The Monitoring can be done by Survey and Surveillance by employing scouts or progressive farmers.
Sclerotinia Rot: A Serious Problem of Rapeseed-Mustard in Rajasthan and Haryana

As the disease appears in February, therefore, the monitoring is to be initiated by middle of February. At the initial stage disease should be observed on collateral hosts plants especially weeds such as Chenopodium spp., wild Palak (Beta vulgaris var bengalensis) which are the common hosts. Alternate hosts are cauliflower, cabbage etc. Being a polyphagous pathogen, it could also be observed in all rapeseed-mustard, carrot, Sunflower and peas.

B. Cultural Control
i. Deep ploughing of field during summer
ii. Crop rotation with non host crops like wheat, barley, rice, maize etc.
iii. Sowing of healthy, certified and clean seeds free from the sclerotial bodies
iv. Use of recommended dose of fertilizers @ N: P: K: S- 60:40:40:40 kg/ha
v. Timely sowing of mustard crop between Oct. 16-31
vi. Maintain optimum plant population in the field
vii. Avoidance of overcrowding of plants in a row to minimize plant-to-plant contact through root and stem to aid reduction of disease spread by Mycelial means
viii. Keep a check on broad-leaf weeds like Chenopodium spp., a collateral host of pathogen
ix. Need based irrigation of mustard field

C. Mechanical Control
i. Destruction of diseased crop debris of previous crop by either burying or burning.
ii. Based on symptom of early ripening of Sclerotinia rot affected plants, they could be rogue out before formation of sclerotia in order to enable reduces soil inoculum.
iii. At the time of harvesting and threshing sclerotia of the fungus get mixed with seed and this represents as an objectionable seed contaminants. These sclerotia could be handpicked among the seeds or removed with the help of winnower or with the help of different size sieves.

D. Biological Control
i. Soil incorporation of mixture Trichoderma harzianum and T. viride based product @ 2.5kg/ha pre-incubated in 50 kg of farm yard manure/ha at the time of preparation of field
ii. Seed treatment with mixture of *T. harzianum* and *T. viride* @10g/kg seeds

iii. Need based foliar spray of mixture of *T. harzianum* and *T. viride* product @ 0.2 per cent soon after *Sclerotinia* stem rot appearance at 20 days intervals may help to check the spread of disease.

**E. Chemical Control**

i. Seed treatment with carbendazim @2g/kg seed is effective

ii. Need based drenching with carbendazim @ 2g/lt. of water is effective

iii. Need based spray of carbendazim @ 2g/lt of water in standing crop is effective.

**F. Resistant Varieties**

Four varieties viz. NPC-9, Kiran, Pusa Karisma and RLM-619 were found resistant to *Sclerotinia* rot (Yadav *et al.*, 2011). Eight genotypes viz. Hyola 401, PBN 9501, PWR 9541, Kiran, RH 9401, RH 492, RW 8410 and PAB 9511 showed resistant reaction to *Sclerotinia sclerotiorum* (Ghasolia and Shivpuri, 2005). Four genotypes viz. PCR-10, RW-8410, RW-8006 and RGH-8006 had resistance against *S. sclerotiorum* as compared to susceptible check (Pathak *et al.*, 2002)
FUTURE THRUST AREAS

*Sclerotinia* rot incited by *Sclerotinia sclerotiorum* (Lib.) de Bary has emerged as the most serious fungal disease of rapeseed–mustard in Rajasthan and Haryana in the recent times which causes serious damage at various crop growth and seed development stages resulting in heavy losses to crop yields. Due to this disease, farmers are facing heavy monitory losses and are therefore, discouraged to take this crop for cultivation in their fields. To avoid this, intensive surveillance of crop is needed to pin point the prevalence and loss. Therefore, year wise survey of Rajasthan and Haryana is needed. Hardly any management practices available for this disease. Moreover, no specific management practices have been recommended in the Package of Practices of Rabi crops for Rajasthan and Haryana except some cultural practices and chemical control. Cultural practices and fungicidal control are not effective because of soil borne nature and wide host range of the pathogen. Therefore, a comprehensive management approach has to be evolved to manage this disease and its rapid spread. This will result in reduction of the disease severity which will increase the production of this important group of oilseed crop. The improved yield will reduce the oil import and will strengthen our foreign exchequer.
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