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A potential menace: Stem rot in mustard

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Abstract
Stem rot is a most serious disease of rapeseed mustard. Earlier, it was considered as a minor disease and now, it has become a serious problem in recent years. Northern region of Madhya Pradesh jointly contributes >60% production of the rapeseed mustard. In search of the new botanicals, biological agents, animal byproducts and chemicals may lead to integrated management of the disease with no fluctuation of the environment. With view of resistance, there was no proven resistance in the brassica genotypes against the disease. Stem rot is a polyphagous and soil born nature, hence, the sclerotia can survival upto 5 years in the soil. The identified of the new genes in rapeseed mustard against this disease though advanced biotechnological approaches. With the view of the above points more need to do work in future on the mustard crop against Stem rot.

Keywords: Stem rot, mustard, chemical, survey, isolates, RAPD

Introduction
Stem rot is one of the most serious disease and causes damage to oilseed Brassica. Earlier, it was considered as minor disease and now, it has become a serious problem in recent years. Stem rot set as a key in foot of the most mustard growing area of northern region of Madhya Pradesh. Disease incidence was recorded upto 60 per cent and in fields where disease incidence was upto 70 per cent, 40-50 per cent seed yield loss was recorded Fig-1. With the view of the Resistance in mustard genotypes, none of the cultivars were found free from infection of the disease till now. The overview article or survey of article is prepared on available related aspects work done on the Stem rot (*Sclerotinia sclerotiorum*) in rapeseed mustard crop has been reviewed by earlier researcher and upto present status of work. The available literature on the concerned topic is briefly reviewed as under:

History and geographical distribution
Shaw and Ajrekar (1915) [71] first recorded that the occurrence of *Sclerotinia* blight on rapeseed and mustard has been made from India and later the disease has been observed in severe from in other countries like Australia (Holtzhausen and Knox Davies, 1974) [33] Brazil (Neto,1955) [52]. Canada (Duczek and Morral, 1971; Plat ford and Bernier, 1975; Davidson, 1977) [26, 21]. China (Yang, 1959) [88] Denmark (Buchwald 1947) [11] England (Sansford,1995) [69], Finland (Jamalainen 1954) [35], France (Brun *et al*. 1981; Hims,1979) [10, 32], Germany (Klemm,1938; Kirchner and Pluschkell,1979; Kruger1976) [42, 41, 45] India (Shaw and Ajrekar, 1915; Roy and Saikia, 1976) [71, 67], Israel (Palti,1959) [57], Italy (Zazzerini and Tosi, 1985) [89], Mexico (Ponce and Mendoza 1983) [59], New South Wales (Loof, 1959) [59], Nepal (Shreshtha, 1986), New Zealand (Wong and Willets,1975) [85], Peru (Bazan and Segura, 1952) [6], South Africa (Holtzhausen and Knox Davies, 1974) [33] Swedan (Djurle,1982) [25] and United Kingdom (Hims, 1979) [32]. Boland and Hall (1994) [9] reported that *Sclerotinia sclerotiorum* (Lib.) de Bary capable to infect over 408 plant species under 75 families. Purdy (1955) [62] concluded that the synonymy with *S. sclerotiorum* several species described from various hosts and locations since 1955 no new information has appeared that would justify alternate of my opinion. Sansford (1995) [69] reported that the stem rot is world-wide problem to mustard cultivation. Vasudeva (1958) [82] reported that the term white blight has been used as a common name of the disease incited by *S. sclerotiorum*. However the disease has also been named as white rot (Rai and Dhawan, 1976; Rai *et al*.1974) [64, 65] White blight (Roy and Saikia, 1976) [67] and stem canker (Klemm, 1938; Kruger *et al.* 1981) [42], based on the specific symptoms produced. The different isolates of *Sclerotinia sclerotiorum* of infected *B. juncea* in

Bharatpur, India was studied by Clarkson *et al.* 2003. Stem rot is a serious threat to oilseed production in Australia (Garg *et al.,* 2010).

Taxonomy and Identification

In the beginning, Madame M.A. libert described *Peziza sclerotiorum* (1837) later Fuckel (1870) [28] erected and described the genus *Sclerotinia* and renamed *Sclerotinia libertiana.* Libert (1837) [46] described that *Peziza sclerotiorium* binomial for the fungus stood and described the genus *Sclerotinia* choose to honor Madame Libert by renaming *Peziza sclerotiorium* with a newly coined binomial, *Sclerotinia libertiana.* Authors in the united states, and other elsewhere, accepted and used *S. libertiana* Fuckel until Wakefield (1924) [83] showed it to be inconsistent with international rules of Botanical nomenclature and cited G. E. Massee as the proper authority for *sclerotinia sclerotiorum* (Lib.) Massee because he had used that bionomial in 1895, de Bary used it in this 1884 contribution de Bary, (1884) [22]. Thus, the proper name and authority for the subject fungus for this symposium seems to be *Sclerotinia sclerotiorum* (Lib.) de Bary. Although technically incorrect, the names *S. libertiana* occasionally used to be consistent with its use in the literature prior to 1924.

A family Sclerotiniaceae (under Ascomycotina) was created in 1945 to accommodate in-operculate discomycetes that produce stromata, stipulated, apothecia, ellipsoidal, ascospores and glucose spermatic 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 Whetzel (1945) [84]. *Whetzelinia* Korf and Dumont, will be considered a superfluous name that *Sclerotinia* Fuckel will be retained for the generic epithet and that type species (lectotype) will continue to be *Sclerotinia sclerotiorum* (Lib.) de Bary as proposed by Dennis (1974) [23] and Buchwald and Neergaard (1973) [42].

Symptomology

The leaves become yellow and die, infection spreads up the stalk and the entire plant dies, often only vascular tissue and disorganized parenchyma remain. Flowers and sometimes the entire flower head are susceptible to infection by ascospores (Morris, 1921) [51]. Baribeau (1923) [3] reported that the plants were affected when they were 5 to 6 feet high as temperature and other factors did not favour infection of young seedlings. The first symptom were the appearance of a thick whitish felting on the stem and a dis-colouration of the underlying tissues at soil level, sometimes as high as 3 ft. Under very wet conditions the attacked stems wilted and frequently bend over at the diseased point. Joshi (1924) [38] described that the first symptom were as a slight yellowing of the leaves of apparently healthy plants followed quickly by the drying up of the whole plant. At this stage a dense white growth of mycelium could be seen at the collar, black sclerotia from 2 to 12 mm in length and very irregular in shape, generally roundish or elongated. Kordes (1933) [44] reported that the fungus attacked the cortex and vascular bundles of the stem base (Up to a height of 10 cm) from the ground causing a rapid wilting. Tthe first field symptom is the appearance of irregularly shaped water soaked spots on stems followed by similar spots on branches and leaves. Collmer and Keen (1986) [19] reported that *Sclerotinia sclerotiorum* overwinters as mycelia within plants or as sclerotia. Sikarwar (1987) [77] noticed that the symptoms appear on stems, leave and pods at different stage of plant growth and under varying environmental condition. Elongated water soaked spots appear on the stem which later get covered by cottony mycelia growth of the fungus. The affected stem becomes soft and easily peeled off into shreds. The lesion finally girdle the stem from where it breaks and the plant dries Sometimes infection is restricted to a smaller area of pith, resulting in slow stunting of the plant and premature ripening, (Kolte, 1988) [43].

Survey and estimation of losses caused by Stem rot

Jamalainen (1954) [35] recorded that in the central and eastern Finland losses caused by the disease have been so high that the cultivation of the crop was stopped in the area restricting it to the southern and western part. The lowest yield in the year of epidemic has been reported from Germany (Kruger, 1975). Roy and Saikia (1976) [67] noticed that attacked crop at early growth stage it completely fails but when attacked at later growth stages the yield is lowered Loss in yield is reported to be as high as 75 to 100 percent in new Zealand (Jarwis and Hawthorne, 1971) [36], In Florida, 10-15 percent in Canada (Morrall *et al*. 1976), 35% in India (Sikarwar, 1987) [77]. Liu (1991) noticed that the Sclerotinia blight is the most important fungal disease of oilseed rape in China and it causes yield losses up to 50 percent average up to 10-20%. The incidence of Sclerotinia blight in northern Madhya Pradesh during the year 1984-1985 ranged from 3.42 to 11.76 per cent at the pre-flowering stage and at the harvesting stage, the disease incidence ranged from 10.12 to 36.72 per cent (Gupta *et al*. 1985) [31]. While the incidence of disease during 1985-86 ranged from 2.50 to 9.37 at the pre-flowering stage the disease incidence ranged from 10.32 to 32.56 at the harvesting stage (Sikarwar, 1987) [77]. Kewate (2011) Observed that the incidence of this diseases in Morena, Bhind, and Gwalior districts were 14.64, 3.17 and 2.76 % respectively. Malt apple agar medium was found best for the growth of *S. sclerotiorum.*

Saharan *et al*., (1985) [68] *Sclerotinia* rot disease caused 10-74 % incidence in mustard growing area. (Ghasolia *et. al*. 2004) [29]. Bharti, *et al.* (2016) [55] surveyed that the heavy disease incidence recorded in Morena (11.52%), Bhind (13.48%) and Gwalior (6.33%) were identified a hot spots but in Sheopur (2.81%) and Datia (5.00%) were recorded fewer incidences as compare to highly incidence districts.

Evaluation of Culture media

Jensen and Lysek (1983) [37] successfully used apple malt agar medium and malt agar medium for the growth of *Sclerotinia fructigena.* Elgorban *et al.* (2013) [27] studied that the maximum mycelial growth, sclerotia and sclerotia dry weight was obtained in Potato dextrose agar as semi-solid media *i.e.* 78 mm, 29 sclerotium and 232 mg, respectively. While Potato dextrose broth as liquid broth media was the best suitable medium to growth of the fungus with 2.29 mg dry weight per flask. Bharti, *et al.* (2015) [56] studied that the ten solid culture Media *viz*., Malt extract apple agar, Malt extract agar, Czapek's Dox agar, Potato carrot agar, Potato dextrose agar, Mustard leaf dextrose agar, Pea leaf dextrose agar, Pea grain dextrose agar, Pea husk dextrose agar and Mustard seed dextrose agar were evaluated against *S. sclerotiorum. The* maximum radial mycelial growth 82.66 mm and 12.00 sclerotia was reported in Potato dextrose agar as semi-solid media, while, the least radial mycelial growth 32 mm and2.00 sclerotia were occurred in Czapek's Dox medium.

Evaluation of *S. sclerotiorum* inoculation techniques

Prasad *et al*. (2009) [61] tested four methods to obtain best production of apothecia. Inoculums placement proved to be the best method of inoculation and showed 86.7% infection followed by tooth pick 55.6 and ascospores inoculation method 53.3%. Soil inoculation method appeared to be less effective as compared to other methods. Rahmanpour *et al.*, (2011) [63] reported that wounded and non-wounded leaves with fungal mycelium inoculation and oxalic acid. Overall, non-significant differences between Brassica genotypes showed the unreliability of the leaf disc assay, whereas leaf inoculation of intact plants by means of either oxalic acid or fungal mycelium demonstrated significant differences in lesion size among Brassica cultivars and species. Scott (1984) [36] described a method for inoculating the swede rape with S. sclerotiorum in the field and glass house using infected barley grains secured in leaf exile with parafilm. Zang *et al*. (2010) investigated that the concentration of mycelial suspension for inoculation system is valuable for evaluation of rape seedling resistance to S. sclerotiorum. Bharti, *et al*. (2017) [90]. The pathogenicity done by different techniques. The results revealed that six techniques were proved successfully infection of *Sclerotinia sclerotiorum*. Paraffin wax film technique was found statistically superior over other inoculation techniques followed by tooth pick, mycelial bit, sclerotial placement, mycelial bit placement inside tender bark and mycelial bit placement on scratched stem. Paraffin wax film technique put secure place for early successfully infection, while the inoculation with sclerotia was found as the late establishment of infection. However, successfully establishment of the infection within 5-8 days after inoculation in the favorable environmental condition in 45-65 days old plants

Studies on variability in *S. sclerotiorum*

Morphological variability

As pointe out by Willettes (1978) vegetative hypae usualy grow away from another. In the formation of initial, there must be an attraction so that hypal fusions occur. Because initials usualy form after growth has covered the substrat, there formation may be a respons to changes in nutrient availibity. The facts that several fungi, including *S. sclerotiorum* form sclerotia when mycelia mates are transferred to medium low in nutrients. This hypothesis was supported by Christias and Lookwood (1973) [17]. Goswami *et al.* (2012) [30] studied that the cultural, morphological and pathogenic characteristics and carpogenic germination of *Sclerotinia sclerotiorum.* Several other aspects on formation of sclerotia, apothecia and germination of sclerotia and ascospores (Humpherson Jones and cook, 1977 [34] have been reported.

Genetic variability through RAPD.

On the basis of electrophoretic studies concluded that S. *sclerotiorum*, *S. trifoliorum* and *S. minor* are three distinct species while according to Crisan (1977) [20] *S. minor* should be treated as a form or at least a variety of *S. sclerotiorum*, The mycelium of the fungus is hyaline, much branched, consisting of large, closely septate hyphae which are intra-cellular and invade all the tissues of the affected plants. The hyphae are 9-18 micron broad and filled with dense protoplasm. The fungus does not produce true conidia or micro-condia Wong and Willetts (1975) [85]. Colagar *et al.* (2010) [18] conducted that study to RAPD studied by 18 random primers. By using of three random primers (Ar0R2, Ar081 and Ar173) in arbitrarily primed (AP-) PCR a total of 284 RADP products were compared in a sample of 12 individuals which contain highly polymorphism. Cluster analysis for PCR products of these three primers performed by UPGMA (UN weighted pair grouped method by arithmetic average) method. RAPD profiles markedly differed between *S. Sclerotiorum* isolates. Genetic diversity of *S. sclerotiorum* populations recovered from different hosts was assessed using Simple Sequence Repeat fingerprinting (Barari *et al.*, 2013) [2]. The genetic diversity of *S. sclerotiorum* populations recovered from canola was assessed using rep-PCR genomic fingerprinting Karimi *et al.* (2011) [39]. Genetic diversity based on percentage of polymorphic bands ranged from 59.5% to 75.21%, demonstrated high level of genetic diversity. The variability found within closely related isolates of *S. sclerotiorum* demonstrate the effectiveness of rep-PCR marker in identifying genetic diversity among *S. Sclerotiorum* isolates.

Epidemiological studies

Chattopadhyay *et al.*, (2005) [15] studied that the critical stage of 50-60 day age of crop seems to have favoured higher Sclerotinia rot incidence on Indian mustard. Gupta *et al*. (2004) studied the sowing on 21 October resulted in the greatest disease incidence (10.5% on average); and disease incidence decreased with the delay in sowing. Crop sown on 5 January were not infected with Sclerotinia blight. The maximum (20.5-25.4´c) and minimum (3.9-10.7´c) temperatures at the flowering stage of crops established through sowing on 21 October were negatively correlated with the development of Sclerotinia blight. Higher relative humidity significantly increased the growth of the *S. sclerotiorum*. The growth of the fungus was significantly increased by the increasing RH%. The best growth of the fungus occurred at 98.6% RH with radial growth of 90 mm. and 15 sclerotium / plate. The sowing dates had significant effect on Sclerotinia rot incidence and yield (Prasad *et al.* 2009) [61]. Correlation analysis showed that there was a significantly positive correlation of maximum and minimum temperature on disease appearance. Bharti *et al*. (2019) [86]. The data revealed that stem rot infection is negatively and significantly influenced by maximum temperature (r= -0.697*) and sunshine hrs (r= -0.855**), while, the maximum relative humidity (r= 0.883**) and minimum relative humidity (r= 0.871**) showed highly significant and positive correlation with the *Sclerotinia sclerotiorum* infection. Further, for predicting the impact of the individual meteorological parameters a regression study was carried out.

Field evaluation of *Brassica* germplasm against *S. sclerotiorum* under artificial inoculation

Bengtsson and Jonson (1995) [7] screened new cultivars of winter rape against Sclerotinia blight. Using the rate of stem lesion expansion as an indicator of the resistance of stem tissue of 25 genotypes of 5 *Brassica* spp to *S. sclerotiorum.* Significant differences were present between species and among cultivars/strains within species Sedun *et al*. (1989) [70]. Four genotypes *viz.*, PCR-10, RW-8410, RW-8006 and RGH-8006 had resistance against *S. sclerotiorum* as compared to susceptible check, (Ghasolia and Shivpuri, 2004) [29]. Sansford, (1995) [69] 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. Shivpuri, *et al.* (2004) [74] reported that the out of 70 genotypes of rape seed mustard revealed that only 8

genotypes *Viz.*, Cutlass, ZYR-6, PCR-10 (*B. juncea*), Westar (*B. napus*), Perkland, Tobin, Torch and Candle (*B. campestris*) were found resistance against *S. sclerotiorum.*

In-vitro* evaluation of botanicals and chemicals against *S. sclerotiorum

Although efficacy of various fungicides against *Sclerotinia* species has been well demonstrated (Singh *et al.* 2014) [79], it has not been controlled consistently and economically due to prolonged viability and unpredictable nature of fungal propagules (Singh and Kapoor, 1993) [78]. Bajoriya (2007) [1] reported that eucalyptus oil @ 5% concentrations as the most effective for the growth inhibition of *S. sclerotiorum* under *in-vitro* condition, followed by *Calotropis* leaf, Eucalyptus leaf, Tobacco leaf, Neem leaf, Neem, *T. viride*, Garlic bulb, Neem oil, *Lantana* leaf and *B. pumalis.* Chattopadhyay *et al*. (2002) [14] recorded that fungicides *viz*, carbendazim (0.1 % a.i.) and mancozeb (0.2% a.i.), caused 100 per cent inhibition of the mycelial growth of *S. sclerotiorum*. Among the botanicals, the bulb extract of *Allium sativum* (1% w/v) showed the best performance. Chaudhary *et al.* (2010) [16] found that among various fungicides used, benomyl and carbendazim proved to be most effective fungicide for seed treatment, spray alone as well as in combination to control sclerotinia-rot of Indian mustard. Carbendazim was observed to completely (100%) inhibit the mycelial growth and sclerotial production of the fungus (Chand *et al.* 2009) [13]. Shivpuri and Gupta, (2001) [75] concluded that the Carbendazim, thiophanate-methyl and phenyl pyrrole completely inhibited the growth of the pathogen at all concentrations, thereby resulting in the lowest number of sclerotia. Mancozeb was found effective at higher concentrations. Copper oxychloride was the least effective, as it did not substantially decrease the growth of *S. sclerotiorum* compared with the control. Extracts of *Allium cepa*, *Azadirachta indica*, *Datura stramonium*, *Ocimum tenuiflorum*, *Polyathia longifolia*, *Tagetes erecta*, *Catharanthus roseus*, *Withania somnifera* and *Allium sativum* inhibited the sclerotial formation almost completely, allowing the formation of 0.71-1.77 sclerotia per plate. Shivpuri *et al*., (1999) [75] reported fungi-toxic effect of plant extracts from 10 plant species. Higher dose of few plant extracts were relatively more effective. Tripathi and Tripathi (2009) [80] find out the efficacy of different plant extracts. Maximum inhibition of pathogen colony growth was observed in *A. sativum* (71.11%), followed by *A. indica* (50.37%). Other effective plant extracts were *O. sanctum* (38.15%) and *C. procera* (22.96%). Tripathi and Tripathi (2010) [81] recorded that the observations revealed that all the tested fungicides except with sulphur dust 6.00 mm growth of the pathogen was recorded and thereby Sulphur (93.33%) inhibition in colony growth of the pathogen was recorded against control. Bharti, *et al.* (2015) [56] studied that carbendazim, propiconazole and thiophanate methyl were recorded completely inhibited mycelial growth and formation of sclerotia, followed by hexaconazole (80.46% and 0.667), thiram (72.65% and 1.333), ridomil (71.08% and 1.333) and mancozeb (69.53% and 0) were found least effective but copper oxychloride (44.13% and 1.333) and sulphur (13.66% and 2.333) were inhibited at par control (0.00% and 3.333) on mycelial growth and formation of sclerotia respectively.

In-vitro* evaluation of Amritjal against *S. sclerotiorum

Basak *et al.* (2002) [5] reported also effect on treated sclerotia of the selected fungus with cow urine had a very effective role on suppression of mycelial growth than that of untreated one. No mycelial growth was observed up to 4 days in treated sclerotia with cow urine. After 5 days only 0.9 mm mycelial growth was measured in treated sclerotia, while in case of untreated sclerotia the growth was 42.6 mm. Application of cow urine and cow dung on growing plants inoculated with the pathogen at different concentrations also proved their inhibitive effects. Bharti, *et al.* (2015) [53] studied that Standarization of botanicals 20, 40 and 60 percent, all conc. of *Allium sativum* were complete inhibited mycelial growth and sclerotia formation. *Zingiber officinalis* and *Curcuma longa* intermediate at 20% (41.93-81.23), 40% (56.59-78.29) and 60% (73.31-89.44) percent inhibition mycelial growth and 3.25-4.75, 2.75-4.00 and 2.00-3.50 sclerotia recorded, respectively. While, Eucalyptus at 20% (79.17) and 40% (83.37) percent mycelial growth, 3.00 and 2.50 sclerotia recoded respectively but at 60% conc. (100) percent inhibition of mycelial growth and formation of sclerotia. The amritjal revealed that the fungal growth is not observed at 20 and 25 percent but at 10percent (78.07%) and 4 sclerotia were observed, while, at the 15 percent (90.05%) mycelial growth inhibited but no sclerotia formed at par control. Hence that above In-vitro studies concluded 20 and 25 percent were significantly inhibited the mycelial growth and production of sclerotia *S. sclerotiorum.*

In vitro* evaluation of bio control agents through dual culture technique against *S. sclerotiorum

Mehta *et al*., (2012) [50] concluded the isolates of *Trichoderma harzianum* - 3 and *T. harzianum* - 4 were significantly better and most potent in reducing the growth of *S. Sclerotiorum*. Similarly, antagonists *T. harzianum* - 4, *T. harzianum* - 3, and *T. virens* reduced sclerotia formation. *Trichoderma hamatum*, followed by *T. harzianum*, proved significantly superior in reducing mycelial growth and sclerotial production of the test pathogen. The percentage mycelial inhibition was 86.3, 73.9 and 34.6 after 3, 4 and 6 DOI, respectively. The sclerotial formation in garlic clove extract (2%)-amended PDA plates initiated after 6 DOI, whereas in the control it started after 4 DOI (Yadav *et al.*, 2011) [87].

Field evaluation of selected botanicals, bio control agents and chemicals for the management of stem rot disease

Among all the five fungicides carbendazim was found to completely (100%) inhibited the mycelia growth of the pathogen (Chand *et al*. 2009) [13]. Meena (2011) reported that the *T. harzianum* and *P. fluorescens* did not differ significantly among themselves. Similar results were observed by garlic bulb extract, *T. harzianum* as seed treatment in combination with *P. fluorescens* spraying was significantly superior for Sclerotinia rot, which were at par with chemical fungicides for Sclerotinia rot management. Foliar spray by garlic bulb extract increased the seed yield significantly as compared to control. Meena *et al.* (2013) [49] reported that the significantly reduced Sclerotinia rot incidence, the combination used in the present study was as effective as the combination of seed treatment with *Trichoderma harzianum* and foliar spraying with *Pseudomonas fluorescens* and *T. harzianum*. Economic returns were higher when using biorational treatments (*A. sativum* bulb extract, *T. harzianum*, *P fluorescens*) compared with chemical fungicides. The combination of seed treatments with *T. harzianum* followed by its use as a foliar spray (17.22), and the similar combination of seed treatments and foliar spraying with the *A. sativum* bulb extract (17.18), resulted in a higher benefit to cost ratio. Mehta *et al.* (2012)

[50] found that the isolates of *Trichoderma harzianum* - 3 and *T. harzianum* - 4 were significantly better and most potent in reducing the growth of *S. sclerotiorum*. Similarly, antagonists *T. harzianum* - 4, *T. harzianum* - 3, and *T. virens* reduced sclerotia formation. Prasad and Kumar (2007) [60] reported that the tested fungicides and garlic extract significantly reduced Sclerotinia disease incidence. Rathi *et al*. (2012) [66] also reported that prophylactic foliar spray with carbendazim @ 0.1% twice at 45 and 60 DAS was most effective in controlling Stem rot disease in Indian mustard. Roy and Significant control of disease through prophylactic sprays with systemic fungicides has been reported under field conditions (Rathi *et al*., 2012) [66]. *Trichoderma harzianum* screened against *Sclerotinia sclerotiorum*. Highest reduction of Sclerotinia rot (69.0%) was achieved by *T. harzianum* isolate GR over control followed by soil application of *T. harzianum* isolate SI-02 with farm yard manure (60.8%) and foliar spray of garlic bulb aqueous extract (60.8%). (Meena *et al*., 2014). Yadav *et al.*, (2011) [87] tested aqueous garlic clove extract (2%) amended PDA was tested for its antifungal activities against *S. sclerotiorum*.

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