ejbps, 2016, Volume 3, Issue 11, 137-146. ***Review Article*** **SJIF Impact Factor 3.881**

EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES

http://www.ejbps.com

ISSN 2349-8870
Volume: 3
Issue: 11
137-146
Year: 2016

INTEGRATED MANAGEMENT OF *SCLEROTIUM ROLFSII*: AN OVERVIEW

S. K. Dwivedi and Ganesh Prasad*

Department of Environmental Science, Babasaheb Bhimrao Ambedkar (A Central) University, Lucknow- 226025.

***Corresponding Author: Ganesh Prasad**

Department of Environmental Science, Babasaheb Bhimrao Ambedkar (A Central) University, Lucknow- 226025.

Article Received on 08/09/2016 **Article Revised on 29/09/2016** **Article Accepted on 20/10/2016**

ABSTRACT

Sclerotium rolfsii is soil-borne saprophytic fungus which causes different types of diseases like collar-rot, sclerotium wilt, stem-rot, charcoal rot, seedling blight, damping-off, foot-rot, stem blight and root-rot in more than 500 plants species including tomato, chilli, sunflower, cucumber, brinjal, soybean, maize, groundnut, bean, watermelon etc. *S. rolfsii* may be controlled through biological agents (*Trichoderma harzianum*, *T .viride T. asperellum*, *Penicillium* sp, *Curvularia* sp, *Aspergillus niger*, *Bacillus subtilis*, *Pseudomonas fluorescens*, *Pseudomonas cf.montelii*, *P. aeruginosa;* most significant), chemical agents (potassium salt, salicylic acid, sorbic acid, carbendazim, carboxin, benomyl, sancozeb, thiovit, dithane M-45, K_2HPO_4, potassium sorbate, captan 50% WP, thiophanate-methyl 70% WP, propiconazole 25% EC and thiram 75% SD, fluazinam, vitavax powder and topsin-M); plant extracts (garlic, clove, allamonda leaf, ginger rhizome, neem leaf, neem seed oil, turmeric rhizome, bel leaf, and onion bulb) and soil solarization. Among all these control measures, biological, soil solarization and medicinal plant extract were the more significant than chemical control.

KEY WORDS: *Sclerotium rolfsii*, biological, chemical, plant-extract and soil solarization.

INTRODUCTION

Sclerotium rolfsii occurs in soil as a saprotroph and attack living plants. *Sclerotium rolfsii* is a soil-borne fungus, facultative parasite and omnipathogenic organism which occurs worldwide and infects more than 500 plant species[10,85] including tomato, cucumber, brinjal, soybean, maize, groundnut, bean, watermelon, etc. It causes different types of diseases such as collar rot, sclerotium wilt, stem rot, charcoal rot, seedling blight, damping-off, foot-rot, stem blight and root-rot in many economically valuable crops.[40] It was first observed by Peter Henry Rolfs in the year 1892 on tomato plants with 70% losses. The hyphae grew upward on the surface of the infected plant covered with a cottony, white mass of mycelium, scattered inside and outside of infected stem nearby the soil surface. The fungus produced numerous small round, white sclerotia of uniform size when immature and dark brown at mature stage.[59]

Sclerotium rolfsii develops at intermediate soil moisture level (70%) of field capacity and at temperature range between 25^0C to 30^0C.[83] *Sclerotium* blight caused by *Sclerotium rolfsii* Sacc.in soybean reduces the crop yield but in certain situations, significant yield losses can also occur due to the monoculture or short rotation of soybean with another plant susceptible to the pathogen.[83] It is spread by the wind, water, animal and soil.[52] Keeping in view the significance of economic crops, there is need for its management. It can be controlled by using chemical, biological, botanical, solar treatment and integrated means. Out of these except chemicals, other means are safer and ecofriendly.

Chemical control

Banodenil and pentachloronitrobezene are effective fungicides against the blight of apple seedling and root rot disease.[23] The high amount of benzaldehyde and velvet bean inhibits mycelial growth and sclerotial germination of *Sclerotium rolfsii*. Yaqub and Shahzad (2006)[113] reported that six fungicides viz. benomyl, sancozeb, thiovit, dithane M-45, carbendazim, and topsin-M were effective against *Sclerotium rolfsii*. No fungicide inhibited the growth of *Sclerotium rolfsii* at low concentration while high concentration of dithane M-45 and sancozeb significantly reduced the growth of *Sclerotium rolfsii*.[113] According to Arunasri et al. (2011),[09] Crossandra, an important flower plant affected by collar rot disease by *Sclerotium rolfsii* Sacc. was controlled by four fungicides, viz., captan 50% WP, thiophanate-methyl 70% WP, propiconazole 25% EC and thiram 75% SD at five different concentrations. The fungicide propiconazole, thiram and captan significantly reduced the mycelial growth of *S. rolfsii.*

The fungicides hexaconazole, propiconazole, difenoconazole; combi product, avatar (hexaconazole 4% + zineb 68%), nativo (tebuconazole 50%+ trifloxystrobin

25%) and vitavax powder (thiram 37.5%+carboxin 37.5%) and bioagents *Trichoderma harzianum* inhibits *Sclerotium rolfsii* under field condition.[68] Tariq et al. (2012)[109] studied that captan, carbendazim, metalaxyl and carboxin were efficient against wilt pathogen under *in vitro* condition. The root-rot in tomato was controlled by using some potassium salt, salicylic acid and sorbic acid.[34]

Mohamedy et al. (2014)[34] reported that chemicals such as K_2HPO_4 (400mM), salicylic acid (100mM), sorbic acid (7.5%) and potassium sorbate (7.5%) control root rot disease of tomato caused by *Fusarium solani, Rhizoctonia solani* and *Sclerotium rolfsii* and induce positive effect on plant growth, yield and fruit quality of tomato grown under field condition during two cropping season. Khan and Javaid (2015)[57] reported that four fungicides tegula (tebuconazole), thiophanate methyl, ridomil gold (metalaxyl+mancozeb) and mancozeb significantly inhibits the radial growth of *S. rolfsii* under *in vitro* condition. Besides it, two fungicides thiophanate methyl and mancozeb substantially control the growth of *S. rolfsii* under *in vivo* condition responsible for causing collar rot disease in Chickpea. Wang et al. (2015)[112] reported that fluazinam has potent antifungal activity against *Sclerotium rolfsii* which causes stem rot. Soil fumigant such as methyl bromide, methane sodium and chloropicrin inhibits the growth of mycelium of *S. rolfsii*.[87]

Biological control

Sclerotium rolfsii form brownish sclerotia that survive in soil for long period tolerate biological and chemical degradation due to the presence of melanin pigment in the outer membrane of sclerotium.[22] *Pseudomonas* species produce antibiotics and antifungal metabolites such as hydrogen cyanide, Fe-chelating siderophore[11,76] gluconase, cellulytic and chitinolytic enzymes.[102] Biswas and Sen (2000)[17] reported that *Tricoderma harzianum* inhibit stem-rot of groundnut caused by *Sclerotium rolfsii.* Anahosur (2001)[07] has studied fungal antagonists viz., *Trichoderma harzianum, Trichoderma viride, Gliocladium virens, Penicillium* sp., *Paeocilomyces lilacinus, Bacillus subtilis, Pseudomonas fluorescens* and Mycorrhizae*;* which inhibit root rot, foot rot, wilts, and damping-off diseases caused by *Sclerotium rolfsii,Macrophomina phaseolina, Rhizoctonia solani,Fusarium sp.* and *Pythium debarianum.* Shlevin et al. (2003)[99] reported that *Fusarium oxysporum, Radicis lycopersici* and *S. rolfsii* during solarization in an attempt to develop a dynamic model for expressing the thermal inactivation of the pathogens. After 20 days of exposure, the population of *F. oxysporum, Radicis lycopersici* and *S. rolfsii* were reduced by 69 to 95% and by 47.5 to 100%, respectively.

Abd-Allah (2005)[02] revealed that *Bacillus subtilis* control *Sclerotium rolfsii* by 92% under greenhouse condition in peanut. *Bacillus subtilis* secrete antifungal substance which is highly antagonistic against *S. rolfsii*.[74] Radawan et al. (2006)[90] reported that *Trichoderma harzianum* and *Trichoderma hamatum* were most effective against *Sclerotium rolfsii* and inhibited the mycelial growth by 79%. *Trichoderma species* have also been used in commercial enzyme productions like cellulases, hemicellulases, proteases and β-1, 3-glucanase.[111] The combination of *Rhizobium* and *T. harzianum* were significantly effective against *S. rolfsii* which caused stem rot disease and promote the plant growth and increase seed production of groundnut.

Trichoderma harzianum has antagonistic activity against *Sclerotium rolfsii* as it produce antibiotics substance such as Viridin, gliotoxin, glioviridin, dermin and trichodermin.[36,39] *Trichoderma* sp. has been reported to have antagonistic activity against *S. rolfsii* and *Fusarium cicer* under *in vivo* condition.[08] *Trichoderma, Penicillium* and *Aspergillus* species significantly inhibited the growth of *S. rolfsii* under *in vitro* condition.[19] Pastor et al. (2010)[79] observed that *Pseudomonas* sp. were more potent antagonistic activity against *Sclerotium rolfsii* in the rhizospheric soil of groundnut. Several species of *Pseudomonas* produce antifungal antibiotics such as 2, 4 diacetyl phloroglucinol, oligomycin, phenazine, pyolyteorin, pyrrolnitrin and pyocyanin which inhibit fungal activity.[42,73,75]

Streptomyces sp. has the biological control activity of root and stem rot as it produces antifungal and antibacterial substances which inhibited *Sclerotium rolfsii* and *Ralstonia salanacearum* in chilli pepper under *in vivo* condition.[18] Actinomycetes produce chitinase enzyme which inhibits *S. rolfsii* growth under *in vitro* condition, controls the stem rot disease and accelerate the growth of Chilli.[82] *Pseudomonas cf.montelii* produce diffusible antibiotic, volatile metabolite, hydrogen cyanide and siderophore that inhibits *Sclerotium rolfsii* under *in vitro* condition and accelerate the germination, shoot length, root length, number of leaves and chlorophyll content of groundnut.[78,91] The arbuscular mycorrhizal fungus *Glomus fasciculatum* suppress the harmful effect of stem rot disease caused by *Sclerotium. Trichoderma harzianum* showed the highest inhibition (83.06%) of mycelial growth of *Sclerotium rolfsii*.[16] Rekha (2012)[95] reported that *Trichoderma* sp. inhibited the mycelial growth and formation of sclerotial bodies of *S. rolfsii*. Samsuzzaman et al. (2012)[98] reported that *Trichoderma harzianum* reduced the mortality in tomato plants inoculated with *S. rolfsii* in soil and increase height and production of tomato, so biofungicide inhibit growth of *S. rolfsii* causes collar rot disease of tomato and no risk of environmental pollution than chemical control.

Arbuscular mycorrhizal fungi (*Glomus fasciculatum)* significantly inhibit *S. rolfsii* which cause stem rot disease of groundnut.[29] *Trichoderma* species have been reported as a biocontrol agent against *S. rolfsii*[84] causing southern stem blight disease of soybean.[21,33,43,44,60] Patro and Madhuri (2013)[81] reported that *T. harzianum* inhibits mycelial growth of *S. rolfsii* under *in vitro* condition which cause foot rot in finger millet. Khalid (2013)[56] isolated four bioagents viz, *Bacillus subtilis, Pseudomonas fluorescens,* yeast and *Trichoderma viride* which inhibited damping-off disease of bean caused by *S. rolfsii*. *Bacillus subtilis, T. viride*, and *P. fluorescens* control 88.7%, 83.7% and 86.3% respectively as bioagents against *S. rolfsii* and plants survived by 90.3%, 86.1% and 87.6% respectively. *Trichoderma asperellum* increased glucanase, chitinase and peroxidase activity in bulbs, roots and leaves of onion and it also inhibits the growth of *Sclerotium rolfsii*.[110] *Trichoderma viride, T.harzianum, Pochonia chlamydosporia, Pseudomonas fluorescens* and *Bacillus subtilis* have been reported as biocontrol agent against *Sclerotium rolfsii* responsible for causing southern blight disease in Zea mays.[45,71] Darvin et al. (2013)[26] selected three species of *Trichoderma (T. viride, T. harzianum* and *T. longibrachiatum)* for inhibition of radial growth of *S. rolfsii. T. viride* and *T. harzianum* have highest radial growth inhibition and *T. longibrachiatum* has lowest radial growth inhibition of *S. rolfsii* using dual culture technique under *in vitro* condition.

Pseudomonas aeruginosa is significantly active and inhibits the growth of *Sclerotium rolfsii* by 73.7% under *in vitro* condition.[11] Adhilakshmi et al. (2014)[04] isolated 30 actinomycetes from the rhizospheric soil of groundnut from different area of Tamil Nadu, India and tested for their antagonistic activity against *Sclerotium rolfsii* Sacc. causing stem rot of groundnut following dual culture technique under *in vitro*. Among the various isolates tested *in vitro*, five isolates ie. CBE, ANR MDU, SA and PDK were found significantly effective to control the mycelial growth of *S. rolfsii*.

Mahato and Mondal (2014)[63] reported that the plaster of Paris, *Azotobacter chroococcum*, vermicompost, *Pseudomonas*, FYM and *Trichoderma viride* were highly effective against *S.rolfsii*. *Trichoderma* and *Pseudomonas* showed highest inhibitory activity (68.28% and 74.25%respectively) against *Sclerotium rolfsii* under *in vitro* condition.[72] Sab et al. (2014)[96] studied eight bio-agents tested against *S. rolfsii* in dual culture technique, all bio-agents inhibit growth of *S. rolfsii* causal agent of collar rot of chickpea, but *Trichoderma harzianum* recorded maximum growth inhibition of *S.rolfsii*, compared to *Pseudomonas fluorescens* and *Bacillus subtilis. Trichoderma harzianum* and *Trichoderma viride* act as biocontrol agent and inhibits 53.8% to 83.1% growth of *Sclerotium rolfsii* and *Rhizoctonia solani*.[65] Six fungal species viz. *Penicillium* sp., *Aspergillus niger, Curvularia* sp., *Trichoderma harzianum, Trichoderma viride* and *Fusarium* species retards the growth of *Sclerotium rolfsii* under *in vitro* condition in dual culture technique.[14] Swathi et al. (2015)[107] reported that *T. harzianum* and *T. virens* were more active against *S. rolfsii* with 100% inhibition under *in vitro* condition. Khalequzzaman (2015)[54] reported that *Rhizobium* biofertilizer was more efficient to control foot and root-rot of Chickpea. *Trichoderma viride* contain antagonistic activity at optimum temperature 37 ^{0}C and pH six against *Sclerotium rolfsii*.[01] Bacteriocinogenic *Lactococcus lactis* JC10 can significantly inhibit mycelial growth of *S. rolfsii* in dual culture technique under laboratory conditions.[67]

Pseudomonas species act as a biocontrol agent and produce antifungal metabolites such as 2,4-diacetylphloroglucinol (DAPG), pyoluteorin, pyrrolnitrin and phenazines which inhibit the growth of *S.rolfsii*.[50] Basumatary et al. (2015)[14] have selected six fungal species viz. *Penicillium* sp, *Curvularia sp Aspergillus niger, Trichoderma harzianum, Trichoderma viride* and *Fusarium* spp as bio-agents against *Sclerotium rolfsii*. The maximum percentage of growth inhibition of *Sclerotium rolfsii* was observed with *Trichoderma harzianum* (77.39%) and *Trichoderma viride* (76.54%), while *Penicillium* sp (29.05%), *Aspergillus niger* (30.48%), *Curvularia* sp (13.57%) and *Fusarium* sp. inhibited the growth by 3.02% under *in vitro* condition. *Trichoderma* species produced β-xylosidase, α-glycosidase, β-glucosidase, cellobiohydrolase, trypsin, chymotrypsin and chymoelastase-like proteases and N-acetyl β-glucosaminidase which are responsible for the biocontrol activity of *Sclerotium rolfsii.*

Elshahawy et al. (2016)[35] reported that ten *Trichoderma* species and seven fungicides were effective against *Fusarium solani, F. oxysporum, Rhizoctonia solani, Macrophomina phaseolina* and *Sclerotium* species. *Trichoderma harzianum* and *T. atroviride* inhibited the growth of *S. rolfsii* but the mutant parent were more efficient compared to parent bio-agent against collar rot disease of chickpea caused by *S. rolfsii.* Mutant strain *T. harzianum* and *T. atroviride* successfully inhibited the excessive growth of *S. rolfsii* by 82.9%.[103] Ramzan et al. (2016)[92] studied 15 bio-agents against *S. rolfsii* responsible for root rot of mungbean in which *Trichoderma harzianum, Bacillus cereus, B. subtilis, T. virens, Pseudomonas fluorescens* and *Micrococcus varians* were effective bio-agents but *Bacillus subtilis* and *Trichoderma harzianum* were more effective. Karthikeyan et al. (2006)[51] reported that *Trichoderma viride, T. harzianum* and *Pseudomonas fluorescens* were inhibitory bioagents against the growth of *Sclerotium rolfsii* (Sacc.) in stem-rot of groundnut. *T. viride* inhibited the mycelial growth of the pathogen by 69.40%, while *P. fluorescens* inhibited 64.40%.

Plant extracts

Butt et al (2016)[20] reported that two important indigenous plants like *Alstonia scholaris* and *Azadirachta indica* leaf extract were more effective against *S. rolfsii* under *in vitro* condition at different concentrations (1%, 2%, 3%, 4% and 5%). Islam and Faruq (2012)[47] studied garlic clove, allamonda leaf, ginger rhizome, neem leaf, kalijira seed, turmeric rhizome, bel leaf, katamehedi leaf and onion bulb were effective against damping-off of tomato but neem leaf extract was most efficient than other extract. Amin et al. (2013)[06] selected different plants viz., rhizome ginger, neem leaf, tobacco leaf, rhizome of turmeric, and cow's urine. All plant extracts inhibited the growth of *Sclerotium rolfsii* at only higher concentration, while rhizome of turmeric inhibited the growth at a low level. Sab et al. (2014)[96] studied ten botanical extracts against *Sclerotium rolfsii* and only one 15% aqueous extract concentration of agave inhibited the growth of *S. rolfsii* by 90% causes collar rot of chickpea. Dania et al. (2014)[24] reported that *Oryza sativa* husk and *Quercus phillyraeoides* extract at different concentration ie. 0.5%, 1.0%, 1.5%, 2.5% and 3.5% w/v under *in vitro* and *in vivo* condition effective against *Sclerotium rolfsii* cause tuber-rot disease of white yam. The extract concentration 3.5% w/v was more effective comparison other.

Tang et al. (2015)[108] reported that *Cyperus dofformis* was more resistance against *Sclerotium rolfsii. Cymbopogon martini* oil was most efficient and inhibited the mycelial growth of *S. rolfsii*.[41] Okigbo et al. (2015)[77] have reported that *Dioscorea bulbifera* extract was most effective against the white yam root rot caused by *S. rolfsii.* Siddiqui et al., (2016)[101] have reported that leave, stem and root extracts of *Nerium oleander*, prepared in aqueous, methanol, ethanol, chloroform and acetone, control the growth of *F. oxysporum, S.rolfsii* and *Macrophomina phaseolina.*

Integrated management

The combination of nitrogenous compound, ammonium bicarbonate and fungicide carboxin control *S.rolfsii* on turf under field condition.[86] *Bacillus subtilis*, *Gliocladium virens* and fungicide quintozene were effective against root rot disease in grapevine nurseries caused by *Sclerotium rolfsii*.[53] Adandonon et al. (2006)[03] first reported that *Moringa* leaf extract combined with *Trichoderma* act as an integrated biocontrol agent against *Sclerotium* damping-off and stem rot disease of cowpea in the field condition. The antagonistic combination of *Trichoderma harzianum* and *Pseudomonas fluorescens* can be used for effective management of collar rot.[104]

Sahani et al. (2008)[97] have reported that combination of $ZnSO_4$ and oxalic acid was 100% effective against the collar rot of chickpea caused by *S. rolfsii* under greenhouse condition. Banyal, et al. (2008)[13] selected ten fungicides viz., carbendazim 50 WP, carbendazim + mancozeb 75 WP, captan 50 WP, chlorothalonil 80 WP, thiabendazole 80 WP, mancozeb 75 WDG, carboxin 75 WP, propineb 70 WP, mancozeb 75 WP and tebuconazole 5 DS; five bioagents *Trichoderma harzianum* (local strain), *Trichoderma viride* (local strain), *Gliocladium virens* (local strain), *Paecilomyces lilacinus* (Bhubaneswar strain) and *T. viride* (Ecoderma). These inhibited *Sclerotium rolfsii* causing collar rot of tomato, but the combination of tebuconazole and *T. viride* (local strain) controls 100% effective against *Sclerotium rolfsii.* Madhavi and Bhattiprolu (2011)[62] reported that tebuconazole and combination of carbendazim and mancozeb were very efficient against *Sclerotium rolfsii* causing root-rot in chili. The combination of the rhizome of turmeric and cow's urine was more efficient against the growth of *Sclerotium rolfsii*.[06]

Microbispora species and fungicide thiram are antagonistic against *Sclerotium rolfsii*.[80] The chemical fungicide (indofil M-45, bavistin, blitox, viavax power, kavach, curzet and krilaxyl gold); plant oils (Karanja oil, mahua oil, neem oil and chaulmoogra oil) and leaf extracts (*Mariya exatica* and *Vinca rosea*) inhibits radial growth of *S.rolfsii* under *in vitro* condition.[64] *Trichoderma viride* and fungicide mancozeb and camazeb significantly inhibit the growth of plant pathogen i.e. *Sclerotium rolfsii*.[31] *Trichoderma viride* selected from ginger soil have been recorded to be very effective in controlling the growth of *Sclerotium rolfsii* but the combination of *T. viride* and mancozeb could be detrimental to tomato plant.[32]

Effect of Solarization on *Sclerotium rolfsii*

Soil solarization is most effective for soil pathogen *S. rolfsii* during the hot summer months where soil temperature level increased that kill many important soil-borne fungal and bacterial plant pathogens. Soil solarization is a hydrothermal procedure which used transparent film to capture solar radiation in the soil. In hot arid region of India solarization is effective against soil pathogen particularly during April – June months.[61] Mihail (1983)[69] recorded three months temperature during soil solarization i.e. in April, June and September; the maximum temperature recorded was during June and concluded that solarization was significantly effective *Macrophomina phaseolina* and *S. rolfsii.* Stapleton and Devay (1986)[105] reported that soil solarization is very efficient for pre-plant, post-plant and soil treatment with the help of plastic film layer against the soil-borne pathogen. Solarization is more effective for organic amendments such as compost, green manures, plant residues and fertilizers; a combination of solarization with organic amendments has a significantly effects against pathogen control.[37]

Bhardwaj and Raj (2004)[15] reported that soil solarization with transparent polyethylene mulch (25 µm) for 40 days (June to July) was effective for the control of collar and root rot of strawberry caused by *S. rolfsii*. Soil solarization inhibit the germination of sclerotia on 40 days completely[15] at 7 cm soil depth. Moctezuma et al. (2006)[70] studied three organic soil combined with solarization inhibited the growth of *Sclerotium rolfsii.*

Table: Control of pathogen of some important crops using antagonistic microbial inoculates and botanicals.

S. No.	Crop	Infected part of crop	Name of disease	Study area	Antagonist	Reference
1.	Chilli	Root	Root-rot	Aurangabad District	plant leaves extract of *Argemone mexicana* Linn, *Eucalyptus globulus Labill* and *Murraya koenigii*	Quadri and Fatima (2016)[89]
2.	Soybean	Root and stem	Foot and collar rot	M. P.	*Trichoderma harzianum*	Bankoliya et al. (2015)[12]
3.	Chickpea	Stem	collar rot	Rawalpindi	Leaves extract and seed oil of Pongame *(Pongamia pinnata*)	Akram et al. (2016)[05]
4.	*Stevia rebaudiana*	Leaves	Sclerotium wilt	Dharwad (karnataka)	*T. harzianum, T. viride, Duranta repens , Eupatorium odoratum, Panchagavya , cow urine, Neem oil, Datura stramonium* and *Jeevamruta*	Shwetha and Hegde (2012)[100]
5.	Sugarbeet	Root	Root Rot	Tamil Nadu	*Trichoderma sp., P. fluorescens and Bacillus subtilis*	Rasu et al. (2013)[94]
6.	Melon	Melon leaves	Southern blight rot	Wilmar Benih Indonesia	Bamboo rhizospheric Microbe ie. *Bacillus subtilis*	Darma et al. (2016)[25]
7.	Plant	Stem	Collar rot	Plandu, Ranchi, Jharkhand	*T. harzianum*	Kumar et al (2012)[58]
8.	Rice	Stem	Stem rice	Sakaeo campus	Plant extracts *H. anthelminthicus* (fruits), *C. magna* (fruits), *C. sappan* (barks), *X. lanceatum* (fruits) *and C. brachiata* (barks)	Jantasorn et al. (2016)[49]
9.	Sunflower	Stem	Collar rot	Sundarbans of West Bengal	*T. viride, P. fluorescence, T. harzianum*, Cow urine, Neem, (*Azadirachta indica*), Tulsi (*Ocimum sanctum*) and Datura *(Datura stramonium)*	Maji and Nath (2016)[66]
10.	Groundnut	Stem	Stem-rot	Madurai	*Trichoderma harzianum*	Ganesan et al. (2007)[38]
11.	Lentil	Root	foot-rot and root-rot	Pulses Research Centre, Ishurdi, Pabna, Bangladesh	neem leaf extract, neem oil, garlic extract, *Trichoderma viride* compost, *T. harzianum* compost, provax 200	Khalequzzaman (2016)[55]
12.	Peanut	Stem	Stem rot	North Lombok District Indonesia	*Trichoderma* sp.	Suheri et al. (2014)[106]
13.	Groundnut (*Arachis hypogaea)*	Stem	Stem rot	Bapatla, Guntur District	*Trichoderma* spp., *Pseudomonas fluorescens* and *Bacillus subtilis*	Darvin and Kumari (2013)[27]
14.	Jute (*Corchorus* spp.)	Stem	Anthracnose and Soft- rot	Dhaka	*Aspergillus niger* and *Trichoderma viride*	Hosen et al. (2016)[46]
15.	Groundnut	Stem	Stem-rot	Semi-Arid Tropics, Patancher	Actinomycetes	Jacob et al.(2016)[48]
16.	Sunflower	Stem and root	Root and collar-rot	PDBC, Bangalore	*Pseudomonas fluorescens , Pseudomonas* spp., *Alcaligenes odorans, P. putida, Streptomyces* spp.and *Bacillus pantothenticus*	Rangeshwaran and Prasad (2000)[93]
17.	Chilli	Root	Root-rot	Aurangabad, Maharashtra	Leaves extracts of *Annona squamosa* Linn, *Brassica campestris* Linn. (Sarson) and *Ocimum sanctum* Linn	Quadri and Fatima (2016)[88]

CONCLUSIONS

The present review article concluded that biological, chemicals, plant extract and soil solarization inhibits growth of *S. rolfsii*. The biological and medicinal plant extract controls of *S. rolfsii* are eco-friendly significant for environment and farmer.

REFERENCE

1. Aanuoluwa EE, Kehinde A, Esthe, BB, Julie AB, Clement AF. Optimizing culture conditions for the antagonistic activities of Trichoderma viride against Sclerotium rolfsii causative agent of southern blight

disease of tomato. Malaysian Journal of Microbiology, 2015; 11(3): 240-245.
2. Abd-Allah EF. Effect of a Bacillus subtilis isolates a Southern blight (*Sclerotium rolfsii*) and lipid composition of peanut seeds. Phytopathology, 2005; 33(5): 460-466.
3. Adandonon A, Aveling TAS, Labuschagne N, Tamo M. Biocontrol agents in combination with Moringa oleifera extract for integrated control of Sclerotium caused cowpea damping-off and stem rot. European Journal of Plant pathology,2006; DOI 10.1007/s 10658-006-9031-6.
4. Adhilakshmia M, Latha P, Paranidharana V, Balachandarb, Ganesamurthyc K, Velazhahan R. Biological control of stem rot of groundnut (Arachis hypogaea L.) caused by Sclerotium rolfsii Sacc. with actinomycetes. Archives of Phytopathology and Plant Protection, 2014; 47(3): 298–311.
5. Akram A, Shaheen I, Akhund S, Nayyar BG, Seerat W. In vitro antifungal activity of Pongamia pinnata against collar rot pathogen (Sclerotium rolfsii) of chickpea. Pure and Applied Biology, 2016; 5(3): 520-528.
6. Amin R, Sarker BC, Adhikary SK, Sultana S, Zubair T. Effect of some botanical extracts and cow’s urine on sclerotium rolfsii causal agent of foot and root rot of betel vine. The International Journal of Engineering and Science, 2013; 2(9): 77-82.
7. Anahosur KH. Integrated management of potato Sclerotium wilt caused by Sclerotium rolfsii. Indian Phytopath, 2001; 54(2): 158-166.
8. Anand S, Reddy J. Biocontrol potential of Trichoderma sp. against plant pathogens. International Journal of Agriculture Science, 2009; 1(2): 30-39.
9. Arunasri P, Chalam TV, Eswara Reddy NP, Tirumala Reddy S, Ravindra Reddy B. Investigations on fungicidal sensitivity of Trichoderma spp and Sclerotium rolfsii (collar rot pathogen) in Crossandra. International Journal of Applied Biology and Pharmaceutical Technology, 2011; 2(2): 290-293.
10. Aycock R. Stem rot and other diseases caused by Sclerotium rolfsii. N.C.state univ. Tech. Bull., 1966; 174: 202.
11. Babu GP, Paramageetham ch. Biocontrol of Sclerotium rolfsii – a polyphagous plant pathogen by pseudomonas aeruginosa isolated from forest litter. International Journal of research in plant science, 2013; 3(1): 1-4.
12. Bankoliya MK, Kumar S, Ashish S. Effect of intercropping on the fungicides of foot and collar rot in soybean. Internat. J. Plant Protec., 2015; 8(2): 375-378.
13. Banyal DK, Mankotia V, Sugha SK. Integrated Management of Tomato Collar Rot Caused by Sclerotium rolfsii. J Mycol Pl Pathol, 2008; 38(2): 2008.
14. Basumatary M, Dutta BK, Singha DM, Das N. Some in vitro observations on the biological control of Sclerotium rolfsii, a serious pathogen of various agricultural crop plants. IOSR Journal of Agriculture and veterinary science, 2015; 8(2)II: 87-94.
15. Bhardwaj U, Raj H. Mulching with transparent polyethylene and root dip in fungicides for the management of collar and root rot of strawberry. Indian Phytopath. 2004; 57(1): 48-52.
16. Bhuiyan MA, Rahman HB, Bhuiyan KA. In vitro screening of fungicides and antagonists against Sclerotium rolfsii. Afr. J. Biotechnol, 2012; 11: 14822–14827.
17. Biswas KK, Sen C. Management of stem rot of groundnut caused by Sclerotium rolfsii through Trichoderma harzianum. Indian phytopath 2000; 53(3): 290-295.
18. Boukaew S, Chuenchit S, Petcharat V. Evaluation of Streptomyces sp for biological control of Sclerotium root and stem & Ralstonia wilt of chili pepper. International Organisation for Biological Control, 2011; 56: 365-374.
19. Bosah O, Igalek CA, Omorusi VI. In vitro microbial control of pathogenic Sclerotium rolfsii. International Journal of Agriculture & Biology, 2010; 12(3): 474-.476.
20. Butt1 BZ, Sana N, Butt S. Manangement of Sclerotium rolfssii through methanolic leaf extract of Alstonia scholaris and Azadirachta indica. J. Bioresource Manage, 2016; 3(2): 1-8.
21. Chandra S. Biological control of southern stem blight of Soybean (Glycine max Merrill) by the selected Trichoderma species under Glasshouse. An International Quarterly Journal of Life Sciences, 2014; 1(1): 18-21.
22. Chet I. Ultrastructural basis of Sclerotium rolfsii survival in soil . Microbial Ecology, 1975; 2: 194-200.
23. Conway KE, Tomasino SF. Sclerotiusiim rolfsii a problem to apple nursery stock in olahoma. Phytopathology, 1996; 75-449.
24. Dania VO, Fadina OO, Ayodele M, Kumar PL. Efficacy of Oryza sativa husk and Quercus phillyraeoides extract for the in vitro and in vivo control of fungal rot disease of white yam (Dioscorea rutundata Poir). Springer plus, 2014; 3: 711.
25. Darma R, Purnamasari IM, Agustina D, Pramudito T, Kumar R, Maurya S, Kumari A, Choudhary J, Das B, Naik SK, Kumar S. Biocontrol potentials of trichoderma harzianum against sclerotial fungi. The Bioscan, 2012; 7 (3): 521-525.
26. Darvin G, Venkatesh I, Reddy GN. Evaluation of trichoderma spp. against sclerotium rolfsii in vitro. Internaational journal of applied biology and pharmaceutical technology, 2013; 4(4): 268-272.
27. Darvin G, Kumari VP. Effect of bio-control agents on radial growth of Sclerotium rolfsii in vitro. International Journal of Applied Biology and Pharmaceutical Technology, 2013; 4(4): 61-64.
28. Deshmukh MA, Gade RM, Belkar YK Koche MD. Efficacy of bioagents, biofertilizers and soil

amendaments to manage root rot in greengram. Legume research - An International Journal, 2016; 39 (1): 140-144.
29. Doley K, Jite PK. Management of stem rot of Groundnut (Arachis hypogaea) cultivar in the field. Nat.Sci.Biol., 2013; 5(3): 316-324.
30. Doley K, Dudhane M, Borde M. Effects of arbuscular mycorrhizal fungi against Sclerotium rolfsii in Groundnut (JL.24). Indian Journal of Fundamental and Applied Life Sciences, 2015; 5(1): 293-302.
31. Ekundayo EA, Boboye BE, Adetuyi FC. In vitro Antifungal Efficacies of Maize Associated Microorganisms. Advances in Microbiology, 2015; 5:258-268.
32. Ekundayo EA, Ekundayo FO, Osinowo IA. Antifungal activities of Trichoderma viride and two fungicides in controlling diseases caused by Sclerotium rolfsii on tomato plants. Advance in Applied Science research, 2015; 6(3): 12-19.
33. Elad Y. Biological control of foliar pathogens by means of Trichoderma harzianum and potential modes of action. Crop Protect, 2000; 19: 709-714.
34. El-Mohamedy RSR, Jabnoun-Khiareddine H, Daat mi-Remadi M. Control of root rot diseases of tomato plant caused by Fusarium solani, Rhizoctonia solani and Sclerotium rolfsii using a different chemical, plant resistance inducers. Tunisian journal of plant protection, 2014; 9: 45-55.
35. Elshahawya IE, Haggard KHE, El-Khaira HA. Compatibility of Trichoderma sp. With Seven Chemical Fungicides Used in the Control of Soil-Borne Plant Pathogens. Research Journal of Pharmaceutical, Biological and Chemical Sciences, 2016; 7(1): 1772.
36. Eziashi EI, Omamor IB, Odigie EE. Antagonism of Trichoderma virile and effects of extracted water-soluble compounds from Trichoderma species and benlate solution on Ceratocystis paradox. Afr. J. Biotechnol, 2007; 6: 388–392.
37. Gamliel A, Stapleton JJ. Improvement of Soil Solarization with Volatile Compounds Generated from Organic Amendments. Phytoparasitica, 1997; 25: 31S-38S.
38. Ganesan S, Kuppusamy RG, Sekar R. Integrated management of stem rot disease (Sclerotium rolfsii) of groundnut (Arachis hypogaea L.) using Rhizobium and Trichoderma harzianum (ITCC - 4572). Turk J Agriculture, 2007; 31: 103-108.
39. Ghildiyal A, Pandey A. Isolation of cold tolerant antifungal strains of Trichoderma species from glacial sites of Indian Himalayan region. Res J Microbiology, 2008; 8:559–564.
40. Gopalakrishnan S, Beale MH, Ward JL, Strange RN. Chickpea wilt: identification and toxicity of methyl fusarubin from Fusarium acutatum. Phytochemistry, 2005; 66: 1536-1539.
41. Guerra YL, Oliveira TAS, Laranjeira D, Lima LM, Filho PAM, Santos RC. Control of Sclerotium rolfsii in peanut by using Cymbopogon martinii essential oil. African Journal of Microbiology Research, 2015; 9(27): 1684-1691.
42. Gupta CP, Dubey RC, Kang SC, Maheshwari DK. Antibiosis mediated necrotrophic effect of Pseudomonas GRC2 against two fungal plant pathogens. Curr. Sci., 2001; 81: 91–94.
43. Haran S, Schikler H, Chet I. Molecular mechanisms of lytic enzymes involved in the biocontrol activity of Trichoderma harzianum. Microbiology, 1996a; 142: 2321-2331.
44. Hermosa MR, Grondona I, Iturriaga EA, Diz-Minguez JM, Castro C, Monte E, Garcia-Acha I. Molecular characterization and identification of biocontrol isolates of Trichoderma spp. Applied Environ.microbiology, 2000; 66: 1890-1898.
45. Hooda KS, Bhatt JC, Joshi D Sushil SN, Gupta HS. Biocontrol agents vis-à-vis fungicides in managing various diseases of tomato (Licopersicon ulescentum mill.) in hills of Uttarakhand. Indian Phytolpath, 2008; 61: 331.
46. Hosen S, Shamsi S, Bashar M. In vitro biological control of Colletotrichum gloeosporioides (penz.) sacc. and Sclerotium rolfsii sacc., causal agent of anthracnose and soft rot of Corchorus capsularis L. Bangladesh J. Bot., 2016; 45(1): 175-180.
47. Islam MT, Faruq AN. Effect of some medicinal plant extracts on the damping-off disease of winter vegetable. World Applied Sciences Journal, 2012; 17(11): 1498-1503.
48. Jacob S, Sajjalaguddam RR, Kumar KVK, Varshney R, Sudini HK. Assessing the prospects of Streptomyces sp. RP1A-12 in managing groundnut stem rot disease caused by Sclerotium rolfsii Sacc. J Gen Plant Pathol., 2016; 82: 96–104.
49. Jantasorn A, Moungsrimuangdee B, Dethoup T. In vitro antifungal activity evaluation of five plant extracts against five plant pathogenic fungi causing rice and economic crop diseases. Journal of Biopesticides, 2016; 9(1): 1-7.
50. Jothi LN, Reddy ECS. Biocontrol potential of indigenous fluorescent Pseudomonas species against Sclerotium rolfsii is causing stem rot of Groundnut. 2th Int. Conf. Exh. Biotech., 2015.
51. Karthikeyan V, Sankaralingam A, Nakkeeran S. Biological control of groundnut stem rot caused by Sclerotium rolfsii (Sacc.). Archives of Phytopathology and Plant Protection, 2006; 39(3): 239-246.
52. Kator L, Hosea ZY, Oche OD. Sclerotium rolfsii; a Scausative organism of southern blight, stem rot, white mold and Sclerotia rot disease. Annals of biological research, 2015; 6(11): 78-89.
53. Keser HA, Ferreira JHS. Chemical and biological control of Sclerotium rolfsii in Grapevine Nurseries. S. Afr. J. Enol. Vitic., 1988; 9(1): 43-44.
54. Khalequzzaman K M. Seed treatment with Rhizobium biofertilizer for controlling foot and root rot of chickpea. International Journal of Scientific Research in Agricultural Sciences, 2015; 2(6): 144-150.

55. Khalequzzaman K M. Control of foot and root rot of lentil by using different management tools. ABC journal of advanced research, 2016; 5(1): 35-42.
56. Khalid EE. Biological control of bean damping-off caused by Sclerotium rolfsii. Research Gate, 2013; 9: 1-11.
57. Khan IH, Javaid A. Chemical control of collar rot disease of Chickpea. Pakistan Journal of Phytopathology, 2015; 27(01): 61-68.
58. Kumar R, Maurya S, Kumari A, Choudhary J, Das B, Naik SK, Kumar S. Biocontrol potentials of Trichoderma harzianum against Sclerotial fungi. The Bioscan, 2015; 7(3): 521-525.
59. Kwon JH, Park CS. Stem rot of tomato caused by Sclerotium rolfsii in Korea. Microbiology 2002; 30(4): 244-246.
60. Lewis JA, Papavizas GC. Biocontrol of plant diseases: the approach for tomorrow. Crop Protection, 1991; 10: 95-105.
61. Lodha S. Soil solarisation: An eco-friendly approach to manage soil borne plant pathogens. CAZRI (DEN NEWS), 2011; 13(1).
62. Madhavi GB, Bhattiprolu SL. Integrated disease management of dry root-rot of chili incited by Sclerotium rolfsii. International Journal of Plant , animal and environmental sciences, 2011; 1(2): 31-37.
63. Mahato A, Mondal B. Sclerotium rolfsii: its isolates variability, pathogenicity and an eco-friendly management option. Journal of Chemical, Biological and Physical Sciences Sec. B, 2014; 4(4): 3334-3344.
64. Mahato A, Mondal B, Dhakre DH, Khatua DC. In vitro sensitivity of Sclerotium rolfsii towards some fungicides and botanicals. Scholars Academic Journal of Biosciences, 2014; 2(7): 467-471.
65. Majdah MY, Al-Tuwaijri, Aboellil AH. Associated change in metabolic activity of host pathogen system in some infected plants by bio-inducer. International Journal of Advanced Research in Biological Sciences, 2015; 2(3): 86-100.
66. Maji A, Nath R. Management through eco-friendly approach of collar rot disease of sunflower caused by sclerotium rolfsii sacc in sundarbans of west Bengal. International Journal of Agricultural Science and Research, 2016; 6(4): 9-12.
67. Mandal M, Jana SC. Antagonistic Effects of Bacteriocin and Bacteriocinogenic Lactobacillus on stem rot causing Sclerotium rolfsii in Betel. International Journal of Bioassays, 2015; 4(11): 4454-4457.
68. Manu TG, Nagaraja A, Chetan, Janaward S, Hosamani V. Efficacy of fungicides and biocontrol agents against Sclerotium rolfsii causing foot rot disease of finger millet, under in vitro conditions. Global Journal of Biology, Agriculture & Health Sciences, 2012; 1(2): 46-50.
69. Mihail JD. Effects of soil solarization and antaoonistic bacteria on macrophomina phaseolina and sclerotium rolfsii. Research Gate university microfilms international, Arizona, 1983.
70. Moctezuma HEF, Belmont RM, Perez AJ, Juarez RN. Pathogenic diversity of Sclerotium rolfsii isolates from Mexico and potential control of southern blight through solarization and organic amendments. Crop Protection, 2006; 25: 195-201.
71. Mohiddin FA, Khan MR. Tolerance of fungal and bacterial biocontrol agents to six pesticides commonly used in the control of soil-borne plant pathogens. Afr. J. Agri. Res., 2013; 8: 5272.
72. Muthukumar A, Venkatesh A. Biological inductions of systemic resistance to collar rot of peppermint caused by Sclerotium rolfsii. Acta. Physiol. Plant, 2014; 36: 1421-1431.
73. Muthukumar A, Nakkeeran S, Eswaran A, Sangeetha G. In vitro efficacy of bacterial endophytes against the chilli damping-off pathogen Pythium aphanidermatum. Phytopathol. Mediterr, 2010; 49: 179–186.
74. Nalisa I, Muskhazli M, Farizan T. Production of the bioactive compound by Bacillus subtilis against Sclerotium rolfsii. Malaysian Journal of Microbiology, 2006; 2(2): 19-23.
75. Nielson MN, Sorensen J, Fels J, Pedersen HC. Secondary metabolite and endochitinase dependent antagonism towards plant pathogenic microfungi of Pseudomonas fluorescens isolates from sugar beet rhizosphere. Applied Environmental Microbiology, 1998; 64: 563–3569.
76. O'Sullivan DJ, O'Gara F. Taits of fluorescent pseudomonas spp. involved in suppression of plant root pathogens. Microbial. Rev.1992; 56: 662-676.
77. Okigbo RN, Opara PU, Anuagasi C L. Efficacy of extracts of water yam (Dioscorea alata) and aerial yam (Dioscorea bulbifera) peels in the control of white yam (Dioscorea rotundata) rot. Journal of Agricultural Technology, 2015; 11(8): 1823-1842.
78. Paramageetham Ch, Babu GP. Antagonistic activity of fluorescent Pseudomonas against a polyphagous soil-born plant pathogen – Sclerotium rolfsii. Open access scientific reports 2012; 1: 9.
79. Pastor NA, Reynoso MM, Tonelli ML, Masciarelli O, Rosaso SB, Tonelli ML, Masciarelli D, Rosas SB, Rovera M. Potential bio control Pseudomonas sp. Pc12 against damping-off of tomato caused by Sclerotium rolfsii. J .Plant Pathol., 2010; 92: 737–745.
80. Patil NN et al. Potential of Microbispora sp.V2 as biocontrol agent against Sclerotium rolfsii, the causative agent of southern blight of Zea may (Baby corn) in vitro studies. Indian Journal of Experimental Biology, 2014; 52: 1147-1151.
81. Patro TSSK, Madhuri J. Evalution of biocontrol agents against foot rot of finger millet caused by Sclerotium rolfsii under in vitro condition. International Journal of food, Agriculture and Veterinary Sciences, 2013; 3(3): 30-32.
82. Pattanapipitpaisal P, Kamlandham R. Screening of chitinolytic Actinomycetes for biological control of

Sclerotium rolfsii stem rot disease of Chilli. Songklanakarin J. Sci. Technol., 2012; 34(4): 387-393.
83. PinheiroVR et al. Development of Sclerotium rolfsii, sclerotia on soybean, corn and wheat straw, under different soil temperature and moisture contents. Pesq. agropec. Bras. Brasilia, 2010; 45(3): 332-334.
84. Podmaja M, Narendra K, Swati J, Sowjanya KM, Babu PJ, Satya AK. In vitro antagonism of native isolates of Trichoderma sp.against Sclerotium rolfsii. International Journal of Research in Pharmaceutical and Biomedical Sciences, 2013; 4(3): 886-891.
85. Punja ZK. The Biology,Ecology and control of Sclerotium rolfsii. Annual review of Phytopathology, 1985; 23: 97-127.
86. Punja ZK, Grogan RG, Unruh T. Chemical control of Sclerotium rolfsii on golf greens in northern California. Plant disease, 1982; 66: 108-111.
87. Puri S. Eco-friendly management strategies for soil borne plant pathogens. Internal journal of advanced research in biological sciences, 2016; 3(1): 69-75.
88. Quadri U, Fatima S. Eco-friendly management of Sclerotium rolfsii causing root rot disease in chilli. International Journal of Advanced Research, 2016; 4(5): 672-678.
89. Quadri U, Fatima S. Screening of Medicinal Plants against Sclerotium rolfsii Isolated from Root Rot of Chilli. International Journal of Innovative Research in Science, Engineering and Technology, 2016; 5(5): 8082-8088.
90. Radwan M, Fadel ALB, Mahareeq I, Mohammad IAL. Biological control of Sclerotium rolfsii by using indigenous Trichoderma spp. isolates from Palestine. Hebron Univ. Res., J.2006; 2(2): 27-47.
91. Rakh RR, Rout LS, Dalvi SM, Manwar AV. Biological control of Sclerotium rolfsii, causing stem rot of Groundnut by Pseudomonas cf.monteilii 9. Recent research in Science and Technology, 2011; 3(3): 26-34.
92. Ramzan N, Noreen N, Perveen Z, Shahzad S. Effect of seed pelleting with bio-control agents on growth and colonization of roots of mungbean by root-infecting fungi. J Sci Food Agric.2016; 7553.
93. Rangeshwaran R, Prasad RD. Biological control of Sclerotium-rot of sunflower. Indian Phytopathology, 2000; 53 (4): 444-449.
94. Rasu T, Sevugapperumal N, Thiruvengadam R, Ramasamy S. Biological Control of Sugarbeet Root Rot Caused by Sclerotium rolfsii. International Journal of Biological, Ecological and Environmental Sciences, 2013; 2(1): 7-10.
95. Rekha D. “Invitro Screening of Native Trichoderma Isolates Against Sclerotium Rolfsii Causing Collar Rot of Groundnut”. I J S N, 2012; 3(1): 117-120.
96. Sab J, Nagaraja A, Nagamma G. Efficacy of bio-pesticides against Sclerotium rolfsii sacc. causing collar rot of chickpea (Cicer arietinum). The bioscan., 2014; 9(1): 335-339.
97. Sahani S, Sharma BK, Singh KP. Management of Sclerotium rolfsii with integration of non-conventional chemical, vermicompost and Pseudomonas syringae. World J. microbiological biotechnology, 2008; 24: 517-522.
98. Samsuzzaman M, Shafiqul Islam ATM, Hossain SKMM, Amin MHA, Kaisher MS. Biological control of collar rot of tomato caused by Sclerotium rolfsii. Bangladesh res. pub. J., 2012; 6(3): 240-247.
99. Shlevin E, Saguy IS, Mahrer Y, Katan J. Modeling the survival of two soilborne pathogens under dry structural solarization. Phytopathology, 2003; 93: 1247-1257.
100. Shwetha GS, Hegde, Yashoda R. Management of Sclerotium wilt of Stevia rebaudiana through biorationals. Internat. J. Plant Protec., 2012; 5(2): 248-251.
101. Siddiqui I, Bokhari NA, Perveen K. Anti-fungal ability of nerium oleander against Fusarium oxysporum, sclerotium rolfsii and macrophomina phaseolina. The Journal of Animal & Plant Sciences, 2016; 26(1): 269-274.
102. Sindhu SS, Dadarwal KR. Chitinolytic and cellulolytic Pseudomonas species antagonistic to fungal pathogens enhances nodulation by mesorhizobium spp. Cicer in chickpea. Miorobial. Rev., 2001; 56: 662-676.
103. Singh R, Maurya S, Upadhyay RS. The improvement of competitive saprophytic capabilities of Trichoderma species through the use of chemical mutagens. Brazilian journal of microbiology, 2016; 47: 10-17.
104. Singh R, Singh PP, Singh V. Integrated management of collar rot of amorphophallus paeoniifolius blume caused by Sclerotium rolfsii Saccardo. Veg. Sci., 2006; 33(1): 45-49.
105. Stapleton JJ, Devay JE. Soil solarization: a non-chemical approach for management of plant pathogens and pests. Crops protection 1986; 5(3): 190-198.
106. Suheri H, Isnaini M, Rohyadi A. Application of organic amendment and Trichoderma sp. to control basal Sclerotium rolfsii on peanut grown on partially degraded land. Journal of degraded and mining lands management, 2014; 1(3): 131-136.
107. Swathi B, Patibanda AK, Prasuna RP. Antagonistic Efficacy of Trichoderma species on Sclerotium Rolfsii in Vitro. Journal of Agriculture and Veterinary Science, 2015; 8(7): 19-22.
108. Tang W, Kuang J, Qiang S. The pathogenicity of sclerotium rolfsii on Cyperus dofformis and its potential host specificity among the *genus* Cyperus. J Plant Pathol Microbiology, 2015; S3: 002.
109. Tariq RR, Razdn VK, Tiwari AK, Shanaz E, Bhat ZA, Hassan MG, Wani TA. Integrated management of wilt complex disease in bell pepper (Capsicum annum). Journal of agricultural science, 2012; 4(7): 141-147.
110. Valle PG, Luna LB, Belmont RM, López CG, Jiménez GS. Induction of resistance to Sclerotium

rolfsii in different varieties of onion by inoculation with Trichoderma asperellum. Eur. J. Plant Pathology, 2013; 138: 223-229.
111. Verma M, Brar K S, Tyagi R D, Surampalli RY, Valero JR. Antagonist fungi, Trichoderma species: a panoply of biological control. Biochemical Engineering Journal, 2007; 37: 1-20.
112. Wang Y, Duan YB, Zhou MG. Baseline sensitivity and efficacy of fluazinam in controlling Sclerotinia stem rot of rapeseed. Eur J Plant Pathology, 2015; 144: 337-343.
113. Yaqub F, Shahzad S. Effect of fungicides on in vitro growth of Sclerotium rolfsii. Pak J. Bot, 2006; 38(38): 881-883.