**Review of Literature:**

Amany *et al* (2003) tested the fungicides benlate and zineb *in vitro* on growth, sporulation and morphological alternations of *Alternaria solani, fusarium oxysporum* and *Sclerotium cepivorum*. Reduction in growth criteria of the tested pathogenic fungi was more correlated with elevation of benlate dose than with zineb. Tolerance of the fungi towards zineb, is correlated with increased ability to synthesize extracellular melanin under fungicidal stress.

Harlapur *et al* (2007) evaluated twenty-three fungicides *in vitro* against turcicum leaf blight of maize caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs. Of the fungicides tested, mancozeb @ 0.25 per cent completely inhibited the growth. Carboxin power @ 0.1 per cent and propiconazole @ 0.1 per cent were the other effective fungicides.

Karima *et al* (2007) Two pesticides, metalaxyl (Ridomil plus 50% WP) and chloropyrifos-methyl (Reldan 50% EC) at different concentrations alone or in mixture were tested against *A. solani in vitro* and greenhouse tests causing early blight disease of tomato and eggplant. *In vitro* spore germination of *A. solani* was more sensitive to the mixture of metalaxyl and chlorpyrifos-methyl followed by metalaxyl and chlorpyrifos-methyl, respectively, while the mycelial growth was reduced by chlorpyrifos-methyl followed by the two pesticide mixture and metalaxyl, respectively. They concluded that, the population of immature stages of *Bemisia tabaci* were reduced by 48.00% on tomato and by 32.00 to 81.00% on eggplant.

Prajapati and Narain (2008) screened ten fungicides and two neem formulations assayed *in vitro* against *Sclerotinia sclerotiorum* (Lib.) De Bary causing stem and pod rot of dolichos bean, vitavax, companion, bavistin, score, mancozeb and thiram proved to be
the most effective as they inhibited the growth of fungus completely (100%). Among the partially effective one, zineb gave the highest inhibition (88.80%) followed by neem formulations. Fungicides and neem formulations found effective and partially effective in in vitro test were further evaluated as foliar spray for the management of disease.

Mathews et al (2009) in vitro screened seven systemic fungicides and two non systemic fungicides against *colletotrichum gloeosporioides* causing anthracnose of mango. Among systemic fungicides, the pathogen was sensitive to carbendazim, thiophanate-ethyl and prochloraz at 50ppm, propioconazole and hexaconazole at 25ppm, thiram and captab at 750ppm were most effective in complete inhibition of the pathogen and among non-systemic fungicides only copper oxychloride at 1000ppm concentration, 100% of inhibition over control was recorded. Whereas mancozeb reported to be less effective when compared to systemic fungicides.

Fazli and Sana (2010) evaluated three fungicides against *Alternaria solani* causing early blight of tomato was studied invitro. All the fungicides (captan, cobox and Dithane M-45) @ 200mg/l significantly (p<0.05) reduced the colony diameters of *A. solani* compared with the control treatments. Dithane M-45 was found to be more effective than captan and cobox.

Zafar et al (2010) evaluated Eight fungicides for their in vitro effect on the colony growth of *Fusarium mangiferae* after 3, 8 and 16 days of inoculation in pre-amended Potato dextrose agar (PDA) medium. The fungicides showed variable response in inhibiting the colony growth of the pathogen according to their nature and specificity at different minimum inhibitory concentrations (MICs). Benlate 50 WP and Carbendazim proved to be the best fungicides giving 100% suppression of the colony growth. The fungicides Score 250 EC, Daconil W 75 and Captan 50 WP proved to be comparatively less effective.
Taskeen-Un- Nisa et al (2011) evaluated fungicides Carbendazim, hexaconzole, bitertanol, myclobutanil, mancozeb, captan and zineb and extracts of *Allium sativum*, *Allium cepa* and *Mentha arvensis* for their effect on the inhibition of mycelial growth and spore germination of *Fusarium oxysporum*. Maximum inhibition in mycelial growth was observed in the hexaconozole at 1000 ppm followed by other fungicides at the same concentration.

**Fungal Antagonists:**

Cheaeh and Page (1997) screened twenty-five isolates of *Trichoderma* spp. Against clubroot (*Plasmodiophora brassicae*) on Chinese cabbage (*Brassica chinensis* L.)‘Wong-Bok’ in a glasshouse experiment. Seventeen of the 25 isolates tested significantly reduced disease severity compared to the untreated control. No phytotoxicity was observed on any of the treatments tested.

El-Katatny et al (2000) screened Twenty four isolates of *Trichoderma* for 1,3-glucanase and chitinase activity. Out of these organisms, a strain identified as *T. harzianum* Rifai secreted highest activities. *In vitro* production of chitinases and 1,3-glucanases by *T. harzianum*, a mycoparasite of phytopathogenic fungi, was examined under various culture conditions. Enzymes production was significantly influenced by the carbon source incorporated into the medium and was stimulated by acidic pH from 5.5 to 6.0. Glucose or GlcNAc (0.5 %) addition along with chitin for chitinase and laminarin for _- _1,3-glucanase, repressed production of these enzymes, while the polysaccharides as sole carbon source enhanced production of the respective enzymes. Production of both enzymes was also enhanced by polysaccharides contained in the mycelium of *S. rolfsii* phytopathogenis fungus. *T. harzianum* culture filtrates, possessing chitinase and _-1,3-glucanase_ activities, were capable of hydrolysing dried or fresh mycelium of the phytopathogenic fungus *S. rolfsii*. Growth of *S. rolfsii* was significantly inhibited (up to 61.8 %) by enzyme preparations from *T. harzianum*. 
Kucuk and Kivanc (2004). Observed Interactions between *Trichoderma harzianum* strains and some soilborne plant pathogens (*Gaeumannomyces graminis* var. *tritici*, *Fusarium culmorum* and *F. moniliforme*) were studied on PDA medium. All *T. harzianum* strains tested produced a metabolite that inhibited growth of plant pathogenic fungi on PDA medium. When grown in liquid cultures containing laminarin, chitin or fungal cell walls as sole carbon sources, 2 strains of *T. harzianum* produced 1,3-b-glucanase and chitinase in the medium.

Celar and Valic (2005) reported that, antagonistic fungi *in vitro* produce extracellular growth-regulating substances independently of plant presence. The results showed that the only culture filtrate which had no influence on seed germination was that of *Gliocladium roseum*. The filtrate of *Trichoderma koningii* had a pronounced negative effect on the first and on the final count of germination of onion, chicory and lettuce seeds. The filtrates of *T. longibrachiatum* and *T. harzianum* stimulated the germination of red beet and chicory or tomato and chicory seeds, respectively. The results indicate that the isolates of the antagonistic fungi studied in the experiments produced *in vitro* growth-regulating substances independently of the plant presence.

Fouzia and Saleem (2005) reported that, *Trichoderma harzianum* and *T. longibrachiatum* were found to inhibit the *in vitro* growth of *S. rolfsii* isolated from maize. *Trichoderma spp.* produced coiling around mycelium of *S. rolfsii* resulting in lysis of hyphae. *T. pseudokoningii*, *T. polysporum* and *Gliocladium virens* also inhibited the growth of *S. rolfsii*.

El-Hasan et al (2006) observed the interactions between eight *Trichoderma spp.* isolates and *Fusarium moniliforme* were investigated. The results obtained from dual culture and the tests on volatile activity showed that the two isolates of *T. harzianum* T23 and T16 exhibited considerable antagonistic potential. In *in vitro* studies, 6PAP demonstrated
potent inhibitory properties upon mycelial growth and sporulation of *F. moniliforme* in both volatile and non-volatile tests as well as on conidia germination and length of germ tubes. Mycelial growth was inhibited by 93.5% using 250 μg ml⁻¹ of 6PAP. Conidia production of the target fungus was inhibited by 250 μg ml⁻¹ of 6PAP in non-volatile and volatile assays by 98.0% and 78.6%, respectively. Germ tube growth was also inhibited by more than 94% using 300 μg ml⁻¹ of 6PAP. The results obtained demonstrated that the metabolite 6PAP exhibited rather fungistatic than fungicidal effects.

Anitha et al (2007) isolated Thirteen isolates of *T. harzianum* were obtained from rhizosphere soil samples collected from field grown crops. They were tested for antagonistic capacity against soilborne pathogens viz, *Sclerotium rolfsii*, *Rhizoctonia solani* and *Fusarium oxysporum*. *T. harzianum* isolates effectively inhibited these pathogens (47–92%) in dual cultures. The most effective strain (Th 001) was mass cultured in Weindling medium at 25 C for 7 d. The metabolites produced in the medium were extracted with methanol and evaluated for antifungal activity. To assess the genetic variability in *T. harzianum*, the isolates were analyzed by using random amplified polymorphic DNA markers. Isolates showed 78-80% similarity with standard culture of *T. harzianum* (MTCC 2050). In contrast, the isolates showed differences in the capacity to produce extracellular metabolites.

Irfan and Khalid (2007) isolated five species of *Trichoderma* viz., *Trichoderma Viride*, *T. harzianum*, *T. Koningii*, *T. aureoviride* and *T. pseudokoningii* and were evaluated for their *in vitro* antagonistic potential against *Fusarium oxysporum*, the cause of wilt disease in sweet peppers (*Capsicum annum*). Among the *Trichoderma* species *T. viride* showed the best performance *in vitro* biological control of *Fusarium oxysporum* followed by *T. harzianum*, *T. aureoviride*, *T. kongii* and *T. pseudokoningii*, respectively, resulting in 62, 36, 24, 18 and 6% reduction in colony growth of the test pathogenic fungus respectively.
Nashwa et al (2008) tested the ability of fifteen isolates of *Trichoderma* spp. Isolated from the rhizosphere of bean plants to inhibit mycelial growth of *Rhizoctonia solani* and *Fusarium oxysporum* f.sp. *phaseoli* causing damping-off and wilt of bean. *Trichoderma harzianum* (Th1), *T. viride* (Tv1) and *T. spirale* (Ts3) isolates showed different inhibitory effect against growth of both tested pathogens. Th1 and Tv1 showed the greatest antagonistic effect to the pathogens followed by Ts3 isolate. The formulation of *Trichoderma* spp. treatments not only suppressed both damping-off and wilt diseases but also enhanced green yield of bean plants compared to infected control, especially, Th1 formulation gave equal green yield compared to healthy control.

Azher et al (2009) examined Mycelial growth, conidal production and biomass yield of three different *Trichoderma* species (*T. harzianum*, *T. viride*, *T. longibrachiatum*) on five different culture media includings Potato Dextrose Agar, Waksman agar, Agar-agar, Czepak’s agar and Corn Meal agar. Potato Dextrose Agar was the best medium in terms of growth spore production and biomass yield. *Trichoderma harzianum* outclassed the three in terms of mycelial growth biomass yield and spore production. *In-vitro*, species of *Trichoderma* strongly antagonised six different seed borne pathogenic fungi viz. *Fusarium moniliforme*, *Fusarium oxysporum*, *Rhizoctonia solani*, *Fusarium solani*, *Botryodiplodia theobromae* and *Alternaria alternata* in dual culture assay. *Trichoderma harzianum* gave maximum inhibition of mycelia growth of all pathogenic fungi.

Cornea et al (2009) isolated new strains of *Trichoderma* spp. from Romanian soils and examined their antagonistic activity against *Phytophthora* spp and *Rhizoctonia* spp. The *in vitro* biocontrol activity of *Trichoderma* spp., as well as of other antagonistic fungi (*Penicillium chrysogenum* *Gliocladium roseum* and *Eppicoccum purpureascens*) on the plant pathogens was increased in the presence of FeCl₃. The interactions between fungal strains (plant pathogens and antagonistic strains) were also examined, in order to determine the mechanism of action of the antifungal strains. It was observed that all of
the *Trichoderma* strains were able to produce large amount of hydrolytic enzymes (chitinase, cellulases and proteases) and to act as mycoparasites for pathogens.

Ebtsam *et al* (2009) reported that, *Trichoderma* and *Bacillus* genera are most feasible biocontrol microorganisms suppress several pathogens like *Fusarium solani* causing root rot of tomato. Both of *T. viride* and *B. subtilis* strains reduced growth percentage by 57.8 and 34.4%, respectively comparing with the control. The dual treatment by *T. viride* + *B. subtilis* decreased the percentage of infection and increased survival rate than individual one. Moreover, the dual inoculation gave the highest records of growth parameters, fruit yields and plant nutrient content than individual one. Thus, it is recommended to use these strains as a common biocontrol practice in agriculture.

Matroudi *et al* (2009) screened 30 *Trichoderma* isolates, three different species *T. harzianum*-8, *T. atroviride* PTCC5220 and *T. longibrachiatum* PTCC5140 against *Sclerotinia sclerotiorum* causing canola stem rot of canola and soyabean, were selected on the basis of their high level of chitinase and/or glucanase activity, along with their rapid growth rate *in vitro*. These showed high growth inhibition of two phytopathogenic isolates of *Sclerotinia sclerotiorum* (S1 and S2), with *T. atroviride* the greatest effect, reducing growth by 85-93%. They showed coil formation and penetration structures against the hyphae of the pathogenic isolates. *T. atroviride* PTCC5220 can be used for assessment of field biocontrol against *S. sclerotiorum*.

Saiprasad *et al* (2009) studied the mode of action of fungus *Trichoderma harzianum* is through secretion of cell wall degrading enzymes including chitinases. Thus, the chitinases genes isolated from T.harzianum have been successfully utilized in the production of transgenic plants with enhanced resistance to several fungi. Expression of chitinase gene in transgenic tobacco plants was found to be higher as revealed by the endochitinase assay and relative quantitative RT-PCR. Its efficacy in inhibiting the fungal
growth was also reported *in vitro* as well as in *vivo* in the detached leaves of tobacco transformants containing the gene.

Abd-El-Khair *et al* (2010) tested antagonistic effect of four *Trichoderma* species, i.e. *Trichoderma album*, *Triechoderma hamatum*, *Trichoderma harzianum* and *Trichoderma viride*, was tested against *F. solani* and *R. solani* *in vitro*, in greenhouse and in field causing Damping off disease of beans. *In vitro* tests, all *Trichoderma* spp. significantly reduced the mycelia growth of two pathogenic fungi. In greenhouse experiment, *T. album*, *T. hamatum*, *T. harzianum* and *T. viride*, as soil treatments, significantly reduced the pre- and post-emergence damping off disease incidence under artificial infection with *F. solani* and *R. solani*. Soil treatments with four *Trichoderma* species significantly reduced the incidence of damping off disease where the percentages disease incidence were in the range of 7.0 -20.0% and 2.4 – 6.5%, compared to 25.7 and 13.5% in control plants, at pre- and post-emergence stages ,respectively. The best protection to damping off disease was obtained by *T. hamatum*, followed by *T. viride*, *T. album* and *T. harzianum*, respectively. The treatments gave the highest plant survival (%) and improved the growth and yield parameters. Results showed that the levels of chitinase, peroxidase and polyphenol oxidase activities highly increased in treated bean plant compared in untreated plants.

Ajith and Lakshmidevi (2010) studied Volatile and non-volatile compounds produced from *Trichoderma* *sps.*, *Viz., Trichoderma saturnisporum*, *Trichoderma harzianum*, *Trichoderma viride*, *Trichoderma reesei* by poisoned food technique against *Colletotrichum capsici*, fungal pathogen responsible for anthracnose disease in Bell peppers (*Capsicum frutescence*). The results showed that all the selected *Trichoderma* *sps* has potential to inhibit the mycelial growth of *C.capsici*. The volatile compounds produced form all the selected *Trichoderma* species showed 30 to 67% inhibition of *C.capsici*, However non-volatile compounds or culture filtrate from *Trichoderma viride* at 3%-4% concentration shows complete mycelial inhibition of the test fungi.
Trichoderma harzianum, T. saturnisporum and T. reesei also have the ability to control growth of C. capsici by 21 to 68% at a concentration of 50% culture filtrate.

Bilal et al (2010) evaluated three bioagents (Trichoderma viride, T. harzianum and Gliocladium virens) were evaluated under in vitro and in vivo conditions against Colletotrichum lindemuthianum causing Bean Anthracnose. All the three antagonistic fungi caused significant inhibition of mycelial growth 57.45 to 69.21 per cent, maximum inhibition of mycelia growth was obtained with T. viride (69.21%) followed by T. harzianum (64.20%). Seeds treated with T. viride showed only 9.87 per cent seed borne infection as compared to 49.56 per cent in control causing 80.08 per cent reduction, followed by T. harzianum and G. virens which caused 74.88 and 68.34 per cent reduction.

Faheem et al (2010) tested six isolates of Trichoderma spp. for their ability to produce volatile metabolites against seven fungal plant pathogens viz., Fusarium oxysporum (causing chilli wilt), Rhizoctonia solani (causing sheath blight of rice), Sclerotium rolfsii (causing collar rot of tomato), Sclerotinia sclerotiorum (causing web blight of beans), Colletotrichum capsici (causing anthracnose of chilli fruit), Helminthosporium oryzae (causing brown spot of rice), Alternaria brassicicola (causing Alternaria blight of cabbage). Studies indicated that T. viride (Tv-1) was most effective in reducing the mycelial growth of F. oxysporum (41.88%), whereas, in case of R. solani T. viride (Tv-2) accounted for maximum reduction in mycelial growth (30.58%) and sclerotial production (65.65%). Volatile metabolites from T. viride (Tv-1) caused maximum reduction in mycelial growth and sclerotial production in S. rolfsii and S. sclerotiorum. Maximum inhibition of mycelial growth of C. capsici and A. brassicicola was recorded with T. viride (Tv-1), whereas, in H. oryzae, T. harzianum (Th-1) accounted for maximum reduction in mycelial growth (37.16%).
Siameto et al (2010) tested sixteen selected isolates of *T. harzianum* were tested for anatognism against five soil borne phytopathogenic fungi (*Rhizoctonia solani, Pythium sp, Fusarium graminearum, F. oxysporum f. sp phaseoli* and *F. oxysporum f. sp Lycopersici*) using dual culture assay and through production of nonvolatile inhibitors. All *T. harzianum* isolates had considerable antagonistic effect on mycelial growth of the pathogens in dual cultures compared to the controls. Maximum inhibitions occurred in *Pythium sp- 055E* interactions (73%). Since all *T. harzianum* isolates evaluated were effective in controlling colony growth of the soil borne pathogens both in dual cultures and in culture filtrates they could be tried as a broad spectrum biological control agent in the green house and under field conditions.

Vinit. K. M. (2010) screened ten strains of *Trichoderma* species against *Pythium aphanidermatum* by dual culture methods. The maximum inhibition of *P. aphanidermatum* was by *T. viride-1433* (72.0%), which was followed by *T.harzianum-4572* (69.8%), *T. viride-793* (62.1%), *T. harzianum-4532* (60.3%) and *T. virens-2194* (59.6%). The least inhibition of *P. aphanidermatum* was recorded in case of *T. harzianum-4* (38.5%) and *T. pseudokoningii- 2048(39.3%).

Živković et al (2010) evaluated antagonistic activities of five biocontrol agents: *Trichoderma harzianum, Gliocladium roseum, Bacillus subtilis, Streptomyces noursei* and *Streptomyces natalensis*, were tested in vitro against *Colletotrichum acutatum* and *Colletotrichum gloeosporioides*, the causal agents of anthracnose disease in fruit crops. Two *Streptomyces* species exhibited the strongest antagonism against isolates of *C. acutatum* and *C. gloeosporioides* with inhibitory activity of 92-99%. The results of this study identify *T. harzianum, G. roseum, B. subtilis, S. natalensis and S. noursei* as promising biological control agents, for further testing against Anthracnose disease in fruits.
Abhiniti et al (2011) Screened 13 isolates of biocontrol fungi and 4 bacterial strains were evaluated against *Rhizoctonia solani* causing Damping off disease in *Capsicum annum* L. Dual culture technique revealed that growth inhibition of the pathogen occurred soon after contact with the antagonist due to the efficient coiling process followed by a substantial production of hydrolytic enzymes. Among all the tested fungal species *Gliocladium virens* and *T. harzianum* (T8) are the most effective isolates at 25°C and inhibit *R. solani* mycelial growth by 74.82% and 73.33% respectively.

Biljana and Jugoslav (2011) studied the effect of *Trichoderma harzianum* on *Rhizoctonia solani* and make a possibility for its usage in tobacco production. At additional treatment with *Trichoderma* after use of fungicide, had a better result than fungicide alone. Furthermore, it has shown some synergistic effect with a certain fungicide. It shows that a bigger content and continuously presence of these biocontrol agent influences on an amendment the root rot disease situation. The investigations have shown that *T. harzianum* has a positive effect on reducing a disease intensity in tobacco seedlings caused by *R. solani*. So, it can be used in biological control of this pathogen.

Ephrem et al (2011) studied biocontrol potential of *Trichoderma viride*-ES1 and *Pseudomonas fluorescens*-Bak150 against potato late blight pathogen, *Phytophthora infestans*, were studied in vitro and under greenhouse conditions. The result showed that *T. viride* (AUDPC=260) and *P. fluorescens* (AUDPC=765.1) significantly (*P*<0.05) reduced the disease compared to the untreated check (AUDPC=1045). *T. viride* was found to be more efficient than *P. fluorescens* and mixed culture. No significant difference was observed between the mixed culture and the inoculated/untreated check. This study revealed that the foliar application of *T. viride*-ES1 has good potential in controlling the late blight disease of potato.

Gaigole et al (2011) reported that, Several strains of the fungus *Trichoderma* species have been found to be effective biocontrol against various soil borne plant pathogenic
fungi like Rhizoctonia solani under greenhouse and field conditions. While evaluating seed germination percentage, it was observed that, experimental set has shown 100% of seed germination ratio as compare to maximum of 71.42 % in control, which is only inoculated with *Rhizoctonia solani* using pot culture technique. While evaluating interaction of each strain against each other, at the end of incubation period, meeting area of *Trichoderma viride*-*Rhizoctonia solani* hyphae was observed under a light microscope the presence of coiling structures for wall disintegration was observed. The effect of metabolites on radial growth of *Trichoderma viride* was recorded, the percent inhibition of average growth controls was calculated as 20mm (2cm).

Mishra *et al* (2011) screened several isolates of *Trichoderma viride* selected for antagonistic screening against fungal pathogens such as *Rhizoctonia solani, Sclerotium rolfsii, Macrophomina phaseolina, Alternaria alternata, Fusarium solani* and *Colletotrichum capsici* of Moong bean (Vigna radiata). The cell free culture filtrate of *T. viride Tr 8* showed 61.5, 58.32, 63.45, 62.62% radial growth at 10% concentration against *R. solani, S. rolfsii, M. phaseolina, C. capsici* respectively. While, 20% concentration observed 100% mycelial growth inhibition.

Rajeswari and Kannabiran (2011) evaluated *in vitro* antagonistic activity of *Trichoderma viride, Trichoderma harzianum,* and *Pseudomonas fluorescens* against *Fusarium oxysporum* causing *Fusarium* wilt in Groundnut. Among them, highest percent inhibition of conidial germination was brought out by *Trichoderma viride* [89.4%] followed by *Trichoderma harzianum* [85.7%] and *Pseudomonas fluorescens* [83.15%] and inhibition of radial mycelial growth were 86.6%, 84.0%, 60.0% respectively. This inhibition is due to the volatile and non volatile metabolites and cell wall degrading enzymes produced by *Trichoderma spp.*

Sreedevi *et al* (2011) screened effective *Trichoderma* spp. for biocontrol of *Macrophomina phaseolina* the causative agent of root rot of groundnut. Among the five
isolates *T. harzianum* (T3), *T. viride* (T1) had maximum antifungal activity against *M. phaseolina* compared to the other *Trichoderma* spp. Metabolites released from *T. harzianum*, *T. viride* were tested in culture medium against *M. phaseolina*. Cell free metabolites of *T. viride*, *T. harzianum* inhibited the growth of *M. phaseolina* in vitro and appeared to be fungicidal. The inhibition varied depending on the *Trichoderma* species producing metabolites, *T. viride* inhibited fungal growth upto 69% and *T. harzianum* upto 72.7% in nonvolatile and 47%, 64.7% in volatile metabolites respectively. The medium was optimized for mass multiplication of *Trichoderma* spp. *T. harzianum*, *T. viride* were tested for their ability to protect groundnut plants from disease caused by *M. phaseolina* in pot culture experiment.

Vishal *et al* (2011) studied *in vitro* potential of *Trichoderma viride* was evaluated against ten fungal pathogens of leafy vegetables by different methods and the effect of physical parameters such as pH and temperature on *T. viride* mycelial growth was also evaluated. *T. viride* had marked significant inhibitory effect on mycelial growth of ten targeted fungal pathogens in dual culture method and slide culture method with respect to their control. Maximum percent inhibition and coiling structure were recorded in *F. moniliforme* and *S. verruculoscum*. On the other hand, in well diffusion method, *F. roesum* and *H. sativum* were found to be most susceptible to *T. viride*. Effect of pH and temperature revealed that *T. viride* had antagonistic activities under a wide range of pH and temperature.

El-Katatny and Abeer (2012) tested *Trichoderma harzianum* spore suspension and culture filtrate were tested for their antagonistic activity on controlling tomato fruit rot caused by *Alternaria* spp. Their culture filtrate inhibited pathogen spore germination possibly due to the released extracellular diffusible metabolite(s). Application of *T. harzianum* spores to tomato fruits decreased disease severity significantly with the most profound effect at higher spore concentrations (108 cells per ml). Similarly, culture filtrate of *T. harzianum* prevented pathogen spore germination on the surface of tomato
fruits leading to decreased incidence of rot symptoms at high culture filtrate concentrations. This work provides strong evidence that *T. harzianum* is a competent antagonist and its spore suspension and culture filtrate can be used efficiently to control postharvest tomato rot.

Kamala and Indira (2012) screened 114 isolates of *Trichoderma* were isolated. Out of the total isolates, 80% shows high degree of antagonism against *Fusarium oxysporum* (wilting disease of common bean) while 68% against *Rhizoctonia solani* (damping off disease of common bean). The interaction between the *Trichoderma* and fungal pathogens were examined microscopically. Several biocontrol mechanisms were studied and analysis data showed that the clearing zone diameter of protease activity of these indigenous *Trichoderma* isolates ranges from 10 to 60 mm. Among them, 84% gave high chitinase activity and their activity ranges between 10 to 85 mm. whereas, β-1,3-glucanases activity showed a clearing zone diameter ranging from 10 to 70 mm. Among all the treatments, T_{83} showed better biocontrol efficacy against the two test fungus as compared to the exotic *Trichoderma harzianum* (ITCC No. 6276) strain.

Seema and Devaki (2012) evaluated *in vitro* efficacy four fungal and one bacterial bioagents viz, *Trichoderma viride*, *Trichoderma harzianum*, *Aspergillus niger*, *Penicillium* spp. and *Bacillus subtilis* against the tobacco sore shin pathogen, *Rhizoctonia solani*. All the antagonists suppressed the formation of sclerotia. The volatile metabolite studies revealed that *T. viride* and *T. harzianum* showed 50% and 40% inhibition in mycelial growth respectively. Microscopic observations of the dual cultures revealed the inhibitory effect was caused by the hyphal interaction between the biocontrol agent and the pathogen causing lysis of pathogen hyphae. This resulted in the reduction of the mycelial growth of the *R. solani*.

**Bacterial Antagonists:**
Izhar et al (1995) reported that, the use of growth promoting bacteria *Pseudomonas aeruginosa*, strain Pa$_6$ and Pa$_{12}$ significantly (p<0.05) reduced the infection of *Macrophomina phaseolina* and *Rhizoctonia solani* and *Fusarium* spp. Infecting chickpea. P. aeruginosa strain Pa$_{12}$ was found effective against *F. oxysporum* and Pa$_6$ against *F. solani*. Combined use of *Bradyrhizobium* sp. (TAL 480) and *Pseudomonas aeruginosa* showed complete control of *R. solani* and *F. oxysporum* infection. Greater number of nodules per plant were produced where bradyrhizobia was used with strains of P. aeruginosa as compared to bradyrhizobia used alone.

Czaczyk et al (2002) studied that, the antifungal activity of *Bacillus coagulans* creates the possibility to use this microorganism in biological control of fungal plant pathogens. Activity of *Bacillus coagulans* (No 6), isolated from lupine compost, against seven pathogenic species of indicator fungi: *Bipolaris sorokiniana, Trichothecium roseum, Rhizoctonia solani, Sclerotinia sclerotiorum, Fusarium oxysporum, Fusarium solani* and *Fusarium culmorum* were examined in this work. The addition of *Bacillus coagulans* to culture of fungi resulted in inhibition of ergosterol biosynthesis in mycelium.

Saleem and Kandasamy (2002) isolated soil bacterium, *Bacillus* sp. strain BC121, isolated from the rhizosphere of sorghum, and showed high antagonistic activity against *Curvularia lunata*. A clear inhibition zone of 0.5–1 cm was observed in dual plate assay. After 10 days of incubation, the bacterial strain grew over the fungal mycelial surface and multiplied extensively on it. Scanning electron microscopic observations showed a clear hyphal lysis and degradation of fungal cell wall. In dual cultures, the *Bacillus* strain BC121 inhibited the *C. lunata* up to 60% in terms of dry weight. This strain also produced a clear halo region on chitin agar medium plates containing 0.5% colloidal chitin, indicating that it excretes chitinase. The role of the *Bacillus* strain BC121 in suppressing the fungal growth *in vitro* was studied in comparison with a mutant of that strain, which lacks both antagonistic activity and chitinolytic activity. The extra-cellular protein precipitate from *Bacillus* strain BC121 culture filtrate had significant growth
retarding effect and mycolytic activity on *C. lunata*. The protein extract from the wild strain, when tested on SDS–PAGE gel showed a unique band corresponding to the molecular mass of 25 kDa, which could be the probable chitinase protein.

Montealegre, J. *et al* (2003) isolated Bacteria from the rhizoplane and surrounding soil of healthy and *Rhizoctonia solani* diseased tomato plants and were identified as *B. subtilis* (one isolate) and *B. lentimorbus* (two different isolates) which are best bacterial strains, based on their ability to control development of Three *R. solani* isolates. All bacterial isolates resulted effective for the *in vitro* control of growth of all *R. solani* isolates, where the control mechanisms used by the bacteria do not involve the secretion of fungal cell wall hydrolytic enzymes, the mechanisms used by these bacteria are the secretion of volatile and difusible metabolites.

Dhanasekaran *et al* (2005) screened twenty six antibiotic producing *streptomyces* were evaluated for their ability to inhibit plant pathogenic *Rhizoctonia solani* causing damping off of tomato seedling *in vitro*. All isolates tested significantly reduced damping off severity in tomato. A variation in their effect on plant disease severity, percentage dead plants and plant biomass in the presence of the pathogen, was observed among the isolates. The isolates namely DPTB110 and DPTB13 showed maximum inhibition zones (17mm) against *Rhizoctonia solani*.

Mansoor *et al* (2007) isolated *Pseudomonas aeruginosa*, a plant growth promoting rhizobacterium and *Paecilomyces lilacinus*, an egg parasite of root knot and cyst nematodes inhibited the growth of *Macrophomina phaseolina, Fusarium solani* and *F. oxysporum* infecting moong bean. *Pseudomonas aeruginosa* inhibited the radial growth of *M. phaseolina, F. solani* and *F. oxysporum* by producing a zone of inhibition of 2, 6 and 10 mm respectively. *Launaea nudicaulis* @ 0.5 and 1% w/w also significantly suppressed infection by *M. phaseolina*. Use of *P. aeruginosa* alone or with *L. nudicaulis* @ 0.1% resulted in complete control of *Rhizoctonia solani* infection. pplication of PGPR
or *P. lilacinus* in combination with common medicinal weed *L. nudicaulis* holds promise for the control of root infecting fungi of mungbean.

Rachana and Shalini (2008) studied antifungal activity of different strains of *Pseudomonas fluorescens* were tested against some plant pathogens such as *Alternaria cajani, Curvularia lunata, Fusarium sp., Bipolaris sp. and Helminthosporium sp.* in *in vitro*. Out of the five strains studied, the best result was shown by A-5, which showed almost complete inhibition against pathogenic fungi such as *Curvularia lunata* and *Fusarium* sp. at 4000 and 5000 μg/mL while strain L-5 was resistant against *Fusarium* sp. and *Helminthosporium* sp. at 5000 μg/mL. Among the fungus tested, bacterial strains C-03 and Pf4-1 were found to be more sensitive to *Fusarium* sp. and *Helminthosporium* sp.

Gordillo *et al* (2009) evaluated *Bacillus* sp strain IBA 33 metabolites, isolated from decaying lemon fruits, were evaluated for the control of pathogenic and non-pathogenic fungi (*Penicillium digitatum, Geotrichum candidum, Penicillium expansum, Aspergillus clavatus, Aspergillus fl avus, Aspergillus niger, and Fusarium moniliforme*). These metabolites were recovered from Landy medium (LM) without aminoacids *A. flavus* growth inhibition was 52% with the metabolites of *Bacillus* sp strain IBA 33 recovered from LM (MBLM) *in vitro* assays. These results showed that *Bacillus* sp strain IBA 33 metabolites specificity against fungi depended on the composition of the LM.

Xin *et al* (2009) used Bacillus subtilis SY₁ and *Pseudomonas fluorescens* W1 in the experiments to determine their bioremediation effect in soil. In the eggplant planting experiment the Bacillus *subtilis* SY₁ has great antifungal effect on pathogens and the growth and stress resistance of the seedlings in the inoculated soil increased. After inoculating, the plant height, dry weight and chlorophyll content increased 56.61%, 33.55% and 40.1% respectively.
Anitha and Rabeeth (2010) tested interactions between *Streptomyces griseus* strains and some soil-borne plant pathogens (*Fusarium oxysporum, Alternaria alternate, Rhizoctonia solani* and *Fusarium solani*) and 2 isolates of *Aspergillus flavus* were studied on PDA medium. When grown in liquid medium having fungal cell walls as sole carbon source, *S. griseus* produced chitinase enzyme in the medium. The lytic enzyme production by the strain *S. griseus* were tested using cell walls of six pathogens as the sole carbon source. Maximum chitinase enzyme activity of 66.67 ± 0.0 IU/ml was observed against *A. flavus* fungal cell wall and minimum enzyme activity of 33.3 ± 0.13 IU/ml was observed in *F. oxysporum* cell wall.

Aeshah *et al* (2011) studied the effect of *Pseudomonas fluorescens* and the chemical fungicides $\alpha$-aminobutyric acid to *Fusarium oxysporum* in banana disease has to the biocontrol solution of these bacteria. Under in vitro conditions *Pseudomonas fluorescens* clearly inhibited *Fusarium oxysporum* f. sp. *cubense*. At a concentration of (50, 200, 250, 350) $\mu$g/ml BABA did not inhibited in vitro germination of conidia and mycelium growth of FOC on PDA medium.

Rakh *et al* (2011) screened 11 *Pseudomonas spp.* isolated from rhizospheric soil and evaluated for their antagonistic activity against *Sclerotium rolfsii*. Out of which *Pseudomonas cf. monteilii* 9, showed highest antagonistic activity against *Sclerotium rolfsii*. In dual cultures, the *Pseudomonas cf. monteilii* 9 inhibited the *Sclerotium rolfsii* up to 94% in terms of dry weight. *Pseudomonas cf. monteilii* 9 produced diffusible antibiotic, volatile metabolites, hydrogen cyanide and siderophore which affect *Sclerotium rolfsii* growth in vitro. This strain also produced a clear halo region on skim milk agar plates, indicating that it excretes protease which played vital role in inhibition of *S. rolfsii*. In pot assay for control of *Sclerotium rolfsii*, *Pseudomonas cf. monteilii* 9 treated seeds showed decrease in incidence of disease up to 45.45 to 66.67% in comparison to untreated seeds.
Vishal (2011) Selected *Pseudomonas aeruginosa* strains MR-2, MR- 5, MR-6, MR-9, MR-15 and MR-18 were positive for siderophore and HCN against *Sclerotina sclerotiorum* infecting tomato. All *Pseudomonas aeruginosa* strains inhibited the growth of *Sclerotina sclerotiorum* by 62-83% inhibition zone as compared to control. *Pseudomonas* MR-18 strains showed maximum inhibition of 83%. *In vitro* study revealed that *Pseudomonas* strains effectively reduced the growth of *Sclerotina sclerotiorum*.

Yazici *et al* (2011) screened Twenty three bacterial isolate out of 190, exhibiting inhibitory affects against *Alternaria solani*, causing early blight disease of tomato in vitro on nutrient agar (NA) medium and in vivo (whole plant). *In vitro* studies indicated that all the 23 bacterial isolates inhibited the mycelial growth of *A. solani* by forming inhibition zone ranging from 9.35 to 31.3 mm. *A. solani* spores suspension were applied on tomato seedlings and plants were incubated in moist chamber at 20°C with 95% relative humidity (RH) and 12 h photoperiods for 21 days. Based on the whole plant tests, *Paenibacillus macerans-GC* subgroup A (1.82) reduced the disease severity of early blight significantly when compared with control.

Alimi *et al* (2012) isolated one hundred and ninety isolates of *Pseudomonas, Erwinia* and *Bacillus* spp. were collected from phyllosphere of healthy and infected wheats.. Among them, eight isolates were selected and purified with the most antagonistic ability against the growth of pathogenic fungal species *F. graminearum* causing *Fusarium* head blight of wheat. Six single isolates and two multiple isolates were positive in production of volatile and diffusible antifungal metabolites against the fungal species *in vitro*.

Elkahoui *et al* (2012) isolated 30 bacterial strains from marine biofilms and screened for their antifungal activity against *Rhizoctonia solani causing* black scurf of potato. Two bacterial strains, *Bacillus subtilis* and *Bacillus cereus*, showed a clear antagonism against *R. solani* on potato dextrose agar (PDA) medium, and the percentage of inhibition was about 44% for the two bacteria strains. The crude extract of *B. subtilis* strain culture in
Luria-Bertani (LB) medium at 48 h of incubation showed a high antifungal activity against *R. solani* growth and no cytotoxic effect on Brine shrimp larvae.

Karimi *et al* (2012) screened 6 isolates of *Pseudomonas* and 6 isolates of *Bacillus* genera isolated against *Fusarium oxysporum* f. sp. *ciceris* causing Fusarium wilt of chickpea. Twelve isolates were selected according to their high antagonistic efficiency in *in vitro* which was shown as inhibition zones. *B. subtilis B*₂₈ isolate showed the highest inhibition percentages (51.16%) than other isolates. *B. subtilis B*₂₈ isolate produced 78.29% extracellular metabolites and *P. aeruginosa P*₁₂ produced 26.35% volatile compounds. These isolates were more than other isolates had, higher inhibition against hyphal pathogen.

Suparman *et al* (2012) tested bacteria isolated from soil, rhizosphere and roots of tomato and other solanaceous plants were tested for their antagonistic effect against *Fusarium oxysporum* f.sp. *lycopersici* (*Fol*) *in vitro*. Out of seven isolates two isolates with potential for controlling *Fol, Burkholderia cepacia* and *Pseudomonas aeruginosa* *(F1)*, were selected for further screening and evaluation. These pathogens significantly inhibited the growth of *Fol in vitro* with percentage inhibition in radial growth of 35.24% and 39.52% respectively.

**Biological control through plant extracts:**

Nwachukwu and Umehuruba (2001) studied efficacy of leaf extracts of basil (*Ocimum basilicum*), bitter leaf (*Vernonia amygdalina*), lemon grass (*Cymbopogen citratus*), neem (*Azadirachta indica*) and paw-paw (*Carica papaya*) on major seed-borne fungi: *Aspergillus niger*, *Aspergillus flavus*, *Botryodiplodia theobromae* and *Fusarium moniliforme* of African yam bean (*Sphenostylis stenocarpa*) seeds, and on seed germination and seedling emergence *in vitro* and in vivo. All the plants leaf extracts (crude and aqueous) significantly (*P* ≤ 0.05) reduced the incidence of seed-borne fungi
tested and increased seed germination and seedling emergence except lemon grass leaf extract when compared with the untreated control. Neem extract was the most effective while lemon grass extract was the least.

Ramezani et al (2002) studied the effect of volatile oils from *Eucalyptus citriodora* and its major constituent citronellal against two well-known rice pathogens, *Rhizoctonia solani* and *Helminthosporium oryzae*. A complete inhibition of *R. solani* and *H. oryzae* was observed at 10 and 20 ppm, respectively. Based on the study, it was concluded that eucalypt volatile oils have potential for the suppression of phytopathogenic fungi.

Okemo et al (2003) tested *in vitro* extracts of *Maesa lanceolata* var. *goulungensis* weir against a broad range of fungal plant pathogens such as *Phytophthora cryptogea*, *Trichoderma virens*, *Aspergillus niger*, *Phoma sp.*, *Fusarium oxysporium*, *Pythium ultimum*, *Cochliobolus heterostrophus*, *Rhizoctonia solani*, *Sclerotium rolfsii* and *Pyrenophora teres*. *M. lanceolata* extracts were very active against all the pathogens tested except *P. ultimum* and *R. solani*.


Odebode (2006) tested antagonistic activity of culture filtrates from *Trichoderma harzianum* Rifai and *Trichoderma pseudo-koningii* Rifai strains against post-harvest pathogens of some fruits *In vitro*. The undiluted culture filtrates of the two *Trichoderma* species completely inhibited germination of conidia/spores of all the rot pathogens, but 50% dilution showed varying degree of inhibition of spore germination. *T. pseudo-koningii* culture filtrate had a rather moderate to strong inhibitory effect on mycelia of the
pathogenic fungi. The highest per cent inhibition of 45.6% of mycelial growth was recorded for *Aspergillus niger* Tiegh.

Sanjay and Ashok (2006) used lipophilic (dichloromethane) leaf extract of medicinal plants against *Alternaria alternata* and *Curvularia lunata* as a test organism in bioautography. Results indicate that five plant species, among the 12 investigated, showed antifungal activity. CHCl$_3$-CH$_3$OH (1:9, v/v) was used as a solvent to develop silica gel TLC plates. Clear inhibition zones were observed for lipophilic extracts of *Vitex negundo* (RF value 0.85). The best antifungal activity was shown by lipophilic leaf extract of *T. orientalis*.

Abass (2007) studied the effect of different concentrations of Henna (*Lawsonia inermis*) leaves extracts on some plant pathogenic fungi which were *Fusarium oxysporum* f.sp. *melonis*; *Thielaviopsis paradoxa*; *Rhizoctonia solani* and *Maugiiniella scaettae*. Results showed the high antifungal activity of extracts was evident with high concentration of extract (300 ppm), which completely inhibited the radial growth on both solid and liquid media (PDA and PD Broth) of the pathogens. was evident with high concentration of extract (300 ppm), which completely inhibited the radial growth on both solid and liquid media (PDA and PD Broth) of the pathogens. the results proved that radial growth of R. solani was 140 ppm, the extract had no effect on the cabbage seeds germination when treated with 5ml of crude extract, and the germination percentage was 80%, while at was 83% in control treatment.

Basem and Amjad (2007) studied the inhibitory effect of extracts from five jordian medicinal plants against five plant pathogenic fungi. The highest growth inhibition of all fungi was found with *Achillea santolina* at 1000ppm, which gave 42.2 and 42.0% of inhibition with *Fusarium oxysporum* and *Rhizoctonia solani*, resp. and the lowest were *Micromeria nervosa* and *Ballota philistaea* which gave 3.6 and 3.5%, resp. against
Penicillium sp. He concluded that the medicinal plants used in the study are a promising source of antifungal compounds.

Irkin and Korukluoglu (2007) showed antifungal activity of “Allium” vegetables that is garlic (Allium sativum L.), onion (Allium cepa L.) and leek (Allium porrum L.) were tested against Aspergillus niger. Minimal inhibitory concentrations (MIC) and minimal fungicidal concentrations (MFC) of aqueous, ethyl alcohol and acetone extracts were determined by disc diffusion and broth dilution methods in the test tubes. Onion extract with ethyl alcohol (275 mg/mL MFC), aqueous garlic extract (325 mg/mL MFC) and aqueous leek extract (900 mg/mL MFC) found the most inhibitory against A. niger.

Pramila et al (2008) screened twenty-six essential oils against Botrytis cinerea causing grey mould of grapes, the essential oils of the ten plants viz. Chenopodium ambrosioides, Eucalyptus citriodora, Eupatorium cannabinum, Lawsonia inermis, Ocimum canum, O. gratissimum, O. sanctum, Prunus persica, Zingiber cassumunar and Z. officinale were found to exhibit absolute fungitoxic activity (100% growth inhibition). The oils did not exhibit any phytotoxic effect on the fruit peel. Therefore, the oils could be recommended as a potential source of ecofriendly botanical fungicide, after long term and wide ranging trials.

Chen et al (2008) collected 18 species of five genera of Zingiberaceae plants from Taiwan area and analyzed for their functional properties. Methanolic extracts of the plants were analyzed for their total phenol compounds, α , α -diphenyl- β –picrylhydrazyl (DPPH) scavenging activity, and reducing power. Antimicrobial activity of these samples was also determined. The results showed that the total phenol compounds of the Alpinia genus averaged 17, 30 mg/g for Curcumis, and the highest, 36.5 mg /g for Vanoverberghia sasakiana.
Çıkrıkçı *et al* (2008) reported curcumin is the most important fraction of turmeric which is responsible for its biological activity. In this study, isolation and biological assessment of turmeric and curcumin have been discussed against standard bacterial and mycobacterial strains such as *E. coli*, *S. aureus*, *E. feacalis*, *P. aeuroginosa*, *M. smegmatis*, *M. simiae*, *M. kansasii*, *M. terrae*, *M. szulgai* and the fungi *Candida albicans*. The antioxidant activity of curcumin and turmeric were also determined by the CUPRAC method.

Ismaiel (2008) studied the inhibitory effects of aqueous garlic extract on growth and penicillic acid production of *Penicillium hirsutum*. Minimal inhibitory concentration (MIC) of the aqueous garlic extract was determined by the agar diffusion assay and it has been found to be 30 mg/ml. observed the increase in garlic concentration induced a reduction in the levels of penicillic acid production when fungus grown in broth. The amount of penicillic acid in presence of 24 mg/ml of garlic was approximately 44% of that present in control culture filtrate after 10 days of incubation, however penicillic acid was not detected completely at the same garlic concentration after 7 days of incubation. This is the first report on inhibition of penicillic acid production by a natural substance like garlic extract.

Riaz *et al* (2008) tested Antifungal activity of different concentrations of leaf extracts of wheat, maize, sunflower, chilies, onion, and marigold against *in vitro* growth of *F. oxysporum* f.sp. *gladioli* (Massey) Snyd. & Hans. causing corms of gladiolus (*Gladiolus grandiflorus sect. Blandus*) cv. Aarti. Extract of marigold, sunflower and chilies were found highly effective where all the employed extract concentrations significantly reduced fungal biomass by 54-79%, 33-85% and 45-57%, respectively.

Shahnaz *et al* (2008) tested fungicidal activity of 16 spices *In vitro* against root rot fungi viz., *Fusarium solani*, *Rhizoctonia solani* and *Macrophomina phaseolina* using paper disc and well methods. Ethanol extract of spices was more effective in the control of root
rot pathogens as compared to aqueous extract whereas 100% w/v aqueous extracts were more effective than 50% w/v aqueous extract.

Uzma et al (2008) extracted Essential oils from the seeds of neem (Azadirachta indica), mustard (Brassica campestris), black cumin (Nigella sativa) and asafoetida (Ferula assafoetida) for their antifungal activity @ 0.5, 0.1 and 0.15% against eight seed borne fungi viz., Aspergillus niger, A. flavus, Fusarium oxysporum, F. moniliforme, F. nivale, F. semitectum, Drechslera hawiinesis and Alternaria alternata. Of these oils, Asafoetida oil @ 0.1% and 0.15% significantly inhibited the growth of all test fungi.

Yasmin et al (2008) selected Fifty five angiospermic plants for evaluating the effect of their aqueous extracts on the in vitro vegetative growth of Fusarium moniliforme Sheldon. Extracts of 17 plants showed varied degrees of inhibitory effects on the test pathogen. For instance the leaf extract of Lawsonia inermis showed maximum inhibition (60.65 %).

Fawzi et al (2009) studied the antifungal activity of 5 plant extracts in either cold distilled water (CDW) or boiling (BDW) against two pathogenic fungi, Alternaria alternata and Fusarium oxysporum. results revealed that plants extracts especially those performed with CDW had a strong antifungal activity with significant inhibition on the growth of the 2 tested fungi and their hydrolytic enzymes, β-glucosidase, pectin lyase and protease. Halfa barr, which was found to be the most efficient extract (75% inhibition), might be a promising material for controlling these fungi.

Singha et al (2009) collected fourteen medicinal plants belonging to 13 families were extracted with petroleum ether (PE), chloroform, methanol and water to yield 60 crude extracts. Using agar diffusion method, these extracts were evaluated for antifungal activity on the growth of five phytopathogenic fungi. Among all the extracts tested, PE,
chloroform and methanol extracts of *Piper betle* L. and PE and chloroform extracts of *Allamanda cathartica* exhibited promising antifungal activity.

Akinbode (2010) studied The efficacy of leaf extracts of *Gliricidia sepium, Tithonia diversifolia, Phyllanthus amarus* and *Morinda Lucida in vitro* to control *Curvularia lunata* causing leaf spot of maize. All the extracts at 100% concentration significantly suppressed the growth of *C. lunata* (P< 0.05). At all concentrations, *P. amarus* is most efficacious and *G. sepium* was the least effective of all the plant extracts against *C. lunata*.

Al-Askar and Rashad (2010) tested Antifungal activity of ethanol-water extracts of four medicinal plants, cinnamon (*Cinnamomum verum Presl.*), anise (*Pimpinella anisum* L.), black seed (*Nigella sativa* L.) and clove (*Syzygium aromaticum* L. Merr. & Perry.) was investigated against pea (*Pisum sativum* L.) root-rot fungus *Rhizoctonia solani*. The highest antifungal activity was recorded for clove extract which causes complete growth inhibition (100%) at concentration of 1% . Clove extract at concentration 4% as well as the chemical fungicide recorded highly significant increase in the percentage of survived plants (40 and 48%, respectively) and highly significant decrease in disease incidence.

Aqsa *et al* (2010) reported the antifungal activity of plant diffusates from 5 indigenous medicinal plant species of Potohar region. Antifungal activity was tested against 3 pathogens attacking commercial crops viz., *Alternaria solani, Rhizoctonia solani* and *Macrophomina phaseolina*. Overall, *Dodonaea viscosa* appeared significantly the most effective and suppressed the radial mycelial growth of the *Alternaria solani* and *Rhizoctonia solani*, whereas, *Adhathoda zeylanica* exhibited maximum inhibition (77.44%) against *Macrophomina phaseolina*. Among 5 concentrations of plant diffusates, the highest inhibition in radial mycelia growth of all 3 pathogens was observed at 100 and 200g/l respectively.
El-Baroty et al (2010) obtained Essential oils from the bark of Cinnamomum zeylanicum (cinnamon) and the rhizomes of Zingiber officinale (ginger) were characterized by analytical TLC and GC/MS, and their antimicrobial and antioxidant compounds were detected by TLC-bio-autography assays. CEO and GEO oils showed significant inhibitory activity against selected strains of bacteria and pathogenic fungi (Aspergillus niger, Penicillium notatum, Mucora heimalis and Fusarim oxysporum), with MIC values ranging from 20 to 120 µg/ml depending upon the microbial species.

Olusanmi and Amadi (2010) evaluated the antimicrobial properties of garlic (Allium sativum) extracts on three fungi namely Aspergillus flavus, Curvularia lunata and Fusarium moniliforme using the pour plate method. At the highest concentration (40ml extract: 120ml molten agar) tested in this study, all the extracts inhibited growth completely in all the test fungi. The test organisms differed in their reaction to the different extracts but on the whole, growth inhibition increased with the concentration of each extract.

Seema and Devaki (2010) tested the effect of 12 essential oils for fungicidal properties against Rhizoctonia solani - the causal agent of sore shin disease of tobacco by poisoned food technique. Essential oil of cinnamon was found most effective, as it recorded complete inhibition of the pathogen at 500 ppm.

Suleiman (2010) observed in vitro fungitoxic activity of crude extracts of neem (Azadirachta indica) (A.) Juss) and pawpaw (Carica papaya) (L.) on Alternaria solani, causing yam rot. The results showed that the methanolic extracts had fungitoxic components that retarded the mycelia growth and of course the disease incidence. The mean percentage inhibition value significantly (P#0.05) higher in case of pawpaw than neem. The inhibitory action of the extracts on mycelia growth increased with increase in concentration.
Ambikapathy et al (2011) studied the antifungal activity of five different medicinal plants namely *Lawsonia inermis* L, *Mimosa pudica* L, *Phyllanthus niruri* L., *Tephrosia purpura* Pens., *Vinca rosea* L. were tested against plant pathogenic fungi *Pythium debaryanum* (causing damping off of disease) by agar well diffusion method. The plant leaves were extracted with various solvents like n-butanol, methanol, aqueous. Among the different plant tested, all the three solvents, the methanolic extracts of *Lawsonia inermis* showed maximum antifungal activity against *Pythium debaryanum*.

Ankita and Kanika (2011) recorded leaf extracts of *Lawsonia inermis* Linn. and *Eucalyptus citriodora* Hook. against 10 plant pathogenic and 2 human pathogenic fungal species. Acetone extract of *L. inermis* leaves and Petroleum ether extract of *E. citriodora* leaves showed highest activity against all tested fungi.

Bahramejad et al (2011) screened 63 plant species belonging to 23 families collected from the west of Iran were screened for antifungal activity against three economically important phytopathogenic fungi, *Cochliobolus sativus*, *Fusarium oxysporum* and *Rhizoctonia solani*. Among them 16 (25%), 10 (16%) and 16 (25%) tested plant species inhibited the mycelial growth of *R. solani*, *F. oxysporum* and *C. sativus*, respectively. According to these results, we conclude that the flora in the west of Iran can be regarded as a rich source of plants with antifungal activity.

Dellavalle et al (2011) evaluated the antifungal activity of extracts of 10 plant species against the phytopathogenic fungus *Alternaria* spp. Three solvents were assayed on different tissues of the plants and among the 29 evaluated extracts, 31% of the extracts inhibited growth. The MIC values ranged from 1.25 to 25.0 µg mL-1 and MFCs values ranged from 1.25 to 10.0 µg mL-1 The extracts of *Salvia sclarea*, *S. officinalis* and *R. officinalis* could be considered as potential sources of antifungal compounds for treating diseases in plants.
Deepika and padma (2011) tested the efficacy of two common weed i.e. *Lantana camara* (Lantana) and *Parthenium hysterophorus* (Congress grass) against *Alternaria* spp. Which is responsible for causing different plant diseases especially in vegetable plants such as tomato, potato, brinjal etc. Maximum inhibition was seen in *Lantana camara* at 20mg/ml concentration and at the same concentration *Parthenium hysterophorus* showed little less inhibition than *Lantana camara*. Thus they concluded that the antifungal components from these plants can be used as an alternative to develop noval fungicides by replacing some chemical commercial antifungal for the disease cause by *Alternaria* spp.

James (2011) studied *in vitro* effects of two fungicidal plants (*Zingiber officinale* and *Ocimum gratissimum*) against *Fusarium oxysporum* and *Botrydioploidia theobromae* and *Aspergillus flavus* causing post harvest yam (*Dioscorea rotundata* Poir) rot. The two concentrations of aqueous and ethanol extracts were found to have inhibitory effects on all the rot fungi isolated from yam, 80% aqueous extract of *Zingiber officinale* inhibited *Fusarium oxysporum* to 66.70%, 80% aqueous extract of *Ocimum. gratissimum* inhibited *Botrydioploidia theobromae* to 60.00% also 73.33% inhibition of *Aspergillus flavus* was recorded using 30% ethanol extract of *Zingiber officinale*, the same concentration of *Ocimum gratissimum* inhibited *Aspergillus niger* to 70.00%.

Lalitha *et al* (2011) showed Antifungal activity of aqueous (10-50% concentration) and solvent extract (500µl and 1000µl concentration) of *Polyalthia longifolia* against ten seed borne fungi of paddy (*Oryza sativa. L*) *in vitro* condition. In aqueous extract, *A. alternata* recorded a maximum inhibition of 92.88% and least inhibition recorded in case of *D. tetramera* (83.02%) at 50% concentration compared to synthetic fungicide, Dithane M-45, Captan, Benlate, Thiram and Bavistin at 2% recommended dosage. In solvent extract petroleum ether extract recorded a complete and maximum inhibition in all the test fungi at 1000 µl concentration.
Murugesan *et al* (2011) antifungal activity of eleven different medicinal plants namely *Aloe vera, Alpinia calcarata, Acalypha indica, Carum copticum, Leucas aspera, Ocimum sanctum, Piper betle, Phyllanthus niruri, Solanum trilobatum, Memecylon umbellatum* and *Tridax procumbens* were tested against plant pathogenic fungus *F. oxysporum*. Among the different plants tested, all the 3 solvent extracts of the *Memecylon umbellatum* showed maximum (21 mm) antifungal activity against the plant pathogen tested. Whereas the other plant extracts were showed moderate to minimum antifungal activity.

Pawar (2011) tested various plant parts against five seed-borne pathogenic fungi *in vitro*. Leaf extracts of 18 plants were screened against 5 seed-borne pathogenic fungi viz. *Alternaria alternata, Aspergillus niger, Curvularia lunata, Fusarium moniliforme* and *Trichoderma viride*. Out of 18 leaf extracts, 9 leaf extracts showed antifungal activity. The extract of *Azadirachta indica* showed maximum activity (Mean activity zone 22.996 mm); while minimum activity was observed with *Holoptelia integrifolia* (Mean activity zone 14.996 mm) against the fungi under investigation.

Prince and Prabakaran (2011) tested the antifungal activity of eight different medicinal plants namely *Aloe vera, Ocimum sanctum, Cenetella asiatica, Piper betle, Calotropis gigantea, Vitex negundo, Ocimum basilicum* and *Azadirachta indica* were tested against plant pathogenic fungus (red rot disease causing agent) *Colletotrichum falcatum* by agar well –diffusion method. The plants leaves were extracted with various solvents like chloroform, ethanol and aqueous. Among the different plant tested, all the three solvents of the *Vitex negundo* showed maximum antifungal activity (25 mm) against the plant pathogen tested. Whereas the other plant extracts were showed moderate to minimum antifungal activity.

Ramteke and Kamble (2011) evaluated 8 phytoextracts against *Fusarium solani* (Mart.) Sacc. causing rhizome rot of ginger (*Zingiber officinale* Rosc.). Out of which alcoholic leaf extracts of 6 plants had 100 % control efficacy (PCE) against both sensitive and
resistant isolates of *Fusarium solani* at 25% concentration. The aqueous leaf extracts of all the tested plants were also inhibitory, but it was with less than 100 PCE.

Thippeswamy et al (2011) investigated the antimicrobial efficacy of six different solvent extracts and isolated constituents of *Samanea saman* (Jacq.) Merr. against 21 microorganisms. The highly significant antifungal activity against all the fungi was observed in methanol extract with percentage of inhibition ranging from 20.4% to 81.6% depending upon fungal species at 1mg/ml concentration. Among the tested fungi, *Fusarium moniliforme* (IC50 0.3mg/ml) was highly sensitive and *Aspergillus tamari* (IC50 5mg/ml) was least sensitive.

Sallam et al (2012) tested the antimicrobial activity of six plant extracts for controlling *Alternaria solani in vitro and in vivo*. In *in vitro* study the leaf extracts of *D. stramonium*, *A. indica*, and *A. sativum* at 5% concentration caused the highest reduction of mycelial growth of *A. solani* (44.4, 43.3 and 42.2%, respectively), while *O. basilicum* at 1% and 5% concentration and *N. oleander* at 5% concentration caused the lowest inhibition of mycelial growth of the pathogen. The greatest reduction of disease severity was achieved by *A. sativum* at 5% concentration and the smallest reduction was obtained when tomato plants were treated with *O. basilicum* at 1% and 5% concentration (46.1 and 45.2%, respectively). *D. stamonium* and *A. sativum* at 5% concentration increased the fruit yield by 76.2% and 66.7% compared to the infected control.