Chapter 3

REVIEW OF LITERATURE

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REVIEW OF LITERATURE

In ancient period plants were used extensively for medicinal and pesticidal purposes. Now a day extensive use of chemical pesticides created several problems like toxicity to all living organisms, destruction of beneficial organisms, and development of resistance by insect and pathogens etc. Thus the ecological hazards caused by the chemical pesticides are posing a great threat to that biosphere. Amongst the several materials available, plant extracts offered greater scope than rest as they are readily available, relatively safe, economical, easily biodegradable and ecofriendly. Hence in present studies efficacy of plant extracts has been tested In vitro and In vivo. It constitutes economical and safe methods of controlling plant diseases and plant pathogens.

Considerable work has been done by different researchers on antifungal properties of certain plant extracts against some fungi, extraction of Azadirachtin from neem seeds. In plant disease control, fungicides by and large are used to prevent infection, caused by the fungi, to do so, it will not repair the damage already done, but it may prevent further spread of the disease. Control by the use of chemicals has met with considerable success but they are costly and cause environmental pollution too.
This chapter deals with the review of research work done by different scientists on the effect of some plant extracts for management of plant pathogens. The major emphasis has been made on the work done on microbicidal properties to support the findings to the present investigation. The review of literature is classified under various heads.

3.1. Crop yield status

In India, cotton is cultivated in different states. The crop covers 8.76 million hectare area on national level, 31-lakh hectare area on state level with the production of cotton 116.44 lakh tonnes on national level and 4.4 lakh tones on state level, which the average yield was 226 kg/ha (Anonymous, 2002).

In India, per capita availability of pulses has gone down 64 g in 1951 to 36-40 g in 1980-81 and further shrink to 32 g in 2000 A.D. Minimum requirement of 80 g/day/capita for balanced nutritional standard due to increase in population and low per hectare yield (Lal and Sachin, 1987). Population growth and increased degree of protein nutrition in Indian diet call for increasing production of pulses. To make India nutritionally secure, at least 20 million tonnes of pulses would be required by 2005, which is expected 23.3 million tones by 2010 (Anonymous, 2001a).

The area under this crop during 1999-2000 was 2.89 million hectare with a production of 1.10 million tonnes with an average productivity of 310 kg/ha. While in Maharashtra, green-gram in Kharif season taken as a sole or mixed crop with sorghum, pigeonpea and maize. The area under this was 657.3 lakh hectare and production was 306.1 lakh tonnes with an average productivity of

The productivity potential of tomato is considered to be as 30 tonnes per hectare (Singhal, 1996). The total area under tomato cultivation in India is about 0.50 million hectare with an annual production of 8.5 million tonnes. The unit productivity in India is 17 tonnes per hectare (Anonymous, 2002a). In Maharashtra, this crop occupies an area of about 30,620 hectare with 4.87 lakh tonnes of production (Anonymous, 2002b).

3.2 Commonly hunted plant diseases of Cotton, Green-gram and Tomato in Akola Region.

Scheffer (1952) reported the production of wilt in tomato infected by *Fusarium* pathogen. He proved that reaction of plants in various stages of diseases indicated that blocking was the immediate cause of wilt. Walker (1952), noticed thirty three fungal, five bacterial and thirteen viral diseases of tomato along with twenty physiological disorders. Amongst the fungal diseases twenty fungi are reported to cause diseases of foliage, stem and fruit.

Stem break/root rot disease of cotton caused by fungus *Macrophomina phaseolina* (*Rhizoctonia bototicola*) is one of the most serious disease of cotton in India (Kulkarni *et al.*, 1958; Kanerley, 1992; Shrinivasan, 1994). The fungi and bacteria associated with cotton seeds deteriorate the milling quality (Ashworth, *et al.*, 1968) in terms of production of toxins like Alfa-toxin. Similarly Wiles (1968), found that fungi and bacteria associated with seeds are known to reduce the germination.
Phillp et al., (1969), studied that Rhizoctonia botriticola pathogen associated with mung infects the roots hypocotyl region and leaf. Rawal and Bedi (1976) observed the incidence of leaf spot caused by Cercospora canescans of mung-bean was very severe under low temperature (14°C) and humidity (85%). Gadge and Patil, (1977), reported that the Curvularia lunata was responsible for causing leaf spot disease in cotton by inoculation of seeds. Rhizoctonia botriticola causes severe blight of mung-bean foliage at 30 – 35°C and high humidity (Grover and Sakuja, 1981).

Mishra et al., (1984), observed that the leaf spot, vein blight, black arm and boll rot is a serious and devastating disease of cotton causing considerable yield losses in cotton. Similar observations were given by (Meshram and Sheo Raj, 1986). Grey mildew of cotton caused by Ramularia areola (Aik) is the major disease for hirsutum particularly on desi cotton. It’s severity results in complete defoliation and reduction in yield.

Sheo Raj et. al., (1989), showed that the bacterium attacked all the above ground parts causing various types of disease symptoms. Due to this disease leaf fall occurs and when bolls are affected reflects in poor quality of lint, thus ultimately reducing the yield and quality. Losses up to 20.7 to 44.8% have been recorded in hirsutum cotton in Vidarbha. Narula et. al., (1990) reported that the disease of cotton is aggravated with number of application of synthetic pyrethroids.

The disease in cotton has four phases i.e. angular leaf spot, vein blight, black arm and boll rot (Singh et. al., 1990). The stem break/root rot
disease of cotton is found in India and other cotton growing areas of the world (Kenerley et al., 1992).

Sheo Raj (1992), observed that amongst diseases of cotton bacterial blight plays an important role in Vidarbha region. Since it is identified as key disease of the region, affecting the crop in leaf, vein, arm and boll phases. Shrinivasan (1994), reported that the bacterial disease of cotton was first studied by Yamaguchi et al., (1992), showed that an isolate MT0062 from tomato roots induced supresiveness to tomato wilt caused by Fusarium oxysporum f. sp. lycopersici. Thakur and Khare (1991) noted that the disease intensity of Colletotrichum dematium was positively correlated with RH and rainfall and negative with maximum and minimum temperature.

Shrinivasan (1994), also reported the efforts to test the efficacy of some plant extracts as herbal plant protection against bacterial blight caused by Xanthomonas campestris PV malvacearum, a major disease of cotton in India. Under various climatic conditions Colletotrichum lindemuthianum disease incidence showed a highly positive correlation with temperature and negative correlation with RH and rainfall (Cherry et al., 1994).

Gahukar (1996), studied that the very high disease incidence by Rhizoctonia botaticola pathogen among mung and tomato. The tomato crop suffers from many diseases i.e. damping off, late blight, early blight, Fusarium wilt and Verticillium wilt, out of which Fusarium wilt is one of the most prevalent and damaging disease of tomato caused by Fusarium oxysporum.
Kale and Mahakal, (1996) considerable losses to tomato crop through younger leaves drop down by wilt. *Fusarium oxysporum* is the causal organism that had caused wilting in tomatoes.

Cotton crop is subjected to several fungal diseases. Chattannavar *et al*., (2000a) and Chattannavar *et al*., (2000b) studied that *Alternaria* blight caused by *Alternaria macrosora* and grey mildew caused by *Ranularia areola* was found to be severe diseases and also limiting the successful yield. Patil *et al*., (2001) noticed that the considerable yield losses in cotton crop is due to some serious and devastating diseases such as leaf spot, vein blight, black arm and boll rot. Patil *et al*., (2002), confirmed that the bacterial blight and grey mildew are the major and predominant disease of cotton in Vidarbha region.

Amongst the various factors affecting cotton yield, the foliar diseases are important one. Chattannavar *et al*., (2002) showed that the different pathogens are responsible for different diseases, out of which Bacterial blight and Grey mildew are major ones and causing heavy losses in yield of cultivated cotton.

### 3.3 Typical bacterial and fungal symptoms associated with Cotton,

**Green-gram, Tomato with losses evaluated in plant growth**

Severe infection causes pre-mature defoliation and severe yield loss. Losses have been reported to the tune of 24-27% and 47-50% in pea (Munjal *et al*., 1963; Shukla *et al*., 1976). Bedi *et al*., (1969), noted that the fungus was responsible for pre-emergence mortality and also causing defoliation in cotton plants.
Sakura (1974), recorded that infection of *Rhizoctonia botanicola* on mung causing leaf blight disease.

Chopra *et al.*, (1975), observed that the 25 microorganisms can attack on cotton seeds which included the species of *Alternaria, Aspergillus, Curvalaria, Cephalophora, Colletotrichum, Cladosporium, Fusarium, Helminthosporium, Myrothecium, Mucor, Rhizopus, Rhizoctonia, Scedonia, Verticillium* and *Xanthomonas*. The *Microphomina phaseolina* is a pathogenic to cotton and fungus caused leaf spot and root rot reported by Shrivastav and Mar (1976). The symptoms of *Myrothecium roridum* were found on cotyledons of cotton seedlings (Dake, 1980).

Beniwal *et al.*, (1983), observed the natural occurrence of anthracnose of green-gram caused by *Colletotrichum capsici*. Symptoms were characterized by production of small, circular, brown spot on leaves which later developed into dark brown sickle shaped or circular to irregular spots in concentric fashion, with grey coloured centers. Spot portion often become papery and fall off, the leaves produce a short hole. Bashan (1984), noted that *Alternaria microspora* from cotton seeds was transmissible from seed to plant.

Mayee and Datar (1986), reported that the first symptom in cotton, angular leaf spot or black arm is initially green, round, water soaked, translucent spots of different sizes appear on the under surface of cotyledons. Eventually infection penetrates to upper side of leaves and appears as angular or irregular and also brown to black lesions were found between veins and along main
leaf vein. Infected area dried-up becomes sunken and radish brown, lesions also
develop on petioles.

Mayee and Datar (1986) also observed that bacterial pustule
is caused by the causal agent *Xanthomonas campestris* and the root rot of cotton is
causd by *Rhizoctonia botanicola*. The chief symptom is a sudden and complete
wilting of plants.

reported 70% and Naik, (2000) recorded 32.45 % yield loss in green-gram due to
powdery mildew. Poor plant protection was the main factor behind low productivity
(Anonymous, 2001). Similarly they also reported that losses in yield due to bacterial
blight during year 2001, was near about 34.33% and the collective loss in protected
and unprotected area was 26.99% in India.

3.4 **Antifungal and antibacterial properties of plant extracts**

Literature on ancient system of medicine in India and on the
present day medical science abounds in instances of effective and gainful use of
plant extracts for control of human ailments. For a cheap and economic control of
plant diseases, use of plant extracts could be quite promising. In plant disease
control, fungicides by and large are used to prevent infections caused by the fungi.
To do so it will not repair the damage already done, but it may prevent further
spread of the disease. Control by the use of chemicals has met with considerable
success but they are costly and cause ecological hazards besides toxic effects to
mankind and animals.

Accordingly, neem leaves, neem seed kernals, neem oil, Ipomoea cornea leaves, and root, vinca rosea leaf, and root. Eucalyptus globulus leaf, Datura meta leaves, Punica granatum leaf, and Parthenium hysterophorus are reported to posses medicinal properties.

A total of about seventy three plant extracts were tested to study the antifungal and antibacterial activities by Sproston et al., (1948). It was noticed that the majority of plant extracts were effective against Sclerotinia fructicola, Colletotrichum lindemuthianum and Rhodotorula glutinis. They also reported that extract of pulp and skin of ripe banana effectively inhibits the growth of fungi, Fusarium oxysporum and Fusarium lycopersici.

Bhatnagar et al., (1961) tested three hundred fifty one different plants to study the antifungal and antibacterial activities, and noticed that thirty six plant extracts were effective against Helminthosporium sativum causing seedling blight and root rot of wheat. The summery about those plants constituents having antimicrobial and antiparasitic activity was given by Sehgal (1961). He also studied the chemistry of those antifungal substances closely related to synthetic work. Fruit rind extract of Punica granatum had strong fungicidal actions (Janardhan et al., 1963).

Smale et al., (1964), carried out extracts in water : ethanol : acetone in 1:1:1 proportion of leaves, stem, flower and fruits of one hundred twenty
five plants and tested the \textit{In-vitro} antifungal activity against different fungi. Bergman (1966), found that, skin of young tulip contains an antifungal substance that inhibits the growth of \textit{Fusarium oxysporum}.

Some plant extracts and exudates i.e. \textit{Neem} (\textit{Azadirachta indica} L.) \textit{Beshram} (\textit{Ipomea cameajaca}) \textit{Kanher} (\textit{Nerium odorum} L.), \textit{Sadafuli} (\textit{Vinca rosea} L.), \textit{Pomegranate} (\textit{Punica granatum}) \textit{Nilgiri} (\textit{Eucalyptus globulus}). \textit{Parthenium} (\textit{Parthenium hysterophorus} L.) \textit{Datura} (\textit{Datura metal} L.) having antifungal and antibacterial properties were reported by Fawcett and Spencer (1966). Similar reports on the antifungal activities of plant extracts were given by Nene \textit{et al.}, (1968).

The root extract of \textit{Plumbago zeylanica} against \textit{Aspergillus niger} was found to be fungitoxic (Bhakuni \textit{et al.}, 1969). The antifungal properties of plant extracts as well as inhibition of spore germination were studied by Shekhawat and Prasad (1971). Khanna and Chandra (1972), also tested fourteen plant species to study the antifungal activity. Only the leaf extracts of \textit{Piper betle} and \textit{Azadirachta indica} showed antifungal activity and inhibits the growth of \textit{Alternaria alternata}.

Bambode and Shukla (1973), tested about thirty six plant extracts for their fungitoxic property against six phytopathogenic fungi namely \textit{Curvularia lunata}, \textit{Alternaria tenuis}, \textit{Helminthosporium sativum}, \textit{Helminthosporium spectrum}, \textit{Fusarium moniliforme} and \textit{Rhizoctonia botaticola}. They observed that some plant like \textit{Punica granatum} and \textit{Plumbago zeylanica} in aqueous and alcoholic solvents showed fairly good fungicidal action, while other plants found to show fungi toxicity.
Disease resistance in some plants is due to the presence of chemical substances in host tissue toxic to specific pathogen (Walker, 1937, Link, 1929 and Ramsey et al., 1946). The studies of the extracts of seventy one commonly occurring plants were carried out for their antimicrobial activity by Sheikh and Agnihotri (1977). They found that leaf extracts of Azadirachta indica gave maximum inhibition of mycelial growth of Helminthosporium species and Colletotrichum papayee. The extract form of Punica granatum completely inhibited the spore germination of Drechslera rostrato and Curvularia lunata (Charya et. al., 1979).

The aqueous extracts of different parts of many plants were tested against Fusarium oxysporum, Alternaria alternata. It was noticed that the extracts of onion, and garlic completely inhibits the spore germination (Kumar et. al., 1979). It was also noticed by Mishra and Dixit (1980) that ether extract of Rumunculus sceleratus leaves exhibited significant antifungal activity against Alternaria tenuis, curvularia lunata, Fusarium nivale and Helminthosporium gramineum.

Rose et al., (1980), obtained alcoholic extracts of plants on the basis of literature data and medicinal folklore and investigated the antimicrobial properties against four bacterial and five fungal species. Out of which only 10% plants showed antibacterial activity while 15% exhibited a marked antifungal property. The plant extracts with higher antimicrobial activities were successively extracted with different solvents like ether, chloroform, acetone and alcohol, out of these the alcohol extracts were proved to be the most active phyto chemicals.
The extracts from different parts and oil of *Azadirachta indica* inhibited the growth of *Fusarium oxysporum*, *Rhizoctonia saloni*, *Sclerotium rolfsii* and *Sclerotinia sclerotium* (Singh et al., 1980). They also suggested a possible role of *Azadirachta indica* extracts and oil in the control of *Cicer aritinum* disease *in vivo*.

The leaf extracts of ten medicinal plants were tested to see the antifungal activity (Bhowmick and Vardhan, 1981). They showed that leaf extracts of *Cinnamomum camphora* and *Catharanthus roseus* were most effective followed by *Azadirachta indica*, *Phyllanthus traternus* and *Vitex negundo* against radial growth, sporulation and spore germination *in vitro*. Kapoor et al., (1981), showed the petal extracts of *Ipomea cornea* and *Ipomea palmata* exhibited antifungal activity against *Alternaria brassicola* and *Fusarium oxysporum*.

The antifungal activity of aqueous extracts of different parts of fifty one plants were studied against four plant pathogens viz. *Drechslera rostrate*, *Fusarium oxysporum*, *Alternaria alternata* and *Corysespora cassicola* (Kumar and Chary 1981). Similar reports on antifungal activity of *Nocardia salmonicolor* actinomycetes against *Sclerotium rolfsii*, *Rhizoctonia botaticola* and *Fusarium oxysporum* has given by Agrawal et al., (1982).

Bhowmick and Vardhan, (1982), studied the relative effectiveness of leaf extracts of *Azadirachta indica*, *Acalpha indica*, *Cinnamomun camphora*, *Lantana camera* and, *Catharanthus roseus* on the growth sporulation and spore germination of *Drechslera turcica* manifesting severe leaf blight of maize.
Same observation was given by Bhowmick and Choudhari (1982) about the antifungal activity of leaf extract of medicinal plant against Alternaria alternata. They showed that in test with ten plants species greatest inhibition In vitro was obtained from Acalpha indica and Azadirachta indica.

Many plants have been tested to observe the efficacy against spore germination of several pathogens and non-pathogenic fungi. Amongst these plant extracts of garlic (Allium sativum) and neem (Azadirachta indica) show good properties (Choudhari and Sen, 1982). Shrivastava and Singh (1982), also tested the antifungal activity of the essential oils from the bulbs of Allium cepa and Allium sativum and from the leaves of Azadirachta indica against Microsporum gypseum and Trychophyton terrestre.

Charya et al., (1984), tried four different leaf extracts, of which Punica granatum (stem) showed total inhibition of spore germination of Curvularia lunata. Grainage et al., (1985), noticed that Allium sativum possess antibacterial activity against Xanthomonas campestris pv. oryzae.

The use of extracts of some plant parts in controlling the nematode management was suggested by Goswami and Vijayalakshmi, (1986). Worked on effect of inoculating tomato (Lycopersicon esculentum Mill) with leaf powder and aqueous leaf extract of neem in presence of Drosophilid buskii was done by Sinha and Saxena (1986). They found that both dry neem powder and aqueous leaf extract treatment exhibited protection against Aspergillus flavus causing fruit rot in tomato. Also the chloroform extract of Azadirachta indica L. showed a
significant inhibition of pathogenic micro-organisms (Thakare and Anjaria, 1986).

Yadav (1986) studied the antifungal properties of plant extracts. Neem leaf (Azadirachta indica) 2% and Parthenium (Parthenium hysterophorus) 1% reported more than 60% fungal inhibition by the poison food technique. Alice and Rao (1987) screened thirty-seven plant extracts for their antifungal effects on Dreschlera oryzae. The maximum inhibition was observed with extracts of Allium sativum, Eupatorium cannabinum and Azadirachta indica bark extract.

Similarly Raghavaih and Jayaramaiah (1987), tested the extracts of 10 species of plants in the laboratory as antifungal agents for the white muscardine disease caused by Beauveria bassiana. They observed that the plants showed different inhibitory effects. Out of which garlic exhibited greatest inhibitory effect while the Datura stramonium and Vinca rosea showed moderate inhibition. Near about one hundred two extracts of eighteen plants were tested to see their antifungal activity towards Aspergillus niger and Candida albicans by Almagboul et al., (1988).

Bharad and Khune (1988) studied the antifungal property of plant extracts viz. Azadirachta indica, Brassica Nigra, Eucalyptus globulus, Ipomea cornea, Punica granatum and Adhatosa visica against eight phytopathogenic fungi. They found that all plant extracts tested have shown antifungal property at 5% concentration against one or more fungi. Azadirachta indica showed good inhibitory effect against Curvularia lunata, Fusarium oxysporum and Colletotrichum capsici. Eucalyptus globulus leaves extract also showed more than 50% inhibition in Rhizoctonia botaticola and Fusarium oxysporum. Azadirachta indica and Punica
granatum showed more than 50% inhibition in Curvularia lunata and Fusarium oxysporum. They also noticed that on sterilization the leaf extracts lost their antifungal activity against all the test fungi except Colletotrichum capsici and Alternaria alternata.

Bhatnagar and McCormick (1988) tested the effect of neem (Azadirachta indica) leaf extracts on Aspergillus growth and Alfa-toxin biosynthesis. The formulation did not affect the fungal growth but essentially blocked the Alfa toxin biosynthesis. About, 17 plant extracts viz Azadirachta indica, Parthenium hysterophorus, Cassia tora and Polyporus dremoporus were studied and these plants exhibited higher antifungal activities. The results showed that, Parthenium hysterophorus was having higher antifungal activity checking the growth of microsporum manum.

The sensitivity of three sclerotial rice pathogen was studied by Banerjee (1989). These are Sclerotium rolfsii, Rhizoctonia oryzae sativae, and Sclerotium hydrophyllum. Also the plant oils from neem (Azadirachta indica), Mahua (Madhuca indica) and citronella (Cymbopogon nardus). Neem and citronella oil strongly inhibited germination of fungi. The extracts from Azadirachta indica, Ipomea cornea and Acacia arabica inhibited the mycellial growth of Sarocladium oryzae and Fusarium oxysporum f. sp. Cepae (Eshwamurthy et.al., 1989).

Ghewande (1989), tested aqueous leaf extracts of Azadirachta indica and Tridax procumbens against leaf spots and rust disease of groundnut and observed that extracts of Azadirachta indica was effective in controlling both the
diseases and increasing the yield of groundnut. The water extracts of Allium sativum, Bougainvillea spectabilis and Azadirachta indica significantly inhibited the mycelial growth and sclerotial germination of Thanatephorus cucumerinicus in vitro (Lakshmanan and Mohan, 1989).

The antimicrobial properties in some plant extracts and chemicals for control of two species of Aspergillus on groundnut was studied by Bansal and Sobti, (1990). It was found that Aspergillus niger incidence was reduced significantly (24 %) by Turmeric powder and Neem extract (2%). Although incidence was least with neem extract (2.66%).

Ganapathy and Narayansamy (1990), screened about fifty four plant products to control late leaf spots (Phaeoisariopsis personata) (Berk and Curt) and rust (Puccinia archidis Speg) diseases of groundnut and observed that water extract of neem leaf, neem cake and neem oil (1%) inhibited all the three diseases. The antifungal activity of leaf extract of neem showed marked reduction in seed mycoflora of weed and caused enhanced seed germination (Khan and Rishikumar, 1990).

The evaluation of antifungal activity of ethanolic extracts of leaves of Azadirachta indica and Datura stramonium was done by Mishra and Tiwari, (1990). Effective inhibition of Pyricularia oryzae conidia and mycelial growth was observed. Similarly, Manasi Mishra and Tiwari (1990) tested extracts of Azadirachta indica, Datura stramonium, and Calotropis procera against Penicillium oryzae, Rhizoctonia solani, Curvularia lunata, Fusarium moniliforme and,
Aspergillus niger and found that all the test extract possessed toxic principle against test pathogens.

Upadhyay and Rai (1990), test leaf extracts of thirteen medicinal plants viz. Argemone maxicana, Azadirachta indica, Caesalpinia bonducella, cassia tora, Casia fistula, Catharanthus roseus (Pink flower), Clerodendron serratum, Eucalyptus globulus, Jatropha curcas, Lowsonia inermis, Ocimum sanctum, Sarca indica and Vitex negundo. The pathogen Curvularia tuberculata cause die-back disease. The result showed that extract of Eucalyptus globulus and Catharanthus roseus completely inhibited (100%) the growth of pathogen, followed by Ocimum sanctum (85.5%), Lowsonia inermis (74.3%), Cassia tora (72.9%) and Azadirachta indica (70%).

The neem leaf extracts (10%, 1%, 0.2% and 0.1%) were proved best against Leveillula tourica (Deshmukh, 1991). It is indicated by 100% inhibition of spore germination and germ tube elongation in vitro and 2% and 1% were effective in controlling the powdery mildew in chilli. Similar results has been reported by Bobade (1992). They stated that neem leaf extract was superior to Ipomea cornea leaf extract at 5% and 2% concentration against Leveillula tourica In-vitro and In-vivo.

Maximum control of powdery mildew of green gram by neem leaves extract among the other plant extracts (Bhakare, 1995). The plant extract were less effective as compared to fungicides and was also reported by Bhakare (1995). They also showed that neem leaf extract at 5% was found superior to wavyding extract as 1%.
The field trials on rice crop were conducted by Narishman et al., (1993). The results of field trials showed that neem seed kernal extract (Neem bark at 5%) applied to rice as a foliar spray at booting and 10 days later gave control of *Sporocadium oryzae* and improvements in yield, comparable to that achieved with 0.1% carbandazin.

The extracts of *Azadirachta indica* were more effective in inhibiting the spore germination of test fungus *in vitro* (Sarvamangala et al., 1993). It was also reported that extracts of *Eucalyptus* sp. proved highly toxic under field conditions and also the leaf extracts of *Eucalyptus* sp. showed promising result in reducing leaf spot disease incidence. Bhakare, (1995) also tested the different plant extracts for studying their antifungal activities. These plant are *Azadirachta indica*, *Colotropis ginantia*, *Catharanthus roseus*, *Eucalyptus* sp., *Parthenium hysterophorus* and *Pongamia pinnata* against the pathogens *Corotelium fici* and *Cercospora moricola* causing leaf rust and leaf spot diseases in mulbery. Here also *Azadirachta indica* was found more effective in inhibiting the spore germination of *corotelium fici* by 91.2%. 

Similar results have also given by Subrata Biswas et al., (1995). *Azadirachta indica* extract again was found effective and significantly minimizes the powdery mildew and leaf rust of mulbery. Thakur et al., (1995), studied about the *Punica granatum* and *Datura metai* which shows antifungal and antibacterial activities. They also found that leaf extract of *Datura metai* showed inhibitory effects against *Alternaria tenuis* and *Xanthomonas campestris* but could not inhibit pathogen *Myrothecium roridum*, while extract of *Punica granatum* was
very effective in inhibiting all the three pathogens.

Anandraj and Leela (1996), tested different plant extracts viz *Azadirachta indica, Chromolaena odorata, Lantena camera, Piper colubrinum* and *Strychnos nuxvomica Invitro* against mycelial growth, sporangial production, zoospore production and release zoospore germination of *Phytophthora capsici*.

The different plant extracts were tried against *Fusarium* disease of mulberry by Gupta *et al.*, (1996). Like other scientist similar reports about plant *Azadirachta indica* was given and it was found to be the most effective in reducing leaf spot incidence by 57.2% caused by *Fusarium moniliformae*.

The extracts of different parts of *neem* like neem seed, neem kernal also vekhand and *Ipomea* leaves were tested against the *Xanthomonas campestris* (Patil and Ghoderao, 1997). They found, 5% crude aqueous extracts of all plants effective in controlling the disease with increase in yield. Amongst the plant extracts, neem seed kernal extract and vekhand extract were found equally effective and at par with chemical treatment in minimising disease incidence. Significantly higher yield was recorded as compared to control.

Near about twelve plant extracts were tested against development of powdery mildew of pea (Sindhan *et al.*, 1999). Like the results of the earlier studies *Azadirachta indica* was found to be highly effective and non-phytotoxic. Similarly *Eucalyptus globulus* and *Vinca rosea* also inhibit the growth of *Alternaria alternata*. Leaf extracts of Datura metal showed inhibitory effects at
the concentration of 100% and 50% against *Alternaria tenuis* as well as *Xanthomonas campestris* pv. Malvacerum was reported by Ahmad and Agnihotri (1972). Sheodhan Singh *et al.*, (1979) and Sheikh and Agnihotri (1977). Similar findings were also reported by Thakur *et al.*, (1995). They also showed that these pathogens were controlled up to 72.5% but could not inhibit the fungal pathogen *i.e.* *Myrothecium roridum*.

Nine different medicinal plants were investigated by Thakur *et al.*, (1995) to study the antifungal and antibacterial properties against cotton pathogens. There results revealed that *Punica granatum* and *Datura metel* have shown antifungal and antibacterial activity. Prithviraj *et al.*, (1998), evaluated efficacy of *Ajoene*, a constituent of garlic (*A. sativum*) and neemazol a product of *neem* (*Azadirachta indica* L.) against powdery mildew of *pea* in the field individually and also in combination. They found that both the products at different concentrations reduced the disease intensity as compared to control.

Bora *et al.*, (2000), tested the efficacy of the aqueous extracts of *Terminalia chebula* and *Sesbania aculeate*. The results revealed that the magnitude of disease in plants treated with *Sesbania aculeate* extract was at par in controlling the disease. Seven neem products and six systemic fungicides for control of powdery mildew of black gram was tested by Raghuchandar *et al.*, (2000), and found that neem oil, neem guard controlled powdery mildew over check. For biological management of *Sclerotium wilt* of *Jasmine* caused by *Sclerotium rolfsii*, different organic amendments like mahua cake; neem cake, groundnut cake and gingelly cake were screened by Ramamoorthy *et al.*, (2000). The organic amendments were
applied at 100 g/pot at 15 days prior to planting and disease incidence was recorded at 60 and 120 days after planting. Among the organic amendments, mahua cake decreased the disease incidence significantly followed by neem cake. Also gingelly cake and groundnut cake recorded disease incidence of 64.06 and 7.031% respectively at 120 DAP.

Recommendations are presented for the control of fungal, bacterial and viral diseases in Russia by Sodova et al., (2000). They outlined the measures for control of potato protection from diseases and pests including the use of plant products. Neem extracts were tested for their antifungal efficacy for controlling covered smut of barley (Sethi et al., 2000).

Studies were conducted by Sharma et al., (2000), at bhaulakaun during 1998-2000 to evaluate the control of ginger yellow caused by Fusarium oxysporum f. sp. in ginger (Zingiber officinale) by using different plant product. Nine different plant extracts were tried by them against development of scab (Venturia inaequalis) lesions and rots on apple fruits. Studies revealed that water extract of Emblica officinalis leaves (15%) were highly effective against storage scab and provided complete control up to 60 days of storage. Singh, (2000), studied the use of plant products in controlling the powdery mildew of pea.

Baravkar, (2001), found that maximum control of powdery mildew of green-gram by Bel leaves extract (5%). Amongst the other plant extract, however, neem leaves extract, Beshram, Nilgiri and Sadaphuli leaves extract were also effective to control disease over check. The maximum spore inhibition (84.11%)
was exhibited by garlic bulb extract, followed by tapioca leaf extract (77.64%) in green-gram (Gupta, 2001). The integrated management of chickpea wilt was studied by Sonawane et al., (2001), by conducting pot culture experiment in a glass-house. They found that 1% garlic extract was most effective in controlling the chickpea wilt.

Management of Sclerotinia rot of Indian mustard was done by Chattopadhyay et al., (2002), by using ecofriendly strategies. The Allium sativum bulb extract caused significant increase in seed germination and radical length of Indian mustard (Brassica juncea). The field experiment results showed that foliar application of bulb extract of Allium sativum provided the best seed yield.

Laboratory experiments on leaf spot (Alternaria alternata) management for gerbera (Gerbera jamesonii) were conducted by Ghosh et al., (2002). Experiments were evaluated Invitro by poison food technique and in pot culture. Plant extracts rhizomes of Curcuma longa and Zingiber officinale, dry fruits of Piper nigrum, cloves of Allium sativum and leaves of Azadirachta indica, Vinca rosea of different concentrations i.e. 1, 3, 5, 7 and 9 % were evaluated. Field experiment were conducted in Tamil Nadu (India), in the rabi seasons of 1998-99 to investigate the effects of plant extracts (From Pithcellobium dulce and Prosopis juliflora leaves), plant oils (Palmarosa oil at 0.1 and 0.05% and neem oil at 3%) in controlling leaf blight in onion (Mohan et al., 2002). It was found that lowest disease percentage was obtained with palmarosa oil and this treatment produced yield at 7650 kg/ha, and was higher than control.
Paul et al., (2002), studied the aqueous extracts of leaves of neem (Azadirachta indica), that had provided control of leaf stripe pathogen (Drechslera graminea) on barley. The results supports the hypothesis that neem extract may act indirectly by inducing plant detence reaction and may be useful in integrated management of leaf stripe disease of barley.

Efficacy of isolates of Sclerotium rolfsii, the cauliflower collar rot pathogen tested by dual culture technique by Prasad et al., (2003). They also tried 3% Eucalyptus leaf, neem leaf (dried) and neem dust, (1.2 and 3%). Result showed that Eucalyptus and neem leaf extracts showed better integrated disease management of selected pathogen.

Root rot of cotton is one of the major soil borne disease caused by Rhizoctonia solani, which causes heavy losses to the crop. Use of chemicals for management of soil borne diseases is a costly measure and also adversely affects on ecosystem. So, the use of plant products is necessary and is proved to be ecofriendly in nature (Kshirsagar et al., 2004). Similarly, they also studied the efficacy of crude extracts of eight plants and reported that extract of Allium sativum, Eucalyptus spp. and Zingiber officinale were found to be effective in inhibiting the mycelial growth of Rhizoctonia solani to the extent of 100%. Similar, observations have been reported (Sunderraj et al., 1996; Baag, 1995; Kuncheve et al., 1997).

3.5 Plant material used for antifungal properties by poison food technique.

Falek (1907), is known to be introducer of poison food technique. Horsfall (1956), mixed the test compound with melted agar before solidification and the effect of mycelial colony growth and sporulation was studied
by placing the test fungus on the solidified media.

3.6 **Plant material used for antifungal properties by zone of inhibition.**

A paper disc plate method for the quantitative evaluation of fungicides and bactericides by using standard bioassay filter paper discs measuring about 12.7 mm diameter was suggested by Thornberry (1950). The discs were saturated with the test products dried in air and placed in the plate of agar medium previously seeded with test organisms. The size of zone of inhibition was recorded.

Ark and Thompson (1959), reported that aqueous extract of garlic (*Allium sativum*) produced zone of inhibition on seeded plate of *Clorospora cingulata, Cladosporium cucumerium, Erwinia amylovora* and *Xanthomonas vesicatoria*.

The extracts prepared from the leaves of *Lawsonia alba*, roots of *Datura stramonium* and inflorescence of *Mentha piperita* were tested by filter paper disc method (Sheikh *et al.*, 1977). The results found that all of them were effective against *Alternaria brassica, Colletotrichum papaya* and *Helminthosporium sp.*

A preliminary report on the use of ‘leaf disc assay’ for determining the antibiotic activity of leaves was given by Curt *et al.*, (1949). The method depends on the diffusion of antibiotic from treated leaf disc (0.5 cm diameter) into an agar medium containing an assay fungus. Ordinarily plants were sprayed with the antibiotic preparation dried up to 2-4 hrs. Leaf disc samples were taken at
random. The amount of antibiotic on the disc was estimated by comparing the resultant inhibition zone with those produced by known amount of antibiotic in filter paper disc.

3.7 Plant material used for antifungal properties by spore germination.

The method was tried by various researchers against the spore germination of some pathogenic fungi.

Raddick and Wallace (1910), were the first to introduce slide spore germination technique. Gilliver (1947), who tested extracts from approximately two thousand flowering species, mostly the mixed extracts of leaves, stem, flowers and roots, and recorded inhibitory effect of conidial germination of apple scab organism Venturia inequalis.

The aqueous extract and organic solvent extract of garlic (Allium sativum L.) produces the zone of inhibition on seeded plates of Glomerella cingulata, Cladosporium cucumerium, Erwinia amylovora, and Xanthomonas vesicatoria (Ark and Thompson, 1959). They mentioned that 5% aqueous extract of garlic completely inhibits germination of spores of downy mildew organism of cucumber, scab of cucumber, bean rust and Glomerella cingulata spores.

About forty seven medicinal plants were screened against Alternaria tenuis, Curvularia lunata, Fusarium nivale and Helminthosporium gramineum (Mishra and Dixit, 1977). It was noticed that some plant extracts caused complete or partial inhibition of spore germination of one or more test fungi.
The leaf, flower, stem, and root extracts of two varieties of *Vinca rosea* inhibited spore germination and sporulation of *Helminthosporium nodulsum*, *Sclerotium rolfsii*, *Pestalotia spp.*, *Fusarium oxysporum*, *Colletotrichum spp.* and *Aspergillus niger* (Narain and Satapathy, 1977). The antifungal activities of volatile fraction of leaf extracts of *Allium cepa*, *Allium sativum*, *Artabotrus uncinalus*, *Clematis gouriana* and *Ranunculus scelevatus* was shown by Mishra and Dixit (1979) against the spore germination of *Alternaria tenuis*, *Curvularia lunata*, *Fusarium nivale*, and *Helminthosporium gramineum*.

Rajiv Kumar and Sachan (1979), observed the leaf extracts of *Aristochia indica*, *Bryophyllum spp.*, *Dioscorca sativa*, *Eucalyptus australiensis* and *Jasminum pubescens* caused effective inhibition of spore germination of *Curvularia pallescens* by hanging drop method.

### 3.8. Antifungal properties of oil-cakes and oils of neem

Khan *et al.*, 1974 and Jagdale *et al.*, (1985) have found nematicidal properties in various oil cakes like neem, groundnut, caster, mustard and mahua.

The oil cake of neem (*Azadirachta indica* L.), Madua (*Madhuca indica* Gunet) Ground nut (*Arachis hypogea* Linn.) and castor (*Ricinus communis* Linn.) adversely effected the frequency of parasitic fungi such as *Colletotrichum atramentarium*, *Rhizoctonia solani* and *Fusarium spp* (Khan *et al.*, 1974). These oil cake amendments also significantly reduced the population of phytopathogens
nematodes. The antimicrobial efficacy of the essential oils of *Curcuma longa* was reported by Banerjee and Nigam (1978).

The antibacterial activity of the essential oil from flowers of *Azadirachta indica* against eight plants and human pathogenic bacteria has been tested by Chopra and Mehta (1981). They observed that all the bacterial species except *Bacillus mycoides* showed sensitivity against this oil. Shrivastav and Singh (1982), also reported antifungal activities of essential oils from the bulbs of *Allium Cepa*, *Allium Sativum* and from the leaves of *Azadirachta indica* against *Microsporum gypseum*, *Trichophyton terrestre*, *Malbranchea pulchella* and *Chryscosporium tropicum*.

Dharam Vir and Sharma (1985), reported the efficacy of fungicidal property of neem oil. Oil of *Azadirachta indica* inhibited growth of *Alternaria alternata* by 61.1% at a concentration of 1%. Dwivedi and Dubey (1986), studied the effect of volatile and non-volatile fractions of two medicinal plants on germination of *Macrophomina phaseolina* sclerotia. They found the deleterious effects of volatile fractions (VF) of hydrodistillates of *Azadirachta indica* and *Eucalyptus globulus*. On germination of these, sclerotia, were more pronounced than non-volatile fraction (NVF). They also observed a notable decrease in sclerotal germination due to volatile fractions and non-volatile fractions of neem oil and neem oil cake extracts after 24 hrs incubation.

An odorous viscous oil from the steam distillate of fresh matured leaves of *Azadirachta indica* exhibited antifungal activity against
*Trichophyton metagrophytes In vitro* (Pant et al., 1986). The neem cake applied with urea significantly reduced brown leaf spot intensity in rice fields (Vishwanathan and Kandiannan, 1990).

Kazmi et al., (1993), reported the antifungal activities of neem seed extracts, *turmeric* and *Valeriana officinalis*, rhizomes and seed oil of mustard against *Alternaria alternata*, *Aspergillus flavus*, *Aspergillus fumigatus* and *Aspergillus wentri* fungi commonly causing spoilage of stored grains. Ratnoo and Bhatnagar (1993) noticed those higher doses of *Neem, Kasumi* and *Mahua* cakes increased the percent germination of seeds from 91.6% to 100%. Neem cake at 5% proved to be most effective in reducing the incidence of *Macrophomina phaseolina*.

In 1997-98 susceptible seeds of groundnut cultivars were treated with neem cake soil amendments by Sheela et al., 2000 to control the collar rot of groundnut caused by *Pseudomonas fluorescens* and it was observed that neem cake was best in controlling the collar rot disease. Different plant products and oils were tried by Nagraj et al., (2001), for controlling the bacterial blight of mulberry caused by *Xanthomonas campestris* pv. moricola by using inhibition zone assay technique. Among the plant product tested i.e. ocimum oil (*Ocimum sanctum*), lemon oil (*Citrus latifolia*), neem (*Azadirachta indica*), garlic (*Allium sativum*) extract. Ocimum oil was effective followed by lemon oil and garlic extract, oil seed cakes was studied against root rot of cotton (*Gossypium hirstum*) caused by *Fusarium solani* under *In vitro* and pot conditions (Patil et al., 2001). Neem cake at 50 g/pot was effective in reducing plant mortality (9.99%) than the control (79.90%).
Plant diseases caused by pathogenic microorganisms are among the most important factors affecting the quality and yield of crop plants, hence varieties of chemical formulations are utilized by the farmers. However, due to their impracticability and economically uncomptance, farmers are still facing the problems of agricultural losses. India is endowed with tremendous medicinal plants but due to incomplete research on medicinal plants in their utilization in agriculture fields, farmers are not aware about the benefits of medicinal plants such as, medicinal plants may be the cheapest, ecofriendly, readily available, universally compatible source for the plant disease management. It is therefore essential that agriculture scientists properly study the medicinal plants in relation to plant disease management. So that, via extension services the outcome of the research should become beneficial for the last farmer in the country. Hence, with the view to study the possibilities of utilisation of medicinal plant for plant disease management, the present investigation entitled “Studies on microbicidal properties of some plants for management of plant pathogens” was carried out.