1. INTRODUCTION

The word *agriculture* is the English adaptation of Latin word ager-field, cultura-cultivation in the strict sense of “tillage of soil. Agriculture is the science, art and business of cultivating soil, producing crops and raising livestock. Agriculture in India is the means of livelihood of almost two third of the population in the country, it has always been India’s most important economic structure. The increase in post-independence agricultural production has been brought about by bringing addition of area under cultivation, extension of irrigation facilities, use of better seeds, better techniques, water management and plant production (Adak and Purohit, 2003).

Agricultural biotech in India has immense potential and India can become a major grower of transgenic rice and several genetically engineered vegetables by 2010 (Anuj Kumar et al., 2009). Uses of devices like plant breeding, pesticides and fertilizers, and technological improvements have sharply increased the yields of cultivation, but at the same time have caused wide spread ecological damage and negative human health impacts (Altieri, 1995). India is also the second largest producer of rice, wheat, sugar, cotton, fruits and vegetables (Kishore et al., 2005).

It is conservatively estimated that diseases, insects and weeds together annually interfere with the production of, or destroy between 31-42% of all crops produced world wide. The loss is usually lower in more developed countries and higher in the developing countries, (i.e.,) countries that need food the most. It has been estimated that, out of the 36.5% total losses, 14.2% by diseases, 10.2% by insects and 12.2% by weeds. Considering that 14.1% of the crop loss by plant diseases alone and the total annual worldwide crop loss from plant diseases is estimated about $220 billion. An additional 6-12% losses of crops after harvest, which are particularly high in developing tropical countries like India due to lack of resources like refrigeration, storage, etc., (Douthwaite et al., 2009).
Tomato (*Lycopersicon esculentum*) is the second most important vegetable crop. Present world production is about 100 million tones of fresh from crops cultivated on 3.7 million hectares. Tomato production has been reported in 144 countries and the major country being China followed by India of 8,637,700 Mt. (Yan *et al.*, 2002). Tomato is known as poor man’s apple, which is cultivated on 70,000 acres of land in Tamilnadu, with the average yield of 140,000 tones of tomato per day being produced. Tomato is considered as a tender warm season crop, that is actually a perennial plant, but it is cultivated as an annual (Rao and Shen, 2002). Many factors are involved in low yield of tomato, among them are infestation by fungi, bacteria, nematodes or viruses and the competing weeds (Villarreal, 1980).

Over 200 diseases have been reported to affect the tomato plant all over the world; among them, leaf spot, early blight, canker (*Alternaria alternata*) and fusarial wilt are the major sources of infection. Both early and late blight can be controlled by using fungicides but it is costly. Integrated disease management programme reduces the cost of healthy cropping and the farmers can easily apply them in the field (Watterson, 1986). Tomato crops were found to be affected by a diversity of insect pests and diseases, some being widely distributed and others restricted to specific areas or crop cycles. The solanaceous plants, especially tomato (*Lycopersicon esculentum*), have provided (and will continue to provide) excellent model systems to study plant-pathogen interactions (Meissner *et al.*, 1997).

*Alternaria sp.* is a large genus of worldwide distribution. Its species are mostly polyphagous fungi and occur as saprobe on dead and decaying organic materials, on seeds and is responsible for causing leaf spot diseases in number of economically important crop plants. Alternaria diseases are among the most common diseases of many plants throughout the world (Agrios, 1997). They affect primarily the leaves, stems, flowers and fruits of annual plants, especially vegetables and ornamentals (Zimand *et al.*, 1996). *Alternaria alternata* is a phytopathogenic fungus having a wide host range causing leaf spots and blights on many plant species (Nishijima and Alvare, 1987).
Alternaria leaf spot and stem canker caused by *Alternaria alternata* pathotype (AAL) was first reported in San Diego, USA in 1960 and was later found worldwide. Symptoms with dark brown to black cankers occur on crown including leaves, petioles and stems. AAL produces host a specific toxin (HST), which cause severe necrosis on stems and leaves of susceptible tomato cultivars, whereas resistant cultivars are tolerant and show no symptoms (Akamatsu *et al.*, 1997). *Alternaria alternata* can also express endo-polygalacturonase (endo-PG) and pectate lyase (PL) activities. These enzymes are responsible for the hydrolysis of pectic components of the plant cell wall (Collmer and keen, 1986).

Lesions produced in the tomato leaves by *Alternaria alternata* are small, chlorotic, water soaked, that spread over the surface of the leaf. The lesions become necrotic and brown and are round to irregular in shape. Lesions can coalesce; give the leaf a ragged and blighted appearance. Tentoxin is produced by the fungus *A. alternata* which causes spots and chlorosis in many plant species. Seedlings with more than one-third of their leaf area chlorotic will die.

In disease management strategy, various concerns about environmental hazards caused by excessive usage of fungicides, development of fungicide-tolerant pathogen strains, non availability of both fungicides and their application technology to resource poor farmers, necessitates the development of more economical and eco-friendly alternative components of disease management (Krishna, 2003).

Plants with therapeutic effects have received the attention of scientists as an alternative method of disease control, which would also protect our environment from the currently used hazardous chemicals. Biological control is the reduction of pathogenic populations through the actions of other living organisms, often collectively referred to as beneficial species. There is an increasing awareness that pesticides and fertilizers cause damage to the environment and affect human health. As a consequence, there is a trend toward finding ways to minimize the use of fungicides (Maas, 1998).
Biological control of fungal diseases of plants is eco-friendly (Krishna and Pande, 2005) and application of specific microorganisms to seed a planting material has been studied extensively over the last two decades (Raaijmakers et al., 2002). Biological control of soil borne plant pathogens by bacteria has been studied as an alternative or complementary approach to physical and chemical disease control measures for over 70 years (Leemann et al., 1995).

Biocontrol agents could be an alternative to chemical pesticides, with benefits to consumers, growers, and the environment. Due to high costs and difficulties in application and effectiveness, only a few biological agents are used successfully against diseases (Musetti et al., 2006). Rhizobacteria, that live in the plant rhizosphere and colonize the root system, have been studied as plant growth promoters for increasing agriculture production and as biocontrol agents against plant diseases. Root colonizing bacteria, especially fluorescent Pseudomonas spp., can efficiently control diseases caused by soil borne pathogens (Maurehofer et al., 1994). Such beneficial rhizobacteria were included among plant growth promoting rhizobacteria (PGPR) (Wei et al., 1991). Since 1991, several reports have shown that some rhizosphere microorganism can induce resistance in plants to root and foliar diseases (Hen et al., 2000).

*Pseudomonas fluorescens* is a root-colonizing biocontrol microbe which suppresses soil-borne plant diseases caused by pathogenic fungi. In many crop-pathogen systems, the primary mechanism of biocontrol by fluorescent *Pseudomonas spp.*, is by the production of antibiotics such as 2,4- diacetyl phloroglucinol (PHL), pyoluteorin (PLT), pyrrdinitin and phenezine-1-carboxylate. Siderophores, including salicylic acid, pyochelin and pyoveridine, which chelate the iron and other metals, also contribute to disease suppression by conferring a competitive advantage to biocontrol agents, for the limited supply of essential trace minerals in natural habitats. Siderophores stimulate the biosynthesis of other antimicrobial compounds, by increasing the availability of these minerals to the bacteria. Antibiotics and siderophores may further function as stress factor or signals, inducing local and systemic host resistance (Srivastava and Shalini, 2008).

* A Study on Biological control of leaf spot of Lycopersicon esculentum .......... 4
The plant growth promoting properties of *Pseudomonas fluorescens* are understood through various theories. Bacteria might induce resistance in host plant, so that it can better resist attack by a true pathogen. It will out-compete other pathogenic soil microbes, e.g. by siderophore, giving a competitive advantage for scavenging iron. Adding to above it may produce compounds antagonistic to other soil microbes, such as phenazine type antibiotics or HCN. These characteristics make *Pseudomonas fluorescens* as a good candidate for using as seed inoculants and root drips for biological control of soil borne plant pathogens (Feys and Parker, 2000).

Management and manipulation of natural communities of antagonistic microorganisms through organic amendments have received less attention, in spite of the fact that these strategies have resulted in highly effective forms of biological control (Hoitink *et al*., 1999). Soil amendments have the potential to provide disease control through a variety of mechanisms, including chemical, such as producing antimicrobial compounds during decomposition and biological activities (Chen *et al*., 2006).

*Parthenium hysterophorus* is an herbaceous ephemeral member of the family *Asteraceae*. In Australia and India, it has achieved the status of “worst weed”. In past 10 years it has become one of the seven most obnoxious weeds of the world (Maharjan and Sumitra, 2006). It is an allelopathic weed and it inhibits the germination and growth of several crop plant and trees. The allelopathic potential of *Parthenium hysterophorus* weed result from the release of phytotoxic substances such as ferulic acid, coffeic acid, vanillic acid, chlorogenic acid, anisic acid, and parahydroxy benzoic acid (Jarvis *et al*., 1985). It becomes essential to convert the hazardous weeds as soil amendment along with *Pseudomonas fluorescens* as a biocontrol agent that will significantly reduce the risk factor to crops and environment.

Several chemical compounds have been reported from world's worst weed *Cyperus rotundus*. Some of these chemicals are widely used in Latin America and China for its medicinal properties. Similarly, decoctions of this plant in Brazil are used for their anti-
infective and anti-inflammatory properties. Pigs eat its tubers; however it makes a poor fodder species; it is also reportedly used as a soil stabilizer (Ellison, 2004). Nut sedge tubers contain allelochemicals including polyphenols, sesquiterpenes, flavonol glycoside, saponin, p-hydroxybenzoic acid, p-coumaric acid, o-coumaric acid, caffeic acid and ferulic acid.

Induced resistance is a state of enhanced defensive capacity developed by a plant reacting to specific biotic or chemical stimuli. Induced resistance is generally systemic and can be triggered by pathogens, certain chemicals and non specific rhizosphere bacteria (Kris et al., 2002). Induced resistance in plants can be split broadly into systemic acquired resistance (SAR) and induced systemic resistance (ISR) (Walters et al., 2005). In 1991, the research groups discovered independently that induced systemic resistance (ISR) is a mode of action of plant growth-promoting rhizobacteria, especially fluorescent pseudomonads, in suppressing diseases. The PGPR bacteria were inoculated into the rhizosphere and remained spatially separated from the pathogen that was inoculated on the above ground plant parts, either into the stem or on the leaf surface (De Vleesschauwer et al, 2009).

ISR is effective against pathogens that are resisted through JA/ethylene-dependent defenses. This suggests that the range of pathogen’s control might be extended when ISR and SAR are combined. When ISR and SAR are activated simultaneously, enhanced disease suppression occurs against pathogens by both SA and JA/ethylene responses. Thus, there appears to be room to increase the effectiveness of induced resistance (Bakker et al., 2003).

Chemicals that are able to induce SAR would offer a number of advantages over current conventional technique for disease control. The treated plants are resistant to same number and type of diseases as that plant in which SAR has been biologically induced. The chemical is used as known direct anti-microbial activity or can be converted by the plant as anti-microbial metabolites.
Salicylic acid (SA) is recognized as an inducer of pathogen related protein (PRP) accumulation and SAR, when sprayed on to plants, and it fulfills all the criteria of an ‘activator’ (Glynn, 2001). SA has long been recognized to play a central role in the establishment of SAR against pathogens because, its level increased in plant tissues following pathogen infection and exogenous application of SA resulting enhanced resistance to a broad range of pathogen (He and Wolyn, 2005).

Salicylic acid is a phytohormone and phenol, ubiquitous in plants generating a significant impact on plant growth and development, photosynthesis, transpiration, iron uptake and transport. It also induces specific changes in leaf anatomy and chloroplast structure. Induced resistance in plants irrespective of SAR or ISR by biological or chemical agents has induced to evolve a strategy that will narrowly focus on countering various plant diseases that will be a sustainable development in the field of agriculture. Stagnation of principles and innovations at in vitro level is not going to nurture the welfare of soil crop consequently farmers, who is born as debt, living as debt and dying as debt.

*Alternaria alternata* is our primitive pathogen reckoned among various other pathogens. The destructive impact due to sabotage caused by *Alternaria alternata* have to be minimized by orienting an alternative mode over chemical mode which will be an appropriate option, which is going to be *Pseudomonas fluorescens*. Retrieving back to conventional agronomical methods with trivial manipulations is going to be the fashion of modern agriculture. Thus the present research will enforce the importance of biofertilizers and biocontrol agents that will nourish the demands of global farmers and rejuvenate the thoughts of agricultural scientists.
Our research in relevance to the issues faced by tomato cultivating farmers is carried out under following entities

1. Isolation and characterization of Pathogen
2. Isolation and characterization of Antagonist
   (i)To evaluate the growth promoting potential and plant defense enzyme and hormones by antagonist
   (ii)To elucidate the antagonistic properties of *Pseudomonas fluorescens*
3. Synergistic study of plant extract as an alternative for carrier formulation
4. *In vivo* study for host response and effective delivery system
5. Induction of systemic resistance using SA, challenge inoculation and disease symptoms