CHAPTER-II

REVIEW OF LITERATURE

Current concern with respect to the diversity of microorganisms which are capable of degrading toxic pollutants has received wider attention in various aspects of environmental research. The identification and isolation of the key organisms play a significant role in degradation of toxic pollutant. Many researchers have been made to characterize bacterial communities and their responses to toxic pollutants to isolate potential degraders and to identify functional genes involved in particular degradation processes. It has evident from the researches that, phototrophic cyanobacteria are very effective in the degradation of petroleum and its derivatives.

Thirty six sand samples collected from nine different localities in Egyptian beaches were investigated for mycobiota by Migahed, (2003). They found that, most of the fungal genera detected belonged to the *Deuteromycotina* with fewer proportions belonging to the *Ascomycotina* and *Zygomycotina*. The genera of highest incidence and their respective numbers of species were: *Penicillium* (35.72%, 6 species) and *Aspergillus* (30.28%, 16 species). The species which showed the highest incidence in all cases was *P. chryogenum*, followed by *P. citrinum*, *A. flavus*, *Chaetomium murorum* and *Trichoderma viride*. The results showed that, small number of genera with wide species diversification predominated among the total population of microflora in Egyptian beaches.

Effect of different organic fertilizers was assessed to determine Population and soil fungal diversity of agricultural soils of Meghalaya, India. A total of 122 fungal species and two sterile mycelia were isolated from all the plots of which 25 fungal genera belonged to *Deuteromycotina*, seven to *Ascomycotina*, four to *Zygomycotina* and one to
Mastigomycotina. The most common genera isolated from all the plots include Penicillium, Aspergillus, Acremonium, Fusarium, Mortierella, Mucor, Paecilomyces, Talaromyces, Trichoderma and Verticillium. The results revealed that organic fertilizers particularly farm yard manure and plant compost has better impact on fungal population, its diversity and the physic-chemical properties of the soil than not adding an organic amendment (Swer et al., 2011).

Assessment of microbial diversity in a soil sample site next to a chemical industrial soil contaminated with heavy metals was carried out by Chihching et al., (2008). 17 different bacterial types viz, Polyangium spp., Sphingomonas spp., Variovorax spp., Hafina spp., Clostridia, Acidobacteria, the enteric and some uncultured strains were found out by 16S rRNA sequence amplified from DNA directly extracted from the soil (culture independent). The strain Acinetobacter, Enterobacter sp. and Stenotrophomonas sp. (culture dependent) tolerated high concentration of cadmium (500 µmol/L and above). The results indicated that the species identified from direct analysis of 16S rDNA of the soil can be quite different from those strains obtained from enrichment culture and the microbial activities for heavy metal resistance might be more appropriately addressed by the actual isolates.

Effect of combined contamination of heavy metals on soil bacterial communities using polyphasic approach was studied by Paul et al., (2005). The results obtained showed that, bacterial community was affected to a certain extent by heavy metals. The PCR-DGGE analysis of 16S rRNA genes showed that there were significant differences in the structure of the microbial community among the soil samples, which were related to the contamination levels. The results also indicated that, some heavy metal-resistant bacteria can survive in the soils with high amount of Pb (204 µg/g soil) and Cd (226.9 µg/g soil).
With respect to environmental pollution is concerned, heavy metals have received wider attention. The major sources of these pollutants to the environment are due to human activities through which, it enters into the food chain. As a result of the increased awareness about harmful effects of environmental pollution, there has been considerable increase in the research to gather information on the impact of heavy metals on the microbiota of wastewaters and contaminated soils, followed by the exploration of various strategies that may be employed to clean up the environment (Pandey and Jain, 2002).

Few researchers state that, the bioremediation of heavy metals by microorganisms is very much dependent on the nature of the site and type of chemicals present in the environment. But, this method is considered as the most cost-effective process that reduces pollutants to non-toxic forms. Many researches focused on various clean-up techniques to remove heavy metals, such as, alkaline precipitation, reverse osmosis and activated sludge treatment practiced for the removal of chromium from heavy metal contaminated sites of tanneries. However, such methods, affect fertility condition of lands by destruction of beneficial microbial diversities such as nitrogen-fixing bacteria and mycorrhizae, during the process of decontamination, thereby further reducing the biodiversity of the area (Gadd, 1992; Wianwiright, 1997; Chaudhry et al., 1999). Apart from above issues, many researchers have diversified their area of research in the field of microbial degradation of toxic pollutants. Out of which, specific literatures related to the present research work were presented as follows.

Engelhardt et al., (1973) worked on purification of an aryl acylamidase of *Bacillus sphaericus*. The properties of the purified compound was assessed by using techniques such as, Ion exchange chromatography, Gel filtration, and Polyacrylamide gel electrophoresis. From the experimental results, it was concluded that, enzyme activity was suppressed by sulphydryl reagents, different metal ions and degradation product of
the purified compound. During the experiments, it was observed that, in the presence of 6M urea, the enzymes were found to be completely inactive.

Metabolism and degradation of vinyl phosphate insecticides was studied by Beynon et al., (1973). The vinyl phosphate insecticides have the general structure (1) in which $R^1$ and $R^2$ are alkyl groups; $R^3$, $R^4$, and $R^5$ can be one of a wide variety of groups including hydrogen, methyl, carboxymethyl, alkyl amido, polychloroaryl, etc., and $X$ is S or O. The variation in the groups provides the range of insecticidal, chemical, and physical properties that exists with the class. All currently commercially available members have both $R^1$ and $R^2$ either methyl or ethyl groups or all except one have an oxygen atom as $X$.

Beveridge and Murray, (1980) carried out an experiments to study the metal deposition sites in the cell wall of Bacillus subtilis. The chemicals present in the cell wall of B. subtilis such as, amine and carboxyl groups were modified in there chemical properties in order to neutralize their electrochemical charge. However, the modified chemical properties of amines did not reduce the metal uptake values compared to native walls, but in case of alteration of carboxyl groups metal deposition was restricted. The above changes were confirmed from X-ray diffraction and electron microscopic studies. The observations suggest that, the form and structure of the metals deposited was different from that of native walls and carboxyl groups provide the major site of metal deposition in Bacillus subtilis wall.

Horitsu et al., (1987) reported the enzymatic reduction of hexavalent chromium by chromium tolerant pseudomonas ambigua G-1 species. The experimental results shows that, when chromium tolerant P. ambigua G-1 was cultivated in nutrient broth containing 150ppm chromium, the metal concentration in the broth was found to be rapidly decreased. It was observed that, the chromium reducing enzyme found in a cell-
free extract of *P. ambigua* G-1 required NADH as a hydrogen donor for the reduction of hexavalent chromium. The specific activities of cell-free extracts of several chromium sensitive mutants showed, decreases to one fourth to one tenth of that of *P. ambigua* G-1 species.

The study of removal of cadmium from dilute aqueous solutions by fungal adsorbent was carried out by Huang *et al.*, (1988). For the experiments, twelve fungal species were used to study metal adsorption behavior in batch reactors. Specific surface area and surface charge characteristics of the fungal biomass were observed during experiments. The adsorption capacity of metal was studies with respect to varied pH conditions. A modified Langmuir adsorption isotherm was applied in order to explain the adsorption characteristics of metals. The adsorption capacity of fungal biomass is also compared with other adsorbents such as activated carbon, oxide, soils and hydroxylapatite. The experimental result shows that, the physico-chemical treatment of fungal biomass does not affect metal adsorption behavior.

Lawrence *et al.*, (1988) reported chromate resistance and reduction in *Pseudomonas fluorescens* strain LB300. For the experimental purpose, *P. fluorescens* LB300 strains was isolated from chromium-contaminated river sediment. Chromate resistance is conferred by the plasmid pLHB1. Strain LB300 was grown in minimal salts medium with as much as 1000 µg of K$_2$CrO$_4$ ml$^{-1}$, and actively reduced chromate to Cr (III) while growing aerobically on a variety of substrates. Chromate was also reduced during anaerobic growth on acetate, the chromate serving as terminal electron acceptor. The experimental results suggest that, the chromate reductase activity is constitutive. Studies with cell-free extracts show that, the reductase is membrane-associated and can mediate the transfer of electrons from NADH to chromate.
George et al., (1988) conducted an experiment to study the fate of dyes in aquatic systems. The experiments were carried out by using 50 dyes to study behavior of dyes with respect to environmental conditions. It was found that, the solubility of the dyes was ranged from $10^{-7}$ to $10^{-6}$ m. This solubility suggests that, increase in concentration of dyes in sediments. The data also indicate that, the solubility computed was overestimated for disperse dyes which is 10 to 100 times smaller than reported for most other compounds. Finally it was concluded that, no significant conclusions has been drawn about the behavior of recently developed dispersive dyes.

Gadd, (1993) carried out research to study interactions of fungi with toxic metals. The study consists of assessment of physico-chemical and biological characteristics. The fungal stains were subjected to assess the resistance and tolerance, under varied environmental conditions in metal contaminated sites. The cellular interactions such as, binding to cell walls, transport of monovalent and divalent fates of toxic metal species has been studied. The experimental results shows, existence of significant interactions between metals and mycorrhizal fungi.

The experiments to compare the effect free and attached cells of *Pseudomonas fluorescens* and its capacity to accumulate heavy metal ions such as, zinc and cadmium at different concentrations like 5,10,50 and 100 µg/ml was carried out by Eldowney, (1994). The experimental results indicate that, the amount of zinc and cadmium accumulated by the cells increased with respect to metal concentration. It was observed that, compared to attached cells of *P.fluorescens*, free cells has reported greater capacity to accumulate zinc and cadmium metal.

Roger et al., (1994) studied the impact of pesticides on soil and water microflora in wetland rice fields. From the experimental results, it was observed that, the pesticides applied with recommended standards on soil does had any major impact on microbial
diversity and activity but, the pesticide application had more effect on invertebrate populations of soil and water of wet land rice fields.

Akhtar and Mohan, (1995) worked on sequestration of metal ions like zinc and cadmium by using *Aspergillus niger*. The experimental result shows that, the mycelial biomass of *A. niger* was found to be effective in sequestering metals ions, like zinc and cadmium from polluted lake waters. They reported that, 75 per cent of the zinc ions (9g/l), from the effluent of a battery-manufacturing unit near the lake, were efficiently removed by recycling the biomass through five cycles. It was also observed that, the same fungal strain was found to be effective for removal of chromium ions (420 mg/l) from electroplating industry effluents by recycling the biomass.

Biosorption of lead from aqueous solutions by using a culture of acidic soil isolates was carried out by Pradhan and Levine, (1995). The isolates were grown in an aerobic, semi-batch culture reactor. By using the direct contact technique, the rate of metal ion sorption on cellular surfaces was determined. From the experiments, they could found that, the rate of biosorption was directly influenced by the pH and initial metal ion concentrations.

Removal of hexavalent chromium from ground water by using yeast (*Saccharomyces cerevisiae*) was reported by Krauter *et al.*, (1996), during the experiments, the removal of hexavalent chromium was very quick. The process of removal of heavy metals by strains of *S. cerevisiae*, started within 2 minutes, when freshly hydrated cells were exposed. The results indicate that, under anaerobic conditions, the removal of hexavalent chromium was slightly greater than under aerobic conditions.

Taiwo *et al.*, (1997) studied the effect of pesticides on soil microorganisms and soil nutrients. For the experiments, the types of pesticides selected were atrazine,
pyrethrin and a mixture of metobromuron and metolachlor. From the experimental results, they have observed that, a significant reduction in soil microbial population was found with respect to decrease in soil nutritional status.

The effect of sewage sludge, on the soil microbial community at two metal contaminated sites of different textured soils of agricultural land was investigated by Erland et al., (1998), the researchers found that, at one site, the microbial community tolerance increased with respect to metal treatments of zinc, copper and nickel. Compared to the unpolluted sludge-treated control, the soil microbial tolerance to specific metals has greatest increase when the same metal was added to the soil. They concluded that, the tolerance to copper increased more in copper polluted treatments. At the other site, the researchers found a significant increase in community tolerance to high levels of zinc.

Zhang et al., (1998) carried out research on adsorption of lead by Rhizopus nigricans which is produced as by-product of pharmaceutical fermentation. Under experimental conditions, capacity to absorb lead by Rhizopus nigricans over a range of the metal ion concentrations. The investigators found that, in case of non-living fungal biomass, the adsorption takes place in the chitin structure of the cell.

Martinez-Toledo et al., (1992) conducted an experiments to study the impact of some organophosphorus insecticides on soil microorganisms. The soil samples were treated with Isofenphos in order to study its impact on total viable bacteria. The experimental results show that, the number of viable bacteria was found to be higher than that of the control groups during incubation. Moreover, it was observed that, the Isofenphos treatment had no inhibitory effect on other microorganisms. It was determined that, there is no inhibitory effect of Isofenphos and phorate pesticides on soil microorganisms.
The experiments to compare the uptake of copper and lead ions by using *Saccharomyces*, *Pseudomonas* and *E. coli* strains was carried out by Afshan *et al.*, (2001). From the experimental results, it has been depicted that, the biosorption process was completed by all the three stains within 10 minutes. However, for both the metals, an increase in the biomass concentration lowered the specific metal uptake, whereas higher initial metal ion concentrations increased their uptake.

Michel *et al.*, (2001) reported the capacity of *Aspergillus niger* to remove heavy metals from wastewater. From the experimental results, they could found that, *A. niger* was best suited for removal of heavy metals from waste water. *A. niger* was able to grow on culture plates amended with the heavy metals to levels that were five times that inhibited the growth of yeast. The researchers reported that, *A. niger* able to remove 70 per cent of the zinc and 91 percent of the copper among heavy metals from the wastewater.

Dias *et al.*, (2002) investigated the biosorption of trivalent chromium, nickel and iron in the steel industry effluents by using *Aspergillus terreus* immobilized in polyurethane foam. The researchers could find that, after six days of incubation, maximum metal uptake was achieved from the effluent stream containing 164.5 mg/l of iron, 96.5 mg/l and 19.6 mg/l of nickel, supplemented with 1 per cent glucose.

Gary *et al.*, (2002) worked on degradation of pesticides by using fungal strains. For the experiments, the pesticides like metalaxyl, atrazine and terbuthylazine was used. The experimental results indicated that, *Hypholoma fasciculare* and *Coriolus versicolor* achieved the degradation of metalaxyl, atrazine and terbuthylazine pesticides in liquid culture. They also observed that, by using white rot fungi, biodegradation of chlorpyrifos using *Hypholoma fasciculare* and *Coriolus versicolor* can be achieved after 42 days.
Gateth Jones, (2000) the main purposes of the project were to collect and isolate fungi into axenic culture for the BIOTECH screening programmes and to maintained isolates for support of other in-house research activities. 1308 fungal cultures were isolated from various parts of Thailand. The percentage of fungi isolated from various parts of Thailand were south 53%, northeast 19%, north 17%, west 7%, central 3% and the east 1% cultures were initially identified by morphological characteristics, colony appearance and spore formation. This isolation has been preserved in the Biotech culture collection. Isolates included *ascomycete* 38.05%, *mitosporic* 21.55%, *Basidiomycete* 20.38%. The Groups of fungi targeted for isolation have been shown to be good producers of bioactive compounds and of lignocellulose degrading enzymes.

Biodegradation of chlorpyrifos with two other pesticides was carried out by Singh et al., (2003). They successfully achieved the biodegradation of chlorpyrifos with its degraded product 3,5,6-trichloro-2-pyridinol (TCP). But, compare to the degraded end products of other two pesticides, quantity of 3,5,6-trichloro-2-pyridinol obtained was very less.

Nikhath and Singacharaya (2002) conducted an experiments to study the physical, chemical and biological characteristics in order to study the process of decolourisation using four fungal strains which were isolated from the textile and soils contaminated with dye. The role of enzymatic activities such as, α amylase, protease, catalase and glucose oxidase was carried out at successive intervals of 7, 14 & 21 days of incubation period. The experimental results shows that, *Aspergillus* and *Mucor mucedo* were resistant in the soils and found to be effective (92 percent) in the decolourization and in enzyme production. *Curvularia lunata* and *Fusarium oxysporum* though occurred abundantly were not so successful in the process of decolourization.
Dave et al., (2003) studied the impact of long-term herbicide applications on the bacterial diversity, structure and function in an agricultural soil. They could find that, the chronic effect of herbicides like, atrazine and metolachlor for about 20 years of application of herbicides on the community structure, abundance and function of bacterial groups in the bulk soil of a maize monoculture. Their results indicate that the long-term use of the herbicides atrazine and metolachlor resulted in an altered soil community structure, in particular for the methanotrophic bacteria.

Teitzel and Parsek, (2003) studied the impact of the heavy metals like copper, lead and zinc on biofilm and planktonic Pseudomonas aeruginosa. For the generation of biofilm, a rotating disk biofilm was used and resistance of biofilms against heavy metals was tested. It was found that, biofilms from 2 to 600 times more resistant to heavy metal stress. When planktonic cells at different stages of growth were examined, it was found that, logarithmic growing cells were more resistant to copper and lead stress than stationary-phase cells. However, biofilms were observed to be more resistant to heavy metals than either stationary-phase or logarithmically growing planktonic cells.

Zhang et al., (1998) carried out research to study metabolism of nitrogen modified lignocelluloses by white rot fungus. The experimental results revealed that, within incubation period ammonia-nitrogen was released, nitrate-nitrogen concentration was decreased and total-nitrogen loss was blocked within incubation period. During metabolism of nitrogen modified lignocelluloses showed greater degradation capacity. During incubation, it was observed that, nitrogen modified lignocelluloses complex colonized by white rot fungus was found to be economic and effective when they are applied into the vast field ecosystem, it might stabilize NH$_4^+$ nitrogen flux & bioremediate the polluted environmental sites.
Omar and Al, (2004) carried out research to test ability of fungal species to degrade three organophosphorus insecticides. For the experimental purpose 13 fungal species was isolated, a good growth of all the fungal species was observed in culture media treated with different concentration of pesticides. But, a variation in growth rate was observed with respect to species, insecticides and its concentration. At 10ppm level, insecticide degradation was highest with all fungi tested. Among the 13 fungal species, *Aspergillus terreus* has recorded, greatest degradation potential followed by *A. tamari, A. niger, Trichoderma harzianum* and *Penicillium brevicompacture*.

Dimitrios *et al.*, (2004) worked on degradation of cadusafos in soils of Northern Greece in which; the land was used for cultivation of potato. The experimental results shows, decrease in degradation of cadusafos was reported in soils treated with antibiotic and in soils from an untreated field conditions. During experiments it was observed that, the bacterial population of the cadusafos treated soil has capacity to degrade the chemically related mematicide ethoprophos but not fenamiphos and oxamyl. They concluded from the research that, this is the first report of the occurrence of enhanced biodegradation of cadusafos in potato fields.

Biodegradation of DDT by white rot fungi *Phanerochaete chrysosporium* was carried out by Masud Hosain *et al.*, (2005). The experiments were carried out in aerobic batch reactors of the fungal process over a period of 7 days. About 30% (v/v) inoculums concentration of the suspended culture of the Basidiomycete is being used for the studies. The experiment shows that, the fungal species can tolerate up to 800 ppm of DDT. The maximum biodegradation of DDT was achieved at optimum pH of 5 and optimum temperature of 40°C. They states that, white rot fungi *P. chrysosporium* is a most effective treatment for waste water contaminated pesticides.
Zhang et al., (2007) isolated seven methyl parathion degrading bacteria from a long term methyl parathion contaminated soil and were found to belong to the genera *Pseudominobacter, Achromobacter, Brucella* and *Ochrobactrum*. The southern blot analysis showed, hydrolase genes were similar to the mpd gene from *Plesiomonas sp*. Gene libraries were constructed for seven organophosphorus pesticide-degrading bacteria, and genes were cloned and sequenced. The sequence analysis revealed that, their hydrolase genes were conserved, and G+C content of the mpd genes were distinctly different from that of the chromosome-located 16S rRNA gene.

Mohammad et al., (2005) studied the impact of three organophosphorus insecticides i.e, malathion, dimethoate and phorate on beneficial rhizotrophic microflora over a period 70 days of incubation in soil. During incubation experiments it was found that, among all groups of soil microflora, aerobic bacteria were most adversely affected by all insecticide. The rate of toxicity was increased in the sequence Phorate>dimethoate>malathion. The microbial number was found to be reduced during 7-11 days of incubation with respect to insecticide treatment. They concluded from the experimental results that, the degraded products of insecticides were used as a carbon and energy source by these microorganisms.

Atkinson et al., (1996) carried out research on bioremediation of industrial effluents contaminated with heavy metals by using waste sludges. For the biosorption industrial effluents, from a metal plating company, was exposed to waste activated sludge to optimise the biosorption process at laboratory scale. Metals assessed were Zn$^{2+}$, Cu$^{2+}$, Cd$^{2+}$, Ni$^{2+}$, Cr$^{3+}$ and Cr$^{6+}$, of which, Zn$^{2+}$ was most prevalent. Biosorption rates of up to 96% were recorded for Zn$^{2+}$ within the first 15 min. Biomass displayed an average adsorptive capacity of 80% at metal concentrations of 50mg.l$^{-1}$ and above. Both fully mixed and upflow column bioreactors were employed during experimentation, using wet
and dried sludge. The findings of this study show that, wet sludge, utilized as biosorbent in a fully mixed process, has superior potential for metal ion biosorption from an industrial effluent.

Yun et al., (2006) reported isolation and identification of a fungal strain capable of utilizing chlorpyrifos as sole carbon and energy sources from soil and degradation of chlorpyrifos in pure cultures on vegetables by fungal strain and its cell-free extract. Compared with the controls, the chlorpyrifos were reduced by 70.3%, 65.6%, 80.6%, 80.6%, and 86.1% under different crop conditions. The investigation reveals that, in cell-free extracts, the chlorpyrifos residues on vegetables were found to be degraded rapidly.

Sohail and Mohammed, (2006) studied the impact of insecticides on total number of soil bacteria. The experiments were conducted under laboratory as well as field conditions. The results of the comparative study between laboratory and field conditions reveals that, the application of chlorpyrifos insecticide played significant role in reduction in total number of bacteria present in soil. However: under field conditions, there is no major effect was observed after 21 days of chlorpyrifos application.

Paul et al., (2005) carried out research on degradation of fenitrothion by using bacterial species used in bioremediation is FDS-1. For the experimental work a fenitrothion degrading strain was used, in order to study, the factors responsible for growth and degradation capacity of fenithrothian in soil microcosms. Under concentration range 1-200 mg/kg⁻¹ microcosms experiments were conducted. The results indicates that, FDS-1 strain has greater potential for bioremediation of fenitrothian and its metabolite contaminated sites.
Helvin Heiomen-Tanski et al., (2006) studied the impact of annual application of pesticides on soil microorganism and crop yields. The persistence of the effect of different class of pesticides in the soil was studied. The herbicide such as parathion, glyphosate, maleic hydrazide was applied to barley. The experimental study showed that, there is no significant change in soil microorganism number was observed the pesticide treatments did not affect significantly the number of several groups of soil micro-organisms. The barley yields were found to be above the average in pesticide treated plots compared to control.

Degradation of the chlorpyrifos using Klebsiella sp was reported by Ghanem et al., (2007). For the experimental purpose, the Klebsiella sp were isolated from an activated sludge of waste water treatment plant. These species was inoculated on mineral salt media containing chlorpyrifos as the only available carbon source. From the experimental results it was concluded that, over a period of four days, in the mineral salt medium, 92% of chlorpyrifos degradation was achieved by the Klebsiella sp were isolated from an activated sludge of waste water treatment plant.

Fang et al., (2008) conducted degradation experiments of chlorpyrifos using Verticillium sp. These fungal species were grown on mineral salt media containing chlorpyrifos as sole carbon source. They have also studied, degradation rate of chlorpyrifos with respect to temperature and pH. They could interpret from the experimental results that, the optimum degradation of chlorpyrifos was achieved at pH 7 and temperature of 35°C indicated that, neutral pH is favorable for degradation of chlorpyrifos.

Sultani et al., (2007) conducted a field experiment under rain fed conditions of Pothowar region of Pakistan to assess physical properties of soil as influenced by various green manure legumes (sesbania, cluster bean and rice bean) and different phosphorous
levels (0, 30, 60, 90 kg P$_2$O$_5$/ha). From the study, it was observed that, phosphorus application showed positive impact on various soil physical properties but did not significantly increase porosity or reduce bulk density.

Benimeli et al., (2008) isolated pesticide resistance strains from pesticide contaminated sites. For the experimental purpose, five Actinomycetes stains were isolated from pesticide contaminated sediments. These strains were isolated in order to grow in the presence of 10µg 1$^{-1}$ lindane, an organochlorine pesticide. The experimental results revel that, the Streptomycin is the only species which is growing best in the presence of lindane.

Biodegradation of chlorpyrifos by single and mixed cultures of soil born plant pathogens was reported by Mihanna et al., (2008). The experiments have been conducted with varied concentrations of chlorpyrifos. The experimental results revel that, the growth of fungal colonies was more on media with higher concentration of chlorpyrifos compared to control. It was observed that, compared to single culture, the mixed cultures of fungi has greater capacity to degrade chlorpyrifos.

Kumar et al., (2008) assessed the physico-chemical characteristics of water and sediment and the textural aspects of sediments in western mangroves of Kachchh-Gujarat, west coast of India, for a period of two years during 1999-2000. From the characterization of surface water and sediments, it was observed that, the nature of soil texture was characterized by the abundance of silt loam, silt clay and silt clay loam. The present baseline information of the physico-chemical characteristics of water, sediment and soil texture would form a useful tool for further ecological assessment and monitoring of these coastal ecosystems of western mangroves of Kachchh.
Gurumurthy et al., (2009) assessed the changes in soil characteristics under different land use patterns. For the experiments, five soil profiles under various agri system like Rice and Tobacco, Areca nut, Silvis system (Eucalyptus) and current fallow land use systems was selected. The investigation indicates that, the soil characteristics, land use and management practices have major influence on soil nutrients status. And it has been recommended that, the five agri systems are safer for cultivation of crops.

Saadatullah Malghani et al., (2009) worked on isolation and identification of profenofos degrading bacteria. For the experimental purpose they used enrichment culture to isolate bacterial strains for the biodegradation of profenofos in soil of Hubei province of central China. Two pure bacterial cultures, named W and Y, were isolated and subsequently characterized by sequencing of 16S rRNA genes and biochemical tests. Isolate W showed 96% similarity to the 16S rRNA gene of a Pseudomonas putida unlike Y which showed 99% similarity to the 16S rRNA gene of Burkholderia gladioli. Both strains grew well at pH 5.5-7.2 with a broad temperature profile ranging from 28\(^\circ\)C to 36\(^\circ\)C. Bioremediation of profenofos-contaminated soil was examined using soil treated with 200 \(\mu g\) g-1; profenofos resulted in a higher degradation rate than control soils without inoculation. In a mineral salt medium reduction in profenofos concentration was 90\% within 96 hours of incubation.

Aurelia, (2009) studied the effect of some pesticides on soil microorganisms and observed that, in the soil sample which is treated with Decis (Insecticide), the total viable bacterial number was found to be higher than that of the control soil during incubation. The Bavistin (Fungicide) and SDMA (Herbicide) pesticides were had no inhibitory effect on the number of total microorganisms.

Vidyalakshmi et al., (2009) carried out research on the biodegradation of chlorpyrifos in soil by enriched cultures; they developed three aerobic bacterial consortia, AC, BC,
and DC, from pesticide-contaminated soils of Punjab. The experimental results show that, they can degrade chlorpyrifos after 21 days of incubation in basal medium by 54, 46, and 61% and chlorpyrifos (50 mg/L) in soil after 30 days by 50, 56, and 64%. *Pseudomonas aeruginosa, Bacillus cereus, Klebsiella sp., and Serratia marsceces* obtained from these consortia showed 84, 84, 81, and 80% degradation of chlorpyrifos (50 mg/L) in liquid medium after 20 days and 92, 60, 56, and 37% degradation of chlorpyrifos (50 mg/L) in soil after 30 days. Populations of *Bacillus cereus, Klebsiella sp., and Serratia marsceces* remained steady in soil experiments except for *P. aeruginosa*, where the population showed a substantial increase.

Vishal *et al.*, (2009) investigated the physico-chemical properties of four form soils in area surrounding Rajkot, Gujrat. The soil samples were collected from four farm soils of different area surrounding Rajkot. Data presentation revealed different values for various soil parameters. From the experimental results, it was confirmed that, physico-chemical characteristics of four farm soils was found be above the permissible limits except basic cations.

Lupwayi *et al.*, (2009) studied the changes in the structure of soil bacterial populations due to the application of fungicide and insecticides. From the experimental results, it was observed that, there was no significant change on soil microbial biomass or bacterial diversity was reported due to the application pesticide. But the functional structures of soil bacteria was found to be altered due to excessive and long term application of fungicides and insecticides.

Ololade *et al.*, (2010) examined the impacts of soil physico-chemical characteristics on different cocoa plantations within six selected communities of Ondo State, Nigeria on cocoa productivity. The results showed that, the pH, organic carbon and cation exchange capacity obtained ranged from 5.1, 0.35 - 4.30% and 2.1- 6.05 meq/100g
respectively which tended to decrease with depth. It was concluded that, there was no major variations was observed with respect to chemical properties with respect to different plantations.

Degradation of organochlorine pesticides by microorganisms was carried out by Maria et al., (2010). For the degradation experiments, *Streptomyces species* M7 were isolated from organochlorine pesticides contaminated sediment. The microorganism was cultured in soil extract medium with lindane (100 µg L⁻¹), was added. During experiments, they observed that, when different pesticide concentrations (100, 150, 200 and 300 µg L⁻¹) were added to the soil medium, an increase in microbial growth was detected with respect to varied concentrations. However; it was observed that, the optimum *Streptomyces* sp. M7. The lindane removal in these conditions was 67.8% at 28 days of incubation period. Later in order to study the pesticide effects on maize plants, the seeds were added to lindane contaminated soil previously inoculated with *Streptomyces* sp. M7. They concluded that, the soil did not affect the germination of maize plants seeded in contaminated soils without *Streptomyces* sp. M7. These results confirm the potential lindane -contaminated soil bioremediation of *Streptomyces* sp. M7.

Chandra et al., (2010) assessed changes in soil physico-chemical properties and microbial diversity due to organic agriculture in semi-arid conditions of agricultural lands. The experiments were conducted in two semi-arid dry land farming region of Maharashtra. The comparative study between organically cultivated field and fallow grassland showed increased microbial biomass, carbon, nitrogen and enzymatic activities compared to fallow grass land soil. The study showed significant increase of microbial diversity and evenness, in organically cultivated field.

Chi-Chu Lo, (2010) worked on the impact of pesticides on soil microorganisms with respect to different class of pesticides like; insecticides, herbicides, fungicides.
the investigation, they concluded that, each type of pesticides has shown the effect on soil microorganisms, which is mainly dependent on its chemical composition and other factors.

Swapnil Rai et al., (2011) carried out research to compare the physico-chemical properties and heavy metal concentration of soil irrigated with sewage water and canal water of Dehradun city, India. From the experiments, it was found that, the mean values of Bulk density 1.26 gm/cm$^3$, Water holding capacity-53.6 %, Electrical conductivity 0.122dsm$^{-1}$, pH-7.5, Organic carbon1.95%, Available potassium-121.66 mg/kg, Nitrogen-2.22% and heavy metal concentration in soil was Pb-52.72, Cu-49.03, Zn-264.09 and Cd-24.66 in sewage water irrigated soil. It was found that, the observed concentration of heavy metals was below the Indian standards except cadmium.

Aly and Abo-Amer, (2012) conducted research on bacteria which has capacity to degrade the cadusafos a type of pesticide. The five *Pseudomonas putida* bacterial stains were isolated from agricultural soil using an enrichment method. The bacterial isolates were characterized by identification of morphological, biochemical and 16S rRNA sequencing. From the characterization of strain PC1 exhibited the greatest cadusafos degradation capacity at 20$^\circ$C and 37$^\circ$C, but was greatly reduced by the presence of carbon sources. Strain PC1 was able to effectively degrade cadusafos in sterilized soil using low inoculums levels. The maximum degradation rate of cadusafos was calculated as 1.1 mg l$^{-1}$ day$^{-1}$, and its saturation constant was found to be 2.5 mg l$^{-1}$. From the results, they conclude that, the bacterial strain PC1, used for bioremediation of contaminated pesticide sites.

Adriano et al., (2012) studied the toxic effects of four sulphonylureas herbicides on soil microbial diversity. For the experiments herbicides applied at different rates such as, the normal field dose and at ten-fold of the field dose. The comparison between rates
of herbicides applied showed that, the normal field dose had slight effects on soil microbial diversity, in case of tenfold of the field dose; the tested herbicides showed significant impact on diversity and biochemical activities soil microorganisms.

Anna et al., (2012) carried out research to study the bioremediation of rhizosphere with Azospirillium and Pseudomonas stutzeri species in the soil contaminated with poly cyclic aromatic hydrocarbons and diesel. In this study the effects of diazothrophic species of bacteria such as, Azospirillum spp and Pseudomonas stutzeri on the degradation of poly-cyclic aromatic hydrocarbons diesel fuel was investigated. Plants were grown in three different soils (chernozem, rendzina, and lessives) for 4 weeks and unplanted. The experimental results demonstrated that, the differences in concentration between the inoculated or non-inoculated soils indicate that, the presence of plant roots, in addition to the passage of time, contributes, to reduction in the bioavailability of a mixture of PAHs and diesel fuel. They finally concluded that, the type of soil contaminants and inoculation has a significant impact on breakdown of poly cyclic aromatic hydrocarbons and diesel in soil.

Wendan et al., (2012) reported a new bioremediation strategy to remove cadmium and carbendazim from soil using a hyper accumulator plant (Sedumal fredii) combined with carbendazim-degrading bacterial strains like Bacillus subtilis, Paracoccussp., Flavobacterium and Pseudomonas sp. A pot experiment was conducted, under greenhouse conditions for 180 days with S. carbendazim-degrading strains. These stains were grown in soil artificially polluted with low and high levels. From the pot experiments, they conclude that, the removal efficiencies of cadmium at low and high levels were found to be 32.3-35.1 % and 7.8-8.2% respectively. It was observed that, at low levels, the cadmium removal efficiencies for carbendazim-degrading bacterial strains significantly increased as compared to control.
Yusuf et al., (2014) studied the impact of commonly used pesticides such as Pendimethaline, Trifluralin, Glyphosate, 2,4-D, and MCPA (Chwastox) on soil microbial activities. For the research purpose, two types of clean soils were amended with recommended level of pesticides and incubated under laboratory conditions at 35°C for a period 15 days. In terms of carbon dioxide production, the microbial activities were measured at successive days like 1, 2, 3, 4, 5, 7, 9, 11, and 15 day intervals. During the carbon dioxide production there was no influence of pesticide applied. However, the total amount of carbon dioxide produced during 15 days was suppressed by all pesticides, except MCPA (Chwastox). The impact of pesticides on microbial activities varied greatly with the type of pesticides used. From experiments, it was concluded that, the MCPA Chwastox did not exert any inhibitory effect on the respiratory rate of microbes, while other selected pesticides showed highly toxic effect on microbial activity soil.

Adriano et al., (2012) studied the toxic effects of four sulphonylureas herbicides on soil microbial diversity under. For the experiments, the types of herbicides used are cinosulfuron, prosulfuron, thifensulfuron methyl, triasulfuron. The herbicides were applied at the normal field dose and at ten-fold of the field dose. The result showed that, the normal field dose had slight effects on soil microflora of the soil. However in case of tenfold of the field dose, the tested herbicides showed stronger effect on soil microbial biomass and its biochemical activities.

Degradation of chlorpyrifos using three bacterial isolates Pseudomonas peli BG1, Burkholderia caryophylli BG4 and Brevundimonas diminuta PD6 was reported by Hossain et al., (2015). From the experimental results, it was concluded that, the pesticide chlorpyrifos was completely degraded by Brevundimonas diminuta PD6 in 12 days. When the concentration chlorpyrifos was increased to 20mg/l, the rate of degradation was found to be maximum by all three isolates at second day of incubation.
Shuyan Deng et al., (2015) studied the organophosphorus pesticides which were collected from the drain outlet of a chlorpyrifos manufacture plant. The isolate which show positive result and named as G1 at an initial concentration of 50 mg/l, degraded 100% of methyl parathion, methyl paraoxon, diazinon, and phoxim, 95% of parathion, 63% of Chlorpyrifos, 38% of profenofos and 34% of triazophos in 24h. From the results, it was concluded that, the Strain G1 was identified as *Stenotrophomonas* sp. can efficiently degrade eight organophosphorus pesticides.

Sunil, (2015) worked on isolation and screening of pesticide resistant cyanobacteria from pesticide contaminated agricultural soils. For the isolation of cyanobacteria, the soil sample was collected from different locations of Baramati-taluka of Pune District. From the isolates, ten cyanobacterial strains were found as endosulfan and monocrotophos tolerating. Out of which, *Synechocystis* strain was found to be highest MCP tolerant (900mg/L). It was concluded that, at pH 7 and 6.4 was optimum for growth *Synechocystis* and *Oscillatoria*. However, both the cultures show optimum growth at 30°Celsius.

Based on the review of literature the present study was undertaken with the following objectives

- Assessment of microbial diversity of soil polluted with industrial pollutants and pesticides in agricultural fields in Mysore District of Karnataka.
- Screening of different isolates of fungi and bacteria for their degradability of pesticides and specific toxic pollutants.
- Morphological and biochemical characterization of potential isolates.