SECTION - A

GENERAL INTRODUCTION

AND

HISTORICAL RESUME
Soil inhabiting organisms including fungi, bacteria and actinomycetes are very well known for playing an important role in the soil by simplifying the complex organic compounds like cellulose and lignin into humus and nutrients which are very easily taken up by the plants. Besides there are certain microbes which cause injurious effects on plants and their products. From by gone ages fungicides are being used for struggling with such sort of adverse effects so as to save our valuable crops.

However in some recent years, use of pesticides including fungicides has been tremendously increased. A generalised account of their usages is shown in the following table.

**TABLE 1**

<table>
<thead>
<tr>
<th>Pesticides</th>
<th>Percent of total pesticide usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1960</td>
</tr>
<tr>
<td>Herbicides</td>
<td>15</td>
</tr>
<tr>
<td>Fungicides</td>
<td>23</td>
</tr>
<tr>
<td>Insecticides</td>
<td>55</td>
</tr>
<tr>
<td>Other products</td>
<td>7</td>
</tr>
</tbody>
</table>

\(^a\) Based on retail prices

\(^b\) Estimated by D.F. Strohbusch B.A.S.F., 1974.
In India approximately 15,000 tonnes of fungicides have been used by the end of the fifth five year plan from which near about half of it was directly introduced into the agricultural lands for combating soil-borne pathogens. Through direct application, incorporation of decaying plant materials or indirect routes such as sprays, dripping from foliage of treated plants, seed treatments, most of the fungicides eventually find their way into the soil. These fungicides may have serious disruptive effects upon soil microorganisms.

In recent years several excellent reviews (Bollen, 1961; Domsch, 1964, 1965; Martin, 1972; Helling et al., 1971; Munnecke, 1967, 1972; Gaur, 1973; Agnihotri, 1971a,b, 1973, 1974) have been put forth on this subject. But most of the literature however deals with insecticides and herbicides. Baker (1970) reported that the use of chemicals, toxic to a wide spectrum of organisms, may be dangerous to subsequent planting because of the indiscriminate destruction of beneficial soil microorganisms. Alconero and Hagedorn (1968) reported that number of Pythium and Aphanomyces decreased in daxon treated soil but other soil fungi did not decrease. Whereas Ko and Farley (1969) reported that PCNB (Pentachloro-nitrobenzene) and its degradation product PCA (Pentachloro-analine) were inhibitory to soil actinomycetes and fungi but had no effect on bacteria. Nabam, mylone, vapam, metasol, mercuric chloride, captan, brassicol and thiride have been reported deleterious to soil fungi (Chandra and Bollen, 1961;
Cordon and Young, 1960; Agnihotri, 1971; Rai and Tiwari, 1975; Mishra et al., 1976-77). A number of other workers (Martin, 1950; Mollison, 1953; Wainwright and Pugh, 1975) however observed that several species become abundant and dominant in the fumigated and fungicide treated soils. Saksena (1960) also reported abundance of *Trichoderma viride* in carbondioxide-sulphide treated soil. Agnihotri (1973) observed *Pythium* species to be highly sensitive to dexon while population of *Mortierella* species which is close to *Pythium* taxonomically as well as physiologically, increased in dexion treated soil. *Mucor* and *Rhizopus* appeared to be unaffected in the benomyl treated soil while numbers of *Penicillium*, *Trichoderma* and *Fusarium* spp. were reduced (Foster, 1975). Richardson (1954) observed that thiram can provide protection for seedlings against soil-borne pathogens for a considerable time even after it has been reduced to nontoxic level. He also reported that thiram resistant saprophytic fungi may be responsible for suppressing to pathogens through either competition or direct antagonism. Waksman and Starkey (1924), Katznelson and Richardson (1943), Kreutzer (1963), Vaartaja and Agnihotri (1969) have also studied the effects of fungitoxicants on the type(s) of fungi in treated soils. Wainwright and Pugh (1975) found that captain treatment increased certain species including *Trichoderma koningii* and *Penicillium nigricans* while species of *Chaetomium* and *Verticillium* decreased in population. Sclerotium forming fungi in general were reported more resistant to fungitoxicants than others (Stark, 1948; Davey and Leach, 1941;

Eno (1957), Pugashetty and Rangaswamy (1969), Agnihotri (1971a, 1973), Cram and Vaartaja (1957), Domsch (1959), Klemmer (1957), Gorden and Young (1960) and Balasubramanian et al. (1973) observed that generally fungicides accelerated or did not effect the bacterial population but several other workers (Tu, 1973; Munnecke and Furguson, 1960; Diatloff, 1970) have reported adverse effects of several fungitoxicants including fungicides and fumigants against various types of bacteria. Agrosan, thiram, captan (Kuthuswamy, 1973); thiram and carboxin (Fisher, 1976) were found deleterious to rhizobia and nitrogen fixing bacteria but contrast to it Keeskers and Vincent (1973), Sardeshpande et al. (1973) and Nene et al. (1969) reported neutral or positive effects of various fungicides on bacteria and nodulation of plants.

A number of compounds have been screened for their successful antifungal activity. About 25 years ago it was estimated that one compound in 1,800 tested could become a marketable pesticides and by 1965 the ratio of success had lessened to one compound in 3,000 tested (Wellman, 1959, 1967). However according to a current estimate one out of 12,000 compounds tested is found useful (Straub, 1976). Thus several fungicides have been tested during the last three decades in laboratories and field conditions as well. Laboratory results of toxicant-organism interactions may be considered quite reliable for knowing the nature and behaviour of the toxicant and organisms.
Many workers have worked on toxicant-organism interactions by using various methods (Evans and Martin, 1935; Horsfall et al., 1940; Leben and Keitt, 1949; Marsh, 1963; McCallan, 1947; Peterson, 1941; Thornberry, 1950; Wilcoxon and McCallan, 1930; Williams and Wills, 1962; Reddick and Wallace, 1910; Loo et al., 1945; Farakas et al., 1960; Bain, 1961; Maxwell and Brodji, 1971; Kodmelwar et al., 1977; Dharamvir, 1976; Singh and Charya, 1974; Singh, 1978). But it has been found that toxicants usually fail to show similar effects under laboratory and natural field conditions (Zentmyer, 1955; Zagallo and Katznelson, 1957; Kreutzer, 1960; Szkolnik, 1978). According to Szkolnik (1978) laboratory and green house tests usually are of short duration and involve a single application of fungicide. Field tests, however, require multiple application for disease control. Zentmyer (1955) reported that several fungicides which showed profound effects against certain fungi, failed to control them in the soil. Sharma and Jain (1965), Mishra and Das (1967), Chaurasia (1976) have also observed similar results.

Although about two decades back very little was known about the soil fungicides and their effects on soil fertility; a great deal is now known. But till now it is very difficult to predict perfectly that what will happen after introducing a particular chemical toxicant in to the soil. The activity of fungicides in the soil is known to be affected by three important factors including physical, chemical and biological factors. Bailey and White (1970), Goring (1967, 1970), Leistra (1970, 1971),
Spencer (1970) and Vyas (1976-77, 1977) reported that several important physical factors of the soil such as soil texture, moisture, temperature etc. played important role in persistence of fungicides and other pesticides in the soil. Whereas Miller and Luckens (1966), Munnecke (1967), Crosby and Li (1969) gave evidences for the chemical breakdown of several individual pesticides including certain fungicides. Richardson (1954) and Munnecke (1958a) observed inactivation of certain fungicides by soil microbes. Chacko and Lockwood (1966) found some fungi and actinomycetes capable of degrading brassicol. Spanis et al. (1962), Edginton and Corks (1967), Munnecke and Mickail (1967) have also supported the theory of biological degradation of fungicides and other pesticides. Hartzfeld (1957) reported that brassicol persisted for one year in the soil. Whereas conversion of PCNB (brassicol) to PCA (pentachloroaniline) was observed only in sterilized soil by Ko and Farley (1969).

Degradation of thiride, difolatan, dithane M-45 and dithane Z-78 by physico-chemical as well as by biological factors of the soil was reported by Vyas (1976-77, 1977). Dubey (1974), Lutman (1974), Dubey and Rao (1975), Sinha et al. (1980) have recently studied similar problem of persistence of pesticides in the soil. Interestingly certain micro-organisms can be used for solving the problem of various kinds of pollution. Suzuki et al. (1968) and Tonomura et al. (1968a,b) have developed a novel detoxification process for industrial waste waters. They developed a strain of Pseudomonas (K62 strain) capable of sorbing mercurials and stimulating their vaporization. They
found that one gram of cells removed 15 mg of mercury from 2.5 liter of industrial waste water and reduced mercury content to approximately 10% of the initial concentration.

Besides the problem of pollution or increasing the residual toxicants into the soil has also compelled the scientists and users to think about the utility of such chemicals on long term bases. Several workers like Hartley (1964), Munnecke et al. (1967, 1970), Goring (1970), Mortland (1970) and Spencer (1970) have discussed the role and importance of physical aspects of the soil after introducing various pesticides into the soil. Besides Luckens (1966), Munnecke (1967), Crosby and Li (1968), have worked on soil chemical and toxicant interactions. Goring (1962a, b) reported no change in the chemical effectiveness in the soil due to its pH, organic matter, texture etc., contrast to the work of Munnecke (1958a) who reported that soil factors such as moisture, temperature and pH played an important role in affecting the toxicity of a toxicant in a soil. There are many other workers (Sund, 1956; Bailey and White, 1964; Talbert and Fletchall, 1965; Hamakar et al., 1966) have also reported soil toxicant interactions. Change in the pH due to addition of some fungicides and fumigants was reported by Weed et al. (1953), Ludwig et al. (1954), Munnecke (1958a), Munnecke and Martin (1964). However Oblisami et al. (1979) reported no change in the pH of soil due to addition of carbofuran an insecticide.

Although generally speaking, fungicides applied properly have had few untowards effects on crops subsequently grown in
the soil, their effects can not be neglected. Sometimes they may cause severe effects on seed mycoflora, seed germination and seedling growth of important crop plants. Thus effects of fungicides on seed myco-flora, seed germination and seedling growth of crop plants subsequently grown in the soil are essential and important aspects which should also be investigated thoroughly.

Rathaiah and Pavgi (1970), Sekhon and Suryanarayana (1970), Wallace and Mills (1970), Khare et al. (1972), Kanaujia (1974), Dwivedi and Tondon (1976), Zarzucha (1977) and Ramaprasanna (1979) reported the effect of several fungicides on seed myco-flora and seed infecting fungi. However a number of workers including Phokharkar (1963), George et al. (1970), Nene (1971), Kanaujia (1974) reported adverse effect and phytotoxicity of fungicides during seed germination and seedling growth of the plants. Thorn and Richardson (1970, 1971) have reported the effects of nine fungicides applied as soil drenches on amino acid transport in tomato plants. Whereas Prasad and Pramer (1968) reported that ferbam (240 - 1000 ppm) induced mutations in *Aspergillus niger* and caused usually high chromosomal aberration in *Allium cepa* root tips. However Pilinskaya (1970) reported the effect of ziram on barley. He also observed chromosomal aberration in leucocytes of nine persons who worked in a factory producing this chemical.

As such on the whole there appear to be many advantages of fungicides while on the other hand there are many dis-
advantages and draw backs as well.

In the same way people from time immemorial have been using fertilizers for the improvement of soil fertility and crop productivity. These days the usefulness of fertilizers has been increased to a great extent which is quite clear from the table given below.

**TABLE : 2**

Season wise consumption of fertilizers  
1974-1975 (Feb. to Jan.) in India.

<table>
<thead>
<tr>
<th>Fertilizers</th>
<th>Kharif</th>
<th>Rabi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>746.5*</td>
<td>1019.2</td>
<td>1765.7</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>228.5</td>
<td>243.0</td>
<td>471.5</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>170.2</td>
<td>165.9</td>
<td>336.1</td>
</tr>
</tbody>
</table>

*Thousand tonnes.
Source: Directorate of Agriculture.

However these chemicals may also cause undesirable effects on soil microbes, seedmycoflora, seed germination, seedling growth of crop plants as well as on the physico-chemical properties of the soil. A number of workers (Eggleton, 1934; Lochhead, 1958; Peterseva and Rogacheva, 1958; Papavizas and Dave, 1961; Katznelson, 1965; Mishra, 1971a,b, 1972) worked on fertilizers and soil micro-organisms interaction and reported significant changes in the microbial population of the soil and rhizosphere. Whereas effects of various fertilizers on some crops were reported by Patilchandrashekhar (1971), Deshmukh et al.

Manickam and Venkataraman (1972) found that cattle manure and chemical fertilizers containing N, P, K caused positive effects in some of the physical properties of the soil. Eno and Blue (1954), Sandhu and Bhumbla (1967), Bezdicek et al. (1971), Jadhav (1976) and Sadashivaiah et al. (1980) also observed interactions between chemical fertilizers and physical and chemical properties of the soil.

Thus keeping all these important aspects in view, experimental work planned and carried out during the cause of these investigations include mainly the following objectives.

(i) **Effect of fungicides and chemical fertilizers on soil micro-organisms (soil fungi and bacterial population).**

(ii) **In vitro** effect of fungicides and chemical fertilizers on certain selected fungi.

(iii) **Persistence of fungicides in the soil.**

(iv) **Effect of fungicides and chemical fertilizers on the chemical nature of the soil.**

(v) **Effect of fungicides and chemical fertilizers on seed mycoflora and seed germination of some important crops.**