INTRODUCTION

1. INTRODUCTION

> "Progress in knowledge of microbial life in the soil may depend very largely on a proper understanding of the size and the extent of microhabitates and on the range of influence of the individual species".
>
> (Burger,1958)

The soil is the home of innumerable organisms that range in size from those too small to be seen with a powerful microscope to large forms such as earth worms. The biology of the soil is always an interesting and important study; a study which will continue to contribute to our knowledge of agriculture and biology. Microbes are most often classified according to their morphology and specific environmental requirements. On the basis of this, three major groups are recognized: fungi, bacteria and actinomycetes.

Fungi constitute a natural group of organisms that are of great scientific and aesthetic interest to students of nature. In a more practical way, they affect all of us as the living agents concerned in the causation of such various processes as the fermentation of wine and bear, the ripening of cheases, the production of antibiotics like penicillin

and other industrial products such as citric acid and vitamins, the decay of timber, the spoilage of leather and textile, the production of many kinds of disease in cultivated plants and the maintenance of soil fertility through the decomposition of dead plant remains in the soil. Although other kinds of organisms may be associated with them, it is the fungi that play the pioneering and often the principal part in the processes listed above, as well as in some others.

Walksman (1916) raised the question whether soil is the home of an indigenous mycoflora, or merely a resting place for fungal spore floating in the atmosphere. He and subsequent workers have indicated that many fungi grow and reproduce in soil; nevertheless, soil is also undoubtedly a 'sink' for a wide range of organisms from other habitats. The term soil fungi has no precise meaning (Harley, 1960). It is applied to the heterogenous collection of fungi which may be isolated from soil, or which have been observed to exist in some form in soil. With some fungi, the soil phase appears to be little more than a resting spore; others appear confined to soil and complete their life cycle there. Interest in fungi occuring in soil has been great and Cooke (1958) considered that soil has probably been studied more extensively than any other natural habitat of fungi. This is

partly because of the importance of fungi as plant pathogens, partly because of their importance in the decomposition of plant and animal residues and partly through interest in mycorhiza and the rhizosphere. Although knowledge of fungal fructification occurring in soil is ancient, Adametx in 1886 is considered to have been the first person to isolate fungi from soil. After that such work was not carried out till 1902 when Oudemans and Koning isolated and described forty-five species of soil fungi from Holland, majority of which were new to science. Succeeding this a large number of contributions were made from different parts of the world including; Hagem (1907), Lendner (1908), Dale (1912 and 1914), Jensen (1912), Harvey (1925), Jensen (1931), Grey and McMaster (1933), Grey and Taylor (1935), Campbell (1938), Garrett (1938a,b and 1963), Tresner et al. (1954), Gilman (1959), Warcup (1967), Hattori (1973) and Brady (1990).

In our country, study of soil fungi started in 1915, when Shaw recorded four isolations from pusa soils. Thakur and Narris (1928) described about twenty-five species from Madras soil with special reference to their power of cellulose decomposition and ammonification. Chaudhuri and Sachar (1934), Chaudhuri (1939) and Chaudhuri and Umar (1939) described a number of fungi from the soil. Galloway (1936) made two hundred isolations from different plots,

representing about thirty genera and allocated them to their approximately systematic positions. Ghatak and Roy (1939) isolated twenty-three fungi belonging to seven genera from the paddy the contributions of Burtler (1939) Dutta and Chaudhury (1944), fields of Bengal. Amongst the other Indian workers, Ravi Prakash and Saksena (1952), Saksena and Mehrotra (1952), Saksena and Murti (1953), Dwivedi (1958), Rai and Tewari (1960), Ghosh and Dutta (1960),Mehrotra and Agnihotri (1961), Mehrotra and Kumar (1961), Rai and Mukerji (1961), Saksena and Sarbhoy (1964) and Singh (1977) deserve a special mention.

Soil fungi may be divided into three groups: yeasts, molds, and mushrooms. Only the last two groups are considered important in soils. Yeasts are rare in soil habitat. The molds are distrinctly filamentous,microscopic or semi-microscopic fungi and they play an infinitely more important role in the soil than the mushroom fungi. Molds develop vigorously in acid, neutral or alkaline soil. Many genera of molds occur in soil, of which the most common ones are Penicillium, Mucor, Fusarium, and Aspergillus. The soil conditions determines their dominance.

Fusarium species are frequently observed in temperate as well as in tropical regions on a wide variety of

substrates. They are plenty in cultivated soil and stored human and animal food in which they produce toxins. There are reports of the presence of Fusarium in the permafrost of the Arctic and Sand of the Sahara. Species of this genus have also been found in air craft fueltanks (Booth 1971). Fusarium is a well-known plant pathogen causing wilt disease. According to Booth (1971), "As with many soil fungi they are abundantly endowed with means of survival, one of the mechanisms of which is the capacity for rapid change, often morphologically as well as physiologically, to a new environment".

Though the studies of soil fungi have been receiving the attention of a large number of workers, yet the ecological factors which govern their distribution have not been studied in detail. In the present investigation four species of Fusarium are used for detailed study. Fusarium udum, a well known causal agent of wilt disease of pigeon pea was isolated from diseased plants in the field of Kayavarohan - a village 30 kms away from Baroda during the survey of wilt disease of pigeon pea in Baroda disrict. F. pallidoroseum,(formerly named as F. semitectum Berk. & Ray. reported to be a causal organism of leaf blight in pigeon pea (Singh 1988)) was isolated from the seeds of pigeon pea (Arya and Mathew 1991). F. oxysporum and F. moniliforme were

isolated from soil mycoflora of the Arboretum of Department of Botany, M.S.University of Baroda.

Cultural and biochemical studies help us in understanding the nutritional behaviour of the microorganisms and the detailed information achieved through these investigations pave way to suggest some suitable control measures. Hurley (1936) in his well-expressed words states, "A knowledge of nutritional requirements of parasitic fungi should be of considerable aid in interpreting the phenomenon of their specificity of certain hosts and of the method of hypahl penetration into the plant tissue as well as, establishment of the organisms after penetration". The importance of such studies have been recognized since the classical work of Louis Pasteur.

Apart from the fundamental knowledge they impart pathway of utilization of various nutritional substances, formation of certain synthetic and breakdown products and several other metabolites. These studies are essential for understanding the general behaviour of the organisms in detail. Need of proper assessment of nutritional and physiological responses before suggesting suitable control measures was emphasized by Tandon (1967). Fungi are highly sensitive to their environment and apart from chemical factors, any change in physical environment may bring about

a marked variation in their cultural behaviour. Effect of various temperatures and hydrogen ion concentration, (The two main determining factors in the development of disease) on the growth and sporulation of the four Fusarium spp. in the still cultures have been investigated. Fungi possess the ability to utilize a wide spectrum of nutrients as sources of energy. A number of organic and inorganic carbon, nitrogen and sulphur compounds were screened and the relative potentialities of the four organisms have been worked out. Chromatographic studies have been undertaken to trace the pathway of their utilization.

Vascular wilt disease caused by fungi are usually highly destructive whether they occur in cultivated crops or in indigenous species. Losses are often such that it is no longer profitable, or some times even possible, to continue to grow the crop without effective control of the disease. There are ample examples of the limiting effect of fungal vascular wilt disease on crop production. In the early 1900's watermelon production was threatened in the major growing areas in southern United States by rapid spread of Fusarium wilt. Cotton production has been reduced in major growing centres of the world by both Fusarium wilt and Verticillium wilt diseases. production of the highly prized bannana variety 'Grose Michel' was abandoned from thousands

of acres of formerly productive land in central America, South America and elsewhere in the world due to invasion of the so called 'Panama disease' caused by Fusarium oxysporum f.sp. Cubense (Mace et al.,1981).

Pigeon pea (Cajanus cajan (L.) Millsp.) provides staple diet for the population in tropical and sub-tropical countries. It is extensively cultivated in developing countries, particularly in Asia and Africa. It is one of the most important pulse crops of India and used as 'Dal' to provide protein food and its green pods as vegetables. The green leaves and tops of plants are fed to animals or utilised as green manure. Husk of pods or seeds with part of Kernel constitutes valuable cattle feed. Dry stalks obtained after thrashing are used for basket making or as fuel or thatching material. Pigeon pea commonly called 'Arhar' in India is growing all over the country and the annual acrage is about 6.0 million acres with a production of about 1.7 million tons of grains.

Pigeon pea wilt caused by Fusarium udum Butler is a serious disease in the Indian subcontinent (Nene 1980, Kannaiyan et al.,1981). The wilt disease was discovered and described by E.J.Butler in 1906. He isolated and identified the causal organism as F. udum. The disease did not drow

much attention till 1920s when W.McRae described it in series of reports of Imperial Mycologists. Work on this disease has been reviewed by Nene et al (1979), Upadhyay (1987), Upadhyay and Rai (1989). Dahiya (1980) and Nene et al. (1985) have compiled an annotated bibliography on pigeon pea and pigeon pea disease respectively. The symptoms of the disease have been described in detail by Butler (1910), Satyanarayan and Kalyansundaram (1952), Subramanian (1963), Chanbe (1968) and Amin et al.,(1976).

Crop rotation and mixed croping are traditional practices. Mundkur (1967) suggested that if long rotations are practiced the intensity of the disease can be effectively reduced. However, the problem with crop rotation in India is that, generally short periods of rotation (1-2 years) are adopted because of low holding of farmers, which is insufficient to eleminate the pathogen from field. The type of the crop used in crop rotation greatly influence the effectivity of the rotation. Bose (1938) found that rotation of pigeon pea with tobacco after every 3-4 years significantly suppresses the disease. Another percautionary measure suggested as early in 1918 is the systematic removal of wilted plants from field and their subsequent burning. However, this practice is neither of much use nor all but feasible (Upadhyay and Rai, 1982). There are several

examples of use of fungicides and other chemicals for the disease management (Sinha, 1975; Ghosh and Sinha, 1981; Upadhyay and Rai, 1981).

Attempts were made to use solar energy for controlling biotic agents in soil and in plant material already in the ancient civilization of India (Katan, 1981). Groosheroy (1939) used the term "solar energy for soil disinfection" for heating the soil by exposure to direct sunlight to control Thielaviopsis basicola. Adoms (1971) came up with the idea to heat the soil for disease control by mulching it with polyethylene sheets during the growing season. Soil solarization is a new soil disinfectation technique first described by Katan et al. in 1976 for controlling soil borne pathogens and weeds,mostly as a preplanting soil treatment. This is a method of covering the soil with transparent polyethylene sheets during hot summer months, there by heating the soil and killing the pests and soil borne microorganisms.

Soil solarization is the third approach for soil disinfestation. The two other main approaches, soil steaming and fumigation, were developed at the end of the 19th century. In the year following the first publication (Katan et al. 1976) soil solarization was investigated in at least 24 countries mostly in the hot regions (Fig.1). Katan et al.

(1987) summarized a bibliography of the whole solarization work done during a period of 10 years i.e. 1976 to 1986.

In the present investigation I tried to find out the effect of solarization on soil microflora. Polyethylene sheets of different thickness and colour were employed to study their capability to increase the soil temperature in the field and to select the suitable ones. Effect of solarization on microbial population in soils amended with medicinally important plants, was also investigated.

Pathological studies consisting of study of disease symptoms, pathogenicity test (proving of Koch's postulates) and detection of Fusaric acid in the four Fusarium species have been undertaken in order to confirm the pathogenic nature of the four entities.

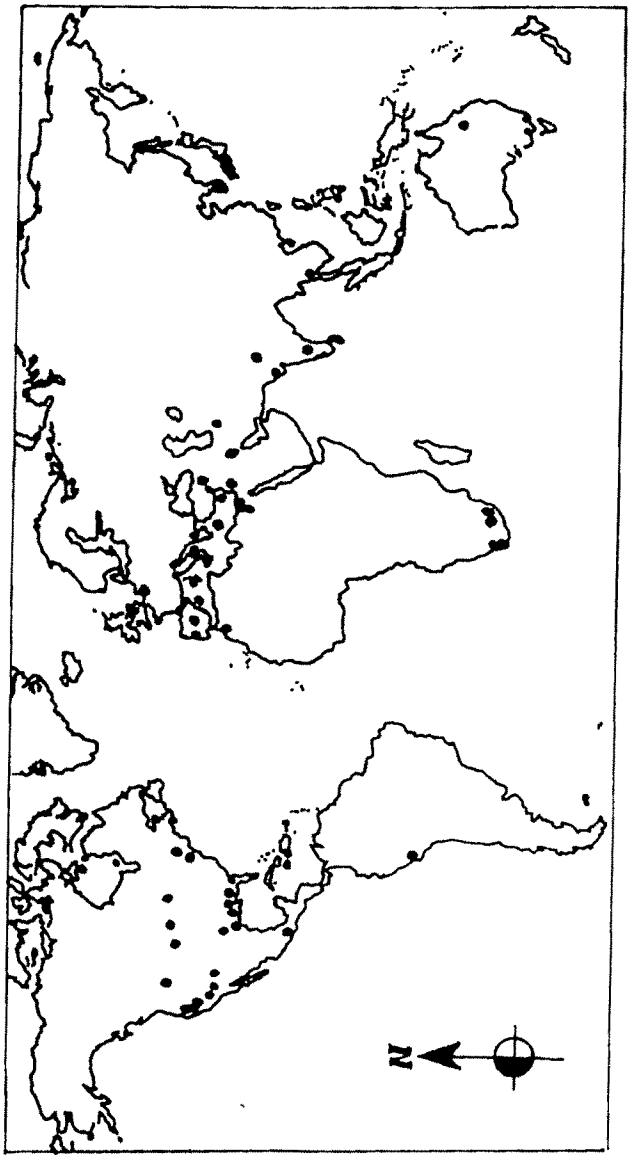

Fig 1 World distribution of sites (indicated as black dots) where solarization has been investigated