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Modern Trends in Indian Agriculture : Plant Pathology

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Introduction : Plant diseases constitute one of the greatest obstacles to efficient and steady agricultural production. While the study of plant pathology has progressed by leaps and bounds in foreign countries, its progress in India, though not of the same magnitude, is still, by no means megre. Considerable headway has been made on the fundamental work relating to soil borne pathogens especially of Fusariose wilts and the information now available is of immense value for planning our future programme of research on sound lines. Furthermore the evolution of disease resistant varieties by breeding and the ready availability of a variety of fungicides, antibioties, other chemicals equipment etc. for plant protection work have to a large extent revolutionised Indian Agriculture. Of late the radio–active isotopes have also entered the field of agriculture and offer great promise for future development of Indian agriculture. The modern developmental trends in plant pathology have been mostly on these lines and a brief account of the same is presented in this paper.

Soil-Borne Fusaria : The soil–borne diseases caused by different apeciea of *Fusarium* are important. In recent years considerable attention has been paid to the study of the mechanism of wilting in the infected plants. The conception of vivotoxins as explained by Dimond and Waggoner (1953) has led to a new orientation to the methods of approach to the study of wilt diseases. The recent researches conducted in India and elsewhere have indicated that the emphasis has shifted from the purely quantitative and qualitative routine investigations of soil mioroflera to one of biological and biochemical approach. It is further observed that a closer understanding of the physiology of wilted plants is essential in understanding the host parasite interaction and the consequential changes in the external and internal symptomotology of wilted plants. The actual mechanism by which wilting occurs has been the subject of considerable controversy and two theories are generally put forward to account for the wilting phenomonon viz the vessel plugging theory and the toxin theory. Evidence in support of each are

presented by research workers adhering to the respective theories; but, in the present state of our knowledge, it is difficult to subscribe categorically to one or other of these views.

Experimental evidence by many workers indicated that the succeptibility of plants to diseases particularly to infection by root disease pathogens is conditioned to a considerable extent by their nutrition (Waiker and Hooker, 1945, Walker and Foster 1946). The control of wilt diseases caused by vascular Fusaria has been reported by amending the infested soils with trace elments especially Zinc and manganese (Sarojini) 1951 and Sulochana 1952). Recent work by Gaumann (1951) with wilt toxins has also indicated that the degree of damage caused by these toxins depends upon the nutritional status of the host, the under nourished being the worst affected. It is reported by Sadasivan and his associates (1954) that the application of many trace elements has brought about profound changes in the soil microflora and the consequent effects on colonisation, survival and pathogenicity of several Fusaria. Investigation carried out by them using wilt sick soil over a pH range of 4–8·3 have shown that the addition of Fe and Mn added individually and in combination to wilt infested soil reduced survival of Fusaria, the Fe/Mn combination being superior to individual elements.

Extensive chromatographic studies on the distribution of various constituents in roots and shoots of resistant and susceptible varieties of cotton have shown that cystine was consistently present, besides the other constituents in the resistant varieties whereas it was absent in the susceptible varieties. The possibility of cystine in the resistant varieties chelating with Fe in the host and rendering the iron unavailable for forming the complex with the toxin which appears to be a prerequisite for toxigenic wilting has also been suggested. The important role of chelation of phytotoxins with heavy metals *in vivo* and *in vitro* in the mechanism of Fusariose wilts of plants has been emphasized by several workers. Investigations carried out in Madras have indicated that chelating agents offer a method of wilt control through the removal of free trace elements in susceptible hosts and heavy metal chelation in pathological wilting.

Greater emphasis has been laid on pH changes in soils since pH has now come to be regarded as an important factor in the mobilisation of ions particularly of heavy metals for plant growth and general microbial activity in soils (Stiles, 1946). It is well known that suitable adjustment of pH of the soils has been used for many years for the control of diseases incited by certain soil borne pathogens.

It is thus seen from the foregoing account that future work has undoubtedly to be one of intensive study of the physiological relationships of the pathogene and the host *in vivo*.

Antibiotics: The phenomenon of antagonism or antibiosis among microorganisms dates back to the early days of bacteriology. In earlier years studies were made on mixed infections, accidental contamination of cultures, the effects of one organism or its metabolic products and even attempts to utilise them for disease control all represented a series of uncordinated observations rather than a system which would fit into a new and important branch of science. The new 'antibiotic age' dates from 1938–39 only when a series of co–ordinated studies were made in several laborateries throughout the world. New antibiotics are constantly being discoverd and several of them have already found important applications as chemotherapehtic agents. Many diseases that could not be combated previously have been found to lend themselves readily to therapy. By constant research it has become possible to step up their yield considerably. The potency has also been increased through selection of strains and improvement in culture technique. As the techniques were perfected mass scale preparations were easily undertaken and now several antibiotics have been made available at considerably reduced cost. In recent yeare phenomenal control of several destructive diseases of crop plants has been reported by various workers. To cite a few instances the following may be mentioned. Gregory *et al.* (1952) reported control of damping off of alfalfa seedlings by spraying actidion. Laben and Meitt (1952) found that Helixin, an antibiotic produced by *Streptomyces* sp. was effective in controlling early blight of tomoato when sprayed at a concentration of 6. 5 mgm/ml. Brian *et al.* (1951) have demonstrated that griseofulvin, an antibiotic obtained from *Penicilliam nigrum* acted as a systemic fungicide and prevented infection by *Botrytis cinerea* on lettuce and *Alternaria solani* on tomato. Brian (1952) reported that Gilotoxin another antibiotic obtained from *Trichoderma viride* acted as systemic fungicide in tomato plants and checked infection by *Alternaria solani*. These citations serve to emphasise the tromendous progress made in recent years in the development of a new branch of chemotherapy comprising the utilisation of antibioties frequently referred to as 'antibiotic therapy'. In this connexion it must however be mentioned that although the use of antibiotics offers a fruitful line of investigation for the control of plant diseases the efficacy of these products is to be ascertained by actual experimentation on different crops under our conditions and then specific recommendations are to be made.

Disease Resistant Varieties in Agriculture: The need for the control of plant disease is becoming increasingly recognised all over the world. Among the control method developed, the discovery of fungicides, antibiotics, chemicals and their use, no doubt, marks a distinct advance in the development of scientific agriculture. But such direct methods of control are not of universal application and are bound to be restricted to a few crop deseases only. But by far the most practicable and economical method is the production of disease resistant crop plants combined with other desirable agronomic qualities. This method is no doubt a long range and time consuming process but in the long run is the most effective and feasible method. The control of the disease by the evolution of disease resistant varieties is further complicated by the existence of physiological races of fungal pathogens produced in nature by hybridization, mutation or otherwise. It is a well known fact that a variety known to be resistant to a particular disease in a locality does not always remain resistant and succumbs to the disease in due course. It is, therefore, evident that there can be no end for the evolution of disease resistant varieties and it shoud be a continuous process. But still accomplishments in this line are many and notable advances have been made in obtaining rust and smut resistant varieties of cereals, wilt resistant tomatoes, flax, corn, cabbage, cowpea, mosaic resistant tobacco, legumes, blight resistant potatoes root-rot resistant sorghums, mildew resistant cucumbers and many, others. In india also considerable advance has been made in this line and several destructive diseases like paddy blast, black rust of wheat etc. have been effectively tackled by the evolution of disease resistant varieties.

Although several diseases have been effectively kept under check by breeding disease resistant varieties studies relating to the exact nature of resistance, the various factors governing resistance, the effect of environment on those factors, the physiology of the host in relation to the pathogen etc. require intensive study. Recent investigations of paddy blast disease in this state on the factors for disease resistance have revealed that the silicification of epidermal cells was associated with the resistance to the disease. Similarly morpological charactors like hairinness, presence of bloom, number of stomata per unit area, thickness of the cutiele and epidermis etc. have been correlated with disease resistance in plants. In certain cases the presence of certain organic constituents like acids, esters, tanins, oils etc. in the host plants were found associated

with resistance. During recent years, therefore in all studies relating to disease resistance more emphasis is laid on correctly determining the factors responsible for disease resistance and then superimpose them on the varieties having other desirable agronomic qualities. Further in all breeding programmes for disease resistant varieties, the prevalence of the physiologic race flora should be borne in mind.

Radiation and Radio-active Isotopes: The use of atomic energy for the development of agriculture, although of recent origin, has already made striking progress. The ready availability of radio isotopes of a large number of elements has opened up the possibility of initiating a multitude of fundamental investigations which will lead to greater efficiency in production and utilization of agricultural products. It has been known for many years that radiations cause heritable mutations in plants and animals. With the advent of the atomic energy several kinds of radiations have been initiated and mutants are produced at considerably shorter time. Further the frequency of the mutation is also increased by the use of atomic power. Pathogens of crop plants are also susceptible to mutation and it is possible to produce strains of reduced virulence by suitable radiation which may prove to be of immense value in the control of plant diseases.

The effect of radiation has been studied in great detail with reference to plant diseases, The bacterial wilt in apples, Fusariose wilt in tomato, brown rot in stone fruits and diseases due to nutritional and mineral deficiencies such as chlorosis and necrosis have all been reported to be controlled by proper radiation. Arresting the growth of parasitic plants in fruit trees such as twining of cuscuta on mango has also been recorded. It has been reported that radiations are useful in determining the maximum virulence of plant pathogens and also in the development of newer fungicides. Radio-active elements have been made use of in inducing resistance to oats against rust disease. Besides these, the radiations and radio active isotopes are being utilised for food preservation through sterilization. Thus it is evident from the above citations that the use of radio-active isotopes for the investigation of plant pothological problems is an entirely new development and how far these observations could be translated into practical uses under Indian conditions is a matter to be investigated by the future scientists, biologists and agriculturists.

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