I N T R O D U C T I O N -

The days of botanical research with hand lense and razor blade are not over and they never will be; but certainly the emphasis of research effort in plant pathology is in our days undergoing a rapid shift a fact quitely revealed by a persual of the titles of recent year's articles in any journal of plant pathology compared with titles of fifteen years ago. Many investigators are now inquiring into how and why of disease quite as much as describing diseases and persuing their cause. In our universities the curriculum for plant pathologists grows and includes more plant physiology and more physical and biological chemistry than ever in an efforts to equip the new generation of plant pathologists with additional tools of the trade.

In recent years much of earlier symptomological approach to the problems of plant disease has given way to integrated study of cause and effect. It is now becoming increasingly clear that a sufficient knowledge of plant physiology and biochemistry is essential for interpreting the metabolic changes in plants during photosynthesis. As a matter of fact the biochemical and pathological trends of research started about 25 years ago and were founded on the physiological research of host parasite relation. These modern trends of research intend to unravel the physico-biochemical processes of the diseased plants (such as photosynthesis, respiration, nitrogen metabolism and growth). They wish to determine the true

causes of cell proliferation; the possibilities for the inhibition of virus multification; the mechanism of fungal toxicity; the mode of action of toxins; the role of harmones or harmonelike substances in pathogenesis as well as to ellucidate the virus biosynthesis. The importance of extracellular enzymes in the etiology of the disease is emphasized by workers currently interested in this area of investigation.

In recent years there has been increasingly more emphasis on the use of biochemical methods and techniques for research in plant pathology and it has now become possible to offer biochemical explanations for several phytopathological phenomena.

The physiology and plant pathology represents those specialities within plant pathology which focus on the physiological and biochemical activities of pathogens and on the response of host plant tissues. A study of pathogenesis involves not only an understanding of the alteration in normal plant metabolism, water balance and growth responses, but also a knowledge of those factors used by pathogen's to aid or assist in its attack or colonization of host tissues. Thus such a physiological plant pathology mainly deals with the activities of toxins, enzymes and growth regulators as factors involved in pathogenesis and to alternation in metabolic pathways, water balance and growth responses in the diseased plants.

Physiological plant pathology may be characterised as a co-ordinated attempt to define interactions of host and pathogen at the level of molecular biology. According to Duggar's (1911) 'Every disease produced by an organism presents the definate problem of certain complex relations between the cells of the host and those of the parasites'. Again according to Duggar-disease is exhibited through abnormal cell activity.

The diseases of useful plants have been observed since ancient times in all parts of world (Orlob, 1973). Theophrastos of Eresos (370-288 B.C.) recorded the observations of eastern mediterranean region.

Ancient farmer practiced control against losses. Although many controls were primitive and mystical. Early farmers were interested mainly in plant protection rather than in speculations of physicians and philosophers on a disease concept. For this reason, there was virtually no contact between farmers and philosophers - scientists for centuries. And the diseases were thought of as punishment by deities or as the effect of mystic agent.

In Planto's (427-347 B.C.) "Symposium" the Physician Eryxymachos specifically included diseases of plants into the concept of disease as being the disturbance of "harmonia" between "well-balanced eros" and "ill-balanced eros". Also it has been suggested in ancient period that "Disease is a self sustaining dynamic entity."

Plant pathology was strongly affiliated with medicine during that early period and physicians applied their concepts, developed for human diseases to plants. Perhaps one way to relate the classical concept of disease to more modern concept as in physiological plant pathology is to substitute "well ordered and regulated" for "hormonia" recognizing that disease is process in disturbed equilibrium.

As Unger had done in 1833, Ward (1911) devoted a great part of his treatise on plant pathology to the introduction to plant physiology. After he had thoroughly discussed the close and intimate connection of both disciplines in his Cronnian lecture (1890). He did not treat "Physiologic diseases" in detail as Sorauer (1847), Frank (1880) and others had. Further he suggested that "pathology is merely abnormal physiology, no matter how it is brought about". Ward (1901) vigorously discussed examples of all kinds of disease incitants on a very broad physiological background. A comparable treatise did not appear untill Gaumann (1946).

Link (1932, 1933) rejected a simple pathogen disease relationship as a "Pseudoetiology" as proposed that a "thoroughgoing etiology" should include all internal and external factors acting on and in the host and the pathogen before infection and during pathogenesis in the etiological complex.

All terrestrial plants need adequate amount of a number of inorganic elements and organic elements for their normal growth. Excess or difficiency of these causes visible abnormalities (Epstein, 1972). Work of Cochrane (1963) reported the importance of inorganic elements in the growth of lower organisms like fungi. According to Benoit et al., (1978) infections modify the normal inorganic metabolism of the host. They further state that host nutrition influences plant diseases and the relationship between the two quite complex. The role of particular element in various hosts remain more or less similar but different hosts responds differently to nutrients and their response differs against the attack of plant pathogens. The leaves of nutrients are important because nutrient balance in the soil or in the plant ditermine their availability uptake and competition all of which result in either favourable or unfavourable relationship between the plant and the pathogen. Once we know the importance of a particular element in defencing against the attack of pathogen we can profitably use this knowledge to control some of diseases at least partly with this objective in mind an attempt has been made to study the effects of rust infection on inorganic constituents in the leaves of groundnut, Caster and Cassia.

McCombs and Winstead (1964), Hasija (1968), Vidhyasekaran et al., (1974) and Sasikumaran et al., (1979) have studied the effect of infection on carbohydrate status of the

host tissue. They have observed that infections modify the carbohydrate metabolism of the host plant.

The role of photosynthesis and respiration in plants had been known for decades, Unger (1833) proposed all kinds of gaseous exchange of diseased plants in his "respiratory function" as cause occasionalis of exanthemata. Ward (1901), however, discussed the enhancement of respiration and "fever" as a pathological effect and as a single of enhanced metabolism (Chattlock, 1882; Richards, 1896; 1897). Respiration showed a more or less steep increase in early phases of disease to a peak followed by a decline (Fischer and Gaumann, 1929), Romer et al., (1938), Maresquelle (1928) suggested that respiratory enhancement is due primarily to the parasite since micro-organisms are characterized by much greater rates of respiration than higher plants.

Changes in photosynthesis were of early interest in phytopathological research. Tubeut (1895) on the basis of histological observations mentioned that chlorophyll is destroyed in necrotic cells but in others it may be diminished by some toxic influences or conserved as in green islands. Montemartini (1904) claimed for some Uredinales and later Grecusnikow (1936) for oat rust, that photosynthesis is raised for a short time after infection and then drops rapidly. According to Sempioc (1950) increase in photosynthesis in early

stages than respiration and then finally reduction in photo-synthesis than respiration is a state of physiological defense (Metabolic resistance) compared to state the respectivity of the host.

Enzymes play a key role in the synthesis and breakdown of complex compounds such as carbohydrates, lipids and proteins. For maximum activity they need a set of optimum conditions. Due to this any external or internal factors, which is capable of excerting an influence on the set of optimum conditions modifies the enzyme activity. It is a common observation that pathogen disturbs the life processes of the host. With this in view the enzyme activities of rust infected groundnut, Caster and Cassia leaves and those of the healthy ones were compared in order to collect the information regarding changes induced by the rust. For the assay of activities of enzymes in rust infected and healthy leaves the recent spectrophotometric method was employed.

The most common of all the diverse symptoms that characterized disease in plants are those that reveal the decomposition of tissues in one or more structures of the host plant. In fact there are relatively few diseases that do not cause a disintegration of plant tissue in some stage of the pathological processes. Rots, blights and similar diseases involving obvious tissue breakdown were among the earliest

maladies of crops recognised by man. The mechanism by which certain micro-organisms are able to convert healthy plant tissue into a soft or mushy pulp remained almost completely unknown until the latter part of the 19th century. During the 100 years in which plant pathology has existed as a Science and particularly during the last decade our knowledge of these types of disease has been greatly extended. However, in modern text-books and in recent phytopathological literature on tissue necrosis most of the early descriptive names for necrotic disease have been retained and as a result they have acquired a certain status of usage as scientific terms in the terminology of plant pathology.

The disintegration in particular cell can be brought about in two ways : (1) the components of middle lamellae or cell walls are decomposed, resulting in seperation and collapse of the individual cell and (2) the protoplast is attacked directly with loss of its integrity as a functional unit and injury to cell membranes. These effects may operate simultaneously and at least one or more components of the cell may disappear completely. In majority of diseased plants where tissue is disorganized the cell walls are affected first and basic components of cell wall cellulose, pectic substances, lignin, non-cellulosic polysaccharides may be decomposed by enzymes of both pathogenic and saprophytic origin. After disorganization of cell wall the protoplast is killed by the action

of toxins and enzymes secreted by pathogen, then pathogen utilizes the contents of the cells for its growth.

It is difficult to generalize most plant pathogens are likely to attack specific types of tissues or organs. In majority of cases, disintegration of parenchymatous tissue of fruits and vegetables produces a soft rot. More is known about bacterial soft rots than about soft rot caused by fungi. Rotting of the tissue is the primary disease process in necrosis and substances that cause necrosis of cells or tissues in most instances have been considered to be of secondary importance. However, in a large group of foliage diseases the respective pathogens cause local or systemic necrosis and death of foliar tissues mainly through the action of the toxins or related substances that injure and disintegrate cell protoplasm. In many cases, however, organs of diseased and healthy plants differ markedly in form. Roots may be short and deformed leaves may be enlarged and thickened petals may resemble leaves.

With this in view the anatomical changes due to rust infection on groundnut, castor and Cassia leaves were studied and compared with healthy one.

Arachis hypogaea L. (Leguminosae)

The importance of groundnut deserves emphasis as it is the world's second largest source of edible oil. India has

long record of groundnut cultivation dating in 16th century. Even now it is one of the most important groundnut producing countries. Groundnut ranks 13th in imporatance among the world food crops. On global basis the groundnut occupies about 19 million hectares with 19.5 million tonnes of production and with an average pod yield of nearly 1000 Kg/ha. India grows groundnut in about 7.6 million hectares and produces around 6.4 million tonnes (nuts in shells) which are nearly 40 per cent of the world area (37.7 per cent of the produce.). The leading states in area and production are Gujarath, Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Madhya Pradesh which together constitute about 80% area and 81% of production. Remaining 20% area is scattered throughout the country.

Groundnut is important oil seed crop and also because of its utility as a food to common people and as a raw material for the industrialist. The crop has attained international status as one of the chief source of vegetable oil in the world and therefore, it is of particular significance to the country as a "Dollar Crop". There is about 46 to 50% oil content in the seeds and about 26 to 31% proteins. Its halms are also useful as fodder to cattles. Groundnut cultivation requires 75 to 150 cm uniformely distributed annual rainfall. It can also grown in summer under irrigation conditions. Groundnut cropping favours 14 to 42°C temperature range.

The groundnut crop form its infancy to maturity is beset by various pathogens. In India it is attacked by over 55 pathogens including viruses. But the most important ones acknowledged for major reductions in yield are the diseases such as leafspots (Ticca), rust, necrosis, bud blight, collar rot, stem rot wilt or dry root rot etc. These diseases render groundnut production highly unstable. Incidence, losses caused identification and disease cycle are important aspects which are prerequisite to understand the distribution pattern, economic importance, selecting and applying appropriate measures at the most appropriate time.

The rust caused by Puccinia arachidis speg. is newly introduced disease in India. It has attracted the attention of the researchers in view of the economic importance of groundnut crop in India. Since the introduction of this disease, many workers in the country reported its occurance and losses caused due to this disease. Krishna Prasad et al., (1977) working at Dharwad reported the losses in the variety SB-11 to the tonnes of 29 per cent in 1976, Singh (1978) from Ranchi (Bihar) estimated 22-24 per cent losses in variety AK-12-24 likewise. Subrahmanym et al., (1980) reported the losses as 52% in variety Robut 33-1 from Hyderabad. Looking to the losses in yield and fast spread of rust in India the disease has assumed special significance in the crop economy of India. (Plate-IA,IB).

Ricinus communis (Linn.) Euphorbiaceae :

By cultivation it has been distributed through not only all tropical and subtropical regions, but also in many of the temperate countries of the globe.

The valuable purgative known as castor oil is fixed oil obtained from the seeds of the Castor Oil plant. Besides being used medicinally, the oil is also employed for lubricating purposes, burning for leather dressing. The Chinese are said to have some mode of depriving it of its medicinal properties so as to render it suitable for culinary purposes.

The castor oil plant is native of India, where it bears several ancient Sanskrit names, the most ancient and most usual being 'Eranda'. It is very variable in habit and appearance, the known varieties being very numerous and having mostly been described as species. The tropical latitudes are most favourable to its growth, it becomes a tree 30 to 40 fee high; in the Warmer Mediterranean countries - Algeria, Egypt, Greece. In Riviera plant is more slender growth attainding an average height of only 10 to 15 feet. In north France it is cultivated as ornamental plant on account of its large and beautiful foliage, it is merely shrubby branched annual herb rarely more than 4 to 5 feet high.

The seeds contain 50% oil, which is a viscus fluid, almost colourless when pure, possessing only a slight

odour and a mild, yet highly nauseous and disagreeable taste. It contains palmitic and several other fatty acids, among which there is one Ricinoleic acid peuculiar to itself. This occurs in combination with glycerine, constituting the greater part of the bulk of the oil. Both the seeds themselves and the cake left after the extraction of the oil are violently purgative, a property which is due to the presence of the highly toxic albumin Ricin. Ricin exhibits its highest toxicity when injected into the blood.

Caster oil is regarded as one of the most valuable laxatives in medicine. It is of special service in temporary constipations and wherever a mild action is essential and is extremely useful for children and the aged. It is used in case of colic and acute diarrhoea due to slow digestion, but must not be employed in cases of chronic constipation, which only aggravates whilst relieving the symptoms. The fresh leaves of this plant are used by nursing mothers in the Canars Islands as an external application, to increase the flow of milk.

The caster oil plant is attacked by over 15 fungal pathogens. Infection can be seen from germination of the seed upto maturity of the plants. Caster plant attacked by various species of Alternaria sp., Cladosporium oxysporum, Corynespora cassicola, Leptosphaerulina ricini, Melampsora

ricini, Oidiopsis taurica, Sphaeceloma ricini, Periconia byssoides etc.

The rust caused by Melampsora ricini (Noronha) gives serious losses in oil production and number, quality, oil content of seeds. It cause the leaves of dry up and wither prematurely. The symptoms are characterised by many yellowish orange spots or lesions on the under surface of the foliage. The disease usually attack the leaves on the lower parts of the plant and if infection occurs early in the season these leaves fall prematurely (Plate II A, II B).

Cassia sophera L. Leguminosae :

Cassia is a weed plant having shruby habit. This plant grow in tropical regions. The tropical climatic conditions are favourable for good growth of plant, which attained height about 10 feet. Stem is cylindrical and woody. Leaves are pinnately compound and dark green.

The rust Uromyces cassiae on it is distructive to the plant growth and was found for the first time and is described as new species. The infection is severe so the effect of infection on anatomical structure of the leaves and biochemistry are studied. (Plate III A, III B).

Plate I : A. Groundnut leaves infected with rust (*Puccinia arachidis*).

B. Groundnut healthy leaves.

Plate II : A. Castor leaf infected with rust (*Melampsora ricini*).

B. Castor healthy leaf.

Plate III : A. *Cassia* leaf infected with rust (*Uromyces cassiae*).

B. *Cassia* healthy leaf.

Plate I-A

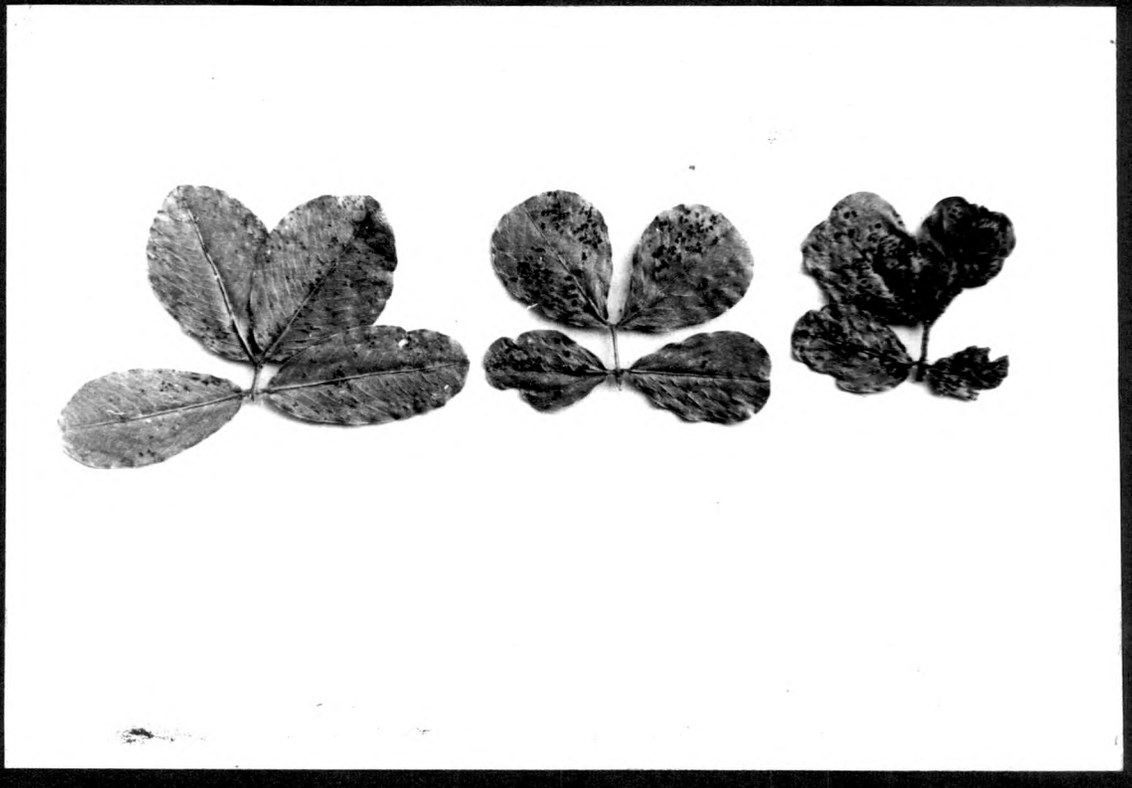

Plate I-B

Plate II-A

Plate II-B

Plate III-A

Plate III-B