PART I

GENERAL AND PATHOGENICITY
AN INTRODUCTION TO HOST

Cucurbitaceae includes fairly large portion of fruit and vegetable yielding plants. It is popular for its conspicuously large fleshy fruits like gourds, cucumbers, melons and pumpkins. According to Chakravarty (1959) the family has a very wide geographical distribution having 660 known species grouped under 90 genera. In India 180 species belonging to 34 genera are found.

The genus *Cucumis* is represented by 39 species. Majority of these species (about 29) occur in tropical Africa. Out of the 6 species recorded in India *C. melo* and *C. sativus* are of common occurrence.

The host *Cucumis utilissimus* Roxb., synonym to *C. melo* L., var. *utilissimus* Duthie and Fuller was selected here for pathological investigations. It is an annual climbing or trailing herb closely resembling cucumber plant (*C. sativus*). The fruits are slender and elongate with their length varying from 10 to 50 centimeters. The colour of the fruit ranges from dark-green to pale turning yellow when mature. The plants are cultivated in most parts of the northern India and are much common in Uttar Pradesh and Punjab. Recently, a number of high yielding varieties have been developed among which *Im-4* is found to be best one. The plants require warm climate. In India, they are grown both in hilly as well as in plain regions. The cultivation is
done both in summer and rainy seasons. The crop grows well in a wide variety of soils but thrives best on well-manured rich loamy soils with adequate supply of water. The crop attains maturity in a short time and the fruits are ready for harvest within 3 to 4 months. The fruit output is appreciably higher ranging from 2800 Kg to 3600 Kg per acre.

The fruits are of high economic value. The tender ones are eaten as such or used as salads. They are also pickled and cooked into curries. Many a times they are used for quenching thirst. The cotyledonary part of seeds is used in confectionary, and the ground kernels are used in the preparation of refreshing drinks. Medicinally, the seeds are cooling, diuretic, highly beneficial in painful micturition and in urine suppression.

The vernacular names of C. utilisimus Roxb. in various Indian languages are:

Hindi = Kakri (Tar Kakdi)
Marathi = Kakdi
Bengali = Kakur
Telugu = Pandiri Dosa

Though the chemical analysis of C. utilisimus, for its various nutritional components has not been worked out so far (The Wealth of India, C.S.I.R., India, Vol. II, pp. 384-392, 1950) but it may not be much different from that of C. sativus being closely allied species. For timely reference
and further need in the correlation of results the details of chemical components of *C. sativus* are being given in following lines:

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>96.4 g</td>
</tr>
<tr>
<td>Protein</td>
<td>00.4 g</td>
</tr>
<tr>
<td>Fat material</td>
<td>00.1 g</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>02.8 g</td>
</tr>
<tr>
<td>Mineral matter</td>
<td>00.3 g</td>
</tr>
<tr>
<td>Calcium</td>
<td>00.03 g</td>
</tr>
<tr>
<td>Iron</td>
<td>01.5 mg/100 g</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>07.0 mg/100 g</td>
</tr>
</tbody>
</table>

The presence of pectolytic enzymes, ascorbic acid oxidase and succinic as well as malic dehydrogenases have also been reported. The values mentioned above have been calculated in 100 grams of raw fruit material (*The Wealth of India, C.S.I.R., India, Vol. II, pp. 384-392, 1950*).

The members of cucurbitaceae, being commonly confined to the tropical parts of the world are often subjected to the attacks by a number of pathogenic forms, because of the suitable environmental conditions prevailing for the disease development. The cucurbitaceous plants, because of their economic losses, have attracted the attentions of a number of cultivators and plant pathologists as well. Drechsler (1925) reported cottony leak of cucumber fruits caused by *Pythium aphanidermatum*. Mitra and Subramanian (1928) found
the occurrence of the same disease on Indian cucumbers. Doran (1932) observed *Pseudoperonospora cubensis* as a causal organism on cucumbers. Brook (1944) found that cucumber crops were heavily damaged by *Pythium* species in United Kingdom. Kapoor and Varma (1948) isolated *Cucumis* virus-2 from bottle gourd in Bombay. Vasudeva et al., (1949) reported a new viral strain of *Cucumis* virus-2 from northern India. McKeen (1954) observed the incidence of powdery mildew on cucumbers and took measures towards the control of the disease. Schmitt (1955) worked out the host specialization of *Erysiphe cichoracearum*. Chean et al., (1959) gave a brief report on the discovery of oosporic stage of *Pseudoperonospora cubensis* causing downy mildew of cucumbers. Anand (1960) purified *Cucumis* virus-2 and worked out its electron microscopic details. Burkholder (1960) made observations on the *Erwinia tracheiphila* responsible for the vascular wilt of cucurbitaceous plants including squashes, pumpkins, gourds, muskmelons and wild cucumber varieties. Lafor (1961) gave a comprehensive list of pathogenic forms occurring on cucumbers in South-West France. Aduvar (1964) reported watermelon mosaic disease from Lajas Valley and found the virus identical to *Cucurbit virus-B*. Dinesca (1964) for the first time recorded symptoms of a new cucumber disease from Romania, induced by *Alternaria cucumerina*. Gabrielson and Campbell (1964) for the first time noticed leaf spots on cucumbers of Western Washington caused by
*Alternaria consortiale*. Hariharasubramanian and Badami (1964) were workers to notice *Cucurbita mosaic* virus, for the first time on Indian pumpkins and studied the nature of the virus particles. Mahadevan (1964) correlated resistance of cucumbers with the production of phenolic compound as a response to the pathogenesis of *Cladosporium cucumerinum*. Rogers (1964) described the symptomatological details and control measures against common diseases of cucurbits. Schmidt (1964) reported incidence of *Colletotrichum lagenerium* producing anthracnose symptoms on melons of Austria and suggested some definite fungicidal treatment against the disease. Alaslopez (1965) noticed the destruction of melon foliage, as well as premature ripening of fruits, as a response to the infection of *Pseudoperonospora cubensis* in Salvador. Allam (1965) recorded typical mosaic viral symptoms on cucurbits of Cario. Mahadevan et al., (1965) worked out the biochemical aspects of resistance in cucumber against *Cladosporium cucumerinum* attack. Rajendran (1965) for the first time noticed perfect stage of *Erysiphe cichoracearum* on *Lagenaria vulgaris*. Ray (1965) gave a list of 42 fruit rot pathogens and also reported *Colletotrichum lagenerium* as pathogenic on cucumbers of Assam. Grote (1966) confirmed that *Sphaerotheca fuliginea* was responsible for the causation of powdery mildew in cucurbits. Singh and Bhargava (1966) studied the role of host nutrition on the multiplicity of watermelon mosaic virus. Jones and Everett (1966) made efforts to control anthracnose, downy mildew and soft-rot
diseases of cucumber caused by _Colletotrichum lagenarium_, _Pseudoperonospora cubensis_ and _Rhizoctonia solani_ respectively. Van Andel (1966) worked out the mode of action of an antiauxin compound against _Cladosporium cucumerinum_, a scab causing form in cucumbers. Jhooty (1967) identified powdery mildew on Indian cucurbits. Kapoor (1967) reported _Sphaerotheca fuliginea_ as a pathogenic organism on some cucurbitaceous plants of India. Ghaffar and Akhtar (1968) observed the survival of _Macrophomina phaseoli_ on the roots of _Luffa acutangula_ in Karachi. Mukhopadhyay and Saha (1968) proved that the cucumber mosaic virus is transmitted through agency of _Cucurbita maxima_ seeds. Raina _et al._, (1968) used aqueous potassium per manganate and bleaching powder against the fruit rot of _Cucumis melo L._, var. _utilissimus_ induced by _Fusarium sp._ Ram (1968) observed _Momordica charantia_ as a host to _Phylosticta cucurbitacearum_ in Kalianpur. Chand and Walker (1969) recorded sequential changes in amino acid pattern during the development of angular leaf spot disease of cucumbers caused by _Pseudomonas angulata_. Crossan and Sasser (1969) suggested crop rotation as a remedy to minimize the frequency of _Cladosporium cucumerinum_ from fields. The rotation of susceptible cantaloupe and cucumber with maize was also found to be beneficial in controlling the pathogen in New York. Desai and Pathak (1969) worked out some pathological details on soft-rot of _Luffa cylindrica_ caused by _Pythium butleri_ in Rajasthan. Sitterly (1969) from
Carolina, suggested longer intervals between successive cucumber crops to lower the percentage of foliar infection by *Mycosphaerella melonis*. He found that an eighteen months rotation was most useful. Wiggell and Simpson (1969) made a note on the symptoms and control of the *Phomopsis* rot of cucumbers. Khan (1970) controlled the powdery mildew attack on *Cucumis melo var. inodorus* in Pakistan. Khan and Khan (1970) from northern parts of India described the cleistothecial stage of *Erysiphe cichoraciarum* on cucurbits. Mishra *et al.* (1970) compared the rhizosphere fungal flora of virus infected and healthy *Cucurbita maxima* plants. Verma *et al.* (1970) made a record of viral infection of cucumber in India. He described the isolate as cucumber green mottle mosaic virus. Bhaskaran *et al.* (1971) recorded the occurrence of *Fusarium* wilt of muskmelon. Jaganathan and Ramakrishnan (1971), thoroughly investigated the properties of two viruses infecting melons and pumpkins of Madras state and established that these are the strains of melon mosaic virus. Jhamaria and Patel (1971) described the symptoms of wilt and cultural characters of *Fusarium* species isolated in Rajasthan. Kamal and Schlosser (1971) developed some resistant hybrids of cucumber having greater tolerance towards viral infection in Lebanon. Kocistra (1971) contributed in the development of resistant varieties of *Cucumis sativus* against *Sphaerotheca fuliginea*. Michail *et al.* (1971) were successful in eradicating
**Rhizoctonia solani**, **Macrophomina phaseoli**, **Fusarium semitectum** and **F. solani** responsible for damping off of cucurbitaceous plants from United Arab Republican. Nagy (1971) gave a note on the identification of powdery mildews of cucurbit on the basis of conidial characters. Pillai (1971) recorded mosaic viral symptoms on **Trichosanthes anguina** from India. Purushothaman and Raghunathan (1971) observed the occurrence of **Cercospora citrullina** on **Cucumis sallosus** in India. Shukla and Singh (1971) traced out the mode of transmission of **Cucumis virus-2D** through injured roots. Bhaskaran and Prasad (1972) developed resistance in **Cucumis sp.** against **Fusarium oxysporum** using certain inhibitors. Omrod and Christie (1972) found **Phomopsis solereticida** as rot causing organism responsible for 50 per cent losses in the yield of green-house cucumbers in north America. Gangopadhyay and Kapoor (1973) isolated **Alternaria cucumerina** causing fruit rot of **Cucurbita pepo** and have successfully evaluated control measures against this disease.

It is apparent from foregoing discussion that the family as such is highly susceptible to a number of pathogenic forms resulting in tremendous economic losses. With this in view a survey was made in vegetable markets and cucumber fields of Saugar city to study the occurrence of cucumber diseases. The disease in question i.e., **Pythium deliense** fruit-rot of **Cucumis utilissimus** was not only found to be much
frequent as transit and storage disease but also in the standing crops. Though this disease was found to be extremely destructive on Cucumis utilissimus, similar symptoms could be seen on other cucurbits also. The fungus is polyphagous as could later be proved by experimentation. The present host was selected for detailed study as it appeared to be the worst victim.

Although, symptomatological, biochemical and control aspects on fruit rot of Cucumis sativus by other pathogens have been studied by various workers, the effects and biochemical changes brought about by Pythium deliense Meures, on Cucumis utilissimus have not been studied so far. Studies were, therefore, undertaken as regards incidence and biochemical changes brought about by P. deliense on Cucumis utilissimus so as to develop suitable control measures against the pathogen. Work done and observations made, in this connection are reported in the following pages.
THE PATHOGEN

Pythium deliense Heures, the causal organism of the present fruit-rot, was isolated from the diseased fruits of Cucumis utilissimus Roxb. (synonym to C. melo L., var. utilissimus Duthie and Fuller), and further confirmed for its pathogenicity. The isolate was identified by Commonwealth Mycological Institute, Identification Services, Kew, England and has been deposited with the Institute's herbarium (Herb, IMI number 223210).

Within the limits of available literature and also on the basis of a thorough review of literature on fruit rot diseases, it was noticed that the pathogen P. deliense is being reported for the first time on C. utilissimus fruits.

The fungus was earlier reported from Jambu, India, by Pandotra et al., (1971) as pathogenic form causing wilt and stem-burn disease on Tephrosia vagellii. But as a fruit-rot pathogen, this is first report.

The cultural characters and measurements of the pathogen are as follows:-

Colonies on PDA coarse, floccose, white attaining 30 mm radial mycelial growth in 36 hours at 30°C. Mycelium aseptate, hyaline to subhyaline forming compact mats at maturity; aerial mycelium 3.3 - 6.6 μ (commonly 4.5 μ) in
diameter; basal mycelium 3.3 - 8.5 μ in diameter. Superficial haustoria-like structures (usually not formed in host cells) finger-like, clavate, clustered, measuring 36.5 - 50 x 16.5 - 20 μ. Sporangia on indeterminate sporangiophores, terminal on lateral branches of mycelium, smooth-walled, spherical to ovate, measure 16.6 - 26.6 x 16.5 - 20 μ. Oogonia abundant in gel cultures, terminal, smooth walled and spherical, 16.6 - 23.3 μ in diameter, each containing one oospore ranging from 15 to 16.5 μ in diameter. Antheridia arising close to the origin of oogonia and usually one per oogonium. Oospores 18.3 - 20 μ, spherical, smooth walled, consisting one centrally placed irregular fat body (Plate 1, and 3).

The measurements of the pathogen mentioned above are in close approximation with the type description of fungus (Meurs, 1934) confirming its identity as P. deliense Meurs.
THE DISEASE

The fruit rot of *Cucumis utilisimus* Roxb., caused by *Pythium deliense* Murr., is quite frequent under storage, transit as well as in cultivators fields of Saurat. On account of the trailing habit of the host plants, many of the fruits come in contact with the soil surface and get infected. This clearly indicates the soil borne nature of the pathogen. Although, the injury is not a prerequisite for the entry of the pathogen (as will be clear from inoculation experiments), but injuries caused on the fruit surface during post-harvest handling clearly facilitate infection.

The infection is generally initiated during the start of monsoon. Water soaked patches appear on the fruit surface which subsequently enlarge and coalesce. In the presence of moisture, which favours the production of sporangia on the surface of the infected fruits as well as the release of zoospores, a profuse growth of cottony mycelium gradually encroaches the entire intact surface of the fruits (Plate 5). But, when the pathogen finds a way through injury, a severe internal rotting is set in, without an appreciable mycelial growth being produced over the fruit surface. At advanced stages of rotting the fruit rind becomes wrinkled, the tissues turn slightly brownish, soft and pulpy, with a
simultaneous release of unpleasant odoriferous juices. These
diseased fruits collapse by this time and are often thrown
in the fields. The ascospores produced in the tissues (Plate 3)
being comparatively resistant, help in the perpetuation of
the disease to the following season.