INTRODUCTION

"Just as when the disease known as Manjithika % falls on a field of ripened sugarcane, that field does not last long, even so, Ananda, in whatever discipline of Dhamma women are allowed to go forth from the home to the homeless life, that godly life will at last long."

-Lord Budha

Sugarcane has an old association with this country. It has been brown in India from the immemorial mention of it occurs in the Vedic literature (500 B.C.). Chinese writers of the 8th Century have been recorded that knowledge of sugarcane and its products were derived from India. In fact, the English word "sugar" is believed to have originated from the Sanskrit word "Sharkara". It also known as Ganna or Ekh in vernacular language, belongs to the family Poaceae, sub-family Panicoideae super tribe Andropogoneae, sub tribe Saccharineae and genus Saccharum is a perennial tropical grass, by Rao et al.,( 2002). There are six recognized species in the genus, three cultivated viz; Saccharum officinarum L; S. barberi Jesw; and S. sinense Jesw; and three wild species; S. spontaneum L; S. robustum. Brand and Jesw, and S. edule Hassk S. officinarum. and S. robustum. with other genera. S. officinarum. is known as Noble Cane and S. robustum wild species. Alexander the Great's soldiers, after their visit to India, are reported to have marveled at the production of honey without the 'intervention of bees'. There are many reasons for believing that India was the original home of sugarcane that is to say of indigenous Indian canes known botanically as Saccharum barberi Jews. These canes are thin or medium in
thickness. The thicker class of canes known botanically as *Saccharum officinarum* L. and originally grown in Mauritius, Java, Brazil, West Indies, were preferably of South Pacific rather than of India origin (Dutta, 1946).

The cultivated varieties of sugarcane in India and abroad are interspecific involving of *S. officinarum*, *S. barberi* and *S. spontaneum* (Rao et al., 1983) and the somatic chromosome number (2n) varies from 100 to 120. It is for reason that the sugarcane varieties are botanically described as *Saccharum spp.* complex hybrid.

Sugarcane (*Saccharum sp. Complex*) is the most important cash-cum-industrial crop of the tropical and subtropical area of the world. It provides useful raw material to over industries which utilize its different part to produce sugar, Jaggery (Gur), Khandsari and a number of agro-byproducts viz, alcohol, paper, chemical, ethanol, cattle feed and electricity for socio-economic development of rural masses and national economy by providing direct and indirect employment about 35 million people in our country. Owing to its perennial nature and dependable and remunerative crop, it is considered as the backbone of farmers (Khan 1988 and Srivastava et al., 1988).

India is the largest producer of sugar in the world with annual production of about 20.11 million mt. It also happens to be the second largest producer of sugar, next to Brazil, with production in the sugar during 2006-07 crossing 28 million mt. The bulk of the Indian sugarcane cultivation and hence location of the sugar mills is in the states of Uttar Pradesh, Maharashtra, Tamil Nadu, Karnataka, Andhra Pradesh, Gujarat, Punjab, Haryana and Bihar. The annual production in the range of 300 to 350 million tons of sugarcane out of which
about 30% is used for gur and chewing purposes and balance for producing sugar.

According to recent estimates of Indian sugar mills Association, during 2006-07 and 2007-08 seasons, sugarcane occupies 345.3 and 365.0 million ha of land that constitutes about 20% of the world are under this crop.

In India, Uttar Pradesh occupies a premier position of sugarcane cultivation accounting for 42.22 and 30.02% of the area and production respectively. Average cane yield of Uttar Pradesh (58.2 mt/ha) is lower than the national average (66.9 mt/ha). Similar to yield, sugar recovery in Uttar Pradesh is also lower 9.51% than the national average (10.27%). The productivity of sugarcane and sugar recovery have been obtained higher in Maharashtra (45,140 thousand metric tons 11.61%) Karnataka (33,754 thousand metric tons 10.30%) “Tamil Nadu (36,336 thousand metric tons” 9.61%) (Anonymous, 2003). Besides the important reasons for the low cane yield in Uttar Pradesh are the climatic factors like short duration for growth and maturity (8-12 months) of the crop than tropical states (12-16 months) and lack of suitable varieties for different agro-climatic conditions. Total sugarcane production is 300.05 million metric tones in our country (Anonymous, 2003). The average cane productivity 68.2 tons/ ha. In our country is lower than that the other countries like Hawaii(150 tons/ha), Egypt (100.3 tons/ha.) Kenya (100.2 tons/ha), Columbia (83.5 tons/ha) and Australia (77.5 tons/ha).

Sugar industry is the second largest agro-based industry in the country. The Indian sugar industry is a key driver of rural development, supporting over about 55 million sugarcane farmers, their dependents and a large mass of agricultural labourers involved in sugarcane cultivation, harvesting, machine
manufacturing etc; of almost 501 sugar mills and ancillary activities, constituting some 7.5% of the rural population. Besides about 0.5 million skilled and semi-skilled workers, mostly from the rural areas are engaged in the sugar industry.

As such, the sugar industry has been a focal point for socio-economic development in the rural areas by mobilizing rural resources, generating employment and higher income, besides giving a fillip to transport and communication facilities. The co-operative sector sugar mills in Maharashtra have been instrumental in bringing major socio-economic changes in rural areas. A number of co-operative sugar factories have also undertaken welfare activities like opening colleges, technical institutions, dispensaries and hospitals etc. in rural areas. It is often said that “Sugar is produced in the field and extracted in the sugar factory”. This is absolutely correct in fact; sugar recovery mainly depends on sucrose content in cane, supply arrangement and machinery.

Sugarcane is considered to be one of the most energy efficient crops for conversion of solar energy into biomass. Expert finding reveal that the input-output ratio is highest for cane in India i.e; 5.6 times as compared to 1.2 to 1.8 times for other crop like Wheat, Rice etc; and sugarcane yields maximum quantity of biomass in the form of baggage, leaves etc.

91 and two varieties viz; UP. 9530 and CoSe 96436 water logged area formers encountered cultivars respectively.

Little attention was paid to sugarcane diseases in India until the end of the 19th century Butler, (1906) then Imperial mycologist started investigation on the diseases of sugarcane. However, work on sugarcane diseases intensified with the occurrence of the first major epiphytotic in 1939-1940 on cane variety, Co213. Intensive work was also taken up by Srivastava at IARI, New Delhi Kirikar at Shahajahanpur and by Ganguly followed by Jha at Pusa.

Sugarcane is subjected to different diseases caused by various micro-organism mainly 40 fungi, 5 bacteria, 8 viral, 3 nematodes, and 8 miscellaneous diseases disorder. American Phytopathological society was last modified on 28 July 2007. About 240 diseases were recorded on sugarcane (Rott et al., 2000) and recently presence of sugarcane bacilliform (badna) virus was found in India. Sugarcane diseases can be grouped into two categories “Seed transmitted” and “Non seed transmitted”. The former group includes all viral, mycoplasmal and many fungal and bacterial diseases that are responsible for great losses in yield, varietal decline and deterioration of the seed stocks. The second group includes minor diseases like, leaf spots, blights, rust and root rot etc., which are neither severe nor of wide occurrence and have only reasonal importance in certain areas. Among the 180 disease reported in India over a period of time only eight, red rot, smut, wilt, pineapple, grassy shoot, ratoon stunting, leaf scaled and mosaic, are major concern. The economic importance and distribution of all the diseases of sugarcane on the varieties on which they occur and the agro-climatic conditions under which these varieties are cultivated by Alexander and Vishanathan, (2002).

Red rot disease, often called as 'Cancer' of sugarcane, is one of the oldest and dreaded diseases affecting adversely the production of millable canes. The disease was first reported from Java (now Indonesia) by Went. 1893 as 'Red Smut'. Barber, 1901 first observed this disease in India and Butler. 1906 coined the name 'Red Rot' the name by which it is known till date.

Red rot may affect any of the vegetative parts of sugarcane plant but is of principal importance, as a disease of standing stalks and the planting seed pieces or seed sets. The diagnostic symptoms of the disease is best seen by splitting the stalk longitudinally, where the affected tissues show characteristic slightly acidic, alcoholic odour and dull red appearance, interrupted by occasional white patches stretched at right angles to the long axis of the stalk.

Amongst the major limiting factors red rot of sugarcane incited by *Colletotrichum falcatum* Went; is the most serious and devastating disease not only in Uttar Pradesh but in the whole of the northern subtropical belt of India.
The injury to stalks of susceptible varieties is sometimes so severe that translocation of the sap to the leaves is interrupted.

The discoloration and withering continues from the tip to the leaf base until the whole crown withers and the plant dies, within 4 to 8 days. Centripetal drying, of 3\textsuperscript{rd} and 4\textsuperscript{th} leaves of the crown is the first diagnostic symptom of red rot.

Externally on the stalks there is discoloration appearing first at the nodes followed by the internodal regions. Reddish brown to dark stripes arise from the nodal region and extend in the internodes (figs – 1 and 2). The symptoms of the disease become apparent on splitting the stalk emit an alcoholic smell. The tissues are reddened throughout the basal portion, especially the vascular bundles, which are intensely red; there may be cross-wise white patches, interrupting the reddened tissues. Since saddening is common symptom of other diseases of sugarcane, the white patch symptom is an important diagnostic characteristic of red rot. The tissues exhibit reddish-brown discoloration. White spots usually develop at right angle to the long axis. In highly susceptible varieties and red discoloration is found throughout the stalk. Some necrotic islands also develop in the nodal and intermodal regions that ultimately disintegrate. In the later stages the internodes usually shrink and dry out. Numerous acervuli of the pathogen develop externally on the nodes that bear innumerable spores of the fungus. The cottony mass of the fungus later develops in disintegrated, hollow region of the internodes. In extreme cases the diseased internodes break away from the nodal region and fall to the ground. The growth of the stalk is checked and the whole cane dies.
Irregular longitudinal disease patches which are reddish to reddish brown in colour also develop on the leaves of the crown bearing minute black dots. The dots are in fact acervuli of the fungus possessing setae, conidiophores and spores.

The perfect stage of *C. falcatum* W. has been described as *Physalospora (Glomerella tucumanensis* (Speg), Arx and Muller). Infection of the disease is caused wither by sproes or ascospores. The pathogen makes its entry into the host tissues through any sort of injury injected by insects or borers or natural growth cracks etc. After the entry the infection thread develops normal hyphas which grows within the host tissues for some time and then emerge out through the cells to the outer surface and develops acervuli.

Rains and heavy dews usually wash the acervuli developed on nodes and internodes and the spores get lodged around the nodes behind the leaf sheath. The spores germinate and the mycelium gets established in bud scales, root primordial or leaf scars and later within the plant tissues.

The spores are hyaline, one celled, falcate or sickle shaped, with one end slightly blunt and the other end pointed. The size of the spores ranges from 16-48 µ to 4-8 µ. The acervuli possess pink spore mass and long black setae.

Strains or biological races of the fungus have been found to occur that differ in pathogenicity or virulence towards different sugarcane varieties. Chlamydospires are also formed by the fungus on the surface of the stalk, within the cane tissues or culture media. These remain viable for some time. They germinate to form infection thread capable of penetrating unbroken surfaces and tissues of the cane plant (Edgerton and Carvajal, 1944).
Transmission of the disease is chiefly by the spores produced externally on internodes which are disseminated by rain, dew drops or by air. The infection also occurs through the movement of air disseminated spores during strong wind, currents or rain flush. Irrigation water is also a source for spread of the disease. Infection in planted sets occurs from the soil or cane debris present in the soil. The fungus does not survive long in the soil without host and is not a true soil borne fungus.

Chona, (1950) held the view that considerable red rot infection can occur through soil, where in the inoculums may survive in the red rot affected cane debris. The infection in such cases takes place through nodal regions of the cane near the ground level. In nature C. falcatum W. spores are produced in great abundance during July-August or even earlier on the nodes of red rot affected canes. During these months mass movement of water takes place in nature owing to heavy downpours of rain, when water flows freely from one field to another and thus carry red-rot inoculums.

Losses to the cane crop is chiefly due to the death of the leaf tissues, plants and tops of the plant, inversion of accumulated sucrose in juice to lower sugars that is glucose and fructose and finally to alcohol and water. This results in reduction in yield and deterioration in varieties. The mycelium growing in the seed cane destroys the buds, making them unfit for use in plantings and damages the stored food material needed by the young shoots. The inversion of sucrose in malleable canes results in low sugar recovery and fabrication problems in milling. In extreme cases death of the plants in the field occurs with the resultant loss of both cane and sugar.
The view of Butler, (1918) that red rot is the chief limiting factor for successful cultivation of sugarcane still holds good this state. It also chiefly contributes varietal failures in the crop. A large number of prominent commercial varieties have thus been wiped out by red rot. Edgerton, (1955) reported that red rot appeared in India in a serious form only on certain thick cane varieties which were introduced. The most severely affected varieties were Bourbon. Many of the Mauritius canes also succumbed to considerable infection.

Red rot epiphytotics in Mauritius (Wiehe, 1944; Australia Hughes., 1953; Egan., 1969; Hawaii Anonymous, 1957; Burma Thaung, 1970) and other countries caused widespread losses. In India, the first documented red rot epiphytotic occurred in 1901 and many major outbreaks have been reported since then, particularly in the northern parts by Chona, (1980).

The first record of the appearance of the disease in an epidemic form is of 1901 in Godawari Delta (Madras). Later severs outbreak of red rot was noticed during 1906 in Champaran (Bihar) and subsequently in Jammu Kashmir during 1922. The spread of the disease from south to north was preferable due to the movement of cane seeds from one locality to another. In U.P. 1936, it’s firstly recorded in Gonda district. Red rot has been continuously causing appreciable damage to sugarcane crop in Rajasthan, Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and Orissa (Agnihotri, 1990). Eastern U.P. and Northern Bihar offer "hot spot" for the disease and have faced several red rot epiphytotics (Agnihotri, 1990). The disease once appeared in the field can not be controlled with available agrochemicals. The outbreak resulted in severe losses to the industry.
However, agrochemical practices, use of resistant varieties and thermotherapy of infected cane setts are usually adopted as prophylactic measure to reduce the chances of red rot epiphytotics. During recent years a large number of red rot resistant varieties have been developed but as soon as a resistant variety is released for commercial cultivation it soon becomes susceptible to red rot due to development of new races of the pathogen causing breakdown of resistance by Waraitch, (1996). According to Satyavir, (1994) knowledge about the variability of the pathogen in nature is a pre-requisite for developing resistance against red rot.

Since new races of red rot pathogen appear regularly in nature due to mutation, it is necessary for pathologists to keep a constant watch on such new races, so that the informations may be exploited for breeding resistance against the evolved mutant by Taylor, (1935).

It is unfortunate that information regarding red rot pathogen in U.P. which offers a "hot spots" for red rot epiphytotics due to its low lying physiographic status, damp humid climate, monoculture of sugarcane and high input of fertilizer and water, have remained neglected by Kar and Singh, (1964).

In present study, therefore, an attempt has been made to collect maximum number of isolates of *C. falcatus* prevalent in U.P. and to study their morphological, physiological, pathological and control behabior so that the information may be generated for plant breeders to evolve red rot resistant cane varieties.