Powdery mildews are a well defined group of fungi belonging to family Erysiphaceae of sub division Ascomycotina. These are biotrophic parasites growing principally on the foliage of angiosperms and cause damage to a variety of crop plants. These are cosmopolitan in origin, prevailing from the tropics to the polar areas and from sea level to 4,000 meters altitude (Hirata, 1966). Maximum reports of their occurrence are from the temperate regions of northern hemisphere, whereas in subtropics and tropics they are sparsely represented (Braun, 1987). Hirata (1976) reported the host range of powdery mildews on 76,607 host plants consisting of 1,431 genera, 163 families and 43 orders of Angiosperms.

The losses caused by powdery mildews in India are tremendous particularly in the yield of peas, grapes, cereals and cucurbits (Munjal et al., 1963). Northern India bordering the mid Himalayan region experiences diverse set of climatic conditions with comparatively low temperature and high humidity and is adorned with turn over of vegetation almost all the year round. All this provides congenial conditions for growth and development of fungi in general and powdery mildews in particular.

Powdery mildew fungi produce a conspicuous white to grayish growth of mycelium on the surface of diseased plant parts. Conidia or
spores of the fungi are produced on the mycelium (Sharma, 1984). Among powdery mildew diseases on several crops and wild plants have been reported to be caused by species of *Erysiphe, Uncinula, Phyllactinia, Podosphaera, Microsphaera, Sphaerotheca, Leveillula, Oidium* and *Ovularioposis* on plants of family cucurbitaceae (Jasmitkaur, 1985; Sharma et. al., 1991; Khan et. al., 1995), Caesalpinaeae (M. Bappamal, 1995) and Asteraceae (Bhat et. al., 1991; Husain and Akram, 1997).

Powdery mildews are easily recognized as parasitic fungi having superficial mycelium with haustoria in the epidermal cell of the host. Similarly are with abundant growth during comparatively at low temperature and high humidity, germination of conidia without external water supply to their high water content and production of dark superficial perithecia.

**Geographical distribution of powdery mildews on cucurbits:**

Powdery mildew of cucurbits is one of the important diseases which is world wide in distribution.

Four species of *Erysiphe* with perithecial stage i.e. *Erysiphe cichoracearum, Erysiphe communis, Erysiphe polygonia, Erysiphe polyphaga,* along with *Levillula taurica* and *Sphaerotheca fuliginea* (Berlese and Peglion, 1892; Hammarlund, 1945; Blumer, 1951; Jagieieski, 1972) have been recorded on cucurbit hosts.

Powdery mildew of cucurbit is very wide in its distribution occurring almost every where in cucurbits growing areas of the world (Salman, 1900).
Erysiphe cichoracearum and Sphaerotheca fuliginea were found to infect cucurbits in various parts of the world. In India, as earlier as 1981 Butler reported the occurrence of both the organisms on cucurbits. Powdery mildew infected fungi Sphaerotheca fuliginea excessively attack cucurbits whereas Erysiphe cichoracearum is confined to other non cucurbitaceous hosts.

It is clear from the literature that three powdery mildew species Erysiphe cichoracearum, Sphaerotheca fuliginea and Levillula taurica are dominant to infect cucurbits Ballantyne (1975), Sitterly (1978). However Khan (1983) have reported that Levillula taurica infecting cucurbits are only from a limited number of countries.

The diseases occurred in the countries which include north America (Humphries, 1983; Jagger, 1926; Barrat, 1942) South America (Bell and Alandia, 1957; Hirata, 1968), Africa (Jorter, 1966; Khar and Abdu, 1972; Omer, 1972), Australia (Clare, 1958; Ballantyne, 1963, 1975), Germany (Roder, 1937; Spencer et al., 1975), Turkey (Bermer, k1958), Iran (Viennot Borgin, 1958), Korya (Hirata, 1968) and India (Butler, 1918; Rajendran, 1965; Khan and Khan, 1970; Khan et al., 1972; Sharma, 1973; Ullasa and Amin, 1981), are discuss.

**North America**

In U.S.A., since 1900 upto 1963 in all reports, the disease has been assigned to only Erysiphe cichoracearum on cucurbits although its perfect stage was seldom found.
Kable and Ballantyne (1963) for the first time in U.S.A. identified powdery mildew of cucurbits in Ithaca district, New York state on the basis of conidial characters as *Sphaerotheca fuliginea* and claimed that this may be prevalent in other areas of the country. Yarwood and Gardner (1964) suggested that in California the powdery mildew on cucurbits was *Sphaerotheca fuliginea*. Since then a number of reports indicated the existence of *Sphaerotheca fuliginea* on cucurbits in conidial stage in different parts of U.S.A. Ellert (1966) obtained *Oidium* sp. resembling *Sphaerotheca fuliginea*. Schroeter and Provvidenti (1968) observed *Sphaerotheca fuliginea* on squash and cucumber at the New York State Agriculture Experiment Station. Kontaxis (1979) emphasized that the causal agent for powdery mildew of squash, probably all cucurbits in California and possibly in the United States, is *Sphaerotheca fuliginea* and not *Erysiphe cichoracearum*.

In Canada, McKeen (1954), mentioned *Erysiphe cichoracearum* on cucurbits in Ontario region. Fisher (1959) also referred to powdery mildew of green house cucumbers as *Erysiphe cichoracearum*. A Ministry of Agriculture report for the year 1953 mentioned *Erysiphe cichoracearum* responsible for powdery mildew of autumn cucumbers in Essex country Ontario. Similar report was made by Bradbury and Fisher (1963) from Ontario. *Erysiphe cichoracearum* is also enlisted on cucurbits in Mexico, Guatemala, El-Salvador, Honduras, Nicaragua, Panama, Bermuda, Jamaica and Trinida (Hirata, 1968).
South America

In South America, an Bolivian list of diseases of temperate crops included *Erysiphe cichoracearum* on cucurbits (Bell and Alandia, 1957). Revilla (1955) had also mentioned the powdery mildew of melon, pumpkin and cucumbers as *Erysiphe cichoracearum*. Rochelle (1972) reported the occurrence of *Erysiphe cichoracearum* on squash and marrow in Brazil. *Erysiphe cichoracearum* is also recognized as causal organism in Venezuela and Uruguay. However, it is known as *Oidium* sp. in Argentina (Hirata, 1968). Powdery mildew of *Cucumis melon* in Peru was recognized by Mont and Villon (1975) as *Erysiphe cichoracearum*. There is no record of *Sphaerotheca fuliginea* from South America.

Africa

De Carvalho (1948) included *Erysiphe cichoracearum* as causal organism of powdery mildew of cucumber and other cucurbits while listing the plant pathogens of economic importance in Mozambique.

The powdery mildew of cucurbits in Egypt attacking all species is caused by *Erysiphe cichoracearum* (Fikry, 1936). Moursi and Sirry (1956) observed the attack of *Erysiphe cichoracearum* on squash throughout the year in Egypt. Elarosi and Wasfy (1971) also found *Erysiphe cichoracearum* on vegetable marrow in Alexandria. Similar observations were made by Khadr and Abdu (1972) in Giza. In Sudan, Tarr (1952, 1955) reported the widespread occurrence of *Sphaerotheca fuliginea* and *Leveillula taurica* on cucurbits and other vegetables. Nour (1957, 1959)
also recorded the presence of *Sphaerotheca fuliginea* on vegetable marrow, pumpkin, cucumber and melon.

In Libya, Pucci (1963) regarded powdery mildew on Water melon as *Erysiphe cichoracearum*. Kranz (1962) also recognized powdery mildew on certain cucurbits in the Eastern region of the country as *Erysiphe cichoracearum*. Khan (1981) for the first time found conidial stage of *Sphaerotheca fuliginea* on cucumbers. Later its perfect stage was found on *Cucurbita pepo* (El-Ammari, 1983). However, *Erysiphe cichoracearum* was found on cucumbers in green houses at Benghazi. Further, *Leveillula taurica* was also found on cucumber in areas both in Western and Eastern parts of the country.

A Kenya Annual Report Department of Agriculture, 1958 enlists *Erysiphe cichoracearum* is an agent continuously hampering the cultivation of cucurbits. *Leveillula taurica* is also reported from cucurbits (Hirata, 1968). *Sphaerotheca fuliginea* has been recognized to cause problems to vegetable crops in Malawi (Spurling, 1973). Morocco, Ethiopia, Senegal, Uganda, Tanzania, Zambia, Zimbabwe, Madagascar and Mauritius are enlisted to have *Erysiphe cichoracearum* on cucurbits, whereas Ghana, Tunisia, Sierra Leone and Canary Island are known to have *Oidium* sp. (Hirata, 1968).

**Australasia**

In Australia, Blackford (1943) reported the occurrence of *Erysiphe cichoracearum* cucumbers in Queensland. McNish (1967) also recorded the
widespread occurrence of *Sphaerotheca fuliginea* on cucurbits in Western Australia. Recently, Ballantyne (1975) after an extensive study of 150 collection of powdery mildew made in New South Wales on numerous cucurbits has established the existence and predominance of *Sphaerotheca fuliginea* in Australia. The existence of *Sphaerotheca fuliginea* in New Zealand has been established by the occurrence of its perithecia *Cucurbita pepo* (Dingley, 1959; Boeswinkel, 1976).

**Europe**

In the Netherlands Prior to 1964, *Erysiphe cichoracearum* was believed to be only causal organism of the disease. Dekkar (1961, 1963) identified *Erysiphe cichoracearum* causing powdery mildew on cucumber. Boerema and Van Kesteren (1964) identified powdery mildew of Cucumber, Melon and gherkins as *Sphaerotheca fuliginea* on the basis of conidial characters. Kooistra (1968) has also observed *Sphaerotheca fuliginea* on cucumber. Perithecia of *Sphaerotheca fuliginea* have now been recorded from Wageningen (Anon, 1965).

In Germany, Roder (1937) reported the occurrence *Erysiphe cichoracearum* on outdoor cucumbers near Berlin. Bremer (1940) observed *Erysiphe cichoracearum* as the agent of cucumber mildew in central Germany. The recent observation of *Erysiphe cichoracearum* in perithecial stage and *Sphaerothecia fuliginea* in conidial stage concomitantly on cucumber by Schlosser (1972) near Bohn is very significant. Keyworth (1959) also recorded the occurrence of *Erysiphe cichoracearum* on
cucumber and vegetable marrow, and Stone (1959) on cucumber. Zaracovitis (1965), however, in his studies on conidial characters, identified powdery mildew on cucumber collected from Berkshire as *Sphaerotheca fuliginea*. A recent report has also indicated its existence on cucumber in U.K. (Spencer *et al.*, 1975).

*Erysiphe cichoracearum* is reported to infect cucurbits particularly vegetable marrow in Switzerland (Mayor, 1947). Besides, *Sphaerotheca fuliginea* is also known to exist in Switzerland (Hirata, 1968). Blumer (1951, 1960), however, claimed that *Erysiphe cichoracearum* also infects cucumber in Switzerland.

Docea and Fratila (1980) observed *Leveillula taurica* on cucumber in Rumania. Earlier *Sphaerotheca fuliginea* has been recorded in perithecial stage in Rumania (Savulescu, 1929). Reports from Austria by Glaeser (1970, 1973) have claimed the widespread occurrence of *Erysiphe cichoracearum* on cucumber.

In U.S.S.R the occurrence of both organisms in perithecial stage on cucurbits was reported by Decken back and Koreneff (1927) from Crimea.

In Moldavia, Armenia, Volga Basin, Crimea, Azerbaijan, Astrakhan and Bylorussia region, the existence of both the species has been established (Rodigin, 1936; Dechenback and Koreneff, 1927; Ragimov, 1961; Nikiforova 1962; Tetrevnikova Babayan and Simonyan, 1956; Dorozhkin and Kapelyan, 1975). Simonyan (1959), however, reported that *Erysiphe cichoracearum* f. *Cucurbitacearum* causes great damage to
cucurbit crops in Armenia. Rudenko (1968) claimed that in Moldavian conditions *Erysiphe cichoracearum* F. sp. *Cucurbitacearum* attacks all cucurbits and *Sphaerotheca fuliginea* f. sp. *Cucurbitacearum*. Cucumber, marrow, pumpkin and muskmelon and both organisms over wintered as celistocarps and produced perithecia annually on a cucumber of cucurbits.

**Asia**

In Asia also, it was believed that *Erysiphe cichoracearum* is responsible for the diseases. However, the reports from the different countries of the continent present a different picture. In Turkey, Bremer *et al.*, (1947) reported *Sphaerotheca fuliginea* in perithecial stage on three cucurbits. In Iran, *Sphaerotheca fuliginea* has been claimed to exist on all cucurbits in subtropical regions of the northern part of the country (Esfandiri, 1947). *Sphaerotheca fuliginea* was also observed on cucurbits in plateau of Azerbbajan, Iran (Viennot Bourgin, 1958). Allison (1952) identified *Erysiphe cichoracearum* as powdery mildew of cucurbit in Iraq. *Erysiphe cichoracearum* has been claimed to exist on cucurbits in Saudi Arabia (Anon, 1967). But recently Abul Hayja and Trabulusi (1981) observed perithecia of *Sphaerotheca fuliginea* on squash and cucumber and claimed that probably all cucurbits in Saudi Arabia are infected by *Sphaerotheca fuliginea* and not *Erysiphe cichoracearum*. In Israel, Rayss (1947), Patil (1962) and Rudich *et al.*, (1969) recognized *Sphaerotheca fuliginea* on cucurbits although earlier reports of powdery mildew on cucumber and vegetable marrow by Reichert *et al.*, (1943) from Palestine
and of cucumbers and melons by Peleg (1953) had recognized it as *Erysiphe cichoracearum*. Thompson (1933) recorded *Erysiphe cichoracearum* in Malaysia and Singapore. Chin *et al.*, (1959) from China diagnosed powdery mildew of cucumbers as *Sphaerotheca fuliginea*.

*Erysiphe cichoracearum* is mentioned to occur in Nepal, Afghanistan, Lebanon and Jordan whereas *Sphaerotheca fuliginea* is recognized in Pakistan. Both species are, however, known to occur in Korea (Hirata, 1968). Powdery mildew of cucurbits in Philippines, Indonesia, Thailand, Cambodia, Burma and Ceylon is referred to as *Oidium sp.* (Hirata, 1968).

Butler (1918) described *Erysiphe cichoracearum* and *Sphaerotheca humuli* (DC.) Burr. var. *fuliginea* Schlecht as the species of *Erysiphaceae* that attack cucurbits in India. He observed perithecia of *Erysiphe cichoracearum* on *Coccinia cordifolia* in Uttar Pradesh. Rajendran (1965) claimed on *Lageneria vulgaris* the perithecia belonging to *Erysiphe cichoracearum* from Mysore, South India.

Jhooty (1967) employing conidial features, identified the causal organism in Punjab as *Sphaerotheca fuliginea*. It was also identified in Himachal Pradesh and Kashmir (Sohi and Nayar, 1969; Khan *et al.*, (1972, 1974). Shivakami *et al.*, (1972) also indicated the occurrence of *Sphaerotheca fuliginea* in conidial stage on cucurbits collected from Delhi and Assam.
Khan and Khan (1970) observed profuse perithecial development of *Sphaerotheca fuliginea* on a number of cultivars of *Lageneria leucantha* and *Cucumis sativus*. Khan *et al.*, (1971) then observed the existence of *Erysiphe cichoracearum* in perithecial stage on *Coccinia cordifolia* a wild cucurbit. Khan *et al.*, (1974) further confirmed the earlier findings and claimed that *Sphaerotheca fuliginea* attacks most of cucurbits and *Erysiphe cichoracearum* is confined to *Benineasa hispida* and *Coccinia cordifolia* in nature. Under glass house conditions perithecial production was observed in *Sphaerotheca fuliginea* on several cultivars. Ullasa and Amin (1981) reported the occurrence of *Leveillula taurica* on *Cucurbita maxima* in Karnataka State in India.

Dave *et al.*, (1971), Khan (1978) and Sharma and Khan (1991) reported that the powdery mildew of *Lagenaria siceraria* was the most severe disease while water melon was free of the disease in all the localities survey in India. However a wild cucurbit *Coccinia grandis* was found to be infected by pathogen. *Sphaerotheca fuliginea* and *Erysiphe cichoracearum* but *Sphaerotheca fuliginea* was wide spread on all the cultivated cucurbits and *Erysiphe cichoracearum* confined to *Coccinia grandis*.

In India, the state of Manipur *Sphaerotheca fuliginea* was observed on *Cucurbita pepo, Cucurbita moschata, Lagenaria siceraria* and *Luffa cylindrical* (Kabitrani and Bhagitrath, 1991).

Pawar (2005) reported occurrence of powdery mildew fungi that is *Sphaerotheca fuliginea* on *Lagenaria siceraria, Luffa cylindrical,*
Cucurbita maxima, Cucurbita pepo, Cucumis sativus and Luffa acutangula and Erysiphe ornotii on Coccinia grandis from Maharashtra.

**Historical accounts and powdery mildew disease:**

Linnaceus (1753) was probably the first to name a “powdery mildew” as an organism by using the binomial *Mucor, Erysiphe* to a white fungus on the leaves of *Humulus, Acer, Lamia Galeopsis* and *Lithospermum*, but recognized as a taxonomic group by Leveille (1851). He did not describe or illustrate either the conidial or perithelial stage. This group as a whole received modern treatment (Taxonomic) by salmon (1900), Homma (1932), Brundza (1933), Yarwood (1953), Blumer (1967), Hirata (1966), Bosewinkell (1977to 1980), Zheng R.Y.(1985), Braun, U. (1988). The word Erysiphale has Greek origin Euthras means red.

Yarwood (1973) reorganized two families (Erysipheaceae and Perisporiaceae) within Erysiphales order. However, Alexopoulous and Mims (1979) placed all Erysiphales in one family i.e Erysipheaceae. Blumer (1967) and Yarwood (1973) recognized only eight genera in Erysipheaceae i.e. *Sphaerotheca, Podosphaera, Erysiphe, Microsphaera, Uncinula, Leveillula, Phyllactinia* and *Acrosporium (=Oidiom)*. For the pathologist not much is known about the origin and evolution of powdery mildew. On the basis of works of Yarwood (1973), imperfect states of powdery mildew will be reported, especially regarding the conidial state of *Brasiliomyces, Cystotheca, Leveillula, Typhulochaeta* and *Uncinula*. This could result in a deeper understanding of the origin and line of development of powdery
mildew (Boesewinkel, 1980), so far most authors have based their theories on the perfect states and have proposed a more or less monophyletic development. As it is still undecided which characteristic are of primary and secondary importance and weather during evolution a reduction or a differentiation of the number of asci and ascospores occurred, there are several radially opposed theories. The most primitive genus is according to (Neger, 1901) the ectopasitic *Sphaerotheca* with one ascus and eight ascospores.

Hirita (1955) decided from his study of the germ tube of *Erysiphaceae* and *Sphaerotheca* and considered the most primitive morphology. Zaracovitis (1965), concluded from his study of the germination of conidia at different humidities that Erysiphe is more advanced in the adaptation to a xerophytic existence and he agreed with Neger (1901) and Hirata (1955) that *Sphaerotheca* and *Podosphaera* represent the most primitive genera.

According to Jaczewki (1927) Erysiphe is most primitive and according to (Blumer, 1933), the section in *Erysiphae* with eight ascospores (Arnaud, 1921) and later on Gaumann (1926), explained that *Leveillula* was more primitive than *Podosphaera* and *Sphaerotheca*. Recently Boesewinkel (1980) reported that development of powdery mildew is polyphyletic one.

**Period of Incidence of powdery mildew:**

It is clear from the literature that period of incidence of powdery mildew on different plants of family cucurbitaceae have been found to be
variable as reported by different workers. The incidence of powdery mildew varies from September to February was observed on *Luffa acutangula*, *Melothria maderaspatane* and *Cucurbita moschata* caused to *Sphearotheca fuliginea* (Khan and Khan, 1970).

Mclean (1970), reported occurrence of powdery mildew during the period of December to May on *Citrullus lanathus*. Whereas Munjal and Kapoor (1973), reported severely attack of powdery mildew due to *Sphaerotheca fuliginea* on *Cucurbita pepo* during the month of February. It was noticed that during March to April powdery mildew reported on bottle guard (*Momordia charantica*) and as incitant was identified as *Sphareotheca fuliginea* (Gupta to Singhvi, 1979).

Patel *et. al.*, (1990) reported appearance of powdery mildews on bottle gourd during rabbit season on *Lagenaria siceraria*, *Cucurbita moschata*, *Cucurbita maxima*, *Luffa cylindrica*, *Cucumis melo*, *Cucumis sativus* and *Cocconia grandis* due to *Sphaerotheca fuliginea*.

In the month of April to June powdery mildew was reported on *Citrullus vulgaris* and *Cucumis sativus* due to *Sphaerotheca fuliginea* by Branzanti and Brunelli (1992).

The disease was severe during March to May and September to November, mild to moderate during December to February and altogether absent during June to August on *Citrullus lanathus*, *Momordica charantia*, and *Trichosanthes cucumerina* (Khan, 1992) while on *Cucumis melo* disease incidence was reported during the month of April to September in
Himachal Pardesh (Bharat 2003). Powdery mildew on *Cucumis sativus* occurred generally epidemic in the mid hills of Himachal Pradesh during August to September every year (Sharma and Sharma 2004).

Recently Pawar (2005) isolated *Erysiphe ornotii* on *Coccinia grandis*. Whereas *Sphaerotheca fuliginea* on *Cucumis sativus, Cucurbita maxima, Cucurbita pepo, Luffa cylindrica, Legenaria sicereria* and *Luffa acutangula* from Marathwada region of Maharashtra State.

**Association of powdery Mildew with other pathogens:**

It is found in the literature that in several cases the host plants are attacked by number of different pathogens simultaneously. Vidhyasekaran and Kandasamy (1972) have reported similar type of simultaneous infection of powdery mildew with rust, *Cercospora* leaf spot and viral in case of *Phaseolus aureus*. Similarly Goswami and Dasgupta (1981) found infection of powdery mildew along with *Alternaria* leaf spot and *Macrophomina* charcoal rot on sunflower crop. The powdery mildew fungus *Erysiphe polygoni* was found to be associated with Downy mildew (*Perenospora arborescens*), root rot (*Macrophomina phaseolina*) and Bacterial soft rot (*Bacterium papaveris*) on *Papawar somniferum* (Malti and Chattopadhyay, 1986).

Abbaiah and Devi (1992) found that carbendazim at 0.1% was the most effective in controlling mixed infection *Erysiphe polygoni* and *Cercospora [Mycosphaerella] Cruenta* on *vigna mungo* crop and providing the highest grain yield. Similarly, Srivastava *et. al.*, (1992) reported that
mancozeb is recommended for mixed disease like purple blotch, caused by *Alternaria pori*, Stemphylium blight caused by *Stemphylium vesicarium*; Cercospora leaf blight caused by *Cercospora duddiae*, powdery mildew caused by *Leveillula taurica* garlic rust caused by *Puccinia porri*.

**Symptoms of powdery mildew on cucurbits:**

Symptoms of powdery mildew mainly include powdery growth on leaves, stem, fruit and flower or on whole plant have been described in details by various workers. Whillaker and Pryor (1947), reported powdery mildew symptoms on leaves, cotyledons and stem appears powdery mass of fungus. Rhodes (1964) reported that the powdery mildew on *Cucurbita moschata* appears on both the upper and lower surfaces of the leaf blades and later spreads to petiole and stem.

Symptoms of powdery mildew of *Cucumis sativus, Luffa leucantha*, caused by *Sphaerotheca fuliginea* appeared of white superficial spots on leaves and stem while become powdery as then enlarge. The superficial mass may ultimately cover the entire host surface. While black, pin-point like bodies representing asci stage of the fungus, appears lead in the season Jhooty (1967), Kapoor (1967); Khan and Khan, (1970); Siradhana and Chaudhari (1972).

The powdery symptoms on *Coccinia cordifolia* develops white mass of the fungus on leaves rarely on stem in Uttar Pradesh Khan et. al., (1972). The mildew develop as small circular patches on both the side of the leaves and stem of young seedlings of *Cucurbita pepo* (Munjal and Kapoor 1973).
Similarly Khan et. al., (1973) noticed perithecia were produced on the leaves and petiole of *Lageneria leucantha* and on *Cucumis sativus* they were confined on the stem and leaves. The powdery mildew developed the symptoms in the form of tiny perithecia on leaves of *Lageneria lucantha* while on *Coccinia indica* it was restricted only on stem, Sharma (1973).

The while floccose circular discrete to Coalescia powdery sports of varies sizes were present on leaves of infected cucurbit. In case of severe infection; entire foliage was covered with talcum like powdery mass. Stem and petiole also exhibited powder spots (Khan & Sharma, 1975).

Kaur and Jhooty (1985), reported that during winter (November to January) severely infection was observed *Lageneria siceraria* in the form of powdery mildew colonies on leaves and fruits of *Luffa cylindrica* and *Lageneria siceraria*.

Sharma and Khan (1991), reported the powdery appearance on leaves and stem of *Lagenaria siceraria, Cucurbita moschata, Cucumis melo, Cucumis sativus* and *Luffa cylindrica* infected leaves dried of and term black as a result defoliation occur. On lower surface on leaves and petioles of *Cucurbita moschata, Cucurbita pepo* mildew develops in mid December, Kabitarrani and Bhaugirath, (1991).

Cheal et. al., (1995), observed that development of powdery mildew on squash plant showed that powdery symptoms first appeared on old leaves mildew can reduced photosynthetic area plant, effect that are likely to reduced yield and quality of fruit.
Recently, Pawar (2005), observed powdery mildew on *Cucumis sativus* with small white patches of powdery [glandular] mass on leaves, spots increase in size. Let in season leaves dry result defoliation while in case of *Cucurbita maxima* due to powdery appearance, affected leaves turn yellow which affects photosynthetic activity of leaves. But in *Cucurbita pepo* petiole may or may not show infection.

**Hyperparasites on powdery mildew fungi of cucurbits:**

It is clear from the literature that the powdery mildew fungi have been found to be attacked by other fungi in the form of hyperparasite, Severe growth of the hyperparasite may be helpful to control the powdery mildew fungi.

Chona and Munjal (1956), reported *Cicinnobolus cesastii* as hyperparasitic fungus on *Sphaerotheca humuli on Cucurbita moschata*. However *Cicinnobolus cesastii* hyperparasite was developed on *Erysiphe cichoracearum* on *Cucumis sativus* in India (Sachan and Singal, 1971). Sztejnberg (1979), reported occurrence of hyperparasite *Ampelomyces quisqualis* on *Sphaerotheca* on *Cucumis sativus* and *Cucurbita moschota*.

The incidence of another hyperparasite *Ampelomyces quisqualis* on *Sphaerotheca fuliginea* on *Cucumis sativus* (Philip *et. al.*, 1990). Similarly the hyperparasite *Ampelomyces quasqualis* was reported on *Sphaerotheca fuliginea* on *Cucumis sativus* (Abo-foul *et. al.*, 1996). Recently Barner (1971), reported growth of hyperparasitic fungus *Ampelomyces quisqualis* on *Sphaerotheca fuliginea* on cucurbits.
Damage or yield loss due to powdery mildew in cucurbits:

When the pathogen causing powdery mildew infect the plant, cucurbit plant shows several abnormalities. Plant lose nutrient and photosynthesis of the plant is also reduced considerably. Powdery mildew also damage plants by causing pre-mature death of plant tissues (Butler, 1918).

Mclean (1970), reported powdery mildew on *Citrullus lanatus* results in immature fruits and invaded the surface and underlying tissues. Amin and Anus (1978) reported that in powdery mildew of *Coccinia cordifolia* due to *Oidium erysiphoides*, 85-90% leaves were attacked and near about 90% of leaf area was covered and injured. Similarly powdery mildew of *Lagenaria leucantha* caused due to *Sphaerotheca fuliginea* reduced growth of plants and increases galls in roots that affects yield of crop (Mittal *et. al.*, 1985).

Khan and Khan (1992), reported that cucurbits crop yield may be affected indirectly by the death of infected leaves and directly by the infection susceptible fruit that either do not develop to maturity.

Cohen *et. al.*, (1993), have been noticed powdery mildew on squash can reduced photosynthetic area of leaves and in severe cases defoliation of plants, effects that are likely to reduced yield and quality of fruits.
Characteristic Feature of Pathogen:

A) *Erysiphe cichoracearum:

**Mycelium:** Yarwood (1937), reported that *mycelium of Erysiphe cichoracearum* branched, hyaline, septate measuring 3.8-8.0µm. Mycelium usually well developed evanascent but sometimes persistent and effused (Khan 1983). Whereas Khan and Sharma (1995), reported in *Erysiphe cichoracearum* mycelium is ectophytic.

**Conidiophores:** Yarwood (1937), reported *Conidiophore of Erysiphe cichoracearum* was straight, hyaline, septate and measuring 132-172 µm in length.

**Conidia:** Yarwood (1937), observed *conidia of Erysiphe cichoracearum* cylindrical, in chain some time one to two 28-40x15.5-19 µm, whereas Khan (1983) reported conidia of *Erysiphe cichoracearum* infects to cucurbitis are barrel-shaped with tendency toward cylindrical in long chain variable in size 24 x 14-26 µ.

**Perfect stage:** Occurrence of perithecia of *Erysiphe cichoracearum* on cucurbitis was reported by various worker, viz, Humphries (1893), Reed (1908), Salmon (1900), Yarwood (1957), Kapoor (1967), and Nagy (1976). Khan and Khan (1972) observed perithecia of *Erysiphe cichoracearum* on *Coccina cordisolia* are scattered to gregarious globose dark brown, 155-177µ in diameter. Appendages numerous, myceloid, inter-woven with mycelium, hyaline to grey Asci 15-25 more or less stalked, 58-72 x 18-25µ. Ascorpores 2; 22-28 x 7-14µ. Khan and Khan (1973), reported occurred of
perithecia of *Erysiphe cichoracearum* on *Benincasa hispida*. perithecia were numerous on the stem than on leaves perithecia measured 99.204μ; Asci 49-82 x 20-30μ; and Ascospores 13-26 x 9-12μ.

Sharma (1973), observed powdery mildew on *Lagenria leucantha* due to *Erysiphe cichoracearum* having perithecia more or less uniformly scattered brown to dark, more or less globose 110-158 μ. Daim. appendages numerous, hypha like, simple or some time branch, variable in length. Asci 6-9 in each perithecium, Ascopore hyaline ovate to sub globose and 13-24.5 x 11.5-18.5μ.

Recently, Khan (1983), described cleiosthecia gregarious of scattered, globose become depressed or irregular, 90-135μ in diameter 10-20μ wide. Appendages numerous, mycelloid, hyaline dark brown, asci 10-25μ, ovate more or less stalked, 60-90 x 25-50μ, ascospores 12-18μ.

B) *Sphaerothecia fuliginea*

*Mycelium:* Khan (1983), have observed mycelium of *Sphaerothecia fuliginea* is hyaline occasionally brown when old, usually evanescent but sometimes persistent forming white circular to irregular patches on the host of cucurbits. Kabitarani and Bhagirath (1991), have reported mycelium of *Sphaerotheca fuliginea* on *Luffa cylindrica* and *Langeneria siceraria* is superficial hyaline uninucleated. Khan and Sharma (1995), reported mycelium of *Sphaerothecia fuliginea* is ectophytic.
Pawar (2005), reported mycelium *Sphaerotheca fuliginea* on *Cucurbita maxima*, *Cucurbita pepo*, *Lagenaria siceraria* and *Luffa cylindrical* is hyaline septate, branched 4.0-4.7µ size.

**Conidiophore:** Kabitrani and Bhagirath (1991), observed conidiophore of *Sphaerotheca fuliginea* become erect, 3-7 septate, 84-148µm, long foot cell, cylindrical followed by 1-3 barrel shaped cells. Khan and Sharma (1995), have reported that conidiophores of *Sphaerotheca fuliginea* on cucurbits are unbranched bearing chain of conidia. Gupta *et. al.*, (2001) observed powdery mildew on *Cucumis sativus due to Sphaerotheca fuliginea* having conidiophores were unbranched and aseptated with cylindrical foot cell.

Pawar (2005), observed the conidiophores of *Sphaerotheca fuliginea* on cucurbits are long, straight simple 103-240µm in length.

**Conidia:** Ballantyne (1975), reported well developed fibrosin bodies occur in conidia of *Sphaerotheca fuliginea*. Khan (1983) found conidia in long chain, of ten with distinct fibrosin bodies, ellipsoid to barrel-shaped 25-37 x 14-25µ. Kabitrani and Bhagirath (1991), reported that powdery mildew on cucurbit due to *Sphaerotheca fuliginea* show conidia in chain 3-7, oblate or ovoid contain irregular shaped fibrosin bodies, 22-38 x 16-24µm.

Khan (1995), reported conidia of *Sphaerotheca fuliginea* are ellipsoidal or with a tendency towards cylindrical form. Bhatar (2003), reported conidia of *Sphaerotheca fuliginea* were ellipsoidal in shape and arranged in long chain in the basipetal succession. The size of conidia war 33.8 x 21.4µm. the conidia exhibited the presence of fibrosin bodies on
Cucumis melo. Pawar (2005) have been observed conidia Sphaerotheca fuliginea are formed in chain often with fibroisin bodies, oval to cylindrical 240-35 x 14.2-19µm, on Cucurbita pepo, Cucurbita maxima, Luffa cylindrica and Lageneria siceraria.

Perfect Stage: The occurrences of perfect stage of powdery mildew fungi are essential for identification many workers reported perfect stage on varies cucurbits. The perithecial stage of powdery mildew fungus Sphaerotheca fuliginea were reported various authors among them (Savulescus, 1929) on Cucumis sativus from Rumania; Katusaki (1955), on Cucumis sativus. Khan et. al., (1972) on Lageneria leucantha and Cucurbita maxima; Sharma (1973) on Lageneria leucantha, Manjal and Kapoor (1973) on Cucurbita pepo; Kontaxis (1979), on Cucurbita pepo from California; El-Ammari (1983), on Cucurbita pepo from Africa; Khan (1991), on Lageneria siceraria; Kabitarani and Bhagirath (1991) on Cucurbita moschata and Cucurbita pepo from India. Bharat (2003) in Cucumis melo.

Khan and Khan (1972) have reported perithecia of Sphaerotheca fuliginea are scattered to densely globular, brown, 86-140µ in diameter, appendages variable in number, usually as long as the diameter of the ascocarp, sometimes longer myceloid brown, tortous, mostly inserted at the base of perithecium. Ascus single, broadly elliptical, subglobose or globose 55-77 x 44-63µ. Ascospores 8, ellipsoid to nearly spherical 18-22 x 11-18µ.
Sharma (1973), reported that perithecia of *Sphaerotheca fuliginea* are scattered, white when young, brown to dark at maturity globose to subglobose, 87-108.5µ diam. Appendages hypha like brown, septate, simple or sometimes branched, variable in number and length. Ascus single, hyaline subglobose to broadly ovate, sessile, 8 spored. 59-74.5 x 46.5-56µ. Ascospores hyaline broadly oblong to ellipsoid 15.5-21.5 x 12.5-15.5µ.

Khan (1983) observed cleiosthecial of *Sphaerotheca fuliginea*, are scattered to densely gregarious, 66-93µ in diam. Usually under 85µ, wall cell usually over 25µ wide. Appendages variable in number usually as long as the diameter of the ascocarp, myceloid, brown, tortours, inter woven with mycelium but sometimes long nearly straight and dark brown solitary ascus, broadly elliptical to subglobuse 50-80 x 30-60µ. Ascospores 8, ellipsoid to spherical 17-22 x 12-20µ.

Kabitarani and Bhagirath (1991), observed cleiosthecial *Sphaerotheca fuliginea* light brown to black globose 104-150µm with about fifth septate mycelioid appendages. Length of the appendages varied, usually so long as the diameter of the cleistothecium. Ascus single globular or pyriform, doubled walled, 52-76 x 56-116µm. Ascospores 8, avoid or globular, single called 14-16 x 16-22µm.

Bharat (2003) observed cliosthecia of *Sphaerotheca fuliginea* were globular, brown and 61.7-78.6 x 53.1-77.8µm in size. Appendages were basally attached, variable in number, usually longer than the diameter of ascocarp. Mycelioid and were brown in colour. The ascocarp had a single
ascus which was elliptical and globose and measured 53-81 x 43-66 µm. Ascus had eight arcospores, which were ellipsoid to nearly spherical and measured 17-24 x 13-19 µm.

**Biochemical Changes:**

Changes in biochemical constitution of the plants due to attack of powdery mildew fungi were reported by various workers.

Allen (1942), reported change in reducing sugar in wheat due to infection of powdery mildew. Similarly, Dayal and Joshi (1968) also found that reducing, non reducing and total sugar content decrease in infected Barbery leaves. Andal and Subba Rao (1956), found similar trend in physiology of infected and healthy plants. Schnathorst (1961) reported the resistance of teafroll.

Hanks and Feldman (1963) reported that physiological activities of the infected plants shows severe charges due to obligate pathogen. Most of the soluble organic substance of the host cell are readily utilized by the pathogen as a result of hydrolysis or as a product of biosynthesis soluble organic substance also appears. Amino-acids contain in the infected leaves reduces continuously. However they their was no quality different in sugar in healthy and disease leaves was reported.

Suryanarand et. al., (1968) also observed change in Amino acid content in the early stage of infection in citrus tree. Sexena et. al., (1974), Observed several physiological order and Tictona granides leaf due to Uncinula tectonae young leaves of Totiza reduce its total sugar, amino acid
gradually during the cause of pathogenis such leaves are fall down which cause great loss to the plant. Garg and Mandihar (1976) observed change in total sugar content in *Abelmoschus esculentus* (Okra) below *Erysiphe cichoracearum*.

Besada (1978), investigated lower level of carbohydrate content in virus-infected cucumber plants than healthy ones. They attributed the resistance of virus-infected plant against Powdery mildew (*Erysiphe cichoracearum*) to their poor content of carbohydrates.

Purothit and Arya (1979), reported that total Phenol content decreased in healthy leaves of *Legenaria siceraria, Momordica charantia Luffa acutangula* inception of disease.

**Management of Powdery Mildew:**

The management of powdery mildew on various crop been suggested that by different fungicides. Mandls and Khare (1969), reported that a safe protective measure for controlling *Erysiphe cichoracearum* in the green house is 1% Bapolysuphide with temperature at 24-25°C and air humidity at 80% while Thiram control effectively another pathogen *Sphaerotheca fuliginea*. While karathene have been found to be effective against powdery mildew of cucurbet. Systemic fungicides, like, Benomyl have been found to be equally effective in controlling this disease. Bannino *et. al.*, (1969), reported that Benomyl has given excellent result to control powdery mildew on cucumber.
Jhooty and Behar (1972) has been found that seed treatment to be quite effective in controlling powdery mildew of cucurbits. Whereas Waraitch et. al., (1975) reported that Benomyl to foliar spay is also quit effective in controlling powdery mildew of bottlegourd.

Bandopadhyay et. al., (1980) suggested that the powdery mildew of different cucurbits significantly controlled by the treatment of karathane. Puzanova (1984), reported that extracted Ampelomycin from Ampelomycon artemiside pre and post-inoculation spray of spore suspension of Fusarium pallido-roseum and Fusarium moniliforme resulted cent-percent control of powdery mildew on detached leaves of cucumber.

The best control of Sphaerotheca fuliginea on bottle guard (Lageneria siceraria) was given by 1-2 spray of calixin (Tridemorph) followed by Bavistin (Carbendazin) and Sulfex-80, Bhatia and Thukur (1989).

Powdery mildew on cucumber was reduced through the application of fungicides such as fenerimol, triadimefon and buprimate (Moustafa et. al., 1990). Similarly, Shina (1990), found that karathane and morestan at 0.2 percent concentration was better than other fungicide recording maximum PDI and maximum yield in Parwal (Trichosanthes dioica).

Khan et. al., (1991) reported that conidial germination to various cucurbits was fungi infecting to various cucurbits was inhabited by the treatment of sulfar dioxide, at 2 different concentration (286 µg/m3 and 57 µg/m3) for various exposure period. Whereas Jim et. al.,(1993), found that
tebuconzole was best fungicides to check the powdery mildew disease of cucumber.

Rangaswami (1993) evaluated sulphur or a best fungicides to control powdery mildew after the treatment of 3 to 4 times fortnightly intervals and Hagiya et. al., (1994), often tolerance strains, by successive use of systematic fungicide such as fenerimol, triadimefon and buprnimate to control the disease.

‘O’ Brien (1994) reported powdery mildew of cucurbit in squash crop. He suggested that spraying and dusting of sulphur or demethylation inhibitor fungicides.

Tripathi et. al., (1995) has been reported that Karathane control was found to be most effective to control powdery mildew (*Sphaerotheca fuliginea*) on bottle gourd (*Lageneria siceraria*).

**Biological control:**

Biologically the leaf extract of *Millsana flussia* and *Reynoutria sachalinesis* applied weekly. Concentration of 2% provided control of powdery mildew (*Sphaerotheca fuliginea*) on long English cucumber (Daayf et. al., 1995).

To control powdery mildew of *Momodrica charantia* fungicides tested were Nimrod [5-butyl-2 ethylamino – 6 methyl pyrimidine, 4-7 dimethyl sulphamales, Benlate (Methyl-1 (butylcarbamoyl) – 2 – benzimidazole, Carbonate), Hexasul (90% wettable sulphur). Karathane (Methyl – n – heptyl); 4-6 dimitrophenyl crotonate], and calixin (N-tridelyl
2, 6 dimethyl morpholine), among them Nimrod and Benlate provide to the most effect in reducing disease incidence followed Hexasul, Karathan and Calixin.

Sharma and Sharma (2004) suggested that systematic fungicide and fruit extracts from *Melia azadirachta* showed anti-sporulent activate. Their was reduction in conidia production resulting in less diseases severity and increase in fruit yield. Due to integrated disease management 79% diseases was control and the fruit yield was reported 21 per hector. Seeds of cucurbiti varieties Khara-75 was treated with the fruit extract of *Melia azadirachta* and five systemic fungicides and it was observed that the disease was control in glass house condition.

Dhanbir Singh (2004); used out of 23 phylloplane isolates of fungi and bacteria, nine viz; *Trichoderma viride*, *Ampelomyces quisqualis*, *Cladosporium cladosporioides*, *Fusarium fumigants*, *Aspergillus niger*, *Alternaria alternate* and *Pestalotiposis dissiminata*, stey were indentified and found antagonistic to *Sphaerotheca fuliginea*. All the test antagonists significantly controlled powdery mildew over check as pre and post inoculation sprays of spore suspension of antagonists on potted plants in glass house. Disease control was better in pre-inoculation spray application of biocontrol agent as compared to post-inoculation application. Maximum disease control was achieved with *Ampelomyces quisqualis* (87%) for the management of powdery mildew of cucurbits.