POWDERY MILDEW FLORA OF ALIGARH

Dissertation

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Master of Philosophy

IN

BOTANY

BY

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DEPARTMENT OF BOTANY
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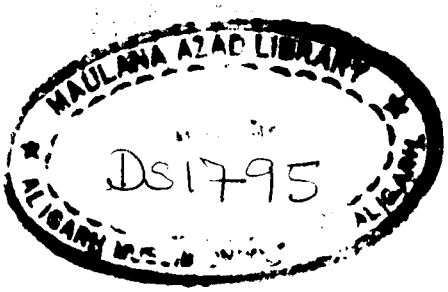

Dedicated to my
Loving Parents

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C E R T I F I C A T E

This is to certify that Mr. Saiyed Iqbal Husain has worked in this department as a Research Scholar under my supervision and guidance. His work on the " Powdery mildew flora of Aligarh." is upto - date and original. He is allowed to submit his dissertation for the consideration of the award of the degree of Master of Philosphy in Botany.

Mohd. Akram

(Dr. Mohd. Akram)

A C K N O W L E D G E M E N T

I was most fortunate to have a highly imaginative, enterprising and accomodative research guide by Dr.Mohd. Akram, Reader, Department of Botany, A. M. U. Aligarh,who inspired me to initiate the research work in the field of Plant Pathology. I deem pleasure in expressing my deep sense of gratitude to him for suggesting a problem of vital interest, skilful guidence and sympathetic behaviour throughout the course of work.

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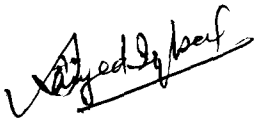
Finally, I beg to express my gratitude, thanks, appreciation and indebtedness to the " ALMIGHTY GOD " for providing and guiding all the channels to work in cohesion and coordination to make this study possible.



(Saiyed Iqbal Husain)

C O N T E N T S

INTRODUCTION

LOCATION OF ALIGARH:

Aligarh district is located in a fertile agriculture area of the Ganga-Yamuna Doab between 27° 29'N. and 28° 11'N. latitude and 77° 29'E. and 78° 38'E longitude. It is bounded by the river Ganga on the northeast and by the river Yamuna on the northwest. The greatest breadth from west to east, from Yamuna to Ganga near the northern border, is about 70 miles and the maximum length from north to south is 45 miles.

Physiologically the area consists of a vast alluvial plain having a gentle slope from north to south and southeast. The highest point on the surface is about 640 feet above the sealevel in the northwest of the district while on the southern border the elevation is about 622 feet. The whole district presents an almost level appearance and is remarkably homogenous in character. The land surface at places is varied by several depressions and elevations. These depressions have resulted from the action of surface water; the elevated portions in the form of sand ridges are remnants of deposition.

The general topographical layout is therefore, very similar to that of the Doab, and on the basis of the alluvial deposits it is divided into two parts i.e., the new alluvium

and the old alluvium. Aligarh district forms part of a region which is known as the Ganga plain. This plain is a depression between the Himalayas in the north and the Deccan plateau in the south. It has been filled with alluvium brought down by the Himalayan rivers.

Important crops which are commonly grown in the Kharif season are maize, millet, arhar, rice and sugarcane. In the Rabi season wheat, barley, gram and peas are most common.

CLIMATE OF ALIGARH:

Aligarh experience the tropical monsoon type of climate with its characteristic seasonal rhythm marked by the north-east and north-west monsoons, extreme of temperature, clear skies, occassionally dusty and low relative humidity. Mean monthly temperature varies considerably throughout the year. The average maximum temperature being 24.8°C from January-March and minimum 10.5°C. Average maximum temperature from April-June is 38.4°C and minimum 24.1°C, being maximum from July-September 32.2°C and minimum 25.6, and from October-December 26.7 and 13.1°C respectively. Such a high range of temperature indicates that though the days are extremly warm, the nights are cool and pleasant.

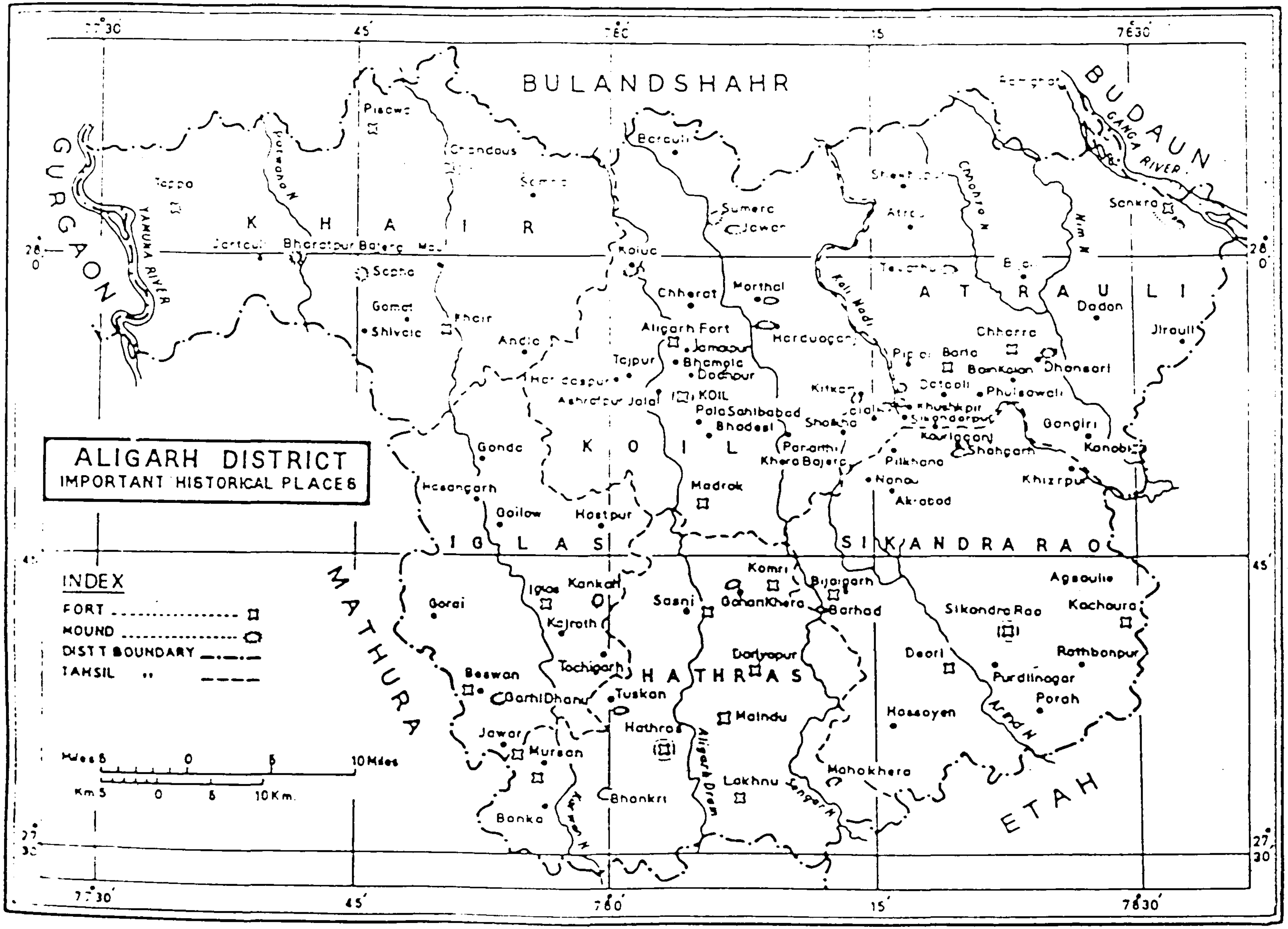
The rains generally set in by the middle of June and continue till the end of September or early October. It is

this period of the year that receive about 90% of the total annual precipitation. The monthly distribution of the rainfall throughout the year is not uniform. Usually the rain start by the middle of June, remain steady in July and August and then decline in amount by September.

The month of June receives an average of 44.8 mm., whereas the average for July, August and September being 241.0 mm., 286.8 mm and 263.8 mm respectively. There is marked decrease in rainfall by the end of September and October. It is evident that July and August account for about 60% of the annual rainfall. The amount of rainfall during the winter season is small, irregular and sporadic.

The relative humidity during the winter season, November to February ranges 63-71% at 8.30 hours, and 45-28% in the evening (17.30 hours). During the summer season, particularly in April and May, the relative humidity is very low. Its value at 8.30 hours is 37% whereas in the evening (17.30 hours) it lowers down to 16-21%. On the onset of monsoon the relative humidity increases and reaches its maximum in August 87% in the morning (8.30 hours) and 78% in the afternoon (17.30 hours).

Map 1


ALIGARH DISTRICT
IMPORTANT HISTORICAL PLACES
INDEX
FORT
MOUND
DISTT BOUNDARY
TAHSIL
10 Km.
BULANDSHAHR
BUDAUN
GANGA RIVER
GURGAON
YAMUNA RIVER
MATHURA
ETAH
KHAIR
KOIL
ATRAULI
IGLAS
HATHRAS
SIKANDRA RAO
Kali Nadi
Aligarh Drain
Sengar N
Karwan N
Nim N
Chhoiya N
Patwaha N
Arind N
Aligarh Fort
KOIL
Pala Sahibabad
Bhadesi
Chherat
Morthal
Madrak
Hastpur
Gonda
Hasangarh
Gorai
Beswan
Jawar
Mursan
Bonka
Hathras
Tuskan
Sasni
Komri
Barhad
Bijaigarh
Sikandra Rao
Kachaura
Rathbanpur
Purdilnagar
Porah
Deori
Hasayen
Mahokhera
Lakhnu
Maindu
Daryapur
Kankar
Iglas
Kajroth
Tochigarh
Bhankri
Akrabad
Nanau
Pilkhana
Khizrpur
Kanobi
Gangiri
Dhansari
Chherra
Dadon
Jirauli
Sankra
Barauli
Sumera
Jawar
Chandous
Pisawa
Tappo
Gomat
Shivala
Khair
Andla
Tajpur
Bhamola
Dadhpur
Jamalpur
Harduaganj
Kauriaganj
Shahgarh
Phulsawali
Bamkalan
Atrauli
Goilow
Ashrafpur Jalal
Kirkan
Shekha
Paraathi
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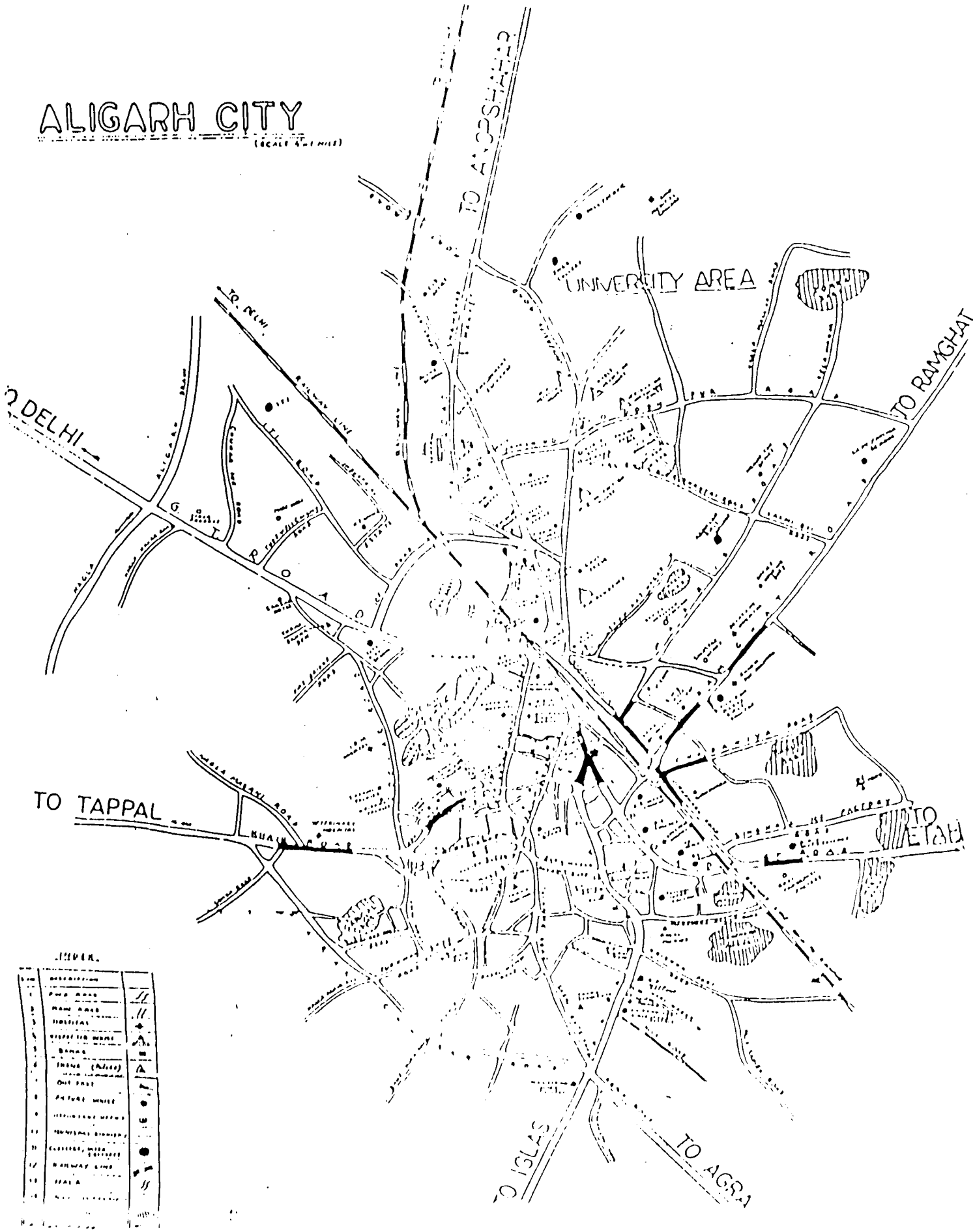
ALIGARH CITY
UNIVERSITY AREA
TO DELHI
TO RAMGHAT
TO TAPPAL
TO AGRA

ECONOMIC IMPORTANCE OF SOME FAMILIES:

A. Family: Compositae:

This is the largest family of the flowering plants containing about 950 genera nearly 20,000 species. The plants are cosmopolitan, being distributed almost throughout the world and in almost every type of climate. The family contains more than 10% of the total number of flowering plants.

A large number of cultivated garden plants are Helianthus annuus, Tagetes erecta, Calendula officinalis, Lactuca sativa, Chrysanthemum sp. etc., are annual herbs. Echinops echinatus, species of Sonchus sp. etc., are either annual or perennial herbs. Vernonia roxburghii may be either a perennial herb or sometimes an under shrub.

Helianthus annuus (Sunflower, Hindi - Surajmukhi)

The plants are extremely ornamental annual herbs 2-15 feet in height with flowerheads usually 3-6 inches wide, but attaining 12-24 inches width under cultivation.

Apart from its ornamental value, it is also of importance as an oil seed or fodder crop. The seeds are mainly used for extracting oil, but are also consumed as raw, roasted or salted. The oil is rich in vitamins A, D and E. it is used

as a cooking and a salad oil for the manufacture of margarine, bakery goods for preserving sardines and as a base for certain medicines. The flowers are a good source of honey. A yellow dye is extracted from petals.

Tagetes erecta (African marigold, Hindi - Genda)

The plants are extremely ornamental and are largely cultivated in gardens, homes and various other places. The flowers are used in the diseases of eyes and for unhealthy ulcers. Internally, they are said to purify the blood.

Carthamus tinctorius (Hindi - Kusum)

The plant is extremely ornamental, and apart from its ornamental value, the flowers yield a beautiful pink dye. The seeds yield a valuable oil, used in healing sores and a rheumatism. The whole plant possesses medicinal properties, and is used as a laxative, diaphoretic and for the remedy of itch, cold, jaundice etc.

Xanthium strumarium (Hindi - Chota datura or Chota gokhru)

The leaves yield a yellow dye, and the seeds yield oil which is used medicinally. The flowers are made into a tincture and are used to relieve toothache. The seeds are chewed

to produce saliva when the mouth gets dry. Young shoots are cooked and eaten.

Dahlia sp.

A small genus of tuberous-rooted perennial herbs with showy flowers. Although dahlias thrive well and bloom on the plains, they rarely produce those handsome, fully double flowers which make them such conspicuous objects of beauty in gardens on the hills.

The tubers of Dahlia have been used for the production of laevulose.

B. Family: Solanaceae:

This is a small family containing 85 genera and about 2,200 species. The plants are distributed both in temperate as well as in tropical regions. They are abundant in Central and South America where there are as many as 38 local genera.

Some of the largest genera of the family are Solanum, possessing about 1,500 species.

Solanum melongena (Egg plant or Brinjal, Hindi - Baigan)

The plants are largely cultivated for fruits which is largely eaten as a vegetable and also preserved as a pickle.

The seeds are often used as a stimulant, and the leaves as a narcotic. The plant is more or less prickly when grown as a field crop, but when gorown in the rich soil of the gardens, the prickles disappear more or less completely.

C. Family: Umbelliferae:

This is a large family containing about 200 genera and 2900 species. The plants are distributed almost throughout the world except the arctic regions. The chief centres of the distribution, however, are found in north temperate region. The family is represented by a number of important plants which are cultivated during the winter months. They are Coriandrum sativum, Foeniculum vulgare, Daucus carota etc.

Coriandrum sativum. (Coriander, Hindi - Dhania)

The plants are largely cultivated during winter months. The fruits, stems and leaves are all eaten. The fruits are used as a condiment in flavouring vegetables, meat and confectionery. The aerial parts (leaves and branches) are also used for flavouring vegetables etc.

Foeniculum vulgare (Fennel; Hindi - Saunf)

The fruits are largely used both as a condiment as well as a carminative. The roots are used as a purgative and the leaves are often cooked and eaten. The oil from seed is used as a vermicide.

Daucus carota (Carrot, Hindi - Gajar)

Carrot juice is rich source of carotene. It is used for colouring butter and other food articles. Carrot seeds are used for adulterating "Bhang". Carrot is a rich source fat-soluble hydrocarbon (C_{40} H_{56}). Vitamins A, B, C, D and E, calcium and phosphorous are common. Pressed juice from carrots is used as a blend for orange juice to give a palatable canned beverage. It is useful in diseases of kidney and in dropsy.

D. Family: Malvaceae:

This family contains about 82 genera and 1500 species. The plants are almost cosmopolitan in distribution being found almost throughout the world.

There is great variation in the habit of plants which may be herbs, shrubs or trees.

Abelmoschus esculentus (Lady's Finger, Hindi - Bhindi)

The plants are largely cultivated for edible pods. The fruits apart from being eaten in various ways are also used for thickening soups and gravies because of their high mucilage contents. A mucilagenous preparation from pods is used as a plasma replacement or blood volume expander. Ripe seeds are roasted and used as a substitute for coffee.

E. Family: Brassicaceae:

This is a fairly large family containing 350 genera and about 2500 species. The plants are almost cosmoplitan, but the major centres of distribution are north temperate regions especially the Mediterranean region. Included in this family are a large number of important vegetable crops as well as several well known gardens and wild flowers.

Brassica rapa (Turnip, Hindi - Salgam)

Its fleshy roots are edible. It is grown as a cold season crop in the plains of the Punjab and U.P., etc., and is sometimes grown on the hills.

Turnip are used in curries, pickles etc., and the tender leaves are used green vegetable.

Brassica campestris (Hindi - Kali Sarson)

Sarson is an important oil seed crop in India and is more commonly grown in Bengal, Bihar and the U.P. and it is also grown in Punjab. Sarson is considered a rather precarious crop susceptible to insect, pests & blight diseases. It is generally grown in the gangetic plain as a mixed crop.

Its oil is used in our houses as a medium of cooking, and as a medium of preserving various pickles. It is also used for lighting purposes. The oil contains glycerides of erucic acid.

F. Family: Chenopodiaceae:

This is medium sized family containing 102 genera and about 1400 species. It is almost cosmopolitan being distributed almost throughout the world, especially in the xerophytic and halophytic areas.

Plants are mostly either annual or perennial herbs. Sometimes they are shrubs and only very rarely there may be small trees.

Chenopodium ambrosioides (Mexican Tea)

The entire plant is aromatic with a camphoraceous odour. A volatile oil of medicinal value is found in the

glandular hairs, specially of the pericarp of the fruit.

The Indian chenopodium oil is mainly derived from C. ambrosioides and has an ascaridol content of 40-45%. All parts of the plant (specially the roots) contain saponin.

G. Family: Euphorbiaceae:

This is a large family containing 283 genera and about 7,300 species. The members of this family are found almost throughout the world except the arctic region.

In our country the family is represented by a number of important plants such as species of Euphorbia, Croton, Ricinus etc.

Croton sparsiflorous

The plant is reported to be rich in potash and nitrogen, and is suitable for composting. The seeds are small and are also rich in potassium and nitrogen.

Bark, root, fruit and seeds of Croton oblongiflolius are used as purgative and in snake-bite. The bark is also used as external application for sprains, and in lever diseases. The seeds and oil of plant are used as a powerful and drastic purgative.

Euphorbia hirta (Hindi - Dudhi)

The plant is used in diseases of children, in worms, bowel complains, cough etc. The leaves are eaten as vegetable. The juice of the plant is given in dysentery and colic. The decoction of the plant is given in bronchial affections and asthma. The latex is used as application for warts.

REVIEW OF LITERATURE

The word powdery Mildew was recognized and named as early as 1753 by Linnaeus, the pathogen which causes powdery mildew comes under the family Erysiphaceae. The members of the family are easily recognizable since they form a white powdery appearance due to the production of enormous number of hyaline conidia, on the surface of the host. Which can be seen by the unaided eye.

Powdery mildew are obligate parasites, ascomycetous fungi which grew principally on foliage of angiosperms and cause damage on a wide variety of crops. The fungus attacks stems, flowers and fruits. Firstly the fungus show very mild infection, producing small patches on the host, later it become chlorotic and may kill the plant as a result of severe infections. Fruits on infected plants ripen prematurely and lack the texture, flavour and sugar-contents. Sometimes fruits too do not set or remain smaller in size. The pathogen is characterized by their superfical hyaline mycelium and haustoria in the epidermal cells of the hosts. Large number of cultivated and wild species of different families have been recorded as the hosts of the members of Erysiphaceae. Due to this disease a considerable amount of damage has been recorded and at times it exceeds 20%.

Jagger (1926), Milbrath (1927) and Mckeen (1954) reported heavy losses in the yield of Muskmelon due to powdery mildew. While Szembel (1930) and Tafradzhiiski (1959) reported that it was very destructive to cucumber.

Jensen pointed out that the powdery mildew caused 52% reduction in the yield of Barley, while on the other hand Last (1957) estimated it to be 68 percent. The reduction was of 83% in gooseberry reported by Cork (1965). The most widespread and destrous losses attributed to a powdery mildew were on grape in France viz. 33-90% losses had been recorded (Arnaud and Arnaud, 1931) and 80% in peaches (Fikry, 1936). Heavy losses due to this group of fungi had also been reported by Cannon (1962) on potatoes; on mint (Ganguly and Pandotra, 1963-64); on tobacco (Wober 1959; Cole 1963) and by Moore (1965) on peppers.

Powdery mildew fungi have wide host range. Salmon (1900) in his "Monograph of Erysiphaceae" listed about 1500 species as the hosts of powdery mildew. Weiss (1950) observe powdery mildew 1340 out of 3100 host species, shown in U.S.D. index of plant disease. Blumer (1967) observed powdery mil dews on 1928 plant species belonging to different families of Angiosperms.

Majority of powdery mildews, including species attacking cucurbits, seldom produce perfect stages. In the absence of perfect stage, the identification is mostly done on the basis of conidial characters. Tarr (1952) and Nour (1957) from Sudan; Clare (1958); Kable and Ballantyne (1963) U.S.A.; Boerema and Van Kesteren (1964), from The Netherlands employing the characters of conida and mycelia; they concluded that Sphaerotheca fuliginea is the causal organism of cucurbit powdery mildew and not Erysiphe cichoracearum. The main characters taken into consideration are the Colour of mycelium, presence of fibrosin bodies in the former and their absence in the later. More recently Zaracovitis (1965); Goster (1966); Blumer (1967); Kapoor (1967) and Mathur et al. (1967) suggested that the two can be differentiated on the basis of production of forked germ tube in S. fuliginea and appressoria like bodies in E. cichoracearum. Whereas, several workers viz: Butler (1918); Jagger (1926); Fikéry (1936); Mckeen, (1954); Schmitt (1955); Ivanoff (1957); Vasudeva (1960); Rajendran (1965); Blumer (1967); Mathur et al. (1971) concluded that E. cichoracearum was causal organism of powdery mildew of cucurbits. However, these reports of the identity of the fungus was entirely based on conidial characters, except those perithecia observed on Coccinia indica, Momordica balsamina by Butler (1918); on Lagenaria leucantha by

Rajendran (1956); and on Coccinia cordifolia and on Bidens hispida by Khan et al. (1971,1972).

The powdery mildew of majority of the members of compositae has been identified as E. cichoracearum. This is recognised by two spored asci and basally inserted appendages which are much larger than the diameter of the ascocrp. S. fuliginea resembles with E. cichoracearum in possessing conidia in long chins which has possible leads to the confusion.

Mckeen et al. (1966) studied the pathogenecity of E. cichoracearum on Helianthus annuus, and examined the infected leaves under electron microscope and concluded that the haustoria of the fungus were elongated, ellipsoidal with twisted branches and were bathed in a cavity surrounding by the plasma membrane of the host. Further observation was made by Mckeen and Bhattacharya (1968) as the changes in the constituents of the host cell wall surrounding the infection peg of powdery mildew fungi; as the leaves infected with E. cichoracearum stained intensly with azure dye, methylene blue and cotton blue.

The brownian movement has been observed in conidia of E. cichoracearum from H. annuus (Yarwood, 1952).

Pertaining to the finding of perfect stages, Neger (1923) reported S. fuliginea on Epilobium montanum (Onagraceae), and Taraxacum officinale (Compositae). Groter and Eicker (1983) reported that the teleomorphic state of E. cichoracearum is newly recorded from South Africa on Zinnia sp. and Dahlia sp. The deviating insertion of its appendages led to its identification as a new variety viz. E. cichoracearum var. transvaalensis. cleistothecia of E. pisi on Sesbania punica and Sphaerotheca xanthi from Bidens formosa were alos found. Perithecia of E. cichoracearum were reported by Lebeda and Buczkowski (1986) on Lactuca spp.

In India various Workers have been observed the perfect stages viz: S. fuliginea on Helianthus annuus (Patil, 1964; Patwardhan, 1965) from Maharashtra and Prasad et al. (1960) from Rajasthan; on Dimorphotheca sinuata by Mathur et al. (1971) from Rajasthan; on Bidens biternata (Khan et al. 1975); on Anaphalis contorta, by Srivastava and Rawat (1982) from Pauri (Garhwal). Paul and Kapoor in 1985 observed the perithecia of Leveillula taurica on Senecio chrysanthemoides from Harwan, Kashmir. The pathogen of powdery mildew has a wide host range. Powdery mildew fungi have been reported on different members of Compositae. Blumer (1933) observed S. fuliginea on Adenostyles alliariae, Arnica montana, Bidens cernuus, B. melanocarpus, B. tripartitus,

Bellidiastrum michelii, Calendula officinalis, Crepis paludosa, C. blattariodes, Erigeron acer, E. caudensa, Helianthemum canum, H. bulgare, H. grandiflorum, Leontodem hispidus and Taraxacum officinale (Compositae). Moore (1947) and Nomura (1974) reported S. fuliginea on Doronicum spp. and Helianthus annuus respectively. According to Cepetti & Gabrila (1976) Sphaerotheca fuliginea on 5 spp. of Calendula, Oidium sp.; on 10 new hosts belonging to various genera including Hirncium sp. Sphaerotheca fuliginea f. sp. cyclachaenae found on Cyclachaena xanthifolia (Gelyuta, 1979). Reed & Dere (1986) reported Sphaerotheca xanthii on Chamomilla suaveolens from Britain; whereas Hou & Lee (1981) observed Sphaerotheca fuliginea on Dahlia pinnata rather than E. cichoracearum from Taiwan.

Hirata (1966) reported that Sunflower had been infected with S. fuliginea in China, France, Japan, Holland, Italy Yugoslavia and Switzerland.

E. cichoracearum have been reported on various hosts viz. Cineraria sp. (Mac Donald, 1939); on Zinnia spp. (Baker and Locke 1946) from California; Eliade and Eugenia (1975) from Romania reported E. cichoracearum on Zinnia elegans and Achilla coaractata on Sunflower, by Klisiewiez & Beard (1976) from California; whereas Shopov (1976) reported E. cichoracearum f. sp. helianthii on Sunflower from Bulgaria.
The Erysiphe cichoracearum was found on Anerboa lipii,

Khan & Ahmad (1979) from Jamahiriya (Libya); whereas in (1980) Khan reported this species on Hedypnosis cretica, Conyza bonariensis and Sonchus oleraceous. Noumuro Yikihiko (1980) observed E. cichoracearum on chrysanthemum boreale. The Helianthus tuberosus was infected with E. cichoracearum in Italy (Lorenzini & Triolo 1981; Ialongo, 1981) in Georgia (USA), Mccarter & kays (1984), Cute & Burns (1984) from USA, Dhanvantari & Jarvis (1985) from Canada, Klemm (1986) from Merat (GDR) and Lebeda (1986) from Czechoslovaka reported the Lactuca sativa as the host of E. cichoracearum. Eshed (1977) observed the oidiumtype mildews from Bellis perennis, Chrysan themum coronarium, while oidiopsis-type reported from Gerbera janiesouii.

Helyuta & Marchenko (1985) reported Uncinula bicornis on Aesculus hippocastamum from USSR, its origin and drawings are available.

In India, the Sunflower has been recorded as the host of S. fuliginea by Jhooty (1965) from chandigarh, whereas, the perfect stages of this pathogen reported on Helianthus annuus (Patil, 1964, Patwardhan, 1965) from Maharashtra; Prasad et al. (1968) and Mathur et al. (1971) reported it from Rajasthan on Dimorphotheca sinuata. Howeve Srivastava & Rawat (1982) observed on Anaphalis contorta from Garhwal Himalayas.

Eryysiphe cichoracearum has been reported on H. annuus (Patel et al. 1949; Pavgi & Upadhaya, 1966); on Sweet Sultan (Centurea moschata) and Acroclinium sp. (Helipterum roserum & H. album) by Jain & Singh (1968); on Inula racemosa by Narain & Saksena (1975); On Vernonia cinerea by Perwez & Akram (1987).

In 1982, Paul & Munjal reported Erysiphe artemisiae On Artemisia scoparia; S. fuliginea on Erigeron bonariensis.

Reed (1908) observed that the cucumber isolats of E. cichoracearum infect Sunflower while the isolates from Sunflower infect cucumber and squash poorly. Miller and Barret (1931), on the other hand, showed that forms on cucumber and Sunflower did not cross infect each other. Schmitt (1955), while confirming these findings showed that Zinnia strains of E. cichoracearum had a wider host range than the form of Inula sp., Helianthus sp., Cerianthe sp., Phlox or cucurbits. Zinnia isolates have been reported to attack Z. elegans. Z. panciflora, Z. verticullata, H. annuus, Arctium minus, A. nemorosum, Xanthium chinense, X. spiriosum, X. strumarium, Mikania scandens, Hieracium alpinum, H. prenanthoides, Inula helenium, Carlina acantis, Lactuca perennis, Cosmos sp., Scorzonera hispenica and Felicia amelloides of the family Compositae. Salkinglossia sinnulata and Cerianthic major of the family Solanaceae and Boraginaeae respectively. The isolates from Phlox sp. were restricted to P. drummendi

and cultivated perennial Phlox. The cucurbit isolates infect only members of cucurbitaceae, but failed to develop on other non-cucurbits.

According to Schnathorst et al. (1958) Calendula isolate of E. cichoracearum was pathogenic on Calendula officinalis and Silybum marianum, while Lactuca sativa isolate on C. officinalis, L. sativa, L. serriola, S. marianum and Z. elegans. Isolates from L. serriola, Salinus sp. and Z. elegans infect L. serriola, S. marianum and Z. elegans. While that from California infect L. serriola and L. marianum. Therefore, the isolates of E. cichoracearum from different hosts and different localities from the same host are different in their host range. Schnathorst et al. (1958) also reported that Lactuca isolates of E. cichoracearum infect both potted and detached leaves of Calendula officinalis var. double mixed, Dahlia variabilis var. unwins dward-Hybrids; H. anqustifolius, H. annuus, L. serriola; Silybum marianum, Senecio cruentus. Z. elegans var. Floredoles scarlet and Giant fantary, Delphinium hybridum var. Giant imperial blue shade.

According to Hasan (1975), plant species comprising a number of cichoraceous plants closely related to chondrilla and cultivated plants belonging to 23-families particularly the cultivated compositae, cucrbitaceae, Solanaceae and

Leguminosae, on which this fungus have been recorded, were inoculated with conida of the powdery mildew. Moreover three cultivars of all cultivated species recorded as hosts of any form of E. cichoracearum were tested. The powdery mildew from Chondrilla juncea did not develop on any of these plants. The isolates of E. cichoracearum from Artemisia vulgaris var. indica maxima can't parasitize A. japonica, whereas the isolates of S. fuliginea from Impatiens balsamina infects Helianthus annuus. Morgan-jones (1975) observed a new species Microsphaecropsis centureae from Centaurea diffusa and its isolate was tested to C. diffusa and C. macularis, both were pathogenic to this pathogen. The fungus Erysiphe cichoracearum was isolated from Sonchus oleraceus and it was only pathogenic to Sonchus spp. on detached leaves of a wide range of plants (Ialongo, 1980), Mitov & Popov (1979) from Bulgaria reported that the isolates of Erysiphe cichoracearum f.sp. helianthii from Sunflower infects Jerusalum artichoke (H. tuberosus) and H. scaberimus and those from H. tuberosus infect Sunflower under Bulgarian conditions, According to Chandra et al. (1982), Dolichos lablab was inoculated with E. polygoni from Cassia occidentalis and Trigonella foenumgraecum; Sphaerotheca euphorbiae from Euphorbia hirata and S. fuliginea from Zinnia elegans, Erysiphe spp. from X. strumarium and Erysiphe cichoracearum from Coccinia cordifolia and E. pisi from Pisum

sativum, only positive results were obtained with isolates from Z. elegans. The isolate of E. cichoracearum from lettuce was inoculated on L. serriola and L. virosa among these two the later showed least infection whereas the former developed mild infection (Lebeda, 1986).

IDENTIFICATION OF THE PATHOGEN AND HOST RANGE:

Sphaerotheca fuliginea, was observed on Abelmoschus esculentus, Helianthus annuus, Solanum melongena and Zinnia elegans at Aligarh. The host range studies revealed that it caused infection only on their respective hosts and failed to infect cultivated, wild and non-cucurbitaceous hosts, Akram and Khan (1978). During the course of preliminary survery of cucurbit powdery growing areas, host range of Sphaerotheca fuliginea (Schlecht) Poll. was observed on Luffa cylindrica and Mukia maderaspatana at Aligarh (U.P.), on Lagenaria leucantha and Cucurbita moschata at Sanatnagar (Kashmir) and on C. moschata at Ranikhet in North India, Akram and Khan (1985).

During the course of survery, large number of cultivated and will cucurbits were found to be infected with powdery mildew, however, perithcia were occasionally observed during winter on Cucurbita maxima Duch., Lagenaria leucantha (Duch.) Rusby and during spring on Coccinia cordifolia (Linn.) Cogn., Khan et al. (1971). Under Indian conditions S. fuliginea attacks most of the cultivated and wild cucurbits and E. cichoracearum is confined to C. cordifolia and Benincasa hispida; In the absence of perfect stage the identity was based on the shape of conidia, presence and absence of

fibrosin bodies and germination of conidia; Khan et al. (1971).

Sphaerotheca fuliginea parasitizing cucurbits is usually found in conidial stage. Perithecia have, however, been reported by Poretzky (1923), Deckenback (1924), Szembel (1926), Deckenback et al. (1927), Rodigin (1936), Uozumi et al. (1952), Palti (1961), Sohi et al. (1969), Khan et al. (1970,71,72) and Dave et al. (1971). Perithecia of S. fuliginea (Schlecht.) Poll. On Cucumis melo and Luffa cylindrica are recorded for the first time from Aligarh (U.P.), also on Citrullus lanatus, Cucumis melo var. utilissimus and C. melo var. momordica; Khan et al. (1978).

Perithecial stage of Sphaerotheca fuliginea (Schlecht.) Poll. has been observed on certain hosts by Khan et al. (1972); cultivated cucurbits are Lagenaria leucantha (Duch.) Rusby and Cucurbita maxima Duch. According to Khan and Khan (1970) and Khan et al. (1971); S. fuliginea not only causes infection on a number of cultivated cucurbits but its perfect stage is also produced on several of them, is the first record; also reported on Bidens biternata Lour. which has not also been included in the host list given by Blumer (1967).

During the survey of powdery mildew on the members of Compositae at Aligarh, Vernonia cinerea Schreb. Was found to be infected with Erysiphe cichoracearum DC. by Perwez and Akram (1987); Several workers have reported powdery mildew on Compositae (Vasudeva, 1960; Jhooty, 1965; Narain and Saxena, 1975; Paul and Munjal, 1982). Effect of temperature and relative humidity on the germination of conidia of Erysiphe cichoracearum (obtained from defferent isolates viz., Helianthus annuus, Cosmea sp. and Xanthium strumarium) has been studied by Mital and Akram (1984). The optimal temperature for germination of conidia ranged from 17 and 20 °C. The optimal relative humidity ranged from 95 and 100 percent. Conidia failed to germinate in free water. The three isolates differed in the percentage of germination at various humidities and temperatures.

According to Saharan and Sheoran (1988) on Rapeseed-mustard powdery mildew caused by E. cruciferarum opiz. ex Junnel, has become one of the widespread and serious disease causing considerable losses in late sown and late maturing cultivars allover India, conidia were incubated at different temperatures (10-35°C) and relative humidities (20-70%) Maximum spore germination (36-70%) was recorded at 40% relative humidity followed by 50% where 35% spores germinated.

Reaction of different cultivated Umbelliferous plants against isolates of powdery mildew Erysiphe umbelliferarum DeBary has been studied by Mital & Akram (1985). Host response of six different Umbelliferous plants viz. Daucus carota L., Coriandrum sativum L., Foeniculum vulgare Mill, Anethum graveolens L., Cuminum cyminum L. and Carum coptium have been studied against three isolates of E. umbelliferarum from Daucus corota, Coriandrum sativum and Anethum graveolens in glass house as well as in the field. D. carota and C. sativum were resistant to A. graveolens isolate and F. Vulgare and A. graveolens were resistant to isolate of D. carota and C. sativum respectively. Cuminum cyminum was susceptible to C. sativum isolate. Disease, however, failed to develop on Carum copticum by all the three isolates. Powdery mildew on Umbelliferous crops is usually prevalent in Rajasthan during February to April. Leaves, young stems, umbels, and seeds are coated with white, powdery mass of fungal mycelium and spores. Erysihpe umbelliferarum DeBary. on carrot (Daucus carota L.) have been reported from India (Uppal and Desai, 1933; Kapoor and Gill, 1960) and Erysiphe polygoni DC. on Cumin (Cuminum cyminum L.) and Coriander (Coriandrum sativum L.) Komirna, (1938) reported E. umbelliferarum f. anethi on fennel (Foeniculum vulgare Mill.) from Russia. and considered it identical with the species described on dill (Anethum graveolens L.) inspite

of certain discrepancies in size of conidia described by Mathur et al. (1974).

The assesment of losses due to powdery mildew in North Gujarat was given by Gohil et al. (1988). According to them Cumin (Cuminum Cyminum L.) is an important rabi crop widely grown in this area. Powdery mildew caused by Erysiphe polygoni DC. has been observed in severe form in this area. The cleistothecial formation of Erysiphe polygoni DC. on pea, which is of rare occurrence has been recorded consistently on pea Crosees. The perfect stage was observed in segregating population of pea in resistant plants alone. The cleistothecial formation is related to host nutrition rather than environment, (Mandloi et al., 1988).

Sohi et al. (1966) reported Erysiphe polygoni DC. on living leaves, stems and inflorescences of Chenopodium ambrosoides L. During the course of periodic surveys of Government farms and orchards in the H.P., a number of powdery mildews were recorded and examined. Litzenberger et al. (1957); Soria et al. (1973) and Gupta et al. (1976) have reported that powdery mildew on moong is caused by Erysiphe polygoni DC. But close examinations of conidial and cleistothecial characters revealed that powdery mildew on moong, Vigna aureus is caused by Sphaerotheca sp. A comparison of different characters of Sphaerotheca macularis and

S. fuliginea given by Blumer (1967) and Premelee (1977) shows that it resembles much with Sphaerotheca fuliginea (Schlecht. ex Fr.) as later given by Chandra et al. (1982).

According to Khan et al. (1971), nine species of powdery mildews infecting various cultivated and wild plants at Aligarh and adjoining areas were recorded. Many of these crops were heavily to moderately infected with different species of powdery mildew viz. Erysiphe heraclei was found on Daucus carota, Foeniculum vulgare and Coriandrum sativum; however, perithecia in nature of this pathogen observed only on D. Carota, that too late in the season; Erysiphe communis was found to infect Brassica rapa; E. polygoni on Chenopodium ambrosoides and Sphaerotheca euphorbiae on Croton sparsiflorus; On Abelmoschus esculentus both S. fuliginea and E. cichoracearum were recorded.

Erysiphe graminis which infects cereals was absent throughout the period of investigations at Aligarh.

According to Kulshrestha and Lal, (1970), a powdery mildew of Croton sparsiflorus is commonly observed every year. During the winter from 1967-68, abundant cleistothecia were observed which have been determined to belong Sphaerotheca euphorbiae (Cast.) Salon. It has been reported earlier from India on Euphorbiaceous weeds, Euphorbia

hirta, E. pilosa and Pedilanthus tithymaloides. Croton is an addition to the host list of the fungus. Prasad and Sinha recorded Erysiphe sp. on this host but their material has not been reported for comparison.

In India, speculation in Erysiphe has mainly been based on Salmon's concept. According to Blumer E. polygoni is an aggregate species comprising many individual species. E. polygoni as described from India was found to comprise eight species viz. E. berberidis, E. betae, E. heraclei, E. martii, E. pisi, E. polygoni, E. ranunculi and E. salviae, Paul and Kapoor, (1983).

During a survey of Kashmir valley three powdery mildews viz., Sphaerotheca pannosa, Phyllacting guttata and Erysiphe cichoracearum were observed on Filipendula vestita, Crotaegus sonarica and Polemonium Kashmiriana respectively, Dhar et al., (1982). They also reviewed the literature which revealed that, so far, none of such pathogens has been reported on these hosts from India. Some new host records of powdery mildews have also been reported by Paul and Munjal, (1982) from India. He reported Erysiphe artemisiae on Arthemisia scoparia; E. communis on Capsella sp.; E. martii on Trifolium repens and Phyllactinia guttata on the leaves of Pyrus scrotina. Srivastava and Rawat, (1982) also reported Sphaerotheca fuliginea

(Schlecht) Poll. on Anaphalis contorta Hook, f. (Asteraceae) from Pauri (Garhwal).

An experiment was performed by Mital and Akram, (1985) showing Cucumis sativus (Cucumber) a common host for Erysiphe cichoracearum and Sphaerotheca fuliginea. Powdery mildew appeared moderately when plants were inoculated with S. fuliginea only. Infection of both pathogen occured when different leaves of a single plant were inoculated with conidia of E. cichoracearum and S. fuliginea, consequently both the pathogens also appeared on a single leaf when a half portion of a leaf was inoculated with conidia of E. cichoracearum and the other half with conidia of S. fuliginea respectively. The time taken for the appearance of the disease is the same in either cases. According to Paul and Kaushal, (1985) the powdery mildew conidia germinate quickly in the absence of water because of relatively large water content in the conidia. The data revealed that conidia of mildews e.g. Erysiphe berberidis and Oidium sp. on Xylosma longifolium showed optimum germination (70-100%) at relative humidity less than 70%, conidia of E. cichoracearum, E. graminis, E. martii , Sphaerotheca fuliginea showed optimum germination percentage at relative humidity varying from 70-100%.

Jhooty has reviewed occurrence of powdery mildews on cucurbits in India. In Rajasthan Sphaerotheca fuliginea (Schl.) Poll. and Erysiphe cichoricearum DC. have been reported under favourable conditions. During Nov. and Dec., 1979, leaves of bottle gourd Lagenaria siceraria (Mol.) Standll and Luffa acutangula were found to be infected with Oidiopsis taurica (Lev.) Salmon at Durgapur, Jaipur. The occurrence of Oidiopsis taurica (Lev.) Salmon alone or concomitantly with S. fuliginea on these hosts is a new record. (Mahrshi & Siradhana,1980). Paul and Bhardwaj (1982), recorded Oidiopsis taurica on Reinwardtia indica.

Some new hosts have been recorded as Erysiphe biocellata Ehrenb. on Ocimum scantum Linn. by Sharma & Chaudhary, (1980) and Erysiphe polygoni on Conium maculatum; Uncinula adunca on Salix babylonica from Kashmir valley by Shah and Qasba, (1980). Similarly Sharma, (1984) reported Uncinula clintonii on Celtis australis L.; U. Clandestina on Ulmus wallichiana Planch and U. adunca on the leaves of two hosts viz. Salix albo L. and S. wallichiana Andress. from Kashmir valley. During a survey of powdery mildews of North - West U.P., Sachan (1977) Uncinula aspera Doidge recorded on the leaves of Ficus religiosa for the first time in India.

A survey of powdery mildew in Madhya Pradesh was conducted by Saxena and Sakhena, (1981) during 1979-80, revealed several new hosts, viz. Erysiphe cichoraceaarum DC. on Dahlia variabilis Desf. and Volutarella divaricata Benth and Hook.; E. polygoni DC. on Papaver rhoeas L.; Leveillula taurica (Lev.) Arnaud. on Calotropis procera Br. and Papaver rhoeas L., Phyllactinia corylea (Pers) Karst. on Morus indica L.; Sphaerotheca macularis (Wall. ex Fr) W.B. Cooke on Fragaria indica Andr.; and Oidium spp. on Jasminum sp. and Vernonia divergens Edgew. Collection have been made on powdery mildews on plants of Kotdwar by Jain, (1984). About 35 different hosts were collected having fungal infection (Erysiphaceae) on leaves, stems, inflorescence and fruit etc. Various species of causal fungi viz. Erysiphe, Leveillula, Oidium, Phyllactinia, Uncinula etc. have been identified on the basis of size and structure of conidia and conidio-phores. Fruiting bodies (Perithecia) are rarely observed on the hosts. Erysiphe and Oidium species are more dominant pathogens in the area. Some new host records for powdery mildews are also reported. These are Oidium sp. on Gonolobus, Thumbergia grandiflora and Erysiphe sp. on Xanthium strumarium.

Development of powdery mildew caused by E. Pisi DC. was studied on twelve pea (P. sativum L.) cultivars

during rabi in 1983-84 and 1984-85. The observations on apparent infection rate showed the cultivars IPS-207, IPS-77, IPS-293, IPS-241 and IPS-198 were resistant to powdery mildew due to retarded mycelial growth (slow mildewing). The slow mildewing cultivars had longer latent period, smaller and fewer conidia per speck in comparison with the fast mildewing (Krishna and Mishra, 1989). Erysiphe pisi DC. often assumes epidemic proportions on Pea (P. sativum L.) especially when favourable weather conditions prevail even for small durations. These studies carried on twelve pea cultivars for relation of slow or fast mildewing during rabi 1983-84 and 1984-85 revealed that cultivars which exhibited slow mildewing possessed a thicker cuticular layer and a thin epidermal layer as compared to fast mildewing cultivars having a thin cuticle and thin epidermis, Krishna et al. (1987).

Powdery mildew, caused by Oidium mangiferae Berth. is one of the most destructive disease of mango Inflorescence affecting all the varieties. Infection of powdery mildew tends to inhibit the fruit set or fruit drop. Biochemical changes in infected panicles at three stages/degrees, namely low (1-10%), medium (11-15%) and severe (51-100%) of cultivar Dashehari were studied. The amount of protein in infected panicles was lightly higher than healthy panicles. Reducing

sugars were lower in low and medium stages. (Prakash et al. 1989). It results in shedding of flowers and small fruits which reduces the yield considerably. (Datar, 1986). For recording the disease intensity twenty inflorescence were observed for the visual symptoms and graded in 5 categories; 1, (about 50% portion of infloresecence showing powdery growth); 2, (small patches on the inflorescence about 26-50% disease); 3, (bigger patches on inflorescence about 51-75% desease); 4, (powdery coating on all parts of inflorescence above 75% dissease, heavy flowers shedding). In this experiment (PDI), percent disease intensity was calculated. Powdery mildews are one of the most frequently encountered diseases of plants in Chotanagpur. Five new hosts for powdery mildews observed during late rainy season to winter of 1970 and 1971. All parasites were ectophytic in nature and cleistothecia were not observed in any of them. On the basis of morphological characters they are being assumed to the form genus Oidium. A hyperparasite, Ciccinobolous cesati was observed in a sevre from on the Oidium sp. attacking Adenostemma viscosum, Datta; (1974).

Prakash and Jhooty, (1987) reported conidia of Microsphaera alphitoides on ber (Ziziphus mauritiana) that initiated germination and appressoria formation after 2 and 4 hours, respectively at 20+2 °C in moist saturated atmosphere,

Sporulation started 96 hours after incubation on susceptible ber leaves. Cardinal temperatures for powdery mildew development were below 10, 20 and 30 °C. Relative humidity levels of 32% and above favoured development of powdery mildew. Powdery mildew caused by M. alphitoides Griff & Mauble is one of the many powdery mildew of Oak (Quercus incana Roxb.). (Srivastava and Kumari, (1983). Disease was first observed in the month of May as white coating on the upper surface of young leaves and buds. As infection advances, white coating ultimately covers entire upper leaf surface. In severe infection powdery mildew may appear on the lower surface of the leaf also. Zahorovoska, (1985) reported Microsphaera hyphophylla and M. alphitoides on Oak (Quercus dalechampii). The first sign of infection usually appears on the leaves of the young sprouts in the second half of June, In the case of very susceptible species of Oak the leaf infection may appear on both sides of the leaf. Sexual stage of a powdery mildew fungus assigned to the genus Microsphaera and causing infections on leaves of Begonia socotrane was described by Viennot, (1984). With the observations of numerous specimens on many ornamental species of Begonia and the other biometrical study of conidial elements, two distinct species occur in France, O. begoniae Putt. The ascosporal stage of which is Erysiphe polyphaga Hamm. and O. begoniae var. macrosporum de mend. et de Seg;

is assigned as Microsphaera begoniae Sivanesan.

Saxena et al. (1983) reported Celosia cristata, a new host for Leveillula taurica. Microscopic examination of this powdery mildew revealed it as L. taurica (Lev.) Arn. A scrutning of the literature reveals that it has not been reported so far and, therefore, constitutes a new host record. In January, 1979, few germ-plasm lines of Chickpea- J.G. 62, P-394, P-3614, P-4083 and Chaffa were found infected with Leveillula taurica to the extent of 40-60 percent at the experimental farm, Khune et al. (1979). Perithecial formation in Leveillula is generally believed to be rather rare and the genus has mostly been reported in its conidial stages all over the world. In a study made by Paul and Kapoor, (1982) two host species were identified as Leveillula taurica (Lev.) Aru. and Oidiopsis sps. Paul and Bhardwaj (1988) reported (Oidium prinsepii sp. nov Oidiopsis taurica of Prinsepia utillis Royle from India.

According to Singh, (1986), the relationship of different chemicals in disease resistance to powdery mildew and susceptibility of the host, pea was taken as test palnt. However leaves from one and a half-month old plants of five resistant (T10, P185, P338, 6587, Rachna) and five susceptible (T56, T163, KS 123, Madhu, Bonnevillia) pea cultivars were selected at random. Standard methods were adopted for the

estimation of total sugars, nitrogen, potassium, calcium and Maganesium. It is evident from the results that in general, leaves of resistant cultivars contained lower amounts of sugars, nitrogen and potassium hence it as high sugar disease.

An attempt was made by Singh et al. (1989), to control the powdery mildew (Oidium lini Skoric) of linseed. (Linum usitatissimum L.) with five Chemicals, nemely sulfex (0.3%), Karathane (0.06%), Calixin (0.1%), Jkstein (0.05%) and topsin M (0.15%). Topsin M appeared to be the best treatemt in comparison to other fungicides in controlling the powdery mildew disease incidence and also increasing the yield significantly.

Powdery mildew of mungbean (Vigna radiata L. Wilczek), mango (Mangifera indica L.), ber (Ziziphus mauritiana Lamk.) and cucumber (Cucumis sativus L.) caused by Erysiphe polygoni DC., Oidium erysiphoides f. sp. mangiferae Berthet, Oidium erysiphoides f. sp. ziziphi Yen and Wang & Sphaerotheca fuliginea (Schlecht) Poll.; the field evaluation of systemic and non systemic fungicides against powdery mildews of these crops was studied by Bhatia and Thakur, (1989). Five trials were laid out during 1981-82 & 1982-83 on chausa variety of mango & Kaithale variety of ber. Susceptible cultivars, namely, local variety of cucumber & Pusa Baisakhi of mung bean were planted in 6x2m and 3x2m plots respectively

and these plots were arranged in a Ramdomised block Design (RBD) with three replicates for each treatment. Fungicides used were Sulfex-70 WP and Sulfex-80 WP, both 0.2%, Calixin 75 EC-0.1%, baristin 50 WP-0.1%, phenyl crotonate and benlate-0.1%. In mungbean, maximum disease reduction was by baristin (73.5%), sulfex-80 (66.0%). Least control given by sulfex-70 (0.2%) which controlled 50.90% disease.

Podery mildew of Cumin (Cuminum cyminum L.) caused by E. polygoni DC. is a widespread disease in Gujarat which reduces the yield considerably. The trials were conducted in randomized block design with four replications. The first spray of the fungicides was given 45 days after sowing the crop, subsequent spraying were carried out at an interval of 15 days. Comprising of 3 spraying in all the incidence of the disease by following 0-5 scale was recorded from five randomly selected plants in each net plot. The yield of grains was recorded in each treatment. All fungicides except Bavistin were significantly superior in their effects over control for checking the disease intensity, Gohil et al. (1985). Same method had also been employed by Shrestha, (1985) to evaluate the efficacy of various fungicides and to combat the powdery mildew of pea by systemic fungicide Bavistin 50 WP. A combination of Lime+Sulphur was also found to be next best fungicide followed by

Karathane and Calixin.

Recently, Bent (1964) reported the efficacy of a pyrimidine derivative "Dimethirimol" coded as pp 675 developed at the Jealotts' Hill Research Station of the Imperial Chemical Industries, U.K. against the powdery mildew of cucurbits caused by Sphaerotheca humuli var. fuliginea (Schl.) Salmon. According to him a related compound from the same laboratory in the name of Ethirimol (PP 149) was also found to be highly promising for the control of barley powdery mildew (Erysiphe graminis var. hordei Lev.). Their efficacy was also studied against powdery mildew of wheat (E. graminis var. tritici E. Marchal) under Shimla conditions by Suryanarayana et al., (1972).

Suhag & Mehta, (1982,83) have also studied economies, efficacy and assimilation of some antipowdery mildew fungicides in cucurbits. They studied the control of Sphaerotheca fuliginea affecting bottlegrourd (Lagenaria siceraria Mol.)Standl; muskmelon (Cucumis melo L.); Cucumber (Cucumis sativus L.) and pumkin (Cucurbita moschata. Duchesne) by plating them in 5x3m plots; whereas for pea (Pisum sativum L.) and summer squash (Cucurbita pepo L.) the plot size was 3x1m, and also ten years old trees of mango (Mangifera indica L.) and Ber (Ziziphus mauritiana Lank) were used for applying fungitoxicant. Before spraying, the experimental

plots/trees were inoculated artificially by dusting with conidial powder of the respective fungi viz. Sphaerotheca fuliqina on summer squash, pumpkin and bottle gourd; E. polygoni on pea; Oidium mangiferae on mango & Oidium erysiphoides f. ziziphi on ber. Fungitoxicants used on their formulated basis were Bavistin (0.1%) and Vigil (0.1%); Sulfex (0.2%), Wetsulf (0.2%), Karathane (0.1%) and Calixin (0.1%).

Erysiphe polygoni DC. causing powdery mildew of moong (Phaseolus aureus Roxb.) appears with the flowering of the crop and affects severly the inflorescence and pod setting, besides powdery growth on stem and leaves. Litzenberger and Stenvenson (1957); Patel, Kamat and Bhide (1963) and Vaheeduddin (1955) reported powdery mildew disease on various Phaseolus spp. and allied pulses. Spraying of fungicides at fortnight intervals appreciabily reduced the powdery mildew incidence in moong, Gupta et al. (1975) increased yield was also obtained by way of controlling disease by spraying fungicides like Cosan, Karathane W.D., Elosal and Thiovit.

According to Suhag and Rana, (1984) & Nema & Krishana, (1982) most reports on the control of Erysiphe polygoni DC. on pea (Pisum sativum L.), suggest 2-3 sprays of fungicides like Bavistin (0.1%), Karathane (0.1%) and Sulfex (0.2-0.25%)

But on the other hand according to, Singh and Mishra, (1975), sulphur dusting was reported to be effective against this disease by several workers (Uppal et al., Pirovano, Peralta and Starker). Starker found that one percent Karathane was superior to sulphur dust in controlling this disease.

Pathak and Joshi, (1972), powdery mildew of wheat (Erysiphe graminis tritici Em. Marchel), has long been regarded as a disease of minor importance in our country. Arya and Ghemawat reported heavy damage due to powdery mildew in the neighbourhood of Jodhpur in Rajasthan. Later in 1966, Arya reported the presence of the disease from more areas of Rajasthan including Mount Abu, Udaipur & Baharatpur. Eleven fungicides were tried against powdery mildew of wheat. The fungicides were Solbar-0.1%; Karathane-0.1%, Morestan-0.1%. Cosan-0.2%, Captan-0.2%, Thiovit-0.2% Oxycarboxin-0.1%, Bisdithane-0.2%, Benlate-0.1%, Dikar-0.2% and Sulphur dust-20 Kg/ha.

Field evaluation of anti-powdery mildew chemicals on some fruits and vegetable crops were laid out during 1979-80 on 10 years old 'Chausa' variety of mango and 'Kaithali' variety of Ber, Suhag and Mehta (1982), similarly susceptible varieties viz. 'Hara Madhu' of Muskmelon and 'Multifrizer' of pea were planted in plots (5x3 m). Each

treatment was replicated four times. Fungicides used were, Bavistin 50 W.P., Calixin 75 E.C., Karathane 48 E.C., Sulfex 70 W.P.

Ber (Ziziphus mauritiana Lank.) is subjected to several diseases but powdery mildew is a great threat to this fruit crop. The powdery mildew of ber caused by Oidium erysiphoides f. ziziphi first reported in 1935 from Poona by Uppal. et al. has become epiphytotic since last 3-4 years. Out of 57 varieties of ber 22 varieties exhibited field resistance to powdery mildew. Two sprays of 0.2% Dinocap give 94% control, Gupta et al. (1978).

Opium poppy (Papaver somniferum) is an important cash crop of the country and is cultivated in U.P., M.P., and Rajasthan. Powdery mildew, Erysiphe polygoni DC. has been found to occur on this crop in Rajasthan in severe form with a view to evolve a suitable fungicidal control of the mildew, a number of field experiments were conducted in poppy growing areas. Sulphur, Copper and Organic fungicides were tested during the period 1960-61 and 1964-65, Kothari and Prasad, (1972).

Verma and Diwedi (1989) reported the effect of anionic, cationic and non-ionic poisions on germination of conidia and germtube length of E. polygoni Maximum inhibition (88-80%)

of germination was obtained with $Hgcl_2$ (0.1 M) followed by gluteraldehyde and formaldehyde. Conidial germination was 30.30% of NaF followed by HgCl. Since all the poisions are capable of inhibiting macromolecular structures, the results indicate the Cytoplasm of some conidia and their germtube was isolated from the environment.

ENVIRONMENT AND POWDERY MILDEWS:

The effect of different environmental factors on powdery mildew has been extensively studied by GrafMarin (1934), Cherewick (1944), Yarwood (1957) and Schnathorst (1965). Yarwood (1957) and Schnathorst (1965), claimed that the development of powdery mildew in general was favoured by warm humid weather (Anonymous, 1946, 1950); in green house conditions as against out door conditions (Steiner, 1908; Tucker, 1852) and hot dry weather (Wager, 1937). Out of these various environmental factors, temperature and moisture have been reported to have a profound effect on powdery mildew.

The cardinal temperature for germination of conidia of different strains of E. cichoracearum ranged between 5 - 35°C, Levykh, 1940; Deslandes, 1954; Rossouw, 1959; Schnathorst, 1960; Morrison, 1961, from lettuce was highest at 18°C, Schnathorst, 1960; for infection was 6 - 10°C (minimum), 18°C (optimum) and 27°C (maximum) respectivel

The another important environmental factor is moisture which influence the germination of conidia, infection and growth of powdery mildews, formation and maturation of perithecia.

Heavy infection of E. cichoracearum on tobacco has been observed in field of high water level by D' Angremond(1924). Cornor (1935) reported that the conidia of E. graminis, Podosphaera leucotricha, Sphaerotheca pannosa and E. cichoracearum succumbed when remained in water for 1 - 3 hours. However,floating conidia germinated readily after 24 hours and produced upright germtubes.

Related to the environmental factors, the more controversial aspect is relative humidity. It also plays an important role for the germination of conidia. Hashioka (1937) found that conidia of S. fuliginea from cucumber germinated between 15 - 85 percent relative humidity. The survival of conidia was 14 days at 76 to 80 percent relative humidity and for 30 days in a saturated atmosphere. Tafradzhiiski (1963) reported that conidia of the same host of S. fuliginea germinated best at 94 percent relative humidity but they failed to germinated in drops of water.

According to Levykh (1940), there are no development of symptoms when tobacco plants inoculated with E. cichoracearum and exposed to 10 percent relative hamidity at 18 - 19^{o}C. However, the typical symptoms appeared at 70 - 76 percent relative humidity. Deslandes (1954) observed that 85% relative humidity was optimum for

infection and sporulation in powdery mildews. Minev (1957), Schnathorst (1960), Morrison (1961, 1964) and Tafradzhiiski (1963) reported that the germination occured slightly below the saturation, Optimum relative humidity ranged between 66 - 68 percent for tobacco strains (Minev, 1957), 95.6 - 98.2 percent for lettuce strains (Schnathorst, 1960) and 94 percent for cucurbit strains (Tafradzhiiski, 1963). Germination of conidia was also observed in calcium chloride chamber at 0.1 percent relative humidity by Morrison (1961, 1964) and Schnathorst (1960). On the other hand, Rossouw (1959) reported the germination of conidia of both at Zero percent and 100 percent relative humidities. Corner (1935), Minev (1957), Morrison (1961, 1964) and Tafradzhiiski (1963) observed that the free water inhibited the germination of conidia. While Deslandes (1954) reported that the conidia of lettuce strains of E. cichoracearum were able to germinate in free water. Schnathorst (1960) observed that moisture stress gave highest germination of conidia of lettuce strains of E. cichoracearum. The development and severity of Powdery mildew was most affected by temperature and atmospheric humidity. Highest germination of conidia of L. taurica from Cynara annuum was achieved at 100 percent relative humidity (Clark and

Ayesuoffei, 1967). At low humidity, there was only a decline in germination but a reduction in mean germ tube length. Morrison (1964) observed that the free water on leaf disc surface in-hibited the germination of conidia of large number of Powdery mildew fungi, but high relative humidity favoured the germination. Nour (1958) studied the effect of the different relative humidities on percentage germination of conidia of various powdery mildew fungi.

It had been claimed that both infection and incidence of Powdery mildews were severe under dry condition rather than wet climatic conditions (Wager, 1937; Anonymous,1945; Boughey, 1949; Palti, 1953). D'- Angremond (1924); Blumer (1927), Deslandes (1954) and Morrison (1961) reported that high relative humidity favoured the incidence of powdery mildew. Brisley (1926); Beeley(1932); Moore (1936); Fisher (1938); Bremer (1940) and Parris (1949) were also of the opinion that over head irrigation favoured the development of powdery mildew. Schnathorst (1959) reported that the growth of mycelium was abnormal, when a film of moisture was present on the surface of epidermis. Yarwood (1939), Schnathorst(1959) and Morrison (1961) on the other hand, reported that the film of free water did not favour the development of the

powdery mildews. An observation was made by Salmon (1903); Yossifovitch (1923) and Moseman *et al.* (1957) that free water was essential for the maturation of ascospores. Disease epidemics on artichoke was associated with limited rainfall and decreasing autumn temperature, cultivars which had almost entire leaf blades and no spines were more resistant than those with lobate leaves (Ciccarona, 1953).

The conidia of powdery mildew fungi have been found to germinate at a wide range of pH. but highest germination has been observed between 6.6 to 7.0 pH. (Yarwood,1957).

Childs (1940) observed a diurnal cycle of ascospores maturation in certain powdery mildew. Periodic microscopic examination of the Sunflower, rose, apple, aster and Cucumber infected with *E. cichoracearum* revealed a more complex diurnal cycle of conidiophore development.Abstriction occurred between 6-8 a. m. and then 2 - 4 p. m. and formation of the succeeding crop of conidia occured between 2-4 p. m. and 6 - 8 a. m. Highest between 8.00 a.m. and 2.00 p. m.

The germination of conidia was also influenced by the time of collection. Yarwood (1936) reported that the

highest germination of conidia of E. polygoni occured when the spores were collected in the after-noon. Their germination however, decreased with the onset of the darkness and the least germination was observed in early morning. Jhooty (1970) while confirming the above findings, pointed out that such diurnal cycle was absent in S. fuliginea, S. macularis, E. graminis and E. cichoracearum. However, Yarwood (1936) suggested that regular alternation of light and dark periods may be responsible for expression of this phenomenon. Jhooty (1971) was of the view that alternation of light and dark periods may not be the basic cause of this phenomenon, but it certainly, influenced the onset of low high cycle in germination of conidia of E. polygoni.

Different environmental factors also influence the production of perithecia (Yarwood, 1957). Buchheium (1928) and Blumer (1948) reported that low relative humidity favoured the formation of perithecia. Similarly Biolotti (1907) reported that generally low temperature favoured the development of perithecia in powdery mildew. On the other hand, Cherewick (1944); Arya and Ghemawat (1954) reported that in E. graminis favoured the formation of perithecia and ascospores at alternating moderate and low temperatures. Schnathorst (1959) reported

that the for-mation and maturation of perithecia was also a matter of time rather than cyclic changes in temperature or alternate wetting and drying. He observed the formation of perithecia of E. cichoracearum at 23°C with 300 foot candle illumination in leaf culture in 7 days. Perithecial development was also reported by Schnathorst (1959) at 13°C with 60 percent relative humidity and 900 foot candle illumination. These observations led to conclude that the perithecia rarely developed in tropics. Bessey (1943) and Ainworth (1950); Yarwood (1957) reported that amongst the different climatic factors, temperature appeared to be more important for perithecial production. However, this is not true in India,a large number of perithecial development had been observed in powdery mildew fungi. Patwardhan (1965) while studying the effect of different factors affecting the development of perithecia in powdery mildew on H. annuus, He also observed the perithecial development on large number of hosts during monsoon season.

An observation was made by Yarwood (1938) that the Sunflower plants grown in Hoagland solutions minus Boron were severely stunted and heavily mildewed, while plants grown with 1 and 10 parts per million of Boron supplied as Boric acid made a normal growth and were much less mildewed.

Severity of mildew is directly related with plant Vigour and that any soil or other factor which promote plant vigourity (Arnaud and Arnaud, 1931; Smith and Blair, 1950). Trelease and Trelease (1928) and Mansson (1955) found that low nitrogen and high potassium reduced the development of powdery mildew. Cole (1964, 1966), on the other hand, reported that the plants grown in water culture fortified with all the elements were more susceptible to E. cichoracearum, than those grown in which the ratio of potassium and nitrogen was low. Laibach (1930) and Homma (1937) reported that low nutritive conditions of host favoured the development of perthecia.

EFFECT OF DIFFERENT FUNGICIDES ON POWDERY MILDEWS :

POWDERY MILDEW FUNGICIDES -

A. Sulphur :

Use of sulphur reviewed by McCallan(1967) and Sharvelle (1969). Sulphur was used in ancient time as a medicine and as a fumigant. Elemental sulphur remains the predominant fungicides for the control of grape powdery mildew Treatment of Sulphur is cheap.

Sulphur is applied mainly as a fine dusting powder at rates which vary between 5 and 40 kg. sulphur ha^{-1}. A small proportion of Kaolin and bentonite is commonly added to prevent the tendency of the particles to clump together. Wettable powder and colloidal liquid formulations are also available; these usually contain 60 - 80% sulphur. They are diluted with water and applied in high volume sprays at about 1000 - 10000 ppm sulphur, or in spray at correspondingly increased concentrations.

Sulphur is also applied by volatilization. Vapour tends to control mildew better on the upper leaf surfaces than on the undersides .

Sulphur exerts its fungicidal action at the surface of leaves, stems, flowers or fruits to which it is applied. It is redistributed over such surfaces to a limited extent by vaporization and also by the action of rain and dew. It does not penetrate into plants or more through them to an extent sufficient to protect the new parts of the plant which appear after treatment and which are often highly susceptible to powdery mildew. It must be applied repeatedly to protect these new tissues and so offset losses caused by weathering.

Powdery mildew develops mainly on the plant surface, Sulphur applied may come into direct contact with existing mycelium and suppress its growth and sporulation. Sulphur tends to work better in warmer countries.

Martin, 1964 and Tweedy, 1969, have suggested that sulphur itself is the primary toxicant, it must first be oxidized to sulphur dioxide or trioxide or to sulphuric acid, or it must be reduced to hydrogen sulphide.

B. Dinitrophenols :

Dinocap is second to sulphur in general importance as a powdery mildew fungicides.Dinocap was first synthesied as an acaricide.Dinocap is a mixture containing 65 - 70% of 2, 6 dinitero - 4 - octyephenylcrotonate (dinocap - 4) and 30 - 35% of 2, 4 - dinitro - 6 - octylphenylcrotonate (dinocap - 6). (Kirby and Hunter, 1965; Byrde et al., 1966; kirby et al., 1966).

Dinocap is formulated manily as a 25% W/W Wettable powder or as a 50% W/V . emulsifiable liquid. High volume sprays applied at concentrations of 200 - 250 ppm dniocap at 10 - 14 day intervals at 100 - 125 ppm at shorter intervals. It is used widely on cucurbits. But is very expensive.

The dinitrophenols are all surface fungicides. Esterification to the crotonate and the addition of the Octyl side - chain is some way confer specificity of action towards powdery mildew.

C. Quinomethionate :

Quinomethionate is a surface fungicide, having protectant, curative and antisporulant

actions, (Sasse, 1960).Formerly known as oxythioquinox. It gives good control of powdery mildew when applied in programmes of repeated sprays, on currents, gooseberries, strawberries and cucurbits in the glass house as well as in the field. It is also more expensive and is phytotoxic to same crops.

D. Drazoxolon :

It acts as a surface protectant,but it does exert, a good curative action against powdery mildews. Its biochemical mode of action is unknown. (Geohegon, 1967).

E. Ditalimofos :

This organophosphorous compound is a surface fungicide and possesses both protectant and curative activities against powdery mildews. (Tolksmith, 1966). Its mode of action is also unknown.

F. 2- Amino - pyrimidines :

Dimethirimol, Ethirimol and Bupirimate (Systemic fungicides),these compunds are readily translocated upwards in the xylem,

but are not moved out of treated leaves and are not transported downwards in the phloem. They can be applied to roots, either by soil incorporation or by seed treatments; alternatively they can be used as sprays.

The pyrimidines have a direct action on powdery mildew fungi. They can inhibit spore germination in vitro. When applied to roots, dimethirimol and ethirimol exert effects at the surface of the leaves, inhibiting mildew development (Bent, 1970). Other effect include a " repellent" action on vegetative powdery mildew hyphae.

G. Pyridine and Pyrimidine Carbinols :

First noted by (Brown et al., 1967, Thayer et al., 1967). It is highly active against powdery mildews. Its trans-laminar action appears particularly good.

Gramlich et al. (1969) reported excellent field control of several powdery mildews from sprays containing unusually low concentrations of fungicides.

H. Triforine :

Triforine is highly active against powdery mildews. It is systemic, moving in the xylem system, and has protectant, curative translaminar effects.

I. Pyrazophos :

Pyrazolopyrimidine is one of the rarely used powdery mildew fungicides which contain phosphorus. It is absorbed by foliage and translocated upwards due to the transpiration steam. Root uptake is relatively poor. Applied as sprays at 7 - 14 days intervals, it gives good control of a wide range of powdery mildews (deWaard, 1974).

J. Benzimidazoles :

The systemic fungicides contains carbendazim and compounds such as benomyl and thiophanatemethyl which are readily converted to carbendazim.

Benomyl gives protectant and curative control of powdery mildews in general(Delp and klopping 1968). It is translocated in the transpiration stream of the plant, it will move from the root to the shoot and from the base to the tips of leaves but not in the reverse directions.

For control of powdery mildews the benzimidazoles are applied almost entirely as sprays. These are repeated at the normal intervals used for surface fungicides.

K. Morpholines :

Dedemorph and tridemorph are two closely related systemic fungicides which are highly active against powdery mildews. (Pomner et al., 1969). The biochemical action of these fungicides is not worked out.

L. Other surface fungicides :

Fluotrimazole, halacrinate and mitrotali-sopropyl are pondery mildew fungicides, manily used as sprays to control the cereal or apple mildew. Piperalin is used in the USA for the

control of powdery mildew on roses and other ornamental plants.

Mode of action of all fungicides appear to work by exerting a fungitoxic action, either directly or after conversion to another active products.

PLAN OF WORK

The members of afore said families are not free from the infection of powdery mildews and considerable amount of damage is reported every year. The review of literature cited above shows that very little attempt has been made to study the causal organism of the powdery mildew on the plants systematically, even there is controversy on the identity of the pathogen. Moreover, nothing is known about the factors affecting the development of the disease. Hence, ~~in the present studies~~, an attempt will be made to study the following aspects.

1. To survey the incidence and severity of powdery mildews on different plants found in Aligarh.
2. Identification of the causal organism on the basis of conidial and perithecial characters, if any.
3. Effect of different relative humidities and temperatures on the germination of conidia of the powdery mildews.
4. Effect of different temperatures and relative humidities on the development of powdery mildewson detached leaves.
5. Host range of the powdery mildewswithin the members of the family and outside the family.

6. To study the varietal resistance of different cultivars against the powdery mildews.

7. To study the effect of different Fungicides on the control of powdery mildews

MATERIALS AND METHODS

SURVEY :

Survey for the incidence of powdery mildews will be made from different localities at Aligarh, where different members of various families are grown. Intensive survey however, will be made at Aligarh and adjoining areas, whereever, these plants are commonly grown. The severity of powdery mildew will be graded as under :

No infection	(-)	No visible disease symptoms.
Mild infection	(+)	Pustules, few, small in size and scattered.
Moderate infection	(++)	Pustules many, larger in size, tending to coalesce.
Severe infection	(+++)	Big pustules covering almost the entire leaf area.

IDENTITY OF THE PATHOGEN :

For identification of the pathogen, leaves of plants infected with powdery mildew from different localities will be brought to the laboratory in polythene bags. In order of having inoculum for further studies, seedlings of the respective hosts in cotyledonous or at 3 - 4 leaf stage, grown in autoclaved soil in 25 cm. sterilized clay - pots, will be

inoculated. For inoculation, technique of dry dusting of conidia of the powdery mildew will be used (Schmitt, 1955). Inoculated plants will be keept in seperate glass house chambers to avoid mixing of the inoculum at 17 - 22°C. The infection which developed within 5-7 days after inoculation will be used for further studies.

In the absence of cleistothecia, mycelial and conidial characters were examined for the identification of the powdery mildew. These characters included colour of mycelium in older pustules (Rodingin, 1936 ;, and Yarwood, 1957); shape of conidia (Alcorn, 1968); Presence and absence of fibrosin bodies (Homma, 1937; Clare, 1958; 1964; kable et al., 1963; and Jhooty, 1967); conidial measurements (Bouwens, 1924, 1927) and type of germ tube (Hirata, 1942, 1955, Kable et al. , 1963 and Zaracovitis, 1965).

For determining the size, conidia will be measured for each of the different powdery mildews and the average range of size will be determined. For the presence and absence of fibrosin bodies, conidia will be mounted in 3% aquous solution of KOH as suggested by Kable and Ballantyne (1963). Conidia will be germinated on glass - slides in humid chamber (Zaracovitis, 1965).

To study the size of germ tube, conidia will be dusted over dry clean glass slides placed on glass triangles in a petridish containing double distilled water at the bottom. Later these will be transferred in an incubator running at 17 - 22°C. After 24 hours of incubation conidia will be stained in cotton blue and mounted in lactophenol for observations.

The sixe of the conidia will be determined by measuring 250 ± 20 conidia. In case the perithecia will be there, number of asci per perithecium will be examined. The measurements and size of ascospores, will be taken into account.

HOST RANGE AND VARIETAL RESISTANCE :

For studying the host range, mature plants and seedlings of various cultivars belonging to different families raised from surface sterilized seeds grown in autoclaved soil will be inoculated with respective causal organism by drying dusting technique. These studies will be carried out in glass house as well as in the field.

The inoculated plants with different isolates will be kept in separate glass house chambers at 8 - 18°C. and regularly examined for the appearance of disease. For field trials

the inoculated plants contained in small pots will be transferred with entire soil to the pits earlier dug at a distance of 8 - 12 feet to avoid injury to the roots. Healthy seedlings will also be transferred serving as control. Temperature in field will be in between 18 - 22°C at the time of tests. For each host - parasite combination there will be five replieates.

After 20 days of inoculation, the intensity of disease will be rated but over all rating will be categorised as :-

Resistant (R) = Mildew failed to appear

Susceptible (S) = Mildew appear.

For studying thevarietal respone of different cultivars of Umbelliferous hosts, inoculation tests will also be made on detached leaves and leaf discs (Morrison, 1960, 1964). Leaves will be removed from the uppermost nodes of healthy plants, grown in clay - pots. Leaf discs will be cut with 1 cm. in diameter by sterilized cork borer and floated on water in petridish. The detached leaves on the other hand will be placed on glass triangles in a petridish with the petiole dipped in water, then will be inoculated with conidia obtained from Umbelliferous plant.

Observations for disease in-tensity will be made daily for two to three weeks after inoculations. Throughout the

studies the production of perithecia will also be examined. Whenever they will be produced, the time taken for the appearance of perithecia will also be recorded. Later on perithecia will be dissected and examined for the presence of asci and ascospores. Following rating for disease intensity will be used throughout (Wheeler, 1969).

Grade	Description	Infection rating.
Highly resistant	Plant completely free from infection.	0
Moderately resistant	Mycelium developing both on leaves and stem covering 26-50% leaf area	2
Susceptible	Many small colonies appearing later coaleseceing and covering 51-75% leaf area. Mycelium developing on steam as well.	3
Highlysusceptable.	Entire plant covered uuniformly by mildew.	4

Percentage disease index will be calculated as follows : (PDI).

$$\text{Percentage disease index} = \frac{\text{Total numerical rating}}{\text{Total leaves X Maximum rating examined}} \times 100$$

EFFECT OF DIFFERENT RELATIVE HUMIDITY AND TEMPERATURE ON INCUBATION PERIOD :

To study the effect of temperature and relative humidity, surface sterilized seeds of susceptible cultivars will be sown in autoclaved soil, contained in 10 cm clay pots. The plants in cotyledonous stage will be inoculated with conidia obtained from the original culture maintained in glass house and transferred to growth chamber maintained at different temperatures viz. 5, 10, 17, 20, 25, 30 and 35°C with 60, 80 and 90% relative humidities respectively.

At each combination of temperature and relative humidity, plants will be regularly examined for the appearance of the disease and the perithecia. Disease intensity will be recorded after 7 days of inoculations.

A maximum period of one month will be provided in order to ensure the production of perithecia except in those where the symptoms fail to appear.

For studying the effect of different relative humidites on conidial germination, super saturated solutions of the following salts will be prepared (Anonymous, 1957).

Super saturated solution	Relative humidity % at 20°C
Sodium nitrate	66
Sodium acetate	78
Ammonium sulphate	81
Zinc sulphate	90
Sodium hydrogen phosphate	95
Double distilled water	100

The super saturated solutions will be transferred to lower chamber of small dessicator which serve as humidity chambers. Freshly developed conidia of the same age will be uniformly dusted over the clean glass slides with the help of glass rod (Nair, Sadasivan and Ellingboe, 1962). The entire assembly will be kept at 20°C. After 4, 8, 12, 24, 36, 48, 60, and 72 hours of incubation, the number of conidia that germinated and those failed to germinate will be counted and the percentage germination of conidia will also be calculated.

To determine the effect of temperature freshly formed conidia will be dusted over the dry clean slides, kept on glass triangle placed in the petridishes containing double distilled water at the bottom and transferred to incubators, each running at - 5, 5, 10, 17, 20, 25 and 30°C. After 4, 8, 12, 24, 36, 38, 60 and 72 hours. of incubation, slides will be examined for germination of conidia as mentioned above.

The conidia that germinated and those which failed to germinate will be counted. There will be three replicates for each treatment.

To determine the role of ascospores in the recurrence of disease, perithecia, if observed, will be subjected to the following treatments.

Leaves and stem portions containing perithecia will be (a) burried for 270 days in small terylene bags, (b) these will be kept in plastic tubes and transferred to different temperature cabinets each running at - 5, 5, 10, 17, 22, 25 and 30°C. These tubes will also be given a treatment of low and high temperature alternately for varying periods.

For each treatment material having perithecia will be fixed to the inner portion of the humidity chamber, the base of which either had slides on glass triangle or the floating leaves. (Schnathorst, 1959).

In each case untreated infected plant will serve as control.

CHEMICAL CONTROL :

The systemic fungicides such as benlate, calyxin will be tested for the control of powdery mildew of different

plants. The effect of these will be studied to control the germination of condia as well as the development of disease. The different concentrations of the fungicides will be 0.00001, 0.0001, 0.1, 0.2, 0.5, and 1.0 percent respectively are tested on germination of conidia. The germination studies technique as outlined earlier will be followed, where conidia will be transferred in a crop of required concentration of fungicides. Plants of 4 leaf stage will be inoculated with powdery mildew and treated with fungicides as follows -

1. Plants will be inoculated with powdery mildew eight days prior to the treatment with fungicides.
2. Plants will be first treated with fungicides and then will be inoculated with mildew after eight days.
3. Plants will be treated with fungicides after symptoms of powdery mildew developed.

In each groups, plants will be treated weekly, fort nightly and monthly with different concentrations of the fungicides tested both as soil drench and spray. For the soil drench 25 ml. solution of different concentrations of fungicides will be incorporated to 250 gm soil. In each case the severity of the disease will be recorded seven days

after final treatment as suggested my Munjal *et al.* (1963) and Srivastava *et al.* (1971). Disease severity will be graded on the basis of intensity of powdery mildew as described earlier. The disease control index will be calculated as follows :

$$\text{Disease Control Index} = \frac{\text{PDI in control} - \text{PDI in treatment}}{\text{PDI in control}} \times 100$$

Where PDI = Percentage Disease Index.

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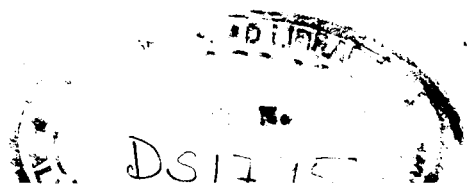

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