



Study of Four New Species of *Cercospora* from Garhwal Himalaya, India

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Abstract: The fungus *Cercospora* of the family Deuteromycetes was studied for the first the time and investigated in the high hilly regions of Garhwal Himalaya Uttarakhand, India. It attacks on the preys and on economically important crops namely-such as *Vicia faba*, *Spinacea oleracea*, *Ricinus communis* and *Beta vulgaris*. The pathogens were *Cercospora canescene*, *Cercospora chenopodii*, *Cercospora ricinelia* and *Cercospora beticola* respectively, which results into heavy cause substantial losses when found discovered in suitable environmental and other conditions and causes heavy losses. This study reveals extensive investigations of the detailed studies of fungus's life cycle and infection period of the fungus time in Garhwal region of the Uttarakhand

Keywords: *Cercospora* • New species • Garhwal Himalaya

Introduction

The Himalaya have been an intense hub of worldwide enthusiasm for observation and research exploration, providing unrivalled philosophical, cultural, literal, and scientific inspiration to the entire world in general and India in particular. This Garhwal Himalaya region is characterized by differentiated climates that delimit ecological regions as evidenced by specific vegetation patterns and reflect the area suitable for agricultural production, with high hilly ranges and high mountains associated with high rainfall, humidity, and thick diversified flora and fauna. This region's fruits, food, and fodder crops are well determined by climatic circumstances. Recognizing this feature simplifies the assessment of existing and potential diseases in the area. *Cercospora* fungi find optical conditions for growth and development on several plants of economic importance of this area. Several studies show that peaks in *Cercospora* airborne conidium concentration were substantially linked with the average temperature of daily hours when relative humidity was greater than 87% Khan and Khan, 2009.

An intense activity is detrimental to all aerial parts of the plants. The presence of various developmental stages and the luxuriance of fruitification forms are responsible for an abundance appearance of *Cercospora* disease. The almost constant high humidity with condensation during the night as well as rain and wind largely favor the dissemination and growth of these fungi. As parasite of legume, ornamental plants and numerous non-economic plants the *Cercospora* (member of Deuteromycetes), a fungal disease has attracted much attention ever the past several decades. Ecologically this zone of Garhwal Himalaya may act as important area since it regulates the meteorology and hydrology of all its surrounding and facilitate Centre to the pathogen causing disease at lower altitude. It feared that the disease is to bind to assume a major status in this area because of the introduction of high yielding varieties of crop plants which are cultivated and high yielding conditions. It should be stress that most of the plants of this region suffer from serious *Cercospora* disease, the epidemic character of which has been confirmed by the development and continuous extension. These mostly



represent a continuous extension. These mostly represent a continuous threat particularly in remote areas. Various associations and institutions have been working together on this pathogen for the last 30-40 years. Currently, surveys are being conducted primarily in the research of major cereals, as well as more broadly in the study of crops that are critical to food supply. The research of such diseases in local wild plants has received little attention. As a result, surveying the area for disease plant material collection, identification, causation, and transmission of the disease is critical. *Cercospora* is an ascomycetes fungal genus; most species have no known sexual stage, and when one is found, it is in the Mycosphaerella. The majority of the species in this genus produce plant disease and leaf spots. *Cercospora* species are associated with leaf curl spot symptoms on various host plants. During the initial stage of infection brownish circular spots with light grey- centers and reddish- brown margins appear on leaves reported by various workers from time to time, Singh, 1931, Chupp, 1953, Kumar et. al., 1980, Khan and Khan, 2009, Behrooz, et. al., 2017, etc.

Behrooz et. al., (op cit) in their studies reported that nine species of the genus *Cercospora* grows on some medicinal and economic crops were found in different locations in southwestern Iran and examined according to morphological characteristics of stomata, conidiophores, conidiogenomes and conidia. Vegetative structure of *Cercospora* is well developed, branched, septate, slender intercellular and brown colored mycelium. Conidia of *Cercospora* are of several distinct morphological types of Moen, 1998. Conidia (spores) are needle shaped (2-3 x 36-107 μm) colorless and have several walls septations in case of leaf blight of soybean. Conidial morphology varies greatly with environmental conditions especially in *Cercospora kikuchii*.

In *Vicia faba* the conidiophores are dark brown to black at the base, paler above, unbranched, straight or curved, usually septate and 25-60 μm long and 4-7 μm wide (often wider at the base) and a sub-acute apex 3 to 18 μm long, 3.5-5.5 μm wide, William, 1987. Behrooz et. al., 2017 reported obclavate to cylindrical or acicular, straight to slightly curved, smooth, thin indistinctly multi septate base, truncate tip sub obtuse, (25-) 40-110 (-135)- (-3-5) (-6) μm conidia of *Cercospora* species.

Genetic variation among isolated was commonly exists in field populations although there is no known sexual stage. Among the fungal diseases *Cercospora* leaf spot of chilli caused by *C. capsica*, one of the major problems of chilli cultivation in Bangladesh Meah and Khan, 1987. The climatic conditions less than 20^o C temperature, 92% relative humidity and PH ⁵⁻⁶ show luxuriant growth, while below 90% disease does not develop. Among the species of *Cercospora* – *Cercospora beticola* is a fundamental pathogen which typically infects plants of genus Beta, within the family of sugar beets, spinach and sweet chard, Wieland et. al., 2004. *Cercospora* is mostly infected with the leafy parts of the plants rendering the photosynthetic activity of infected plants leading to losses in yield, Incipient symptoms consisted of small necrotic lesions on the surface of the leaves which later coalesced, giving irregular and brightened appearance with the production of abundant conidia, Moen, 1998. The pathogen sporulated abundantly at 20 -30^oC by poorly at 10^oC. At 40^oC no sporulation occurred. Sporulation on lesions was greatest near moisture potential -6MB. The best temperature for germination was in the range of 20- 30^oC and declined with decreasing water potential (Moen 1998). Fluctuations in number of *Cercospora beticola* conidia in relation to environment and disease severity in sugar beet was reported by Khan and Khan, when



working in North Dakota State University (2009). Other studies reveal that temperature, wetness period, plant maturity, pathogen variability and inoculum all influenced infection of faba bean (*Vicia faba*) by *C. zonata* in a controlled environment, Rohan Benjamin, 2011.

Materials and Methods: During the present course of study a survey of *Cercospora* fungi was made. For this study different fields, gardens, roadside lad, forest boarding areas and slopes of the peaks at varying elevation of Srinagar, Garhwal (Uttarakhand) was selected. A total of 11 slopes were collected from various spots of the locality and detailed accounts of the disease development were observed.

Diseased leaves collected were placed in plastic bags. Some specimens of each diseased plant were preserved in the Herbarium of the Botany Department, University of Garhwal (Srinagar). For the detailed morphological studies of *Cercospora* fungi, the diseased part of the fungus from the leaf surface was eased off with fine scalpel and placed on a glass slide. Mounted in Cotton Blue and examined. For histopathological study a free hand section of 10 μ thick were cut from the diseased portion of leaves. The shape of the different types of sexual and asexual reproductive structures and their shape and size was measured with the help of an ocular micrometer. For each case twenty - five measurements were taken. Diagrams of these structures were drawn with the help of camera Lucida. The pathogens were identified on the basis of symptoms and structures and nature of the spores.

Results and Discussion: On the basis of detailed studies on symptoms of disease on the hosts and morphology, sexual and asexual parts etc. were studied. Four species of *Cercospora*- observed and discussed here in

the present- *Cercospora canescens*, *C. chenopodii*, *C. ricinelia* and *C. beticola*.

1. *Cercospora canescens* Ellis & Martin. On - *Vicia faba* L. (Fabaceae). *Vicia faba* is a common vegetable crop of Garhwal hills. During the course of study initiation of disease was recorded on the young leaf during the month of February. At first the disease appears as a circular spot on the upper surface of leaf. The center of the spot is grey while the margin is dark in color.

Microscopic examination of diseased part revealed the presence of intercellular, branched, septate, endophytic mycelia. Stomata not visible, conidiophores may give out from stomata, which are septate, straight, or slightly curved and measured 81.00 - 90.00 μm x 3.00 - 3.00 μm in size. Conidia are small, septate, and colorless, mostly present at the tip of the conidiophores, measured 15.00 - 21.00 μm x 3.00 - 3.00 μm in size (Fig. 1)

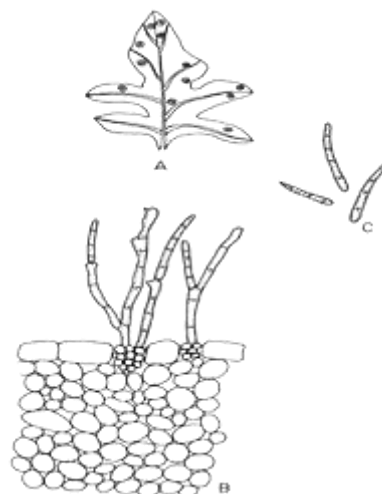


Fig.1. *Cercospora canescens* on *Vicia faba*. A. Symptoms., B. T. S. of leaf showing conidiophores and stoma, C. Conidia.

The diseased specimen has been collected during the month of February. *C. canescens* has been reported from various members of



the family Fabaceae, However, *Vicia faba* is a new host record for this fungus.

2. *Cercospora chenopodii* var. *Micromacula* Dearn. On - *Spinacea oleracea* L. (Chenopodiaceae).

Spinacea oleracea is the most common vegetable of Garhwal hills. Initiation of disease was recorded on young leaf during the month of January. Leaf spots are present on the upper surface of the leaf, which are few in number and larger in size. The middle portion of spots were brownish while the margin was grey in color.

Microscopic study shows that individual as well as tuft of conidiophores are branched mostly towards the tip, septate, straight, or curved, bearing conidia. Conidiophore measured 90.00- 81.00 μm x 6.00- 6.00 μm in size Conidia are slightly curved, cylindrical, somewhat tapering towards tip, septate and measured 21.00 -39.00 μm x 3.00 - 3.00 μm in size (Fig. 2). The diseased specimen has been collected from Pauri (Garhwal) during the month of January.



Fig. 2 *Cercospora chenopodii* on *Spinacea oleracea* L., A. Symptoms, B. T. S of leaf showing conidiophores, C. Conidia.

3. *Cercospora ricinella* Saccardo & Berlese on *Ricinus communis* L. (Euphorbiaceae).

Ricinus communis is common plant growing widely on waste land. Initiation of disease was recorded on the lower leaf during the month of December. Leaf spots are emphygenous, circular to angular, pale yellow finally becoming pale in color. Bright, present on the upper surface of the whole leaf.

Microscopic observation of diseased part revealed the presence of intercellular, branched, septate and endophytic mycelia. Stomata are brown and measured 18.00 x 18.00 μm in size, mostly hypophyllous, roundish. Conidiophores are in fascicles, cylindrical, straight to curved, sparingly septate, pale yellow towards the apex becoming polar and bearing conidia. Conidiophores may give out from stroma and measured 56.00 - 36.00 μm x 6.00 - 6.00 μm in size. Conidia are acicular to obclavate, septate, subhyaline, tapering slightly towards tip, tip acute and measure 60.00 x 3.00 μm in size. (Fig.3).



Fig. 3. *Cercospora ricinella* on *Ricinus communis*. A. symptoms, B. T. S. of leaf showing Conidiophore, C. Conidia.



The diseased specimen has been collected from Srinagar (Garhwal) during the month of December.

4. *Cercospora beticola* Saccardo on *Beta vulgaris* L. (Chenopodiaceae).

Beta vulgaris is a common vegetable of Garhwal hills. During the course of study initiation of disease recorded during the month of March. Leaf spots are amphigenous, circular to sub-circular, many greys in Centre, margin in red to brown in color, which again surrounded by pale ring, 2 - 3 mm in diameter, sometimes very big.

Microscopic examination of diseased part revealed the presence of intercellular branched septate, endophytic mycelia. Stomata are fairly prominent. Conidiophores may give out from stroma. Conidiophores are somewhat dark, unbranched, cylindrical, slightly curved and measured 24.00 - 21.00 μm x 6.00 - 6.00 μm in size. Conidia are cylindrical, straight, tapering at the tip septate and measured 30.00 - 30.00 μm x 3.00 - 3.00 μm in size (Fig. 4).

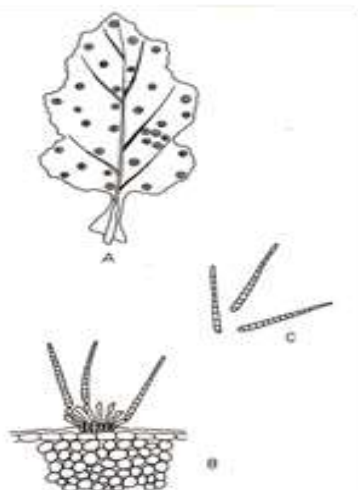


Fig. 4. *Cercospora beticola* on *Beta vulgaris*. A. Symptoms, B. T. S. of Leaf showing Conidiophore and C. Conidia

The specimen has been collected from Pauri during the month of March. *Cercospora beticola* has been reported from various parts

of India by Vasudeva **but it is new report from this part of Garhwal Himalaya.**

Studies on *Cercospora* disease is being carried out with increasing awareness both in India and abroad. Yet very little attention has been paid to this kind of disease in this country. The term *Cercospora* has been applied for various members of Dematiaceous Hyphomycetes with colorless or colored conidia which are smooth subotuse or obclavate. Genus *Pseudocercospora* recently have already been added in this group.

Dematiaceous Hyphomycetes with colorless or colored conidia which are smooth subotuse or obclavate. Genus *Pseudocercospora* recently have already been added in this group.

On the basis of broad survey of *Cercospora* disease of Garhwal Himalayan region revealed that many plant species including the members of dicotyledones and monocotyledons were joined to be the victim of this disease.

It was general agreement that cercosporae disease were nowhere, more abundant than in hilly regions, where high relative humidity and thick forest provide suitable conditions for the development of this disease.

Results on diseased specimen collection basis references show that most of the species are able to grow on a broad range of hosts. But in some others the range is restricted. Vasudeva (1962) stated that most of the *Cercospora* species display host preference and they can grow only on the specific host. The observations of the present survey tend to support the finding of the above work display host preference and they can grow only on the specific host.

The data presented in this study brings to light certain facts regarding the morphology and variations within these fungi. As we gain mere knowledge about this group it is becoming of widely distinct forms (Vasudeva, 1961). In



this manuscript the *Cercospora colecasiae* have the largest size of spores which measured 60.00 -60.00 μm x 3.00 - 3.00 μm and the smallest size of spores were reported from *Cercospora canescens* which measured 15.00 – 21.00 x 3.00 – 3.00 μm . The morphology of *Cercospora* also differs from species to species as in Sugar beet, spinach and sweet chard within the family also reported later by Wieland et. al., 2004).

Vasudeva (1961) observed that in many species of *Cercospora* the conidia and conodiophores turn pale or brownish with age.

Meah and Khan, 1987 also reported change in conidia colour when studied *Cercospora* disease in Chilli. Similar observations were recorded during the present study.

The problem of variation as induced by environment further complicated the issue. Length of conidia and the group character for the identifying the species of this genus is now considered obsolete. Thirumalachar and Chupp (1948) observed that during rainy season the length larger than observed during the normal period. The results of the present study are according to the previous findings. In most of the cases spores of the *Cercospora* species collected during rainy season were larger in size.

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The most highlighted results of this manuscript are-

- i) The disease initiated mostly during rainy season, but it could not progress during the early winter.
- ii) The disease was exposed to severity condition because of the temperature and relative humidity.
- iii) Since *Cercosporae* studied here has not been surveyed before in Garhwal hilly region.

iv) All of them are new for the country and reported for the first time.

- a/ *Cercospora beticola* on Beta vulgaris ((Chenopodiaceae)
- b/ *Cercospora chenopodii* on Spinacea oleraceae (Fabaceae)
- c/ *Cercospora canescens* on Vicia faba (Fabaceae)



d/ *Cercospora ricinella* on *Ricinus communis*.
(Euphobiaceae)

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