STUDIES ON FUNGAL DISEASES OF SOME CUCURBITACEOUS VEGETABLES OF BALRAMPUR DISTRICT OF EASTERN UTTAR PRADESH - (INDIA)

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Abstract: Cucurbits represent the major vegetable and fruit crops in the world. The reported members of this family are *Cucumis sativus* (Cucumber), *Momordica charantia* (Bitter gourd), *Luffa actutangula* (Ridge gourd), *Cucurbita pepo* (Pumpkin) and *Lagenaria siceraria* (Bottlegourd). The survey revealed Powdery mildew, Anthracnose, Alternaria leaf spot and Fusarium crown and root rot as the prominent diseases. Each disease was identified by its peculiar characteristic symptoms. The pathogen responsible for inciting these diseases were identified as *Erysiphe cichoracearum and Podosphaera xanthii(*Powdery mildew*),Colletotrichum orbiculare (*Anthracnose), *Alternaria cucumerina (*Alternaria leaf spot*) and Fusarium* spp. (Crown and root rot). The studies were conducted in the year 2017-2018 on prominent fungal diseases of Cucurbitaceous vegetables prevalent in district Balrampur. The survey conducted in major cucurbitaceous vegetables growing areas of Balrampur district viz., Ranjeetpur and Naharbalaganj which reveal that the crop losses may occur due to ecological, agronomical and biological factors. Among the biotic factors like pests and diseases, fungi constitute a major problem in the production and storage affecting the productivity of cucurbits.
Key words: Cucurbitaceous vegetables, fungal diseases, Cleistothecia, Balrampur.

INTRODUCTION

Agriculture plays a vital role in the Indian economy. Over 70 per cent of the rural households depend on agriculture as their principal means of livelihood. It was the single largest sector which contributed approximately 14.6 % of India's GDP (Gross Domestic Product) during the year 2010-2011. India is the second largest producer of vegetables after China. According to an estimate, India need to produce 215,000 Mt of vegetables from 2015 in order to provide nutritional security and Cucurbitaceae members being a large group of vegetables provide better scope to enhance overall productivity and production. The worldwide harvest of cucumbers, gherkins, squashes and pumpkins were approximately 213 million Mt with 33% growth and watermelon, muskmelon, cantaloupe along with other melons constitute the 126 million Mt with 12% growth in 2010. (Egel and Martyn, 2007; Cucurbitaceae is the largest family of summer vegetable crops, which includes approximately 125 genera and 960 species. Cucurbit crops are well known for their nutritive value and health benefits. These are consumed either as immature fruits or mature fruits or young shoots and leaves. The Cucurbitacins and triterpenoids impart bitter flavour to many cucurbits and serve as attractants of beetles such as Diabrotica.

The crop losses may occur due to ecological, agronomical and biological factors. Among the biotic factors like pests and diseases, which are of prime importance, are included a wide range of fungal pathogens affecting the productivity of cucurbits.Wilt and rot are the major soil borne fungal diseases caused by Fusarium spp., whereas powdery mildew is the result of *Erysiphe cichoracearum* and *Sphaerotheca fuliginea,* resulting up to 70% yield loss. The moisture content of the seed, storage period, prevailing temperature and degree of seed invasion are the factors which influence the development of seed-borne fungi. The pathogen may be present either externally or internally or associated with the seed as a contaminant. It may cause seed abortion and rot, necrosis, reduction or elimination of germination capacity as well as seedling damage at later stages of plant growth resulting in the development of the disease. There are many approaches to control the disease like use of resistant varieties, selection of suitable chemical fungicides and adoption of different cultural practices. The increase of the soil borne disease makes the importance to search conventional and eco-friendly practices in the agriculture to control the pathogen.

REVIEW OF LITERATURE

Balrampur district is well known for the cultivation of cucurbitaceous crops and covers a huge part among vegetables arriving in the markets. The district Balrampur is situated in Terai region of U.P. Field survey of various cucurbits growing areas were regularly conducted during January 2017-to January2018 to study the cucurbitaceous diseases. Blancard et al. (1994) have published a colour atlas of cucurbit diseases for better study and observations on identification and control. Some Indian records of cucurbit diseases in field as well as storage along with the losses inflicted by them are studied in the past. Notably, these contributions are those of Suryanarayana and Nath (1963); Kakkar and Tandon, (1964); Rao (1964a,b, 1965a,b, 1966); Srivastava et al. (1964); Sathiarajan and Wilson (1965); Grover (1965); Shreemali and Bilgrami (1968); Jhooty and Grover (1971); Singh (1972, 1973, 1974, 1980); Prakash (1974a,b); Singh et al. (1975); Laxminarayana and Reddy (1976); Sharma and Bhargava (1977); Tripathi and Grover (1977); Kritagyan etal. (1980); Mandal and Dasgupta (1980); Khatva and Chakravarty (1981), Ullasa and Amin (1981) and Reddy and Reddy (1989a, b).

Cucurbits are the targets of various fungi and show records of new diseases. Khanna and Chandra (1975) reported some new market diseases from Uttar Pradesh, India. . Prasad and Ambasta (1987) observed a severe fruit rot of *Luffa cylindrica* in the field as well as markets of Muzaffarnagar. The causal agent was identified as *Fusarium equiseti*. Cvjetkovic et al. (1988) identified Sphaerotheca fuliginea (but not Erysiphae cichoracearum) as causal organism of powdery mildew of cucumber on the basis of conidia, mode of germination and presence of fibrosin bodies. Mir et al. (1988), from Jammu and Kashmir, observed the occurrence of *Erysiphae cichoracearum* on pumpkin, cucumber and *Lagenaria siceraria* for the first time from India. Mukerji and Bhasin (1986) have also reported fungal records on different members of Cucurbitaceae causing spoilage.

Recently, Ulbrich and Smolka (1994) have for the first time reported cleistothecial stages of both *Sphaerotheca fuliginea* and *Erysiphe cichoracearum* on greenhouse cucumbers. Maholay (1994) from India has reported longevity of persistence of *Macrophomina phaseolina* in different cucurbitaceous members. Bains and Singh (1996) reported occurrence of *Alternaria alternata* in association with powdery mildew on same cucurbits.

From Andhra Pradesh, Laxminarayana and Reddy (1977) reported post-harvest diseases collected from various parts of the country. Singh and Chohan (1978, 1980,1984) have done extensive work on diseases of cucurbits including watermelon and muskmelon in the Punjab region. Rai et. al.,(1982) carried out an extensive work on post-harvest diseases in Allahabad in U.P. and other markets. Fungal diseases of vegetables prevailing in different markets of Chandigarh were recorded by Sohi et. al.(1984) and Kaira and Sohi (1985). These were classified and assigned to be incited by fungi belonging to 23 different genera.

Cucurbits get infected by two species of Powdery mildew pathogens - *Sphaerotheca fuliginea* and *Podosphaera xanthii*. Mildews are wide spread and infect all types of crop plants causing total losses in plant growth and crop yield.

Alternaria leaf spot and blight are caused on Cucumbers worldwide by *Alternaria cucumerina* and *Alternaria alternata*. Spores are transported by wind over long distances through rain, warm and 60-80% humid conditions which are favourable for the spread of infection. Germination capacity of Cucurbitaceae seeds is influenced by both external and internal factors. Germination failure of seeds is mainly due to temperature, gas exchange, water activity as well as growth hormones involved in regulating germination. Farrag and Mohram (2012) reported F. Solani and F. Oxysporum survive as conidia, mycelia and spore on the seed coat or seed surface. Invasion of the seed surface by pathogens can halt or slow germination. Fusarium spp. was the major soil-borne pathogens distributed worldwide. The fungi cause wilt and rot diseases in 80 plant species including cucurbits and cause up to 100% yield loss. Pathogens survive in soil in the form of chlamydospores for many years, mycelia enter the epidermal tissues invading through roots, extend to the vascular bundles and form spores in plants. Soil-borne fungi can be controlled by using chemical fungicides, but residues of fumigants or fungicides in the soil increase human health risk and environmental pollution. Chemical fertilizers used increase the resistance of the soil-borne pathogens, soil solarisation, crop rotation and grafting are also used to control root diseases (Zhao et al., 2011).

MATERIALS AND METHOD

Regular surveys were conducted during winter and summer crops in 2017-2018 in various crop field of Balrampur district viz., Ranjeetpur and Naharbalaganj. A number of other roadside vendors, stalls in various part of the city were also visited frequently for the observation of fungal diseases. During the survey, field diseases of cultivated as well as wild cucurbits were observed and noted. The present research deals with the survey on the diseases of Cucurbitaceous vegetable crops of district Balrampur (UP) that mainly caused by fungi. The study was conducted under the following objectives:

1. Collection of infected vegetables from different locations of Balrampur district by conducting regular surveys.
2. Microscopic analysis of the infected parts of vegetables through section cutting and identifying the pathogen on the basis of reproductive structures.
3. Causal pathogen was attempted to identify applying Koch's Postulates
4. Studying the character and host range of the identified plant pathogens.

The samples from every infected fields were collected and carefully wrapped in paper bags, the location and the date of collection, host, symptomatology noted on the spot; and the samples thus collected were kept in clean polyethylene bags of which the mouth was kept open (un-tied) and were immediately brought to the laboratory. The samples were then incubated under bell jar / desiccators from time to time to facilitate the growth of infecting fungi and for further investigations after primary processing.

Isolation of fungi from diseased cucurbit samples

The samples brought to the laboratory collected during survey were taken out of the polyethylene and the paper bags and the visual observations noted regarding the symptomatology, percent area affected, and the nature of damage, etc separately. Isolations of fungi associated with the diseased cucurbit samples were done with the methods given below:

i) Tissue Sectioning to study the histopathology: The infected sample were sectioned with the help of razor after placing the tissue in water. These sections were then stain with the help of cotton blue, and then place the stained section on slide and then cover it with coverslip.

ii) Direct Isolation:

Various fungi were directly isolated from visible fungal colonies of the leaf surface with the help of needle. Such colonies, later on, were transferred on slide and stained with cotton blue.

After preparing slide study it under compound microscope.

Identification of fungi in pure cultures:

Identification of fungus is done on the basis of reproductive body and sporulation. The initial observations of the colony character were noted by observing the slide under compound microscope which was prepared in cotton blue lactophenol.

Attempts were done for identification of the pathogen by applying Koch's Postulates.

RESULTS AND DISCUSSION

1- OCCURRENCE

To study the occurrence of fungal diseases of cucurbitaceous vegetables, a survey of cucurbits growing areas of Balrampur District were conducted during winter and summer crops in 2017-2018 in various crop field of Balrampur district viz., Ranjeetpur and Naharbalaganj.

2- SYMPTOMATOLOGY

(i). Powdery mildew of Pumpkin

The first symptoms appear are the tiny, white to dirty grey spots on leaves and stems. Most extensive development of the mildew occur on the abaxial surface of the leaves .As these spots enlarge the superficial powdery mass may ultimately cover the entire host surface. Black, pin-pint bodies representing the ascigerous stage of the fungus, appear rarely late in the season. The effect of severe infection may be premature defoliation of the plant. The fruits remain underside and are often deformed.

(ii). Powdery mildew of *Momordica charantia*

Powdery mildew of *Momordica charantia* is caused by *Erysiphe cichoracearum*. The symptoms appear as talc like colonies on the upper surface of the older leaves. As the disease progress, the entire leaf surface becomes colonized by the fungus. Severely infected leaves become yellow and then necrotic. These leaves die within a short period of time and result in large scale defoliation.

(iii). Fusarium crown and root rot of Pumpkin

The symptoms include stunting of the plant and there is a distinctive dark brown necrotic rot of the crown and upper portion of the tap root.

(iv). Cucumber Anthracnose

The symptoms of anthracnose appear as water-soaked lesions on leaves, which then turn as yellowish circular spots and later as brown to black. The spots turn brown and enlarge considerably. The petioles, fruit pedicel, and stem can also become infected, resulting in vine defoliation, fruit decline, and death of plant. Long dark spots develop on stems. The most noticeable symptoms appear on the fruits. The young, growing fruits may turn black, shrivel, and drop if fruit pedicels are infected. The symptoms appear as roughly circular, sunken, and water-soaked spots with dark borders on mature fruits. Within the lesion, small, black fruiting structures (acervuli) are formed.

(v). Alternaria leaf spot of Ridgegourd and Bottlegourd

Alternaria leaf spots were observed to be vey seious disease of bottlegourd and ridgegourd during the survey, resulting in reduced yield, size and quality. It is also known as target leaf spot or Alternaria blight, caused by *Alternaria cucumerina* and *Alternaria alternata*. The disease is seed and soil borne. High humidity and temperature in the range of 15°C–32°C is quite favorable for its development. The symptoms appear as small circular tan spots 1–2 mm in diameter on the upper surface of the older or crown leaves that may be surrounded by a yellow halo. Lesions formed on the lower leaf surface tend to be more diffused. These spots later coalesce to form large lesions, which may be more than 10 mm in diameter. These lesions show a target-like pattern of rings that is typical of most Alternaria spp. These lesions bear concentric rings that may cause severe leaf drop. Dark sunken brown spots initiate the disease on fruits, which later develop dark powdery lesions. It causes damage by defoliating the vines and leads to reduction in fruit yield, size, and quality. Partial defoliation may even cause the fruit to sunscald and ripen prematurely. The first symptoms usually were observed at the time of initial fruit development as fruits turn brown and reduce in size, which later turn black and mummified. The fungus overwinters as dormant mycelium (saprophyte) in diseased and partly decayed crop debris, in weeds of the cucurbit family, and possibly in the soil. Conidia are produced in the spring and act as the primary inoculum. The inoculum is carried by wind for long distances and splashing water from diseased plants to susceptible tissues. The conidia can survive under warm and dry conditions for several months. The period between infection and the appearance of symptoms varies from 3 to 12 days.

IDENTIFICATION OF THE PATHOGEN

Sphaerotheca fuliginea

Mycelium is hyaline, occasionally brown when old, usually evanescent but sometimes persistent, and forms white circular to irregular patches on the host surface. Conidia are in long chains, often with distinct fibrosin bodies, ellipsoid to barrel shaped, 27-31*15-18µm in size. Cliestothecia are rare, scattered to densely gregarious, 66-98 µm in diameter, usually under 85 mm. The wall (peridium) cells are usually over 25 mm wide. Appendages are variable in number, usually as long as the diameter of the ascocarp, myceloid, tortuous, brown, interwoven with the mycelium but sometimes long nearly straight and dark brown. There is a single ascus contains 8 ascospores which are ellipsoid to nearly spherical and measure 17-22*12-20 µm.

Erysiphe cichoracearum

Mycelium is usually well developed, evanescent but sometimes persistent and effused. Conidia are in chains, ellipsoidal or barrel shaped, variable in size, 34.8×15.2 µm. Cleistothecia are gregarious or scattered, globose, becoming depressed or irregular, 90-135µm in diameter .Wall cells of the cleistothecia are usually indistinct, 10-20µm wide. Appendages are numerous, basally inserted, myceloid, intervowen with the mycelium, and hyaline to dark brown, 1-4 times as long as the diameter of the cliestothecium. They are rarely branched. Ten to 25 asci are present per ascocarp. The asci are ovate to broadly ovate, rarely subglobose, more or less stalked, 60-90×25-50µm in size. Ascospores, two per ascus, rarely three, measure 20-30×12-18µm.

Fusarium solani sp. cucurbitae

The mycelium consists of branched, septate, intracellular hyphae. Conidia are hyaline and mostly 2-celled.

Colletotrichum orbiculare

Conidia were hyaline, aseptate, straight and cylindrical to clavate, 9-12.5µm×4-5.5µm.

Alternaria cucumerinas

The mycelium is well developed and conidia occur singly and also in chain.In the survey almost all the cucurbit plants are infected with some or other types of leafy symptoms.The major infection was by the Alternaria leaf spot on Ridgegourd and Bottlegourd and Powdery mildew on Pumpkin and Bittergourd.They were well spread and extensively prevalent in all fields as they were favoured by the atmospheric condition to spread and infection.Fusarium crown and root rot is also reported in Pumpkin which is caused by *Fusarium solani sp. cucurbitae*.Cucumber anthracnose has been reported to be one of the most destructive disease in the commercial cucumber production.

The extent of infection is a result of combination of time, moisture, temperature, and inoculum concentration. Therefore there is urgent need to control these diseases.

CONCLUSION

The Family Cucurbitaceae is one of the most important plant families that supplies edible products and useful food fibres to the human. Most of the species of this family have been used as human food. The cucurbits are among the most demanded vegetables all over the world. This important group of vegetables is perishable and is prone to be attacked by various microbes as well as pests. Despite of such importance of cucurbits and the heavy losses inflicted to them there is no systematic and thorough probe available on the diseases of cucurbits. Thus, realizing the importance and considering the need of a thorough and systematic probe into some diseases in greater details the present investigation on 'Fungal diseases of some cucurbitaceous vegetables' was undertaken.

In the present study, an extensive survey was conducted during the year 2017-2018 in different fields of Balrampur district of Eastern U.P., viz Ranjeetpur and Naharbalaganj to observe fungal symptoms on five different cucurbitaceous vegetables grown under natural field conditions. These crops included: *Cucurbita pepo (Squash), Momordica charantia (Bittergourd), Cucumis sativa (Cucumber), Lagenaria siceraria (Bottlegourd) and Luffa cylindrica (Ridgegourd).* During the survey, the plants which were exhibiting symptoms of powdery mildew, anthracnose, fusarium crown and root rot and alternaria leaf spot were selected for studying the symptoms and associated causal organisms. Carrying away of the diseased fruits from fields to markets resulted to be one of the causes of spread and occurrence of that pathogen resulting diseases in cucurbits. The study on diseases of collected samples revealed the regular occurrence of a number of diseases is due to fairly common microbes especially fungi on cucurbits. Some established plant pathogens like *Erysiphe, Podosphaera, Alternaria and Colletotrichum* were observed inciting on cucurbits.

In the present investigation, during the surveys, cucurbits alone showed up to 70% loss that will be due to fungal diseases. These fungal diseases can be controlled by the use of disease-free seed, by growing tolerant and resistance varieties, and by burning the diseased crop debris. Fungicides should also be applied at an interval of 7-10 days to control the disease.

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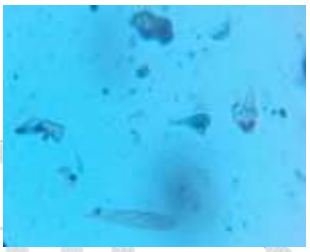
Table of figures

Symptoms of Fusarium crown and root rot on Pumpkin. **Characteristic of Anthracnose(cracked center)**



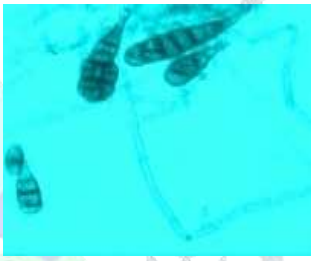
Ridgegourd Field survey leaf ***Alternaria cucumerina*** **on spot and Section showing conidia**





Symptoms and conidia of alternaria leaf spot on leaf of Bottlegourd.





Cleistothecia on leaves without a hand lens. Cliestothecia developing on leaf surface



Powdery mildew of *Momordica charantia* and cliestothecium.. Cleistothecia on leaves without a hand len. cliestothecia developing on leaf surface