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Incidence and severity of postharvest fruit rot of chilli (*Capsicum annum* L.) in Meghalaya

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ABSTRACT

An intensive survey was carried out in the market area of Ri-bhoi and East Khasi Hills districts of Meghalaya during July to September and November to February, 2018-2019 in a thirty days of interval. The highest incidence was recorded in the month of July in Byrnihut (23%) of Ri-bhoi district and the lowest was found in Laitumkhrah of East Khasi Hills district *i.e* 2% during November. Disease severity measured by 0-9 scale was recorded highest in Byrnihut (32.33%) in the month of July, 2018 and the lowest was recorded in the month of November in Laitumkhrah (2.22%) of East Khasi Hills district. Based on the pathogenic variability, one virulent isolate of Colletotrichum capsici (Cc-3), causing fruit rot in chilli was selected among the 15 isolates obtained from the collected samples of both the districts. There was no disease incidence observed in December (2018) and January (2019). This study revealed that fruit rot of chilli is one of the severe postharvest disease of chilli during summer in Meghalaya.

1. Introduction

Chilli *(Capsicum annuum L.)* is one of the important spice and vegetable cum cash crop of India. India ranks as a leading producer, consumer and exporter of chilli in the world (Begum *et al.,* 2015). It is a crop suitable for cultivation in both tropical and sub-tropical region, at a temperature of 20-25˚C. Chilli has a rich content of vitamin C and provitamin A (Carotene), riboflavin and thiamine. The strong spicy pungency of chilli is due to presence of alkaloid capsicin which is having medicinal properties like anti-bacterial, anti-carcinogenic, antialergic and anti-diabetic properties. The crop, chilli is a native of tropical America and was introduced by the Portuguese in India in seventeenth century. Since then it became a part of vegetable cultivation in India. In India chilli is grown in 2.87 lakh ha area and production is 34.06 lakh MT (Annonymous, 2017). In Meghalaya, it is an important cash crop and grown in 2208 ha area with a production of 12831MT (Anonymous, 2013). Fruit rot is one of the major constraint, which causes up to 25% loss to the crop (Saha and Singh, 1988). Almost all the farmers of the country use the seeds of their own farms although it is affected by several seed borne diseases like anthracnose and which became their own destructor, affect the growth of the crop from sowing to harvesting, transportation, marketing and storage. Fruit rot of chilli caused by Colletotrichum capsici, is one of the major destructive postharvest disease of chilli in India which causes considerable loss (Ramchandran *et al.,* 2007). *C. capsici* causing fruit rot and die-back of chilli plant is both seed and air borne in nature (Perenzny *et al.,* 2003). Symptoms of the disease in the ripe fruit is

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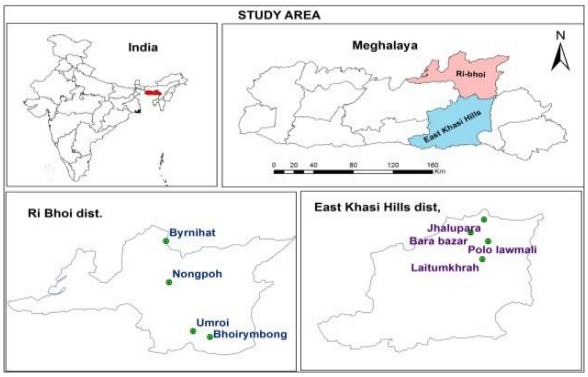

Figure 1. Location of survey area

characterised by appearance of small circular spots on the skin of the fruit in early stage. Infected tissues form depression in the fruit and later the spots become enlarge, sunken, dark coloured with black margin and produced acervuli on the infected lesion (Figure 2). The fruit rot stage causes huge damage to the fruits since the lesions on the fruit reduces the market value of the crop (Siddique *et al.,* 1977). Although chilli is the major vegetable crop grown throughout Meghalaya, there is not much report on fruit rot of chilli. Therefore, the present investigation was undertaken to shed some light on the disease incidence and severity of fruit rot of chilli in major markets of two districts and to check the variability among the associated pathogens responsible for causing the disease.

Figure 2. Chilli fruit showing fruit rot symptom

2. Materials and Methods

The present study was carried out in the Plant Pathology Laboratory of School of Crop Protection, College of Post graduate Studies in Agricultural sciences, Central Agricultural University (Imphal), Umiam, Meghalaya in the year 2018-19. The survey was conducted in the monsoon (July, August, September) and in winter (November, December, January and February) season of 2018-19 in two districts of Meghalaya (Figure 1) and four markets were selected from each district. *i.e* Ri-Bhoi (Byrnihut, Nongpoh, Bhoirymbong and Umroi), East khasi hills (Bara bazar, Jhalupara, Laitumukrha and Polo). From each market three shops were selected and disease incidence and disease severity of fruit rot of chilli was recorded from a sample size 100.Per cent disease incidence: Per cent disease incidence was calculated by using the following formula: Per cent disease incidence = n/N×100(Bhat *et al.,* 2010)

Where,

n = Number of chilli showing fruit rot symptom, N =Total number of chilli present in the lot.

Percent Disease Index: Per cent disease index was calculated to estimate the disease severity of fruit rot disease as per the formula given by Wheeler (1969).

$$\text{Fruit rot PDI} = \frac{\text{Sum of numerical disease ratings}}{\text{Total no. of samples} \times \text{Maximum of disease rating scale}} \times 100$$

Fruit rot severity was recorded by referring the following 0-9 scale given by Mayee and Datar (1986).

Percent fruit infection	Grade	Reaction
0	0	Immune
1-10%	1	Resistant
11-25%	3	Moderately Resistant
26-50%	5	Moderately susceptible
51-75%	7	Susceptible
>75%	9	Highly susceptible

Isolation of the pathogen

For isolation infected portions of the fruit along with little bit of healthy portion were cut into several small pieces after microscopic examinations followed by surface sterilization with 0.1% mercuric chloride for 1min and then rinsed 3 - 4 times in sterile distilled water. The bits were than aseptically placed on potato dextrose agar media in petri plate and incubated at 25 ±1˚C for 7 days.

Pathogenic variability

Pathogenic variability study was done mainly to check the degree of virulence of the isolates and to identify the most virulent one. Fifteen isolates of the pathogen obtained from the samples collected from different market places were inoculated in the local chilli cultivar (*Capsicum annum*) of Meghalaya which is more common in the market. At first the fruits were surface sterilised with 0.1% HgCl2 followed by serial washing in sterile distilled water. Inoculation was carried out by making wound on the middle of the fruits and then 10µl conidial suspension was inoculated (Madhavan *et al.,* 2010). Inoculated fruits were kept in humid chamber at 25±1˚C for 7 days. The lesions on the fruits were measured by using the same 0-9 scale given by Mayee and Datar, 1986. Per cent disease index was calculated to estimate the disease severity of fruit rot disease as per the formula given by Wheeler, 1969. Based on the rate of disease severity, the most virulent isolate was selected. Ri-Bhoi district during this study, 2018-2019. The study revealed that occurrence of postharvest fruit rot of chilli is one of the major problem in these two districts of Meghalaya which causes major yield loss. The disease incidence was ranged from 0-23% in Ri-Bhoi district, 0%- 16.33% in East Khasi Hills district (Table 1) and disease severity was ranged from 0%- 31.11% in Ri-Bhoi district, 0%-27% in East Khasi Hills district (Table 2). Highest disease incidence was recorded in Byrnihut of Ri-Bhoi district *i.e.* 23% in July month and lowest was found in Laitumkhrah of East Khasi Hills district *i.e* 2% in the month of November. Highest severity was recorded in Byrnihut (31.11%) of Ri-Bhoi district in July and Lowest was recorded in Laitumkhrah (2.22%) of East Khasi Hills district in November.

3. Result and Discussion

Disease incidence and severity

The Survey was carried out in major districts of Meghalaya *i.e.* East khasi hills district and Koppad and Mesta, 2017 also reported that the overall disease severity of fruit rot of chilli was in the range of 19.21 to 59.14 per cent in Sankeshwar village in Belagavi district of Karnataka, India while, 19.21 per cent incidence of the disease was recorded at Hulkoti village in Gadag district of Karnataka, India. There was no incidence of disease in the month of December, 2018 and January, 2019 in all the markets of both the districts. This might be because of the lower temperature (average 13˚C) in Meghalaya during December-January since the disease is favoured by high temperature (25-30˚C) and warm humid weather (Farr *et al.,* 2006; Tripathi *et al.,* 2016). The average temperature of Byrnihut is 35˚C in July and it is situated at 250m above mean sea level, due to which disease incidence and severity was found highest in the region.

Isolation of the pathogen

The mycelial growth of the fungus were subjected to microscopic examination for observing the acervulus (Figure 3) and shape of conidia of the pathogen. It was confirmed that out of fifteen isolates nine were found as C. capsici with the production of hyaline, falcate shaped conidia (Figure 4) and six of them were C. gleosporoides with hyaline, globular shaped conidia (Figure 5). It coincides with the findings of (Rajamanickam, and Sethuraman, 2015) that C. capsici produces hyaline conidiophore containing hyaline falcate conidia. Freeman *et al.,* 1998 also reported from their study on characterization of *C. gleosporoides* that it produces hyaline, single celled, ovoid to oblong shaped conidia.

Pathogenic variability

Pathogenic variability is used to determine severity of the pathogen which is basically a qualitative character. Based upon the degree of infection pathogenicity of different genotypes can be measured. The isolates were inoculated into a local chilli cultivar (*Capsicum annum*) of Meghalaya and observation was recorded after seven days of inoculation by measuring the disease lesions on the fruit using the 0-9 scale given by Mayee and Datar, 1986, it was observed that the isolates Cc-3(C. capsici) collected from Bara bazar of East Khasi Hills district showed highest disease severity (43%) with the production of distinct symptoms and acervuli.

Table 1. Disease Incidence (%) of postharvest fruit rot of chilli

Location/Month	Monsoon			Winter			
	July	August	September	November	December	January	February
Ri-Bhoi District							
Byrnihut	23.00* (4.79)^{a}	20 (4.46)^{a}	17.00 (3.95)^{a}	11.00 (3.31)^{a}	0 (0.71)	0 (0.71)	13.00 (3.60)^{a}
Nongpoh	19.00 (4.35)^{b}	16.33 (4.04)^{b}	14.00 (3.73)^{ab}	8.33 (2.87)^{ab}	0 (0.71)	0 (0.71)	11.00 (3.31)^{b}
Bhoirymbong	17.66 (4.20)^{bc}	14.00 (3.73)^{bcd}	11.66 (3.41)^{cd}	6.00 (2.44)^{bc}	0 (0.71)	0 (0.71)	7.00 (2.64)^{de}
Umroi	16.00 (3.99)^{cd}	12.00 (3.45)^{de}	10.00 (3.16)^{d}	3.67 (1.91)^{d}	0 (0.71)	0 (0.71)	6.33 (2.51)^{e}
East Khasi Hills							
Barabazar	18.33 (4.39)^{b}	15.00 (3.87)^{bc}	13.33 (3.65)^{abc}	8.00 (2.82)^{b}	0 (0.71)	0 (0.71)	9.33 (3.05)^{c}
Jhalupara	17.00 (4.16)^{bc}	13.67 (3.69)^{cd}	12.00 (3.46)^{bcd}	5.33 (2.30)^{cd}	0 (0.71)	0 (0.71)	8.00 (2.82)^{cd}
Polo	16.33 (4.03)^{c}	13.33 (3.65)^{cd}	11.33 (3.36)^{abc}	5.00 (2.21)^{cd}	0 (0.71)	0 (0.71)	6.00 (2.44)^{e}
Laitumkhrah	14.00 (3.69)^{d}	10.67 (3.26)^{e}	7.00 (2.63)^{e}	2.00 (1.38)^{e}	0 (0.71)	0 (0.71)	4.00 (1.98)^{f}
CD(0.05)	0.29	0.34	0.31	0.44	0	0	0.26

*Mean of the three replications.

Figure in the parenthesis indicate square root transformation. Means having common letter are not significantly different. 'F' test – at 5 per cent level.

Therefore isolate Cc-3 was recorded as the most virulent one followed by Cg-1(C. glosporoides), Cc-9(C. capsici), Cg-2(C. glosporoides), Cg-6(C. glosporoides), Cc-1(C. capsici), Cc-5(C. capsici), Cg- 3(C. glosporoides), Cg-5(C. glosporoides), Cc-6(C.capsici), Cc-7(C. capsici), Cc-2(C. capsici), Cc-4(C. capsici), Cc-8(C. capsici) which causes disease severity 38%, 36%, 34%, 33.33%, 32%, 31%, 31%, 26.67%, 26%, 25%, 25% and 24% respectively, while Cg-4(C. glosporoides) collected from Bhoirymbong was found to be the less virulent one as it has shown lowest disease severity *i.e* 23% (Table 3). The most virulent isolate produced acervuli in a scattered manner and recorded maximum fruit rot incidence (Thind and Jhooty, 1990). It also agrees the report of Masoodi *et al.*, 2012 that characteristic symptoms produced by *C. capsici* on the inoculated chilli fruits seven days after inoculation. However the present study revealed that most virulent isolates (Cc-3) cause acervuli in concentric rings and it belonged to C.capsici.

From the present study it can be concluded that the incidence and severity of fruit rot of chilli was found more in Byrnihut of Ri-Bhoi district (23% and 31.11% respectively) in the month of July, 2018 and less were recorded in Laitumkhrah of East Khasi Hills district (2.22% and 2% respectively) in the month of November, 2018. Isolate Cc-3 belonged to C.capsici was found to be the most virulent among the fifteen which produces specific symptoms along with acervuli in concentric rings. By considering the findings on disease incidence and severity, fruit rot of chilli is one of the major postharvest constraints of chilli production in Meghalaya which reduces the market yield up to a remarkable extent.

Table 2. Disease severity of postharvest fruit rot of chilli

Location/Month	Monsoon			Winter			
	July	August	September	November	December	January	February
Ri-Bhoi District							
Byrnihut	31.11* (5.57)^{a}	29.00 (5.38)^{a}	28.67 (5.35)^{a}	15.55 (3.94)^{a}	0 (0.71)	0 (0.71)	17.67 (4.20)^{a}
Nongpoh	28.67 (5.35)^{b}	25.00 (5.00)^{b}	26.00 (5.09)^{b}	13.33 (3.65)^{b}	0 (0.71)	0 (0.71)	15.00 (3.87)^{b}
Bhoirymbong	26.67 (5.16)^{c}	20.00 (4.47)^{c}	19.00 (4.35)^{c}	11.00 (3.31)^{c}	0 (0.71)	0 (0.71)	12.00 (3.46)^{c}
Umroi	24.67 (4.96)^{d}	17.33 (4.16)^{e}	17.33 (4.16)^{d}	8.88 (2.97)^{d}	0 (0.71)	0 (0.71)	10.33 (3.21)^{d}
East Khasi Hills							
Barabazar	27.00 (5.19)^{c}	18.67 (4.32)^{d}	15.55 (3.91)^{e}	11.11 (3.33)^{c}	0 (0.71)	0 (0.71)	13.67 (3.69)^{B}
Jhalupara	25.00 (4.99)^{d}	16.00 (4.00)^{f}	13.67 (4.47)^{c}	6.67 (2.58)^{e}	0 (0.71)	0 (0.71)	9.00 (3.00)^{d}
Polo	24.67 (4.96)^{d}	15.55 (3.91)^{f}	15.00 (3.87)^{e}	4.44 (2.10)^{f}	0 (0.71)	0 (0.71)	6.33 (2.51)^{e}
Laitumkhrah	22.22 (4.71)^{e}	13.33 (3.65)^{g}	11.11 (3.33)^{f}	2.22 (1.48)^{g}	0 (0.71)	0 (0.71)	4.67 (2.15)^{f}
CD(0.05)	0.13	0.10	0.13	0.23	0	0	0.22

*Mean of the three replications. Figure in parenthesis indicate the square root transformation. Means having common letter are statistically non-significant. 'F'-test at 5% level.

Figure 3. Acervulus

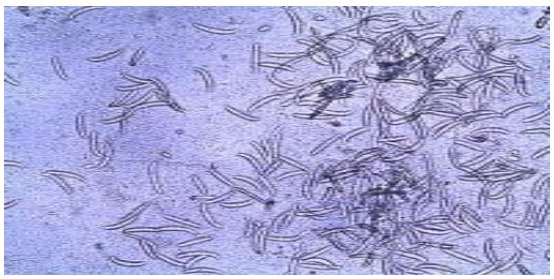

Figure 4. Conidia of C. capsici

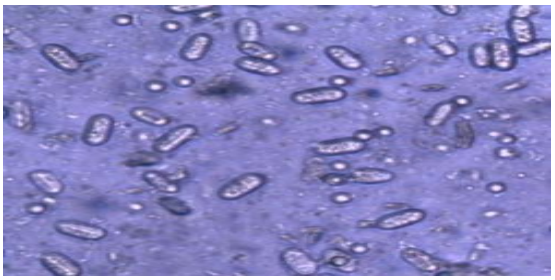

Figure 5. Conidia of C. gleosporoides

Figure 6. Cc-3 showing fruit rot symptoms after inoculating.

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