# Effect of epidemiological factors on fruit-rot of chilli caused by *Alternaria alternata* (Fr.) Keissler

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**Abstract**

Chilli (*Capsicum annuum* L.) is an important spice crop grown in many states of India, Chilli fruits suffer from various rotting fungi like Alternaria alternata, Colletotrichum capsici, Choanerhorce cucurbitarum and many other fungi. Fruit rot of chilli caused by Alternaria alternata (Fr.) keissler is one of the important post-harvest diseases. The epidemiological studies revealed that injury of chilli fruits was found to be a prerequisite for infection. Fruits inoculated without injury did not produce any symptoms of rot. Pin-pricking method of making injury proved to be the most efficient method of inoculation. All the fruit exhibited symptoms of rot when inoculated at unripe, semi-ripe and ripe stages, however, the ripe stage of the fruit was found highly susceptible.

**Keywords:** chilli, fruit-rot, Alternaria

## Introduction

*Capsicum annuum* L. (Chilli), is one of the important spices cultivated all over the world. In India, dry chilli is grown over an area of 7.94 lakh hectares with a production of 13.04 lakh tones and productivity of 1.6 tons per hectare (Kappad & Mesta, 2017) [6]. Chilli (*Capsicum annum* L.) commonly known as "Mirch" or "Mirchi is an important condiment crop that belongs to the family Solanaceae and is a native of tropical America and the West Indies. Chilli is a perennial sub-shrub that produces fruit in groups. It comprises many chemicals, including steam-volatile oils, fatty oils, capsaicinoids, carotenoids, vitamins, protein, fiber and mineral elements (Bosland and Votava, 2003) [2]. It is also an excellent source of vitamins A, B, C (340mg per 100 grams), E and P. Fresh green chilli peppers contain more vitamin C than citrus fruits and fresh red Chilli has more vitamin A than carrots (Osuna-Garcia *et al*., 1998; Marin *et al*., 2004) [12, 8]. Chilli (Capsicum annuum L.), an important economic crop worldwide, is severely infected by fruit rot, which may cause yield losses of up to 50%. Chile peppers are susceptible to several distinct fruit rots. The fungus causes one of these fruit rots *Alternaria alternata* (Fr.) Keissler (Shannon,1989) [17]. The disease was first reported in New Mexico in the 1950s as an internal mold of red chile peppers, most noticeable after frost (Leyendecker, 1950) [7]. Symptoms of Alternaria rot begin as water-soaked, grey lesions on either the side or blossom-end of the fruit (Snowden, 1932) [18]. As the lesions progress, they darken and become covered with spores. Internal necrosis and mycelial growth occur on the seeds, placenta, and pericarp, but is not noticed until the pepper is cut (Halfon & Rylski, 1983) [4].

## Materials and methods

### 1. Mode of infection

To investigate whether the pathogen can infect uninjured fruits. If not, what type of injury provides maximum infection? Fruits without injury and with different types of injury were inoculated with a uniform amount of inoculum of the pathogen. Matured fruits of chilli were used in this study. The fruits were surface sterilized by dipping in 0.1 per cent $HgCl_2$ solution for 1-2 minutes, followed by 3 items of washing with sterilized water. After the complete evaporation of water, the fruits were inoculated with the fungus. The inoculum was taken from seven days old cultures of the fungus grown in a petri dish. Each treatment was replicated four times. The following methods were used for inoculation:

#### a) Pin pricking method

The fruit's skin, within the periphery of 2 mm diameter, was pricked with the help of a sterilized needle. The inoculum was placed on the pricked area with the fungal growth facing the fruit surface.

#### b) Scraping method

The fruit's skin within the periphery of 2 mm diameter was scraped thrice with a razor blade and the inoculum was placed on a scraped area with the fungal growth facing the surface.

#### c) Rubbing method

Two fruits were rubbed softly with each other for 10 seconds and inoculum was placed on the rubbed area with the fungal growth facing the fruit surface.

**d) Cork-borer-wounding method**

A hole of 2 mm diameter and 2 mm depth was made with the help of a sterilized cork borer. The inoculum was inserted into the hole and the host tissue was replaced on the hole.

**e) Inoculation without injury**

The inoculum was placed on the uninjured fruit surface with the fungal growth facing the fruit surface. In all the treatments, the inoculum was covered by a thin layer of sterilized cotton dipped in sterilized water to maintain more than 90 per cent R.H. The inoculated fruits were sealed in moistened polythene bags and exposed to sunlight daily for 5 minutes and incubated at 25$\pm$1°C. The fruits were examined daily until the appearance of the symptoms to record the incubation period. Disease severity was recorded on the 3$^{rd}$ and 6$^{th}$ days of inoculation. Incidence and severity in each treatment were recorded as follows:

$$\text{Incidence (\%)} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits}} \times 100$$

The intensity was recorded on the basis of the percent of the fruit area infected. This was assessed with the help of the assessment key suggested by Mayee and Datar (1986) [9] with slight modifications devised for this purpose. Interpolations were made, if required. After finding out the percent area infected on each fruit, the mean for the treatment was calculated. The method of inoculation found most efficient was used in all subsequent investigations.

**2. Effect of maturity and ripeness of fruits on fruit-rot development**

Fruits of uniform size at the following stages of maturity and ripeness were inoculated by the pin-pricking method described under 1.

a) Immature and unripe fruits
b) Mature and semi-ripe fruits
c) Mature and ripe fruits

Fully formed unripe fruits stored at 25°C for 2 days change to semi-ripe and ripe fruits, respectively. These two stages, as well as immature fruits, were incubated on the same day. The inoculated fruits were incubated at 25$\pm$1°C temperature. The experiment was arranged in a completely randomized design. Data on the incidence and severity of the rot was recorded on the 3$^{rd}$ and 6$^{th}$ day of inoculation according to the method described under 1.

**Results and discussion**

**Mode of infection**

The inoculation by pin-pricking method proved significantly most effective for infection and disease development of *Alternaria alternata* over other methods (table1, fig. 1). It gave the highest disease severity at all incubation periods, followed by the cork-borer, scraping and rubbing methods. However, later methods do not differ significantly. The disease was maximum on the 6$^{th}$ day of inoculation. Symptoms of the disease did not appear when fruits were inoculated without injury. The incidence of fruit rot was 100 per cent in all inoculation methods on both 3$^{rd}$ and 6$^{th}$ day of inoculation.

Injury to fruits is known to aid different kinds of fruit rot in many types of fruits (Pathak, 1980; Raut *et al*. 1989; Khaleeque and Khan. 1991)[13,14,5]. In the present study, injured fruits helped in the development of fruit rot in chilli, whereas uninjured fruits did not get infected, suggesting that careful handling of the fruits can minimize the rot during harvesting, transport and storage.

**Table 1:** Incidence and severity of fruit-rot in chilli inoculated by different methods and incubated up to 6th days at 25$\pm$1°C

| S. No. | Method of inoculation | Incidence (%) | | Severity (%) | |
|---|---|---|---|---|---|
| | | 3rd day of inoculation | 6th day of inoculation | 3rd day of inoculation | 6th day of inoculation |
| 1. | Pin-pricking | 100 | 100 | 25.50 | 36.20 |
| 2. | Cork-borer | 100 | 100 | 16.20 | 21.75 |
| 3. | Scrapping | 100 | 100 | 8.25 | 12.50 |
| 4. | Rubbing | 100 | 100 | 6.40 | 9.02 |
| 5. | Control (Without injury) | 00 | 00 | 0.00 | 0.00 |
| Sem$\pm$ | | | | 1.86 | 1.95 |
| C.D. (P=0.05) | | | | 4.02 | 4.15 |

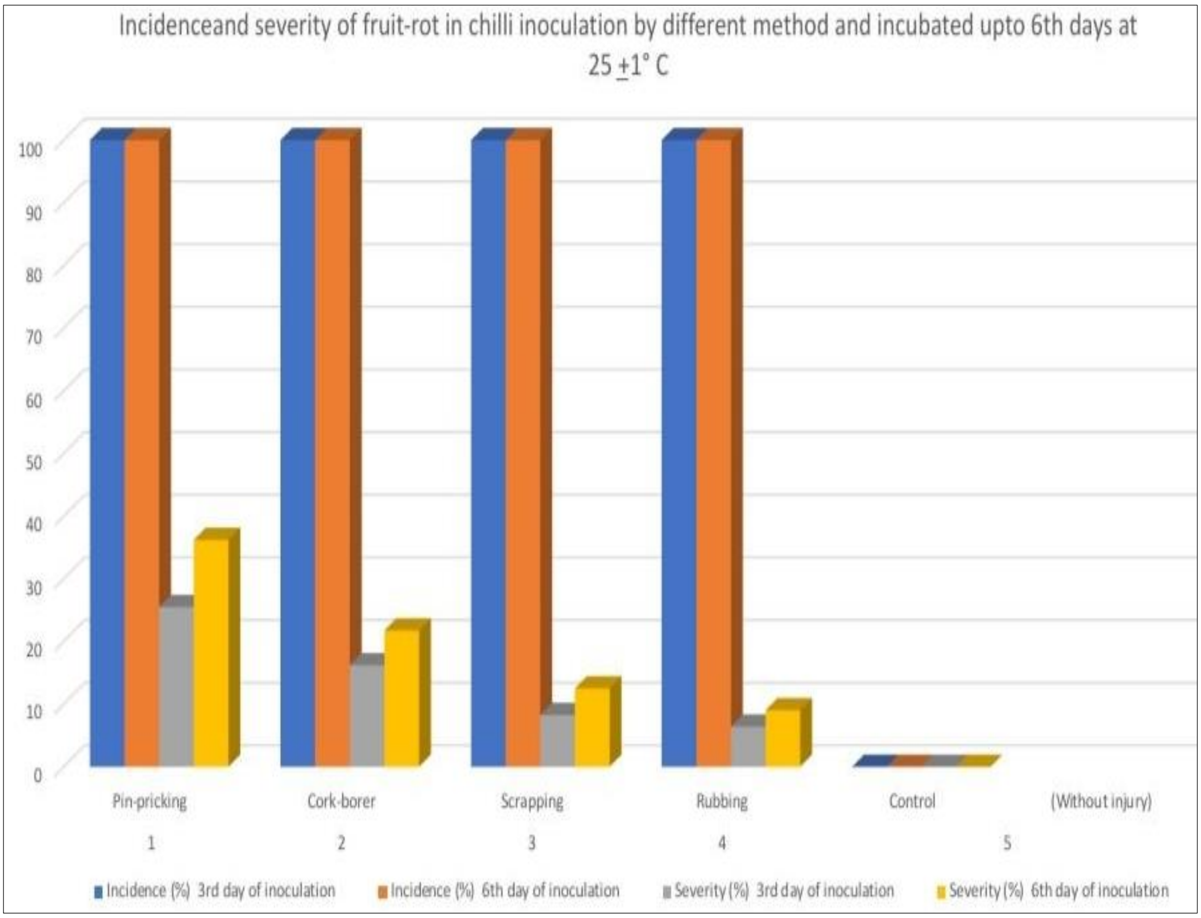


**Fig 1:** Incidence and severity of fruit-rot in chilli inoculated by different methods and incubated up to 6th days at 25±1°C

**Effect of fruit maturity and ripeness on disease development**

At all the stages of maturity and ripeness, a 100 per cent incidence of fruit rot was recorded on both the 3rd and 6th day of inoculation (table 2, fig. 2). Among the three stages, the ripe stage was found to be the most susceptible to fungal infection. The difference in disease severity was highly significant among unripe, semi-ripe and ripe stages on the 6th day of inoculation. Symptoms of various rots in different types of fruits did not appear when inoculated at the immature stage, as has been reported by Mehta *et al*., 1975[11] and Saxena *et al*.,2016 [16]. Mature and ripe fruits of chilli have been reported to be most susceptible to fruit rots caused by several fungi (Basak *et al*.,1994: Mc Govern and Polston, 1995; Roy *et al*., 1997) [1,10,15]. However, in the present study Alternaria alternata was found to exhibit symptoms in all the stages of fruit maturity but the maximum severity of the disease was found at the ripe stages of fruit development.

**Table 2:** Incidence and severity of fruit-rot in chilli inoculated at different maturity and ripeness stages of fruit and incubated up to 6th day at 25± 1°C

| S. No. | Stage of fruit at the time of inoculation | Incidence (%) | | Severity (%) | |
|---|---|---|---|---|---|
| | | 3rd day of inoculation | 6th day of inoculation | 3rd day of inoculation | 6th day of inoculation |
| 1. | Immature and unripe | 100 | 100 | 5.00 | 8.50 |
| 2. | Mature and semi-ripe | 100 | 100 | 11.25 | 20.65 |
| 3. | Mature and ripe | 100 | 100 | 18.70 | 34.50 |
| SEm± | | | | 1.76 | 1.48 |
| C.D. (P=0.05) | | | | 3.99 | 3.34 |

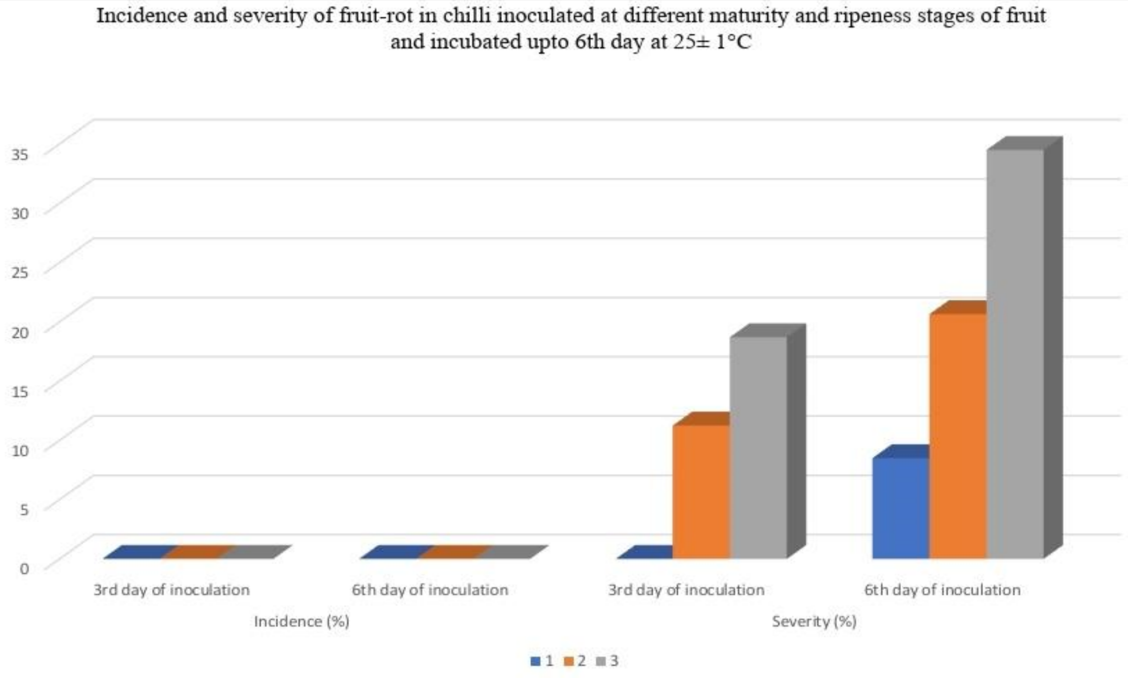


**Fig 2:** Incidence and severity of fruit-rot in chilli inoculated at different maturity and ripeness stages of fruit and incubated up to 6th day at 25±1°

## Conclusion

In the present study, it may be concluded that the injury of fruits is a prerequisite for infection. The pin-pricking method was most effective than other methods of inoculation. Inoculated fruits exhibited maximum severity at the mature and ripe stages.

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