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## FUNGAL DISEASES IN FRUIT OF BER (*Zizyphus mauritiana*) IN TROPICAL AND SUBTROPICAL REGION OF INDIA

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### ABSTRACT

Fifty five fruits samples of Ber (*Zizyphus mauritiana*) from Jaipur and Chomu Revealed 12 fungal species were found associated with fruits. These were *Actinomycetes*, *Alternaria alternate*, *Aspergillus candidus*, *A. flavus*, *A. versicolor*, *Chaetomium globosum*, *C. spinosum*, *Gliocladium roseum*, *Fusarium oxysporum*, *Penicillium sp.*, *Rhizoctonia bataticola* and *Rhizopus nigricans*, which are dominant and affected disease akin to Powdery mildew, Leaf spot, Wilt, Rust, Viral diseases, Mycoplasmal, Post-harvest diseases and insect damage fruit.

**Keywords:** *Zizyphus mauritiana*; Powdery mildew; leaf spot; Wilt; Rust; Viral diseases; Mycoplasma; Post-harvest diseases.

### INTRODUCTION

*Zizyphus mauritiana* is an important fruit producing tree of family Rhamnaceae. In India, it is grown in Punjab, Uttar Pradesh, Bihar and Rajasthan. In Rajasthan the fruit of *Zizyphus mauritiana* is grown dominantly in the Jaipur and Chomu.

*Zizyphus jujuba* and *Zizyphus mauritiana* are two important tree species of genus *Zizyphus*, *Zizyphus mauritiana* is more common in tropical and subtropical region and *Zizyphus jujuba* is found in temperate parts of world. Their fruits are edible and supply vitamin C, sugars and mineral to human diet. The fruit while unripe are exposed to many fungi. The fruit and tree are infected and contaminated by many serious diseases at some stage in field or during post harvesting or transit. Surolia<sup>1</sup>.

First time in Kanpur, India *Powdery mildew* (caused by *Oidiosis sp.*) on *Zizyphus jujube* reported. Mehta<sup>2</sup>, Hsies and Tsai<sup>3</sup> reported *Botrytis cinerea* (casual organism of leaf blight) *Z. jujuba*, *Fusarium decemcellulare* (*Calonectria rigidiuscula*) was reported by

Singh and Singh<sup>4</sup> from India, Galls Cause by *Eriophes cernuous* on *Z. mauritiana* and later Kamal et al.<sup>5</sup> reported *Erysiphe acaciae* on *Zizyphus spp.* *Aspergillus flavus* was reported by Singh and Sumbali<sup>6</sup> on the surface of *Z. mauritiana* fruits.

In addition to the fungi described above, some other fungi have also been reported to cause fruit rot diseases by various works such as *Phomopsis natsume*, Lal et al.<sup>7</sup>, *Geotrichum sp.*, Sumbali and Mehrotra<sup>8</sup> on fruits of *Z. mauritiana*. Sharma et al.<sup>9</sup>

*Z. mauritiana* is attacked by about 80 insect species, Butani<sup>10</sup>. Many sorts of leaf spot originate on *Z. mauritiana* like *Isariopsis* mouldy leaf spot, *Cercospora* leaf spot, *Clabosporium* leaf spot, *Alternaria* leaf spot, *Phoma* leaf spot, *Tandonella* leaf spot. Garg and Gupta<sup>11</sup> reported *Fusarium fusarioides* as a casual organism of wilt of *Z. mauritiana* for the first time in India. Gjareum<sup>12</sup> reported pathogen *Phakospora zizyphi vulgaris* causes leaf rust of *Z. mauritiana* for the first time in Cape Verde Island. Viral diseases in *Zizyphus* are primarily

affected by spike disease as described by Brierley<sup>13</sup>. Pandey et al.<sup>14</sup> reported a Mycoplasma like disease (Witches-broom disease) of *Z. mauritiana*, for the first time in India. Several Post-harvest diseases may cause fruit diseases like Fusarium rot, Epicoccum rot, Cladosporium rot, Stem end rot, Phytophthora rot, pestalotia rot, Alternaria rot, Phoma rot, Trichotecium rot, Rhizoctonia rot, Colletotrichum rot.

## MATERIALS AND METHODS

Total Fifty five fruits samples of *Zizyphus mauritiana* (Ber) were collected from fields and market of Jaipur and Chomu. The fruit samples were kept open large petriplates at room temperature.

Twenty five fruits were taken at random and were examined on 1<sup>st</sup> day i.e. day of collection for the presence of asymptomatic and symptomatic fruits showing scab or any other deformities like cracked, insect-damaged and rotted fruits. Extent of damage during storage was recorded on 8<sup>th</sup> day of their collection.

For incubation fruits collected on the same day as well as after storage of 8 day were used. 2 fruits from each category of symptom were taken out randomly. Each fruit was cut into 10 small pieces of almost equal size and 10 pieces of symptomatic category was used as such whereas other 10 pieces of sodium hypochlorite for 2 min. Both untreated and pretreated pieces of fruits were placed on moistened blotters as in Standard Blotter Method (SBM). The incubated fruit pieces were studied on 8<sup>th</sup> day for mycoflora associated with them and extent of damage to the fruits. Extent damage to the fruits during their storage, loss and mycoflora associated were also observed.

## RESULT AND DISCUSSION

Fifty five samples were collected from fields and markets of Chomu and two vegetable markets (Sanganeri gate and Lalkothi mandi) of Jaipur.

The fruit showed predominantly four types of disorder viz., fruit with scab, rotted fruit, insect damaged fruits and cracked fruit (Table-1).

**Fruit with Scab (Fig. 2A):** The occurrence and incidence of fruit with fruit with scab were higher in samples collected from market than in field. The incidence varied from 4-48% and 12-28% respectively.

It carried higher number of fungi. The market samples of Chomu and Jaipur revealed 10 and 9 fungal species respectively in untreated fruits. The dominant fungi associated were *Alternaria alternate*, *Aspergillus flavus*, *A. versicolor*, *Penicillium sp.*, *Fusarium oxysporum*, *Rhizoctonia bataticola* and *Rhizopus nigricans*. The samples of Jaipur market carried high infection than Chomu. *Gliocladium roseum* was also recorded in samples of Jaipur (10-20%). Fruits collected from Chomu showed higher incidence of *Alternaria alternate*, *Aspergillus flavus*, *A. versicolor* and *Penicillium sp.*

The chlorine pretreatment generally resulted in reduction or elimination of saprophytic fungi viz., *Actinomycetes*, *Alternaria alternate*, *Aspergillus candidus* and *Chaetomium globosum*. The storage period resulted in decrease in occurrence and incidence of fungi, but both *Fusarium oxysporum* and *Rhizoctonia bataticola* showed increase in incidence in the pretreated fruits.

**Rotted Fruits (Fig. 1B and 2B):** This is mainly due to excessive growth of *Fusarium oxysporum*. Other fungi such as *Penicillium sp.* and *Aspergillus flavus* also occur after 8 days storage. Incidence of rotted fruits was 4-40% in market samples and 12-32% in samples of field. Rotted fruit revealed 6,8,10,6 and 7,6,9,5 fungal species in untreated and pretreated fruit samples collected from different locations respectively. The dominant fungal species were *Aspergillus flavus* (10-90%), *A. versicolor* (10-60%), *Penicillium sp.* (10-100%), *Fusarium oxysporum* (10-20%), and *Rhizoctonia bataticola* (10-40%). *Fusarium oxysporum* and *Rhizoctonia bataticola*

mostly observed in samples collected from Chomu markets. Chlorine pretreatment showed reduction in occurrence as well as incidence of the most of the fungi.

The fruits collected from Jaipur market showed higher incidence of the fungi than that of Chomu. The fruit samples from field revealed only six fungal species viz., *Actinomyces* (10%), *Aspergillus flavus* (10-30%), *A. versicolor* (10-30%), *Penicillium sp.* (80-100%), *Rhizoctonia bataticola* (10-40%), *Rhizopus nigricans* (10%). *Gliocladium reseau* and *Rhizopus nigricans* which are not recorded on 1<sup>st</sup> day of collection were observed in 8<sup>th</sup> day.

#### **Insect Damaged Fruits (Fig. 1C and 2C):**

Occurrence of Insect Damaged Fruits was relatively less and its incidence varied from 4-32% and 4-8% in market and field samples respectively. Fruit damage caused by insects showed 7,7,8,5 and 8,5,5,4 fungal species in untreated and pretreated fruit samples collected from four locations. These fruits were mostly associated with *Aspergillus flavus*, *A. versicolor*, *Penicillium sp.*, and *Rhizopus nigricans*. Their incidence was high in market samples, both of Chomu and Jaipur than that of field samples. In field samples *Aspergillus flavus*, *A. versicolor*, *Penicillium sp.*, *Rhizopus nigricans* occur maximum in fruits of all locations with incidence ranging from 10-60%.

Chlorine pretreated caused reduction in incidence of complete elimination of the fungi recorded in untreated fruit samples. A fungus completely eliminated was *Fusarium oxysporum* which was recorded in market samples of Jaipur and Chomu in untreated fruits.

On 8<sup>th</sup> day of storage 5,5,6,5 and 3,6,3,5 fungal species were recorded in untreated and pretreated fruit samples respectively. Their incidence was generally reduced. But the market samples of Chomu showed increase in infection of *Penicillium sp.* (10-100%) after 8 days of storage.

**Cracked Fruits (Fig. 1D and 2D):** Cracks in fruits were observed in both samples collected from field (12-28%) and market (8-36%). Such fruits on storage develop growth of fungi like *Aspergillus versicolor* and *A. flavus*.

The fruit with cracks revealed 7,8,9,9 and 4,7,9,10 fungal species in untreated and pretreated fruit samples of 4 locations. *Aspergillus flavus*, *A. versicolor*, *Penicillium sp.* were dominant. *Gliocladium reseau* was also high in market samples of Jaipur. The field samples carried low incidence of these fungi except *Penicillium sp.* where 30-100% incidence was recorded in 8 samples. The cracked fruits obtained from Jaipur market (Lalkothi mandi) showed higher occurrence and incidence *Alternaria alternate*, *Aspergillus flavus*, *A. versicolor*, *Penicillium sp.* and *Rhizoctonia bataticola*. These fungi occurred in 6(10-20%), 19(10-60%), 12(10-80%), 22(10-90%) and 7(10-20%) samples respectively.

After 8 days of storage 7,6,5,6 and 6,3,6,6 fungal species were observed in untreated and pretreated fruits of four locations.

#### **Fungi Associated With Symptomatic Fruits (Table-2 and 3; Fig. 3):**

The normal fruits when incubated revealed 7 and 9 fungal species in untreated and pretreated fruits collected from market of Chomu, whereas in field samples the number of species were 5 and 6 respectively. Of these *Aspergillus versicolor*, *Penicillium sp.* and *Rhizopus nigricans* were dominant. *Fusarium oxysporum* and *Rhizoctonia bataticola* occurred in 2 and 6 samples with 10% and 10-30% incidence in untreated fruits respectively. Their occurrence was slightly increased after pretreatment.

The market fruits of Chomu and Jaipur showed relatively high occurrence and incidence of *Aspergillus flavus*, *Penicillium sp.* and *Rhizopus nigricans*. Occurrence of *Fusarium oxysporum* was low and *Rhizoctonia bataticola* was not recorded in untreated normal fruits in any of the sample collected from markets of Jaipur.

The fruits from field revealed relatively lower number of fungi in untreated and pretreated samples. Their incidence was also low except *Penicillium sp.* which was recorded in 4 and 7 samples with 20-80% and 10-90% incidence.

Storage period did not show much effect on incidence of fungi with normal fruit; however a slight increase in occurrence of *Aspergillus flavus*, *Penicillium sp.* and *Rhizopus nigricans* was noticed with the market samples of Chomu in untreated fruits. In samples of Jaipur, complete elimination of *Alternaria alternate*, *Chaetomium globosum* and *Fusarium oxysporum* was seen after 8 days storage.

*Zizyphus mauritiana* Lam. Is an important fruit tree in Rajasthan. The fruits are edible. It has sweet fleshy mesocarp and it is easily attacked by a large number of fungal and bacterial pathogens. Deterioration also occurs in the field by insect and mechanical damages like cracks during harvesting and marketing. Such infected and damage fruit shows very short shelf life and reduces the edible and market value.

In present study, the fruits were collected from field as well as market of Jaipur and Chomu. Both places are major producer of *Zizyphus mauritiana*. The fruits were subjected to direct observation for disease symptoms and isolation of fungi. The fruits are large sized; hence their pieces were incubated on moistened blotters.

As such four types of disease symptoms viz., scab, rotting and cracked including insect and mechanical damage were observed. Of these occurrence of scab was higher. But fruits showing rotting symptoms and insect infestation deteriorated rapidly than others and resulted in increase in incidence of such infected fruits because of contamination and infection of other healthy fruits and the shelf life was reduced.

The important diseases and pathogens of *Zizyphus mauritiana* are *Fusarium* rot by *Fusarium decemcellulare*, *F. equiseti* and *F. pallidoroseum*; *Epicoccum* rot by *Epicoccum nigrum*; *Cladosporium* rot by *Cladosporium*

*cladosporioides*; *Phytophthora* rot by *Phytophthora palmivora* and *Alternaria* rot by *Alternaria alternate*.

*Botrytis cinerea*, *Cladosporium cladosporioides*, *Myrothecium roridum*, *Curvularia lunata*, *Verticillium albo-atrum* are common fungi of fruits, but some of these are important pathogens causing serious fruit diseases such as fruit rot caused by *Myrothecium roridum* and *Alternaria tenuissima*.

In present study total 11, 13, 13, 11 fungi were isolated from fruits of Sanganeri gate, Lalkothi mandi, market and fields of Chomu respectively. The fruits obtained from market carried higher occurrence and incidence of fungi as it included both field as well as storage fungi which occurred after harvesting. The occurrence and incidence of fruit with scab were higher in samples collected from market than in field. In rotted fruits rotting increases during storage, this is mainly due to excessive growth and sporulation of *Fusarium oxysporum*. In cracked fruits of *Aspergillus flavus* and *A. versicolor* were observed after storage.

## CONCLUSION

The fruits were cracked either during harvesting or by poor handling after their harvesting. In such fruits the endocarp was exposed and fungi easily colonized. This resulted in quick deterioration of fruits.

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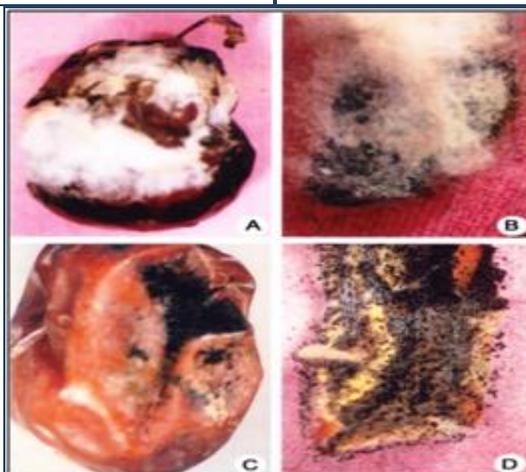
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**Figure-2 (A-D):** Fruits of *Zizyphus mauritiana* showing various types of symptoms after 8 days storage.  
 A : Fruit with scab, B : Rotted Fruit, C : Fruit with Insect Damage, D : Cracked Fruits

**Figure-1 (A-D):** Fruits of *Zizyphus mauritiana* showing various types of symptoms.  
 A : Healthy Fruit X 9.5. B : Rotted Fruit X 8.5. C : Fruit with Insect Damage X 9. D : Cracked Fruits X 9.5.



**Figure-3 (A-D):** Mycoflora associated with different symptomatic fruits of *Zizyphus mauritiana*.  
 A: Growth of *Fusarium oxysporum* on fruits surface X 7. B: Incubated fruit piece showing growth of *Fusarium oxysporum* X 10. C: Growth of *Aspergillus versicolor* on fruits surface X 9. D: Piece of Fruit with *Aspergillus versicolor* in incubation test X 11.

**Table 1: Number of fruit samples of *zizyphus mauritiana* studied for examination of disease symptoms, abnormality and their incubation on standard blotter method (sbm)**

Location	Number of Samples collected	Samples studied for SBM	Asymptomatic fruits	Symptomatic fruits			
				Fruits with scab	Rotted fruit	Insect damaged fruits	Cracked fruit
<b>Jaipur</b> Sanganeri gate mandi	11	11	11 (24-60)	11 (8-48)	9 (4-40)	8 (4-32)	10 (8-28)
<b>Jaipur</b> Lalkothi mandi	23	23	23 (16-52)	23 (4-32)	23 (8-40)	11 (4-16)	23 (12-36)
<b>Chomu</b> Market	13	13	13 (28-48)	13 (12-28)	13 (12-36)	6 (4-24)	13 (8-24)
<b>Chomu</b> Field	8	8	8 (28-48)	8 (12-28)	8 (12-32)	3 (4-8)	8 (12-28)

**Table 2: Occurrence and percent range of fungi associated with normal looking and different symptomatic fruits of *zizyphus mauritiana* collected from jaipur (sanganeri gate mandi) in untreated and pretreated fruit samples incubated on sbm on 1<sup>st</sup> day of the collection**

Fungi	Untreated					Pretreated				
	Normal fruits	Fruits with scab	Rotted fruit	Insect damaged fruits	Cracked fruit	Normal fruits	Fruits with scab	Rotted fruit	Insect damaged fruits	Cracked fruit
<i>Actinomyces</i>	6 (10-20)	7 (10-40)	6 (10-30)	5 (10-40)	6 (10-20)	-	6 (10-20)	4 (10-20)	-	-
<i>Alternaria alternata</i>	-	1(40)	-	-	-	-	-	-	1(20)	-
<i>Aspergillus flavus</i>	10(10-100)	10(10-100)	5(10-90)	7(50-100)	5(10-30)	9(10-70)	7(20-60)	5(10-70)	5(40-90)	3(10-20)
<i>A. versicolor</i>	8 (30-100)	11 (30-100)	7(10-60)	6 (50-100)	7 (10-50)	10 (20-70)	5 (10-20)	6 (10-40)	5 (40-70)	-
<i>Chaetomium globosum</i>	-	-	-	-	-	-	-	-	1(10)	-
<i>C. spinosum</i>	-	1(20)	-	-	-	-	-	-	-	-
<i>Drechslera holodes</i>	-	--	-	-	-	--	-	-	1(20)	-
<i>Fusarium oxysporum</i>	2(10)	-	-	2(10)	1(10)	1(10)	1(10)	2(10)	-	3(10-50)

<i>Gliocladium roseum</i>	1(30)	5(10-20)	1(10)	3(10-50)	3(10-20)	3(10-50)	1(20)	3(10-30)	2(10-30)	2(10)
<i>Penicillium sp.</i>	11(10-100)	11(10-100)	7(10-80)	7(10-100)	5(10-20)	8(10-80)	9(10-80)	6(10-20)	5(30-90)	3(10)
<i>Rhizopus nigricans</i>	11((270-100)	10(30-100)	6(50-100)	7(90-100)	6(2-100)	3(30-50)	7(30-50)	5(10-60)	3(10-40)	-

**Table 3: Occurrence and percent range of fungi associated with normal looking and different symptomatic fruits of *Zizyphus mauritiana* collected from jaipur (sanganeri gate mandi) in untreated and pretreated fruit samples incubated on SBM on 8<sup>th</sup> day of the collection.**

Fungi	Untreated					Pretreated				
	Normal fruits	Fruits with scab	Rotted fruit	Insect damaged fruits	Cracked fruit	Normal fruits	Fruits with scab	Rotted fruit	Insect damaged fruits	Cracked fruit
<i>Actinomyces</i>	6 (10-30)	6 (10-30)	5 (10-30)	-	-	-	6 (10-30)	3 (10-20)	-	-
<i>Alternaria alternate</i>	-	1(10)	-	-	-	-	-	-	-	-
<i>Aspergillus flavus</i>	10 (10-100)	9 (40-90)	6 (10-100)	7 (10-100)	7 (10-100)	8 (10-90)	5 (10-40)	6 (10-40)	6 (40-90)	5 (30-40)
<i>A. versicolor</i>	6 (60-100)	9 (90-100)	4 (80-90)	7 (10-100)	8 (20-100)	10 (10-80)	6 (10-90)	3 (20-40)	6 (10-60)	4 (10-40)
<i>Chaetomium spinosum</i>	1 (10)	-	-	-	-	-	-	-	-	-
<i>Fusarium oxysporum</i>	1 (10)	6 (10-80)	4 (10-90)	2 (10)	1 (60)	4 (10-20)	-	1 (70)	-	1 (10)
<i>Gliocladium roseum</i>	-	1 (10)	-	-	1 (20)	-	-	-	-	1 (10)
<i>Penicillium sp.</i>	9 (60-90)	7 (80-90)	6 (30-100)	6 (60-100)	9 (40-90)	10 (40-90)	4 (20-80)	6 (10-40)	4 (4-10)	3 (20-50)
<i>Rhizoctonia bataticola</i>	-	-	-	-	1 (20)	-	-	-	-	-
<i>Rhizopus nigricans</i>	9 (60-100)	5 (10-90)	5 (10-100)	6 (20-80)	4 (10-90)	-	-	3 (10-30)	-	3 (10-60)