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Market survey and disease dynamics of post-harvest black mould rot of pomegranate in southern Karnataka

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Abstract

Pomegranate (*Punica granatum* L.) is an economically important fruit crop widely cultivated in tropical, subtropical, and arid regions. However, post-harvest diseases, particularly black mould rot caused by *Aspergillus niger*, significantly reduce fruit quality and market value. The present investigation was undertaken to assess the incidence, epidemiology, and pathogenicity of post-harvest black mould fruit rot in major fruit markets of Bengaluru, Tumkuru, Shimoga, and Chitradurga districts of Karnataka. A fortnightly survey was conducted from November-December 2015 to March-April 2016. Disease incidence was recorded from randomly selected fruit samples in retail markets. The results revealed that black mould rot was prevalent throughout the survey period, with incidence ranging from 4.44 to 12.48% and an overall mean incidence of 8.05%. The highest incidence (12.48%) was recorded in April 2016, while the lowest (4.44%) occurred in January 2016, indicating seasonal influence on disease development. Symptomatology included initial skin discoloration, water-soaked lesions, softening of arils, and development of black spore masses leading to complete fruit decay. The pathogen was isolated, purified, and identified based on morphological and cultural characteristics as *Aspergillus niger*. Pathogenicity tests confirmed Koch's postulates, as inoculated fruits developed typical symptoms within six days, whereas uninoculated controls remained healthy. Epidemiological studies demonstrated that mechanical injury is a prerequisite for infection. Fruits inoculated without injury did not develop symptoms, emphasizing the importance of careful handling. The study highlights the economic significance of black mould rot and underscores the need for improved post-harvest handling and management strategies to reduce losses and enhance shelf life of pomegranate fruits.

Keywords: Pomegranate, black mould rot, *Aspergillus niger*, post-harvest disease, survey, pathogenicity, epidemiology

Introduction

Pomegranate (*Punica granatum* L.) is an important fruit crop cultivated extensively in tropical, subtropical, and arid regions of the world. Owing to its high nutritional value, therapeutic properties, and export potential, it has gained considerable commercial importance in India. However, post-harvest diseases significantly reduce marketable yield and cause substantial economic losses. Among these, fruit rot diseases are major constraints affecting both field and market quality of pomegranate fruits.

Several fungal pathogens are known to cause fruit rot in pomegranate. Reports indicate the occurrence of black heart rot, black rot, and black mould caused by *Aspergillus niger* under different nomenclatures (Kanwar and Thakur, 1972; Bilgrami *et al.*, 1979) [16, 17]. Despite these reports, systematic studies on the prevalence, severity, and epidemiology of post-harvest black mould fruit rot remain limited. A survey was conducted during November-December 2015 to March-April 2016 in major pomegranate-growing districts of Karnataka, namely Bengaluru, Tumkur, Shimoga, and Chitradurga, covering both field conditions and retail fruit markets. The survey revealed that pomegranate fruits were affected by black mould rot predominantly caused by *Aspergillus niger* and other related species. Disease incidence ranged from 10 to 20% in different retailers' shops across the surveyed markets, indicating considerable post-harvest losses. Epidemiological observations revealed that mechanical injury to fruits is a prerequisite for infection.

Fruits inoculated without injury failed to develop symptoms, whereas fruits subjected to cork-wounding, pin-pricking, scraping, and rubbing methods developed typical rot symptoms. Among these methods, cork-wounding proved to be the most efficient for pathogen establishment. The disease was observed in fruits inoculated at unripe, semi-ripe, and ripe stages; however, maximum severity occurred when fruits were inoculated at the ripe stage.

Although the survey clearly established the prevalence and epidemiological behavior of post-harvest black mould fruit rot in major pomegranate-growing districts, comprehensive studies on its management are lacking. Therefore, the present investigation was undertaken to assess the prevalence and severity of post-harvest black mould fruit rot of pomegranate in Bengaluru, Tumkur, Shimoga, and Chitradurga districts and to generate baseline information for developing effective disease management strategies.

Materials and Methods

Survey for the incidence of black mould rot in pomegranate was carried out in fruits markets of Bengaluru, Tumkur, Shimoga and Chitradurga. The mature and ripe fruit were transported by trucks and tractors. They are packed in corrugated fiber board boxes with cushioning materials. Their transportation usually takes one to more than a day. The fruits reach markets mostly at ripening stage. From markets, the fruits reach wholesalers and then the retailers within 1-10 hours. The period of disposal in shops is normally 2-4 days.

In order to know the incidence of fruit rot of pomegranate, four locations such as Bengaluru, Tumkur, Shimoga and Chitradurga were selected on the basis of number of retailers of pomegranate fruits. The survey was conducted at fortnightly intervals for six months from November to December 2015 to March to April 2016. (On each visit the rot incidence was recorded on the basis of number of fruits infected out of five samples, each of 100 fruits examined in each of the five shops. Fruits were selected at random at each of the four locations. Rotted fruits representing symptoms of black mould rot were collected at each visit

and brought to the laboratory for isolations and symptomatological studies).

Black mould fruit rot

Initially the skin color slightly faded out at the site of infection is slightly depressed. Later, the lesion becomes water soaked and gradually enlarges and coalesces to form bigger spots. The aril becomes soft and watery fluid. Spots covered Management of Post -harvest diseases of Pomegranate (*Punica granatum* L.) to improve the shelf life 23 by black spore masses. Finally, the fruit decays both externally and internally (Plate. 1).

Pure culture of pathogenic fungus showed well developed hyphae profusely branched, septate and hyaline. Culture was initially dirty white, soon changing to carbonaceous black; Mycelium produced abundant conidiophores, which were nonseptate, thick walled light brown near the vesicle, conidial head dark brown to carbonaceous black, globose upto 400-410 µm in diameter, large number of sterigmata present in chains. Conidia were globose, thick walled, light colored, measuring 2.5- 4 µm (Plate. 2).

Isolation and Purification of the fungus

For isolation of the fungus, small pieces of diseased pomegranate fruit were taken. They were surface sterilized (by dipping them 1:1000 mercuric chloride solution for 1-2 minute followed by three washings in sterilized water) and plated on 2% Potato Dextrose Agar (PDA) contained in Petri-dishes. These were incubated at 25 ± 1 °C in BOD incubators. Subcultures from uncontaminated peripheral growth were made on PDA slants. After sporulation, spore suspension was made in sterile water and dilution was adjusted that in one mixed with 25 ml of melted sterilized agar (0.2%) and poured in to sterilized Petri-dishes. After 12 hours of incubation in BOD incubators, the germinating spore was located under the microscope and transferred to PDA slants. This was subsequently allowed to grow and sporulate. Mono conidial culture was maintained by periodical transfer on PDA slant (Table 1).

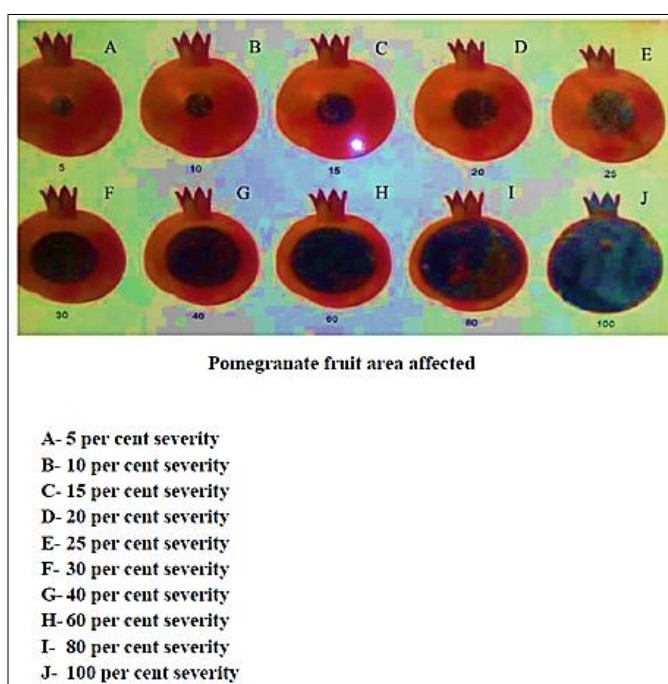


Plate 1: Pomegranate fruit area affected



Plate 2: Symptoms of black mould fruit rot of pomegranate caused by *Aspergillus niger*.

Identification of the fungus

Associated fungus was identified on the basis of their morphological and colony characters. The identity was further confirmed from the laboratory in the Department of plant pathology.

Pathogenicity

Mature and healthy pomegranate fruits were collected from different fruit markets were placed in brown paper bags and brought to the laboratory. These pomegranate fruits were stored at 25-28 °C for one day. For testing the pathogenicity of fungal isolates, ripe fruits of pomegranate were used. The fruits were surface sterilized by dipping them in mercuric chloride solution for 1 to 2 minutes followed by 3

washing with sterilized water and inoculated with the isolated fungus. A hole of 2 mm diameter and 2 mm depth was made with the help of sterilized cork borer. The inoculum was placed in the hole and the hole was plugged with the host tissue corked out earlier. The inoculums consisted of 2 mm diameter disc containing mycelium and spores of the fungus cut away from the periphery of 7 days old culture grown in Petri-dishes. The inoculated fruits were kept in new polythene bags which were moistened internally with sterilized water. The bagged fruits were 2016 Manjunath, S. N., M.Sc., Agri. (Horti.) 24 sealed and kept at 25 ± 1 °C in BOD incubator. The same procedure was followed for control treatment except the fruits were not inoculated.

Table 1: Fungi causing fruit rot in pomegranate

Sl. No.	Fungi	Name of fruit rot	References
1	<i>Aspergillus castaneus</i>	Distal end rot	Kheswalla (1936) ^[2]
2	<i>A. flavus</i>	Fruit rot	Srivastava (1971) ^[10]
3	<i>A. nidulans</i>	Core rot	Kanwar and Thakur (1973) ^[18]
4	<i>A. clavatus</i>	Black rot	Kanwar and Thakur (1973) ^[18]
5	<i>A. niger</i>	Black heart rot	Bilgrami et al. (1979) ^[17]
6	<i>A. niveus</i>	Fruit rot	Sharma et al. (1981) ^[9]
7	<i>A. versicolor</i>	Fruit rot	Sharma et al. (1981) ^[9]
8	<i>Alternaria alternata</i>	Fruit rot	Kanwar and Thakur (1973) ^[18]
9	<i>A. solani</i>	Black grain rot	Vyas and Panwar (1976) ^[14]
10	<i>A. solani</i>	Heart rot	Vyas and Panwar (1976) ^[14]
11	<i>Cladosporium oxysporum</i>	Fruit rot	Panwar and Vyas (1974) ^[7]
12	<i>Coniella granti</i>	Fruit rot	Nattrass (1932) ^[19]
13	<i>Nectriella personiana</i>	Fruit rot	Perisic (1940) ^[20]
14	<i>Penicillium expansum</i>	Penicillium rot	Srivastava et al. (1964) ^[11]
15	<i>Phoma sorghina</i>	Fruit rot	Patwardhan (1925)
16	<i>Phomopsis spp.</i>	Speckle rot	Mehta (1952) ^[21]
17	<i>Rhizoctonia solani</i>	Soft rot	Kanwar and Thakur (1972) ^[16]
18	<i>Rhizopus stolonifer</i>	Soft rot	Kanwar and Thakur (1972) ^[16]
19	<i>Sclerotium spp.</i>	Fruit rot	Kanwar and Thakur (1972) ^[16]
20	<i>Spicaria spp.</i>	Spicaria rot	Kanwar and Thakur (1972) ^[16]

Results

Pomegranate has high commercial value and also hike in market price depends on season. After harvesting, fruits suffer from huge loss occurs during transportation and storage. Black mould fruit rot is an important post-harvest disease of pomegranate. The loss is upto 10-20%. Hence, surveyed incidence of black mould fruit rot in pomegranate of four districts fruits markets from November- December 2015 to April-May 2016 and results are presented herewith.

Occurrence and incidence of the disease

Fortnightly survey was carried out for the incidence of black mould rot of pomegranate in Bengaluru, Tumkuru, Shimoga and Chitradurga fruits markets conducted during November-December 2015 to March-April 2016 revealed that the highest incidence (12.5%) of the rotting of fruits was found during April, 2016, whereas lowest incidence (4.3%) was found during January 2016 and average incidence of black mould fruit rot was 8.05% black mould rot was encountered

on every visit, but its incidence fluctuated during the survey period. (Table 2)

Pathogenecity and identity of the incidents

The surface sterilized ripe fruits inoculated separately with isolated incitants (*Aspergillus niger*) showed symptoms of the rot on 6th day of inoculation, Un-inoculated fruits

remained healthy upto the 6th day of inoculation. The symptoms observed in each inoculated fruits with separate incitants were similar to those seen in naturally infected fruits. Re-isolation from infected areas of inoculated fruits in each rot yielded the same culture which was identical to one used for inoculation of the fruits.

Table 2: Incidence of black mould fruit rot in pomegranate of four districts fruits markets surveyed from November- December 2015 to April-May 2016

Date of survey	Per cent disease incidence of black mould fruit rot on pomegranate in various fruit markets				
	Bengaluru	Tumkuru	Shimoga	Chitradurga	Treatment mean
16/11/2015	8.3	9.0	8.4	9.6	8.82
02/12/2015	7.5	8.4	6.5	9.2	7.9
16/12/2015	5.6	7.8	6.8	6.6	6.7
02/01/2016	4.2	5.0	5.5	6.5	5.3
16/01/2016	3.5	4.0	4.5	5.2	4.3
02/02/2016	5.4	6.0	6.2	7.0	6.15
16/02/2016	5.9	7.0	8.7	9.5	7.77
02/03/2016	8.0	9.5	9.0	9.6	9.08
16/03/2016	8.1	8.0	10.2	10.0	9.07
02/04/2016	10.4	10.4	11.5	12.0	11.07
16/04/2016	13.5	11.5	12.0	13.0	12.5
Mean over locations	7.30	7.87	8.11	8.92	8.05
SEM = 0.4884					
CD=2.74					
CV=12.42					
*Average based on 4 retailers/fruits markets.					

Discussion

The fortnightly survey conducted in Bengaluru, Tumkuru, Shimoga, and Chitradurga fruit markets from November-December 2015 to March-April 2016 revealed clear monthly variation in the incidence of black mould rot of pomegranate. The highest incidence (12.48%) was recorded during April 2016, while the lowest incidence (4.44%) was observed in January 2016. This variation may be attributed to changes in environmental factors such as temperature and relative humidity, which are known to influence fungal growth and sporulation. Additionally, inoculum density, physiological maturity of fruits, harvesting practices, handling methods, and the presence of nutritive substrates on the fruit surface could have contributed to fluctuations in disease incidence during the survey period. Injury to fruits plays a critical role in the development of post-harvest rots. Previous studies have reported that mechanical damage facilitates infection by various fruit rot pathogens (Pathak, 1980; Whiteside, 1982; Khatri and Godara, 1999; McDonald *et al.*, 1985) [8, 15, 1, 3]. The present investigation corroborates these findings, as black mould rot developed only in injured pomegranate fruits, whereas uninjured fruits did not exhibit infection. This indicates that wounds serve as primary entry points for *Aspergillus niger*, enabling colonization and disease establishment. The results highlight the importance of minimizing mechanical injury during harvesting, grading, packing, transport, and storage to reduce disease incidence. Careful handling practices have also been recommended for controlling black mould rot of citrus caused by *Aspergillus niger* (Khatri and Godara, 1999) [1]. Therefore, adoption of improved post-harvest handling and sanitation measures could significantly reduce black mould rot incidence in pomegranate and enhance fruit shelf life and marketability.

Conclusion

The fortnightly survey conducted in major fruit markets of Bengaluru, Tumkuru, Shimoga, and Chitradurga from November-December 2015 to March-April 2016 confirmed the consistent prevalence of black mould rot of pomegranate throughout the study period. The disease incidence varied seasonally, reaching a maximum of 12.48% in April and a minimum of 4.44% in January 2016, indicating the influence of environmental conditions on disease development.

The findings demonstrate that post-harvest black mould rot poses a significant threat to the market quality and economic returns of pomegranate, a high-value commercial fruit crop. Since the disease persists across months and contributes to measurable losses, timely adoption of appropriate post-harvest handling, storage, and disease management practices is essential. Implementation of suitable preventive measures can help minimize post-harvest losses, enhance shelf life, and improve the market value of pomegranate fruits.

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