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Status of pre and post-harvest fungal diseases of pomegranate in major growing regions of Karnataka

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Abstract
Pomegranate (*Punica granatum* L.) is one of the oldest and most economically important fruit crop valued for its nutritional richness, medicinal properties and increasing global market demand. However, its production and marketability are severely constrained by several pre and post-harvest fungal diseases, which cause significant losses in fruit yield, quality and shelf life. To assess the status of fungal diseases in major pomegranate growing regions of Karnataka, an intensive field and market survey was conducted in Vijayapura, Ballari, Bagalkote, Chitradurga, Tumakuru, Raichur and Koppal districts. Fungal diseases were recorded in all the surveyed locations. Among field survey, overall disease incidence ranged from 17.50 to 46.06 per cent, with the maximum incidence at Sevalalnagar (46.06 %) of Chitradurga district and the minimum at Sira (17.50 %) of Tumakuru district. Ballari recorded the maximum district mean incidence (43.82 %), whereas Tumakuru recorded the minimum (18.75 %). Anthracnose was the most widely distributed disease, occurring in all 19 surveyed villages, with incidence ranging from 10.98 to 38.46 per cent. *Alternaria* and *Coniella* fruit rots were recorded in 10 villages each, while *Aspergillus* fruit rot was observed in two villages. In market samples, overall post-harvest disease incidence ranged from 22.05 to 34.98 per cent, with the maximum incidence in Bagalkote (34.98 %) and the minimum in Vijayapura (22.05 %). Among the individual diseases, *Aspergillus* fruit rot recorded the maximum incidence of 17.85 per cent in Bagalkote, while *Penicillium* fruit rot reached 14.28 per cent in Koppal.

Keywords: Field, fungal diseases, market, pomegranate, survey

Introduction
Pomegranate (*Punica granatum* L.), belonging to the family Lythraceae, is an economically important fruit crop widely cultivated in tropical and subtropical regions of the world. It is believed to have originated in Iran and subsequently spread to the Mediterranean region and other parts of the world. Owing to its refreshing taste, nutritional and medicinal properties, pomegranate is popularly known as the “Fruit of Paradise”. The fruits are consumed fresh and processed into juice, concentrates, syrups, jellies and other value-added products, contributing significantly to domestic and international trade (Prasad *et al*., 2003 [5]; Anaida *et al*., 2018) [1].

India is one of the major producers and exporter of pomegranate, with Maharashtra, Karnataka, Gujarat, Andhra Pradesh and Telangana being the principal growing states. In Karnataka, the crop is predominantly cultivated in Chitradurga, Vijayapura, Tumakuru, Dharwad, Bagalkote, Raichur and Koppal districts. Commercial varieties include Ganesh, Mridula, Arakta and Bhagwa. Its drought tolerance, wider adaptability, good keeping quality and remunerative market prices have encouraged its cultivation (Sheikh, 2006) [6]. According to APEDA, India exported 72,011 metric tonnes of pomegranate valued at US$ 69.08 million during 2023–24, highlighting its importance in the horticultural export sector.

Despite its economic importance, pomegranate production and fruit quality are affected by several fungal diseases occurring during pre and post-harvest stages. Important fungal pathogens associated with pomegranate include *Colletotrichum* spp., *Alternaria* spp., *Coniella granati*, *Aspergillus* spp., *Penicillium* spp., *Botrytis cinerea* and *Fusarium* spp. These pathogens cause symptoms such as brown to black lesions, sunken spots, internal discoloration, softening, fruit rot and mummification. Pre-harvest infections may remain latent until fruit maturity, whereas post-harvest infections develop during harvesting, handling, transportation, storage and marketing, resulting in considerable deterioration and economic losses (Munhuweyi *et al*., 2016) [3].

Although Karnataka is an important pomegranate producing state, variations in the occurrence and distribution of fungal diseases across growing regions and marketing centres necessitate regular monitoring. Therefore, the present investigation was undertaken to assess the status, occurrence and incidence of major pre and post-harvest fungal diseases of pomegranate in important growing districts and markets of Karnataka, identify predominant diseases and determine their distribution across different locations.

Material and Methods
An intensive roving survey was carried out to assess the incidence of pre and post-harvest fungal diseases of pomegranate fruit in the districts of Karnataka *viz*., Koppal, Raichur, Bagalkote, Chitradurga, Tumakuru, Ballari and Vijayapura. Two pomegranate fields were selected from

each village and fungal disease incidence was recorded. The market survey in the districts of Koppal, Raichur, Bagalkote, Ballari and Vijayapura was also conducted and disease incidence was calculated.

The percentage of disease incidence in both field and market samples was calculated using the formula described by Wheeler (1969) [7].

$$\text{Per cent disease incidence} = \frac{\text{Number of infected fruits}}{\text{Total number of fruits observed}} \times 100$$

The incidence of individual fungal diseases was recorded separately to determine their distribution and prevalence across the surveyed locations. The observations were compiled and compared at village, taluk and district level to assess the status and distribution of pre- and post-harvest fungal diseases of pomegranate in major growing regions of Karnataka.

Results and Discussion

A roving survey was conducted in major pomegranate growing districts of Karnataka, *viz*., Koppal, Raichur, Bagalkote, Chitradurga, Tumakuru, Ballari and Vijayapura, to assess the occurrence and incidence of fungal diseases under field conditions. The surveyed orchards were predominantly cultivated with the Bhagwa variety, with crop ages ranging from two to ten years. Five major fungal diseases, namely anthracnose, *Alternaria* fruit rot, *Coniella* fruit rot, *Aspergillus* fruit rot and *Penicillium* fruit rot, were recorded across the surveyed locations.

The overall incidence of fungal diseases varied considerably among the surveyed villages, ranging from 17.50 to 46.06 per cent (Table 1). The maximum disease incidence was recorded at Sevalalnagar village of Chitradurga district (46.06 %), followed by Orvai (45.10 %) and Amarapura (45.06 %) villages of Ballari district. The minimum incidence was observed at Sira village of Tumakuru district (17.50 %). At the taluk level, mean disease incidence ranged from 18.75 to 45.06 per cent, with the maximum incidence in Ballari taluk (45.06%), followed by Kurugodu taluk (42.56 %) of Ballari district. The minimum incidence was recorded in Sira taluk of Tumakuru district (18.75 %). Among the districts, Ballari recorded the maximum mean disease incidence (43.82 %), followed by Bagalkote (39.48 %), whereas Tumakuru recorded the minimum incidence (18.75 %).

Among the fungal diseases recorded, anthracnose was widely distributed across all 19 surveyed villages, with incidence ranging from 10.98 to 38.46 per cent. The maximum incidence was observed at Ukkali village of Vijayapura district (38.46 %), followed by Sevalalnagar of Chitradurga district (29.77 %). The minimum incidence was recorded at Neerloti village of Koppal district (10.98 %). *Alternaria* fruit rot was recorded in 10 out of 19 villages, with incidence ranging from 7.36 to 16.29 per cent. The maximum incidence was observed at Sevalalnagar (16.29 %), followed by Orvai (16.17 %), while the minimum was recorded at Mustigarahally village of Tumakuru district (7.36 %).

Similarly, *Coniella* fruit rot was recorded in 10 villages, with incidence ranging from 5.39 to 18.77 per cent. Amarapura village of Ballari district recorded the maximum incidence (18.77 %), followed by Sreenivasapuram camp (16.21 %), whereas Kanakapura village of Koppal district recorded the minimum incidence (5.39 %). *Aspergillus* fruit rot occurred at relatively lower levels and was detected in only two villages. The incidence ranged from 3.03 to 7.14 per cent, with the maximum at Neerloti village of Koppal district (7.14 %) and the minimum at Manguli village of Vijayapura district (3.03 %).

A separate survey was conducted in major pomegranate markets to assess the incidence of post-harvest fungal diseases (Table 2). The overall incidence of fungal diseases in market samples ranged from 22.05 to 34.98 per cent. The maximum incidence was recorded in Bagalkote market (34.98 %), followed by Koppal (34.27 %) and Ballari (32.13 %), while Vijayapura market recorded the minimum incidence (22.05 %).

Among the individual diseases, *Alternaria* fruit rot incidence ranged from 6.42 to 14.40 per cent, with the maximum recorded in Raichur market (14.40 %). Anthracnose incidence varied from 7.14 to 10.71 per cent, with the maximum incidence in Bagalkote market (10.71 %). *Coniella* fruit rot was recorded only in Ballari market, with an incidence of 14.28 per cent. *Aspergillus* fruit rot ranged from 8.00 to 17.85 per cent, reaching its maximum in Bagalkote market (17.85 %). *Penicillium* fruit rot was also detected in market samples, with incidence ranging from 5.51 to 14.28 per cent, the maximum being recorded in Koppal market (14.28 %).

The district-wise frequency of individual fungal diseases also showed considerable variation (Table 3). Anthracnose recorded the maximum frequency in Chitradurga district (28.53 %), followed by Bagalkote (19.05 %), whereas the minimum frequency was observed in Koppal district (11.08 %). *Coniella* fruit rot was most frequent in Ballari (13.86 %), followed by Vijayapura (10.58 %). The maximum frequency of *Aspergillus* fruit rot was recorded in Bagalkote (17.85 %), followed by Ballari (10.71 %). *Penicillium* fruit rot was recorded in Koppal (14.28 %) and Vijayapura (5.51 %). In contrast, *Alternaria* fruit rot was most frequent in Raichur (12.53 %), followed by Bagalkote (9.26 %), with the minimum frequency in Vijayapura (2.58 %). Considering the overall incidence reported in Table 3, Koppal recorded the maximum value (46.64 %), followed by Bagalkote (46.16 %) and Ballari (45.36 %), while Tumakuru recorded the minimum incidence (18.75 %).

The observed variation in fungal disease incidence among the surveyed districts could be attributed to differences in environmental conditions, crop age, orchard management practices, fruit maturity and the availability of pathogen inoculum. The widespread occurrence of anthracnose indicates the importance of *Colletotrichum* spp. as a major pathogen associated with pomegranate fruit diseases in Karnataka. Its predominance may be associated with favourable temperature and moisture conditions, infection during fruit development and the ability of the pathogen to establish latent infections.

The present findings are in agreement with Benagi *et al*. (2011) [2], who reported anthracnose incidence of 15–25 per

cent, *Alternaria* disease incidence of 2–15 per cent and fruit rot incidence of 5–15 per cent in major pomegranate-growing regions of Northern Karnataka. Similarly, Nargund *et al*. (2012) [4] identified *C. gloeosporioides* as an important pathogen causing anthracnose in pomegranate, contributing to fruit decay and quality deterioration. The association of *Alternaria*, *Aspergillus*, *Penicillium* and *Coniella* with pomegranate fruit rot observed in the present investigation is also supported by Munhuweyi *et al*. (2016) [3], who reported *A. alternata*, *A.* niger, *Penicillium* spp. and *C.* granati among the important fungal pathogens associated with pomegranate fruit diseases and post-harvest losses. Overall, the survey established the widespread occurrence of multiple fungal pathogens associated with pomegranate fruits in Karnataka, with considerable variation in their distribution and incidence across locations.

Table 1: Status of fungal diseases of pomegranate fruit in fields across different districts of Karnataka

Sl. No.	District	Taluk	Village	Variety	Crop age (Year)	Pre-harvest disease incidence (%)	Frequency (%)			
							Anthracnose	*Alternaria* fruit rot	*Coniella* fruit rot	*Aspergillus* fruit rot
1	Koppal	Kushtagi	Shakapur	Bhagwa	2	40.09	24.47	0.00	15.62	0.00
		Taluk mean				40.09	24.47		15.62	
		Koppal	Budihal	Bhagwa	2	30.29	16.66	13.63	0.00	0.00
		Taluk mean				30.29	16.66	13.63		
		Yalburga	Hirearalahalli	Bhagwa	3	33.33	21.11	0.00	12.22	0.00
		Taluk mean				33.33	21.11		12.22	
		Gangavathi	Kanakapura	Bhagwa	4	18.62	13.23	0.00	5.39	0.00
			Neerloti	Bhagwa	2	29.65	10.98	11.53	0.00	7.14
		Taluk mean				24.14	12.10	5.77	2.70	3.57
		District mean				31.97	18.58	4.85	7.64	0.90
2	Raichur	Lingasugur	Lingasugur rural	Bhagwa	8	40.40	17.12	12.32	10.96	0.00
			Adavibhavi	Jain	5	20.52	13.10	2.58	7.42	0.00
		Taluk mean				30.46	15.11	6.16	9.19	
		Raichur	Turkandona	Bhagwa	10	27.51	12.92	8.98	5.61	0.00
		Taluk mean				27.51	12.92	8.98	5.61	
		District mean				32.06	14.01	10.65	7.40	
3	Bagalkote	Bagalkote	Murnala	Bhagwa	5	39.48	27.38	12.10	0.00	0.00
		Taluk mean				39.48	27.38	12.10		
		District mean				39.48	27.38	12.10		
4	Chitradurga	Hiriyur	Hiriyur	Bhagwa	6	28.42	28.42	0.00	0.00	0.00
			Sevalalnagar	Bhagwa	5	46.06	29.77	16.29	0.00	0.00
		Taluk mean				37.24	29.09	8.15		
		Challakere	Kaluvehalli	Bhagwa	6	27.96	27.96	0.00	0.00	0.00
		Taluk mean				27.96	27.96			
		District mean				32.61	28.53	4.08		
5	Tumakuru	Sira	Mustigarahally	Bhagwa	5	19.99	12.63	7.36	0.00	0.00
			Sira	Bhagwa	5	17.50	17.50	0.00	0.00	0.00
		Taluk mean				18.75	15.06	3.68		
		District mean				18.75	15.06	3.68		
6	Ballari	Ballari	Amarapura	Bhagwa	4	45.06	26.29	0.00	18.77	0.00
		Taluk mean				45.06	26.29		18.77	
		Kurugodu	Orvai	Bhagwa	3	45.10	28.93	16.17	0.00	0.00
			Sreenivasapuram camp	Bhagwa	5	39.99	23.78	0.00	16.21	0.00
		Taluk mean				42.56	26.36	8.09	8.11	
		District mean				43.82	26.33	4.05	13.44	
7	Vijayapura	Basavana Bagewadi	Manguli	Ganesh	4	37.49	16.96	10.30	7.20	3.03
			Ukkali	Bhagwa	6	38.46	38.46	0.00	0.00	0.00
		Taluk mean				37.98	27.71	5.15	3.60	1.52
		Vijayapura	Kumatagi	Bhagwa	7	31.34	21.18	0.00	10.16	0.00
		Taluk mean				31.34	21.18		10.16	
		District mean				34.66	24.45	2.58	6.88	0.76

Table 2: Status of fungal diseases of pomegranate fruit in markets across different districts of Karnataka

Sl. No.	District	Variety	Post-harvest disease incidence (%)	Frequency (%)				
				Anthracnose	*Alternaria* fruit rot	*Coniella* fruit rot	*Aspergillus* fruit rot	*Penicillium* fruit rot
1	Koppal	Bhagwa	34.27	8.57	0.00	0.00	11.42	14.28
2	Raichur	Bhagwa	22.40	0.00	14.40	0.00	8.00	0.00
3	Bagalkote	Bhagwa	34.98	10.71	6.42	0.00	17.85	0.00
4	Vijayapura	Bhagwa	22.05	8.27	0.00	0.00	8.27	5.51
5	Ballari	Bhagwa	32.13	7.14	0.00	14.28	10.71	0.00

Table 3: Frequency of fungal diseases of pomegranate fruits across different districts of Karnataka

Sl. No.	District	Fruit rot disease incidence (%)	Frequency (%)				
			Anthracnose	*Alternaria* fruit rot	*Coniella* fruit rot	*Aspergillus* fruit rot	*Penicillium* fruit rot
1	Koppal	46.64	11.08	4.85	7.64	8.79	14.28
2	Raichur	41.94	14.01	12.53	7.40	8.00	0.00
3	Bagalkote	46.16	19.05	9.26	0.00	17.85	0.00
4	Chitradurga	32.61	28.53	4.08	0.00	0.00	0.00
5	Tumakuru	18.75	15.06	3.68	0.00	0.00	0.00
6	Ballari	45.36	16.74	4.05	13.86	10.71	0.00
7	Vijayapura	39.55	16.36	2.58	10.58	4.52	5.51

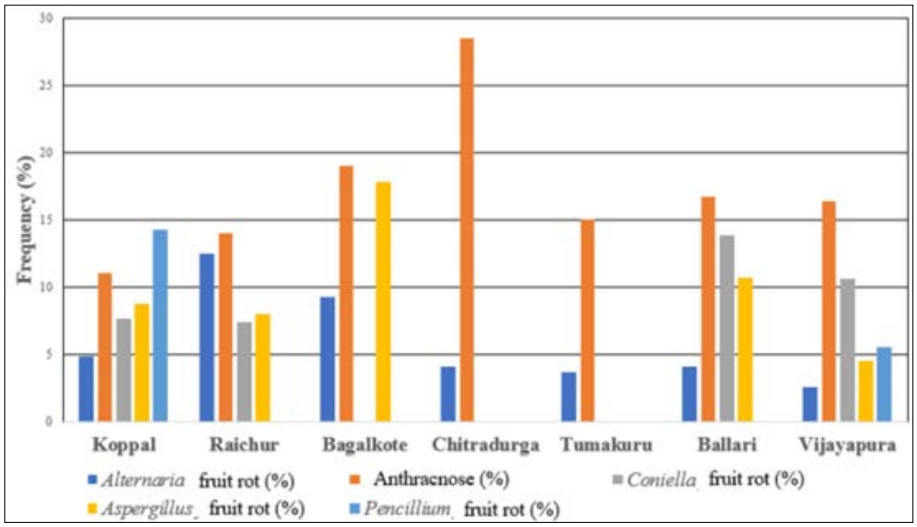


Fig 1: Frequency of fungal diseases of pomegranate fruits in different districts of Karnataka





A. Turkandona B. Hiriyur C. Sreenivasapuram camp D. Adavibhavi E. Sira F. Mustigarahally

Plate 1: Intensity of pre-harvest pomegranate fruit diseases in surveyed fields



Koppal Vijayapura Ballari

Plate 2: Post-harvest diseases of pomegranate fruits observed in surveyed markets

Conclusion

The present study revealed the widespread occurrence of pre and post-harvest fungal diseases in major pomegranate growing regions of Karnataka. Field disease incidence ranged from 17.50 to 46.06 per cent, with the maximum incidence at Sevalalnagar (46.06 %) and the minimum at Sira (17.50 %). Ballari recorded the maximum district mean incidence (43.82%), while Tumakuru recorded the minimum (18.75 %). Anthracnose was the predominant field disease, followed by fruit rots caused by *Alternaria*, *Coniella*, *Aspergillus* and *Penicillium* species. In markets, post-harvest disease incidence ranged from 22.05 to 34.98 per cent, with the maximum incidence in Bagalkote (34.98 %) and the minimum in Vijayapura (22.05%). The findings highlight the importance of appropriate orchard management, hygienic harvesting and handling and proper storage practices to reduce fungal losses. Regular disease surveillance and integrated management strategies are essential to minimize pre and post-harvest losses and maintain the quality and marketability of pomegranate fruits.

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