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Survey for the post-harvest diseases of onion with special reference to black mould in Chikkamagaluru, Chitradurga and Davanagere districts of Karnataka

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Abstract
Onion (*Allium cepa* L.) is one of India's most valuable vegetable crops and is grown for domestic and export purposes, as well as a valued commodity for consumption, both medicinal and commercial. Some post-harvest diseases deteriorate the quality and quantity of the onion crop. Among many post-diseases black mould, basal rot, green mould and soft rot are the most important. A roving survey was carried out during 2019-2020 in the vegetable markets (APMC Markets) and in onion growing villages of Chikkamagaluru, Chitradurga and Davanagere districts of Karnataka to know the severity of onion post-harvest diseases. The per cent disease index was recorded using 0-5 scale. The maximum per cent disease index of black mould (10.10 %) was recorded in the farmer's fields of Chitradurga district and the least severity (8.90 %) was noticed in the farmer's fields of Chikkamagaluru district. In case of APMC markets, the maximum disease severity of black mould (56.00 %) was recorded in Davanagere district followed by Chitradurga (35.00 %) and the least severity (25.50 %) was noticed in Chikkamagaluru district. Compared to onion field, disease severity is more in APMC markets.

Keywords: APMC markets, basal rot, black mould, green mould, post-harvest diseases, per cent disease index, soft rot

Introduction
Onion (*Allium cepa* L.) a bulbous, biennial herb, is one of the most important commercial vegetable crop grown in India. Popularly it is also called a "poor man's Kasturi". It belongs to the family Alliaceae and genus *Allium* with approximately three hundred species (Thompson and Kelly, 1979) [9]. The onion originates from the area comprising of North-West India, Afghanistan, the Soviet Republics of Tajik and Uzbek and Western Tien Shan. The Mediterranean Sea is the secondary centers of origin (Choudhary, 1983) [2].

India is the second-largest producer of onion within the global, after China, accounting for 16 per cent of the world area, the total area under onion cultivation is 1219.53 thousand hectares with a production of 22819.42 thousand metric tonnes. The notable onion growing states in the country are Maharashtra, Madhya Pradesh, Karnataka, Gujarat, Bihar, Rajasthan, Andhra Pradesh, Haryana, West Bengal, and Uttar Pradesh. These states account for nearly 90 per cent of the full onion production of the country. In Karnataka onion growing area is about 166.00 thousand hectares with a production of 2558.00 thousand metric tonnes. The most important onion growing districts are Chitradurga, Bagalkot, Koppal, Bellary, Dharwad, Belgaum, Chikkamagaluru and Bijapur (Anon., 2018).

According to the American Phytopathological Society (APS) onion crop in field suffers from twenty fungal, eight bacterial, one viral, one phytoplasmal, six nematodes and four other different diseases.

Major post-harvest diseases which affect onion are Black mould (*Aspergillus Niger* van Tiegh.), Basal rot (*Fusarium oxysporium* Schlect.), Blue mould (*Penicillium digitatum* Sac.), Neck rot (*Botrytis alli* Munn.), White rot (*Sclerotium cepivorum* Berk.), Smut (*Urocystis cepulae* Frost.), Smudge (*Colletotrichum circinans* Berk.), Green mould (*Aspergillus flavus* Link.) and Soft rot (*Erwinia carotovora* subsp. *carotovora* Bergey.). Among the post-harvest diseases of onion, black mould caused by *Aspergillus Niger* was the predominant one and cause 80 per cent spoilage. Therefore, a survey was conducted to record the per cent disease index of post-harvest diseases especially black mould.

Material and Methods
An intensive roving survey was carried out during 2019-2020 in the vegetable markets (APMC Markets) and in onion growing villages of Chikkamagaluru, Chitradurga and Davanagere districts of Karnataka to know the severity of onion post-harvest diseases. In eachdistrict, two taluks were selected, in each taluk one APMC market and five villages were selected and in each village two farmers field were surveyed. Infield, plants were selected and in APMC markets bulbs were chosen in a zigzag manner on an average of ten in number and in each location the severity of post-harvest diseases of onion was recorded by using disease rating scales (0-5 scale) given by Mayee and Datar, (1986) [10] and depicted in Plate 1.

Table 1

Grade	Per cent bulb area infected
0	No infection
1	1 to10per cent infection
2	11 to 25per cent infection
3	26 to 50per cent infection
4	51 to 75per cent infection
5	>75per cent infection

Further, these scales were converted into per cent disease index (PDI) using the formula given by Wheeler (1969).

$$\text{Per cent disease index} = \frac{\text{Sum of individual disease rating}}{\text{Number of bulbs examined} \times \text{Maximum disease grade}} \times 100$$

Plate 1: Onion bulb infected with *A. niger*showing various degree of black mould infection (0-5)

Results and Discussion

The data from the survey revealed that the severity of black mould disease ranged from 4.00 percent to 16.00 per cent in various farmers' fields. Maximum disease severity of black mould (16.00 %) was recorded in D. S. Halli village of Chitradurga taluk (Chitradurga district) followed by Yarehalli (14.00 %) village of Kadur taluk (Chikkamagaluru district). Least disease severity (4.00 %) was observed in Ballikere village of Kadur taluk (Chikkamagaluru district) symptoms are depicted in plate 2.

In Chikkamagaluru district, highest disease severity of black mould was recorded in Yarehalli village (14.00%), while that of least disease severity was noticed from Ballikere village (4.00 %) of Kadurtaluk. While in Ajjampura taluk maximum disease severity was found in Gowrapura village (12.00 %) and minimum disease severity was noticed in Mallenahalli village (6.00 %) and data presented in Table 1a.

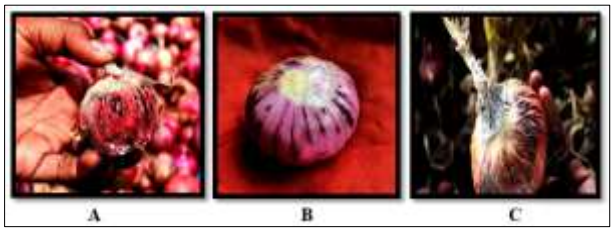

Plate 2: Symptomatology of Black Mould A) Black powdery masses of spores on scalesB) Black streaks radiating from the base or the top of the bulb C) Dry and Papery scale

In Chitradurga district, maximum disease severity of black mould was noticed in D. S. Halli (14.00%), while the least disease severity was recorded in Belagatta (6.00%) village of Chitradurga taluk. While in Hiriyur taluk maximum disease severity was observed in maskalvillage (12.00%) and minimum disease severity was found in Babbur village (6.00%) and data presented in Table 1b.

Other postharvest diseases like green mould and *Fusarium* basal rot were also observed. Among the field surveyed the highest per cent disease severity of green mould was observed in Chillahalli (7.00%) followed by Belaghatta (5.00%), kunchiganaha (4.00%) and Krishnarajapura (4.00%), which remains unnoticed in other villages. Similarly, the maximum disease severity of *Fusarium* basal rot was recorded in Ingluranahalli (8.00%) village, while that of least disease severity was noticed from Sokke village (2.00%) and their symptoms were depicted in plate 3 and 4, respectively.

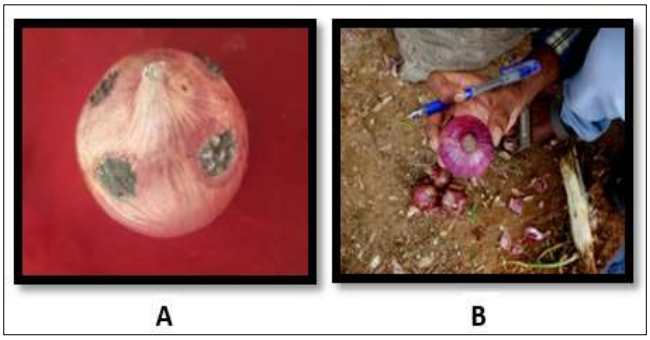

Plate 3: Symptomatology of Green Mould A) Green powdery masses of spores present on bulb B) Powdery green spores arranged as streak along the veins

Plate 4: Symptomatology of *Fusarium* Basal Rot A) drying and Drooping of leaves B) Whitish mouldy growth at base of the bulb

In the case of APMC markets, per cent, disease severity of black mould was ranged from 18.00 to 60.00 per cent. Maximum disease severity (60.00%) was recorded in Harihara APMC market, whereas least disease severity was noticed in Ajjampura APMC market (18.00%). Similarly, the highest disease severity of green mould was observed in Davanagere APMC market (12.00%). In comparison, that of least disease severity was noticed from Kadur APMC market (3.00%). In contrast, the maximum disease severity of soft rot was found in kadur APMC market (10.00%), least disease severity was observed in Hiriyur APMC market (2.00%) and data presented in the Table 1c and symptom of soft rot was depicted in plate 5.

Plate 5: Symptomatology of Soft Rot A) Softening of tissues B1 and B_2) Rotting of scales

Among the districts surveyed, the mean maximum severity of black mould disease (10.10%) was reported in the farmer's fields of Chitradurga district and the mean least severity (8.90%) was found in the Chikkamagaluru district farmer's fields. In case of APMC markets, the mean maximum disease severity of black mould (56.00%) was recorded in Davanagere district followed by Chitradurga (35.00%) and the mean least severity (25.50%) was noticed in Chikkamagaluru district and results were presented in Table 1d. From the table, we can say that disease severity is more in APMC markets than in fields

Sudarshan Rao (1975) [7] claimed that survey and monitoring are the basis for any effective plant defence that depends on early identification of the disease followed by the timely implementation of controls. Hence, in the present investigation, a roving survey was undertaken in major onion growing areas and also in APMC markets of Chikkamagaluru, Chitradurga and Davanagere districts of Karnataka to assess the severity of post-harvest diseases especially black mould of onion.

From the results of the survey, it was observed that onion bulbs were more vulnerable to the attack by pathogens and it was evidenced by more disease severity on bulbs, irrespective of location and variety. In general, the occurrence and severity of the disease in different agro-climatic zones and varieties vary from season to season, which may be due to differences in the pathogen, host varieties or climatic conditions. Rao and Rajasaheb (1992) [6] found in their survey that the incidence of disease within the storehouse was higher (14.00 % - 23.00 %) compared to disease incidence on onion bulbs in the field (4.00 % - 12.00 %). It seems that environmental conditions particularly rainfall, temperature and humidity influence the disease incidence and severity. Soil texture and water table also affect the growth and development of black mould on an onion. Srinivasan *et al.* (2002) [5] showed that black mould rot of onion was predominant during storage and caused the loss of 2.90 per cent to 12.09 per cent from June to February. He reported that onion bulbs, being perishable, contain about 86.8 per cent of moisture that form an ideal medium for proliferation of many post-harvest diseases causing fungi. Raju and Naik (2007) [4] in their survey and assessment recorded the maximum PDI of black mould in June-2004 (16.20 %). They revealed that which could be due to optimum temperature (36.80 ºC) with variation in relative humidity (32-78 %). Khatoon *et al.* (2017) [3] reported that Bhubaneswar locality of Odisha had with favourable environmental conditions showed maximum PDI of black mould disease on onion bulb.

Table 1a: Survey for post-harvest diseases of onion in Chikkamagaluru district during the year 2019-20

Sl. No	District	Taluk	Villages	Cultivar	GPS Co-ordinates	Soil type	Per cent disease severity		
							BM*	FBR**	GM***
1	Chikkamagaluru	Ajjampura	Beguru	Mahalaxmi	13.73630/76.89649	Black soil	7.00	-	
			Gondenahalli	Local	13.70965/75.97505	Black soil	11.00	4.00	
			Gowrapura	Neembekar	13.72787/76.01635	Black soil	12.00	5.00	
			Mallenahalli	Local	13.70985/76.00141	Black soil	6.00	--	
			Sokke	Laxmi	13.71563/75.95012	Black soil	8.00	2.00	
			Mean				8.80	2.20	
		Kadur	Ballekere	Rhona	13.48852/76.03733	Black soil	4.00	--	
			Channapura	Local	13.69321/75.99820	Black soil	10.00	3.00	
			Ingluranahalli	Laxmi	13.62999/75.97359	Black soil	12.00	8.00	
			Pattanagere	Local	13.53444/75.99061	Black soil	5.00	-	
			Yarehalli	Mahalaxmi	13.64201/75.98162	Black soil	14.00	3.00	
			Mean				9.00	2.80	
			Total mean				8.90	2.50	

*BM - Black mould, FBR** - fusarium basal rot, GM*** - Green mould

Table 1b: Survey for post-harvest diseases of onion in Chitradurga district during the year 2019-20

SL. No.	District	Taluk	Villages	Cultivar	GPS Co-ordinates	Soil type	Per cent disease severity		
							BM*	FBR**	GM***
2	Chitradurga	Chitradurga	Belagatta	Local	13.85324/76.48936	Red soil	6.00	3.00	5.00
			D.S.Halli	Local	14.19156/76.47399	Black soil	16.00	4.00	-
			Ingaladalu	Local	14.17334/76.46805	Black soil	8.00	5.00	-
			kunjigenalu	Prem	14.22833/76.39877	Red soil	10.00	-	4.00
			kyadigere	Local	14.17212/76.47140	Red soil	13.00	-	-
			Mean				**10.60**	**2.40**	**1.80**
		Hiriyur	Babbur	Local	13.96013/76.64808	Black soil	12.00	-	-
			Chillahalli	Sataragarva	14.03807/76.76149	Black soil	8.00	4.00	7.00
			Devarakotta	Local	14.01913/76.72783	Black soil	10.00	3.00	-
			Krishnarajapura	Sataragarva	13.96758/76.65242	Black soil	11.00	5.00	4.00
			Maskal	Local	13.98283/76.67432	Black soil	7.00	6.00	-
			Mean				**9.60**	**3.60**	**2.20**
			Total mean				**10.10**	**3.00**	**2.00**

*BM - Black mould, FBR** - fusarium basal rot, GM*** - Green mould

Table 1c: Severity of post-harvest diseases of onion in different APMC markets

Sl. No.	Name of the District	Name of APMC markets	Name of the cultivar	GPS Co-ordinates	Per cent Disease Severity		
					BM*	GM**	SR***
1.	Chikkamagaluru	Ajjampur	Mahalaxmi	13.720953/75.997012	18.00	6.00	8.00
		Kadur	Rhona	13.54626/76.021814	33.00	3.00	10.00
		Mean			25.50	4.50	9.00
2.	Chitradurga	Chitradurga	Nasik red	14.229937/76.395023	42.00	8.00	6.00
		Hiriyur	Sataragarva	13.958628/76.621268	28.00	4.00	2.00
		Mean			35.00	6.00	4.00
3.	Davanagere	Davanagere	Nasik red	14.463404/75.928263	52.00	12.00	6.00
		Harihara	Nasik red	14.500705/75.802513	60.00	10.00	4.00
		Mean			56.00	11.00	5.00

*BM - Black mould, GM** - Green mould, SR***- Soft rot

Table 1d: District mean severity of post-harvest diseases of onion in different fields and APMC markets

Sl. No.	District	Per cent Disease Severity in fields (Mean)			Per cent Disease Severity in APMC markets (Mean)		
		BM*	FBR#	GM**	BM	GM	SR##
1	Chikkamagaluru	8.90	2.50	-	25.50	4.50	9.00
2	Chitradurga	10.10	3.00	2.00	35.00	6.00	4.00
3	Davanagere	-	-	-	56.00	11.00	5.00

*BM - Black mould, FBR# - fusarium basal rot, GM** - Green mould, SR##- Soft rot

Conclusion

Although post-harvest diseases especially black mould were found prevalent in all the onion growing areas and APMC markets surveyed the occurrence of pathogens and severity was probably more influenced by environmental conditions. The increase in disease incidence and severity was observed with increase in Temperature, humidity and rainfall and also the severity is differed from onion variety to variety.

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