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Post-harvest deterioration of banana fruits and its control using fungicides

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ABSTRACT

Post-harvest deterioration is the most important cause of loss in banana production and this is mainly as a result of microbial invasion of the fruits. This research was therefore carried out to identify and control the fungal organism responsible for post-harvest deterioration of banana fruits. Mancozeb, carbendazim, propiconazole and SAAF at tested concentration were used as antifungal agents and the susceptibility of four, of the isolated major pathogenic fungi to them was observed in culture. The tested organisms were *Lasiodiplodia theobromae* Pat.Griffth and Maubl, *Fusarium moniliformae* Sheld, *Fusarium* sp. and *Aspergillus niger* van Tiegh. Maximum disease control of 98.76 per cent and 98.67 per cent of fruit rot was observed in propiconazole and SAAF treated fruits, respectively followed by carbendazim (96.79%) under storage condition up to eating ripe stage.

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INTRODUCTION

Banana (*Musa paradisiaca* L.), fruit is one of the most important commercial fruit and vegetable crops grown all over the world in the tropical and subtropical areas. It is the second largest fruit crop, belonging to family Musaceae in order Scitamineae. It is indigenous to indo-Malayan region. Cultivation of edible bananas is believed to have been started in this region in prehistoric times. It is possibly the world's oldest cultivated crop. It can be grown round the year and it is widely adopted in India. Apart from this, it is considered as potential 'Dollar earning crop'. It is known since the dawn of ancient history as one of the delicious fruits in the world. Major banana producing countries are India, China, Philippines, Brazil, Ecuador, Indonesia, Costa Rica, Mexico, Thailand and Colombia. It is cultivated on an area of 4.88 Mha. with an average production of 93.7 MT. in world, India produced 28.6 per cent of total banana production of the world during 2008-09 (FAO, 2008-09). In India it was cultivated on an area of 0.709 M hectares (11.6% of total fruit area) with a production of 26.2 MT (38.3% of total fruit production) with a productivity of 37.0 MT/ha during 2008-09 and in Gujarat it was cultivated in 609 lakh hectares with 3.57 MT production and shared 13.6 per cent of total national banana production during 2008-09 (NHB, 2009). It ranks six in terms

of area and third in production with a second in productivity of 58.7t/ha (NHB, 2009). India is the largest banana consumer and producing country in the world followed by Brazil. The ripe fruits are edible, delicious and very nutritious. The content of carbohydrates is very high with a calorific value of 67-137mg/100g fruit. It is good source of vitamin A (190 IU/ 100g of edible portion) and vitamin C (100mg/100g pulp) and fair source of vitamin B and B2. The fruits are rich in magnesium, sodium, potassium and phosphorus. The cultivated banana is susceptible to many diseases, mostly fungal pathogens which attack various parts of the plant from root to fruit. Bananas are highly perishable commodities with post harvest losses estimated to the tune of 25-30 per cent (Kachhwaha *et al*., 1991). Banana fruit suffers from many serious diseases such as fruit rot, crown rot, finger rot, cigar - end rot and pitting disease. The current postharvest problems for bananas are mainly concerned with storage and marketing. It is necessary to identify the pathogen causing above said diseases and ultimately to reduce the yield loss of the banana fruit.

The necessity of anti-microbial agents which are cheap, easier to be available for the control of post-harvest rot of banana fruits makes this research a necessity. The study therefore tries to investigate the effects of fungicides on post-harvest fruit rot of banana.

MATERIAL AND METHODS

Source of materials :

The banana fruits with symptoms of rots and healthy banana fruits were obtained from field as well as markets in Navsari and Surat districts of south Gujarat.

Isolation of fungal pathogens :

Repeated isolations were carried out from the crown portion, rotted pulp, reddish spot on pericarp and dried tip end rot, after washing thoroughly with tap water. The infected tissues were cut into small bits, surface sterilized with 0.1 per cent mercuric chloride solution (1 g/lit.) for 20 second followed by three subsequent washings of sterilized distilled water and then transferred aseptically on Potato dextrose agar (PDA) medium in Petriplates. The Petriplates were incubated at room temperature for development of fungal growth. The plates were observed daily, the initial growth observed was picked up aseptically and it was transferred to PDA slants. The pure culture thus obtained was further purified by aerial mycelia tip technique. The pure fungal cultures were stored safely in slants in the refrigerator at 4°C.

Determination of per cent occurrence of fungal pathogens :

This was done to determine the per cent occurrence of the different fungal isolates. Isolations were made from four different rotted banana fruits and were cultured differently. The number of occurrence for each of the isolates in the four different samples were recorded and calculated as a ratio of the total number of occurrence and was then expressed as a percentage (Table A). The Formula of Muhammad *et al*. (2004) was at followed :

$$\text{Per cent colonization} = \frac{\text{Number of pieces colonized by a pathogen}}{\text{Total number of pieces}} \times 100$$

Identification of isolates :

The pure culture isolates obtained from the diseased banana fruits were used for the purpose of identification. The characteristics observed were matched against those available in manual of Barnett and Hunters. These cultures were also sent to Agharkar Research Institute, Pune for identifications and confirmation.

Pathogenicity tests :

Each of the fungi isolate obtained from the diseased banana fruits was tested for its ability to cause the same disease condition in a healthy banana fruits. To prove the Koch's postulate, mature and semi ripen healthy banana fruits (cv. Grand Naine) were collected from field as well as from fruit market of Navsari.

Post-harvest application of fungicides for control of banana fruit rot disease :

Chemical treatments applied to the post-harvest phase to prevent losses due to diseases are also important. They

Table A : Occurrence of disease and disorders of banana fruits in markets of Navsari and Surat districts during the year 2008 and 2009

Disease/ Disorders	Frequency of occurrence avg. of two years	Micro-organisms isolated
Crown rot	72	*Lasiodiplodia theobromae, Fusarium moniliformae, Fusarium* sp., *Aspergilus niger*
Ripe rot	10	*Lasiodiplodia theobromae, Fusarium moniliforme,*
Blossom end rot	4	*Fusarium* sp.,*Acremonium* sp.
Red spots	24	*Curvularia* sp.
Peelinjury/bruising	8	*Fusarium* sp.

All fruit assessments were made at the "eating ripe" stage.

must only, however, be used in confirmity with recognized legal standards. Mancozeb (2500 ppm), carbendazim (250 ppm), propicanazole (250 ppm) and mancozeb+carbendazim (SAAF, 1500 ppm) that gave the best inhibition of tested pathogens *in vitro* were used as the post-harvest dip treatments. Mancozeb @ 3.33 g/lit., carbendazim @ 0.5 g/ lit., propicanazole @ 1ml/litre and mancozeb + carbendazim (SAAF) @ 0.33 g/lit. were dissolved in water to get a final concentration of 2500, 250, 250 and 1500 ppm a.i. Banana cv. Grand Naine fruits were harvested at uniform maturity stage and were treated by dipping for 2 minutes in the respective fungicidal solutions. A Randomized Complete Block Design was followed with four replicates considering one hand as one replication having 10-12 healthy fruits. The fruit samples were subjected to the above treatments and placed in tray to natural ripening at ambient temperature (25-32°C) up to full ripening stages. Per cent disease index (PDI) was worked out on the basis of per cent disease severity scale 0-5 mentioned below :

Scale	Description
0.	Fruit completely healthy.
1.	Disease present only near the crown or tip with a little browning of pericarp portion and fruit completely healthy.
2.	< 10 percent pulp rot with browning of pericarp
3.	10- 25 percent pulp rot with browning of pericarp
4.	25- 50 percent pulp rot with browning of pericarp.
5.	> 50 percent pulp rot with browning of pericarp

Per cent disease index (PDI) was calculated using to the formula (Rose, 1974).

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of fruit examined} \times \text{maximum rating}} \times 100$$

The efficacy (E) of each chemical treatment was calculated as under :

$$E = \frac{\text{PDI of control fruits} - \text{PDI of treated fruits}}{\text{PDI of control fruits}} \times 100$$

RESULTS AND DISCUSSION

Many different fungi were successfully isolated from different banana fruit rots, they included, *Lasiodiplodia theobromae*, *Fusarium moniliforme*, *Fusarium* sp., *Aspergillus niger*, *Acremonium* sp. and *Curvularia* sp. all of which were associated as pathogens when tested on healthy fruits (Table 1). Crown rot was the major post harvest disease caused by fungal pathogens *viz.*, *L.theobromae, F. moniliforme* and *A. niger* and the frequency of occurrence was 72 per cent followed by ripe rot due to *L.theobromae* and *F. moniliforme* with 10 per cent occurrence. Of these two fungal pathogen, *Lasiodiplodia theobromae* most frequently occurred in both diseases followed by *Fusarium moniliforme. Fusarium* sp. and *Acremonium* sp. were found associated with blossom end rot disease. *Curvularia* sp. produced symptoms when fruit fully ripened or at over ripen stage, it caused infection up to pericarp only and did not cause pulp rot. It was found to develop rapidly during fruit ripening thereby reducing the quality and marketability of banana fruits during 2008 and 2009 in Navsari and Surat markets at consumable level. The present results corroborate with Cordeiro and Matos (2005) who have recorded the same pre-harvest and post-harvest banana pathogens.

Post-harvest application of fungicides :

In post-harvest treatment, propiconazole and SAAF proved to be the highly effective fungicide for the control of banana fruit rot disease followed by carbendazim (Table 1). Minimum per cent disease index (PDI) was observed in propiconazole and SAAF treated (1.0%) fruit followed by carbendazim (2.5%). Maximum PDI (4.0%) was observed in mancozeb treated fruits which was 94.7 per cent control. Mancozeb and carbendazim produced brownish discoloration on fruit skin after 4-6 days of storage, but there was no

Table 1 : Effect of post-harvest application of fungicides on banana fruit rot disease development under storage conditions

Sr. No.	Fungicides (ppm)	Per cent disease index**	Per cent disease control**
1.	Mancozeb (Dithane M-45 75%WP) (2500)	4.0 (11.53)*	94.7 (77.34)*
2.	Carbendazim (Bavistin 50 WP) (250)	2.5 (9.97)	96.79 (80.52)
3.	Propiconazole (Tilt 25 % EC) (250)	1.0 (7.03)	98.76 (85.06)
4.	Carbendazim 12 per cent + Mancozeb 63 per cent (SAAF 75 WP) (1500)	1.0 (7.03)	98.67 (84.77)
5.	Control	76.5 (61.34)	0.0 (4.05)
S.E. ±		1.83	1.03
C.D. (P=0.05)		5.51	3.11
C.V. (%)		20.22	9.95

*Figures in the parentheses are angular transformed (x+0.5) values, **Average of four replications.
Fruit assessment was done at the "eating" stage.

effect on pulp. The present results are more or less in agreement with the results obtained by Khanna and Chandra (1976) who reported that benomyl and aretan were highly toxic as they completely checked the banana (var. Harichal) fruits rot pathogen *viz.*, *Fusarium moniliforme* and *F. roseum* as pre and post inoculation treatment up to 8 days. Ved and Dharamvir (1984) got complete control of banana fruit rot decay caused by *Aspergillus flavus* and *Aspergillus fumigatus* by treating the fruits with thiophanate methyl, benlate, thiobendazole, bavistin, propionic acid and sodium metabisulphite at 2000 ppm up to 8 days of storage. Latchmeah and Santkhurn (1991) gave fungicidal treatments at three different concentrations of thiophanate-methyl and benomyl which inhibited the different rots in the range of 89.6 to 100.0 per cent. Godara (1994) found the lowest severity of post harvest rots of ripe and semi-ripe citrus fruits treated with bavistin (500 ppm) in both pre and post-inoculation treatments. Ramma *et al.* (1999) found benomyl 500 ppm and thiabendazole @ 1000 ppm which completely inhibited crown rot pathogens up to 9 days after harvest.

The results of the present study suggests that banana fruits treated before storage with Propiconazole and SAAF 75 WP would help in the management of banana fruit rots under storage condition.

Summary and conclusion :

Isolation of fungi were made from infected banana fruits by tissues isolation and associated fungi were identified as *Lasiodiplodia theobromae* Pat., *Fusarium moniliforme* Sheld, *Fusarium* sp., *Aspergillus niger*, *Acremonium* sp. and *Curvularia* sp., which were further, confirmed the identification by Agharkar Research Institute, Pune.

Crown rot was the major post harvest disease due to fungal pathogens *viz.*, *L.theobromae*, *F. moniliforme* and *A. niger.* the frequency of occurrence of these pathogens was 72 per cent on ripe banana fruits of Grand Naine cultivar. The next fruit rot disease was due to *L.theobromae* and *F. moniliforme* with 10 per cent occurrence.

Maximum per cent disease inhibition (98.79%) was observed in propiconazole and SAAF followed by carbendazim treated fruits. Mancozeb and carbendazim showed phytotoxic effect producing brownish discoloration which was observed after 4-6 days of storage, but there was no effect on pulp.

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