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Research Article

In vivo evaluation of salts, bioagents, hot water treatment and fungicides against anthracnose of papaya caused by *Colletotrichum gloeosporioides*

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ABSTRACT

Papaya suffers from several diseases and anthracnose is one of them and this disease is one of the limiting factors for papaya marketing because it caused postharvest losses. Under *In vivo* evaluation of effect of salts, biocontrol agents solution at two concentrations (2 and 5 per cent) and hot water treatment at 49ºC for 20 minutes, the least PDI was found in case of sodium chloride + hot water treatment (26.67%) followed by sodium chloride (33.33%), hot water treatment (46.67%) and *T. harzianum* +*Pseudomonas fluorescence* (43.33%) at 5 per cent concentration and more growth of fungus was noticed in *T. harzianum* (76.67%). Similarly *in vivo* evaluation of fruit treatment with different fungicides at the two concentration (0.05 and 0.10%), carbendazim was found to be effective and it showed least PDI (26.67%) followed by mancozeb (40.00%) at 0.1 per cent concentration and carbendazim (40.00%) at 0.05 per cent concentration. Less inhibition was noticed in benomyl (83.33%) at 0.05 per cent concentration.

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INTRODUCTION

Papaya (*Carica papaya* L.) is an important fruit crop, which belongs to the family *Caricaceae*. *Carica* is the largest of the four genera with 48 species, among which *Carica papaya* L. is most important one cultivated all over the world (Badillo, 1971). The popularity of papaya fruit has made it ubiquitous in tropical and subtropical regions of the world. Papaya is the native of tropical America (Singh, 1990). Papaya is prone to many diseases incited by fungi, bacteria, nematodes and viruses leading to heavy loss in yield, of which papaya anthracnose caused by *Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc. appears to be more severe causing devastation of papaya fruits during transit and storage. Papaya anthracnose is the most important disease throughout the year in India and a major limiting factor in transit and storage. It is important in many other tropical regions where papaya is grown (Bolkan *et al.,* 1976). First symptoms of papaya anthracnose are round, water-soaked, and sunken spots on the surface of the ripening fruit. Brown sunken spots develop on the fruit surface. The symptoms appear only upon ripening and may not be apparent at the time of harvest. The flesh beneath the affected portion becomes soft and begins to rot (Baker *et al*., 1940 and Dickman and Alvarez, 1983).

MATERIALS AND METHODS

In vivo study was carried out on papaya fruits against postharvest anthracnose disease caused by *Colletotrichum gloeosporioides* by imposing various salts and bioagents at 2 and 5 per cent concentrations. The treatments given were sodium chloride, sodium chloride + hot water, calcium chloride, *Trichoderma harzianum, Pseudomonas fluorescens, Trichoderma harzianum + Pseudomonas fluorescens,* hot water treatment and distilled water, which served as control. Fruits were treated with hot water at 49ºC for 20 minutes. Disease intensity in different treatments was scored using the following 0-5 scale (Prasanna Kumar, 2001).

Per cent Disease Index (PDI) of postharvest disease was

Grade	Per cent disease on the fruit surface
0	No. disease
1	0.1 – 5
2	5.1 -10
3	10.1 – 25
4	25.1 – 50
5	> 50

calculated by using the formula given by Wheeler (1969).

Papaya fruits were washed through tap water to remove dust and soil particles and surface sterilized in sodium hypochlorite and rinsed thrice with distilled water. Small wounds were made by sterilized needle on the fruits surface. These papayas were dipped in postharvest treatment solution as mentioned before for ten minutes. They were allowed to dry and cotton swabs dipped in spore suspension of *C. gloeosporioides* were introduced to surface of papaya. Sufficient humidity was provided by placing the cotton swabs dipped in water along with them. Observations were taken by following 0–5 scale on seven day after inoculation and data were analysed statically. *In vitro* study was carried out on papaya fruits against postharvest anthracnose disease caused by *C. gloeosporioides* by imposing various fungicides at 0.05 and 0.1 per cent concentrations. Half gram (0.5 g) and one gram (1 g) of chemical was mixed with 1000 ml of sterilized water, respectively so as to get 0.05 and 0.1 per cent concentration. The medium was thoroughly shaken for uniform mixing of chemical. The treatments given were mancozeb, carbendazim, antracol, benomyl, hexaconazole, captan and distilled water, which served as control. Disease intensity in different treatments was scored using 0-5 scale (Prasanna Kumar, 2001).

RESULTS AND DISCUSSION

The data pertaining to the *in vivo* evaluation of salt, bioagents and hot water treatment on *Colletotrichum gloeosporioides* are presented in Table 1 and Fig. 1a and b. The minimum per cent disease index was observed in sodium chloride + hot water (49°C) (31.66%) followed by sodium chloride (43.33%) and hot water (46.67%). Next best treatment was *Trichoderma harzianum + Pseudomonas fluorescence* (50.00%) followed by calcium chloride (53.33%) and *Pseudomonas fluorescence* (56.67%). Maximum PDI was observed in *Trichoderma harzianum* (66.67%). Among the tested two concentrations, 5 per cent concentration was

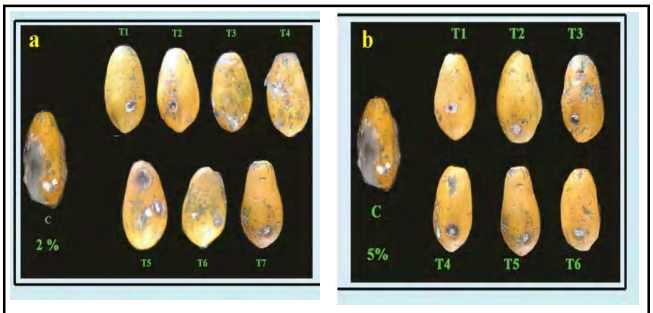

Fig. 1a: T_1 = Sodium chloride + hot water (49ºC); T_2 = Sodium chloride; T_3 = Hot water (49ºC); T_4 = Calcium chloride; T_5 = *Trichoderma harzianum;* T_6 = *Pseudomonas fluorescens;* T_7 = *Trichoderma harzianum + Pseudomonas fluorescens;* C = Control

Fig. 1b: T_1 = Sodium chloride + hot water (49ºC); T_2 = Sodium chloride; T_3 = Calcium chloride; T_4 = *Trichoderma harzianum;* T_5 = *Pseudomonas fluorescens;* T_6 = *Trichoderma harzianum + Pseudomonas fluorescens;* C = Control

Fig. 1 : Effect of salts, biocontrol agents and hot water against *C. gloeosporioides*

Table 1: *In vivo* evaluation of salt, bioagents and hot water treatment against anthracnose of papaya

Sr. No.	Treatments	Per cent disease index (PDI) at 6 DAI		
		2 %	5%	Mean
1.	Sodium chloride	53.33 (46.91)*	33.33 (35.26)	43.33 (41.07)
2.	Sodium chloride + Hot water (49ºC)	36.67 (37.27)	26.67 (31.09)	31.66 (34.16)
3.	Calcium chloride	60.00 (50.77)	46.67 (43.09)	53.33 (46.91)
4.	*Trichoderma harzianum*	76.67 (61.12)	56.67 (48.83)	66.67 (54.95)
5.	*Pseudomonas fluorescens*	60.00 (50.77)	53.33 (46.91)	56.67 (48.82)
6.	*Trichoderma harzianum + Pseudomonas fluorescence*	56.67 (48.83)	43.33 (41.17)	50.00 (44.98)
7.	Hot water (49ºC)	46.67 (43.09)	46.67 (43.09)	46.67 (43.09)
8.	Control	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
	Source	S.E. ±		C.D. (P=0.01)
	Treatments (T)	0.21		0.81
	Concentration (C)	0.10		0.40
	T x C	0.30		1.14

* Figures in parentheses indicate angular transformed values.

significantly different over 2 per cent concentration. Minimum PDI was observed in sodium chloride + hot water (49°C) (26.67%) followed by sodium chloride (33.33%) and *Trichoderma harzianum* + *Pseudomonas fluorescence* (43.33%). Maximum PDI was observed in *Trichoderma harzianum* (76.67%) followed by calcium chloride (60.00 %) and *Pseudomonas fluorescence* (60.00%) which were on par with each other.

***In vivo* evaluation of fungicides**:

Per cent disease index (PDI) at 8 days after postharvest treatment at two different concentrations (0.05 and 0.1 per cent) is presented in Table 2 and Fig. 2a andb. Data significantly differed over control. Among the different fungicides, carbendazim (33.33%) was found to be most effective followed by mancozeb (46.67%) and antracol (58.33%). Captan (61.33%) followed by hexaconazole (63.33%) was found to be next best effective fungicides. Among the two concentrations tested 0.1 per cent was found to be significant over 0.05 per cent. Minimum PDI was observed in carbendazim (26.67%) followed by mancozeb (40.00%) and antracol (53.33%) at 0.10 per cent concentration. Maximum PDI was observed in benomyl (83.33%) at 0.05 per cent.

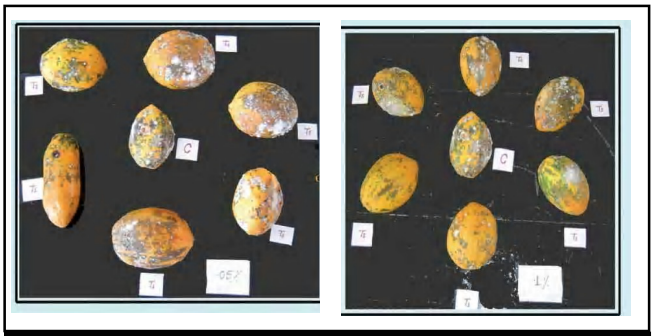

Fig. 2: Effect of fungicides against *C. gloeosporioides*. T_1 = Mancozeb; T_2= Carbendazim; T_3 = Antracol; T_4 = Captan; T_5 = Hexaconazole ;T_6 = Benomyl ;C = Control

Effect of salt, biocontrol agents and hot water treatment 49°C for 20 minutes were tested against the postharvest disease of papaya. In this investigation, least per cent disease index was noticed in sodium chloride + hot water treatment (31.66%) followed by sodium chloride (43.33%) and hot water treatment (46.67%). Sodium chloride + hot water at 49°C (26.67%) was found to be effective over the all other tested treatments at 5 per cent concentration followed by sodium chloride (33.33%) at 5 per cent and *Trichoderma harzianum* + *Pseudomonas fluorescens* (43.33%) at 5 per cent concentration. Hot water treatment and calcium chloride at 5 per cent were found to be equally effective to reduce the infection of pathogen (46.67%). Allong *et al*. (2000) reported that a hot water treatment of 48-50°C for 20 minutes was found to delay fungal storage rots in fruits of papaya cultivars without negatively affecting sensory quality. The postharvest phase of anthracnose can be controlled by submerging fruits in water at 46 to 49ºC for 20 minutes shortly after harvest (Akamine, 1953; Akamine and Arisumi, 1953 and Tsai, 1969). But this treatment leads to the uneven degreening of fruits (Patel *et al*., 1973). Khare and Dhingra (1974) reported that some fungicides can completely check the growth of the fungus in culture. Many chemical compounds have been used as part of postharvest treatment of tropical fruits for the prevention or retardation of microbial infection. In this present investigation, fruits dipped in different fungicides solution at two different concentration (0.5% and 0.1%), carbendazim (33.33%) was found to be the best over all the other tested fungicides followed by mancozeb (46.67%) and captan (61.83%). Among the two concentrations was tested, 0.1 per cent concentration found to be effective over 0.05 per cent concentration. Carbendazim (26.67%) was found having least

Table 2 : *In vivo* evaluation of fungicides against *Colletotrichum gloeosporioides*

Sr. No.	Treatments	Per cent disease index (PDI) at 8 DAI		
		0.05 %	0.1%	Mean
1.	Antracol	63.33 (52.73)	53.33 (46.91)	58.33 (49.80)
2.	Benomyl	83.33 (65.91)*	46.67 (43.09)	65.50 (54.77)
3.	Captan	80.00 (63.43)	43.33 (41.17)	61.83 (52.38)
4.	Carbendazim	40.00 (39.23)	26.67 (31.09)	33.33 (35.14)
5.	Hexaconazole	70.00 (56.79)	56.67 (48.83)	63.33 (52.79)
6.	Mancozeb	53.33 (46.91)	40.00 (39.23)	46.67 (43.05)
7.	Control	90.00 (71.57)	90.00 (71.57)	90.00 (71.57)
	Source	S.E. ±	C.D. (P=0.01)	
	Treatments (T)	0.31	1.24	
	Concentration (C)	0.17	0.66	
	T x C	0.45	1.75	

* Figures in parentheses indicate angular transformed values

PDI followed by mancozeb (40.00%) at 0.1 and carbendazim (40.00%) at 0.05 per cent was found to be equally effective against the growth of pathogen. Maximum growth of pathogen was noticed in benomyl (83.33%) at 0.05 per cent. Similar studied were conducted by many workers like Spalding and Reeder (1972); Quimio and Quimio (1974) and Singh and Bhargava (1977), who reported that fruit dipped in benomyl gave a better control of disease. Bolkan *et al.* (1976) and Tsai (1969) have found that when papaya fruits were dipped for 3 minutes in either benomyl or thiabendazole solution (with a sticker) reduced the postharvest decay caused by *C. gloeosporioides*.

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