RESEARCH ARTICLE

Evaluation of benzimidazole fungicides on *Penicillium expansum* causing blue mold of apples

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ABSTRACT

The present study assayed the effect of the certain fungicides viz. dithane Z-78, polyram, acrobat, kocide, dithiocarbmate, thiobendazole and diphenylamine on blue mold of apple caused by *Penicillium expansum* Link. Twenty isolates of *P. expansum* were isolated from infected apples collected from various fruit markets of Maharashtra. All these isolates were tested their sensitivity against carbendazim on PDAmedium.MIC of carbendazim was determined against isolates.*Pe*-9 MIC-750.6µg/ml was sensitive while isolate *Pe*-15 MIC-970.3µg/ml was tolerant. Pe-9(MIC-1900.2µg/ml) was sensitive and Pe-15 MIC-2470.3µg/ml was tolerant i*n vivo*. Carbendazim resistant mutant (Pe-EMS-10, MIC-4850.6µg/ml) is equally important to control using different fungicides. *P.expansum* was tested against carbendazim and other fungicides. *In vitro* the fruitful results were observed that the (PCE) values at 50 %Conc. (44.02 - 49.28) while at 100 %Conc. (50.89-61.39) individually and in mixture with Carbendazim the PCE value increased at 50 % Conc.(55.39 - 68.98) while at 100% (68.72 -73.57). PCE value at 50% Conc. (51.62 - 56.95) individual and mixture (57.25 - 59.26) while at 100 from alone (58.32 - 69.36) and in mixture (71.63-79.82) PCE value increased as compared with individual value(*In vivo*). Without fungicide served as control.

Key word: *Penicillium expansum*, Blue mold, Apple and Carbendazim fungicide.

INTRODUCTION

Blue mold of apple (*Pyrus malus* L.) caused by *Penicillium expansum* Link. Postharvest apples are stored in order to provide market with quality of fruits. Fungal diseases occur regularly during storage and can cause severe yield and economic losses. Postharvest losses on

apples were up to 80 - 90% (Anderson, 1956). In 2004 report was published suggesting that deterioration during storage caused 5 to 25% losses of total yield (Jijakli and Lepoivre, 2004). The major postharvest pathogens of apple according to literature are *Penicillium expansum, Botrytis cinerea*, *Monilinia fructigena* (Snowdon 1990; Konstantinou *et al.,* 2011). Fungal pathogens were isolated from rotten apple viz. *Venturia inaequalis*, *Colletotrichum acutatum*, *Mucor piriformis*, *Rhizopus arrhizus*, *Alternaria alternata*, *Aspergillus flavus* and *A. fumigatus* (Baviskar and Suryawanshi 2015). Therefore its management is equally important to blue mold of apple caused by *Penicillium expansum.* Very few reports have been available on blue mold control using fungicides. Therefore, post harvest diseases of apple strongly recommended Carbendazim and thiobendazole. (Wicks, 1977; Staub and Sozzi, 1984; Dahiwale *et al.*, 2009; Dahiwale and Suryawanshi, 2010). However, there are few reports suggested the emergence of carbendazim resistance in this pathogen (Nene and Thapliyal, 1992; Gangawane 1981, Abdelfettah *et al.,* 2007; Dahiwale and Suryawanshi, 2011, Suryawanshi 2015).

MATERIALS AND METHODS

During 2013-2014 survey of infested apples collected from various markets in Maharashtra. Seven fungicides were selected for this investigation. Twenty isolates of *P.expansum* isolated from infested apples were tested against carbendazim on agar plates (*in vitro*) and *in vivo.* Fungicides viz. dithane Z-78, polyram, acrobat, kocide, dihtiocarbamate, thiobendazol, diphenylamine and carbendazim were mixed with 2X PDA medium with equal quantity of fungicide pour in the petriplates by food poisoning method. The carbendazim conc. was also adjusted along with other fungicides conc. at 50 and 100µg/ml. Individual and combine effect of fungicides was observed. After solidify the medium, plates were inoculated with resistant mutant of *Penicillium expansum* (*Pe*-EMS-10) at the center and incubated at 27±2°C. After 8 days growth was measured and Percentage Control Efficacy (PCE) was determine. *In vivo* studies apple were dipped in various fungicides at 50 and 100µg/ml. The fruits were inoculated with resistant mutant and wrapped with tissue paper and incubated for 15 days at 27±2°C temperature. PCE was calculated (Cohen, 1989).

RESULTS AND DISCUSSION

Seven fungicides viz. dithane Z-78, polyram, acrobat, kocide, dihtiocarbamate, thiobendazole and diphenylamine were used individually and in mixture with carbendazim. The Conc. was used at 50µg/ml and 100µg/ml in PDA medium and PCE was determined. *In vitro* results are indicated in (Table 1), that the individually all the fungicides showed less PCE against *P. expansum*. The PCE was higher i.e. dithane Z-78(61.39) and kocide (57.33) when compared with carbendazim at 100µg/ml, diphenylamine was least effective. When the fungicides were used in mixture with carbendazim, PCE was highly increased with all the fungicides. It went up to 55.39-68.98at 50µg/ml Conc., use of acrobat with carbendazim PCE appeared to be more fruitful than other fungicides and at the Conc. of 100µg/ml PCE was more than that of lower Conc. Thiobendazole was more fruitful PCE (73.57) followed by dithiocarbamate, dithane Z-78, acrobat and kocide in decreasing manner.

The *in vivo* results are reveled in (Table 2) that treatment of dithiocarbamate gave lowest PCE (51.62) at 50µg/ml. whereas higher Conc. dithane Z- 78 PCE was 69.36 and followed by acrobat, thiobendazole, dihtiocarbamate and polyram PCE range (63.42-67.49). A mixture of carbendazim with thiobendazole gave higher PCE (59.26) at 50µg/ml., whereas higher Conc. acrobat gave very fruitful PCE at 100µg/ml (79.82) followed by thiobendazole, dithane Z-78, diphenylamine, polyram, kocide and dihtiocarbamate PCE range (77.50-71.63) in decreasing order. Similar results were observed by(Forster and Staub, 1996) at

600mg/L of boscalid and 60mg/L of cyprodinil in combination with 40mg/L fludioxonol against *B. cinerea* on table grapes and other fruit crops (Blacharski *et al.,* 2001; Latorre *et al.,* 2001; Wedge *et al.,* 2007). Cyprodinil plus fludioxonol effectively controlled *P. expansum*, *R. stolonifer*, and *A. niger* and also the results compared with earlier studies have reported that tolerance of benzimidazole fungicides and calcium chloride on *Alternaria alternata* and *Penicillium expansum* rot during storage of pears (Wicks, 1977; Abdelfettah *et al.,* 2007).

Table 1: Percentage Control Efficacy (PCE) of Carbendazim individually and in mixture with other fungicide against resistant isolate of *Penicillium expansum* on agar plate

Sr. No.	Fungicide(µg/ml)	PCE individual	PCE mixture with Carbendazim
1.	Dithane Z-78		
	50	47.39	55.39
	100	61.39	72.85
2.	Polyram		
	50	48.12	63.67
	100	50.89	68.72
3.	Acrobat		
	50	48.47	68.98
	100	53.89	72.62
4.	Kocide		
	50	46.14	61.88
	100	57.33	70.71
5.	Dithiocarbamate		
	50	49.28	55.40
	100	56.15	72.98
6.	Thiobhandazole		
	50	45.98	59.27
	100	54.28	73.57
7.	Diphenylamine		
	50	44.02	56.19
	100	53.29	71.81
8.	Carbendazim	56.84	---
	(µg/ml)		
	SE	3.276	5.333
	CD (P= 0.05)	6.784	11.51
	(P= 0.01)	7.993	15.99

Table 2: Percentage Control Efficacy (PCE) of Carbendazim individually and in mixture with other fungicide against resistant isolate of *Penicillium expansum* on apple.

Sr. No.	Fungicide(µg/ml)	PCE individual	PCE mixture with Carbendazim
1.	Dithane Z-78		
	50	53.37	59.12
	100	69.36	75.32
2.	Polyram		
	50	51.62	59.04
	100	63.42	73.44
3.	Acrobat		
	50	56.95	58.27
	100	67.49	79.82
4.	Kocide		
	50	54.95	58.48
	100	58.32	73.00
5.	Dithiocarbamate		
	50	51.62	57.25
	100	64.21	71.63
6.	Thiobhandazole		
	50	54.78	59.26
	100	65.26	77.50
7.	Diphenylamine		
	50	52.52	56.09
	100	63.92	74.21
8.	Carbendazim	72.82	---
	(µg/ml)		
	SE	1.875	2.449
	CD (P= 0.05)	3.883	5.089
	(P= 0.01)	4.575	6.009

CONCLUSION

Use of chemicals is an important tools in management of blue mold. Fungicides continue to be most effective means of controlling blue mold of apple caused by *P. expansum.* Easily available and convenient to use the fungicide. For effective management we need to educate one and all familiaring with various brands and formulation regarding their proper and rational use to achieve effective control of apple diseases. To minimize the use of fungicides and avoid hazards to man and environment. The most people have shown great reliance on one or more fungicides which often has lead to many problems.Lastly we conclude with this fungicides (dithane Z-78, polyram, acrobat, kocide, dihtiocarbamate, thiobendazol, diphenylamine and carbendazim)

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