RESEARCH ARTICLE

Control of *penicillium expansum* Link Causing Blue Mold of Pear Using Some Fungicides

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ABSTRACT

Blue mold of pear is caused by *Penicillium expansum* Link. Thom. ex. is one of the most serious post harvest disease in India. Total twenty three isolates of *P. expansum* were isolated from infected pear fruits for sensitivity tested against carbendazim on Potato Dextrose Agar (PDA) medium. Sensitivity of these isolates to carbendazim was determined using food poisoning method. *In vitro* Minimum Inhibition Concentration (MIC) for carbendazim was determined; isolate Pe-9 MIC-750.6µg/ml was sensitive while isolate Pe-15 MIC-970.3 µg/ml was tolerant. *In vivo* Pe-9 MIC-1900.2µg/ml was sensitive. Pe-15 MIC-2470.3µg/ml was tolerant. Carbendazim resistant mutant (Pe-EMS-10, MIC-4850.6µg/ml) is equally important to manage using different fungicides. *P. expansum* was tested against carbendazim and other fungicides viz. dithane Z-78, polyram, acrobat, kocide, dithiocarbmate, thiobendazole and diphenylamine. *In vitro* results revealed that the Percentage Control Efficacy (PCE) values range at 50% Conc. (44.02 - 49.28%) while at 100% Conc. (50.89 - 61.39%) individually and in mixture with carbendazim increased its PCE from at 50% Conc. (55.39 - 68.98%) while at 100% (68.72 -73.57%). *In vivo* PCE 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 further increased and without fungicide served as control.

Key word: Pear, blue mold, *Penicillium expansum*, carbendazim resistant, fungicides.

INTRODUCTION

Blue mould of pear (*Pyrus communis* L.) caused by *Penicillium expansum* Link. Thom. ex. pear among them, are usually stored after harvest. During cold storage losses of economic importance are produced by several decays due to fungal rot. *Penicillium expansum, Botrytis cinerea* and *Glomerella cingulata* are well-known postharvest pathogens. They produce blue, gray rots and fruit rot of pear respectively (Goepfert, 1980). The control of blue mold is especially important in storage condition. Use of carbendazim is recommended for the management of

fruit diseases (Gangawane, 1981). Certain fungicides viz. dithane Z-78, polyram, acrobat, kocide, dithiocarbamate, thiobendazole, diphenylamine and carbendazim were used to manage the blue mold.

Therefore its management is equally important to post harvest blue mold of pear caused by *Penicillium expansum.* Very few reports have been available on blue mold management using fungicides. Therefore, post harvest diseases of pear strongly recommended carbendazim and thiobendazole. (Wickst, 1977; Staub and Sozzi, 1984; Dahiwale *et al.*, 2009; Mahendra Dahiwale and Suryawanshi, 2010). However, there are few reports suggesting the emergence of carbendazim resistance in this pathogen. Fungicides used to control blue mold disease of pear (Amrani and Najim, 1985; Ramdani, 1989; El Hassani, 1991; Nene and Thapliyal, 1992; Selmauoui and Douira, 1999; Maouni *et al.,* 2002; Koffmann and Penrose, 2003; Chamorn Maneerat and Yasujoshi Hayata, 2006; Abdelfettah *et al.,* 2007; Kanetis *et al.,* 2007; Dahiwale and Suryawanshi, 2011).

MATERIAL AND METHODS

During 20014-2015 survey of infested fruits of pear collected from various markets in Maharashtra. A total of seven fungicides were selected for this study. 23 isolates of *P. expansum* from pear fruits were tested against carbendazim on agar plates and on fruits. 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 Petri-plates. The food poisoning method used for testing fungicidal effect on *P. expansum*. The carbendazim conc. was also adjusted along with other fungicides conc. at 50 and 100µg/ml to see the combine effect of fungicides. After solidify plates were inoculated with resistant mutant (Pe-EMS-10) at the center and incubated at 27±2°C. After 8 days growth was measured and Percentage Control Efficacy (PCE) was calculated. For *in vivo* studies pear fruits were dipped in above mentioned fungicides at 50 and 100µg/ml. The fruits were inoculated with resistant mutant Pe-EMS-10 and wrapped with tissue paper and incubated for 15 days at 27±2°C temperature. The Percentage Control Efficacy (PCE) was calculated (Cohen, 1989). During *in vitro* and *in vivo* studies it was seen that seven fungicides were inhibitory against *P. expansum*.

RESULTS AND DISCUSSION

There are 23 isolates were tested using carbendazim and sensitivity was determined using food poisoning method. Sensitivity of *Penicillium expansum* to carbendazim on agar plate and on pear Pe-9 MIC-750.6µg/ml was sensitive while isolate Pe-15 MIC-970.3 µg/ml was tolerant and Pe-9 MIC-1900.2µg/ml was sensitive and Pe-15 MIC-2470.3µg/ml was tolerant were observed and determined the MIC value (Table 1 and 2). The plates were inoculated with carbendazim resistant mutant (Pe-EMS-10) of *P. expansum* and control using different fungicides.

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 50 µg/ml and 100µg/ml in PDA medium and PCE was determined. During *in vitro* study the results in (Table 3) indicated that 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 55.39-68.98% at 50µg/ml Conc., use of acrobat with carbendazim PCE appeared to be more fruitful than other fungicides. At the Conc. of 100µg/ml PCE was more than that of lower Conc. Thiobendazole gave maximum PCE (73.57%) followed by dithiocarbamate, dithane Z-78, acrobat and kocide in decreasing manner.

The *in vivo* results are reveled in (Table 4) that treatment of dithiocarbamate gave lowest PCE (51.62%) at 50µg/ml. whereas higher Conc. 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 T, 1977; Abdelfettah Maouni *et al.,* 2007) and correlate results and Percentage Control Efficacy was calculated.

Table1: Sensitivity of *P. expansum* to carbendazim *in vitro* on agar plate.

Sr. No.	Isolate No.	Data Characteristics of Dose Response Curve				
		Regression Constant	Regression Coefficient	Correlation Coefficient	ED_{50} (µg/ml)	MIC (µg/ml)
1	Sensitive	1.4428	-0.0018	-0.8083	290.6	750.6
2	Tolerant	4.2678	-0.0041	-0.9419	540.3	970.3

Table 2: Sensitivity of *P. expansum* to carbendazim *in vivo* on pear.

Sr. No.	Isolate No.	Data Characteristics of Dose Response Curve				
		Regression Constant	Regression Coefficient	Correlation Coefficient	ED_{50} (µg/ml)	MIC (µg/ml)
1	Sensitive	8.9933	-0.0038	-0.9771	950.5	1900.2
2	Tolerant	10.440	-0.0042	-0.9905	1200.7	2470.3

Table 3: 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 (µg/ml)	56.84	---
	SE	3.276	5.333
	CD (P= 0.05)	6.784	11.51
	(P= 0.01)	7.993	15.99

Table 4: Percentage Control Efficacy (PCE) of Carbendazim individually and in mixture with other fungicide against resistant isolate of *Penicillium expansum* on pear.

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 (µg/ml)	72.82	---
	SE	1.875	2.449
	CD (P= 0.05)	3.883	5.089
	(P= 0.01)	4.575	6.009

CONCLUSION

The biomass of phytoplankton is totally correlated with the surrounding factors. The maximum biomass was recorded in monsoon due to availability of nutrient. The formation of phytoplankton was least in monsoon Chandran (1985) and post monsoon because of high temperatures. The phytoplankton shows the negative correlation with temperature. The qualitative and quantitative values were high during monsoon only. It is also noticed that the productivity is directly correlated with dissolved oxygen. During monsoon the nitrate concentration was high due to which accelerate the luxuriant growth of phytoplankton. Temperature is an abiotic factor, which helps in controlling the growth of phytoplankton. Thakur (2011) Chandran (1982), the cause of rapid decline of phytoplankton during post monsoon and pre monsoon was due to grazing by zooplankton.

Conflicts of interest: The authors stated that no conflicts of interest.

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