Int.J.Curr.Microbiol.App.Sci (2018) *7*(3): 3310-3315

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 03 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.703.381

Compatibility of *Pseudomonas fluorescens* with Pesticides *in vitro*

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Keywords

Pseudomonas fluorescens, Compatibility, Fungicides, Insecticides and weedicides

Article Info

Accepted:
26 February 2018
Available Online:
10 March 2018

A B S T R A C T

The compatibility of *Pseudomonas fluorescens* with 6 fungicides, 10 insecticides and 10 weedicides was tested under laboratory condition. Strain *P. fluorescens*16was highly compatible with propiconazole, tebuconazole, trifloxistrobin + tebuconazole, azoxystrobin, carbendazim and carbendazim + mancozeb at 100 ppm and moderately compatible at 500 ppm concentration and poorly compatible with propiconazole, tebuconazole, trifloxistrobin + tebuconazole and carbedazim at 1000 ppm by showing poor growth but showed good compatibility with azoxystrobin. All insecticides and herbicides were found to be compatible with *P. fluorescens*. The study indicated that most of the fungicides, insecticides and weedicides can be mixed with *P. fluorescens* for use in agriculture.

Introduction

Biological control is an environmentally sound and effective means of reducing or mitigating diseases and disease effects through the use of beneficial microorganisms. Among the bacterial biocontrol agents *Pseudomons fluorescens* have gained much importance as it is very effective in root colonization and biocontrol activity by producing antifungal metabolites including antibiotics, hydrogen cyanide and siderophores (O'Sullivan and O'Gara, 1992). In recent years, emphasis has been laid on the combined use of biocontrol agents along with chemical pesticides for effective management of pests, diseases and weeds. In the present study, the compatibility of *P. fluorescens* with the 10 insecticides, 6 fungicides and 10 herbicides was done in *in vitro*

Materials and Methods

A study on compatibility of effective strain of *P. fluorescens* (PF 16) with fungicides, insecticides and herbicides was conducted during 2014 under laboratory conditions using poison food technique. Three doses of each pesticide viz., 100 ppm, 500ppm and 1000 ppm were used for the study. Nutrient agar (NA) plates amended with concentrations of pesticides were prepared by serial dilutions. A

loopful of active *P. fluorescens* culture was streaked on individual NA plates amended with appropriate concentrations of pesticides and incubated for 48 h. Five replications were maintained for each pesticide and concentration. To measure the compatibility, growth of strain *P. fluorescens* on pesticide amended media was rated as + + + (Good); + + (Moderate); + (Poor); and – (No growth) and compared with growth of *P. fluorescens* on non-amended pesticide NA plates.

Results and Discussion

Compatibility of *Pseudomonas fluorescens* with fungicides *in vitro*

The results pertaining to compatibility of *P. fluorescens* with six fungicides are presented in Table 1. Strain *P. fluorescens*16was compatible with propiconazole, tebuconazole, trifloxistrobin + tebuconazole, azoxystrobin, carbendazim and carbendazim + mancozeb based on its growth and rated as good at 100 ppm concentration.

The strain was moderately compatible to propiconazole, tebuconazole, trifloxystrobin + tebuconazole and carbendazim at 500 ppm concentration and highly compatible with azoxystrobin and carbendazim + mancozeb and did not show any deleterious effect on the growth of *P. fluorescens* (Plate 1). The strain was poorly compatible with propiconazole, tebuconazole, trifloxistrobin + tebuconazole and carbedazim at 1000 ppm by showing poor growth but showed good compatibility with azoxystrobin.

The results of present study are in accordance with the earlier research reports. Among the bacteria, *P. fluorescens* was found to be more compatible with fungicides than *B. subtilis* and the maximum tolerance concentration for the former being 1600 µg mancozeb/ml, and 50,000 µg/ml for captan and carbendazim (Mohiddin and Khan 2013). The biocontrol bacteria *viz.*, *Pseudomonas fluorescens* and *Bacillus subtilis* were found more tolerant to fungicides than fungi. This may be due to the reason that, some bacteria can use pesticides as nutrients and hence can tolerate higher concentrations of chemicals (Kishore and Jacob, 1987; Aislabie and Jones, 1995). The results of present investigation are in conformity with the compatibility studies of Ahila Devi and Prakasam (2013) and Anand *et al.,* (2009) as *Pseudomonas fluorescens* and *B. subtilis* were compatible with azoxystrobin 25 SC at 5, 10, 50, 100, 250 ppm and 300 ppm concentration. Kataria *et al.*, (2002) reported that lower rates of azoxystrobin in combination with *P. fluorescens* strain 36 resulted in better antagonist interactions against *Rhizoctonia solani* Kuhn. Sendhil Vel *et al.*, (2004) found that the growths of Pf1 and *Bacillus subtilis* were not affected by azoxystrobin even at high concentrations.

Compatibility with insecticides

The results pertaining to compatibility of *P. fluorescens* with insecticides are presented in Table 2. Strain *P. fluorescens*was compatible with all the tested insecticides *viz*., imidacloprid, monocrotophos, chlorpyriphos, trizophos, diafenthiuran, sulphur, spinosad, fipronil, acephate, acetamiprid at all the three concentrations.

Mathew (2003) studied the compatibility of *P. fluorescens* with nine pesticides and found that mancozeb, carbendazim, chlorpyriphos and imidacloprid were highly compatible with *P. fluorescens* strain P11 at there commended dose for field use. Another study on the compatibility of diafenthiuron with antagonistic microorganisms of plant pathogens *viz.*, *Trichoderma viride* and *Pseudomonas fluorescens* revealed that diafenthiuron had some inhibitory effect on the mycelial growth of *T. viride*.

List of pesticides used for compatibility studies

S. No.	Pesticide
	Fungicides
1.	Propiconazole250 EC
2.	Tebuconazole 430SC
3.	Trifloxystrobin25%W/W + tebuconazole 50%W/W, 75 WG
4.	Azoxystrobin 250SC
5.	Carbendazim 50%DF
6.	Carbendazim12 % + mancozeb 63%WP
	Insecticides
7.	Imidacloprid 70 WG 70%@.025g
8.	Monocrotophos 36%SL @1.6 ml/l
9.	Chlorpyriphos 20%EC @2.5ml/l
10.	Trizophos 40%EC @1.25 ml/l
11.	Spinosad 45% EC 0.25ml/l
12.	Diafenthiuran 50%WP @ 1.25g/l
13.	Sulphur @3g/l
14.	Fipronil granules @8kg/ac
15.	Acephate @1g/l
16.	Acetamiprid@ 0.2g/l
	Herbicides
17.	Quizalopop Ethyl 5% EC
18.	Pyrithiobac Sodium 10%EC
19.	Oxyflorofen 3.5%EC
20.	Cyhalopop Butyl 10%EC
21.	Glyphosate + ammonium Sulphate 71SG
22.	Pendimethalin 30% EC
23.	2, 4 D Sodium Salt 80%WP
24.	Imazithaphir 10% EC
25.	Atrazin 50%WP
26.	Glyphosate 41%SL

Table.1 Compatibility of *Pseudomonas fluorescens* isolate with commonly used fungicides

Fungicides	Growth of *Pseudomonas fluorescens 8*		
	100 ppm	500 ppm	1000 ppm
Propiconazole250 EC	+ + +	+ +	+
Tebuconazole 430SC	+ + +	+ +	+
Trifloxystrobin25per centW/W + tebuconazole 50per centW/W, 75 WG	+ + +	+ +	+
Azoxystrobin 250SC	+ + +	+ + +	+ + +
Carbendazim 50per centDF	+ + +	+ +	+
Carbendazim12 per cent + mancozeb 63per centWP	+ + +	+ + +	+ +
Control	+ + +	+ + +	+ + +

[1]Rate of growth of *Pseudomonas fluorescens strain 8* in nutrient agar amended with various concentrations of fungicides: + + + = Good; + + = Moderate; + = Poor; and - = No growth.

Table.2 Compatibility of *Pseudomonas fluorescens* isolate with commonly used insecticides

Insecticide	Growth of *Pseudomonas fluorescens 8*		
	100 ppm	500 ppm	1000 ppm
T1-Imidacloprid 70 WG 70%@.025g	+ + +	+ + +	+ + +
T2- Monocrotophos 36% SL @1.6 ml/l	+ + +	+ + +	+ + +
T3- Chlorpyriphos 20%EC @2.5ml/l	+ + +	+ + +	+ + +
T4- Triazophos 40%EC @1.25 ml/l	+ + +	+ + +	+ + +
T5- Spinosad 45% EC 0.25ml/l	+ + +	+ + +	+ + +
T6- Diafenthiuran 50%WP @ 1.25g/l	+ + +	+ + +	+ + +
T7- Sulphur @3g/l	+ + +	+ + +	+ + +
T8- Fipronil granules @8kg/ac	+ + +	+ + +	+ + +
T9- Acephate @1g/l	+ + +	+ + +	+ + +
T10- Acetamiprid@ 0.2g/l	+ + +	+ + +	+ + +
T11- Control	+ + +	+ + +	+ + +

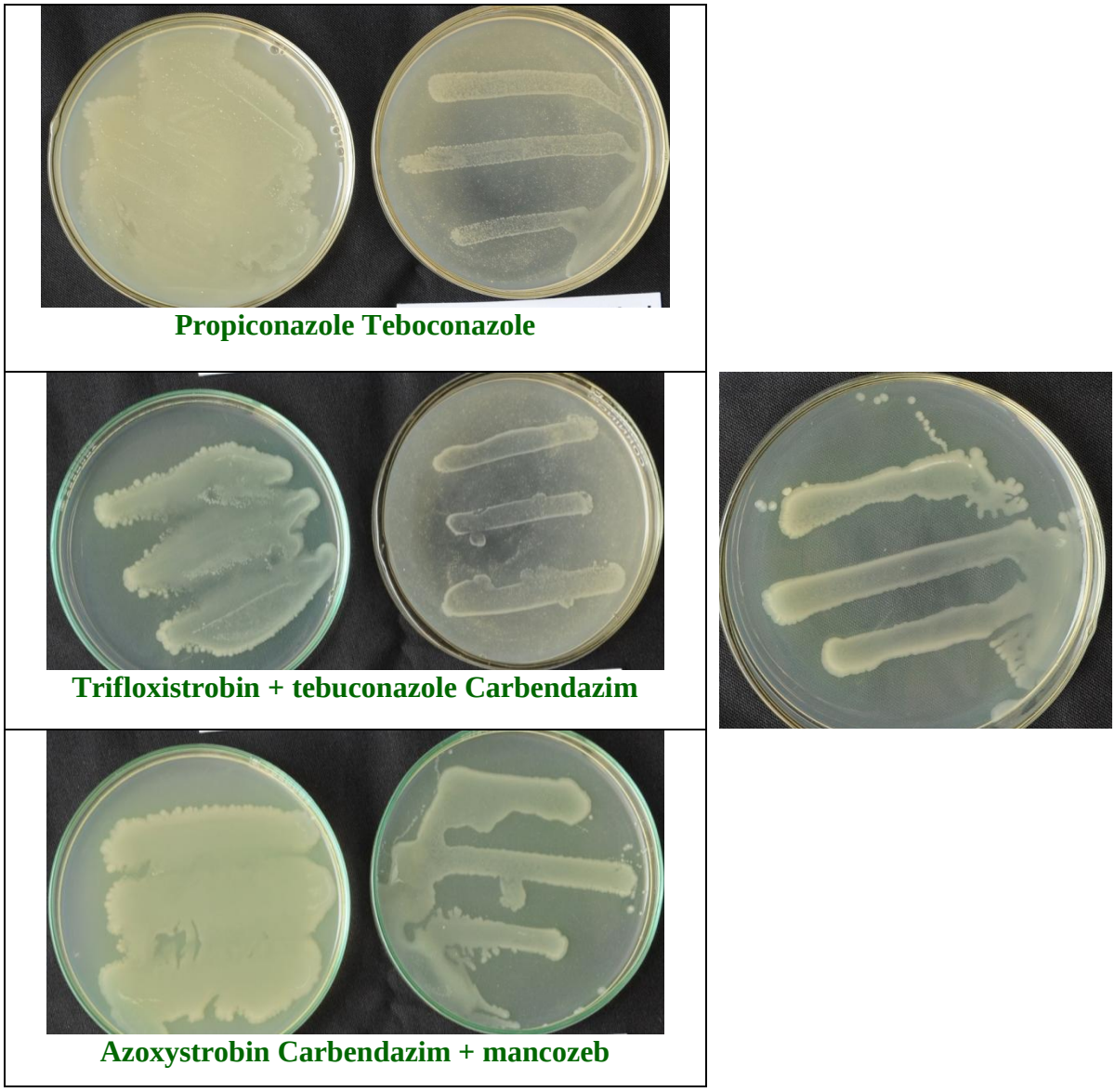
[1]Rate of growth of *Pseudomonas fluorescens strain 8* in nutrient agar amended with various concentrations of fungicides: + + + = Good; + + = Moderate; + = Poor; and - = No growth.

Table.3 Compatibility of *Pseudomonas fluorescens* isolate with commonly used Herbicides

Herbicide	Growth of *Pseudomonas fluorescens 8*		
	100 ppm	500 ppm	1000 ppm
T1- Quizalopop Ethyl 5 % EC	+ + +	+ + +	+ + +
T2- Pyrithiobac Sodium 10 % EC	+ + +	+ + +	+ + +
T3- Oxyflorofen 3.5 % EC	+ + +	+ + +	+ + +
T4- Cyhalopop Butyl 10% EC	+ + +	+ + +	+ + +
T5- Glyphosate + ammonium Sulphate 71SG	+ + +	+ + +	+ + +
T6- Pendimethalin 30% EC	+ + +	+ + +	+ + +
T7- 2, 4 D Sodium Salt 80 %WP	+ + +	+ + +	+ + +
T8- Imazithaphir 10% EC	+ + +	+ + +	+ + +
T9- Atrazin 50 %WP	+ + +	+ + +	+ + +
T10- Glyphosate 41% SL	+ + +	+ + +	+ + +
T11- Control	+ + +	+ + +	+ + +

[1]Rate of growth of *Pseudomonas fluorescens* strain 8 in nutrient agar amended with various concentrations of fungicides: + + + = Good; + + = Moderate; + = Poor; and - = No growth.

Plate.1 Compatibility of *Pseudomonas fluorescens* with different fungicides at 1000ppm



Diafenthiuron did not affect thegrowth of *P. fluorescens* and thus can be used simultaneously for the control of insect pests and seed and soil borne diseases of cardamom.

Compatibility with herbicides

The results pertaining to compatibility of *P. fluorescens* with herbicicides are presented in Table 3 and found that the strain *P. fluorescens* was compatible with all the tested herbicides *viz*., quizalopop ethyl, pyrithiobac sodium, oxyflorofen, cyhalopop butyl, glyphosate + ammonium, sulphate, pendimethalin, 2, 4- D sodium salt, imazithaphir, atrazin and glyphosate at all the three concentrations.

Surendran *et al.*, 2012 reported that *P. fluorescens* (PF 43) is highly compatible with 2,4 D sodium salt, metsulfuron methyl 10% + chlorimuron ethyl 10%Wp, cyhalopop butyl 10 EC, pyrazosulfuron ethyl 10WP, pretilachlor %) EC, penoxsulam 24 SP, bispyribac sodium 10SC. Beethi and Pillai (2008) reported that compatibility of *P.*

fluorescens was questionable with pretilachlor while, it showed compatibility with 2,4 D sodium salt. A combination of biocontrol agents with chemicals will have an additive effect and results in enhanced disease control compared to their individual application (Guetsky *et al.*, 2002). This is necessary to find out the possibility of its utilization in integrated disease management. The present investigation indicated that most of fungicides, insecticides and herbicides tested were compatible with *P. fluorescens* and it could be recommended to the farmers.

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How to cite this article:

Hanuman, L.N. and Bindu Madhavi, G. 2018. Compatibility of *Pseudomonas fluorescens* with Pesticides *in vitro*. *Int.J.Curr.Microbiol.App.Sci.* 7(03): 3310-3315.
doi: https://doi.org/10.20546/ijcmas.2018.703.381