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Compatibility of *Pseudomonas fluorescens* with Fungicides used in Banana Cultivation

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***Abstract* – *Pseudomonas fluorescens* is a Plant Growth Promoting Rhizobacteria (PGPR) as well as broad spectrum biocontrol agent for integrated disease management of banana. A study was carried out to evaluate the compatibility of *P. fluorescens* (KAU strain) with eleven fungicides commonly used in management of banana diseases by poisoned food technique. Each fungicide was tested at four concentrations viz., 0.05%, 0.1%, 0.2% and 0.3%. The results of the study proved that, seven fungicides viz., propiconazole, hexaconazole, tebuconazole, difenconazole, azoxystrobin, carbendazim and famoxadone + cymoxanil compatible at all tested concentrations. Kresoxim methyl was less compatible and mancozeb, copper oxy chloride and copper hydroxide are not compatible with *P.fluorescens*.**

***Keywords* – Pseudomonas Fluorescens, Fungicide Compatibility, Banana Diseases, Poisoned Food Technique.**

I. Introduction

As diseases and pests are major threat to banana crop, large quantities of plant protection chemicals are used in its cultivation. The uncontrolled use of plant protection chemicals in banana cultivation leads to pollution of atmosphere, water, soil and cause ill effects to human beings and other living entities. The awareness of the deleterious effects of plant protection chemicals in agriculture paved the way for organic/ sustainable agriculture.

Pseudomonas fluorescens is a Plant Growth Promoting Rhizobacteria (PGPR) as well as a broad spectrum biocontrol agent for soil borne as well as foliar pathogens including nematodes (4). This is an ideal candidate in organic agriculture and plays significant role in integrated disease management of banana. To overcome severe pest infestation in banana, application of insecticides and fungicides may be essential. At such situations, information on plant protection chemicals which are compatible to biocontrol agents are required (7, 9, 1, and 8). Hence the present study was carried out to evaluate the compatibility of biocontrol agent, *P. fluorescens* with eleven fungicides commonly used for management of banana diseases.

II. Materials and Methods

The compatibility of the KAU culture of *Pseudomonas fluorescens* with commonly used fungicides in banana cultivation was carried out *in vitro* by poisoned food technique. Four concentrations were selected for each fungicide viz., 0.05%, 0.1%, 0.2% and 0.3% based on the recommended dose. The details of fungicides used are given in Table1.

Table 1. Fungicides evaluated for compatibility to *Pseudomonas fluorescens*

Sl. No.	Common name, trade name and group of fungicide	Concentration (%)
1	Propiconazole – Tilt 25 EC -Triazole	0.05, 0.1, 0.2, 0.3
2	Difenoconazole – Score 25EC - Triazole	0.05, 0.1, 0.2, 0.3
3	Hexaconazole - Contaf 5EC - Triazole	0.05, 0.1, 0.2, 0.3
4	Tebuconazole - Folicur 25.9 EC - Triazole	0.05, 0.1, 0.2, 0.3
5	Azoxystrobin - Amistar 25 SC - Strobilurins	0.05, 0.1, 0.2, 0.3
6	Krersoxim methyl – Ergon 44.30 W/W - Strobilurins	0.05, 0.1, 0.2, 0.3
7	Carbendazim - Bavistin 50WP - Benzimidazole	0.05, 0.1, 0.2, 0.3
8	Famoxadone 22.5% + Cymoxanil 30 % - Equation Pro -Combination fungicide	0.05, 0.1, 0.2, 0.3
9	Copper oxy chloride – Fytran 50 WP – Copper fungicide	0.05, 0.1, 0.2, 0.3
10	Copper hydroxide - Kocide 77 WP - Copper fungicide	0.05, 0.1, 0.2, 0.3
11	Mancozeb - Indofil M45 75 WP - Dithiocarbamate	0.05, 0.1, 0.2, 0.3

Required quantity of the fungicide was added aseptically in to 100 ml King's B medium, just before pouring to sterilized Petri dishes. Petri dish containing King's B medium without fungicide was served as control. The culture of *P. fluorescens* was streaked on the respective plates and was incubated at 28 ± 1^{o} C for 48 hours. The growth of *P. fluorescens* in the poisoned plates was recorded as (-) : no growth, (+) : poor growth, (++) : moderate growth, (+++) : good growth. Three replications were maintained for each treatment.

III. Results and Discussion

Among the eleven fungicides, seven fungicides belongs to Triazoles, Strobilurins, Benzimidazole groups and the combination fungicide showed compatibility at all tested concentrations ie., up to 0.3% concentration (Table 2). The compatibility of Triazole fungicides *viz.*, propiconazole, hexaconazole and tebuconazole with *P. fluoresens* were reported earlier but with low concentrations of fungicide , upto 1000 ppm (3,5). The compatibility of difenoconzole

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fungicide with *P. fluoresens* was not reported. The results of present study proved that the commonly used Triazole fungicides in banana including difenconazole are compatible with *P. fluorsence* up to 0.3% concentration.

Among the Strobilurin fungicides, azoxystrobin showed compatibility up to 0.3%, whereas Krersoxim methyl showed compatibility only at lower concentration ie., 0.05 % where as less compatible with higher concentrations (Table 2). The compatibility of *P. fluorescens* with azoxystrobin was tested earlier at different concentrations up to 300 ppm and reported that it was compatible with all the concentrations (2).The compatibility of krersoxim methyl was not reported earlier.

Carbendazim, the Benzimidazole fungicide showed compatibility with *P. fluorescens* up to 0.3%. The earlier workers reported the compatibility of carbendazim with *P. fluorescens* up to 0.1% (11,6). The combination fungicide, Equation Pro (famoxadone + cymoxanil) showed compatibility with *P. fluorsence* at all tested concentration. The compatibility of Equation Pro with *P. fluorescens* was not reported earlier.

The copper fungicides, copper oxy chloride and copper hydroxide was compatible at 0.05 % where as not compatible at other concentration tested (Table 2). The perusal of literature revealed that some strains of *P.fluorscens* recorded compatibility with higher concentration of fungicides (6, 10). The Dithiocarbamate fungicide, mancozeb was less compatible/ tolerant at 0.05 and 0.1% and not compatible at 0.2 and 0.3 %. The tolerance of *P. fluoresens* up to 0.3% of mancozeb was reported earlier (6).

Table 2. Compatibility of *Pseudomonas fluorescens* with selected fungicides

Sl. No.	Treatments (Fungicides))	Concentration (%)			
		0.05	0.1	0.2	0.3
1	Propiconazole	+++	+++	+++	+++
2	Difenoconazole	+++	+++	+++	+++
3	Hexaconazole	+++	+++	+++	+++
4	Tebuconazole	+++	+++	+++	+++
5	Azoxystrobin	+++	+++	+++	+++
6	Krersoxim methyl	+++	++	++	++
7	Carbendazim	+++	+++	+++	+++
8	Famoxadone + Cymoxanil	+++	+++	+++	+++
9	Copper oxy chloride	+	-	-	-
10	Copper hydroxide	++	-	-	-
11	Mancozeb	+	+	-	-
12	Control	+++	+++	+++	+++

(-) : No growth (+) : Poor growth (++) : Moderate growth (+++) : Good growth

CONCLUSION

Pseudomonas fluorscens is compatible with propiconazole, difenoconazole, hexaconazole, tebuconazole, azoxystrobin, carbendazim and famoxadone + cymoxanil, the common fungicides used in banana cultivation. Kresoxim methyl a strobilurine fungicide was less compatible and mancozeb, copper oxy chloride and copper hydroxide are not compatible with *P.fluorescens*. The present study indicates the possibilities of combined use of fungicides with bio control agent *P. fluorsence* for the effective management of banana diseases.

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