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In Planta Studies on Downy Mildew Disease of Bittergourd Using Fungicides and Bioagents

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A B S T R A C T

Bittergourd is one of the most popular vegetable cultivated throughout India and extensively grown in Kerala. The fruits are used in a variety of culinary preparations and possess high nutritive and medicinal value. The commercial cultivation of bittergourd is very successful because of its high demand and market value. The major constraint faced in the cultivation of bittergourd is the incidence of diseases. Among the various diseases inflicting bittergourd, downy mildew is one of the most serious diseases in the state during the monsoon period leading to heavy economic losses. It is caused by the oomycete *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow. which is one of the most destructive pathogens of all cucurbits that affects the crop both in the field and those grown in passive or traditional greenhouses. Hence, two research experiments were carried out at the College of Horticulture, Vellanikkara in 2013-14, and two farm trials were laid out in farmer's field in 2014-15 to study the effect of fungicides and bioagents against downy mildew disease of bittergourd. The research experiment was conducted with ten treatments and three replications. Treatments were applied on symptom appearance. Three sprays were given at 14 days interval except for systemic fungicide (2 sprays) and incidence and severity of the disease were recorded before first spraying and 10 days after each spraying using 0-5 scale for both diseases and per cent disease severity (PDS) was calculated. In this study, the systemic fungicide pyraclostrobin (0.5 gl^{-1}) and the combination fungicide, cymoxanil + mancozeb (2gl^{-1}) having label claim as well as the bioagent, *P. fluorescens* were found effective and therefore were selected for farm trial experiments. In the farm trial laid out at Vaniayampara, it was noticed that all treatments were found effective than control, recording 13.63 – 19.88 per cent disease severity against 45.5 per cent in control (Table 2). Minimum severity was recorded in pyraclostrobin (0.5gl^{-1}) (13.63%) followed by cymoxanil + mancozeb (2gl^{-1}) (15.13%) and *P. fluorescens* (2%) (19.88%) and the highest yield was recorded in pyraclostrobin (0.5gl^{-1}) (18.27 kg/cent) followed by *P. fluorescens* (2%) (17.89 kg/cent).

Introduction

Bittergourd is one of the most popular vegetable cultivated throughout India and extensively grown in Kerala. This vegetable is also known as bittermelon in other parts of the world. In India this vegetable is called as "Karela". The fruits are used in a variety of culinary preparations and possess high nutritive and medicinal value. The fruits are rich in vitamin C and contain alkaloids like momordicine, saponine and albuminoides

which are medicinally important. The commercial cultivation of bittergourd is very successful because of its high demand and market value. The major constraint faced in the cultivation of bittergourd is the incidence of diseases. Among the various diseases inflicting bittergourd, downy mildew is one of the most serious diseases in the state during the monsoon period leading to heavy economic losses. It is caused by the oomycete *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow. which is one of the most destructive pathogens of all cucurbits that affects the crop both in the field and those grown in passive or traditional greenhouses. It is seen especially damaging in warm, humid climates where the pathogen thrives. The disease affects plants of all ages. Although the disease only infects foliage, a reduction in photosynthetic activity early in plant development results in stunted plants and yield reduction.

The disease is characterized by yellow to white patches on the upper surfaces of older leaves (Plate 1). On the underside, these areas are covered with white to greyish, cotton-like fungi. These "downy" masses are most often noticed after rain or heavy dew and disappear soon after sunny weather resumes. As the disease progresses leaves may eventually turn crisp and brown and fall off. The pathogen produces large lemon-shaped sporangia with a conspicuous papilla where the sporangia are borne singly on pointed tips of sporangiophores that branch at acute angles. This disease overwinters on plant debris and in the soil. A reduction of production costs by eliminating these diseases would make bittergourd cultivation more competitive in the market. However, currently the most effective means to control downy mildew is the use of fungicides. These fungicides either inhibit germination, growth or multiplication of the pathogen (Agrios, 1997). Under the above circumstances, an attempt was made to manage downy mildew disease of bittergourd using fungicides and bioagents.

Materials and Methods

Hence, two research experiments were carried out at the College of Horticulture, Vellanikkara in 2013-14, and two farm trials were laid out in farmer's field in 2014-15 to study the effect of fungicides and bioagents against downy mildew disease of bittergourd. The research experiment was conducted in the seed production plot of Central Nursery, Vellanikkara during June to September 2013 with variety Preethi, design RBD with ten treatments and three replications (Plate 2). The seeds were sown in mounds @ 4 seeds/ mound and agronomic practices were adopted as per the 'Package of Practices' recommendation of KAU 2011. Adequate plant protection measures were taken for control of fruit flies and other pests. Treatments were applied on symptom appearance. Three sprays were given at 14 days interval except for systemic fungicide (2 sprays) and incidence and severity of the disease were recorded before first spraying and 10 days after each spraying using 0-5 scale for both diseases and per cent disease severity (PDS) was calculated. Initial symptom of downy mildew was noticed at 60 days after sowing. The fungicides and bioagents which were found effective in the experiment were further selected for farm trial and the farm trials were conducted at Vaniyampara during June - Sept 2014 and Sept - Dec 2014 (Plate 3).

Results and Discussion

In this study, the application of all the fungicides significantly reduced the disease severity and consequently increased yield in the fungicide treatments as compared to the unprotected check (Table 1). However, the minimum disease severity was recorded in the

treatment pyraclostrobin (T_2) which was closely followed by the combination fungicides, famoxadone + cymoxanil and cymoxanil + mancozeb which were on par with each other (Fig. 1.). Among the bioagents, *Pseudomonas fluorescens* was more effective than *Trichoderma viride* and it was on par with the combination fungicides which may be due to the production of defense related enzymes (Morsy and Belal, 2014). With respect to yield, no significant difference was noticed among the treatments and this may be due to the late occurrence of downy mildew disease (Plate 4). The systemic fungicide pyraclostrobin (0.5 gl^{-1}) and the combination fungicide, cymoxanil + mancozeb (2gl^{-1}) having label claim as well as the bioagent, *P. fluorescens* were found effective and therefore were selected for farm trial experiments. In the farm trial laid out at Vaniayampara, it was noticed that all treatments were found effective than control, recording 13.63 – 19.88 per cent disease severity against 45.5 per cent in control (Table 2).

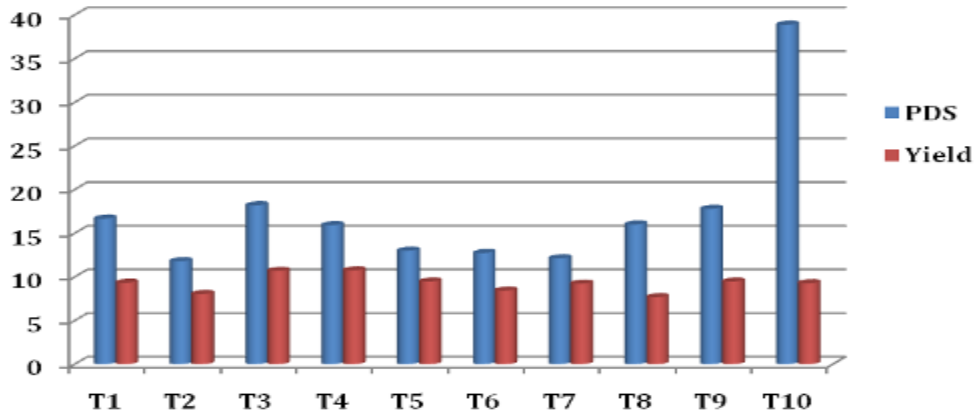
Table.1 Effect of treatments on per cent disease severity and yield of bittergourd

Treat. No	Treatments	Per cent disease severity	Per cent reduction over control	Yield, kg/plot ($8m^2$)
T_1	Azoxystrobin (1.5 mll^{-1})	16.67^{bc}	57.11	9.33
T_2	Pyraclostrobin (0.5 gl^{-1})	11.80^{a}	69.64	8.03
T_3	Propineb (3gl^{-1})	18.20^{c}	53.17	10.68
T_4	Fenamidone+ mancozeb (2gl^{-1})	15.93^{abc}	59.01	10.75
T_5	Cymoxanil+ mancozeb (2gl^{-1})	13.00^{ab}	66.55	9.45
T_6	Famoxadone+ cymoxanil (1$mll^{-1)}$	12.73^{ab}	67.24	8.42
T_7	*P.fluorescens* (20gl^{-1})	12.13^{ab}	68.79	9.22
T_8	*T.viride* (20 gl^{-1})	16.00^{abc}	58.83	7.67
T_9	Mancozeb (2gl^{-1})	17.80^{c}	54.20	9.45
T_{10}	Control	38.87^{d}	-	9.28
	CD (0.05)	**4.30**		**NS**

Table.2 Effect of different treatments on per cent disease severity and yield of bittergourd

Treat No.	Treatments	Per cent severity			Yield (kg/cent)		
		Farm trial - I	Farm trial -II	Mean	Farm trial -I	Farm trial -II	Mean
T_1	Pyraclostrobin (0.5 gl^{-1})	13.75	13.50	13.63	10.58	25.95	18.27
T_2	Cymoxanil+Mancozeb (2gl^{-1})	14.00	16.25	15.13	7.30	24.65	15.98
T_3	*P.fluorescens* (20gl^{-1})	24.75	15.00	19.88	12.18	23.60	17.89
T_4	Control	27.50	63.50	45.5	10.41	18.55	14.48

Fig.1 Effect of treatments on per cent disease severity and yield of bittergourd



T1 -Azoxystrobin (0.15%), T2- Pyraclostrobin (0.05%), T3- Propineb (0.3%), T4 -(Fenamidone +Mancozeb 0.2%), T5 -Cymoxanil +Mancozeb (0.2%), T6- Famoxadone +Cymoxanil (0.1%), T7-P.f (2%), T8 -*T.viride* (2%), T9-Mancozeb (0.2%), T10-Control

Plate.1 Symptoms of downy mildew disease of bittergourd

Plate.2 Field experiment of downy mildew of biitergourd

Plate.3 Farm trial conducted at Vaniyampara

Plate.4 Yield from different treatments of farm trial

Minimum severity was recorded in pyraclostrobin ($0.5gl^{-1}$) (13.63%) followed by cymoxanil + mancozeb ($2gl^{-1}$) (15.13%) and *P. fluorescens* (2%) (19.88%) and the highest yield was recorded in pyraclostrobin ($0.5gl^{-1}$) (18.27 kg/cent) followed by *P. fluorescens* (2%) (17.89 kg/cent). According to Raziq (2008) and Beckerman (2009), prophylactic spraying of strobilurins like azoxystrobin, pyraclostrobin, kresoxim methyl, trifloxystrobin at seven to ten days interval is found to be effective in reducing the disease incidence. These fungicides are known to stimulate defense reactions and the synthesis of phytoalexin which, in turn, suppressed the activities of the pathogen, and thereby reduced disease severity. Thus, the application of fungicide pyraclostrobin

@0.5gl^{-1} and combination fungicide, cyamoxanil + mancozeb @ 2gl^{-1} minimized the downy mildew attack and consequently increased yield. An interval of 14 days between the sprays was found to be effective in controlling the disease. On the basis of this study, at least two sprays of fungicides should be made for the control of downy mildew disease. These fungicides should be used as part of an integrated control strategy, incorporating prudent cultural practices. The results also suggest that biocontrol agents can also be used as alternative and safe method to fungicides for controlling downy mildew disease of bittergourd. The spray should be started on the appearance of the disease symptoms, especially if weather conditions are conducive to the development of the disease. The crop should be sprayed when the weather is clear, as in rainy season, the spray is not effective. To avoid the spread of the disease, pests like leaf hoppers should be controlled well in time, because these pests injure the plants, thus providing sites for the entry of the fungal spores and propagating the disease.

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