

Integrated management of Downy Mildew of gherkins caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow

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Gherkin (*Cucumis sativus* L.) belongs to family Cucurbitaceae, a native of tropical Africa, which is harvested raw for pickling. This exotic vegetable being grown in several parts of Karnataka for export. This vegetable is suffering from several economically important foliar diseases among which downy mildew caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow. is posing a serious threat to the successful large-scale cultivation. Integrated disease management study undertaken in field conditions during late *kharif* 2010-11 in Medleri village of Haveri district, Karnataka with Ajax genotype. Four fungicides, one botanical (*Allium sativum*) and one bioagent (*Pseudomonas fluorescens*) which were effective under *in vitro* studies. The treatments with foliar sprays of Metalaxyl-MZ → Fenamidon + Mancozeb → Dimethomorph at 0.2 per cent recorded least per cent disease index (30.27 PDI) which was found on par with Metalaxyl-MZ (30.42 PDI) and Fenamidon + Mancozeb (30.55 PDI) spray alone. The highest cost benefit ratio was obtained in Metalaxyl-MZ (1:14.63) followed by Metalaxyl-MZ → Garlic bulb extract → Metalaxyl-MZ (1:10.08). As the rotation of different molecules of fungicides avoids the resistance development by the pathogen against fungicides, rotation of fungicides is beneficial rather than the single molecule usage.

Key words : Gherkin, Downy mildew, *Pseudoperonospora cubensis*, Integrated disease management

INTRODUCTION

Gherkin or pickling cucumber (*Cucumis sativus* L.) is an exotic vegetable being grown in several parts of Karnataka exclusively for export markets in Spain, Australia, Germany, USA etc. Several private organizations in Karnataka are engaged in the cultivation and export of this vegetable through contract farming. Gherkins are consumed as salads or as pickles. They are also known for their medicinal properties. This vegetable is suffering from several economically important foliar diseases like downy mildew caused by *Pseudoperonospora cubensis* (Berk. and Curt.) Rostow., which is posing a serious threat to the successful large scale cultivation of this vegetable in India. Integrated plant disease management is currently implemented for plant disease control to reduce the use of fungicides, to enforced ecofriendly low cost and effective management of disease by integrating all available management strategies like cultural, biological, and chemical with resistant varieties. Integrated

disease management study has been undertaken in field conditions during late *kharif* 2010 in Medleri village of Haveri district, Karnataka with Ajax genotype. Four fungicides, one botanical (*Allium sativum*) and one bioagent (*Pseudomonas fluorescens*) which are effective under *in vitro* studies have been taken for field evaluation to develop IDM for gherkin downy mildew.

MATERIALS AND METHODS

A field experiment was conducted during November 2010 to January 2011 at Farmer's field, Medleri village of Haveri district of Karnataka state, under irrigated condition. The experiment was laid out in completely randomized block design (RBD) with thirteen treatments and replicated thrice. In each treatment ten plants were tagged and the efficacy of four fungicides, one botanical and one bioagent, were tested in different combinations with one untreated control. The fungicides were dissolved in known quantity of water to obtain 0.2 per cent

concentration. The botanical solution was prepared by macerating the known quantity of botanical and dissolved in known quantity of water to get 10 per cent concentration. The bioagent of commercial formulation was dissolved in known quantity of water to get 6 per cent concentration. The first spray was given at the appearance of the infection on the lower leaves. Second and third spray was given after 15 days interval. The downy mildew severity was recorded one day before the first spray and 7 days after every spray using per cent disease index (PDI) formula given by Wheeler (1969) : $PDI = \frac{\text{Sum of numerical rating}}{\text{Total no of samples} \times \text{Maximum of Rating scale}} \times 100$ and benefit cost ratio calculated by $\frac{\text{Additional returns over control (Rs/ha)}}{\text{Treatment cost} + \text{wages (Rs/ha)}}$

The treatment details are furnished below :

Treatment no	Treatment	Concentration (%)
T ₁	Metalaxyl 8% + Mancozeb 64% WP (Ridomil MZ 72 WP)	0.2
T ₂	Fenamidon 10%+ Mancozeb 50% WP (Sectin 60 WP)	0.2
T ₃	Dimethomorph 50 % WP (Acrobat 50 WP)	0.2
T ₄	Famoxadone 16.6% + Cymoxanil 22.1% SC (Equation Pro38.7SC)	0.2
T ₅	T ₁ → T ₂ → T ₃	0.2
T ₆	T ₂ → T ₃ → T ₁	0.2
T ₇	T ₃ → T ₁ → T ₂	0.2
T ₈	Garlic bulb extract (<i>Allium sativum</i>)	10
T ₉	T ₁ → T ₈ → T ₁	
T ₁₀	T ₂ → T ₈ → T ₂	
T ₁₁	<i>Pseudomonas fluorescens</i>	6
T ₁₂	T ₈ → T ₁₁ → T ₈	
T ₁₃	Control	

RESULTS AND DISCUSSION

Integrated plant disease management is currently implemented for plant disease control to reduce the use of fungicides, to enforced ecofriendly low cost and effective management of disease by integrating all available management strategies like cultural, biological, and chemical with resistant varieties. Field experiment was conducted during late *kharif* 2010-11 in Medleri village of Haveri district. Four fungicides, one botanical and one bioagent which were effective under *in vitro* studies viz., Metalaxyl 8% + Mancozeb 64% WP (Ridomil-MZ 72

WP), Fenamidon 10% + Mancozeb 50%WP (Sectin 60 WP) Dimethomorph 50%WP (Acrobat 50WP), and Famoxadone 16.6% + Cymoxanil 22.1%SC (Equation Pro 38.7 SC), Garlic bulb extract and *Pseudomonas fluorescens* as a component of integrated disease management along with control as a water spray were evaluated against downy mildew of gherkins under natural epiphytotic condition. The results (Tables 1 and 2,) after last spray revealed that among thirteen treatments, T₅ (Ridomil-MZ→ Sectin→Acrobat) (30.27 PDI), T₁(Ridomil MZ) (30.42 PDI) and T₂(Sectin) (30.55PDI) were significantly superior over other treatments. Whereas botanical, Garlic bulb extract alone (47.77 PDI) and bioagent alone *Pseudomonas fluorescens* (66.31 PDI) were not effective. Among the 8 fungicides tested against *Pseudoperonospora cubensis in vitro* Ridomil MZ proved most effective at all concentrations. Similar results were also obtained with Acrobat MZ, Ofurace, Acrobat, Antracol, Patatol and Aqomine which were next best in their efficacy in decreasing order while Indofil M-45 was least effective and reduced sporangia production by 87.2 per cent (Deshrajsharma *et al.* 2003). The management of downy mildew requires the use of tolerant cultivars in conjunction with fungicide applications (Elizabeth *et al.*, 2010). The chemically and biologically mediated systemic resistance in cucurbits against *P. cubensis* and some other fungal pathogens could be efficient part of Integrated Disease Management which is currently implemented to reduce use of fungicides (Anand *et al.*, 2007). Even though the bioagents were not effective but the botanical Garlic bulb extract combination with fungicide is quite good but not effective compared to fungicide treatments. The efficient management of cucurbit downy mildew is possible by incorporating prevention and agro technical aspects of drip irrigation with resistant varieties, systemic fungicides, and botanical like *Allium sativum* (Lebeda and Cohen, 2011). However, the highest cost benefit ratio was obtained in T₁ (Metalaxyl 8% + Mancozeb 64% WP) (1:14.63) followed by T₉(Ridomil MZ→Garlic bulb extract →Ridomil- MZ) (1:10.08) T₅(Ridomil MZ→ Sectin→ Acrobat) (1: 9.58). Least cost benefit ratio was found in T₄ (Famoxadone 16.6% + Cymoxanil 22.1%SC) (1:2.47) and garlic bulb extract (1:2.72) because of high treatment cost. To avoid the resistance development against fungicides by pathogen, the rotation of different effective fungicides should be

Table 1 : Field evaluation of integrated management options against downy mildew of gherkins

Treatment No.	Treatments	Concen- tration %	Downy mildew severity (PDI) %										Yield t/ha
			Before spray 20 DAS	7days after 1 st spray 28 DAS	14 days after 1 st spray 36 DAS	7days after 2 nd spray 44 DAS	14 days after 2 nd spray 52 DAS	7 days after 3 rd spray 60 DAS	14 days after 3 rd spray 68 DAS				
T ₁	Metalaxyl 8% + Mancozeb 64% WP (Ridomil- MZ 72 WP)	0.2	15.07 (22.83)*	18.37 (25.31)	21.47 (27.55)	24.62 (29.69)	27.36 (31.50)	28.90 (32.48)	30.42 (33.43)	5.20			
T ₂	Fenamidon 10%+ Mancozeb 50% WP(Sectin 60 WP)	0.2	15.04 (22.81)	22.59 (28.28)	24.68 (29.72)	28.25 (32.03)	29.95 (33.08)	30.03 (33.20)	30.55 (33.51)	4.77			
T ₃	Dimethomorph 50 % WP (Acrobat 50 WP)	0.2	15.04 (22.81)	25.51 (30.29)	27.49 (31.58)	29.21 (32.68)	32.34 (34.59)	33.43 (35.30)	36.17 (36.94)	3.84			
T ₄	Famoxadone 16.6% + Cymoxanil 22.1% SC (Equation pro38.7SC)	0.2	15.04 (22.81)	24.46 (29.60)	28.51 (32.16)	31.27 (33.97)	34.28 (35.79)	36.32 (37.03)	38.37 (38.25)	3.33			
T ₅	T ₁ → T ₂ →T ₃	0.2	15.02 (22.79)	18.64 (25.50)	22.15 (28.02)	24.67 (29.71)	28.59 (32.26)	29.10 (32.62)	30.27 (33.34)	5.17			
T ₆	T ₂ → T ₃ → T ₁	0.2	15.04 (22.81)	23.14 (28.72)	26.18 (30.67)	27.73 (31.53)	30.30 (33.35)	30.16 (33.23)	30.92 (33.74)	4.76			
T ₇	T ₃ → T ₁ → T ₂	0.2	15.02 (22.79)	24.38 (29.49)	28.75 (32.39)	27.42 (31.53)	27.01 (31.27)	28.62 (32.31)	32.77 (34.88)	4.45			
T ₈	Garlic bulb extract	10	15.08 (22.84)	27.66 (31.70)	30.87 (33.71)	34.54 (35.95)	37.07 (37.46)	41.19 (39.89)	47.77 (43.70)	1.30			
T ₉	T ₁ → T ₈ → T ₁		14.96 (22.75)	19.11 (25.84)	22.35 (28.17)	31.31 (33.95)	35.96 (36.80)	37.80 (37.90)	39.18 (38.72)	3.43			
T ₁₀	T ₂ → T ₈ → T ₁		15.11 (22.86)	21.71 (27.67)	25.94 (30.58)	32.67 (34.83)	36.80 (37.32)	38.87 (38.53)	40.48 (39.48)	3.34			
T ₁₁	<i>Pseudomonas fluorescens</i>	6	15.08 (22.84)	27.97 (31.90)	32.87 (34.95)	41.45 (40.04)	52.34 (46.32)	59.10 (50.22)	66.31 (54.52)	1.04			
T ₁₂	T ₈ → T ₁₁ → T ₈		15.07 (22.83)	27.23 (31.64)	30.79 (33.67)	39.30 (39.30)	50.37 (45.19)	55.39 (48.08)	61.05 (51.37)	1.27			
	Control		14.97 (22.75)	29.24 (32.67)	42.28 (40.53)	57.93 (49.55)	68.61 (55.93)	76.64 (61.12)	86.37 (68.42)	0.81			
	SEm±		NS	1.30	1.33	1.40	1.55	1.26	1.13	0.43			
	C D		NS	3.82	3.89	4.09	4.52	3.69	3.91	1.26			

* Figures in the parenthesis are arc sine transformed values

Table 2 : Economics of integrated disease management options against downy mildew of gherkins

Treatment no	Treatments	PDI	Yield t/ha	Treatment cost (Rs/ha)	Treatment cost + wages (Rs/ha)	Net income (Rs/ha)	*Additional returns over control (Rs/ha)	B : C ratio
T ₁	Metaxyl 8% + Mancozeb 64% WP (Ridomil- MZ 72 WP)	30.42	5.20	4200	4500	78000	65850	14.63
T ₂	Fenamidon 10%+ Mancozeb 50% WP)(Sectin 60 WP)	30.55	4.77	5928	6228	70500	58350	9.37
T ₃	Dimethomorph 50 % WP (Acrobat 50 WP)	36.17	3.84	9120	9420	57000	44850	4.76
T ₄	Famoxadone 16.6% + Cymoxanil 22.1% SC (Equation pro38.7SC)	38.37	3.33	14808	15108	49500	37350	2.47
T ₅	T ₁ → T ₂ → T ₃	30.27	5.17	6416	6716	76500	64350	9.58
T ₆	T ₂ → T ₃ → T ₁	30.92	4.76	6416	6716	70500	58350	8.69
T ₇	T ₃ → T ₁ → T ₂	32.77	4.45	6416	6716	66000	53850	8.02
T ₈	Garlic bulb extract	47.77	1.30	2400	2700	19500	7350	2.72
T ₉	T ₁ → T ₈ → T ₁	39.18	3.43	3600	3900	51450	39300	10.08
T ₁₀	T ₂ → T ₈ → T ₂	40.48	3.34	4752	5052	50100	37950	7.51
T ₁₁	<i>Pseudomonas fluorescens</i>	66.31	1.04	720	1020	15600	3450	3.38
T ₁₂	T ₈ → T ₁ → T ₈	61.05	1.27	1840	2140	19050	6900	3.22
	Control	86.37	0.81	-	-	12150	-	-

*Net income was calculated by considering market rate of gherkin Rs. 15,000/ton.

used for spray and even the cultural practices like removing base leaves; avoiding the irrigation in evening hours, with moderate resistant variety like Sparta we can manage the downy mildew of gherkins effectively.

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