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Noorulla Haveri
Scientist, Plant Pathology, ICAR-Krishi Vigyan Kendra, Kolar, Karnataka India

K Thulasiram
ICAR-Krishi Vigyan Kendra, Kolar, Karnataka India

Shashidhar KR
ICAR-Krishi Vigyan Kendra, Kolar, Karnataka India

Correspondence
Noorulla Haveri
Scientist, Plant Pathology, ICAR-Krishi Vigyan Kendra, Kolar, Karnataka India

Integrated approach for management of downy mildew of cucumber caused by *Pseudoperonospora cubensis*

Noorulla Haveri, K Thulasiram and Shashidhar KR

Abstract

The study was conducted in field conditions for two growing seasons during *rabi* 2017-18 and *rabi* 2018-19 (On Farm Testing - OFT) by ICAR-Krishi Vigyan Kendra, Kolar, Karnataka to develop effective integrated approach against downy mildew of cucumber. In the study, the approach comprising of soil application of *Trichoderma harzianum* enriched farm yard manure (@1 kg/100 kg FYM spot application), Seed treatment with Metalaxyl (2g/kg seeds), Prophylactic spray with Mancozeb @ 0.25% before onset of the disease followed by Curative sprays with Metalaxyl + Mancozeb @ 0.2%, and Dimethomorph @ 0.1% + Mancozeb @ 0.2% at weekly interval at onset of the disease was found most effective against the disease in field conditions. Further, the same approach was found superior in terms of yield and economics over control. Thus, this approach will be a suitable alternative to sole chemical management and will serve as effective IDM against downy mildew of cucumber under field conditions.

Keywords: Downy mildew, *Trichoderma harzianum*, on farm testing (OFT), fungicides and cucumber

Introduction

Downy mildew caused by *Pseudoperonospora cubensis* (Berkeley & Curtis) Rostov, is one of the most destructive diseases of cucumber (Wehner and Shetty, 1997)[15]. Symptoms firstly appear as pale green areas on the upper leaf surfaces, corresponding lower leaf surface change to yellow angular spots often restricted by veins. A fine dark brown to grayish downy growth soon appears on the lower leaf surface. Infected leaves generally die but may remain erect while the edges of the leaf blades curl inward. The lower leaves in the plant are infected first later infection spreads upward causing defoliation, stunted growth, poor fruit development and sometimes gives the entire plant a burnt like appearance (Bernherdt *et al.*, 1988)[2].

The control of epidemics of cucumber downy mildew was possible by growing resistant cultivars before 2004. However, a resurgence of the disease in 2004 and subsequent breakdown of the resistance resulted in yield losses of up to 40% (Colucci *et al.*, 2006)[5]. Presently, the disease continues to threaten production of cucurbits in warm humid regions around the world, including most production areas of India (Kagadi *et al.*, 2002)[10]. The resurgence of cucurbit downy mildew now requires renewed and improved management options for effective disease control in the field conditions.

Currently, disease management relies heavily on multiple applications of systemic fungicides that can effectively control the disease and protect yield when applied in a timely manner. The *P. cubensis* belongs to the group of 'the highest risk pathogens' with high evolutionary potential and thus employment of regular fungicidal use encourages the development of resistance in the pathogen (Urban and Lebeda, 2006)[14] increases the production cost and detrimental to the environment. Further, like all obligate plant pathogens, *P. cubensis* can survive and reproduce on living plant tissue or foliage during crop cycle and overwinter via oospores in absence of crop (Cohen *et al.*, 2011)[4]. Thus employment of biological agents will be suitable option to address the pathogen overwintering structure oospores for effective disease management.

Keeping in view the above facts it is imperative to formulate an effective region specific integrated disease management module consisting of diverse strategies against the disease. Effectiveness of prophylactic application of fungicides on onset of favorable environment before disease occurrence followed by curative sprays on disease onset has been reported by Jana Pavelkova *et al.* (2014)[8] in Cucumber. Further, most of the researchers have explored the possibility of using antagonistic bio-agents against *P. cubensis* in cucumber (Ahmed Mohamed *et al.*, 2006) [1]. Thus, the present study was conducted to evolve effective IDM approach by combining diverse strategies like cultural, biological and chemical measures.

Materials and Methods

The field experiment was conducted during two growing seasons, *Rabi* 2017-18 and *Rabi* 2018-19 by ICAR-Krishi Vigyan Kendra, Kolar, Karnataka, India (The experiment was conducted as a part of On Farm Testing - OFT). The experiment was laid out in randomized block design with three treatments and eight replications using the commercial cucumber hybrid Chitra. The soil of the experimental plot was red sandy loam in texture. The crop was raised as per the agronomic practices recommended by University of Horticultural Sciences, Bagalkot, Karnataka (India). The treatment details are mentioned hereunder,

M 1: Indiscriminate spray of one or combination of two fungicide *viz.,* Mancozeb @ 0.2%, Dimethomorph @ 0.1% + Metiram @ 0.2%, Copper Oxy Chloride @ 0.3%, Fenamidone + Mancozeb @ 0.3%, Metalaxyl + Mancozeb @ 0.2%, Cymoxanil + Mancozeb @ 0.3%, Copper Hydroxide @ 0.2%, Propineb @ 0.2%, Chlorothalonil @ 0.2% at weekly intervals starting from disease onset till completion of crop cycle.

M 2: Seed treatment with Thiram (2g/kg seeds), Prophylactic spray with Mancozeb @ 0.2% before onset of the disease, curative spray with Cymoxanil+Mancozeb @ 0.2% at onset of the disease.

M 3: Soil application of bio-agent enriched Farm yard manure (*Trichoderma harzianum* @ 1 kg / 100 kg FYM), Seed treatment with Metalaxyl (2g/kg seeds), Prophylactic spray with Mancozeb @ 0.25% before onset of the disease, Curative sprays with Metalaxyl + Mancozeb @ 0.2%, and Dimethomorph @ 0.1% + Mancozeb @ 0.2% at weekly interval at onset of the disease.

For soil application of bio-agents, 1 kg each talc formulation of *Trichoderma harzianum* (10^8 cfu/gram) was mixed with 100 kg well decomposed farm yard manure (FYM) and allowed to multiply for 15 days with 25-30% moisture level under proper shade conditions (Nirmalkar *et al.,* 2017)[11]. This enriched FYM was applied to the field (row application) just prior to transplanting. Seeds were treated with respective chemical before sowing. The prophylactic foliar sprays with fungicides were applied before onset of disease but on onset of disease favorable environment, whereas the curative foliar sprays were applied at onset of disease.

The late blight disease severity assessments were made by following 1-9 severity scale (Jenkins and Wehner, 1983)[9] and details of which are given in the below table.

The late blight disease severity assessments were made by following 1-9 severity scale

Scale	Description
0	No damage/ No symptoms
1	1-10 % of symptomatic leaf area
2	11-20 % of symptomatic leaf area
3	21-30 % of symptomatic leaf area
4	31-40 % of symptomatic leaf area
5	41-50 % of symptomatic leaf area
6	51-60 % of symptomatic leaf area
7	61-70 % of symptomatic leaf area
8	71-80 % of symptomatic leaf area
9	81-100 % symptomatic leaf area or dead

The disease index (%) was computed using the following formula (Wheeler, 1969) [16],

$$\text{Disease index (\%)} = \frac{\text{Sum of all individual ratings}}{\text{Total no. of plants examined x maximum score}} \times 100$$

All treatments were applied as described above and twenty plants each treatment block were selected for recording the observations. Disease severity was assessed one week after the last spray. The growth parameter like plant height was also measured in both the seasons. Fruits from each treatment were harvested separately and yield per plot was recorded further, benefit: cost ratio was also calculated. Yield data were pooled from all the harvests of each plot and expressed as t/ha. The original data was arc sine transformed and subjected to analysis of variances (ANOVA) and critical difference (CD) was used to separate the treatment means.

Results and Discussion

The present study was conducted to evolve region specific effective integrated disease management (IDM) approach against cucumber downy mildew. In the study, three IDM modules were tested in field condition for two growing seasons. During *rabi* 2017-18, the modules tested were significantly differed with respect to disease control of which M3 module has recorded significantly least downy mildew severity (11.09%) followed by M2 (21.11%) and significantly highest severity (26.79%) was noted in M1 module. Similar trend was observed during *rabi* 2018-19, wherein M3 module recorded significantly least downy mildew severity (12.35%) followed by M2 (22.10%) and M1 module found least effective with significantly highest severity (28.07%). Likewise in the pooled data two seasons M3 module was found most promising with lowest mean disease severity of 11.72 % followed by M2 (21.61%) and the module M1 was found least effective and exhibited the significantly highest mean disease severity of 27.43 % (Table 1).

Further, the modules exhibited significant variation in plant height during both the growing season. Of the three modules tested highest mean plant height of 166.52 cm was noted in M3 followed by M2 (160.97 cm) and M1 recorded least mean plant height of 156.93 cm (Table 2).

Additionally, the modules tested were also found most promising in enhancing the yield and benefit cost ration (BCR) in both the growing seasons tested. In this regard, M3 module witnessed significantly highest mean yield of 29.40 t/ha with a BCR of 2.46 followed by M2 (24.69 t/ha of yield and 2.10 of BCR) whereas M1 module recorded significantly least mean yield (21.80 t/ha) and BCR (1.91) (Table 3).

The present study demonstrates that, the M3 module was most effective against the cucumber downy mildew under field conditions. This agrees with the findings of Ahmed Mohamed *et al.* (2016)[1], who demonstrated the cumulative effect between various IDM components *viz.,* soil application of bio-agents, prophylactic fungicidal spray followed by curative fungicidal sprays against cucumber downy mildew compared to individual treatments and control. Similarly, Rajni Singh Sasode *et al.* (2018)[12] reported the effectiveness of IDM module against pearl millet downy mildew consisting of seed treatment (Metalaxyl), bio-agents application (*Trichoderma harzianum*), botanical spray (Neem leaf extract @10%) and the fungicidal spray (Mancozeb prophylactic, Metalaxyl+mancozeb and Amectoctradin+ Dimethomorph curative).

In the study, soil application of bio-agent (*Trichoderma harzianum*) enriched FYM lead to better management of the disease along with the other IDM components. This is in agreement with Elad and Kapat (1999)[6], who established a successful antagonism of plant pathogens by saprophytic microorganisms operating by nutrient competition, hyperparasitism, antibiosis and/or induced host resistance. Moreover, the efficacy of the tested bioagents against downy mildew may be due to Mycoparasitism is considered as a prime mechanism of plant pathogens control whereby a species or strain of microbe directly attacks and feeds on other fungi and in turn reduces the inoculums load in soil (Harman, 2000)[7]. The abundance of *P. fluorescens* and *T. harzianum* in the rhizosphere, the mycelium and other propogules of pathogen present in crop debris incorporated in soil seemed to be parasitized by the bio-agents (Shanthiyaa *et al.,* 2013)[13]. Further, depletion of essential nutrients at the point of contact, fast and high rate of sporulation and colonization capacity of bio-agents may have suppressed the infection by pathogen (Yao *et al.,* 2015)[17]. Besides, the prior application of bio-agents may have induced the systemic resistance in plant which in turn leads to better disease control (Boregowda Nandini *et al.*,2017)[3].

In our study, prophylactic sprays with mancozeb before onset of disease followed by curative sprays with Metalaxyl + Mancozeb and Dimethomorph + Mancozeb at onset of disease had additive effect in reducing the late blight severity in field. These results are in line with Kagadi *et al.* (2002)[10] who reported that, upon onset of congenial weather for late blight development the prophylactic spray with mancozeb serve as protective layer on foliage and destroy the sporangia landed on the foliage thereby delaying in onset of the disease. Due to delay in onset of disease crop may escape most susceptible stage for the disease further slows down the development disease epidemic. Immediately on onset of disease three curative fungicidal sprays at weekly interval effectively check the disease progress. This finding was supported by Jana Pavelkova *et al.* (2014) [8].

In conclusion, from the results reported in this study IDM module M3 consisting of diverse disease management strategies (soil application of bio-agents prior to planting, fungicidal seed treatment, prophylactic fungicidal sprays followed by curative fungicidal sprays) which are likely to be active during the complete crop cycle and found most effective in managing the cucumber downy mildew in field conditions.

Table 1: Effect of IDM modules on the severity of downy mildew of cucumber in the field experiment (On farm testing) conducted during *Rabi* 2017 and *Rabi* 2018

Modules*	Disease severity (%)		
	***Rabi* 2017-18**	***Rabi* 2018-19**	**Mean of *Rabi* 2017-18 and *Rabi* 2018-19**
M1	26.79 (31.19)**	28.07 (32.01)	27.43 (31.60)
M2	21.11 (27.37)	22.10 (28.06)	21.61 (27.71)
M3	11.09 (19.46)	12.35 (20.58)	11.72 (20.03)
S.Em.±	1.347	1.649	-
CD (0.05)	4.03	4.94	
CV (%)	9.62	8.76	

*Treatment details are given in materials and methods section

**Figures in parentheses are arc sine transformed values

Table 2: Effect of IDM modules on plant height of cucumber in field experiment (On farm testing) conducted during *Rabi* 2017-18 and *Rabi* 2018-19

Modules*	Plant height (cm)		
	***Rabi* 2017-18**	***Rabi* 2018-19**	**Mean of *Rabi* 2017-18 and *Rabi* 2018-19**
M1	158.45	155.40	156.93
M2	163.02	158.91	160.97
M3	170.41	162.62	166.52
S.Em.±	1.374	1.071	-
CD (0.05)	4.12	3.21	
CV (%)	7.62	8.84	

*Treatment details are given in materials and methods section

Table 3: Yield and economics of cucumber in field experiment (On farm testing) conducted during *Rabi* 2017-18 and *Rabi* 2018-19

Modules*	***Rabi* 2017-18**		***Rabi* 2018-19**		**Mean of *Rabi* 2017-18 and *Rabi* 2018-19**	
	Yield (t/ha)	**B:C ratio**	**Yield (t/ha)**	**B:C ratio**	**Yield (t/ha)**	**B:C ratio**
M1	23.80	1.94	19.80	1.87	21.80	1.91
M2	27.30	2.18	22.07	2.01	24.69	2.10
M3	31.50	2.47	27.30	2.44	29.40	2.46
S.Em.±	1.033	-	0.701	-	0.671	-
CD (0.05)	3.09		2.11		2.01	
CV (%)	10.31		8.97		9.33	

*Treatment details are given in materials and methods section

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References

1. Ahmed Mohamed, Amany Hamza, Aly Derbalah. Recent Approaches for Controlling Downy Mildew of Cucumber under Greenhouse Conditions. Plant Protection Sciences. 2016; 52(1):1-9.

2. Bernhaedt E, Dodson J, Waterson J. Cucurbit Diseases: a Practical Guide for Seeds Men, Growers and Agricultural Advisors. Saticoy, Petoseed Co, 1988.
3. Boregowda Nandini, Puttaswamy Hariprasad, Harischandra Sripathy Prakash, Nagaraja Geetha. *Trichoderma* oligosaccharides priming mediates resistance responses in pearl millet against downy mildew pathogen. Journal of Applied Biology & Biotechnology. 2017; 5(02):97-103.
4. Cohen Y, Rubin AE, Galperin M. Formation and infectivity of oospores of *Pseudoperonospora cubensis*, the causal agent of downy mildew in cucurbits. Plant Disease. 2011; 95:874.
5. Colucci SJ, Wehner TC, Holmes GJ. The downy mildew epidemic of 2004 and 2005 in the Eastern United States. Proceedings Cucurbitaceae. 2006; 403-411.
6. Elad Y, Kapa A. Role of *Trichoderma harzianum* protease in the biocontrol of *Botrytis cinerea*. European Journal of Plant Pathology. 1999; 105:177-189.
7. Harman GE. Myths and dogmas of biocontrol: changes imperceptions derived from research on *Trichoderma harzianum* T-22. Plant Disease. 2000; 84:377-393.
8. Jana Pavelkova, Ales Lebeda, Bozena Sedlakova. Efficacy of fosetyl-Al, propamocarb, dimethomorph, cymoxanil, metalaxyl and metalaxyl-M in Czech *Pseudoperonospora cubensis* populations during the years 2005 through 2010. Crop Protection. 2014; 60:9-19.
9. Jenkins JSF, Wehner TC. A system for the measurement of foliar diseases in cucumber. Cucurbit Genet. Cooperative report. 1983; 6:10-12.
10. Kagadi, SR, Deadman, ML, Pawar, DR, Gadre, UA. Effects of Fungicide Control of Downy Mildew (*Pseudoperonospora cubensis*) on Yield and Disease Management of Ridge Gourd (*Luffa acutangula*). The Plant Pathology Journal. 2002; 18(3):147-151.
11. Nirmalkar, VK, Shyam Singh, Rajkumar Singh Tiwari, Prasant P, Dushyant Kumar Kaushik. Field Efficacy of *Trichoderma harzianum* and *Rhizobium* against Wilt Complex of Chickpea. International Journal of Current Microbiology and Applied Sciences. 2017; 6(7):1421-1429.
12. Rajni Singh Sasode, Pandya RK, Pramod Kumar Fatehpuria. Management of pearl millet downy mildew by the application of bio-agents, chemicals and botanical. International Journal of Chemical Studies. 2018; 6(1):606-608.
13. Shanthiyaa V, Saravanakumar D, Rajendran L, Karthikeyan G, Prabakar K, Raguchander T. Use of *Chaetomium globosum* for biocontrol of potato late blight disease. Crop Protection. 2013; 52:33-38.
14. Urban J, Lebeda A. Fungicide resistance in cucurbit downy mildew - methodological, biological and population aspects. Annals of Applied Biology. 2006; 149:63-75.
15. Wehner, TC, Shetty NV. Downy mildew resistance of the cucumber germplasm collection in North Carolina field tests. Crop Science. 1997; 37:1331-1340.
16. Wheeler BJ. An Introduction to Plant Diseases. 1969; John Wiley and Sons, Ltd.
17. Yao Y, Li Y, Chen Z, Zheng B, Zhang L, Wang Q. Biological control of potato late blight using isolates of *Trichoderma*. American Journal of Potato Research. 2015; DOI 10.1007/s12230-015-9475-3.