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RESEARCH NOTE

Evaluation of valifenalate 6 % + mancozeb 60 % WG against downy mildew of cucumber

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ABSTRACT: Field studies were carried out to evaluate valifenalate 6 % + mancozeb 60 % WG against downy mildew of cucumber incited by *Pseudoperonospora cubensis*. The results revealed that, application of valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha had recorded lowest downy mildew severity (7.99%) with maximum yield of 12.23 t/ha which was significantly superior over standard check and untreated control. Therefore valifenalate 6 % + mancozeb 60 % WG can be an additional option for effective management of downy mildew of cucumber in order to break the fungicide resistance development by the pathogen against mancozeb. Subsequent testing on phytotoxicity revealed that there were no visual phytotoxic symptoms observed during the experimentation.

Keywords: Cucumber, valifenalate, disease severity, downy mildew, fungicide, phytotoxicity

Cucumber (*Cucumis sativus* L.) is an annual vegetable crop, grown during warm season across the world. In India, the crop is extensively cultivated under natural condition as it is grown in tropical, subtropical and milder temperate zones during *Kharif* and summer. On the onset of *rabi*, it is taken up in protected controlled conditions (Rai *et al*., 2008). Cucumber is attacked by various fungal, bacterial, phytoplasmal and viral diseases. Among them, fungal diseases such as *Alternaria* leaf blight, *Cercospora* leaf spot, *Septoria* leaf spot, target leaf spot, anthracnose, downy mildew, powdery mildew, *Fusarium* wilt, *Verticillium* wilt and gummy stem blight have a prominent role in reducing cucumber yield.

Downy mildew of cucumber incited by *Pseudoperonospora cubensis* is a common threatening disease which appears as angular, yellow lesions on the top surface of the infected leaf and corresponding underside of the leaf shows gray to black fuzz (sporangia) which gives dirty or velvety appearance. It causes abundant reduction in yield in terms of quality and quantity (Lebeda and Cohen, 2011). *P. cubensis* is an obligate parasite and overwinters on live cucurbit plants in areas with mild winter climates or plants growing in greenhouse/ protected environment (Keinath, 2015). *P. cubensis* attacks at least 50 cucurbit species which includes cucumber, cantaloupe, muskmelon, pumpkin, squash and watermelon (Lebeda and Widrlechner, 2003).

Traditionally, cucumber downy mildew was managed by an integrated approach that combined planting of resistant cultivars, cultural practices that reduce leaf wetness and a timely but limited application of broad-spectrum protectant or oomycete-specific fungicides (Holmes *et al*., 2006). Fungicide acts as an important tool for management of downy mildew in case of highly susceptible varieties during humid weather. The Fungicide Resistance Action Committee (FRAC) considers *P. cubensis* a pathogen with a high risk for development of resistance. Systemic fungicides should be used in combination with protectant fungicides to reduce the chance of developing fungicide resistant strains of the pathogen (Urban and Lebeda, 2006). Keeping all above in view, the present investigation was carried out to evaluate new combi-fungicide valifenalate 6 % + mancozeb 60 % WG against severity of downy mildew of cucumber and yield parameters.

The field experiment was laid out during 2020-21 and 2021-22 in a randomized complete block design with nine treatments and replicated thrice using local cucumber variety with a spacing of 125 × 90 cm. The first foliar spray of recommended fungicides was given as per the respective treatments after the onset of diseases, the second spray was given 10 days after the imposition of first spray and the last spray was given at an interval of 10 days. The disease severity on each treatment was recorded prior to the imposition of the

treatment and 10th day after first, second and third spray during the experimentation and the per cent disease severity was analyzed statistically. The final scoring of the disease severity was recorded as per disease index by following 0-5 scale as described by Jamadar and Desai (1997) given below (Table 1). Fifteen leaves randomly selected on five cucumber plants/plot were assessed for scoring the severity of diseases. The data were computed to percent disease index (PDI) using following formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Number of leaves observed}} \times \frac{100}{\text{Maximum disease rating value}}$$

The PDIs were suitably transformed into arcsine values and analyzed. The weight of cucumber fruits harvested/plucked were summed up for calculating total yield/plot and converted into t/ha and statistically analyzed.

Table 1. Disease rating scale used to assess the severity of downy mildew on cucumber leaves

Grade	Description (% leaf area infected)
0	No infection of downy mildew
1	0-10
2	10.1-15
3	15.1-25
4	25.1-50
5	> 50

To know the phytotoxic effect, the fungicide was sprayed at recommend dose (x, 1.5 x and 2.0 x), cucumber plants were observed at 1, 3, 5, 7 and 10 days after each application for phytotoxic symptoms like leaf injury, wilting, vein clearing, necrosis, yellowing, stunting, epinasty and hyponasty.

The pooled data of 2020-21 and 2021-22 revealed that downy mildew intensity in the trial ranged between 8.54 and 9.74 before implementation of treatments and was non-significant with each other. All the spray treatments were significant in managing disease in comparison to untreated control (Table 2). The fungicides were tested against downy mildew of cucumber and the results revealed that, the treatment plots sprayed with three applications of valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha - with 10 days interval has recorded minimum severity of downy mildew (7.99 %) which was followed by valifenalate 6 + mancozeb 60 % WG at 2500 g/ha (T_4) and at 2000 g/ha (T_3) with 8.33 and 9.20 per cent downy mildew, respectively which are on par with each other and are significantly superior over remaining treatments including standard check (T_7-mancozeb 75 % WP at 2000 g/ha with 24.09 %) and untreated control check (47.78 %). Among all the tested chemicals, the maximum percentage of reduction over control of downy mildew in cucumber was recorded with valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha (T_5) (83.29 %) which was followed by valifenalate 6 % + mancozeb 60 % WG at 2500 g/ha (T_4) (82.56) and at 2000 g/ha (T_3) (80.79) (Table 2).

Yield data recorded in response to different treatments are presented in table 2. Maximum yield of 12.23 t/ha was recorded with valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha (T_5) treatment followed by valifenalate 6 % + mancozeb 60 % WG at 2500 g/ha (T_4) and at 2000 g/ha (T_3) with 11.99 and 11.60 t/ha, respectively. These treatments are on par with each other and significantly superior over the rest of the treatments including standard (9.41 t/ha). The economics of valifenalate 6 % + mancozeb 60 % WG in managing the downy mildew of cucumber revealed that, the maximum BC ratio was recorded by valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha (T_5) with 1.31 followed by valifenalate 6 % + mancozeb 60 % WG at 2500 g/ha (T_4) and at 2000 g/ha (T_3) with 1.28 and 1.21, respectively against 0.68 by the standard check (Table 2). Further the phytotoxicity of valifenalate 6 % + mancozeb 60 % WG was tested, the observations revealed that, no visual phytotoxic symptoms such as leaf injury, leaf vein clearing, yellowing, stunting, wilting, necrosis, hyponasty and epinasty were observed on cucumber.

Table 2. Effect of formulation of valifenalate 6 % + mancozeb 60 % WG on downy mildew and yield of cucumber (Pooled data of 2020-21 and 2021-22

Tr. No	Treatment detail	Dose (g or ml/ ha)	Downy mildew (Severity (PDI))				ROC after 3rd spray (%)	Yield (t/ ha)	Benefit cost ratio
			Before spray	After I spray	After II spray	After III spray			
T1	Control	-	9.52 (17.95)*	27.08 (31.35)	38.06 (38.06)	47.78 (43.72)	-	7.14	-
T2	Valifenalate 6 % + mancozeb 60 % WG	1500	9.74 (18.16)	13.53 (21.57)	15.06 (22.82)	17.11 (24.42)	64.20	10.65	0.98
T3	Valifenalate 6 % + mancozeb 60 % WG	2000	9.29 (17.72)	8.26 (16.33)	8.94 (16.94)	9.20 (17.49)	80.79	11.60	1.21
T4	Valifenalate 6 % + mancozeb 60 % WG	2500	9.51 (17.95)	7.22 (15.57)	7.90 (16.32)	8.33 (16.92)	82.56	11.99	1.28
T5	Valifenalate 6 % + mancozeb 60 % WG	3000	8.54 (16.97)	6.74 (15.01)	7.67 (16.06)	7.99 (16.67)	83.29	12.23	1.31
T6	Valifenalate 10 % WG	1500	8.76 (17.15)	13.41 (21.47)	16.05 (23.60)	18.36 (25.34)	61.67	9.78	0.79
T7	Mancozeb 75 %WP	2000	8.62 (17.06)	17.91 (25.01)	19.23 (25.98)	24.09 (29.37)	49.66	9.41	0.68
T8	Ametoctradin 27 % + dimethomorph 20.27 %	800-1000	9.69 (18.12)	15.83 (23.44)	17.67 (24.85)	20.40 (26.84)	57.29	9.75	0.69
T9	Cymoxanil 8 % + mancozeb 64 % WP	1500	9.51 (17.96)	16.28 (23.77)	17.23 (24.51)	20.40 (26.84)	57.35.	9.66	0.73
	S. Em ±		**0.42**	**0.41**	**0.39**	**0.39**	**-**	**0.19**	
	CD at 5%		**NS**	**1.22**	**1.16**	**1.17**	**-**	**0.57**	

*Figures in the parenthesis are Arcsine transformed values; NS: Non significant; ROC: Reduction over control

The outcomes of present investigation are in agreement with Kagadi *et al*. (2002) who reported that 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. Alavi and Dehpour (2010) explained that application of mancozeb at 2000 ppm reduced the severity of downy mildew in cucumber with 24.4 per cent. Valifenalate is a new active ingredient discovered by Isagro Ricerca, belonging to group of CAA (Carboxilic Acid Amides), subgroup valinamide carbamates. The oomycetes fungi *P. cubensis* is the exclusive target of valifenalate, as it mainly inhibits the cell wall synthesis (Bermano *et al*., 2010). Noorulla *et al*. (2019) and Srividhya *et al*. (2019) also reported that curative sprays with metalaxyl + mancozeb at 0.2 % and dimethomorph at 0.1 % + mancozeb at 0.2 % at weekly interval at onset of the disease were found most effective against the disease in field conditions.

Based on the results of the present study, it can be concluded that valifenalate 6 % + mancozeb 60 % WG at 3000 g/ha (T_5) is effective in reducing downy mildew

disease of cucumber with high economic returns and could be an affective component of integrated disease management in cucumber.

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