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Management of downy mildew of cucumber by lowering toxic fungicide applications

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ABSTRACT

The results for management of downy mildew disease of cucumber revealed that the integration of treatments of fungicide and nutrients were more effective as compared to sole applications of fungicide, nutrients and combination treatments of different nutrients. The average infection rate was observed less in treatment T_5 (metalaxyl 4 % + mancozeb 64 % WP and potassium salt of active phosphorus sprayed alternatively). The disease progress curve revealed that the disease intensity was not uniform. The maximum disease progress curve value was observed in the treatment T_{11} (absolute control) and the lowest AUDPC value was observed in treatment T_5 than any other treatment. None of the attempted treatment showed any kind of phytotoxicity on plant parts of cucumber crop. The alternate spraying of fungicide (metalaxyl 4 % + mancozeb 64 % WP) and PSAP, i.e. treatment T_5 found effective over all other treatments during successive four observations and recorded 68.75, 64.89, 63.67 and 66.46 per cent downy mildew disease control during third, fourth, fifth and sixth observation, respectively. The alternate spraying of fungicide (metalaxyl 4 % + mancozeb 64 % WP) and chitosan, i.e. treatment T_3 found the second best treatment to lower downy mildew disease for all observations except first and second observation.

Key words : *Cucumber, Downy mildew, Management*

Introduction

Management of downy mildew and powdery mildew diseases is highly dependent on chemical fungicides. The phytopathogens have been combated effectively by foliar spray of chemical fungicides like copper oxychloride, metalaxyl + mancozeb, chlorothalonil, cymoxanil + mancozeb, fosetyl-Al, etc. However, the phytotoxicity of such fungicides coupled with prolonged persistence in tissues and huge residue accumulation in soil have resulted in dreadful consequences with respect to environment and human health. Few downy mildew fungi developed resistance against fungicides.

In such case, nutrients are important for growth and development of plants and also microorganisms and they are important factors in disease management (Agrios, 2005). Phosphorus (P_2O_5) has been shown to be most beneficial when it is applied to seedlings to control fungal diseases where vigorous root development permits plants to escape disease (Huber and Graham, 1999). It has been shown that potassium (K_2O) fertilization can reduce the intensity of several infectious diseases of obligate and facultative parasites. The application of zinc (Zn) reduces disease severity and boron (B) has a direct influence on functioning in cell wall structure and stability of host plant and has a beneficial effect on reducing disease severity. Chitosan molecule triggers a defence response within the plant, leading to the formation of physical and chemical barriers against invading pathogens.

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Hence, the study was undertaken to evaluate efficacy of alternate spray treatments of fungicides and nutrients with intension to reduce use of fungicides and development of fungicide resistance in pathogen.

Materials and Methods

The research work was conducted at Vegetable Improvement Project, NARP, Ganeshkhind, Pune - 67 during 2017-18. The cucumber variety *Himangi* was sown in second week of July during *kharif* season in Randomized Block Design (RBD) with three replications. Sprayings were carried out early in the morning or late in the evening to avoid drift losses of fungicides and other chemicals.

Evaluation of treatments under field

Four sprays of each treatment were taken up starting from the onset of disease at 10 days interval. The first spray was carried out 20 days after sowing with knapsack sprayer and subsequent sprays were carried out after 30, 40 and 50 days after planting**.** The disease scoring was carried out from five randomly selected plants in each row of each replication after five days of spraying as per 0-9 scale. Plants were observed to record the disease severity until physiological maturity using 0-9 scale (Table 1). The statistical analysis was carried out according to the standard method. The per cent disease intensity and per cent disease control was calculated by using the standard formulae given by Mckinney (1923).

Table 1. Disease Rating Scale

Scale	Leaf area infected
0	Leaf area free from infection
1	Leaf area infected up to 1%
3	Leaf area infected up to 10%
5	Leaf area infected up to 25%
7	Leaf area infected up to 50%
9	Leaf area infected more than 50%

Per cent disease Index (PDI) =

$$\frac{\sum \text{Numerical ratings}}{\text{Total no.leaves observed}} \times \frac{100}{\text{Maximum Grade}}$$

Per cent Control (PDC) = $\frac{C - T}{C} \times 100$

Where,
PDC= Per cent disease control
C= PDI in control treatment plot
T= PDI in treatment plot

Progress of downy mildew disease over a period of time

It was calculated by using two formulae, i.e. rate of infection and AUDPC

Rate of infection (units day^{-1})

An apparent infection rate (r) is the speedometer of epidemics of the plant disease as described by Van der Plank (1963) and is calculated by using following formula

$$r = \frac{2.3}{t_2 - t_1} \log_{10} \frac{x_2 (1 - x_1)}{x_1 (1 - x_2)}$$

Where r is rate of infection, $t_2 - t_1$ is the days between first observation and subsequent observation and x_1 and x_2 denoted the amount of disease on t_1 and t_2 dates, respectively.

AUDPC (Area Under Disease Progress Curve)

Disease progress curve has given a better idea to study the epidemics of plant diseases (Wilcoxson *et al*., 1975).

$$A = \Sigma x_i + (x_i - _1)d$$

Where A is AUDPC, x_i is PDI at i^{th} interval and d is time period between observations.

Yield of cucumber

Yield of marketable fruits was calculated as per each treatment and replications and was converted into ton per hectare (t/ha).

Observations on phytotoxicity

The phytotoxic effects such as chlorosis, tip burning, necrosis, epinasty, hyponasty, scorching, burning of flowers and fruits due to fungicidal treatments were recorded by visual observations based on 0 - 9 scale as in Table 2.

Results and Discussion

The first observations were recorded on per cent disease intensity 5 days before first spraying. The per cent disease index ranged between 1.31 to 1.74 per cent (Table 3). The results indicated that, all the treatments were statistically non significant over one another.

There was minimum downy mildew incidence at

Table 2. Scale of rating for phytotoxicity symptoms

Rating scale	Percentage of plant parts showing symptoms	Rating scale	Percentage of plant parts showing symptoms
0	No symptoms	6	51 – 60
1	01 – 10	7	61 –70
2	11 – 20	8	71 – 80
3	21 – 30	9	81- 90
4	31 – 40	10	91 – 100
5	41 – 50		

early growth stage of cucumber crop. Similarly, Lebeda (1990), reported that host plants may be infected at all developmental stages *viz*. seedlings, young and adult plants but symptoms on young and newly developing leaves are rather rare. The second observations for per cent disease intensity were recorded 5 days after first spray, the PDI was in the range of 4.34 to 9.43 per cent Table 3. Lowest value of PDI (4.34 per cent) was noticed in treatment T_4 (potassium salt of active phosphorus). During 3rd, 4th, 5th observation on downy mildew, the lowest value of PDI was in was noticed in treatment T_5 (T_1 and T_4 alternatively) than untreated control. The last observation i.e. 6th observation clearly showed that treatment T_5 (T_1 and T_4 alternatively) showed less PDI of downy mildew and gave best control of disease.

The result of the experiment revealed that, all the attempted treatments controlled the downy mildew disease as compared to absolute control. The maximum PDC of 53.94 per cent was observed in treatment T_4, i.e. potassium salt of active phosphorus (@ 4 g/lit) during 2nd observation (Table 4). Bhise *et al*. (2017), also evaluated potassium phosphite against *Plasmopara viticola* causing downy mildew of grape and concluded that it was most effective in controlling the downy mildew pathogen *in vitro*. During 3rd observation the maximum PDC of 68.75 per cent was observed in the treatment, T_5, i.e. alternate sprays of T_1 (metalaxyl 4 % + mancozeb 64 % WP) @ 2 g/L and T_4 (potassium salt of active phosphorus) @ 4 g/L. Sawant *et al*. (2016) found that the combination application of PSAP and mancozeb fungicide significantly reduced the downy mildew incidence in grapes than sole application of PSAP. During 4th, 5th observation on downy mildew, the maximum PDC was in was noticed in treatment T_5 (T_1 and T_4 alternatively). The last observation, i.e. 6th observation clearly showed that treatment T_5 (T_1 and T_4 alternatively) showed maximum PDC of downy mildew and gave best control of disease as compared to absolute control. For downy mildew management in cucumber a chemical fungicide (metalaxyl 4 % + mancozeb 64 % WP @ 2 g/L) is commonly used by crop growers. This fungicidal treatment was compared with all attempted treatments. Here, obtained values were positive and negative. Positive means the treatments were superior over chemical fungicide. The 4th, 5th and 6th observation showed that the treatments T_5, T_3, T_4 and T_6 had better control of downy mildew over sole fungicidal treatment. The treatments T_{11}, T_7, T_9, T_{10}, T_8 and T_2 had negative values and were found inferior to sole fungicide in control of downy mildew (Table 5).

The progress curve revealed that the disease intensity was not uniform among the treatments. The progress of downy mildew disease was higher due to favourable environmental conditions. The AUDPC values ranged between 779.43 to 2107.78 (Table 6). The maximum disease progress was observed in treatment T_{11} (absolute control) with value of 2107.78. The lowest AUDPC value (779.43) was observed in treatment T_5 (metalaxyl 4 % + mancozeb 64 % WP and potassium salt of active phosphorus alternatively) compared to any other treatment. The disease progress was slow in Treatment T_5 compared to all other attempted treatments. Even comparison between values of rate of infection (r) and AUDPC, it is very clear that T_5 is most effective in managing downy mildew of cucumber.

The yield values showed variation due to effects of different treatments. The yield values ranged from 11.49 t/ha to 16.38 t/ha. The maximum yield of 16.38 t/ha was recorded in treatment T_5 (T_1 and T_4 alternatively). The alternate sprays of fungicides and nutrients increased the yield of cucumber. The minimum yield was recorded in treatment T_{11} (absolute control) (11.49 t/ha) Table 7.

Table 3. Effects of spray treatments on downy mildew of cucumber

Tr. No.	Treatment details	Dose	Post spray	Mean PDI at Pre spray I	II	III	IV	V	Rate of infection (units day^{-1})	AUDPC values
1	Metalaxyl 4 % + Mancozeb 64 % WP	2 g/L	1.44 (6.86)	6.42 (14.66)	11.28 (19.62)	14.48 (22.36)	21.79 (27.81)	20.69 (27.05)	0.06	1049.15
2	Chitosan	4 ml/L	1.31 (6.55)	6.38 (14.61)	12.50 (20.70)	15.62 (23.27)	22.40 (28.23)	22.52 (28.32)	0.07	1113.17
3	T_1 and T_2 alternatively	2 g/L & 4 ml/L	1.50 (7.01)	5.76 (13.87)	7.59 (15.99)	12.82 (20.97)	17.39 (24.64)	17.44 (24.67)	0.06	850.20
4	Potassium salt of active phosphorus	4 g/L	1.45 (6.90)	4.34 (12.00)	11.51 (19.82)	13.58 (21.61)	21.14 (26.98)	19.81 (26.41)	0.06	990.24
5	T_1 and T_4 alternatively	2 g/L & 4 g/L	1.69 (7.44)	6.49 (14.75)	7.16 (15.50)	11.77 (20.05)	14.50 (22.08)	15.53 (23.20)	0.05	779.43
6	T_2 and T_4 alternatively	4 ml/L & 4g/L	1.59 (7.44)	7.48 (15.83)	10.57 (18.97)	13.90 (21.89)	21.42 (27.22)	20.01 (26.56)	0.06	1030.94
7	Commercial combination of micronutrients Zn, Mn, Mg, B, Mo, Fe	5 ml/L	1.68 (6.64)	5.28 (13.25)	18.06 (25.11)	24.78 (29.84)	35.29 (36.41)	41.04 (39.82)	0.06	1183.40
8	T_7 and T_1 alternatively	5 ml/L & 2 g/L	1.74 (7.14)	8.27 (16.70)	12.53 (20.72)	16.06 (23.62)	23.81 (29.02)	24.32 (29.54)	0.07	1280.00
9	T_7 and T_2 alternatively	5 ml/L & 4 ml/L	1.61 (7.20)	8.59 (17.03)	12.57 (20.74)	18.54 (25.49)	25.30 (30.11)	28.30 (32.13)	0.07	1224.10
10	T_7, T_2 second, T_1 third, T_4 fourth	5 ml/L 4 ml/L 2 g/L & 4 g/L	1.42 (6.79)	7.56 (15.95)	13.00 (21.13)	16.84 (24.22)	24.66 (29.42)	27.37 (31.53)	0.08	1678.89
11	Untreated control (water spray)		1.52 (6.79)	9.43 (17.88)	22.91 (28.58)	33.52 (35.36)	39.91 (39.17)	46.29 (42.86)	0.09	2107.78
	S.E (m) ±	0.93	0.47	0.49	0.18	2.27	0.22			
	C.D. (0.05)	N.S.	1.40	1.44	0.55	6.75	0.67			

Values in parentheses are arc sin transformed. * PDI- Per cent Disease Index; AUDPC : Area Under Disease Progress Curve.

Table 4. Effects of spray treatments on downy mildew and yield of cucumber

Tr. No.	Treatment details	Dose	Terminal PDI	PDC over Control (T_{11})	PDC over Fungicide (T_1)	t ha^{-1}	Yield: Per cent change over Control T_{11}	Yield: Per cent change over Fungicide T_1
1	Metalaxyl 4 % + Mancozeb 64 % WP	2 g/L	20.69	55.30	0.00	13.47	17.23	0.00
2	Chitosan	4 ml/L	22.52	51.34	-8.84	12.73	10.79	-5.49
3	T_1 and T_2 alternatively	2 g/L & 4 ml/L	17.44	62.32	15.72	15.11	31.51	12.18
4	Potassium salt of active phosphorus	4 g/L	19.81	57.20	4.26	14.54	26.54	7.94
5	T_1 and T_4 alternatively	2 g/L & 4 g/L	15.53	66.46	24.98	16.38	42.56	21.60
6	T_2 and T_4 alternatively	4 ml/L & 4g/L	20.01	56.78	3.31	13.99	21.76	3.86
7	Commercial combination of micronutrients Zn, Mn, Mg, B, Mo, Fe.	5 ml/L	41.04	11.34	-98.33	12.25	6.61	-9.06
8	T_7 and T_1 alternatively	5 ml/L & 2 g/L	24.32	47.47	-17.52	13.14	14.36	-2.45
9	T_7 and T_2 alternatively	5 ml/L & 4 ml/L	28.30	38.87	-36.76	12.04	4.79	-10.62
10	T_7, T_2 second, T_1 third, T_4 fourth	5 ml/L, 4 ml/L,2 g/L & 4 g/L	27.37	40.88	-32.25	12.90	12.27	-4.23
11	Untreated control (water spray)		46.29	0.00	-123.70	11.49	0.00	-14.70
	S.E (m) ±	0.22			0.91			
	C.D. (0.05)	0.67			2.70			

PDC : Per cent Disease Control, PDI : Per cent Disease Index

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