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Efficacy of iprovalicarb and copper oxychloride combination for the management of downy mildew of cucumber

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ABSTRACT

Downy mildew (*Pseudoperonospora cubensis*) is an important disease capable of causing heavy losses to cucumber in a short time and as a result judicious and timely application of fungicides remains one of the most important strategies for management of this disease. The present study was undertaken during two seasons of year 2019 and 2021 under field conditions to assess the efficacy of iprovalicarb 8.4% + copper oxychloride 40.6% WG (750 g, 1000 g and 1250 g/ ha) in comparison with copper oxychloride 50% WP @ 1015 g/ha and cymoxanil 8% + mancozeb 64% WP @ 1500 g/ ha against downy mildew of cucumber. Results from two years experiment indicated that three foliar applications of iprovalicarb 8.4% + copper oxychloride 40.6% WG @ 1000 g/ha at 7 days intervals were highly effective when applied as soon as the first symptoms of the downy mildew appear. The treatment iprovalicarb 8.4% + copper oxychloride 40.6% WG @ 1000 g/ha provided 74.52 and 80.69 per cent disease control during 2019 and 2021, respectively.

Key words: Cucumber, *Pseudoperonospora cubensis*, management, fungicide, *Cucumis*

Cucumber (*Cucumis sativus*) is an important annual vegetable crop commercially grown in the regions of humid, subtropical and temperate environments belonging to family *Cucurbitaceae*. Cucumber is the fourth most important economic crop after tomato, cabbage and onion in Asia (Tatlioglu, 1993). According to Atlas Big, among cucurbits, production of cucumber is second largest in the world, majorly contributed by China, Iran, Russia, Turkey and America (75% of the world production) (Anonymous, 2022a). During the year 2020-2021, India has exported 1,23,846 metric tonnes of cucumber valued $ 114 million of agricultural processed product as cucumber pickle, globally referred as gherkins or cornichons (Anonymous, 2022b). Punjab ranks 5th with the share of area and production i.e. 17.70 thousand hectares and 286.46 thousand tonnes, respectively (Anonymous, 2022c).

Cucurbits are attacked by several diseases and downy mildew disease caused by oomycetes *Pseudoperonospora cubensis* (Berk. and M.A. Curtis) Rostovzev is one of the most damaging diseases of cucurbitaceous crops all over the world (Palti and Cohen, 1980; Thomas, 1996). Total crop failure can happen if downy mildew infection occurs early in the crop season and no fungicides are used. The disease is characterized by the presence of pale-yellow spots on the upper surface of leaves which in advance stages coalesce to infect larger portions of leaves, which is followed by necrotic areas on leaves. On the corresponding lower surface of leaves, greyish coloured downy mycelial growth occurs bearing lemon shaped sporangia which is visible particularly in humid weather (Anonymous, 2022c). Sporangia produced on overwintered cucurbit vines are the primary source of inoculum and can be dispersed by wind. Downy mildew results in poor fruit setting, thereby causing reduction in yield and huge losses to cucumber growers. High humidity, heavy dew favor the disease development and after infection, downy mildew continues to grow under dry weather conditions as well. In Punjab, it occurs almost every year starting from end of April and causing severe damage. Since downy mildew is the compound interest disease, which proliferates very fast in congenial

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conditions. Earlier downy mildew of cucumber was managed by integrated approach that combined with tolerant/ resistant varieties, agronomical practices and timely application of protectants (Holmes and Thomas, 2006). Over last two decades, population structure of *P. cubensis* has been changed which led to emergence of virulent strains in cucurbit production regions (Cohen *et al*., 2015; Holmes *et al.,* 2006; Lebada and Urban, 2007). Due to prevalence of new strains and non-availability of resistant cultivars, use of judicious fungicides remains one of the most important strategies in IDM programs targeted against this disease. The goal of this study is to evaluate the effectiveness and optimize the dosage of this new fungicide iprovalicarb 8.4% + copper oxychloride 40.6% WG as a novel management option against downy mildew disease of cucumber.

MATERIALS AND METHODS

The experiment trials were carried out at the Research Farm of Plant Pathology, Department of Plant Pathology, Punjab Agricultural University (PAU), Ludhiana during two years in 2019-2021 (Zaid season) against cucumber downy mildew having geographical positions 30.9010°N and 75.8071°E. Cucumber seeds cultivar Punjab Naveen were grown in pots under growth room (controlled environment conditions). The plants were watered daily and maintained well prior to start this study. Inoculum for this study was prepared from *P. cubensis* isolate maintained on detached leaves of cucumber in trays and on potted plants under growth room conditions. For inoculum production, stock plants inoculated with the isolate were used to harvest the sporangia by washing the leaves with distilled water and adjusted the sporangial suspension at desired concentration (4.5 x 10^4 sporangia/ml) with the help of haemocytometer.

Specimens of iprovalicarb 8.4% + copper oxychloride 40.6%, iprovalicarb 50% WG and copper oxychloride 50% WP were obtained from Bayer Crop Science, Limited, Maharashtra. Commercial samples of cymoxanil 8% + mancozeb 64% WP used in the experiment were procured and evaluated for bio-efficacy under field conditions against downy mildew of cucumber.

For field trials and fungicide application, seeds of susceptible cultivar of cucumber Punjab Naveen were obtained from the Department of Vegetable Science, PAU, Ludhiana and raised in the field by following standard agronomic practices recommended by PAU (Anonymous, 2022c). The treatments were arranged into randomized complete block design (RCBD), including untreated control and each treatment was replicated thrice. Depending on the study, iprovalicarb 8.4% + copper oxychloride 40.6% at different concentrations *viz*., 750 g, 1000 g and 1250 g/ha which have not been used before for the control of downy mildew disease in Punjab were tested and commercial formulations fungicides iprovalicarb 50% WG @ 210 g/ha, copper oxychloride 50% WP @ 1015 g/ha and cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ ha were used in this experiment as standard checks (Table 1). The seedlings were planted in plot size 4 x 6 m^2. The crop was artificially inoculated after one month of transplanting with the pathogen through spray suspension method. In control plots only plain water was sprayed. To facilitate the infection, foliar applications of water were done after inoculation for three days. The first spray of fungicides was started

Table 1. Treatment details for efficacy evaluation of iprovalicarb 8.4% + copper oxychloride 40.6% against downy mildew of cucumber

Sr. No.	Treatment	Dosage /ha	
		(g) a.i.	Formulation (g/ha)
T1	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	63 + 304.5	750
T2	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	84 + 406	1000
T3	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	105 + 507.5	1250
T4	Iprovalicarb 50% WG	105	210
T5	Copper oxychloride 50% WP	507.5	1015
T6	Cymoxanil 8% + Mancozeb + 64% WP	1080	1500
T7	Untreated control	-	-

soon after the initial appearance of disease symptoms using knapsack sprayer fitted with a hollow cone nozzle. Afterward two more sprays were given after seven days. The fungicides were applied using the rates and formulations listed in Table 1. All agronomic practices such as weeding, cultivation were kept uniform for all treatments.

Disease incidence and disease severity were assessed from ten randomly selected plants from each replicate per treatment before first application and seven days after each application of fungicide. Disease was scored on 0-9 scale (Jenkins and Wehner, 1983) and the details of 0-9 scale were as follows: -

Scale	Chlorosis and necrosis (%)
0	No symptoms/damage
1	1-10%
2	11-20%
3	21-30%
4	31-40%
5	41-50%
6	51-60%
7	61-70%
8	71-80%
9	81-100%

Per cent disease index (PDI) for the analysis of disease severity and per cent disease control were calculated using the following formulae:

$$\text{Per cent disease index} = \frac{\text{Total sum of all disease ratings}}{\text{Total number of assessed x Maximum score in scale}} \times 100$$

$$\text{Per cent disease control} = \frac{\text{PDI in untreated} - \text{PDI in treatment}}{\text{PDI in untreated}} \times 100$$

Data related to total marketable yields were recorded from each plot for each treatment and converted into quintals per hectare.

Data on disease parameters (disease incidence, disease severity, yield) were analysed using analysis of variance (ANOVA) by using CPC-1 software and results were interpreted to work out the optimum dose for the test molecule.

RESULTS AND DISCUSSION

Bio-efficacy of iprovalicarb 8.4% + copper oxychloride 40.6% WG against downy mildew of cucumber during 2019

The data (Table 2) revealed that all the test fungicides proved effective in controlling downy mildew as compared with untreated control. The first application was given at the onset of disease in traces (DI<1) in all the plots. Seven days after 1st spray, among the different treatments, the minimum disease incidence (8.50%) was found in iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha which was found to be at par with cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha and iprovalicarb 8.4% + copper oxychloride 40.6%@ 1000 g/ha with 9.36% and 10.63% disease incidence, respectively. This was followed by iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha, iprovalicarb 50% WG @ 210 g/ha and copper oxychloride 50% WP @ 1015 g/ha with 23.38, 28.41 and 32.08 per cent disease incidence, respectively. The maximum disease incidence (41.43%) was recorded from untreated control. With respect to disease incidence, seven days after 2nd application of fungicides, showed that minimum disease incidence was observed in iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (14.16 %) which was found to be similar with cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha (15.67%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (17.60 %). The treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (28.19%) and iprovalicarb 50% WG @ 210 g/ha (31.88%) were found to be similar with each other. The treatment copper oxychloride 50% WP @ 1015 g/ha (42.19 %) was inferior to all the chemical treatment but superior to untreated control (59.77%). Seven days after third spray, the data showed that the minimum disease incidence was found in fungicide treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (23.50%), cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha (25.10%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (29.47%). This was followed by iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha, iprovalicarb 50% WG @ 210 g/ha and copper oxychloride 50% WP @ 1015 g/ha which showed 42.71, 45.56 and 52.25 per disease incidence,

respectively. The maximum disease incidence was recorded in untreated control (86.20%).

The data with respect to per cent disease severity was also recorded from all the treatments and presented in Table 2. Before the application of first spray, disease was noticed in traces in all the treatments. Seven days after the 1st spray, treatments iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha, cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha were found to be superior over all the other treatments with 4.18, 4.81 and 5.30 per cent disease severity, respectively. This was followed by iprovalicarb 8.4% + copper oxychloride 40.6% @ 750 g/ha (8.89%) and iprovalicarb 50% WG @ 210 g/ha (11.11%) which were found to be similar with each other. The treatment copper oxychloride 50% WP @ 1015 g/ha (12.22%) was found to be inferior as compared to all the fungicide treatments but superior to untreated control (19.77%). With respect to per cent disease severity after 2nd application, showed that the minimum disease severity (6.52%) was observed in iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha which showed parity with cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha (7.26%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (7.77%). This was followed by treatment iprovalicarb 8.4% + copper oxychloride 40.6% @ 750 g/ha (11.62%) and iprovalicarb 50% WG @ 210 g/ha (13.26%) which were found to be statistically at par with each other. The treatment copper oxychloride 50% WP @ 1015 g/ha was found to be inferior as compared to other fungicide treatments with 16.70 per cent disease severity. The maximum disease severity (26.87%) was recorded from untreated control. Seven days after third spray, data showed that the minimum disease severity was found in fungicide treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (9.85%), cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha (11.28%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (11.77%) which were found to be statistically similar among each other. The treatments iprovalicarb 50% WG @ 210 g/ha (15.26%), iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (15.62%) and copper oxychloride 50% WP @ 1015 g/ha (18.37%) showed parity among each other. The maximum disease was recorded in untreated control with per cent disease severity (46.20%).

With regards to terminal disease control, the maximum (78.68%) disease control was observed in treatment iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha followed by in cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha (75.59 %) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (74.52 %). The treatments iprovalicarb 50% WG @ 210 g/ha, iprovalicarb 8.4% + Copper oxychloride 40.6% @ 750 g/ha and Copper oxychloride 50% WP @ 1015 g/ha gave 66.98, 66.18 and 60.25 per cent disease control, respectively.

The application of iprovalicarb 8.4% + Copper oxychloride 40.6% WG @ 1250 and 1000g/ha, along with cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha resulted in the highest and statistically equivalent yield, producing 163.87, 158.32 and 161.33 q/ha, respectively. This was followed by iprovalicarb 50% WG @ 210 g/ha (141.58 q/ha), iprovalicarb 8.4% + Copper oxychloride 40.6%@ 750 g/ha (140.03 q/ha) and copper oxychloride 50% WP @ 1015 g/ha (136.42 q/ha). The lowest yield was recorded from untreated control (107.16 q/ha) (Table 2).

Bio-efficacy of iprovalicarb 8.4% + copper oxychloride 40.6% WG against downy mildew of cucumber during 2021

It is evident from the Table 3 that all the fungicide treatments were superior as compared to untreated control during 2021 season. The first application was given at the onset of disease in traces in all the plots. After seven days of 1st spray, among the different treatments, the minimum disease incidence (3.10%) was found in iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha which was found to be at par with cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha and iprovalicarb 8.4% + Copper oxychloride 40.6%@ 1000 g/ha with 3.42, 4.37 per cent disease incidence respectively. This was followed by iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (10.61%), iprovalicarb 50% WG @ 210 g/ha (12.49%), copper oxychloride 50% WP @ 1015 g/ha (13.62%). The maximum disease incidence (19.58 %) was recorded from untreated control. With respect to disease incidence, seven days after 2nd application of fungicides, showed that minimum disease incidence was observed in iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (6.90%) which was found to be statistically similar with cymoxanil 8% + mancozeb 64 WP @ 1500 g/ha

Table 2. Efficacy of iprovalicarb 8.4% + copper oxychloride 40.6% WG against downy mildew of cucumber during 2019

S. No.	Treatments	Dose (g/ha)	Disease incidence (%)				Disease severity (%)				Per cent disease control	Yield (q/ha)
			Before 1st spray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray	Before 1st spray	7days after 1st spray	7days after 2nd spray	7 days after 3rd spray		
T1	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	750	T	23.38 (28.78)	28.19 (31.88)	42.71 (40.71)	T	8.89 (17.20)	11.62 (19.18)	15.62 (23.20)	66.18	140.03
T2	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	1000	T	10.63 (18.92)	17.60 (24.66)	29.47 (32.76)	T	5.30 (13.20)	7.77 (16.05)	11.77 (19.73)	74.52	158.32
T3	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	1250	T	8.50 (16.71)	14.16 (21.87)	23.50 (28.21)	T	4.18 (11.35)	6.52 (14.49)	9.85 (18.14)	78.68	163.87
T4	Iprovalicarb 50% WG	210	T	28.41 (32.09)	31.88 (34.28)	45.56 (42.42)	T	11.11 (19.36)	13.26 (21.21)	15.26 (22.92)	66.98	141.58
T5	Copper oxychloride 50% WP	1015	T	32.08 (34.42)	42.19 (40.45)	52.25 (46.27)	T	12.22 (20.37)	16.70 (24.01)	18.37 (25.32)	60.25	136.42
T6	Cymoxanil 8 % + Mancozeb 64 % WP	1500	T	9.36 (17.47)	15.67 (22.59)	25.10 (30.26)	T	4.81 (12.22)	7.26 (15.63)	11.28 (19.32)	75.59	161.33
T7	Untreated control	-	T	41.43 (40.04)	59.77 (50.62)	86.20 (68.72)	T	19.77 (26.37)	26.87 (31.15)	46.20 (42.80)	-	107.16
	CD (p= 0.05)		-	5.64	5.99	6.65	-	2.59	3.10	3.15	-	15.35

Observations given are mean of three replications; Figures in parentheses are arc sine transformed value; T= Traces

(8.22%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (8.57 %). The treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (17.11%), iprovalicarb 50% WG @ 210 g/ha (19.62%) and copper oxychloride 50% WP @ 1015 g/ha (20.66%) were found to be statistically similar among each other. The untreated control was inferior to all the chemical treatment with 38.25 per cent disease incidence. Seven days after third spray, the data showed that the minimum disease incidence was found in fungicide treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (12.23%), cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha (14.82%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (17.71 %). This was followed by treatments iprovalicarb 50% WG @ 210 g/ha, iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha and copper oxychloride 50% WP @ 1015 g/ha which showed 24.56, 25.78 and 27.59 per disease incidence, respectively. The maximum disease incidence was recorded in untreated control (76.58%).

The data with respect to per cent disease severity was also recorded from all the treatments and presented in Table 3. Before the application of first spray, disease was noticed in traces in all the treatments. Seven days after the 1st spray, treatments iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha, cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha were found to be superior over all the other treatments with 2.13, 2.42 and 2.47 per cent disease severity respectively. This was followed by in treatments iprovalicarb 8.4% + copper oxychloride 40.6% @ 750 g/ha (4.28%), iprovalicarb 50% WG @ 210 g/ha (5.49%) and copper oxychloride 50% WP @ 1015 g/ha (5.96%) which were found to be statistically at par among each other. The maximum disease severity was recorded from untreated control (9.25%). With respect to per cent disease severity after 2nd application, data showed that the minimum disease severity (3.23%) was observed in iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha which showed parity with cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha (4.56%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (4.71%). This was followed by iprovalicarb 8.4% + copper oxychloride 40.6% @ 750 g/ha (7.11%), iprovalicarb 50% WG @ 210 g/ha (8.29%) and copper oxychloride 50% WP @ 1015 g/ha (8.33%) which were found to be statistically at par among each other. The maximum disease severity (16.58%) was recorded from untreated control. Seven days after third spray, data showed that the minimum disease severity was found in fungicide treatments iprovalicarb 8.4% + copper oxychloride 40.6%@ 1250 g/ha (5.56%), cymoxanil 8 % + mancozeb 64 % WP @ 1500 g/ha (6.82%) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (7.71%) which were found to be statistically at par among each other. The treatments iprovalicarb 50% WG @ 210 g/ha (9.89%), iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (10.11%) and copper oxychloride 50% WP @ 1015 g/ha (11.59%) showed parity among each other. The maximum disease was recorded in untreated control with per cent disease severity (39.91%).

With regards to terminal disease control, the maximum (86.06%) disease control was observed in treatment iprovalicarb 8.4% + copper oxychloride 40.6% @ 1250 g/ha followed by in cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha (82.91 %) and iprovalicarb 8.4% + copper oxychloride 40.6% @ 1000 g/ha (80.69 %). The treatments iprovalicarb 50% WG @ 210 g/ha, iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha and copper oxychloride 50% WP @ 1015 g/ha gave 75.22, 74.67 and 70.95 per cent disease control, respectively.

The application of iprovalicarb 8.4% + Copper oxychloride 40.6% @ 1250 g/ha and 1000g/ha along with cymoxanil 8% + mancozeb 64% WP @ 1500 g/ha resulted in the highest and statistically equivalent yield, producing 172.21, 164.65 and 166.89 q/ha, respectively. This was followed by iprovalicarb 50% WG @ 210 g/ha (152.74 q/ha), iprovalicarb 8.4% + copper oxychloride 40.6%@ 750 g/ha (151.36 q/ha) and copper oxychloride 50% WP @ 1015 g/ha (147.53 q/ha). The lowest yield was recorded from untreated control (120.47q/ha) (Table 3).

From the findings of the present investigation based on the two seasons of field trials, it is concluded that iprovalicarb 8.4% + copper oxychloride 40.6% WG @ 84 + 406 g a.i. /ha (1000 g/ha) is an effective treatment for the control of downy mildew of cucumber when applied as soon as the initial symptoms of the disease appears. Also, application of iprovalicarb 8.4% + copper oxychloride 40.6% at the recommended dose did not result into any

Table 3. Efficacy of iprovalicarb 8.4% + Copper oxychloride 40.6% WG against downy mildew of cucumber during 2021

S. No.	Treatments	Dose (g/ha)	Disease incidence (%)				Disease severity (%)				Per cent disease control	Yield (q/ha)
			Before 1st spray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray	Before 1st spray	7 days after 1st spray	7 days after 2nd spray	7 days after 3rd spray		
T1	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	750	T	10.61 (18.87)	17.11 (24.28)	25.78 (30.44)	T	4.28 (11.71)	7.11 (15.24)	10.11 (19.43)	74.67	151.36
T2	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	1000	T	4.37 (11.95)	8.57 (16.87)	17.71 (24.86)	T	2.47 (8.83)	4.71 (12.13)	7.71 (15.21)	80.69	164.65
T3	Iprovalicarb 8.4% + Copper oxychloride 40.6% WG	1250	T	3.10 (10.06)	6.90 (14.74)	12.23 (20.15)	T	2.13 (8.28)	3.23 (10.15)	5.56 (13.53)	86.06	172.21
T4	Iprovalicarb 50% WG	210	T	12.49 (20.66)	19.62 (26.19)	24.56 (30.42)	T	5.49 (13.53)	8.29 (16.62)	9.89 (18.99)	75.22	152.74
T5	Copper oxychloride 50% WP	1015	T	13.62 (21.56)	20.66 (26.90)	27.59 (31.59)	T	5.96 (14.07)	8.33 (16.62)	11.59 (19.82)	70.95	147.53
T5	Cymoxanil 8 % + Mancozeb 64 % WP	1500	T	3.42 (10.40)	8.22 (16.48)	14.82 (22.39)	T	2.42 (8.80)	4.56 (12.17)	6.82 (14.77)	82.91	166.89
T6	Untreated control	-	T	19.58 (26.03)	38.25 (38.15)	76.58 (61.06)	T	9.25 (17.50)	16.58 (23.95)	39.91 (39.15)	-	120.47
	CD (p= 0.05)			5.15	5.24	5.30		2.81	3.09	3.57	-	12.87

Observations given are mean of three replications; Figures in parentheses are arc sine transformed value; T= Traces

phytotoxic symptoms in the trials. In another study conducted by Katsube (2001) reported that strobilurin resistant strains could be controlled by chlorothalonil, mancozeb, oxadixyl and copper which were earlier used for downy mildew control. Chaudhry *et al. (*2009) described that minimum downy mildew incidence was recorded by spraying Success(9%), Ridomil gold (9%) and Alliet (11%) as compared to untreated control (78%). Furthermore, Satou (2003) suggested various fungicides for the control of downy mildew in cucumber and other vegetables. Significant reduction in cucumber downy mildew disease severity has also been observed in field experiments in Michigan when using mixtures including oxathiapiprolin (Goldenhar and Hausbeck, 2019).

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