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Effect of foliar sprays of fungicides on powdery mildew severity and fruit yield of cucumber during *Kharif* season

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Abstract

The experiment was conducted on the experimental farm of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, MPKV, Rahuri during *Kharif* seasons of 2018-19 and 2019-20 to check the Effect of foliar sprays of fungicides on powdery mildew severity and fruit yield of cucumber. The data obtained during *Kharif* 2018-19 it was revealed that all the treatments were significantly superior over unsprayed control. All treatment recorded significantly low disease severity over control at 50, 60 and 70 DAS. The disease severity recorded after first spray (50 DAS), indicated minimum disease severity (22.74%), recorded in the plot which was protected with hexaconazole which followed by propiconazole (26.38%) and penoconazole (28.75%) respectively.

Keywords: Cucumber, foliar spray, powdery mildew, fungicides

Introduction

Vegetables are an essential component of human diet for maintenance of good health. Eating vegetable provides health benefits people who eat more vegetables as part of an overall healthy diet likely to have a reduced risk of some chronic diseases. Vegetables supply carbohydrates, proteins, fats, vitamins and mineral elements which are the most essential requirements of our body.

In the family of *Cucurbitaceae*, the two major species found of cucumber powdery mildew are; *Golovinomyces cichoracearum* var. *cichoracearum* (D.C.) V.P. Heluta (Syn. *Erysiphe cichoracearum* D.C.) and *Podosphaera xanthii* (Castagne) U. Braun and N. Shishkoff (Syn. *Sphaerotheca fuliginea*, formerly known as *Sphaerotheca fusca* Blumer) (Sitterly, 1978; Miazzi *et al.*, 2011). There are in total six species of powdery mildew fungi recorded on cucurbits in different parts of the world, but it is difficult to separate the species because some species have many similarities. *Leveillula* sp., is usually considered a synonym of *Golovinomyces* sp. (Sitterly, 1978).

Powdery mildew can appear in most parts of the cucumber plant, but is most common in young tissues on the upper side of the leaves (Agrios, 2005). The root is not infected and fruits are free of visible infection (Sitterly, 1978). The first signs of infection are circular white spots, in both the upper and lower surface of the leaf (Robinson and Decker-Walters, 1997). The white lesions increase in number, until they cover both leaf surface and stems (Sitterly, 1978). Leaves that are seriously affected will become brown and shrunken. When young leaves are infected it can result in chlorosis. When conditions are ideal the powdery mildew can cover the whole leaf, cause leaves to die, which results in premature defoliation. Powdery mildew may also cause reduced yields with failed maturity and small and deformed fruits (Sitterly, 1978). Powdery mildew and downy mildew together causes up to 50 -70 per cent loss (Sitterly, 1978 and Awad, 2000).

At present cucumber is grown in an area of 2090 thousand hectares with a production of 65.33 million tonnes and productivity of 31.25 t/ha in the world (Vegetable Statistics), The total area under cucumber cultivation in India is 71000 hectare with a production of 1202000 tonnes with an average productivity of 16.92 tonnes.

In Western Maharashtra, it is mainly grown in major area Karjat, Jamkhed Tahsil of Ahmednagar district Bhor, Purander tahsil of Pune district; Kavathemahankal, Tasgaon tasil in Sangli district, Karveer, Gaganavada tahsil in Kolhapur district in Maharashtra, research work on important aspect of this disease and pathogens previously have not been done. Pathogen survives in different forms during unfavourable environmental condition and the appearance and progress of disease is region specific. Hence, it is necessary to conduct a survey of the disease, so that it's distribution and extent of spread can be understood and hot

spots may be located which also helps in natural screening for host plant resistance. Plant disease epidemiology as a sub discipline of plant pathology is concerned with the factors that cause plant epidemics. Environmental factors play important role in development of the disease. The environmental variables *viz.*, temperature, humidity, rainfall, sunshine, wind speed and number of rainy days are the most crucial, since they affect the pathogen, host or host pathogen interaction during pathogenesis. For disease development weather variables have been established in several host pathogen system. However, major information is available on the role of this climatic factor on the development of powdery mildew of cucumber. Therefore, it is important to study the correlation between meteorological factors and disease severity that affect the spread of disease in time and space.

Limited information is available on germination and survival of cucumber powdery mildew fungus *Erysiphe chichoracearum* in nature. Keeping this fact in view, it is important to study the effect of temperature on the survivability of pathogen. Considering the threat of powdery mildew to the crop, it is also important to study the effect of

leaf wetness and age of plant on powdery mildew development as a part of epidemiological study. The method of survival and spread of the pathogen needs to be worked out to delink the infection chain at appropriate time to manage the disease effectively. A single method of control may not be complete to manage this disease effectively. Hence, it is important to develop suitable disease management strategies through cultural practices like effect of dates of sowing and chemical practices like sensitivity of fungicides on spore germination and effect of foliar sprays of fungicides, bioagents and botanicals on powdery mildew severity and yield of Cucumber with a view to formulate an integrated approach against the disease under field condition.

Material and Methods

Fungicides

The following fungicides with their recommended dose to be effective against powdery mildew of cucumber and allied crops were used. The fungicides required for the experimental work were obtained from local market Rahuri.

Table 1: List of fungicides: common name, trade name, chemical name

Sr. No.	Common name	Trade name	Chemical name	Source
1.	Hexaconazole @ 5% EC @ 0.1%	Contaf (0.1%) 5 EC	(RS-2-(2,4- dichlorophenyl)-1-(1- H-1,2,4,- triazole-1-yL)- Hexane-2-OL	Rallis India Ltd., Mumbai, 400 001
2.	Penoconazole 10% EC @ 0.1%	Topas 10 EC (0.1%)	1-(2-(2,4 dichlorophenyl)-penty)-1H-1,2,4-triazole	Gharda Chemicals Ltd., Mumbai
3.	Tebuconazole @ 0.1%	Folicur 25 EC (0.1%)	(RS)-1-T-chlorophenyl-4,4-dimethyl-3 (1H-1, 2,4- trizole-1-methyl) pentane-3-1	Bayer India Ltd., Mumbai
4.	Tridemorph 25% EC @ 0.1%	Bayleton 25 WP (0.1%)	2, 6-Dimethyl-4-tridecylmorpholine	Sulphur Mills Pvt. Ltd., Mumbai
5.	Propiconazole 10% EC @ 0.1%	Tilt 25 EC (0.1%)	Dinitro-(1-methyl-heptyle) phenylcrotonate (capryl-dinitrophenyl crotonate)	De-Pondde Nemours and Company
6.	Sulfer 80% WP @ 0.1%	Sulfex 80% WP (0.1%)	Elemental sulphur	Sulphur Mills Pvt. Ltd., Mumbai
7.	Control (water)	-	-	-

Experimental details

Experiment site

The experiment was conducted on the experimental farm of Department of Plant Pathology and Agricultural Microbiology, Post Graduate Institute, MPKV, Rahuri during *Kharif* seasons of 2018-19 and 2019-20.

Layout and plan

The field experiments were conducted in Randomized Block Design (RBD) with seven treatments with three replication and pot culture experiment was conducted in Completely Randomized Design (CRD) with seven treatments and three replications.

Details of layout

Design : RBD
 Plot size : 2.70 x 3.40 m
 Spacing : 1.0 X 0.5 m
 Treatments : Seven (7)
 Replications : Three (3)
 Variety : Himangi
 Sowing date : 30 June (2018-19 and 2019-20)
 Fertilizer dose : 100.50.50 N:P:K g/ha., After one month of sowing top dressing of 50Kg N/ha.
 Insecticide : Imidacloprid WG70, 0.7 gm/ 10 lit water

Fungicides spraying schedule

The aqueous solution of required concentration of various treatments was prepared in water just before spraying. Three sprays of each solution was given, first at 50 days second at 60 days and third at 70 days after sowing during *Kharif* season of the year 2018-19 and 2019-20. The spray was done with the help of knapsack sprayer with hollow cone nozzle. During spraying of fungicide complete coverage of plant surface was ensured and the spray drifts of different treatments were avoided by taking appropriate precautions.

Interculture operation

After four weeks of germination, weeding and irrigation were done. Three weedings and two irrigations were needed.

Effect of foliar sprays of fungicides on powdery mildew severity and yield of cucumber during *Kharif* 2018-19 and 2019-20:

The field trials were conducted during *Kharif* 2018-19 and *Kharif* 2019-20 crop seasons, in Randomized Block Design (RBD) with seven treatments and three replications. Row to row distance was maintained at 1 m, plant to plant distance was maintained at 0.5 m. Cultivar of cucumber was sown on 30st June. Fertilizer basal dose 100:50:50 kg N:P:K per hectare was applied before sowing. After one month of sowing top dressing of 50 kg N/ha was applied.

Crop was sprayed twice with each fungicide at their recommended doses. The details of fungicides are given in Table 1. First spraying was done at the onset of disease symptoms and repeated after 10 days interval. Control plots was sprayed with same volume of water. Disease severity was recorded before the beginning of first spray and subsequent observations were recorded before each spray and finally disease severity was recorded 10 days after last spray. Before harvesting ten plants were selected randomly from each plot and total number of fruit per plot were counted. Fruit yield (kg/plot) was also recorded and finally converted in to 1/ha. Data was statistically analyzed using appropriate stastical method.

Observation

The ultimate aim of disease management is the increase in production. The yield attributes was studied as follows.

Fruit yield (q/ha)

At each harvesting the weight of all fruit from an individual treatment plot was recorded. At end of cropping the total yield of fruit summed up and average yield per plot was worked out. The net plot yield in kilogram was converted into yield in q/ha.

Data analysis

The data was statistically analyzed by using proper statistical techniques. Data recorded in percentage were first transformed to arcsin values before analysis and the treatments were compared to means of critical difference at five percent level of significance.

$$CD = \sqrt{2EMS/r}$$

Where, CD= Critical difference

r = Number of replications

t= t value at error degree of freedom

EMS = Error means of square

Result and Discussion

Effect of foliar sprays of fungicides on powdery mildew severity and fruit yield of cucumber during *Kharif* season 2018-19 and 2019-20: The field experiment was carried out

to evaluate the efficacy of six fungicidal with one check (water) for the control of powdery mildew of cucumber disease severity, yield parameter during 2018-19 and 2019-20 during crop season presented in Table 4.8 and 4.9 and Fig. 4.7-4.10.

Disease severity

The data on powdery mildew severity indicated that all the fungicides resulted in significant decrease powdery mildew severity during 2018-19 crop seasons (Table 4.8 Fig. 4.7) as compared to control treatment spraying were undertaken first treatment sprays was done immediately after initiation of disease symptoms (50 DAS) and subsequent treatments sprays at an interval of 10 days were given and observation on disease incidence and disease intensity were recorded at 50, 60 and 70 DAS.

The data obtained during *Kharif* 2018-19 it was revealed that all the treatments were significantly superior over unsprayed control (Table 4.8 and Fig. 4.8). All treatment recorded significantly low disease severity over control at 50, 60 and 70 DAS. The disease severity recorded after first spray (50 DAS), indicated minimum disease severity (22.74%), recorded in the plot which was protected with hexaconazole which followed by propiconazole (26.38%) and penoconazole (28.75%) respectively. While maximum disease severity recorded at 50.10 per cent was recorded in control plots. The disease severity recorded after second spray (60 DAS) was also indicated statistically significance over control. It recorded data revealed that the minimum severity (28.57%), was recorded in the plots treated with hexaconazole which was followed by propiconazole (33.07%) and ponoconazole (36.64%), respectively. While maximum severity (68.23%) was recorded in control plot. Similarly, the disease severity recorded after third spray (70 DAS) at the time of maturity was indicated statistically significance over control. It was revealed that, minimum severity (34.02%) was recorded in the plots protected with hexaconazole which was followed by propiconazole (37.88%), penoconazole (39.15%), respectively. While maximum disease severity (86.18%) was recorded in control plots.

The data on powdery mildew severity on cucumber plant during 2019-20 (Table 4.9) followed the same pattern as recorded during previous crop season

Table 2: Effect of foliar sprays of fungicide on powdery mildew severity and yield of cucumber during *kharif* 2018-2019

Treatment	PDI before 1 st spray	PDI after spray			Mean PDI	PDC after spray			Mean PDC	Yield (qt/ha)
		50 DAS	60 DAS	70 DAS		50 DAS	60 DAS	70 DAS		
Hexaconazole 5% EC (@ 0.1%)	9.17 (17.62)	22.74 (28.30)	28.57 (35.41)	34.02 (37.47)	28.44	55.61	59.13	60.52	58.42	84.99 (68.74)
Penoconazole 10% EC @ 0.1%	8.06 (16.48)	28.75 (32.38)	36.64 (38.23)	39.15 (37.8)	34.84	42.61	43.36	55.73	49.73	76.51 (61.47)
Tebuconazole @ 0.1%	9.33 (17.73)	30.22 (33.13)	43.55 (41.26)	39.22 (38.72)	37.66	39.68	40.17	54.49	44.78	74.47 (59.76)
Tridemorph 25% EC @ 0.1%	10.35 (18.75)	33.74 (34.73)	39.70 (39.06)	43.88 (40.90)	39.10	34.65	41.81	50.24	42.23	58.02 (49.65)
Propiconazole% EC @ 0.1%	9.28 (17.73)	26.38 (30.82)	33.07 (34.49)	37.88 (37.94)	32.44	47.34	51.53	56.05	51.64	80.42 (65.09)
Sulfex 80% WP @ 0.1	7.63 (16.02)	36.35 (35.05)	40.28 (38.81)	44.76 (39.65)	40.79	33.43	42.43	52.70	42.85	66.37 (55.45)
Control	9.00 (17.41)	50.10 (45.06)	68.23 (69.50)	86.18 (68.72)	67.17	0.0	0.0	0.0	0.0	52.99 (46.80)
S.E. +	0.55	1.51	1.87	1.87	-	-	-	-	-	2.24
CD at 5%	1.62	4.67	5.76	5.78	-	-	-	-	-	6.90
CV%	8.29	9.65	11.17	10.44	-	-	-	-	-	14.67

The disease severity recorded after first spray (50 DAS) indicated minimum disease severity (26.12%) was observed in the plot which was protected with hexaconazole which was at par with propiconazole (27.40%), followed by penoconazole (30.98%) and tebuconazole (32.88%),

respectively. While maximum disease severity (50.10%) was recorded in control plot. The disease severity recorded after second spray (60 DAS) was also indicated statistically significance over control. It was revealed that the minimum severity (30.52%) was recorded in plats protected with

hexaconazole which was at par with propiconazole (31.46%), followed by penoconazole (33.25%) and tebuconazole (39.14%), respectively. While maximum disease severity (68.23%) was recorded in control plot. Similarly, the disease severity recorded after third spray (70 DAS) at the time of maturity was indicated statistically significance over control. Data on powdery mildew was revealed that, the minimum severity (36.90%) was recorded in the plots protected with hexaconazole which was followed by propiconazole (38.90%) and penconazole (42.34%), respectively. While, maximum disease severity (86.18%) was recorded in control plot. The data on powdery mildew severity on cucumber plant during both crop season (Table 4.10) followed the same pattern as recorded during previous crop season. The disease severity recorded after first spray (50 DAS) indicated minimum disease severity (24.43%) was observed in the plot which was protected with hexaconazole which was at par with propiconazole (26.89%), followed by penoconazole (30.73%)

and tebuconazole (32.04%), respectively. While maximum disease severity (51.84%) was recorded in control plot. The disease severity recorded after second spray (60 DAS) was also indicated statistically significance over control. It was revealed that the minimum severity (30.66%) was recorded in plots protected with hexaconazole which was at par with propiconazole (32.27%), followed by penoconazole (33.85%) and tebuconazole (38.39%), respectively. While maximum disease severity (70.96%) was recorded in control plot. Similarly, the disease severity recorded after third spray (70 DAS) at the time of maturity was indicated statistically significance over control. The data on powdery mildew was revealed that, the minimum severity (36.66%) was recorded in the plots protected with hexaconazole which was followed by propiconazole (38.39%) and penconazole (41.78%), respectively. While, maximum disease severity (89.57%) was recorded in control plot.

Table 3: Effect of foliar sprays of fungicide on powdery mildew severity and yield of cucumber during *kharif* 2019-20

Treatment	PDI before 1 st spray	PDI after spray			Mean PDI	PDC after spray			Mean PDC	Yield (qt/ha)
		50 DAS	60 DAS	70 DAS		50 DAS	60 DAS	70 DAS		
Hexaconazole 5% EC (@ 0.1%)	7.47 (15.85)	26.12 (30.54)	30.52 (33.46)	36.60 (37.88)	30.41	53.24	58.58	61.37	60.40	85.77 (66.07)
Penoconazole 10% EC @ 0.1%	7.35 (15.73)	30.98 (34.02)	33.25 (38.12)	42.34 (40.59)	35.52	36.66	49.36	55.59	47.20	78.10 (58.85)
Tebuconazole@ 0.1%	9.31 (17.76)	32.88 (34.02)	39.14 (38.12)	44.34 (40.59)	37.78	36.66	49.36	55.59	46.20	73.62 (60.25)
Tridemorph 25% EC @ 0.1%	8.51 (16.94)	33.18 (33.89)	40.64 (38.39)	47.58 (41.86)	39.94	41.79	44.85	52.04	46.23	56.77 (48.93)
Propiconazole% EC @ 0.1%	9.33 (17.73)	27.40 (31.54)	31.46 (34.07)	38.90 (38.56)	35.59	48.85	57.31	58.51	54.89	80.10 (63.95)
Sulfex 80% WP @ 0.1	7.86 (16.26)	34.23 (35.60)	40.32 (36.83)	43.28 (39.97)	40.51	37.97	49.80	52.27	46.68	65.70 (55.06)
Control	9.00 (17.41)	50.10 (45.06)	68.23 (69.50)	86.18 (68.72)	67.17	0.0	0.0	0.0	0.0	54.99 (46.80)
S.E. +	0.55	1.51	1.87	1.98	-	-	-	-	-	2.24
CD at 5%	1.62	4.67	5.76	5.94	-	-	-	-	-	6.90
CV%	8.763	9.41	11.53	13.31	-	-	-	-	-	9.68

Table 4: Effect of foliar sprays of fungicide on powdery mildew severity and yield of cucumber (Pooled)

Treatment	PDI before 1 st spray	PDI after spray			Mean PDI	PDC after spray			Mean PDC	Yield (qt/ha)
		50 DAS	60 DAS	70 DAS		50 DAS	60 DAS	70 DAS		
Hexaconazole 5% EC (@ 0.1%)	8.59 (17.02)	24.43 (29.42)	30.66 (34.28)	36.66 (37.68)	30.29	52.87	60.92	62.18	60.10	84.88 (67.41)
Penoconazole 10% EC @ 0.1%	8.26 (16.64)	30.73 (33.58)	33.85 (39.69)	41.78 (39.66)	35.45	40.72	42.43	54.47	47.87	77.78 (59.31)
Tebuconazole@ 0.1%	8.76 (17.74)	32.04 (33.20)	38.39 (38.18)	44.25 (39.29)	37.22	42.05	45.90	55.06	46.67	73.56 (60.86)
Tridemorph 25% EC @ 0.1%	9.82 (18.24)	31.96 (34.31)	40.17 (38.73)	44.73 (41.38)	39.95	38.35	43.39	51.18	44.31	64.40 (49.29)
Propiconazole% EC @ 0.1%	9.31 (17.73)	26.89 (31.18)	32.27 (34.43)	38.39 (38.25)	32.52	48.13	54.52	57.14	53.26	79.60 (64.52)
Sulfex 80% WP @ 0.1	8.68 (17.09)	34.29 (35.32)	38.30 (37.82)	43.02 (39.41)	40.54	35.78	44.20	52.20	45.06	66.04 (55.26)
Control	9.1 (17.52)	51.84 (45.17)	70.96 (70.26)	89.57 (73.49)	70.79	0.0	0.0	0.0	0.0	53.81 (47.40)
S.E. +	0.40	1.05	1.61	2.18	-	-	-	-	-	2.57
CD at 5%	1.2	3.13	4.93	6.30	-	-	-	-	-	7.92
CV%	9.13	10.80	11.25	10.88	-	-	-	-	-	12.55

A perusal of the data on the effects of fungicides on powdery mildew severity under field conditions indicated that numbers of sprays had no effect on powdery mildew severity and only non-significant increase in disease severity was observed when the number of sprays was increased.

Fruit yield (q/ha)

The data on fruit yield as affected by foliar sprays of fungicide during 2018-19 and 2019-20 crop season revealed that all the fungicides resulted in significant increased in fruit yield as compared to control.

The data indicated that among the fungicides evaluated, three sprays of hexaconazole resulted in maximum fruit yield (84.99 q/ha) which was at par with three foliar sprays of propiconazole (80.42 q/ha). While minimum fruit yield (52.99 q/ha) was recorded control plot during 2018-19. Similar observation regarding yield were also recorded during 2019-20 crop season. Three sprays of hexaconazole resulted maximum fruit yield (85.77 q/ha) which was at par with three

foliar sprays of propiconazole (80.10 q/ha) while minimum fruit yield (54.99q/ha) was recorded in control plots. Similar observation regarding yield were also recorded during both crop season. Three sprays of hexaconazole resulted maximum fruit yield (84.88 q/ha) which was at par with three foliar sprays of propiconazole (79.60q/ha) while minimum fruit yield (53.81q/ha) was recorded in control plots.

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