JOURNAL OF PURE AND APPLIED MICROBIOLOGY, Dec. 2016. Vol. **10**(4), p. 3105-3109

Efficacy of Bioagents, Plant Extracts and Fungicides against Chilli Powdery Mildew Incited by *Leveillula taurica* (Lev.) Arn

M.V. Hareesh[1], R. Ganesha Naik[1], K. Jayalakshmi[1], T. Basavaraj Naik[2] and S. Pradeep[3]

[1]Department of Plant Pathology, College of Agriculture, University of Agricultural and Horticultural Sciences, Shivamogga - 577 225, India.
[2]Agricultural and Horticultural Resserch Station, Bavikere, University of Agriculturla and Horticultural Sciences, Shivamogga - 577 144, India.
[3]Organic Farming Research Centre, University of Agricultural and Horticultural Sciences, Shivamogga - 577 225, India.

http://dx.doi.org/10.22207/JPAM.10.4.85

(Received: 16 August 2016; accepted: 04 October 2016)

Powdery mildew of chilli incited by *Leveillula taurica* (Lev.) Arn. is a devastating disease of chilli. In the present investigation, management of Powdery mildew disease was undertaken during 2015-16 by the application of fungicides, bioagents and botanicals under field conditions. Among the twelve treatments, Myclobutanil (0.1 %) spray was found most effective in reducing the disease severity (PDI 17.37) followed by Triadimefon (PDI 20.70) and Hexaconazole (PDI 23.75) compared to control (PDI 88.24) respectively. The bioagents, *Pseudomonas fluorescens* (PDI 61.14) and *Trichoderma harzianum* (PDI 63.79) and the plant extracts *viz*., *Azardiracta indica* (PDI 62.56) and *Allium sativa* L. (PDI 63.54) were found less effective in reducing the disease severity as compared to fungicidal treatments respectively. Further, Myclobutanil and Triadimefon recorded higher dry chilli yield of 12.72 and12.27 q/ha. The highest cost: benefit ratio was obtained in Myclobutanil (1:2.43) sprayed plots followed by Triadimefon (1:2.39) respectively.

Keywords: Severity, *Leveillula taurica,* Bioagents, Plant extracts, fungicides.

Chilli (*Capsicum annum* L.), is an important commercial vegetable cum spice crop in India. India is a major producer, consumer and exporter of chilli and the crop is being grown in almost all the states. In addition to its domestic importance, chilli has tremendous export potential as a spice crop. Chilli suffers from many diseases caused by fungi, bacteria, viruses, nematodes and also abiotic stresses. Among the fungal diseases, powdery mildew, leaf spot and anthracnose or fruit rot are the most prevalent ones.

The powdery mildew caused by *Leveillula taurica* (Lev.) Arn. is a major constraint in chilli production in India causing heavy yield loss ranging from 14 to 20%, due to severe defoliation and reduction in photosynthesis, size and number of fruits per plant (Mathur *et al*., 1972; Sivaprakasam *et al*., 1976; Gohokar and Peshney, 1981; Sharmila *et al.,* 2004). Many systemic and non-systemic fungicides were reported to manage the powdery mildew and anthracnose of chilli. The information on the efficacy of new fungicides, bioagents and plant extracts against powdery mildew is insufficient. Hence, there is a need to evaluate new fungicides, bioagents and plant extracts against *Leveillula taurica*. By considering the the seriousness of disease and the economic damage caused by the disease, the present investigation was carried out by using different fungicides, bioagents and plant extracts for its efficacy against powdery mildew of chilli under field condition.

* To whom all correspondence should be addressed.

MATERIALS AND METHODS

A field experiment was conducted during *kharif and rabi* 2015-16 at College of Agriculture, University of Agricultural and Horticultural Sciences, Shivamogga. The experiment was laid out in Randomized Block Design with three replications and twelve treatments. Chilli local variety Byadagi kaddi seeds were sown in small beds and the nursery was raised. The seedlings of twenty five days old were transplanted at a spacing of 75×45 cm in plot size of 3.0×2.0 m with the recommended intercultural practices. All the foliar sprays were given as per their doses. Treatments includes two bioagents, *viz.*, *Trichoderma harzianum* (6×10^7 cfu/ml of water-1%) and *Pseudomonas fluorescens* (6×10^7 cfu/ml of water-1%), five plant extracts, *viz.*, *Azardiracta indica* (10%), *Allium sativa* (5%), *Agave americana* (5%), *Tagetes indica* (5%) and *Eichhornia crassipes* (5%) and four fungicides, *viz,* Wettable sulphur (0.3%) Triadimefon (0.1%), Myclobutanil (0.1%) and Hexaconazole (0.1%) with one untreated control were evaluated for their efficacy on management of powdery mildew disease. The first spray of the fungicides, biagents and plant extracts was done soon after the first appearance of disease. The same concentration were followed for second and third sprays at 12 days interval. The severity of the disease was scored at 10 days interval after each spray. The per cent disease index (PDI) was recorded on 10 plants and 10 leaves on lower, middle and upper leaves by using 0-9 scale (Mayee and Datar, 1986) and per cent disease reduction over control (PDC) was calculated and angular transformed data were analyzed statistically. Finally the dry chilli yield was recorded from each treatment. The cost: benefit ratio was worked out based on the cost of fungicides, bioagents and plant extracts spray cost, yield and the market value of chilli during 2015-16.

$$PDI = \frac{\text{Sum of individual ratings}}{\text{Total no. of observed leaves x Max. disease grade}} \times 100$$

$$PDC = \frac{PDIC - PDIT}{PDIC} \times 100$$

PDC = Per cent disease index over control
PDIC = PDI in control
PDIT = PDI in treatment

RESULTS AND DISCUSSION

During kharif 2015, the percent disease index (PDI) was to the tune of 88.24 percent. Proportionately different fungicides, bioagents and plant extracts controlled the disease effectively. Among the different fungicides, the percent disease index was significantly less (PDI 17.37) in Myclobutanil sprayed plots followed by Triadimefon (PDI 20.70) and Hexaconazole (PDI 23.75) and Wettable Sulphur (PDI 45.37). Whereas, the other treatments like *Pseudomonas fluorescens*, neem leaf extract, garlic bulb extract and *Trichoderma harzianum* were statistically on par with each other with PDI of 61.14, 62.56, 63.54 and 63.79 respectively and they were significantly superior over untreated control (Table 1).

Chemicals are the most common and practical method for the management of powdery mildew disease. The strobilurin fungicides, *viz*., azoxystrobin (Quadris), trifloxystrobin (Flint) and pyraclostrobin (Cabrio) have recently been labeled for the management of powdery mildew on chilli, but only preliminary reports are available on the efficacy of these fungicides against the severe form of the disease (Alexander and Waldenmaier, 2002). The strobilurin fungicides represent important class of chemicals for the management of a broad range of fungal diseases in agricultural production systems.

The highest per cent disease reduction of 80.31 per cent was recorded in Myclobutanil followed by Triadimefon (76.55) and Hexaconazole (73.08). Treatments like Wettable Sulphur, *Pseudomonas fluorescens* and neem leaf extract recorded considerably more per cent disease reduction (48.59, 30.71 and 29.10) respectively. Lowest per cent reduction of 6.56, 7.12 and 8.67 was recorded in marigold leaf extract, water hyacinth leaf extract and agave leaf extracts treatments respectively. Whereas, the other treatments which showed considerable per cent disease reduction over control were garlic bulb extract (28.0) and *Trichoderma harzianum* (27.71) respectively. These findings are in conformity with

Table 1. Efficacy of bioagents, plant extracts and fungicides against powdery mildew of chilli under field conditions during 2015-16

Tr. No	Treatments	Conc. (%)	Per cent disease index (PDI) Before 1st spray	After 1st spray	After 2nd spray	After 3rd spray	Per cent disease reduction over control	Dry chilliyield (q/ha)	B:C ratio
T_1	*Trichoderma harzianum*	1.0	15.80(23.32)*	26.76(31.16)	48.77(44.31)	63.79(53.04)	27.71	7.72	1:1.28
T_2	*Pseudomonas fluorescens*	1.0	15.27(22.96)	27.95(31.89)	45.10(42.20)	61.14(51.48)	30.71	7.94	1:1.34
T_3	Neem leaf extract	10.0	16.73(24.10)	29.12(32.67)	47.88(43.80)	62.56(52.32)	29.10	7.88	1:1.37
T_4	Garlic bulb extract	5.0	16.34(23.84)	28.07(31.98)	46.92(43.25)	63.54(52.89)	28.00	7.83	1:1.20
T_5	Marigold leaf extract	5.0	16.04(23.60)	34.37(35.89)	63.03(52.61)	82.45(65.40)	6.56	6.93	1:1.06
T_6	Agave leaf extract	5.0	15.34(23.06)	31.71(34.26)	61.51(51.70)	80.59(63.95)	8.67	7.15	1:1.12
T_7	Water hyacinth leaf extract	5.0	16.17(23.63)	32.42(34.71)	62.30(52.17)	81.96(65.22)	7.12	6.98	1:1.10
T_8	Wettable sulphur	0.3	15.30(22.97)	25.14(30.08)	35.17(36.39)	45.37(42.35)	48.59	8.88	1:1.62
T_9	Triadimefon	0.1	16.23(23.70)	21.78(27.82)	23.12(28.73)	20.70(27.05)	76.59	12.27	1:2.39
T_{10}	Myclobutanil	0.1	15.47(23.15)	17.29(24.56)	19.52(26.21)	17.37(24.61)	80.31	12.72	1:2.43
T_{11}	Hexaconazole	0.1	17.17(24.46)	23.86(29.24)	25.89(30.58)	23.75(29.15)	73.08	11.77	1:2.37
T_{12}	Untreated control	-	16.12(23.57)	36.16(36.95)	70.17(56.93)	88.24(70.19)		6.45	1:0.98
	S. Em±		1. 43	1.10	1.26	1.79		0.02	
	C. D at 5%		NS	3.32	3.78	5.37		0.06	

the reports of Sharmila *et al.* (2004) showed that control of chilli powdery mildew was achieved with the application of Penconazole followed by Propiconazole. Ekbote (2006) reported that Anvil 5SC (Hexaconazole) at 0.15 per cent was found best and recorded the lowest per cent disease index. Sudheendra Astaputre *et al.* (2007) reported that all Triozole fungicides (Penconazole followed by Triademefon, Propiconazole, Hexaconazole and Difenconazole) were found effective in reducing powdery mildew of chilli. Surwase *et al.* (2009) reported that Hexaconazole, Penconazole, botanical NSKE (5%) and *Trichoderma harzianum* (0.5%) were found highly effective and economical for controlling powdery mildew of pea.

The dry chilli yield was significantly superior in all the treatments as compared to untreated control. The highest yield was recorded in Myclobutanil treated plots (12.72 q/ha) which was significantly superior over all other treatments followed by Triadimefon (12.27 q/ha) and Hexaconazole (11.77 q/ha). The least yield of 6.45 q/ha was recorded in untreated control. This management effect was mainly due to translaminar and systemic movement of myclobutanil, triadimefon and hexaconazole, inside the tissues and it is widely distributed from the application side by diffusion. The results were supported by (Ahiladevi and Prakasam, 2014) who reported that effective management of powdery mildew disease of chilli by using azoxystrobin 25% SC. Alharbi *et al.* (2014) revealed that spraying with Topaz 200 EW significantly reduced the disease severity (3.5%) and increased the fruit yield of pepper (244.5 g/plant). Azit et al., 2014, reported that combi-fungicide UPF-509 (Azoxystrobin 8.3% + Mancozeb 66.7%) 75% WG at 1200, 1500 and 1800 g/ha along with recommended fungicides found effective in reducing the powdery mildew diseases in chilli and recorded maximum fruit yield of 22.28 q/ha.

Further, the results revealed that highest cost benefit ratio was obtained in Myclobutanil treated plots (1:2.43) followed by Triadimefon (1:2.39) and Hexaconazole (1:2.37). Among plant extracts and bioagents, garlic bulb extract recorded highest B:C ratio of 1:1.20 followed by Neem leaf extract (1:1.36), *Trichoderma harzianum* (1:1.28), *Pseudomonas fluorescens* (1:1.34) sprayed plots respectively. The plots sprayed with plant extracts like marigold leaf, agave leaf and water hyacinth leaf extracts were found to be less effective with low cost benefit ratio. This clearly indicated that three sprays of Myclobutanil (0.1%) are more useful not only in reducing the cost of protection but also gave higher benefits as compared to other treatments and can be recommended for the management of chilli powdery mildew. This is followed by Triadimefon and Hexaconazole applications. Similar types of findings were reported by many workers (Sharmila *et al.*, 2004 and Alharbi *et al.* 2014).

In the present study, the fungicide myclobutanil and tridimefon were found superior in reducing the chilli powdery mildew disease severity which remain on par with each other and thus helped for getting highest dry chilli fruit yield and B:C ratio. Alternatively the bioagent, *P. fluorescens* and plant extract, neem leaf extract can also be employed in the integrated management of chilli powdery mildew.

REFERENCES

1. Ahila Devi, P. and Prakasam, V., 2014, Efficacy of Azoxystrobin 25 SC along with bioagents on chilli powdery mildew diseases under field condition. *World Sci. Res. J.*,
2. **2**(1): 8-12.
3. Ajith Kumar, K., Savitha, A. S., Biradar, S. A., Rajanna, B. and Ramesh, G., 2014, Management of powdery mildew and anthracnose disease of chilli *Capsicum annum (L). Pest management in Horti. Ecosystems*., 20(**1**): 80-83.
4. Alexander, S. A. and Waldenmaier, C. M. 2002. Management of anthracnose in bell pepper. Fungic. Nematicide Tests (online) Report 57(55): 1094.
5. Alharbi, Asmaa, A. and Alawlaqi, M. M., 2014, Impact of some *Bacillus* spp., inducer resistant chemicals and cow´s skim milk on management of pepper powdery mildew disease in Saudi Arabia. *Life Sci., J.*, **11**(4): 1-7.
6. Ekbote, S. D., 2006, Bio-efficacy of Anvil 5SC against chilli powdery mildew. *Indian Soc. Mycol. Pl. Pathol.*, **36**: 57.
7. Gohokar, R. T. and Peshney, N. L., 1981, Chemical control of powdery mildew of chilli. *Indian J. Agric. Sci.*, **51**: 663-665.
8. Mathur, R. I., Singh, G. and Gupta, R. B. L., 1972, Chemical control of powdery mildew of chilli (*Capsicum annum*) caused by *Leveillula taurica. Indian J. Mycol. Pl. Pathol.*, **2**: 182-

183.
9. Mayee, C. D. and Datar, V. V., 1986, Phytopathometry. Technical Bulletin-1 (Special bulletin-3), *Marathwada Agric. Univ. Parbhani*, Maharashtra, India. p.29.
10. Sharmila, A. S., Kachapur, M. R. and Patil, M. S., 2004, Field evaluation of fungicides against powdery mildew *Leveillula taurica* (Lev.) Arn. on chilli (*Capsicum annum* L.). *J. Mycol. Pl. Pathol.*, **34**: 98-99.
11. Sivaprakasam, K., Jaganathan, R., Pillayarsamy, K. and Anavaradham, 1976, Control of powdery mildew of chillies. *Madras Agric. J.*, **63**: 52-54.
12. Sudheendra Ashtaputre, S., Srikanth Kulkarni., Rao, M. S. L. and Shivaprasad., 2007, Management of powdery mildew of chilli using triazole. *J. Pl. Dis. Sci.*, **2**(2): 132-134.
13. Surwase, A. G., Badgire, D. R. and Suryawanshi, A. P., 2009, Management of pea powdery mildew by fungicides, botanicals and bio-agents. *Ann. Pl. Prot. Sci.*, **17**(2): 384-388.