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STUDIES OF BIO EFFICACY AND PHYTOTOXICITY OF AZOXYSTROBIN 120 + TEBUCONAZOLE 240 SC POWDERY MILDEW *(LEVEILLULA TAURICA)* IN CHILLI

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Abstract

Chilli (*Capsicum annuum* L.) is an important cash crop among the spices. powdery mildew is caused by *Leveillula taurica* (Lev.) Arn., is a major constraint in chilli production in India, causing heavy yield loss ranging from 14 to 20%. The present study was taken up with an aim to evaluate the Studies of Bioefficacy and phytotoxicity of Azoxystrobin 120 + Tebuconazole 240 SC against *Powdery mildew* (*Leveillula taurica*) in Chilli, Experimental findings indicate that efficacy of the fungicidal products of Azoxystrobin 120 + Tebuconazole 240 SC (249 gm/ha, 830ml/ha)to increase crop yield, and disease management of powdery mildew was observed more or less equal to Azoxystrobin 23 % EC, Tebuconazole 25.9 % EC, Myclobutanil 10 % WP and Difenoconazole 25 % EC (Market sample) Among the different doses of Azoxystrobin 120 + Tebuconazole 240 SC plants treated @ 830 ml/ha was recorded highest yield and lowest powdery mildew disease incidence followed by dose 676 ml/ha and 520 ml/ha. When compared to control. The occurrence of natural enemies spiders, Dragon fly, Damsel fly and wasps population were not affected in the plots treated with Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha Phytotoxicity. The use of Azoxystrobin 120 + Tebuconazole 240 SC fungicide is found to be safe to chilli crop and none of the symptoms like chlorosis, necrosis, scorching, epinasty and hyponasty symptoms were recorded even at the highest dosage of treatment *viz.*, 3320 ml/ha and up to 10 days of after I,II and III spraying

Key words : Azoxystrobin+Tebuconazole, *Powdery mildew Leveillula taurica*, bioefficacy, chilli and Phytotoxicity.

Introduction

Chili (*Capsicum annum* L.), also known as 'red pepper' is traditionally used as vegetables, spices, condiments, sauces and pickles, and has value added in pharmaceuticals, cosmetics and beverages. India is the major producer, consumer and exporter of chilli in the world with an area of 287.05 thousand hectare and production of 3406.0 thousand MT green pods (Anonymous, 2017) The important chilli growing states are Andhra Pradesh, Odisha, Maharashtra, West Bengal, Karnataka, Rajasthan and Tamil Nadu. India contributes one-fourth of the total quantity of chilli exported in the world (Subbaih and Jeyakumar, 2009) Chilli suffers from many diseases caused by fungi, bacteria, viruses, nematodes and other abiotic stresses. Among the fungal diseases, powdery mildew is caused by *Leveillula taurica* (Lev.) Arn., is a major constraint in chilli production in India, causing heavy yield loss ranging from 14 to 20%. (Mathur *et al.*, 1972; ohokar and Peshney, 1981; Suthin Raj *et al.*, 2014). By considering the seriousness of diseases and the economic damage caused by the diseases, Fungicides act as chemical and abiotic components involved in induced systemic resistance in plants against pathogens and reduce the disease severity (Davidse and Ward, 1984). These fungicides interact with the plant constituents after spraying and cause quantitative and qualitative changes (Kotastane and Vyas, 1992; Suthin Raj *et al.*, 2013b). Fungicides application results in biochemical changes in plants is important to investigate the effectiveness and mode of action of the chemical against pathogens. several fungicides have been recommended against

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powdery mildew but still there is a need to widen the choice by introducing new molecules. Fungicides are successful in controlling plant diseases but their excessive, irrational and indiscriminate use can pose problems pertaining to the safety of consumers. There may be serious residue problems especially when these are applied at the maturing stage. As many of the fruits and vegetables are consumed as raw products, fungicide residues on them may lead to health problems. The residue levels in the soil or edible parts vary with the dose of the fungicides used and with total number of sprays done (Tripathi *et al.,* 1976; Mithyantha *et al*., 1977). Hence there is a need to detect the presence of residues in the harvested produce well in advance before it is available for consumption or export to developed countries. The present investigation was carried out by using different doses of Azoxystrobin 120 + Tebuconazole 240 SC for its bio-effectiveness studies of diseases incidence, yield population of natural enemies and phytotoxicity studies against powdery mildew disease of chilli

Materials and Methods

Field studies

Field experiments was carried out between November, 2016 and May, 2017 in the Pootukaran thoopu village, Dharmapuri district, Tamil Nadu, India. Pure seeds of local susceptible variety (Chilli/K1) were sown in well-prepared seed bed having sandy loam soil during the 3rd week of November, 2016 at a shallow depth 5 cm apart and covered with finely sieved well rotten leaf mold. After sowing, beds were covered with straw until germination which normally takes seven to nine days and watered through watering can regularly. Nursery beds were covered with 200 μm ultraviolet (UV)-stabilized polyethylene film supported by bamboo poles with open sides to protect seedlings from rain and direct sunlight. Seedlings were hardened by withholding water 4 days before transplanting. One month old seedlings were transplanted in the main field during the 3rd week of December, 2016 following randomized complete block design with 3 replications at 50 × 50 cm spacing with 25 plants for each replication in a 5×5 m per treatment plot. Standard cultural practices were followed uniformly in all the experimental plots (Chattopadhyay *et al.,* 2007).

Assessment of Powdery mildew diseases

Percent Disease Index =

$$\frac{\text{Sum of all numerical grades}}{\text{Number of leaves observed}} \times \frac{100}{\text{Maximum grade}}$$

Examine 5 plants within the plot during development stages and grade the disease incidence as per the scale below.

Score	Symptoms
0	**No symptom on any plant**
1	Small powdery specks on the leaves covering 1% or less area
3	Powdery lesions small, scattered covering 1 - 10% of leaf area
5	Powdery patches big, scattered covering 11 - 25% of the leaf area
7	Powdery patches big, coalescing covering 26 - 50% of leaf area
9	Powdery growth covering 51% or more of leaf area turn yellow and dry up

Effect on Natural Enemies

The population of the natural enemies *viz*., Spiders, Dragon fly, Wasp and damsel fly was also assessed following standard procedures in the fungicide treated and untreated plots and recorded.

Treatment details : Eight treatments

Treatments	Product name	Dosage per ha	
		A.I. (gm)	Formulation (ml)
T_1	Azoxystrobin 120 + Tebuconazole 240 SC	156	520
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	203	676
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	249	830
T_4	Azoxystrobin 23 % EC	125	500
T_5	Tebuconazole 25.9 % EC	187.5	750
T_6	Myclobutanil 10 % WP	0.004%	0.04%
T_7	Difenoconazole 25 % EC	0.0125% or 12.5 g / 100 litres of water	0.05% or 50 ml / 100 litres of water
T_8	Control	-	-

Phytotoxicity:

Treatments details for phytotoxicity

Product Name	Dosage	
	a.i. g/ha	Formulation ml/ha
Azoxystrobin 120 + Tebuconazole 240 SC	249	830
Azoxystrobin 120 + Tebuconazole 240 SC	498	1660
Azoxystrobin 120 + Tebuconazole 240 SC	996	3320

Phyto-toxicity at 'X 'and '2X' dose was recorded at 1, 3, 5, 7 and 10 days after application following the scale given below.

Crop response/ Crop injury	Rating
0-00	0
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

Fruit yield

The chilli fruits were harvested periodically and the yield per hectare was calculated and recorded as t/ha.

Results

Powdery mildew disease

In general, all the fungicide treatments showed significant inhibitory effect in reducing the powdery mildew disease when compared to control. Among the various treatments, the treatments with Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha proved very effective and revealed supremacy in controlling the Powdery mildew disease of chilli. The least per cent disease index with 4.67, 4.23 and 3.65 was recorded after first, second and third spray respectively. This was followed by the dosage level with Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha which recorded 5.78, 5.37 and 4.87 after first, second and third spray respectively. The market sample of Tebuconazole 25.9 % EC @ 750 ml/ha, Azoxystrobin 23 % EC@ 500 ml/ha, Difenoconazole 25 % EC and Myclobutanil 10 % WP were on par with each other in reducing powdery mildew incidence. While the untreated control recorded the maximum PDI (31.87, 33.65, 35. 67 **)** was recorded (Table 1).

Effect on the population of natural enemies

It was conspicuous to note that the occurrence of natural enemies spiders, Dragon fly, Damsel fly and wasps population were not affected in the plots treated with Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha (Table 3).

Phytotoxicity

The use of Azoxystrobin 120 + Tebuconazole 240 SC fungicide is found to be safe to chilli crop and none of the symptoms like chlorosis, necrosis, scorching, epinasty and hyponasty symptoms were recorded even at the highest dosage of treatment *viz.*, 3320 ml/ha and up to 10 days of after I,II and III spraying (Table 3a, 3b,34c). This was inaccordance with the results of Sendhil Vel *et al.,* (2004) and Sundaravadana (2005) reported that there were no phytotoxic symptoms throughout the cropping season of grapevine and mango due to azoxystrobin application. Ahiladevi *et al.*, (2013) reported that there were No phytotoxic symptoms were recorded after spraying on the plants even at highest dose.

Fruit Yield

The results showed that all the treatments with fungicides recorded higher green chilli yields when compared to control. However, among the treatments, Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the maximum green chili yield with 8.20 t/ha which was at par with the treatment level with Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha when compared to control. The results were in accordance with Raju *et al.,* (2017).

Discussion

In the present study, foliar spray with Azoxystrobin 120 + Tebuconazole 240 SC fungicide @ 830 ml/ha as foliar spray once at disease initiation stage and repeated twice at 10 days interval effectively controlled the incidence of *Powdery mildew* caused by *Leveillula taurica* in chilli and also enhanced the yield of chilli fruits significantly without producing any phytotoxic effect. Similar results were also reported by several workers Similar findings have also been found by Kumar *et al.* (2017) reported that the maximum disease control and high green fruit yield, dry fruit yield and seed yield could be obtained from the spray with suitable concentration of fungicide Tebuconazole as compared to Benomyl. Similar results were also reported by several workers Ganeshan *et al.*, (2011), Adinarayana *et al.*, (2012), Kumbhar and More (2013), Ahiladevi and Prakasam (2013), Suthin Raj *et al.*, 2013a, Islam *et al.*, (2015) and Daunde *et al.*, (2018). According to the fungicide resistance action committee (FRAC, 2004) preventive use and a limited number of applications of strobilurins

Table 1: Evaluation of bio-efficacy of Azoxystrobin 120 + Tebuconazole 240 SC Powdery mildew on Chilli.

Treatments No.	Treatments	Formulation (ml)/ ha	Powdery Mildew PDI % after first spray		Powdery Mildew PDI % after Second spray		Powdery Mildew PDI % after Third spray		Yield t/ha
			PDI %	% reduction over control	PDI %	% reduction over control	PDI %	% reduction over control	
T_1	Azoxystrobin 120 + Tebuconazole 240 SC	520	6.98(0.27)	78.09	6.56(0.24)	80.50	6.23(0.22)	82.53	7.51
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	676	5.78(0.19)	81.86	5.37(0.16)	84.04	4.87(0.13)	86.34	7.91
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	830	4.67(0.12)	85.34	4.23(0.10)	87.42	3.65(0.07)	89.76	8.20
T_4	Azoxystrobin 23 % EC	500	7.68(0.33)	75.90	7.31(0.30)	78.27	6.98(0.27)	80.43	6.56
T_5	Tebuconazole 25.9 % EC	750	6.57(0.24)	79.38	6.40(0.23)	80.98	5.95(0.20)	83.34	7.02
T_6	Myclobutanil 10 % WP	0.04%	8.23(0.38)	74.17	8.13(0.37)	75.83	7.97(0.36)	77.65	6.31
T_7	Difenoconazole 25 % EC	0.05% or 50 ml / 100 litres of water	7.89(0.35)	75.24	7.65(0.33)	77.26	7.25(0.30)	79.67	6.48
T_8	Control		31.87(5.82)	.....	33.65(6.50)	.....	35.67(7.30)	.....	5.28
	SEd		0.74		0.56		0.54		0.62
	CD (p=0.05)		1.43		1.12		1.42		1.36

Table 2: Effect of Azoxystrobin 120 + Tebuconazole 240 SC on the population of natural enemies.

Tr.No	Treatments	Dosage per ha	'Spiders (Nos.)			'Dragon fly (Nos.)			'Damsel fly (Nos.)			'Wasp (Nos.)		
			First spray	Second spray	Third spray	First spray	Second spray	Third spray	First spray	Second spray	Third spray	First spray	Second spray	Third spray
T_1	Azoxystrobin 120 + Tebucon azole 240 SC	520	10.99	11.16	11.70	1.71	1.73	1.86	5.11	5.30	5.26	3.46	3.87	3.99
T_2	Azoxystrobin 120 + Tebucon azole 240 SC	676	11.12	11.56	11.85	1.86	1.69	1.90	4.90	5.26	5.35	3.90	4.12	4.35
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	830	11.15	11.45	11.77	1.81	1.75	1.82	4.70	5.64	5.30	3.76	3.26	2.79
T_4	Azoxystrobin 23 % EC	500	9.81	10.56	10.81	1.50	1.75	1.79	4.50	4.89	5.17	3.70	3.89	3.92
T_5	Tebuconazole 25.9 % EC	750	11.98	12.95	12.60	1.87	1.86	2.00	4.95	5.50	5.51	3.54	4.15	4.70
T_6	Myclobutanil 10 % WP	0.04%	8.66	8.70	5.76	1.52	1.10	0.75	4.80	3.59	3.17	1.50	1.40	1.31
T_7	Difenoconazole 25 % EC	0.05% or 50 ml / 100 lit of wa	11.14	11.40	11.70	1.75	1.70	1.80	4.76	5.64	5.34	3.75	3.21	2.78
T_8	Control		12.23	11.45	11.77	1.80	1.75	1.81	4.76	5.63	5.33	3.74	3.20	2.77
	SEd		0.02	0.01	0.03	0.01	0.31	0.01	0.03	0.01	0.02	0.01	0.04	0.03
	CD (p=0.05)		0.06	0.03	0.07	0.02	0.63	0.04	0.08	0.02	0.05	0.02	0.09	0.07

Table 3a: Phytotoxicity of Azoxystrobin 120 + Tebuconazole 240 SC, before spray, 1 day after spray, 3 days after spray, 5 days after spray, 7 and 10 days after spray I (II season).

Treatments	Phytotoxicity Symptoms- Days after I spray of test chemical (DAS)																																							
	Leaf Injury						Wilting						Vein Clearing						Necrosis						Epinasty						Hyponasty						Stunting					
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3b: Phytotoxicity of Azoxystrobin 120 + Tebuconazole 240 SC, before spray, 1 day after spray, 3 days after spray, 5 days after spray, 7 and 10 days after spray II (II season).

Treatments	Phytotoxicity Symptoms- Days after II spray of test chemical (DAS)																																							
	Leaf Injury						Wilting						Vein Clearing						Necrosis						Epinasty						Hyponasty						Stunting					
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3c: Phytotoxicity of Azoxystrobin 120 + Tebuconazole 240 SC, before spray, 1 day after spray, 3 days after spray, 5 days after spray, 7 and 10 days after spray III (II season).

Treatments	Phytotoxicity Symptoms- Days after III spray of test chemical (DAS)																																	
	Leaf Injury					Wilting					Vein Clearing					Necrosis					Epinasty					Hyponasty					Stunting				
	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10	0	1	3	5	7	10
Azoxystrobin 120 + Tebuconazole 240 SC 830 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 1660 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Azoxystrobin 120 + Tebuconazole 240 SC 3320 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

are recommended (*i.e.,* no more than six per season or up to three sequential applications) to reduce the risk of phytotoxicity and development of fungicide resistance pathogen strains. Asit Kumar Mandal *et al*., (2018) Found that tebuconazole (Rainbow) 25.9% EC to increase crop yield and disease management powdery mildew was observed more or less equal to Azoxystrobin23% SC and Tebuconazole 25.9% EC (Market sample).Ruth *et al.,* (2017) Found that, Proquinazid 20 % EC was found effective against powdery mildew disease of chilli, at all the concentrations tested, which resulted in more fruit yield/ ha, Asit Kumar Mandal *et al*., (2018), Affourtit *et al*., (2000), Senthil Vel *et al*., (2004) and Sundaravadana (2005) also reported that there were no phytotoxic symptoms throughout the cropping season of grapevine and mango due to Azoxystrobin application. These earlier reports add value to the present findings.

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