Plant Archives Volume 20 No. 1, 2020 pp. 831-836 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STUDY OF BIO-EFFICACY AND PHYTOTOXICITY OF AZOXYSTROBIN 120 + TEBUCONAZOLE 240 SC AGAINST *FRUIT ROT AND DIEBACK* (*COLLETOTRICHUM CAPSICI*) DISEASE IN CHILLI

T. Sivakumar, R. Kannan, P. Renganathan K. Sanjeevkumar and S. Sudhasha

Department of plant pathology, Faculty of Agriculture, Annamalai University, Annamalai Nagar 608002, (Tamil Nadu), India.

Abstract

Chilli (*Capsicum annum*) is the fourth most important vegetable crop in the world and first in Asia, Anthracnose (fruit rot and die back) caused by *Colletotrichum capsici* (Syd. Butler and Bisby) is prevalent throughout the chilli growing areas of India. Field experiments were carried out to study the effect of Azoxystrobin 120 + Tebuconazole 240 SC at the rate of 830, 676, and 520ml/ha along with other market fungicides on anthracnose disease of chilli caused by *Colletotrichum capsici.* Maximum control of *C. capsici* (15.93, 15.41 and 14.72 after first, second and third spray leaves and fruit respectively) was recorded with 249 g a.i. The fruit yield also has significantly increased recorded the maximum green chilli yield with 9.13 t/ha per cent yield increase over control. No phytotoxic effects such as leaf tip/surface injury, wilting, vein clearing necrosis, epinasty, hyponasty,fruit injury of azoxystrobin 25 SC were observed at the doses of 3320, 1660, and 830 ml/ha. 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.

Key words : Azoxystrobin**,** anthracnose, bioefficacy, chilli *Colletotrichum capsici,* and phytotoxicity.

Introduction

Chilli (*Capsicum annuum* L.) belongs to the family Solanaceae is mainly cultivated for green fruits as table purpose and dry chilli as spice and is popularly known as "red pepper" and is one of the most admired and very much remunerative, annual herbaceous vegetable crop. In India, chilli is widely cultivated in Andhra Pradesh, Telangana, Madhya Pradesh, Karnataka, West Bengal, Odisha, Maharashtra and Tamil Nadu. In India, chilli is cultivated over an area of 775 thousand hectares with annual production of 1492 thousand metric tonnes (Anonymous, 2014) which accounts for 25% of the world production. Chilli is attacked by several fungal, bacterial and viral diseases. Among them, anthracn ose isthe most important diseases incurring serious losses, if not cared (Suthin Raj *et al.*, 2013b). Anthracnose (fruit rot and die back) caused by *Colletotrichum capsici* (Syd. Butler and Bisby) is widespread throughout the chilli growing areas of India (Jeyalakshmi, 1996; Suthin Raj *et al.*, 2013a; Suthin Raj *et al.*, 2014). Several fungicides have been recommended against anthracnose but still there is a need to make wider the option by introducing new molecules. Azoxystrobin, produced by the Basidiomycetes fungus, *Strobilurus tenacellus* (Pers. ex Fr.) Singer, has a novel mode of action (Hewit, 1998). Its fungicidal action results from the inhibiting mitochondrial respiration of higher fungi, which is achieved by the prevention of Electron transfer between cytochrome b and cytochrome c (Becker *et al.*, 1981). The present study was carried out using a new formulation *viz.*, Azoxystrobin 120 + Tebuconazole 240 SC for its bio efficacy and phytotoxicity against chilli anthracnose disease.

***Author for correspondence :** E-mail: sivaindu_agri@yahoo.co.in

Materials and Methods

Field studies

Field experiments was carried out between

November, 2016 and May, 2017 in the Pootukaran thoopu village, Dharmapuri district, TamilNadu, 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 ìm ultraviolet (UV)-stabilized polyethylene film supported bybamboo 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 5X5 m per treatment plot. Standard cultural practices were followed uniformly in all the experimental plots (Chattopadhyay *et al.*, 2007).

Assessment of Fruit rot & Die-back

Calculate the percent disease Index using the following formula

$$PDI = \frac{\text{Sum of all numerical grades}}{\text{Total no of leaves / bunches assesed} \times \text{Maximum grade}} \times 100$$

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

Score	Symptoms
0	No infection
1	First symptom, 19% infection
2	20-39% infection
3	40-59% infection
4	60-79% infection
5	80-100% infection

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.

Fruit yield

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

Results and Discussion

Fruit rot & Die-back

The results are clearly revealed the supremacy of the test product in reducing the Fruit rot & Die-back incidence in chilli. Among the various treatments, Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha effectively controlled the Fruit rot & Die-back disease and recorded the least per cent disease index 15.93, 15.41 and 14.72 after first, second and third spray. This treatment was followed by Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha recorded 16.23, 16.12 and 15.14 percent disease index and it was at par to Azoxystrobin 120 + Tebuconazole 240 SC @ 520 ml/ha and Tebuconazole 25.9 % EC 750 ml/ha. While the maximum PDI of 32.63 was recorded in the untreated control. The same trend was recorded after second and third spray (Table 1). The similar results were also available in the literatures.Chemicals are the most common and practical method to control anthracnose diseases.. Ahiladevi *et a*,.2013 reported that azoxystrobin 25 SC is effective in reducing anthracnose disease in fruits and leaves. Asit Kumar Mandal *et al.*, (2018) indicate that efficacy of the fungicidal products of Tebuconazole(Rainbow) 25.9% EC to increase crop yield and disease management of fruit rot of chilli.

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:

For phytotoxicity and residues

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

Effect on the population of natural enemies

It was clear from the results 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 2).

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 the test chemical *viz.*, 3320 ml/ha and up to 10 days of after sprayings (Table-4a, 4b & 4c). This was in accordance with the results of Nithyamenakshi *et al.* (2006), the fungicides azoxystrobin and difenoconazole were generally non phytotoxic at or below the recommended dose for field application (2.2 µg a.i ml-1). But at higher concentration, both the fungicides exhibited concentration dependant phytotoxicity in *Vigna catjung* Walp. 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.

Table 1: Evaluation of bio-efficacy of Azoxystrobin 120 + Tebuconazole 240 SC Fruit rot & Die-back on Chilli.

Treatments No.	Treatments	Formulation (ml)/ ha	Fruit rot & Die-back PDI % after first spray		Fruit rot & Die-back PDI % after Second spray		Fruit rot & Die-back 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	17.73(24.90)	45.66	17.62(24.81)	50.00	17.03(24.37)	55.74	7.81
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	676	16.23(23.75)	50.26	16,12(23.67)	54.25	15.14(22.89)	60.65	8.12
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	830	15.93(23.52)	51.17	15.41(23.11)	56.27	14.72(22.56)	61.74	9.13
T_4	Azoxystrobin 23 % EC	500	19.71(26.35)	39.59	19.23(26.00)	45.43	18.52(25.48)	51.87	6.91
T_5	Tebuconazole 25.9 % EC	750	17.93(25.05)	45.05	17.84(24.98)	49.37	17.15(24.46)	55.43	7.40
T_6	Myclobutanil 10 % WP	0.04%	26.02(30.67)	20.25	25.61(30.40)	27.32	24.12(29.41)	37.31	6.13
T_7	Difenoconazole 25 % EC	0.05% or 50 ml / 100 litres of water	19.02(25.85)	41.71	18.93(25.79)	46.28	17.75(24.91)	53.87	6.15
T_8	Control		32.63(34.83)	-	35.24(36.41)	-	38.48(38.33)	-	4.75
	SEd	-	0.02	-	0.01	-	0.01	-	0.01
	CD (p=0.05)	-	0.05	-	0.03	-	0.02	-	0.02

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

Tr.No	Treatments	Formulation (ml)/ ha	'Spiders (Nos.)			'Dragon fly (Nos.)			'Damsel fly (Nos.)			'Wasp (Nos.)		
			I spray	II spray	III spray	I spray	II spray	III spray	I spray	II spray	III spray	I spray	II spray	III spray
T_1	Azoxystrobin 120 + Tebuconazole 240 SC	520	11.92	11.76	11.82	1.79	1.75	1.77	4.76	4.70	5.70	3.70	3.24	2.74
T_2	Azoxystrobin 120 + Tebuconazole 240 SC	676	12.00	11.82	11.02	1.80	1.76	1.78	4.79	4.71	5.69	3.69	3.29	2.79
T_3	Azoxystrobin 120 + Tebuconazole 240 SC	830	11.01	11.92	12.00	1.82	1.81	1.83	4.83	4.60	5.73	3.77	3.35	2.84
T_4	Azoxystrobin 23 % EC	500	11.92	11.91	11.93	1.70	1.76	1.76	4.70	4.73	5.41	3.69	3.19	2.81
T_5	Tebuconazole 25.9 % EC	750	11.97	11.92	11.93	1.81	1.80	1.82	4.91	5.12	5.62	3.62	3.12	2.72
T_6	Myclobutanil 10 % WP	0.04%	10.23	10.40	9.56	1.54	1.57	1.60	4.80	4.90	5.71	2.90	3.32	2.15
T_7	Difenoconazole 25 % EC	0.05% or 50 ml / 100 litres of water	11.54	11.42	11.82	1.76	1.76	1.80	4.78	5.66	5.63	3.96	3.21	2.79
T_8	Control		12.12	11.92	12.07	1.81	1.82	1.85	4.806	5.70	5.73	3.77	3.30	2.82
	SEd	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.02	0.01
	CD (p=0.05)	0.02	0.03	0.02	0.02	0.04	0.03	0.03	0.02	0.01	0.05	0.02	0.05	0.03

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	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

Fruit Yield

The results showed that all the treatments with chemical fungicides recorded higher green chilli yield when compared to control. However, among the treatments the treatment with Azoxystrobin 120 + Tebuconazole 240 SC @ 830 ml/ha recorded the maximum green chilli yield with 9.13 t/ha which was at par with the treatment level with Azoxystrobin 120 + Tebuconazole 240 SC @ 676 ml/ha.(Table 1) The results were in accordance with Raju *et al*., (2017) and Asit Kumar Mandal *et al*., (2018).

Acknowledgements

The authors are thankful to M/s. NACL Industries Limited Punjagutta Hyderabad for funding and providing the valuable suggestions during my research period.

References

Ahiladevi, P. and V. Prakasam (2013). Bioefficacy of Azoxystrobin 25 SC along with bioagents against chilli anthracnose diseases under field conditions. *Pest Management in Horticultural Ecosystems*,**19:** 57-62.

Anonymous (2014). Indian Horticulture Database, Ministry of Agriculture, Government of India.

Mandal, A.K., I. Jamir, P.K. Maurya, T. Bhattacharjee and A. Chattopadhyay (2018**)**. Bio-efficacy evaluation of tebuconazole 25.9% EC against fruit rot and powdery mildew diseases of chilli under the Gangetic Plains of West Bengal. *International journal of chemical study*, **6(3):** 2180-2183.

Becker, W.F., G. Von Jagow, T. Anke and W. Steglich (1981). Ou d ema nsin, st r o b i lur i n-A, str o b il ur in -B a nd myxothiazole: New inhibitors of the bc1 segment of the respiratory chain with an E-,-methoxyacrylate system as a common structural element. *FEBS Letters*,**132:** 329-333.

Chattopadhyay, A., S. Dutta, I. Bhattacharya, K. Karmakar and P. Hazra (2007). Chilli. In: Technology for Vegetable Crop Production. All India Coordinated Research Project on Vegetable Crops, Nadia, West Bengal, India, 25-34.

Hewitt, H.G. (1998). Strobilurins: Fungicides. In: Crop Protection. CAB International. New York Indian Horticultural Database, 2011-2012.

Investigations on phytotoxicity of two new fungicides Azoxystrobin and Difenoconazole. *American Journal of Plant Physiology*, **1:** 89-98.

Jeyalakshmi, C. (1996). Studies on fruit rot and die-back disease of chilli(*Capsicum annuum* L.) incited by *Colletotrichum capsici* (syd.) Butler and Bisby. M.Sc. (Ag.) T hesis.Tamil Nadu Agric. Univ., M adur ai. India, 216.

Raju, J., N. Adivappar and K. Jayalakshmi (2017). Management of powdery mildew of capsicum under protected cultivation. *Int. J. Chem. Studies*, **5:** 1213-1215.

Sendhil Vel, V., T. Raguchander, S. Nakkeeran, G. Amutha and T. Marimuthu (2004). Bioefficacy of Azoxystrobin against downymildew of grapevine. *Pestology*, **28:** 44-51.

Sundaravadana, S. (2005). Evaluation of B ioefficacy, Phytotoxicity and residues of azoxystrobin 25 SC against major diseases of rice and mango.Ph.D. Thesis, Tamil Nadu Agric. Univ., Coimbatore, India, 190.

Suthin Raj, T., D.J. Christopher and H.A. Suji (2014). Morphological, pathogenic and genetic variability in *Colletotrichum capsici* causing fruit rot of chilli in Tamilnadu, India. *African journal of biotechnology*, **13(17):** 1786-1790.

Suthin Raj, T., D.J. Christopher and H.A. Suji (2013a). Evaluation of virulence and methods of inoculation of *Colletotrichum capsici* (SYD) Butler and Bisby. *International journal of Agricultural sciences*, **9 (2):** 802-805.

Suthin Raj, T., D.J. Christopher and H.A. Suji (2013b). Effect of plant products on the *in vitro* production of cellulolytic and pectinolytic enzymes by *Colletotrichum capsici*. *Pl.Dis.Res.*, **23(1):** 24-27.