Pest Management in Horticultural Ecosystems,
Vol. 19, No. 1 pp 57-62 (2013)

Bioefficacy of Azoxystrobin 25 SC along with bioagents against chilli anthracnose diseases under field conditions

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ABSTRACT : Field experiments were carried out to study the effect of azoxystrobin 25 SC at the rate of 100, 125, and 150g a.i ha^{-1} along with other fungicides on anthracnose disease of chilli caused by *Colletotrichum capsici.* Maximum control of *C. capsici* (PDI of 4.44 and 2.78 on leaves and fruit respectively) was recorded with 150 g a.i. The fruit yield also has significantly increased recording 59.88 and 55.30 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 100, 125, 150 and 250 g ai ha^{-1}.

Keywords: Azoxystrobin**,** anthracnose, bioefficacy, chilli, *Colletotrichum capsici,* phytotoxicity

INTRODUCTION

Chilli (*Capsicum annum*) is the fourth most important vegetable crop in the world and first in Asia, with world production f oapproximately 122.34 million tonnes of fresh chilli and 2.8 tonnes of dry chilli in 2010 (Indian Horticultural Database). Demand for chilli in the world is increasing every year. Chilli is a very remunerative spice crop of the Indian subcontinent (Sharma *et al.,* 2005) and occupies an area of about 0.81 million ha (Suthin Raj and Christopher, 2009) which accounts for 25per cent of the world production (Chandra Nayaka *et al*., 2009). In Tamil Nadu, chilli is cultivated on 49.0 thousand hectares with 31.8 thousand tonnes of production. Chilli is attacked by several fungal, bacterial and viral diseases. Among them, anthracnose and powdery mildew are the major diseases incurring heavy losses, if not cared. Anthracnose (fruit rot and die back) caused by *Colletotrichum capsici* (Syd. Butler and Bisby) is prevalent throughout the chilli growing areas of India (Jeyalakshmi, 1996). Several fungicides have been recommended against anthracnose but still there is a need to widen the choice 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 activity results from the inhibiting mitochondrial respiration of higher fungi, which is achieved by the prevention of Electron transfer between cytochrome b & cytochrome c (Becker *et al.,* 1981). The present investigation was carried out using a new formulation viz., azoxystrobin 25 SC for its bio efficacy and phytotoxicity against chilli anthracnose disease.

MATERIALS AND METHODS

Field studies

A new formulation Azoxystrobin 25 SC w/w of United Phosphorus, Limited, Mumbai was used for all studies in the present investigation. The new formulation was compared with two fungicides *viz.*, azoxystrobin 23 SC, hexaconozole and chlorothalonil (75%) WP (2%) SC and two fungal pathogens *viz.*, *Pseudomonos fluorescens* and *Bacillus subtilis.* Two field trials were conducted during 2011 and 2012 at Kinathukadavu and Mathampatti using variety *viz.*, Sierra. The trials were laid out in a Randomized Block Design (RBD) with nine treatments and three replications in a plot size of 20 m^2 and with a spacing of 90 × 60 cm. The treatments comprised as follows:

T1 - Spraying of Azoxystrobin@ 100 g a.i ha^{-1} immediately after the first appearance of disease symptoms followed by two sprays at 15 days interval

T2 - Spraying of Azoxystrobin@ 125 g a.i ha^{-1} immediately after the first appearance of disease symptoms followed by two sprays at 15 days interval

T3 - Spraying of Azoxystrobin @150 g a.i ha^{-1}immediately after the first appearance of disease symptoms followed by two sprays at 15 days interval

T4 - Spraying of Azoxystrobin (Amrister) @ 125 g a.i ha^{-1}immediately after the first appearance of disease symptoms followed by two sprays at 15 days interval

T5 - Spraying of hexaconazole @60 g a.i ha^{-1}immediately afte*r* the first appearance of disease symptoms followed by two sprays at 15 days interval

T6 - Spraying of chlorothalonil @ 600 g a.i ha^{-1}immediately after the first appearance *of* disease symptoms followed by two sprays at 15 days interval

T7 - Spraying of *P. fluorescens* @ 0.2 per cent with 2.0 x 10^{8} CFU/g immediately after the first appearance of disease symptoms followed by two sprays at 15 days interval

T8 - Spraying of talc-based formulation of *B. subtilis.* @ 0.2 per cent after the first appearance of disease followed by two sprays at 15 days interval

T9 - Untreated control –water spray

The recommended package of practices was followed for the trial. The observation on the disease incidence was recorded before initiation of spray and after third spray.

The severity of anthracnose disease was recorded on 10 plants and in each plant 10 fruits were selected at random in each replication of the treatment.Percent Disease Index (PDI) was calculated usingstandard score chart as described earlier.

$$PDI = \frac{\text{Sum of numerical ratings}}{\text{Total number of fruit observed}} \times \frac{100}{\text{Maximum category value}}$$

Similarly, the incidence of powdery mildew was also scored in 10 plants and 10 leaves were scored at random in each plant and PDI was worked out as per the standard formula.The yield details were also recorded.

Phytotoxicity

The fungicide was sprayed at the concentration of 250 g a.i/ha and compared with other doses as mentioned in the previous study. The phytotoxicity symptoms were recorded a week after last spray and observations on the following parameters *viz.*, leaf tip/surface injury, wilting, vein clearing necrosis, epinasty, hyponasty and fruit injury were recorded (Archana, 2009).

RESULTS AND DISCUSSION

Efficacy of Azoxystrobin 25 SC against anthracnose of chilli

Field studies

In order to confirm the results from the glasshouse studies two field trials were conducted during 2011 and 2012 at two locations in Coimbatore district. Three doses of Azoxystrobinat 150g ai/ha, 125 g ai/ha and 100 g ai/ha were compared with azoxystrobin,hexaconazole and chlorothalonil and the two bioagents *P.fluorescens* and *B.subtilis* strains. Three sprays were given, starting the first spray on the initiation of the disease. The disease incidences were record just before spray and subsequent observations were taken week after each spray.

Anthracnose

The results from two season trails clearly revealed that Azoxystrobin 150 g a.i/ha provided the maximum control of the anthracnose disease, followed by Azoxystrobin at 125 g a.i/ha. The effect was noticed both in leaves and fruits when compared to other fungicides. In addition, the Azoxystrobin at the rate of 150 g a.i /ha recorded the maximum yield of27.18 t/ha which was on par with the spray treatment of Azoxystrobin at the rate of 125 g a.i/ha with yield of 26.57 t/ha. Untreated control yielded only 17 t/ha. From this study, it is evident that Azoxystrobin at the rate of 150 g a.i /ha was considered as the optimum dose to combat the disease.The similar results were also available in the literatures.

Chemicals are the most common and practical method to control anthracnose diseases. However, fungicide tolerance often arises quickly, if a single compound is relied upon too heavily (Staub, 1991). The fungicide traditionally recommended for anthracnose management in chilli is Manganese ethylenebis dithiocarbamate (Maneb) (Smith, 2000) although it does not consistently control the severe from of anthracnose on chilli fruit. The strobilurin fungicides azoxystrobin (Quadris), trifloxystrobin (Flint), and pyraclostrobin (Cabrio) have recently been labeled for the control of anthracnose on chilli, but only preliminary reports are available on the efficacy of these fungicides against the severe form of the disease (Alexander, 2002). Anand *et al* ., 2010 found that Pf1 at 2.5 kg ha^{-1} tested in combination with reduced concentration of azoxystrobin at the rate of 250 ml ha^{-1} was highly efficient in management of chilli anthracnose .Dale, 1999 found that Amistar(Azoxystrobin) at 125-250 mg ai/l provided longer disease protection than benomyl against anthracnose disease of chili (*Colletotrichum capsici*).

The strobilurin fungicides represent important class of chemicals for the management of a broad range of fungal diseases in agricultural production systems. Sudaravadana *et al*. 2007 found that treating trees with these *viz.*, 1, 2 and 4 ml/l. concentrations provided 100

Table 1. Effect of different fungicides and bioagents on the incidence of anthracnose of chilli under field condition (Season I) (Kinathukadavu-Coimbatore)

Treatment	PDI on leaves		Per cent decrease over control	PDI on fruits		Per cent decrease over control	Yield t/ha	Yield increase over control
	Before Spray	After 3 rd Spray		Before Spray	After 3rd Spray			
Azoxystrobin@ 100 g a.i ha^{-1}	14.80 ^{b}	12.45 ^{c}	67.40	9.46 ^{b}	7.22 ^{b}	72.30	26.11 ^{abc}	53.58
Azoxystrobin@ 125 g a.i ha^{-1}	8.96 ^{a}	6.67 ^{b}	82.60	5.82 ^{a}	3.89 ^{a}	85.10	26.57 ^{ab}	56.29
Azoxystrobin@ 150g a.i ha^{-1}	6.84 ^{a}	4.44 ^{a}	88.40	5.91 ^{a}	2.78 ^{a}	89.40	27.18 ^{a}	59.88
Azoxystrobin @ 125 g a.i(Amrister)	8.46 ^{a}	6.22 ^{ab}	83.70	6.12 ^{a}	4.00 ^{a}	84.68	24.00 ^{bcd}	41.18
Hexaconazole @ 60 g a.i ha^{-1}	23.16 ^{c}	20.89 ^{d}	45.39	17.48 ^{d}	15.55 ^{d}	40.40	23.17 ^{cde}	36.29
Chlorothalonil @ 600 g a.i ha^{-1}	15.98 ^{b}	13.78 ^{c}	64.00	13.26 ^{c}	10.55 ^{c}	59.60	22.43^{de}	31.94
P. fluorescens@ 0.2%	25.23 ^{d}	23.24 ^{e}	39.19	19.22 ^{e}	17.24 ^{e}	33.97	22.00 ^{de}	29.41
B. subtilis@ 0.2%	27.16 ^{d}	25.32 ^{e}	33.75	21.36 ^{f}	19.64 ^{f}	24.77	21.04 ^{e}	23.76
Control	41.46 ^{f}	38.22 ^{f}	-	29.36 ^{g}	26.11 ^{g}	-	17.00 ^{g}	
SEd	1.09	0.99		0.83	0.71			1.39
D(0.05)	2.34	2.11		1.75	1.51			2.93
Cv%	7.39	7.29		7.15	7.38			7.35

Values are means of three replications

Figures in the parentheses represent arcsine transformed values

The common letters show non- significant differences among the treatments based on DMRT

Table 2. Effect of different fungicides and bioagents on the incidence of anthracnose of chilli under field condition (Season II) (Madampatti – Coimbatore)

Treatment	PDI on leaves			PDI on fruits				
	Before Spray	After 3 rd Spray	Per cent decrease over control	Before Spray	After 3rd Spray	Per cent decrease over control	Yield	Yield increase over control
Azoxystrobin@ 100 g a.i ha^{-1}	16.42 ^{b}	14.32 ^{c}	64.62	10.26 ^{c}	8.46 ^{b}	71.23	28.60^{ab}	47.27
Azoxystrobin@ 125 g a.i ha^{-1}	10.32 ^{a}	8.75 ^{b}	78.38	7.81 ^{ab}	5.32 ^{a}	81.91	30.12 ^{a}	55.09
Azoxystrobin@ 150g a.i ha^{-1}	8.88 ^{a}	6.12 ^{a}	84.88	6.48 ^{a}	4.71 ^{a}	83.98	30.16 ^{ab}	55.30
Azoxystrobin @ 125 g a.i ha^{-1} (Amrister)	11.26 ^{a}	8.74 ^{b}	78.40	9.54 ^{b}	6.86 ^{a}	76.67	26.18 ^{c}	34.80
Hexaconazole @ 60 g a.i ha^{-1}	24.84 ^{c}	22.68 ^{d}	43.97	19.26 ^{d}	17.12 ^{d}	41.78	26.00^{bc}	33.88
Chlorothalonil @ 600 g a.i ha^{-1}	17.32 ^{b}	15.16 ^{c}	62.54	14.86 ^{e}	12.53 ^{c}	57.39	24.80 ^{c}	27.70
P. fluorescens @ 0.2%	26.82 ^{cd}	24.48 ^{de}	39.52	21.26 ^{e}	19.66 ^{e}	33.15	22.00 ^{d}	13.28
B. subtilis@ 0.2%	28.44 ^{d}	26.32 ^{e}	34.98	22.47 ^{f}	20.48 ^{f}	30.36	20.00 ^{d}	12.98
Control	43.68^{e}	40.48 ^{f}	-	32.81^{g}	29.41 ^{g}		19.42 ^{d}	
SEd	1.19	1.07		0.93	0.82		1.26	
CD(0.05)	2.52	2.28		1.97	1.74		2.67	
Cv%	6.98	7.11		7.10	7.28		6.12	

Values are means of three replications

Figures in the parentheses represent arcsine transformed values

The common letters show non- significant differences among the treatments based on DMRT

and more than 60 per cent reduction of panicle and leaf anthracnose compared to untreated mango trees for which disease incidences were 27.73 and 53.68 PDI. This controlling effect was mainly due to translaminar and systemic movement of azoxystrobin, inside the tissues, azoxystrobin is widely distributed from the application side by diffusion (Vincelli, 2002).

Phytotoxicity of Azoxystrobin 25 SC

The observations on the leaf tip, surface injury, wilting, vein clearing, necrosis, epinasty, hyponasty and fruit injury were recorded during both the seasons. The observations showed that azoxystrobin 25 SC even at 250g a.i ha^{-1} did not show any phytotoxicity symptoms. Similarly other fungicides tested also did not exhibit any phytotoxicity symptoms. A number of fungicides are being routinely used for crop protection but their phytotoxic effects have been often ignored (Vyas, 1993). Curative and eradicant activity of strobilurins against several airborne pathogens have been reported (Reuveni, 2001; Anesiadis *et al.,* 2003). According to the fungicide resistance action committee (FRAC, 2004) preventive use and a limited number of applications of strobilurins 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 (Affourtit *et al.,* 2000).

This was in accordance with the results of Nithyameenakshi *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. Findings of our field studies suggest that azoxystrobin 25 SC is effective in reducing anthracnose disease in fruits and leaves at the concentrations of 150 and 125 g a.i ha^{-1}. No phytotoxic symptoms were recorded after spraying on the plants even at highest dose. The azoxystrobin 25 SC on chilli anthracnose disease will increase the choice of fungicides.

ACKNOWLEDGEMENTS

The authors are thankful to M/S United Phosphorus Limited, Mumbai for funding and providing the valuable suggestions during my research period.

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MS Received : 14 Feb 2013
MS Accepted : 2 Apr 2013