Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 18-25

CS Azad
Department of Plant Pathology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

RP Singh
Department of Plant Pathology, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

A Kumar
Department of Plant Pathology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Correspondence
A Kumar
Department of Plant Pathology, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India

Evaluation of Fungicides on management of Dieback and Fruit Rot Disease Causing *Alternaria tenuissima* (Kunze ex Pers.) WILTSHIRE of Chilli

CS Azad, RP Singh and A Kumar

Abstract
Field experiments were conducted for two consecutive *Kharif* seasons of 2014 and 2015 at vegetable research centre, Pantnagar, Uttarakhand, to study the efficacy of different fungicides chlorothalonil, propineb, azoxystrobin, Kresoxym methyl, difenoconazole, tebuconazole, hexaconazole, flutriafol, azoxystobin + flutriafol and metiram + pyraclostrobin against dieback disease of chilli caused by *Alternaria tenuissima*. All the tested fungicides were found to be significantly superior over check in reducing incidence and severity of early dieback caused by *A. tenuissima.* The minimum mean disease incidence and severity was recorded in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} 11.83 and 10.67 followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} 14.92 and 14.0 over control 52.78 and 40.67 at terminal spray respectively.The minimum fruit rot and maximum total yield was found in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} 29.32% and 37.01 q/ha followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} 34.10% and 35.40q/ha at final picking respectively.Highest marketable yield (25.51q/ha) was obtained in treatment Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (24.61q/ha) and Azoxystrobin 23 SC @ 125 g a.i. ha^{-1} (23.36 q/ha) with 70.70, 69.63 and 68.01 per cent avoidable loss, respectively.

Keywords: *Alternaria tenuissima*, Chilli, Dieback, fruit rot, fungicides

1. Introduction
Chilli (*Capsicum annum* L.) is considered as one of the most important commercial spice crop. Chilli belongs to the solanaceae family and is a native of tropical America. It is grown throughout the world for its green and red ripe fruits as it is a lucrative crop and form indispensable adjuvant almost in every house. Chilli fruit is used as fresh, cooked, pickled and canned in sauces and as powder for hot spices. Pungency in chilli, which is due to the presence of capsaicin, is a digestive stimulant and a cure for rheumatic troubles. Among the spices consumed in India dried chilli powder contribute the major share. Green chillies are rich source of vitamins especially vitamin A, C, B1, B2 (Saimbhi et al., 1977, Sayed and Bagvandas, 1980) [18, 19] and also rich in vitamin P (rutin), which is of immense pharmaceutical importance (Purseglove, 1977) [15] and hence, it is recommended for the treatment of cholera, hoarseness, dropsy and colic toothache (Peirce, 1987) [14].
India is one of the major chilli producing countries in the world. Introduction of chilli in India is believed to be 17th century through Portuguese. In India, chilli is cultivated over an area of 775 thousand hectares with an annual production of 1492 thousand tonnes and productivity of 1.9 metric tonnes per hectare whereas in Uttarakhand state, it is cultivated over an area of 2091 hectares with an annual production of 7493 metric tonnes with a productivity of 3.58 metric tonnes per hectare (NHB, 2014) [13].
Chilli is affected by 750 pathogens of different origins, reported from different part of the world, but only a few pathogen cause considerable damage. Among the fungal diseases dieback, leaf spot and fruit rot is caused by *Alternaria spp.*, damping off caused by *Pythium* spp., *Phytophthora* spp. and other fungi, seedling blight caused by *Rhizoctonia* spp., wilt caused by *Fusarium* spp., anthracnose and dieback caused by *Colletotrichum capsici* are major diseases. Among all these *Alternaria* spp. are responsible for dieback, leaf spot and fruit rot have been identified as major limiting factor in chili cultivation. The pathogens are seed, soil and air borne in nature (Mehrotra, 1980; Singh, 1983, Singh, 1987) [10, 22, 21].
This disease caused both pre- and post-harvest fruit decay (Bosland and Votava, 2003) [2]. It causes severe damage to leaves, twigs and fruits in the field as well as in storage and causes heavy loss upto 84 per cent (Thind and Jhooty, 1985) [23]. Infected fruits lose their normal red colour and turn straw coloured or in some cases, pale white.

Economic losses caused by the disease are mainly attributed to lower fruit quality and marketability. Several workers have attempted to control dieback of chilli by use of different fungicides (Sharma and Thakore, 1999; Deshmukh et al., 2004; Rathore, 2004, Gopinath et al., 2006) [20, 3, 17, 6]. Considering the severity of this disease and its frequent occurrence in the fields, spoilage during transit and storage it has been felt necessity to develop effective management strategies. Thus, attempts have been made to evaluate the efficacy of different fungicides against dieback of chilli for two consecutive years for the protection of disease with increase yield.

2. Materials And Methods

2.1. Experimental site

A field trial was carried out for two successive years during kharif seasons of the years 2014 and 2015 at the vegetable research centre of University, GBPUAT, Pantnagar in randomized block design with three replication. The Variety Pant chilli 1 was used for this study. Recommended agronomical package and practices were followed for all the treatments.

2.2. Fungicides used

To study the efficacy of different fungicides under field condition, ten different fungicides viz. chlorothalonil, propineb, azoxystrobin, krefoxym methyl, difenoconazole, tebuconazole, hexaconazole, flutriafol, azoxystrobin + flutriafol and metiam + pyraclostrobin and control (without application of fungicide) were used against dieback of chilli. First spray was given just after the appearance of the disease symptoms followed by four more foliar sprays at 20 days interval. Fungicides were used as foliar spray and its dose is given in (Table 1). Fungicide spray was made by knapsack sprayer of 15 litre capacity fitted with a hallow cone triple action nozzle. The 500 litre ha^{-1} water was used for each spray. The suspension of each fungicide was prepared separately by adding required quantity of respective fungicides in required amount of water. First spray was given just after the appearance of the disease symptoms followed by 4 more foliar sprays at 20 days interval.

2.3. Observations

After seven days of each spray observation on disease incidence and severity was recorded. Incidence of dieback was taken on plot basis by given formula.

$$\text{Percent disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants}} \times 100$$

For disease severity five randomly selected plants were tagged in each plot and subsequent disease rating was done on scale of 0-5 suggested by Vishwakarma and Sitaramaiah (1986) [24] and Percent disease index (PDI) was calculated as described by McKiney (1923) [9].

The detail of 0-5 scale is as under:

Scale	Area covered by disease
0	No disease
1	Up to 5 % of area infected
2	>5 – 10 % of area infected
3	>10 – 25 % of area infected
4	>25 – 50 % of area infected
5	Above 50 % of area infected

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total number of plants observed x maximum rating value}} \times 100$$

Harvesting was done at three different intervals on plot basis. Picking details are given in table 3.8. Fruit yield was taken on plot basis and expressed as quintal/ha. Total numbers of healthy and infected fruits were recorded on five tagged plants per plot and percent fruit rot was calculated by following formula.

$$\text{Percent fruit rot} = \frac{\text{Number of diseased fruits}}{\text{Total number of fruits}} \times 100$$

2.4 Statistical Analysis

The data was analysed statistically by Completely Randomized Design (CRD) or Randomized Block Design (RBD) using statistical software STPR developed by G. B. Pant University of Agriculture and Technology, Pantnagar. Data recorded were compared by the means of critical differences at one per cent level of significance in laboratory studies and five per cent level of significance in field studies.

3. Result and Discussion

3.1 Effect of fungicidal spray on incidence of Alternaria tenuissima on chilli

The data on incidence of chilli presented in Table 2 showed that all the fungicides reduced the disease incidence of dieback significantly as compared to check in both the kharif 2014 and 2015. The minimum mean disease incidence was recorded after 7 days of all the five spray in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} (6.11,7.70, 9.21, 10.79 and 11.83) followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (8.17, 9.76, 11.27, 13.33 and 14.92) over control(40.16, 42.22, 43.33, 39.60 and 52.78). Per cent disease control at 7 days after all the five spray ranged from 4.67-84.78% where Propineb gave lowest per cent disease control ranged 4.67-7.71% whereas Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} gave highest per cent disease control ranged 77.59-84.78% over control (Fig. 1).

The result of the study are in accordance with Mazur et al. (2002) [8] who found that azoxystrobin was found effective in controlling the diseases caused by *Alternaria tenuissima.* Fugro et al. (1995) [5] recorded that the fungicidal sprays of chlorothalonil (0.25%) reduced the incidence of Alternaria blight of tomato by 20 per cent.

3.2 Effect of fungicidal spray on severity of Alternaria tenuissima on Chilli

The effect of fungicidal spray on severity of *Alternaria tenuissima* on Chilli presented in Table 3 and revealed that all the fungicides reduced the disease severity significantly as compared to check in all the five spray. Disease severity recorded at 7 days after I, II, III, IV and V sprays in 2014 and 2015 ranged from 0.00-28.00 and 0.00-33.33 percent respectively. Maximum mean disease severity was recorded in check (22.67, 26.00, 30.00, 35.33 and 40.67%) in all the five sprays while no disease was found in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} in first spray (Fig. 1). The minimum mean disease severity was recorded after 7 days of all the five spray in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} (0.00, 2.67,3.33, 8.00 and 10.67%) followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (2.00,4.00,7.33,10.67 and 14.00%) over control(22.67,26.00,

30.00,35.33 and 40.67%). The highest percent disease control at 7 days after all the five spray was recorded in Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} ranged from 73.77-100.00 whereas the lowest disease control percentage was ranged from 11.32-17.65 in treatment Propineb 70 WP over control.

The results of the study are in accordance with Mazur et al. (2002) [8] who found that azoxystrobin was found effective in controlling the diseases caused by *Alternaria tenuissima.* Fugro et al. (1995) [5] recorded that the fungicidal sprays of chlorothanlonil (0.25%) reduced the incidence of Alternaria blight of tomato by 20 per cent. Efath et al. (2013) who reported that hexaconazole at 0.06% was most effective in managing foliar blight of onion caused by *A. tenuissima*. Bal (1984) [1] also observed that propineb gave excellent control against Alternaria leaf blight of strawberries incited by *A. tenuissima.* It seems that Azoxystrobin 125 SC + Flutriafol 125 SC, Azoxystrobin 23 SC and Flutriafol 250 EC tested in chilli for the first time as no previous record was found. It can be concluded that Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} can be used for chemical control of chilli. towards the management of leaf spot, fruit and early dieback of chilli

3.3 Effect of fungicidal spray on fruit rot of chilli

The effect of fungicide on fruit rot of chilli was evaluated on both the kharif 2014 and 2015 (Table 4). The percent fruit rot at I, II and III picking were recorded minimum an all the treatments as compared to control in both the seasons. The mean fruit rot in I, II and III pickings ranged 24.36-73.38, 27.03-76.11 and 29.32-79.63 respectively. The maximum mean fruit rot was recorded in all the three pickings in check (73.38, 76.11 and 79.63%) while minimum in Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} (24.36,27.03 and 29.32%) followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (28.76,31.81 and 34.10%) to check. The percent disease control in I, II and III pickings ranged from 10.53–66.81, 7.71-64.48 and 6.30-63.18 over control respectively. Maximum disease control was recorded in Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} i.e. 66.81, 64.48 and 63.18% followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} 60.81, 58.20 and 57.18% whereas lowest percent disease control was recorded in Propineb 70WP 10.53, 7.71 and 6.34 in I, II and III pickings respectively (Fig. 1).

The results of the present study are in accordance with Raja (2011) who found hexaconazole highly effective against *A. tenuissimia*. Naik and Sabalpara (2007) [12] also observed that fungicides viz. difenoconazole 1ml/l hexaconazole 1ml/l, chlorothalonil 1.5g/, propineb 2.5 g/l, gave high disease control against *A. tenuissimia.* Azoxystrobin 125 SC + Flutriafol 125 SC, Azoxystrobin 23 SC and Flutriafol 250 EC were tested for the first time on chilli in present trial.

3.4 Effect of fungicidal spray on fruit yield of chilli

The results of the experiment presented in Table 5 showed that all the treatments increased the yield significantly as compared to check. In both the year total yield ranged from 11.44 – 38.44 and 10.60-35.58 q/ha respectively. The lowest mean total yield was recorded in check (11.02 q/ha) whereas highest (37.01 q/ha) in Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} (38.44q/ha) followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (35.40q/ha), Azoxystrobin 23 SC @ 125 g a.i. ha^{-1} (33.58 q/ha).

Marketable yield in the year 2014 and 2015 ranged from 7.89 – 27.33 and 7.06-23.69 q/ha. The highest mean marketable yield (25.51 q/ha) was recorded in Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} which was at par with Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (24.61q/ha) followed by Azoxystrobin 23 SC @ 125 g a.i. ha^{-1} (23.36 q/ha) whereas lowest marketable yield (7.47 q/ha) was recorded in check.

Per cent avoidable loss ranged from 28.04 – 70.70. Highest per cent avoidable loss (70.70%) was in Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} and lowest (28.04%) in Propineb followed by Azoxystrobin 125 SC + Flutriafol 125 SC @ 12.5 + 12.5 g a.i.ha^{-1} (69.63%), Azoxystrobin 23 SC @ 125 g a.i. ha^{-1} (68.01%), Azoxystrobin 23 SC @ 100 g a.i. ha^{-1} (64.72%), Flutriafol 250 EC @ 125 g a.i. ha^{-1} (64.05%), Tebuconazole (63.16%), Flutriafol 250 EC @ 100 g a.i. ha^{-1} (59.40%), Hexaconazole (55.28%), Chlorothalonil (51.73%), Difenoconazole (49.09%), Metiram 55 + Pyraclostrobin (41.41%), Kresoxim methyl (30.78%). Least per cent avoidable loss (28.04%) was recorded in Propineb (Fig. 1).

Among all the treatments, Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} was found superior by giving highest marketable yield as well as highest per cent avoidable loss, thus Azoxystrobin 125 SC + Flutriafol 125 SC @ 14.28+14.28 g a.i ha^{-1} can be recommended for the management of foliar diseases of chilli like leaf spots as well as fruit rot.

The results are in accordance with the studies of Kushwaha et al. (2010) [7] who reported that fungicide application increased the yield. Similarly, Mohan et al. (2004) [11] who reported that the triazole fungicides gave highest pathogen inhibition and produced highest yields. Devanathan and Ramanujam (1995) [4] reported that foliar spray of Chlorothalonil (0.2%) reduced the disease intensity and increased yield significantly as compared to unsprayed plot in case of early blight of tomato Azoxystrobin 23 SC, Flutriafol 250 EC and Azoxystrobin 125 SC + Flutriafol 125 SC have not been tested earlier.

Table 1: Evaluation of fungicides against *Alternaria tenuissima* (Kunze ex Pers.) Wiltshire. under field conditions

S.No.	Fungicide	Dosages	
		g a.i. ha^{-1}	Formulation g/ml ha^{-1}
1	Chlorothalonil 75 WP	600	800
2	Propineb 70 WP	350	500
3	Azoxystrobin 25 SC	100	400
4	Azoxystrobin 25 SC	125	500
5	Kresoxym methyl 44.3 SC	250	500
6	Difenoconazole 25 EC	125	500
7	Tebuconazole 25.9 EC	125	500
8	Hexaconazole 2 SC	60	3000
9	Flutriafol 25 EC	100	400
10	Flutriafol 25 EC	125	500
11	Azoxystrobin 25 SC + Flutriafol 25 SC	12.5 + 12.5	800
12	Azoxystrobin 25 SC + Flutriafol 25 SC	14.28 + 14.28	914
13	Metiram 55 + Pyraclostrobin 5 WG	963 + 88	1750
14	Control	-	-

Table 2: Effect of fungicidal spray on incidence of *Alternaria tenuissima* on Chilli

Treatments	Dose (g a.i. ha^{-1})	7 Days after I spray				7 Days after II spray				7 Days after III spray				7 Days after IV spray				7 Days after V spray			
		2014	2015	Mean	PDC*	2014	2015	Mean	PDC	2014	2015	Mean	PDC	2014	2015	Mean	PDC	2014	2015	Mean	PDC
Chlorothalonil 75 WP	600	22.86	24.44	23.65	41.11	24.76	26.67	25.71	39.10	26.67	28.89	27.78	35.90	28.57	31.11	29.84	39.84	28.57	33.33	30.95	41.36
Propineb 70 WP	350	35.24	38.89	37.06	7.71	38.10	41.11	39.60	6.20	40.95	44.44	42.70	1.47	43.81	47.78	45.79	7.67	49.52	51.11	50.32	4.67
Azoxystrobin 23 SC	100	13.33	12.22	12.78	68.18	15.24	15.56	15.40	63.53	17.14	17.78	17.46	59.71	19.05	20.00	19.52	60.64	20.00	22.22	21.11	60.00
Azoxystrobin 23 SC	125	11.43	11.11	11.27	71.94	14.29	13.33	13.81	67.29	16.19	16.67	16.43	62.09	18.10	18.89	18.49	62.72	19.05	21.11	20.08	61.96
Kresoxim methyl 44.3 SC	250	29.52	32.22	30.87	23.12	31.43	34.44	32.94	21.99	33.33	36.67	35.00	19.23	38.10	38.89	38.49	22.40	39.05	44.44	41.75	20.91
Difenoconazole 25 EC	12.5	23.81	25.56	24.68	38.54	25.71	27.78	26.75	36.65	28.57	30.00	29.29	32.42	30.48	33.33	31.90	35.68	32.38	35.56	33.97	35.64
Tebuconazole 25.9 EC	125	17.14	17.78	17.46	56.52	19.05	20.00	19.52	53.76	20.95	22.22	21.59	50.18	23.81	24.44	24.13	51.36	25.71	27.78	26.75	49.33
Hexaconazole 5 EC	60	18.10	18.89	18.49	53.95	19.05	21.11	20.08	52.44	22.86	22.22	22.54	47.99	24.76	26.67	25.71	48.16	26.67	28.89	27.78	47.37
Flutriafol 250 EC	100	18.10	17.78	17.94	55.34	20.00	21.11	20.56	51.32	20.95	23.33	22.14	48.90	23.81	24.44	24.13	51.36	24.76	27.78	26.27	50.23
Flutriafol 250 EC	125	15.24	15.56	15.40	61.66	17.14	17.78	17.46	58.65	19.05	20.00	19.52	54.95	21.90	22.22	22.06	55.52	22.86	25.56	24.21	54.14
Azoxystrobin 125 SC + Flutriafol 125 SC	12.5 + 12.5	8.57	7.78	8.17	79.64	9.52	10.00	9.76	76.88	11.43	11.11	11.27	73.99	13.33	13.33	13.33	73.12	14.29	15.56	14.92	71.73
Azoxystrobin 125 SC + Flutriafol 125 SC	14.28 + 14.28	6.67	5.56	6.11	84.78	7.62	7.78	7.70	81.77	9.52	8.89	9.21	78.75	10.48	11.11	10.79	78.24	11.43	12.22	11.83	77.59
Metiram 55 + Pyraclostrobin5 WG	963 + 88	24.76	26.67	25.71	35.97	26.67	28.89	27.78	34.21	29.52	31.11	30.32	30.04	33.33	34.44	33.89	31.68	35.24	38.89	37.06	29.78
Control		38.10	42.22	40.16	-	40.00	44.44	42.22	-	40.00	46.67	43.33	-	44.76	54.44	49.60	-	46.67	58.89	52.78	-
CD at 5 %		1.25	1.02			1.16	1.22			1.43	1.29			1.64	1.23			1.62	1.49		
CV		10.57	9.59			8.93	10.25			10.14	9.95			10.52	8.66			9.80	9.57		
	*PDC = Per cent disease control																				

Table 3: Effect of fungicidal spray on severity of *Alternaria tenuissima* on Chilli

Treatments	Dose (g a.i. ha^{-1})	PDI** 7 Days after I spray				PDI 7 Days after II spray				PDI 7 Days after III spray				PDI 7 Days after IV spray				PDI 7 Days after V spray			
		2014	2015	Mean	PDC*	2014	2015	Mean	PDC	2014	2015	Mean	PDC	2014	2015	Mean	PDC	2014	2015	Mean	PDC
Chlorothalonil 75 WP	600	6.67	14.67	10.67	52.94	10.67	18.67	14.67	43.59	14.67	22.67	18.67	37.78	18.67	26.67	22.67	35.85	24.00	29.33	26.67	34.43
Propineb 70 WP	350	14.67	22.67	18.67	17.65	17.33	26.67	22.00	15.38	22.67	29.33	26.00	13.33	26.67	36.00	31.33	11.32	30.67	41.33	36.00	11.48
Azoxystrobin 23 SC	100	4.00	6.67	5.33	76.47	5.33	10.67	8.00	69.23	6.67	14.67	10.67	64.44	10.67	18.67	14.67	58.49	16.00	21.33	18.67	54.10
Azoxystrobin 23 SC	125	1.33	5.33	3.33	85.29	4.00	9.33	6.67	74.36	5.33	10.67	8.00	73.33	9.33	14.67	12.00	66.04	14.67	18.67	16.67	59.02
Kresoxim methyl 44.3 SC	250	13.33	21.33	17.33	23.53	16.00	25.33	20.67	20.51	21.33	28.00	24.67	17.78	25.33	32.00	28.67	18.87	29.33	37.33	33.33	18.03
Difenoconazole 25 EC	12.5	8.00	17.33	12.67	44.12	10.67	21.33	16.00	38.46	17.33	24.00	20.67	31.11	21.33	28.00	24.67	30.19	25.33	33.33	29.33	27.87
Tebuconazole 25.9 EC	125	4.00	10.67	7.33	67.65	8.00	16.00	12.00	53.85	10.67	18.67	14.67	51.11	16.00	22.67	19.33	45.28	22.67	25.33	24.00	40.98
Hexaconazole 5 EC	60	5.33	13.33	9.33	58.82	9.33	17.33	13.33	48.72	13.33	20.00	16.67	44.44	17.33	24.00	20.67	41.51	22.67	29.33	26.00	36.07
Flutriafol 250 EC	100	4.00	10.67	7.33	67.65	6.67	14.67	10.67	58.97	10.67	18.67	14.67	51.11	14.67	22.67	18.67	47.17	20.00	25.33	22.67	44.26
Flutriafol 250 EC	125	4.00	6.67	5.33	76.47	5.33	12.00	8.67	66.67	6.67	14.67	10.67	64.44	12.00	18.67	15.33	56.60	17.33	22.67	20.00	50.82
Azoxystrobin 125 SC + Flutriafol 125 SC	12.5 + 12.5	0.00	4.00	2.00	91.18	1.33	6.67	4.00	84.62	4.00	10.67	7.33	75.56	6.67	14.67	10.67	69.81	10.67	17.33	14.00	65.57
Azoxystrobin 125 SC + Flutriafol 125 SC	14.28 + 14.28	0.00	0.00	0.00	100.00	0.00	5.33	2.67	89.74	0.00	6.67	3.33	88.89	5.33	10.67	8.00	77.36	6.67	14.67	10.67	73.77
Metiram 55 + Pyraclostrobin5 WG	963 + 88	10.67	17.33	14.00	38.24	14.67	22.67	18.67	28.21	17.33	25.33	21.33	28.89	22.67	29.33	26.00	26.42	28.00	33.33	30.67	24.59
Control		18.67	26.67	22.67	-	21.33	30.67	26.00	-	26.67	33.33	30.00	-	30.67	40.00	35.33	-	34.67	46.67	40.67	-
CD at 5 %		2.55	3.64			3.57	2.66			3.65	2.17			2.66	2.09			2.96	1.82		
CV		22.5	17.14			22.76	9.36			17.15	6.52			9.36	5.15			8.15	3.83		
	PDC* = Per cent disease control PDI** = Per cent disease index																				

Table 4: Effect of fungicidal sprays on fruit rot of chilli

Treatment		Dose (g a.i. ha^{-1})	Fruit rot at I Picking (%)				Fruit rot at II Picking (%)				Fruit rot at III Picking (%)			
			2014	2015	Mean	Disease control (%)	2014	2015	Mean	Disease control (%)	2014	2015	Mean	Disease control (%)
T1	Chlorothalonil 75 WP	600	49.05	52.65	50.85	30.71	52.90	56.84	54.87	27.90	56.19	59.84	58.01	27.14
T2	Propineb 70 WP	350	63.16	68.16	65.66	10.53	67.46	73.01	70.24	7.71	72.02	77.20	74.61	6.30
T3	Azoxystrobin 23 SC	100	34.50	37.29	35.89	51.09	38.57	41.54	40.05	47.37	41.14	43.90	42.52	46.60
T4	Azoxystrobin 23 SC	125	28.92	31.49	30.21	58.84	34.28	37.03	35.65	53.15	36.72	39.27	37.99	52.29
T5	Kresoxim methyl 44.3 SC	250	60.68	65.02	62.85	14.36	63.92	68.68	66.30	12.89	67.80	72.23	70.01	12.08
T6	Difenoconazole 25 EC	12.5	52.89	56.18	54.54	25.68	56.15	60.06	58.10	23.65	59.46	63.09	61.28	23.05
T7	Tebuconazole 25.9 EC	125	42.10	45.46	43.78	40.35	45.10	48.77	46.94	38.33	48.22	51.63	49.92	37.30
T8	Hexaconazole 5 EC	60	47.31	50.70	49.00	33.22	50.79	54.52	52.65	30.82	53.91	57.37	55.64	30.12
T9	Flutriafol 250 EC	100	40.12	43.29	41.70	43.17	45.37	48.87	47.12	38.08	48.46	51.72	50.09	37.09
T10	Flutriafol 250 EC	125	37.87	40.81	39.34	46.39	42.09	45.27	43.68	42.61	44.87	47.83	46.35	41.79
T11	Azoxystrobin 125 SC + Flutriafol 125 SC	12.5 + 12.5	27.53	29.98	28.76	60.81	30.47	33.15	31.81	58.20	32.84	35.35	34.10	57.18
T12	Azoxystrobin 125 SC + Flutriafol 125 SC	14.28 + 14.28	23.18	25.53	24.36	66.81	25.74	28.33	27.03	64.48	28.10	30.54	29.32	63.18
T13	Metiram 55 + Pyraclostrobin5 WG	963 + 88	54.02	57.75	55.88	23.85	58.43	62.52	60.47	20.54	61.88	65.68	63.78	19.90
T14	Control		70.60	76.16	73.38	-	73.90	78.31	76.11	-	77.58	81.68	79.63	-
	Cd at 5%		2.38	2.60			2.04	2.23			2.28	2.86		
	CV		3.14	3.52			2.48	2.53			2.60	3.06		

Table 5: Effect of fungicidal sprays on fruit yield of chilli

Treatments		Dose (g a.i. ha^{-1})	Total yield (q/ha)			Marketable yield (q/ha)			Avoidable loss (%)
			2014	2015	Mean	2014	2015	Mean	
T1	Chlorothalonil 75 WP	600	23.66	21.85	22.76	16.33	14.64	15.48	51.73
T2	Propineb 70 WP	350	15.50	14.36	14.93	11.22	9.56	10.39	28.04
T3	Azoxystrobin 23 SC	100	31.77	29.42	30.59	22.78	19.59	21.18	64.72
T4	Azoxystrobin 23 SC	125	34.89	32.28	33.58	25.22	21.51	23.36	68.01
T5	Kresoxim methyl 44.3 SC	250	16.22	15.07	15.64	11.55	10.04	10.80	30.78
T6	Difenoconazole 25 EC	12.5	21.89	20.27	21.08	15.89	13.47	14.68	49.09
T7	Tebuconazole 25.9 EC	125	27.55	25.46	26.51	19.89	16.93	18.41	59.40
T8	Hexaconazole 5 EC	60	24.89	23.02	23.95	18.11	15.32	16.71	55.28
T9	Flutriafol 250 EC	100	30.66	28.40	29.53	21.66	18.91	20.29	63.16
T10	Flutriafol 250 EC	125	31.33	29.07	30.20	22.22	19.36	20.79	64.05
T11	Azoxystrobin 125 SC + Flutriafol 125 SC	12.5 + 12.5	36.77	34.02	35.40	26.55	22.66	24.61	69.63
T12	Azoxystrobin 125 SC + Flutriafol 125 SC	14.28 + 14.28	38.44	35.58	37.01	27.33	23.69	25.51	70.70
T13	Metiram 55 + Pyraclostrobin5 WG	963 + 88	18.66	17.29	17.98	14.00	11.52	12.76	41.41
T14	Control		11.44	10.60	11.02	7.89	7.06	7.47	-
	Cd at 5 %		1.54	1.46		1.07	1.12		
	CV		10.60	10.82		10.25	10.87		

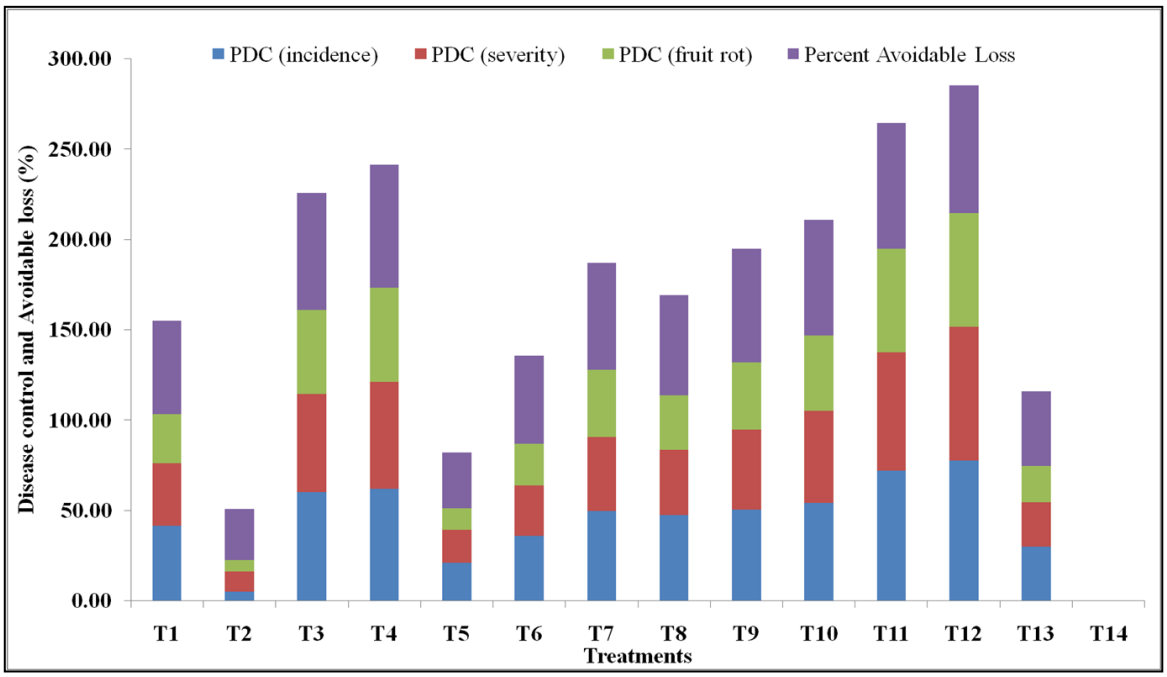

Fig 1: Effect of fungicidal spray on incidence, severity, fruit rot and percent avoidable loss of *Alternaria tenuissima* on Chilli

4. Conclusion

Based on the present study, it can be concluded that most of the fungicides have good control over dieback and fruit rot disease of chilli. Thus fungicides used for managing the chilli diseases play important role towards the management of chilli diseases. Therefore Azoxystrobin 125 SC + Flutriafol 125 SC @ (14.28+14.28) g a.i ha^{-1} which have better control over disease can be recommended for chemical control of chilli.

5. References

1. Bal E. Occurrence, symptoms and control of Alternaria disease in straw berries. De boer en de tuinder actueel 1984; 90(31):15.
2. Bosland PW, Votava EJ. Peppers: Vegetable and Spice Capsicums. CAB International. 2003, 233.
3. Deshmukh GP, Kurundkar BP, Mehetre NM. Efficacy of Zetron, a bio-pesticide in the management of chilli anthracnose. Journal of Mycology and Plant Pathology. 2004; 34(2):301-303.
4. Devanathan M, Ramanujam K. Evaluation of fungicides for the management of early blight of tomato, caused by *Alternaria solani*. Madras Agricultural Journal. 1995; 82:228-229.
5. Fugro PA, Rajput JC, Mandokhot AM, Patil VH. Management of Alternaria blight of tomato in Konkan region of Maharastra. Indian Journal of Mycology and Plant Pathology. 1995; 25:84.
6. Gopinath K, Radhakrishnan NV, Jayaraj J. Effect of propiconazole and difenoconazole on the control of anthracnose of chilli fruits caused by *Colletotrichum capsici*. Crop Protection. 2006; 25(9):1024-1031.
7. Kushwaha A, Srivastava A, Nigam R, Srivastava N. Management of alternaria blight of pigeonpea crop through chemicals. International Journal of Plant Protection. 2010; 3(2):313-315.
8. Mazur S, Nawrocki J, Kucmierz J. Control of fungi infecting seeds of chickpea. Progress in Plant Protection 2002; 42(2):829-831.
9. Mc-Kinney HH. Influence of soil temperature and moisture on rot of wheat seedlings by *Helminthosporium sativum*. Journal of Agricultural Research. 1923; 26:195-217.
10. Mehrotra RS. Plant Pathology. Tata Mc. Graw Hill Publication Co. Ltd., New Delhi, 1980, 770.
11. Mohan C, Thind TS, Prem R, Arora JK. Promising activity of triazoles and other fungicides against fruit rot of chilli and stemphylium blight of onion. Plant Disease Research Ludhiana. 2004; 19(2):200-203.
12. Naik BM, Sabalpara AN. Management for the control of leaf spot of Indian bean caused by *Alternaria tenuissima* (Fries) Wiltshire. Indian Phytopathology. 2007; 60(2):271-272.
13. NHB. Indian Horticulture Database. National Horticulture Board. India: Ministry of Agriculture, Government of India, 2014.
14. Peirce, Lincoln C. Vegetable characteristics production and marketing.New York, John Willey and Sons, 1987, 325.
15. Purseglove JW. Reported vitamin P content in chilli. Tropical crops dictyledons I and II. Longman, Landon. 1977, 524-525.
16. Raja P. Efficacy of fungicides against leaf spot of eggplant. Annals of Plant Protection Sciences. 2011; 19(1):252-254.
17. Rathore BS. Performance of some new fungicides in controlling die-back and fruit rot of red pepper. Plant Disease Research. 2004; 19(2):196-199.
18. Saimbhi MS, Kan G, Nandpuri KS. Chilli are rich in vitamins especially vitamin C. Qualita Plantarum. 1977; 27:171-175.
19. Sayed S, Bagvandas M. Chilli contents vitamin C. South Indian Horticulture. 1980; 28:42-47.
20. Sharma YK, Thakore BBL. Control of die-back of chillies with Iprobenphos and its residues. Journal of Mycology and Plant Pathology. 1999; 29(3):294-299.
21. Singh RS. Diseases of vegetable crops IInd edition Oxford and IBH Publishing Co, New Delhi, India, 1987, 362.
22. Singh RS. Plant Diseases. Oxford and IBH Pub. Co. New Delhi, 1983, 564.
23. Thind TS, Jhooty JS. Relative prevalence of fungal diseases of chilli fruits in Punjab. Indian Journal of

Mycology and Plant Pathology. 1985; 15:305-307.
24. Vishwakarama SN, Sitaramaiah K. Relative efficacy of fungicides in field for the control of die-back and fruit rot of chilli (*Capsicum annum* L.), Advances in Biological Research. 1986; 4:128-137.