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HORTICULTURE

Field evaluation of fungicides against *Alternaria porri* (Ellis) Cif., causing purple blotch of onion (*Allium cepa*L.)

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ABSTRACT

Field evaluation of several fungicides including new molecules was undertaken for the management of purple blotch disease of onion caused by *Alternaria porri*(Ellis) Cif. The experiments were conducted during *kharif of* 2012 and 2013 using susceptible variety Arka Nikethan.Cymoxanil 8% + Mancozeb 64% WP @ 2500 ppm and Mancozeb 70% WP @ 2500 ppm were effective in reducing the disease severity by 54.86 and 52.88 % over untreated control. However, Mancozeb 70% WP and Cymoxanil 8% + Mancozeb 64% WP recorded the maximum yield of 39.71 and 37.06 t/ha and obtained benefit cost ratio of 33.85 and 20.67. Thus these two fungicides can be recommended for the effective and economical management of the disease.

Highlights

- Mancozeb 70% WP and Cymoxanil 8% + Mancozeb 64% WP were the best fungicides for effective management of economically important Purple blotch disease in onion.

Keywords: Non-systemic fungicides, systemicfungicides, combination products

Onion (*Allium cepa*L.) is one of the five most important vegetable crops grown widely across the world. India is a traditional grower and assumes second position in onion production with 86.34 million tonnes from 4.36 million hectares area (FAOSTAT 2013). Onion is cultivated round the year throughout the country. The major onion growing states are Maharashtra (33%), Karnataka (17%), Gujarat (10%), Bihar (7%), Madhya Pradesh (7%), Andhra Pradesh (5%), Rajastan (3%), Haryana (3%) and others (15%) (Indian Horticulture Database 2011).Onion is susceptible for numerous pests and diseases throughout growing period under field conditions.Alternaria blight is one of the most devastating disease (Marmath *et al.*, 2013).Purple blotch of onion caused by *Alternaria porri* (Elllis) Cif.,is a major disease affecting the foliage severely resulting in crop loss ranging from 30 to 100 per cent. The disease may reach epidemic states during the favourable conditions of high relative humidity (80-90%) and optimum temperature (24±10C) (Yadav *et al.*, 2013). In view of importance of the crop and effect of fungal disease on yield, there is a need for the development of effective control methods. Though resistant cultivars would be most effective economic choice presently no such resistant varieties are available in India (Shashikanth *et al.*, 2007). Management of disease using fungicides is efficient strategy; however indiscriminate use of fungicides leading to development of resistance in pathogen population demands new molecules to combat the disease. Hence, the present study was undertaken to determine the field efficacy of fungicides for the management of purple blotch disease of onion.

Materials and Methods

The study was conducted during *kharif* in two consecutive years of 2012 and 2013 at Indian Institute of Horticultural Research, Hessaraghatta, Bangalore.

Fungicides

A total of 13 fungicides including 5 non-systemic fungicides, 4 systemic fungicides and 4 combination products were evaluated against purple blotch disease of onion. Fungicides evaluated and their concentrations tested are listed in Table 1.

Field evaluation of effective fungicides against purple blotch of onion

The experiment was laid out in randomized block design with 13 fungicide treatments and untreated control with 4 replications. The general agricultural practices being followed for onion were adopted for all the experimental plots. FYM (30 t/ha) and NPK (Urea: 65 kg, single Super phosphate: 366 kg, murate of Potash: 46.5 kg) were added to all the plots. Onion seeds @ 3g/plot (cv. Arka Niketan) were directly sown in 15cm wide rows in a plot measuring 1.5 sq. mt. Forty days after sowing; thinning of seedlings was carried out to maintain a spacing of 10cm between plants and 15 cm between rows. The field was kept free from weeds by frequent hand weeding during the early stages of the crop. A total volume of 500 litres spray solution was used per hectare. The first foliar application was carried out as soon as the symptom of the disease was noticed in the field. Observations on disease scoring were recorded one day prior to each foliar application. A total of three foliar applications were given at ten days intervals.

Table 1. List of fungicides evaluated

	Chemical Name	Commercial Name	Concentration / litre
A	Non Systemic Fungicides		
1	Captan 50% WP	Captaf	2.5g
2	Chlorothalonil 75% WP	Kavach	2.5g
3	Copper oxy chloride 50% WP	Blitox	2.5g
4	Mancozeb 70% WP	Dithane M-45	2.5g
5	Propineb 70 WP	Antracol	2.5g
B	Systemic fungicides		
6	Difenconozole 25% EC	Score	1.0ml
7	Triademorph 80% EC	Calixin	0.75g
8	Hexaconozole 5% SC	Contaf	0.75ml
9	Propiconozole 25% EC	Tilt	1.0ml
C	Combination products		
10	Pyraclostrobin 6.7% + Dimethomorph 12% WG	Cabrio team	2.5g
11	Pyraclostrobin 5% + Metiram 55% WG	Cabrio top	2.5g
12	Cymoxanil 8% + Mancozeb 64% WP	Curzate M8	2.5g
13	Metalaxyl-M 4% + Mancozeb 64% WP	Ridomil MZ	2.0g

Sandovit (0.05%) was added to spray solution to avoid immediate runoff. Intensity of disease was recorded by selecting five plants at random from each plot and 5 leaves were selected from each plant. The area covered by the disease was assessed using 0-5 scale (Mayee and Datar 1986) and expressed as Percent Disease Index (Shakyawar *et al.,* 2014).

Per cent disease index (PDI)

$$PDI = \frac{\text{Total sum of numerical ratings}}{\text{Maximum disease rating} * \text{Number of observations taken}} * 100$$

AUDPC (area under disease progress curve) was calculated according to the equation of Campbell and Madden (1990.

AUDPC = ∑ ½ (Si + Si+1) x (ti+1-ti)

Si = Disease intensity at time t i

Si+1 = Disease intensity at time ti+1

ti= Time when disease intensity was Si

t i+1 = Time when intensity Si+1

Harvesting and computing yield records

The crop was harvested when the leaves turned yellow and the top fall occurred. Bulbs harvested from each plot were weighed and expressed as kg per plot. On the basis of yield per plot, the total bulb yield was computed and expressed in tonnes per hectare.

Benefit: Cost Ratio (BCR)

The economics of treatments was worked out by considering the prevailing rates of inputs, produce, labour charges and expressed as an incremental benefit cost ratio. Additional benefit due to increased yield in each treatment over control was worked out based on the pooled yield of two years. The benefit cost ratio was calculated using additional benefits of the produce and additional cost of the treatment.

$$B:C\ ratio = \frac{\text{Additional benefits of the produce from each treatment}}{\text{Additional cost of each treatment}}$$

Statistical Analysis

The PDI calculated and the yield data obtained were analysed using ANOVA.

Results

The results revealed that all the fungicides were effective in management of the disease under high disease pressure.

Field evaluation of effective fungicides against purple blotch of onion – 1st season

During the first season Cymoxanil 8% + Mancozeb 64% WP was significantly effective by recording a least PDI of 23.99 as against 53.78 in untreated control. This was followed by Mancozeb 70% WP, Pyraclostrobin 5% + Metiram 55% WG, Pyraclostrobin 6.7% + Dimethomorph 12% WG, Metalaxyl- M 4% + Mancozeb 64% WP, Triademorph 80% EC and Propineb 70 WP with PDI of 26.82, 30.43, 31.06, 31.11, 36.39 and 37.61 respectively. However, the maximum yield of 40.56 t/ha was recorded in Mancozeb 70% WP followed by 37.67, 36.11, 35.18 and 34.20 t/ha in Cymoxanil 8% + Mancozeb 64% WP, Metalaxyl-M 4% + Mancozeb 64% WP, Pyraclostrobin 5% + Metiram 55% WG and Pyraclostrobin 6.7% + Dimethomorph 12% WG respectively as against 21.18 t/ha in untreated control.

Cymoxanil 8% + Mancozeb 64% showed less AUDPC of 277.36 followed by Mancozeb 70% WP, Pyraclostrobin 5% + Metiram 55% WG and Pyraclostrobin 6.7% + Dimethomorph 12% WG by recording 283.08, 327.15 and 328.30 as against 613.19 in untreated control.

Field evaluation of effective fungicides against purple blotch of onion – 2nd season

The disease incidence was comparatively high during the second season than the first season. Mancozeb 70% WP was effective with a least PDI of 27.55 and yield of 38.86 t/ha as against a PDI of 61.59 and yield of 20.16 t/ha in untreated control. This was followed by PDI of 28.09, 32.00, 32.56, 33.74 and 37.65 and yield of 37.67, 35.18, 34.20, 36.11 and 32.80 t/ha in Cymoxanil 8% + Mancozeb 64% WP, Pyraclostrobin 5% + Metiram 55% WG, Pyraclostrobin 6.7% + Dimethomorph 12% WG, Metalaxyl- 4% + Mancozeb 64% WP andTriademorph 80% EC respectively.

Mancozeb 70% WP and Cymoxanil 8% + Mancozeb

64% WP showed less AUDPC of 313.03 and 339.85 followed by 378.42, 386.08 and 392.22 in Metalaxyl-M 4% + Mancozeb 64% WP, Pyraclostrobin 6.7% + Dimethomorph 12% WG and Pyraclostrobin 5% + Metiram 55% WG as against 699.57 in untreated control.

Pooled analysis revealed Cymoxanil 8% + Mancozeb 64% WP and Mancozeb 70% WPas effective in reducing the disease severity by recording least PDI of 26.04 and 27.18 as against 57.69 in untreated control. The maximum yield of 39.71 and 37.06 t/hawere recorded in Mancozeb 70% WP and Cymoxanil 8% + Mancozeb 64% WP as against 20.67 t/ha in untreated control. Thus, these two fungicides achieved benefit cost ratio of 33.85 and 20.67. Triademorph 80% EC recorded a PDI of 37.02 andyield of 31.80 t/ha and obtained benefit cost ratio of 20.97.

Table 2. Field evaluation of fungicides against purple blotch of onion

Treatment	1st season					2nd season				
	PDI	% decrease over control	AUDPC	Yield t/ha	% increase over control	PDI	% decrease over control	AUDPC	Yield t/ha	% increase over control
Captan 50% WP	43.93**	18.32	480.63	23.29**	9.96	46.50**	24.50	548.80	24.93**	23.66
Chlorothalonil 75% WP	40.52**	24.66	416.62	31.44**	48.44	41.44**	32.72	474.32	30.18**	49.70
Copper oxy chloride 50% WP	40.18**	25.29	408.88	26.78**	26.44	42.26**	31.38	489.88	26.40**	30.95
Mancozeb 70% WP	26.82**	50.13	283.08	40.56**	91.50	27.55**	55.27	313.03	38.86**	92.76
Propineb 70 WP	37.61**	30.07	349.06	30.91**	45.94	40.46**	34.31	475.12	29.36**	45.63
Difenconozole 25% EC	43.44**	19.23	477.42	28.07**	32.53	44.33**	28.02	505.73	27.18**	34.82
Triademorph 80% EC	36.39**	32.34	349.94	32.80**	54.86	37.65**	38.87	419.33	30.80**	52.78
Hexaconozole 5% SC	41.91**	22.07	405.75	27.44**	29.56	47.39**	23.06	598.24	25.76**	27.78
Propiconozole 25% EC	41.44**	22.95	406.22	28.02**	32.29	45.99**	25.33	588.35	27.73**	37.55
Pyraclostrobin 6.7% + Dimethomorph 12% WG	31.06**	42.25	328.30	34.20**	61.47	32.56**	47.13	386.08	32.42**	60.81
Pyraclostrobin 5% + Metiram 55% WG	30.43**	43.42	327.15	35.18**	66.10	32.00**	48.04	392.22	34.07**	69.00
Cymoxanil 8% + Mancozeb 64%	23.99**	55.39	277.36	37.67**	77.86	28.09**	54.39	339.85	36.44**	80.75
Metalaxyl-M 4% + Mancozeb 64% WP	31.11**	42.15	343.86	36.11**	70.49	33.74**	45.22	378.42	33.53**	66.32
Control	53.78		613.19	21.18		61.59		699.57	20.16	
CD 5%	0.94			0.16		2.80			0.15	
CD 1%	2.35			0.39		6.99			0.38	

**Significant at at both 5% and 1%,* Significant at 1%

Table 3 Field evaluation of fungicides against purple blotch of onion – pooled analysis

Treatment	PDI		Yield t/ha		
	Pooled mean	% decrease over control	Pooled mean	% increase over control	B:C
Captan 50% WP	45.21	21.63	24.11	16.64	6.26
Chlorothalonil 75% WP	40.98	28.96	30.81	49.06	14.15
Copper oxy chloride 50% WP	41.22	28.55	26.59	28.64	9.85
Mancozeb 70% WP	27.18	52.88	39.71	92.09	33.85
Propineb 70 WP	39.04	32.33	30.13	45.78	16.25
Difenconozole 25% EC	43.89	23.93	27.62	33.63	9.27
Triademorph 80% EC	37.02	35.83	31.80	53.85	20.91
Hexaconozole 5% SC	44.65	22.60	26.60	28.69	12.31
Propiconozole 25% EC	43.72	24.22	27.88	34.87	12.48
Pyraclostrobin 6.7% + Dimethomorph 12% WG	31.81	44.86	33.31	61.16	7.23
Pyraclostrobin 5% + Metiram 55% WG	31.22	45.89	34.62	67.50	7.90
Cymoxanil 8% + Mancozeb 64%	26.04	54.86	37.06	79.27	20.67
Metalaxyl-M 4% + Mancozeb 64% WP	32.43	43.79	34.82	68.47	17.51
Control	57.69		20.67		

Discussion

The fungal diseases are spreading rapidly and are becoming epidemic in many crops due to changing environment. Fungicides are capable of controlling the disease; however indiscriminate use of fungicides builds resistance in pathogen and necessitates the evaluation of new molecules to combat disease. Alternaria blight disease severity varies with the micro-climatic conditions at the particular location. Application of fungicides at critical stages of 45 and 75 days after sowing has been reported to minimise losses due to the disease and increase benefit for the users (Meena *et al.*, 2004).

The effectiveness of Captan was noticed against purple blotch disease of onion (Sharma, 1986), *A. cassia* on cowpea seed (Noelani *et al.*, 2002) and *A. brassicae* (Khan *et al.*, 2007). Effectiveness of Chlorothalonil in the management of purple blotch of onion was reported and recommended as foliar application at fortnightly interval (Abhinandan *et al.*, 2004). These works are in agreement with our studies. In contrast, Captan and Chlorothalonil were least effective against *A. alternata* causing leaf blight of groundnut (Kantwa *et al.*, 2014). Chlorothalonil and Mancozeb were effective in reducing the leaf blight caused by *A. alternata* causing Chrysanthemum leaf blight (Arun Kumar *et al.*, 2011) and both were recommended for purple blotch (Gevens 2011). Chatage and Bhale (2011) showed the effectiveness of Mancozeb and Chlorothalonil against *A. pluriseptata* incitant of IVY ground fruit. Mancozeb was reported as highly effective fungicide in the management of purple blotch of onion (Chethana and Kachapur 2010, Shahnaz, 2013). Meena *et al.*, (2011) proved the efficacy of Mancozeb in a multi-location trial in different states of India against Alternaria blight in Indian mustard. It was effective against *A. tenuis* (Begum *et al.*, 2010), *A. solani* (Chaudhary *et al.*, 2010, Gondall *et al.*, 2012), *A. alternata* (Kantwa *et al.*, 2014). The effectiveness of Mancozeb against several Alternaria species is in accordance with the present work. Gholve *et al.*, (2012) reported Mancozeb as least effectiveness of against *A. macrospora* affecting cotton, which is in contrast with our work. Wickramaarachchi *et al.*, (2004) stated Propineb as least effective fungicide under field conditions against purple blotch of onion which is in contrast with the present work where a benefit cost ratio of 16.25 was recorded. Efficacy of Propineb was stated against *A. alternata* causing chrysanthemum leaf blight under field conditions (Arun Kumar *et al.*, 2011). Propineb and Mancozeb were effective against leaf spot of cauliflower caused by *A. brassicae* (Mishra *et al.,* 2009). Propineb, Copper oxychloride and Mancozeb were effective against Alternaria leaf spot of cotton (Bhattiprolu and Rao, 2014).

Evaluation of new fungicide molecules, systemic fungicides in particular is essential for the effective management of disease since the fungicidal resistance development was reported against the pathogen (Mesta *et al.*, 2003). Mesta *et al.*, (2011) reported the effectiveness of Difenconazole in reducing PDI against Alternaria blight of sunflower. Triademorph was reported to manage the leaf spot of Indian bean caused by *A. tenuissima* (Fries) Wiltshire (Naik and Sabalpara, 2007). Undhad *et al.*, 2011 indicated effectiveness of Hexaconazole in reducing the disease severity of purple blotch disease of onion. It was effective in controlling chrysanthemum leaf blight caused by *A. alternata* under field conditions and also improved yield (Arun Kumar *et al.*, 2011). Hexaconazole and Propiconazole were best in reducing the PDI and increasing the yield in sunflower under field conditions (Mesta *et al.*, 2011).All the above stated works are in line with our studies.

The combination products will be a best choice in management of disease because the probability of gaining resistance by pathogen is less compared to individual molecules. Chaudhary *et al.*, (2010) found Metalaxyl- Mancozeb as bestin checking the early blight disease of tomato.Its effectiveness was also reported against *A. tenuis* (Begum *et al.*, 2010), *A. brassicae* causing Alternaria blight in rapeseed mustard (Khan *et al.*, 2007). All the above stated works are in conformity with the present study. The other combination products tested in the present study are not reported against any Alternaria species according to the available literature. Cabrio top was reported as least effective against Fusarium oxysporium f. sp. Ciceri causing gram wilt (Subhani *et al.*, 2011). Curzate M8 was reported effective against *Pseudoperenosporacubensis* causing downy mildew of cucumber (Girija and Chethana, 2009) and *Sclerotiumrolfsii* causing foot rot of Amorphophallus (Mondal and Khatua 2013).

Conclusion

Mancozeb 70% WP performed better in managing the disease and enhancing the yield with a high benefit cost ratio. Alternatively Cymoxanil 8% + Mancozeb 64% WP may be used, as the use of combination product will be a better choice in managing the disease and also to overcome resistance development in the pathogen.

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