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Evaluation of Newer Combination of Azoxystrobin and Tebuconazole for the Management of Purple Blotch of Onion

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Systemic fungicides *viz.*, azoxystrobin, tebuconazole, difenconazole, propiconazole, carbendazim, thiophanate methyl and azoxystrobin 11 % + tebuconazole 18.3% SC were evaluated at 0.1, 0.15 and 0.2 per cent concentration against *Alternaria porri*, which causes purple blotch of onion under *in vitro* condition. Among the fungicides, azoxystrobin 11 % + tebuconazole 18.3 % SC was found to be highly effective at 0.1, 0.15 and 0.2 per cent concentrations with the maximum per cent inhibition of 98 to 100. This was found to be significantly superior over all the other treatments. Field experiments were also carried out to know the efficacy of azoxystrobin 11% + tebuconazole 18.3% SC at 500, 750 and 1000 ml/ha against purple blotch of onion. This fungicide at 1000 ml/ha significantly reduced the disease with the PDI of 31.00 followed by the dose at 750 ml/ha (34.00 PDI) and recorded 21.91 and 21.31 t/ha yield, respectively as compared to the maximum PDI (81.00) and minimum yield (10.04 t/ ha) in control.

Key words: Azoxystrobin 11% + tebuconazole 18.3% SC, Onion, Purple blotch.

Onion is one of the potential foreign exchange earners, as India is the second largest after China, producing 1.6 million MT annually (FAO, 2012). Though India ranks first in terms of area under onion cultivation; stands second in terms of production due to less productivity, as compared to other countries. The productivity of onion in India is 14.35 t/ha, which is at least five times lesser as compared to Republic of Korea (66.16 t/ha), Spain (55.26 t/ha), Netherlands (51.64 t/ha) and Myanmar (46.21 t/ha) (Chengappa *et al.,* 2012). This crop is mainly cultivated during *kharif* and *rabi* seasons and used in raw form as salad and also for cooking as vegetable (Singh *et al.*, 1994). Onion is found to be rich source of minerals, vitamins, polyphenols and a number of phytonutrients.

The major onion producing states in India include Maharashtra, Karnataka, Gujarat, Bihar and Madhya Pradesh; where 32.6 per cent of the total contribution is from Maharashtra (Anil and Vinay, 2014). Immense market demand with the entry of diverse processed products of onion has made people to take up onion under large acreage, which has resulted in higher production. Despite the achievement in production technology and availability of good varieties, this crop suffers from many yield limiting diseases comprising of purple blotch, downy mildew, Stemphylium blight, apart from post harvest diseases. Among them, purple blotch caused by *Alternaria porri* (Ellis) Cif is a serious fungal disease that affects onion during *Kharif* season resulting in more yield loss than *Rabi* (Srivatsava *et al.,* 1994). Application of fungicides is the most common and practical method to manage purple blotch of onion. However, frequent application of fungicides over a period of time will lead to the development and emergence of resistant strains.

Spraying of mancozeb, difenconazole, tebuconazole and azoxystrobin were found to be effective in managing the disease (Gupta *et al.*, 1994 and Chethana *et al*., 2011). Savitha *et al.* (2014) proved the efficiency of difenconazole (0.1%) along with *Pseudomonas fluorescens* (0.5%) in reducing purple blotch of onion.

Most of the new generation fungicides are highly specific and possess single site mode of action. Strobilurin group of fungicides possess broad spectrum activity and site specific against a wide range of pathogens. They are excellent inhibitors of spore germination and known for their protectant activity (Sahu *et al*., 2013). This group includes azoxystrobin and trifloxystobilurin molecules. Tebuconazole belongs to triazole group of fungicide, which is found to be effective against the growth and development of *Alternari* and bring about demethylation of C-14 during ergosterol biosynthesis resulting in the accumulation of C-14 methyl sterols. The biosynthesis of these ergosterols is critical to the formation of cell wall of fungi. Lack of normal sterol production slows down or stops the growth of the fungus and prevents the further infection of invasion of host tissue (Ginoya and Gohel, 2015).

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Considering the seriousness and economic damage caused by purple blotch of onion, the present investigation was carried out, by using new formulation of azoxystrobin 11 % + tebuconazole 18.3 % SC at different concentrations to test *in vitro* and *in vivo* bio-efficacy.

Materials and Methods

In vitro evaluation of fungicides was carried out at College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka. The efficacy of systemic fungicides along with test chemical *viz*., azoxystrobin 23 % SC, tebuconazole 25.9 % EC, difenconazole 25 % EC, propiconazole 25 % EC, carbendazim 50 % WP, thiophanate methyl 70 % WP and azoxystrobin 11 % + tebuconazole 18.3 % SC at 0.1, 0.15 and 0.2 per cent were assayed by poison food technique (Shravelle, 1961). Required quantity of individual fungicide was added separately into molten and cooled potato dextrose agar to get the desired concentration. Later, 20 ml of the poisoned medium was poured into sterile Petri plates. Mycelial disc of 5 mm size from actively growing culture of the fungus were cut using a sterile cork borer and one disc each was placed at the centre of each agar plate. Control was maintained without adding any fungicide to the medium. Each treatment was replicated thrice and incubated at room temperature (28±2°C) for nine days and the colony diameter was measured. The efficacy of fungicides was expressed as per cent inhibition of mycelial growth over control. The per cent inhibition was calculated by using the formula suggested by Vincent (1947).

$$I = \frac{C - T}{C} \times 100$$ where,

I= per cent inhibition

C= colony diameter of fungus in control

T= colony diameter of fungus in treatment

The field experiment on the evaluation of fungicides was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Raichur during *kharif* 2013 and 2014. The experiment was laid out in a randomised block design with seven treatments and three replications. Onion seeds, variety N-52 were sown in plots (4.0 X 3.0 m) at a spacing of 15x10 cm. All recommended agronomic practices were followed.

Fungicides *viz*., azoxystrobin 23 % SC, tebuconazole 25.9 % EC and their combination product azoxystrobin 11 % + tebuconazole 18.3 % SC at 500, 750 and 1000 ml/ha were evaluated against *A. porri* under natural condition and compared with standard check and untreated check. All the foliar sprays were given as per their doses mentioned in protocol (Table 2). The first spray of fungicide was done immediately after initiation of the disease. The same concentration was followed for second and third sprays at 15 days interval with unsprayed/untreated plots served as control. The severity of purple blotch was recorded at 10 days interval after each spray. The disease severity was recorded on five plants with five leaves each at random by using 0-5 scale suggested by Sharma (1986). The per cent disease index (PDI) was worked out using the formula of Wheeler (1969).

$$PDI = \frac{\text{Sum of all the numerical disease ratings}}{\text{Total No. of leaves observed}} \times \frac{100}{\text{Max. disease grade (5)}}$$

The disease severity data was transformed to arc sine values before analysis of variance (ANOVA). Duncan's multiple range test (DMRT) was used to determine the most significant treatment (Steel *et al*., 1997).

Results and Discussion

Results on the efficacy of different fungicides on growth of *Alternaria porri* are presented in Table 1. It was observed that all the systemic fungicides had showed significant differences in their efficacy to inhibit the growth of the pathogen over control. The maximum per cent inhibition of mycelial growth was recorded (98.11, 100 and 100) with azoxystrobin + tebuconazole at 0.1, 0.15 and 0.2 per cent, respectively. This fungicide was found to be significantly superior over all other treatments. Azoxystrobin inhibited the mycelial growth to an extent of 92.44, 94.30 and 95.11 per cent at 0.1, 0.15 and 0.2 per cent respectively, which was however, found to be on par with difenconazole at 0.1, 0.15 and 0.2 per cent. The least mycelial inhibition was noticed in thiophanate methyl and carbendazim treatment (44.47 and 49.23 per cent, respectively).

The present study revealed that azoxystrobin + tebuconazole at 0.15 and 0.2 per cent could successfully inhibit the growth of *Alternaria porri* followed by azoxystrobin and difenconazole (0.1%), which were also found to be equally effective. Mishra and Gupta (2012) and Chethana *et al*. (2011), also noticed the effectiveness of azoxystrobin and difenconazole in inhibiting the mycelial growth of purple blotch pathogen.

The pooled mean data of the field experiments recorded during two seasons (Table 2) clearly revealed that all the treatments were significantly superior over control in managing purple blotch of onion. However, the minimum PDI (31.00) was recorded with azoxystrobin 11 % + tebuconazole 18.3 % SC at 1000 ml/ha with the maximum yield of 21.91 t/ha. This treatment was found to be the most effective in managing purple blotch of onion. Foliar spray of azoxystrobin 11 % + tebuconazole 18.3 % SC at 750 ml/ha was found to be the next in order of efficacy (Table 2) followed by azoxystrobin 11 % + tebuconazole 18.3 % SC at 500 ml/ha. Whereas, in

Table 1. Effect of fungicides on inhibition of mycelial growth of *A. porri* under *in vitro*.

Fungicides	Per cent inhibition at			
	0.1 %	0.15 %	0.2 %	Mean
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	98.11	100	100	99.37
	(82.11)*	(90.00)	(90.00)	(87.37)
Azoxystrobin 23 % SC	92.44	94.30	95.22	93.95
	(74.05)	(76.20)	(77.27)	(75.84)
Tebuconazole 25.9 % SC	90.04	90.48	89.89	90.21
	(71.61)	(72.05)	(71.70)	(71.79)
Difenoconazole 25 % SC	92.11	94.15	96.11	93.83
	(73.69)	(76.10)	(77.46)	(75.75)
Propiconazole 25 % SC	75.26	81.19	80.22	79.51
	(60.18)	(64.30)	(64.98)	(63.15)
Carbendazim 50 % WP	47.59	49.26	53.33	49.23
	(43.62)	(44.58)	(45.49)	(44.56)
Thiophanate methyl 70 % WP	41.48	42.96	48.89	44.47
	(40.07)	(40.95)	(44.41)	(41.81)
	S. Em±	CD (P=0.05%)		
Fungicides(F)	0.44	1.67		
Concentration(C)	0.29	1.09		
F×C	0.76	2.89		
CV	2.00			

* Figures in the parenthesis are Arc Sine transformed values.

the control, the maximum PDI (81.00) with minimum yield (10.04 t/ha) was noticed. Although the effective management was recorded with azoxystrobin 11 % + tebuconazole 18.3 % SC at 1000 ml/ha, the maximum benefit cost ratio (3.46) was obtained with azoxystrobin 11 % + tebuconazole 18.3 % SC at 750 ml/ha (Table 3). All the fungicides tested could significantly reduce the purple blotch disease and increase the bulb yield as compared to standard check.

Table 2. Evaluation of azoxystrobin 11 % + tebuconazole 18.3 % SC against purple blotch of onion

Treatments	Concentration (%)	Qty.(ml or g/ha)	PDI				Bulb yield (t/ha)
			Before I spray	After I spray	After II spray	After III spray	
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	55 + 91.5	500	21.33 (27.49)	27.67 cdef (31.73)	34.33c (35.87)	38.33 c (38.25)	19.52 c
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	82.5+137.25	750	20.33 (26.73)	23.00 b (28.63)	29.67 b (32.98)	34.00 b (35.66)	21.31 b
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	110+183	1000	19.67 (26.67)	21.67 ab (27.74)	27.67 ab (31.73)	31.00 a (33.83)	21.91 ab
Azoxystrobin 23 % SC	125	500	21.00 (27.27)	28.33 def (32.15)	37.67 def (37.85)	44.33 e (41.74)	14.80 ef
Tebuconazole 25.9 % EC	187.5	750	21.33 (27.49)	29.00 ef (32.55)	39.00 f (38.64)	45.33 f (42.32)	13.81 f
Difenconazole 25 % EC	125	500	22.00 (27.96)	30.33 f (33.40)	38.00 ef (38.05)	43.67 def (41.36)	14.89 def
Control			21.00 (27.97)	43.00 g (40.98)	66.00 g (55.34)	81.00 g (64.16)	10.04 g
SEM			1.05	0.93	0.83	0.62	0.41
CD (P=0.05%)			NS	2.86	2.57	1.90	1.28

*Figures in parenthesis are angular transformed value

Chemical method is the most practical and effective ons for the immediate management of purple blotch of onion and farmers normally spray mancozeb. The strobilurin and triazole have recently been labelled for the management of this disease, but only preliminary reports are available as on date. Ginoya and Gohel (2015) found that azoxystrobin 18.2% + difenconazole 11.4% were superior in the management of fruit rot of chilli caused by *Alternaria alternata* under *in vitro*. The fungicides difenconazole and azoxystrobin belong to triazole and strobilurin group, respectively. Strobilurin fungicides are quionone outside inhibitors (QoI), which are known to interfere with energy production in fungus, thus preventing the ATP production.

Table 3. Economics of different fungicidal treatments on cost benefit ratio

Treatment details	Dose (ml or g/ha)	Cost of cultivation (Rs.)	Treatment cost (Rs.)	Bulb yield (t/ha)	Gross returns (Rs.)	Cost of cultivation + Treatment cost (Rs.)	Net returns (Rs.)	B:C
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	500	53800	5175	19.52 ^{c}	195185 ^{c}	58975	136210 ^{c}	3.31
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	750	53800	7762.5	21.31 ^{b}	213148 ^{b}	61562.5	151586 ^{b}	3.46
Azoxystrobin 11 % + Tebuconazole 18.3 % SC	1000	53800	10350	21.91 ^{ab}	219074 ^{ab}	64150	154924 ^{ab}	3.42
Azoxystrobin 23 % SC	500	53800	10125	14.80 ^{ef}	147963 ^{ef}	63925	84038 ^{ef}	2.31
Tebuconazole 25.9 % EC	750	53800	3690	13.81 ^{f}	138148 ^{f}	57490	80658 ^{f}	2.40
Difenconazole 25 % EC	500	52840	3000	14.89 ^{def}	148889 ^{def}	55840	93049 ^{def}	2.67
Control		51880	5175	10.04 ^{g}	100370 ^{g}	51880	48490 ^{g}	1.93
SEM				0.41	4141		4141	
CD (P=0.05%)				1.28	12761		12761	

The combination product used in the present study, azoxystrobin 11 % + tebuconazole 18.3 % SC (Table 1 and 3) belongs to stobilurin and triazole group, which might have killed the fungal spores resulting in lower disease incidence and increased yield. Further studies on spore germination assay with this combination fungicide may reveal the truth. Akbari and Parakhia (2007), also proved the field performance of propiconazole (0.05 %) against sesame blight caused by *Alternaria alternata* in (80 %). Jambhulkar *et al.* (2012) reported that spraying of azoxystrobin 23 % SC had reduced Alternaria blight severity by 38.9 per cent as compare to control. The strobilurin fungicide, Pristine 38 % WG (164+126g ai/ha) was found to be effective in managing early blight of tomato up to an extent of 31.88% recording 58.16 t of yield/ha (Sahu *et al.,* 2013).

From the results it is concluded that azoxystrobin 11 % + tebuconazole 18.3 % SC at 1000 ml/ha could be used for the effective management of purple blotch of onion. Three sprays with this new combination fungicide at 15 days interval, starting from the earliest day of the observation of the symptoms in the field, recorded the maximum disease reduction with increased bulb yield.

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