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Varietal reaction of onion cultivars against *Alternaria porri* causing purple blotch and its management

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ABSTRACT: Ten onion cultivars were evaluated during *kharif* 2021-22 and 2022-23 for their reaction to *Alternaria porri* under field conditions. Of them, three varieties *viz*., Arka Kalyan, Arka Niketan and Arka Bheema showed resistant reaction while two varieties *viz.,* Rampura and Satara local were moderately resistant and rest were moderately susceptible. Among 10 fungicides, 10 botanicals and six bio agents evaluated *in vitro* against *A. porri*, 0.1%Azoxystrobin-23EC, 0.1%Tebuconazole-25EC, *Allium sativum* (15%) and *Trichoderma harzianum* recorded the maximum inhibition of mycelial growth of *Alternaria porri*. The field evaluation of different fungicides and botanicals during indicated that 0.1%Tebuconazole-25EC was recorded minimum PDI of 22.68 and yield of 271.00q/ha. 0.1% Azoxystrobin-23EC,0.1%Difenconazole-25EC,0.2%Mancozeb-75WP and *Allium sativum* cloves extract were next best treatments in reducing the disease intensity by recording PDI of 24.00, 26.00, 28.00 and 46.00 and yield of 268.00q/ha, 262.65q/ha, 264.00q/ha and 234.65q/ha respectively. During *kharif* 2022-23 also 0.1%Azoxystrobin-23EC was found to be the effective treatment followed by 0.1%Tebuconazole-25EC.

Keywords: *Alternaria porri,* fungicides, management, onion, purple blotch

INTRODUCTION

Onion (*Allium cepa* L.) is an important bulbous vegetable crop of global importance and it is used as vegetable, salad and spice in the daily diet by large population. It has been reported to be rich in phytochemicals especially flavonols which are medicinal (Javadzadeh *et al*., 2009). Onion is regarded as highly export oriented crop and earn valuable foreign exchange for the country. Several factors have been identified for the low productivity of onion in India. The most important factor is the purple blotch disease caused by *Alternaria porri* (Ellis) C if. Which affects both bulb and seed crop throughout India. The yield loss of onion in India due to this disease under favorable conditions varies from 5.0 to 96.5per cent (Gupta and Pathak, 1988). In earlier studies, Sharma. (1997) Chethana *et al.* (2011) and Behera *et al.* (2013) were reported the screening of some varieties to locate the tolerance and resistant types. In the present studies, an attempt has been made to test Onion varieties against purple blotch disease and its management. Spraying of broad spectrum fungicides has been recommended for management of disease. Control achieved by these chemicals is inadequate. Therefore, it is thought worthwhile to test the efficacy of more promising chemicals like Propineb-50WP, Metiram-50WP, Hexaconazole-5EC, Azoxystrobin-23EC, Tebuconazol-25EC, Myclobutanil-10WP, and Difenconazole - 25EC against fungus. Not much light has been shed on biological control, botanicals which are effective against *Alternaria porri*. Hence, an attempt has been made to test commonly available botanicals and bio agents against the pathogen.

MATERIALS AND METHODS

Reaction of Onion cultivars

An experiment was conducted at College of Horticulture, Bidar, Karnataka during *Kharif* 2021-22 and 2022-23 in Randomized Complete Block Design with a plot size of 3.6 m x 1.8 m. Ten cultivars viz., Satara Local, Rampura, Arka Kalyan, Agripound Dark Red, Ballary Red, Arka Niketan, Nasik Red, Telagi Red, Kumata and Arka Bheema seedlings were planted at a spacing of 15 cm x 10 cm (row to row x plant to plant) and all the recommended agronomic practices were followed to raise a good crop except fungicidal spray to avoid the killing of fungal pathogen (Anonymous, 2017). As there was heavy incidence of purple blotch during both the years, the cultivars were scored for the disease incidence under natural field conditions without artificial inoculation. At bulb development stage, disease score was measured on ten randomly selected plants from each plot at fortnightly intervals by using 0 to 5 point rating scale (Sharma, 1986).

Scale	Severity
0	No disease symptoms
1	A few spots towards tip covering 1 to 10 per cent leaf area
2	Several dark purplish brown patch covering 11 to 20 percent leaf area
3	Several patches with paler outer zone covering 21 to 40 percent leaf area
4	Leaf streaks covering 41 to 75 per cent leaf area and breaking of the leaves from center
5	Leaf streaks covering more than 76 percent leaf area followed by complete drying and breaking of the leaves from the center.

Percent Disease Index was worked out as follows.

$$\text{Percent Disease Index (PDI)} = \left[\frac{\text{Sum of individual ratings X 100}}{\text{Number of plants or leaves examined X maximum disease grade}} \right]$$

Table 1. Performance of onion cultivars against *Alternaria porri* under field conditions

Cultivar	Reaction	Percent Disease Index		Yield (q/ha)	
		kharif 2021-22	*kharif 2022-23*	*kharif 2021-22*	*kharif 2022-23*
Satara Local	MR	24.65^{e}	22.00^{d}	227.00^{fg}	226.00^{e}
Rampura	MR	24.00^{e}	24.00^{d}	182.65^{h}	183.65^{g}
Arka Kalyan	R	08.67^{f}	10.00^{e}	315.00^{b}	316.32^{b}
Agripound Dark Red	MS	36.00^{d}	34.65^{c}	298.66^{d}	297.32^{c}
Ballary Red	MS	38.00^{cd}	40.00^{b}	187.32^{h}	184.65^{g}
Arka Niketan	R	09.34^{f}	08.67^{e}	307.34^{c}	312.32^{b}
Nasik Red	MS	44.00^{b}	42.00^{b}	222.67^{g}	220.32^{f}
Telagi Red	MS	48.00^{a}	50.00^{a}	231.00^{f}	236.65^{d}
Kumata	MS	38.00^{cd}	40.00^{b}	238.00^{e}	236.67^{d}
Arka Bheema	R	10.00^{f}	09.32^{e}	331.00^{a}	332.00^{a}

Note: 1. R = Resistant, MR = Moderately Resistant, MS = moderately susceptible, S=Susceptible HS = highly susceptible

2. In the vertical columns means followed by same letters are not different statistically by DMRT (P=0.05).

***In vitro* evaluation of fungicides**

Ten fungicides with different modes of action at recommended dose were evaluated in the laboratory for their efficacy against *Alternaria porri* by the poisoned food technique (Nene and Thapliyal, 1979). Each treatment was replicated 3 times. The molten sterilized PDA was used as nutrient medium and required quantity of each fungicide was added separately so as to get a required concentration of that fungicide. The fungicides were thoroughly mixed by stirring and about 15 ml poisoned medium was poured to each of the 90mm

petri dishes and allowed for solidification. The actively growing periphery of 9 day old culture of *Alternaria porri* was carefully cut by using a gel cutter and transferred aseptically to centre of each petri dish containing the poisoned solid medium. Suitable control was maintained by growing the cultures on PDA without the fungicides. The plates were incubated at 27±1^{O}C for 9 days and the colony diameter was recorded 9 days after growth (Table-2). The percent inhibition of mycelial growth over control was calculated using the formula of Vincent (1947).

$$I = \frac{C-T}{C}$$

I = per cent inhibition of mycelial growth
C = radial growth of fungus in control
T = radial growth of fungus in treatment.

***In vitro* evaluation of botanicals**

Healthy plants were selected from which the fresh leaves and other parts were obtained and thoroughly washed with tap water then air dried. Aqueous plant extract was prepared by grinding 100g leaves/other parts with 100ml distilled water (w/v) using a blender and filtrate was collected by passing through double layered muslin cloth. The supernatant was taken as standard plant extract solution (100%). All the extracts obtained were passed through filter paper used for assay. The poisoned food technique (Nene and Thapliyal, 1979) was followed to evaluate the efficacy of botanicals in laboratory against *Alternaria porri* at 15% concentration (Table-3). Each treatment was replicated 3 times. The method followed for conducting the experiment was same as that used for fungicide evaluation.

***In vitro* evaluation of bio-agents**

Dual culture technique (Dennis and Webster, 1971) was followed to study interaction of six antagonists in the laboratory. Six bio-agents with a control treatment were used for evaluation. Pour 20ml of PDA into 90mm petri dishes and allowed for solidification. Discs measuring 5 mm of *Alternaria porri* was taken from 9 day old culture and was placed at one end of the petri dish then respective antagonistic organisms were inoculated at the opposite side (Table-4). A control was maintained by inoculating only *Alternaria porri* at one end in case of fungal antagonistic. In case of bacterial antagonistic *Alternaria porri* was placed at both ends of petri plates and bacterial culture was inoculated at centre of the petri plate, control was maintained by inoculating *Alternaria porri* at the both the ends of the petri plates. Each treatment was replicated four times and incubated for 6 days at 27 ± 1^{0}C. The activity of antagonistic organisms

Table 2. *In vitro* evaluation of fungicides against *Alternaria porri*

Treatments	Fungicides	Concentration (%)	Percent inhibition of mycelia growth
T1	Propineb -50WP	0.2	80.08 ^{e}
T2	Metiram-50WP	0.2	57.62^{h}
T3	Mancozeb-75WP	0.2	82.63^{d}
T4	Chlorothalonil-75WP	0.2	47.37^{i}
T5	Copper oxy chloride-50WP	0.3	72.42^{g}
T6	Myclobutanil-10WP	0.1	73.40^{g}
T7	Azoxystrobin-23EC	0.1	92.58^{a}
T8	Difenconazole-25EC	0.1	87.05^{c}
T9	Tebuconazole-25EC	0.1	88.87^{b}
T10	Hexaconazole-5EC	0.1	77.47^{f}

Note: In the vertical columns means followed by same letters are not different statistically by DMRT (P=0.01).

Table 3. *In vitro* evaluation of botanicals against *Alternaria porri*

Treatments	Botanicals	Plant Parts used	Concentration (%)	Percent inhibition of mycelia growth
T1	*Allium cepa*	Bulbs	15	28.62[i]
T2	*Allium sativum*	Cloves	15	65.37[a]
T3	*Clerodendron inerme*	Leaves	15	57.36[b]
T4	*Azadirachta indica*	Leaves	15	39.50[e]
T5	*Lantana camera*	Leaves	15	35.44[f]
T6	*Aloe vera*	Leaves	15	55.30[c]
T7	*Ocimum sanctum*	Leaves	15	33.24[g]
T8	*Glyricidia maculata*	Leaves	15	26.27[j]
T9	*Eucalyptus globes*	Leaves	15	48.20[d]
T10	*Durantha repens*	Leaves	15	30.50[h]

Note: In the vertical columns means followed by same letters are not different statistically by DMRT (P=0.01).

Table 4. Effect of different antagonists on growth of *Alternaria porri*

Treatments	Antagonists	Percent inhibition of mycelia growth
T1	*Trichoderma harzianum*	54.00[a]
T2	*Trichoderma viride*	52.25[a]
T3	*Trichoderma virens*	41.00[c]
T4	*Trichoderma konnigii*	48.25[b]
T5	*Pseudomonas fluorescence*	20.25[e]
T6	*Bacillus subtilis*	31.50[d]

Note: In the vertical columns means followed by same letters are not different statistically by DMRT (P=0.01).

were recorded by measuring the colony diameter of *Alternaria porri* in each treatment and compared with control.

Management of purple blotch, *Alternaria porri*

The field experiment was laid out in RCBD with 13 treatments and 3 replications during *Kharif* 2021-22 and 2022-23 at College of Horticulture, Bidar, Karnataka. Healthy Telagi Red seedlings were planted in the field with 15cm X 10cm (row to row X plant to plant) spacing in plot size of 3.6m X 1.8m. All other cultural practices and pest control practices were followed as recommended in package of practices (Anonymous, 2017). The first spraying was carried out as soon as first symptom of disease was noticed in the field. 4 sequential sprays of fungicides and botanicals were taken at an interval of 15 days (Table-5). Disease severity was recorded on ten randomly selected plants in each plot, just one day before each spraying and fifteen days after last spraying. An observation on severity of disease on foliage was recorded by using 0 to 5 point scale and PDI was worked out. The bulb yield in each plot was recorded and computed to hectare basis, the percent increase over control was calculated.

RESULTS AND DISCUSSION

Reaction of onion cultivars

All the screened genotypes were categorized for their reaction on the basis of PDI values. Those with 1- 10 PDI value were considered as resistant, while those with 11-25 PDI as moderately resistant, 26-50 PDI as

Table 5. Effect of different fungicides and botanicals on purple blotch of onion caused by *Alternaria porri*

Treatment	Mean PDI		Bulb yield (q/ha)		Percent yield increase over control	
	Kharif 2021-22	*Kharif 2022-23*	*Kharif 2021-22*	*Kharif 2022-23*	*Kharif 2021-22*	*Kharif 2022-23*
T1- 0.3% Copper oxy chloride-50WP	35.34^{f}	34.65^{e}	247.32^{f}	246.67^{e}	28.59	29.15
T2-0.2% Metiram-50WP	39.32^{e}	41.34^{d}	247.65^{f}	249.65^{d}	28.76	30.70
T3-0.2% Mancozeb-75WP	28.00^{hi}	29.32^{f}	264.00^{b}	264.67^{b}	37.26	38.57
T4- 0.2%Propineb -50WP	32.67^{g}	31.34^{ef}	252.00^{e}	250.65^{d}	31.02	31.23
T5-0.1%Hexaconazole-5EC	30.00^{h}	30.64^{f}	259.34^{c}	260.00^{c}	34.83	36.12
T6- 0.1%Azoxystrobin- 23 EC	24.00^{ij}	22.66^{g}	268.00^{a}	270.67^{a}	39.34	41.71
T7-0.1%Tebuconazole-25EC	22.68^{j}	24.00^{g}	271.00^{a}	267.00^{ab}	40.89	39.79
T8-0.1%Difenconazole-25EC	26.00^{i}	24.00^{g}	262.65^{b}	268.00^{a}	36.55	40.31
T9-0.1% Myclobutanil-10WP	33.34^{fg}	34.00^{e}	255.32^{d}	250.00^{d}	32.74	30.89
T10-15%*Allium sativum*	46.00^{d}	48.00^{c}	234.65^{g}	233.32^{f}	21.99	22.15
T11-15% *Aloe vera*	49.32^{c}	48.65^{c}	227.32^{h}	230.34^{g}	18.18	20.59
T12- 15% *Clerodendron inerme*	52.00^{b}	53.32^{b}	229.67^{h}	225.32^{h}	19.40	17.96
T13-Control	62.00^{a}	64.00^{a}	192.34^{i}	191.00^{i}	-	-

Note: In the vertical columns means followed by same letters are not different statistically by DMRT (P=0.05).

moderately susceptible, 51-75 PDI as susceptible and more than75 PDI as highly susceptible (Mishra *et al.,* 2009). Observations indicated that out of ten varieties evaluated, none of them were found highly resistant. However, three varieties viz., Arka Kalyan, Arka Niketan and Arka Bheema showed resistant reaction. Whereas, two varieties viz., Rampura and Satara local showed moderately resistant reaction and rest of them showed moderately susceptible reaction against purple blotch (Table1). At the time of harvest, bulb yield was recorded and computed to hectare basis. No relationship between disease severity and bulb yield was observed, it might be due to genetic potential of cultivars. Utilization of resistant cultivars in farming system is the most simple, effective and economical method in the management of plant diseases. Besides this, the resistant cultivars conserve the natural resource and reduce the cost, time and energy when compared to the other methods of disease management. Similar kind of work done by earlier workers who reported that the variety Arka Kalyan was found moderately resistant (Chethana *et al*., 2011 and Kavitha *et al*., 2017). The results are in agreement with Bal *et al*. (2019) who reported that the variety Arka Niketan was found resistant reaction.

***In vitro* evaluation of fungicides**

The results indicated that significant difference among fungicides in inhibiting the growth of the *Alternaria porri.* Among ten fungicides were evaluated, Azoxystrobin-23EC(92.58%) recorded maximum inhibition of mycelia growth of pathogen followed by Tebuconazole-25EC(88.87%), Difenconazole-25EC(87.05%),Mancozeb-75WP(82.63%), Propineb-50WP(80.08%), Hexaconazole-5EC(77.47%) and least inhibition was observed in Chlorothalonil-75WP (47.37%)(Table-2). *In vitro* evaluation of fungicides provides useful and preliminary information regarding efficacy of fungicides against pathogen within a short period and it is very much necessary before they are planned to be used under field experiments. Similar observations were reported by Priyanka *et al*. (2017) who studied the efficacy of six fungicides under *in vitro*

against *A. porri* at three different concentrations (0.1, 0.2 and 0.3 %) and found that 100 per cent mycelia growth inhibition with propiconazole, difenoconazole and tebuconazole at all the concentrations tested. Triazoles are the potent group of fungicides having a strong ergosterol synthesis inhibitory action which blocks the cytochrome P-450 dependant enzyme and C-14 alpha de-methylase which are needed to convert lanosterol to ergosterol. The biosynthesis of these ergosterols is critical to the formation of cell walls of fungi. Lack of normal sterol production slows or stops the growth of the fungus and preventing further infection and/or invasion of host tissues. The results on the efficacy of Mancozeb-75WP are in conformity with Chethana *et al.* (2011). The results are in agreement with Arunakumara K.T. (2006) who reported propineb-50 WP as effective fungicide against *A. solani* causing early blight of tomato. Chlorothalonil-75 WP was less effective against *A.porri* (Chethana *et al.,* 2012).

***In vitro* evaluation of botanicals**

The results revealed that effect of plant extracts on the fungal growth was significant. The *Allium sativum* cloves extract was found effective in inhibiting the mycelia growth (65.37%) followed by *Clerodendron inerme* (57.36%), *Aloe vera* (55.30%), *Eucalyptus globes* (48.20%) and least inhibition was observed in *Glyricidia maculata* (26.27%) (Table3). The results are in conformity with Prasad and Naik (2003) and Mesta *et al.,* (2011) where Garlic clove extract was found effective in inhibiting the mycelial growth of *Alternaria solani* and *Alternaria helianthi* respectively. The effectiveness of Garlic clove extract as a pesticide is due to volatile oil which contains dialyl disulphide, diallyl trisulphide and sulphodoxides derived from allicin (Vijayalakshmi *et al.,* 1999). Pramodkumar (2007) reported *Clerodendron* leaf extract as one of the best plant extract in inhibiting the mycelial growth of *Alternaria porri.*

In vitro* evaluation of antagonists against *Alternaria porri

All the *Trichoderma* sp inhibited the growth of *Alternaria porri* effectively. Among these antagonists *Trichoderma harzianum* showed highest inhibition (54.00%) followed by *Trichoderma viride* (52.25%) (Table4). This may be due to higher competitive ability of *Trichoderma* sp. either by mycoparasitism, antibiosis and also due to possibilities of existence of microbial interactions *viz*., stimulation, inhibition, mutual intermingling of growth of antagonistic isolate over test pathogen. Vinale *et al*. (2008) reported that *Trichoderma* sp. produced secondary metabolites such as 6-pentyl-alpha-pyrone (6pp), iso-cyanide derivatives, acids (heptelidic and koningic acid), peptaibols and cell wall degrading enzymes (CDWE) which are involved in the growth inhibition of many phytopathogenic fungi. Imtiaz and Lee (2008) reported *Trichoderma harzianum* and *Trichoderma virens* are most effective in inhibiting the growth of *Alternaria porri.*

Management of purple blotch, *Alternaria porri*

In subsequent sprays all the fungicides and botanicals treated plots recorded significantly less percent disease index over control. During *Kharif*-2021-22, among fungicides 0.1%Tebuconazole-25EC was significantly effective in reducing the disease intensity by recording a PDI of 22.68 and yield of 271.00q/ha (Table5). 0.1% Azoxystrobin-23EC,0.1% Difenconazole - 25EC, 0.2% Mancozeb-75WP, 0.1%Hexaconazole - 5EC and 0.2% Propineb-50WP were next best treatments found effective in reducing the disease intensity by recording a PDI of 24.00,26.00,28.00,30.00 and 32.67 and yield of 268.00q/ha, 262.65q/ha, 264.00q/ha, 259.34q/ha and 252.00q/ha respectively. Among botanicals tested, minimum PDI of 46.00 and yield of 234.65q/ha was recorded in *Allium sativum* cloves extract (15%) and maximum PDI of 62.00 and yield of 192.34q/ha was recorded in the control plot (Table5). Again during *Kharif* - 2022-23, among fungicides 0.1% Azoxystrobin - 23EC was significantly effective in reducing the disease intensity by recording a PDI of 22.66 and yield of 270.67q/ha (Table6). 0.1% Tebuconazole-25EC, 0.1% Difenconazole-25EC, 0.2% Mancozeb-75WP, 0.1% Hexaconazole-5EC and 0.2% Propineb were next best treatments found effective in reducing the disease intensity by recording a PDI of 24.00, 24.00, 29.32, 30.64 and 31.34 and yield of 267.00q/ha, 268.00q/ha, 264.67q/ha, 260.00q/ha and 250.65q/ha respectively. Among botanicals tested, PDI of 48.00 and yield of 233.32q/ha was recorded in *Allium sativum* cloves extract (15%) and maximum PDI of 64.00 and yield of 191.00q/ha was recorded in the control plot (Table5). Studies conducted by Wangikar *et al.* (2012) on management of purple blotch of onion in Marathawada region of Maharashtra revealed that lowest disease severity of purple blotch with spray of Mancozeb-75WP at 0.25%, Hexaconazole-5EC at 0.1% and Difenconazole-25EC at 0.05%. Gupta et al. (2012) reported that systemic fungicides Tebuconazole-25EC at 0.1% and Azoxystrobin-23EC at 0.1% effectively controlled purple blotch disease of Garlic. Chethana *et al.* (2015) reported that Mancozeb-75WP at 0.25% effectively controlling purple blotch of Onion. The

results on the effectiveness of foliar application of *Allium sativum* cloves extract in the management of *Alternaria* blight are in conformity with Nashwa and Abo-Elyousr (2012).

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