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Research Article

EFFECT OF FUNGICIDES ON ALTERNARIA BLIGHT OF CUMIN CAUSED BY *ALTERNARIA BURNSII*

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Abstract: Studies on the relative efficacy of fungicides in both *in vitro* and *in vivo* against cumin blight. Azoxystrobin was found most effective followed by propiconazole in both conditions. Difenconzole were found least effective among these fungicides, Azoxystrobin recorded 21.90 per cent disease intensity with 65.17 per cent disease control and 5.82 q/ha seed yield by increasing 216.30 per cent seed yield.

Keywords: *Alternaria blight, Fungicides, Cumin*

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Introduction

India is one of the largest producers, consumers and exporters of seed spices. Among the seed spices, cumin (*Cuminum cyminum* L.) is one of the important crops and is also locally known as "Zeera" in Hindi. It belongs to order umbellales and family umbelliferae and believed to have originated from Egypt [1].

Cumin is popularly used for flavouring food and as herbal medicine and culinary for flavouring vegetables, pickles and soups, *etc*. Its seeds contain 17.7pre cent protein, 23.8 per cent fat, 35.5 per cent carbohydrates and 7.7 per cent minerals. In addition to this, cumin seeds also contain 6.2 per cent moisture, 0.09 per cent calcium, 0.45 per cent phosphorus, 0.048 per cent iron, 1.6 per cent sodium, 2.1 per cent potassium and also vitamin B1, B2, niacin, vitamin-A, vitamin-C *etc*. [2,3]. Cumin seeds are aromatic and nutty flavoured. Volatile oil from cumin seeds is used in perfumery, liquor, flavoring and cardinals and it has stimulatory carminative, stomatic, antidiarrhoeal and dyspepsial medicinal properties [4].

Alternaria blight caused by *Alternaria burnsii* is one of the most dreaded diseases and a major production constraint for the successful cultivation of cumin crop. The blight of cumin was first reported from Bombay province and the causal agent was identified as Alternaria spp. [5] but later on the fungus was named as *Alternaria burnsii* [6]. The disease is now widespread in all the cumin growing states of India as well as in Pakistan [7]. The blight pathogen *Alternaria burnsii* is internally and externally seed-borne [8]. The disease leads to serious yield losses under favourable weather conditions [9]. Seed losses to the extent of 83 per cent due to blight has been reported. The persistent cold and cloudy weather is congenial for the blight development [10,11].

Materials and Methods

The inhibitory effect of fungicides was tested on potato dextrose agar (PDA) medium, using Poisoned Food-Technique. The fungicides were tested at three concentrations *i.e*., 100, 300 and 500 ppm. Suitable quantity of fungicide was added to sterile and molten potato dextrose agar medium to get desired concentration, just before pouring in sterilized petri dishes and was allowed to solidify. The mycelial disc of five mm diameter taken from periphery of seven days old actively growing culture of *A. burnsii* were transferred at the centre of agar surfaces in petri dishes. The inoculated petri dishes were kept in BOD incubator at 25 +1°C for seven days. Three replications were kept for each treatment.

The experiment was conducted in Completely Randomized Design (CRD). The mycelial growth was recorded after seven days *i.e*. when the full growth of pathogen was recorded in control petri dishes. The potato dextrose agar without fungicide severed as control. The inhibition of mycelial growth of *A. burnsii* was calculated as follows [12]:

Per cent mycelial growth inhibition = [C-T / C] x 100

Where,

C= Mycelial growth observed in control

T= Mycelial growth observed in treatment

The disease control efficacy of fungicides against cumin blight in field under artificial inoculated condition was studied during two rabi crop seasons 2014-15 and 2015-16. Cumin variety RZ-19 was used in the trial. The experiment was conducted following Randomized Block Design (RBD) keeping three replications and having plot size 3x3 m^2. The treatments included in the experiment are mentioned below:

Name of fungicides	Trade name	Dose (*In vitro*) (ppm)	Dose (*In vivo*) (%)
Mancozeb	Indofil- M- 45	100, 300, 500	0.2
Carbendazim + mancozeb	Companian	100, 300, 500	0.2
Azoxystrobin	Amistar	100, 300, 500	0.2
Propiconazole	Tilt	100, 300, 500	0.2
Hexaconazole	Sitara	100, 300, 500	0.2
Difenconazole	Score	100, 300, 500	0.2

The crop was sown on 20th November in both the years. The *Alternaria burnsii* culture was raised on potato dextrose agar. The spore suspension was prepared in sterilized distilled water and the concentration was adjusted to 10-15 spores/microscopic field observed at 10 x magnification. The spore suspension was sprayed at 60 days after sowing. The fungicides were sprayed after three days of inoculation. Second spray was given at seven days interval. The intensity of blight was recorded after 7 days of second spray. Per cent disease control was calculated by following formula:

Per cent disease control = [(Disease intensity in control– Disease intensity in treatment) / Disease intensity in control] x 100

Disease grade was recorded on ten randomly selected plants from each plot. The seed yield was recorded in different treatments after harvest of the crop.

Table-1 *Effect of fungicide on mycelial growth of Alternaria burnsii after 7 days of incubation at 25+1 °C*

Fungicides	Per cent inhibition of mycelial growth* concentration (ppm)			Mean
	100	300	500	
Mancozeb	76.30(60.87)	78.50(62.38)	100.00(90.00)	84.93(67.16)
Carbendazim + mancozeb	64.00(53.13)	72.12(58.13)	100.00(90.00)	78.71(65.52)
Azoxystrobin	84.65(66.93)	98.00(81.87)	100.00(90.00)	94.22(76.08)
Propiconazole	80.00(63.43)	93.12(74.79)	100.00(90.00)	91.04(72.58)
Hexaconazole	60.30(50.94)	71.74(57.89)	100.00(90.00)	77.35(61.58)
Difenconazole	71.16(57.52)	78.21(62.17)	100.00(90.00)	83.12(65.74)
Control	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
	SEm±	CD (P=0.05)		
Fungicide (F)	1.58	4.53		
Concentration (c)	1.04	2.96		
F x C	2.74	7.84		

** Average of three replications, Figures in parentheses are angular transformed values*

Table-2 *Effect of fungicides on cumin blight and seed yield*

Fungicides	Concentration (%)	Per cent disease intensity*			Decrease in PDI over control (%)	Yield (q/ha)			Increase in yield over control (%)
		2014-15	2015-16	Pooled		2014-15	2015-16	Pooled	
Mancozeb	0.2	26.30(30.85)	28.20(32.08)	27.25(31.47)	56.66	5.54	5.21	5.38	192.39
Carbendazim + mancozeb	0.2	28.90(35.52)	32.31(34.64)	30.61(33.59)	51.32	4.81	4.59	4.70	155.43
Azoxystrobin	0.2	20.40(26.85)	23.40(28.93)	21.90(27.90)	65.17	5.97	5.67	5.82	216.30
Propiconazole	0.2	22.16(28.08)	26.70(31.11)	24.43(29.62)	61.15	5.70	5.54	5.62	205.43
Hexaconazole	0.2	31.40(34.08)	36.90(37.41)	34.15(35.76)	45.69	4.51	4.44	4.48	143.48
Difenconazole	0.2	26.90(32.04)	30.20(33.30)	28.55(32.67)	54.6	5.40	5.16	5.28	186.96
Control	-	59.10(50.24)	66.65(54.73)	62.88(52.46)	-	2.01	1.67	1.84	-
SEm±		0.84	1.10	0.93		0.16	0.18	0.20	
CD (p=0.05)		2.49	3.27	2.78		0.48	0.54	0.59	
CV		6.35	7.81	6.85		7.35	8.65	9.25	

** Average of three replications, Figures in parentheses are angular transformed values*

Results

Efficacy of fungicides on mycelial growth of *Alternaria burnsii*

The efficacy of fungicides *viz*. mancozeb, carbendazim 2% + mancozeb 63% WP, azoxystrobin, propiconazole, hexaconazole and difenoconazole were tested on potato dextrose agar (PDA) medium, using Poisoned Food Technique. The fungicides were tested at three concentrations *i.e.*, 100, 300 and 500 ppm. All the tested fungicides were found significantly inhibited the mycelial growth of *Alternaria burnsii*. The growth of the fungus decreased with the increase in concentrations of respective fungicides. Fungicide azoxystrobin was found most effective to inhibited mycelial growth (94.88%) followed by propiconazole (91.04%), mancozeb (84.93%), difenoconazole (83.12%), carbendazim + mancozeb (78.71%) and hexaconazole (77.35%) [Table-1].

Efficacy of different fungicides on intensity of Alternaria blight and seed yield of cumin in field condition

The efficacy of non-systematic and systematic fungicides *viz*. mancozeb 0.2 per cent, carbendazim + mancozeb WP 0.2 per cent, azoxystrobin 0.2 per cent, propiconazole 0.2 per cent, hexaconazole 0.2 per cent and difenoconazole 0.2 per cent were tested against *Alternaria burnsii* of cumin under field conditions. All the fungicides were found to be significantly superior over check in controlling the disease in both the years 2014-15 and 2015-16. [Table-2]. The minimum percent disease intensity was recorded with azoxystrobin (21.90%), followed by propiconazole (24.43%), mancozeb (27.25%), difenoconazole (28.55%), carbendazim + mancozeb (30.61%) and hexaconazole (34.15%) and against control (62.88%).

Similarly fungicidal sprays against Alternaria blight have significant effect on seed yield. Pooled analysis of seed yield data for 2014-15 and 2015-16 revealed that two sprays with azoxystrobin @ 0.2 per cent at seven days interval gave better yield of 5.82 q/ha followed by propiconazole 5.62 q/ha over check 1.84q/ ha. The lowest seed yield 4.48 q/ ha was recorded in hexaconazole @ 0.2 per cent. Further, it can be concluded that azoxystrobin minimum disease intensity 21.90 per cent of Alternaria blight and maximum seed.

Discussion

In the present investigation, fungicidal studies were done to find out their efficacy on disease control against *Alternaria burnsii* and increase the seed yield in cumin. In *in vitro* test, all the fungicides namely mancozeb, carbendazim 2% + mancozeb 63% WP, azoxystrobin, propiconazole, hexaconazole and difenoconazole tested at 100, 300 and 500 ppm concentration inhibited the mycelial growth of *Alternaria burnsii*. Azoxystrobin gave maximum inhibition of mycelial growth at 100, 300 and 500 ppm concentrations. All the fungicides effectively inhibited growth of fungus at 500 ppm concentration, carbendazim 2% + mancozeb 63% WP were not so effective at lower concentration. Although there was increase in growth inhibition with the increase in concentration. Because of these chemicals either inhibit the germination, growth and multiplication of the pathogen or are directly toxic.

In the present investigation, the fungicides performed better in reducing per cent disease incidence and increasing seed yield. Among the six fungicides tested *in vivo* Azoxystrobin was observed highly superior over other fungicides and recorded minimum (21.90%) disease intensity by decreasing 65.17 per cent disease intensity with maximum 5.82 q./ha seed yield. Propiconazole was observed second best and recorded 24.43 per cent disease intensity with 5.62 q./ha seed yield. Our observations are in conformity with the findings of Akbari *et al*. (1996) [13]. Better efficacy or poor performance of various fungicides against *A. burnsii* in present investigation can be attributed to the toxic effects of fungicides on essential physiological processes of fungal cells. Effective fungicide gives better protection to crop against pathogens and thereby leads to less disease incidence and more yield potential. Azoxystrobin, a strobilurin fungicide shows highly site-specific mode of action, and specifically inhibits the energy formation in fungal cells. Propiconazole prevents biosynthesis of ergosterols essential for cell well formation of fungi.

Md. Abdul Wadud *et al*. (2017) [14] efficacy of fungicides for the management of Alternaria blight of cumin. The experiment was laid out in a randomized block design with three replications. Eight fungicides namely Amister top 325 SC, Cabriotop, Companion, Trizole 75 WG, Protect 52.2 WP, Rovral 50 WP, Secure 600 WG, Deconil 500 SC along with control (untreated) were included as treatment in this study.

The fungicides were sprayed 3 times at an interval of 8 days from disease initiation (pre-flowering stage). The lowest (6.24%) disease severity was recorded in Amister top sprayed plots and the highest (78.81%) disease severity was recorded in control plots. The highest percent efficacy of disease control (91.77) was recorded from Amister top sprayed plots and the lowest (48.06%) was recorded in rovral sprayed plots followed by protect, secure, trizole and companion sprayed plots. The highest yield (467.60 kg/ha) was obtained from amister top sprayed plots and the lowest yield (60.03 kg/ha) was recorded in trizole sprayed plots which was followed by protect, rovral and companion sprayed plots. Azoxystrobin proved to be effective against Alternaria blight of raya and carrot under field condition [16]. Maximum disease control (83.46%) was recorded from mancozeb followed by propiconazole (78.39%), propineb (74.66%), carbendazim+ mancozeb (68.58%), tridemorph (63.58%) and hexaconazole (59.13%) against *A. tenuissima* causing leaf spot of Indian bean under field condition [17]. Among the foliar sprays of four fungicides *viz*., difenoconazole 25 EC (0.025 & 0.05%), mancozeb 75 WP (0.25%), carbendazim 50 WP (0.1 %) and wettable sulphur (0.25%) tested against Alternaria blight and powdery mildew diseases of cumin, difenoconazole 25 EC (0.05%) was found superior in controlling both the diseases. Though other treatments were also at par with difenoconazole [18]. Sunder (2005) [19] reported that seed treatment with Bavistin (2.5 g/kg) + foliar sprays of Indofil M-45 (0.2%) were found most effective fungicides in controlling Alternaria blight of cumin under field condition. Kumari *et al*. (2006) [20] reported that mancozeb was found most effective to check mycelial growth and conidial germination of *Alternaria alternata* causing blight of periwinkle. It also gave maximum (68%) disease control when sprayed twice (0.25%) on artificially inoculated plants. Akbari and Parakhia (2007) [21] determined the efficacy of systemic and non-systemic fungicides against *Alternaria alternata* causing blight of sesame both *in vitro* and *in vivo* conditions and found that in systemic fungicides tridemorph, propiconazole, hexaconazole and difenonazole proved to be equally good and completely inhibited the growth even at a minimum concentration of 50 ppm. Non- systemic fungicides, thiram and mancozeb gave cent per cent inhibition of *A. alternata* at a concentration of 500 ppm. The field performance of propiconazole (0.05%) was remarkable, gave a high control of disease in leaves (80%), stems (78%) and capsules (80%) and higher yield of grain (886 kg/ha). Carbendazim and hexaconazole were also found effective and remained at par with propiconazole. Shekawat *et al*., (2013) [22] tested four fungicides *viz*. tebuconazole, azoxystrobin, carbendazim and mancozeb and two botanicals *viz*. azadirachtin and neem oil in combination as well as individual under pot culture and the combination of tebuconazole with azadirachtin was found most effective when applied as mixed foliar spray completely inhibited the mycelial growth of all five isolates of *A. burnsii* causing cumin blight.

Conclusion

Studies on the relative efficacy of fungicides in both *in vitro* and *in vivo* against cumin blight. Azoxystrobin was found most effective followed by propiconazole in both conditions. Difenconzole were found least effective among these fungicides, Azoxystrobin recorded 21.90 per cent disease intensity with 65.17 per cent disease control and 5.82 q/ha seed yield by increasing 216.30 per cent seed yield.

Application of research: Through the research work, the findings are for management of cumin blight Azoxystrobin was found most effective followed by propiconazole in both conditions. Difenconzole were found least effective among these fungicides, Azoxystrobin recorded 21.90 per cent disease intensity with 65.17 per cent disease control and 5.82 q/ha seed yield by increasing 216.30 per cent seed yield.

Research Category: Plant pathology

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Research project name or number: Research station study

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: College of Agriculture, Jobner, 303329

Cultivar / Variety / Breed name: Cumin (*Cuminum cyminum* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
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