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Management of cumin blight by novel fungicides: A menacing disease of south-western Rajasthan

JITENDAR KUMAR SHARMA[1]*, KAPIL SHARMA[2], H V S SHEKHAWAT[1], NEESHU JOSHI[1], VIJAY KAMAL MEENA[1], LEKHA[1] and ANIRUDH CHOUDHARY[3]

Agriculture Research Sub-station (Agriculture University, Jodhpur, Rajasthan), Sumerpur, Pali, Rajasthan 306 902, India

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ABSTRACT

A study was carried out during winter (*rabi*) seasons of 2019–20 and 2020–21 at Agricultural Research Sub-station (Agriculture University, Jodhpur), Sumerpur, Pali, Rajasthan to find out the best novel fungicide for management of cumin blight. The experiment was laid out in a randomized block design (RBD) comprised of 10 treatments i.e. Four fungicides, combination of Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre (500 and 750 ml/ha), Tebuconazole 25% WG (500 and 750 g/ha), Azoxystrobin 23% SC (500 and 750 ml/ha) and Thiophanate-methyl 70% WP (750 and 1000 g/ha) in two different concentrations and one check (Mancozeb 75% WP @1000 g/ha) and one un-treated control, replicated thrice. The susceptible variety GC-4 (Gujarat cumin-4) of cumin (*Cuminum cyminum* L.) was used for the experiment. The *in vivo* study recorded variable sensitivity of different fungi-toxicants against cumin blight pathogen. Among the different fungi-toxicants, Tebuconazole 25% WG @750 g/ha, was found highly efficacious by observing lowest per cent disease intensity (8.89% and 12.11%) at 15 days after first foliar spray and 15 days after second foliar spray respectively and maximum yield (645 kg/ha). The combination of Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre @750 ml/ha and Tebuconazole 25% WG @500 g/ha also found effective in controlling the cumin blight. While Azoxystrobin 23% SC @500 and 750 g/ha, Thiophanate-methyl 70% WP @750 and 1000 g/ha and Mancozeb 75% WP @1000 g/ha were found least effective.

Keywords: Alternaria blight, Cumin, Disease intensity, Fungicides

Cumin (*Cuminum cyminum* L.) is an economically prime seed spice and it is mostly cultivated in India, Syria, United Arab Emirates, Turkey, Iran, Pakistan, Egypt and Italy. India is estimated to produce 70% and more cumin of the world. Area under cumin cultivation in India is 10.36 lakh ha with production of 7.25 lakh tonnes and productivity of 634.98 kg/ha (Anonymous 2022). In Rajasthan, cumin is grown during *rabi* season which is a good source of financial earnings to the farmers. It is mainly grown in Barmer, Jodhpur, Jalore, Jaisalmer and Nagaur districts. Cumin cultivated in an area of 6.09 lakh ha and gave production of 3.03 lakh tonnes with average productivity of 457.57 kg/ha (Anonymous 2022).

Cumin suffers from several pathogens, which adversely affect the economic yield of farmers (Dange 1995, Sharma *et al*. 2010). The vascular wilt caused by *Fusarium oxysporum* f.sp. *cumini*, powdery mildew caused by *Erysiphe polygoni* DC and alternaria blight caused *Aternaria burnsii* are major cumin diseases and occur in moderate to severe form in farmer's field of Rajasthan reported by Sharma *et al*. (2013). The second most devastating disease of cumin is blight which is caused by *Alternaria burnsii* and is an accountable disease which causes economic yield losses of up to 70% (Holliday 1980). Cumin blight was first time seen in India in Gujarat by Uppal *et al*. (1938), and in Rajasthan by Joshi (1955).

Recently developed newer fungi-toxicant molecules are widely used by several farmers of south-western Rajasthan without any authentic knowledge, so there is an essentiality of conduction experiments for testing the most effective fungi-toxicants or their combo-products for the elimination of blight pathogen of cumin with its lowest residue quantity on seed. There is very little guidance available related to novel fungi-toxicants against alternaria blight of cumin, which is a major issue because the disease causes around 70% economic loss to the crop, so the present plant pathological management study was carried out to produce the information on the management of cumin blight by novel fungicides.

[1]Agriculture Research Sub-station (Agriculture University, Jodhpur, Rajasthan), Sumerpur, Pali, Rajasthan; [2]Rajasthan College of Agriculture (Maharana Pratap University of Agriculture and Technology), Udaipur, Rajasthan; [3]College of Agriculture (Agriculture University, Jodhpur, Rajasthan), Sumerpur, Pali, Rajasthan. *Corresponding author email: jksharma.sharma35@gmail.com

MATERIALS AND METHODS

The study was carried out during winter (*rabi*) seasons of 2019–20 and 2020–21 at Agricultural Research Sub-station (Agriculture University, Jodhpur), Sumerpur, Pali, Rajasthan which is located at zone IIb (Transitional plain of luni basin). The experiment was laid out in a randomized block design (RBD) comprised of 10 treatments i.e. Four fungicides, Tebuconazole 25% WG @500 (T_1) and 750 (T_2) g/ha; combination of Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre @500 (T_3) and 750 ml/ha (T_4); Azoxystrobin 23% SC @500 (T_5) and 750 (T_6) ml/ha; and Thiophanate-methyl 70% WP @750 (T_7) and 1000 (T_8) g/ha; One check i.e. Mancozeb 75% WP @1000 g/ha (T_9); and One un-treated control (T_{10}), replicated thrice. Experiment was conducted in a plot size of 3 m × 4 m and susceptible variety GC-4 (Gujarat cumin-4) of cumin was used to for the experiment.

Two foliar sprays of each treatment were given, the 1st foliar spray was given when the disease initiated and 2nd foliar spray was given after 15 days gap. The per cent disease intensity was noted at the disease initiation stage, 15 days after first foliar spray (before the second spray) and 15 days after the second foliar spray. Total 25 plants were randomly chosen from each plots and marked/tagged for subsequent assessment of disease. The observations of per cent disease intensity of Alternaria blight cumin were figured by using a disease rating scale of 0–9 grade proposed by Mayee and Datar (1986) (Table 1). Percent disease intensity (PDI) was calculated in accordance to McKinney (1923).

Data were analyzed statistically by ANOVA. The gross return of particular treatments was calculated by quantity of seed yield of each treatment multiplied by the market sale price of cumin seeds. The cost benefit (B:C) ratio was calculated as:

$$\text{Cost benefit ratio} = \frac{\text{Gross return}}{\text{Total cost of cultivation}}$$

Here total cost of cultivation refers to the total expenses amount incurred in one hectare of cumin cultivation and the expenses of fungicides treatment are also added except control.

RESULTS AND DISCUSSION

The disease intensity was significantly affected by the different fungicides. The cumin blight intensity (PDI) at initiation of disease stage or before the spray was ranged from 4.00–5.33%. The data of disease initiation stage were showed that all the fungi-toxicant recorded non-significant reaction with Alternaria blight (Table 2). After 15 days of first foliar spray (before second spray), all the fungicides were recorded significantly superior over control for the management of cumin blight. The lowest per cent disease intensity (7.56, 10.22 and 8.89%) was recorded in the field block treated with Tebuconazole 25% WG @750 g/ha, which was at par with combo product of Pyraclostrobin + Epoxiconazole @750 ml/ha (8.44, 10.89 and 9.67%) and Tebuconazole 25% WG @500 g/ha (8.89,

Table 1 Disease rating scale for Alternaria blight of cumin

Rating scale	Description
0	No symptoms were seen in all plant parts.
1	Minute, irregular brownish to blackish spots seen 1% or less leaves area.
3	Minute, circular to irregular brownish to blackish lesion seen in 1–10% of the leaf area.
5	Circular to irregular dark brownish to blackish lesions in increasing form covered 11–25% leaf or stem area.
7	Lesions become larger and merging to form large dark brown to black patches and covered leaf area of 26–50%. Lesions also seen on stem and other part of plant.
9	Lesions become more enlarged mixed-up and form irregular, dark brown to black patches which covered leaf area 51% and more. Symptoms found in all plant parts and at last whole plant on dry up stage.

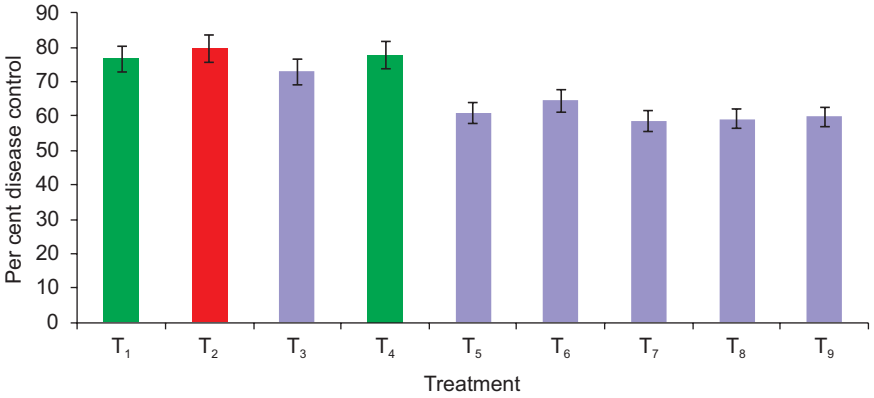

Fig. 1 Effect of different fungicidal treatments on the management of cumin blight. Treatment details are given under Materials and Methods.

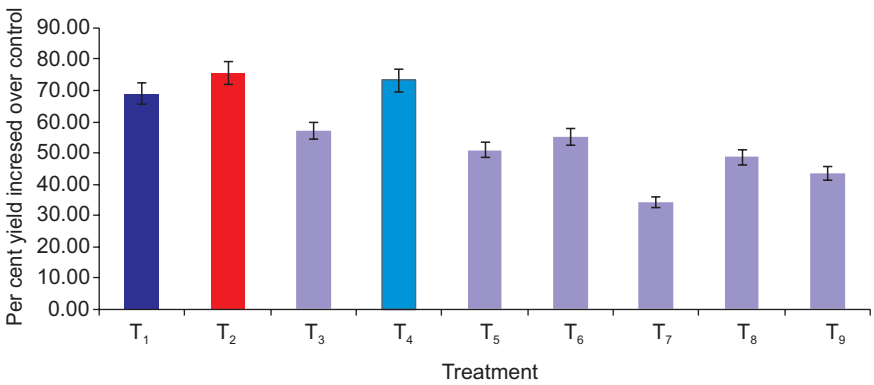

Fig. 2 Effect of different fungicidal treatment on the increase in yield over control. Treatment details are given under Materials and Methods.

11.11 and 10.00%). While combo product of Pyraclostrobin + Epoxiconazole 50 g/litre @ 500 ml/ha, Azoxystrobin 23% SC (500 and 750 ml/ha), Thiophanate-methyl 70% WP (750 and 1000 g/ha) and Mancozeb 75% WP @1000 ml/ha were found less effective against cumin blight.

Moreover, after 15 days of 2nd foliar spray similar result was found as intensity was significantly minimized by every fungicide over respective un-sprayed plot. Significantly lowest cumin blight intensity (10.67, 13.56 and 12.11%) was observed in the field block, which treated with Tebuconazole 25% WG @750 g/ha, which was at par with combo product of Pyraclostrobin + Epoxiconazole @750 ml/ha (12.44, 14.22 and 13.33%) and Tebuconazole 25% WG @500 g/ha (13.11, 14.89 and 14.00%). While combo product of Pyraclostrobin + Epoxiconazole @500 ml/ha, Azoxystrobin, Thiophanate-methyl and Mancozeb were found least effective.

The data of per cent disease control revealed that Tebuconazole @750 g/ha, recorded maximum disease control (79.81%) of cumin blight followed by combo product of Pyraclostrobin + Epoxiconazole @750 ml/ha (77.78%) and Tebuconazole @500 g/ha (76.67%). Rest of the treatments found least effective in controlling the cumin blight (Fig. 1). The influence of the treatments on seed yield revealed that Tebuconazole @750 g/ha recorded maximum yield (645 kg/ha) with highest yield increase over control which was at par with combo product of Pyraclostrobin + Epoxiconazole @750 ml/ha (636 kg/ha) and Tebuconazole @500 g/ha (620 kg/ha). Whereas, the result of cost benefit ratio showed that combo product of Pyraclostrobin + Epoxiconazole @750 ml/ha (2.45), Tebuconazole @750 g/ha (2.42) and Tebuconazole @500 g/ha (2.40) recorded highest cost benefit ratio (Table 3 and Fig. 2).

Tebuconazole and Epoxiconazole both are triazole fungicides, which affect in the synthesis of sterol compounds of fungus and obstruct the ergosterol formation procedure. As we know ergosterol is most important part of fungal cell wall and non-appearance of ergosterol caused irrecoverable injury to the fungal cell wall and fungus dies. The triazoles hamper the fungal conidia and haustoria formation. It reduces the fungal sterol amount which leads to change in membrane volatility and actions of enzymes links to membrane by polar fatty acids immersing (Nene and Thapliyal 1993, Amresh *et al*. 2013, Karuna *et al*. 2014, Sharma *et al*. 2017). Tebuconazole 25.9 EC not only manage of cumin blight and but also maximize the economic yield of cumin (Yadav *et al*. 2022). Similarly, Shekhawat *et al*. (2013) noted that foliar spray of tebuconazole was highly efficacious against cumin blight. Whereas, Khalequzzaman (2016) revealed that Rovral 50 WP (Iprodione) highly effective against cumin blight followed by Companion and Secure. Azoxystrobin + Tebuconazole @1 litre/ha found effective against cumin blight reported by Jat *et al*. (2021).

Wadud *et al*. (2017) evaluated eight different fungicides and found that Amister Top (Azoxystrobin and Difenoconazole) recorded lowest disease severity and maximum disease control which was followed by Deconil

Table 2 Management of cumin blight by novel fungicides during *rabi* 2019–21

Treatment	Dosage formulation (g or ml/ha)	Per cent disease intensity (PDI)						Per cent disease control
		Pre-treatment			15 days after 1st spray			15 days after 2nd spray			
		2019–20	2020–21	Pooled	2019–20	2020–21	Pooled	2019–20	2020–21	Pooled	
T_1, Tebuconazole 25% WG	500	4.67	5.56	5.11	8.89	11.11	10.00	13.11	14.89	14.00	76.67
T_2, Tebuconazole 25% WG	750	4.89	4.89	4.89	7.56	10.22	8.89	10.67	13.56	12.11	79.81
T_3, Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre	500	3.78	4.22	4.00	11.33	11.33	11.33	16.89	15.56	16.22	72.96
T_4, Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre	750	3.56	4.00	3.78	8.44	10.89	9.67	12.44	14.22	13.33	77.78
T_5, Azoxystrobin 23% SC	500	4.44	4.67	4.56	15.56	20.67	18.11	19.33	27.33	23.33	61.11
T_6, Azoxystrobin 23% SC	750	4.67	5.11	4.89	12.00	19.56	15.78	18.22	24.22	21.22	64.63
T_7, Thiophanate-methyl 70% WP	750	4.67	5.33	5.00	17.11	21.33	19.22	22.89	26.89	24.89	58.52
T_8, Thiophanate-methyl 70% WP	1000	4.44	4.67	4.56	14.44	19.33	16.89	20.89	28.00	24.44	59.26
T_9, Check: Mancozeb 75% WP	1000	4.67	5.33	5.00	15.11	19.11	17.11	22.44	25.78	24.11	59.81
Control	-	4.89	5.78	5.33	23.78	28.67	26.22	49.78	70.22	60.00	-
SEm±			NS		0.80	0.49	0.51	1.35	1.07	0.89	
CD (P=0.05)					2.41	1.48	1.53	4.06	3.20	2.65	
CV (%)					10.40	5.90	5.76	11.38	7.18	6.56	

and Cabriotop. Similarly, Kakraliya *et al*. (2021) tested different fungi-toxicants under lab and field conditions for the control of cumin blight and found that Azoxystrobin and propiconazole recorded minimum disease and found most effective against cumin blight.

Pipliwal *et al*. (2017) conducted an experiment to perceive the inhibitory effect of different fungi-toxicant and botanical extracts under lab condition and revealed that fungi-toxicant tebuconazole and mancozeb noted cent per cent reduce in the germination of conidia of *A. burnsii*. Fagodiya *et al*. (2022) tested different fungicides and phytoextract with and without combination and found that the combine application of Azoxystrobin + Mancozeb at 0.36% with neem oil @0.5% were highly suppressive against the leaf spot and also boost the economic yield of the crop. Moreover, the combination of Azoxystrobin + Mancozeb as alone was the next best treatment against leaf spot of soybean. Singh and Verma (2010) reported that among the different fungicides, mancozeb was highly effective by reducing the growth of mycelium and germination of asexual spore of *A. alternata*. Similarly, mancozeb was also found best against Alternaria blight of Adusa plants under *in vivo* conditions, similar result for cumin blight management reported by Vihol *et al*. 2009. Similarly, a field experiment was conducted by Singh and Singh (2005) to the control of linseed blight (*Alternaria lini* and *Alternaria linicola*) and reported that thiophanate methyl as a seed treatment and foliar spraying of mancozeb @0.25% were most effective in reducing the disease. Whereas, Choudhary *et al*. (2024) conducted an experiment for the minimization of Alternaria blight (early) of tomato and revealed that Hexaconazole and Azoxystrobin were highly effective for the reduction of the pathogen and minimization of the disease.

However, to manage the blight disease of cumin field experiments were conducted by Kumar *et al*. (2015) by combining the application of biocontrol agents (fungal and bacterial) and fungicide (mancozeb) and noted that five spray of mancozeb resulted highest disease reduction than after 3 foliar spray of mancozeb with *T. harzianum* 0.2% (two spray). Similarly, Sharma and Pandey (2013) also found that Tebuconazole and Mancozeb noted most effective in the control of blight disease of cumin caused by *Alternaria burnsii*. Godika *et al*. (2014) evaluate several fungi toxicants against Alternaria blight of mustard and noted that Roveral (0.2%) was highly effective fungi toxicant against Altenaria blight disease. Kalra *et al*. (2014) conducted an experiment for the evaluation of different fungi-toxicants against leaf blight of *Mentha arvensis* L. and reported that among the different fungicides, Chlorothalonil recorded maximum disease control followed by mancozeb, thiophanate-methyl and copper oxychloride.

A study on integrated management of cumin blight was done by Jadon *et al*. (2020) and found that combination of neem cake as soil mixing compound of @ 250 kg/ha + Vermicompost @ 2 tonnes/ha + *Trichoderma viride* as seed dressing @4 ml/kg seed + 1 foliar spray by Dithane M-45 @2 ml/litre with combinations of Dinocap @300 ml in 750 litre of water at 45 DAS + 1 foliar spray of Imidachloprid @333 ml/ha at 55 DAS + neem oil (2 foliar spray) @2% at 50 and 60 DAS were found highly effective and gave maximum yield of cumin. Gohel and Gohel (2023) conducted an experiment on chemical management of cumin blight and found that thiram 75 ws @3 g/kg as a seed treatment then after foliar spraying of fungi-toxicant combo product metiram + pyraclostrobin or fluxapyroxad + pyraclostrobin as three foliar spray at 15 days' gape were found highly effective against cumin blight and also recorded the highest cost-benefit ratio.

Several workers or authors, previously found that epoxiconazole reduced mycelia growth of fungi, in accordance with refer to agreement or conformity with the fact of Siegel (1981) that triazole fungi-toxicant reduced ergosterol production, thus eliminating the functional membranes formation of the fungi. Whereas, Strobilurin fungicides are also known as Quinone inhibitor fungi toxicants because they have their distinctive mechanism

Table 3 Cost-benefit ratio of different fungicidal treatments in the management of cumin blight during *rabi* 2019–21

Treatment	Dosage formulation (g or ml/ha)	Total cost of cultivation	Yield	Market price (per kg)	Gross return (₹)	Cost benefit ratio
T_1, Tebuconazole 25% WG	500	34000	620.33	131.55	81605	1:2.40
T_2, Tebuconazole 25% WG	750	35000	645.00	131.55	84850	1:2.42
T_3, Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre	500	33400	577.00	131.55	75904	1:2.27
T_4, Pyraclostrobin 133 g/litre + Epoxiconazole 50 g/litre	750	34100	636.33	131.55	83710	1:2.45
T_5, Azoxystrobin 23% SC	500	37200	554.67	131.55	72966	1:1.96
T_6, Azoxystrobin 23% SC	750	39800	569.33	131.55	74896	1:1.88
T_7, Thiophanate-methyl 70% WP	750	34200	492.67	131.55	64810	1:1.90
T_8, Thiophanate-methyl 70% WP	1000	34900	546.33	131.55	71870	1:2.06
T_9, Check: Mancozeb 75% WP	1000	32820	526.33	131.55	69239	1:2.11
Control	-	32000	367.33	131.55	48323	1:1.51

of action. They most importantly bind with the quinol oxidation (Q_o) region of cytochrome b and reduce the mitochondrial respiration by blocking of the electron transfer cycle and eliminates the production of NADH and ATPs (Hnátová *et al*. 2003, Balba 2007, Isamu and Makoto 2005 and Feng *et al* 2020). There are several pre-mixtures of triazoles and Strobilurins are available in the market, both have its self- mechanism of action, they expanded the disease spectrum, make better activity and prevents in development of resistance. Moreover, being a potential source of foreign exchange, assurance of quality of spices as per the strict norms set by the importing nations needs to be maintained which has been often neglected by the growers in India. In such circumstances, chemical pesticides (fungicide) residues specially 'mancozeb' on cumin seed is the one of the major halts for the export increment (Singh *et al*. 2013) because cumin growers vigorously used mancozeb for the management of cumin blight, that why this study was conducted for management of cumin blight and replace mancozeb by newer fungicides. Similarly, Sharma and Lekha (2023) reported that combo of Tebuconazole + Trifloxystrobin @500 g/ha and Pyraclostrobin + Epoxiconazole @500 ml/ha were highly effective to eliminates the important threat i.e. Alternaria leaf spot of sesame.

In this study, Tebuconazole 25% WG @750 g/ha, combo-product of Pyraclostrobin + Epoxiconazole @750 ml/ha and Tebuconazole 25% WG @500 g/ha effectively reduced cumin blight (76–80%) and found most effective. But looking the circumstances of chemical pesticides residues on cumin seed for export promotion, combo-product of Pyraclostrobin + Epoxiconazole @750 ml/ha and Tebuconazole 25% WG @500 g/ha is recommended to farmer community for the management of cumin blight.

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