ISSN 2515-8260 Volume 07, Issue 04 , 2020

A STUDY ON THE EPIDEMIOLOGY AND MANAGEMENT OF ALTERNARIA BLIGHT ON CUMIN CAUSED BY ALTERNARIA BURNSII

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DOI: 10.48047/ejmcm/v07/i04/381

Abstract

The illness has been devastating to all cumin fields. The studies' goals were to determine the pathogen's intensity, cultural, morphological, pathogenic, and molecular variability; to assess losses; to determine the impact of various environmental factors on the progression of the disease; and to develop a sustainable management strategy utilising fungicides and host plant resistance. Disease samples taken from the primary cumin growing regions of Gujarat in 2016–17 and 2018–19 showed striking symptomatic differences. There were noticeable cultural and physical differences amongst ten isolates of Alternaria burnsii collected from several cumin-growing locations. The sporulation efficiency of just four of the ten isolates investigated (isolates A2, A4, A5, and A9) ranged from 80.15 to 72.30 to 78.90 to 67.25 mm.

Keywords: *Epidemiology, Management, Alternaria Blight, Alternaria Burnsii.*

1. Introduction

Flowering plant Cumin (Cuminum cyminum L.), belonging to the Apiaceae family, native to southern Asia and the Middle East. Traditional medicine may make use of cumin, but there is currently no reliable evidence to support its usage as a treatment. Anti-inflammatory, diuretic, carminative, and antispasmodic are only few of cumin's traditional applications. Dyspepsia, jaundice, diarrhoea, flatulence, and indigestion are just few of the conditions it has been used to treat. The powdered form of cumin has several applications; it may be used topically, inserted subcutaneously, inhaled via a pipe, or swallowed. Cumin is also widely utilised in the commercial food industry as a flavouring agent and as a key ingredient in curry and chilli powders. In addition to being dusted over bread and pastries, its seeds have been crushed and included into dishes including fish and meat. Alcohol, sweets, and sauces may all benefit from the oil, which is obtained by steam distillation. Creams, lotions, and fragrances all employ it for its aromatic properties. Though it originated in the Levant and Upper Egypt, cumin is today cultivated mostly in hot nations like India, North Africa, China, and the United States. When it comes to cumin seed, India is a major producer and consumer. Cumin

seed is grown mostly for export in Iran, Turkey, and Syria in addition to India. All around the globe, people use it as a spice and a medicine. Although it has fallen out of favour as an Eastern herbal cure in the West, it is widely used as a carminative in veterinary medicine.[1-3]

Cumin, or 'jeera' as it is called in India, is a vital spice in Indian cuisine, used to season a wide variety of dishes. The flavour of cumin seeds comes from a volatile oil they contain. This volatile oil accounts for up to 2.5%–3.5% of the weight of native cumin cultivars. Obesity, stomach discomfort, and dyspesia are just few of the many ailments for which cumin seeds are a common ingredient in ayurvedic remedies. The following are some of the nutrients found in cumin seeds: The macronutrient breakdown is as follows: 17.7% protein; 23.8% fat; 35.5% carbohydrates; 7.7% minerals. Cumin seeds have a moisture content of 6.2 percent, along with 0.09 percent calcium, 0.45 percent phosphorus, 0.04 eight percent iron, 1.6 percent salt, 2.15 percent potassium, vitamin B1, B2, niacin, vitamin-A, vitamin-C, etc. Both in terms of production and consumption, India is a prominent player in the global cumin market. Nearly 80% of the harvest is used inside the country of India. Only in Rajasthan and Gujarat is this crop grown; collectively, these two states account for more than 95% of the country's cumin output, with Gujarat alone accounting for 85%.[4-5]

Major Jeera producing regions are Banaskantha and Mehsana in Gujarat, and Barmer, Jalore, Jodhpur, and Nagaur in Rajasthan. Additional major contributions to Indian production come from the states of West Bengal, Uttar Pradesh, Andhra Pradesh, and Punjab. A sub-tropical environment that is both reasonably chilly and dry is suitable for growing cumin. The cumin plant cannot withstand excessive humidity or frequent downpours. Soils rich in organic matter and with good drainage are ideal for growing cumin.[6-7]

2. Literature review

Baswana, K.S. & Thakral, K.K. (2019) Alternaria burnsii's mycelium is said to start off hyaline and change colours to olive buff or olive green as it matures. Later on, the hyaline, branching, septate hyphae take on a dark olive green hue. Single or several chains of 2–8 spore-bearing conidia are generated; these spore-bearing structures have a smooth, rounded base and a tapering, septate or non-septate beak. They have 1-3 longitudinal and 3-6 transverse septa. Conidium's body may be anything from a pale brown to a dark olive green, and it darkens with time. Conidiophores are geniculate, 3-5-celled, light in colour, and septate; they are also branching, upright, straight or slightly curved.[8]

Deepak & Patni, V. (2018) Several nations in the subtropics rely heavily on the spice cumin, which is grown from seed. Cumin cultivation is continually threatened by illnesses that result in both quantitative and qualitative production losses. In subtropical regions, Alternaria blight is the most harmful pathogen to cumin. It's quite common and damaging since it destroys every portion of the plant above ground, including the seed, leading to a loss of harvest. There have been reports of losses as high as 70%. Cumin blight caused by Alternaria burnsii was originally documented in Pakistan. Fungicides, biological agents, botanicals, and their combinations are only some of the methods used to combat this disease, which is a significant barrier to sustainable cumin production. However, the effectiveness of these therapeutic practises is influenced by a number of variables, including pathogenic variability. Research was conducted to identify potential solutions for controlling the Alternaria blight of cumin.[9]

El-Deeb H.M. & Arab Y.A. (2017) Twenty-four isolates of Alternaria brassicae, a pathogen that attacks rapeseed and mustard, were studied for their genetic variability in terms of their ability to cause disease. Because they were able to infect each of the seventeen host differentials, the isolates BTD, BBK, DSA, GNR, HSR, and PNT seemed to exhibit a broad virulence pattern. Among the twenty-one host differentials tested, BHP, BRT, GDP, HSRP, JPR, NGN, B. alba, and Midas-1 were the most successful. Isolates B chin and VRN were only pathogenic in 13 of the possible host differentials. Only twelve isolates were pathogenic on the B. alba 'Local' host differential, making it the most vulnerable. These findings demonstrated the presence of diversity among Alternaria brassicae isolates in India by classifying all twenty isolates into one of fourteen groups based on eight host differentials.[10]

Gemawat, P.D. & Prasad, N. (2016) Isolates of the fungus Alternaria alternata were examined for their cultural, morphological, and pathogenic differences in senna (Cassia angustifolia) grown in Jaipur, Nagour, Bikaner, Jaisalmer, and Jodhpur throughout the state of Rajasthan. Each isolate had unique colony characteristics, colony diameter, sporulation, and pathogenic behaviour on senna, in addition to causing distinctive illness symptoms. The Jaipur strain had the greatest mean infection percentage (80%), followed by the Nagour and Jodhpur isolates. There was a 30 percent infection rate with the Jaisalmer isolate, making it the least virulent. The pathogenicity of the isolates varied widely, from 30 to 80 percent.[11]

Khalequzzaman, K. M. (2015) There was a great deal of cultural and morphological heterogeneity among the A. burnsii isolates when they were tested on three different media:

Potato Dextrose Agar, Richard's Synthetic Agar, and Czapek's Dox. Furthermore, it was discovered that Potato Dextrose Agar and Czapek's Dox Agar were both great medium for cultivating and sporulating A. burnsii isolates. Light green, occasionally yellowish green septate mycelial development, then grey to black, with dirty white to brownish colony edge, fluffy radial, plain irregular radial, and fluffy knotting growth pattern on three different mediums. Conidium length, width, beak length, and number of septa were all found to vary significantly across the 15 A. burnsii strains studied.[12]

3. Methodology

Information on the experiments conducted, as well as the methods and criteria used have been provided.

Experimental site

The current studies were conducted at the Krishi Vigyan Kendra, Anand Agricultural University, Arnej, takuka: Dholka, district: Ahmedabad, Gujarat, during rabi 2016–17 and 2018–19. Arnej is located at a height of 427 metres above mean sea level (MSL), at coordinates 21°450′ N and 22°55′ 0″ E. The lack of irrigation water in the area prevented the experiment from happening in 2017-18. This part of Gujarat is located in Agro Climatic Zone VIII, which includes both the Bhal and coastal regions.

3.1 Survey for prevalence of cumin blight in gujarat

The study was conducted in 2016 and 2018 during the Rabi growing seasons in Gujarat's key cumin farming districts. Ten cumin fields were sampled from each tehsil (administrative division) during the survey. In order to provide an accurate picture of the prevalence of disease in a given region, we divided each field into five sections, one each in the four cardinal directions and the centre. Fields were surveyed to determine the prevalence of blight, and diseased samples were collected for pathogen isolation and identification. Arnej, Jagudan, Patan, Radhanpur, Sanand, Mandal, Dhandhuka, Rapar, Tharad, and Unjha, all of which are important cumin-growing regions in Gujarat, were selected at random to provide the data in Table 3.1.

According to the criteria proposed by Jat (2015), the severity of the condition was rated on a scale from 0 to 5. Disease severity was documented using the following visual rating system:

0 = Immune to illness

1 = Leaf and umbel blight affects 1-10% of the plant.

2 = Leaf, stem, and umbel blight affects 11%-20% of the plant

3 = Leaf, stem, and umbel blight coverage is between 21 and 35 percent.

4 = Leaf, stem, and umbel blight affecting 36% to 60% of the affected area

5 = more than 60% of leaf, stem, and umbel impacted by the disease

The percentage of infected people was determined using the following formula:

$$PDI = \frac{\text{Sum of numerical disease rating}}{\text{No. of plants assessed x Maximum disease rating}} \times 100$$

3.2 Variability of isolates of alternaria causing blight

The rate of sporulation, spore morphology, and size of conidia, as well as other morphological and cultural characteristics, of ten different A. burnsii isolates were analysed.

3.3 Screening of cumin varieties/germplasms for resistance to blight under field conditions

Table 3.2: Screening for blight: a list of cultivars and germplasms

1	GC-2	8	JC-02-36	15	JC–99–16
2	CG-4	9	JC–26–5	16	JC–02–21
3	Western11	10	JC–91–262	17	JC–100–58
4	Avani111	11	JC–94–44	18	JC–25–127
5	JC-02-32	12	JC–02–27	19	JC–02–36
6	JC–02-28	13	JC–95–197	20	JC–00–72
7	JC-00-61	14	JC–00–22		

During the 2016 and 2018 Rabi seasons, the instructional farm at KVK, Arnej was planted with 20 different varieties/germplasms of cumin obtained from the Main Spice Research Station, Jagudan, SDAU, District: Mehsana, and the local market. Two 3 m long rows were planted with each variety/germplasm, with 30 cm between rows and 10 cm between plants. In both years, the crop was planted on November 15th. During the testing phases, every single

practise from the suggested set was implemented. Disease severity was reported on a 0–5 scale, and responses were grouped by grade according to how severely affected people were.

Disease rating scale

Grade	Percent areainfected	Diseasereaction
0	No reaction	HighlyResistant(HR)
1	0.1-10	Resistant(R)
2	10.1 – 25	ModeratelyResistant(MR)
3	25.1 – 50	ModeratelySusceptible(MS)
4	50.1 – 75	Susceptible(S)
5	More than 75	HighlySusceptible(HS)

3.4 In vitro and in vivo evaluation of fungicides against Alternaria burnsii

3.4.1 In vitro evaluation of fungicides against Alternaria burnsii

Nine different fungicides were tested at three different dosages using the "poisoned food technique" to inhibit radial development and sporulation of the pathogen in vitro.

Table 3.3: Specifics on fungicides, including their doses, are provided

Tr.No.	Treatments	Concentrations (%)
1	Mancozeb75WP	0.15, 0.20, 0.25
2	KresoximMethyl44.3SC	0.05, 0.10, 0.20
3	Chlorothalonil75WP	0.15, 0.20, 0.25
4	Carbendazim12%+Mancozeb63%75WP	0.15, 0.20, 0.25
5	Azoxystrobin18.2%+Difenoconazole11.4%29.6SC	0.025, 0.05, 0.10
6	Metiram70WG	0.15, 0.20, 0.25
7	Propiconazole 25 EC	0.05, 0.01, 0.02
8	Propineb70WP	0.05, 0.10, 0.20
9	Tebuconazole 50%+Trifloxystrobin25%75WG	0.05, 0.10, 0.20
10	Control (untreatedcheck)	--

At the time of pouring, the necessary concentrations of fungicides were achieved by aseptically incorporating the measured amounts of fungicides into melted sterilised PDA medium. Before being put into sterile Petri dishes, the medium was vigorously shaken to ensure that the fungicides were evenly distributed. Pathogen mycelial discs, 7 days old and 5

mm in diameter, were used to inoculate the Petri dishes. These Petri dishes spent 8 days in a BOD incubator at 27 2 0C. The fungus was also cultured in fungicide-free PDA medium to serve as a control.

Following the method provided by Vincent (1947), we determined the percentage of suppression of fungal growth for each treatment.

$$PGI = \frac{C - T}{C} \times 100$$

Where,

PGI = Inhibition of Growth, in Percentage

C = Managed expansion (in millimetres)

T = Extension as a result of therapy

3.4.2 In vivo evaluation of fungicides against cumin blight

During Rabi 2016 and Rabi 2018, a field experiment was carried out at the Krishi Vigyan Kendra, Anand Agricultural University, in the rural area of Arnej (District Ahmedabad).

In this experiment, the fungicides that proved successful in the lab were put to use in the field. The effectiveness research used the GC 4 type of cumin. Below is a rundown of all seven fungicides that were used:

Tr.No.	Treatments	Concentration (%)
1	Mancozeb75WP	0.25
2	KresoximMethyl44.3SC	0.20
3	Chlorothalonil75WP	0.25
4	Azoxystrobin18.2%+ Difenoconazole11.4%29.6SC	0.10
5	Propiconazole 25 EC	0.02
6	Propineb70WP	0.20
7	Tebuconazole 50%+Trifloxystrobin25%75 WG	0.05
8	Control (untreatedcheck)	--

In both years, the crop was planted on November 15th. Row spacing was maintained at 30 cm and plant spacing was maintained at 10 cm in this randomized block design experiment. There were three sets of each therapy. Disease progression in the treated plots was monitored

with regular visits. The first spray was administered within days of the first symptoms of the condition, with further sprays given every 10 days. The recommended set of agronomic practices was used in the trial. The amount of fungicidal suspension applied per acre was 500 litres. The severity of the illness was recorded using the following scale.

0 = Immune to illness

1 = Leaf and umbel blight affects 1-10% of the plant.

2 = Leaf, stem, and umbel blight affects 11%-20% of the plant

3 = Leaf, stem, and umbel blight coverage is between 21 and 35 percent.

4 = Leaf, stem, and umbel blight affecting 36% to 60% of the affected area

5 = The PDI formula was applied to a sample with more than 60% of the leaf, stem, and umbel areas affected by the disease.

$$PDI = \frac{\text{Sum of numerical disease rating}}{\text{No. of plants assessed x Maximum disease rating}} \times 100$$

At 6 days after each spray, 10 plants were chosen at random from each plot, and their blight severity was recorded. The number of seeds produced per acre was also noted.

Statistical analysis

Analysis of variance was used for statistical analysis of the data collected from the different studies.

4. Results

This study was conducted on the fungus Alternaria burnsii, the causal agent of cumin blight, during rabi 2016–17 and rabi 2018–19 at the Department of Plant Pathology at BACA and at the Krishi Vigyan Kendra, Anand Agricultural University in Arnej, takuka: Dholka, district: Ahmedabad, Gujarat.

4.1 Survey for Alternaria blight of cumin

The cities of Arnej, Jagudan, Patan, Radhanpur, Sanand, Mandal, Dhandhuka, Rapar, Tharad, and Unjha—all of which are important cumin producing regions in Gujarat—were surveyed

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during the rabi seasons of 2016–17 and 2018–19. Ten cumin fields were analysed in the study. Table 4.1 shows that between 12.02% and 35.44% of the measured area was infected with the illness throughout the 2016–17 and 2018–19 growing seasons. In 2016, Tharad had the highest prevalence of illness (35.44%), followed closely by Radhanpur (32.24%). While in 2018, Radhanpur (34.40%) and Jagudan (33.40%) had the highest rates of illness severity, respectively. There have been reports of catastrophic crop failure in Haryana and Gujarat as a result of the illness in both Rajasthan and Gujarat.

Table 4.1: Prevalence of cumin blight in Gujarat's cumin-growing regions: a Rabi 2016 and 2018 survey

Areasurveyed	Disease Intensity (%)	
	2016-17	2018-19
Arnej	27.80	25.80
Jagudan	31.62	33.40
Patan	21.80	18.20
Radhanpur	32.24	34.40
Sanand	16.61	15.80
Mandal	18.64	12.02
Dhandhuka	23.20	25.03
Rapar	31.80	30.09
Tharad	35.44	31.40
Unjha	28.60	26.40
Average	**26.77**	**25.25**

4.2. Screening of cumin germplasm for resistance to blight under natural field conditions

During rabi 2016–17 and rabi 2018–19, the Krishi Vigyan Kendra at Anand Agricultural University in Arnej, takuka: Dholka, district: Ahmedabad, Gujarat, examined a total of twenty germplasm/varieties under field conditions. Alternaria blight, caused by the fungus Alternaria burnsii, was initially noticed in very vulnerable cultivars. The studied germplasm/varieties were classified as highly resistant (HR), resistant (R), moderately

resistant (MR), susceptible (S), and highly susceptible (HS) based on their response to the illness. (Table 4.2) displays the findings.

Table 4.2: Screening of cumin varieties/germplasms for resistance to blight under field conditions

Sr. No.	Variety/ germplasm	2016	Disease reaction	2018	Disease reaction	Final reaction
1	GC2	37.83	MS	36.62	S	S
2	GC4	25.77	MS	26.69	MS	MS
3	Western11	30.36	MS	29.76	MS	MS
4	Avani111	30.42	MS	30.49	MS	MS
5	JC-02-32	50.74	S	49.85	MS	S
6	JC–02-28	31.16	MS	31.32	MS	MS
7	JC-00-61	26.36	MS	27.975	MS	MS
8	JC-02-36	53.66	S	51.74	S	S
9	JC–26–5	24.28	MR	25.28	MS	MS
10	JC–91–262	19.97	MR	20.57	MR	MR
11	JC–94–44	31.52	MS	30.32	MS	MS
12	JC–02–27	37.24	MS	36.1	MS	MS
13	JC–95–197	31.49	MS	30.22	MS	MS
14	JC–00–22	42.63	MS	42.22	MS	MS
15	JC–99–16	38.21	MS	38.61	MS	MS
16	JC–02–21	62.22	S	60.38	S	S
17	JC–100–58	31.39	MS	30.59	MS	MS
18	JC–25–127	32.34	MS	31.61	MS	MS
19	JC–02–36	60.40	S	60.26	S	S
20	JC–00–72	70.11	S	69.76	S	S

Table 4.3: classification of plant strains

S.No.	Varieties/germplasms	Number ofgermplasms/varieties	Hostreaction
1	NIL	-	HighlyResistant(HR)
2	NIL	-	Resistant(R)
3	JC–91–262	1	ModeratelyResistant(MR)
4	GC4,Western11,Avani 111, JC–02-28, JC-00-61, JC–26–5, JC–94–44, JC–02–27, JC–95–197,JC–00–22,JC–99–16 JC–100–58, JC–25–127	13	ModeratelySusceptible (MS)

5	GC 2, JC-02-32, JC-02-36, JC–02–21, JC–02–36, JC–00–72	6	Susceptible(S)
6	Nil	-	HighlySusceptible(HS)

Twenty germplasm/varieties were evaluated, and as can be shown in Table 4.3, not one of them was disease-free. On the other hand, JC-91-262 was rated as MR, or moderate resistance. There were 13 moderately sensitive (MS) germplasm/varieties: GC 4, Western 11, Avani 111, JC-02-28, JC-00-61, JC-26-5, JC-94-44, JC-02-27, JC-95-197, JC-00-22, JC-99-16, JC-100-58, and JC-25-127. Susceptible (S) germplasm/varieties include GC 2, JC-02-32, JC-02-36, JC-02-21, JC-02-36, and JC-00-72. conducted a test to determine whether genotypes or cultivars of cumin were resistant to Alternaria blight. Fifty cumin genotypes/varieties were tested for resistance to Alternaria blight in the field and in a greenhouse. Under both field and screen house circumstances, only five genotypes—AC-167, RZ-209, UC-198, UC-216, and JC-11—were shown to be moderately resistant. Thus, the current study's moderately resistant line may be used in breeding programmes to create resistant cultivars of cumin.

4.3 in vitro and in vivo evaluation of fungicides against cumin blight

On potato dextrose agar (PDA) medium, many fungicides were evaluated for effectiveness using the poisoned food approach. These included mancozeb, carbendazim + mancozeb, chlorothalonil, azoxystrobin + difenoconazole, propiconazole, kresoxim methyl, metiram, propineb, and tebuconazole + trifloxystrobin. Three different concentrations of the fungicides were tried. Mycelial growth of A. burnsii was shown to be strongly inhibited by all tested fungicides. As fungicide concentrations were increased, the fungal growth was stunted. Mycelial growth was observed to be inhibited by the fungicides tebuconazole 50% + trifloxystrobin (100%), propiconazole (100% at 0.2% concentration), and tebuconazole (96.67%) and tebuconazole (92.59%) at concentrations of 0.1 and 0.05%, respectively (Table 4.4).

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Table 4.4: Analysing the efficacy of several fungicides against A. burnsii in vitro

Tr. No.	Treatments	Conc.(%)	Radial growth(mm)	Growth inhibition(%)
T_1	Mancozeb75WP	0.15	58.20	62.96
		0.20	55.50	66.30
		0.25	52.40	70.00
T_2	KresoximMethyl44.3SC	0.05	64.20	54.81
		0.10	60.10	60.37
		0.20	53.70	68.52
T_3	Chlorothalonil75WP	0.15	61.20	58.89
		0.20	58.50	62.59
		0.25	54.60	67.41
T_4	Carbendazim 12 % +Mancozeb63%75WP	0.15	79.30	30.63
		0.20	78.70	31.67
		0.25	78.40	32.33
T_5	Azoxystrobin 18.2 % + Difenoconazole 11.4 %2 9.6SC	0.025	62.00	57.81
		0.05	60.00	60.52
		0.10	56.90	64.52
T_6	Metiram70WG	0.15	87.70	15.19
		0.20	86.10	18.15
		0.25	84.00	22.22
T_7	Propiconazole25EC	0.05	6.67	92.59
		0.01	2.99	96.67
		0.02	0.00	100.00
T_8	Propineb70WP	0.05	71.50	43.70
		0.01	69.20	47.41
		0.20	67.50	50.00
T_9	Tebuconazole 50 % + Trifloxystrobin 25 % 75WG	0.05	0.00	100.00
		0.10	0.00	100.00
		0.20	0.00	100.00
T_{10}	Control(Untreatedcheck)	--	90.00	--
	S.Em.±	--	0.39	--
	C.D.at5%	--	1.11	--
	C.V.%	--	1.74	--

Mancozeb 0.2%, kresoxim methyl 44.3 SC 0.20 %, chlorothalonil 75 WP 0.20 %, propiconazole 0.02%, azoxystrobin 18.2% + difenoconazole 11.4%, and other non-systematic and systematic fungicides have been shown to be effective. Several treatments were tried in the field against Alternaria burnsii of cumin, including tebuconazole 50% + trifloxystrobin 25% (75 WG 0.05%), propineb (70 WP 0.2%), and a fungicide (29.6 SC 0.10%). In both 2016 and 2018, it was discovered that all of the fungicides were markedly more effective than check at suppressing the disease (Table 4.22). When compared to the control group, those who took propiconazole had a decrease in illness severity of 27.0%, while those who took Tebuconazole 50% + Trifloxystrobin saw a decrease of 28.10%.

Table 4.5: Controlling cumin blight using a variety of fungicides in the wild

Trt. No.	Treatments	Conc.(%)	Diseaseintensity(%)					Diseaseintensity(%)					PDI Pooledoverperiods
			2016					2018					
			1st spray	2nd spray	3rd spray	4th spray	Pooled	1st spray	2nd spray	3rd spray	4th spray	Pooled	
T_1	Mancozeb 75WP	0.25	34.2 (11.17)	36.8 (13.05)	39.4 (15.01)	41.2 (16.47)	38.0 (13.92)	34.0 (11.07)	37.0 (13.19)	39.1 (14.77)	42.7 (17.78)	38.3 (14.20)	38.2 (14.06)
T_2	KresoximMethyl44.3 SC	0.20	33.4 (10.67)	36.3 (12.68)	39.6 (15.20)	41.9 (17.05)	37.9 (13.90)	33.9 (10.97)	36.8 (13.06)	39.2 (14.89)	45.6 (20.33)	39.1 (14.81)	38.5 (14.36)
T_3	Chlorothalonil75 WP	0.25	35.0 (11.74)	36.9 (13.12)	41.0 (16.40)	44.9 (19.69)	39.7 (15.24)	39.6 (15.20)	38.4 (14.26)	40.4 (15.86)	43.8 (18.71)	40.6 (16.01)	40.2 (15.62)
T_4	Azoxystrobin18.2%+ Difenoconazole11.4 %29.6SC	0.10	47.3 (21.91)	50.9 (25.48)	55.4 (30.33)	61.4 (37.25)	54.1 (28.74)	47.8 (22.33)	53.4 (28.04)	56.7 (31.65)	63.7 (40.15)	55.7 (30.54)	54.9 (29.64)
T_5	Propiconazole25EC	0.02	23.9 (5.23)	26.0 (6.34)	27.6 (7.14)	29.8 (8.46)	27.0 (6.79)	23.5 (5.00)	25.9 (6.19)	28.0 (7.40)	30.0 (8.49)	27.0 (6.77)	27.0 (6.78)
T_6	Propineb70 WP	0.20	38.7 (14.55)	46.8 (21.43)	48.9 (23.46)	51.7 (26.25)	46.8 (21.42)	42.7 (17.78)	47.9 (22.48)	48.8 (23.35)	53.2 (27.83)	48.3 (22.86)	47.6 (22.14)
T_7	Tebuconazole50 %+ Trifloxystrobin25%75WG	0.05	24.0 (5.27)	28.1 (7.39)	30.1 (8.55)	30.9 (9.08)	28.4 (7.57)	24.1 (5.29)	27.6 (7.14)	27.7 (7.26)	31.3 (9.36)	27.9 (7.26)	28.1 (7.42)
T_8	Control(Untreatedcheck)	-	66.1 (43.35)	64.8 (41.68)	64.3 (40.80)	67.2 (44.83)	65.7 (42.67)	68.0 (46.01)	68.0 (46.11)	65.6 (42.62)	68.7 (46.96)	67.7 (45.43)	66.7 (44.05)
S.Em. ±			0.12	0.13	0.13	0.14	0.08	0.13	0.13	0.13	0.14	0.06	0.04
CDat5%			0.37	0.40	0.40	0.44	0.25	0.41	0.40	0.39	0.44	0.18	0.11
CV%			5.58	5.60	5.22	5.41	3.40	5.92	5.52	5.19	5.27	2.36	1.47

5. Conclusion

Maximum disease severity was found in Tharad (35.49%), followed by Rapar (31.8%), in 2016; in Radhanpur (34.40%), followed by Jagudan (33.40%), in 2018; and in all of Gujarat's key cumin farming locations. Isolate A9 (Tharad) was the most virulent due to its early onset of illness symptoms, whereas isolate A6 (Mandal) was the least virulent. Mancozeb (0.20%) was shown to be effective in reducing Alternaria blight. Maximum relative humidity was positively correlated with illness severity, as measured by meteorological indicators. The late sowed (5th December) crop was more severely infected with disease than the earlier planted crop.

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