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Effect of selected botanicals on Alternaria blight of cumin (*Cuminum cyminum* L.)

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Abstract
Cumin (*Cuminum cyminum* L.) which is locally known as "Jeera" in Hindi is a important spice crop. The most dreaded disease in cumin crop is Alternaria blight which is caused by *Alternaria burnsii* and it is a major production constraint for the successful cultivation of cumin crop in India. It occurs as small necrotic spots initially and later coalesce to form large brown to black spots. Four botanicals *viz*., neem oil, thyme essential oil, citronella essential oil and peppermint essential oil along with mancozeb were tested @ 0.2% *in vivo* during *Rabi* 2020-2021 for their efficacy against disease, plant growth parameters and yield. Among the botanicals, plant height at 90 DAS (43.20 cm), number of branches per plant (7.40), number of umbels per plant (14.66) and yield (6.03 q/ha) significantly increased and disease intensity at 60 DAS (24.39%) significantly decreased in T_4- peppermint essential oil @0.2% followed by T_3- citronella essential oil @0.2%, T_2- thyme essential oil @0.2% and T_1- neem oil @0.2% when compared with T_5-mancozeb @0.2% and T_0- control (untreated check). Higher gross return value (Rs. 72,360/ha) net return value (Rs. 36,960/ha) B:C ratio (2.04) was found in the treatment T_4-peppermint essential oil followed by T_3-citronella essential oil, T_2-thyme essential oil and T_1-neem oil when compared to T_5- mancozeb and T_0- control.

Keywords: Alternaria blight, *Alternaria burnsii*, citronella essential oil, neem oil, peppermint essential oil, thyme essential oil

Introduction
India is one of the largest producers, exporters and consumers of seed spices. Among them, cumin (*Cuminum cyminum* L.) which is locally known as "Jeera" is one of the important crop. It belongs to family Apiaceae and order Umbellalas. It is believed to be native of Mediterranean region (Kunal *et al.*, 2017) [7]. It is having medicinal value and one of the major export crops. It is a *Rabi* crop grown during month of October- November and harvested during February-March. Climate should be moderately cool and dry. It is mainly grown in Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, West Bengal, Karnataka, Andhra Pradesh and Tamil Nadu (Sharma *et al.*, 2013) [12]. It is drought tolerant, tropic or semi tropic crop. It has a short growth period of 100-120 days. The optimum temperature required is 25-30^{0}C. Its seeds contain proteins, fats, carbohydrates, minerals, Vitamin-A, Vitamin B_1, Vitamin B_2 and Vitamin-C (Chadha, 2006) [1]. Cumin seeds are nutty flavoured and aromatic. Oil from cumin seeds is used in perfumes, liquor and cardinals and it has stimulatory carminative, stomatic, anti-diarrhoel and dyspepsial properties (Singh *et al.*, 2007) [14]. The world's largest cumin producing country is India, contributing 70% of total world output. Other major cumin producing countries are Syria (13%), Turkey (5%), UAE (3%), and Iran (Gondalia *et al.*, 2019) [4]. Rajasthan and Gujarat are the only major Indian states that produce cumin. The total area under Jeera has increased by about 25% at 10,25,600 hectares.

Alternaria blight which is the most dreaded disease caused by *Alternaria burnsii* is a major production constraint for the successful cultivation of cumin crop in India. Cumin blight was first reported from Mumbai province to be caused by Alternaria species (Uppal, 1933) [17] but later on, the correct identity of fungus as *Alternaria burnsii* was established (Uppal *et al.*, 1938) [18]. Initially small, whitish necrotic spots appear on the serial parts on the tips of young leaves. These necrotic spots enlarge and coalesce with each other and changes to purple, brown and finally to black. When severe infection occurs, failure in seed formation and if sometimes seeds are produced, these get shriveled, light and non-viable. Cumin blight is widely prevalent in the states of Rajasthan, Gujarat, Haryana and West Bengal and causes yield losses upto 70% (Sekhawat *et al.*, 2013) [13]. *Alternaria burnsii* survives in crop debris and spread through seeds. It is internally and externally seed-borne (Singh *et al.*, 2016) [15].

The control strategies for Alternaria blight are use of botanicals as the popular resistant varieties are not available. However, environmental factors like temperature, relative humidity and pathogenic variability influence the development and severity of this disease. Concerted studies are needed to understand the epidemiology, including population biology of the Alternaria species involved in causing cumin blight for disease control (Mehta and Solanki, 1990) [8].

One such attempt has been made to evaluate the effect of peppermint essential oil, citronella essential oil, thyme essential oil and neem oil against Alternaria blight (*Alternaria burnsii*) *in vivo*.

Material and Methods

Experimental site

The experiment was conducted at the Central Research Field and Department of Plant Pathology, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during *Rabi* season 2020-2021.

Methodology

Collection of disease samples

Plants showing typical symptoms, in the field of standing crop i.e., the infected plant part of cumin is selected. These disease plant materials were brought to the lab for further investigation.

Identification of the fungus by slide preparation

Examination of the fungal colony characteristics was done through microscopic examination. Using a sterile needle, a small portion of the infected plant part was taken and placed on a sterile glass slide. It was stained using lactophenol and cotton blue and covered with the coverslip. Then, the microscope was used for the examination of morphological characteristics of fungal structures (Grahovac *et al.*, 2012) [5].

Morphological Characters of *Alternaria burnsii*

The conidia are single or in chains. They are smooth with rounded base and pointed towards the apex. Beak is septate or non septate. They possess 3-6 transverse and 1-3 longitudinal septa which are called as muriform conidia. The conidiophore is branched, erect, straight or somewhat bent (Singh *et al.*, 2016) [15].

Evaluation of fungicide and botanicals *in vivo*

The efficacy of non-systemic fungicide and botanicals against *Alternaria burnsii* was carried out in field condition.

Disease intensity

Disease intensity (%) formula given by Wheeler (1969) [19] was used for the calculation:

$$\text{Disease intensity (\%)} = \frac{\text{Sum of all disease ratings}}{\text{Total number of rating} \times \text{Maximum disease grade}} \times 100$$

Observations recorded

Pre-harvest and post-harvest observations were recorded during the course of experiment. Pre-harvest observations were plant height, number of branches per plant, number of umbels per plant, disease intensity and post-harvest observations were yield and B:C ratio.

Results and Discussion

Table 1: Effect of botanicals on plant height (cm), number of branches per plant and number of umbels per plant

Tr. No.	Treatments	Plant height (cm)			Number of branches/plant	Number of Umbels/plant
		30 DAS	60 DAS	90 DAS		
T_0	Control (untreated check)	7.30	10.63	21.96	4.00	11.00
T_1	Neem oil	12.43	21.43	30.10	5.00	12.33
T_2	Thyme essential oil	14.26	34.26	36.60	5.16	13.33
T_3	Citronella essential oil	14.40	36.40	39.06	6.56	14.33
T_4	Peppermint essential oil	16.53	38.86	43.20	7.40	14.66
T_5	Mancozeb	19.23	40.56	50.90	7.73	14.33
S.Ed. (±)		0.67	1.25	2.01	0.65	0.87
CD (5%)		1.50	2.79	4.45	1.44	1.99

Plant height (cm)

The plant height of cumin significantly increased in treatment T_4 – peppermint essential oil @ 0.2% (43.20 cm) followed by T_3 – citronella essential oil @ 0.2% (39.06 cm), T_2 – thyme essential oil @ 0.2% (36.60 cm) and T_1 – neem oil @ 0.2% (30.10 cm) when compared to T_5 – mancozeb @ 0.2% (50.90 cm) and untreated control T_0 – (21.96 cm). Among the treatments, (T_2, T_3) and (T_3, T_4) were found non – significant to each other.

Number of branches per plant

The number of branches per plant of cumin significantly increased in treatment T_4 – peppermint essential oil @ 0.2% (7.40) followed by T_3 – citronella essential oil @ 0.2% (6.56), T_2 – thyme essential oil @ 0.2% (5.16) and T_1 – neem oil @ 0.2% (5.00) as compared to T_5 – mancozeb @ 0.2% (7.73) and untreated control T_0 – (4.00). Among the treatments, (T_1, T_2), (T_2, T_3), (T_3, T_4, T_5) and (T_4, T_5) were found non – significant to each other.

Number of umbels per plant

The number of umbels per plant of cumin significantly increased in treatment T_4 – peppermint essential oil @ 0.2% (14.66) followed by T_3 – citronella essential oil @ 0.2% (14.33), T_2 – thyme essential oil @ 0.2% (13.33) and T_1 – neem oil @ 0.2% (12.33) as compared to T_5 – mancozeb @ 0.2% (14.33) and untreated control T_0 – (11.00). Among the treatments, (T_1, T_2), (T_2, T_3, T_5, T_4), (T_3, T_5, T_4) and (T_5, T_4) were found non – significant to each other.

Table 2: Effect of botanicals on Disease intensity (%), yield (q/ha) and B:C ratio

Tr. No.	Treatments	Disease Intensity (%)			Yield (q/ha)	B:C Ratio
		30 DAS	45 DAS	60 DAS		
T_0	Control (untreated check)	18.90	27.05	47.27	2.70	1.10
T_1	Neem oil	15.74	22.33	38.68	3.33	1.094
T_2	Thyme essential oil	14.47	20.10	31.55	4.43	1.47
T_3	Citronella essential oil	12.76	15.93	27.37	5.90	1.96
T_4	Peppermint essential oil	10.49	16.58	24.39	6.03	2.044
T_5	Mancozeb	11.08	14.84	22.55	7.16	2.29
S.Ed. (±)		0.93	0.96	0.89	0.27	
CD (5%)		2.07	2.14	1.97	0.60	

Disease intensity (%)

The disease intensity (%) significantly decreased in treatment T_4 – peppermint essential oil @ 0.2% (24.39) followed by T_3 – citronella essential oil @ 0.2% (27.37), T_2 – thyme essential oil @ 0.2% (31.55) and T_1 – neem oil @ 0.2% (38.68) as compared to T_5 – mancozeb @ 0.2% (22.55) and highest disease intensity was found in untreated control T_0 – (47.27). Among the treatments, (T_5 and T_4) were found non-significant to each other.

Yield (q/ha)

The yield of cumin significantly increased in treatment T_4 – peppermint essential oil @ 0.2% (6.03 q/ha) followed by T_3 – citronella essential oil @ 0.2% (5.90 q/ha), T_2 – thyme essential oil @ 0.2% (4.43 q/ha) and T_1 – neem oil @ 0.2% (3.33 q/ha) as compared to T_5 – mancozeb @0.2% (7.16 q/ha) and untreated control T_0 – (2.70 q/ha). Among the treatments, (T_3 and T_4) were found non – significant to each other.

Results of benefit cost ratio among the treatments were observed. The cost of cultivation (Rs. 36,040/ha) and the highest gross returns (Rs. 72,360/ha) and net returns (Rs. 36,960/ha) were recorded in treatment T_4. The lowest was observed in untreated control with T_0 with gross returns (Rs. 24,300/ha), cost of cultivation (Rs. 22,000/ha) and net returns (Rs. 2300/ha).

Discussion

Peppermint essential oil is one of the most widely used essential oil, having components such as menthol and isomenthone (Prakash *et al.*, 2013) [11] which are useful for significant increase in plant growth. Hussain *et al.* (2010) [6] in his study revealed that components present in the peppermint oil are responsible for the significant increase in the physiological growth of the plants. Inhibition of growth of fungal pathogen was due to the presence of major components such as menthol, menthone and menthofuran (Mohammad *et al.*, 2013) [9]. The essential oil of peppermint can be used as a alternative for control of Alternaria species (Franca *et al.*, 2018) [3]. Perveen *et al.* (2020) [10] concluded that peppermint oil showed the potential to inhibit Alternaria species by inhibiting both the mycelia growth and conidia germination. The anti-fungal activity of the peppermint essential oil was due to the synergistic effect of the main components of the oil (Tian *et al.*, 2012) [16]. Chand *et al.* (2002) [2] revealed that menthol in peppermint oil because of its anti-microbial activity enhances shelf life of edible grains.

Probable reasons for such findings may be due to the presence of menthol, menthone and menthyl acetate which comprise the main components of this oil. Plant height is gradually increased due to suppressing the growth of fungus by menthol. It turns the fungal cell membrane permeable. It causes loss of cytoplasmic content. It improves biological and physiological process in plants. The application of peppermint essential oil significantly improved the plant height. It is having anti-fungal activity against *Alternaria burnsii* which helped for good plant growth may lead plant to maximum height. Peppermint essential oil is apparently the best inhibitor for fungal pathogen. Inhibition of growth of fungal pathogen may be due to the damaged cell membrane and cell wall having different capacity to penetrate oil into the chitin based cell walls of fungal hyphae. The use of peppermint essential oil in the control of Alternaria species have many advantages over the agrochemical traditional use, such as the fast degradation, low toxicity in the environment low cost of production, and lack of health risks to the producer and final consumer. It has the ability inhibit the growth of *Alternaria burnsii*. It lowers the health risk along with being economical and eco-friendly makes the peppermint oil a suitable ingredient for the development of a natural fungicide, which can reduce the use of chemical fungicides.

Conclusions

The *in vivo* results revealed that plant height (cm) 30, 60, 90 DAS, number of branches per plant, number of umbels per plant and yield (q/ha) significantly increased and disease intensity (%) in cumin at 30, 45, 60 DAS significantly decreased in the treatment T_4 – peppermint essential oil @ 0.2%. The higher gross return value, net return value and B:C ratio were also recorded.

To reduce the use of fungicides and to control the environmental pollution and soil health many researches are undergoing, one such attempt is the use of plant based products such as essential oils. The findings of the present experiment are limited to one crop season (December 2020 to March 2021) under Prayagraj agro-climatic conditions, as such to validate the present findings more such trials should be carried out in future.

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