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Effect of selected botanicals on *Alternaria* leaf spot of coriander (*Coriandrum sativum* L.)

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Abstract

Coriander (*Coriandrum sativum* L.)” is also known as ‘cilantro’ belongs to the family Apiaceae. The commonly found pathogen *Alternaria alternata* that is responsible for the disease Alternaria leaf spot in coriander. The common symptoms of Alternaria leaf spot are tiny dark coloured circular spots on foliage and stems of coriander. This shows negative effect on yield and also produces a very low quality which may notably reduce the market value of coriander due to the presence of spots and lesions on foliage. Management of this disease mainly depends on chemical methods. To reduce the use of chemical fungicides and due to the negative impact of chemical methods on environment and soil health one such attempt has been made to evaluate the effect of selected botanicals *in vivo* at Central Research Field and Department of Plant Pathology, SHUATS, Prayagraj and Uttar Pradesh. Selected botanicals viz., citronella essential oil, peppermint essential oil, thyme essential oil and neem oil at 0.2% concentration and mancozeb @0.2% were tested *in-vivo* against alternaria leaf spot of coriander during *Rabi* 2020-2021 for their efficacy against the disease, plant growth & yield parameters. Among the treatments used in this study significantly lowest disease intensity (26.26%) in coriander at 30, 45 and 60 DAS, maximum percent reduction over control (46.32), highest plant height (72.26 cm), higher number of branches per plant (27.33), higher number of umbels per plant (15.00), highest yield (7.00 q ha⁻¹), higher gross return value (Rs. 56,264 ha⁻¹), net return value (Rs. 37,26 ha⁻¹) and B: C ratio (2.96) were recorded in treatment T₃ – citronella essential oil @0.2% followed by T₄ – peppermint essential oil @0.2%, T₂ – thyme essential oil @0.2% and T₁ – neem oil @0.2% (56.66 cm) as compared to T₅ – mancozeb @0.2%(treated check) and T₀ – control(untreated check).

Keywords: *Alternaria alternata*, Alternaria leaf spot, citronella essential oil, coriander, neem oil, peppermint essential oil, thyme essential oil

Introduction

Coriander (*Coriandrum sativum* L.) is a member of the family Apiaceae (2n=22). Plants of coriander usually grow up to 20 inches height. The leaves are irregular in shape, widely lobed, slender and feathery. The inflorescence of coriander is racemose type and the flowers are carried in small umbels. The favourable temperature for vegetative growth is 15-25°C and for seed formation 20-30°C is considered good. Excessive rain affects the crop yield and quality badly (Singh and Bhandari, 2015) [19]. Coriander is aboriginal to regions traversing from Southern Europe and Northern Africa to South Western Asia. India is the World's top producer of coriander in 2019 with 14, 48,000 tonnes production and export of 2, 81,758 tonnes which is 34% of the total world exports (Anonymous, 2019) [2]. Uttar Pradesh produced 5.26 thousand metric tons in the year 2020. The country's annual production of coriander seeds was over 755 thousand metric tons (Anonymous, 2020) [3].

The commonly found pathogen *Alternaria alternata* that is responsible for the disease Alternaria leaf spot in coriander (Muniz and Porto, 1999) [15]. The common symptoms of Alternaria leaf spot are tiny dark coloured circular spots on foliage and stems of coriander. This shows negative effect on yield and also produces a very low quality which may notably reduce the market value of coriander due to the presence of spots and lesions on foliage (Hashmi and Ghaffar, 1991; Boedo *et al.*, 2012 and Mangwende *et al.*, 2018) [10, 5, 13].

Due to the negative impact of chemical methods on environment and soil health, Non-chemical methods were used as alternative means of managing the disease viz., botanicals as treatments because of their intact status and their ample approval by consumers. Botanicals appeared to be efficient and also show assuring results in the management of several fungi species, due to their antimicrobial activity. Bakkali (2008) [4] and Kumar *et al.* (2008) [11] accentuated that the cytotoxic property of plant oil and essential oils was due to their lipophilic nature. These oils interact with the lipid layer on the plasma membrane and cross the cell wall.

In this study plant oil and essential oils like neem oil, citronella essential oil, peppermint essential oil and thyme essential oil were used which contain azadirachtin, citral, menthol and thymol as major constituents, respectively (Mahanta *et al.*, 2007) [12]. This reported significant variation in antifungal activity against *Alternaria alternata* (Chen *et al.*, 2014; Franca *et al.*, 2018; Tajidin *et al.*, 2012; Alla *et al.*, 2011 and Sekhawat *et al.*, 2013) [6, 8, 20, 1, 18].

Therefore an attempt has been made to evaluate the potential application of botanicals against *alternaria* leaf spot of coriander under *in vivo* conditions.

Materials and Methods

Experimental site

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

Materials required

Disease sample, glass slide, cover slip, lactophenol, cotton blue, needle, forcep, compound microscope.

Methodology

Collection and identification of the fungus by slide preparation

Examination of the fungal colony characteristics was done through microscopic examination. The coriander leaves showing small, circular and brown necrotic leaf spots covered with yellow zone was collected from the field. Using a sterile needle small infected portion of a leaf placed on a sterile glass slide. Next, staining was done using lactophenol and cotton blue after that coverslip was used to cover the slide. Then, the microscope was used for the examination of morphological characteristics of fungal structures (Grahovac *et al.*, 2012) [9].

Morphological characters of *Alternaria alternata*: (Meena *et al.*, 2014) [14]

Conidia were simple, pale to dark brown in colour and generally formed in chains. Conidia have both horizontal and vertical septa (muriform) conidia. Conidiophores were pale to dark brown in colour. Hyphae were brown with light brown conidiophores at the top of each branch.

Observations recorded: (Duwal *et al.*, 2019) [7]

Pre-harvest and post-harvest observations were noted during the period of experiment. Pre-harvest observations were height of the plant (cm), 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

Effect of selected botanicals and fungicide *in vivo*

Plant height (cm)

The maximum height of coriander plant at 90 DAS was noted in treatment T₃ – citronella essential oil @0.2% (72.26 cm) followed by T₄ – peppermint essential oil @0.2% (63.93 cm), T₂ – thyme essential oil @0.2% (59.23 cm) and T₁ – neem oil @0.2% (56.66 cm) as compared to T₅ – mancozeb @0.2% (79.26 cm) and untreated control T₀ – (45.73 cm). Comparing the treatments with CD value (4.84), all the treatments (T₁, T₂, T₃, T₄, T₅) were found significant over untreated control T₀ (control +FYM). The treatments (T₁, T₂) and (T₂, T₄) were found non – significant to each other.

Number of branches per plant

The maximum number of branches per plant of coriander were noted in treatment T₃ – citronella essential oil @0.2% (27.33) followed by T₄ – peppermint essential oil @0.2% (25.00), T₂ – thyme essential oil @0.2% (22.00) and T₁ – neem oil @0.2% (20.00) as compared to T₅ – mancozeb @0.2% (33.00) and untreated control T₀ – (17.00). Comparing the treatments with CD value (1.27), all the treatments (T₁, T₂, T₃, T₄, T₅) were found significant over untreated control T₀ (control +FYM).

Number of umbels per plant

The maximum number of umbels per plant of coriander were recorded in treatment T₃ – citronella essential oil @0.2% (15.00) followed by T₄ – peppermint essential oil @0.2% (14.00), T₂ – thyme essential oil @0.2% (14.00) and T₁ – neem oil @0.2% (12.66) as compared to T₅ – mancozeb @0.2% (17.33) and untreated control T₀ – (10.00). Comparing the treatments with CD value (2.55), all the treatments (T₁, T₂, T₃, T₄, T₅) were found significant over untreated control T₀ (control +FYM). The treatments (T₁, T₂, T₄, T₃), (T₂, T₄, T₃), (T₄, T₃) and (T₃, T₅) were found non – significant to each other.

Table 1: Effect of selected botanicals and fungicide on plant height (cm) at 30, 60 and 90 DAS, number of branches per plant and number of umbels per plant of coriander at 90 DAS

Tr. No.	Treatments	Plant height (cm)			Number of branches per plant	Number of umbels per plant
		30 DAS	60 DAS	90 DAS		
T ₀	Control (untreated check)	14.08	25.73	45.73	17.00	10.00
T ₁	Neem oil	16.66	36.66	56.66	20.00	12.66
T ₂	Thyme essential oil	19.56	39.23	59.23	22.00	14.00
T ₃	Citronella essential oil	25.26	55.26	72.26	27.33	15.00
T ₄	Peppermint essential oil	22.93	44.26	63.93	25.00	14.00
T ₅	Mancozeb	27.93	63.60	79.26	33.00	17.33
	S.Ed. (±)	0.99	1.72	2.18	0.57	1.15
	CD (5%)	2.20	3.82	4.84	1.27	2.55

Disease intensity (%)

Minimum disease intensity (%) was recorded in treatment T₃ – citronella essential oil @0.2% (26.26) followed by T₄ – peppermint essential oil @0.2% (30.89), T₂ – thyme essential oil @0.2% (33.96) and T₁ – neem oil @0.2% (39.60) as compared to T₅ – mancozeb @0.2% (23.40) and highest

disease intensity was found in untreated control T₀ – (48.92). Comparing the treatments with CD value (3.10), all the treatments (T₁, T₂, T₃, T₄, T₅) were found to be significant over untreated control T₀. The treatments (T₄, T₂) were found non-significant to each other.

Percent reduction over control

The highest percent disease control was recorded in treatment T₅ – mancozeb @0.2% (52.16%) followed by T₃ – citronella essential oil @ 0.2% (46.32%) followed by T₄ – peppermint essential oil @0.2% (36.85%) and T₂ – thyme essential oil @0.2% (30.58%). The lowest percent disease control was recorded with the treatment T₁ – neem oil @0.2% (19.05%).

Yield (q ha⁻¹)

The highest total yield of coriander was recorded in treatment T₃ – citronella essential oil @0.2% (7.00 q ha⁻¹) followed by T₄ – peppermint essential oil @0.2% (6.80 q ha⁻¹), T₂ – thyme essential oil @0.2% (6.06 q ha⁻¹) and T₁ – neem oil @0.2%

(5.06 q ha⁻¹) as compared to T₅ – Mancozeb @0.2% (8.06 q ha⁻¹) and untreated control T₀ – (3.20 q ha⁻¹). Comparing the treatments with CD value (0.54), all the treatments (T₁, T₂, T₃, T₄, T₅) were found significant over untreated control T₀ (control + FYM). The treatments T₄ and T₃ were found non – significant to each other.

Results of benefit cost ratio among the treatments were observed. The cost of cultivation (Rs. 19000 ha⁻¹) with higher gross return value (Rs. 56,264 ha⁻¹) and net return value (Rs. 37,264 ha⁻¹) were recorded in treatment T₃ – citronella oil. The lowest was observed in untreated control with T₀ with gross return value (Rs. 17,600 ha⁻¹), cost of cultivation (Rs. 10,000 ha⁻¹) and net return value (Rs. 15,600 ha⁻¹).

Table 2: Effect of selected botanicals and fungicide on disease intensity (%), yield (kg ha⁻¹) and B: C ratio

Tr. No.	Treatments	Disease intensity (%)			Disease intensity (%)	Yield (q ha ⁻¹)
		30 DAS	45 DAS	60 DAS		
T ₀	Control (untreated check)	19.48	31.03	3.20	-	3.20
T ₁	Neem oil	16.75	26.20	5.06	19.05	5.06
T ₂	Thyme essential oil	15.00	23.16	6.06	30.58	6.06
T ₃	Citronella essential oil	11.06	17.72	7.00	46.32	7.00
T ₄	Peppermint essential oil	13.96	19.11	6.80	36.85	6.80
T ₅	Mancozeb	10.25	15.61	8.06	52.16	8.06
	S.Ed. (±)	1.07	1.21	1.39	-	0.25
	CD (5%)	2.38	2.70	3.10	-	0.54

The probable reasons for such findings may be due to the antifungal property of botanicals that may have reduced the hyphal growth of *Alternaria alternata* and suppressed the disease. The fungal growth decreased with an increase of plant oil and essential oils concentration. Neem oil and essential oils exhibits cytotoxic property that comes from their lipophilic nature. Essential oils like citronella oil show antifungal property and are best alternative inhibitors to chemical synthetic fungicides against plant pathogens because of the presence of major chemical constituents such as citral, citronellal and geraniol which may also have induced lysis, changes in cell wall composition, plasma membrane disruption and may also have interfered with the enzymatic reactions of the mitochondrial membrane. The antifungal activity of neem oil, peppermint essential oil and thyme essential oil might be due to the presence of major constituents such as azadirachtin, menthol and thymol, respectively Patel *et al.* (2017) [16], Franca *et al.* (2018) [8], Chen *et al.* (2014) [6], Mahanta *et al.* (2007) [12] and Ragupati *et al.* (2020) [17].

Conclusions

As per the results obtained from this study, significantly lowest disease intensity (%) in coriander at 30, 45 and 60 DAS, highest plant height (cm), highest number of branches per plant, highest number of umbels per plant, highest yield (q ha⁻¹), higher gross return value, net return value and B: C ratio were recorded in treatment T₃ – citronella essential oil @0.2%. Therefore it is concluded that citronella essential oil is effective against *Alternaria alternata* as compared to control treatment and other botanicals used in this study. This is one such attempt to reduce the environmental stress by avoiding the heavy use of chemicals to control diseases. Future line of work is needed with botanicals for the management of alternaria leaf spot.

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