Original Research Article

Essential Oils for the Management of Sheath Blight of Rice

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A B S T R A C T

Keywords

Sheath bight of rice, Rhizoctonia solani, Essential oils and Poison food technique

A total of seven essential oils *i.e.* Citronella oil, Eucalyptus oil, Cedarwood oil, Nirgundi oil, Lemongrass oil, Clove oil and Neem oil were evaluated at 100ppm, 200ppm and 300ppm against *Rhizoctonia solani* causing sheath blight of rice by poison food technique. At 100ppm Neem essential oil showed maximum growth inhibition per cent (51.48%) followed by Nirgundi oil, Cedar wood oil, clove oil, citronella oil, Lemongrass oil and Eucalyptus oil. At 200ppm Cedarwood oil showed maximum mycelial growth inhibition per cent as 69.26% fallowed by Lemongrass (65.19%). At 300ppm both Cedarwood oil and Lemongrass oil have produced maximum inhibition (82.96%).Treatments under field condition, Cedarwood oil @1.0 ml/L has shown 57.38% of disease control and has given 48.24% higher yield than control check. After Cedarwood oil, Lemon grass oil @1.25 ml/L and Neem oil @1.0 ml/L have produced disease control of 54.43% and 48.31% respectively.

Introduction

Rice (*Oryza sativa* L.) is the world's most important cereal crop and is a staple food crop for 60% of the world's population. Rice is grown across the world in an area of about 163.62 million hectares with an annual production of 501.4 million tons (Anonymous, 2019). It is a major source of calories for more than 70% population in India. In India, it is grown in 44.5 million hectares in desired ecological conditions with an annual production of 116.0 million tons and productivity 3.91 tons/ha (Anonymous, 2019). In Bihar, it covers an area of 3.306 million hectares with an annual production of

8.1 million tons and productivity of 2.45 tons/ha (Anonymous, 2018). It has to bring up rice production around 130 million tons by 2030, to fulfill the food requirements of the increasing population in India (Viraktamath, 2012).

Rice outcomes are affected by biotic and abiotic components which cause yield losses up to 20-30%. In the case of biotic constraints, fungal diseases are highly predominant in rice-growing areas across the world. Sheath blight of rice caused by *Rhizoctonia solani* Kuhn [Teleomorph: *Thanetophorus cucumeris* (Frank) Donk] is a potentially devastating fungal disease under

suitable conditions (Dath, 1990). In India, this pathogen has become more prevalent in most of the improved varieties, which are currently grown in India. The disease generally appears at the maximum tillering stage and affects all plant parts above water-line *viz.* sheath, internode, upper leaves, and panicles.

Lesion formation on infected sheaths of lower rice leaves may lead to softness of the stem and subsequently stem lodging (Wu *et al.,* 2012). In addition, the fungus survives between crops as "sclerotia" that can lie dormant in the soil for at least two to three years (University of Arkansas Cooperative Extension Service, 2015). Since, *Rhizoctonia solani* is a typical soil borne fungus and its management through chemicals is expensive and not feasible, because of the physiological heterogenicity of the soil and other edaphic factors etc. might prevent effective concentrations of the chemical reaching to the pathogen. And also, synthetic chemicals cause the adverse affects on human health and the environment, and this has promoted man to produce natural pesticides. The increasing incidence of resistance among pathogens towards synthetic chemicals is also a cause for serious concern. This approach mainly emphasizes on the management through eco-friendly means *i.e.* through the use of essential oils.

Essential oils are volatile, natural, complex compounds characterized by a strong odour and are formed by aromatic plants as secondary metabolites. They are usually obtained by steam or hydro-distillation first developed in the middle Ages by Arabs. Known for their antiseptic, i.e., bactericidal, viricidal and fungicidal and medicinal properties and their fragrance, they are used in preservation of foods and as antimicrobial, analgesic, sedative, anti inflammatory, spasmolytic and locally anesthesic remedies

(Bakkali, *et al.,* 2008). At present, approximately 3000 essential oils are known, 300 of which are commercially important especially for the pharmaceutical, agronomic, food, sanitary, cosmetic and perfume industries (Silva, *et al.,* 2003). Some of them constitute effective alternatives or complements to synthetic compounds of the chemical industry, without showing the same secondary effects (Carson and Riley, 2003). They possess a wide spectrum of biological activities and their antibacterial, antifungal, insecticidal and pesticidal properties have made them highly sought secondary metabolites (Isman, 2000). Considering the role of essential oils in organic production present study was about to find out best one among the available essential oils for the management of sheath blight of rice.

Materials and Methods

Laboratory experimental details

Laboratory experiment was conducted at department of plant pathology, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samasthipur, Bihar. Commercially available seven essential oils were used in this experiment (Table 1).

Preparation of essential oils stock solutions

Emulsifying agent was used for dissolving the essential oils in sterilized distilled water. Initially, 3ml of emulsifying agent was added to 997 ml of sterilized water to get 0.3% emulsifier. Each essential oil of 0.5 ml was dissolved in 124.5 ml of 0.3% emulsifying agent to make 4000ppm stock solution.

Evaluation method

Essential oils evaluated against *R. solani* by using poison food technique at 100ppm, 200ppm and 300ppm of concentration. To get

desired concentrations, 1.5 ml, 3 ml and 4.5 ml of stock solutions added in 58.5 ml, 57 ml and 55.5 ml of sterilized PDA media respectively; mixed thoroughly and poured into Petri plates under aseptic condition. Later 9 mm of pathogen (3 to 4 days old culture) containing PDA disc was transferred on to solidified treated media. For the control plate 0.3% of emulsified PDA was used. Each treatment has been done with three replications. Inoculated plates were kept in BOD at 28 ± 1 °C. Observations on mycelial growth were recorded after 72 hours of incubation. Data on sclerotia production was taken after 120 hours of incubation 28 ± 1 °C.

By using following formula percentage growth inhibition of *Rhizoctonia solani* was calculated.

Inhibition percentage

$$= \frac{(C - T) \times 100}{C}$$

Where, C = Diameter of fungal growth (mm) in control plate.

T = Diameter of fungal growth (mm) in treated plate.

Field experimental details

The present field experiment was conducted during *Kharif*-2019 at university farm of Dr. Rajendra Prasad Central Agricultural University, Pusa (latitude 25.98 N, longitude 85.67 E and altitude 51.8 m above the mean sea level), Samastipur, Bihar. Preparation of field, leveling and other operations were performed by tractor drown implements. Crop was fertilized by recommended dose of NPK (100:60:40) and zinc sulphate (20 kg/ha) as per required time. Weeding was done at appropriate time for best management practices. The experiment was conducted in a randomized block design (RBD) with three replications and plot size of 5×2 m (spacing 15×15 cm) on sheath blight susceptible variety MTU 7029 (Swarna).

Treatments details

Field experiment was formulated with above mentioned seven essential oils at their recommended dosage along with emulsifying agent. The two spraying stages were made; fist spray was done after onset of sheath blight disease symptoms and second was done at ten days after the first spray.

Disease recordings

Assessment was done on upper 4-6 leaves. Ten leaves from 1 m^2 randomly collected and average per cent disease severity was calculated for each plot. Data was analyzed using OPSTAT software.

Per cent disease severity was calculated by using formulae:
Disease severity (%)

$$= \frac{\text{Area of plant tissue effected} \times 100}{\text{Total area}}$$

Results and Discursion

In vitro* evaluation of essential oils against *R. solani

The significant variation present in the growth inhibition produced by essential oils against *R. solani*. Readings on Colony growth (G in mm) and Per cent growth inhibition (I) have been provided in Table 2 and visualized in Figure 1. Experimental results revealed that at 100ppm, 200ppm and 300ppm of concentration, essential oils given per cent growth inhibition range from 17.04% to 51.48%, 26.67% to 69.26% and 42.22% to 82.96% respectively. Sclerotia production was reduced in essential oil treatments as compared to control (Table 3).

At 100ppm, Neem essential oil showed maximum growth inhibition per cent (51.48%) followed by Nirgundi oil (39.63%), Cedar wood oil (38.89%), Clove oil (34.07%), Citronella oil (27.04%), Lemon grass oil (21.48%) and Eucalyptus oil showed least Per cent growth inhibition (17.04%).

No sclerotia were observed in Clove oil and Neem oil treatment. Very few sclerotia were produced in Cedarwood oil, Nirgundi oil. Moderate number of sclerotia was observed in Lemongrass oil and citronella oil whereas Eucalyptus oil supported excellent production of sclerotia.

At 200ppm, Cedar wood oil showed maximum growth inhibition per cent (69.26%) followed by Lemon grass oil (65.19%), Neem oil (57.41%), Nirgundi oil (56.67%), Clove oil (56.30%), Citronella oil (38.7%) and Eucalyptus oil(26.67%). Sclerotia production was completely inhibited by Ceedarwood oil, Neem oil and clove oil. Nirgundi oil and Lemongrass oil produced very few amount of Sclerotia whereas Citronella oil and Eucalyptus oil treatments given moderate amount.

At 300ppm, both Cedar wood oil and Lemon rass oil showed maximum growth inhibition per cent (82.96%) followed by Clove oil (65.56%), Neem essential oil (62.78%), Nirgundi oil (61.85%), Citronella (59.26%) and Eucalyptus oil (42.22%). Except Citronella oil and Eucalyptus oil, all essential oils completely inhibited the sclerotia formation.

Anti fungal nature of different essential oils against *R. solani in vitro* have been investigated by multiple workers. *In vitro* results were compared with the experimental data reported by Lingwal *et al.,* (2014), according to them, at 100ppm, 200ppm and 300ppm Clove oil, Eucalyptus oil,

Lemongrass oil and Citronella oil produced per cent growth inhibition of (42.35%, 73.53% and 81.65%), (64.49%, 65.10% and 68.63%), (43.53%, 65.29% and 89.80%) and (38.82%, 59.61% and 83.53%) respectively; Here, it can be say that as compared to present study all essential oils shown maximum growth inhibition and Eucalyptus oil shown highest growth inhibition at lowest concentration compared with other essential oils which was contrary to present experiment.

According to Sehajpal *et al.,* (2009) out of eight essential oils, Clove oil (*Syzygium aromaticum*) was given maximum growth inhibition at 1000ppm. Lee *et al.,* (2020) have reported Lemongrass essential oil was given 100% of growth inhibition at 5 mg/paper disc.

An experiment conducted by Kandhari (2007) has reported that Neem seed kernel based product Achook (Azadirachtin 0.15% WW) was showed 65.1% growth inhibition of *R. solani.* Anti fungal nature of Cederwood oil against *R. solani* and other plant pathogens was reported by Chang *et al.,* (2008).

In vivo evaluation of different essential oils against sheath blight disease of rice

Selected seven essential oils along with emulsifier were treated against sheath blight disease caused by *R. solani in vivo.* Readings related to disease severity, per cent disease control, yield and per cent increase in yield provided in Table 4 and visualized in Graph 1.

Experimental results revealed that, at recommended doses of all essential oils contrary to sheath blight in filed climate (*in vivo*) have produced notable disease control as compared to untreated check.

Table.1 List of essential oils used in this study

S. No.	Name of the essential oil	Botanical name	Family
1	Citronella	*Ciybopogan nardus*	Poaceae
2	Eucalyptus oil	*Eucalyptus globulus*	Myrtaceae
3	Cedarwood oil	*Cedrus deodara*	Pinaceae
4	Nirgundi oil	*Vitex negundo*	Verbinaceae
5	Lemongrass oil	*Cymbopogon flexuosus*	Poaceae
6	Clove oil	*Syzygium aromaicum*	Myrtaceae
7	Neem essential oil	*Azadirachta indica*	Meliaceae

Table.2 Average colony growth (in diameter) and per cent growth inhibition of *R. solani* at different concentrations of essential oils after 72 hours of incubation 28 ± 1 ℃

Treatments	Concentrations					
	100ppm		200ppm		300ppm	
	G	I	G	I	G	I
Citronella oil	65.67	27.04	55.17	38.7	36.67	59.26
Eucalyptus oil	74.67	17.04	66.00	26.67	52.00	42.22
Cedar wood oil	55.00	38.89	27.67	69.26	15.33	82.96
Nirgundi oil	54.33	39.63	39.00	56.67	34.33	61.85
Lemon grass oil	70.67	21.48	31.33	65.19	15.33	82.96
Clove oil	59.33	34.07	39.33	56.30	31.00	65.56
Neem oil	43.67	51.48	38.33	57.41	33.50	62.78
Control	90.00	0.00	90.00	0.00	90.00	0.00
Factors	CD at 5%			SEm±		
Essential oils (A)	1.235			0.433		
Concentration (B)	0.756			0.265		
Interaction (A×B)	2.139			0.75		

G – Average colony diameter (mm); I – Average growth inhibition per cent

Table.3 Effect of different concentrations of essential oils on sclerotia production of *Rhizoctonia solani* after 120 hours of incubation at 28+ 1°C
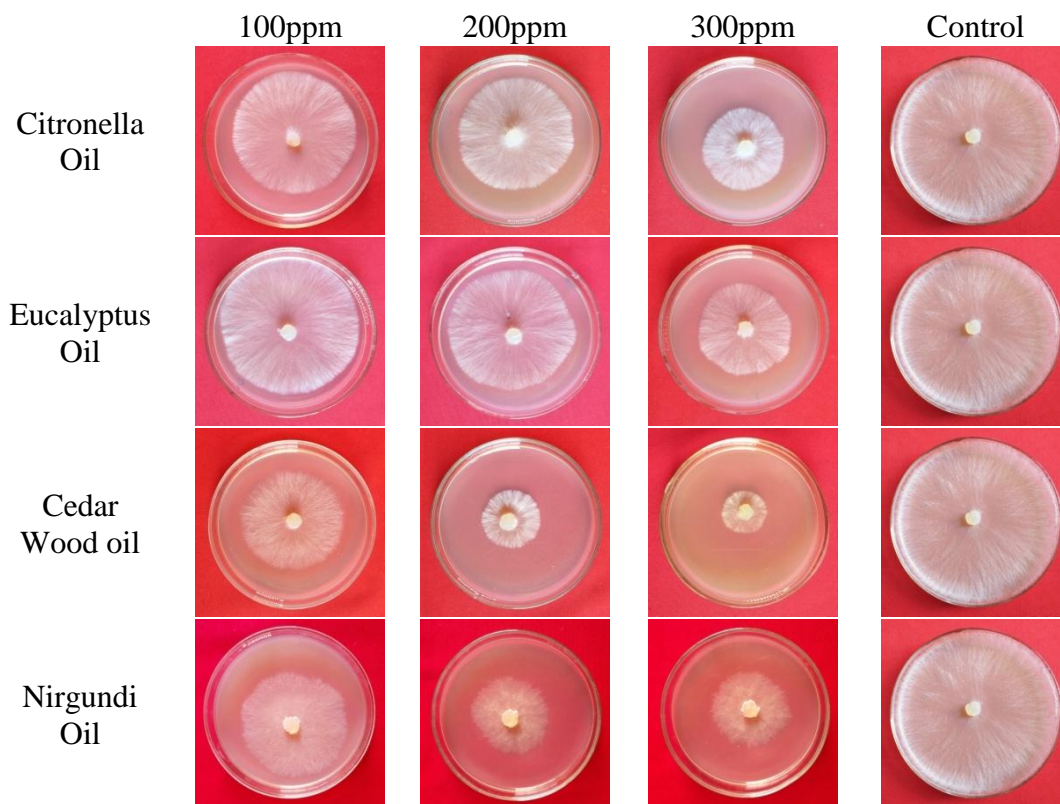
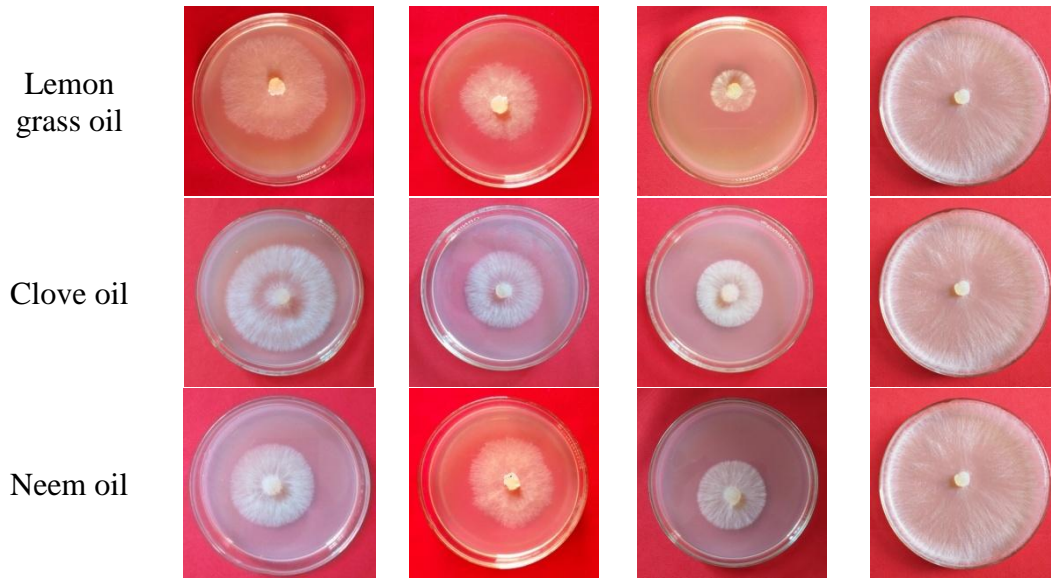| S. No.	Essential oils	Concentrations		
		100ppm	200ppm	300ppm
1	Citronella oil	++	++	+
2	Eucalyptus oil	+++	++	+
3	Cedar wood oil	+	-	-
4	Nirgundi oil	+	+	-
5	Lemongrass oil	++	+	-
6	Clove oil	-	-	-
7	Neem oil	-	-	-
8	Control	+++	+++	+++

+++ Excellent production, ++ Good production, + Poor production, - No production

Table.4 Effect of essential oils on disease severity, percent disease control, yield and percent increase in yield
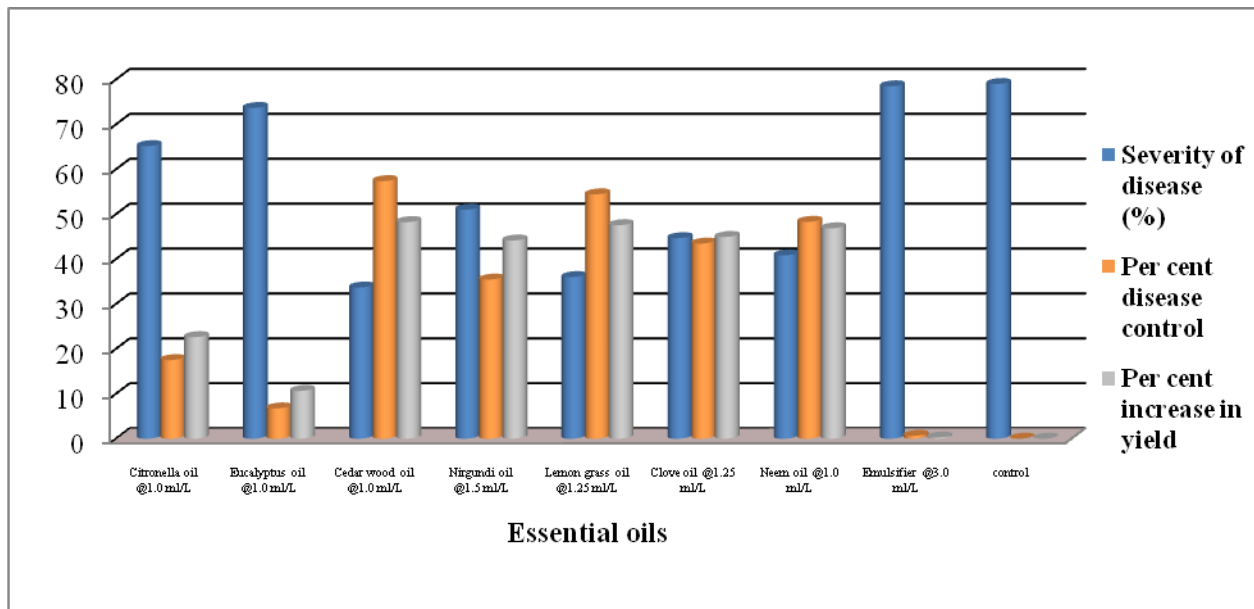
Treatments	Per cent disease severity	Per cent disease control	Yield		Per cent increase in yield
			Kg/plot	Kg/ha	
Citronella oil @1.0 ml/L	65.17	17.51	2.60	2600.00	22.62
Eucalyptus oil @1.0 ml/L	73.67	6.75	2.25	2250.00	10.64
Cedar wood oil @1.0 ml/L	33.67	57.38	3.88	3883.33	48.24
Nirgundi oil @1.5 ml/L	51.00	35.44	3.60	3600.00	44.14
Lemon grass oil @1.25 ml/L	36.00	54.43	3.83	3833.33	47.56
Clove oil @1.25 ml/L	44.67	43.46	3.65	3650.00	44.93
Neem oil @1.0 ml/L	40.83	48.31	3.78	3783.33	46.86
Emulsifier @3.0 ml/L	78.50	0.63	2.02	2015.00	0.25
Control	79.00	0.00	2.01	2010.00	0.00
C.D.	2.969	3.758	0.109	109.054	2.517
SEm±	0.982	1.243	0.036	36.065	0.832
C.V.	3.046	7.341	2.034	2.035	4.892

Fig.1 Effect of various essential oils on growth of *R. solani* at different concentrations

Lemon grass oil			
Clove oil			
Neem oil			

Graph.1 Effect of essential oils on per cent disease severity, per cent disease control and per cent increase in yield

It showing, two sprays of Cedar wood oil @1.0 ml/L has produced 57.38% of disease control and has given 48.24% of more yield than control check. Next best essential oil was Lemongrass oil @1.25 ml/L which has produced 54.43% of disease control with 47.56% of higher yield and it was followed by Neem oil @1.0 ml/L, Clove oil @1.25 ml/L, Nirgundi oil @1.5 ml/L, Citronella oil @1.0 ml/L, Eucalyptus oil @1.0 ml/L and Emulsifier @3.0 ml/L as they produced 48.31%, 43.67%, 35.44%, 17.51%, 6.75% and 0.63% of disease control, and 46.86%, 44.93%, 44.14%, 22.62% and 10.64% of high yield respectively.

According to AICRIP Progress Report- Plant Pathology-2019, At Moncompu, spraying of

Cedarwood oil @2.0 ml/L (T3) was effectively reduced the disease with 48.36% and increased the grain yield from 2233 kg/ha to 3217 kg/ha and spraying of Lemongrass oil @2.0ml/l (T5) effectively reduced the disease wherein percentage of disease reduction was 83.00% and grain yield was 3367 kg/ha. Spraying of Neem oil @2.0ml/l (T7) was effective in reducing the disease severity at Chinsurah and Ludhiana. The percentage of disease reduction was varied between 18.05% and 23.57% compared to control and similarly the grain yield was also increased compared to control (CHN – 4900 kg/ha; LDN – 7133 kg/ha). Janki *et al.,* (2010) reported that among thirteen essential oils, Wintergreen and Eugenol (constituent of clove oil) showed maximum disease reduction of 82.3% and 70.7%, respectively by spraying on the plants.

By observing *in vitro* and *in vivo* results it can be conclude that at least concentration (100ppm), Neem essential oil has reduced maximum mycelial growth compared to other essential oils. But at high concentration (300ppm), Cedarwood oil fallowed by Lemongrass oil shown maximum growth inhibition of *R. solani*. There was reduced or negligible amount of sclerotia production was observed in essential oil treatments compared to control. In field condition also, two sprays of Cedar wood oil @1.0 ml/L was shown maximum reduction in disease severity followed by Lemongrass oil @1.25 ml/L, Neem oil @1.0 ml/L, Clove oil @1.25 ml/L.

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