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Evaluation of essential oils against rice sheath blight disease in kuttanad wetland ecosystem

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Abstract

Field experiments were conducted at Rice Research Station, Kerala Agricultural University, Moncompu during *Rabi 2018-19*, *Kharif2019* and *Kharif 2020* under AICRIP programme for rice sheath blight control through organic essential oils. The tested essential oils were citronella oil, eucalyptus oil, cedar wood oil, nirgundi oil, lemon grass oil, clove oil, neem essential oil, emulsifier with standard check fungicide carbendazim 50 WP. The pooled analysis of three seasons showed that neem essential oil @ 2 ml/l was superior in reducing the sheath blight disease incidence (19.28 %) on par with standard check fungicide carbendazim 50 WP (21.64 %) and lemon grass oil @ 2 ml/l (23.11 %). The data on severity proved that the neem essential oil treatment resulted in less severity of sheath blight (16.32%) compared to lemon grass oil (17.85 %) and standard check fungicide carbendazim (18.91%). The neem essential oil treatment also yielded the highest (6532 kg/ha) followed by standard check fungicide carbendazim (5878 Kg/ha) and lemon grass oil (5762 kg/ha).

Keywords: Rice, sheath blight, essential oil, fungicide, severity

Introduction

Rice (*Oryzae sativa* L.) is the primary staple food in many countries. In India, it is cultivated in an area of 44 M ha with 105 M T of production and 2386 kg ha^{-1} of productivity. Sheath blight is a fungal disease of rice caused by a necrotrophic soil-borne fungus *Rhizoctonia solani*–AGA1-IA. It survives either as sclerotia or mycelia in the debris of host plants. The sclerotia float to the surface of flooding water in the rice fields and germinate on rice sheaths forming infection cushions or appressoria during the infection process (Richa *et al.,* 2016). *R. solani* can attack rice plants at any growth stage (Dath, 1990) but disease incidence and severity increase with increase in plant age (Singh *et al.,* 2004) and the resistance and susceptibility in rice genotypes are better differentiated on mature plants than on seedlings (Dath, 1990).

The weather and soil conditions such as high relative humidity, temperature and extremely acidic soil pH prevailing during *Kharif* and *Rabi* in Kuttanad are conducive for the occurrence of sheath blight disease. Sheath blight is a worldwide destructive disease causing significant yield loss and quality degradation (Savary *et al*., 2006). Sheath blight of rice is important location specific disease in Kuttanad region of Kerala causing 30-37 per cent yield loss (Surendran *et al*., 2019). This region is a hot spot for rice diseases and chemical fungicides are commonly used to control diseases. Periodic prophylactic spraying at booting stage to ward off disease incidence has become a regular practice of Kuttanad farmers. However, this practice has often resulted in spontaneous disease outbreaks. The indiscriminate use of fungicides to control sheath blight disease has led to acute environmental pollution in this region. Laterally it leads to health hazards to human beings and all other living organisms. Hence, eco-friendly fungicidal formulations have become the need of the hour to reduce this environmental pollution. Essential oils or crude plant extracts can be used as pesticide (Strangarlin *et al.,* 1999) and induce fruit resistance through proper elicitor compounds (Schwan-Estrada *et al.,* 2005).

Currently, biofungicides based on natural product are effective against plant diseases. The agricultural use of natural products is an advisable and desirable alternative to the application of synthetic chemicals. Application of natural essential oils from lemon grass (*Cymbopogon citratus*) against anthracnose (*Colletotrichum gloeosporioides*) has been increasingly compromised by the development of pathogen resistance (Duamkhanmanee, 2008). Studies on evaluation of essential oils against sheath blight disease was proposed as a new disease management approach under AICRIP programme during the year 2018 and it was conducted at Rice Research Station, Moncompu. Considering the yield loss due to this disease and keeping in view the effect of chemical pesticides resulting in environmental pollution, the present study involving field experiments were carried out to evaluate different essential oils available in the market, for their efficacy against sheath blight of rice.

Materials and Methods

Field experiments were conducted at Rice Research Station, Moncompu, Alappuzha during *Rabi 2018-19*, *Kharif 2019* and *Kharif 2020* under AICRIP programme for sheath blight control. The treatments included essential oils such as citronella oil, eucalyptus oil, cedar wood oil, nirgundi oil, lemon grass oil, clove oil and neem essential oil as well as emulsifier and standard check fungicide carbendazim 50 WP. The experiments were laid out in randomised block design with 3 replications in 5×2m plots using the susceptible variety Uma (MO 16). The N, P, K fertilisers were applied as per Package of Practices recommendations. The treatments were applied as foliar spray after the appearance of sheath blight symptoms under natural conditions. Three sampling units of 1 m^2 area were fixed in each plot at random and observations were recorded on disease incidence and severity before the spray and 15-20 days after the spray. Percentage of disease incidence was calculated based on the number of infected tillers on 25 plants per sampling unit. Degree of severity was graded based on height of the plant portions affected by the disease and expressed as percentage of the total area as per the SES scale of rice (IRRI, 2014). Grain yield of each plot was recorded and expressed in kg/plot at 14% moisture. Data on percentages were transformed to arcsine values and analysis of variance was performed with transformed values. Significance among mean treatments was determined according to Duncan's multiple range test (Gomez and Gomez, 1984).

Results and Discussion

During *Rabi 2018-19*, observations on sheath blight incidence showed that the eucalyptus oil was the most effective in reducing sheath blight incidence (14.42 %) followed by cedar wood oil (15.56 %), standard check fungicide carbendazim (16.11 %) and neem essential oil (19.73 %). Disease severity was also less in neem essential oil (18.05 %), lemon grass oil (18.81 %), eucalyptus oil (19.55 %) treatments and was on par with standard check fungicide carbendazim (20.44 %), compared to other treatments. The grain yield data showed that the neem essential oil recorded highest yield of 8996 kg/ha followed by emulsifier (8837 kg/ha) and standard check fungicide carbendazim (8400 kg/ha).

During *Kharif* 2019, the essential oils *viz*., neem essential oil (19.73% & 15.56%), lemon grass oil (20.62% & 16.32%), eucalyptus oil (24.73% & 22.30%) and systemic fungicide carbendazim (22.87% & 18.72%) were found equally effective in controlling the sheath blight incidence and severity, respectively. The recorded yield was comparatively low and neem essential oil treated plot showed higher yield of 3400 kg/ha compared to other treatments.

During *Kharif 2020*, the data showed that the neem essential oil was found superior in decreasing the sheath blight disease incidence (18.43 %) and severity (15.34%) followed by lemon grass oil (24.88% and 18.24%), carbendazim (25.70% and 17.36%) and Citronella oil (25.99% and 18.53%). The maximum yield of 8367 kg/ha was obtained with lemon grass oil followed by neem essential oil (7200 kg/ha) and standard check fungicide carbendazim (6333 kg/ha). The control plot recorded the lowest yield of 5133 kg/

ha. The pooled data of three seasons **(Table 1)** revealed that, neem essential oil (T_7) treatment resulted in maximum reduction in disease incidence (10.99%) followed by carbendazim (13.65%), eucalyptus oil (15.12%), lemon grass oil (15.49%) and emulsifier (21.11%).

Sheath blight severity was also the least in neem essential oil treatment (7.99) compared to lemon grass oil (9.43), standard check fungicide carbendazim (10.51), citronella oil (11.28) and emulsifier (12.08) **(Table 2).**

Yield data **(Table 3 and Fig.1)** revealed that the highest yield (6532 kg/ha) was recorded in the treatment T_7 (neem essential oil) followed by standard check fungicide carbendazim (5878 kg/ha), lemon grass oil (5762 kg/ha) and emulsifier (5757 kg/ha).

Even though the lemon grass oil showed highest yield during *Kharif 2020*, the pooled data of three seasons revealed that the neem essential oil was significantly superior to all other treatments including standard check fungicide. Bowers and Lock (2004), reported that the cinnamon oil and clove oil effectively reduced the incidence of both pre-emergence rotting and post emergence wilting of peanut seedlings in *A. niger* infested soil.

In the current study, neem essential oil showed maximum reduction in sheath blight incidence and severity when compared to lemon grass oil, emulsifier and citronella oil.

Souza Junior *et al.,* (2009) found that essential oils from "alecrim-pimenta" (*Lippia sidoides Cham*.), wild basil (*Ocimum gratissimum L*.), lemon grass (*Cymbopogon citratus Stapf*) and "cidrao" (*Lippia citriodora Kunth*) inhibited the germination and mycelial growth of *Colletotrichum gloeosporioides* conidia. Rozwalka *et al.,* (2008) proved that the partial or total inhibition of *Glomerella cingulata* and *C. gloeosporoioides* mycelial growth *in vitro* showed that most of the studied essential oils and medicinal plants present biologically active compounds with antifungal effect.

In the present study, the pooled data analysis of three seasons showed that neem essential oil, lemon grass oil and emulsifier were highly effective and on par with

Table 1. Influence of different essential oils on sheath blight disease incidence (%) during *Rabi 2018-19*, *Kharif2019* and *Kharif 2020* (pooled data of three seasons)

S. No	Fungicides	Dose/L	Sheath blight Incidence (%)			
			Rabi 2018-19	***Kharif2019***	***Kharif 2020***	**Mean**
1	Citronella oil	2.0 ml/l	15.92 (23.50)	37.03 (37.46)	19.25 (25.99)	24.06(29.33)
2	Eucalyptus oil	2.0 ml/l	6.29 (14.42)	17.59 (24.73)	21.48 (27.56)	15.12(22.87)
3	Cedar wood oil	2.0 ml/l	7.22 (15.56)	32.03 (34.45)	33.70(35.49)	24.32 (29.53)
4	Nirgundi oil	2.0 ml/l	7.96 (16.32)	40.55(39.52)	31.85(34.33)	26.79(31.11)
5	Lemon grass oil	2.0 ml/l	16.29(23.73)	12.40(20.62)	17.77(24.88)	15.49(23.11)
6	Clove oil	2.0 ml/l	12.77(20.88)	33.70(35.49)	30.37(33.40)	25.75(30.46)
7	Neem essential oil	2.0 ml/l	11.48(19.73)	11.48(19.73)	10.00(18.43)	10.99(19.28)
8	Emulsifier	2.0 ml/l	13.88(21.81)	29.07(32.58)	20.37(26.78)	21.11(27.35)
9	Carbendazim	0.6 g/l	7.78(16.11)	15.18(22.87)	18.88(25.70)	13.65(21.64)
10	Control	--	52.96(46.66)	72.96(58.63)	67.40(55.18)	64.44(53.37)
	LSD @5% (*P*= 0.05)		**0.216**	**6.177**	**8.673**	
	CV (%)		**9.883**	**10.470**	**15.361**	

*Figures given in parentheses are arcsine transformed values

Table 2. Influence of different essential oils on sheath blight disease severity (%) during *Rabi 2018-19*, *Kharif2019* and *Kharif 2020* (pooled data of three seasons)

S. No	Fungicides	Dose/L	Sheath blight severity (%)			
			Rabi 2018-19	*Kharif 2019*	*Kharif 2020*	Mean
1	Citronella oil	2.0 ml/l	12.53(20.70)	10.40(18.81)	10.91(18.53)	11.28(19.55)
2	Eucalyptus oil	2.0 ml/l	11.23(19.55)	13.21(21.30)	12.13(20.36)	12.19(20.36)
3	Cedar wood oil	2.0 ml/l	13.33(21.39)	12.10 (20.36)	13.19 (21.22)	12.87(20.96)
4	Nirgundi oil	2.0 ml/l	13.58(21.56)	12.03(20.27)	13.27(21.30)	12.96(21.05)
5	Lemon grass oil	2.0 ml/l	10.46(18.81)	7.96(16.32)	9.89(18.24)	9.43(17.85)
6	Clove oil	2.0 ml/l	12.46(20.62)	11.63 (19.91)	12.67 (20.79)	12.25(20.44)
7	Neem essential oil	2.0 ml/l	9.60(18.05)	7.28 (15.56)	7.09(15.34)	7.99(16.32)
8	Emulsifier	2.0 ml/l	13.40(21.47)	10.79 (19.09)	12.05(20.27)	12.08(20.27)
9	Carbendazim	0.6 g/l	12.21(20.44)	10.37(18.72)	8.95(17.36)	10.51(18.91)
10	Control	--	19.58(26.21)	21.23(27.42)	15.62(23.26)	18.81(25.70)
	LSD @5% (*P*= 0.05)		**1.808**	**NS**	**1.559**	
	CV (%)		**3.884**	**11.989**	**3.451**	

*Figures given in parentheses are arcsine transformed values

Table 3. Influence of different essential oils on grain yield (kg/ha) during *Rabi 2018-19*, *Kharif2019* and *Kharif 2020* (pooled data of three seasons)

S. No	Fungicides	Dose/ l	Grain yield (kg/ha)			
			Rabi 2018-19	*Kharif2019*	*Kharif 2020*	Mean
1	Citronella oil	2.0 ml/l	6908	3367	5800	5358
2	Eucalyptus oil	2.0 ml/l	7461	2833	5133	5142
3	Cedar wood oil	2.0 ml/l	6779	3067	5200	5015
4	Nirgundi oil	2.0 ml/l	7531	3233	5667	5477
5	Lemon grass oil	2.0 ml/l	5552	3367	8367	5762
6	Clove oil	2.0 ml/l	7404	2700	6033	5379
7	Neem essential oil	2.0 ml/l	8996	3400	7200	6532
8	Emulsifier	2.0 ml/l	8837	2867	5567	5757
9	Carbendazim	0.6 g/l	8400	2900	6333	5878
10	Control	--	3065	2200	5133	3466
	LSD @5% (*P*= 0.05)		**1713.811**	**610.447**	**942.029**	
	CV (%)		**14.204**	**11.888**	**9.318**	

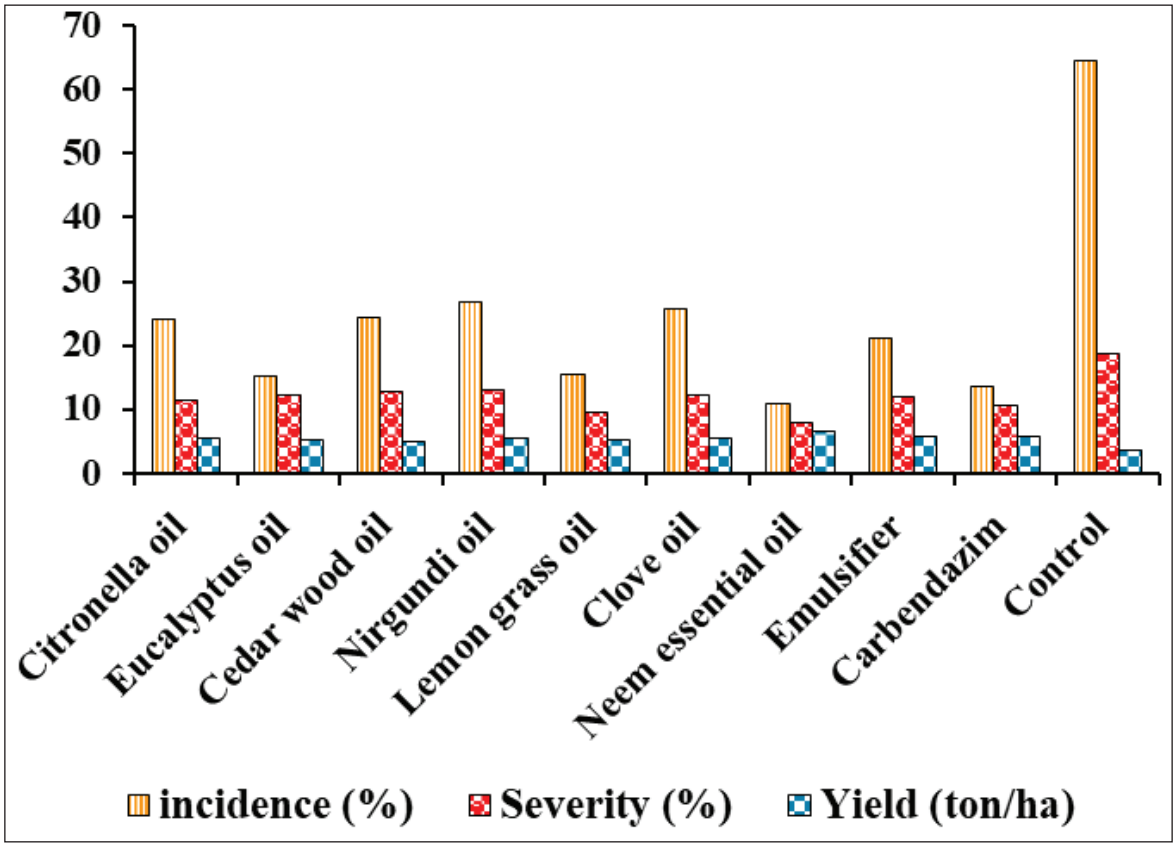

Figure 1. Effectiveness of different essential oils on sheath blight disease incidence, severity (%) and grain yield (ton/ha)

standard check fungicide carbendazim. The essential oils were very effective and could significantly reduce the sheath blight disease incidence and severity compared to the chemical fungicide. Essential oils are made up of many different volatile compounds which showed the anti-fungal and anti-microbial effects due to the result of many compounds acting synergistically (Jobling, 2000).

The present results also conform to the earlier findings that the selected essential oils *viz*., neem essential oil, lemon grass oil and emulsifier with different mechanisms of disease control will have an additive phototonic effect and result in higher yield.

Overall, it was evident from the present study that the neem essential oil, lemon grass oil and emulsifier @ 2.0 ml/l can be recommended for the effective control of rice sheath blight disease and thereby reduce the use of toxic chemical fungicides in the Kuttanad ecosystem.

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