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Eco-friendly management of brown spot disease of rice by the application of essential oils in Bihar

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Abstract
Brown spot of rice caused by *Bipolaris oryzae* (*Cochliobolus miyabeanus*), is worldwide occurrence and is known to cause substantial quantitative and qualitative losses in grain yield. The field experiment was performed during the year 2019-20 in kharif season at Bihar Agricultural University research farm, Sabour. The present investigation was done to assess the effect of essential oil against Brown spot disease of rice. All the essential oils are significantly reduced the disease infection. The minimum percent of disease incidence and disease severity were recorded in case citronella oil @ 2 ml/l (11.37% and 15.85%) which was found at par with lemon Grass oil with (13.39% and 18.81). The highest yield was recorded (62.00 q/ha) in case citronella oil @ 2 ml/l which was at par with lemon Grass oil @ 2 ml/l (60.33 q/ha) as comparison to control (39.83 q/ha). The minimum number of infected tiller was recorded in case citronella oil @ 2 ml/l was 33.00. The maximum percent of decrease disease severity and increase yield over control were recorded 55.65% and 66.04% in citronella Oil @ 2 ml/l. This work concluded that the two essential oil *i.e.*, Citronella oil and lemon Grass oil @ 2 ml/l could have potential as control agents against brown spot disease of rice. The fungicides used in disease management are expensive for resource-poor farmers and may negatively correlation with ecosystems. Therefore, natural essential oil is significant sources of new agrochemicals with large antimicrobial spectrum properties for the control of brown spot disease.

Keywords: Rice, essential oil, antifungal activity, B. oryzae, management

Introduction
Rice is one of the third most important food crops in the world, forms the staple diet of 2.7 billion people. It is the most valuable staple food crop for more than 60% of the world people. The population will increase up to 4.6 billion by 2050. The projected demand for rice can only be met by maintaining steady increase in production over the years (Khush, 1996) [10]. The increasing weakness of the production sector is due to many constraints and among them brown spot disease are severely affected the rice yield. Brown spot (BS) caused by *Bipolaris oryzae* (Bredade Haan) Shoemaker (teleomorph *Cochliobolus miyabeanus*, is a serious seed-borne and seed transmitted disease of rice worldwide (Agarwal *et al.* 1989) [1]. The pathogen attacks the crop from seedling to milk stage, symptoms of brown spot appear in the early stages of growth as minute blight of seedlings and later coleoptile, leaf blade, leaf sheath and glume, being most prominent on leaf blades and glumes. On leaves, typical spots are brown in colour with grey or whitish center, cylindrical or oval in shape resembling sesame seeds usually with yellow halo while young spots are small, circular and may appear as dark brown or purplish brown dots. Several spots coalesce and the leaf dries up. The affected nursery can often be recognized from a distance by scorched appearance due to death of the seedlings and drastically reduction in grain weight and yield (Agarwal *et al.* 1989) [1]. Essential oils are obtained from non-woody parts of the plants, particularly foliage, stem. They are complex mixture of terpenoids and variety of aromatic phenols, oxides, ethers, alcohols, esters, aldehydes and ketones that determine the characteristics aroma and odour of the donor plants. Presence of volatile monoterpenes or essential oils in the plants provides an important defense strategy to the plants, particularly against herbivorous insect pest and plant pathogenic fungi (Langenheim, 1994) [11]. The volatile compounds from plants, especially essential oils have been demonstrated to possess potent antifungal, antibacterial, insecticidal and nematocidal activity (Ngueface *et al.*, 2007) [13]. Biologically active essential oils represent a rich source of an alternative and perhaps, environmental more acceptable disease compounds. These are natural fungicidal plant volatiles and have numerous opportunities exist to explore their usefulness in controlling plant disease. The practical use of natural compounds as control agents is receiving increased attention and this is partly due to their non-toxicity and

biodegradability (Mason *et al.*, 1996) [12]. Antifungal compounds present in the essential oil of *P. graveolens* include *citronellol, geraniol, citronellyl* formate and linalool (Ana *et al.*, 2014) [4]. α-citral, z-citral, limonene, caryophyllene, cerenl acetate, geraniol and citral are the main components of *C. citratus* oil (Farhang *et al.*, 2013) [6]. The antifungal action of palmarosa oil is mainly attributed to its geraniol content. In addition to geraniol, geranyl acetate, linalool and β-carboxy phyllene have also been reported to possess antifungal activity (Anjali *et al.*, 2003) [5]. Management of *Bipolaris oryzae* by fungicides can be spectacular but this is relatively short-term measure and more over the accumulation of harmful chemical residues some time cause ecological problems. An attempt was therefore made to test relative efficacy of different essential oil for the eco-friendly management of brown spot disease of rice under field conditions.

Methods and Material

Experimental Details

Field experiment was conducted in N-5/6 block of research farm of Bihar Agricultural University, Sabour. It is situated at 25º23'N latitudes, 87º07'E longitudes and 37.19m above the mean sea level respectively. The experimental site was rainfed upland and having loam soil type. Preparation of field, planking and other operations were performed by tractor drown implements. Sowing was done by manual hand plough with 30 kg/ha seed rate as per technical programme. Crop was fertilized by recommended dose of NPK (100:60:40) and zinc sulphate (20 kg/ha) as per required time. Weeding and insecticides application were 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 15 m^2 (spacing 15cm×20cm) on rice variety Rajendra Mahsuri-1 at Bihar Agricultural University research farm, Sabour during Kharif season of 2019-20.

Treatments Details

This experiment was formulated with nine essential oils (Table1). The two spraying stage was done and the number of sprays was limited to 10 days interval after onset of brown spot disease.

Observations

Disease severity was recorded on the basis of 0 to 9 scale (Aluko, 1970) [2]. Assessments were made on the four uppermost leaves of each plants. 25 leaves were randomly collected in each plot in 1 m^2 area and assessment was done as per infection percent area of each leaves on the basis of rating scale. The percent disease intensity (PDI) was computed using the following formula (Pandey *et al.*, 1989) [15]:

[Sum of all numerical ratings = PDI = × 100 /Total number of observations x Maximum rating].

For calculating the disease incidence, 1 m^2 area was randomly selected in each plot and per cent disease incidence were calculated from this formula given by Singh and Dube (1978) [16]

[Percentage of disease incidence = No. of infected tillers/m^2 × 100/Total No. of tillers/m^2]

Yield Attributing Characters and Data Analysis

The total number of tillers and the total number of infected tillers in one square meter area. Plant height (cm), panicle length (cm), No. of tillers/ m2, data was recorded from randomly selected five plants of each replication and grain yield (q/ha) were recorded after sun drying of grain. All data were statistically analyzed using an analysis of variance (ANOVA) to determine the least significant difference (P<0.05).

Result & Discussion

The significant difference in disease parameters was found among the treatments against brown spot disease. Among the different treatments, citronella oil @ 2 ml/l was found highly effective in the management of disease and showed minimum percent of disease incidence and disease severity (11.37% and 15.85%), which was found at par with the lemon grass oil @ 2ml/l (13.39% and 18.81%), followed by carbendazim 1g/l (14.53% and 23.25%) respectively. The maximum percent of disease incidence and disease severity *i.e.* 31.39% and 46.60% were recorded in case of control (Untreated) (Table 2 & Fig 1).

Among the different treatments, maximum per cent decrease the disease severity and increase yield over the control was recorded with (66.04% and 55.65%) in case citronella oil @ 2 ml/l which was at par with the lemon grass oil @ 2 ml/l (59.69% and 51.46%) followed by carbendazim @ 1g/l with (50.16% and 42.68%), eucalyptus oil @ 2 ml/l (53.66% and 44.77%), cedar wood oil @ 2 ml/l (38.37% and 37.24%), nitrunda oil @ 2 ml/l (30.48% and 31.80%), clove oil @ 2 ml/l (22.22% and 20.08%), neem essential oil @ 2 ml/l (19.05% and 11.72%) and emulsifier @ 2 ml/l (11.74% and 7.11%) respectively in (Table 2).

The data revealed that the maximum yield was recorded with (62.00 q/ha) in case citronella oil @ 2 ml/l which was found at par with the lemon grass oil @ 2 ml/l (60.33 q/ha) followed by, Eucalyptus oil@ 2 mg/l (57.67 q/ha), carbendazim@ 1g/l (56.83 q/ha), cedar wood oil @ 1g/l (54.67 q/ha), nitrunda oil @ 1g/l (52.50q/ha), clove oil @ 1g/l (47.83 q/ha), neem essential oil @ 1g/l (44.50q/ha) and emulsifier @ 1g/l (42.67 q/ha) respectively. However, lowest yield was observed with (39.83 q/ha) in case Control (Table 2 & Fig 1).

The treatment citronella oil @ 2 ml/l recorded the least number of infected tiller/m^2 (33.00) and was found at par with the treatment lemon grass oil (39.00) followed by carbendazim 1g/l (43.33), eucalyptus oil, cedar wood oil, nitrunda oil, clove oil, neem essential oil and emulsifier @ 2 ml/l each respectively. However, highest number of infected tiller/m^2 was observed in (Untreated) control (3.41%) (Table 2). The data revealed that the number of tiller/m^2, plant height (cm) and panicle length (cm) was non-significant recorded among the treatments (Table 3).

In the present study, the use of different essential oils against *Bipolaris oryzae* in rice proved to be most effective under field conditions. The reduced disease severity of brown spot and induced resistance by seed treatment or foliar spraying with plant extracts in the field condition were reported (Amadioha 2000; Harish *et al.* 2008) [3, 7] The present study supported that the essential oils of *Cymbopogon citratus, Ocimum gratissimum* and *Thymus vulgaris* could be used as seed treatments to control seed-borne fungi in rice. Under field conditions, the combined use of the essential oil of *C. citrinus* as a seed treatment and spraying the plants with 2% ethanol followed by 2% (w/v) aqueous extracts of *C. citrinus* or *C. citratus* increased the emergence of seedling, tillering percentage, panicles/plant and the grain yield by 25-55% and the brown spot severity was reduced by 60-80% (Nguefack *et al.*, 2013) [14]. Harish *et al*. (2008) [7] also found that spraying rice plants twice with neem cake extract and *Nerium oleander* leaf extract in the field reduced the severity of brown spot by

70% and 53% and increased the yield by 23% and 18%, respectively. Khoa *et al.* (2011) [9] demonstrated that foliar spraying and seed soaking with an aqueous extract of *Chromolaena odorata* resulted increase grain yield up to a 57%. Seed treatments using the essential oil of C. *citrinus* significantly reduced the incidence of *B. oryzae* in seeds compared to the non-treated controls. This antifungal effect could be related to the high content (73.8%) of 1, 8-cineole, which is known to be one of the active compounds in the *C. citrinus* essential oil (Jazet *et al.* 2009) [8]. However, the treatment of the seeds alone could not protect the emerged plants from infection that occurred later during the growth period. The foliar application of a methanol leaf extract of *Datura metel* induced systemic resistance in the treated rice plants and significantly reduced the severity of brown spot, sheath blight and bacterial blight of rice under greenhouse conditions. Kumar *et al.* (2016) [17] also found that, out of six essential oils tested, three oils showed fungicidal properties against *F. moniliforme* with MIC range of 0.1%. Three essential oils *viz., C. citratus, C. martinii* and *P. graveolens* was found to be more effective and inhibited growth of pathogen with least concentration of 0.1%, while *C. nardus, E. globules* and *O. sanctum* oils were effective at 0.1% MIC.

Conclusion

The present investigation showed that essential oils have antifungal activity and reduced the severity of brown spot disease of rice. These essential oils are natural fungicides and highly effective against Brown spot disease of rice. The essential oils citronella oil and lemon grass oil @ 2 ml/l could be used as eco-friendly management of the brown spot disease and increase the yield by sustaining the environment.

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Table 1: Details of essential oils used in present study.

Treatments	Essential Oils	Dosage
T_1	Citronella oil	2 ml/l
T_2	Eucalyptus oil	2 ml/l
T_3	Cedar wood oil	2 ml/l
T_4	Nitrunda oil	2 ml/l
T_5	Lemon grass oil	2 ml/l
T_6	Clove oil	2 ml/l
T_7	Neem essential oil	2 ml/l
T_8	Emulsifier	2 ml/l
T_9	Carbendazim	1 g/l
T_{10}	Control	-

Table 2. Effect of essential oils on disease incidence, disease severity and yield against brown spot disease of rice.

S. No.	Essential Oil	Dosage	Disease Incidence (%)	Disease Severity (%)	Decrease disease severity over the control (%)	Yield (q/ha)	Increase yield over the control (%)
T_1	Citronella oil	2 ml/l	11.37* (19.67)**	15.85* (23.43)**	66.04	62.00	55.65
T_2	Eucalyptus oil	2 ml/l	14.77 (22.56)	23.80 (29.04)	53.66	57.67	44.77
T_3	Cedar wood oil	2 ml/l	18.72 (25.62)	28.59 (32.29)	38.73	54.67	37.24
T_4	Nitrunda oil	2 ml/l	20.74 (27.08)	32.44 (34.70)	30.48	52.50	31.80
T_5	Lemon grass oil	2 ml/l	13.39 (21.45)	18.81 (25.67)	59.69	60.33	51.46
T_6	Clove oil	2 ml/l	24.51 (29.65)	36.29 (37.02)	22.22	47.83	20.08
T_7	Neem essential oil	2 ml/l	25.51 (30.32)	37.77 (37.90)	19.05	44.50	11.72
T_8	Emulsifier	2 ml/l	27.43 (31.56)	41.18 (39.90)	11.74	42.67	7.11
T_9	Carbendazim	1g/l	14.53 (22.39)	23.25 (28.80)	50.16	56.83	42.68
T_{10}	Control		31.39 (34.05)	46.66 (43.06)	0.00	39.83	0.00
	CD (0.05%)		1.10	1.33	-	25.64	-
	CV		2.42	2.33	-	2.85	-
	S.Em(±)		0.37	0.44	-	8.56	-

*Mean values of three replication **Angular transform values

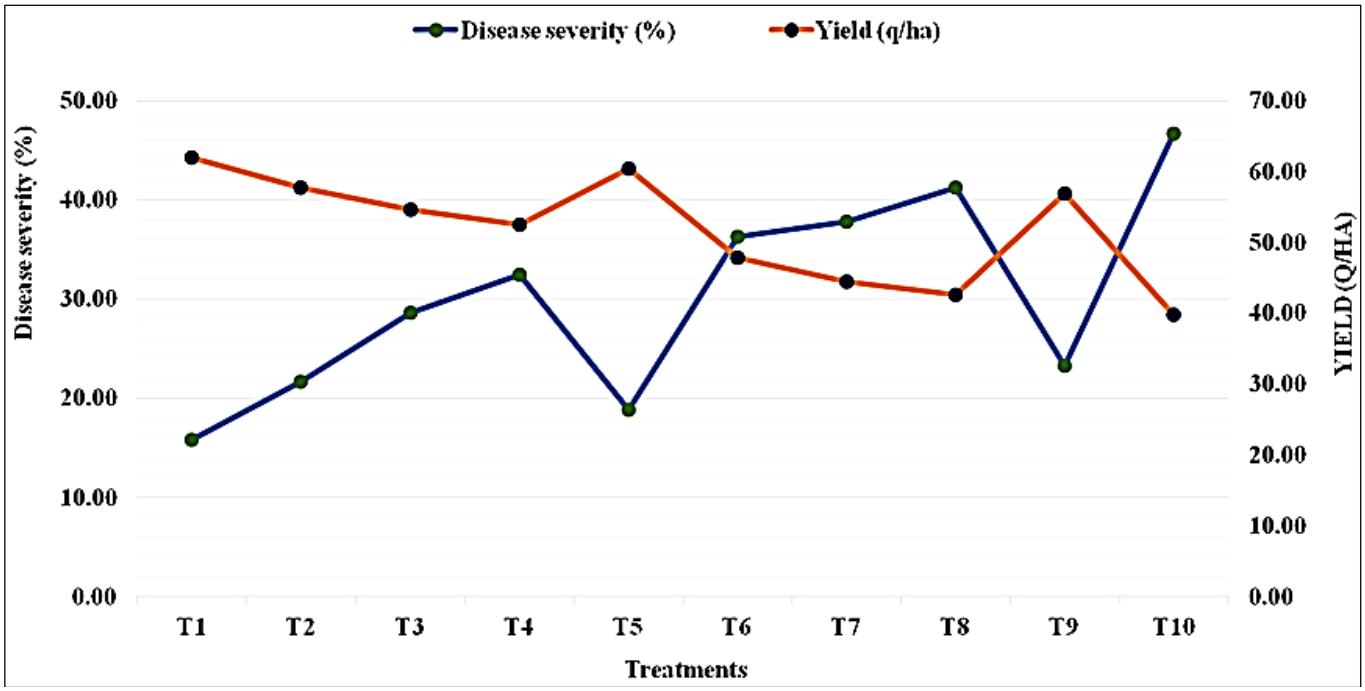

Fig 1: Effect of essential oils on percentage of disease severity and grain yield (q/ha) against brown spot disease of rice.

Table 3: Effect of essential oils on yield attributing character against Brown spot disease of rice

S. No.	Essential oils	Dosage	Total No. of tiller/m^2*	No. of infected tiller/m^2	Plant height(cm)	Panicle length(cm)
T_1	Citronella oil	2 ml/l	291.00	33.00	128.00	28.33
T_2	Eucalyptus oil	2 ml/l	297.33	44.00	129.00	28.00
T_3	Cedar wood oil	2 ml/l	301.00	56.33	129.00	27.83
T_4	Nitrunda oil	2 ml/l	287.67	59.67	129.00	28.17
T_5	Lemon grass oil	2 ml/l	291.33	39.00	128.33	27.67
T_6	Clove oil	2 ml/l	292.67	71.67	128.33	28.50
T_7	Neem essential oil	2 ml/l	292.67	74.67	127.00	28.33
T_8	Emulsifier	2 ml/l	286.00	78.33	128.67	28.50
T_9	Carbendazim	1g/l	298.33	43.33	128.33	28.50
T_{10}	Control		292.00	91.67	129.00	27.50
	CD (0.05%)		NA	4.60	NA	NA
	CV		2.91	4.50	0.76	2.40
	S.Em(±)		4.93	1.53	0.56	0.39

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