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An Innovative Approach for Management of Rice Blast with Organics

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Abstract

Commercially available botanicals *viz.*, Mustard oil cake (MOC) and compost *viz.,* FYM and Vermicompost (VC) extracts were used in the present investigation in order to study the efficacy in reducing the growth of rice blast pathogen *in vitro.* Similarly, inhibitory effect of local antagonists *viz., Trichoderma harzianum, Gliocladium virenns* and *Trichoderma koningii* were evaluated against rice blast pathogen *in vitro*. Efficacy of botanical extracts, compost extract and combination with bioagent extract were evaluated both in nursery and field condition. It was observed that all the extracts at 0.05, 0.1 and 0.2% concentration significantly inhibit the radial growth of *Pyricularia oryzae in vitro*. However, MOC extract at 0.2% concentration showed significantly higher inhibitory effect on *P. oryzae*. In another test, *T. harzianum* showed maximum inhibition *in vitro*. In nursery all extracts either amended or unamended with *T. harzianum* when mixed with cow urine @ 20% reduced blast incidence, but efficacy was higher with extract amended with *T. harzianum*. In field condition, all extracts either amended or unamended with *T. harzianum* and sprayed at 45 DAP and 60 DAP @ 10% and 20% reduced the blast incidence significantly . However, efficacy was higher with 20% of extract amended with *T. harzianum* as compared to extract unamended with *T. harzianum*.

Key words: Botanicals, bioagent, rice, blast, vermicompost, mustard oil cake, cow urine

Introduction

Rice blast disease caused by *Pyricularia oryzae* is distributed in about 85 countries in all continents, where the rice plant is cultivated, in both lowland and upland conditions. Although the damage is very much influenced by environmental factors, this disease is recognized as one of the most serious diseases of the rice plant worldwide because of its extensive distribution and destructiveness under favourable conditions. Rice blast causes economically significant crop losses of 10-30% annually. Each year it is estimated to destroy enough rice to feed more than 60 million people (Scardaci *et al.,* 2003)

One of the major challenges facing organic producer is disease management. Biocontrol agents are not readily available and method of application is not properly known. Use of compost extract is a simple, less expensive and potentially effective method to manage various diseases. Keeping this in view, a study was undertaken with an aim to determine the effectiveness of compost extract or botanical and bioagent in reducing blast disease pathogen both in nursery and field condition.

Materials and Methods

In vitro studies

Commercially available botanicals *viz.*, Mustard oil cake (MOC) and compost *viz*., FYM and Vermicompost (VC) extracts were used to study the efficacy in reducing rice blast pathogen *in vitro*. All the extracts were prepared at different concentrations *viz*, 0.05, 0.1, 0.2 per cent and were evaluated against *P. oryzae in vitro* by employing poisoned food technique. Copper oxychloride (COC) at 50 ppm, 100 ppm and 500 ppm were used as standard and only sterile water was used as absolute control. Similarly effect of different antagonists *viz., Trichoderma harzianum* (ITCC NO. 7077)*, Gliocladium virens* (ITCC NO 4302) and *T. koningii* (ITCC NO 4177) were tested by dual culture technique against *P. oryzae* (Dennis and Webster, 1971). The experiments were replicated five times and incubated at 28±1°C. The radial growth of the fungus at different concentration of the extracts and per cent inhibition over control were measured, recorded and tabulated after 24-72 h of inoculation.

Field Studies

Efficacy of botanical extracts, compost extract were used individually as well as amended with bioagent extract for evaluating both in nursery and field condition. Different extract : cow urine solutions were prepared containing 20% extract and 20% fresh cow urine. Then the rice seeds (cv. Mahsuri) were mixed with the prepared solution for 24 h at room temperature. Then supernatant was discarded and only seeds were incubated for 48h for germination before sowing. Thirty days old seedlings were transplanted in the main field. Seed treatment with COC (0.2%) and spraying the field with carbendazim (0.1%) were used as standard in nursery and main field, respectively. Only water was used in the both the cases as absolute control. Per cent disease control and per cent reduction were measured, recorded and tabulated.

Results and Discussion

***In vitro* studies**

All the extracts at all the concentrations significantly inhibited the radial growth of *P. oryzae in vitro as* compared to absolute control (Table 1 & Fig. 1). Among the extracts, MOC extract at 0.2 per cent showed significantly higher inhibitory effect (66.22%) on *P. oryzae* at 24 h of incubation. However, COC showed maximum inhibitory effect (100%) compared to all the extracts. Inhibitory effect of MOC, FYM and VC might be due to release of antifungal substances, phenolic substances and S containing of substances. Davey and Papavizas (1960) and Padmadaya (2003) reported that FYM contain humic and fusaric acid while, Sharma and Gupta (2003) reported that MOC could reduce the growth of the pathogens such as *Rhizoctonia*, *Alternaria* spp due to the presence of allicin allyl propyl disulphide and allyl disulphide.

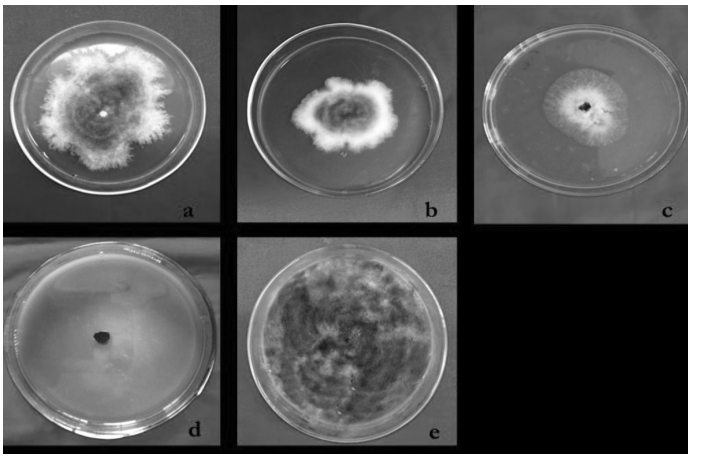

Figure 1. Radial growth of P. oryzae with different extracts
a. FYM b. VC c. MOC d. Fungicide e. Control

Table 1. Radial growth of *P. oryzae* (mm) against botanical and compost extracts at different concentrations *in vitro*

Treatments	Concentrations (%)	Radial growth of *P. oryzae* (mm)			% inhibition over control		
		Hours of incubation					
		24h	48h	72h	24h	48h	72h
FYM	0.05	37.14	58.54	77.80	14.62	14.54	13.55
FYM	0.1	34.40	55.70	74.30	20.9	18.68	17.41
FYM	0.2	31.60	50.50	70.20	27.35	26.27	22.00
MOC	0.05	23.21	40.50	58.10	46.64	40.87	35.44
MOC	0.1	20.70	38.50	54.60	52.41	43.11	39.27
MOC	0.2	17.30	26.10	48.30	66.22	61.31	46.33
VC	0.05	28.12	45.63	64.50	34.48	33.38	28.33
VC	0.1	24.56	40.20	60.80	43.54	41.31	32.44
VC	0.2	21.30	34.60	56.50	51.03	49.63	37.22
COC	50 ppm	0.25	0.25	0.25	100.00	100.00	100.00
COC	100ppm	0.25	0.25	0.25	100.00	100.00	100.00
COC	500ppm	0.25	0.25	0.25	100.00	100.00	100.00
Control		43.50	68.50	90.00			
SEd(±) $CD_{0.05}$		1.30 2.44	0.91 1.93	1.36 3.04	-	-	-

All the antagonists were also found to significantly reduce the radial growth of *P. oryzae* (Table 2 & Fig. 2). However *T. harzanium* showed maximum inhibitory effect (47.23%) followed by *T. koningii* (38.54%) and *G. virenns* (16.58%) after 24 h incubation. The inhibitory effect of antagonists on radial growth of *P. oryzae* might be due to the production of toxic and volatile substances for antibiosis, or it may be through mycoparasitism. The potential of *T. harzianum* to produce volatile (eg. Pyrones) and non-volatile secondary metabolite (eg terpenes) has been reported by Reino *et al.* (2008).

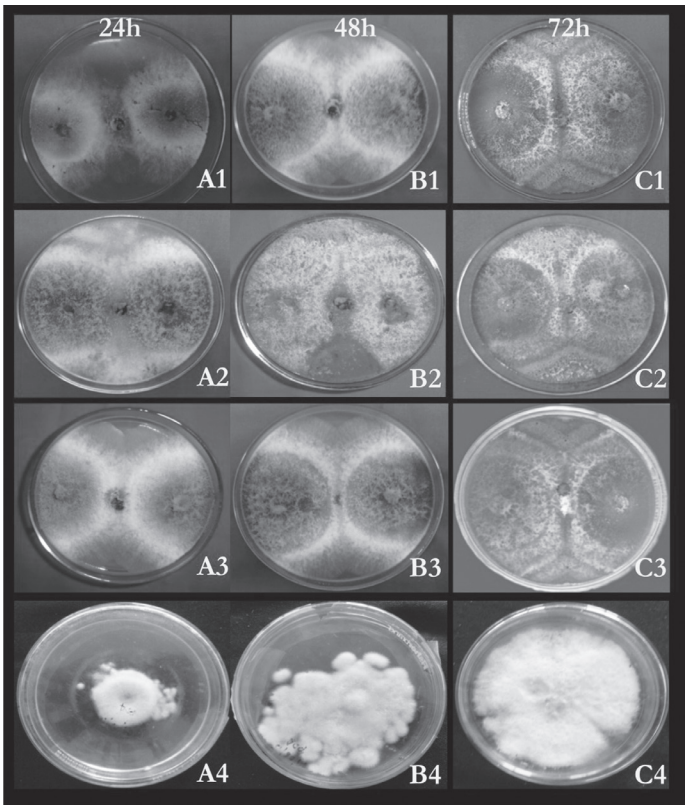

Figure 2. Inhibitory effect of different antagonists on P. oryzae
P. oryzae + T. koningii(A1, B1, C1)
P. oryzae + G. virens(A2, B2, C2)
P. oryzae + T. harzianum(A3, B3, C3)
P. oryzae alone (A4, B4, C4)

Table 2. Inhibitory effect of different antagonists against *P. oryzae in vitro*

Treatment	Radial growth (mm)			% inhibition over control		
	Hours of incubation (h)					
	24h	48h	72h	24h	48h	72h
T_1=*P. oryzae* +*Trichoderma koningii*	12.23	7.36	3.48	38.54	85.79	96.13
T_2=*P. oryzae* + *Gliocladium virens*	16.60	9.96	5.5	16.58	80.52	93.88
T_3=*P. oryzae* +*Trichoderma harzianum*	10.50	5.5	2.2	47.23	89.38	97.55
T_4=*P. oryzae* alone	19.9	51.80	90	--	--	--
SED (±)	0.42	0.61	0.53			
$CD_{(0.05)}$	1.10	1.39	1.48			

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Field Studies

In nursery all extracts either amended or unamended with *T. harzianum* when mixed with cow urine @ 20% reduced blast incidence, but efficacy was higher with extract amended with *T. harzianum* (Table 3). MOC amended with *T. harzianum* along with cow urine showed highest reduction in disease incidence (42.50%) followed by VC amended with *T. harzianum* along with cow urine (26.53%). However, seed treatment with COC (0.2%) showed maximum reduction in disease (77.70%) as compared to all other treatments.

Table 3. Per cent disease incidence of blast in nursery treated with plant and compost extracts and bio-control agents amended extract

Treatment	Per cent disease incidence (%)			Percent disease reduction over control
	15 DOS	30 DOS	Mean	
$T_{1=}$ Seed treatment with extract of VC (20%) + cow urine (20%)	6.62 (14.89)	8.36 (16.74)	7.49 (15.89)	13.00
$T_{2=}$ Seed treatment with extract of MOC (20%) + cow urine (20%)	6.12 (14.18)	7.54 (15.87)	6.83 (15.12)	20.67
$T_{3=}$ Seed treatment with extract *T. harzianum* amended VC (20%) + cow urine (20%)	5.30 (13.31)	6.80 (15.12)	6.05 (14.18)	26.53
$T_{4=}$ Seed treatment with extract *T. harzianum* amended MOC (20%) + cow urine (20%)	4.25 (11.83)	5.65 (13.69)	4.95 (12.797)	42.50
$T_{5=}$ Seed treatment with COC (0.2%)	1.25 (6.29)	2.59 (9.28)	1.92 (9.30)	77.70
$T_{6=}$ Water treatment (control)	7.89 (16.31)	9.33 (17.76)	8.61 (17.05)	
SED (±)	0.52	0.61		
$CD_{(0.05)}$	1.09	1.38		

In field condition after transplanting of treated seedlings in nursery, all extracts either amended or unamended with *T. harzianum* sprayed at 45 DAP and 60 DAP @ 10% and 20% reduced the disease incidence significantly (Table 4). However, efficacy was found to be higher at 20% of extract amended with *T. harzianum* as compared to extract unamended with *T. harzianum*. Application of MOC extract amended with *T. harzianum* @ 20% on showed significantly higher reduction (26.02%) followed by MOC extract (22.23%) and VC extract (20.65%) amended with *T. harzianum* @ 10%.

Table 4. Percent disease incidence and disease severity of blast after application of compost and botanical extract either unamended or amended with *T. harzanium* after transplanting

Treatments	Conc.	Percent disease incidence of blast					Percent disease severity of blast				
		DOS					DOS				
		45	60	75	Mean	Inh/C	45	60	75	Mean	Inh/C
T_1=Extract of vermicompost	10	10.59 (19.00)	15.58 (23.42)	30.60 (33.58)	19.01 (25.84)	6.68	4.40 (12.11)	10.00 (18.43)	13.10 (21.22)	9.16 (17.46)	3.47
T_2=Extract of vermicompost	20	10.42 (18.81)	14.55 (22.38)	30.12 (33.27)	18.43 (25.49)	7.94	4.29 (11.97)	8.84 (17.26)	11.82 (20.45)	8.3 (16.74)	12.53
T_3=Extract of Mustard oil cake	10	9.33 (17.61)	14.82 (22.63)	28.67 (32.39)	17.41 (24.65)	10.97	4.38 (12.11)	8.80 (17.26)	11.11 (19.55)	8.09 (16.43)	14.75

Treatments	Conc.	Percent disease incidence of blast					Percent disease severity of blast				
		DOS					DOS				
		45	60	75	Mean	Inh/C	45	60	75	Mean	Inh/C
T_4=Extract of Mustard oil cake	20	8.37 (16.74)	13.60 (21.64)	27.61 (31.63)	16.36 (23.81)	14.44	4.12 (12.11)	8.82 (17.26)	10.62 (19.00)	7.85 (16.22)	17.28
T_5=*T. h* amended Extract of V.C	10	8.12 (16.54)	12.62 (20.79)	27.11 (31.37)	16.02 (23.58)	14.84	4.14 (11.68)	8.23 (16.64)	10.22 (18.63)	7.53 (15.89)	20.65
T_6=*T. h* amended Extract of V.C	20	7.61 (16.00)	12.45 (20.62)	26.22 (30.79)	15.91 (23.50)	15.13	4.11 (11.68)	8.68 (17.15)	10.34 (18.72)	7.71 (16.11)	18.75
T_7=*T. h* amended Extract of MOC	10	6.62 (14.89)	10.90 (19.23)	25.37 (30.20)	14.49 (22.38)	19.17	4.20 (11.83)	8.10 (16.54)	9.84 (18.24)	7.38 (15.79)	22.23
T_8=*T. h* amended Extract of MOC	20	5.44 (13.44)	9.72 (18.18)	24.12 (29.40)	13.24 (21.30)	23.07	3.63 (10.94)	7.91 (16.32)	9.52 (17.95)	7.02 (15.34)	26.02
T_9= Carbendazim	0.1	3.42 (10.63)	6.92 (15.23)	8.33 (16.74)	5.56 (13.56)	51.02	3.10 (10.14)	6.86 (15.12)	7.20 (15.56)	5.72 (13.81)	39.72
T_{10}=Control (water spray)	—	11.66 (19.91)	18.70 (25.62)	33.64 (35.43)	21.66 (27.69)		4.94 (12.39)	10.29 (18.63)	13.26 (21.30)	9.49 (17.95)	
SED (±) $CD_{(0.05)}$		0.58 (1.14)	0.52 (1.01)	0.94 (1.62)			0.49 NS	0.53 (1.01)	1.03 (1.48)		

The values in parenthesis are transformed angular value
Inh/C : Per cent inhibition over control

In both nursery and field conditions, reduction of disease incidence of blast was possibly due to the anti fungal substances releases by compost extract. These antifungal substances might have caused alternation of cellular level of pathogen and finally led to inhibition of mycelial growth by premature ageing. High level of ammonia is released from compost, manures and cow urine which might have caused immediate reduction in plant pathogen activity by antibiosis. Rich *et al*. (1989) reported that release of certain compounds like phenols, ricitin from compost were found to be toxic to the plant pathogen. Similarly, compost extract was found to be effective in inhibiting the growth of pathogen as a result of induced defense mechanism of rice plant (Samerski and Weltzien, 1988; Hoitink e*t al*. 1997).

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