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RESEARCH ARTICLE

Screening of new molecules of fungicides against *Sclerotium rolfsii*, *Rhizoctonia bataicola* and *Fusarium* sp. causing root rot/wilt complex of soybean

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ABSTRACT

The root trot/ wilt complex of soybean has become a major production constraint in Karnataka. The associated pathogens causing the root rot/ wilt are identified as *Sclerotium rolfsii*, *Rhizoctonia bataicola* and *Fusarium* sp. in northern Karnataka, either in combination of two or more than two pathogens. *In vitro* screening of fungicides, bioagents and botanicals was taken up to identify an effective molecule against all the three pathogens. *In vitro* studies revealed that Mancozeb, Carbendazim, Thiophanate methyl, Hexaconazole, Propiconazole, Carbendazim + Mancozeb and Carboxin + Mancozeb were more effective in inhibiting the mycelial growth of all the three pathogens.

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INTRODUCTION

Soybean [*Glycine max* (L.) Merill] is a protein rich oilseed crop. It is considered as a golden bean, miracle bean and wonder crop of the 20th century because of its characters and usage. In India, losses due to various diseases are estimated as 12 per cent of total production. The root trot/ wilt complex has become a major production constraint in Karnataka. Soybean is being attacked by more than 100 pathogens (Sinclair and Shurtleff, 1975). Plant pathogens exhibit variations in their morphological, biological and pathogenic characters. Although wilt complex disease has assumed economic importance in India and Karnataka, so far there is very limited information on identification of new molecules against more than pathogenic agent. Looking into the magnitude of severity of this complex disease in Northern Karnataka, studies were conducted on the effectiveness of new molecules against associated pathogens.

MATERIALS AND METHODS

In order to know the effective chemical and bioagent against wilt/root complex involving three pathogens (Sangeetha,2011), a large scale screening of these molecules was taken up in laboratory at Department of Plant Pathology ,University of Agricultural Sciences,Dharwad.

In vitro evaluation of chemicals against *S. rolfsii, Rhizoctonia* sp. and *Fusarium* sp.

The efficacy of non-systemic fungicides (at the concentration of 0.15, 0.2, 0.25 and 0.3%), four systemic fungicides (at the concentration of 0.05, 0.1 and 0.15 %) and four combiproducts (at the concentration of 0.05, 0.1 and 0.15%) were assayed *in vitro* against *S. rolfsii, Rhizoctonia* sp. and *Fusarium* sp. The fungicides used are given hereunder:

Required quantity of individual fungicide was added separately into sterilized molten and cooled Potato dextrose agar so as to get the desired concentration of the fungicides. Later, 20 ml of the poisoned medium was poured into sterilized

Contact fungicides		
Common name	Chemical name	Trade name
Captan	N-trichloromethyl mercapta 4-cyclohexene-1,2-dis carboximide N-trichloromethyl thiotetra hydro othalamide	Captaf 50 WP
Mancozeb	Manganese zinc ethylene bis dithiocarbomate + zinc	Indofil M 45
Zineb	Zinc ethylene bis dithiocarbomate	Dithane Z-78
Systemic fungicides		
Hexaconazole	(RS)-2-(2,4-dichloro phenyl)-1-(14-1, 2, 4-triazole-1 yl) hexane-2-1	Contaf 5%EC
Propiconazole	1-(2,4 di chlorophenyl) -4-ropyl-1, 3-dioxolan-2-methyl) –H-1,4-triozole	Tilt 25EC
Thiophanate methyl	Dimethyl 4,4(o-phenlene) bis (3-thioalphanate)	Roko 50 WP
Carbendazim	2-(methoxy-carbomyl)-benzimidazole	Bavistin 50 WP
Combiproducts		
Carbendazim 12% + Mancozeb 63%	Methyl 1-1-2 benzimidazole carbonate + Manganese zinc ethylene bis dithiocarbomate + zinc	Saff 75% WP
Zineb 64% + Hexaconazole 4%WP	Zinc ethylene bis dithiocarbomate + (RS)-2-(2,4-dichloro phenyl)-1-(14-1,2,4-triazole-1 yl) hexane-2-1	Avthar 68%WP
Tricyclozole 18% + Mancozeb 62%	Manganese zinc ethylene bis dithiocarbomate + zinc	Merger 80%WP
Carboxin 37.5% + Thiram 37.5%	3-(3,5-diclorophenyl)-N-(1-methylethyl)-2,4- dioxo-1-lemadazolidine carboximide + Tetramethyl thiuram disulphide	Vitavax power 75% WP
Cymoxanil 8%+ Mancozeb	Manganese zinc ethylene bis dithiocarbomate + zinc	Curzate
Captan 70% + Hexaconozole 5%	N-trichloromethyl mercapta 4-cyclohexene-1,2-dis carboximide N-trichloromethyl thiotetra hydro othalamide + RS)-2-(2,4-dichloro phenyl)-1-(14-1,2,4-triazole-1 yl) hexane-2-	Taquat 75 WP

Petriplate. Mycelial disc of five mm size from actively growing zone of seven days old culture was cut by a sterile cork borer and one such disc was placed at the centre of each agar plate. Control treatment was maintained without adding any fungicide to the medium. Three replications were maintained for each concentration. Then such plates were incubated at room temperature and radial growth was measured when fungus attained maximum growth in control plates. Per cent inhibition of mycelial growth over control was calculated by using the formula given by Vincent (1947) :

$$I = \frac{C - T}{C} \times 100$$

where,

I = Per cent inhibition

C = Growth in control

T = Growth in treatment

All the data were subjected for statistical analysis as per procedure of Sukhatme and Amble (1985).

RESULTS AND DISCUSSION

In vitro evaluation of fungicides provides useful and preliminary information regarding efficacy of fungicides against pathogens within a shortest period of time and therefore, serve as guide for field testing. The results are presented in Table 1 to 3.

In the present investigation, among the non-systemic fungicides, the maximum per cent inhibition (81.80%) was observed in case of Mancozeb followed by 69.22 per cent in Zineb at 0.3 per cent concentration in S. rolfsii at 0.3 per cent concentration Irrespective of the concentrations maximum per cent inhibition of mycelial growth (75.50%) was observed in Mancozeb followed by Captan (65.55%) (Table 1). Pushpavathi and Rao (1998) reported 70.43 and 88.46 per cent inhibition of radial growth of *Sclerotium rolfsii* with Mancozeb at 1000 and 1500 ppm concentration, respectively. Similar results were also observed by Prabhu (2003) in soybean and Banyal *et al*. (2008) in tomato.

Among the systemic fungicides tested, cent per cent inhibition of mycelial growth was observed in Hexaconazole and Propiconazole in all the concentrations and least inhibition of mycelial growth was observed in Carbendazim (56.20%) (Table 2). Prabhu (2003) and Ammajamma (2010) reported that Propiconazole and Hexaconazole were found effective in all the concentrations tested. Ineffectiveness of Carbendazim against the pathogen *in vitro* is in conformity with the findings of Sharma and Verma (1985). Among the different combiproduct fungicides, cent per cent inhibition of mycelial growth was

Table 1: ***In vitro*** evaluation of contact fungicides against ***S. rolfsii, Rhizoctonia bataticola*** and ***Fusarium*** sp.

Fungicides	Per cent inhibition of mycelial growth/ concentration (%)														
	Sclerotium rolfsii					*Rhizoctonia bataticola*					*Fusarium* sp.				
	0.15	0.2	0.25	0.3	Mean	0.15	0.2	0.25	0.3	Mean	0.15	0.2	0.25	0.3	Mean
Captan	64.44	62.90	66.20	68.80	65.55	68.80	77.70	78.10	85.00	77.4	65.30	67.16	74.76	80.20	71.85
	53.35)*	(52.47)	(54.45)	(56.05)	54.08)	5.57)*	61.54)	(62.96)	67.06)	61.78)	53.89)*	(55.01)	0.17)	(60.55)	(58.16)
Mancozeb	70.66	72.90	77.90	81.80	75.50	65.55	74.70	81.00	92.50	78.42	84.33	86.90	96.20	96.20	90.90
	(57.27)	(58.61)	(61.94)	64.82)	(60.66)	(53.94)	(60.13)	64.23)	74.08)	(63.09)	(66.66)	68.75)	78.72)	(78.72)	(73.21)
Zineb	45.50	37.90	61.40	69.22	53.50	13.60	27.33	45.80	51.00	34.42	20.30	25.06	33.2	64.4	35.74
	(42.59)	(46.66)	(51.59)	(56.30)	49.29)	(21.52)	(31.22)	42.06)	(45.26)	35.07)	(26.62)	30.20)	(35.37)	(53.38)	(36.4)
	A (CF)	B (C.)	A x B (CF x C)			A (CF)	B (C.)	A x B (CF x C)			A (CF)	B (C.)	A x B (CF x C)		
S.E.	0.64	0.74	1.29			0.14	0.16	0.28			0.20	0.023	0.40		
C.D.(0.01)	2.56	2.96	5.13			0.57	0.66	1.14			0.80	0.92	1.60		

Table 2: ***In vitro*** evaluation of systemic fungicides against ***S. rolfsii, Rhizoctonia bataticola*** and ***Fusarium*** sp.

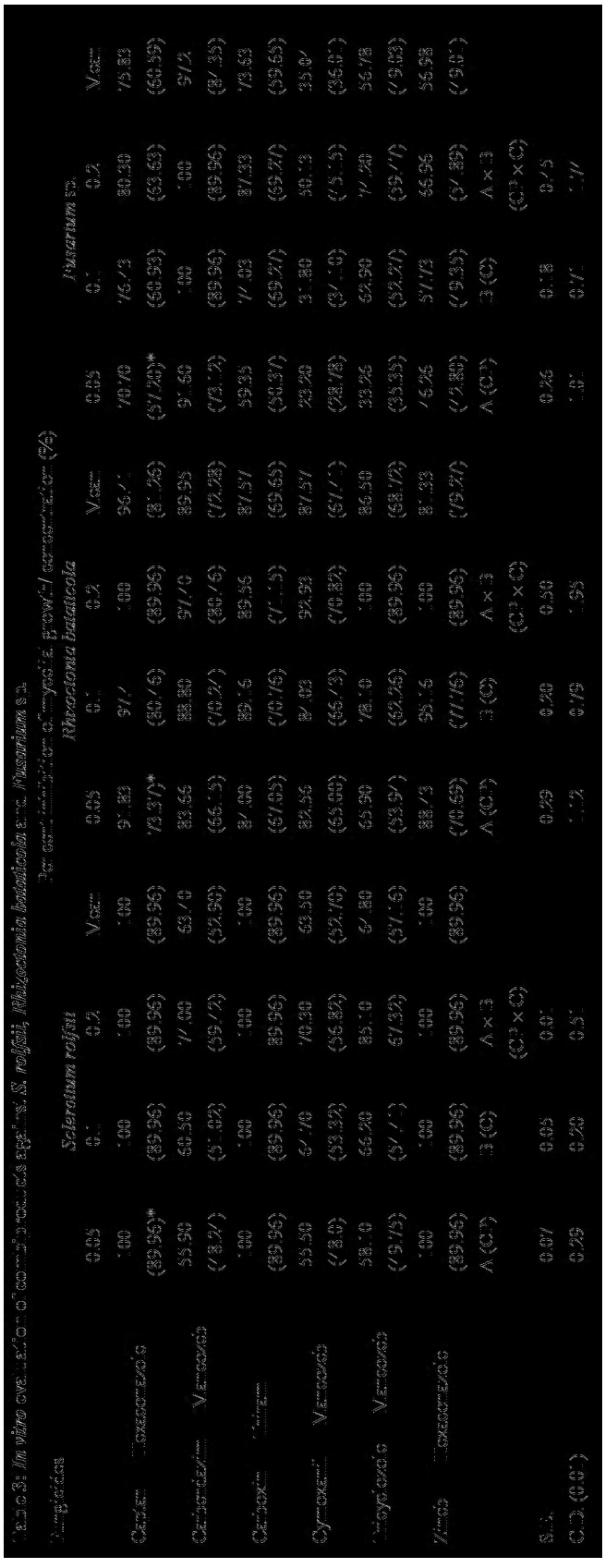
Fungicides	Per cent inhibition of mycelial growth/ concentration (%)											
	Sclerotium rolfsii				*Rhizoctonia bataticola*				*Fusarium* sp.			
	0.05	0.1	0.2	Mean	0.05	0.1	0.2	Mean	0.05	0.1	0.2	Mean
Carbendazim	37.55	61.00	70.33	56.20	100	100	100	100	87.66	90.05	96.20	91.30
	(37.52)*	(51.19)	(56.99)	(48.57)	(89.96)*	(89.96)	(89.96)	(89.96)	(69.41)*	(71.58)	(78.73)	(73.24)
Hexaconazole	100	100	100	100	89.56	90.70	94.80	91.60	82.16	84.20	84.50	83.62
	(89.96)	(89.96)	(89.96)	(89.96)	(71.15)	(72.26)	(79.15)	(74.19)	(64.87)	(66.55)	(70.42)	(67.28)
Propiconazole	100	100	100	100	90.73	94.03	100	94.92	87.70	92.50	100	93.4
	(89.96)	(89.96)	(89.96)	(89.96)	(72.27)	(72.72)	(89.96)	(78.32)	(70.12)	(74.08)	(89.96)	(78.05)
Thiophanate	59.86	80.60	85.40	75.22	100	100	100	100	84.20	87.90	100	90.7
methyl	(50.55)	(63.84)	(67.51)	(60.63)	(89.96)	(89.96)	(89.96)	(89.96)	(66.55)	(70.15)	(89.96)	(75.33)
	A (SF)	B (C)	SFxC		A (SF)	B (C)	SFxC		A (SF)	B (C)	SFxC	
S.E.	0.54	0.04	0.09		0.93	0.80	1.61		0.15	0.13	0.26	
C.D. (0.01)	2.13	0.37	0.18		3.69	3.19	4.59		0.60	0.52	1.04	

observed in Captan + Hexaconazole, Caboxin + Thiram and Zineb + Hexaconazole for the first time against the soybean pathogens in all the concentrations (Table 3). Similar, results were observed by Ammajamma (2010) in coleus affected by *S. rolfsii*.

In case of *Rhizoctonia* sp. among the non- systemic fungicides evaluated, maximum inhibition of mycelial growth (78.42%) was observed by Mancozeb followed by 77.40 per cent in Captan. Where as at 0.3 per cent concentration maximum inhibition of mycelial growth (92.50 per cent) was observed in Mancozeb followed by 85.00 per cent in Captan. Least inhibition of mycelial growth (34.42 %) was observed in Zineb (Table 1). The results are in conformity with observation made by Sachidananda (2005).

Among the systemic fungicides cent per cent inhibition was observed in Thiophanate methyl and Carbendazim at all the concentrations followed by Propiconazole (94.92 %) and 91.60 per cent inhibition in Hexaconazole (Table 2). Similar results were observed by Peshney *et al*.(1992) and Sachidananda (2005). Among the different combiproduct assessed, maximum inhibition of mycelial growth (96.41 %) was observed in Carbendazim + Mancozeb which were significantly on par with the Carboxin + Thiram with mycelial inhibition of 94.53 per cent (Table 3). Similar results were observed by Ammajamma (2010) in coleus. The present study identified the role of combiproducts in managing *S. rolfsii*, *Rhizoctonia* sp. and *Fusarium* sp. The effectiveness of combiproduct Carbendazim + Mancozeb, Captan + Hexaconazole for more than one pathogen, clearly gave us road map for managing complex root rot infections in soybean. These chemicals identified will be an effective improvement in developing IDM strategies against root rot/ wilt complex in soybean in future.

For *Fusarium* sp., the present study revealed that, among the non-systemic fungicides, maximum per cent inhibition of mycelial growth (90.90 %) was recorded in Mancozeb followed by Captan (71.85 %) (Table 1). Sumitra(2006) observed that Mancozeb at 0.3 per cent was found effective. Among the systemic fungicides, maximum inhibition of mycelial growth (93.40 per cent) was recorded in Propiconazole followed by 91.30 per cent in Carbendazim (Table 2). Sumitra (2006) reported that Carbendazim at 0.025, 0.05 and 0.1 per cent inhibiting the *Fusarium oxysporum* f.sp. *gladioli* completely. Propiconazole and Hexaconazole were also found effective. Carbendazim being a benzimidazole group of fungicides, they interfere with energy production and cell wall synthesis of fungi. (Nene and Thapliyal, 1973). Among the combiproducts, maximum inhibition of mycelial growth (97.20%) was recorded in Carbendazim + Mancozeb followed by Captan + Hexaconazole (75.83 %) and least inhibition of mycelial growth(35.04 %) was recorded in Cymoxanil + Mancozeb (Table 3). Sumitra (2006) observed less inhibition



in Carbendazim + Mancozeb (78.11%) in comparison with present findings.

Conclusion:

In vitro studies revealed that Mancozeb, Carbendazim, Thiophanate methyl, Hexaconazole, Propiconazole, Carbendazim + Mancozeb and Carboxin + Mancozeb were more effective in inhibiting the mycelial growth of all the three pathogens. These could be used to develop an effective management strategy against wilt/root rot complex of soybean in India.

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