Research Paper :

Management of Root Rot of Sage *(Salvia officinallis)* Caused by *Fusarium solani* and *Rhizoctonia solani*

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SUMMARY

An attempt was made to manage these pathogens in glasshouse and field conditions by using different fungicides, microbial antagonists, botanicals and oranic amendments. Among the eight different fungicides tested *in vitro* mancozeb and carbendazim at all the concentrations completely inhibited the *F. solani* and R. *solani* where as propiconazole was effective only against *R. solani* at all concentrations tested. Baycor was found least effective against both the pathogens. Out of seven biocontrol agents tested under laboratory condition in dual culture, *Trichoderma viride* and *T. virens*, maximum inhibition of both the pathogens followed by *T. harzianum* and *T hamatum*. Maximum inhibition of mycelial growth of both the pathogens was observed in 5 per cent neem leaf extract. Neem cake was found to be effective in reducing wilt incidence up to 18.75 and 31.25 per cent at 5 and 2 per cent, respectively. Application of carbendazim (0.1 %) mancozeb (0.2%) and neem cake followed by garlic bulb extract have effectively controlled the disease incidence. However, carbendazim treated plots were found highly effective in managing the disease of sage.

Key words : *Salvia officinallis, Fusarium solani, Rhizoctonia solani,* Fungicides, Organic amendments.

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Sage (*Salvia officinalis* Linn.) belonging to the family Lamiaceae is known as common sage, garden sage, dalmation sage; In Kannada, it is called as Sannakarpoorada gida. Sage is a native of Mediterranean countries *viz.*, Southern France, Italy and Morocco. It is cultivated in the temperate zones of Europe, Yugoslavia in Dalmation Islands, adjacent coast of Adriatic Sea and Albania (Verghese, 1999).

Sage crop is cultivated in Sugandhavana, Division of Horticulture, GKVK, Bangalore. It is vulnerable to many diseases, of which root rot caused by *Fusarium solani* and *Rhizoctonia solani* were reported by Sunanda (2000). Root and crown rot of sage is caused by *Phytophthora cryptogea* L. Anonymous (2002). As it is a newly introduced crop on which the root rot is a serious malady that causes considerable loss and not much information is available regarding association of the pathogen(s) and their management. Hence, present investigation was undertaken to manage root rot disease with fungicides, microbial antagonists and organic amendments.

MATERIALS AND METHODS

The experiments on *Fusarium solani* and *Rhizoctonia solani* causing root rot of *Salvia officinalis* were conducted in the Department of Plant Pathology and at Sughandhavana, Division of Horticulture, U.A.S., G.K.V.K, Bangalore during *kharif* 2005. Preliminary investigations of the disease were initiated on various aspects with reference to pathogens, pathogenicity, symptomatology and survivability of the pathogen, host range studies, effect of organic amendments and management of the disease with fungicides, biocontrol agents and botanicals.

The earliest symptoms observed under field conditions were partial bleaching, drooping of lower leaves, pale yellowing and loss of turgidity. Further, browning and blighting of leaves led to shedding. Close observation of the infected plants at collar region showed water-soaked patches on the stem followed by brown discoloration. As and when the disease advances, entire stem showed sunken and dried up patches with girdling. From the infected stem, bark could be easily peeled off. The infected plants could be easily pulled up from the soil which reveal discolouration and rotting of roots.

The pathogens associated with sage root rot were isolated from different parts such as tertiary and secondary roots, root hairs and bark of the infected sage plants, collected from the Sugandhavana. Repeated isolations from the infected plant yielded *Fusarium* species and *Rhizoctonia* species. Further, early infected

plants invariably yielded *Fusarium* spp. Under subsequent infection both *Fusarium* and *Rhizoctonia* were isolated.

RESULTS AND DISCUSSION

Among the contact fungicides tested, mancozeb was found to be effective with cent per cent inhibition of mycelial growth at all the concentrations against *F. solani* and *R. solani*. Least per cent inhibition was noticed in chlorothalonil followed by captan against *F. solani* whereas captan followed by chlorothalonil has least per cent mycelial inhibition against *R. solani*. Among the systemic fungicides tested against *F. solani* and *R. solani*, carbendazim recorded cent per cent inhibition followed by benomyl at 0.1 per cent. Propiconazole at all the concentrations completely inhibit the mycelial growth of *R. solani*, whereas, in case of *F. solani* maximum inhibition of 77.77 per cent was noticed at 0.1 per cent concentration of propiconazole. The least inhibition (17.40 and 9.72 per cent) was noticed in baycor against *F. solani* and *R. solani*, respectively (Table 1 and 2).

The results obtained are on concordant with the results of many workers such as Gangopadhyay and Grover (1985), Chauhan *et al.* (1988) and Verma and Singh (1999) who have reported carbendazim as most effective chemical against *F. solani* and *R. solani*. Similarly, Beti and Irani (1996) and Sud *et al.* (1999) found mancozeb as most effective chemical in controlling *F. solani* and *R. solani*.

In vitro evaluation of biocontrol agents (Table 3) revealed stronger antagonism by *T. viride* (TY-23) and *T. virens* (TYS-12). All the species of *Trichoderma* showed more hyphal inhibition compared to bacterial antagonists. This can be attributed to higher competitive ability of *Trichoderma* spp. against *F. solani*. *Trichoderma virens* (TYS-12) and *T. viride* (TY-23) were found to be the best bioagents to inhibit the growth of *F. solani* and *R. solani* followed by *T. harzianum* and *T. hamatum*. Least per cent mycelial inhibition was noticed in case of *B. subtilis* isolate (33.14% and 11.11%), followed by *Pseudomonas* isolate (40.36% and 48.51%) against *F. solani* and *R. solani*, respectively. The results were in agreement with many workers on various species of *Fusarium* and *Rhizoctonia* by using *T. Viride* and *T. Virens*. Duda and Sierota (1987) found that *T. viride* and *T. virens* were effective biocontrol agents against damping off of scot pine caused by *F. oxysporum* and *R.. solani*. Mukhopadhyaya *et al.* (l989) observed the control of collar rot and root rot of chickpea by the application of wheat saw dust preparation of *T. harzianum*.

Organic amendments in the form of oil cakes, crop residues dried and fresh leaves, green manures and FYM (compost) significantly reduces the soil borne plant pathogens. These amendments promote biological activity by providing nutrients and favourable conditions for the antagonists. In the present study, addition of Neem cake, Pongamia cake, Groundnut cake, Eupatorium dried leaves and FYM as soil amendments gave good protection against root rot disease of sage. Neem cake was found

Table 1: *In vitro* evaluation of different fungicides against *Fusarium solani*

Sr. No.	Per cent mycelial inhibition over control						Mean
	Non systemic fungicides		Concentrations (in per cent)				
	Common name	Trade name	0.025	0.05	0.1	0.2	
1.	Captan	Captan 50 WP	45.16 (42.65)**	60.92 (51.25)	72.22 (58.12)	83.33 (65.92)	65.51
2.	Chlorothalonil	Kavach 75 WP	55.55 (48.20)	61.11 (51.33)	66.66 (51.33)	72.22 (58.37)	63.88
3.	Mancozeb	Indofil- M 45	100.00 (10.02)	100.00 (10.02)	100.00 (10.02)	100.00 (10.02)	100.00
	Mean		66.90	74.01	79.62	85.18	
	S.E.±				0.08		
	C.D. (P=0.01)				0.25		
Sr. No.	Systemic fungicides		Concentrations (in per cent)				Mean
	Common name	Trade name	0.01	0.025	0.05	0.1	
1.	Bitertanol	Baycor 25 WP	2.40 (8.82)**	11.29 (19.71)	22.40 (28.31)	33.50 (35.42)	17.4
2.	Benomyl	Benomyl 50 WP.	83.14 (65.58)	88.69 (70.27)	93.33 (75.16)	100.00 (89.42)	91.29
3.	Carbendazim	Bavistin 50WP.	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.0
4.	Hexaconazole	Contaf 5 EC.	33.51 (35.42)	44.62 (41.88)	61.11 (51.50)	65.55 (54.21)	51.19
5.	Propiconazole	Tilt 25 EC	61.11 (51.50)	66.66 (54.68)	72.22 (58.19)	77.77 (61.86)	69.44
	Mean		56.02	62.25	69.81	75.36	
	S.E.±				0.10		
	C.D. (P=0.01)				0.30		

* * Figures in the parenthesis are Arcsine transformed values

Table 2: *In vitro* evaluation of different fungicides against *Rhizoctonia solani*

Sr. No.	Per cent mycelial inhibition over control						Mean
	Non systemic fungicides		Concentrations (in per cent)				
	Common name	Trade name	0.025	0.05	0.1	0.2	
1.	Captan	Captan 50 WP	0.00 (0.70)*	11.11 (3.40)	38.88 (6.25)	70.00 (8.39)	29.99
2.	Chlorothalonil	Kavach 75 WP	44.44 (6.74)	64.44 (8.05)	70.00 (8.39)	80.00 (8.97)	64.72
3.	Mancozeb	Indofil- M 45	100.00 (10.02)	100.00 (10.02)	100.00 (10.02)	100.00 (10.02)	100.00
	Mean		48.14	58.51	69.62	83.33	
	S.E.±				0.007		
	C.D. (P=0.01)				0.02		
Sr. No.	Systemic fungicides		Concentrations in per cent				Mean
	Common name	Trade name	0.01	0.025	0.05	0.1	
1.	Bitertanol	Baycor 25 WP	1.11 (6.04)**	4.44 (12.16)	11.11 (19.47)	22.22 (28.12)	9.72
2.	Benomyl	Benomyl 50 WP.	72.22 (58.37)	80.00 (63.43)	88.88 (70.52)	100.00 (89.42)	85.27
3.	Carbendazim	Bavistin 50WP.	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.00
4.	Hexaconazole	Contaf 5 EC.	86.66 (68.57)	94.44 (76.36)	100.00 (89.42)	100.00 (89.42)	95.27
5.	Propiconazole	Tilt 25 EC	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.00 (89.42)	100.00
	Mean		72.00	75.80	80.00	84.44	
	S.E.±		0.04				
	C.D. (P=0.01)		0.11				

* Figures in the parenthesis are square root transformed values
** Figures in the parenthesis are Arcsine transformed values

Table 3 : *In vitro* evaluation of microbial antagonists against *Fusarium solani* and *Rhizoctonia solani* (duel culture technique)

Sr. No.	Microbial antagonists	Per cent inhibition	
		Fusarium solani	*Rhizoctonia solani*
1.	*Bacillus subtillis*	33.14 (32.61)	11.11 (10.59)
2.	*Pseudomonas fluorescens*	40.36 (40.51)	48.51 (48.32)
3.	*Trichoderma virens* (TVS 12)	94.81 (93.85)* *	95.55 (94.58)
4.	*Trichoderma viride* (TV 23)	94.44 (93.48)	94.44 (93.48)
5.	*Trichoderma harzianum* (TH 10)	72.40 (72.18)	61.29 (61.81)
6.	*Trichoderma hamatum* (THM 138)	66.47 (66.14)	86.47 (86.14)
7.	*Trichoderma konigii* (Tk 2014)	63.14 (63.14)	70.73 (70.73)
	S.E. ±	0.39	0.40
	C.D. (P=0.01)	1.64	1.70

** Figures in the parenthesis are Arcsine transformed values

to be significantly superior over all other amendments (Table 4). The superiority of this amendment may be due to release of some inhibitory substances on decomposition, affecting the population of pathogen. Besides the nutrient content of these amendments may have a possible role in enhancing the host growth and vigour, increasing antagonistic microbial activity enabling them to withstand or resist to the attack of pathogen. Several earlier workers reported that varied concentrations (0.5 to 5%) of amendments effectively reduced soil bone diseases (Papavizas, 1973; Kotasthane and Gupta, 1986).

Field experiments were carried out in sick soil of sugandhavana during Feb. 2004-June-2004 to manage the root rot disease using fungicides, biocontrol agents and botanicals and organic amendments. The two fungicides *viz.*, carbendazim (0.1 %), mancozeb (0.2 %) two organic amendments namely, neem cake (250 g / m^2) and pongamia cake (250 g / m^2), *Trichoderma viride* (TV 23) and *T. virens* (TVS 12) (5 g/plants) were evaluated individually against *F. solani* and *R.. solani* the incitant of root rot disease in sage (Table 5).

All the plots drenched with chemicals significantly reduced the disease over control. However, maximum disease reduction was recorded in carbendazium (0.1 %) and mancozeb (0.2%) These results are comparable with findings of Lakshmi and Jayarajan, (1987) and Rathnamma (1994) who reported that MEMC, thiram and carbendazim effectively checked the growth of *F. solani*. Although *T. viride* and *T. virens* were found highly effective *in vitro* condition, but have little antagonistic effect in the natural

Table 4 : Effect of organic amendments on disease incidence caused by *Fusarium solani*

Sr. No.	Organic amendment	Per cent disease incidence	
		2%	5%
1.	Neem cake	3 1.25 (33.75)**	18.75 (22.75)
2.	Groundnut cake	68.75 (74.71)	57.50 (50.52)
3.	Pongamia cake	43.75 (41.25)	37.50 (38.75)
4.	Cromolina dried leaves	93.75 (82.07)	75.00 (63.60)
5.	FYM	81.25 (70.96)	62.50 (52.50)
6.	Control	100.00 (89.42)	100.00 (89.42)
S.E. ±		6.79	6.61
C.D. (P=0.01)		20.20	19.64

** Figures in the parenthesis are Arcsine transformed values

Table 5 : Effect of different treatments on the incidence of root rot disease of sage caused by *Fusarium solani* and *Rhizoctonia solani* under field conditions

Sr. No.	Treatment	Disease incidence (%)	Reduction over control (%)
1.	Carbendazim (0.1%)	16.66	80.77
2.	Mancozeb (0.2 %)	23.32	73.09
3.	Neem cake (250gm/mts)	39.99	53.85
4.	Pongamia cake (250gm/mts)	56.66	34.62
5.	*Trichoderma viride* (5gm/ plant)	49.99	42.31
6.	*Trichoderma virens* (5gm/ plant)	53.33	38.46
7.	Control	86.66	-
S.E.±		3.46	
C.D. (P=0.01)		9.87	

soil. This could be probably due to tack of survival of the antagonists or the mechanism of antagonism might be ineffective to suppress the pathogen in the complex soil environment. A major problem that beats the subject of microbial antagonism in soil is that many mechanisms of biocontrol by *Trichoderma* are presumptive and proof is difficult to come by (Hornby *et al.,* 1990).

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