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Efficacy of systemic fungicides and antagonistic organism for the management of Phytophthora foot rot of black pepper in arecanut cropping system

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Abstract

Black pepper vines were less affected when the vines were treated either with metalaxyl gold MZ 64 WP (Ridomil gold) @ 2.5 g/vine or potassium phosphonate (0.5 per cent) as spray (@ 2 l-vine) and drench twice (@ 3 l-vine) during before on set of monsoon and second application in the month of August coupled with soil application of antagonistic organism i.e., *Trichoderma harzianum* @ 50 g (cfu 107) along with 1 kg of neem cake to the root zone of the vine. Application of systemic fungicides alone i.e., metalaxyl MZ 68 WP (Ridomil gold) @ 2.5 g/vine or potassium phosphonate (0.5 per cent) as spray (@ 2 l-vine) and drench twice (@ 3 l-vine) also showed effectiveness in the combating the disease.

Key words: black pepper, metalaxyl gold, potassium phosphonate, *Trichoderma harzianum*

Introduction

Black pepper the "King of Spices" is cultivated in about 1.9 lakh ha in India with the lowest productivity (294 kg ha-1) as compared to Thailand (3594 kg ha-1), Malaysia(1888 kg ha-1) and Vietnam (1100 kg ha-1) and Brazil (883 kg ha-1) (Sadanandan, 2000). Radhakrishnan *et al*., 2002 attributed factors such as continuous cultivation of low yielding varieties, non availability of improved high yielding varieties, non adoption of appropriate agronomic practices, losses due to diseases/pests/droughts etc as main reasons for low productivity.

Black pepper, native to tropical forests in Western Ghats of India is cultivated in Kerala with production of 80 per cent followed by Karnataka, Tamil Nadu, Maharastra and Assam. In Karnataka the crop is grown as inter crop in arecanut garden in Uttara Kannada, Dakshina Kannada, Shimoga, and trained on shade trees in Coffee and tea estates in Chikmaglore, Kodagu, Hassan. Black pepper is ideal for cultivation in Uttara Kannada due to presence of sub mountainous tracts of Western Ghats comprising of hot and humid climate with annual rainfall of 2500 mm with 104 rainy days in a year.

Phytophthora foot rot (*Phytophthora capsici*) and slow decline (*Meloidogyne incognita and Radopholus similis*) are among the various biotic factors which affect the cultivation of black pepper in Uttara Kannada. These two diseases are soil borne in nature causing huge loss in terms of production (Lokesh and Gangadharappa, 1995). The infection is seen on all parts of the plant viz., leaf, stem, spike, root and collar resulting in yellowing,

defoliation, wilting and death of the vines. The use of 'Cu' based fungicides for P. capsi management it difficult owing to high rainfall which limits the spray schedule besides unsuitable in large plantation as it leaves 'Cu' in the environment. Hence, an attempt was made to use systemic fungicides and antagonistic organisms individually and their combinations for the effective management of the disease in arecanut cropping system.

Materials and methods

The experiment in RBD was laid out in farmer's field in Sirsi, Uttara Kannada Dist. Karnataka. The garden is an arecanut based multistoried cropping system for six years from 2000-01 to 2005-06 the vines were eight to 10 years old trained on arecanut standards. The gardens were located at an altitude of 619 m. MSL with latitude of 14 36' N and longitude of 74 50' E The average rainfall of the region was 2600 mm and soil were latertic sandy loam in nature with pH 6.8 and a nutrient status of 110 kg , 38 kg and 242 kg/ ha NPK respectively.

The vines were treated alone and in combinations of fungicides viz., metalaxyl gold MZ 68 WP (Ridomil gold MZ 68 WP, @ 100 ppm, i.e., 2.5 g-l), Potassium phosphonate (Akomin, @ 0.5 per cent), as spray (@ 21 per vine) and drench (3 l/vine), bioagent viz., *Trichoderma harzianum* (Source of *T. harzianum*) (@ 50 g of inoculum (10 7cfu) mixed with one kg of neem cake) as soil application and organic amendments viz., neem cake (@ 1 kg per vine) as soil application.. The treatments were imposed twice in the season i.e., first week of June and second week of August. The black pepper vines without any fungicidal application were served as control. The observation were taken on leaf infection (%), collar infection (%), defoliation (0 to 3 grades) and foliar yellowing (0 to 3 grades) was recorded during onset of monsoon, peak monsoon and post monsoon.

Results and discussion

During 2000-01, the Phytophthora foot rot of black pepper was least (15.0%) in the vines treated with Potassium phosphonate (@ 0.5 per cent) as spray (@ 2 l per vine) and drench (3 l per vine) along with soil application of T. harzianum (@ 50 g of 107 cfu in one kg of neem cake) during first week of June and second week of August. This was followed by the black pepper treated as spray and drench with either gold MZ 68 WP (@ 100 ppm, 17.50 per cent) or potassium phosphonate (@ 0.5 per cent, 17.50 per cent). The untreated black pepper vines showed disease incidence of 52.50 per cent (Table 12).

In the year 2001-02, black pepper vines treated with Metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g/l) as spray (2 l-vine) and drench (3 l-vine) alone and in combination with bioagent i.e., *Trichoderma harzianum* (@ 50 g of 107 cfu/vine) or Potassium phosphonate (@ 5 ml- l) as spray and drench in combination with bioagent i.e., *T. harzianum* (@ 50 g/vine) twice in the season (June and August) showed least incidence of Phytophthora foot rot disease (15 per cent). The disease incidence was highest in the untreated vines (62.50 per cent, Table1).

During 2002-03 black pepper vines showed least incidence of disease (7.5 per cent) where the vines treated twice in the season (June and August) with metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g-l) as spray (2 l-vine) and drench (3 l-vine) alone and in combination with bioagent i.e., *Trichoderma harzianum* (@ 50 g of 107 cfu-vine). Black pepper vines treated with potassium phosphonate (@ 5 ml- l) as spray and drench in combination with bio-agent i.e., *T. harzianum* (@ 50 g-vine) twice in the season showed reduced disease incidence (10.00 per cent). The disease incidence was highest in the untreated vines (40.00 per cent, Table 1).

During 2003-04, Phytophthora foot rot disease incidence in black pepper was least (7.5 per cent) where the vines were treated twice in the season (June and August) with

Table 1. Management of Phytophthora disease of black pepper in farmers' field at Sirsi (2000-01 to 2003-04 pooled data)

Sl. No.	Treatments	Percent disease incidence 2000-01	2001-02	2002-03	2003-04	Pooled
1.	Metalaxyl MZ 68 WP (@ 100 ppm, 2.5 g l -1) as spray (2 l vine -1) and drench (3 l vine -1) twice	17.50 (24.16) *	15.00 (22.48)	7.50 (13.82)	7.50 (11.25)	11.87 (17.93)
2.	Potassium phosphonate (Akomin, @ 0. 5 per cent) as spray and drench twice	17.50 (24.16)	17.50 (24.53)	10.00 (15.86)	12.50 (20.47)	14.38 (21.54)
3.	Soil application of *Trichoderma harzianum* (10^7 cfu, @ 50 g vine -1) with 1 kg of neem cake twice	27.50 (30.87)	50.00 (45.00)	25.00 (29.74)	32.50 (34.50)	33.75 (35.02)
4.	Metalaxyl MZ 68 WP (@ 100 ppm, 2.5 g l-1) as spray (2 l vine -1) and drench (3 l vine -1) twice + Soil application of *Trichoderma harzianum* (10 7 cfu,@ 50g vine -1) with 1 kg of neem cake twice	17.50 (24.53)	15.00 (22.50)	7.50 (13.82)	7.50 (13.82)	11.88 (18.67)
5.	Potassium phosphonate (Akomin, 0.5 per cent) as spray and drench twice + Soil application of *Trichoderma harzianum* (10 7 cfu, @ 50 g vine-1) with 1 kg of neem cake twice	15.00 (22.13)	15.00 (22.50)	10.00 (15.86)	12.50 (17.89)	13.13 (19.59)
6.	Neem cake application @ 1 kg vine -1	37.50 (37.72)	55.00 (47.89)	32.50 (33.97)	35.00 (36.06)	40.00 (38.91)
7.	Untreated control	52.50 (46.50)	62.50 (52.34)	40.00 (39.17)	45.00 (42.11)	50.00 (45.03)
	S Em	3.12	2.20	4.45	4.32	1.84
	CD @ 5 %	9.30	6.54	13.08	12.70	5.16

*angular transformed values

metalaxyl gold MZ 68 WP (Ridomil gold) (@ 2.5 g-l) as spray (2 l-vine) as well as drench (3 l-vine) alone or and in combination with bioagent i.e., *Trichoderma harzianum* (@ 50 g of 107cfu-vine, Table 4). This was followed by application of potassium phosphonate (@ 5 ml-l) as spray as well as drench or and in combination with bio-agent i.e., *T. harzianum* (@ 50 g-vine) twice in the season to black pepper vines showed reduced disease incidence (12.50 per cent). The disease incidence was highest in the untreated vines (45.00 per cent).

In the year 2004-05, black pepper vines were free from leaf infection, collar infection, defoliation , minimum foliar yellowing (0.22 grade) and maximum yield (3.68 kg fresh yield-vine and 1.12 kg dry yield-vine) when Ridomil gold (@ 2.5 g^{-l}) applied as spraying (2 l-vine) and drenching (3 l-vine) along with the soil application of *Trichoderma harzianum* @ 50 g in one kg of neem cake to the root zone during first week of June and second week of August. A combination of Potassium Phosphonate (@ 5 ml^{-l}) as spraying and drenching and soil application of *Trichoderma*

harzianum @ 50 g in neem cake twice during the season was also effective in combating the disease. The unprotected vines were showing high incidence of leaf infection (16.02 per cent), collar rot (10 per cent), defoliation (0.99 grade), foliar yellowing (1.06 grade) and low yield (2.07 kg fresh yield/ vine and 0.56 dry yield kg/vine, Table 2)

During 2005-06, Phytophthora foot rot of black pepper was minimum with respect leaf infection (5.46 per cent), defoliation (0.42 grade) and foliar yellowing (0.67 grade) no collar infection and maximum yield (4.39 kg fresh yield/vine and 1.38 kg dry yield/vine) with application of Ridomil gold (@ 0.25 per cent) as spraying (@ 2 l-vine) and drenching (@ 3l/vine) along with *Trichoderma harzianum* (@50 g, cfu 107) and one kg of neem cake as application to root zone of the vines during June and August 2005. However, treating the vine with potassium phosphonate (@ 0.5 per cent) as spraying (@ 2l/vine) and drenching (@ 3l/vine) two times during June and August 2005 with bio agent *T. harzianum* (@50 g ,cfu 107) and one kg of neem cake as root zone application combated the disease with less leaf infection (6.51per cent), collar infection (2.50 per cent), defoliation (0.92grade) foliar yellowing (0.71 grade) and more yield (3.62 kg fresh yield/vine and 1.12 kg dry yield/vine). There was maximum leaf infection (29.84 per cent), collar infection (20 per cent), defoliation (2.05 grade) and foliar yellowing (1.96 grade) and minimum yild 1.34 kg fresh yield/vine and 0.39 kg dry yield / vine) in untreated vines. (Table 3).

Pooled 2000-01 to 2005-06 : Black pepper vines were less affected when the vines were treated either with metalaxyl MZ 64 WP (Ridomil gold) @ 2.5 g/vine or potassium phosphonate (0.5 per cent) as spray (@ 2l per vine) and drench twice (@ 3l per vine) during before on set of monsoon and second application in the month of August coupled with soil application of antagonistic organism i.e., *Trichoderma harzianum* @ 50 g (cfu 107) along with 1 kg of neem cake to the root zone of the vine. Application of systemic fungicides alone i.e., metalaxyl gold MZ 64 WP (Ridomil gold) @ 2.5 g/vine or potassium phosphonate (0.5 per cent) as spray (@ 2l/vine) and drench twice (@ 3 l-vine) also showed effectiveness in the combating the disease. There was more incidence of the disease when vines were applied with either neem cake or *Trichoderma harzianum* alone. There was maximum incidence of the disease in the unprotected vines. (Table 1).

The results were in conformity with findings of the following scientists. . Papavizas and Bowers (1981) reported that Metalaxyl was more effective in inhibiting production of sporangia and oospores, and at low concentrations. (< 2.5 mu g a.i.-ml) in inhibiting oospore germination.

Rajan and Sarma (1997) reported that biocontrol agents *Trichoderma* spp. and *G. virens* showed varying degrees of inhibition on growth of *Phytophthora capsici*.. Potassium phosphonate (Akomin), an antifungal compound was found to control root rot in black pepper. They clearly established that the compatibility of biocontrol agents with potassium phosphonate, which forms a component in the integrated disease management programme.

Hegde and Anahosur (1998) reported that field trials from 1992 and 1993 on the integrated management of foot rot of black pepper where in application of neem cake + *Trichoderma harzianum* + Ridomil MZ [metalaxyl] + garlic and mustard seed extract + mulching of the wet soil with transparent polythene sheets during the hot summer was the most effective treatment and resulted in maximum survival of vines.

Sarma 1994 reported that Phytophthora foot rot of black pepper was least when all recommended cultural practices was imposed, including the use of disease-free planting stock, and chemical control with copper oxychloride soil drenches and Bordeaux mixture sprays alternated with Ridomil [metalaxyl] against *P. capsici*. Applications of

Table 2. Control of Phytophthora foot rot disease in farmers field an observation trial (2004-05) Locations: Hosable and Edahalli (Pooled)

Treat. No	Treatmen	Foliar infection (%)				Collar infection (%)	Defoliation (grade)										Foliar Yellowing (grade)												Yield (kg/vine)	
		Bottom	Middle	Top	Mean		May/June Onset of monsoon			July/Aug Peak monsoon Bottom Middle				Dec/Jan Postmonsoon				May/June Onset of monsoon				July/Aug Peak monsoon				Dec/Jan Postmonsoon					
							Bottom	Middle	Top	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Bot	Middle	Top	Mean	Bottom	Middle	Top	Mean	Fresht	Dr
T1	Ridomil	0.00	0.00	0.00	0.00	2.5	0	0	0	0.0	0.00	0.00	0.00	0.25	0.25	0.00	0.17	0	0	0	0	0.0	0	0.00	0.75	0.33	0.17	0.42	3.52	0.9
T2	Pot. Phosphonte	3.57	0.00	0.00	1.19	5	0	0	0	0.0	0.00	0.00	0.00	0.75	0.75	0.25	0.58	0	0	0	0	0.0	0	0.00	0.75	0.55	0.20	0.50	2.99	0.8
T3	T.harzia num	7.69	4.59	4.19	5.49	10	0	0	0	0.5	0.50	0.00	0.33	1.25	1.13	0.25	0.88	0	0	0	0	0.0	0	0.00	1.48	1.10	0.65	1.08	2.43	0.6
T4	T1+ T3	0.00	0.00	0.00	0.00	0	0	0	0	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0.0	0	0.00	0.50	0.17	0.00	0.22	3.68	1.1
T5	T1+ T4	0.00	0.00	0.00	0.00	0	0	0	0	0.0	0.00	0.00	0.00	0.50	0.50	0.00	0.33	0	0	0	0	0.0	0	0.00	0.50	0.25	0.13	0.29	3.21	0.8
T6	Neem cake	11.52	9.64	6.22	9.13	15	0	0	0	0.5	0.50	0.17	0.39	1.00	1.00	0.30	0.77	0	0	0	0	0.5	0	0.17	1.10	0.88	0.65	0.88	2.34	0.6
T7	Control	24.48	15.60	7.99	16.02	20	0	0	0	1.0	0.30	0.30	0.53	1.25	1.00	0.72	0.99	0	0	0	0	1.0	0	0.33	1.19	1.00	1.00	1.06	2.07	0.5
SEm ±		1.72				-	-			0.10				0.10				-			0.13				0.06				0.18	0.0
CD @ 5%		5.29				-	-			0.32				0.32				-			NS				0.19				0.53	0.1

Table 3. Control of Phytophthora foot rot disease in farmers field an observational trial (2005-06) Locations : Hosable and Edahalli (Pooled)

Treat. No	Treatmen	Foliar infection (%)				Collar infection (%)	Defoliation (grade)												Foliar Yellowing (grade)												Yield (kg/vine)	
		Bottom	Middle	Top	Mean		May/June Onset of monsoon			July/Aug Peak monsoon				Dec/Jan Postmonsoon				May/June Onset of monsoon			July/Aug Peak monsoon				Dec/Jan Postmonsoon				Fresh	D
							Bott	Mid	Top	Bottom	Middle	Top	Mean	Bottom	Middle	Top	Mean	Bott	Mid	Top	Bottom	Middl	Top	Mean	Bottom	Middle	Top	Mean		
T1	Ridomil	9.44	4.92	2.88	5.75	5.00	0	0	0	0.00	0.00	0.00	0.00	0.75	0.75	0.25	0.58	0	0	0	0.00	0.00	0.0	0.00	0.75	0.75	0.50	0.67	3.90	1.
T2	Pot. Phosphont	8.49	8.61	5.17	7.42	7.50	0	0	0	0.00	0.00	0.00	0.00	1.13	1.25	0.75	1.04	0	0	0	0.00	0.00	0.0	0.00	1.10	0.75	0.40	0.75	3.41	1.
T3	T. harzianum	18.07	19.27	11.34	16.23	5.00	0	0	0	0.50	0.00	0.00	0.17	1.50	1.25	0.83	1.19	0	0	0	0.00	0.00	0.0	0.00	1.50	1.75	0.50	1.25	2.54	0.
T4	T1+T3	8.49	4.35	3.54	5.46	0.00	0	0	0	0.00	0.00	0.00	0.00	1.00	0.25	0.00	0.42	0	0	0	0.00	0.00	0.0	0.00	1.25	0.75	0.00	0.67	4.39	1.
T5	T1+T4	9.55	6.43	3.55	6.51	2.50	0	0	0	0.00	0.00	0.00	0.00	1.33	0.92	0.50	0.92	0	0	0	0.00	0.00	0.0	0.00	1.38	0.50	0.25	0.71	3.62	1.
T6	Neem cake	25.29	24.15	19.11	22.85	10.00	0	0	0	1.00	0.00	0.17	0.39	2.00	1.17	0.50	1.22	0	0	0	0.50	0.00	0.0	0.17	1.75	1.25	0.75	1.25	1.49	0.
T7	Control	33.83	30.27	25.42	29.84	20.00	0	0	0	1.00	1.30	0.30	0.87	2.63	2.00	1.53	2.05	0	0	0	1.00	1.00	0.0	0.67	2.50	2.25	1.13	1.96	1.34	0.
SEm ±		0.81				1.92	-			0.16				0.13				-			0.14				0.16				0.09	0.
CD @ 5%		2.61				5.90	-			0.51				0.40				-			0.42				0.49				0.27	0.

Table 4. Control of Phytophthora foot rot disease in farmers field an observational trial (2004-05&2005-06) Locations : Hosable and Edahalli (Pooled)

No at. No	Treatment	Foliar infection (%)	Collar infection (%)	Defoliation (grade)			Foliar Yellowing (grade)			Yield (kg/ vine)	
			Mean	May/June On set of monsoon	July/ Aug Peak monsoon	Dec/Jan Post monsoon	May/June On set of monsoon	July/ Aug Peak monsoon	Dec/Jan Post monsoon	Mean	
				Meam	Mean	Mean	Mean	Mean	Mean	Fresh	Dry
T1	Ridomil	2.87	3.75	0	0.00	0.38	0	0.00	0.54	3.75	1.10
T2	Pot. Phos phont	4.31	6.25	0	0.00	0.81	0	0.00	0.63	3.22	0.95
T3	T. harzia num	10.86	7.50	0	0.25	1.04	0	0.00	1.17	2.49	0.72
T4	T1+	2.73	0.00	0	0.00	0.21	0	0.00	0.45	4.19	1.30
T3											
T5	T1+	3.26	1.25	0	0.00	0.63	0	0.00	0.50	3.41	0.99
T4											
T6	Neem cake	15.99	12.50	0	0.39	1.00	0	0.17	1.07	1.93	0.57
T7	Control	22.94	20.00	0	0.70	1.52	0	0.50	1.52	1.70	0.50
SEm±		1.05	0.92	-	0.10	0.09	-	0.11	0.08	0.10	0.04
CD @ 5%		3.22	2.75	-	0.31	0.27	-	0.34	0.24	0.29	0.12

neem cake at 1 kg/vine increase the population of microbial antagonists and the addition of VAM propagules boosts plant growth and suppresses root infections.

The results of the present finding clearly showed that the disease could be managed by application of either metalaxyl gold (100 ppm) or potassium phosphonate (@ 0.5 per cent) in combination with *T. harzianum* (@ 50 g vine-1) with one kg of neem cake to the root zone during June and August for effective management of the disease.

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