

## RESEARCH ARTICLE

# Evaluation of combination of potassium phosphonate and *Trichoderma harzianum* on management of *Phytophthora* foot rot of black pepper (*Piper nigrum* L.) under arecanut cropping system

■ M.S. LOKESH<sup>1\*</sup>, S.V. PATIL<sup>2</sup>, S.B.GURUMURTHY<sup>3</sup>, M.G. PALAKSHAPPA<sup>4</sup> AND M. ANANDARAJ<sup>5</sup>

<sup>1</sup>Department of Plant Pathology, AICRP on Spices, Horticulture Research Station (U.H.S.) Sirsi, UTTARA KANNADA (KARNATAKA) INDIA

<sup>2</sup>Department of Agronomy, College of Horticulture, (U.H.S.), Sirsi, UTTARA KANNADA (KARNATAKA) INDIA  
Email: sangappavpatil@gmail.com

<sup>3</sup>Department of Agricultural Microbiology, College of Horticulture, (U.H.S.), Sirsi UTTARA KANNADA (KARNATAKA) INDIA

Email: sbgurmurthy@yahoo.com

<sup>4</sup>Department of Plant Pathology, AICRP on Sesame and Niger, University of Agricultural Sciences, DHARWAD (KARNATAKA) INDIA

Email: pal\_uasd@gmail.com

<sup>5</sup>Indian Institute of Spices Research, CALICUT (KERALA) INDIA

Email: anandaraj@spices.res.in

## ARTICLE INFO

**Received** : 09.02.2012  
**Revised** : 18.06.2012  
**Accepted** : 12.09.2012

**Key Words :**

Potassium phosphonate,  
*Trichoderma harzianum*,  
Black pepper, Bordeaux  
mixture, Neem cake

\*Corresponding author:  
lokeshsirsi@rediffmail.com

## ABSTRACT

Phytophthora foot rot (*Phytophthora capsici* Leonian) was significantly least on black pepper (*Piper nigrum* L.) vines wherein disease incidence was minimum leaf yellowing, least defoliation, minimum death of vines and highest yield (green berry yield and projected yield) due to protection of vines to foliage and root zone with application of potassium phosphonate (@ 0.3 %) as spraying (@ 2 l<sup>vine</sup>) and drenching (@ 3 l<sup>vine</sup>) and soil application of *Trichoderma harzianum* Rifai. (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone during pre-monsoon (June) and peak monsoon (August). In case of farmers practice wherein only affected vines were applied with 1 per cent Bordeaux mixture to the foliage after appearance the disease. Those vines registered maximum leaf yellowing and maximum defoliation, maximum death of vines and lowest yield (green berry yield and projected yield).

**How to view point the article :** Lokesh, M.S., Patil, S.V., Gurumurthy, S.B., Palakshappa, M.G. and Anandaraj, M. (2012). Evaluation of combination of potassium phosphonate and *Trichoderma harzianum* on management of *Phytophthora* foot rot of black pepper (*Piper nigrum* L.) under arecanut cropping system. *Internat. J. Plant Protec.*, **5**(2) : 356-360.

## INTRODUCTION

Black pepper (*Piper nigrum* L.), the king of spices, and traditional historic spice is being cultivated as mixed crop in arecanut and coffee cropping system and also as pure crop since ancient times in India. Black pepper perennial woody

climber is native of the Western Ghats of South India. The cultivation of crop in the world is mainly confined to India, Brazil, Indonesia, Malaysia, Thailand, Sri Lanka and Vietnam. In India, Black pepper is being cultivated in Kerala (96%), Karnataka (3%) and to a lesser extent in Maharashtra, Andhra Pradesh, Tamil Nadu and North Eastern regions in an area of

2.2 lakh ha with a production of 70,000 tonnes. During the year 2008-2009, India exported more than half of the pepper produced here, that is 25,250 tonnes valued at Rs. 414.00 crores. Indian pepper fetches a premium price in major international markets because of its preference and intrinsic quality (Thomas, 2010).

In Karnataka, black pepper is cultivated in Coorg, Uttara Kannada, Dakshina Kannada, Shimoga, Chikmagalore and Hassan districts. Among the diseases of this crop, Phytophthora foot rot caused by *P. capsici* Leonian is a major and serious malady, causing huge economic loss and is the major constraint in its cultivation in Uttara Kannada district. of Karnataka under arecanut cropping system.

However, there is lot of literature available on the disease control with use of contact and systemic fungicides and bioagents. But there is lack of information on use of potassium phosphonate and bioagents in combination for management of the disease in arecanut cropping system. Hence, an attempt was made to investigate the efficacy of potassium phosphonate and *Trichoderma harzianum* (MTCC-5179) and compared with the farmers practice for control of the disease.

## MATERIALS AND METHODS

A field experiment on management of foot rot of black pepper was carried out by applying fungicides, bioagents and plant product like neem cake in a farmer's garden at Hosabale village, Sirsi taluka of Uttara Kannada district of Karnataka in central Western Ghats of India during 2006-07 to 2007-08 for two years. The object of the experiment was to know the efficacy of potassium phosphonate and *Trichoderma harzianum* combination on the disease management.

The vines were cultivated in arecanut as mixed crop, wherein the vines were trained to arecanut standards. The treatment details included fungicides, bioagents and their combinations. In each treatment, seven pepper vines were selected with seven replications. The treatments were taken as pre-monsoon and peak monsoon application, in June and August, respectively.

*T. harzianum* was obtained from Indian Institute of Spices Research, Calicut, Kerala and it was mass multiplied on moist wheat bran preparations (1:1 v/v) (Jahagirdar *et al.*, 2000). *T. harzianum* (50 g/ vine) was mixed with finely powder neem cake of 1 kg and was incorporated into top 10 cm layer of soil around the root zone during the month of June and August.

The fungicides *viz.*, Potassium phosphonate (0.3%), Bordeaux mixture (1%), copper oxychloride (0.2%) were applied as spraying (@ 2 l<sup>-vine</sup>) and drenching (@ 3 l<sup>-vine</sup>) along with biocontrol agent, *T. harzianum*. The treatments were compared with the farmers' practice wherein Bordeaux mixture (1%) was taken up as spraying once after the disease appearance and only to the affected vines.

Treatment details	
Treatment No.	Details
T <sub>1</sub>	Potassium phosphonate (0.3 %) + <i>Trichoderma harzianum</i> (MTCC-5179)
T <sub>2</sub>	Bordeaux mixture (1 %) spraying + Copper oxychloride (0.1 % a.i. ) drenching
T <sub>3</sub>	Farmers practice : 1 % Bordeaux mixture as spraying once after the disease appearance and only to affected vines

Number of vines showing leaf infection were recorded and presented as per cent leaf infection. For intensity of leaf infection, three areas (0.5 sq. m.) were randomly selected in the canopy of black pepper vines, preferably each at lower level, middle level and upper level of the canopy and number of leaves present and number of leaves infected by the disease were recorded and presented as per cent leaves infested by the disease.

Number of vines died due to the disease as death of vines were recorded and presented as per cent dead vines. Number of vines showing foliar yellowing and defoliation were recorded individually and presented as per cent disease index (PDI). For the intensity either foliar yellowing or defoliation grades were given based on the visual observations using the following scale, preferably in lower, middle and upper level and presented as foliar yellowing index/defoliation index.

Index	Foliar yellowing /Defoliation
0	Nil
1	Up to 25 %
2	25 to 50 %
3	More than 50 %

The treatments were applied twice in a year *i.e.*, June and August during 2006-2007 to 2007-2008. The observations on leaf infection, foliar yellowing, defoliation death of vines and yield (both green berry kg<sup>-vine</sup> and projected yield kg<sup>-ha</sup>) were recorded. The observations made for the disease incidence recorded from the experimental vines in the garden at different stages of disease development were subjected to statistical analysis as described by Gomez and Gomez (1984).

## RESULTS AND DISCUSSION

Disease incidence of black pepper with respect to leaf infection (%), foliar yellowing (PDI) defoliation (PDI), death of vines (%) and yield (both green berry kg<sup>-vine</sup> and projected yield kg<sup>-ha</sup>) were presented for each year *i.e.*, 2006-2007 and 2007-2008 and also presented and pooled from 2006-2007 to 2007-2008 data separately.

The data revealed during the year 2006-07 that disease incidence of Phytophthora foot rot of black pepper was with respect to less leaf infection (5.60 per cent), less foliar yellowing ( 10.00 PDI), less defoliation (13.33 PDI), no death of vine and highest green berry yield of 1.80 kg per vine when vines were treated during onset of monsoon (June) and again during third week of August with Potassium phosphonate (@ 0.3 per cent) as spraying (@ 2 l<sup>-vine</sup>) and drenching (@ 3 l<sup>-vine</sup>) and soil application of *Trichoderma harzianum* (MTCC-5179) @ 50 g<sup>-vine</sup> with one kg of neem cake to the root zone. This was closely followed by chemical check with application of (1 %) Bordeaux mixture as spraying (@ 2 l<sup>-vine</sup>) and copper oxychloride (@ 0.1 % a.i.) as drenching (@ 3 l<sup>-vine</sup>) where in less leaf infection ( 6.80 per cent), less foliar yellowing ( 16.66 PDI), low defoliation (19.98 PDI), less death of vine (4.0 per

cent) and more green berry yield of 1.74 kg per vine were recorded. Black pepper vines were severely affected by the disease viz., more leaf infection (20.00 per cent), more foliar yellowing (60.00 PDI) and high defoliation ( 56.66 PDI), more death of vines ( 12.00 per cent) with green berry yield of 1.45 kg per vine wherein the farmers practice of application of fungicide i.e., one per cent Bordeaux mixture as spray after appearance of the disease (Table 1).

The results during the year 2007-2008 indicated that black pepper vines were least infected with Phytophthora foot rot of black pepper where the vines were protected with potassium phosphonate (@ 0.3 per cent) as spraying (@ 2 l<sup>-vine</sup>) and drenching (@ 3 l<sup>-vine</sup>) and soil application of *Trichoderma harzianum* (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon ( June 2007) and

**Table 1: Management of Phytophthora disease of black pepper in farmers' field as adoptive trial (2006-2007)**

Treatments	Leaf infection (per cent)	Foliar yellowing (PDI)	Defoliation (PDI)	Death of vine (Per cent)	Green berry yield (kg/vine)	Projected yield (kg/ha)**
T <sub>1</sub> . Potassium phosphonate (0.3 %) + <i>Trichoderma harzianum</i> +1 kg neem cake	5.60 (9.40)	10.00 (18.36)	13.33 (21.33)	0.0 (0.00)	1.80 (7.70)	742.50
T <sub>2</sub> . Bordeaux mixture (1 %) spraying + Copper oxychloride (0.1 % a.i.) drenching	6.80 (12.06)	16.66 (23.62)	19.98 (26.30)	4.0 (6.14)	1.74 (7.57)	717.75
T <sub>3</sub> Farmers, practice, Bordeaux mixture (1%) as spraying once after the disease appearance and only to affected vines	20.00 (24.60)	60.00 (50.76)	56.66 (48.87)	12.0 (17.16)	1.45 (6.91)	598.45
S.E. ±	3.77 (5.00)	2.23 (1.68)	1.96 (1.34)	2.30 (3.16)	0.06 (0.13)	
C.D. @ 5 %	11.63(15.41)	7.14(5.16)	6.05 (4.13)	7.07 (9.75)	0.18 (0.39)	

\*arc sin transformed values \*\* 32 per cent drv age

**Table 2 : Management of Phytophthora foot rot disease in black pepper (adaptive trial) (2007-2008)**

Treatments	Leaf infection (per cent)	Foliar yellowing (PDI)	Defoliation (PDI)	Death of vines (%)	Green berry yield (kg/vine)	Projected yield (kg/ha)**
T <sub>1</sub> .Potassium phosphonate (0.3 %) + <i>Trichoderma harzianum</i> + 1 kg neem cake	4.57 (10.67)*	14.28 (21.88)	12.92(20.91)	10.20(14.13)	0.77 (5.04)	319.39
T <sub>2</sub> . Bordeaux mixture (1 %) spraying + Copper oxychloride (0.1 % a.i.) drenching	7.23 (13.71)	16.32 (23.76)	17.00 (24.04)	12.24(19.03)	0.72 (4.85)	291.54
T <sub>3</sub> Farmers practice, Bordeaux mixture (1%) as spraying once after disease appearance and only to affected vines	23.29 (28.59)	31.97 (34.32)	36.73 (37.23)	38.76 (38.38)	0.60 (4.44)	248.09
S.E. ±	2.35 (2.80)	1.86 (1.34)	2.07 (1.50)	3..33 (3.77)	0.03 (0.12)	14.61
C.D. @ 5 %	7.26 (8.78)	5.74 (4.14)	6.38 (4.63)	10.26 (11.60)	0.10 (0.35)	45.03

\*arc sin transformed values , \*\* 33 per cent dry age

peak monsoon (Aug. 2007). The vines were depicting least leaf infection (4.57 %), least yellowing (14.28 PDI), defoliation (12.92 PDI) and death of vines (10.20 per cent) and highest green berry yield (0.77 kg per vine and 319.39kg /ha projected yield). In case of chemical check wherein the vines were applied with (1 per cent) Bordeaux mixture as spraying (@ 2 l<sup>-vine</sup>) and drenching (@ 3 l<sup>-vine</sup>) with copper oxychloride (@ 0.1 per cent a.i.) during June and August 2007, exhibited low incidence of leaf infection (7.23%), less foliar yellowing (16.32 PDI), low defoliation (17.00 PDI), less death of vines (12.24) and more green berry yield (0.72 kg/vine and 291.54 kg/ha projected yield). Upon comparison to the farmers' practice for the disease management by application of Bordeaux mixture (@ 1 per cent) to the affected vines after the appearance of the disease as spraying, recorded maximum leaf infection (23.29%), maximum leaf yellowing (31.97 PDI), maximum defoliation (36.73 PDI) and more death of vine (38.76) and least green berry yield (0.60 kg per vine and 248.09 kg/ha projected yield (Table 2).

Pooled data of two years (2006-07 and 2007-08) showed that *Phytophthora* foot rot incidence was least on black pepper vines wherein disease incidence was minimum leaf infection (5.09 %), foliar yellowing (12.14 PDI), least defoliation (13.12 PDI), minimum death of vines (5.10 %), highest yield (1.29 kg<sup>-vine</sup> green berry yield and 532.13 kg<sup>-ha</sup> projected yield and highest cost benefit ratio (1:2.35) due to protection of vines to foliage and root zone with application of potassium phosphonate (@ 0.3 %) as spraying (@ 2 l<sup>-vine</sup>) and drenching

(@ 3 l<sup>-vine</sup>) and soil application of *Trichoderma harzianum* (MTCC-5179) @ 50 g per vine with one kg of neem cake to the root zone during pre monsoon ( June) and peak monsoon (August, Table 3). This was followed by application to the vine as spraying (@ 2 l<sup>-vine</sup>) with 1 per cent Bordeaux mixture and drenching (@ 3 l<sup>-vine</sup>) with copper oxychloride (@ 0.1 per cent a.i.) during June and August revealed leaf infection (7.01 %) foliar yellowing (16.49 PDI), low defoliation (18.49 PDI), less death of vines (8.12 %) more yield (1.23 kg<sup>-vine</sup> green berry yield and 507.37 kg<sup>-ha</sup> projected yield) and more cost benefit ratio (1:2.15). The above treatments were compared with the farmers practice wherein only affected vines were applied with 1per cent Bordeaux mixture to the foliage after appearance the disease. Those vines recorded highest leaf infection (21.64 %), maximum leaf yellowing (45.95 PDI) and maximum defoliation (46.69 PDI), maximum death of vines (25.38%) and lowest yield 1.03 kg<sup>-vine</sup> green berry yield and 424.88 kg<sup>-ha</sup> projected yield .

In the present investigation of field trial on integrated disease management of *Phytophthora* foot rot of black pepper, with various treatments or their interactions revealed a positive effect on significant reduction in disease intensity on treated vines. The present investigation results showed that crucial stages during disease development and death of vines were leaf infection, foliar yellowing, defoliation and final stage is death of vine with initiation of the disease after start of monsoon in the month of June and death of vine in late monsoon *i.e.*, in September –October. Treating the vines

**Table 3 : Management of *Phytophthora* foot rot disease in black pepper (adaptive trial) pooled (2006-2007 and 2007-2008)**

Treatments	Leaf infection (%)	Foliar yellowing (PDI)	Defoliation (PDI)	Death of vines (%)	Green berry yield (kg/vine)	Projected yield (kg/ha)**	Cost :Benefit ratio
T <sub>1</sub> . Potassium phosphonate (0.3 %) + <i>Trichoderma Harzianum</i> +1 kg neem cake	5.09 (10.04)	12.14 (20.12)	13.12 (21.12)	5.10 (7.07)	1.29 (6.37)	532.13	1:2.35
T <sub>2</sub> . Bordeaux mixture (1 %) spraying + Copper oxychloride (0.1 % a.i.) drenching	7.01 (12.88)	16.49 (23.70)	18.49 (25.17)	8.12 (12.59)	1.23 (6.21)	507.37	1:2.15
T <sub>3</sub> Farmers, practice Bordeaux mixture (1%) as spraying once after the disease appearance and only to affected vines	21.64 (26.60)	45.95 (42.54)	46.69 (43.05)	25.38 (27.77)	1.03 (5.67)	424.88	-
S.E. ±	3.01 (4.06)	4.65 (5.10)	4.49 (5.12)	3.89 (4.32)	0.13 (0.88)		
C.D. @ 5 %	8.74 (11.79)	13.51 (14.82)	13.06 (14.88)	11.30 (12.57)	0.39 (2.55)		

\*arc sin transformed values \*\*33 per cent dry age

during June and August months with fungicides and bioagents helped in reducing the inoculum levels in the soil and protected the vines from various stages on infection viz., leaf infection, foliar yellowing, defoliation and death of vine.

The vines applied with combination of systemic fungicide and bioagents along with plant product neem cake, i.e. Potassium phosphonate as spray and drench followed by bioagents *T. harzianum* (MTCC-5179), and neem cake to the root zone as soil application combated the disease significantly and brought down leaf infection, foliar yellowing, defoliation and death of vine to the lowest level. This indicates that there may be synergistic effect of treatment combination on reducing the inoculums and triggering the protection to the vine against the disease. The present investigation on integrated disease management is practical oriented and showed that the components of IDM as eco-friendly, economically feasible and compatible. The application of neem cake + phorate + Bordeaux mixture + Akomin (Potassium phosphonate) was found effective in Phytophthora disease of pepper (Anonymous, 1996). The combined application of *Trichoderma viride* + Akomin brought down incidence of black pepper wilt (Anonymous, 1996). The present study on the results of integration of systemic fungicides and bio-agents were also found similar to the findings of Hegde and Anahosur (1998), Jahagirdar *et al.* (2000) and Srinivasan *et al.* (2003).

Thus, potassium phosphonate (0.3 %) as spraying and drenching with soil application of *T. harzianum* (MTCC-5179), (50 g vine<sup>-1</sup>) along with neem cake (1 kg vine<sup>-1</sup>) to the black pepper vines against Phytophthora foot rot served as best treatment when compared to the farmers practice with use of 1 per cent Bordeaux mixture as spray. The outcome of the

present findings are best practices for protecting the black pepper vines during monsoon against the dreaded disease of the crop.

#### Acknowledgement :

The authors are grateful to Dr. M. Anandaraj Director and Project Co ordinator (Spices), Indian Institute of Spices Research, Calicut, India for his encouragement, technical guidance and financial support for conducting the experiments. The authors also acknowledge the help of progressive farmer, Mr. Ramananda Hegde, Hosabale, Sirsi, Uttara Kannada, Karnataka for supporting and providing plantation for the experiment.

#### REFERENCES

- Anonymous (1996).** Annual Progress. Report. (1996). Indian Institute of Spice Research, Calicut (KERALA) INDIA.
- Gomez, K.A. and Gomez, A.A.(1984).** *Statistical procedure for agricultural research*, John Wiley and Sons Inc., New York, UNITED STATES of AMERICA.
- Hegde, S.G. and Anahosur, K.H. (1998).** Integrated management of foot rot of black pepper. *Karnataka J. Agric. Sci.*, **11**: 78-82.
- Jahagirdar, S., Siddaramaiah, A.L. and Chandrappa, H.M. (2000).** Eco-friendly integrated management of foot rot of black pepper (*Piper nigrum*). *Mysore J. Agric. Sci.*, **34**: 47-54.
- Srinivasan, V., Sasikumar, B., Thankamani, C. K., Veena, S. S. and Sarma, Y. R. (2003).** Annual Report (2002-03). Indian Institute of Spice Research, Calicut (KERALA) INDIA p.49.
- **WEBLIOGRAPHY**
- Thomas, K.V. (2010).** Awards for excellence in exports and productivity ASEAN pact opening markets for India. [www.indianspices.com/php/pic\\_month.php](http://www.indianspices.com/php/pic_month.php).

\*\*\*\*\*