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Management of foot rot (*Phytophthora capsici*) disease of black pepper (*Piper nigrum* L.) through fungicides and cultural practices in Southwestern Ethiopia

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ABSTRACT

The pathogen *Phytophthora capsici*, which causes black pepper foot rot, is the most detrimental disease that affects black pepper productivity and lowers qualitative and quantitative spike yields in southwest Ethiopia. The effectiveness of several fungicides and cultural methods against *Phytophthora capsici* in black pepper was tested in a field experiment. Five commercial fungicides and cultural practices were examined, and a natural *Phytophthora capsici* infection was noted. Disease incidence was determined by visually observing leaf blight, spike infection, leaf shedding, and vine yellowing. The most effective fungicide, with a disease incidence of 14.3%, was Koka blue 50 WG (Copper oxychloride) spraying when combined with cultural approaches. More 720 WP (Mancozeb + Cymoxanil), a combination of cultural practices and 19.1% disease incidence, came next. Agro-laxyl 63.5 WP (Metalaxyl + Mancozeb) and Progress 250 EC (Propiconazole 25%) combined with cultural practices were also effective against Phytophthora infection and found better than only cultural practices applied plot and control.

Keywords: Black pepper, Cultural practices, Fungicides, Integration, Phytophthora foot rot

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Introduction

Southwest Ethiopia has long been a center for cultivating black pepper (*Piper nigrum* L.), the king of spices. Black pepper is planted as a sole crop supported by live *Erythrina indica, Grevillea robusta*, etc. trees. In southwestern Ethiopia, one of the main diseases that affect black pepper production is foot rot disease, which is brought on by *Phytophthora capsici* (Jibat and Alo, 2021). According to Kifelew and Adugna (2018), this disease can cause a loss of vines of up to 21.4%, and in some gardens, that loss may even reach 95% (Anandaraj *et al.*, 1989). Plant pathogen *Phytophtora capsici* is a polycyclic oomycete, and it is difficult to find host resistance. Black pepper's leaf, stem, spike, collar, and root are all infected by the disease. On leaves, the infection starts as water-soaked lesions that enlarge into dark brown spots with fimbriate margins and occasionally a greyish color. Depending on the disease's intensity, foliar infection causes variable degrees of defoliation. Spikes become infected, which causes them to shed. On delicate and woody stems, infection appears as dark, moist areas that progressively decay and cause die-back symptoms. According to Manohara *et al.* (2004), the most significant vine infections are collar and root infections, which cause quick wilting, defoliation, and vine mortality.

Debris from infected plants, the main source of inoculum, can support the pathogen's year-round survival in the soil. According to Ravindran (2000), the disease is spread by termites, slugs, rain splash, soil, water, contact with roots, infected items, and water. An integrated strategy integrating cultural and chemical control is required for the effective management of this disease because *Phytophthora capsici* is a polycyclic oomycete plant pathogen, and host resistance against the pathogen is not readily available (Anandaraj, 2000). However, chemical control is mainly used management method for black pepper foot rot. For the prevention of foot rot, it is advised to use fungicides like metalaxyl, phosphonates, and copper-based fungicides (KAU, 2011; Anandaraj, 2000). However, continuous use of a single fungicide molecule led to the formation of resistant pathogen isolates (Gisi and Cohen, 1996), which is why combination products are now utilized (Ramachandran *et al.*, 1991). Contact fungicides do not effectively control the disease during periods of heavy rain, especially following the development of the disease in the field (KFRI, 1996). Therefore, there is a clear need for more fungicides to be included in the integrated disease management plan to reduce the number of pathogens in the soil and manage infections. It has been discovered that a number of new fungicides have action against this oomycete disease (Thind, 2011). Taking into account the ones mentioned above, the present study was conducted with the following objective:

- To evaluate the effect of cultural practices and fungicides on the black pepper foot rot disease epidemics development.

Materials and Methods

During the main cropping seasons of 2021 and 2022, the field experiment was carried out at Tepi Agricultural Research Centre. Since the sites are hot spots for the disease and the field is severely affected by it, the experiment solely depended on natural foot rot epidemics. The trial was set up using a randomized block design, with five different fungicides combined with cultural practices and check as treatments and three replications. Six plants per treatment, or two plants per plot in each replication, were used. The treatments include Progress 250 EC (Propiconazole 25%) + Cultural practices, Koka blue 50 WG (Copper oxychloride) + Cultural practices, Agro-laxyl 63.5 WP (Metalaxyl + Mancozeb) + Cultural practices, Cultural practices alone control, and Ethiozeb 80% WP (Mancozeb) + More 720 WP (Mancozeb + Cymoxanil) + Cultural practices. Beginning with the appearance of foot rot signs on the leaf, stem, root, and spike of black pepper plants, fungicide treatments were applied at intervals of fifteen days. The cultural practices used contribute to the development of diseases and, if properly applied, are crucial to managing the disease. All of the treatments, except control, adopted recommended cultivation practices such as managing shade and canopy, support tree pruning and weed control, frequent and complete black pepper spike harvesting, sanitizing wilted branches and spikes, mulching, plant and field hygiene, and other practices.

Disease assessment

During two years of treatment applications, natural infections caused by Phytophthora infections were noted every 15 days. Disease incidence was recorded by visually observing leaf blight, spike infection, leaf shedding, and vine yellowing. The experimental plants were evaluated and scored using a scale of 0 to 5 based on the infected area. Infection rates are expressed as follows: 0 = No infection, 1 = 1–10% infection, 2 = 1–25% infection, 3 = 26–50% infection, 4 = 51–75% infection, and 5 = greater than 75% infection. For analysis, the severity scores were then converted to the percentage of disease incidence (PDI) (Wheeler, 1969).

$$\mathrm{PDI}(\%) = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves observed X Maximum disease score}} \mathrm{X100}$$

Where; PDI = Percent disease incidence

Data analysis

Analysis of variance was carried out to determine how treatments affected disease incidence. For mean separation, the least significant difference (LSD at 5% probability level) was used. The Statistical Analysis System (SAS) Version 9.3 (SAS Institute, 2014) was used for all data analysis.

Results and Discussion

The findings revealed that most fungicides significantly outperformed the control in Phytophthora infection control in black pepper field (Table 1). Except for Ethiozeb 80% WP (Mancozeb) combination with cultural practices and cultural practices alone treated plants, all evaluated fungicides significantly decreased disease incidence compared to control plants. When Koka blue 50 WG (Copper oxychloride) was applied with cultural activities, the lowest disease incidence rate (14.3%) among the fungicides and cultural practices was noted. More 720 WP (Mancozeb + Cymoxanil) paired with cultural practices (19.1%) and Progress 250 EC (Propiconazole 25%) mixed with cultural practices (21.3%) were the subsequent effective treatments. Both cultural practices alone and cultural practices combined with Ethiozeb 80% WP (Mancozeb) were less successful in treating the foot rot disease of black pepper.

Table 1. Effect of fungicides and cultural treatments on Phytophthora foot rot infection incidence in black pepper fields during the main cropping season of 2021/2022.

Treatments	Disease incidence (%)	% reduction over control
T1: Koka blue 50 WG (Copper oxychloride) + Cultural practices	14.3[c]	56.8
T2: Agro-laxyl 63.5 WP (Metalaxyl + Mancozeb) + Cultural practices	21.7[b]	36.3
T3: Progress 250 EC (Propiconazole 25%) + Cultural practices	21.3[b]	35.6
T4: Ethiozeb 80% WP (Mancozeb) + Cultural practices	28.3[a]	14.5
T5: More 720 WP (Mancozeb + Cymoxanil) + Cultural practices	19.1[b]	42.2
T6: Cultural practice only	31.3[a]	5.4
T7: Control	33.1[a]	-
LSD (5%)	4.8	
CV (%)	10.66	

Means followed by the same letter(s) within a column and between adjacent columns are not significantly different at 5% level of significance.

A combined analysis of the two years of data showed that all the tested fungicides significantly decreased the disease, as demonstrated by the lower percent disease incidence. The most effective treatment was Koka blue 50 WG (Copper oxychloride) combined with cultural practices, which decreased the disease incidence by 56.8% in comparison to the control. The second-best treatment found was More 720 WP (Mancozeb + Cymoxanil) combined with cultural practices, which caused 42.2% less disease than the control. Similar to this outcome, research by Ramachandran *et al.* (1991); Anandaraj and Sarma (1995); KAU (2011) showed that application of Bordeaux mixture and copper oxy chloride reduced Phytophthora foot rot infection than control. According to Anjaneya Reddy *et al.* (2015) and Padmaja *et al.* (2015), several novel fungicide compounds with various modes of action have been tested and reported against several Phytophthora species. When soil was treated with Reason (Fenamidone) + Previcur Flex (Propamocarb) and Dimethomorph, Michael and Martin (2008) found higher pepper plant survival in soil infested with *Phytophthora capsici*. Anith and Manomohandas (2001) and Manoranjitham *et al.* (2001) published reports on the use of biocontrol agents in combination for improved disease control. For better disease suppression, the fungal-bacterial combination may use one or more of their antagonistic mechanisms working separately or simultaneously in a synergistic manner.

Conclusion

The characteristics of the pathogen and the potential for fungicide residues to persist in pepper make management of pepper foot rot disease challenging. Using fungicides alone to completely control the disease is quite challenging. Along with chemical control techniques, an integrated approach combining phytosanitation, proper cultural practices, and the use of bio-pesticides is required. Black pepper's Phytophthora infection was significantly reduced in the current study as a result of foliar application of Koka blue 50 WG (Copper oxychloride) in combination with cultural practices, which was repeated three times during the season. For stronger defense against the devastating plant pathogen *Phytophthora capsici* in black pepper, much more study may be done by combining chemical fungicides with microorganisms that encourage plant growth.

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References

Anandaraj, M. 2000. Diseases of black pepper. In: Black Pepper (*Piper nigrum*). Ravindran, P. N. (ed.). Harwood Academic Publishers: Amsterdam, The Netherlands, pp. 245-275.

Anandaraj, M., Abraham, J. and Balakrishnan, R. 1989. Crop loss due to foot rot disease of black pepper. *Indian Phytopathol.* 42: 473-476.

Anandaraj, M. and Sarma, Y.R. 1995. Diseases of black pepper (*Piper nigrum* L.) and their management. *J. Spices Aromatic Crops.* 4: 17-23.

Anith, K.N. and Manomohandas, T.P. 2001. Combined application of *Trichoderma harzianum* and *Alcaligenes* sp. strain AMB 8 for controlling nursery rot disease of black pepper. *Indian Phytopathol.* 54: 335-339.

Anjaneya Reddy, B., Sreenath, A., Rekha, D. and Devappa, V. 2015. Field efficacy of new fungicide molecules against late blight of potato in Southern Karnataka. Abs. *In:* 3rd International Symposium on *Phytophthora*: Taxonomy, Genomics, Pathogenicity, Resistance and Disease Management, Chowdappa P. Vinayaka Hegde and Muralikrishna, H. (eds.) ICAR-IIHR, Bengaluru, 9-12, September, 2015. p. 54.

Gisi, U. and Cohen, Y. 1996. Resistance to phenylamide fungicides - A case study with *Phytophthora infestans* involving mating type and race structure. *Annu. Rev. Phytopathol.* 34: 549-572. https://doi.org/10.1146/annurev.phyto.34.1.549

Jibat, M. and Alo, S. 2021. Characterization of *Phytophthora capsici* foot rot disease of black pepper in Ethiopia. *J. Plant Pathol. Microbiol.* 12: 537.

KAU. 2011. Package of Practices Recommendations: Crops. 14th edition. Directorate of Extension, Kerala Agricultural University, Thrissur, India. 360p.

KFRI, 1996. Fungicidal management of quick wilt disease of black pepper in forest plantations. KFRI Research Report 111, Kerala Forest Research Institute, Peechi, Thrissur, p. 12.

Kifelew, H. and Adugna, G. 2018. Study on P*hytophthora capsici* Cause of Foot Rot Disease on Black Pepper (*Piper nigrum* L.), Tepi, Ethiopia. *Int. J. Res. Stud. Agril. Sci.* 4(5): 1-7. http://dx.doi.org/10.20431/2454-6224.0405001

Manohara, D., Mulya, K. and Wahyuno, D. 2004. *Phytophthora* disease on black pepper and the control measures. *Focus on pepper.* 1: 37-49.

Manoranjitham, S.K., Prakasam, V. and Rajappan, K. 2001. Biocontrol of damping off of tomato caused by *Pythium aphanidermatum. Indian Phytopathol.* 54: 59-61.

Michael E. Matheron and Martin Porchas, 2008. Efficacy of new fungicides as potential management tools for Phytophthora crown and root rot on pepper plants. Vegetable Report. p. 152.

Padmaja, G., Kanaka Mahalakshmi, B., Uma Devi, G. and Sridevi, D. 2015. Studies on efficacy of fungicides and their dosage against *Phytophthora colocasiae* causing leaf blight of Taro Abs. *In:* 3rd International Symposium on *Phytophthora* : Taxonomy, Genomics, Pathogenicity, Resistance and Disease Management, Chowdappa P. Vinayaka Hegde and Muralikrishna, H. (eds.) ICAR-IIHR, Bengaluru, 9-12, September, 2015. p. 49.

Ramachandran, N., Sarma, Y.R. and Anadaraj, M. 1991. Management of Phytophthora infection in black pepper. *In:* Sarma Y. R. and Premkumar (Eds) Diseases of Black Pepper. In: Proc. International Workshop on Joint Research for the Control of Black Pepper Diseases. 27-28 October 1988, Goa, India. pp. 158-174.

Ravindran, P.N. 2000. Constraints and yield gaps in Black pepper. In: Black Pepper (*Piper nigrum*). Ravindran, P.N. (ed.). Harwood Academic Publishers: Amsterdam, The Netherlands. pp. 497-504.

SAS Institute. 2003. SAS/STAT User's Guide, Version 9.3. Cary, SAS Institute Inc, NC, USA.

Thind, T.S. 2011. New generation anti oomycete fungicides: Prospects and limitations. *Plant Dis. Res.* 26: 159.

Wheeler, B.E.J., 1969. An introduction to plant diseases. An introduction to plant diseases. John Wiley & Sons, Inc., New York, USA. 374p.