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RESEARCH GAPS IN INSECTS AND DISEASES OF BLACK PEPPER (*Piper nigrum*): A REVIEW

M.S.A. TALUCDER[*1&2], A.U. KHAN[1&3], M. KAMRUJJAMAN[1&4], M.A.S. ROBI[1], M.P. ALI[5] AND M.S. UDDIN[1]

[1]Climate-Smart Agriculture Lab, Department of Agroforestry and Environmental Science, Sylhet Agricultural University, Sylhet-3100, Bangladesh; [2]Interdisciplinary Research for Future Agriculture, Sylhet Agricultural University, Sylhet-3100, Bangladesh; [3]Department of Entomology, Sylhet Agricultural University, Sylhet-3100, Bangladesh; [4]ACI Motors Limited, Sylhet Division, Sylhet-3100, Bangladesh; [5]Entomology Division, Bangladesh Rice Research Institute, Gazipur-1701, Bangladesh.

*Corresponding author & address: Mohammad Samiul Ahsan Talucder, E-mail: talucdermsa.aes@sau.ac.bd
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ABSTRACT

Talucder MSA, Khan AU, Kamrujjaman M, Robi MAS, Ali MP, Uddin MS (2020) Research gaps in insects and diseases of black pepper (*Piper nigrum*): a review. *J. Expt. Agric.* 10(1), 44-52.

Black pepper (*Piper nigrum*) is economically high-ranking and the most widely used spice crop around the globe including Bangladesh. The objective of this study is to document the research gaps in insects and diseases of black pepper in Bangladesh with other growing countries. The article is based on mostly existing literature and partly field observation from Sylhet region in Bangladesh. So far, many research works were done on these issues but all are not available to the policy makers, extension workers and public in a systematic manner to date. In the black pepper growing countries, major insects are pollu beetle (*Longitarsus nigripennis*), scale insects (*Lepidosaphes piperis* and *Aspidiotus destructor*), top shoot borer (*Cydia hemidoxa*), leaf gall thrips (*Liothrips karnyi* and *Gynaikothrips uzeli*), and root mealy bugs (*Diconocoris hewetti*) and pepper whitefly (*Aleurodicus disperses*) and major diseases are root rot (*Fusarium solani*), yellow wilt (*Fusarium oxysporum*), nematode (*Meloidogyne incognita* and *Meloidogyne javanica*), stunt disease were reported. On the contrary, leaf blight (*Colletotrichum gloeosporioides*) and algae leaf spot (*Cephaleuros virescens*), foot rot (*Fusarium solani*), wilt diseases and flea beetle, ant (*Tetramorium* spp.), pepper white flies, spiders were reported in Bangladesh. In addition, quick wilt and slow decline infection as well as top shoot borer and pollu beetle infestation like symptoms were also observed which requires further confirmation. It is noted that, black pepper growers in Bangladesh have no idea on the insects and diseases attack and their appropriate management which hinders expansion of area and production of black pepper in Bangladesh. More attention is required for proper management of insects and diseases of black pepper in Bangladesh. Hence, direct field observation on insects and diseases of black pepper is ongoing in the black pepper germplasm centre situated in Tilagorh Eco-Park of Sylhet and agroforestry field laboratory of Sylhet Agricultural University which will be reported in the next manuscript.

Key words: *black pepper, piper nigrum, insects, diseases*

INTRODUCTION

Black pepper (*Piper nigrum*), "King of spices" (Srinivasan 2007), is the most traded important spices crop in the world (Ravindran 2000b; Hema 2007). Presently, it is largely cultivated in India, Brazil, Indonesia, Malaysia, Vietnam and China (Philip *et al.* 1992; Talucder 2019).

It is cultivated sporadically in Bangladesh, specially in the Sylhet region. According to AIS (2016), the area under organized cultivation of spices crops is 374 thousand hectares, which shared only 3% of cultivable land, where the cultivable land under black pepper is about only 5 ha in Sylhet, Habigonj and Bogura district which produces only 6 Metric tons. However, the area and production status of black pepper are not available in the BBS (2017). Haque *et al.* (2017) reported that Bangladesh imports more than 120 thousand tons of turmeric, ginger, black pepper, cinnamon and cardamom. Black pepper has a high domestic demand in Bangladesh. Estimated 16.7 million homestead of the country occupy about 0.3 million hectare of land, which is increasing sharply with the increase of population. There is a great scope to cultivate black pepper under agroforestry framework. In addition, the climatic and soil condition of Sylhet region are congenial for the growth and development of black pepper (Talucder 2015; Talucder 2018a; Talucder 2018b).

Several factors are responsible for decreasing yield of black pepper, among which insects and diseases are serious concern for black pepper cultivation. In India, the yield of black pepper is decreasing mainly due to disease and insect infestation (Sarma *et al.* 1991). But, there are very few research articles on insects and diseases of black pepper in Bangladesh. Therefore, this review documented the research works on insects and diseases of black pepper in different countries which will help in future program for enhancing black pepper productivity.

MATERIALS AND METHODS

To document the present status of the scientific information on insects and diseases of black pepper, a review of the existing journal literature, books, report, blogs and newspaper were carried out. Keywords (black pepper, *Piper nigrum*, insects, diseases) search in the google, google scholar, web of science database (www.thomsonreuters.com/web-of-science) and a full-text search of the science direct (www.sciencedirect.com) database were carried out. Information was also collected from government organization as well as non-government organizations by personal communication.

INSECTS AND DISEASES OF BLACK PEPPER IN DIFFERENT COUNTRIES

Insects of Black Pepper

The black pepper has substantial economic importance for the exporting its product in world market. Its production is hampered due to a number of insect attacks in the pepper vine. Pepper is infested by 56 species of insects in India damaging various parts of the vine such as roots, stems, shoots, leaves, spikes and berries. However, Devasahayam *et al.* (1988) found five insects causing significant damage to the fruit of black pepper which were classified as major and minor based on the nature and extent of damage. The major pests are those which frequently cause a very distinct economic damage and minor pests are those insects which are often found but cause less serious damage (Halteren 1979). However, depending on the severity and extent of damage, pollu beetle, top shoot borer, leaf gall thrips and scale insects could be considered as major pests (Devasahayam 2000; Daba *et al.* 2017).

The bark weevil/stem borer of pepper (*Lophobaris piperis*), leaf gall thrips (*Liothrips karnyi*), pollu beetle (*Longitarsus nigripennis*), top shoot borer (*Cydia hemidoxa*), scale insects (*Lepidosaphes piperis*), pepper berry bug (*Dasynus piperis*), pepper lace bug (*Diconocoris hewetti*) and pepper whitefly (*Aleurodicus dispersus*) are commonly observed in black pepper field (Table 1). Among them pollu beetle, scale insects, top shoot borer, leaf gall thrips and root mealy bugs are considered as the major insect pests (Devasahayam 2000). The nature of damage of major insect pests briefly documented below:

Pepper stem borer (*Lophobaris piperis*): The pepper stem borer is one of the major pests in black pepper vine plant. They are also known as bark weevil. The black pepper plants were attacked by borer and damaged the stem and branches. The borer caused 42.83% damage by attacking on the base of the pepper stem (Indriati and Trisawa 2011). The caterpillars of the moth bore into tender shoots which turn black and dry up. Soetopo (2012) reported that the borer makes damage young flowers, fruits, shoots, leaves, stem and branches. Higher infestation occurs during July-November when new shoots emerges. They can cause yield loss up to 72% (Lestari *et al.* 2019). Stem borer insect is becoming a serious problem at Bebeke State farm in Ethiopia (Daba *et al.* 2017; Girma 2015).

Pepper whitefly (*Aleurodicus dispersus)*: The pepper whitefly is a major insect in humid tropical areas around the world (Yap and Zehnder, 2016). The lower leaf surface of black pepper is mainly infested by adult white flies. Yap (2018) observed that the fly could defoliate and caused decline in pepper vine vigor and yield of fruit. The adult insects decrease the vigor of vine and yields. The vigor of infested vine is reduced 17.1% and 50% for whitefly adult and nymphs, respectively and the heavy colonization of the fly encouraged the sooty mould and reduced photosynthesis rate (Anonymous 2016).

Root mealy bugs (*Planococcus* sp., *P. citri, P. lilacinus, Dysmicoccus brevipes and F. virgata*): Mani *et al*. (2016) stated that the mealy bugs were associated with damaged roots and pepper vines. Infested plant shows poor growth, leaves wilt or turn yellow. Several infestations are occurred during the post monsoon.

Leaf gall thrips (*Liothrips karnyi*): Leaf gall thrips are more serious pest in younger vine and nursery plants (Devasahayam and Koya, 1994). They feed on leaves. The infested leaves become thick, malformed and crinkled (Ravindran *et al.* 2000). Leaf gall thrips are observed seriously infesting black pepper plants (23.2-28.4%) in southwestern part of Ethiopia (Daba *et al.* 2017). Apart from leaf gall, the pest infestation resulted in reduction in size and malformation of infested leaf. Banerjee *et al*. (1981) also recorded that the leaf thrips were the most serious pest of black pepper in south Wynad area in Kerala.

Top shoot borer (*Cydia hemidoxa*): In young plant, the top shoot borer mainly damages the vines and 100% damage the terminal shoot. In June to December, 57% reduction in growth of vine is occured by top shoot borer. The adult moths are more available in young and tender shoot during July-November which bore the tender shoot and feed terminal part of vine (Devasahayam and Koya, 1994).

Scale insects (*Lepidosaphes piperis and Aspidiotus destructor*): Two types of scale insects are found in black pepper plant such as mussel scale and coconut scale which are becoming serious insect pests of black pepper (Selvakumaran *et al.* 1996). The mussel scale covers the stems, lateral branches, mature leaves and resulting in yellowing and drying of leaves and mortality increase in young vines. The infested branches show wilt in the field. The coconut scale infests mature leaves. In post-monsoon and summer, the infestation rate is observed higher than the other time (Selvakumaran *et al.* 1996).

Pollu beetle (*Longitarsus nigripennis*): Pollu beetles belonging to Chrysomelidae families are the most destructive pest of black pepper in India (Devasahayam *et al.* 1988) and feed on tender shoots, leaves of black pepper in the lower advancement (Devasahayam and Koya, 1994). The larva bores the young spikes. The necrotic patches are developed infested spikes and the berries become gloomy. The plants in shades area of crop plantations are mainly infested by this type of insect (Ravindran 2000a).

Table 1. List of insects and diseases of black pepper

Common name	Scientific name	Pest status	References
		Insects	
Stem borer	*Lophobaris piperis*	Minor	Indriati and Trisawa, 2011; Soetopo 2012; Lestari *et al.* 2019.
Whitefly	*Aleurodicus dispersus*	Minor	Yap and Zehnder, 2016; Yap 2018; Ann 2019.
Root mealy bugs	*Planococcus* sp.	Minor	Mani *et al.* 2016
Leaf gall thrips	*Liothrips karnyi* Bagn.	Major	Ravindran *et al.* 2000; Devasahayam and Koya, 1994.
Top Shoot borer	*Cydia hemidoxa* Meyr.	Major	Devasahayam and Koya, 1994
Scale insects	*Lepidosaphes piperis*	Major	Selvakumaran *et al.* 1996
Pollu beetle	*Longitarsus nigripennis*	Major	Devasahayam and Koya, 1994; Ravindran *et al.* 2000.
Bug	*Ferrisia virgata*; *Planococcus* sp.; *Pseudococcus* sp.; *Xenococcus annandalei*	Minor	Koya *et al.* 1996
		Diseases	
Foot rot	*Fusarium solani* f. sp. *piperis* Leon	Major	Kueh 1990; Sarma *et al.* 1992; Anandaraj 2000; Anith *et al*. 2002; Sarma 2003; Manohara *et al.* 2004; Tremacoldi 2010; Sarma *et al*. 2013; LSPA 2017.
Wilt	*Fusarium oxysporum*	Major	Truong *et al.* 2008; Mustika 2015; Maria *et al.* 2001; Syakir *et al.* 2019; Anandaraj 2000.
Nematode	*Meloidogyne incognita*	Major	Holdeman 1986; Sarma *et al.* 1991; Maria *et al.* 2001; Tremacoldi 2010; Shahnazi *et al*. 2012; Thuy *et al.* 2012; Sarma *et al.* 2013; Mustika 2015; LSPA 2017; Syakir *et al.* 2019; Krishna and Eapen, 2019.
Anthracnose	*Colletotrichum gloeosporioides* Penz	Minor	Nair *et al.* 1987; Santhakumari and Rajagopalan, 2000; Sainamole *et al.* 2008.
Stunt disease	*Cucumber mosai virus*-CMV and *Piper yellow mottle virus*-PYMoV	Minor	Bhat *et al*. 2018

Diseases of Black Pepper

Crop loss in black pepper due to diseases is mainly induced by soil borne fungi, nematodes and viruses. Sarma *et al.* (1991) observed that at least 17 diseases infested in black pepper plant. In recent years, this index has been exhibiting fluctuations, mainly owing to incidence of fungal diseases such as root rot (*Fusarium solani* f. sp. *piperis*), yellow wilt (*F. oxysporum*), anthracnose (*Colletotrichum gloeosporioides*), and Phytophthora rots (*Phytophthora capsici*) (Tremacoldi 2010; Sarma *et al.* 2013; LSPA 2017). The major diseases of black pepper are foot rot, wilt, nematode and the minor diseases are stem blight (*Nectria haematococca*), phytophthora rots (*Phytophthora capsici*) and anthracnose (*Colletotrichum gloeosporioides*). The other diseases are wilt, anthracnose, stunt disease (viral) (Sarma *et al.* 1991) and wrinkled leaf disease (Kueh and Sim, 1992) (Table 1). The nature and severity of disease depend on place, environment and time of infection. The major diseases are documented below:

Foot rot (*Fusarium solani*): Foot rot is a major disease of black pepper throughout the world. In India, foot rot is the major economical disease (Sarma *et al.* 1992). Foot rot is a soil borne pathogen. *Fusarium* is the causal agent of foot rot disease (Anith *et al*. 2002) and 30% yield loss for the agent in India and other south East Asian countries (Sarma 2003). In another study, it was observed that it is the most destructive of all diseases causing an annual crop loss of 5-10% (Kueh 1990) and up to 95% (Manohara *et al.* 2004). Anandaraj (2000) observed that the disease infested all part of the vine. One or more black spots are distinctive in marginal part of leaves. The spot develops quickly and cover all the leaves causing defoliation. In final stage, the vine is wilted. It can infect the roots, stems, leaves and fruit at any stage of plant growth. The epidemic of foot rot depends on environmental conditions,

drainage, soil moisture, soil fertility, cultivar and cultural practices (Anandaraj 2000). The disease is found in almost all growing areas black pepper (Truong *et al*. 2008).

Wilt (*Fusarium oxysporum*): In Indonesia the production of black pepper is facing problem for wilt infections (Mustika 2015). The pathogen was identified by Dr. Brayford from Intemational Mycological Institute as *Fusarium oxysporum*, a new pathogenic formae to black pepper, whose origin is still unidentified (Maria *et al*. 2001). Wilt disease reduced 18.6 to 43.7% yield loss in East Java, Indonesia (Syakir *et al*. 2019). Anandaraj (2000) observed that the wilt diseases of pepper found all pepper growing areas in the world. The infested vines exhibit yellowing. In moist soil and post monsoon season, the symptoms reappear, exhibit defoliation and die-back. Nematodes infested in the root and then degenerate of the root. The vine infested with *M. incognita* and root with *R. similis* causes necrotic lesions on roots which lead to breakup of roots. Ultimately the infested plant dies within 3-4 years (Peethambaran *et al.* 2008).

Nematode (*Meloidogyne incognita* and *M. javanica*): The parasite nematodes cause damage in about 365 plant species including black pepper (Holdeman 1986; Krishna and Eapen, 2019). The nematodes cause yellowing and wilt disease in pepper plant. The pepper plants are wilted after heavy infection by sunny, warm and dry weather in Malaysia (Shahnazi *et al*. 2012). Thuy *et al.* (2012) noted that 35 plant nematodes taxa belonging to 19 genera and 11 families were identified associated with pepper plant in Vietnam. Around 16.6 to 65.8% yield loss was observed due to *Meloidogyne incognita* in East Java, Indonesia (Syakir *et al.* 2019).

Anthracnose/Fungal pollu (*Colletotrichum gloeosporioides*): Anthracnose or pollu disease is increasingly becoming major at higher elevations. The disease is seen throughout the crop season and maximum damage is caused during August to September. The damage ranges from 28% to 34% (Nair *et al.* 1987). Santhakumari and Rajagopalan (2000) observed 100% yield loss for the disease. This disease is found in both the nurseries and main fields. The older vine, leaves, spikes are infested by this disease. More infestation is found in shaded place of plantation. In spike brownish spots are observed and is more severe at higher elevations (Sainamole *et al.* 2008). In this condition, decrease vine growth and photosynthesis in the black pepper plant.

Stunt disease (*Cucumber mosaic virus* and *Piper yellow mottle virus*): The virus disease also known as mosaic, little leaf, wrinkled leaf and stunted disease in pepper growing areas. The disease is more damaging particularly at high elevations. CMV is transmitted by aphids whereas mealybugs transmit PYMoV. The infested vine exhibit shortening of internodes and the leaves become narrow, leathery in texture, puckered and crinkled. In this stage, plant face nutrition problem and the diseases available at temperature (35°C) (Bhat *et al.* 2018).

Table 2. Yield loss of black pepper caused by pest reported in the literature

Insects	**Yield Loss (%)**	**References**
Top shoot borer	57 up to 100	Dhanya *et al.* 2019
Stem borer	43 to 72	Indriati and Trisawa, 2011; Lestari *et al*. 2019.
Pollu beetle	30 to 40	Devasahayam *et al.* 1988
Leaf gall thrips	6 to 16	Daba *et al.* 2017
Diseases	**Yield Loss (%)**	**References**
Anthracnose	28 to 34 and up to 100	Nair *et al.* 1987; Santhakumari and Rajagopalan, 2000.
Foot rot	5-10 and up to 95	Kueh 1990; Manohara *et al.* 2004; Krishnamoorthy and Parthasarathy, 2011.
Nematode	16.6 to 65.8	Syakir *et al.* 2019
Wilt	18.6 to 43.7	Syakir *et al.* 2019

INSECT AND DISEASES OF BLACK PEPPER IN BANGLADESH

Very few researches have done on insects and diseases of black pepper in Bangladesh (Khalequzzaman and Wadud 2015; Islam 2019; Azad *et al*. 2020). Khalequzzaman and Wadud (2015) isolated leaf blight (*Colletotrichum gloeosporioides*) and algae leaf spot or red rust (*Cephaleuros virescens) of* black pepper at spices research centre, BARI, Shibganj, Bogura, Bangladesh during 2014-15. They reported that leaf blight severity was lower in May and higher in November. Algae leaf spot severity was minimum in March and maximum in October. Ant (*Tetramorium* spp.) (Azad *et al.* 2020), flea beetle (Islam 2019), wilt (Islam 2019) and foot rot disease (Islam 2019; Azad *et al.* 2020) were also reported in Bangladesh.

Kamrujjaman (2019) surveyed owners of black pepper garden at Jaintiapur upazila in Sylhet district during July 2018 to April 2019 to explore indigenous management techniques, processing, marketing, livelihood potential and constraints of the black pepper gardening. He reported that the positive response of the respondents about insects-

pests infestation which was 94.29% and negative response was only 5.711%. He also reported that black pepper was affected by different types of spiders and rotting diseases. He also reported that black pepper attacked by spiders during winter season. Ripcord used for controlling insect by the farmers. On the other hand, tilt is used for controlling rotting disease of black pepper. Kamrujjaman (2019) also found different symptom of diseases in the plants during his field visits. The author pointed out knowledge gaps regarding pest and its decisive management in the study area.

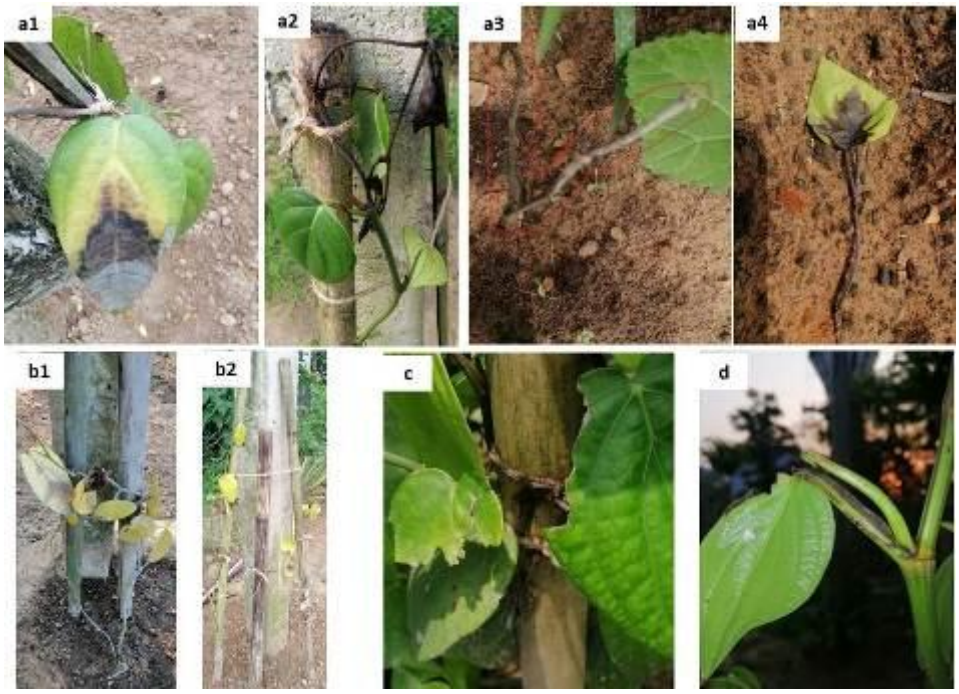

Fig. 1. Above ground symptoms were found during the establishment of black pepper germplasm in the Agroforestry field laboratory, Sylhet Agricultural University.

Fig. 2. Above ground symptoms were found during the field visit in the black pepper garden in Jaintiapur upazila, Sylhet during dry season in 2019.

Talucder (2019) observed several black spots with narrow border as well as defoliation on new foliage of black pepper at the black pepper germplasm centre situated in Tilagorh Eco-Park of Sylhet and agroforestry field laboratory of Sylhet Agricultural University (SAU) in Bangladesh (Fig. 1a1). Newly emerged tender runner shoots

as well as soft leaves of black pepper near soil surface with ash and black color during rainy season were observed at the agroforestry field laboratory of SAU (Fig. 1a2). Some collar region affected plants were also observed (Fig. 1a3,4). In this case, vines were broken down at the nodes without black spots. Author also noticed dead entire vine without any characteristic leaf lesson. Wilted yellowish foliage were also found (Fig. 1b1,2). Top shoot borer like damage (Fig. 1c) and white fly (Fig. 1d) were also observed in black pepper germplasm in the agroforestry field laboratory.

Talucder (2019) visited Jaintiapur upazila during dry season in 2019. Author found yellowish foliage plants (Fig. 2a). Some black pepper plants were seen wilted. Some plants were observed with lower number of leaves in the homesteads (Fig. 2b). These visual symptoms observed by Talucder (2019) are resembled with *Phytophthora* foot rot or so called quick wilt (e.g., Kueh 1990). These visual symptoms also seemed similar with parasitic slow decline disease (e.g., Krishna and Eapen, 2019). Infected blackish berries were also found in the black pepper spikes during field visit in January 2019 (Fig. 2c). This black coloured berries looks like pollu beetle infestation (e.g., Devasahayam and Koya, 1994). Interestingly, black pepper growers have no idea about these diseases in terms of nature of damage as well as its management. Black pepper growers speculated that these might be due to lack of water during dry season (Kamrujjaman 2019; Talucder 2019). This requires details investigation for confirmation.

CONCLUSION AND RECOMMENDATIONS

This review illustrated that there is huge research gaps on insects and diseases of black pepper in Bangladesh. Although, Daba *et al.* (2017) mentioned that insects and diseases are vital constraint of black pepper cultivation at any growing stage and reduce yield significantly. But very few attempts were taken for research on pests and diseases of black pepper in Bangladesh. For developing effective control measure, it is very crucial to know the causal agent and their nature of damage for securing early establishment of black pepper and increasing its productivity. Therefore, researches on identification of causal agents, their nature of damage and management as well as awareness building of black pepper growers through information dissemination could increase the productivity of black pepper.

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