INVENTORY OF RED CHILI (*CAPSICUM ANNUM* L.) PLANT DISEASES IN PAKEM DISTRICT, SLEMAN REGENCY

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ABSTRACT

Red chili is cultivated practically everywhere and plays a crucial role in Indonesian culture, economy, and cuisine. Plant diseases have been the main factor driving the country's yield reduction of red chili. This research was conducted to observe chili plant diseases in Hargobinangun Subdistrict, Pakem District, Sleman, Yogyakarta. Chili variety Twist-42 was planted in the area. The Twist-42 variety is a local variety that is well adapted in the middle plains between 450 – 650 masl (meters above sea level) and is a good variety in both the dry and rainy seasons. There were 360 red chili plants as samples. The diseases found are Yellow leaf curl disease, Anthracnose, Ralstonia wilt, and Root knot nematode (*Meloidogyne* spp.).

Keywords: Chili, Yellow leaf curl, Anthracnose, Ralstonia wilt, and Root knot nematode.

INTRODUCTION

Chili peppers play a crucial role in Indonesian culture, economy, and cuisine. They are widely cultivated and have become an integral part of local diets. Chili peppers in Indonesia are not only used in food but also have medicinal and ornamental applications (Wijaya et al., 2020). The diversity of chili peppers in Indonesia is reflected in their various local names, morphological characteristics, and genetic variability (Arumingtyas *et al.*, 2017). Chili production has seen rapid growth due to technological advancements and improved market infrastructure (Mariyono & Sumarno, 2015). Factors influencing farmers' adoption of chili-based agribusinesses include age, experience, access to technology, markets, and credit. Their importance is further emphasized by their impact on the economy through multiplier effects (Mariyono & Sumarno, 2015). The red chili market in Indonesia is well-integrated, with Medan serving as the price leader (Kustiari *et al.,* 2018).

Red chili is cultivated practically everywhere in the nation, and one of them is Yogyakarta province (Siregar & Suroso, 2021). According to BPS, the national production of red chili reached 1.55 million tons in 2023. Red chili production in Yogyakarta declined in 2022 to 35.384 tons and increased in 2023 to 46.622 tons. The production of red chili is fluctuated due to several factors, such as inevitably causing significant fluctuation in chili prices, eventually making farmers and traders uncomfortable. Another cause is plant diseases that have been the main factor driving the country's yield reduction of red chili (Utami *et al.*, 2022).

Chili plants in Indonesia face significant disease challenges, particularly from begomoviruses. The Pepper yellow leaf curl Indonesia virus (PepYLCIV) is a major threat, causing yield losses of 20-100%. Recent studies have shown that PepYLCIV can also be seed-transmitted, with detection rates of 25-100% in seedlings from infected plants (Fadhila *et al.*, 2020). This virus is primarily transmitted by whiteflies (*Bemisia tabaci*), resulting in symptoms such as leaf curling, chlorosis, and necrosis (Nurtjahyani & Murtini, 2015). The incidence and severity of begomovirus infections vary across regions, with some areas reporting disease incidence as high as 73% (Widodo *et al.,* 2023). While capsaicin content in chili peppers does not correlate with resistance to *Fusarium oxysporum*, another pathogen affecting chili crops (Ferniah *et al.,* 2018). The widespread presence of begomoviruses remains a significant concern for chili cultivation in Indonesia. The inventory of red chili plant diseases in Kabandungan Sub-District, Sukabumi Regency, Indonesia, identified *Colletotrichum capsici* and Gemini virus as plant diseases (Ramadhan *et al.*, 2023). The study also identified pathogenic fungi associated with red chili seeds, including *Aspergillus* sp*., Penicillium* sp*., Verticillium* sp., and *Curvularia* sp. (Sukapiring *et al*., 2023).

Fusarium wilt disease typically appears in the later stages of plant development, beginning with older leaves and progressing to younger ones, ultimately leading to the plant's death. Symptoms include yellowing of older leaves, vein clearing, stunted growth, and epinasty (downward curling of leaves). In younger plants, infection can cause rapid wilting and death, while in mature plants, symptoms may include adventitious root formation, wilting, defoliation, and necrosis along leaf margins. The pathogen initially infects seed tissues, increasing inoculum levels and allowing it to invade seedlings. Since the disease is soil-borne and heavily influenced by soil moisture, reducing moisture levels can decrease its incidence. Soil solarization may be used to suppress the pathogen if cost-effective. Ridge sowing with optimal irrigation is recommended to avoid excess moisture, which fosters disease development. Increasing soil pH with hydrated lime can inhibit Fusarium growth. Chemical control is challenging due to potential negative impacts on soil and the environment. Biological control using chitin-degrading microorganisms, such as chitinolytic bacteria, has shown promise in managing Fusarium wilt in chilies without harming seedling growth (Shaneen et al., 2021).

This research was conducted to observe chili plant diseases in Pakem District, Sleman, Yogyakarta. Plant diseases at this location have not been reported, so the information obtained from this research can be used to develop plant disease control strategies.

METHODOLOGY

The research was conducted on a red chili plantation in Hargobinangun Subdistrict, Pakem District, Sleman, Yogyakarta. Hargobinangun sub-district has an altitude of 400 meters above sea level with an average annual rainfall of 3.764 mm/year and an average temperature of 26° C with coordinates 7°40'03"S 110° 24' 30"E. Chili variety Twist-42 was planted at the area. The Twist-42 variety is a local variety that is well adapted in the middle plains between 450 – 650 masl (meters above sea level) and is a good variety in both the dry and rainy seasons. There were 360 red chili plants as samples. This research was carried out by observing abnormalities in chili plants and field conditions around the planting area using a purposive sampling method. Observations were made visually, recorded using a digital camera, and then described and identified based on symptoms and literature review.

RESULT AND DISCUSSION

1. Yellow leaf curl

Symptom. Yellow leaf curl disease (Figure 1) represents a major constraint on chili pepper production in Indonesia. The causative agent of this disease is the Pepper yellow leaf curl virus (PYLCV), first reported in Central Java, where it has been associated with yield losses ranging from 20% to 100%. The rapid dissemination of PYLCV across chili crops in Indonesia has been documented, with incidences reported in various regions, including Central Java, West Java, Yogyakarta, and Lampung, since the early 2000s. Infection by PYLCV manifests in distinctive symptoms, including yellow mosaic, mottling, and chlorosis. Initial symptoms typically present as green mosaic patterns on the upper leaves, followed by upward or downward leaf cupping and yellowing. As the infection progresses, affected plants exhibit stunted growth, particularly during seed development. Field observations of viral infections indicate that symptomatology can vary or exhibit similarities, likely due to the influence of different viral strains. The expression of these symptoms is modulated by the genetic variety of the plants and environmental conditions, with leaf morphology posited as a contributing factor to the resistance of certain genotypes to PYLCV infection (Selangga and Listihani, 2021).

Control. Management strategies include integrated approaches combining cultural, chemical, and biological methods. Effective measures involve using neem cake in seedbeds, covering nurseries with nylon nets, applying insecticides like Cyantraniliprole, planting maize border crops, and using silver agrimulch sheets (Daunde & India Aicrp, 2020). Insecticides showed efficacy in controlling the whitefly vector. The use of resistant varieties will reduce the severity and incidence of the disease (Hussain *et al*., 2017). Eco-friendly pest management practices have proven effective in reducing pest populations and improving benefit-cost ratios (Mondal & Mondal, 2012). Advanced techniques like CRISPR/Cas-mediated resistance are being explored for improved disease management (Shingote *et al*., 2022).

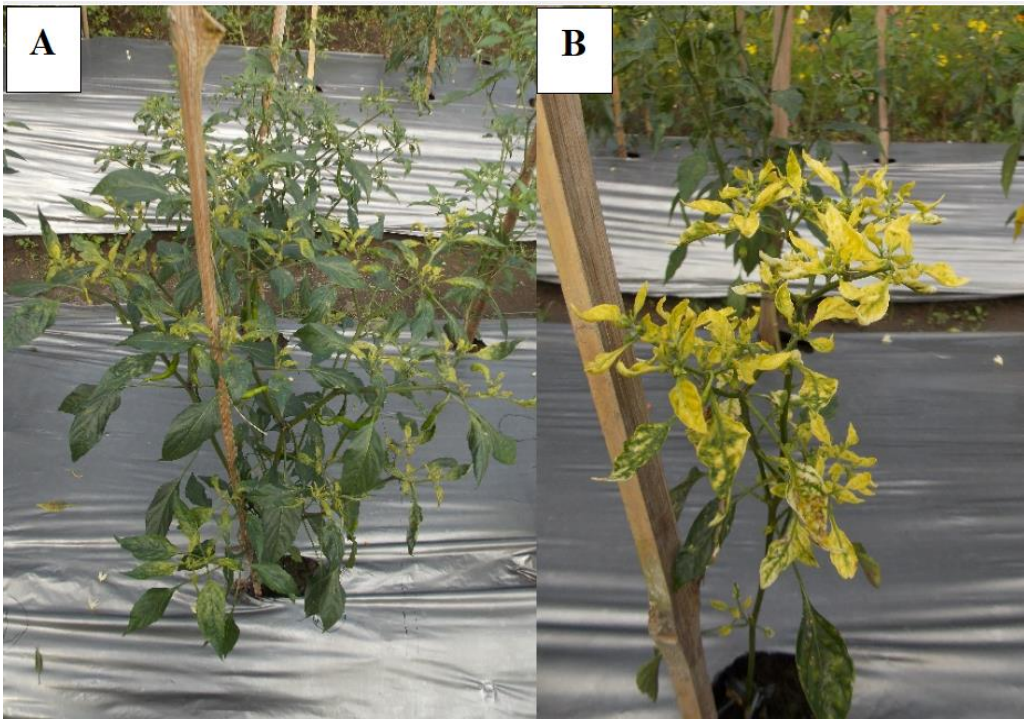

Figure 1. Symptoms of Begomovirus infection in red chilies in the field.
A = early symptom. B = late symptom.

2. Anthracnose

Symptom. Under favorable conditions, characteristic symptoms manifest on ripe chili fruit as sunken, circular, or angular lesions (Figure 2). These lesions often coalesce, leading to severe fruit rot. Typically, the lesions are distinguished by black spots arranged in concentric rings at maturity. In the early stages, orange to pink conidial masses may be visible on the fruit's surface. Microscopic examination reveals that the dark spots are acervuli structures, which contain setae hairs that trap the conidia of the pathogen. The pathogen survives unfavorable conditions by forming microsclerotia within plant debris, seeds, or soil. This pathogen is capable of infecting all parts of the host plant, including stems and leaves. On stems and leaves, lesions appear as small, sunken grayish-brown spots with dark margins, where the development of acervuli in concentric rings is easily observed (Saxena *et al.,* 2016)

Control. No single management approach has proven effective in controlling the disease comprehensively. Consequently, an integrated strategy combining various methods, including chemical, biological, and physical controls, along with intrinsic resistance, is generally recommended for disease management. The strategy for managing the spread and establishment of *Colletotrichum* spp. can be categorized into four main approaches: the implementation of cultural practices, the application of chemical control, the use of resistant plant varieties, and the adoption of biological control measures (Saxena *et al.,* 2016)

Figure 2. Symptoms of Fruit Rot (Anthracnose) in Red Chilies.

3. Ralstonia wilt

Symptom. The identification of wilted plants was based on the characteristic symptoms associated with the disease. These symptoms encompass wilting, stunted growth, yellowing of the foliage, leaf epinasty, and the formation of adventitious roots on the stem. Additionally, narrow dark stripes corresponding to the infected vascular bundles were observed beneath the epidermis. Internally, the disease was marked by the progressive discoloration of vascular tissues, primarily affecting the xylem, and the exudation of a slimy, viscous ooze upon transverse sectioning of the stems (Aslam and Mukhtar, 2023).

Control. Avirulent strains of *Ralstonia solanacearum, Pseudomonas spp., Bacillus spp.,* and *Streptomyces spp.* are well-established biological control agents (BCAs). Additionally, less commonly utilized BCAs such as *Acinetobacter sp., Burkholderia sp.,* and *Paenibacillus sp*. have been identified. The efficacy of BCAs is influenced by inoculation methods, which include soil pouring or drenching, root dipping, and seed coating. The incorporation of various organic materials, such as plant residues, animal waste, and simple organic compounds, has been frequently reported to mitigate bacterial wilt diseases. The combined application of BCAs and their substrates has demonstrated enhanced suppression of bacterial wilt in tomatoes. Suppression mechanisms are primarily attributed to antibacterial metabolites produced by BCAs or those present in natural products; however, research on host resistance to the pathogen is growing. Enhanced or modified soil microbial communities also play an indirect role in disease suppression. Emerging control strategies include biological soil disinfection using substrates that release volatile compounds. This review highlights recent advancements in control measures and underscores the significance of integrated pest management (IPM) for managing bacterial wilt diseases (Nion and Toyota, 2015).

Figure 3. Symptom of Ralstonia wilt in Red Chilies.

Meloidogyne javanica exacerbated the severity of bacterial wilt induced by *Ralstonia solanacearum* across all inoculum densities. The presence of *M. javanica* in plants inoculated with the bacterium accelerated the onset and progression of wilt symptoms. Concurrent inoculation of both pathogens led to further reductions in the growth parameters of chili plants. Consequently, rigorous control measures are recommended for the effective management of this disease complex (Asghar *et al.,* 2020).

4. Root knot nematode - *Meloidogyne* spp.

Symptoms. The specific symptom of *Meloidogyne* sp. is gall in roots (Figure 4-A). Galls and enlarged root tissue, which contain nematodes, are visible on infected host roots. After reaching the root, the nematodes use a biochemical process to puncture the hard tissues and enter the vascular system. Additionally, chemicals that resembled sap clogged the root veins of the diseased plants. This prevents nutrients and water from moving from roots to other organs (Putri *et al.*, 2020; Thiyagaraja & Kuppusamy, 2014). It also causes other symptoms like stunted growth, low flowering, and low yield. Root galls indicated *Meloidogyne* sp. capability to form feeding sites. The higher the ability of nematodes to form feeding sites, the more severe the galls that are formed (Putri *et al*., 2020).

Control. Management strategy to control root-knot nematodes are integrated systems. For example, using biocontrol agents, one of the biological control agents is *Bacillus* sp. According to Kamonwan *et al* (2024), Bacillus strains studied can be utilized effectively to manage *Meloidogyne enterolobii*, the causal agent of chili root-knot disease. They indicated potential enzymes i.e., protease and lipase as cell wall degrading enzymes to control *M. enterolobii* effectively. Another control is using a moderate-resistant variety as a preventive control. Chili pepper var. Red Star 2060 was more susceptible to *M. incognita* than chili pepper var. Pilar F1 and chili pepper var. Kastilo F1 (Putri *et al*, 2020).

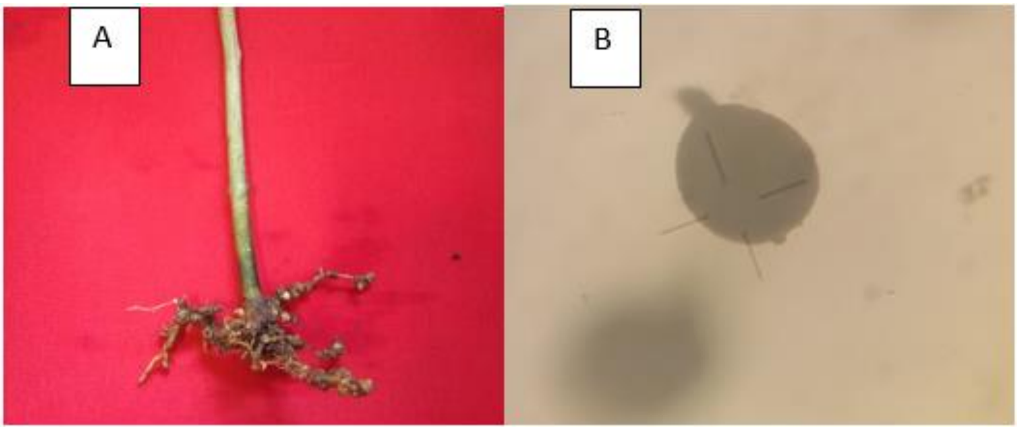

Figure 4. Symptoms of Root Knot in Red Chili Plants (A) and Microscopic appearance of female nematodes *Meloidogyne* sp. causing Root Knot (B).

CONCLUSION

Plant diseases found in red chili plantation in Pakem District, Sleman, Daerah Istimewa Yogyakarta are yellow leaf curl disease, Anthracnose, Ralstonia wilt, and Root knot nematode (*Meloidogyne* spp.).

REFERENCES

Arumingtyas, E. L., Kusnadi, J., Sari, D. R. T., & Ratih, N. (2017). Genetic variability of Indonesian local chili pepper: The facts. In AIP Conference Proceedings (Vol. 1908, No. 1). AIP Publishing.

Asghar, A., Mukhtar, T., Raja, M. U., & Gulzar, A. (2020). Interaction between *Meloidogyne javanica* and *Ralstonia solanacearum* in chili. Pakistan journal of Zoology, 52(4) : 1525-1530.

Aslam, M. N., & Mukhtar, T. (2023). Distributional spectrum of bacterial wilt of chili incited by Ralstonia solanacearum in Pakistan. Bragantia, 82, e20220196.

BPS. (2024). Produksi Tanaman Sayuran, 2021-2023. Diakses pada (https://www.bps.go.id/id/statistics-table/2/NjEjMg==/produksi-tanaman-sayuran.html)

Ramadhan, R. A., Amalia, D., Permana, I. and Rahmatullah, P. (2023). Inventory of Chili Pests and Diseases in Kabandungan Sub-District, Sukabumi Regency. Indonesian Journal of Crop Science, 5(2) : 84-89. doi: 10.25077/jijcs.5.2.44-49.2023.

Dewi Novina Sukapiring, Lily Novianty, Siti Nurlani Harahap. (2023). Inventory of Pathogenic Fungi by Red Chili Seeds (*Capsicum annuum* L.) from Deli Serdang Regency, North Sumatra. Jurnal Pembelajaran Dan Biologi Nukleus 9(3): 528-534.

Fadhila, C., Lal, A., Vo, T. T., Ho, P. T., Hidayat, S. H., Lee, J.,& Lee, S. (2020). The threat of seed-transmissible pepper yellow leaf curl Indonesia virus in chili pepper. Microbial pathogenesis, 143 : 104132.

Ferniah, R. S., Pujiyanto, S., & Kusumaningrum, H. P. (2018). Indonesian red chilli (C*apsicum annuum* L.) capsaicin and its correlation with their responses to pathogenic *Fusarium oxysporum*. NICHE Journal of Tropical Biology, 1(2) : 7-12.

Hussain, M. S., & Atiq, M. (2017). Susceptibility of chilli lines/varieties towards Chilli leaf curl virus and its management through vector control. Pakistan Journal of Phytopathology, 29(1): 17-22.

Kamonwan Puttawong, Natthidech Beesa, Supot Kasem, Kansiree Jindapunnapat, Buncha Chinnasri, Anongnuch Sasnarukkit, Potential of *Bacillus* spp. against root-knot nematode, *Meloidogyne enterolobii* parasitizing chili (*Capsicum annuum* L.). Crop Protection, 184 : 106780 https://doi.org/10.1016/j.cropro.2024.106780.

Kustiari, R., Sejati, W. K., & Yulmahera, R. (2018). Integrasi pasar dan pembentukan harga cabai merah di Indonesia. Jurnal Agro Ekonomi, 36(1) : 39-53.

Mariyono, J., & Sumarno, S. (2015). Chilli production and adoption of chilli-based agribusiness in Indonesia. Journal of Agribusiness in Developing and Emerging Economies, 5(1) : 57-75.

Mondal, B., & Mondal, P. (2012). Ecofriendly pest management practices for leaf curl complex of chilli (*Capsicum annuum* L.). Journal of Biopesticides, 5, 115.

Nion, Y. A., & Toyota, K. (2015). Recent trends in control methods for bacterial wilt diseases caused by *Ralstonia solanacearum*. Microbes and environments, 30(1): 1-11.

Nurtjahyani, S. D., & Murtini, I. (2015). Karakterisasi tanaman cabai yang terserang hama kutu kebul (*Bemisia tabaci*).University Research Colloquium : 1-6.

Putri, R.I., S. Indarti and A. Widiastuti. 2020. Responses of *Capsicum annuum* Varieties Toward Root Knot Nematode Meloidogyne Incognita Infection. Jurnal Perlindungan Tanaman Indonesia, 24 (2) : 133-138, doi:10.22146/jpti.23978.

Saxena, A., Raghuwanshi, R., Gupta, V. K., & Singh, H. B. (2016). Chilli anthracnose: the epidemiology and management. Frontiers in microbiology, 7 : 1527.

Selangga, D. G. W., & Listihani, L. (2021). Molecular identification of Pepper yellow leaf curl Indonesia virus on chili pepper in Nusa Penida Island. Jurnal Hama dan Penyakit Tumbuhan Tropika, 21(2), 97-102.

Shaheen, N., Khan, U. M., Azhar, M. T., Tan, D. K., Atif, R. M., Israr, M. & Rana, I. A. (2021). Genetics and genomics of Fusarium wilt of chilies: A review. Agronomy, 11(11), 2162.

Shingote, P. R., Wasule, D. L., Parma, V. S., Holkar, S. K., Karkute, S. G., Parlawar, N. D., & Senanayake, D. M. J. B. (2022). An overview of chili leaf curl disease: Molecular mechanisms, impact, challenges, and disease management strategies in Indian subcontinent. Frontiers in Microbiology, 13 : 899512.

Siregar, J. J., & Suroso, A. I. (2021). Big Data Analytics Based Model for Red Chili Agriculture in Indonesia. In F. Saeed, F. Mohammed, & A. AlNahari (Eds.), Innovative Systems for Intelligent Health Informatics (Vol. 72, pp. 554–564). Springer International Publishing. https://doi. org/10.1007/978-3-030-70713-2_51

Thiyagarajan, Samaraj Subramanian and H. Kuppusamy. (2014). Biological Control of Root Knot Nematodes in Chillies through *Pseudomonas fluorescens's* Antagonistic Mechanism. Journal of Plant Sciences, 2(5), 152-158. https://doi.org/10.11648/j.jps.20140205.12.

Utami, D., Meale, S. J., & Young, A. J. (2022). A panglobal study of bacterial leaf spot of chilli caused by *Xanthomonas* spp. Plants, 11(17), 2291. https://doi.org/10.3390/plants11172291

WIDODO, C. J., TAUFIK, M., KHAERUNI, A., & MALLARANGENG, R. (2023). Determination of Begomovirus on chili plants (*Capsicum* sp.) in Buton and Muna Islands, Southeast Sulawesi, Indonesia. Biodiversitas: Journal of Biological Diversity, 24(2).

Wijaya, C. H., Harda, M., & Rana, B. (2020). Diversity and potency of *Capsicum* spp. grown in Indonesia. Capsicum London: IntechOpen, 3-24.