Moler disease and cultivation practiced by shallot farmers in Brebes Central Java

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Abstract. Shallot is one of the leading commodities for farmers in Brebes, Central Java. Brebes is the largest supplier of Indonesia's national shallot production. This is what makes Brebes famous as a center for shallot production. However, recently farmers have been faced with the attack of pathogens that cause Moler disease, which recently increased their attacks so that certain conditions cause significant yield losses of up to 40%. The relationship between increasing the intensity of moler and cultivation practised by shallot farmers in Brebes is discussed in this text. The research was conducted through a survey by taking seven districts with the Brebes district’s highest production area. Five farmers were selected for each speed. The data was excavated from farmers with a questionnaire about the shallot cultivation practice carried out by farmers. The results showed that the cultivation practices carried out by farmers had the potential to increase the intensity of moler disease. The practice that is meant is without crop rotation or varieties, without organic fertilizers, intensive application of fungicide, and balanced fertilization.

1. Introduction
Shallots are a mainstay commodity for the Brebes district of Central Java. Central Java province contributes around 30% of Indonesia's national production, and Brebes is the largest supplier [1]. Economically, shallot farming is very attractive and promising, with a B / C ratio of 1.41 [2]. The high-yielding varieties of shallots can be harvested two months after planting. Therefore, many Brebes farmers are very enthusiastic about depending on their livelihoods on shallot production. The farmer's hope cannot be avoided from the obstacles they have to face. Recently, some farmers in Brebes have complained about a decline in land productivity and an attack by the pathogen Fusarium oxysporum f.sp. cepae, which in the initial attack causes leaf twisted symptoms, so farmers call it moler disease. In the last three years, the attack of molecular pathogens has increased significantly, especially in the rainy season, and can cause up to 40% [3]. Some farmers think that this disease is the cause of the decline in land productivity. Many factors can induce the increasing incidence of Moler disease in Brebes. One of the factors that need attention is the practice of shallot cultivation carried out by local farmers. This paper discusses the increased incidence of moler disease in Brebes and its relationship to farmers' cultivation.
2. Methods
The research was carried out in Brebes Regency, Central Java, Indonesia, from August to September 2020. The data was collected using a survey method of shallot farmers and their land. Brebes Regency has 17 sub-districts that have shallot land. Seven of the 17 districts, seven districts were selected as samples. The seven samples are the ones that have the largest area of shallot land. The seven sub-districts are Larangan, Tanjung, Bulakamba, Wanasari, Songgom, Jatibarang, and Brebes. Five farmers were selected in each district as a sample of respondents. Using a questionnaire, the respondent farmers were asked about everything related to shallot cultivation, including varieties planted, crop rotation, variety rotation, organic fertilizers, N, P, K fertilizers, pesticides, and the origin of seeds. The data obtained were presented in tabular form and analyzed descriptively.

3. Result and discussion

3.1. Moler conducive soil
The attack of moler pathogens in Brebes' shallot cultivation has shown an increasing trend in the last three years (Table 1). In general, molecular pathogens' attack varies greatly from the lowest 0.2% to the highest 60%. This shows that not all land shallot lands are conducive to moler pathogens, while some still show moler disease suppression. This suppressive soil area can be used as an approach model in the development of land conservation that has been degraded by disease pathogens [4, 5, 6, 7, 8, 9]. The suppressive soil area is included in the very low criteria [20].

The essential character factors in conducive or suppressive soils are biological factors [8, 9, 10, 11, 12]. Many studies have shown that these physical factors' involvement in suppressive soils is that these soils' suppressive properties can be transferred to conducive soils to convert them to suppressive soils [13, 14]. Suppressive soils have a community structure with higher diversity and population and are complicated than conducive soils [4, 8, 10, 11, 12]. Mazzola MJ [15] explained that rhizosphere bacteria could be manipulated to develop suppressive soils against certain diseases. The results of previous studies on garlic, basal rot suppressive soil indicated that the bacterial community was more diverse than that of conducive soil [16, 17]. In other suppressive soils, fungi' role can be more significant than bacteria, as reported by Xiong et al. [18], which occurred in Fusarium vanilla wilt. The soil's low organic matter can cause the low population of conducive soil microbes in Brebes.

Table 1. Disease intensity of Moler caused by Fusarium oxysporum f.sp. cepae on shallots in 2017 to 2020 at Brebes, Central Java

| Year    | Season | Highest | Lowest | Average | Standard Deviation |
|---------|--------|---------|--------|---------|--------------------|
| 2017/2018 | Dry    | 2.00    | 0.20   | 1.49    | 0.58               |
|         | Rainy  | 25.00   | 15.00  | 20.00   | 2.43               |
| 2018/2019 | Dry    | 4.00    | 0.50   | 1.84    | 0.57               |
|         | Rainy  | 30.00   | 20.00  | 26.63   | 3.18               |
| 2019/2020 | Dry    | 4.00    | 0.20   | 2.21    | 0.82               |
|         | Rainy  | 60.00   | 25.00  | 32.14   | 5.76               |

3.2. Impact of shallot cultivation without organic matter
Soil organic matter is one of the health indicators where healthy soils generally have a high organic matter content [18]. The survey results showed that almost none of the respondent farmers planted garlic by providing organic fertilizers (Table 2). Of the 35 respondents, only one farmer said that he had used organic fertilizers. The soil analysis of the diseased plant samples showed that the soil organic matter content from the shallots' conducive soil was 1.04% (complete data not presented). This soil organic matter content is included in the very low criteria [20].

The low level of organic matter in the conducive soil of shallots in Brebes can be considered one of the factors causing this conducive character. Organic amendments such as organic fertilizers are essential in developing disease-suppressive soils [21, 22]. And soil health [23, 24]. Soil containing high organic matter provides a suitable environment for functional microbes in the soil, including
antagonistic and other microbes involved in plant health [9, 10, 11, 14, 22, 23, 25]. Low organic matter content and soil microbial community structure will affect soil nutrients' quality [22, 26].

### Table 2. Shallot cultivation practised by farmers and disease intensity of moler at Brebes Central Java

| Culture Practices          | Number of respondent(%) | Disease Intensity of Moler (%) | Explanation                                      |
|---------------------------|--------------------------|--------------------------------|--------------------------------------------------|
| CV. Bina                   | 35(100)                  | 32.14                          | No other variety are planted                      |
| Own seed                   | 35(100)                  | 32.14                          | Own farmer cluster is included                    |
| Plant rotation             | 0(0)                     |                                | -                                                |
| No Plant Rotation          | 35(100)                  | 32.14                          | -                                                |
| Variety rotation           | 0(0)                     |                                | -                                                |
| No Variety Rotation        | 35(100)                  | 32.14                          | -                                                |
| No Organic fertilizer      | 35(100)                  | 32.14                          | -                                                |
| Nitrogen Fertilizer        | 14(40.00)                | 31.43                          | 13.07 ppm (very low)                             |
| Phosphate Fertilizer       | 11(31.42)                | 29.55                          | 13.07 ppm (very low)                             |
| Potassium Fertilizer       | 1(2.86)                  | 50.00                          | 13.07 ppm (very low)                             |
| NPK compound fertilizer    | 0(0)                     |                                | -                                                |
| Synthetic chemical fungicides | 35(100)              | 32.14                          | 3 or 5 or 7 days starting at the age of 20-30 days after the plant until just before harvest |
| Bio pesticide              | 0 (0)                    | -                              | -                                                |

3.3. **Impact of shallot cultivation without balanced fertilization**

Plant nutrients are an essential factor in managing plant diseases [22, 27, 28]. The results of the survey provide information that the Brebes farmers are not wise in managing plant health. Generally, this shows that most farmers (40%) only use nitrogen fertilizer, and only one farmer out of 35 respondents uses potassium fertilizer (Table 2). The results of the analysis showed that in conducive land, the macronutrient content of N, P, K was low, namely 0.25%, (moderate) 13.07 ppm (very low), and 0.33 me% (low) (complete data no presented) [20]. Therefore, the low soil fertility status of the shallot cultivation area in Brebes should be assumed to be a contributing factor to the increased attack of molecular pathogens. In addition to not having farmers use organic fertilizers, unbalanced inorganic fertilization can be a factor in the shallots' low soil fertility in Brebes.

This phenomenon is consistent with the field's facts conducive to basal rot of garlic in Tawangmangu, Central Java, which indicates that the intensity of garlic basal rot tends to be high on land with low soil macronutrient content of Phosphorus and Potassium [29]. *F. o. f.sp. cepae* on garlic performs as a weak parasite, whose virulence is increased in plants that grow less fertile or lack nutrients [29, 30]. *F. o. f.sp. cube* in banana [31].

3.4. **Impact of intensive fungicide application**

The survey results showed that the application of fungicides by shallot farmers in Brebes was very intensive. The application was made periodically for 3, 5, or 7 days (Table 2). Intensive application of fungicides can negatively impact non-target microorganisms, including functional ones [32]. The most widely used fungicide is propined. Too intensive application of functions can promote pathogen resistance [33, 34]. Therefore, it is essential to conduct an empirical study of the impact of propine on non-target microorganisms and moler pathogens' resistance.

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References
[1] [BPS] 2019. Distribusi perdagangan bawang merah Indonesia tahun 2019. (Jakarta: Badan Pusat Statistik RI).
[2] Agrowindo. 2020. Peluang usaha budidaya bawang merah dan analisa usahanya. Available from: http://www.agrowindo.com/peluang-usaha-budidaya-bawang-merah-dan-analisa-usahanya.htm
[3] Supyani, SH. Poromarto S H, Supriyadi, Hadiwiyono. 2020. Moler disease of shallot in brebes central java in the last three years: the intensity and resulting yields losses is increasing. Presented online in the 2nd Sriwidjaja International Conference of Environmental Issues Conducted on Oct.21st. 2020.
[4] Hadiwiyono. 2013. Tanah Supresif dalam Praktik Pengelolaan Penyakit Tumbuhan. Sains Tanah-J. Soil Sci. Agroclim. 7 31-40
[5] Hadiwiyono. 2008. Tanah supresif: Terminologi, sejarah, karakteristik, dan mekanisme. J. Perlind. Tan. Indones 14 47-54.
[6] Chandrashekar C, BhatRavinder J C, and Chandrashekar Kn K. 2012. Suppressive soils in plant disease management. In book: Eco-friendly Innovative Approaches in Plant Disease Management. Chapter: 14 (Dehradun: International Book Distributors). pp 242-255
[7] Cook R J. 2014. Plant health management: Pathogen suppressive soils. Encyclopedia of Agriculture and Food Systems. (Elsevier) pp 441-455. Available from: https://doi.org/10.1016/B978-0-444-52512-3.00182-0.
[8] Song C, Zhu F, Carrióń VJ, Cordovez V. 2020. Beyond plant microbiome composition: Exploiting microbial functions and plant traits via integrated approaches. Front Bioeng Biotecnol. 8 896.
[9] Mazzola M. 2002. Mechanisms of natural soil suppressiveness to soilborne diseases. Antonie Van Leeuwenhoek. 81 557-64.
[10] Weller DM, Raaijmakers JM, Gardener BB, Thomashow LS. 2002. Microbial populations responsible for specific soil suppressiveness to plant pathogens. Annu Rev Phytopathol. 40 309-48.
[11] Schlatter D, Kinkel L, Thomashow L, Weller D, Paulitz T. 2017. New insights from the Soil Microbiome. Phytopathology. 107 1284-1297.
[12] Mazzola M, Freilich S. 2017. Prospects for Biological Soilborne Disease Control: Application of Indigenous Versus Synthetic Microorganisms. Phytopathology. 107 256-263.
[13] Raaijmakers J M, and Mazzola M 2016. Soil immune responses. Science 352 1392–1393.
[14] Gómez Expósito R, De Bruijn I, Postma J, and Raaijmakers J M 2017. Current insights into the role of rhizosphere bacteria in disease suppressive soils. Front. Microbiol. 8 2529.
[15] Mazzola MJ 2007. Manipulation of rhizosphere bacterial communities to induce suppressive soils. Nematol. 39 213-220.
[16] Hadiwiyono, R.D. Wuspada, S. Widono, S.H. Poromarto, Z.D. Fatawi. 2009. Kesupresifan tanah terhadap busuk pangkal (Fusarium oxysporum f. sp. cepae) bawang putih di Tawangmangu, Karanganyar. Sains Tanah 6 1-6.
[17] Zainal D. Fatawi, Hadiwiyono, Salim Widono 2012. Analysis of rhizosphere bacterial community in suppressive and conducive soils to basal rot of garlic based on PCR-RISA. Biomirror 3 9-12.
[18] Xiong W, Li R, Ren Y, Liu C, Zhao Q, Wu H, Jousset A, Shena Q. 2017. Distinct roles for soil fungal and bacterial communities associated with the suppression of vanilla Fusarium wilt disease. Soil Biol. Biochem. 107 198-207.
[19] Fonte S J, Yeboah E, Ofori P, Quansah G W, Vanlauwe B, Six J. 2009. Fertilizer and residue quality effects on organic matter stabilization in soil aggregates. Soil Sci. Soc. Am. J. 73 961–966.
[20] Balai Penelitian Tanah, 2009. Analisis Kimia Tanah, Tanaman, Air dan Pupuk. Balai Penelitian dan Pengembangan Pertanian RI (Bogor: Balai Penelitian Tanah).
[21] Baileya KL and G Lazarovits G. 2003. Suppressing soil-borne diseases with residue management and organic amendments. Soil Tillage Res. 72 169-180.
[22] Wingate. E. 2020. Building Disease-Suppressive Soils for Organic Agriculture. Organic Farmer. Available form: http://organicfarmermag.com/2020/11/building-disease-suppressive-soils-for-organic-agriculture/

[23] Titiek Yulianti T. 2010. Bahan Organik: Perannya dalam Pengelolaan Kesehatan Tanah dan Pengendalian Patogen Tular Tanah Menuju Pertanian Tembakau Organik. Bul. Tan. Tembakakau, Serat, Minyak Industri. 2 26-32

[24] Bonilla N, Gutiérrez-Barranquero J A, Antonio de Vicente A. and Cazorla, F M. 2012. Enhancing soil quality and plant health through suppressive organic amendments. Diversity 4 475-491.

[25] Bonilla N, Cazorla F M, Martínez-Alonso M, Hermoso J M, González-Fernández J, Gaju N, Landa B B, de Vicente A. 2012. Organic amendments and land management affect bacterial community composition, diversity and biomass in avocado crop soils. Plant Soil. 357 215–226.

[26] Lin W, Lin M, Zhou H, Wu H, Li Z, Lin W. 2019. The effects of chemical and organic fertilizer usage on rhizosphere soil in tea orchards. PLoS ONE 14 e0217018.

[27] Dordas C. 2008, Role of nutrients in controlling plant diseases in sustainable agriculture. Agron. Sustain. Develop. 28 33-46.

[28] Gupta N, Debnath S, Sharma S, Sharma P, Purohit J. 2017. Role of Nutrients in Controlling the Plant Diseases in Sustainable Agriculture. ed Meena V, Mishra P, Bisht J, Pattanayak A. Agriculturally Important Microbes for Sustainable Agriculture. (Singapore: Springer).

[29] Hadiwiyono, Widono S. 2008. Hubungan faktor lingkungan tanah terhadap intensitas busuk pangkal bawang putih di Tawangmangu. Agrin 12 15-22.

[30] Cahyani VR, Hadiwiyono, Rahayu D P, Siswanto A, Prasetyo D. 2014. Succession of fungal community structure in degradative land caused by basal rot pathogen of garlic. Sains Tanah. 11 47-51.

[31] Widyantoro A, Hadiwiyono, Subagia. 2019. Biological control of Fusarium wilt on banana plants using biofertilizers. Biodiversitas. 21 2119-2123

[32] Yang C, Hamel C, Vujanovic V, Yantai GanY. 2011. Fungicide: Modes of action and possible impact on non-target microorganisms. ISRN Ecol. 2011 130289

[33] Hobbelen PH, Paveley ND, van den Bosch F. 2014. The emergence of resistance to fungicides. PLoS One. 9 e91910.

[34] Lucas J A, Hawkins N J, Fraaije B A. 2015. The evolution of fungicide resistance. Adv. Appl. Microbiol. 90 29-92.