Disease intensity of moler and yield losses of Shallot cv. Bima caused by *Fusarium oxysporum f.sp. cepae* in Brebes Central Java

Supyani¹23, S H Poromarto¹23, Supriyadi¹23, F I Permatasari¹, D H Putri¹, D T Putri¹ and Hadiwiyono¹23

¹Agrotechnology Department, Agricultural Faculty of Universitas Sebelas Maret (UNS), Surakarta, Indonesia
²Magister Program of Agronomy, Agricultural Faculty of Universitas Sebelas Maret (UNS), Surakarta, Indonesia
³Doctoral Program of Agricultural Sciences, Agricultural Faculty of Universitas Sebelas Maret (UNS), Surakarta, Indonesia

Corresponding author: supyani_id@yahoo.com

Abstract. Brebes Central Java is one of the central production of shallot in Indonesia. In the latest years, shallot farmers in Brebes face a new problem in their production, that is the increasing attack of *Fusarium oxysporum f.sp. cepae* (FOCe) which causes Moler disease (MD). Based on a previous survey of respondents, the most common variety planted by the farmer in Brebes was cv Bima that had disease intensity up to 60% with yield losses over 40%. The field data related to disease intensity and yield losses caused by the pathogen are still very limited. This paper reports the occurrence of disease intensity of MD and its correlation to yield losses based on the primary data that was collected through a direct assessment on the field of shallot plantings in Brebes. The results show that the disease intensity of MD varies from 0 to 75% which significantly affects yield losses. Yield losses of same shallot plantings are over 50%.

1. Introduction

Shallots are a leading horticultural commodity in some areas because they are short-age and have high economic value with a B/C ratio of 1.65 [1]. One of the shallot production centers in Indonesia is Brebes, Central Java, where most farmers from season to season grow shallots in a very intensive production effort without crop rotation. Onion farming, which is very intensive and unwise, has been promoted to become the root of a new problem, namely the increasing intensity of Moler disease of shallots (MDS) in recent years [2]. MD in Indonesia is caused by *Fusarium oxysporum f.sp. cepae* (FOCe) [3,4]. Abroad, this pathogen is also known to cause Fusarium basal plate rot or Fusarium basal rot in other *Allium* species such as onions and garlic [5,6]. This pathogen has been reported to be an important pathogen of garlic in Tawangmangu, Central Java and its surrounding sub-districts since the 2000s [7]. Based on the previous survey, the most widely planted variety by farmers in Brebes was cv Bima that had a disease intensity up to 60% and yield losses above 40% [8]. However, the primary data related to the yield lost due to that pathogen from the field are very limited. This paper reports the occurrence of disease intensity and yield loss based on the results of direct data collection in the field, namely shallot plantings in Brebes, Central Java.
2. Materials and methods
The research was conducted using the survey method in the shallots at the harvest age from 6 sub-districts in Brebes. From each sub-district, 5 shallot plantings in each sub-district that have the largest land area were chosen. Thus, there are a total of 30 sample shallot plantings. The sub-districts that were sampled were Larangan, Tanjung, Bulakamba, Wanasari, Jatibarang, and Brebes. The samples were determined by purposive sampling in the shallot plantings that had a minimum 1,000 m² planting area. The intensity was observed directly on 10 beds of shallot plantings. The intensity was calculated by the following formula:

\[
DI = \frac{\sum (n \times v)}{N \times Z} \times 100%
\]

\(DI\) = Disease intensity
\(n\) = The number of plants observed shows a certain score
\(v\) = Attack percentage score

The scoring are:
0 = beds with shallots showing no MDS symptom
1 = beds with symptoms of 1-25% MDS
2 = beds with 26-50% symptoms of MDS
3 = beds with 51-75% symptoms of MDS
4 = the bed has shallots with symptoms of MDS 71-100%

The results were determined systematically on 5 sample plant groups in a diagonal pattern. Each plant group consisted of 10 plants so that in total there were 100 sample plants per onion plantation. Yields were then converted to yields per hectare. Yield loss was determined by data from onion cropping lines with zero percent FOCe attack intensity or no symptoms of mole, with the following formula:

\[
Yl = \frac{Ymf - Ys}{Ymf} \times 100\%
\]

\(Yl\) = yield losses (%)
\(Ymf\) = yield of MDS-free shallot plantings (ton.ha⁻¹)
\(Ys\) = yield of sample shallot plants

The data obtained were analyzed by regression correlation analysis of disease intensity versus yield, and yield losses.

3. Results and discussion
Data MDS intensity and yield loss on 30 shallot plantings showed a significant effect, which was shown from the occasion when the intensity was high, the yield loss was low and vice versa (Figure 1). Of the 30 shallot plantings, there are at least three lands that are free from FOCe attack or with zero percent MDS intensity with an average yield of 16.2 ton.ha⁻¹. This significant effect was confirmed statistically based on the results of simple correlation regression analysis of MDS intensity (\(X\)) as the independent variable on the yield of shallots as the dependent variable (Figure 2).

The analysis results obtained the formulation of the relationship \(\hat{Y}_y = -0.1255X + 17.035\) and \(R^2 = 0.92\). Based on this formulation, it can be interpreted that every one percent increase in MDS intensity will decrease 0.13 ton.ha⁻¹ with a confidence level of 92%. Meanwhile, the effect of disease intensity (\(X\)) on yield losses (\(Y_{yl}\)) obtained by the formula \(Y_{yl} = 0.8192X - 4.5398\) and \(R^2 = 0.98\). This means that every one percent increase in the molecular intensity will cause an increase in yield loss of 0.82% with a confidence level of 98% (Figure 3).
The intensity of the disease in this field is linear to previous results based on secondary data based on farmers' information in which MDS pathogens have caused significant yield losses [7]. This field

Figure 1. Diversity of Moler disease intensity on thirty shallot planting samples cv. Bima in Brebes, Central Java

Figure 2. Regression correlation of effect of moler disease intensity on yield of cv. Bima of shallots in Brebes, Central Java

Figure 3. Regression correlation of effect of moler disease intensity on yield losses of cv. Bima of shallots in Brebes, Central Java
data also coincided with the results of experimental tests on tray plants which showed that the cv. Bima was moderately susceptible and in artificial inoculation the yield losses ranged from 40.04-55.97%. Yield loss is affected by susceptibility/resistance of planted varieties. FOCe attack on resistant and moderate varieties can cause yield losses between 2.13-4.38 and 27.26-40.04 respectively [9].

MDS is caused by FOCe. This pathogen in garlic shows a weak pathogenic or weak parasitic character [10]. Many species of the genus *Fusarium* are weak pathogens [11]. The intensity of disease caused by pathogen attack will increase in weak plants than that in optimal growth or fertile crops. Susilowati et al. [12] reported that based on its suitability for the shallot production business, the area of shallot consisted of only 29.3% or 50,440.7 hectares and most of them are moderate, namely 55.5% or 95,819.9 hectares, and the rest are marginal and not suitable for shallot cultivation (14.8% or 25,678,3 hectares). The extent of land that is not suitable for shallot cultivation in Brebes is due to the unwise practice of shallot cultivation by farmers. Unwise cultivation practices such as planting practices without organic fertilizers, without crop rotation and varieties, use of less pathogen-free seeds, and very intensive use of pesticides [2]. The results of another study showed that soils that were free of FOCe attack or attacked with a low intensity of less than 5% had better fertility compared to soils that were heavily affected by FOCe [13]. Therefore in Brebes it is believed that the increase in FOCe attack in shallots is caused by land degradation. The decrease in soil chemical fertility due to the lack of use of organic fertilizers will also affect biological control activities by local functional microorganism complexes. Soil organic matter has been shown to be involved in soil suppression [14–17], which in disease control practice can be applied in the form of compost [18,19]. Organic compost can also improve saline soil [20–23].

Acknowledgements
This work was supported by Mandatory Research Scheme of UNS’s PNBP which Contrack Number: 260/UN27.22/HK.07.00/2021.

References
[1] Haris F A, Anna F and Netti T 2015 *SEPA* 11 249–60
[2] Supriyadi, Supyani, Poromarto S H and Hadiwiyono 2020 Moler disease and cultivation practiced by shallot farmers in Brebes Central Java Presented in the 1st International Seminar on Agriculture, Biodiversity, Food Security, and Health (Maluku: Pattimura University)
[3] Wiyatiningsih S, Wibowo A and Triwahyu P E 2009 *Jurnal Pertanian MAPETA* 12 1–17
[4] Nugroho B, Astiani D and Mildaryani W 2011 *Agrin* 15 8–17
[5] Higgins G and Scheufele S 2016 *Compendium of Onion and Garlic* ed HFSchwartz and S K Mohan (Minnesota: APS Press)
[6] Le D, Audenaert K and Haesaert G 2021 *JPSL* 46 241–53
[7] Hadiwiyono 2004 *Prosidng Simposium Nasional I tentang Fusarium* ed S Susanto (Purwokerto: PFI Komisariat dan Jur. Hama & Penyakit Tumb. F. Pertanian Unsoed) pp 203–210
[8] Supyani, Poromarto S H, Supriyadi and Hadiwiyono 2021 *IOP Conf. Series: Earth and Environmental Science* 810 012004
[9] Hadiwiyono, Sari K and Poromarto S H 2020 *Caraka Tani: J Sustain Agric* 35 250–7
[10] Hadiwiyono and Widono S 2008 *Agrin* 12 15–22
[11] Tan J et al. 2020 *Mol. Plant Pathol.* 21 1559–72
[12] Susilawati D M, Maarif M S, Widiatmaka and Lubis I 2019 *JPSL* 9 507–26
[13] Poromarto S H, Supyani, Supriyadi and Hadiwiyono 2021 *Chemical Characters of Disease Supressive and Conducive Soil of Moler on Shallot in Brebes Central Java* unpublished
[14] Bonanomi G, Antignani V, Capodilupo M and Scala F 2020 *Soil Biol. Biochem.* 42 136–144
[15] Bonilla N, Gutiérrez-Barranquero J A, de Vicente A and Cazorla F M 2012 *Diversity* 4 475–91
[16] Cucu M A, Gilardi G, Pugliese M, Ferrocino I and Gullino M L 2020 *Appl. Soil Ecol.* 154 103659
[17] De Corato 2020 *Rhizosphere* 13 100192
[18] Hadar Y and Papadopoulou K K 2012 *Ann. Rev. Phytopathol.* 50 133–53
[19] Mehta C M, Palni U, Franke-Whittle I H and Sharma A K 2014 *Waste Manag.* 34 607–622
[20] Lakhdarab A, Rabhia M, Ghnayaa T, Francesco G, Montemurro F, Jedidib N and Abdellya C 2009 *J. Hazard Mater* 171 29-37
[21] Rady M M, Semida W M, Hemida K A and Abdelhamid M T 2016 *Int. J. Recycl. Org. Waste Agricult.* 5 311–21
[22] Martínez-Blanco J, Lazcano C, Christensen T H, Muñoz P, Rieradevall J, Møller J and Boldrin A 2013 *Agron. Sustain. Develop.* 33 721–32
[23] Rachman A, Dariah A and Sutono S 2018 *Pengelolaan Sawah Salin Berkadar Garam Tinggi* (Jakarta: IAARD Press)