Efficacy of different dose of fungicide Mancozeb against purple blotch complex (Alternaria porri) of Shallot

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Abstract. Shallot (Allium ascalonicum L) is subjected to attack by a number of diseases caused by fungi, bacteria, and viruses which are the major constraints for higher production. Among the several diseases which attacked shallot, purple blotch disease of shallot caused by Alternaria porri (Ellis) Cif, is one of the most destructive disease; causing accountable losses of about 57 percent. Present study was aimed to determine the efficacies of different doses of fungicide (Mancozeb) against Alternaria leaf blight in shallot. A field experiment for the evaluation of different doses of mancozeb was conducted at Subang, West Java. The research used randomized complete block design (RCBD), with 6 treatments and 5 replications. The treatments were six doses of mancozeb (3 g/L; 2.25 g/L; 1.5 g/L; 0.75 g/L; 0.5 g/L and 0 g/L of water) were applied after 7 days intervals. All Mancozeb doses reduce the disease severity compared to untreated control. Among the different treatments, minimum disease intensity (13.33 %) was observed when the plots were sprayed with mancozeb 3 g/L followed by mancozeb 2.25 g/L (20.27%), mancozeb 1.5 g/l (20.53%), mancozeb 0.75 g/L (21.07%) and mancozeb 0.50 g/L of water respectively.

1. Introduction

Shallots are a leading vegetable commodity that has high economic value and can affect the inflation rate. The national average productivity of shallots is still below 10 ton / ha (9.29 ton / ha), and the harvested area in 2016 reached 158,172 ha [1]. One of the diseases that often infects shallot plants is purple blotch disease caused by Alternaria porri. The disease can cause yield losses of 3 - 57% depending on the growing season [2]. In the dry season during the planting period from April to July, A. porri disease can be also found in shallot plants aged eight days after planting [3]. This indicates that A. porri can attack both in the dry and rainy season. Symptoms caused by purple blotch disease are characterized by the presence of small, curved spots, white to gray in color. If enlarged, the spots appear ringed and slightly turn purple. The edge is purplish red surrounded by a yellow zone. In humid weather, the surface of the spots is covered by conidiophores and fungal conidium which are brown to black. The tip of the infected leaves turns yellow. The disease can be transmitted through the air and develops well when the humidity is high with an average temperature above 26°C [4]. Prepared mass inoculum and physiological factors of the attack of A. porri can be reduced in controlled environment [5].

Purple blotch disease will always appear in shallot fields with moderate to severe attacks if the weather conditions are favorable. This happens because the cured purple blotch disease is probably already resistant to the fungicide used. Various ways to control purple blotch disease have been widely used, including using biological agents such as Trichoderma harzianum [6,7].
fluorescens [8,9,10]; however, is still on a laboratory scale and has not been carried out in the field. Control of plant diseases, especially fungi, still rely on fungicides and farmers tend to overuse fungicides. Fungicides that have been tried to control A. porri include those with active ingredients Mancozeb, Carbendazim, Metalaxyl + Mancozeb, Iprodione and Propiconazole [11] Mancozeb, tebuconazole and azoxystrobin [12]. The active ingredient of diphenoconazole 250g / l effectively suppresses the growth of A. porri and S. vesicarium at a concentration of 0.5-2 ml / l. Besides of betel leaf extract concentration toward percentage of inhibition A. porri [13,14]. To anticipate the occurrence of side effects due to the use of fungicides, the use must be more selective by applying fungicides that are effective and able to control the target disease. The research objective was to determine the effectiveness of the active ingredient fungicide concentration: mancozeb 80% against purple blotch disease (Alternaria porri) on shallot (Allium ascalonicum L).

2. Materials and methods

The research was conducted in Subang, at an altitude of 430 m above sea level, from November 2019 to February 2020, uses the Bima Brebes variety of shallots. The study used a randomized block design, with six treatments and each treatment was repeated five times as follows:
A. Fungicide with active ingredient mancozeb 80% 3 g / l
B. Fungicide with active ingredient mancozeb 80% 2.25 g / l
C. Fungicide with active ingredient mancozeb 80% 1.50 g / l
D. Fungicide with active ingredient mancozeb 80% 0.75 g / l
E. Fungicide with active ingredient mancozeb 80% 0.50 g / l
F. Control (without fungicide)

The research plot size was 1.5 x 10 m. The number of plants in one research plot consisted of 50 plants. The spacing used was 15 cm x 20 cm. Fertilizer used was manure at a dose of 30 ton / ha, NPK (16:16:16) 600 kg / ha, given three times; 1/3 part was given 10 days before planting together with manure, the rest was given at the age of 15 days and age 30 days after planting, using black silver plastic mulch. Insecticides was used according to local recommendations to prevent pests. Fungicide treatments were applied by spraying around the shallot plants with a maximum number of applications of six times and spraying intervals twice a week. The volume of spray used was 400 - 600 L / ha. Determination of sample plants was carried out systematically with a diagonal shape. The number of sample plants observed in each treatment plot was 15 plants. The intensity of purple blotch disease was calculated using the formula:

\[ I = \frac{\sum n v}{N V} \times 100\% \]

\( I \) = level of crop damage (intensity of attack)
\( n \) = number of plants with the same damage category
\( v \) = score of each damage category
\( V \) = score for the most severe damage
\( N \) = total number of plants observed

The scale of attack (v) is determined as follows:
0 = no attack
1 = Leaf area attacked 1-20%
2 = Leaf area attacked 21-40%
3 = Leaf area attacked 41-60%
4 = Leaf area attacked 61-80%
5 = Leaf area attacked 81-100%

After obtaining the results of the intensity of disease severity, then determining the AUDPC (disease progression curve) value of the treatment efficacy in suppressing pathogens. The AUDPC formula is calculated using trapezoidal integration [15].
\[ AUDPC = \sum_{i}^{n-1} \frac{Y_i + Y_{i+1} + 1}{2} X (t_{i+1} - t_i) \]

where

- \( AUDPC \) = disease progression curve
- \( Y_{i+1} \) = Observation data \( i + 1 \)
- \( Y_i \) = Observation data \( i \)
- \( t_{i+1} \) = Observation time \( i + 1 \)
- \( t_i \) = Observation time \( i \)
- \( n \) = Number of observations

Observation data included attack intensity, plant phytotoxicity due to fungicides as treatment, yield components (number of tubers and tuber weight per plant, and tuber yield weight for each treatment plot). Data were analyzed using variance to determine the effect of treatment on the data collected, and analysis of differences. Treatment using the Duncan test at the confidence level of 95%.

To determine the effectiveness of the tested fungicides, the efficacy level was calculated. It is said to be effective if the level of efficacy (TE) is more than or equal to 50%. TE the test fungicide is calculated from the results of the last observation using the formula:

\[ LE = \frac{(IS_K - IS_P)}{IS_K} \times 100\% \]

(\( LE = \) level of efficacy; \( IS_K = \) intensity of disease attack in control / without fungicide; \( IS_P = \) intensity of disease attack on fungicide treatment).

3. Results and discussion

3.1. Intensity of purple blotch disease (Alternaria porri)

Symptoms of purple blotch attack on shallot plants are indicated by the presence of small, curved spots, white to gray in color. If enlarged, the spots appear ringed and slightly purple in color. The edge is purplish red surrounded by a yellow zone. The disease is caused by the fungus Alternaria porri [4] (Figure 1).

![Figure 1. Symptoms of a purple blotch attack (Alternaria porri), b. conidia Alternaria porri](image)

The results of observations on the intensity of purple blotch attack before and after application are shown in Table 1. Based on table 1, it appears that the results of observations before application, the intensity of the attack of purple blotch disease are almost evenly distributed with an average attack between 1.87 - 4.53%. These symptoms began to be found in shallot plants aged 16 days after planting.
(DAP), but after the first application, namely at the time of observation four days after application or shallot plants aged 20 DAP, the intensity of attacks on the control (without application) showed an average high attack intensity reached 9.07%. This condition continued up to 15.74% at the observation seven days after application (7 DAA), while those given the fungicide treatment showed slower increase. In eleven days after application (11 DAA), the intensity of the attacks increased from previous observations ranging from 6.13% to 21.31% which based on statistical analysis there was a significant difference between treatment concentrations of 3 g / l with a concentration of 0.75. g / l and 0.5 g / l. In 18 DAA observations, it appeared that the intensity of the attacks is increasing, but the treatment concentration of 3 g / l attacks is relatively the lowest (7.20%) compared to other treatments. This condition continued until the next observation with the intensity of the attack of the last observation (32 DAP) reached 13.33% despite the intensity of attacks on other treatments ranged from 20.27 - 43.20%. The severity of the attack would be higher if the symptoms are associated with other diseases such as Stemphylium vesicarium which can reach 91.50% [16]. A. porri and S. vesicarium are both potentially important pathogens in winter-grown Allium crops and purple leaf blotch symptoms were considered to be a complex caused by both pathogens [17]. Disease incidence was high in matured old leaves than young leaves on purple leaf blotch [18,19].

Table 1. The average intensity of the purple blotch disease (Alternaria porri) attack on shallots before and after application

| Treatment          | Intensity of the purple blotch disease (%) |
|--------------------|--------------------------------------------|
|                    | Observation (-1) 4 DAA 7 DAA 11 DAA 18 DAA 25 DAA 32 DAA |
| A. Mancozeb 80% 0.0 g/l | 2.93 a 3.20 a 4.27 a 6.13 a 7.20 a 12.53 a 13.33 a |
| B. Mancozeb 80% 2.50 g/l | 1.87 a 3.47 a 4.80 a 7.19 ab 11.47 ab 18.93 ab 20.27 ab |
| C. Mancozeb 80% 1.50 g/l | 3.47 a 4.53 a 7.73 a 9.62 abc 11.20 ab 18.14 ab 20.53 ab |
| D. Mancozeb 80% 0.05 g/l | 3.20 a 3.73 a 8.00 a 13.07 c 13.60 b 19.20 ab 21.07 ab |
| E. Mancozeb 80% 0.50 g/l | 3.47 a 4.53 a 7.20 a 11.47 bc 14.13 b 22.94 b 24.27 b |
| F. Control          | 4.53 a 9.07 b 15.74 b 21.31 d 25.07 c 36.80 c 43.20 c |

**DAA = Days after application**

**Mean score followed by the same letter are not significantly different at the 5 % significance level according to DMRT**

3.2. Fungicide efficacy level

Based on the efficacy level of the fungicide from the last observations, it appeared that the highest level of efficacy was produced in the treatment with concentration of 3 g / l with the percentage of suppression of 69.14% (Table 2). Meanwhile, other concentration treatments ranged from 51.23 to 53.08%, namely on concentration of 0.75-2.25%. The treatment with concentration of 0.5 g / l had the lowest level of efficacy which only reached 43.82%. Based on the level of efficacy, treatment at a concentration of 0.5 g / l was less effective in controlling purple blotch disease.

Table 2. The level of efficacy of fungicides with active ingredients: mancozeb 80% against purple blotch disease (Alternaria porri) in shallot

| Treatments          | Intency of disease (%) | The level of efficacy (%) |
|---------------------|------------------------|---------------------------|
| A. Mancozeb 80% 3.00 g/l | 13.33                   | 69.14                     |
| B. Mancozeb 80% 2.50 g/l | 20.27                   | 53.08                     |
| C. Mancozeb 80% 1.50 g/l | 20.53                   | 52.48                     |
| D. Mancozeb 80% 0.75 g/l | 21.07                   | 51.23                     |
| E. Mancozeb 80% 0.50 g/l | 24.27                   | 43.82                     |
| F. Control          | 43.20                   |                           |

3.3. AUDPC and Inhibition of each treatment

To measure the disease severity over a certain time, a calculation was carried out using the disease
progression curve (AUDPC) and the inhibitory power of each treatment at 16–48 days after planting (DAP) on the intensity of the purple blotch disease symptoms (Figures 2 and 3).

Based on Figure 2 and from the results of the AUDPC calculation, it can be discussed that the higher the AUDPC value, the lower the percentage of inhibition on the control. In Figure 2, the lowest AUDPC is shown by treatment with a concentration of 3 g/l, this means that at concentration of 3 g/l, purple blotch disease can be suppressed higher than other treatments. In Figure 2 it can also be discussed that the AUDPC in all treatments is lower than the control and provides a greater percentage of inhibition than the control (Figure 3). This shows that the treatment can control the development of purple blotch disease. From Figure 3, it can be seen that of the five treatments tested, there are three treatments that gave a high response in inhibiting purple blotch disease, it is the treatment with an inhibitory power percentage of more than 50% which are concentration of 3 g/l (68.70%); 2.25 g/l (55.31%) and 1.5 g/l (53.31%).

The lower AUDPC rate is, the more effective treatments in controlling the pathogen, and conversely, the greater the AUDPC number is, the less effective treatments to the pathogen infection [20,21,22].

**Figure 2.** Mean AUDPC of each treatment against purple blotch disease at the observation 16 – 48 days after planting

**Figure 3.** The percentage of inhibition of each treatment against purple blotch disease was observed 16–48 days after planting
3.4. Production
The shallot plants were harvested at the age of 57 days after planting. Shallot yields can be seen in Table 3 and Table 4. Based on Table 3, it can be discussed that the highest yield components of plant samples per clump (wet weight, dry weight and number of tubers) were produced from treatment with a concentration of 3 g/l, but statistically The results obtained were not significantly different from the concentration of 1.5 g/l for dry weight and for the number of tubers with all treatments except for the concentration of 0.5 g/l and control.

Table 3. Wet weight, dry weight, number of tubers and weight loss of shallot bulbs per clump

| Treatments               | Wet weight (gr) | Dry weight (gr) | Weight loss (%) | Number of tuber |
|--------------------------|-----------------|-----------------|-----------------|-----------------|
| A. Mancozeb 80% 3.00 g/l | 106.92 b        | 88.78 c         | 21.18 a         | 10.68 c         |
| B. Mancozeb 80% 2.50 g/l | 87.98 ab        | 62.58 ab        | 28.18 a         | 8.93 bc         |
| C. Mancozeb 80% 1.50 g/l | 92.28 ab        | 66.13 bc        | 27.49 a         | 8.96 bc         |
| D. Mancozeb 80% 0.75 g/l | 87.45 ab        | 62.38 ab        | 28.45 a         | 9.20 bc         |
| E. Mancozeb 80% 0.50 g/l | 62.60 a         | 41.83 a         | 33.17 a         | 7.92 ab         |
| F. Control               | 71.45 a         | 49.63 ab        | 30.33 a         | 6.92 a          |

*) Mean score followed by the same letter are not significantly different at the 5% significance level according to DMRT

The highest production of wet tuber weight and dry weight (2 weeks shelf life) per plot with a size of 1.5 x 10 m was from shallot plants with a concentration of 3 g/l, which were 25.60 kg and 20.05 kg, respectively. This result was significantly different with the treatment concentration of 0.5 g/l and control.

Table 4. Wet weight, dry weight of shallot per plot (1.5 x 10 m)

| Treatments               | Wet weight (kg) | Dry weight (kg) |
|--------------------------|-----------------|-----------------|
| A. Mancozeb 80% 3.00 g/l | 25.60 b         | 20.05 b         |
| B. Mancozeb 80% 2.50 g/l | 22.00 ab        | 15.64 ab        |
| C. Mancozeb 80% 1.50 g/l | 21.60 ab        | 15.45 ab        |
| D. Mancozeb 80% 0.75 g/l | 21.40 ab        | 15.41 ab        |
| E. Mancozeb 80% 0.50 g/l | 18.80 a         | 12.67 a         |
| F. Control               | 18.00 a         | 12.52 a         |

*) Mean score followed by the same letter are not significantly different at the 5% significance level according to DMRT

4. Conclusion
The concentration of fungicides made from active ingredient mancozeb 80% based on efficacy and inhibitory percentage to suppress attacks of purple blotch disease are 3 g/l; 2.25 g/l and 1.5 g/l with the respective fungicide efficacy levels of 69.14%; 53.08% and 52.48%, and the inhibition respectively 68.70%; 55.31% and 53.31%. The highest production of shallots per plot resulted from a concentration of 3 g/l, with a dry weight of 20.05 kg.

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