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Response of Several Shallot (*Allium cepa* var. *ascalonicum*) Varieties to *Alternaria porri*

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ABSTRACT
Shallots are a valuable commodity in Indonesian civilization. However, due to different obstacles, production remains low. The prevalence of purple blotch disease caused by *Alternaria porri* is one of the major challenges in shallot production. A fungus infects its host through the stomata. The use of resistant cultivars is one of the initiatives to combat purple blotch disease. This study aimed to determine the resistance of several shallot varieties to purple blotch disease, identify and obtain resistant shallot varieties, and determine the relationship between stomatal density and the average intensity of the purple blotch disease attack. This study uses shallot cultivars released by the Balai Penelitian Tanaman Sayuran (BALITSA) Lembang. This study employed a randomized completely block design (RCBD) with ten shallot varieties as the treatments with three replications. The Agrihorti-1 and Katumi varieties had the lowest attack intensity, while the Sembrani and Maja Cipanas varieties had the highest assault intensity. Bima Brebes, Trisula, Mentes, Violetta-1, Kramat-1, Agrihorti-1, Agrihorti-2, and Katumi varieties were resistant to purple blotch disease, however, Sembrani and Maja Cipanas were susceptible. A low or weakly positive association exists between stomata density and the mean intensity of purple blotch illness.

Keywords: Purple blotch; Resistance; Shallot; Susceptible; Stomata density

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INTRODUCTION

Shallot (*Allium cepa* var. *ascalonicum*) is one of the horticultural crops that has long been cultivated among Indonesian farmers. In 2023-2027, the projected consumption of shallots is likely to increase by 0.46% per year or an average of 3.03 kg/capita per year (Center for Agricultural Data and Information Systems 2020).

Economic constraints that many farmers face are price fluctuations and high production costs. Meanwhile, the most encountered technical constraints include quality seeds, Plant Disturbing Organisms (PDO) attacks, and cultivation techniques (Soetiarso and Setiawati 2005). One important disease that is a constraint in shallot production is purple blotch caused by *Alternaria porri* (Ell.) Cif. (Nirwanto 2008).

Pest attacks in shallot cultivation are important, especially when associated with a decrease in the quantity and quality of production. (Putrasamedja et al. 2012). Potential yield loss by pests in old and young plant stadia can reach 20-100% depending on shallot cultivation management (Tanjung 2016). Purple spot disease has now been widely reported and causes significant yield losses of around 40% (Putri 2017), even Marlitasari et al. (2016) mentioned that the disease can cause yield losses of 3%-57% depending on the growing season.

Inappropriate use of pesticides can endanger the health of farmers and consumers, non-target microorganisms, and have an impact on environmental pollution of soil and water (Yuantari et al. 2015). Efforts to suppress purple spot disease in shallot plants need to be made to reduce the impact caused by using synthetic fungicides and reduce the risk of yield loss due to the disease, one of which is by utilizing shallot varieties that are resistant to purple spot disease.

The utilization of resistant variety components in pest control efforts is very necessary, considering that fluctuations in pest attacks are largely determined using varieties and climatic conditions. Utilizing tolerant varieties, the availability of new high-yielding varieties is also needed to cope with the increasing population and decreasing land area (Sari et al. 2017).

Prasojo (2018) said that the Vegetable Crops Research Center (Balitsa) has released and registered 14 shallot varieties that are suitable for planting in low to highlands. Some of the 14 varieties are Sembrani, Trisula, Mentes, Maja Cipanas, Bima Brebes, Kramat-1,

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Katumi, Agrihorti-1, Agrihorti-2, and Violetta-1. It was reported that the Kramat-1 variety is less resistant to purple spot disease, while the Violetta-1 variety is somewhat resistant to purple spot disease.

To determine the response of resistance or susceptibility of each variety, therefore testing the resistance of several varieties of shallots to purple blotch disease, so that one or more resistant shallot varieties with high productivity will be obtained and accepted among the community. In addition, observations of stomatal density were also made to determine its relationship with the intensity of purple spot disease attack related to the resistance of each shallot variety.

After knowing some of the responses of shallot varieties to *A. porri* fungus infection that causes purple spot disease in shallot plants, it is expected to be a source of information to get a solution to the problem of purple spot disease in shallots, as well as getting shallot varieties that are resistant and useful to support shallot production in Indonesia.

MATERIALS AND METHODS

Research location and time

This research was conducted in the experimental garden of the Vegetable Crops Research Center (BALITSA), precisely on Jl. Tangkuban Perahu, Cikole Village, Lembang District, West Bandung Regency, West Java 40391. located at the foot of Mount Tangkuban Parahu at coordinates 107°30' East Longitude and 60°30' South Latitude located in Cikole Village, Lembang District, West Bandung Regency, West Java Province at an altitude of ± 1,250 m above sea level. Geologically, the soil type in the area is Andisol soil with type B climate, with average daily temperature ranging from 19-24 °C, air humidity ranging from 34-90%, and an average rainfall of 2,207.5 mm.year$^{-1.}$ The research was conducted from July 2019 to October 2019 (before the pandemic).

Methods and analysis

This research was organized using a Randomized Block Design (RAK) consisting of 10 treatments and 3 replications. The experiment was conducted on an area of 20 m x 8 m, consisting of 30 plots of 1.5 m x 1.5 m per plot, each plot was planted with 30 plants, and 10 samples were taken randomly.

Each replication consisted of 10 plots, and each plot consisted of 10 samples of shallot plant clumps so the entire sample was 10 x 10 x 3 = 300 samples. Observations were conducted once a week.

Research observations

Observation of purple spot disease intensity.

Observation of the disease intensity of purple blotch is calculated using the following formula.

$$DI = \frac{\Sigma(v \times n)}{Z \times N} \times 100\%$$

Notes:

- DI = Intensity (%)
- n = Number of clumps that have the same damage value (score)
- Z = Highest attack category score
- N = Number of clumps observed
- v = Damage score value based on the leaf area of all affected plants.

The disease scoring uses the following categories.
0 = No diseased clump of shallot observed,
1 = leaf damage > 0-20%,
2 = leaf damage > 20-40%,
3 = leaf damage > 40-60%,
4 = leaf damage > 60-80%, and
5 = extent of leaf damage > 80-100% (Moekasan et al. 2005)

The criteria for the response of shallot varieties to purple spot disease and determined based on the disease intensity according to Syukur et al. (2009) as follows: disease intensity 0-10%= highly resistant, 11-20%= resistant, 21-40%= moderate, 41-70%= susceptible, and 71-100%= very susceptible

Counting the number and density of stomata was done when the plants were 61 days after planting (DAP) and the plants had entered the generative phase. Observations were made using a stereo microscope by taking leaf samples in each treatment, then the leaf surface of 1 mm2 was cut thinly using a razor blade and taken using tweezers. Then the leaf incision was placed on an object glass and covered with cover glass. Observe under a stereo microscope with 40 x 10 magnification, then the observed stomata are counted.

The number of stomata that have been observed is then calculated by using the stomatal density formula according to Lestari (2006) as follows.

$$\text{Stomata Density} = \frac{Number\ of\ Stomata}{Unit\ Area\ of\ Field\ of\ View}$$

RESULTS AND DISCUSSIONS

Observation of purple spot disease attack intensity

Observations of purple spot disease attack intensity were made when the plants were 31 DAP. The intensity of the disease attack was recorded when the plants showed symptoms of purple spot disease caused by *Alternaria porri* fungus. The results of the observation of the intensity of purple spot disease attack on shallot plants are presented in Table 1.

Based on the results of Duncan's multiple range test analysis at the 5% real level, the average intensity of purple spot disease caused by the fungus *A. porri* on shallots obtained from 31 DAP observations has shown significant symptoms of infection in several varieties, where treatment C (Trident variety) and J (Katumi variety) are significantly higher in attack intensity compared to other treatments and significantly different in attack intensity from treatments B, D, and E, but not significantly different in attack intensity from treatments

A, F, G, H, I. Treatment B, D, Disease score and E, significantly lower in attack intensity than C and J, and not significantly different in attack intensity from treatments A, F, G, H, I. Treatments B, D, and E, was significantly lower in attack intensity than C and J, and was not significantly different in attack intensity from treatments A, F, G, H, I. At 31 Days After Planting (DAP), some shallot varieties have entered the generative phase because the plants have begun to appear in umbel buds. This is following previous research conducted by Hilman et al. (2014) that the development of shallot flowers in the highlands in the first stage of umbel buds appears 14-19 DAP. In the second stage, the umbel buds develop to the maximum and are wrapped by a light green membrane until 44-51 DAP (30-32 days after the umbel appears) when the umbel membrane begins to break. Based on this, the *A. porri* fungus begins to infect shallot plants when the plants begin to form bulbs or enter the generative phase.

Table 1. Disease development of purple spots on several varieties of shallots

Varieties	Day After Planting (DAP)					
	31	38	45	52	59	66
A	1.33 ab	4.00 a	17.33 a	27.33 a	39.33 a	50.00 a
B	0.00 b	0.00 B	10.67 abc	22.00 ab	29.33 B	36.00 B
C	2.67 a	3.33 a	10.67 abc	19.33 ab	23.33 bcd	30.67 cd
D	0.67 b	4.67 a	12.00 ab	22.00 ab	28.67 bc	41.33 ab
E	0.00 b	2.00 ab	8.67 abc	18.00 b	24.67 bcd	30.67 cd
F	0.67 ab	1.33 ab	10.00 abc	20.67 ab	26.67 bcd	34.67 Bc
G	1.33 ab	1.33 ab	8.00 bc	18.00 b	24.00 bcd	30.67 cd
H	0.67 ab	2.00 ab	6.00 bc	17.33 b	20.00 d	24.00 e
I	0.67 ab	2.00 ab	11.33 abc	18.00 b	27.33 bcd	31.33 cd
J	3.33 a	3.33 ab	4.67 c	17.33 b	21.33 cd	24.67 de

In each subsequent observation, the observation results of the intensity of purple spot disease attack on several shallot varieties showed an increase. The occurrence of this increase is due to factors that support the development of diseases such as pathogens, hosts, and the environment. This is per the statement of Chatri (2016) that disease in plants only occurs in a place if there are three factors, namely susceptible plants (hosts), virulent pathogens, and a suitable environment. The three factors interact with each other to cause disease in plants. This interaction is often described as the disease triangle.

According to Hadisutrisno et al. (1996), weather factors play an important role in the daily conidium dispersal of *A. porri* fungus and the intensity of purple spot disease. The weather factors such as temperature, humidity, and average rainfall at the time of the study ranged from 15.8-26.8°C, 88.4-92.4%, and 1.78 mm.

This is following the opinion of Manengkey and Senewe (2011) that temperature can affect the number of spores that can germinate. In general, the minimum temperature for spore germination is 1-3°C and the maximum temperature is 30-36°C. Meanwhile, according to Kumar et al. (2023) The maximum mycelial growth of A. *porri* was recorded on 30°C temperature.

The results of the 38 DAP observation showed that treatments A, C, and D were significantly higher in attack intensity than the other treatments and significantly different in attack intensity from treatment B, but not significantly different in attack intensity from treatments E, F, G, H, I, J. Treatment B was significantly lower in attack intensity than the other treatments and significantly different in attack intensity from treatments A, C, and D, but not significantly different in attack intensity from treatments E, F, G, H, I, J.

The results of the 45 DAP observation showed that treatment J was significantly lower in attack intensity than the other treatments and significantly lower with treatments A and D, but not significantly lower with treatments B, C, E, F, G, H, I. Treatment A was significantly higher in attack intensity and significantly different in attack intensity from treatments G, H, J, but not significantly different in attack intensity from treatments B, C, D, E, F, I. Treatment D significantly differed higher attack intensity with treatment J, but did not significantly differ higher attack intensity with treatments A, B, C, E, F, G, H, I. Treatments G and H significantly differed in attack intensity with treatments A and D, but did not significantly differ in attack intensity with treatments B, C, E, F, I, and J. The observation results of 52 DAP showed that treatment A was significantly higher in attack intensity than the other treatments and significantly different in attack intensity with treatments E, G, H, I, and J, but did not significantly differ in attack intensity with treatments B, C, D, F. Treatment E was significantly different in attack intensity from treatment A, but not significantly different in attack intensity from treatments B, C, D, F, G, H, I, J.

The average observation of purple spot disease attack intensity at 59 DAP showed that variety H was significantly lower in disease intensity than the other treatments and significantly different in attack intensity with varieties A, B, and D, but not significantly different in attack intensity with treatments C, E, F, G, I, and J. Treatment A was significantly higher and significantly different in attack intensity than the other treatments. Treatment B was significantly different in attack intensity from treatment A, but not significantly different in attack intensity from treatments C, D, E, F, G, and I. Treatment D significantly differed in attack intensity from treatment A but did not significantly differ in attack intensity with treatments B, C, E, F, G, H, I, and J.

The average observation of purple spot disease attack intensity at 66 DAP showed that treatments H and J were significantly different in the lowest attack intensity.

Treatment A was significantly higher in attack intensity compared to all other treatments, but not significantly higher than treatment D, followed by treatments B, F, C, E, G, H, and I.

Although in practice the intensity of purple spot disease attack always increases (Figure 1), the intensity of attack in each variety is different. This indicates that each variety has a different level of resistance to purple spot disease. The research of Nirwanto (2007), suggested that the reality in the field shows that the same stretch of land with various compositions of shallot plants can cause different levels of purple spot disease attack. This shows the vulnerability of each type of shallot plant that is different in the disease. It can be seen from the analysis of the average observation of 59 DAP-66 DAP (Table 5.) shows that treatment A (Sembrani variety) has the lowest resistance of other treatments, while treatment J (Katumi variety) and H (Agrihorti-1 variety) have a significantly higher resistance compared to other treatments. The following is a graph of the development of purple spot disease in several varieties of shallots presented in Figure 1.

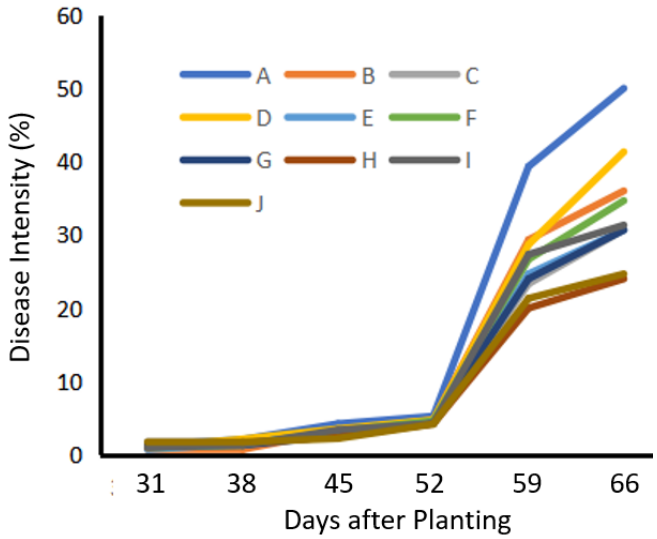

Figure 1. Graph of purple spot disease development in several varieties of shallots

The difference in susceptibility of each shallot variety to purple spot disease is thought to be influenced by genetic factors such as gene levels, the number of genes, and differences in the types of genes of each shallot variety. Variations in resistance to pathogens among plant varieties are caused by differences in the type and number of resistance genes in each variety (Andersen et al. 2018). Nirwanto (2007) also stated that gene levels indicate the resistance or susceptibility of a host plant to pathogens. Furthermore, Muis et al. (2015) explained that genetically the nature of plant resistance is influenced by the presence of several genes that make up the chromosome, in which the resistance varieties are usually composed of several resistance genes known as horizontal resistance. There are resistant genes that control the metabolism of toxin production produced by plants that can suppress disease development. Even Rahim et al. (2012) in Yuliani and Rohaeni (2017) mentioned that the development of resistant genes in plants is the result of coevolution between the host and the pathogen that has been going on for a long time. Based on this, Sastrahidayat et al. (2013) stated that plant resistance to infection is the ability of plants that be antagonistic to pathogens, and pathogens have no effect on plants. Furthermore Kaur et al. (2022), added that this is because plants have mechanical and chemical barriers that can cause infection.

Mechanical and chemical barriers are thought to be active and passive resistance mechanisms possessed by each variety of shallot plants. Active and passive resistance mechanisms arise in the genetic system of the host and pathogen that interact with host reactions to prevent the development of the pathogen itself (Kaur et al. 2022). Active resistance mechanisms are the results of chemical and physical properties of plants that limit the development of pathogens, where the mechanism only works after the host has experienced pathogen invasion (Sastrahidayat et al. 2013).

Some active resistance mechanisms are the result of the development of plant cell structures, tissues, and cytoplasm. In addition, it can also be in the form of compounds released by the affected plant parts (Rostini 2011). Meanwhile, plants that have a passive resistance mechanism have a morphological structure that makes it difficult to be infected by pathogens (Carezzano et al. 2023). Therefore, Rahman et al. (2021) state that if the cuticle and wax layer are thick, it will inhibit and prevent fungal penetration. This shows that there are differences in the thickness of the cuticle layer, wax layer, number of leaf hairs, and number of stomata in each shallot variety, thus affecting plant resistance in limiting pathogen development.

One of the active resistance mechanisms in shallots is the presence of compounds in shallots that can inhibit the development of pathogens. As it is known, shallots contain allicin compounds and essential oils that are bactericidal and fungicidal against bacteria and fungi (Moldovan et al. 2022). The active ingredients of essential oil consist of cycloaliin, methylaliin, kaemferol, quercetin, and floroglusin (Muhlisah and Hening 2009).

It is suspected that the essential oil content in each shallot variety is different so each variety has a different resistance level. This essential oil is thought to inhibit the development of *A. porri* fungus. Based on this, it indicates that each shallot variety has a different level of resistance based on active and passive resistance mechanisms.

In addition to gene levels, active and passive resistance possessed by each variety including the content of essential oil compounds of shallot plants, the presence of endophytic bacteria is also one of the factors that can inhibit the growth of *A. porri* fungus. The results of research by Pitasari and Ali (2018) show that endophytic bacterial isolates from shallot plants provide antagonistic power that has a significant effect on the pathogenic fungus *A. porri* in the PDA medium. According to (Mardhiana et al. 2017), Endophytic bacteria are bacteria that can live, develop well, and associate with plant tissue without causing disease symptoms in the plant. According Medison et al. (2022),

endophytic bacterial communities can withstand pathogen attacks, thought to be related to the adaptability of these bacteria in specific hosts and tissue types. Furthermore, Pitasari and Ali (2018) in their research results stated that for endophytic bacteria from shallot plants, more isolates were obtained from the leaves than from the bulbs and roots. This according to Pitasari and Ali (2018) is thought to be due to the flow of photosynthetic products from the leaves to all parts of the plant through the phloem, so that it can be utilized by endophytic bacteria as a source of nutrition.

Based on this, susceptible plants are suspected to have more endophytic bacteria in the leaves than resistant plants. Endophytic bacteria can also produce secondary metabolites that can control plant pathogens (Medison et al. 2022). It is suspected that each endophytic bacterium produces antibiotics, whereas if there are many endophytic bacteria in plant tissue, there will also be many antibiotics produced that can be toxic to the bacteria themselves.

This follows the opinion of Pitasari and Ali (2018) that many endophytic bacterial isolates produce excessive amounts of antibiotic compounds so that they are toxic and can inhibit and even kill the bacteria themselves which in turn causes the bacterial population to decrease and the inhibitory power to be low. This is supported by the results of research by Pitasari and Ali (2018) that antibiotics produced by endophytic bacteria in copious quantities can have a negative effect on the bacteria themselves. Based on the description above, the criteria for the response of each shallot variety to purple blotch disease can be known from the results of the average intensity of purple blotch disease (Table 1).

Table 2. Criteria for the degree of resistance of some red shallot varieties based on the average disease intensity of purple blotch at 66 days after planting

Varieties	66 DAP	Response category
A	50.00	susceptible
B	36.00	moderate
C	30.67	moderate
D	41.33	susceptible
E	30.67	moderate
F	34.67	moderate
G	30.67	moderate
H	24.00	moderate
I	31.33	moderate
J	24.67	moderate

Observation of stomata density of shallot

Observations of the number of stomata were made when the plants were 61 DAP at that time the plants had entered the generative phase. The observation of the number of stomata aims to determine the effect of the number of stomata on the intensity of purple spot disease caused by the fungus *A. porri*. The results of the observation of stomatal density are presented in Table 3.

In general, the *A. porri* fungus can enter the plant through wounds or natural openings in the plant (stomata). This shows that the number of stomata affects the number of fungi that enter the plant. Presumably, the greater the number of stomata in a plant, the greater the opportunity and number of fungi to enter the plant. Based on the results of the study the average disease intensity of purple blotch disease caused by the *A. porri* in variety Sembrani has the highest average disease intensity which is 50.00% and the criteria for susceptibility (Table 3), has the highest stomatal density which is 232.33 stomata.mm^{-2}. While variety Agrihorti-1 has the lowest stomatal density of 140.67 stomata/mm^2 and the lowest average attack intensity of 24.00%, followed by treatment J (Katumi variety) which has a stomatal density of 146.33 stomata.mm^{-2} and a low average attack intensity of 24.67%.

Table 3. Stomatal density and disease intensity of purple spot disease of shallot varieties

Varieties	Stomatal density (per mm^2)	Disease intensity (%)
A	232.33	50.00
B	173.33	36.00
C	228.00	30.67
D	171.33	41.33
E	201.33	30.67
F	176.00	34.67
G	154.33	30.67
H	140.67	24.00
I	195.33	31.33
J	146.33	24.67

Figure 2 shows the relationship between stomatal density and the average intensity of purple spot disease attack at 59-66 DAP. The linear line in Figure 2. illustrates the relationship between stomatal density and the average intensity of purple spot disease. The linear line shows the equation Y= 0.1418X + 7.49 with a regression value of 0.3193. The following is a graph of the correlation relationship between stomata density and purple spot disease intensity.

The correlation between stomatal density and disease intensity is positive. This shows that the higher the stomatal density, the higher the disease intensity. However, both have a weak or low correlation (Kārkliņa et al. 2021), when viewed from the regression value of 0.3193. This indicates that stomatal density influences the intensity of purple blotch in shallot plants which is 31.93% and 78.07% of other factors. The effect of stomatal density on purple spot disease is small because other factors affect the intensity of purple spot disease such as the thickness of the epidermal layer and biochemical reactions that occur in plants after being attacked by pathogens (Marlitasari et al. 2016).

The relationship between stomata and the intensity of plant leaf disease is generally positive. Stomatal density was positively correlated with the disease intensity of

downy mildew of corn. Higher disease intensity has lower chlorophyll content compared with the lower intensity (Agustamia et al. 2017). Whereas Suriani et al. (2018) proved that he rust infection rate on all accession were categorized by mild to moderate. Density of the stomata of each maize germplasm accession was significantly correlated with rust severity, the increase of stomata density could increase of rust severity at 0.73%. Apet and Kadam (2020), reported that the stomata size, pore size and frequency were positively correlated and increased the per cent disease intensity Citrus Canker caused by *Xanthomonas axonopodis* pv. *citri*.

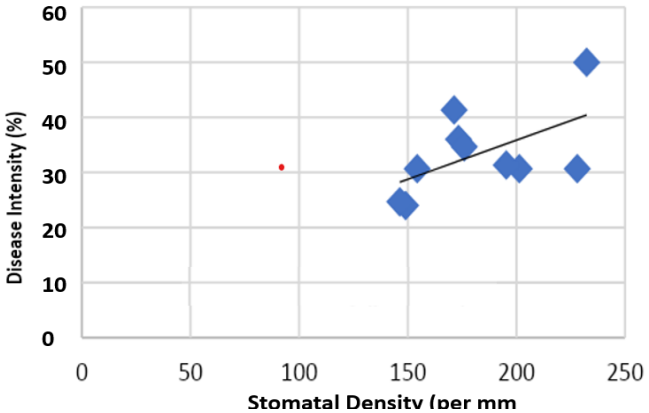

Figure 2. Correlation between stomatal density and purple spot disease intensity

Observation of weight of shallot yield

Observation of the weight of shallot harvest is done after harvest (87 DAP). The results of the analysis of the average weight of shallot yield are presented in Table 4. Based on the results of Duncan's test analysis at the 5% real level, the results of the analysis of the average weight of the harvest of shallot samples per 10 plants showed that treatment A had the lowest yield weight compared to all other treatments and was significantly lower in weight than treatments B, C, D, F, G, and I, but not significantly lower than treatments I, H, and J. Treatment B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatments B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatment D was significantly different in weight from treatment A, but not significantly different from the other treatments. Treatments E, H, and J were not significantly different in weight from the other treatments.

Based on the results of Duncan's test analysis at the 5% real level, the results of the analysis of the average weight of the harvest of shallot samples per 10 plants showed that treatment A had the lowest yield weight compared to all other treatments and was significantly lower in weight than treatments B, C, D, F, G, and I, but not significantly lower than treatments I, H, and J. Treatment B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatments B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatment D was significantly different in weight from treatment A, but not significantly different from the other treatments. Treatments E, H, and J were not significantly different in weight from the other treatments.

Table 4. Results of analysis of average weight of yield of several varieties of shallots

Treatments	Average Weight of Yield (g)		Productivity (t. ha^{-1})
	Each 10 Plants	Each-Plot	
A	114.00 c	314.33 e	1.40
B	282.00 a	781.33 abc	3.47
C	273.33 a	752.00 abc	3.34
D	255.00 ab	865.00 ab	3.84
E	222.00 abc	597.00 cd	2.65
F	245.67 ab	722.33 bc	3.21
G	326.33 a	998.67 a	4.44
H	222.67 abc	722.00 bc	3.21
I	321.00 a	939.33 ab	4.17
J	134.67 abc	350.33 de	1.56

Based on the results of Duncan's test analysis at the 5% real level, the results of the analysis of the average weight of the harvest of shallot samples per 10 plants showed that treatment A had the lowest yield weight compared to all other treatments and was significantly lower in weight than treatments B, C, D, F, G, and I, but not significantly lower than treatments I, H, and J. Treatment B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatments B, C, G, and I were significantly higher in weight than all other treatments and significantly higher than treatment A, but not significantly higher than treatments D, E, F, H, and J. Treatment D was significantly different in weight from treatment A, but not significantly different from the other

treatments. Treatments E, H, and J were not significantly different in weight from the other treatments.

The low yield weight of treatment A is because the observation of attack intensity presented in Table 4 shows that treatment A has the highest attack intensity in almost every observation. Whereas the Sembrani variety is one of the shallot varieties that have high yield potential, which reaches 23 t.h^{-1} (Firmansyah et al. 2014), this is because the plant has many leaves that cannot photosynthesize properly, so the plant is unable to produce carbohydrates to meet the needs of the plant. This is equivalent to the statement of Hekmawati et al. (2018) that if the percentage of healthy leaves is low, it causes a photosynthetic process that is not optimal and has an impact on inhibiting the process of tuber formation and maturation and reducing tuber quality. Hekmawati et al.(2018) also stated that the low green leaf area causes a low photosynthesis rate, resulting in shallot bulbs with low weight.

Even so, the correlation results between the weight of harvest yields of several shallot varieties have the equation $y = -2.2644X + 315.3$ with a regression value of 0.0617. The equation shows a negative value, this does not indicate that the higher the disease intensity, the lower the yield weight. This can also be seen from the regression value which shows that the correlation between the two is very low or very weak (Widiyanto 2013).

The correlation of purple spot disease intensity with the yield weight of some shallot varieties can be presented in Figure 3.

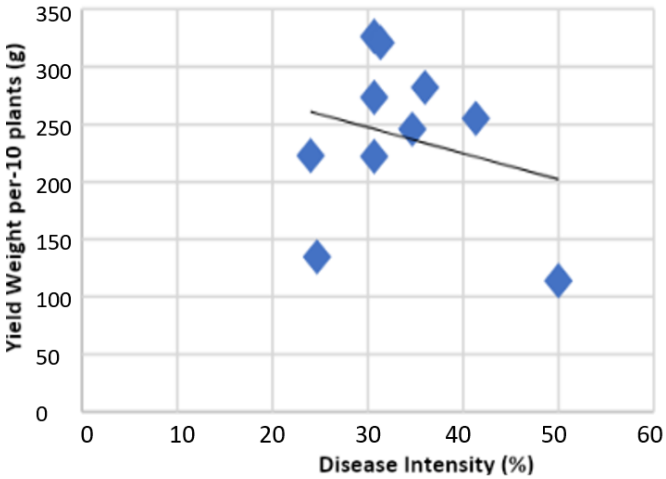

Figure 3. Correlation of purple spot disease intensity with yield weight of some varieties

The results of the analysis of the average weight of harvest per plot showed that variety A was not significantly different from the lower weight of harvest with treatment J, but significantly different from the lower weight of harvest with other treatments. It is suspected that the weight of yields including the number of bulbs and the diameter of the bulbs is influenced by genetic factors in each shallot variety.

This follows the opinion of Azmi et al. (2011) that the character of the number of shallot bulbs is much influenced by genetic factors and little influenced by the environment. The reality in the field also shows that treatment J (Katumi variety) has a smaller bulb size compared to other treatments (Figure 4).

Even though the potential yield of shallot bulbs Katumi variety is quite high, it can reach 8.0-24.1 t.ha^{-1}, this variety is admirably adapted to the lowland's altitudes of 6-80 m.a.s.l in the dry season (Prasojo 2018). It is suspected that this is because the Katumi variety is less suitable for planting in the highlands, resulting in smaller bulbs.

Shallot varieties in the highlands are also thought to have a relatively smaller size than the usual size, this can be seen from the productivity of shallot varieties in the field based on the results of the study (Table 4) showing lower results than the productivity of bulb yields in each description of shallot varieties.

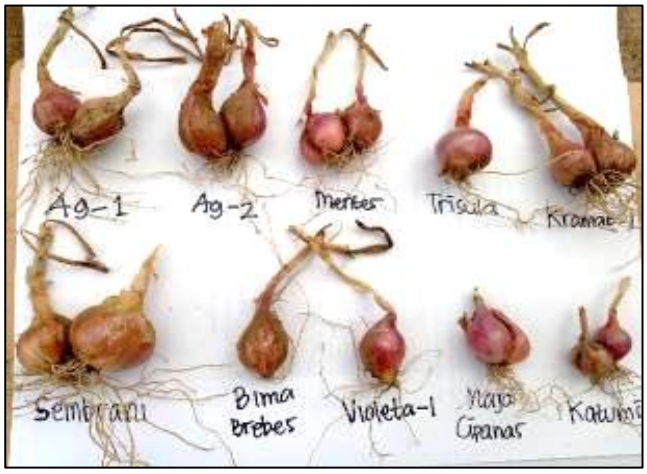

Figure 4. Bulbs ten varieties of shallot

This follows the opinion of Azmi et al. (2011) that high-yielding varieties in one place do not necessarily provide high yields in other places. Because to get optimal production requires a suitable environment. Putrasamedja et al. (2012) added that in addition to environmental factors, genetic factors are also important.

CONCLUSIONS

Agrihorti-1 and Katumi varieties have the lowest disease intensity, while Sembrani and Maja Cipanas varieties have the highest disease intensity. Varieties Bima Brebes, Trisula, Mentes, Violetta-1 Kramat-1, Agrihorti-1, Agrihorti-2, and Katumi have a degree of resistance rather vulnerable, while Varieties Sembrani and Maja Cipanas have a degree of resistance vulnerable. The stomatal density and purple blotch intensity at 66 days after planting have a positive correlation with a linear equation $Y = 0.1418X + 7.49$ with a regression value of 0.3193.

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