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Inventory of Diseases in Red Shallot Plants *(Allium ascalonicum)*

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Abstract. Shallots (*Allium ascalonicum*) are a popular spice vegetable cultivated in Indonesia, ranging from lowlands to highlands. Their demand continues to grow as they are an essential kitchen commodity, although their prices often fluctuate. This research aimed to examine the disease symptoms in shallot plants caused by pathogenic fungi and to identify the types of pathogenic fungi present on agricultural land in Bangsalan Village, Boyolali Regency. The study consisted of three blocks, each containing 12 plots, and each plot comprising 15 plants. From each plot, five plants were randomly selected as samples. This qualitative research utilized observational and descriptive methods, where symptoms observed in the field were described and identified based on macroscopic and microscopic characteristics. Macroscopic identification revealed symptoms such as wilting, rot, and spots on both leaves and tubers. Microscopic identification confirmed infections by the fungi *Colletotrichum* sp. (causing anthracnose), *Fusarium* spp., and *Aspergillus* sp. on shallots. The findings from this study provide valuable recommendations for managing shallot diseases in subsequent planting seasons if similar symptoms are observed.

Key words: *Aspergillus* sp; *Colletotrichum* sp.; *Fusarium* spp.; Shallots; Symptom.

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INTRODUCTION

The shallot plant (*Allium ascalonicum*) is a native plant that is widely cultivated by people, especially in Indonesia. The shallot plant comes from Brebes, Central Java and its adaptability is good enough to be planted in all regions in Indonesia. This plant contains flavonoid compounds (Azmi., 2020) that can improve human immune system (Henri et al., 2020). Obstacles in shallots cultivation are disease attacks which often disrupt plant production and quality (Oktaviani et al., 2020; Cennawati et al., 2023).

Indonesia's shallot production in 2022 totaled 1.9 million tons; a decrease of approximately 2% compared to 2021's production of 2 million tons. Central Java is the highest producer, with 55 tons in 2022, followed by East Java with 47 tons, and West Nusa Tenggara with 20 tons (BPS, 2022). In 2020, Thailand received the largest share of Indonesia's shallot exports at 67.54%, with Singapore, Malaysia, and Taiwan also being key destinations. Between 2016 and 2020, the top seven shallot-producing countries contributed 71.37% to the total global exports. Indonesia has a great potential to increase shallot exports and reduce imports, with the support of appropriate policies to increase added value and sustainability of national agricultural productivity (Sjafrina et al., 2023; Marianah et al., 2024; Zegeye et al., 2024).

The challenge in cultivating the Bali Karet or Buto Ijo variety of shallots lies in increasing demand that is not matched by stable productivity and prices, especially due to disease outbreaks. Pathogenic fungi pose a significant problem. Infections are characterized by symptoms such as wilting, rot, and spots on the leaves and tubers. *Fusarium* infections cause leaf color changes, plant wilting, and tuber discoloration and rot. *Colletotrichum* sp. causes necrosis and thrives in damp conditions. *Aspergillus* infections, being caused by a tolerant cosmopolitan fungus, result in curling and yellowing of leaves even under normal conditions. (Wibowo et al., 2023; Resti et al., 2024). To date, no research has been conducted on the symptoms and causes of diseases affecting the

Bali Karet variety in the Boyolali area or other shallot-growing regions, leaving a lack of effective recommendations for disease control.

Boyolali is an ideal location for horticultural development due to its combination of lowland and highland areas, which can be optimally utilized. However, attacks by plant pathogens, including infectious diseases caused by fungi, bacteria, and viruses, pose significant challenges to shallot cultivation. These disease attacks hinder the development of shallots, leading to a decline in both the quality and quantity of yields. This research aims to examine the symptoms of diseases in shallot plants caused by pathogenic fungi and to identify the types of fungi present on agricultural land in Bangsalan Village, Boyolali Regency. The findings of this study will provide valuable information and recommendations for managing and controlling shallot cultivation in future planting seasons, especially if similar symptoms reappear.

METHODS

Research Design

This research was carried out in August 2023 - December 2023 in Bangsalan Village, Boyolali District, on sandy Regosol soil type. The research was conducted qualitatively with an exploratory approach (Resti et al., 2024). The research samples were taken from 36 test plots, with three samples per plot. Sampling was carried out using purposive sampling, where samples were taken randomly (Campbell et al., 2020) from plants that showed symptoms of disease (Resti et al., 2024), namely wilting, rotting, and spots both on the leaves and onion bulbs. Observations were made by identifying macroscopic characteristics, based on visible symptoms, and microscopic characteristics, by looking at visible conidia/spores (Dubey et al., 2017; Muscat et al., 2020).

Land preparation

In the planting area, the soil was plowed or hoed to a depth of 20-30 cm. Then, three beds were created as blocks, each 100 cm wide and 25 cm high, with a distance of 50 cm between blocks. Each block consisted of 12 plots, with each plot measuring 100 cm by 50 cm, and spaced 20 cm between the plots. Each plot contained 15 plants, from which 5 were randomly selected as samples. Before mulching, each bed was treated with 50 kg of dolomite lime for one planting period. Basic fertilizers were applied at a rate of 300 kg/ha, with SP-36 at 180 kg/ha, and ZA fertilizer at 100 kg/ha. These basic fertilizers were spread and mixed evenly with the soil one to three days before planting (Hasanah et al., 2022).

Preparation and Planting of Seeds

Seedlings from shallot bulbs that met the criteria must be 75 day after planting (DAP) and medium sized (5-10g). The appearance of the seed tubers had to be fresh, healthy, and firm. The seeds were selected and cleaned from the dry outer skin. Seedlings that were ready to be planted were crushed. Cutting of the seedlings' tip were only done if the shallot seedlings were not = ready to be planted (e.g., shoot growth in the bulb is 80%). Trimming the see tubers helped break the dormancy period and accelerate the growth of plant shoots. The ready-to-plant seeds were planted in mounds that have been previously prepared at a distance of 40×20 cm (Purba et al., 2020; Hasanah et al., 2022).

Observation

This research was qualitative in nature with observational and descriptive methods. Observations were analyzed descriptively regarding the symptoms found in plants in the test field. Samples were taken randomly and then identified based on macroscopic and microscopic characteristics (Resti et al., 2024).

Analysis of Results

Qualitative data analysis techniques were carried out descriptively, describing the existing situation based on visible facts or what they are and then comparing them with related literature (Safitri et al., 2019; Nasir and Sukmawati, 2023).

RESULTS AND DISCUSSION

Anthracnose

The timing of symptom onset for onion anthracnose is not well-documented. The pathogen often remains invisible in nursery environments, with initial signs emerging as water-soaked lesions on leaves approximately 30 days post-planting. These lesions eventually transition into white specks and then into chlorotic, depressed spots located on the older leaves (Dutta et al., 2022).

Anthracnose in shallot can attack all parts of the plant such as leaves and fruit plant twigs. The disease is caused by *Colletotrichum* sp., which causes spotting symptoms on leaves (A1).

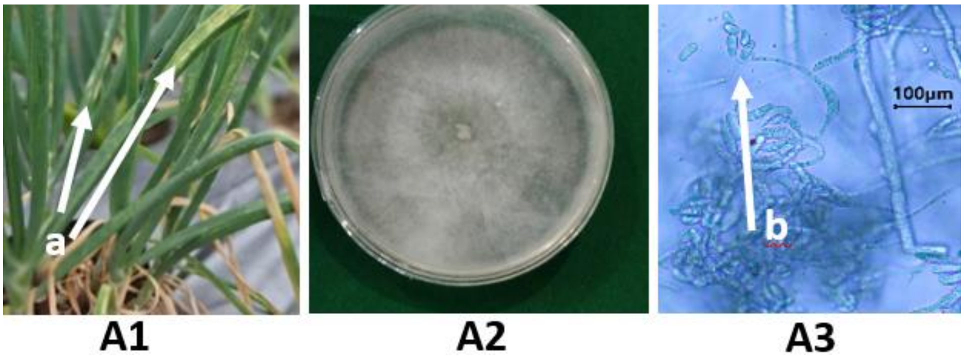

Figure 1. Symptoms of Anthracnose (A1), isolation of *Colletotrichum* sp colonies on PDA medium (A2), microscopic conidium of *Colletotrichum* sp with 40x magnification (A3), a: spots on leaves; b: conidium of *Colletotrichum* sp.

Symptoms of shallot infection begin with the appearance of blackish-brown spots, which then expand into soft rot areas. At the center of these spots areblack dots, consisting of fungal conidia and setae, often due to a previous infection by *Colletotrichum* sp. This fungus can attack various parts of plants, including stems, leaves, and roots. In shallot plants, it specifically affects the stems and leaves during cool weather with moderate rainfall. Initial symptoms appear on the first five young leaves from the apical part of the plant (Kadir. et al., 2019; Safitri et al., 2019; Dutta etal., 2022).

Colletotrichum sp which causes Anthracnose on shallots in Bangsalan Village, Boyolali Regency, Central Java, initially presents as small sunken spots on the leaves. After an incubation period of 2-4 days, small white spots appear on the distal parts of the leaves and gradually expand, leading to tissue death. A distinguishing characteristic of this disease is the appearance of yellow-brown conidia spots in a cylindrical pattern (Safitri et al, 2019) In this study, *Colletotrichum* sp. attacked all parts of the shallot plants.

Environmental factors such as pH, temperature, humidity, plant spacing, and environmental cleanliness influence the spread of *Colletotrichum* sp. Plant spacing that is too tight reduces air circulation, increases humidity, and causes the appearance of fungal diseases. The disease is usually less common in the dry season and in well-drained areas, but is more likely to occur in the rainy season and in very humid areas (Dubey et al., 2017; Pardosi, 2021; Ramadina et al., 2024).

Fusarium spp.

Plants infected with the *Fusarium* spp. fungus show symptoms of wilted leaves, chlorosis, stunted growth, and stem base rot. This fungal attack is known as Moler disease, and causes the plant to wilt quickly, appear thin, and droop as if it is about to collapse (Sudantha & Suwardji, 2021; Widono et al., 2023).

Plants are vulnerable to uprooting because of disrupted root growth, and can even start to rot. In heavy attacks, plants can fall and die as the *Fusarium* fungus infects the base layer of the tuber (B1), and the tuber (B2),

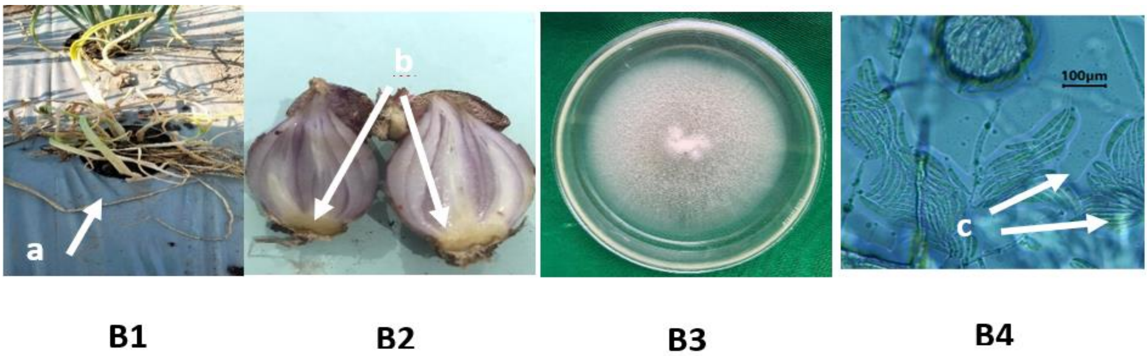

Figure 2. Symptoms of *Fusarium*s spp. at the base (B1) and tubers (B2), isolation after 8 day old colonies on PDA medium (B3), microscopic conidium of *Fusarium* spp. with 40x magnification (B4) a: rotten and twist; b: spot of fruit; c: conidium of *Fusarium* spp.

Symptoms of infection that appear at the beginning of plant growth can inhibit plant development (Marianah et al., 2024). Infections occuring in the roots or near the stem at the soil surface are often the starting point for pathogen attack, inhibiting the transport of nutrients and air (Herlina, 2020; Herlina & Istiaji, 2021), causing the leaves to turn yellow and twist, then eventually wilt and die (Marianah et al., 2024). The symptoms shown begin with spots at the base of the tuber and then spread upwards and to the sides, causing the plant to die starting from the tip of the leaf spreading to the bottom (Jannah et al., 2024).

The initial symptoms of tuber rot disease caused by *Fusarium* spp. on shallots include brown spots appearing on the tubers. Isolations of shoot rot disease reveal white mycelium, which gradually changes color from cream to black over time. Microscopic examination of tuber rot shows oval-shaped macroconidia. Early infection during plant growth leads to stunted development, while infection during later stages causes yellowing on leaves, twisting, and ultimately, wilting and death (Zul Mazwan et al., 2020; Marianah et al., 2024).

Fusarium spp. most common fungal infections start from the seeds as the fungus is readily existent in the soil and continues to attack the roots and stems. Water is a significant medium for infection in leaves and fruit (Shin et al., 2023). *Fusarium* species can infect onion plants during the seedling phase, but characteristic symptoms typically appear in mature plants or after harvest, manifesting as yellowing on leaves, wilting, and curling. Understanding and studying basal plate rot disease symptoms in the field, both in shallots and other onion varieties is crucial, as identifying the disease's cause is a key factor in its control. Symptom variations may arise due to infections caused by different *Fusarium* species (Kintega et al., 2020). *Fusarium* spp. of shallots can damage all parts of the plant, including stems, leaves and roots. Infected stems will rot brown. The leaves initially have wet black spots on the tips, which then spread throughout the leaf. The shoots of infected plants will become yellowish brown. Attacks on seeds or young plants can cause death, while on mature shallot plants it can inhibit their growth (Rovicky et al., 2024).

Fusarium spp. can exhibit both normal and abnormal morphology. Abnormalities in its mycelium are often caused by exposure to bacterial chitinase enzymes and chitinolytic fungi, which degrade the chitin in fungal cell walls. The application of chitinolytic bacteria to the inhibition zone can cause the fungal mycelium to bend and wrinkle. Macroscopically, *Fusarium* spp. appears as white, slightly yellowish, cotton-like, fibrous mycelium with a somewhat rough texture. Microscopically, its macroconidia are crescent-shaped with pointed tips and have three to five partitions (Bahri et al., 2024; Mendieta-Brito et al., 2024). In this study, *Fusarium* spp. was observed to attack all parts of the shallot plant, with the bulbs being most affected. It causes diseases in the stems, leaves, and tubers, with isolated samples showing the presence of *Fusarium* spp. in diseased bulbs.

***Aspergillus* sp.**

Common symptoms in plants, such as curling and yellowing of leaves, are caused by the presence of *Aspergillus* sp., a fungus that is tolerant and can grow in a variety of environmental conditions. *Aspergillus* sp. is a widespread fungus that can grow well in soil, plant material, and the human environment. Infection on leaves causes necrotic symptoms with discoloration that spreads and extends along the direction of the leaf veins. If the infection is severe, the leaves will turn brownish yellow, resembling a burnt color (White, 2020).

Microscopic observations show that *Aspergillus* sp. hyphae have a tree-like branching pattern with parallel contours. The resulting colonies have an attractive color variation, ranging from white to black, depending on the dominant species.

Based on the description of (Dubey et al., 2017), *Aspergillus* sp. has erect conidiophores with enlarged tips forming round, colorful conidia. *Aspergillus* sp. has a characteristic septate and branched hypha, with conidiophores emerging from swollen footprint cells or mycelium carrying the sterigma. Conidia grow in chains of green, brown, or black. *Aspergillus sp*. can live in media with high sugar and acid content. The use of Potato Dextrose Agar as an isolation medium was effective in identifying the presence of *Aspergillus* sp and microscopic analysis confirmed the presence of fungal sporangia.

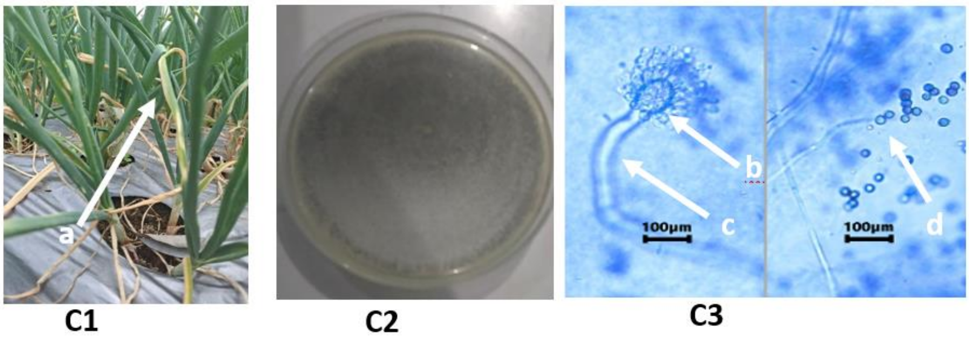

Figure 3. Symptoms of *Aspergillus* sp. (C1), isolation of *Aspergillus* sp colonies on PDA medium (A2), microscopic conidium of *Aspergillus* sp with 40x magnification (A3), a: on leaves; b: vesicle, metula, and phialide c: conidiophore; d: conidia.

The analysis of thirteen onion isolates based on macro- and microscopic characteristics identified them as *Aspergillus* sp section *Nigri*. Macroscopic features included black colonies with a narrow white margin, 29–50 mm colony sizes, and floccose textures with sparse white mycelium. Microscopically, vesicles were sub-globose to globose and measured 33.958–82.736 µm. Conidial heads were either radiate or loosely radiate, uni- or biseriate. Conidia were sub-globose to globose, smooth to distinctly roughened, and displayed a color range from colorless to brownish. The size of the conidia varied between 2.459 and 7.862 µm (Dubey et al., 2017; El-Dawy et al., 2024).

The research outcomes will serve as a basis for providing effective recommendations to address disease issues in shallot cultivation during future planting periods, should the same symptoms recur.

CONCLUSION

The resulting research on the inventory of shallot plant diseases (*Allium assolonicum*) has been carried out, suggesting that 3 disease symptoms were caused by the fungus *Colletotrichum* sp., *Aspergillus* sp., and *Fusarium* spp. Identification of symptoms and causes of disease is necessary to determine effective and efficient control techniques for shallot cultivation. Further research can be conducted to include control tests, both using chemical methods and organic pesticides derived from local wisdom, based on the observed symptoms.

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REFERENCES

Azmi, S. Z. K., Sunarno, S., Rahmah, S. A., Andriani, M., Farobi, A. R. L & Ahlina, L. N. (2020). Ethnobotanical Study of Utilization of Quercetin Flavonoid Compounds in Red Onion (*Allium cepa* L.) as Inhibitor of Spike Sars-CoV-2 Protein against ACE2 Receptors. *Biosaintifika: Journal of Biology & Biology Education*, *13*(3), 356-362. https://doi.org/http://dx.doi.org/10.15294/biosaintifika.v13i3.32027

BPS. Central Statistic Agency (2022). *Vegetable Crop Production, 2021-2023.* https://www.bps.go.id/id/statistics-table/2/NjEjMg==/produksi-tanaman-sayuran. html

Bahri, S., Mawardi, A. L., Mardiyah, A., Fadly, F., & Lestami, A. (2024). Shallot Resistance in Integration With Biological Agents To Wilt Disease *(Fusarium oxysporum f* Sp. *cepae*). *Sabrao Journal of Breeding and Genetics*, *56*(5), 2056–2066. https://doi.org/10.54910/sabrao2024.56.5.28

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing*, *25*(8), 652–661.
https://doi.org/10.1177/1744987120927206

Cennawati, Syam'Un, E., & Haring, F. (2023). Effect of three fungi species application and concentration on production and pest attack on shallot (*Allium ascalonicum* L). *IOP Conference Series: Earth and Environmental Science*, *1230*(1). https://doi.org/10.1088/1755-1315/1230/1/012201

Dubey, J. P., Hemphill, A., Calero-Bernal, R., & Schares, G. (2017). General Biology. In *Neosporosis in Animals*. https://doi.org/10.1201/9781315152561-3

Dutta, R., K, J., Nadig, S. M., Manjunathagowda, D. C., Gurav, V. S., & Singh, M. (2022). No Title Anthracnose of Onion (*Allium cepa* L.): A Twister Disease. *Pathogens (Basel, Switzerland)*, *11*(8), 884.

El-Dawy, E. G. A. M., Hussein, M. A., & El-Nahas, S. (2024). Description and management of *Aspergillus* spp section Nigri causing post-harvest bulbs rot of onion. *Scientific Reports*, *14*(1), 1–13. https://doi.org/10.1038/s41598-024-53849-9

Hasanah, Y., Mawarni, L., Hanum, H., Irmansyah, T., & Manurung, K. R. (2022). The Role of Cultivation Methods and Lowlands Growing Environment on the Growth of Shallot (*Allium ascalonicum* L.) Varieties. *IOP Conference Series: Earth and Environmental Science*, *977*(1), 12001. https://doi.org/10.1088/1755-1315/977/1/012001

Henri, H., Nababan, V., & Hakim, L. (2020). Ethnobotanical Study of Early Childhood Medicinal Plants Used by the Local People in South Bangka Regency, Indonesia. *Biosaintifika. Journal of Biology & Biology Education*, *12*(3), 414–421. https://doi.org/http://dx.doi.org/10.15294/biosaintifika.v12i3.22221

Herlina L, Istiaji B, W. S. (2021). *The causal agent of Fusarium disease infested shallots in Java islands of Indonesia*. https://doi.org/DOI: 10.1051/e3sconf/202123203003.

Herlina L, I. B. (2020). The use of effector gene based-markers to facilitate identification of *Fusarium* sp. infected shallot in Java, Indonesia. *Biodiversitas*, *10.13057/b*. https://doi.org/10.13057/biodiv/d2110xx 21 (10): 4677-4685. DOI: 10.13057/biodiv/d2110xx

Jannah, E. M., Ilhamiyah, I., & Erlina, S. (2024). Management Of Pest And Disease Control In Sallots (*Allium ascalonicum* L) Farm Activities Sub-District Sungai Ulin Banjarbaru City. *At-Tadbir : Jurnal Ilmiah Manajemen*, 646–651. https://doi.org/10.31602/piuk.v0i0.16177

White.J.R. (2020). *Aalborg Universitet Microorganisms in Occupational Settings Working Towards an Evaluation of Risks and Exposure During Work with Animals White , John Kerr*.

Kadir. N. Ab, Naher, L., & Sidek, N. (2019). Economical important phytopathogenic diseases in *Vanilla planifolia*. *A Review Paper. Journal of Tropical Resources and Sustainable Science (JTRSS)*, *7*(2), 77–82. https://doi.org/10.47253/jtrss.v7i2.513

Kintega KR, Zida PE, Soalla R, Tarpaga VW, Sankara P, S. P. (2020). Sankara P, Sereme P. 2020. Determination of *Fusarium* spp species associated with onion plants (*Allium cepa*) in field in Burkina Faso causing damping-off and bulb rots. *Am J Plant Sci*, *11*(1), 64–79. https://doi.org/10.4236/ajps.2020.111006.

Marianah, L., Nawangsih, A. A., Munif, A., Giyanto, & Tondok, E. T. (2024). Variation in symptoms and morphology of *Fusarium* spp. on shallot associated with basal plate rot disease in Brebes District, Central Java Province, Indonesia. *Biodiversitas*, *25*(5), 2198–2208. https://doi.org/10.13057/biodiv/d250538

Mendieta-Brito, S., Sayed, M., Son, E., Kim, D. S., Dávila, M., & Pyo, S. H. (2024). Identification, Characterization, and Antibacterial Evaluation of Five Endophytic Fungi from Psychotria poeppigiana Müll. Arg., an Amazon Plant. *Microorganisms*, *12*(8). https://doi.org/10.3390/microorganisms12081590

Muscat, A., Sardella, D., Decelis, S., Gougouli, M., Koutsoumanis, K. P., Marín, S., & Valdramidis, V. P. (2020). Characterization of Fungal Surface Contaminants of the Small Maltese June Pear, Pyrus communis var. bambinella. *Journal of Food Protection*, *83*(8), 1359–1367. https://doi.org/https://doi.org/10.4315/JFP-19-567

Nasir, N., & Sukmawati, S. (2023). Analysis of Research Data Quantitative and Qualitative. *Edumaspul: Jurnal Pendidikan*, *7*(1), 368–373.

Oktaviani, Z., Hayati, M., & Kesumawati, E. (2020). The response of shallot (*Allium ascalonicum* L.) growth and yield to gibberelline concentration and the interval of NASA liquid organic fertilizer. *IOP Conference Series: Earth and Environmental Science*, *425*(1), 12071. https://doi.org/10.1088/1755-1315/425/1/012071

Pardosi, D. (2021). *Penampilan Morfofisiologis Beberapa Varietas Tanaman Cabai Rawit (Capsicum frutescens l.) terhadap Cekaman Kekeringan*.

Purba, J. H., WAHYUNI, P. S., ZULKARNAEN,

Z., SASMITA, N., YUNITI, I. G. A. D., & PANDAWANI, N. P. (2020). Growth and yield response of shallot (*Allium ascalonicum* L. var. Tuktuk) from different source materials applied with liquid biofertilizers. *Nusantara Bioscience*, *12*(2), 127–133. https://doi.org/10.13057/nusbiosci/n120207

Ramadina, S., Utari, P., Purnamasari, A., & Khairi, A. (2024). *A major pest and diseases of shallot (Allium cepa L . Aggregatum group) in Bima Regency A major pest and diseases of shallot (Allium cepa L . Aggregatum group) in Bima Regency*. *January*, 12–23.

Resti, Z., Darnetty, Khairul, U., Liswarni, Y., Siregar, S. L. K., & Tores, F. N. (2024). Distribution and level of damage by basal stem rot disease (*Fusarium oxysporum f* sp *cepae*) on shallots in West Sumatera. *BIO Web of Conferences*, *99*. https://doi.org/10.1051/bioconf/20249904004

Rovicky, A., Widowati, W., & Astutik, A. (2024). Pest and Disease Control Strategies to Increase the Productivity of Shallot Plants (*Allium ascalonium* L.). *Riwayat: Educational Journal of History and Humanities*, *7*(3), 1253–1260. https://doi.org/10.24815/jr.v7i3.40246

Safitri YA, Hasanah U, Salamiah, Samharinto, P. M. (2019). Distribution of major diseases of shallot in South Kalimantan, Indonesia. *Asian J Agric*, *3*(2), 33–40. https://doi.org/DOI: 10.13057/asianjagric/g030201.

Shin, J. H., Lee, H. K., Back, C. G., Kang, S. hyun, Han, J. won, Lee, S. C., & Han, Y. K. (2023). Identification of *Fusarium* Basal Rot Pathogens of Onion and Evaluation of Fungicides against the Pathogens. *Mycobiology*, *51*(4), 264–272. https://doi.org/10.1080/12298093.2023.2243759

Sjafrina, N., Budiyanto, A., Lukas, A., Yani, A., Astuti, P., Arianto, A., Arif, A. Bin, Marimin, Udin, F., Anggraeni, E., & Mahendri, I. G. A. P. (2023). Institutional Model and Strategy for Downstream Development of Shallot Agroindustry in Indonesia. *Industrial Engineering and Management Systems*, *22*(4), 489–502. https://doi.org/10.7232/iems.2023.22.4.489

Sudantha, I. M., & Suwardji, S. (2021). Biodiversity of *Trichoderma* antagonist saprophytic fungi and its use for biocontrol of *Fusarium* wilt disease on shallots at Lombok Island, West Nusa Tenggara, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *886*(1). https://doi.org/10.1088/1755-1315/886/1/012123

Wibowo, A., Santika, I. A., Syafitri, L. M., Widiastuti, A., Subandiyah, S., & Harper, S. (2023). Incidence of twisted disease and cultivation practice of shallot farmers in Bantul coastal area, Yogyakarta, Indonesia. *Journal of Tropical Plant Pests and Diseases*, *23*(1), 23–30. https://doi.org/10.23960/jhptt.12323-30

Widono, S., Poromarto, S. H., Supyani, Noviantoro, W., & Hadiwiyono. (2023). Relationship of weather factors on the progress of shallot moler disease in Brebes, Central Java in the rainy and dry seasons: Intensity increases in humid and warm air. *IOP Conference Series: Earth and Environmental Science*, *1200*(1). https://doi.org/10.1088/1755-1315/1200/1/012062

Zegeye MB, Alemu TA, Sisay MA, M. (2024). Factors affecting onion Kobo, production: An empirical study in the Raya. *PLOS ONE*, *June*(14), 1–17. https://doi.org/https://doi.org/10.1371/journal.pone.0305134

Zul Mazwan, M., Tarik Ibrahim, J., & A M Fadlan, W. (2020). Risk Analysis of Shallot Farming in Malang Regency, Indonesia. *Agricultural Social Economic Journal*, *20*(3), 201–206. https://doi.org/10.21776/ub.agrise.2020.020.3.3