Sainmatika: Jurnal Ilmiah Matematika dan Ilmu Pengetahuan Alam
Volume 22 No. 1, June 2025 DOI 10.31851/sainmatika.v22i1.18174
https://jurnal.univpgri-palembang.ac.id/index.php/sainmatika

The Efficacy of Citronella Extract (*Cymbopogon nardus* L.) in Inhibiting The Development of Anthracnose Disease in Chili Plants (*Capsicum annuum* L.)

Titi Tricahyati[1*], Harman Hamidson[1], Arsi[1], Suparman[1], Chandra Irsan[1], Filli Pratama[1], Ahmad Sultoni Pulungan[2]
*e-mail: tricahyati.titi@unsri.ac.id

[1]*Program Study of Plant Protection, Faculty of Agriculture, Sriwijaya University, Palembang, Indonesia*
[2]*Student Program Study of Agricultural Science, Faculty of Agriculture, Sriwijaya University, Palembang, Indonesia*

ABSTRACT

Chili (*Capsicum* spp.) are members of the Solanaceae family, which includes many cultivated plants. They are frequently used by farmers and have a spicy taste that makes them a popular ingredient in Indonesian cuisine.The objective of this study is to observe the effect of citronella extract on the inhibition of anthracnose disease caused by *Colletotrichum capsici* in chili plants.This disease, caused by the aforementioned pathogen, manifests as blackish-brown patches on the affected area. The affected area undergoes desiccation and detachment over time.The experimental design employed a Group Randomized Design (GRD) method, comprising six treatments (P0, P1, P2, P3, P4, P5), each repeated five times.The experimental treatment involved the application of citronella extract, varying in dosage concentration among the treatments. This research was carried out on the Agrotech Training Center land of the Faculty of Agriculture, Sriwijaya University.

Keywords: Anthracnose, *Colletotrichum capsici*, chili, citronella

INTRODUCTION

The chili plant (*Capsicum annuum* L.) is a plant belonging to the genus Capsicum. This plant is commonly known as red chili. It is one of the most widely cultivated hoticultural plants in Indonesia. The use of chili pepper as an ingredient in traditional dishes in Indonesia has led to the frequent cultivation of this plant by communities, contributing to its high economic value. This is evidenced by the consumption of chili peppers, as reported by the Central Statistics Agency (CSA), which reached 636.56 thousand tons in 2022, marking a 6.78% increase or 40.42 thousand tons from the previous year.However, the susceptibility of chili plants to diseases can lead to a decline in productivity, both in terms of quality and quantity. According to (Zakia, 2017) The cultivation of chili plants in a variety of locations and throughout the year has been identified as a contributing factor to their increased susceptibility to diseases. Consequently, it is imperative to exercise greater vigilance and provide additional care during the cultivation of chili plants. Failure to do so can result in the disruption of plant growth and development due to fungal diseases, particularly anthracnose, which is caused by the fungus *Colletotrichum capsici*. (Azizi, *et al*,. 2020).

Anthracnose disease, a fungal pathogen, poses a significant threat to chili plants, with the potential to cause losses reaching 80% of a single plant. The disease's ability to infect chili plants is attributed to the presence of the

p-ISSN 1829 586X
e-ISSN 2581-0170

pathogen's spores in the soil borne which can easily spread to all parts of the chili plant tissue (Sumardiyono, 2021). The fungal disease known as anthracnose disease has been observed to primarily affect plants during the pre- and post-harvest phases. The onset of the disease is characterized by the appearance of black spots on the fruit of the plant. These spots subsequently expand and spread throughout the fruit, resulting in visible symptoms of the disease. (Hakim, Syukur & Widodo, 2014). The utilization of chemical fungicides in elevated concentrations by farmers is a persistent practice that is often observed prior to the onset of the disease itself. This approach is undertaken despite the potential consequences, including the possibility of incurring losses that can reach 50% or more of the total yield, if the disease is not effectively addressed (Nurjasmi & Suryani, 2020). The utilization of chemical fungicides has been demonstrated to exert deleterious effects on plants and PDO (plant-disrupting organisms), which exhibit resistance and engender substantial economic losses. The consequences of chemical fungicide application are expeditious; however, they present a considerable hazard due to their capacity to inflict harm on humans, plants, and the environment (Khulillah, *et al*,. 2019). Consequently, it is imperative to implement an alternative approach to mitigate this phenomenon, namely the utilization of biological fungicides derived from plant sources. Citronella extract (*Cymbopogon nardus* L.) is a plant-based fungicide employed in the control of anthracnose disease in chili plants. Citronella plants are frequently utilized as a practical ingredient in the formulation of plant-based fungicides. In addition to their ease of procurement, citronella plants are available at remarkably affordable prices (Zulkipli, *et al*, 2018). As with vegetable fungicides in general, citronella extract has been shown to inhibit the growth and development of diseases. It is also safe for the environment because it does not leave harmful residues that could potentially compromise the quality of plant products. The bioactive compounds contained in this plant-based fungicide have also been demonstrated to be effective in controlling pathogens carried by seeds, both Vitro And in vivo (Syabana, *et al*,. 2015). According to (Iskarlia R. Gusti, 2014) The citronella plant under consideration contains citronella and geraniol, which have been shown to function as inhibitors of the growth of bacteria and fungi. This property is attributable to the generally antibacterial and antifungal nature of these compounds.

MATERIAL AND METHOD

Place and Time

This research was carried out in July until December at the ATC Land (Agrotech Training Center), Faculty of Agriculture, Sriwijaya University. Pathogen identification activities are carried out at the Phytopathology Laboratory, Plant Protection Study Program, Faculty of Agriculture, Sriwijaya University from July to September 2024.

Tools and Materials

The tools used in this study are: 1) ATK (Paper Stationery), 2) Bunsen, 3) Hoe, 4) Petri Cup, 4) Cup, 5) Cover Glass, 6) Syringe, 7) Camera, 8) Laminar Air Flow, 9) Lighter, 10) Microscope, 11) Preparation, 12) Water Hose, 13) Thermometer, 14) Thermogrometer, 15) Tissue

The materials used in this study are: 1) Alcohol, 2) Aquadest, 3) NPK, 4) Manure, 5) Urea, 6) Samples of chili stem rot.

p-ISSN 1829 586X
e-ISSN 2581-0170

Research Methodology

The research was executed using a Group Random Design (GRD) on land with six treatments and five replicates, resulting in a total of 30 mounds. Treatment 0 was administered as a control treatment, employing a 70% propenib chemical fungicide. Treatments 1 to 5 involved the application of citronella extract (*Cymbopogon nardus* L.) Citronella Essential Oil at concentrations of 5%, 10%, 15%, 20%, and 25%, respectively.

The following table presents a detailed treatment arrangement and repetition protocol for chili plants.

TREATMENT	REPITITION				
	I	II	III	IV	V
I	A1	D2	C3	B4	F5
II	B1	F2	A3	C4	D5
III	C1	A2	F3	A4	C5
IV	D1	E2	B1	E4	E5
V	E1	C2	D3	F4	B5
VI	F1	B2	E3	D4	A5

Information:

A : Treatment 1 (Control using 70% propenib)
B : Treatment 2 (5% Citronella Extract)
C : Treatment 3 (10% Citronella Extract)
D : Treatment 4 (15% Citronella Extract)
E : Treatment 5 (20% Citronella Extract)
F : Treatment 6 (25% Citronella Extract)

How it works

Land Preparation

The experimental site was meticulously partitioned into five replicates, each comprising six treatments. The land is meticulously cultivated using a hoe and manure. The land area is 15 x 25 m, encompassing a total of 30 mounds. Each mound measures 2 meters in length and 1.2 meters in width, and each mound features two rows, with a total of four planting holes. Additionally, each mound is paired with plastic mulch.

Plant Preparation

The plant preparation for the research was conducted using one-month-old local varieties of red chili plant seedlings. The chili seeds were obtained from professional farmers.

Planting seedlings

The process of planting seedlings is initiated when they reach one month of age. The planting method involves the creation of holes in the soil, into which chili seeds are inserted. Each planting hole is treated with a single chili seed, with a spacing of 60 x 60 cm between each seed, alternating every 2 rows. This results in a total of 4 seeds per 30 rows. The total number of plants in a single field is calculated as 8 x (5 x 6), yielding a total of 240 plants.

Plant Maintenance

Fungicide Concentration Analysis and Applications

The application of citronella extract is carried out on chili plants in the morning, where the application is given according to the predetermined concentration. The application is carried out using a sprayer and sprayed on all parts of the chili plant. The ratio of citronella extract (Citronella) and water mixe d is 1.25ml: 5L. In the control treatment, a 70% propenib chemical fungicide was given with a ratio of 20 g: 5L. Application is carried out with doses according to table 1.

Table 1. Arrangement of Treatment for Field Tests.

No.	Treatment	Concentration (mL/L)
1	Control (Propenib 70% chemical fungicide)	20g/5
2	Citronella Extract	1,25/5
3	Citronella Extract	2,5/5
4	Citronella Extract	3,75/5
5	Citronella Extract	5/5
6	Citronella Extract	6,25/5

Observation

The observation carried out was by observing the symptoms of the disease by determining the score on the chili plant which was then calculated with a set formula. Furthermore, identification activities were carried out in the

Phytopathology laboratory of the Department of Plant Pests, Faculty of Agriculture, Sriwijaya University. Identification was carried out by comparing the identification results with journals that were suitable and had the same morphological characteristics.

Observation Parameters

These observation parameters include the intensity level of disease attacks and the incidence of disease attacks. At intensity, attacks are calculated by looking and calculated by determining the score on the plants in each treatment, the score provisions can be seen according to Table 2. The incidence of attack on leaf spot was calculated by looking at the spots in each treatment.

The formula used in calculating the intensity of disease attacks according to (Afrizal, 2018) that is:

$$KP = \frac{\sum(n\ x\ v)}{N\ x\ V}\ 100\%$$

Information:

KP : Severity of the disease

n : number of plants with a certain score

N : number of plants observed (sample)

V : highest score or scale

Table 2. Disease symptom score.

Score	information
0	Healthy plants
1	≤10% of the affected parts
2	>10% - ≤25% of the sore part
3	>25% - ≤50% of the affected parts
4	>50% of the affected parts

Meanwhile, the disease incidence formula carried out in this study is:

$$P = \frac{n}{N}\ x\ 100\%$$

Information:

P : Percentage of disease incidence of plants (%)

n : Number of plants affected by the disease

N : Number of plants observed

Calculation of Disease Development Rate

The calculation of the rate of disease progression is performed to obtain a representation of the progression of the disease at specific temporal points. The formula for calculating the rate of disease progression is as follows(Yadi Suryadi, 2019) :

$$\text{AUPDC} = \sum_{i=1}^{n-i} \frac{yi+yi+1}{2}\ x\ (ti + {}_1 - t)$$

Information:

AUPDC : Area of Disease Progression Curve (%*3 days)

yi+1 : Observation data to -i + 1

Ti+1 : Observation Time to -i + 1

Yi : Observation Data

It : Observation Time -i

Data analysis

The data is then subjected to rigorous statistical analysis using the Microsoft Excel program, resulting in a precise and accurate presentation of the findings in the form of tables, images, and graphs.

RESULT AND DISCUSSION

Colletotrichum capsici

The results of this study demonstrate that the fungus *Colletotrichum capsici* exhibits microscopic morphological characteristics, namely conidia that are oval in shape and tapered at each end. Conidia are characterized by a partitioned structure, a transparent coloration, a single-celled composition, and dimensions ranging from 5 to 15 μm in size.

Figure 1. Conidia *Colletotrichum capsici* at magnification 40x and 20 μm scale

Symptoms of an attack

The anthracnose disease that afflicts chili plants has the capacity to attack the fruit and leaves, thereby causing fruit rot and leaf rot. In the case of the fruit, the disease begins with the appearance of blackish-brown spots that subsequently spread, resulting in the rotting of the fruit. The presence of black spots in the center of each spot is indicative of the disease. Fruits that exhibit symptoms of anthracnose undergo desiccation. In the case of the leaves, anthracnose manifests as patches that are generally blackish-brown. Like in fruits, symptoms on the leaves also cause the leaves to dry out and fall.

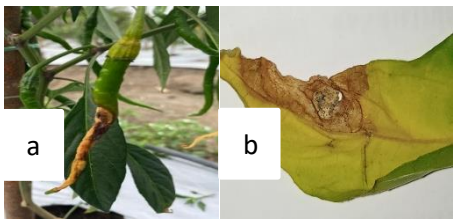

Figure 2. Symptoms of anthracnose attack on fruit (a), Symptoms of attack on leaves (b)

Attack Intensity

The results showed that treatment with citronella extract (*Cymbopogon nardus*) had a real effect on the intensity of anthracnose disease in fruits and leaves.

The results of the study indicated the initial symptoms of anthracnose attacks on the leaves, with the highest intensity observed in the control treatment (P0) and the second treatment (citronella extract at a dose of 2.5 ml / 5L) at week 10. Conversely, the lowest intensity of foliar attacks occurred in weeks 10 and 11. Notably, at week 10, the lowest sermon intensity was observed in treatment 1 (citronella extract at a dose of 1.25 ml / 5L) and treatment 2 (citronella extract at a dose of 2.5 ml / 5L). At week 11, the lowest attack intensity was observed in treatment 1 (citronella extract at a dose of 25 ml / 5L), treatment 2 (citronella extract at a dose of 2.5 ml / 5L), and treatment 5 (citronella extract at a dose of 6.25 ml / 5L).

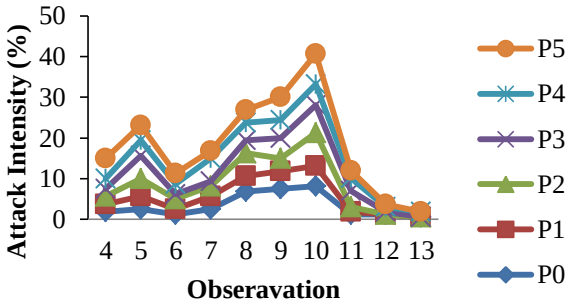

Figure 3. Intensity of Anthracnose disease in chili leaves

In fruits, the initial symptoms of anthracnose disease attacks occur in the 7th week of each treatment (P0, P1, P2, P3, P4, P5). The highest intensity of attacks occurred in the 9th week of the control treatment (P0). While the lowest attack intensity occurred week to week 11 and 12 in the same treatment, namely; Treatment 1 (citronella extract at a dose of 1.25 ml / 5L), treatment 2 (citronella extract at a dose of 2.5 ml / 5L), treatment 3 (citronella extract at a dose of 3.75 ml / 5L), treatment 4 (citronella extract at a dose of 5 ml / 5L), treatment 5 (citronella extract at a dose of 6.25 ml / 5L).

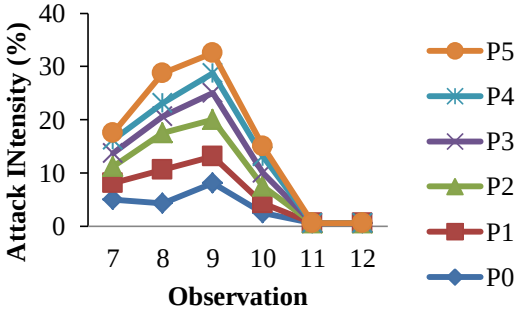

Figure 4. Intensity of anthracnose disease in chili fruits

Attack Percentage

The findings indicated that the average incidence of anthracnose disease attack was highest in chili leaves during week 10 of the control treatment (chemical fungicide Propenib 70%) and treatment 2 (citronella extract with a dose of 2.5 ml /

5L), with an average percentage of 22.5%. Conversely, the mean percentage of anthracnose disease attacks on chili leaves was observed in the 12th and 13th weeks. At week 12, the lowest percentage of attacks was recorded in treatment 1 (citronella extract with a dose of 1.25 ml / 5L) and treatment 2 (citronella extract with a dose of 2.5 ml / 5L), with an average amount of 0%.

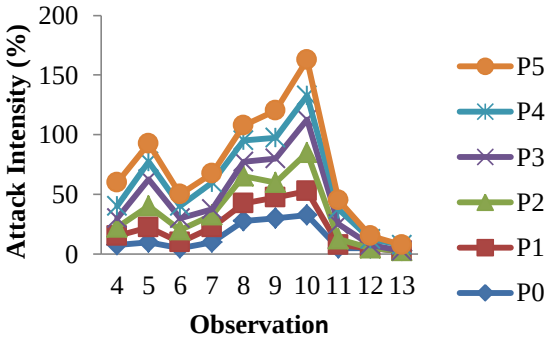

Figure 5. Percentage of anthracnose disease attacks on chili leaves

In the fruit section, the highest percentage of anthracnose disease was at week 9 in the control treatment (chemical fungicide Propenib 70%) with an average number of 32.5%, while the lowest average percentage of anthracnose disease attacks was at weeks 11 and 12. The lowest percentages at week 11 and week were both in treatment 1, treatment 2, treatment 3, treatment 4, treatment 5.

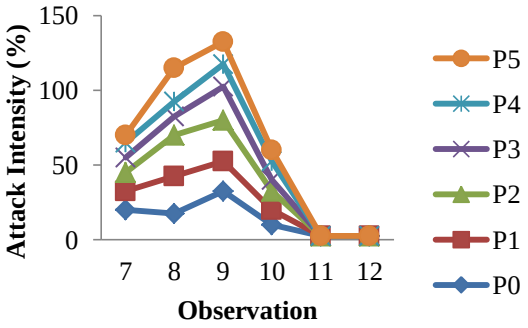

Figure 6. Percentage of anthracnose disease attacks on chili fruit

Healthy fruit weight

The findings demonstrated that the application of citronella extract exerted a tangible influence on the weight of healthy fruit yields from chili plants. Treatment 4 (citronella extract at a dose of 5 ml / 5L) yielded the highest average fruit weight in the 4th harvest, with an average fruit weight of 333.8 grams. Conversely, the treatment that yielded the lowest average fruit weight was observed in treatment 1 (citronella extract with a dose of 1.25 ml / 5L) in the 2nd harvest, yielding an average fruit weight of 63 grams.It was observed that the weight yield of chili fruits increased from the 2nd to the 4th week, after which it decreased in the 5th week due to weather changes that coincided with the onset of the rainy season, which promoted the growth of the disease.

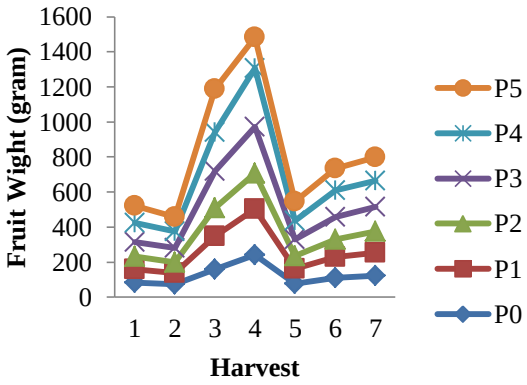

Figure 7. Average weight of healthy chili fruit after harvest

Weight of rotten fruit

The findings indicated that the maximum weight of rotten fruit in chili fruits was attained in the 3rd treatment (citronella extract at a dose of 3.75 milliliters per 5 liters) of the 4th harvest, with an average weight of 77.6 grams. Conversely, the lowest average weight of rotten fruit in chili was observed in the 1st treatment, which involved the application of lemongrass extract at a dose of 1.25 milliliters per 5 liters, during the 2nd harvest. This treatment resulted in an

p-ISSN 1829 586X
e-ISSN 2581-0170

average weight of 12.6 grams of rotten fruit in chili.

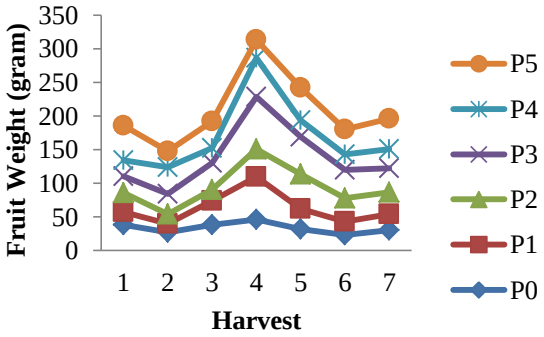

Figure 8. Average weight of rotten chili fruit after harvest

DISCUSSION

The anthracnose disease, caused by the fungus *Colletotrichum capsici*, has been known to cause significant economic losses to chili plants, reducing productivity and often resulting in plant death. This disease affects both the fruit and the leaves, manifesting as spots that cause the fruit and leaves to rot and lose commercial value. The initial symptom of the disease is the presence of small, blackish spots with a slightly curved shape. The disease also causes a change in the texture of the chili surface, which becomes wrinkled, and the fruit rots, causing it to fall off. Fruits that exhibit symptoms of round and concave spots of varying sizes, with some small and some large, generally develop these spots easily in young fruits (Prihatiningsih et al., 2020).

The data from the observation of the intensity of attacks on the fruits and leaves of chili peppers treated with citronella extract treatment 1, 2, 3, 4, 5 did not differ significantly from anthracnose disease. The use of citronella extract in treatments 1, 2, 3, 4, 5 effectively inhibited the growth of anthracnose disease attacks. The results of the observations indicated that the intensity of the disease on the leaves was most prevalent in the control treatment (chemical fungicide propenib 70%) and treatment 2 (citronella extract at a dose of 2.5 milliliters per 5 liters), with an average intensity of 8.12%. In the fruit section, the highest disease attack intensity was observed in the control treatment, with an average number of 8.12%. This phenomenon can be attributed to abiotic factors associated with weather changes that resulted in precipitation. According to the quote (Azizi, *et al*,. 2020) the incidence of anthracnose disease is elevated during the rainy season due to the optimal environmental conditions for fungal spore germination and plant infection. These conditions include high air humidity levels, which are characteristic of this season.

The results of the lowest disease attack intensity in chili leaves were obtained in the 1st and 2nd treatments in the 11th week, treatments 1, 2, and 5 in the 12th week, with an average number of 0%. In the case of fruits, the intensity of attacks exhibited the lowest average number in the 1st, 2nd, 3rd, 4th, and 5th treatments in the 11th and 12th weeks, with an average result of 0%. In contrast to weeks 1, 2, and 3, the average results of intensity also showed 0%, as in those weeks the fruits had never been attacked by anthracnose. This is in contrast to the 11th and 12th weeks, which experienced anthracnose disease attacks in the previous week and subsequently disappeared in that same week. Just like the previous research by (Syabana, *et al*,. 2015) who said that the application of citronella extract has the potential to be a botanical fungicide to inhibit the growth of anthracnose disease.

Citronella extract has been demonstrated to possess the capacity to impede the proliferation of pathogens that are responsible for the onset of diseases. This effect can be attributed to the presence of antifungal compounds within the citronella extract. The mechanism of action of these antifungal compounds in killing mushrooms can be categorized into two mechanisms: (1) impairment of the integrity of the cendawa cell membrane, and (2) interference with protein synthesis or induction of cytoplasmic coagulation. Leite et al., (2015) Meanwhile, according

to (Setyawati & Yuliani, 2023) Geraniol compounds have been shown to be effective in the elimination or inhibition of fungal growth. This is achieved by compromising the integrity of cell membranes, thereby disrupting the metabolic systems of sorbitol and ergosterol. However, the mechanism by which geraniol compounds induce this effect is not fully understood. It has been observed that geraniol compounds increase the release of potassium from within the cell to the outside environment.

The growth of chili plants treated with citronella did not exhibit a significant difference across all observations. This phenomenon can be attributed to the presence of favorable weather conditions, including the onset of precipitation, which is reported to be an uncommon occurrence. Rainfall in this context functions as a hindrance to the activity of citronella compounds, which are utilized to impede the growth of mushrooms. In addition to impeding citronella activity, rainfall also promotes the development of fungi, which are responsible for infecting plants with pathogens (Azizi, *et al*,. 2020).

CONCLUSION

The present study was conducted in light of the research that has been carried out, which demonstrated the efficacy of citronella extract in the inhibition of anthracnose disease development in chili plants caused by *Colletotrichum capsici*. The most efficacious treatments were identified as those administered at a dose of 1.25ml/5L (Treatment 1), 2.5ml/5L (Treatment 2), and 6.25ml/5L (Treatment 5). These treatments exhibited a reduction in the severity of anthracnose disease attacks, with the highest recorded reduction being 0%.In the case of fruits, the citronella extract treatments were found to be equally effective. The average inhibitory effect of these treatments on anthracnose disease development was found to be 0%.

Acknowledgments

This research is funded by the DIPA Budget of the Public Service Agency of Sriwijaya University for Fiscal Year 2024, Number SP DIPA-23.17.2.677515/2024, dated November 24, 2023, in accordance with the Rector's Decree Number 0013/UN9/LP2M.PT/2024, chaired by Dr. Ir. Harman Hamidson, M.P. Therefore, it is not permissible to disseminate and/or publish the data contained in this thesis without written permission from Dr. Ir. Harman Hamidson, M.P.

REFERENCES

Afrizal, A., D., S. R., Nurdin, M., & Susilo, F. X. 2018. Intensity of pest and pathogen attacks on hydroponic agroecosystems of rice plants (*Oryza sativa* L.) with various planting media. *Journal of Tropical Agrotechnics*, *6*(2), 86–90. https://doi.org/10.23960/jat.v6i2.2599

Aoudou, Y., Leopold, T. N., Michel, J. D. P., Xavier, E. F., & Moses, M. C. 2010. Antifungal properties of essential oils and some constituents to reduce foodborne pathogen. *Journal of Yeast and Fungal Research* , *1*(1), 001–008.

Aziziy, M. H., Tobing, O. L., & Mulyaningsih, Y. 2020. Study of Anthracnose Attack on the Growth of Red Pepper (*Capsicum annuum* L.) after Application of Neem Leaf Solution and Banana Hump Mol. *Journal of Agronida*, *6*(1), 24.

Hakim, A., Syukur, M., & Widodo, . 2014. Anthracnose Disease Resistance to Local Chili Peppers and Introduced Chili. *Agrohorti Bulletin*, *2*(1), 31.

Iskarlia R. Gusti. (2014). Vegetable fungicide from citronella plant (*Cymbopogon nardus)* to inhibit fungal growth on rubber stems (*Hevea brasillensis* Mueli, Arg). *Journal of Science and Applied*

Sciences of Hasnur Polytechnic, *3*(1), 4.

Khulillah, I. N., Abadi, A. L., & Aini, L. Q. 2019. The Effect of Fungicides on Soil Bacterial Diversity in Batu City. *Journal of Land and Land Resources*, *6*(2), 1209–1218.

Leite, M. C. A., De Brito Bezerra, A. P., De Sousa, J. P., & De Oliveira Lima, E. 2015. Investigating the antifungal activity and mechanism(s) of geraniol against Candida albicans strains. *Medical Mycology*, *53*(3), 275–284.

Muriyati, Trisyono, Y. A., Witjaksono, & Wahyono. 2012. Effects of citronella grass extract on the oviposition behavior of carambola fruit fly (*Bactrocera carambolae*) in mango. *ARPN Journal of Agricultural and Biological Science, Vol.7, No.*(9), 672–680.

Nurjasmi, R., & Suryani, S. 2020. Test of Actinomycetes Antagonists against *Colletotrichum capsici* Pathogen Causing Anthracnose Disease in Cayenne Pepper Fruit. *Scientific Journal of Respati*, *11*(1), 1–12.

Prihatiningsih, N., Djatmiko, H. A., & Erminawati, E. 2020. Epidemiological component of anthracnose disease in chili plants in Baturaden District, Banyumas Regency. *Journal of AGRO*, *7*(2), 203–212.

Setyawati, F. D., & Yuliani, Y. 2023. Biofungicide Activity of Citronella Extract (*Cymbopogon nardus* L.) and Water Hyacinth (*Eichhornia crassipes*) in Inhibiting the Growth of Curvularia lunata. *LenteraBio : Periodical Scientific Biology*, *13*(1), 32–43.

Sumardiyono, C., Joko, T., Kristiawati, Y., & Chinta, Y. D. 2021. Diagnosis and control of anthracnose disease with fungicides. *Journal of Tropical Plant Pests and Diseases*, *11*(2), 194–200.

Syabana, M. A., Saylendra, A., & Ramdhani, D. 2015. Anti-fungal Activity of Fragrant Lemongrass Leaf Extract (*Cymbopogon nardus* L.) Against *Colletotrichum* sp Causes of Anthracnose Disease in Chili Fruits (*Capsicum annum* L.) in vitro and in vivo. *Agrologia*, *4*(1), 21–27.

Yadi Suryadi, Susilowati, D., I Made Samudra, & Tri Puji Priyatno. 2019. Effect of Antifungal Chitosan Application for Anthracnose Disease Control in Chili. *Tropic Agricultural Journal*, *6*(1), 108–118.

Zakia, A., Ilyas, S., Budiman, C., , S., & Manohara, D. 2017. Increasing Chili Plant Growth and Controlling Phytophthora Rot through Seed Biopriming with Rizobacteria from East Java Chili Plantations. *Indonesian Journal of Horticulture*, *8*(3), 171–182.

Zulkipli, S., Marsuni, Y., & Rosa, H. O. 2018. Field Test of Some Vegetable Pesticides to Suppress the Development of Anthracnose Disease in Large Chili Plants. *Journal of Plant ProtectionTropika*, *1*(2), 32–34.