

Application of *Cymbopogon nardus* as a control of Plant Disturbing Organism *Cercospora* leaf spot in chili (*Capsicum annuum* L.)

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ABSTRACT

Chili (*Capsicum annuum* L.) is one of the most valuable agricultural commodities in Indonesia and is always in demand. One of the most common problems encountered in the cultivation of this crop is the presence of diseases that affect the plant, one of which is *Cercospora* leaf spot. Using environmentally friendly materials to control plant diseases is currently a necessary factor. The application of *Cymbopogon nardus* as a plant disease controller has been widely adopted. The author was interested in testing the ability of *C. nardus* to control *Cercospora* leaf spot disease in chilli plants. The study was conducted in the ATC (Agriculture Training Centre) field trial in South Sumatra. Pathogen identification was carried out in the Phytopathology Laboratory, Department of Pest and Disease Management, Faculty of Agriculture, Sriwijaya University. The results of the study showed that the application of a *C. nardus* concentration of 6.25 mL/5 L resulted in the lowest leaf spot growth at observations 12 and 13. Using *C. nardus* extract for control is an environmentally friendly method that can be used for control.

Keywords: Leaf spot, chilli, *Cercospora*, disease, lemongrass

INTRODUCTION

Capsicum annuum L., commonly known as chilli, is a crop that is in constant demand to ensure market supply in Indonesia and worldwide (Shaheen et al., 2021). In the context of commercial chilli cultivation, agricultural practices are often subject to various impediments that have the potential to compromise the yield of the crop. These impediments have been observed to result in a decline in productivity of up to 85% (Delai & Muhae-ud-din, 2024). Problems caused by biotic factors can be caused by diseases such as *Fusarium* wilt caused by the fungus *Fusarium* sp., *Cercospora* spotting caused by the fungus *Cercospora* sp.,

anthracnose caused by the fungus *Colletotrichum* sp., and attacks from viruses (Pamekas, Ganefianti & Destinawati, 2023).

In light of the pressing need to address environmental concerns, there is an imperative for the development of sustainable methodologies for the management of plant diseases, particularly in the context of reducing reliance on synthetic fungicides (Ahmed et al., 2023). Extracts derived from various plant sources have also been employed as a means to control plant diseases, including those derived from palmarosa, citronella, lemongrass, cinnamon, thyme, clove and oregano (Parikh et al., 2021).

Cymbopogon sp. is a plant that can produce essential oils with various properties for humans, animals and other organisms (Silva et al., 2021). Furthermore, the roots of *Cymbopogon* sp. have been shown to possess the capacity to function as a regulatory agent against fungal pathogens (Akponah & Ubogu, 2023). Endophytic fungi obtained from the roots and leaves of *Cymbopogon* sp. were also found (Rahmi et al., 2022).

From the research by Kgang et al., (2022), stated that the combination of *Cymbopogon* sp. and mint extracts is an effective combination for the control of *Botrytis cinerea* and *Penicillium expansum*. The combination of 25% *Cymbopogon* sp. and 75% *Blumea balsamifera* is a good combination to suppress the development of *Phytophthora megakarya* (Membang et al., 2024). *Cymbopogon* sp. has an antimicrobe that actively plays a role in growth inhibition on pathogenic fungi from *Botrytis cinerea*, *Alternaria solani*, *Rhizoctonia solani*, *Fusarium oxysporum*, and *Pythium ultimum* (Gangavarapu & Palwai, 2022). Extracts from *Cymbopogon* sp. also showed the ability to inhibit the growth of the pathogenic fungus *Pestalotiopsis microspore* that attacks tea plants (Mendez et al., 2025). The use of *Cymbopogon* sp. can also be applied to post-harvest control, such as on grapes (Cofelice et al., 2021; Lopes et al., 2023).

C. citratus contains β -Myrcene, Neral, Geraniol, Citral, trans- β -Ocimene, Linalool, α -Cyclogeraniol, Isoneral, Isogeraniol, Citronellol, 2-Undecanone, 8-Hydroxymenthyl, Geranyl acetate, 2-Tridecanone, δ -Cadinene, Selin-6-en-4 α -ol, α -Cadinol (Silva et al., 2021). From the many benefits produced from *C. nardus* extract, the author suspects that *C. nardus* extract can suppress the development of Cercospora leaf spot disease that attacks chili plants. The results of this study are also expected to provide information to the public and especially the cultivators of chili plants to use *C. nardus* extract as a control of Cercospora leaf spot.

MATERIAL AND METHOD

Place and Time

The research was conducted in the experimental field of ATC (Agrotech Training Center), Faculty of Agriculture, Sriwijaya University. Pathogen identification was carried out at the Phytopathology Laboratory, Plant Protection Study Program, Sriwijaya University, from August to December 2024.

Tools and Materials

The following tools were utilised: stationery, Bunsen burners, hoses, petri dishes, cover glasses, syringes, cameras, lighters, microscopes, preparations, water hoses and tissues. The materials utilised in this research encompass 70% alcohol, distilled water, NPK fertiliser, manure, and leaf samples afflicted by disease spots.

Research Methodology

This study used a Randomized Group Design (RGD) on a field with 5 treatments and 6 replicates which contained 30 mounds. The treatments used were control without treatment, treatments 1 to 5 with *C. nardus* extract with concentrations of 1.25 mL/5L, 2.5 mL/5L, 3.75 mL/5L, 5 mL/5L and 6.25 mL/5L.

Land Preparation

Land preparation begins with seeding chili plant seeds, followed by making thirty mounds with each mound measuring 2 m long, 1.2 m wide, 30 cm high and 60 cm distance between mounds. Application of manure as a base fertilizer on the land, then covered using plastic mulch. The application of *C. nardus* extract is carried out every week for 13 weeks from 7 DAT old plants, *C. nardus* extract applied to chili plants is mixed using water and then sprayed using a sprayer on chili plants.

Observation

Observations were made on chili plants that showed symptoms of Cercospora leaf spot, previously the author had studied the typical symptoms caused by the attack of

the fungus *Cercospora* sp. on the leaves of chili plants. The incidence and intensity of disease attack were calculated using the formula Townsend & Heuberger (1943)

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

Description:

P = Percentage of infection

n = Number of plants infected with disease

N = Number of plants observed

Table 1. Disease symptom scores

Scale	Description	Attack Criteria
0	Healthy leaves	No symptoms
1	≤ 10% of the leaf is affected	Very mildly affected
2	>10% - ≤ 25% of the leaf is affected	Mildly affected
3	>25% - ≤ 50% of the leaf is affected	Moderately affected
4	>50% of the leaf is affected	Severely affected

Disease attack intensity is calculated using the formula

$$I = \frac{(\sum n \times v)}{(Z \times N)} \times 100\%$$

Description:

I = Intensity of attack

n = Number of plants in each symptom category

v = Score or scale value of each category

Z = Score or scale value of the highest category

N = Total number of plant parts

Data Analysis

Data from the observations were analyzed statistically using Microsoft Excel and RStudio. The processed data were presented in the form of figures and tables.

RESULT AND DISCUSSION

From the research that has been done, *Cercospora* leaf spots have been present on plants since the plants were 14 DAT (Figure 1). This is in accordance with the opinion of Islam et al. (2015),

which states that *Cercospora* leaf spots can be found starting from 12 DAT plants. Based on observations in the field, a typical symptom of leaf spot disease caused by *C. capsici* is the appearance of small, round, brown spots on the leaf surface that grow irregularly around the spots. The colour is off-white facing downward and the edges of the affected chili leaves are dark brown. From the results of microscopic identification of *C. capsici* found in the laboratory there are conidia and conidiophores of *C. capsici*. The conidiophores of *C. capsici* found are brown, have hyphae that are branched and not straight and insulated, the conidia of *C. capsici* found are gray and cylindrical, straight, and insulated. The application of *C. nardus* extract shows the ability of these compounds to suppress the spread of the fungus *Cercospora* sp. which attacks chili plants in the field. The incidence and intensity of *Cercospora* leaf spot disease applied with *C. nardus* can be seen in Table 2 & Table 3.

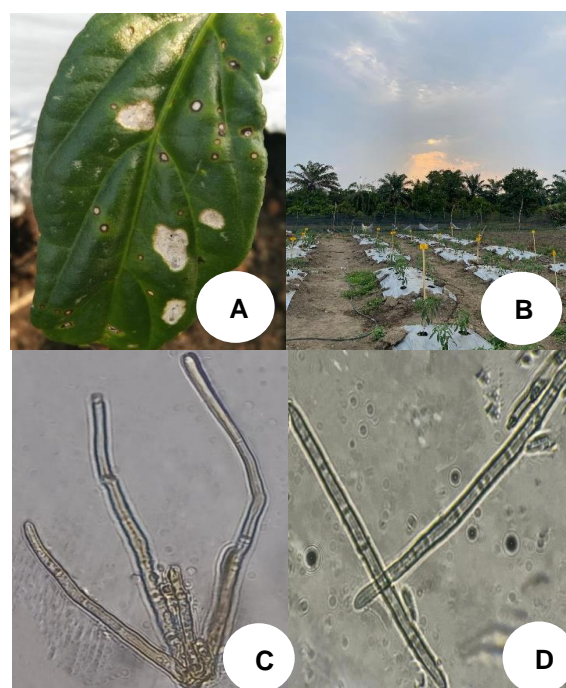


Figure 1. *Cercospora* spot symptomatic chili leaves (A), observation area (B), *Cercospora* conidiophores (C), and *Cercospora* hyphae (D)

Table 2. Incidence of *Cercospora* leaf spot disease under *C. nardus* extract application.

Treatment	Disease incidence of <i>Cercospora</i> sp. observation to.... (±SE)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
P1	32.50±4.47	47.50±4.18	57.50±4.47	47.50±4.18	52.50±5.48	55.00±4.47	57.50±4.47	55.00±5.70	50.00±3.54	40.00±5.48	42.50±2.74	40.00±2.24	32.50±2.74
P2	32.50±2.47	42.50±7.58	55.00±2.74	50.00±3.54	47.50±2.24	57.50±4.47	55.00±5.70	50.00±5.00	47.50±5.48	37.50±3.54	37.50±3.54	35.00±2.24	30.00±2.74
P3	40.00±4.18	32.50±2.74	62.50±5.00	57.50±4.47	55.00±6.71	50.00±3.54	60.00±6.52	45.00±2.74	42.50±2.74	35.00±4.18	40.00±4.18	32.50±2.74	30.00±2.74
P4	35.00±6.52	62.50±6.12	60.00±6.52	55.00±5.70	55.00±5.70	62.50±5.00	42.50±6.71	50.00±5.00	50.00±3.54	42.50±6.71	47.50±6.52	40.00±4.18	40.00±4.18
P5	40.00±4.18	50.00±7.07	52.50±4.18	55.00±4.47	65.00±2.24	45.00±5.70	47.50±10.25	42.50±2.74	50.00±3.54	35.00±2.24	45.00±2.74	27.50±2.24	27.50±2.24
F Count	1.95tn	2.83*	0.39tn	0.97tn	1.31tn	2.40tn	0.82tn	0.75tn	0.52tn	0.49tn	0.63tn	4.36*	1.71tn
F Tabel	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71
BNJ 5%	-	7.14	-	-	-	-	-	-	-	-	-	3.27	-

Note: tn = not significantly different; *= significantly different; These original data were transformed using square root transformation prior to analysis.

Table 3. Intensity of *Cercospora* leaf spot disease applied with *C. nardus* extracts

Treatment	Disease intensity of <i>Cercospora</i> sp. observation to.... (±SE)												
	1	2	3	4	5	6	7	8	9	10	11	12	13
P1	8.13±1.12	11.88±1.05	14.38±1.12	11.88±1.05	13.13±1.37	13.75±1.12	14.38±1.12	13.75±1.43	12.50±0.88	10.00±1.37	10.63±0.68	10.00±0.56	8.00±0.68
P2	8.13±0.68	10.63±1.90	13.75±0.68	12.50±0.88	11.88±0.56	14.38±0.68	13.75±1.43	12.50±1.25	11.88±1.37	9.38±0.88	9.38±0.88	8.75±0.56	7.50±0.68
P3	10.00±1.05	8.13±0.68	15.63±1.25	14.38±1.12	13.75±1.68	12.50±1.05	15.00±1.63	11.25±0.68	10.63±0.68	8.75±1.05	10.00±1.05	8.13±0.68	7.50±0.68
P4	8.75±1.63	15.63±1.53	15.00±1.63	13.75±1.43	13.75±1.43	15.63±1.63	10.63±1.68	12.50±1.25	12.50±0.88	10.63±1.68	10.88±1.63	10.00±1.05	10.00±1.05
P5	10.00±1.05	12.50±1.77	13.13±1.05	13.75±1.12	16.25±0.56	11.25±1.05	11.88±2.56	10.63±0.68	12.50±0.88	8.75±0.56	11.25±0.68	7.50±0.68	6.88±0.56
F Count	1.95tn	3.06*	0.34tn	0.98tn	1.30tn	2.44tn	0.86tn	0.70tn	0.52tn	0.45tn	0.58tn	3.64*	1.64tn
F Tabel	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71	2.71
BNJ 5%	-	2.57	-	-	-	-	-	-	-	-	-	1.38	-

Note: tn = not significantly different; * = significantly different; These original data were transformed using root transformation prior to analysis.

C. nardus consists of several major components such as citral (30.36-45.44%), β -myrcene (6.83-9.50%) and geraniol (2.81-7.43%) (Souza *et al.*, 2022). These compounds play a role in suppressing the growth of the *Cercospora* leaf spot fungus on chili plants. From the results of the research that has been done, the incidence of *Cercospora* disease attack on chili plants shows that the attack rate tends to be lower at the highest dose of 6.25 mL / 5L. According to Ashaq *et al.*, (2024), compounds such as citral, linalool geraniol, limonene, and myrcene, found in *C. nardus* compounds can also damage the fungal plasma membrane, leak ions such as Ca²⁺, K⁺ and Mg²⁺, and destroy mitochondria.

There are many factors that can influence such as environmental sanitation factors that are less cleaned, humidity factors, high temperature factors, rainfall factors and others that can cause the spread of *C. capsici* leaf spot disease. The disease initially affects the older leaves, subsequently spreading to the younger leaves. The early symptoms of *C. capsici* leaf spot disease, which are commonly found in the field, are small, round, brown spots that are initially small but gradually become larger and can damage leaves and cause them to fall off.

From the research results (Achugbu *et al.*, 2022) The application of *Cymbopogon* sp. also showed the highest diameter and length results on corn cobs. The effectiveness of the use of *C. nardus* extract can also show better results if accompanied by balanced NPK fertilization between 50-75%, good irrigation arrangements (Mahmoud *et al.*, 2023). In this study, the application of NPK fertilizer was also routinely carried out once a week, this is thought to be a factor that supports the lack of *Cercosporas* sp. disease attack on the land. The provision of fertilizer as a balanced plant nutrient causes better plant

productivity, plants show growth and development starting from leaves, stems, to fruit.

In addition to its role as a control of *Cercospora* leaf spot disease, the use of *C. nardus* extract has antimicrobial and antioxidant properties and tends to be safer for consumption by consumers (Faheem *et al.*, 2022). *C. nardus* also has the potential to be used as a food preservative to extend the shelf life of food (Valková *et al.*, 2022). From the results of this study, the utilization of *C. nardus* not only has an impact on controlling *Cercospora* disease but can also be an alternative natural preservative for agricultural products. This allows consumers who consume these products to be safer and have minimal residue from harmful chemicals.

CONCLUSION

The highest incidence percentage was found in the 5th week observation which was 65%, the lowest incidence percentage in the 12th and 13th week observations which was 27.5%. The highest intensity was found in the 5th week observation which was 16.25% and the lowest in the 12th and 13th week observations which was 6.88%.

REFERENCES

- Achugbu, A. *et al.* 2022. Evaluation of Plant Fungicides in the Control of Fungi Affecting the Growth and Cob Yield of Maize in Awka. Asian Journal of Research in Botany. 8(3), pp. 37–45.
- Ahmed, H. F. A. *et al.* 2023. Activity of Essential Oils and Plant Extracts as Biofungicides for Suppression of Soil-Borne Fungi Associated with Root Rot and Wilt of Marigold (*Calendula officinalis* L.). MDPI Horticulturae. 9(222), pp. 1–22. doi: <https://doi.org/10.3390/horticulturae9020222>.

- Akponah, E. & M, Ubogu. 2023. Phytopathogenic Fungal Growth Inhibition by Actinomycetes Isolated from the Rhizosphere of *Cymbopogon citratus* (Lemongrass). *Acta Microbiologica Bulgarica*. 39(3), pp. 308–316. doi: 10.59393/amb23390312.
- Ashaq, B. *et al.* 2024. Insights into chemistry, extraction and industrial application of lemon grass essential oil -A review of recent advances. *Food Chemistry: X*. 22(May), p. 101521. doi: 10.1016/j.fochx.2024.101521.
- Cofelice, M. *et al.* 2021. Alginate-Assisted Lemongrass (*Cymbopogon nardus*) Essential Oil Dispersions for Antifungal Activity. *MDPI Foods*, 10(1528), pp. 1–12. doi: <https://doi.org/10.3390/foods10071528>.
- Delai, C. & Muhae-ud-din, G. 2024. A comprehensive review of integrated management strategies for damping-off disease in chili. *Frontiers in Microbiology*. 15(1479957), pp. 1–17. doi: 10.3389/fmicb.2024.1479957.
- Faheem, F. *et al.* 2022. Uncovering the Industrial Potentials of Lemongrass Essential Oil as a Food Preservative: A Review. *Antioxidants*. 11(4), pp. 1–21. doi: 10.3390/antiox11040720.
- Gangavarapu, Y. and S, Palwai. 2022. Antifungal Activity of Lemongrass Oil Against Pathogenic Fungi. *International Journal of High School Research*. 4(1), pp. 34–38. doi: 10.36838/v4i1.7.
- Islam, MS, Fatema, K, Alam, KMB, Meah, MB . 2015. Diagnosis and prescription for *Cercospora* leaf spot of chilli. *Journal of the Bangladesh Agricultural University*. 13(2). 191-196.
- Kgang, I. E. *et al.* 2022. Effects of lemon (*Citrus Limon* L.), lemongrass (*Cymbopogon citratus*) and peppermint (*Mentha piperita* L.) essential oils against of *Botrytis cinerea* and *Penicillium expansum* . *JSFA reports*. 2(8), pp. 405–414. doi: 10.1002/jsf2.75.
- Lopes, V. C. *et al.* 2023. Antifungal activity of lemongrass and thyme essential oils and effect on gray mold control and postharvest quality of “Italia” grape. *Bragantia*. 82, pp. 1–13. doi: 10.1590/1678-4499.20220202.
- Mahmoud, N. *et al.* 2023. The Impact of Irrigation Intervals and NPK/Yeast on the Vegetative Growth Characteristics and Essential Oil Content of Lemongrass. *Horticulturae*. 9(3). doi: 10.3390/horticulturae9030365.
- Membang, G. *et al.* 2024 Assessing the Efficacy of Lemongrass (*Cymbopogon citratus*) and Sambong (*Blumea balsamifera*) Extracts in Combating Black Pod Disease: Sustainable Solutions for Controlling *Phytophthora megakarya* in Cameroon Cocoa Plantations. *American Journal of Plant Sciences*. 15(07), pp. 519–537. doi: 10.4236/ajps.2024.157036.
- Mendez, F. L. *et al.* 2025. Bioefficacy of *Cymbopogon citratus* in controlling grey blight disease in tea (*Camellia sinensis*) caused by *Pestalotiopsis microspora*. *Physiological and Molecular Plant Pathology*. 138(March), p. 102638. doi: 10.1016/j.pmpp.2025.102638.
- Pamekas, T, DW, Ganefianti, and N, Destinawati. 2023. Characterization and Disease Severity of Pathogenic Microbes on 20 Red Chili Genotypes. *Jurnal Ilmu Pertanian Indonesia*. 28(3), pp. 361–369. doi: 10.18343/jipi.28.3.361.
- Parikh, L., BO, Agindotan and ME, Burrows. 2021. Antifungal activity

- of plant-derived essential oils on pathogens of pulse crops. *Plant Disease*. 105(6), pp. 1692–1701. doi: 10.1094/PDIS-06-20-1401-RE.
- Rahmi, ZY, Yurnaliza, dan LDS, Hastuti. 2022. Isolation and screening of lovastatin-producing endophytic fungi from lemongrass (*Cymbopogon nardus*). *Biodiversitas*. 23(8), pp. 4189–4194. doi: 10.13057/biodiv/d230841.
- Shaheen, N. *et al.* 2021. Genetics and Genomics of Fusarium Wilt of Chilies: A Review. *MDPI Agronomy*. 11(2162), pp. 1–19. doi: <https://doi.org/10.3390/agronomy11112162> Academic.
- Silva, MTR. *et al.* 2021. Arbuscular mycorrhizae maintain lemongrass citral levels and mitigate resistance despite root lesion nematode infection. *Rhizosphere*, 19(February). doi: 10.1016/j.rhisph.2021.100359.
- Souza, B. C. *et al.* 2022. Inoculation of lemongrass with arbuscular mycorrhizal fungi and rhizobacteria alters plant growth and essential oil production. *Rhizosphere*. 22(March), p. 100514. doi: 10.1016/j.rhisph.2022.100514.
- Townsend, GR & JW, Heuberger. 1943. Methods for estimating losses caused by diseases in fungicide experiments. *The Plant Disease Reporter*. 27, 340-343.
- Valková, V. *et al.* 2022. Chemical Composition and Antifungal Activity of Lemongrass Essential Oil. *Scientific Papers: Animal Science and Biotechnologies*. 2022(2), p. 55.