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Effect of two synthetic fungicides on the mycelial growth of *Cercospora elaeidis* and *Curvularia* sp., two foliar disease pathogens of oil palm

AURORE BEL MARTINE KABLAN KAN [1], ISMAEL ABRAHAM CISSE [1, 2, *], SÉKOU DIABATÉ [1] and MONGOMAKÉ KONÉ [2]

[1] *Phyto/Physiopathology Unit, Central Biotechnology Laboratory, National Center for Agricultural Research (CNRA), Km 17 : 01 BP 1740 Abidjan 01, Côte d'Ivoire.*
[2] *Laboratory of Biology and Plant Production Improvement, Faculty of Natural Sciences, Nagui Abrogoua University (UNA), 02 BP 801 Abidjan 02, Côte d'Ivoire.*

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Abstract

Oil palm (*Elaeis guineensis* Jacquin) is a key crop in the Ivorian economy; however, its production is severely constrained by fungal diseases, particularly curvulariosis and cercospora leaf spot in nurseries. This study aimed to evaluate in vitro the antifungal efficacy of two synthetic fungicides applied at different concentrations against major oil palm pathogenic fungi.

The antifungal activity of Antracol 70 WP (propineb, a dithiocarbamate contact fungicide) and Nativo 300 SC (tebuconazole + trifloxystrobin, a mesostemic fungicide) was assessed based on their effects on mycelial growth inhibition. Both fungicides significantly reduced fungal growth in a dose-dependent manner. Complete inhibition of mycelial growth (100%) was achieved at a concentration of 150 ppm for both products. At lower concentrations, Antracol 70 WP exhibited moderate antifungal activity against *Curvularia elaeidis*; however, its inhibitory effect increased markedly with rising concentrations, leading to total growth suppression beyond a threshold dose.

Overall, the results demonstrate that Antracol 70 WP, despite being a contact fungicide, can fully inhibit fungal growth at sufficiently high concentrations, while Nativo 300 SC provides faster and more effective inhibition due to its systemic properties and dual mode of action. These findings highlight the potential of both fungicides for the management of foliar fungal diseases in oil palm nurseries.

Keywords: Oil palm; *Elaeis guineensis*; Curvulariosis; Cercospora leaf spot; fungicides; Antracol 70 WP; Nativo 300 SC

1. Introduction

The oil palm (*Elaeis guineensis* Jacq.), a monocotyledon belonging to the Arecaceae family, is a major crop cultivated for two types of oils: red palm oil extracted from the fruit pulp and palm kernel oil obtained from the seed [1]. With yields exceeding 4 tons of palm oil per hectare per year, this species has become the world's leading source of vegetable fats [2] . Beyond its economic importance, oil palm cultivation plays a crucial social role in producing countries, particularly for communities living near plantation areas [3].

Nevertheless, oil palm production faces numerous constraints, both abiotic and biotic. Among the latter, attacks by pests and pathogenic fungi pose a serious threat to plantation sustainability. In nurseries and young plantations, fungi of the genera *Cercospora* and *Curvularia* are respectively responsible for cercosporiosis and curvulariosis, two foliar diseases that compromise seedling survival and, under high infection pressure, can lead to significant yield losses [4].

* Corresponding author: ISMAEL ABRAHAM CISSE

To improve oil palm productivity in Africa, it is essential to develop effective strategies to combat these fungal diseases. While tolerant lines against Fusarium wilt have already been developed [5], the judicious use of synthetic fungicides also represents a relevant alternative. In this context, different concentrations of two synthetic fungicides, belonging to distinct chemical families, were evaluated *in vitro* to assess their impact on the mycelial growth of *Curvularia sp.* and *Cercospora elaeidis*.

2. Materials and methods

2.1. Fungal Material

The fungal material consisted of strains of two pathogenic fungi. One strain of *Curvularia* sp. was isolated from the leaves of a young oil palm seedling showing leaf spot symptoms in a nursery. This isolate underwent culture purification and is preserved in the mycotheque of the Oil Palm Phytopathology Laboratory at CNRA (National Centre for Agricultural Research). The *Cercospora elaeidis* strain was isolated from symptomatic leaves of oil palm plants in the experimental nursery of Dabou.

2.2. Chemical Materials

The culture medium used for pathogen isolation and purification was Potato Dextrose Agar (PDA). The effects of two synthetic fungicides were evaluated *in vitro* on the mycelial growth of the two-oil palm pathogenic fungi. These were Antracol 70 WP (active ingredient: propineb, a dithiocarbamate), which is a contact fungicide, and Nativo 300 SC (active ingredients: tebuconazole and trifloxystrobin), which is a mesostemic fungicide (Table 1).

Table 1 Characteristics of the synthetic fungicides tested

Commercial Name	Active Ingredient(s)	Chemical Family	Formulation Type	Active Ingredient Concentration	Mode of action
Antracol	Propineb	Dithiocarbamate	70 WP	700 g/kg	Contact
Nativo	Tébuconazole Trifloxystrobin	Triazole Strobilurin	300 SC	200 g/l 100 g/l	Mesostemic

3. Methods

3.1. Fungal Strain Multiplication

Curvularia sp. and the *Cercospora elaeidis* isolate were cultured on mold medium (PDA). A 1 cm diameter disc containing the pathogenic fungus was then placed in the center of a Petri dish containing the culture medium. Discs of *Cercospora elaeidis* and *Curvularia* sp. were deposited in Petri dishes containing PDA medium.

3.2. Evaluation of Fungicide Effect

As the fungicides were in concentrated form, a 100 mL stock solution at 1000 ppm was prepared by dissolution in distilled water. The PDA medium was dissolved in distilled water before being autoclaved at 120 °C under a pressure of 1 bar for 30 minutes. After cooling the media to a temperature of approximately 45°C, the fungicides, from the stock solutions, were aseptically incorporated into the different culture media to obtain concentrations corresponding to the various treatments (Table 2). Control treatments (T0) were prepared without the addition of fungicide to the culture media. The different mixtures were poured into Petri dishes. Each treatment was replicated three (03) times.

Table 2 Fungicide concentrations tested in treatments

Fungicide Concentration (ppm)	0	1	5	10	25	50	100	150
Corresponding Treatment	T0	T1	T2	T3	T4	T5	T6	T7

3.3. Measurement of Pathogen Mycelial Growth

After the contents of the Petri dishes solidified, two perpendicular diameters were drawn on the back of each dish to allow measurement of fungal mycelial growth.

Then, a 1 cm diameter disc containing the pathogenic fungus was placed in the center of the corresponding Petri dish. Finally, all Petri dishes were incubated at a temperature of 25 °C. Starting the following day, mycelial growth in each Petri dish was measured daily until the culture medium surface was completely covered in the control Petri dishes, i.e., for a period of ten (10) days after culturing. The percentage of mycelial growth inhibition (MGI) was calculated using the formula proposed by Houmni *et al*. in [6]:

$$\textbf{ICM}\ (\%) = (\mathbf{1} - \frac{\mathbf{DTx}}{\mathbf{DT0}})\ \mathbf{x\ 100}$$

where: DTx is the average diameter of fungal colonies in the presence of the fungicide. DT0 is the average diameter of fungal colonies in the control Petri dishes.

3.4. Statistical Analysis

The data obtained were recorded in an Excel 2013 spreadsheet and processed using Statistica 7.1 software by applying one-way Analysis of Variance (ANOVA 1). In case of a significant difference between means, the Newman-Keuls test was used at the 5% threshold to separate the means.

4. Results

4.1. Effect of Nativo 300 SC on mycelial Growth of *Curvularia* sp.

Figure 1 illustrates the inhibition rate of *Curvilaria* sp according to the different treatments applied during the assay. No inhibitory effect was observed in the control treatment (T0). From T1 onward, a progressive increase in the inhibition rate was recorded, indicating a dose- or treatment-dependent response. The inhibition rate increased from approximately 23% at T1 to nearly 50% at T3, then rose sharply at T4, reaching about 70%. Treatments T5 and T6 maintained high inhibition levels, ranging between 78% and 87%. The highest inhibition rate was observed at T7, with complete inhibition (100%) of fungal growth.

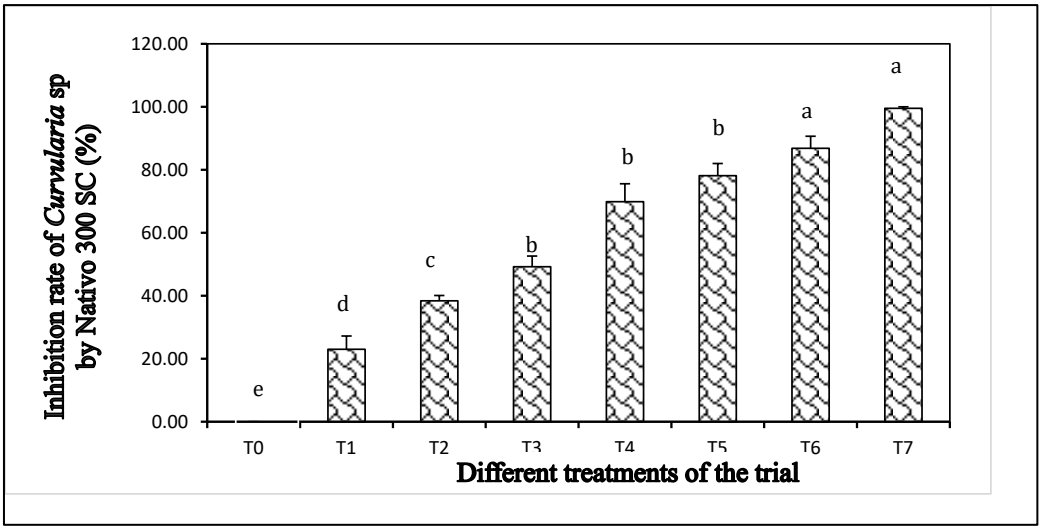

Figure 1 Inhibition rate of *Curvularia* sp. according to different concentrations of the active ingredient of the fungicide Nativo 300 SC (T0= no fungicide; T1=1 ppm; T2=5 ppm; T3=10 ppm; T4=25 ppm; T5=50 ppm; T6=100 ppm; T7=150 ppm)

4.2. Effect of Antracol 70 WP on mycelial Growth of *Curvularia* sp

Figure 2 presents the inhibition rate of the fungal pathogen under the different treatments applied during the assay. The control treatment (T0) showed no inhibitory effect. A low inhibition rate was observed at T1 (approximately 10%), followed by a slight increase at T2 (around 17%). From T3 onward, a marked increase in fungal growth inhibition was

recorded, reaching about 39% at T3 and nearly 60% at T4. Treatments T5 and T6 resulted in high inhibition rates, estimated at 68% and 84%, respectively. Complete inhibition of fungal growth (100%) was achieved at T7.

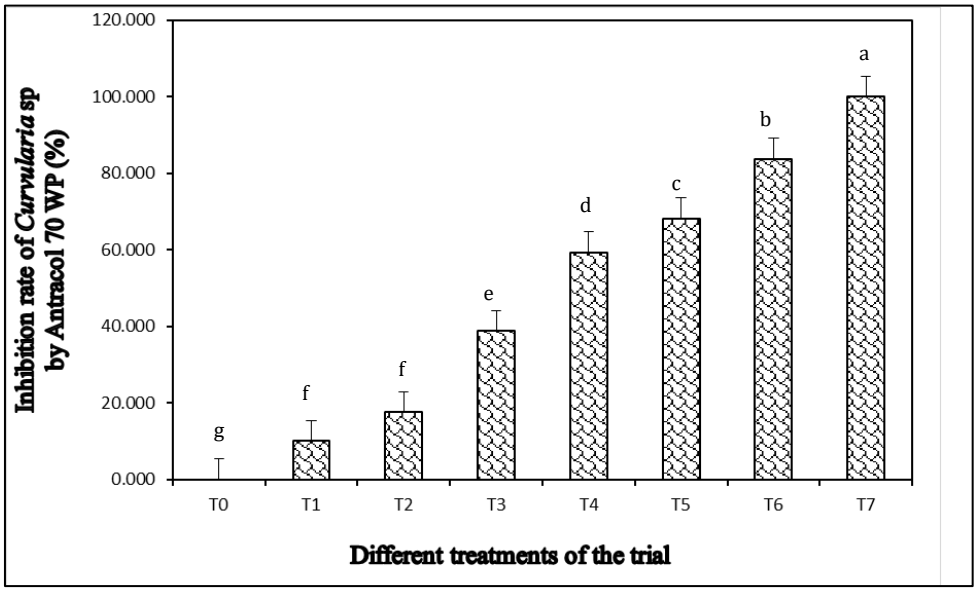

Figure 2 Inhibition rate of *Curvularia* sp. according to different concentrations of the active ingredient of the fungicide Antracol 70 WP (T0 = no fungicide; T1 = 1 ppm; T2 = 5 ppm; T3 = 10 ppm; T4 = 25 ppm; T5 = 50 ppm; T6 = 100 ppm; T7 = 150 ppm)

4.3. Effect of Nativo 300 SC on mycelial Growth of *Cercospora elaeidis*

Figure 3 shows a histogram indicating the inhibition rate of the fungus by the fungicide Nativo based on ten treatments, from T0 to T9. The inhibition rate increases gradually from T0 to T6, reflecting an increase in the effectiveness of the treatments as the doses increase. From T7 onwards, the values reach a high plateau, suggesting that treatments T7 to T9 induce maximum inhibition.

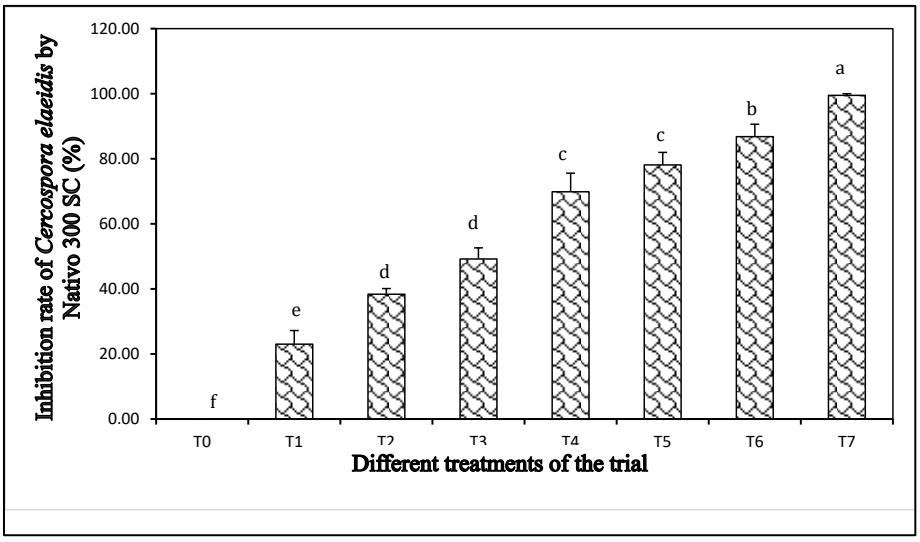

Figure 3 Inhibition rate of *Cercospora elaeidis*. according to different concentrations of the active ingredient of the fungicide Nativo 300 SC (T0 = no fungicide; T1 = 1 ppm; T2 = 5 ppm; T3 = 10 ppm; T4 = 25 ppm; T5 = 50 ppm; T6 = 100 ppm; T7 = 150 ppm)

4.4. Effect of Antracol 70 WP on mycelial Growth of *Cercospora elaeidis* .

Figure 4 shows the inhibition rate of the fungal pathogen as a function of the different treatments applied during the assay. No inhibition was observed in the control treatment (T0). Low inhibition rates were recorded at T1 and T2, with

values close to 10% and 17%, respectively. A clear increase in fungal growth inhibition was observed from T3, reaching approximately 39%. This inhibitory effect intensified at T4, with an inhibition rate close to 60%, and continued to increase at T5 and T6, with values of about 68% and 84%, respectively. Complete inhibition of fungal growth (100%) was obtained at T7.

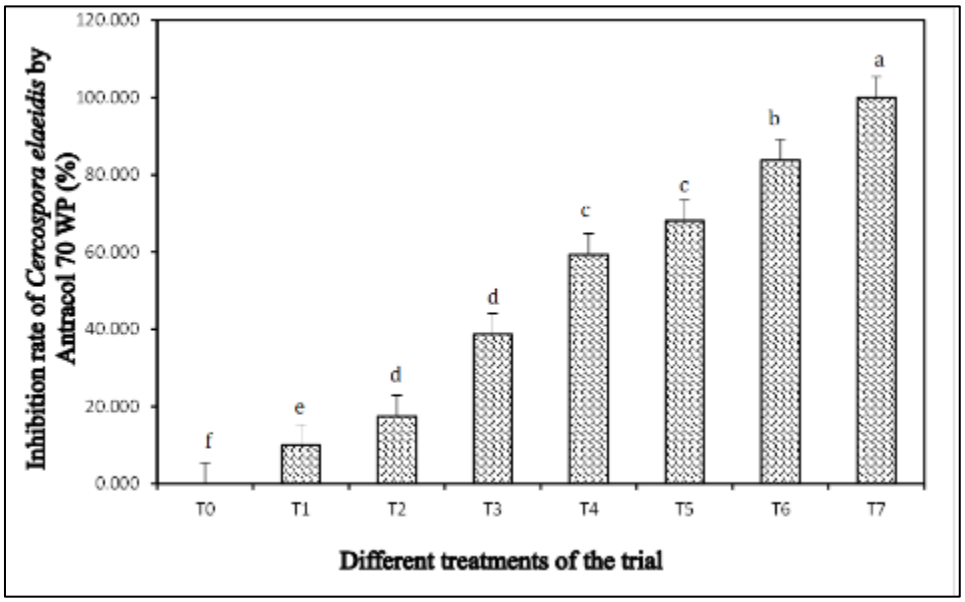

Figure 4 Inhibition rate of *Cercospora elaeidis*. according to different concentrations of the active ingredient of the fungicide Antracol 70 WP (T0 = no fungicide; T1 = 1 ppm; T2 = 5 ppm; T3 = 10 ppm; T4 = 25 ppm; T5 = 50 ppm; T6 = 100 ppm; T7 = 150 ppm)

5. Discussion

The synthetic fungicides Nativo 300 SC and Antracol 70 WP exhibited significant *in vitro* efficacy against *Curvularia elaeidis*, with mycelial growth inhibition clearly dependent on the applied concentrations. For both products, inhibitory activity increased progressively with increasing doses, leading to complete suppression of fungal growth from treatment T7 onwards.

Nativo 300 SC showed a rapid and pronounced dose response relationship. Noticeable inhibition was observed even at low concentrations, followed by a steady increase in efficacy until complete inhibition (100%) was achieved from T7. This high level of effectiveness can be attributed to the systemic nature of the product and its dual mode of action. Trifloxystrobin, a strobilurin fungicide, inhibits mitochondrial respiration by blocking electron transfer at the Qo site of complex III in the cytochrome bc1 complex, while tebuconazole, a triazole compound, disrupts sterol biosynthesis by inhibiting the 14α-demethylase enzyme, which is essential for fungal cell membrane integrity. The complementary action of these two active ingredients explains the rapid and sustained antifungal effect observed. Similar findings were reported by [7], who demonstrated significant inhibition of spore germination and mycelial growth of *Alternaria alternata* and *Fusarium oxysporum* at higher doses of strobilurin triazole fungicides.

In contrast, Antracol 70 WP exhibited a more gradual increase in antifungal activity. Low concentrations resulted in limited inhibition, whereas a significant increase in mycelial growth suppression was observed at intermediate doses, ultimately reaching complete inhibition at treatment T7. This response pattern is characteristic of contact fungicides with a multi-site mode of action. Propineb, the active ingredient of Antracol, belongs to the dithiocarbamate group and interferes with multiple enzymatic processes by binding to sulfhydryl groups, thereby affecting fungal metabolism, spore germination, and mycelial development. This multi-site mechanism, as described by [8], reduces the risk of resistance development compared with single-site fungicides. The present results are consistent with those of [9], who reported complete inhibition of mycelial growth of *Colletotrichum gloeosporioides* and *Corynespora cassiicola* by dithiocarbamates.

From an agronomic perspective, both fungicides proved effective against *Curvularia elaeidis*; however, their distinct modes of action suggest complementary uses. Nativo 300 SC is particularly suitable for curative treatments or early stages of infection due to its rapid and systemic activity, whereas Antracol 70 WP is better suited for preventive

applications aimed at protecting crops before symptom onset. Incorporating these fungicides into an integrated disease management strategy combining fungicide rotation, alternation with biocontrol agents, and dose optimization is essential to reduce selection pressure and maintain long-term efficacy. This approach is especially important given that excessive reliance on synthetic fungicides has been associated with the emergence of resistant fungal strains and adverse environmental effects, as widely documented by the Fungicide Resistance Action Committee [10].

In conclusion, the results demonstrate that both Nativo 300 SC and Antracol 70 WP are capable of completely inhibiting the mycelial growth of *Curvularia elaeidis* at sufficient concentrations. Nativo exhibits a faster antifungal effect due to its systemic and dual mode of action, whereas Antracol shows a progressive efficacy associated with its multi-site mechanism. These findings are consistent with previous reports on other phytopathogenic fungi, including *Alternaria*, *Fusarium*, and *Penicillium*, and highlight the importance of judicious fungicide use for the sustainable management of fungal diseases [11].

6. Conclusion

The effect of the synthetic fungicides Nativo 300 SC and Antracol 70 WP on the development of *Curvularia elaeidis* , the causal agent of leaf spot disease, was evaluated under in vitro conditions in this study. Mycelial growth inhibition increased with increasing concentrations of the fungicidal active ingredients. Complete inhibition of fungal growth (100%) was achieved from treatment 150 ppm for both fungicides. At lower concentrations, Antracol 70 WP exhibited limited antifungal activity against *Cercospora elaeidis*; however, as the dose increased, its inhibitory effect became more pronounced. Beyond a certain concentration, *Cercospora. elaeidis* no longer grew on the culture medium. These results confirm that Antracol 70 WP, despite being a contact fungicide, is capable of totally suppressing mycelial growth at sufficiently high doses, while Nativo 300 SC provides a faster and more effective inhibition due to its systemic nature and dual mode of action. After this laboratory trial stage, it would be appropriate to extend the fungicide efficacy tests to real conditions at the nursery stage.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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