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# *IN VITRO* ASSESSMENT OF FUNGICIDAL EFFICACY AGAINST *COLLETOTRICHUM GLOEOSPORIOIDES* PENZ. AND SACC.

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**ABSTRACT**

During 2023–2024, an in vitro experiment was conducted in the P.G. Research laboratory of the Department of Plant Pathology, N.M. College of Agriculture, Navsari Agricultural University, Navsari, to assess the effectiveness of fungicides against mango anthracnose (*C. gloeosporioides*). Using a Complete Randomized Design, the seven fungicides were evaluated for their ability to inhibit *C. gloeosporioides in vitro* at three concentrations (250, 500, and 1000 ppm). The effectiveness was evaluated using mean colony diameter (mm) and per cent growth inhibition (PGI). Among fungicides, azoxystrobin 23 SC demonstrated superior results by attaining inhibition rates of 58.15, 63.70, and 78.49 per cent at 250, 500 and 1000 ppm, respectively. In comparison, propineb 70 WP and copper oxychloride 50 WG showed considerably lower efficacy across all concentrations. Among ready mix-fungicides, pyraclostrobin 5 + metiram 55 WG exhibited significantly superior performance and completely inhibited the pathogen at all tested concentrations. Tebuconazole 50 + trifloxystrobin 25 WG also demonstrated excellent efficacy, with inhibition rates of 91.85, 93.70 and 95.92 per cent at 250, 500 and 1000 ppm, respectively.

***Keywords*:** Mango anthracnose, fungicides, *in vitro*, colony diameter, growth inhibition.

## Introduction

The most well-liked and resilient tropical fruit in the world is the mango (*Mangifera indica* Linnaeus), sometimes referred to as the "King" of all fruits and is known as the “King” of all fruits. Mangos belong to the Anacardiaceae family and are grown all over India. The term "mango" is derived from the Tamil word "mangkay". It is regarded as one of the most important and popular fruits in Asia. According to the National Horticulture Board (NHB), India produces 20,444 thousand MT of mangoes annually on an area of 2291 thousand hectares. The principal mango-producing states in India include Uttar Pradesh, Andhra Pradesh, Karnataka, Bihar, Gujarat, Tamil Nadu, and Telangana.

Bana *et al*. (2023) carried out a study that lasted five years (2016–20) to evaluate the damage that primary insect diseases and pests due to mango crops in humid tropical locations and the results showed that powdery mildew, pre- and post-harvest anthracnose, and stem end rot were the main diseases impacting mango trees. Anthracnose is the major pre- and post-harvest mango disease caused by *C. gloeosporioides*. About 25 to 3000 of fruit loss in total mango production has been reported under humid conditions due to the incidence of anthracnose and SER (Uddin *et al*., 2018). Investigation on fungicidal efficacy against *C. gloeosporioides* is crucial for developing effective disease management strategies. Mango anthracnose causes significant pre-harvest losses. Evaluation of fungicides helps identify potential fungicides against mango anthracnose.

## Materials and Methods

The present investigation was carried out to evaluate the efficacy of fungicides against mango

anthracnose in PG Research laboratory of Department of Plant Pathology, N. M. College of Agriculture, NAU, Navsari during 2023-24. Total eight treatments of fungicide with control (Table 1) were assessed by Poison food technique (Grover and Moore, 1962). The pathogen *C. gloeosporioides* of mango was grown on PDA in Petri plates for seven days prior to setting the experiment. Fungicide suspension was prepared in PDA by adding required quantity of fungicide to obtain the desired concentration based on active ingredient and whole product present in the chemical. Twenty ml of poisoned medium was poured into each of the sterilized Petri plates and each treatment was replicated thrice.

**Table 1:** Treatment details of fungicides and their concentration for *in vitro* evaluation

| Sr. No. | Treatments | Concentrations (ppm) | | |
|---|---|---|---|---|
| **Fungicide** | | | | |
| $T_1$ | Azoxystrobin 23% SC | 250 | 500 | 1000 |
| $T_2$ | Copper Oxychloride 50% WP | 250 | 500 | 1000 |
| $T_3$ | Propineb 70% WP | 250 | 500 | 1000 |
| **Ready mix fungicide** | | | | |
| $T_4$ | Carbendazim 12% + Mancozeb 63% WP | 250 | 500 | 1000 |
| $T_5$ | Tebuconazole 50% + Trifloxystrobin 25% WG | 250 | 500 | 1000 |
| $T_6$ | Azoxystrobin 25% EC + difenoconazole 25% EC | 250 | 500 | 1000 |
| $T_7$ | Pyraclostrobin 5% + Metiram 55% WG | 250 | 500 | 1000 |
| $T_8$ | Control | - | - | - |

**Observations**

The observations on mycelial growth (mm) and per cent growth inhibition of test fungi were recorded after 7 days of incubation. The per cent growth inhibition (PGI) of pathogen in each treatment was calculated according to formula given by Vincent (1947).

$$PGI = \frac{DC - DT}{DC} \times 100$$

Where,

PGI = Per cent growth inhibition

DC = Average diameter of mycelial colony from control set (mm)

DT = Average diameter of mycelial colony from treated set (mm

**Statistical analysis**

To assess the effectiveness of different fungicides on *C. gloeosporioides*, an *in vitro* experiment with eight treatments and three repetitions was carried out using a Complete Randomized Design (CRD). As described by Panse and Sukhatme (1985), the data were stringently statistical analyzed using the analysis of variance (ANOVA) approach.

## Results and Discussion

This study was carried out to evaluate the efficacy of different fungicides against mango anthracnose (*C. gloeosporioides*) under *in vitro* conditions. Eight treatments were tested, including both fungicides at three different concentrations (250, 500 and 1000 ppm). The parameters considered were percent growth inhibition (PGI) and mean colony diameter of *C. gloeosporioides*.

**At 250 ppm Concentration**

The results of the study are presented in Table 2 and depicted in Fig. 1 and Photo 1. It revealed that the mycelial diameter of the fungus ranged from 0.00 to 58.67 mm. Among ready mix fungicides, pyraclostrobin 5 + metiram 55 WG completely inhibited mycelial growth (0.00 mm) of *C. gloeosporioides*. The next best treatment was tebuconazole 50 + trifloxystrobin 25 WG (7.33 mm) and azoxystrobin 25 EC + difenoconazole 25 EC (21.00 mm). Among the fungicides, azoxystrobin 23 SC was the most effective, inhibiting mycelial growth of 37.67 mm. The next best treatment was propineb 70 WP and copper oxychloride 50 WG which were less effective, recording mycelial growth of 54.33 mm and 58.67 mm, respectively.

The results of per cent inhibition of *C. gloeosporioides* varied between 34.81 to 100.00 per cent (Table 2 and Figure 2). Among ready mix fungicides, pyraclostrobin 5 + metiram 55 WG recorded cent per cent inhibition (100.0 %) of *C. gloeosporioides*. The next best treatment was tebuconazole 50 + trifloxystrobin 25 WG and azoxystrobin 25 EC + difenoconazole 25 EC, which recorded 91.85 per cent and 76.66 per cent inhibition, respectively. Among the fungicides, azoxystrobin 23 SC was the most effective with inhibition of 58.15 per

cent. The next best treatment was propineb 70 WP and copper oxychloride 50 WG, which recorded 39.63 per cent and 34.81 per cent inhibition, respectively.

**Table 2:** *In vitro* efficacy of different fungicides against *C. gloeosporioides*

| Tr. No. | Treatments | Mean colony diameter (mm) | | | PGI (%) | | |
|---|---|---|---|---|---|---|---|
| | | Concentration (ppm) | | | Concentration (ppm) | | |
| | | 250 | 500 | 1000 | 250 | 500 | 1000 |
| T1 | Azoxystrobin 23% SC | 37.67 | 32.67 | 19.33 | 58.15 (49.69) | 63.70 (52.96) | 78.49 (62.39) |
| T2 | Copper Oxychloride 50% WP | 58.67 | 52.33 | 50.67 | 34.81 (36.16) | 41.85 (40.31) | 43.67 (41.45) |
| T3 | Propineb 70% WP | 54.33 | 48.67 | 44.33 | 39.63 (39.01) | 45.93 (42.66) | 50.71 (45.41) |
| T4 | Carbendazim 12% + Mancozeb 63% WP | 27.33 | 22.33 | 17.33 | 69.63 (56.56) | 75.19 (60.12) | 80.72 (63.97) |
| T5 | Tebuconazole 50% + Trifloxystrobin 25% WG | 7.33 | 5.67 | 3.67 | 91.85 (73.47) | 93.70 (75.48) | 95.92 (78.44) |
| T6 | Azoxystrobin 25% EC + Difenoconazole 25% EC | 21.00 | 18.67 | 15.67 | 76.67 (61.13) | 79.26 (62.91) | 82.59 (65.36) |
| T7 | Pyraclostrobin 5% + Metiram 55% WG | 0.00 | 0.00 | 0.00 | 100.00 (90.00) | 100.00 (90.00) | 100.00 (90.00) |
| T8 | Control | 90.00 | 90.00 | 90.00 | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) |
| | S.Em.± | - | - | - | 0.63 | 0.57 | 0.76 |
| | CD at 5% | - | - | - | 1.88 | 1.71 | 2.29 |
| | CV% | - | - | - | 2.15 | 1.87 | 2.37 |

Note: Data in parentheses are arcsine transformed values and data outside parentheses are original values

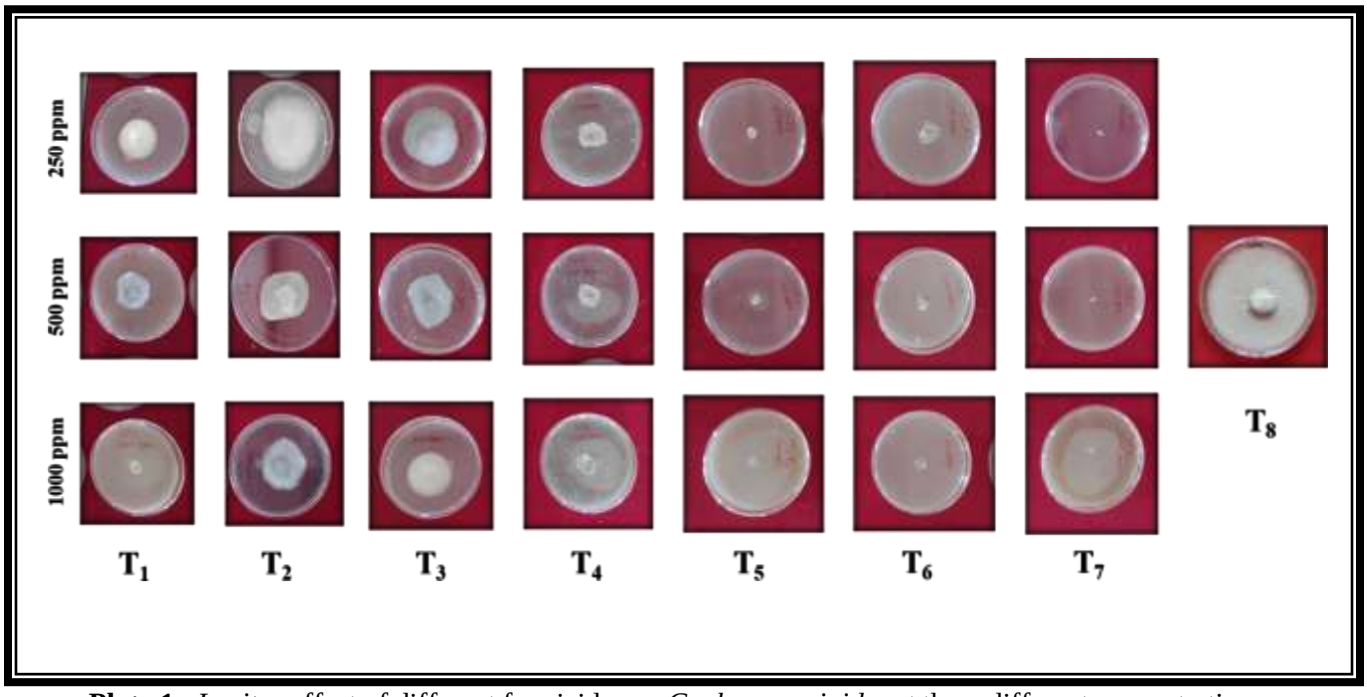


**Plate 1:** *In vitro* effect of different fungicides on *C. gloeosporioides* at three different concentrations

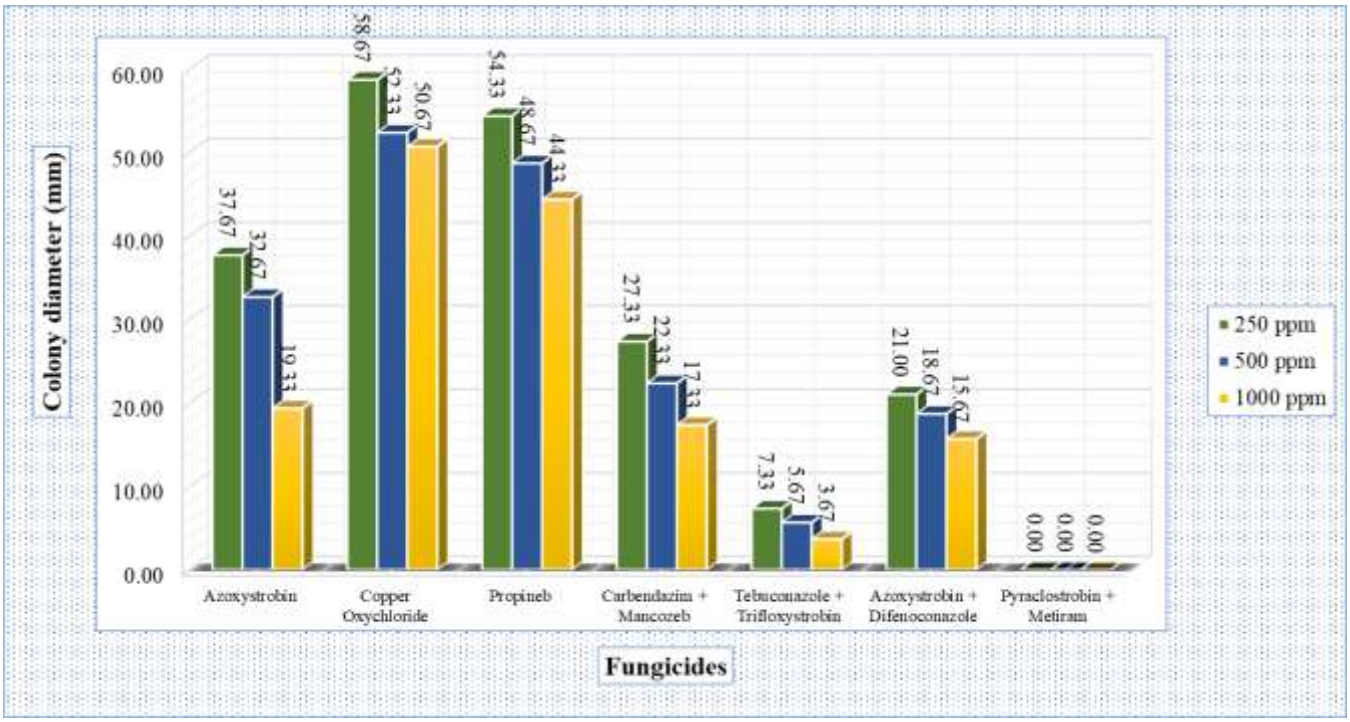


**Fig. 1:** *In vitro* effect of different fungicides on mean colony diameter of *C. gloeosporioides*

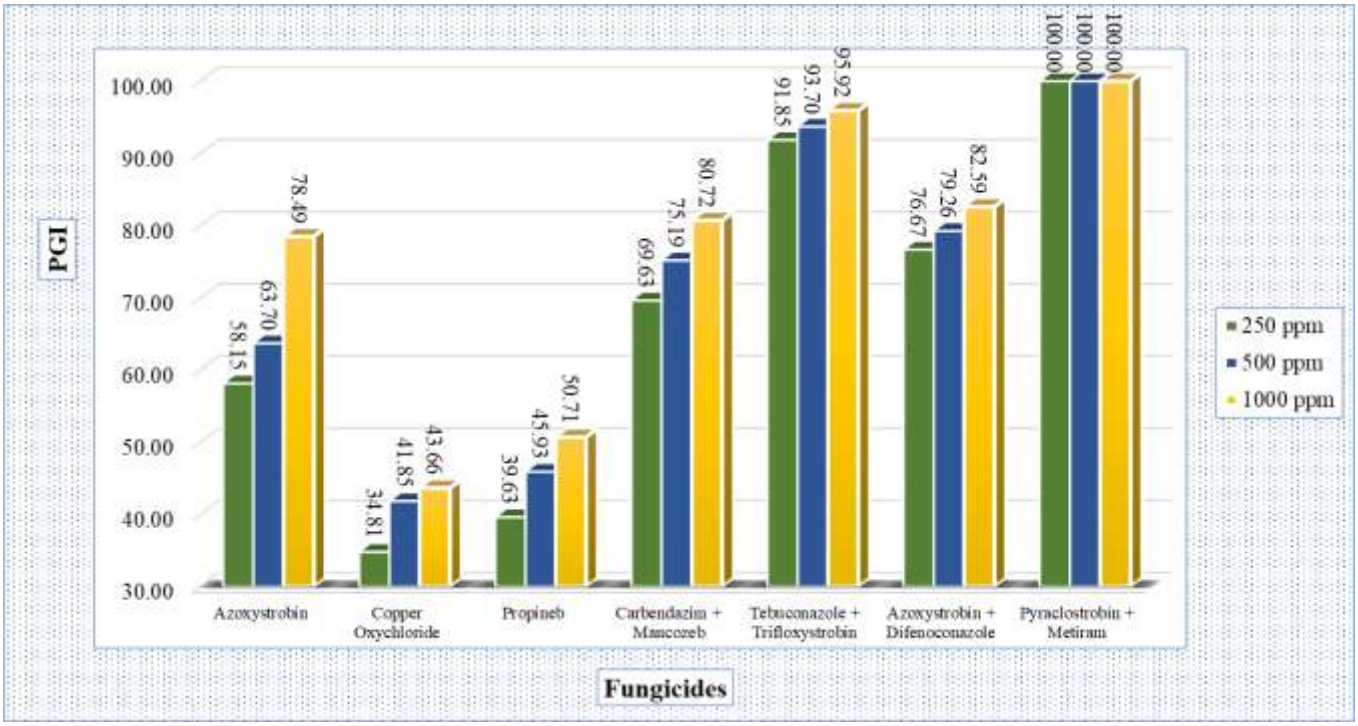


**Fig. 2:** *In vitro* effect of different fungicides on per cent growth inhibition of *C. gloeosporioides*

**At 500 ppm Concentration**

The results of the study are presented in Table 2 and Figure 1. The mycelial diameter of the fungus ranged from 0.00 to 52.33 mm. Among ready mix fungicides, pyraclostrobin 5 + metiram 55 WG completely inhibited mycelial growth (0.0 mm) of *C. gloeosporioides*. The next effective treatments were tebuconazole 50 + trifloxystrobin 25 WG and azoxystrobin 25 EC + difenoconazole 25 EC, which inhibited mycelial growth by 5.67 mm and 18.67 mm, respectively. Among the fungicides, azoxystrobin 23 SC was the most effective, inhibiting mycelial growth of 32.67 mm. The next best treatment was propineb 70 WP and copper oxychloride 50 WG, which were less effective, recording mycelial growth of 48.67 mm and

52.33 mm, respectively. The results of this study suggest that ready mix-fungicides are more effective than single fungicides in inhibiting mycelial growth of mango anthracnose.

The results of per cent inhibition of *C. gloeosporioides* at 500 ppm concentration varied from 41.85 to 100.00 per cent (Table 2 and Figure 2). Among ready mix fungicides, pyraclostrobin 5 + metiram 55 WG recorded cent per cent inhibition (100.0%) of *C. gloeosporioides*. The next effective treatment was tebuconazole 50 + trifloxystrobin 25 WG and azoxystrobin 25 EC + difenoconazole 25 EC, which recorded 93.70 per cent and 79.26 per cent inhibition, respectively. Among the fungicides, azoxystrobin 23 SC was the most effective with inhibition of 63.70 per cent. The next best treatment was propineb 70 WP and copper oxychloride 50 WG, which recorded 45.93 per cent and 41.85 per cent inhibition, respectively.

**At 1000 ppm Concentration**

The results of the study are presented in Table 2 and Figure 1. The mycelial diameter of *C. gloeosporioides* ranged from 0.00 to 50.67 mm. Among all ready mix fungicides, pyraclostrobin 5 + metiram 55 WG completely inhibited mycelial growth (0.00 mm) of *C. gloeosporioides*. The next effective treatments were tebuconazole 50 + trifloxystrobin 25 WG and azoxystrobin 25 EC + difenoconazole 25 EC, which inhibited mycelial growth by 3.67 mm and 15.67 mm, respectively. Among the fungicides, azoxystrobin 23 SC was the most effective, inhibiting mycelial growth of 19.33 mm. The next best treatment was propineb 70 WP and copper oxychloride 50 WG, which were less effective, recording mycelial growth of 44.33 mm and 50.67 mm, respectively. The results suggested that ready mix fungicides are more effective than single fungicides in inhibiting mycelial growth of *C. gloeosporioides.*

The results of per cent inhibition of *C. gloeosporioides* at 1000 ppm concentration fluctuated between 43.67 to 100.00 per cent (Table 2 and Fig. 2). Among ready mix fungicides, pyraclostrobin 5 + metiram 55 WG recorded cent per cent inhibition (100.00%) of *C. gloeosporioides*. The next effective treatment was tebuconazole 50 + trifloxystrobin 25 WG and azoxystrobin 25 EC + difenoconazole 25 EC, which recorded 95.92 per cent and 82.59 per cent inhibition, respectively. Among the fungicides, azoxystrobin 23 SC was the most effective with inhibition of 78.49 per cent. The next best treatment was propineb 70 WP and copper oxychloride 50 WG, which recorded 50.71 per cent and 43.67 per cent inhibition, respectively.

Among different ready mix fungicides, pyraclostrobin 5 + metiram 55 WG and tebuconazole 50 + trifloxystrobin 25 WG were the most effective in inhibiting mycelial growth of *C. gloeosporioides*. This is likely due to the synergistic effect of the two active ingredients, which target different stages of the fungal life cycle. Among fungicides, azoxystrobin 23 SC and propineb 70 WP were the most effective, but their efficacy was lower than that of the ready mix fungicides.

The results of present investigation are more or less similar to Bhagwat *et al*. (2016), who assessed the efficacy of different fungicides against mango anthracnose in NAU, Navsari and found that pyraclostrobin + metiram (0.1%) and propiconazole (0.1%) recorded significantly minimum per cent disease intensity (6.90 and 8.55%) and highest per cent disease control (74.68 and 68.62%) of mango anthracnose. The superior performance of pyraclostrobin 5% + metiram 55% WG and tebuconazole 50% + trifloxystrobin 25% WG observed in this study supports the findings of Balba (2007), who reported that strobilurin fungicides effectively controlled pathogens by inhibiting mitochondrial respiration in the pathogen.

Similarly, Golakiya *et al*. (2020) found that ready-mix fungicides, azoxystrobin 11 + tebuconazole 18.30 SC, epoxiconazole 50g/l + pyraclostrobin 133g/l and tebuconazole 50 + trifloxystrobin 25 WG (98.99%) were significantly inhibited the growth of *C. gloeosporioides* under *in vitro.* Similar results were also found by Malipatil *et al*. (2021) observed that ready mix fungicides tryfloxystrobin 25 + tebuconazole 50 were completely inhibiting the growth of *C. gloeosporioides* at all three (0.10, 0.20, 0.30%) tested concentrations.

Similarly, Chavan *et al*. (2023) assessed seven broad spectrum fungicides against *C. gloeosporioides* and results of mycelial growth inhibition revealed that azoxystrobin 23 SC (90.00% and 93.33%), hexaconazole 5 EC (86.11% and 91.66%), propiconazole 25 EC (83.88 % and 88.88 %), difenoconazole 25 EC (82.22 % and 88.33 %) and tebuconazole 25.9 EC (78.33% and 81.60%), respectively each @ 500 and 1000 ppm found superior. More or less similar results was also found by Inayat *et al*. (2024) who tested fungicides at three concentrations (0.05, 0.1 and 0.15) which inhibiting the growth of *C. gloeosporioides* and revealed that azoxystrobin 20 SC and tebuconazole + trifloxystrobin 75 WG achieving 50 per cent mycelial inhibition and preventing

sporulation across all three concentrations.

The findings conclusively demonstrate that ready mix fungicides, particularly pyraclostrobin 5 + metiram 55 WG and tebuconazole 50 + trifloxystrobin 25 WG, offer superior control compared to single fungicides across all tested concentrations. The complete inhibition achieved by pyraclostrobin 5 + metiram 55 WG at all concentrations highlights its potential as a highly effective treatment option for mango anthracnose management. The strong performance of ready mix fungicide containing strobilurin group of fungicides, paired with compounds having different modes of action, reinforces the value of multi-site targeting approaches for fungal pathogen management. Among the fungicides, azoxystrobin 23 SC emerged as the most effective option, particularly at higher concentrations, suggesting its utility in integrated disease management programs where rotation of active ingredients is desired for resistance management.

## Conclusion

The study confirmed that under *in vitro* conditions, ready mix fungicides were more effective than single fungicides in inhibiting the mycelial growth of *C. gloeosporioides*, the causal agent of mango anthracnose. Among the ready mix fungicides, pyraclostrobin 5 + metiram 55 WG and tebuconazole 50 + trifloxystrobin 25 WG showed the highest efficacy, with complete inhibition of mycelial growth at all three concentrations (250, 500, and 1000 ppm) tested. Among single fungicides, azoxystrobin 23 SC showed the highest efficacy. However, tebuconazole 50 + trifloxystrobin 25% WG also showed excellent efficacy (95.92% inhibition at 1000 ppm). The results suggest that ready mix fungicides could be a promising option for managing mango anthracnose due to their synergistic effects and broad-spectrum activity.

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## References

Balba, H. (2007). Review of strobilurin fungicide chemicals. *J. Environ. Sci. Heal. Part B*, **42** (4): 441-451. (Doi: https://doi.org/10.1080/03601230701316465)

Bana, J., Sharma, H., Chavan, S., Sharma, D. and Patil, S. (2024). Assessment of losses caused by major insect-pests and diseases of mango (*Mangifera indica* L.) under humid tropics. Pest *Management in Horticultural Ecosystems*, **29** (2): 213-220.

Bhagwat, R.G., Mehta, B.P. and Patil, V.A. (2016). Evaluation of fungicides and biological agents for the management of mango anthracnose. *Inter. J. of Environ. and Agril Res.*, **2** (4): 49-52.

Chavan, R.A., Sontakke, P.L., Bantewad, S.D. and Kumbhar, M.S. (2023). *In vitro* efficacy of fungicide against major fungi causing leaf spot of mango. *J. Pl. Dis. Sci*., **18** (2): 150-152.

Golakiya, B., Akbari, L.F. and Marakna, N.M. (2020). *In vitro* evaluation of different fungicides against pomegranate anthracnose caused by *Colletotrichum gloeosporioides*. *Int. J. Chem. Stud.*, **8** (4): 3669-3674.

Grover, R.K. and Moore, J.D. (1962). Toximetric studies of fungicides against the brown rot organisms, *Sclerotinia fructicola* and *S. laxa*. *Phytopathology*, **52** (9): 876-880.

Inayat, S., Ullah, A., Anwar, A. and Kaleem, A. (2024) *In vitro* evaluation of fungicides against mango anthracnose caused by *Colletotrichum gloeosporioides*. *Am. J. Biomed. Sci.*, **12** (2): 16-21.

Panse, V.G. and Sukhatme, P.V. (1985). Statistical Methods for Agriculture Workers, ICAR, Publ. New Delhi, 4th Edn., Pp. 87-89.

Uddin, M.N., Hossain, S.S., Talukder, A., Mansura, M. and Jahan, N. (2018) Management of anthracnose disease of mango caused by *Colletotrichum gloeosporioides*: A Review. *Acta Scientific Agri-culture*, **2**(10): 169-177.

Vincent, J.M. (1947). The esters of 4-hydroxybenzoic acid and related compound. Part 1. Method for the study of their fungistatic properties. *J. Soc. Chem. Ind.*, **66** (5): 149-155.