Journal of Advances in Biology & Biotechnology

Volume 27, Issue 9, Page 325-332, 2024; Article no.JABB.121429
ISSN: 2394-1081

Bioefficacy of Novel Chemical Fungicides for Management of Mango Powdery Mildew

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/jabb/2024/v27i91302

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/121429

Original Research Article

Received: 24/06/2024
Accepted: 26/08/2024
Published: 28/08/2024

ABSTRACT

Mango (*Mangifera indica* L.), the king of the fruits, is considered the most important fruit among millions of people worldwide, particularly in India. Among all diseases, powdery mildew caused by *Oidium mangiferae* is one of the most common, wide spread and serious diseases throughout the world causing significant yield losses. In this study experiments were conducted for two seasons by using new fungicides to control the disease along with some old ones. Among all fungicides tested Tebuconazole 50% + Trifloxystrobin 25% WG reduced the disease severity significantly. In both the seasons (pooled) Tebuconazole 50% + Trifloxystrobin 25% WG worked significantly by reducing the disease with PDI of 3.33 per cent and per cent disease reduction over control of 87.51.

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Cite as: *C. R., Jahir Basha, Manjula C. P., Akash Bevanur, and Indhu P. 2024. "Bioefficacy of Novel Chemical Fungicides for Management of Mango Powdery Mildew". Journal of Advances in Biology & Biotechnology 27 (9):325-32. https://doi.org/10.9734/jabb/2024/v27i91302.*

Keywords: Mango; Oidium mangiferae; powdery mildew; tebuconazole; trifloxystrobin.

1. INTRODUCTION

Mango (*Mangifera indica* L.), known as the national fruit of India, occupies nearly half of the total area under fruits in the country. In the world scenario, India shares about 56 per cent of total mango production. Mango is a tropical fruit and being in high demand fetches a good price all over the world [1]. In Karnataka the area under this crop was 173972 ha with production of 739803 tonnes and 4252 kg/ha of productivity [2].

However, the crop is challenged by several diseases such as powdery mildew, anthracnose and blossom blight which cause large scale yield loss of mango crop affecting the economy of farmers across the country. *Oidium mangiferae*, which causes powdery mildew in mango trees, is the main constraint on mango output [3]. The disease results in foliar, flower, and fruit infections, although the most dangerous one blossom infection causes yield losses of between 22.35 and 90.41 percent [4,5]. However, many management strategies have been recommended to prevent mango powdery mildew. The constant search for better and safer fungicides against serious diseases is intended to reduce the diseases as much as possible. Keeping the above points in view, the present investigation was undertaken to evaluate the efficacy of some systemic, non-systemic and combinations of both types of fungicides against powdery mildew of mango.

2. MATERIALS AND METHODS

Powdery mildew symptoms were observed on inflorescence and leaves/ branches of infected tree. Selected fungicides were sprayed to evaluate the efficacy against powdery mildew of mango. Sprayings were done two times, first spray at disease initiation stage and second at 30 days after 1st spray. Powdery mildew severity was recorded on ten inflorescences per tree per treatment, 15 and 30 days after first spray and 15 and 30 days after second spray. Per cent disease index was assessed based on visual observation and graded in 0-5 scale [6] (Table 1) and PDI was calculated as per the standard formula given by Wheeler [7]. The treatment details have been provided in Table 2.

$$\text{Per cent disease index} = \frac{\text{Sum of all disease ratings}}{\text{Total No. of leaves observed}} \text{ X } \frac{100}{\text{Maximum disease rating}}$$

Table 1. Disease rating scale of powdery mildew of mango

Score	Description
0	Inflorescences healthy, no trace of infection
1	Trace powdery growth on about 1-20% portion of inflorescence
2	Slight infection, 21-40% portion of the inflorescence covered with powdery growth
3	Moderate infection, 41-60% portion of the inflorescence covered with powdery growth
4	Severe infection, 61-80% portion of the inflorescence covered with powdery growth
5	Very severe infection, 81-100% portion of inflorescence is covered with heavy powdery growth, colour turning grayish and small fruit (pea size) covered with powdery coating

Table 2. Treatment details

Sl. No.	Treatments	Dosage/L (g/ml)
1	Carbendazim 12% + Mancozeb 63% WP	2.0
2	Sulphur 80% WP (first spray)	3.0
	Carbendazim 50% WP (second spray)	1.0
3	Tebuconazole 50% + Trifloxystrobin 25% WG	0.5
4	Tebuconazole 50% + Trifloxystrobin 25% WG	0.75
5	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.15
6	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.2
7	Hexaconazole 5% EC	1.0
8	Carbendazim 50% WP	1.0
9	Sulphur 80% WP	3.0
10	Control	-

3. RESULTS AND DISCUSSION

An experiment was conducted to evaluate different fungicides to control mango powdery mildew in field condition. It clearly showed that the significant effect of fungicides in reducing the severity of disease. Bio-efficacy of fungicides on mango powdery mildew during two seasons is presented in Table 3, 4, 5 and Fig. 1. Before imposing treatments, no significant difference was found among the treatments. During first season, Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.75 g/l showed least disease index (3.00%) which is statistically on par with Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.5 g/l (3.67%) compared to untreated control (23.67%), followed by Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC @ 0.2 ml/l (5.67%), Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC @ 0.15 ml/l (7.33%) and Carbendazim 12%+ Mancozeb 63% WP @ 2 g/l (8.33%). Similar trend was observed during second season, Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.75 g/l showed least disease index (3.66%) which is statistically on par with Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.5 g/l (4.00%) compared to untreated control (29.66%) followed by Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC @ 0.2 ml/l (7.00%), Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC @ 0.15 ml/l (8.33%) and Carbendazim 12% + Mancozeb 63% WP @ 2 g/l (9.33%).

The pooled analysis of two years data showed that Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.75 g/l and 0.5 g/l was found effective to control the powdery mildew disease with 87.51 and 85.67 per cent of disease reduction over control, followed by Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC @ 0.2 ml/l and 0.15 ml/l found effective with 76.16 and 70.63 per cent of disease reduction over untreated control.

Combi products are more efficient in managing diseases compared to solo fungicides as relying on one single fungicide is unscientific as continuous usage of a particular fungicide results in development of resistance [8]. Several workers have reported the efficacy of different fungicides *viz*., wettable sulphur, dinocap, carbendazim, benomyl, tridemorph, tridemephon, bitertanol, oxythioquinone, thiophanate methyl, flusilazole [9-13,5,14-16]. Though wettable sulphur and carbendazim have been reported to be the best for the management of powdery mildew, during the present study these did not provide satisfactory disease control as compared to other fungicides. It might be due to a resistant strain of the fungus has emerged. Among the fungicides

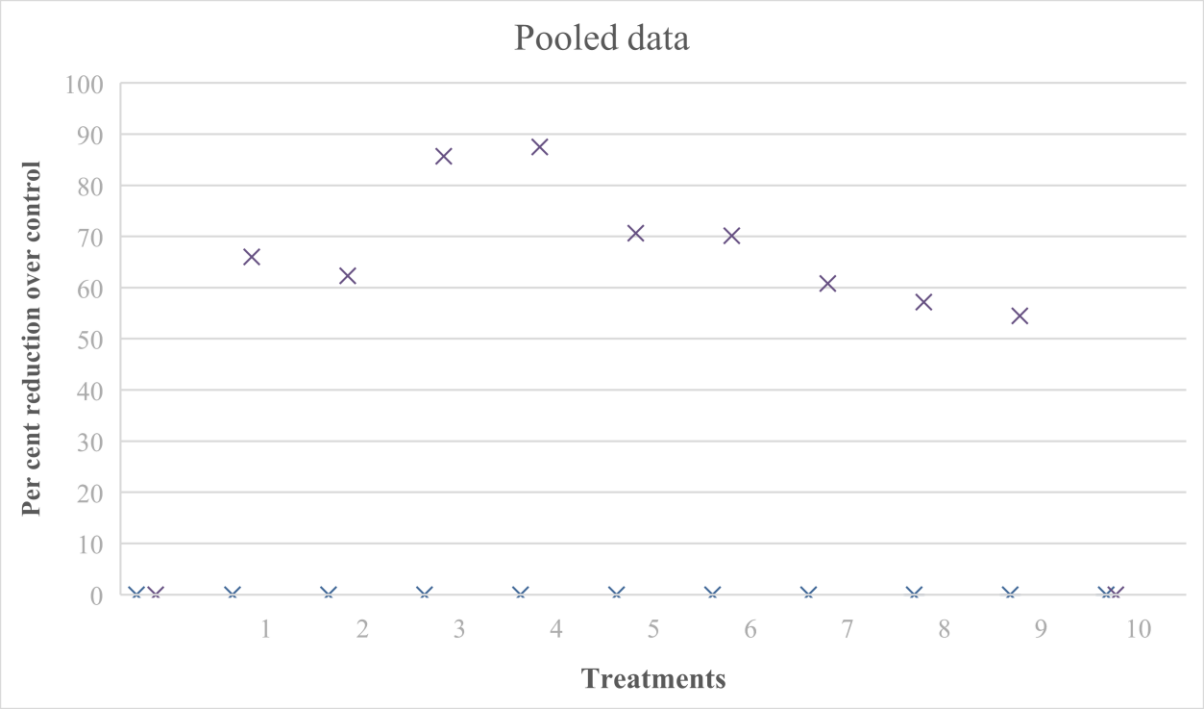

Fig. 1. Bio-efficacy of novel fungicides on Mango Powdery mildew (Pooled data)

Table 3. Bio-efficacy of novel fungicides on Mango Powdery mildew (First season)

Sl. No	Treatments	Dosage/L (g/ml)	PDI at different intervals (Days)					Reduction of PDI over control (%)
			Before First spray	15 days after first spray	30 days after first spray	15 days after second spray	30 days after second spray	
1	Carbendazim 12%+ Mancozeb 63% WP	2.0	15.00 (3.94)	8.33 (2.97)	10.33 (3.29)	7.33 (2.80)	8.33 (2.97)	64.67
2	Sulphur 80%WP (first spray) Carbendazim 50% WP (second spray)	3.0 1.0	13.00 (3.67)	10.67 (3.34)	11.00 (3.39)	8.33 (2.97)	9.67 (3.19)	59.33
3	Tebuconazole 50% + Trifloxystrobin 25% WG	0.5	13.0 (3.67)	6.67 (2.68)	8.00 (2.92)	3.00 (1.87)	3.67 (2.04)	84.67
4	Tebuconazole 50% + Trifloxystrobin 25% WG	0.75	14 (3.81)	4.27 (2.18)	6.00 (2.55)	2.00 (1.58)	3.00 (1.87)	87.33
5	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.15	15 (3.94)	9.33 (3.14)	10.67 (3.34)	8.33 (2.97)	7.33 (2.80)	69.03
6	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.2	14.00 (3.81)	7.33 (2.80)	9.67 (3.19)	5.0 (2.35)	5.67 (2.48)	76.00
7	Hexaconazole 5% EC	1.0	14.00 (3.81)	11.67 (3.49)	11.33 (3.44)	9.67 (3.19)	10.00 (3.24)	57.67
8	Carbendazim 50% WP	1.0	15.00 (3.94)	12.00 (3.54)	12.67 (3.63)	10.33 (3.29)	11.00 (3.39)	53.67
9	Sulphur 80% WP	3.0	15.00 (3.94)	13.67 (3.76)	13.33 (3.72)	11.33 (3.44)	11.67 (3.49)	50.33
10	Untreated control	-	14.00 (3.81)	17.00 (4.18)	19.66 (4.49)	21.33 (4.67)	23.67 (4.92)	-
	SEm ±		0.09	0.05	0.05	0.06	0.07	-
	CD (5%)		0.27	0.14	0.17	0.19	0.21	-

Note – PDI - Per cent Disease Index

Table 4. Bio-efficacy of novel fungicides on Mango Powdery mildew (Second season)

Sl. No	Chemical treatments	Dosage/L (g/ml)	PDI at different intervals (Days)					Reduction of PDI over control (%)
			Before first spray	15 days after first spray	30 days after first spray	15days after second spray	30days after second spray	
1	Carbendazim 12%+ Mancozeb 63% WP	2.0	13.66 (3.76)	9.66 (3.19)	11.33 (3.44)	9.00 (3.08)	9.66 (3.19)	67.33
2	Sulphur 80%WP (first spray) Carbendazim 50% WP (second spray)	3.0 1.0	14.00 (3.81)	10.33 (3.29)	11.00 (3.39)	9.00 (3.08)	10.33 (3.29)	65.33
3	Tebuconazole 50% + Trifloxystrobin 25% WG	0.5	14.00 (3.81)	7.00 (2.74)	8.33 (2.97)	3.66 (2.04)	4.00 (2.12)	86.67
4	Tebuconazole 50% + Trifloxystrobin 25% WG	0.75	15.00 (3.94)	5.66 (2.48)	6.33 (2.61)	2.33 (1.68)	3.66 (2.04)	87.66
5	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.15	14.00 (3.81)	9.66 (3.19)	10.33 (3.29)	7.00 (2.74)	8.33 (2.97)	71.91
6	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.2	15.33 (3.98)	8.66 (3.03)	10.00 (3.24)	6.33 (2.61)	7.00 (2.74)	76.33
7	Hexaconazole 5% EC	1.0	15.00 (3.94)	12.00 (3.54)	12.00 (3.54)	10.33 (3.29)	10.66 (3.34)	64.00
8	Carbendazim 50% WP	1.0	15.66 (4.02)	11.66 (3.49)	12.33 (3.58)	11.00 (3.39)	11.66 (3.49)	60.67
9	Sulphur 80%WP	3.0	14.66 (3.89)	13.00 (3.67)	13.33 (3.72)	12.00 (3.54)	12.33 (3.58)	58.67
10	Untreated control	-	16.00 (4.06)	19.00 (4.42)	21.66 (4.71)	25.33 (5.08)	29.66 (5.49)	-
	Sem $\pm$		0.04	0.08	0.08	0.08	0.09	
	CD (5%)		0.11	0.26	0.24	0.25	0.28	

Note – PDI - Per cent Disease Index

Table 5. Bio-efficacy of novel fungicides on Mango Powdery mildew (pooled data of two seasons)

Sl. No	Chemical treatments	Dosage/L (g/ml)	PDI at different intervals (Days)					Reduction of PDI over control (%)
			Before First spray	15 days after first spray	30 days after first spray	15days after second spray	30days after second spray	
1	Carbendazim 12%+ Mancozeb 63% WP	2.0	14.33 (3.85)	8.99 (3.08)	10.83 (3.37)	8.17 (2.94)	8.99 (3.08)	66.00
2	Sulphur 80%WP (first spray)	3.0	13.50	10.50	11.0	8.67	10.0	62.33
	Carbendazim 50% WP (second spray)	1.0	(3.74)	(3.32)	(3.39)	(3.03)	(3.24)	
3	Tebuconazole 50% + Trifloxystrobin 25% WG	0.5	13.50 (3.74)	6.84 (2.71)	8.17 (2.94)	3.33 (1.96)	3.84 (2.08)	85.67
4	Tebuconazole 50% + Trifloxystrobin 25% WG	0.75	14.50 (3.87)	4.97 (2.34)	6.17 (2.58)	2.17 (1.63)	3.33 (1.96)	87.51
5	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.15	14.50 (3.87)	9.50 (3.16)	10.50 (3.32)	7.67 (2.86)	7.83 (2.89)	70.63
6	Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC	0.2	14.67 (3.89)	7.99 (2.91)	9.84 (3.21)	5.67 (2.48)	6.34 (2.61)	76.16
7	Hexaconazole 5% EC	1.0	14.5 (3.87)	11.83 (3.51)	11.66 (3.49)	10.0 (3.24)	10.33 (3.29)	60.83
8	Carbendazim 50% WP	1.0	15.33 (3.98)	11.83 (3.51)	12.50 (3.61)	10.66 (3.34)	11.33 (3.44)	57.17
9	Sulphur 80%WP	3.0	14.83 (3.92)	13.33 (3.72)	13.33 (3.72)	11.66 (3.49)	12.0 (3.54)	54.5
10	Untreated control	-	15.00 (3.94)	18.00 (4.30)	20.66 (4.60)	23.33 (4.88)	26.66 (5.21)	-
	Sem $\pm$		0.06	0.07	0.07	0.07	0.08	-
	CD (5%)		0.19	0.20	0.20	0.22	0.24	-

Note – PDI - Per cent Disease Index

examined, Tebuconazole 50% + Trifloxystrobin 25% WG demonstrated superior disease control. It might be due to this fungicide is more efficient in reducing inoculum and new infections, both of which act as reservoirs for the disease's secondary spread. Based on this study Tebuconazole 50% + Trifloxystrobin 25% WG can be exploited for the better management of mango powdery mildew in order to maximize profit to the mango growers.

4. CONCLUSION

In conclusion, the study demonstrated that Tebuconazole 50% + Trifloxystrobin 25% WG, at both 0.75 g/l and 0.5 g/l, was the most effective fungicide for controlling mango powdery mildew, with disease reduction rates of 87.51% and 85.67% over the control. The combination of Fluxapyroxad 250 g/l + Pyraclostrobin 250 g/l SC also showed significant efficacy. The use of combi fungicides proved superior in managing the disease compared to solo fungicides, likely due to their broader spectrum of action and reduced risk of resistance development. Thus, Tebuconazole + Trifloxystrobin is recommended for effective management of mango powdery mildew to enhance yield and profitability for mango growers.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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https://www.sdiarticle5.com/review-history/121429