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Evaluation of fungicides against *Phytophthora palmivora in vitro*

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Abstract
Foot rot is one of the ruinous disease in papaya which leads to the complete failure of crop. *Phytophthora palmivora* is one of the causal agent of foot rot disease. For its effective management, five chemicals *viz*., Dimethomorph 9% + Mancozeb 60% WP, Fosetyl- AL 80 WP, Metalaxyl 4% + Mancozeb 64% WP, Copper oxy chloride 50% WP and Fenamidone 10% + Mancozeb 50%WG were evaluated at different concentrations against the pathogen *in vitro*. Among all the chemicals tested, Metalaxyl 4% + Mancozeb 64% WP and Fenamidone 10% + Mancozeb 50%WG was proven as best in controlling the pathogen with 100 per cent inhibition at all the tested concentrations followed by Copper oxychloride 50% WP with 98.88% inhibition at 0.3% concentration and 98.70% inhibition at 0.2% concentration respectively. The lowest per cent inhibition (2.22%) was seen in Dimethomorph 9% + Mancozeb 60% WP at 0.1% concentration.

Keywords: Chemicals, percent inhibition

Introduction
Papaya (*Carica papaya* L.) is one amongst the foremost important commercial fruit crops cultivated in tropical and subtropical regions of the world. It is believed that papaya is originated from the Caribbean coast of Central America, starting from Argentina to Chile to southern Mexico through natural hybridization between *Carica peltata* and another wild species. Papaya is successfully cultivated in India with an area of 0.15 mha with a production of 5.95 mMT and productivity of 40.42 MT/ha (NHB, 2021-22). Andhra Pradesh is the largest producer of papaya in the country accounting 26.17 percent, with the production of 1.50 mMT from an area of 0.02 mha having the productivity of 80 t/ha. (NHB, 2021-22). In Andhra Pradesh it is mainly cultivated in Kadapa, Ananthapur, Kurnool and Chittoor districts. The commercial papaya production has been hampered worldwide because of high susceptibility of the crop to varied fungal, viral and bacterial diseases. Important diseases in the field and storage are powdery mildew, anthracnose, *Phytophthora* root rot, black spot disease, papaya ring spot, papaya leaf curl and papaya mosaic virus. Among various diseases, foot rot is reported as the most serious and important disease in papaya (Mora & Morales, 1980; Guadalupe, 1981) [1]. This ends up in complete failure of the crop. The incidence of foot rot disease principally occurs in rainy season and also in heavy, excessively wet and poorly drained soils and the severity depends upon humidity, intensity of rainfall coupled with temperature. The damage is often observed within the roots, collar, and stem region of the plant. The disease appears with greatest frequency as water-soaked patches on the stem near the ground level. These patches enlarge rapidly, girdle the stem and causes the tissues to rot resulting in honey comb like appearance. The chemical control is one of the best methods in controlling the disease effectively. So, the present investigation was carried out to assess the potency of fungicides against *Phytopthora palmivora in vitro*.

Materials and Methods
Preparation of pure culture of pathogen
Initially, the root samples were washed thoroughly under tap water to remove the adhered soil. Further, they were surface sterilized with 70% ethanol for 10-20 sec followed by washing in three changes of sterile distilled water each 1 min successively and blotted them in between sterile filter papers and placed aseptically on Potato dextrose agar. Further, it was incubated at 25±2 °C. After 2-3 days of incubation, the single hyphal tips of fungus grown from the diseased piece were transferred to sterilized petriplate containing PDA medium separately under aseptic conditions.

The pure culture of the pathogen was maintained and stored in incubator at 25± 2 °C for further studies.

Poison food technique

The fungicides were evaluated against the test pathogen by employing poisoned food technique. Initially, fungicidal solutions of different concentrations were prepared in 100 ml conical flasks and media was poisoned by dissolving these solutions in warm media at 50 °C and vortexed well before pouring. Aseptically, the PDA medium amended with the test fungicides were poured (20 ml / plate) into 90 mm petri plates and then allowed to solidify at room temperature. For each of the test fungicide at its concentrations, three replications were maintained. After solidification of the PDA medium, 5mm culture disc acquired from actively growing 7 days old pure culture of pathogen was inoculated aseptically by placing it in the centre and incubated in an inverted position at 25 ± 2 °C. Petri plates with plain PDA (without any fungicide) were inoculated with disc of pathogen and perpetuated as control. Radial growth of the pathogen was recorded at an interval of 24 hours and continued till control plates were fully covered with mycelial growth of the test pathogen. Per cent inhibition of the test pathogen with the test fungicides over control was calculated by using the following formula (Vincent, 1927) [4].

$$PI = \frac{C-T}{C} \times 100$$

Where
PI = Per cent Inhibition
C = Radial growth of control plate (mm)
T = Radial growth of pathogen treated plate (mm)

Table 1: List of fungicides evaluated against *Phytophthora palmivora*

S. No.	Chemical name	Concentration (%)
1	Dimethomorph 9% + Mancozeb 60% WP	0.1, 0.2 and 0.3
2	Fosetyl- AL 80 WP	0.05, 0.1 and 0.2
3	Metalaxyl 4%+Mancozeb 64% WP	0.05, 0.1 and 0.2
4	Copper oxy chloride 50% WP	0.1, 0.2 and 0.3
5.	Fenamidone 10% +Mancozeb 50%WG	0.5, 1.0 and 1.25

The Per cent inhibition data was analysed statistically.

Statistical analysis

Completely randomized design (CRD) was used for laboratory experiments in the present investigation. The percentage, mean and standard deviation were calculated to understand the effect of each treatment on various parameters to meet the objectives of the study.

Results and Discussion

Five fungicides were assessed for their efficacy against the *Phytophthora palmivora* by poisoned food technique (Plate-1). Among all the fungicides tested, Metalaxyl 4% + Mancozeb 64% WP and Fenamidone 10% + Mancozeb 50% WG showed 100 per cent inhibition at all the three concentrations *viz*., 0.05%, 0.1%, 0.2% and 0.5%, 1.0%, 1.25% respectively followed by copper oxy chloride 50% WP with 98.88% inhibition at 0.3% concentration and 98.70% inhibition at 0.2% concentration. Fosetyl- AL 80 WP showed 88.88 per cent inhibition at 0.2% concentration. Copper oxy chloride 50% WP and Fosetyl- AL 80 WP showed similar per cent inhibition (83.33%) at 0.1% concentration. The lowest per cent inhibition was seen with Dimethomorph 9% + Mancozeb 60%WP at 0.3% and 0.2% concentrations and Fosetyl- AL 80 WP at 0.05% concentration is 43.88%, 19.92% and 10.55% respectively. The least per cent inhibition was 2.22% with Dimethomorph 9% + Mancozeb 60% WP at 0.1% concentration. (Table-2, Figure-1)

The results of the experiment were in agreement with writings of Tey and wood (1982) [5], Amrinder *et al*. (2009) [6] and Moosa *et al*. (2016) [7] that the combination of Metalaxyl + Mancozeb showed the 100% inhibition of the *Phytophthora* sp at all tested concentrations. Jayalakshmi *et al*. (2017) [9] reported that Fenamidone + Mancozeb and Metalaxyl + Mancozeb showed 100 percent reduction of mycelial growth at 0.2% concentration. Thomas and naik (2017) [8] reported that Fenamidone + Mancozeb and Metalaxyl + Mancozeb showed increased per cent inhibition as the concentration increased. Jagatap *et al*. (2012) also reported the similar findings.

Table 2: Evaluation of fungicides against *Phytophthora palmivora in vitro*

S. No.	Treatment	Concentrations (%)	Mean radial growth of pathogen (mm)	Per cent Inhibition
1	Dimethamorph 9% + Mancozeb 60% WP	0.1	88.00	2.22 (8.57)**
		0.2	72.06	19.92 (26.51)
		0.3	50.50	43.88 (41.48)
2	Fosetyl- AL 80 WP	0.05	80.50	10.55 (18.95)
		0.1	15.00	83.33 (65.90)
		0.2	10.00	88.88 (70.52)
3	Metalaxyl 4%+Mancozeb 64% WP	0.05	0.00	100.00 (90.00)
		0.1	0.00	100.00 (90.00)
		0.2	0.00	100.00 (90.00)
4	Copper oxy chloride 50% WP	0.1	15.00	83.33 (65.90)
		0.2	1.16	98.70 (83.45)
		0.3	1.00	98.88 (83.93)
5	Fenamidone 10% +Mancozeb 50%WG	0.5	0.00	100.00 (90.00)
		1.0	0.00	100.00 (90.00)
		1.25	0.00	100.00 (90.00)

6	Control	-	90.00	0.00 (0.00)
SE m±		-	-	0.051
C.D. at 5%		-	-	0.377

**Figures in parenthesis are arc sine transformed values.

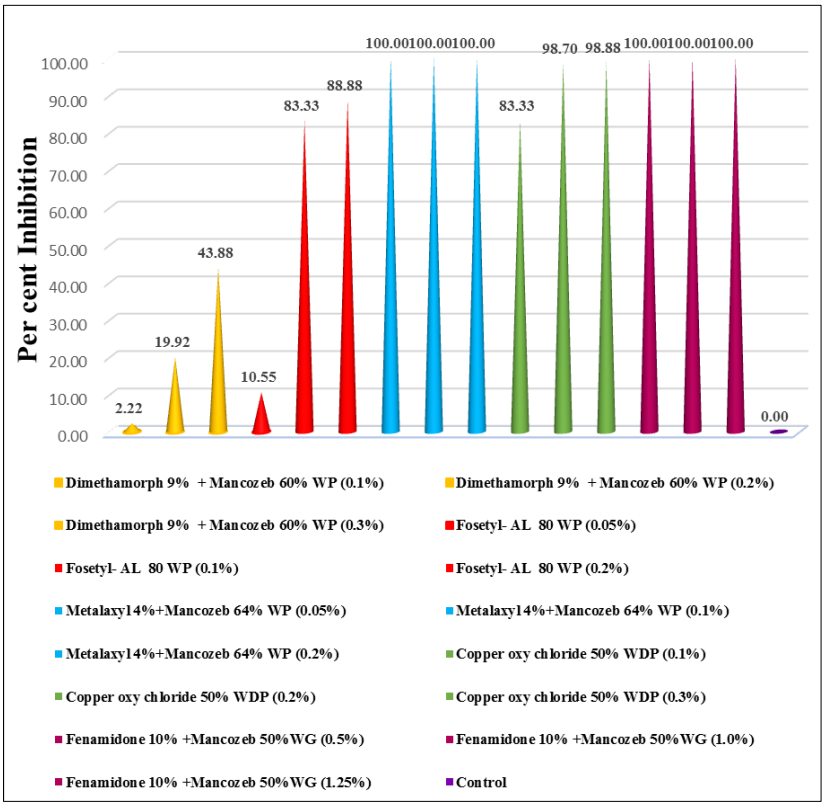

Fig 1: Per cent inhibition of the *P. palmivora* with fungicides

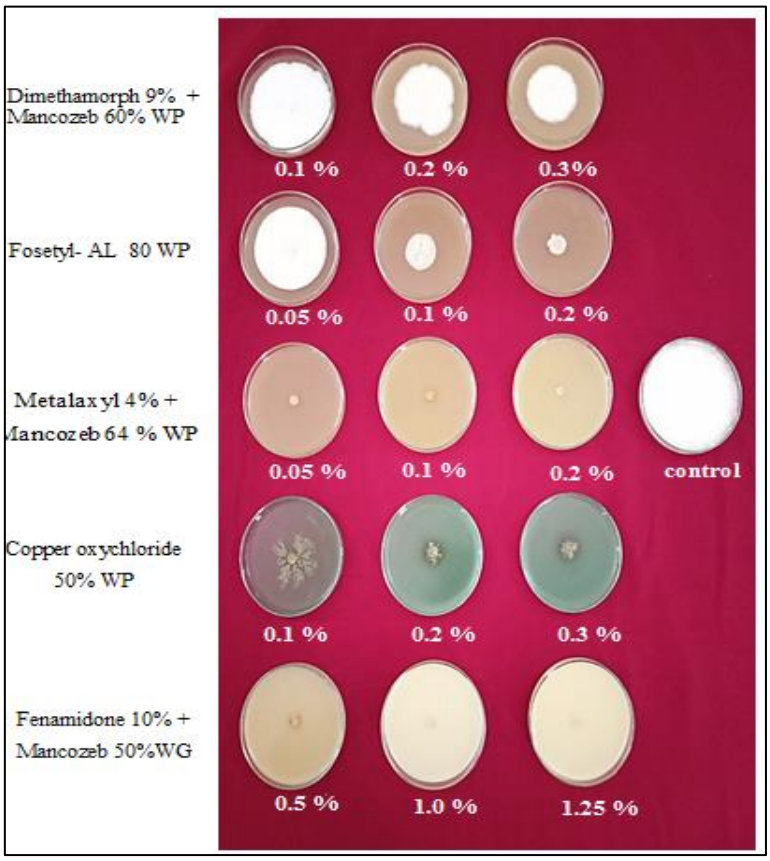

Plate 1: *Invitro* evaluation of fungicides against *Phytophthora palmivora*

Conclusion

Fungicides play a major role in controlling the diseases effectively. Among all the fungicides tested Metalaxyl 4% + Mancozeb 64% WP and Fenamidone 10% + Mancozeb 50% WG at lowest concentration *viz*.,0.05% and 0.5% respectively inhibited the growth of the pathogen.

Acknowledgement

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