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Symptomatology and evaluation of fungicides for management of black spot disease in Apple Ber

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ABSTRACT

The experiment was carried out during three consecutive years (2023–24, 2024–25 and 2025–26) on Apple ber. Among the various foliar pathogens affecting ber, the black spot caused by a fungus *Isariopsis personata* var. *zizyphi* producing regular black coloured fringed spots on the lower leaf surface. Spraying of Tebuconazole 50% + Trifloxystrobin 25% (WG) (0.1%) immediately after the appearance of the symptoms found most effective by reducing the leaf spot disease from 46.94 PDI to 17.20 PDI with yield of 64.39 kg/ tree.

Introduction

Ber (*Zizyphus mauritiana* Lamk.) commonly referred as Indian Jujube, Indian date and Chinese apple throughout the world play a major role in attaining the food security. Ber and apple ber are the highly recommended crops for the rainfed, arid and semi-arid regions which support the regular income of the small and marginal farmers all over India. Ber crop could be cultivated well in the marginal land with poor soil fertility and give good yield with less input (Mareeswari *et al*., 2012). This fruit crop required minimum inputs and highly recommended for Horti–Agri–Pastoral System of cultivation.

Though it is a highly remunerative crop, it's production is interrupted by many foliar diseases like, powdery mildew, rust, Alternaria, Cercospora, Phoma and black leaf spot (Kumar *et al.*, 2017). Among these, black spot fungus caused by the fungus *Isariopsis personata* var. *zizyphi* produces some black powdery growth on the lower surface of leaves. It reduced the photosynthetic area which resulted in yield reduction. In advance cases the pathogen causes necrotic patches and rotting on fruits. In severe cases the leaf spot incidence ranged up to 55% disease index. It is the most devastating disease in ber cultivation during monsoon season and causing economic losses.

Material and Methods

The experiment was carried out in the B2 block located of RRS, Aruppukottai, Tamil Nadu (Latitude 9.945º and Longitude 77.92º) over three consecutive years (2023–24, 2024–25 and 2025–26). Experiment was carried out on eight year old plants of Apple ber in randomized block design with seven treatments replicated thrice. Two trees are being maintained for each replication planted at 8 m x 8 m spacing. The treatments included Tebuconazole 50% + Trifloxystrobin 25% (WG) at 0.1% (T_1), Hexaconazole 5% EC at 0.1% (T_2), *Bacillus subtilis* (Bbv 57) at 0.5% (T_3), Azadirachtin (Neem oil, 1500 ppm) at 0.15% (T_4), garlic extract at 10% (T_5), Chlorothalonil at 0.2% (T_6) and control (T_7).

Normally the disease occurred during the second week of December every year. First spray was made

immediately after the occurrence of the disease and second spray at 15 days intervals. Per cent Disease Index (PDI) is calculated on 15th day after the second spray. Fruits were harvested at physiological maturity. Average fruit yield per tree was recorded. In each year the spray was scheduled during the month of December during which the disease occurred. The pooled mean was derived and statistically analyzed.

Four branches, one from each side of the tree were selected. Ten leaves from each branch were examined. The disease severity was assessed using a rating scale ranging from 0 to 5 based on the extent of leaf area affected. A grade of 0 indicated no symptoms on the leaf. Grade 1 corresponded to 1–10% of the leaf area covered, while grade 2 represented 11–25% coverage. Grade 3 was assigned when 26–50% of the leaf area was affected, and grade 4 indicated 51–75% coverage. A grade of 5 denoted severe infection, with 76–100% of the leaf area covered. PDI was calculated as the formula given by Mckinney (1923).

$$\text{PDI} = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves x Maximum grade in the scale}} \times 100$$

$$\text{PROC} = \frac{\text{PDI in control plot} - \text{PDI in treatment plot}}{\text{PDI in control plot}} \times 100$$

Results and Discussion

Symptoms and morphological confirmation of the pathogen

The pathogen produces round and blackish, fringed spots on the lower surface of the leaves (Fig. 1). These blackish growth merge with each other and lead to the reduction of chlorophyll content and finally affects the photosynthetic efficiency of the crop. The occurrence of the disease has been noticed in the ber orchards of RRS Aruppukottai during the past 15 years. It belongs to the Phylum: Ascomycota, Class: Dothidiomycetes and Order: Capnodiales Taxonomically it is highly related with sooty mould fungus (*Capnodium* spp.). While observing under microscope under the 40 X magnification, the mycelia are dark brown colored. Conidia are dark brown, septate (3-4 septations) and spindle shaped, broad in the middle portion and tapering towards the end (Fig. 2).

The disease was observed during the late December month of every monsoon season. Gupta *et. al.* (1977) recorded the occurrence of *Isariospsis* leaf spot for the first time from Haryana. Verma and Kumar (1992) discovered that cloudy weather with medium temperature during October-November is favourable for the disease development. Black spots which are sooty, tuft, circular to irregular in shape developed on the under surface of the leaves. In advance cases, the blackish mycelia covered the entire leaf surface and showed bleaching of chlorophyll and discolouration in turn resulted in yield loss.

Saha *et al.* (2022) reported that black spot disease affected approximately 70–80% of the leaf area. While observing under 40 X, magnification the conidiophores were long, multiseptate and dark brown. Conidia were light brown, multicellular, broader at the middle, tapering towards the end, bent and measuring 17-42 x 8.5-10.2 µm in size. This morphological observation is in conformity with our findings and assured that the pathogen is *Isariopsis personata* var *zizyphi* irrespective of the locations under study.

Fig. 1. Black, round and fringed spot of black spot disease

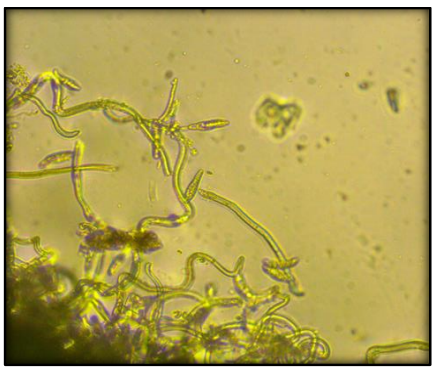

Fig. 2. Brownish, septate mycelia of *I. personata var. zizyph*i under 40 X magnification

Evaluation of fungicides, botanicals and bio control agents against black spot

The results presented in Table 1 indicated significant differences among treatments in reducing disease intensity (PDI), increasing percent disease control (PDC) and improving yield over the three consecutive years under field conditions. Among all treatments, Tebuconazole 50% + Trifloxystrobin 25% WG @ 0.1% consistently recorded the lowest PDI (26.11,

17.00 and 8.50) and the highest disease control (51.04%, 69.10% and 73.84%) during 2023–24, 2024–25 and 2025–26, respectively. It also produced the highest pooled yield (64.43 kg/ tree), making it the most effective treatment.

Chlorothalonil @ 0.2% was the next best treatment, showing comparatively low PDI and high disease control across all years, with a pooled yield of 62.16 kg/ tree. Neem oil @ 0.15% and Hexaconazole 5% EC showed moderate effectiveness, with intermediate PDI reduction and yield improvement.

Biological and botanical treatments such as *Bacillus subtilis* @ 0.5%, Garlic extract @ 10% and Neem oil @ 0.15% were less effective compared to chemical fungicides, recording higher PDI and lower yields.

Table 1. Effect of different fungicide treatments on the incidence of black spot

Treatments	2023-24			2024-25			2025-26			Pooled mean		
	PDI	PROC	Yield (kg/ tree)	PDI	PROC	Yield (kg/ tree)	PDI	PROC	Yield (kg/ tree)	PDI	PROC	Yield (kg/ tree)
T_1: Tebuconazole 50% + Trifloxystrobin 25% (WG) @ 0.1%	26.11^{a}	51.04	63.28	17.00^{a}	69.1	65.50^{a}	8.50^{a}	73.84	64.5^{a}	17.20^{a}	64.66	64.43^{a}
T_2: Hexaconazole 5% EC @ 0.1%	29.85^{bc}	44.03	58.38	27.50^{c}	50.91	60.70^{b}	13.75^{b}	57.69	59.31^{c}	23.70^{ab}	50.88	59.46^{ab}
T_3: *Bacillus subtilis* (Bbv 57) @ 0.5%	33.39^{d}	37.39	47.43	44.00^{e}	20.00	51.25^{d}	20.15^{c}	38.00	46.25^{e}	32.51^{c}	31.80	48.31^{cd}
T_4: Neem oil (Azadirachtin) @ 5%	28.17^{ab}	47.18	55.35	36.00^{d}	34.55	57.50^{c}	18.25^{c}	43.85	49.48^{d}	27.47^{bc}	41.86	54.11^{bc}
T_5: Garlic extract @ 10%	32.23^{cd}	39.40	47.77	45.50^{e}	18.18	49.50^{d}	24.35^{d}	25.08	38.34^{f}	34.03^{c}	27.55	45.20^{d}
T_6: Chlorothalonil @ 0.2%	27.97^{ab}	47.55	60.32^{ab}	24.00^{b}	56.36	63.90^{a}	10.00^{a}	69.23	62.25^{b}	20.66^{ab}	57.71	62.16^{a}
T_7: Control	53.33^{e}	-	42.43^{d}	55.00^{f}	-	40.00^{e}	32.50^{e}	-	27.57^{g}	46.94^{d}	-	36.00^{e}
CD (0.05)	2.54		5.38	1.63		1.77	1.55		0.55	7.99		5.99
SEd	1.16		2.47	0.75		0.89	3.38		1.21	3.67		2.75
CV (%)	4.32		5.64	2.53		1.79	10.44		1.37	15.53		6.375

Overall, the pooled data clearly demonstrated spraying of Tebuconazole 50 % + Trifloxystrobin 25 % (WG) performed well in the management of black spot disease of ber reducing the leaf spot from 46.94 to 17.20 percentage (pooled data) which was followed by Chlorothalonil (0.2%) (20.66 PDI) and Hexaconazole (0.1%) (23.70 PDI) compared to control (46.94 PDI). The above best performing fungicide recorded the highest yield (64.43 kg/ tree) compared to control (36 kg/ tree).

Kumar *et al*. (2003) also attempted to manage the black spot disease in the ber cultivar Gola. Spraying of Carbendazim 50 WP (0.1%) @ 10 litre solution per plant during the early November was found to be most effective in the management of the disease in turn showing 77.21% reduction over control (PDC) followed by Mancozeb (0.2%) (54.78 PDC) and neem powder, Nimuri (54.37 PDC). Kumar *et al.* (2017) concluded that spraying of Propiconazole @ (0.1%) immediately after the occurrence of the disease and at 15 days interval recorded 73% reduction over control and increased the yield from 40 kg/ tree to 88.80 kg/ tree of cv. Gola. Zhang *et al.* (2021) investigated the antifungal activity of the fungicide Propiconazole against the fungus *Penicillium digitatum*. They reported that it inhibits the fungal enzyme 14-α-demethylase (CYP51), a key component of the cytochrome P450–dependent pathway responsible for ergosterol synthesis, an essential sterol in the fungal cell membrane. Singh *et al*. (2024) recorded minimum disease intensity (14%) in the plots sprayed with Propiconazole 25 EC@ (0.1%) followed by Carbendazim @ (0.1%) and Copper oxychloride @ (0.3%) (26%) respectively. Likely, the trees sprayed

with Propiconazole recorded the maximum yield (63.83 kg/ tree) followed by Carbendazim (60.65 kg/ tree) compared to control (49.41 kg/ tree).

Conclusion

Ber black spot is a major disease causing significant yield losses in ber-growing regions of India, primarily by reducing the effective photosynthetic leaf area due to characteristic black fungal growth on the leaf surface. The present study clearly demonstrated that fungicidal treatments effectively manage the disease. Among the treatments, Tebuconazole 50% + Trifloxystrobin 25% (WG) proved most effective, recording a 64.66% reduction over control and the highest yield (64.43 kg/ tree). This was followed by Chlorothalonil (57.71% disease control) and Hexaconazole (50.88% disease control). Overall, the results highlight the superiority of combination fungicide in controlling ber black spot and improving productivity compared to untreated plants.

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Conflict of Interest

The authors of this paper do not have any conflict of interest.

Data Sharing

All relevant data are within the manuscript.

References

Gupta, J.H., Nath, R. and Srivastava, V. P. 1977. A new leaf spots disease of *Zizyphus mauritiana* Lamk. *Indian Phytopathology*, 30: 271-272.

Kumar, P., Singh, H. K. and R.P. Saxena. 2003. Ber germplasm screening and management of black leaf spot disease under Eastern UP conditions. *Journal of Applied Horticulture,* 5.1: 43-44.

Kumar, S., Kumar, P., Singh, D., Mishra, P. and Singh, S. 2017. Management of isariopsis leaf spot of ber (*Zizyphus mauritiana* Lamk.) through fungicides. *Plant Archives*, 17 (1): 199-200.

Mareeswari, P, Geethalakshmi, I., Senthil, A. and Rajaram, V. 2012. Efficacy of fungicides against black leaf spot of ber caused by *Isariopsis indica*. *Indian Journal of Arid Horticulture*, 7(1-2): 74-75.

Mckinney, H.H. 1923. A new system of grading plant diseases. *Journal of Agricultural Research*, 26: 195- 218.

Saha, R., Rana, D., Murmu, S. and Misra, D.K. 2022. Exploration of different important diseases of ber (*Zizyphus mauritiana*) in West Bengal. *Environmental Ecology*, 40(2B): 682-692.

Singh, N., Chauhan, R.S., Yadav, N.K., Buswal, M.K. and Singh, B. 2024. Efficacy of fungicides and botanicals against black leaf spot disease of ber (*Zizyphus mauritiana* LAMK.) under field conditions. *Plant Archives,* 24(2). https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.098

Verma, K.S. and S. Kumar. 1992. Pathogencity and histopathology of *Isariopsis indica* var. *zizyphi* on ber. Indian Phytopathology Proc. of 43rd and 44th Annual Meeting Abstract of Papers, 44.

Zhang, J., Zhang, B., Zhu, F. and Fu, Y. 2021. Baseline sensitivity and fungicidal action of propiconazole against *Penicillium digitatum*. *Pesticide Biochemistry and Physiology*, 172: 104752. https://doi.org/10.1016/j.pestbp.2020.104752.