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Management of *Alternaria* leaf spot [*Alternaria alternata* (Fr.) Keissler] of Ber (*Zizyphus mauritiana* Lamk.)

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Abstract

Field experiment was conducted during the year 2019-2020 on Cultivar 'Gola' to assess the efficacy of different fungicides for management of leaf spot of ber caused by *Alternaria alternata*. The crop was regularly monitored for the first appearance of disease. The minimum per cent disease intensity (14.00%) maximum disease control (76.67%) and maximum fruit yield (123.62q/ha) was recorded in Tebuconazole 25% + Trifloxistrobin 50% WG followed by Azoxystrobin 18.2% + Difeconazole 11.4% SC (16.80%, 72.50%, 112.65q/ha); Carbendazim 12% + Mancozeb 63% WP (20.75%, 65.42%, 109.66q/ha); Tebuconazole 25 EC (21.90%, 63.50%, 106.80q/ha), Propiconazole 25 EC (23.30%, 61.17%, 101.20q/ha), respectively after third spray. The Cost of production, gross income, net return and C: B ratio was maximum in Tebuconazole 25% + Trifloxystrobin 50% WG (Rs. 494480, Rs. 86611 ha⁻¹, Rs. 407869, 1:4.70), followed by Azoxystrobin 18.2% + Difeconazole 11.4% SC (Rs. 450600, 86111 ha⁻¹, Rs. 364489, 1:4.23), respectively.

Keywords: *Alternaria alternata*, *Zizyphus mauritiana* Lamk., Trifloxistrobin

Introduction

Indian jujube or ber [*Zizyphus mauritiana* (Lamk.)] is one of the most common fruit; indigenous to an area joined from India to China belongs to family Rhamnaceae. Ber is rich in the mineral especially phosphorous, calcium, and iron. It is also known as Chinese date or Chinese fig or plum and commonly considered as poor man's fruit. It is popularly called the king of arid zone fruit (Singh, *et al.* 1983; Pareek, 1983; Yamadagni, 1985 and Shoba and Bharathi, 2007) [17, 11, 21, 15]. This fruit probably originated in India. It is reported to be grown in other countries like Iran, Syria, Australia, USA, France, and certain part of Italy, Spain, Africa, etc. Precisely, it is seen to grow under tropical and sub-tropical as well as Mediterranean region of the world.

India ranks second among ber growing countries in the world after China, occupying approximately 44,000 ha area and 425 metric tonnes production (2015-16). The major ber growing states in India are Punjab, Haryana, Uttar Pradesh, Rajasthan, Gujarat, Maharashtra and Andhra Pradesh. The per capita consumption of ber is lowest in India. In certain areas, it is substitute of mango and citrus cultivation with more profitable than growing of cereals.

In view of the gaining popularity, area under this fruit is being increased gradually day by day. In Uttar Pradesh, ber orchards are found in Varanasi, Aligarh, Ayodhya, Agra and Raebareli districts (Singh *et al.* 1973) [16]. The fruit is eaten raw or as pickles or used in beverages. It is quite nutritious fruit which is rich in the group of vitamins (Morton, 1987; Pareek and Dhaka, 2008; Pareek *et al.*, 2009) [10, 12, 13]. In India, the ripe fruits are mostly consumed raw, but are sometimes stewed ripe fruits are preserved by sun drying and a powder is prepared for out-of-season purposes.

Several species of *Zizyphus* can endure extreme stress caused by drought, salinity and in some cases water logging. Production of ber is affected by a large number of biotic and abiotic stresses (Sydow and Sydow, 1907; Uppal *et al.*, 1935; Chona *et al.*, 1959; Rao, 1971; Gupta and Madaan, 1977) [19, 20, 4, 14, 5].

Ber is attacked by many of the biotic diseases caused by fungi and other pathogenic agents. Among these, *Alternaria alternata* is one of the most important, widespread and easily recognized disease. In Uttar Pradesh, *Alternaria* leaf spot of ber disease was minor but due to climatic changes, it was recorded moderate to severe form among the commercial cultivars during recent years. The present investigation aims ultimately to find out a management strategy for leaf spot of ber disease that suits agro-climatic conditions of the country. In the absence of stable resistant varieties, use of newly molecules of fungicides against *Alternaria*

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leaf spot of ber is the only recommendation for the management of leaf spot of ber.

Materials and Methods

The experiment was conducted with recommended agronomic practices during 2019-20 at Main Experimental Station, Horticulture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj (26°47' N, 82°12' E, 113 msl), Ayodhya (U.P.), India; on Cultivar 'Gola' to assess the efficacy of fungicides for management of leaf spot of ber caused by *Alternaria alternata*. The university come under sub-tropical zone, often subjected to extremes of weather *i.e.* very hot summers and cold winters.

Trials were conducted using a Randomized Block Design with 10 treatments including control in 3 replications and data were statistically analyzed. The spray of fungicides @ 10 liter/plant was scheduled just after initiation of the disease under field condition. Percentage data of disease index and disease control were transformed to arc sine before calculation.

Three spray of fungitoxicants *viz.*, Tebuconazole 25% + Trifloxistrobin 50% WG (0.05%), Azoxystrobin 18.2% + Difeconazole 11.4% (0.2%), Carbendazim 12% + Mancozeb 63% WP (0.2%), Propiconazole 25 EC (0.1%), Hexaconazole 5% EC (0.1%), Tebuconazole 25 EC (0.2%), Carbendazim 50% WP (0.1%), Propineb 70% WP (0.2%), Mancozeb 75% WP (0.2%) with a check having water spray (control) were tried under field conditions in order to determine their effectiveness in reducing the disease severity and improving the yield/fruit weight and benefit cost (B:C) ratio of ber fruits were calculated. Spraying was done at 15 days intervals, starting from first appearance of the disease symptoms. Observations were recorded on disease incidence/ intensity and yield (kg/ha). The observations in respect of disease intensity on leaves were recorded after 15 days after each spray. Hundred leaves (25 from each side of tree) were observed following 0-5 grade scale of Mckinney (1923) [8] as given in table-1.

Table 1: Scale for disease intensity

Grade/ Numerical scale	Description
0	No infection
1	0.1-5% area covered with the pathogen
2	5.1-20% area covered with the pathogen
3	20.1-50% area covered with the pathogen
4	50.1-75% area covered with the pathogen
5	>75.1% area covered with the pathogen

The yield data were recorded at the time of harvesting of fruits. The fruits of a tree were harvested at 4 stages according to maturity of the fruits time to time and weighed simultaneously. The total yield of a tree was calculated by adding the weight of fruits harvested at 4 phases of maturity and yield data was calculated q/ha.

The per cent disease index (PDI) and per cent disease control (PDC) were calculated by using following formula.

$$PDI = \frac{\text{Sum of all numerical ratings}}{\text{Total number of leaves examined} \times \text{Highest rating}} \times 100$$

$$PDC = \frac{\text{Per cent disease in control} - \text{Per cent disease in treatments}}{\text{Per cent disease in control}} \times 100$$

The benefit cost ratio was calculated by the help of table-2 clearly indicated that cost of production varies as variation in different treatments dividing the net income by respective cost of cultivation of different treatments using the following formula:

$$\text{Benefit cost ratio} = \frac{\text{Net income}}{\text{Total cost of cultivation}}$$

Table 2: Cost of inputs and outputs during 2019-20

S. No.	Particulars/Items	Rate (Rs.)
1.	Ploughing rates/ha (500x5)	2500
2.	Cost of hoeing plant basin/year/ha	3000
3.	Cost of irrigation/year/ha (1500x4)	6000
4.	Cost of labour use in irrigation/year/ha (15x174)	2610
5.	Cost of harvesting/year/ha (40x174)	6960
6.	Rental value/ha	3500
7.	Interest on working capital	2357
8.	Miscellaneous charges/ha	1000
9.	Urea/kg (Rs 6.50 x 318.03 kg)	2067
10.	DAP/kg (Rs 29 x 235.65 kg)	6815
11.	MOP/kg (Rs 16 x 308 kg)	4928
12.	FYM/kg (Rs 2.5 x 12480 kg)	31200
13.	Labour charge/day (one)	174
14.	Transport Charge	8700
14.	Tebuconazole 25% + Trifloxistrobin 50% WG (Rs 1200/100g x 400g)	4800
15.	Azoxystrobin 18.2% + Difeconazole 11.4% SC (Rs430/100 ml x1000 ml)	4300
16.	Carbendazim 12% + Mancozeb 63% WP (Rs1200/kg x 2.5 kg)	3000
17.	Propiconazole 25 EC (Rs 230/100ml x 1.25 L)	2875
18.	Hexaconazole 5% EC (Rs160/100 ml x 1.5 L)	2400
19.	Tebuconazole 25 EC (Rs200/100 ml x 1 L)	2000
20.	Carbendazim 50% WP (Rs 500/kg x 4.68 kg)	2340
21.	Propineb 70% WP (Rs 230/100g x800 g)	1840
22.	Mancozeb 75% WP (Rs 340/kg x 9.36 kg)	3120

Results and Discussion

It is well known that by using resistant variety is the best measure for management of disease. However, due to development of new strains against resistant varieties, it becomes difficult for farmers to manage the disease. Then chemicals become the last option to manage the disease and reduce losses caused by the pathogen. Therefore, the present study was carried out to find out effective fungicides against leaf spot of ber and results were given in table 3 and Fig. 1.

The results revealed that all the treatments reduced the disease severity and increase the per cent disease control in comparison to untreated plots. Results indicated that minimum disease intensity and maximum disease control was recorded in plants having the treatment with T₁ (Tebuconazole 25% + Trifloxistrobin 50% WG @ 0.05% (14.0, 76.67) which was found significantly superior among all treatments, followed by T₂ (16.50, 72.50), T₃ (20.75, 65.42), T₆ (21.90, 63.50), T₄ (23.30, 61.17), T₅ (24.40, 59.33), T₇ (24.40, 59.33), T₉ (25.60, 57.53) and T₈ (28.10, 53.17), respectively (Table-3). Maximum fruit yield (q/ha) was recorded with T₁ (Tebuconazole 25% + Trifloxistrobin 50% WG) (123.62) followed by T₂ (112.65), T₃ (109.66), T₆ (106.80), T₄ (101.20), T₅ (100.70), T₇ (99.67), T₉ (85.40) and T₈ (93.10). It is apparent from the spraying of different fungi-toxicants significantly reducing the disease incidence

providing yield increase with superiority of the fungicidal treatments over the control (table-3).

The present investigation was in similarly with Bala (2003) who achieved highest disease control (78.79%) against *Alternaria* leaf blight of ber with indofil M-45 followed by bordeaux mixture (75.17%). Similar findings were also recorded by Singh *et al.* (2016) [18] recorded effective management *Alternaria* leaf spot of ber disease. Out of seven treatments maximum per cent disease control (77.33) was recorded with difenconazole followed by propiconazole (75.00) and copper oxychloride (68.71) whereas neem oil (53.45) proved least effective and all the treatments enhance the yield, where as Anil *et al.* (2014) [11] were also evaluated different fungicides against *Alternaria* leaf blight of cotton. Fungicides viz., Hexaconazole (0.1%), Tebuconazole (0.1%), Propiconazole (0.1%), Difenconazole (0.1%), Penconazole (0.1%), Propineb (0.2%), Chlorothalonil (0.2%), Carbendazim (0.1%), Mancozeb (0.2%) were sprayed after

initiation of disease infection, three sprays were taken with 20 days interval and per cent disease index (PDI) was calculated after final spray. Propineb (0.2%) was effective in controlling disease with per cent disease control of 76.09 followed by Difenconazole @ 0.1% with 66.96 control (water spray). Kaur *et al.* (2020) [7] were also tested two sprays of azoxystrobin and mancozeb in mid-January and mid-February were effective in managing the disease.

Chaudhary *et al.* (2020) [13] tested some fungicides against *Alternaria* leaf spot of *Lehsua* and found that Tebuconazole + Trifloxistrobin had the minimum per cent disease intensity. While Mishra *et al.* (2012) [9] studied the efficacy of fungicides against *Alternaria* blight (caused by *Alternaria alternata*) of tomato. The fungicides significantly reduced the disease severity and increased the yield of tomato. Jayarajan and Cheema (1972) [6] confirmed that *Alternaria alternata* of ber effectively managed by weekly spray of either one of the fungicides like Difolatan, Dithane Z-78 or mancozeb 0.2%.

Table 3: Effect fungicides against *Alternaria* leaf spot of ber during 2019-20

S. No.	Treatments	Disease intensity (%)			Disease control (%) after III spray	Yield (q/ha)
		After I spray	After II spray	After III spray		
1.	T ₁ =Tebuconazole 25% + Trifloxistrobin 50% WG	2.30 (8.71)	6.10 (14.28)	14.00 (21.97)*	76.67 (61.78)*	123.62
2.	T ₂ =Azoxystrobin 18.2% + Difeconazole 11.4% SC	2.70 (9.45)	7.15 (15.48)	16.50 (23.96)	72.50 (58.39)	112.65
3.	T ₃ =Carbendazim 12% + Mancozeb 63% WP	3.40 (10.62)	9.00 (17.45)	20.75 (27.10)	65.42 (54.14)	109.66
4.	T ₄ =Propiconazole 25 EC	3.80 (11.24)	10.10 (18.50)	23.30 (28.82)	61.17 (51.47)	101.20
5.	T ₅ =Hexaconazole 5% EC	4.00 (11.53)	10.60 (18.97)	24.40 (29.56)	59.33 (50.39)	100.70
6.	T ₆ =Tebuconazole 25 EC	3.60 (10.93)	9.50 (17.95)	21.90 (27.90)	63.50 (52.97)	106.80
7.	T ₇ =Carbendazim 50% WP	4.00 (11.52)	12.20 (20.44)	24.40 (29.56)	59.33 (50.39)	99.67
8.	T ₈ =Propineb 70% WP	4.60 (12.36)	10.60 (18.99)	28.10 (32.00)	53.17 (46.82)	93.21
9.	T ₉ =Mancozeb 75% WP	4.20 (11.83)	11.10 (19.46)	25.60 (30.39)	57.33 (49.27)	85.54
10.	T ₁₀ =Control	11.00 (19.35)	27.00 (31.26)	60.00 (50.77)	00 (00)	80.30
	SEM±	0.36	0.77	0.93	2.63	5.46
	CD (P=0.05)	1.07	2.30	2.78	7.87	11.48

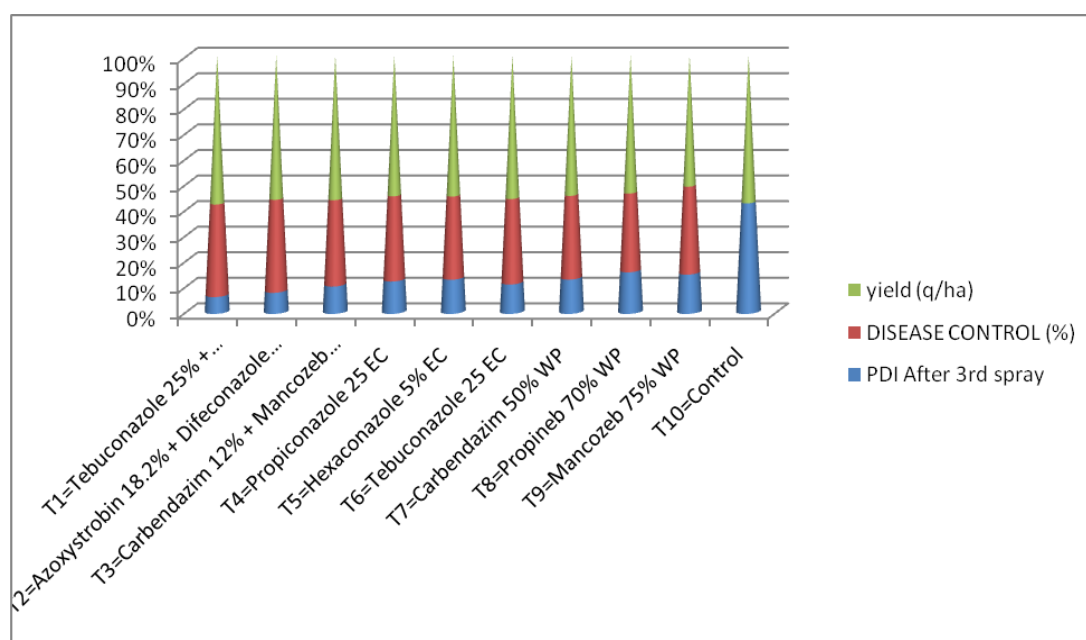


Fig 1: Effect of fungicides against *Alternaria* leaf spot of ber

Perusal of the data pertaining to Table-4 clearly showed that net profit per rupees invested was recorded maximum in T₁ (Tebuconazole 25% + Trifloxistrobin 50% WG) 1:4.70

followed by T₂ (1:4.23), T₃ (1:4.17), T₆ (1:4.09), T₄ (1:3.78), T₅ (1:3.78), T₇ (1:3.73), T₉ (1:3.49). The lowest C:B ratio was recorded in T₈ (Propineb 70% WP) 1:3.45.

Table 4: Economics of different fungicides treatments during 2019-20

S. No.	Treatments	Yield/ treatment (q/ha)	Gross income	Cost of production	Net returns	C:B Ratio
1.	T ₁ =Tebuconazole 25% + Trifloxistrobin 50% WG	123.62	494480	86611	407869	1:4.70
2.	T ₂ =Azoxystrobin 18.2% + Difeconazole 11.4% SC	112.65	450600	86111	364489	1:4.23
3.	T ₃ =Carbendazim 12% + Mancozeb 63% WP	109.66	438640	84811	353829	1:4.17
4.	T ₄ =Propiconazole 25 EC	101.20	404800	84686	320114	1:3.78
5.	T ₅ =Hexaconazole 5% EC	100.70	402800	84211	318589	1:3.78
6.	T ₆ =Tebuconazole 25 EC	106.80	427200	83811	343389	1:4.09
7.	T ₇ =Carbendazim 50% WP	99.67	398680	84151	314529	1:3.73
8.	T ₈ =Propineb 70% WP	93.21	372840	83651	289189	1:3.45
9.	T ₉ =Mancozeb 75% WP	85.54	282160	84931	297229	1:3.49

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