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Management of coffee black rot disease caused by *Koleroga noxia* Donk.

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Black rot disease of coffee is the second important disease of coffee. A field experiment was conducted in 2020 and 2021 two seasons to know the efficacy of different fungicides in managing the black rot disease of coffee. A total of eight fungicides were evaluated against the black rot disease of coffee. Results indicated that, out of eight fungicides tested, tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/L was found significantly superior in managing the disease. In both the seasons percent disease reduction was significantly higher in the plants sprayed with tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/L and was on par with the fungicide pyraclostrobin 13.3% + epoxyconazole 5% w/v SE @ 1ml/L followed by tebuconazole 25.6 SC @ 1ml/L when compared to other fungicides and unsprayed control plants. From the present findings, it can be concluded that the fungicides tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/L and pyraclostrobin 13.3% + epoxyconazole 5% w/v SE @ 1ml/L can be used for the effective management of the disease.

Keywords: Epoxyconazole, pyraclostrobin, tebuconazole, trifloxystrobin

INTRODUCTION

Coffee crop is the top foundation of the world's economy. It is one of the most preferred beverages of the world and is traded next to petroleum. Coffee cultivation is practiced in more than 80 countries across four continents. Including India, economy of countries like Central America, Colombia and Brazil, hangs on mainly through production of coffee to earn foreign currency and which in turn extends employment to number of people in the coffee sector. More than 100 million people are involved in the coffee industry and their socio-economic status is dependent on this agro-based industry. India is one of the leading countries in coffee production and stands among the ten top coffee growing countries of the world. Indian coffee is grown mostly in southern states under shaded conditions.

Coffea arabica L. (arabica coffee) and *Coffea canephora* Pierre ex Frohener (robusta coffee) are the two commercial exploited coffee species. Unlike other crops coffee is also influenced by many abiotic and biotic factors which hinders the coffee production. In India, coffee plant is affected by eight major diseases and are caused by fungal pathogens. Fortunately, so far diseases caused by bacteria, virus and phytoplasma on coffee are not reported from India (Daivasikamani *et al.* 2016).

Black rot or koleroga disease of coffee is placed among second major disease of coffee in India. The damage caused by this disease to plants and crop loss in a severely affected plantation can go up to an extent of 20 to 30 %. The disease is caused by the fungus *Koleroga noxia*.The pathogen is also termed as *Corticium koleroga (Cke.), Ceratobasidium anceps* and *Pellicularia koleroga* which are the synonyms of the black rot fungus. It is also called as thread blight of coffee in other countries (Belachew *et al.* 2015).The fungus infects both arabica coffee and robusta coffee. It is seasonal disease mainly confined to rainy season and this disease is generally noticed in valley areas of the plantations.The fungus attacks the leaves, twigs and berries of the coffee plant. The most prominent symptoms are blackening and rotting of the infected leaves, developing berries and young twigs. Affected

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leaves get detached from branches and hang down by means of slimy fungal strands. On green berries the characteristic blackening starts from one side and spreads gradually in a narrow band. Close examination reveals the presence of characteristic mycelial strands running along the twig, petioles and spreading mostly on the lower surface of the leaves. Affected leaves and berries show a white web consisting of closely interwoven mycelia when surface moisture is drained. Defoliation and berry drop from the infected branches occur in advanced stage of disease (Anon., 2014; Bhat *et al.* 2014).

Black rot disease is normally associated with the stalk rot disease of coffee and both these are confined to rainy season and are together called as monsoon rots. Continuous heavy rainfall which leads to build up of soil saturation effect, high relative humidity, low temperature and prolonged wetness of the leaves are favourable conditions for the pathogen.These atmospheres will lead to 'wet feet'conditions and favours the pathogen growth. Currently, due to the climate change due to the erratic and continuous rains around the coffee growing regions the disease is spreading creating huge loss among the Indian coffee growers. Cultural management practices like thinning of the shade, avoiding monoculture of shade trees and training the coffee bushes are followed to reduce the inoculum of the pathogen, however coffee growers has to depend on chemical spray to manage the disease effectively. At present, Indian coffee planters are managing the disease by applying 1% Bordeaux mixture and carbendezim 50 WP @ 1g/L to the affected bushes during pre-monsoon and mid monsoon respectively (Daivasikamani *et al.* 2017, Santoshreddy *et al*. 2019). Therefore, in order to find an alternative fungicide, studies were carried out to test the efficacy of different fungicides against the pathogen to manage the disease effectively.

MATERIALS AND METHODS

The experiment was carried out at the Central Coffee Research Institute (CCRI), Balehonnur, Koppa taluk, Chikmagalur district, Karnataka. The experiment was conducted in a randomized block design with nine treatments and three replications by using *Coffea arabica* cultivar Sln.9 (15 years old variety) with 35 plants for each replication. The fungicides found effective under *in vitro* conditions were identified for the study. A total of eight fungicides including the recommended fungicides (carbendezim 50 WP @ 1ml/L and 1% Bordeaux Mixture) were used for the experiment. Untreated control was also maintained. The treatments were imposed before the onset of monsoon and during the mid-monsoon season. The treatment details are presented in the Table 1. Observations on the disease incidence was recorded during the monsoon period once in 30days after the imposition of the fungicide. Percent disease incidence and percent disease reduction was calculated by the formula given below:

Assessment of the disease

Disease incidence and disease reduction was obtained by the following formula.

$$\text{Disease incidence (\%)} = \frac{\text{Total number of infected plants}}{\text{Total number of plants observed}} \times 100$$

$$\text{Disease Reduction (\%)} = \frac{\text{Disease incidence in control} - \text{Disease incidence in treatment}}{\text{Disease incidence in control}} \times 100$$

RESULTS AND DISCUSSION

Fungicide molecules do not create yield, but protect an inherent yield potential of plant, so that the grower may realize in the absence of disease. In the field, securing effective disease management by fungicide application is dependent upon, the disease pressure and effectiveness of the fungicide to manage the disease. In the present study, eight different fungicides were evaluated against the koleroga disease of coffee. Experimental results indicated that, the treatments were found to be significant. All the fungicides tested were effective when compared to control. During the study period the fungicides tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/Land pyraclostrobin 13.3% + epoxyconazole 5% w/v SE@ 1ml/L were effective when compared to other fungicides tested. During the first season of the study, statistical analysis of the data was found to be significant among the treatments. The mean incidence of the all the observations recorded was in the range of 0.67% to 53.35%. Disease reduction was calculated and results indicated that, the fungicide tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/L recorded maximum (98.74%)

Table1: Treatment Details

Fungicides	Concentration
T_1-Carbendezim 50 WP	1g/L
T_2-Propiconazole 250 EC	1ml/L
T_3-Tebuconazole 25.6 SC	1ml/L
T_4-Tebuconazole 50%+ Trifloxystrobin 25% w/w WG	1g/L
T_5-Pyraclostrobin 13.3% + Epoxyconazole 5% w/v SE	1ml/L
T_6-Carbendazim 12% + Mancozeb 63% WP	2g/L
T_7-Mancozeb 75 WP	2g/L
T_8-Bordeaux mixture	1%
T_9-Untreated Control	-

Table2 : Efficacy of the fungicides against black rot disease during 2020 season

Treatments	Black Rot Incidence (%)				
	July 2020	Aug. 2020	Sept. 2020	Mean	Disease Reduction (%)
T_1-Carbendezim 50 WP @ 1g/L	14.29 (22.2)	28.6 (32.3)	21.50 (27.2)	21.43	59.83
T_2-Propiconazole 250 EC @ 1ml/L	7.14 (5.15)	15.4 (23.1)	14.29 (22.2)	12.27	77.00
T_3-Tebuconazole 25.6 SC @1ml/L	14.29 (22.2)	8.8 (17.3)	7.69 (16.1)	10.25	80.79
T_4-Tebuconazole 50%+ Trifloxystrobin 25% w/w WG @ 1g/L	0.00 (0.00)	0.00 (0.00)	2.00 (8.13)	0.67	98.74
T_5-Pyraclostrobin 13.3% + Epoxyconazole 5% w/v SE@ 1ml/L	0.00 (0.00)	0.00 (0.00)	7.69 (16.0)	2.56	95.20
T_6-Carbendazim 12% + Mancozeb 63% WP @ 2g/L	42.86 (40.9)	43.2 (41.1)	43.20 (41.1)	42.86	19.66
T_7-Mancozeb 75 WP @ 2g/L	18.18 (25.2)	36.3 (37.1)	18.18 (25.2)	24.24	54.56
T_8-Bordeaux mixture @1%	7.69 (16.1)	21.4 (27.6)	7.14 (15.5)	12.09	77.34
T_9-Untreated Control	57.14 (44.7)	56.2 (48.6)	46.70 (43.1)	53.35	-
CD @5%	1.32	0.85	1.27	-	

disease reduction and was found on par with pyraclostrobin 13.3% + epoxyconazole 5% w/v SE@ 1ml/L (95.20%). Next effective fungicide was tebuconazole 25.6 SC @1ml/L with the disease reduction of 80.70%. The fungicide propiconazole 250 EC @ 1ml/L reduced the disease upto 77% and was on par with recommended fungicide Bordeaux mixture @1%. The systemic recommended fungicide carbendezim 50 WP @ 1g/L recorded disease reduction of 59.83%. Less effective fungicide was carbendazim 12% + mancozeb 63% WP @ 2g/L and reduced disease upto 19.66% (Table2).

Table 3: Efficacy of the fungicides against black rot disease during 2021 season

Treatments	% Black Rot Incidence				
	July 2021	Aug. 2021	Sept. 2021	Mean	% DR
T_1-Carbendezim 50 WP @ 1g/L	38.64 (34.47)	38.64 (38.44)	21.43 (27.58)	32.90	33.74
T_2-Propiconazole 250 EC @ 1ml/L	20.45 (26.90)	27.27 (31.49)	14.29 (22.22)	20.67	58.37
T_3-Tebuconazole 25.6 SC @1ml/L	18.6 (25.53)	25.58 (30.33)	7.69 (16.10)	17.29	65.18
T_4-Tebuconazole 50%+ Trifloxystrobin 25% w/w WG @ 1g/L	6.82 (15.14)	7.84 (16.26)	7.84 (16.26)	7.50	84.89
T_5-Pyraclostrobin 13.3% + Epoxyconazole 5% w/v SE@ 1ml/L	13.64 (21.68)	15.73 (23.36)	13.25 (21.35)	16.54	71.38
T_6-Carbendazim 12% + Mancozeb 63% WP @ 2g/L	36.66 (37.26)	34.09 (35.46)	42.86 (40.91)	37.87	23.73
T_7-Mancozeb 75 WP @ 2g/L	29.55 (32.94)	40.91 (39.82)	18.18 (25.24)	29.55	40.48
T_8-Bordeaux mixture @1%	29.55 (32.94)	31.82 (34.45)	25.18 (30.13)	28.85	41.89
T_9-Untreated Control	47.73 (43.72)	54.55 (47.63)	46.67 (43.11)	49.65	-
CD@ 5%	1.69	1.16	1.27	-	-

During the year 2021, the fungicide tebuconazole 50%+ trifloxystrobin 25% w/w WG @ 1g/L recorded maximum (84.89%) disease reduction followed by (71.38%) pyraclostrobin 13.3% + epoxyconazole 5% w/v SE@ 1ml/L. The fungicide tebuconazole 25.6 SC @1ml/L recorded 65.18% disease reduction. The recommended fungicides Bordeaux mixture @1% and carbendezim 50 WP @ 1g/L were not effective as the above-mentioned fungicides and recorded disease reduction of 41.89% and 33.74% respectively (Table 3). It was also observed that in the combination of triazoles and strobilurin group of fungicides, the severity of disease was less compared with other fungicides and also the persistence of the fungicide was longer. Muller *et al.* (2009) recommended that chemical control with cupric compounds can be used in extreme cases of thread blight disease on coffee but in the present study it was observed that the cupric compound was less effective compared to other fungicides tested. It has been reported that the fungicide propiconazole was effective in inhibiting the mycelia growth of the pathogen, *Koleroga noxia* and also that spraying of carbendazim 50 WP@ 0.03% and Bordeaux mixture 1% were effective in controlling black rot disease in coffee, however in the present study these fungicides were not much effective as the triazoles and combinations of triazoles and strobilurin fungicides. This may be due to the development of resistance in response to continuous usage of the same fungicides for the management of the disease. Madhu *et al.* (2020) revealed that the fungicide, pyraclostrobin 133 g/l + epoxiconazole 50 g/l and carbendazim 12% + mancozeb 63% WP could completely inhibit the mycelial growth at 0.1% and 0.15%. In combination fungicides, due to the presence of more than one active ingredient multiple target sites are interrupted, which thereby increases the potency of the fungicide likewise in the present study also the combined products of triazoles and strobulurin fungicides i.e.,Tebuconazole 50%+ Trifloxystrobin 25% w/w WG @ 1g/L and Pyraclostrobin 13.3% + Epoxyconazole 5% w/v SE@ 1ml/L were highly effective and can be used for the management of black rot disease of coffee.

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