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Efficacy of new generation fungicides against *Corynespora* leaf fall disease of rubber (*Hevea brasiliensis*)

SK Mushrif, MJ Manju and Jacob MathewDOI: <https://doi.org/10.22271/chemi.2020.v8.i4r.9863>**Abstract**

Corynespora leaf fall disease of rubber caused by *Corynespora cassiicola* a minor disease once became a major threat to the rubber cultivation especially in South Karnataka in late nineties. Recently it was found severe in some pockets of Kerala and also in nurseries. In this direction a study was conducted to identify some of the new fungicides for the control of this disease. *In vitro* studies showed that the fungicides viz., thiophanate methyl, iprodione + carbendazim, pyraclostrobin+metiram and the recommended fungicide carbendazim exhibited high level of efficacy both in arresting the mycelial growth and inhibiting the germination of the spores. Based on *in vitro* studies eight fungicides were selected and were evaluated in nursery against *corynespora* leaf fall disease. Among eight fungicides, the fungicides fungicides pyraclostrobin+metiram, iprodione + carbendazim were effective followed by the fungicides thiophanate methyl and mancozeb.

Keywords: *Corynespora* leaf fall disease, *Corynespora cassiicola*, fungicides**Introduction**

Rubber tree (*Hevea brasiliensis*) is a deciduous plant that belongs to the *Euphorbiaceae* family. It was introduced to tropical Asia in 1876 by Sir Henry Wickam (Dijkman, 1951). The successful transfer of *H. brasiliensis* to Asia and the subsequent establishment of rubber plantations were successful due to the demand for its raw material (Venkatachalam *et al.*, 2013) [25]. Natural rubber is produced from the Para rubber tree, which is of the height of 30 to 40 m in the Amazonian forest (its natural habitat) (Venkatachalam *et al.*, 2013) [25]. *H. brasiliensis* is the primary source of natural rubber (NR) (Rahman *et al.*, 2013) [16] and also the only species planted commercially. The natural rubber obtained from the Para rubber tree (*H. brasiliensis*) is a unique biopolymer of great importance. Thus, it cannot be replaced by synthetic rubber alternatives because of its significant applications (Venkatachalam *et al.*, 2013) [25]. South-East Asia produces 92% of natural rubber, followed by Africa and Latin America with 6 and 2%, respectively. Major rubber producing countries include Vietnam, Thailand, Indonesia, India, Malaysia and China, (Saha and Priyadarshan, 2012) [21]. India is currently the sixth largest producer of NR in the world with one of the highest productivity (694,000 tonnes in 2017-18). Traditional rubber-growing states comprising Kerala and Tamil Nadu account for 81% of production. Major non-traditional rubber growing regions are the North Eastern states of Tripura, Assam and Meghalaya, Odisha, Karnataka, Maharashtra and West Bengal.

There are several limitations in the production of natural rubber especially the diseases. The major leaf diseases include the abnormal leaf fall disease, powdery mildew disease, *corynespora* leaf fall disease and colletotrichum leaf disease (Edathil *et al.*, 2000) [5]. Among them, the *corynespora* leaf fall (CLF) disease caused by *Corynespora cassiicola* of rubber is prevalent in almost all rubber growing regions of the world (Jacob, 2006a) [9]. The disease normally appears during refoliation period by infecting new flushes and subsequently causing die-back symptoms of young branches in severity (Manju *et al.*, 2002) [13]. The symptoms include shot hole, browning and blacking of veins forming fish bone or railway track symptoms, blight and finally leading to shriveling and defoliation. Repeated defoliation and refoliation leads to dieback symptoms and in severity complete drying up of infected trees has been observed in a few plantations (Jacob, 1997) [8].

During the past two decades, the pathogen has caused extensive damage to rubber tree plantations and may become a potential limiting factor in rubber yield in Asia (Breton *et al.*, 2000; Jacob 2006b) ^[1, 10]. Young leaves are extremely susceptible to the disease. The disease is observed to be more prominent and widely distributed since 1975 in Malaysia (Kamar, 1994) ^[11]. Several authors have reported the economic importance of the *Corynespora* disease. In Sri Lanka, the disease which appeared in a polybags nursery of the clone RRIC 103 in 1985 spread rapidly in all rubber growing regions of the island devastating nearly 4000 ha by 1989. Consequently, the clone RRIC 103 was uprooted through an island-wide campaign. The clone RRIC 103 which was high yielding and otherwise very promising had to be withdrawn from the recommendation (Liyanage *et al.*, 1989) ^[12]. Chee (1990) ^[20] estimated that the crop loss due to this disease if occurring in severe form would be nearly 20 per cent. The crop loss estimated in Indonesia is 30-50 per cent in individual plantations.

In India, CLF disease of *H. brasiliensis* has been originally reported as a minor disease affecting nursery plants (Ramakrishnan and Pillay, 1961) ^[18]. Later, sporadic incidence of *Corynespora* on mature trees was reported from Kodumon, Chittar, Shaliacary, Kaliyar and Cheruvally during 1969 to 1976 (George and Edathil, 1980) ^[7]. But, in late nineties, this disease assumed a severe form in Nettana area of Karnataka. The first incidence of epidemic form of *Corynespora* leaf disease was observed in the Rubber Research Institute of India (RRII), Hevea Breeding Sub Station at Nettana in South Karnataka during 1996 (Rajalakshmi and Kothandaraman, 1996) ^[17]. In traditional rubber growing belt of Kerala state, the disease has not been noticed in severe form. However, very recently, a few plantations and nurseries in some pockets were severely affected by this disease.

The disease is mainly managed by fungicides particularly in nurseries where almost all the clones are very much affected by this disease. Thus, management of this disease at nursery level ensures good quality of planting materials that in the long turn benefit the rubber growers in terms of productivity. Though, several fungicides have been recommended to control this disease, the continuous use of fungicides over a long period may pose the risk of development of resistance in the pathogen against the fungicides. Therefore, it is always important to have the alternative fungicides in pipe line in case of development of resistance by the pathogen to the fungicides. Keeping this in view, the present study was conducted to know the efficacy of new generation fungicides against *corynespora* leaf fall disease.

Material and Methods

Isolation

Rubber leaves exhibiting typical leaf symptoms of *corynespora* leaf fall disease were collected from rubber nursery plants at Ulickal Nursery, Ulickal, Iritty and these leaves were used for the isolation of the pathogen. The isolation was done according to tissue segment methodology of Rangaswami (1958) ^[19]. The pathogen was purified using single spore isolation method (Riker and Riker, 1936) ^[20]. The identification was done through colony colour, morphology and spore characters. The pure culture of the pathogen was maintained on PDA slants at 27±1 °C.

In vitro evaluation of fungicides

In vitro evaluation of fungicides against the mycelial growth of *Corynespora cassiicola*

Twelve fungicides comprising of non-systemic, systemic and combi-products (Table1) were evaluated *in vitro* for their efficacy in inhibiting the mycelial growth of *C. cassiicola* on PDA medium at different concentrations of 10,25, 50, 100, 250 and 500ppm of their active ingredient with three replications each using Poisoned food technique (Shravelle, 1961).

The fungus was grown on PDA medium for ten days prior to setting up the experiment. The PDA medium was prepared and melted. The required quantity of individual fungicide was added separately into molten and cooled PDA medium so as to get the desired concentration of the fungicides. Later, twenty ml of poisoned medium was poured in each sterilized Petri dishes. Suitable check was maintained without addition of fungicide. Mycelial disc of 5 mm was taken from the periphery of nine days old colony was placed in the center of Petri dishes and incubated at 27±1 °C for 10 days and three replications were maintained for each treatment. Radial growth of the fungus was measured when fungus attained maximum growth in control. Per cent inhibition of mycelial growth of the fungus was calculated using the following formula (Vincent 1947) ^[26]. $I = \{(C-T)/C\} \times 100$

Where,

I = Per cent inhibition

C = Radial growth in control

T = Radial growth in treatment (fungicide).

Efficacy of the fungicides on the inhibition of germination of the spores

The effect of different levels of concentrations of fungicides as used in the above experiment were studied on germination of spores of *C. cassiicola* following 'hanging drop' method using cavity slides. For this purpose the culture was flooded with 10 ml distilled water and the colony surface mechanically disturbed with a paint brush to suspend the spores. The resulting suspension was filtered through muslin cloth and the concentration of spores in the suspension was adjusted to 10×10^4 spores/mL with sterile distilled water using haemocytometer (Fernando *et al.*, 2010) ^[6]. At the same time the stock solution of each fungicide was prepared and 1ml of fungicide solution with double concentration was mixed with 1 ml of the spore suspension so as to get the required concentration of the fungicide. From this mixture 0.02 ml was placed on a clean and sterilized cavity slide with spore suspension. Control was maintained with only distilled water. Such cavity slides were kept in moist chamber for 12 hours of incubation. The per cent germination of spores was calculated on a count of 100 spores for each replication of a treatment. A spore was considered as germinated when the length of germ-tube was longer than half the length of the spore. The mean percentages of conidial germination of 12 drops were determined. Finally, the percentage inhibition of conidial germination with respect to control was calculated as follows using the method followed by Sharma and Mohanan (1991) ^[22].

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

I = percent inhibition of conidial germination with respect to control

T = percent inhibition in treatment

C = percent ungerminated conidia in control.

The experiment was conducted statistically using Completely Randomized Design with 3 replications for each of the fungicide concentrations. The data were analyzed statistically.

Nursery evaluation of selective fungicides *Corynespora* leaf fall disease of rubber

Evaluation of new generation fungicides was carried out at Ulickal nursery on the polybags budded plants of the clone RRII 105. Totally 7 fungicides *viz.*, iprodione + carbendazim, fenamidone + mancozeb, tebuconazole, carbendazim, mancozeb, pyraclostrobin+ metiram and thiophanate methyl which were found effective during *in vitro* evaluation were selected. The experiment was carried out for two consecutive years *i.e.* 2012 and 2013. The spray schedule was fixed at 10 days interval for 2-3 months depending upon the prevalence of the disease severity. The first spray was given as soon as the first symptom of disease was seen in the nursery. The experiment was laid out statistically in Randomized Block Design with 9 treatments and 3 replications. Each replication had 30 budded plants. The disease severity was recorded 10 days after the completion of spray schedule. For recording the disease severity, 10 plants were selected randomly in each replication of individual treatment and severity of the disease on the foliage of the plants was assessed on a 0-5 scale where 0 = no disease; 1 = very light (up to five spots); 2 = light (5-10 spots and 10-25 % leaf fall); 3 moderate (> 10 spots and 26-50 % leaf fall); 4 = severe (large lesions and 51-75 % leaf fall) and 5 = very severe (large lesions and > 75 % leaf fall). The Per cent Disease Index (PDI) was calculated by using following formula proposed by Wheeler (1969) [27].

$$\text{Disease Index (PDI)} = \frac{\text{Sum of the individual disease ratings}}{\text{Number of fruits or leaves observed} \times \text{Maximum disease grade}} \times 100$$

Results

It is well known fact the continuous use of the same fungicide although hazardous to the environment may pose the problem of resistance development in the fungus. And availability of new fungicides necessitates evaluation of fungicides under *in vitro* and field conditions to know their efficacy, and initiate spray schedule in field conditions. Hence, the present study was carried out to evaluate the fungicide *in vitro* and nursery evaluation of effective fungicides against *Corynespora* leaf fall disease.

In vitro evaluation of fungicides

In vitro evaluation of fungicides against the mycelial growth of *Corynespora cassicola*

Among various fungicides studied *in vitro*, the fungicides thiophanate methyl and iprodione + carbendazim were highly effective as they arrested the growth of the pathogen completely at 10 ppm (Table 2). However, the recommended fungicide carbendazim exhibited the same trend as that of the above two fungicides. This was followed by the fungicide pyraclostrobin+metiram at 50 ppm. The fungicides mancozeb, picoxystrobin and fenamidone + mancozeb at 100 ppm inhibited the growth of the pathogen completely. The other fungicides *viz.*, iprovalicarb + copper propineb, bitertanol, trifloxystrobin + tebuconazole and copper hydroxide were ineffective even at 500 ppm with the per cent inhibition of 62.59, 43.70, 76.67 and 59.63 respectively. From the mean

data it was observed that among all the fungicides, the fungicides thiophanate methyl, iprodione + carbendazim and the recommended fungicide carbendazim were highly effective showing complete inhibition of the pathogen followed by the fungicide pyraclostrobin+metiram recording 85.06 per cent of inhibition of the growth of the pathogen.

Efficacy of the fungicides on the inhibition of germination of the spores

The results (Table 3) indicated that among the fungicides the fungicide iprodione + carbendazim was highly effective as this fungicide completely inhibited the germination of spores from 50 ppm onwards followed by thiophanate methyl which inhibited germination of spores by 91.92 per cent. At 100 ppm complete inhibition of the germination spores was noticed in the treatments involving the fungicides thiophanate methyl, pyraclostrobin+metiram, fenamidone + mancozeb and the recommended fungicide carbendazim. The other fungicides tebuconazole and mancozeb were effective from 250ppm onwards. The least effective fungicide was copper hydroxide which had 83.80 per cent of inhibition of spores even at 500ppm. From the mean data on per cent inhibition of the spores it was noticed that the fungicides iprodione + carbendazim, the recommended fungicide carbendazim, thiophanate methyl pyraclostrobin+ metiram were found to be very promising in inhibiting the spore germination.

Nursery evaluation of selective fungicides *Corynespora* leaf fall disease of rubber

The study was conducted at Ulickal nursery on the polybags budded plants of the clone RRII 105. Totally seven fungicides which were found promising in the *in vitro* trial were included in this trial. The evaluation was taken up for two consecutive years *i.e.* 2012 and 2013. Here the disease severity is expressed as Per cent Disease Index (PDI).

The data (Table 4) showed that in 2012 the fungicides pyraclostrobin+ metiram (0.1% dosage) was very effective with PDI of 7.22 closely followed by the fungicide thiophanate methyl with PDI of 7.24 and were statistically on par with each other. However, the other fungicides *viz.*, mancozeb, pyraclostrobin+ metiram (0.1% dosage) and iprodione + carbendazim with PDI of 8.03, 8.21 and 9.48 were statistically on par with the first two fungicides. The fungicide tebuconazole was found to be least effective with PDI of 16.63.

Similar trend was observed during 2013 trial. Though the least PDI of 9.63 was observed in the plots imposed with the fungicides pyraclostrobin+ metiram (0.2% dosage) and iprodione + carbendazim, the fungicides thiophanate methyl (9.64 PDI), pyraclostrobin+ metiram (0.1% dosage) (10.14 PDI) and mancozeb (12.64 PDI) were found to be statistically on par with above fungicides. However, maximum disease severity (16.42 PDI) was observed in the plot treated with fenamidone + mancozeb followed by the fungicide carbendazim with PDI of 15.11.

The two year data were pulled and analysed statistically. The results showed that among the various fungicides studied, the fungicides pyraclostrobin+ metiram (0.2% dosage), thiophanate methyl, pyraclostrobin+ metiram (0.1% dosage), iprodione + carbendazim and mancozeb with PDI of 8.43, 8.44, 9.56 and 10.34 respectively were effective and statistically on par with each other.

Discussion

The *Corynespora* leaf fall disease which was a minor disease on rubber has now emerged as serious threat to the rubber

plantations in South Karnataka and very recently showing its prominence in Kerala devastating the rubber plantations in some pockets. The disease has become equally severe in nurseries. In this direction experiment was conducted to know the efficacy of new generation fungicides against this disease. The *in vitro* results showed that the fungicide iprodione+carbendazim, thiophanate methyl and carbendazim were highly effective in arresting the mycelial growth of the pathogen followed by the fungicide pyraclostrobin+ metiram. In spore inhibition studies, the fungicides iprodione+carbendazim and carbendazim followed by thiophanate methyl and pyraclostrobin+ metiram were found promising. Clark *et al.* (2011) [3] in their studies on the sensitivity of *Corynespora cassiicola* to the fungicides found that the pathogen was sensitive to the fungicides like iprodione and thiophanate methyl. In our studies the fungicide carbendazim which is also a recommended fungicide was found to be effective *in vitro* which is in agreement with the earlier studies conducted by Fernando *et al.* (2010) [6] who observed carbendazim to be very effective under *in vitro* conditions against *Corynespora cassiicola* on rubber. Patel (2005) [14] in his studies found the fungicides carbendazim and mancozeb were promising under lab conditions. Prosper *et al.* (2018) [15] reported high level efficacy of pyraclostrobin and

carbendazim against *C. cassiicola* in rubber. In another laboratory studies the fungicide pyraclostrobin was observed to be very promising in inhibiting the germination of the spores of *C. cassiicola*, the causal agent of target spot of soybean (Teramoto *et al.*, 2017) [23].

The nursery studies on the evaluation of fungicides against corynespora leaf fall disease caused by *C. cassiicola* revealed that the fungicides pyraclostrobin+ metiram thiophanate methyl, iprodione + carbendazim and mancozeb were effective in containing the disease severity. The least effective fungicides were tebuconazole and fenamidone+mancozeb (Sectin). Vawdrey *et al.* (2008) [24] in their experiment on field efficacy of fungicides against brown spot disease of papaya caused by *C. cassiicola* noticed that the fungicide pyraclostrobin was more effective than the recommended fungicide mancozeb in controlling the disease.

In the present studies, the fungicides thiophanate methyl, iprodione + carbendazim, the recommended fungicide carbendazim and pyraclostrobin+metiram were effective *in vitro*. In the nursery evaluation of the selected fungicides against corynespora leaf fall disease, the fungicide pyraclostrobin+metiram, iprodione + carbendazim followed by the fungicides thiophanate methyl and mancozeb were effective.

Table 1: Details of fungicides used in the study

Common name	Chemical group	Mode of action	FRAC code
Contact fungicides			
Mancozeb	Dithio-carbamates and relatives	Multi-sitecontactactivity	M03
Copper hydroxide	Inorganic	Multi-sitecontactactivity	M01
Systemic fungicides			
Thiophanate methyl	Thiophanates	β -tubulin assembly in mitosis	1
Carbendazim	Benzimidazoles	β -tubulin assembly in mitosis	1
Bitertanol	Triazole	Sterol Biosynthesis inhibitors	3
Tebuconazole	Triazole	Sterol Biosynthesis inhibitors	3
Picoxystrobin	Methoxy-acrylates	Quinone outside inhibitors	11
Combiproducs			
Pyraclostrobin+ Metiram	Methoxy-acrylates+Dithio-carbamates and relatives	Quinone outside Inhibitors + Multi-site contact activity	11+M03
Iprodione + Carbendazim	Dicarboximides+Benzimidazoles	Affect osmotic signal transduction+ β -tubulin assembly in mitosis	2+1
Fenamidone + Mancozeb	Imidazolinones+Dithio-carbamates	Quinone outside nhbitors + Multi-site contact activity	11+M03
Tebuconazole + Trifloxystrobin	Triazole+Oximino-acetates	Sterol Biosynthesis inhibitors+Quinone outside inhibitors	3+11
Iprovalicarb + Propineb	Valinamidearbamates+	Affect Cell wall biosynthesis+ Multi-site contact activity	40+ M03

Source: Frac code list 2020

Table 2: *In vitro* evaluation of fungicides on the inhibition of mycelial growth of *Corynespora cassiicola*

Sl. No.	Fungicides		Per cent inhibition of mycelial growth						Mean Inhibition (%)
	Treatments	Trade name	Concentration (ppm)						
			10	25	50	100	250	500	
1	Iprovalicarb + Propineb	Melody Duo	1.85 (6.52)	15.19 (22.88)	34.07 (35.70)	46.30 (42.87)	55.93 (48.40)	62.59 (52.29)	35.99
2	Pyraclostrobin+ Metiram	Cabrio Top	51.85 (46.07)	58.52 (49.92)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	85.06
3	Bitertanol	Baycor	20.74 (27.07)	23.70 (29.06)	31.48 (34.11)	33.33 (35.26)	40.74 (39.66)	43.70 (41.38)	32.28
4	Thiophanate methyl	Hexastop	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00
5	Tebuconazole + Trifloxystrobin	Nativo	47.04 (43.30)	57.41 (49.27)	66.30 (54.51)	71.11 (57.50)	73.70 (59.15)	76.67 (61.13)	65.37
6	Copper hydroxide	Kocide 3000	0.00 (0.46)	5.19 (13.09)	9.26 (17.69)	16.67 (24.10)	52.22 (46.27)	59.63 (50.55)	23.83
7	Tebuconazole	Folicur	48.89 (44.37)	62.59 (52.30)	73.70 (59.15)	81.85 (64.79)	100.00 (89.54)	100.00 (89.54)	77.84
8	Iprodione + Carbendazim	Quintal	100.00	100.00	100.00	100.00	100.00	100.00	100.00

			(89.54)	(89.54)	(89.54)	(89.54)	(89.54)	(89.54)	
9	Picoxystrobin	Acanto	33.70 (35.48)	37.78 (37.98)	46.67 (43.09)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	69.69
10	Fenamidone + Mancozeb	Sectin	20.74 (27.07)	46.67 (43.08)	60.00 (50.77)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	71.23
11	Carbendazim	Bavistin	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	100.00
12	Mancozeb 75% WP	Indofil -M-45	12.59 (20.72)	25.56 (30.36)	67.78 (55.41)	100.00 (89.54)	100.00 (89.54)	100.00 (89.54)	67.65
13	Control		0.00 (0.46)	0.00 (0.46)	0.00 (0.46)	0.00 (0.46)	0.00 (0.46)	0.00 (0.46)	0.00
		S.Em±	1.08	0.88	0.62	0.45	0.43	0.33	
		CD (P=0.01)	4.27	3.45	2.45	1.78	1.70	1.30	
		CV (%)	4.70	3.31	1.98	1.20	1.10	0.80	

Note: Figures in parenthesis are arc sign transformed values

Table 3: *In vitro* evaluation of fungicides on the inhibition of spore germination of *Corynespora cassiicola*

Sl. No.	Fungicides		Per cent inhibition of spore germination over control						Mean Inhibition (%)
	Treatments	Trade name	Concentration (ppm)						
			10	25	50	100	250	500	
1	Iprovalicarb + Propineb	Melody Duo	15.22 (22.95)	33.33 (35.26)	43.41 (41.20)	56.52 (48.75)	75.33 (60.24)	100.00 (89.53)	53.97
2	Pyraclostrobin+ Metiram	Cabrio Top	69.86 (56.70)	82.57 (65.36)	89.82 (71.40)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	90.37
3	Bitertanol	Baycor	22.54 (28.32)	32.17 (34.56)	51.56 (45.90)	67.54 (55.27)	86.49 (68.47)	100.00 (89.53)	60.05
4	Thiophanate methyl	Hexastop	79.75 (63.29)	88.08 (69.83)	91.92 (73.51)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	93.29
5	Tebuconazole + Trifloxystrobin	Nativo	36.45 (37.12)	50.25 (45.14)	71.67 (57.84)	85.11 (67.31)	96.30 (78.97)	100.00 (89.53)	73.30
6	Copper hydroxide	Kocide 3000	17.83 (24.92)	22.79 (28.50)	31.59 (34.19)	41.12 (39.89)	60.76 (51.22)	83.80 (66.26)	42.98
7	Tebuconazole	Folicur	58.41 (49.85)	71.09 (57.49)	83.26 (65.86)	95.98 (78.46)	100.00 (89.53)	100.00 (89.53)	84.79
8	Ipridione + Carbendazim	Quintal	84.67 (66.97)	90.94 (72.52)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	95.94
9	Picoxystrobin	Acanto	53.41 (46.96)	66.81 (54.83)	76.56 (61.06)	84.71 (67.01)	100.00 (89.53)	100.00 (89.53)	80.25
10	Fenamidone + Mancozeb	Sectin	65.98 (54.33)	74.57 (59.72)	87.64 (69.46)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	88.03
11	Carbendazim	Bavistin	83.44 (66.00)	89.46 (71.06)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	100.00 (89.53)	95.48
12	Mancozeb 75% WP	Indofil -M-45	68.70 (56.00)	79.09 (62.79)	85.22 (67.41)	93.55 (75.31)	100.00 (89.53)	100.00 (89.53)	87.76
		S.Em±	0.93	0.76	0.69	0.59	0.54	0.03	
		CD (P=0.01)	3.67	3.00	2.73	2.32	2.13	0.17	
		CV (%)	3.36	2.40	1.86	1.39	1.14	0.08	

Note: Figures in parenthesis are arc sign transformed values

Table 4: Efficacy of new fungicides against *Corynespora* leaf fall disease

Fungicides	Trade name	Dosages (%)	Per cent Disease Index (PDI)		
			2012	2013	Pooled mean
Ipridione + Carbendazim	Quintal	0.1	9.48 (17.84)	9.63 (18.01)	9.56 (17.98)
Fenamidone + Mancozeb	Sectin	0.2	10.85 (19.17)	16.42 (23.87)	13.64 (21.63)
Tebuconazole	Folicur	0.1	16.63 (24.04)	13.22 (21.26)	14.93 (22.71)
Carbendazim	Bavistin	0.2	11.24 (19.55)	15.11 (22.83)	13.18 (21.28)
Mancozeb	Indofil-M-45	0.27	8.03 (16.37)	12.64 (20.80)	10.34 (18.73)
Pyraclostrobin+ Metiram	Cabrio Top	0.1	8.21 (16.63)	10.14 (18.50)	9.18 (17.59)
Pyraclostrobin+ Metiram	Cabrio Top	0.2	7.22 (15.50)	9.63 (18.00)	8.43 (16.84)
Thiophanate methyl	Hexastop	0.1	7.24 (15.573)	9.64 (18.04)	8.44 (16.88)
Control			28.00	36.23	32.12

		31.928	(37.00)	(34.52)
S.Em ±		1.05	1.06	0.74
CD (P=0.05)		3.13	3.20	2.21
CV (%)		9.23	8.40	6.12

Note: Figures in parenthesis are arc sign transformed values

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