INHIBITION OF *PHELLINUS NOXIUS* CAUSING BROWN ROOT DISEASE OF RUBBER USING NEW FUNGICIDES

C. Bindu Roy, E. Edwin Prem, Bikku Babu and Limiya Joseph

Rubber Research Institute of India, Rubber Board, Kottayam - 686 009, Kerala, India

Received: 08 March 2020 Accepted: 09 April 2020

Roy, C.B., Prem, E.E., Babu, B. and Joseph, L. (2020). Inhibition of *Phellinus noxius* causing brown root disease of rubber using new fungicides. *Rubber Science*, **33**(1): 49-52.

Among the root diseases of rubber *(Hevea brasiliensis)*, brown root disease is predominant in the traditional rubber growing regions of South India. *In vitro* sensitivity of fifteen new fungicides was evaluated using poisoned food technique, which identified five fungicides *viz.* Tebuconazole; Hexaconazole; Epoxyconazole+Pyraclostrobin; Tebuconazole+Trifloxystrobin and Metiram+Pyraclostrobin on par with the standard recommended fungicides Tridemorph and Propiconazole which are currently banned from the market. These fungicides are being taken for field testing in order to confirm their efficiency in the field.

Key words: Brown root disease, Fungicides, *Phellinus noxius, Hevea brasiliensis*

Rubber trees are affected by several root diseases causing severe damage in most countries (Wastie, 1975). Trees are affected by root diseases irrespective of their age ultimately leading to their death. Although root disease caused by different fungi have been reported in rubber (Nandris *et al*., 1987), the major diseases reported are white root, red root and brown root diseases caused by *Rigidoporus lignosus*, *Ganoderma philippii* and *Phellinus noxius*, respectively. The intensity of root disease varies in different countries (Nandris *et al*., 1987). In India, root disease occurrence is sporadic and is mostly observed in replanted areas. While brown root, purple root and Poria root diseases have been reported from India, the most damaging white root disease has not been reported. Brown root rot is the major root disease in rubber growing regions of India. Root rot hinders absorption and translocation of water and nutrients in the affected plants. The common symptoms of the disease on rubber trees are yellowing of foliage, buckling of leaves, drying of canopy, total drying of trees, encrustation of soil on roots, presence of spongy fruiting body on root surface or near collar region, damage to tap root and also root decay. The affected trees start wilting and ultimately die (Rajalakshmy and Jayarathnam, 2000). Root diseases in general are difficult to manage once it takes its grasp on trees. Many plantations of rubber, tea, cocoa, coffee, oil palm and mahogany established on cleared forest sites have been devastated by *P. noxius.* Loss of up to 60 per cent of rubber trees in a plantation after 21 years from planting was reported (Nandris *et al*., 1987). Further, *Hevea* clones resistant to *P. noxius* have not been

Correspondance: Bindu Roy C. (Email: binduroy@rubberboard.org.in)

reported. The standard recommended fungicides for the control of brown root disease are Tridemorph 0.5 per cent (6.25 ml L^{-1}) or Propiconazole 0.13 per cent (5 ml L^{-1}). Both Propiconazole and Tridemorph are systemic fungicides that retard the development of fungi by interfering sterol biosynthesis leading to cell membrane disruption and arrest of cellular growth. Both these fungicides have been withdrawn and are not currently available in the market due to their reported health hazards (Gupta, 2017). The present study is aimed at identifying potential alternate fungicides for management of brown root disease.

Source of isolates

Diseased root samples were collected from rubber growing regions of South India, surface sterilized and cultured on potato dextrose agar (PDA) medium to isolate the pathogen. The cultures were initially white but turned brownish with irregular patches of darker tissue after six to eight days of incubation, characteristics of *P. noxius*. The cultures were preserved on PDA medium at room temperature for further studies.

Preparation of fungicide stock solution

A stock solution of 25,000 ppm for each fungicide was prepared and stored at 4^0C (Table 1). Working concentration for each fungicide was prepared by directly adding the required volume of stock solution on to cooled molten PDA medium and mixing. The poisoned medium (20 ml each) was plated in sterile petri dish.

Determination of minimum inhibitory concentration of various fungicides against *P. noxius*

Fifteen fungicides were used in the study to find out their effectiveness in inhibiting *P. noxius* (Table 1). Poisoned food technique (Grover and Moore, 1962) was adopted to test the fungicide sensitivity. Inhibition of mycelial growth of *P. noxius* was assessed on PDA media amended with the respective fungicide at varying concentrations. Each plate was inoculated at the centre of the petri dish (containing media) with a 5 mm mycelial disc of the pathogen, taken from the periphery of actively growing 10 day old culture. Petri dishes with the inoculum were incubated at 26±2°C. Five replicates for each treatment were maintained. Control plates were maintained similarly by inoculating *P. noxius* on PDA medium. Effect of the fungicide was assessed by measuring

Table 1. **List of fungicides tested against *P. noxius* and their active ingredient**

No.	Fungicide	Active ingredient
1	Aliette	Fosetyl aluminium 80 per cent
2	Nativo	Tebuconazole 50 per cent + Trifloxystrobin 25 per cent
3	Tilt	Propiconazole 25 per cent
4	Contaf	Hexaconazole 5 per cent
5	Folicur	Tebuconazole 25.9 per cent
6	Indofil M-45	Mancozeb 75 per cent
7	Sectin	Fenamidone 10 per cent + Mancozeb 50 per cent
8	Tagsin-M	Thiophanate methyl 70 per cent
9	Melody Duo	Provalicarb 5.5 per cent + Propineb 61.25 per cent
10	Mantram	Metiram 55 per cent + Pyraclostrobin 5 per cent
11	Quintal	Iprodione 25 per cent + Carbendazim 25 per cent
12	Baycor	Bitertanol 25 per cent
13	Calixin	Tridemorph 80 per cent
14	Fytran	Copper oxychloride 50 per cent
15	Opera	Epoxyconazole + Pyraclostrobin 18.3 per cent

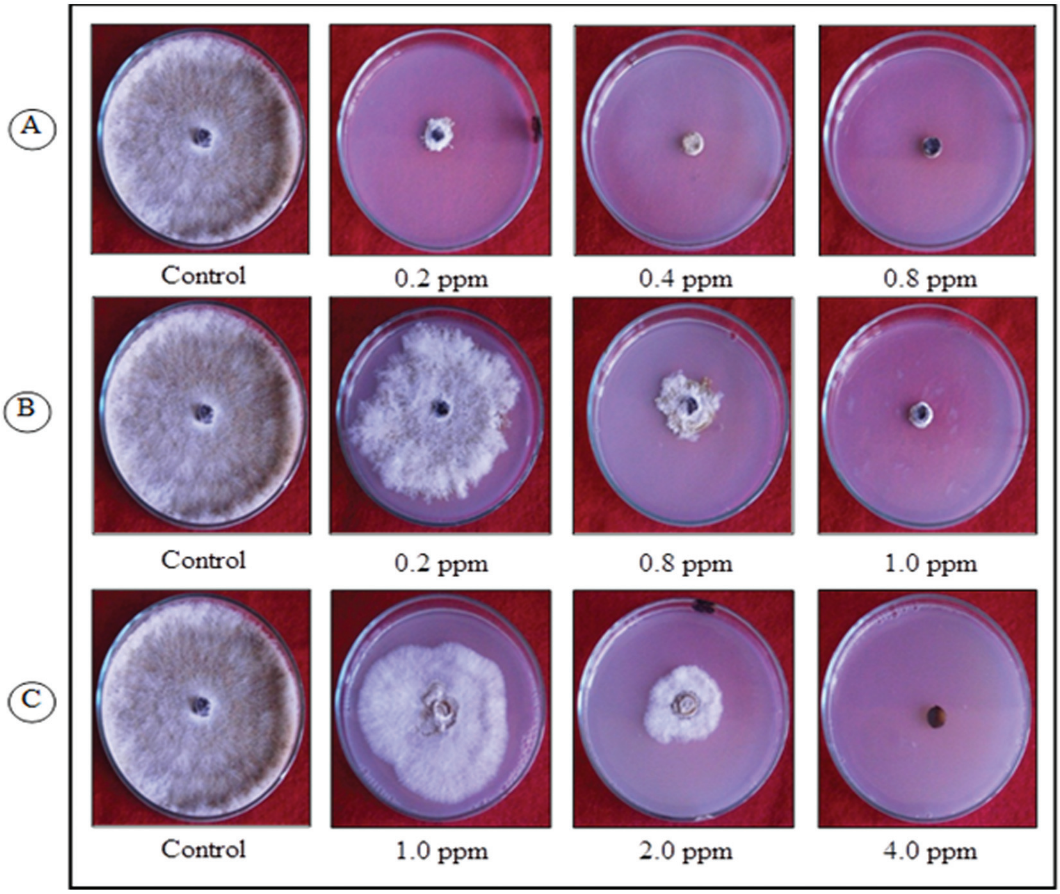

Fig.1. Inhibition of growth of *P. noxious* by A.Tebuconazole, B. Hexaconazole, C. Epoxyconazole + Pyraclostrobin

Table 2. **Fungicides found effective against growth of *P. noxius* at 0.1-20 ppm**

Fungicides	Fungicide concentration (in ppm) and mean growth of *P. noxius* (in mm)																
	0.1	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	3.5	4	4.5	5	10	15	20
Tebuconazole	90	71	22	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Hexaconazole	90	70	20	13	8	0	0	0	0	0	0	0	0	0	0	0	0
Epoxyconazole + Pyraclostrobin	90	90	62	52	42	32	20	13	12	8	6	0	0	0	0	0	0
Tebuconazole + Trifloxystrobin	90	90	90	90	90	81	71	44	31	22	16	13	7	0	0	0	0
Propiconazole	90	81	78	72	68	63	51	41	31	23	12	8	3	0	0	0	0
Tridemorph	90	90	90	90	90	90	74	64	61	58	56	52	52	42	34	23	0
Metiram + Pyraclostrobin	90	90	90	90	90	90	90	90	90	90	90	90	90	74	46	24	0
Control	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90	90

Table 3. **Fungicides found effective against growth of *P. noxius***

Fungicide	Concentration at which growth is fully inhibited (ppm)
Mancozeb	40
Iprodione + Carbendazim	100
Bitertanol	100
Fenamidone + Mancozeb	200
Fosetyl aluminium	1750
Provalicarb + Propineb	2000
Copper oxychloride	2000
Thiophanate methyl	5000

growth of mycelia after seven days of inoculation. Minimum inhibitory concentration (the lowest concentration of fungicide that inhibits visible growth of fungus after incubation) in all the replications was observed for each fungicide in comparison with the growth in control plates (Andrews, 2001).

Various fungicides have been suggested for managing brown root disease (Andrews, 2001; Mappes and Hiepko, 1984). Although regular field treatments with these fungicides are expensive, it is the only strategy that has been adopted. The present study identified five fungicides which were superior to or on par with Propiconazole and Tridemorph in checking the growth of *P. noxius.* They were Tebuconazole 25.9 per cent, Hexaconazole 5 per cent, Epoxyconazole+Pyrichlorstrobin 18.3 per cent, Tebuconazole 50 per cent+Trifloxystrobin 25 per cent and Metiram 55 per cent +Pyraclostrobin 5 per cent inhibiting at 0.8 ppm, 1 ppm, 4 ppm, 5 ppm and 20 ppm respectively (Fig. 1; Table 2). Tridemorph also showed inhibition at 20 ppm. Similarly, Mancozeb 75 per cent, Iprodione 25 per cent + Carbendazim 25 per cent, Bitertanol 25 per cent and Fenamidone 10 per cent + Mancozeb 50 per cent were found effective below 200 ppm. However, Fosetyl aluminium inhibited *P. noxius* at 1750 ppm; Provalicarb+Propineb and Copper oxychloride at 2000 ppm and Thiophanate methyl at 5000 ppm (Table 3). This study identified five fungicides which showed *in vitro* inhibition on the growth of *P. noxius*, better or on par with Propiconazole 25 per cent and Tridemorph 80 per cent. Further tests on the efficacy of these fungicides in the field are in progress.

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