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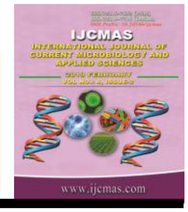

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Evaluation of Different Fungi Toxicants against *Corynespora cassiicola* causing Corynespora Leaf Fall (CLF) Disease of Rubber [*Hevea brasiliensis* Muell. Arg.,]

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A B S T R A C T

Corynespora leaf fall (CLF) disease of rubber incited by *Corynespora cassiicola* is listed as a fourth most serious leaf disease of rubber in South East Asia. As the rubber is a tree crop it grows up to 60 – 70 feet height, management of this disease is not easy and it involves more price tag. The use of effective and economical management strategies is plays a vital role in efficient disease management in rubber plantations. To develop a tool to integrated disease management approach, tested different bio-agents, plant extracts and fungicides against *Corynespora cassiicola.* Among the bio-agents tested *Trichoderma viride* inhibited the growth of fungus to the maximum extent followed by *T. harzianum, Bacillus subtilis* and to some extent *Pseudomonas florescence.* Complete inhibition of the fungal growth was not observed in any of the botanicals used. However, considerable amount of growth inhibition was noticed in garlic bulb extract and neem seed kernel extract. Among the fungicides tested SAAF [combination fungicide containing mancozeb and carbendazim] @ 2g/l was found to be more effective as compared to other fungicides. SAAF a fungicide having both contact and systemic action it provides additional protection to the plants form bud break to various stages of leaf development. The information generated from the study could be a useful in develop the tool to an integrated CLF disease management in rubbers plantation.

Keywords

Corynespora leaf fall disease, Biological agents, Fungicides and rubber

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Introduction

Corynespora leaf fall (CLF) is one of the major leaf diseases of rubber in traditional rubber growing regions of India (Edathil *et al.,* 2000). CLF disease occurs regularly during the refoliation period and causes economic annual yield loss of more than 45 percent (Soepena *et al.,* 1996). Owing to constant fungicides application for the effective disease management, uses of cost-effective disease management approaches have more implication in disease management in rubber plantations. In addition to fungicides wide range of bio agents are used for management of this disease. Antagonists like

Bacillus subtilis, Rhizobium spp, Streptomyces spp, Pseudomonas fluorescens, Trichoderma harzianum, T. viridae, are used in in-vitro as potential bio-control agent against the pathogens causing diseases of rubber (Vanith *et al.*, 1994; Kochuthresiamma Joseph 2006).

The use of bacterial antagonists as bio-pesticides for the control of various insect pests and plant pathogens are currently rapt considerable interest of which PGPR and endophytes have engrossed more attention (Hallman *et al.*, 1997). Endophytic micro organisms can reside within the cells (Jacob *et al.*, 1985), in the intercellular space (Patriquin, 1978) and in the vascular system (Bell *et al.*, 1995).

Considering the serious outbreak of CLF disease in South East Asia and its impacts on rubber industries, integrated disease management was focused in many of the rubber growing countries on planting of resistant clone, eradication of susceptible clones, restriction for introduction of clone, multiclonal planting, use of biological and chemical control (Mathew, 2006). Chemical control of this disease with high volume spraying is concentrated mainly on rubber nurseries and immature plantations. The fungicides like macozeb @ 2.55g/l and carbendazim @ 1g/l are at the moment recommended and adopted in the field for the control of CLF disease. Current investigations were carried out to evaluate the different bioagents, extracts of different plant species and fungicides against *Corynespora cassiicola.*

Materials and Methods

Evaluation of bioagents and plant extracts

The bioagents were evaluated by inoculating bioagents and the test fungus side by side on a single petridish containing solidified PDA medium. Inoculated plates were incubated at 28 $\pm$ 1^0 C for eight days and seven replications were maintained for each treatment. The diameter of the colony of both bioagents and the pathogen was measured in two directions and average was recorded. Per cent inhibition of growth of test fungus was calculated by using formula of Vincent (1947). For botanicals, fifty grams of fresh healthy plant parts (Table 1) collected from field were washed with distilled water and air-dried and crushed in 50 ml of sterile water. The crushed product was filtered through muslin cloth and collected the filtrate. The prepared solution gave 100 percent, which was further diluted to required concentrations of 5.0, 7.5 and 10.0 percent. The extracts were tested against *C. cassiicola* on the cultural media using poison food technique under *in vitro* condition.

Evaluation of fungicides

Thirteen fungicides were tested against *C. cassiicola* on potato dextrose agar media using poison food technique under *in vitro* condition. The fungicides were tried at 250 and 500 ppm concentrations. The poison food technique was followed to evaluate the efficacy of fungicides in inhibiting the mycelial growth of *C. cassiicola.*

Further, five most promising fungicides in *in-vitro* viz., indofil M- 45 (macozeb), bavistin (carbendazim), SAAF (macozeb+ carbendazem), score (difenconazole), contaf + captan (hexaconazole+captan) were then subjected to field evaluation. The field trials were conducted in three consecutive disease seasons in CLF disease hot spot areas. Susceptible clone RRII 105 six year old plantations were selected for the study and unsprayed control plot was also maintained. Treatments were imposed after the initiation of symptoms in the field with ten replications and four rounds of sprayings were carried out at on interval of 10 to 12 days. Spraying was undertaken using power operated horizontal double piston (HDP sprayer) high volume sprayer. The disease intensity was assessed after each round of spraying by scoring the disease in a 0 - 5 scale based on the leaf spot, leaf deformation and leaf fall (Manju *et al.*, 2001). The per cent disease index (PDI) (Mc Kinny., 1923) and disease suppression was calculated and the data was subjected to statistical analysis.

Results and Discussion

Four bioagents and five plant extracts were tested against *C. cassiicola* in laboratory conditions. Among the bio-agents tested *Trichoderma viride* and *T. harzianum* are found superior to the other bio-agents and gave fungal growth inhibition of 66.50 and 65.80 percent respectively. Similar trend of good growth inhibition was observed in *Bacillus subtilis* (60.58%) fallowed by the least growth inhibition (25.67%) was observed for *Pseudomonas fluorescens* (Fig. 1). Among the plant extracts, garlic bulb extract was found to be the best in inhibit the mycelial growth (60.50%) at 10 percent concentration and found superior to all other plant extracts tested. Neem seed kernel and onion bulb extracts also gave positive response by inhibiting the mycelial growth more than 50 percent over control. Ginger rhizome and datura leaf extracts recorded only 44.50 and 31.20 percent inhibition of mycelial growth respectively (Fig. 2).

Biological method of diseases control through antagonistic micro organisms and plant products is a potential non-chemical, cheaper and safer means of disease management which reduce not only toxicity hazards but also eco-friendly approach’s (Kumar and Gupta 1999). Many of the bio-control agents are in the field use and also it is a common practice in horticulture crops (Jan Mohd Junaid *et al.*, 2013**).** But bio-control options for foliar diseases like rust in coffee, blister blight in tea, leaf fall of rubber are not attractive as promising chemical control options ensure better protection and are economically viable (Sarma and Anandaraj 1998). Several problems exist for realisation of commercial exploitation of biological agents in deciduous tree crop like rubber as the applied antagonist on the phylloplane may not be retained over seasons. Root colonising and endophytic bacteria are the potential bioagents as they operate by stimulating the defence in advance of the pathogen (Joseph *et al.*, 1994; Cook and Baker 1983). Also application of endophytic bacteria increases the defence related enzymes such as peroxidase, polyphenol oxidase, chitinase and β-1,3 glucanase in the plants up to 10 days after challenge inoculation with *C. cassiicola* and endophytes collected from *Hevea* elicited ISR against *C. cassiicola* in rubber seedlings upon root and foliar application (Philip *et al.*, 2005). In general, continuous and indiscriminate use of pesticides in rubber plantations results in the development of resistance race of the pathogen, suppression of native beneficial microflora, ground water and food pollution. The bio-control options for plantation crops like rubber is need to be pursued on priority basis to avoid the pesticide residue problems**.**

Eight fungicides were tested at two different concentrations (ppm) against *C. cassiicola* through poisoned food technique in the laboratory. The result revealed that, there was a significant difference between chemicals tested. Among the thirteen water-based fungicides tested in the laboratory, four *viz.*, Carbendazim, Carbendazim + Mancozeb, Hexaconazole, Mancozeb and Difenconazole were found more effective against *C. Cassiicola*, showed complete inhibition of mycelial growth at 250 ppm. The fungicides

Difenconazole and Contaf + Captan are showed only 90 to 93 per cent inhibition of mycelial growth. Other fungicides recorded above 70% inhibition in the highest concentration (500 ppm) tried (Table 2).

Table.1 Details of the botanicals and plant part used in the study

Sl. No.	Plant (common name)	Scientific name	Plant part used
1.	Neem	*Azadirachta indica*	Seed kernel
2.	Datura	*Datura stramonikora*	Leaves
3.	Onion	*Allium cepa*	Bulb
4.	Garlic	*Allium sativum*	Bulb
5.	Ginger	*Zingiber officinale*	Rhizome

Table.2 *In-vitro* evaluation of different fungicides against *C. cassiicola*

Fungicides	Percent inhibition	
	250 ppm	500 ppm
Carbendazim 50 WP	100.00	100.00
Hexaconazole 5 EC	84.67	86.00
Tridemorph 80 EC	82.22	89.44
Metalaxyl MZ 72 WP	75.60	79.60
Phosphorous acid 40 EC	59.33	80.20
Mancozeb 75 WP	100.00	100.00
Copper oxychloride 50 WP	71.20	84.20
Thiram 75 WP	82.98	84.00
Carbendazim 12% + Mancozeb 63%	100.00	100.00
Difenconazole 25 EC	91.22	93.44
Hexaconazol + captan	91.22	94.44
Rovarol 50 WP	88.98	89.97
Propiconazole 25 EC	60.20	64.20
LSD at (0.01%)	0.46	0.48

Table.3 Efficacy of fungicides in CLF disease management in rubber plantation

Treatments	Final Per cent Disease intensity			
	Dosage	**Season I**	**Season II**	**Season III**
SAAF (Mancozeb+carbendazim)	2g/l	11.40	10.73	11.75
Bavistin (Carbendazim)	1g/l	14.60	12.35	12.25
Contaf+Captan (Hexaconazol+captan)	2g/l	27.10	29.70	32.00
Score (Difenconazole)	0.4ml/l	22.20	25.30	27.10
Indofil M-45 (Mancozeb)	2.55g/l	15.80	13.35	14.60
Control	Unsprayed	41.40	38.60	43.30
LSD at (0.05%)		3.60	30.40	3.48

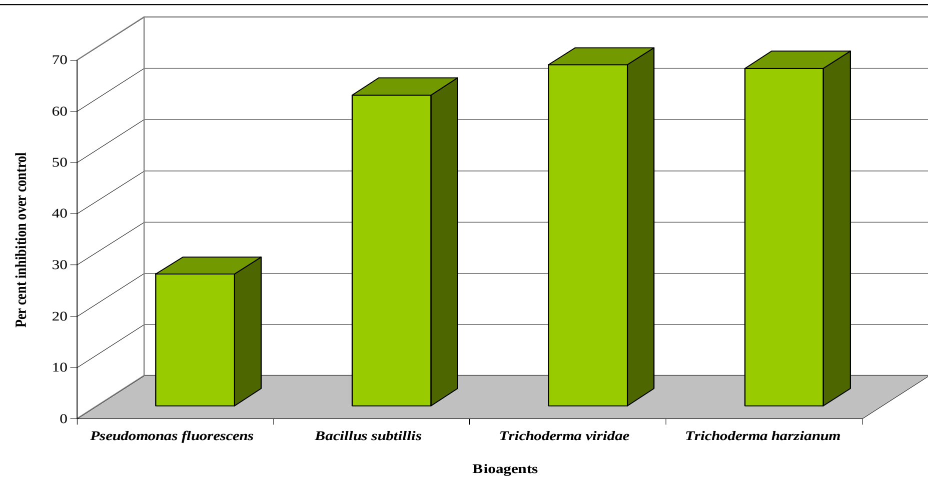


Fig. 1: ***In-vitro*** **evaluation of bio agents against *C. cassiicola***

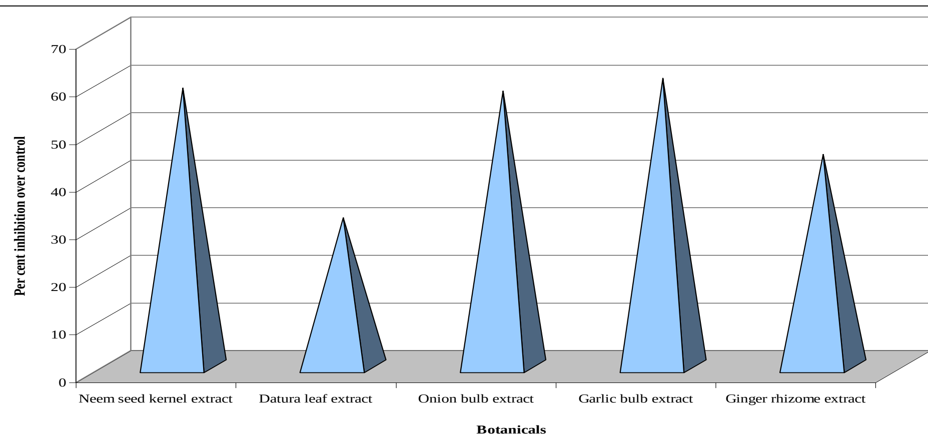
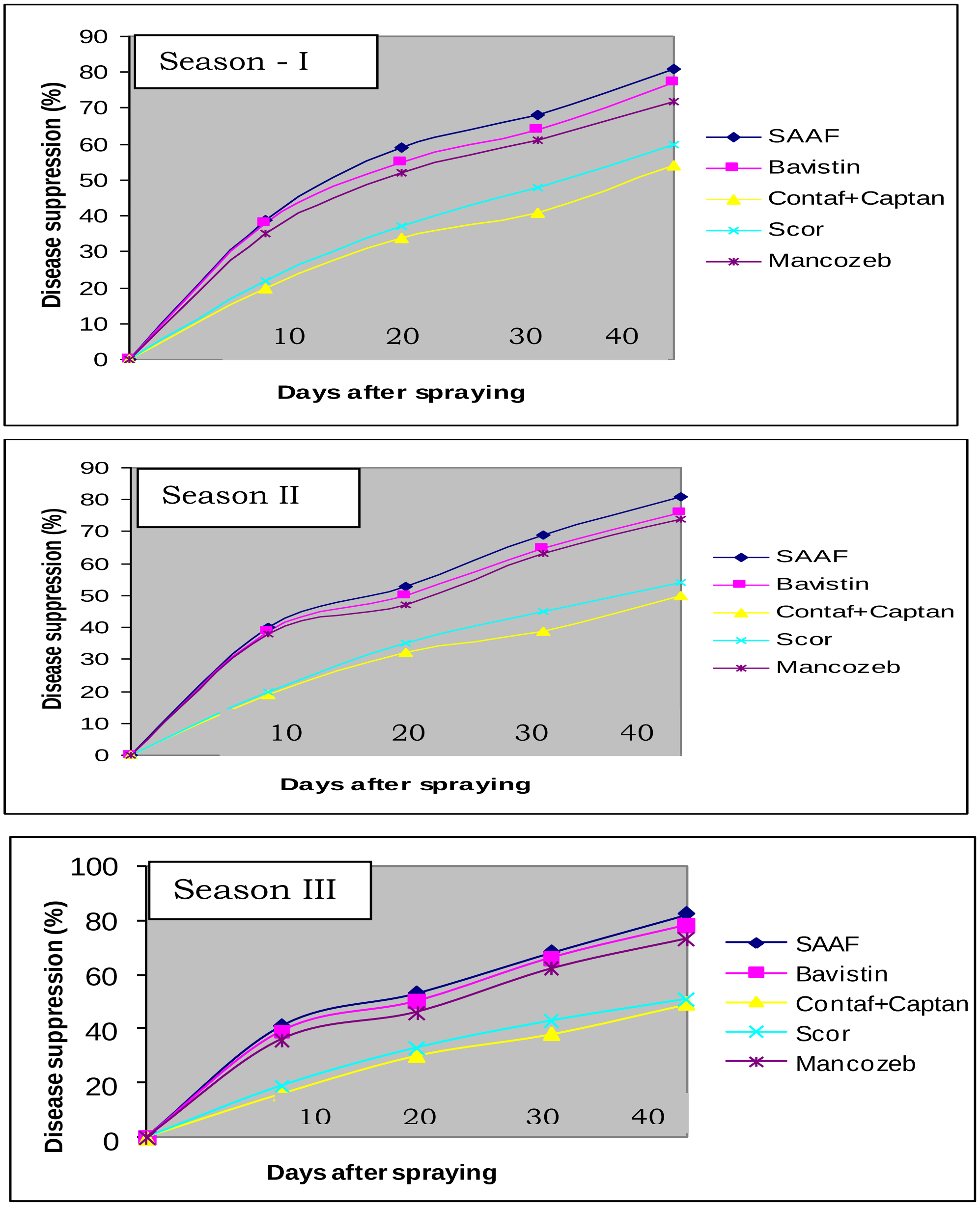


Fig. 2: ***In-vitro*** **evaluation of botanicals against *C. cassiicola***

Fig.3 Percent disease suppression after each round of spraying



Efficacy of five selected fungicides was tested against CLF disease in main field and results are presented Table 3. Results indicated that spraying of SAAF @ 2g/l (combination of macozeb + carbendazim) found to be more superior to other fungicides. The plots treated with SAAF recorded final percent disease intensity of 11.40, 10.73 and 11.75 respectively during first, second and third disease season. However, when compared to score and contaf + captan, presently recommended fungicides indofil M – 45 and bavistin are found to be useful in CLF disease management. Plots treated with indofil M – 45 recorded the disease intensity of 14.60, 13.35 and 14.60 while plots treated with bavistin recorded 14.60, 12.35 and 12.25 per cent respectively. The plots treated with score and contaf + captan recorded higher disease intensity in all the three disease seasons.

Comparative disease suppression observed after the individual rounds of spraying is presented in Figure 3. SAAF @ 2g/l showed higher rate of disease suppression in all the three season. SAAF is a fungicide that contains both contact as well as systemic action. SAAF by virtue of its systemic nature, penetrates into the plant system and improves the distribution on the surface, consequently, showing better disease control (Vyas, 1993) and it protects the younger leaves from the initial infection as well as subsequent leaf growth. The regular and repeated use of systemic/contact fungicides could lead to development of resistance in the pathogen. This can be handled safely by using efficient fungicides either in mixture or alternatively for effective disease management (Delp, 1980). Use of SAAF in immature rubber is more advisable and beneficial for better disease management than the contact/systemic single fungicides recommended for CLF disease management in immature rubber plantations.

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