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EVALUATION OF DIFFERENT FUNGICIDES AND PLANT EXTRACTS FOR MANAGEMENT OF LEAF RUST OF *QUERCUS SERRATA* THUNB CAUSED BY *CRONARTIUM QUERCUUM* MIYABE EX SHIRAI

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ABSTRACT

Commercially available seven fungicides viz. Dhanustin 50% WP (Carbendazim 50% WP), Beam (Tricyclazole 75% WP), Xantho (Hexaconazole 5 EC), Result (Propiconazole 25 EC), Kitazin 48 EC (Iprobenfos), Indofil Z 78 (Zineb 75% WP), Dhanuka M-45 (Mancozeb 75% WP) and aqueous extracts of seven medicinally valued plant species viz. Azadirachta indica (leaf), Melia azedarach (leaf), Vitex trifolia (leaf), Melothria perpusilla (leaf), Phlogacanthus thyrsiflorus (leaf), Acorus calamus (rhizome), and Zingiber officinale (rhizome) were tested to assess their efficacy on management of leaf rust of an Oak tree (Quercus serrata) caused by Cronartium quercuum under field condition. In general, foliar spray at different concentrations of fungicides and plant extracts significantly reduced the percent disease index (PDI). Application of higher concentrations of tested fungicides and the plant extracts showed better disease control. Among the fungicides, 0.3% Dhanuka was found to be the most effective, which showed the highest value (80.19%) of percent disease control (PDC) in comparison to untreated plants and leaf extract of A. indica and V. trifolia at 15% concentration were also found to be most effective recording the highest value (78.94%) of percent disease control among the plant extracts.

KEYWORDS: *Disease CONTROL, Disease Severity, Quercus Serrata, Leaf Rust, Fungicides, Plant Extracts*

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INTRODUCTION

Sericulture industry is one of the priority agro based industries in developing countries like India. For production of about 0.5 – 1.00 gm shell of oak tasar silk cocoon by silkworm *Antheraea proylei* Jolly, 72-100 gms of *Quercus serrata* Thunb. Leaves are consumed. Leaf rust caused by *Cronartium quercuum* Miyabe ex shirai is an important and major foliar disease of *Q. serrata* in Manipur (Das and Pandey, 1991) affecting silk cocoon production when fed these infected leaves to silkworms. The pathogen is heteroecious with the spermogonial and aecial states on Pinus species and the uredinial and telial states on *Quercus* and *Castanea* species (Sadato Yamazaki and Keizo Katsuya, 1987).

The disease occurs severely during the summer to autumn seasons (Srivastav and Ibohal, 2002) in Manipur when a successful rearing of oak tasar silkworm is needed to increase seed production. Leaf rust infected *Q. serrata* leaves became brittle and unfit for feeding to the silkworm *A. proylei* (Ghosh, *et al*., 1992). There is adverse effect on economic characters of mulberry silkworms when fed with disease infected leave (Naomani *et al*., 1970). The size of silkworm larvae was reduced on feeding with fungal infected leaves resulting in smaller sized cocoons as well as poor quality silk (Sullia and Padma, 1987). Not only poor silk quality but also higher mortality of silkworms was found to be associated with the feeding of fungal disease infected leaves (Manimegalai and Chandramohan, 2007). Control of foliar fungal diseases using chemical fungicides and plant extracts are available but control of leaf rust of *Q. serrata* is limited. Application of systematic fungicide Benodanil on the host tree *Pinus banksianae* just before the peak period of basidiospores production of *C. quercuum* is observed to be effective (Bergdahl and French, 1984). Many other fungicides @ 0.1% and 0.2% concentrations for two sprays which start from the initial appearance of rust disease was found reducing up to 50% in mulberry plants (Gunasekhar *et al*., 1995). The effective management of fusiforme rust of slash and loblolly pine plantations caused by *C. quercuum* f. sp. *fusiforme* was successful in USA during 1960s (Schmidt, 2003). The fungicides Triadimefon were effective to control this disease (Kelley, 1980; Rowan, 1982). Not only fungicides, plant extracts also have been used for a long time as the main strategy for management of obligate fungal diseases (Ghewande, 1989; Amaresh and Nargund 2000). Several plant extracts were found to be effective in controlling obligate plant leaf diseases including leaf rust of different plants (Minaas *et al*., 2001; Chandrasekara *et al*., 2012; Subramani *et al*., 2012). The present study was made for evaluation of commercially available seven fungicides and aqueous extracts of seven medicinally important locally available plant species in the management of leaf rust of *Q. serrata* plantations under field conditions.

MATERIAL AND METHOD

Leaf rust caused by *C. quercuum* was studied for evaluation of effect of different chemical fungicides and plant extracts in the management of the disease. The field experiment was conducted at the farm of Regional Tasar Research Station, Central Silk Board, Ministry Textiles, Government of India, Mantripukhri, Imphal. *Quercus serrata* plantations at the farm exhibited sufficient natural population of the pathogen and therefore the study was undertaken under natural conditions.

Leaf Rust Management with Fungicides and Plant Extracts

Five systemic and two non-systemic (contact) fungicides and seven widely used medicinal plants were used for evaluation of their efficacies in the management of leaf rust of *Q. serrata*. Field experiments were conducted during April to November every year as per the natural incidence of leaf diseases. Three concentrations i.e. 0.1, 0.2 and 0.3% for the fungicides and 5, 10 and 15% for the plant extracts were taken for spraying under field conditions.

Preparation of Plant Extracts

Freshly collected 100g each of healthy plant parts (leaf or rhizome) of *Azadirachta indica* A. Juss. (Verbanaceae), *Zingiber officinale* Rosc. (Zingiberaceae), *Vitex trifolia* L. Verbanaceae), *Acorus calamus* L. (Acoraceae), *Phlogacanthus thyrsiflorus* Nees. (Acanthaceae), *Melothria perpusilla* (Blume) Cogn. (Cucurbitaceae) and *Melia azedarach* L. (Meliaceae) were washed thoroughly in running tap water, surface sterilized with 70% alcohol then washed in sterile distilled water and macerated with sterile distilled water at 1:1 (w/v) ratio using mortar and pestle. The plant

extract was filtered through Whatman no. 1 filter paper.

The filtrate thus obtained was considered as 100% concentration of plant extract (Vidyasagar and Rajasab, 2001).

From this concentrated extract desired concentrations of 5%, 10% and 15% plant extracts were prepared by adding sterile distilled water.

Field Application of Fungicides and Plant Extracts

The experiment was conducted on randomized oak bushes grown in ½ acre of plot under conditions of natural infestation with seven treatments. Spacing of the bushes was 4X4 ft. The host leaves were checked at 9 -10 am for incidence of the foliar disease and at the initial stage of disease incidence the branches were tagged with replication numbers. Branches having 15-25 leaves each were selected for treatment. Spraying of fungicides and plant extracts was carried out using an atomizer in the evening hours (4-5 pm) when there was no wind current to avoid drift from the spraying leaves. Care was taken while spraying not to cross to other branches. For each treatment 3 branches from 1 bush were randomly selected and each branch was treated as a replication. The control branches were sprayed with sterilized distilled water. To prevent washing of spores from infected leaves by rainfall, transparent polythene sheets were stretched above the bushes. Spraying was performed for two times, the first spray was given at the onset of each disease while the second spray was given after 7 days of the first spray.

Observations for recording the percent disease index (PDI) for each treatment were made for three times, the first being made before the spray, the second observation was made after 7 days of the first spray while last observation was made after 7 days of the second spray.

The method of Gunashekar and Govindaiah (1994) was followed for assessment of disease rating. Percent disease index before and after spray were calculated employing the formula used by Vidyasagar and Rajasab (2001).

$$\text{Percent Disease Index (PDI)} = \frac{\text{Sum of numerical values}}{\text{Total no. of infected leave X Maximum leaves grading (5) observed}} \text{ X } 100$$

(*Numerical values are obtained from the product of number of infected leave and value of each grade*).

After recording PDI of each treatment for disease the percent disease control (PDC) was calculated by following the formula given by Munshi *et al.* (1994).

$$\text{Percent disease control (PDC)} = \frac{\text{Control PDI - Treatment PDI}}{\text{Control PDI}} \times 100$$

PDI – Percent disease index, PDC – Percent disease control

RESULTS AND DISCUSSIONS

Management of Leaf Rust Disease with Fungicides

All the tested fungicides found reducing the percent disease index significantly after two sprays. Among the different concentrations of 7 fungicides Dhanuka (Mancozeb) 0.3% prevented maximum disease index over untreated control by 80.18% after second spray followed by 0.2% concentration of the same fungicide after second spray with 72.28%, Kitazin 0.3% after second spray with 71.28%. Among the fungicides the least effective fungicide is Result 0.1% with an efficacy of 35.62% after first spray (Table 1) over the control lot.

Systematic fungicide like Benodanil treatment of the host tree just before the peak period of basidiospores production of *C. quercuum* is observed effective in control (Bergdahl and French, 1984). Triadimefon fungicide was also effective to control this disease (Kelley, 1980; Rowan, 1982). Schmidt, (2003) successfully managed the fusiforme rust of slash and loblolly pine plantations caused by *C. quercuum* f. sp. *fusiforme*. It is further noted that higher the concentration greater reduction of disease severity after the spray. However, the degree of disease reduction varied from one fungicide to another. The high effectiveness of fungicides may be due to increased permeation of chemicals into the plant leave cells and greater interaction of fungicides with the pathogens in host cells (Grover, 1986). More permeation with higher concentration might have caused more injury to cells of pathogens on the leaves resulting lesser disease severity. The best effective fungicide Mancozeb 0.3% among the fungicides in the present study regarding foliar spray in containing the disease is additional information for the management of LR disease of *Q. serrata* leave. An important point to note was that the response of fungicides was visual. After the treatment of leaves with fungicides, the leaves were found absence of active LR spore growth on the infected leaf area leaving brown colour scratch mark. These results are supported by the workers who have tried the Mancozeb 0.2% against the rust disease on ground nut crops (Patil and Kalekar, 1974; Siddaramaiah *et al.*, 1977) and its application is first successful attempt. Gunasekhar *et al*. (1995) tried many fungicides @ 0.1% and 0.2% concentrations for two sprays which start from the initial appearance of rust disease under field condition to control the leaf rust disease of mulberry plantations and found reducing up to 50%. The study revealed that different treatments significantly ($P \leq 0.05$) reduced disease severity and it may be concluded that commercial fungicide Dhanuka 0.3% spray for two times just at the initial stage of LR disease development on the leaf could provide good control of *C. quercuum* incidence on *Q. serrata* leaves.

Management of Leaf Rust Disease with Plant Extracts

Data from the table 2 revealed that extracts of all the 7 medicinally valued plant species exhibited strong antifungal activity showing significant reduction in severity of leaf rust disease on *Q. serrata* leaves. The plant extracts have been using since long time as the main strategy for management of the obligate fungal diseases (Ghewande, 1989; Amaresh and Nargund 2000). All plant extracts were found reducing leaf rust disease with varying efficacy. Data revealed that disease reduction was found highest with the extracts of 15% *A. indica* (78.94%) and *V. trifolia* (78.94%) followed by *Z. officinale* (77.90%). Minimum disease control among the 15% plant extracts were recorded with *M. azedarach* (54.75%). Among the 10% plant extracts the highest disease reduction of 76.86% was recorded with *A. indica* and minimum was recorded with *M. azedarach* (49.48%). However, highest disease reduction among 5% extracts solution spray recoded with *Z. officinale* (55.44%). The minimum disease reduction was observed with 5% *M. azedarach* (24.11%). Highest reduction of LR in mulberry plants with the extracts *A. indica* was observed by Chandrasekara *et al*. (2012). Many of plant extracts were found to be effective in controlling obligate plant leaf diseases including leaf rust of different plants (Minaas *et al*., 2001; Chandrasekara *et al*., 2012; Subramani *et al*., 2012). Plants sprayed with different extracts at the initial developmental stage of diseases significantly lower the incidence and severity than the untreated control. The effect of plant extracts might be mainly due to the inhibitory effects of the antifungal compounds in the extracts on germination of the fungal spores. The reduction of disease severity was found increased by increasing concentration of plant extracts. Increasing the reduction in disease severity by increasing concentration of the extracts might be mainly due to higher concentration of the antifungal compounds, which were present in the water extracts. Shetty *et al*. (1989) stated that the difference in activity between the extracts might be due to variation in the concentration

and composition of antifungal compounds in different plant extracts.

The study propose the inclusion of *A. indica* and *V. trifolia* leaf extracts as natural controls of leaf rust disease of *Q. serrata* leaf as an eco-friendly means.

Thus, plant extracts with antifungal activity can be conveniently used as alternative, eco-friendly methods for the management of leaf rust disease in oak plantations.

Table 1: Effect of Commercial Fungicides Spraying on Disease Severity (PDI) of Leaf Rust of *Quercus Serrata* Leave

Fungicide Conc. / Fungicide	0.1%					0.2%					0.3%				
	DI			DC		DI			DC		DI			DC	
	S0	S1	S2	S1	S2	S0	S1	S2	S1	S2	S0	S1	S2	S1	S2
Xantho	17.00 ±1.1	16.00 ±1.1	12.33 ±2.2	44.82	63.00	19.67 ±2.5	18.33 ±2.8	14.00 ±2.8	36.79	58.42	18.33 ±3.1	16.67 ±3.2	12.00 ±2.8	42.51	64.36
Kitazin	16.22 ±0.6	13.00 ±0.8	12.00 ±1.9	55.17	64.36	15.00 ±2.0	13.67 ±0.9	10.67 ±1.8	52.86	68.31	15.67 ±1.7	12.00 ±1.2	9.67 ±1.7	58.62	71.28
Indofil	21.67 ±1.6	18.00 ±1.7	14.67 ±2.6	37.93	56.43	21.33 ±1.3	17.00 ±1.1	14.67 ±2.4	41.38	56.43	22.00 ±1.2	16.67 ±1.2	14.00 ±2.3	42.52	58.42
Beam	22.67 ±0.9	18.67 ±0.6	16.00 ±2.6	35.72	52.18	22.67 ±1.4	18.67 ±0.8	14.33 ±2.3	35.62	57.11	20.67 ±1.5	14.67 ±1.2	11.33 ±2.0	49.41	66.35
Dhanustin	17.67 ±1.5	15.67 ±1.5	13.33 ±2.3	45.97	60.41	18.67 ±2.4	16.00 ±1.8	14.00 ±2.4	44.83	58.42	17.67 ±1.5	15.33 ±1.3	12.67 ±2.1	47.14	62.37
Dhanuka	15.00 ±2.5	12.33 ±2.0	10.67 ±2.2	57.48	68.31	10.67 ±2.1	8.00 ±1.3	9.33 ±1.7	60.93	72.28	15.67 ±1.5	11.33 ±0.8	9.67 ±1.7	72.41	80.19
Result	21.67 ±2.0	18.67 ±1.5	16.33 ±3.0	35.62	51.5	21.67 ±2.2	18.33 ±1.2	16.67 ±2.7	36.79	50.49	23.00 ±1.6	17.67 ±1.9	15.67 ±2.7	39.07	53.46
Control	19.33 ±1.2	29.00 ±0.8	33.67 ±1.2			19.33 ±1.2	29.00 ±0.8	33.67 ±1.2			19.33 ±1.2	29.00 ±0.8	33.67 ±1.2		
SEM(±)	2.03	1.83	1.91			2.54	2.00	1.76			2.48	2.34	1.68		
CD (p=0.05)	4.13	3.73	3.90			5.19	4.08	3.59			4.96	4.77	3.43		

DI = % Disease index; DC = % Disease control; S0 = before first spray; S1= after first spray; S2 = after second spray; ± = S.E.

Table 2: Effect of Plant Extract Spraying on Disease Severity (PDI) of Leaf Rust of *Quercus Serrata* Leave

Extract Conc. / Plant Sp	5%					10%					15%				
	DI			DC		DI			DC		DI			DC	
	S0	S1	S2	S1	S2	S0	S1	S2	S1	S2	S0	S1	S2	S1	S2
Z. off.	14.33 ±3.2	12.33 ±2.4	11.00 ±2.3	55.44	65.27	17.00 ±3.2	11.67 ±2.2	10.00 ±2.1	57.82	68.42	18.67 ±3.1	10.67 ±2.1	7.00 ±1.4	61.44	77.90
V. tri.	15.33 +3.0	13.00 +2.7	11.33 −2.1	53.02	64.22	11.67 +2.3	10.00 +2.2	8.33 +1.8	63.86	73.70	18.00 −3.1	9.33 +2.3	6.67 +1.5	66.28	78.94
A. ind.	15.67 ±2.8	13.67 ±2.8	9.00 ±2.1	50.60	71.58	14.00 ±3.0	12.00 ±2.7	7.33 ±1.8	56.63	76.86	14.67 ±2.4	8.00 ±1.4	6.67 ±1.1	71.09	78.94
P. thy.	23.00 ±3.6	18.67 ±3.1	15.67 ±3.51	32.53	50.52	20.33 ±3.9	17.33 ±3.2	15.33 ±3.5	37.37	51.59	15.67 ±3.2	13.33 ±2.6	10.67 ±1.9	51.83	66.31
M. aze.	22.67 ±3.6	21.00 ±3.4	17.67 ±2.8	24.11	44.21	23.67 ±3.9	20.67 ±3.2	16.00 ±2.7	25.3	49.48	20.33 ±3.5	17.00 ±3.1	14.33 ±3.0	38.56	54.75
A. cal.	19.33 ±3.4	19.33 ±3.1	15.33 ±2.9	30.14	51.59	23.00 ±3.8	17.33 ±3.0	14.67 ±3.0	37.37	53.68	20.67 ±3.4	17.33 ±3.0	12.33 ±2.18	37.37	59.99
M. per.	21.33 ±3.4	19.33 ±3.2	14.67 ±2.5	30.14	53.68	23.00 ±3.7	18.00 ±2.9	14.33 ±2.3	34.95	54.75	21.67 ±3.4	18.00 ±3.0	12.33 ±2.0	34.95	59.99
Control	23.67 ±1.2	27.67 ±0.9	31.67 ±0.9			23.67 ±1.2	27.67 ±0.9	31.67 ±0.9			23.67 ±1.2	27.67 ±0.9	31.67 ±0.9		
SEM(±)	2.34	2.31	2.43			2.71	2.08	1.87			2.06	2.21	1.90		
CD (p=0.05)	4.78	4.72	4.95			5.53	4.25	3.81			4.20	4.51	3.87		

Z. off.=Zingiber officianles; *V. tri. = Vitex trifolia; A. ind. =Azadirachta indica; P. thy. = Phlogacanthus thyrsiflorus; M. aze =Melia azedarach; A. cal. =Acorus calamus; M. per. =Melothria perpusilla.*

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