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Scope for biological control of powdery mildew of mulberry with *Illeis bielawskii* Ghorpade, a mycophagous coccinellid

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ABSTRACT: Mulberry powdery mildew disease caused by *Phyllactinia corylea* (Pers.) Karst is a production constraint during winter months. A mycophagous coccinellid, *Illeis bielawskii* Ghorpade was found to be associated with the disease. Population of *I. bielawskii* among mulberry varieties ranged from 2.47numbers / plant (MR2) to 15.92 / plant (Kanva 2). The egg, larval and pupal periods were 2.97, 9.00 and 3.22 days, respectively. The adult longevity was 20-25 days. The grubs and beetles actively fed on the fungus and the rate of feeding was found to be highest in adult (118.91 cm^2), followed by fourth instar grub (43.28 cm^2). Safety studies conducted revealed that there was no significant difference in hatching of eggs between control (no insecticide treatment) and the insecticide treatments, *viz.*, malathion, methyl demeton and dichlorvos. However, a mortality of 50 and 46.67 per cent was observed when grubs were fed with mildew affected leaves treated with malathion and dichlorvos. To be effective as a biocontrol agent, it should not behave as a vector. Studies conducted on disease-vector relationship revealed that *I.bielawskii* does not have any significant role in disseminating the powdery mildew pathogen, *P. corylea*.

KEY WORDS: Feeding rate, grub mortality, hatchability, *Illeis bielawskii*, *Phyllactinia corylea*, mulberry, vector.

INTRODUCTION

Mulberry (*Morus alba* Linn.) constitutes the sole food plant of mulberry silkworm, *Bombyx mori* Linnaeus. It is a fast growing plant with leaves rich in protein, sugars and moisture essential for high yield of cocoons. The nutrient content is highly affected by a number of foliar diseases, among which powdery mildew caused by *Phyllactinia corylea* is serious and the loss due to the disease is estimated to be 10–15per cent. Feeding of mildew affected leaves adversely affected the growth and health of silkworm resulting in partial or complete failure of the cocoon crop (Noamani *et al.*, 1970). The fungicide carbendazim is effective against the disease. However, a safe period of 10 days is essential (Dandin, 2000). The fungus also has a wide host range and hence biological control with the mycophagous coccinellid *Illeis bielawskii* Ghorpade can be the best suited management strategy under mulberry ecosystem. It is a yellow coloured beetle distinguished by its hemi-spherical shape, absence of two black spots on the pronotum and greyish patch on the elytral disc (Ghorpade, 1976). Kumar *et al.* (2000) observed the beetle feeding on *P. corylea*. They also reported that the mycelia of the fungus did not degenerate on mildew cleared leaves

as a result of feeding by the beetle. Very little information is available on the biological control of powdery mildew with *I. bielawskii*. The present study was focussed on the assessment of the population of *I.bielawskii,* studying the biology under laboratory conditions, determining the predatory potential, finding the safety of insecticides to various stages of *I. Bielawskii* and determining the role of *I. bielawskii* as a vector.

MATERIALS AND METHODS

Population assessment

In situ counts on the immature stages (eggs, grubs and pupae) of *I. bielawskii* were made on 30 plants @ 10 plants / replication for a particular mulberry variety and expressed as number per plant.

Development period and predatory potential

The culture of *I. bielawskii* was maintained in the laboratory on potted plants. Twenty newly hatched larvae of *I. bielawskii* were utilized to conduct studies on the development period on *P. corylea.* Each larva was considered as a replicate. Mildew affected leaves were collected from infested plants and brought to the laboratory. A bouquet was prepared with individual leaves and kept in a round bottomed plastic jar covered with a lid. A single larva was released on the infested leaves kept in the jar. Fresh leaves covered with mildew were offered until pupation of *I. bielawskii.* For predatory potential, 20 cm^2 mildew affected leaf bits were provided every day. The area fed was determined using graphical method.

Safety of insecticides to *I. bielawskii*

Dichlorvos 76 WSC is normally used in the mulberry ecosystem due to its high LD_{50} value and quick dissipation. Hence, studies were conducted to study the effect of insecticides, *viz.,* dichlorvos malathion, methyl parathion, quinolphos and fenthion on eggs and grubs of *I. bielawskii.* Five ml of the required concentration of insecticides was sprayed on filter paper discs and air dried. Eggs of *I. bielawskii* were released in three replications @ 100 numbers / replication and observed for hatching. Mildew affected leaves were dipped in insecticide solution, air dried and fed to the grubs and the mortality was recorded after 24 hrs. The data obtained are subjected to statistical analysis using Duncan's Multiple Range test (DMRT).

Role as vector

An experiment was conducted under screen house condition to study whether the mycophagous coccinellid, *I. bielawskii,* disseminates the powdery mildew pathogen. Ten numbers of 75 days old potted plants (Healthy/ Infected) of Kanva 2 variety of mulberry were used for each treatment. One-day-old adults of *I. bielawskii* were released @ 10 nos./ plant for the two treatments, *viz.,* infected plant+ *I. bielawskii* and healthy plant + *I. bielawskii.* Observations were made on Per cent Disease Index (PDI) at 7 and 14 days after treatments. PDI was calculated based on the formula, PDI = Sum of all numerical rating (grades)

Total number of leaves x maximum disease rating

The infected leaves were graded based on the disease intensity.

Grade 1 = No disease, Grade 2 = 1-5% of leaf area affected, Grade 3 = 6-20% of leaf area affected, Grade 4 = 21-50% of the leaf area affected, Grade 5 = 51% and above leaf area affected.

RESULTS AND DISCUSSION

Population assessment

The population of *I. bielawskii* was high (14.06 / plant) on S1 and Kanva 2 (15.92 / plant) varieties of mulberry indicating that these two varieties were more susceptible to powdery mildew (Table 1). The population was lower on V1, DD and MR2 varieties of mulberry, MR 2 being a mildew resistant variety. Manimegalai *et al.* (2006) reported that the incidence of *P. corylea* was least in MR 2 and V1 varieties of mulberry followed by DD.

Table 1. Population of *I. bielawskii* on different varieties of mulberry

Varieties	Population* of *I. bielawskii* (Nos./ plant)				Mean
	Year				
	2003-04	2004-05	2005-06	2006-07	
VI	4.32	5.37	2.70	1.15	3.39
DD	1.86	2.83	2.37	2.92	2.50
Kanva 2	17.8	19.12	11.47	15.27	15.92
MR 2	3.32	4.51	1.16	0.90	2.47
S1	15.62	21.40	6.31	12.92	14.06
Palladam local	10.12	9.16	6.69	8.97	8.74
S54	13.16	11.00	11.82	10.59	11.64
SE.d	1.12	1.20	0.96	1.07	1.14
CD(0.05)	2.46	2.62	2.15	2.32	2.27

* Number of eggs, grubs and pupae / plant

Table 2. Development of *I. bielawskii* on mulberry powdery mildew fungus, *P. corylea*

Stage / Instar	Duration in hours (Mean ± SE)
Egg	71.3±1.23 (2.97)
Larva	
I instar	47.60±1.17 (1.98)
II instar	24.00±0.94 (1.00)
III instar	47.80±1.23 (1.99)
IV instar	96.90±1.37 (4.03)
Pupa	77.2±5.53 (3.22)
Adult	480-600 (20-25)

Figures in parentheses are duration in days.

Development period and predatory potential

The egg, larval and pupal periods of *I. bielawskii* were 2.97, 1.98, 9.0 and 3.22 days, respectively, when cultured on *P. corylea*. The adult lived for 20-25 days (Table 2). Kumar *et al.* (2000) reported four larval instars. The present result is in line with the findings of Geetha *et al.* (1990) who reported that the larval period of *I. bielawskii* was 8.4-8.8 days. The data on mean leaf area fed by different instars are given in Table 3. The feeding efficiency of first, second and third instars was comparatively poorer than that of the fourth instar (1074 mm^2/ day). Geetha *et al.* (1999) also reported that the feeding efficiency was higher in fourth instar. The predatory potential was highest (118.91 cm^2) for adults followed by fourth instar (43.28 cm^2). The consumption increased with the age of *I. cincta* larva. A mean total area of 51.56 cm^2 was consumed by a single larva during its development.

Table 3. Feeding rate /efficiency of *I. bielawskii* on *P.corylea*

Stage/instar	Feeding efficiency (mm^2) of fungus / day	Feeding efficiency (cm^2) of fungus (throughout the particular instar in grub and adult stage)
Grub		
I	28.00[e]	0.55[d]
II	85.40[d]	0.85[d]
III	346.00[c]	6.88[c]
IV	1074.00[a]	43.28[b]
Adult	594.53[b]	118.91[a]
CD (P = 0.05)	8.17	3.42

Table 4. Effect of insecticides on the egg hatchability and larval mortality of *I. bielawskii*

Insecticides (ml/l)	Hatchability (%)	Mortality (%) 24 hrs after treatment
Malathion (2 ml/l)	90.00[a]	46.67[b]
Methyldemeton (2 ml/l)	86.00[ab]	50.00[b]
Dichlorvos (2 ml/l)	91.00[a]	100.00[c]
Quinalphos (2 ml/l)	82.00[b]	100.00[b]
Fenthion (2ml/l)	84.00[b]	90.00[c]
Control	94.00[a]	0.00[a]

In a column, means followed by the same letter(s) are not significantly different by DMRT (P = 0.05).

Table.5. Disease-vector relationship of mulberry powdery mildew with *I. bielawskii*

Treatment	Percent Disease Index (PDI)			
	Initial	7 DAT	14 DAT	Per cent increase
Infected (5) +Healthy Plant (5)	0.00[a]	26.24[ab]	32.96[b]	32.96[c]
Infected plant (10)+ *I. bielawskii*	60.20[b]	64.12[b]	67.26[b]	7.06[b]
Healthy plant (10)+ *I. bielawskii*	0.00[a]	3.39[a]	4.16[a]	4.16[ab]
Control-Infected plant (10)	61.13[b]	63.46[b]	65.61[b]	4.48[a]
Control-Healthy plant (10)	0.00[a]	1.22[a]	3.28[a]	3.28[ab]

Figures in parentheses indicate the number of mulberry plants.; DAT- Days after treatment; In a column, means followed by the same letter(s) are not significantly different by DMRT (P = 0.05).

Disease-vector relationship of *I. bielawskii* on mulberry

The increase in PDI recorded in the treatment healthy plant + *I. bielawskii* was 4.16 per cent as against 3.28 per cent in healthy plants (Table 5). Similarly, 7.06 per cent increase in PDI was recorded in the treatment, infected plant + *I. bielawskii* compared to 4.48 per cent in infected plant alone. This study was attempted for the first time and the results revealed that *I. bielawskii* does not have any significant role in disseminating *P. corylea*.

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