ISSN: 0976-1675

www.rjas.org

Research Journal of Agricultural Sciences

© Centre for Advanced Research in Agricultural Sciences

Research Paper

DI: 6158-2805-205

Eco-friendly Management of Mealy Bug (*Maconellicoccus hirsutus* Green) on Som Plant (*Machilus bombycina* King) using Bio-pesticides

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Received: 28 May 2020; Revised accepted: 03 July 2020

A B S T R A C T

A field experiment was conducted under Uttar Banga Krishi Viswavidyalaya at Pundibari, Coochbehar, West Bengal, India to study seasonal occurrence of mealy bug (*Maconellicoccus hirsutus* Green) on som plant *(Machilus bombycina* King) and its management using bio-pesticides. The mealy bug was active throughout the year. The peak population of mealy bug (18.68/3 leaves) was recorded on 10th standard meteorological week i.e. on 2nd week of March. Correlation co-efficient (r) study between pest population with environmental parameter showed that there was significant positive (+) correlation with temperature difference and significant negative (-) correlation with temperature (minimum and average) and relative humidity (maximum, minimum and average). On the other hand, non-significant negative (-) correlation found between mealy bug population and maximum temperature. Bio-efficacy of different treatments against mealy bug showed that Imidacloprid (CONFIDOR 17.8 SL) 1 ml/ 5L was found superior for management of mealy bug (77.39% reduction of mealy bug population) followed by Azadirachtin (NIMARIN 1500 ppm) 2.5 ml/L (57.38% reduction of mealy bug population). However botanical extract of tobacco 50.00 ml/L (5%) (50.48% reduction of mealy bug population), Garlic 50.00 ml/L (5%) (48.73% reduction of mealy bug population), Spilanthes 50.00 ml/L (5%) (45.40% reduction of mealy bug population), polygonum 50.00 ml/L (5%) (40.91% reduction of mealy bug population) and Pongamia 50.00 ml/L (5%) (30.37% reduction of mealy bug population) were found satisfactory to manage the pest.

Key words: Abiotic factors, Botanical extracts, Mealy bug, Organic cultivation, Seasonal occurrence

Muga silk worm (*Antheraea assama* Westwood) primarily feeds on Som (*Machilus bombycina* King) plant (Bhattacharya *et al.* 1993, Tikader and Rajan 2012). The plant is very prone to attacked by different type of insect pests like gall insect, stem borer, leaf defoliating beetle, aphid, leaf miner, leaf roller, red tree ant etc. (Borgohain 2015). Kumar *et al.* (2011) found that som plant is infested by shoot borer, trunk borer, leaf miner, leaf gall and mealy bug. Due to attack of insect-pests it becomes difficult for the farmers to conduct silk worm rearing (Singh *et al.* 2000). Application of insecticides for the insect-pests control is not advocated as their residual effects is harmful for the silk worm (Subharani and Jayaprakash 2015). Botanical insecticide like onion, garlic, zinger, custard apple, turmeric, chrysanthemum, neem, pongamia, tobacco etc. have used for the management of insect-pest in sericulture (Singh and Saratchandra 2005). Ghosh and Senapati (2002) reported that Azadirachtin / neem found moderate control of flea beetle (41.70%) on eggplant in terai region of West Bengal, India. Azadirachtin and extracts of Polygonum were found moderate to higher flea beetle control, recording more than 50% mortality (Ghosh 2014). *Polygonum*, locally known as "Biskanthali" (Sarkar and Mukherjee 2005) and its crude leaf and flower extracts of *Polygonum hydropiper* are responsible for mortality of *Heterotermes indicola* and *Coptotermes heimi* (Badshah *et*

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al. 2005). Ghosh *et al.* (2009) found that *Polygonum* plant extracts provided 59.77% aphid suppression in ladys finger field. Nicotine is another promising botanical pesticide (Ujvary 1999) and found effective against *Bemisia tabaci* Genn. (Dhaliwal and Arora 2001). A rapid degradation of persistency was found in Imidacloprid which was very important for pest control (Ghosh *et al.* 2012). Considering the economic importance present studies on seasonal occurrence of mealy bug (*Maconellicoccus hirsutus* Green) on som plant *(Machilus bombycina* King) and its management using bio-pesticides were undertaken.

MATERIALS AND METHODS

The field experiment was conducted under Uttar Banga Krishi Viswavidyalaya (State Agricultural University) at Pundibari, Coochbehar, West Bengal, India to study seasonal occurrence of mealy bug (*Maconellicoccus hirsutus* Green) on som plant (*Machilus bombycina* King) and its management using bio-pesticides for two years. The experimental area was situated between 25°57' and 27°N latitude and 88°25' and 89°54' E longitude at terai zone of West Bengal. The soil of the experimental field was sandy loam with pH 6.9.

Seasonal incidence of mealy bug

To study the seasonal incidence of mealy bug on som plant and their influence on weather condition, some randomly selected som plants were taken. Som plants were grown under recommended agronomic practices without adopting any plant protection measures. The plants were fertilized once a year (90 g Urea + 140 g Single Super Phosphate + 30 g Muriate of potash / plant) after the first rain and spacing was maintain as 3 m × 3 m in 5 m × 5 m sized plots containing 4 plants with three replications. Mealy bug population was recorded per 3 leaves basis from top, middle and bottom leaves from four randomly selected plants per replication at seven days interval (standard meteorological week) throughout the year. The readings were started in the month of January and ended in December in both the years. Recorded data were presented graphically with important weather parameters like temperature, relative humidity. Correlation co-efficient (r) was worked out between incidence of mealy bug and important weather parameters during the period to find out influence of weather on population fluctuation.

Bio-efficacy of plant extracts (botanicals) against mealy bug

To study bio-efficacy of plant extracts, there were seven pesticides were taken with three sprays at ten days interval was made for each pesticide. Spraying had been done in the month of March-April starting with the initiation of infestation of mealy bug. Som plants were grown under recommended agronomic practices. The plants were fertilized once a year (90 g Urea + 140 g Single Super Phosphate + 30 g Muriate of potash / plant) after the first rain and spacing was maintain as 3 m × 3 m in 5 m × 5 m sized plots containing 4 plants. The treatments were replicated three times in a randomized block design.

Treatments details are given here under

Treatments	Dose ml/L (%)
T_1: *Polygonum hydropiper*	50.00 ml/L (5%)
T_2: *Pongamia pinnata*	50.00 ml/L (5%)
T_3: Azadirachtin (NIMARIN 1500 ppm)	2.5 ml/L
T_4: Garlic (*Allium sativum*)	50.00 ml/L (5%)
T_5: Imidacloprid (CONFIDOR 17.8 SL)	1 ml/ 5L
T_6: Tobacco (*Nicotiana tabacum*)	50.00 ml/L (5%)
T_7: *Spilanthes paniculata*	50.00 ml/L (5%)
T_8: Untreated control	-

Five botanical extracts (prepared by following certain methodology), viz. *Polygonum hydropiper* floral parts, *Pongamia pinnata* leaves, Garlic bulb (*Allium sativum*), Tobacco (*Nicotiana tabacum*) leaves and *Spilanthes paniculata* floral parts, one plant based insecticide formulation, Azadirachtin (NIMARIN 1500 ppm) were evaluated and compared with the chemical insecticide, Imidacloprid (CONFIDOR 17.8 SL).

Preparation of plant extracts

Polygonum (*Polygonum hydropiper*) plants were collected from Uttar Banga Krishi Viswavidyalaya Campus. The floral parts of the plant were separated and dried out in sunlight for three days. Then it was made powder form by a mixture grinder. 50 g of powder was taken into conical flask (500 ml) and mixed with 250 ml of methanol. The material was allowed to stand for 72 hours at room temperature with occasional stirring. After 72 hours the extract was filtered through Whatman 42 filter paper and residues was washed twice with methanol. Pongamia (*Pongamia pinnata*) leaves, garlic (*Allium sativum*), spilanthes (*Spilanthes paniculata*) (floral parts) were extracted in methanol in the same way. The tobacco (*Nicotiana tabacum*) leaves were extracted in water as follows. The leaves were dried and powdered in a grinder. The powdered sample (100 g) were transferred to a container and dipped in 1000 ml water. The material was allowed to stand for 72 hours at room temperature with occasional stirring. After 72 hours the extract was filtered through Whatman 42 filter paper and added 15 ml liquid soap.

Data recording

To study bio-efficacy of plant extracts, mealy bug population were recorded 3, 6, and 9 days after each spraying. Total mealy bug population per 3 leaves from top, middle and bottom leaves from four randomly selected plants per replication was recorded. The results were expressed as mealy bug population reduction percentage compared to population recorded on control plot. Percent reduction of mealy bug population over control was calculated by the following formula (Abbott 1925).

$$Pt = \frac{Po - Pc}{100 - Pc} \times 100$$

Where, Pt = Corrected mortality, Po = Observed mortality and Pc = Control mortality.

Data were analyzed by using INDO-STAT software for analysis of variance following randomized block design treatment means were separated by applying CD Test (critical difference) at 5% level of significance.

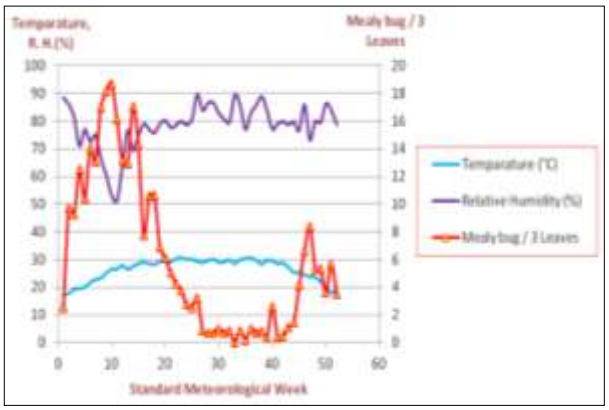

Fig 1 Seasonal incidence of mealy bug population as influenced by temperature and relative humidity

RESULTS AND DISCUSSION

Seasonal incidence of mealy bug

The average data of mealy bug population for the two years found that the pest was active throughout the year. Higher population level of the pest was found during 2nd to 18th standard meteorological week i.e. 2nd week of January to 1st week of May and lower population level of the pest was found during 27th to 44th standard meteorological week i.e. 1st week of July to 1st week of November. The peak population (18.68/3 leaves) was recorded on 10th standard week and it was on 2nd week of March (Fig 1).

Correlation between mealy bug and environmental parameters

Correlation studies (Table 1) between mealy bug population and environmental parameter revealed that mealy bug population had a significant positive (+) correlation with temperature difference while significant negative (-) correlation with temperature (minimum and average) and relative humidity (maximum, minimum and average). On the other hand, non-significant negative (-) correlation found between mealy bug population and maximum temperature. This indicates that activity of mealy bug population decreased with the rise of temperature and relative humidity.

Table 1 Correlation co-efficient between mealy bug and environmental parameters

Environmental parameter		Correlation co-efficient (r)	Co-efficient of determination (R^2)	Regression equation
Temperature °C	Maximum	-0.171	0.029	Y= -0.33x + 16.38
	Minimum	-0.435**	0.189	Y= -0.662x + 16.14
	Difference	0.577**	0.332	Y= 1.073x - 3.661
	Average	-0.352**	0.124	Y= -0.498x + 19.28
Relative humidity (%)	Maximum	-0.559**	0.312	Y= -0.449x + 43.55
	Minimum	-0.839**	0.703	Y= -0.457x + 39.72
	Average	-0.777**	0.603	Y= -0.540x + 48.44

*Significant at 5% level of significance; **Significant at 1% level of significance

Table 2 Efficacy of plant extracts against mealy bug on Som plant

Treatments	Dose ml/Liter (%)	Over all efficacy (% reduction or increase) 1st Year					Over all efficacy (% reduction or increase) 2nd Year				
		Pre-treatment Obs. mealy bug/3 leaves	3 DAT	6 DAT	9 DAT	Mean	Pre-treatment Obs. mealy bug/3 leaves	3 DAT	6 DAT	9 DAT	Mean
T_1: Polygonum	50.00 ml/L (5%)	14.57	52.11 (45.84)	37.33 (37.63)	33.23 (35.16)	40.89 (39.54)	12.42	51.94 (46.12)	38.07 (38.06)	32.78 (34.83)	40.93 (39.67)
T_2: Pongamia	50.00 ml/L (5%)	15.83	31.51 (34.13)	30.63 (33.54)	29.63 (32.89)	30.59 (33.52)	10.56	31.15 (33.90)	30.64 (33.53)	28.70 (32.33)	30.16 (33.25)
T_3: Azadirachtin (NIMARIN 1500 ppm)	2.5 ml/L	13.87	66.31 (54.57)	58.85 (50.11)	45.79 (42.56)	56.98 (49.08)	12.91	65.70 (54.23)	58.71 (50.04)	48.94 (44.38)	57.79 (49.55)
T_4: Garlic	50.00 ml/L (5%)	12.89	53.52 (47.03)	50.97 (45.56)	43.66 (41.32)	49.38 (44.64)	11.53	52.65 (46.52)	48.23 (43.99)	43.40 (41.14)	48.09 (43.88)
T_5: Imidaclorprid (C0NFIDOR 17.8 SL)	1 ml/ 5L	16.67	81.01 (64.24)	86.74 (68.76)	64.34 (53.35)	77.36 (62.12)	13.67	80.66 (63.97)	85.73 (67.96)	65.88 (54.32)	77.42 (62.08)
T_6: Tobacco	50.00 ml/L (5%)	15.52	52.18 (46.26)	50.31 (45.18)	48.56 (44.17)	50.35 (45.20)	10.53	51.44 (45.84)	50.74 45.42)	49.66 (44.83)	50.61 (45.36)
T_7: Spilanthes	50.00 ml/L (5%)	13.71	50.59 (45.34)	48.03 (43.87)	40.11 (39.26)	46.24 (42.82)	11.98	49.79 (44.88)	47.22 (43.39)	36.70 (37.23)	44.57 (41.83)
T_8: Untreated control	---	15.47	0.00	0.00	0.00	0.00	12.63	0.00	0.00	0.00	0.00
S Em (±)	---	---	1.67	1.66	1.77	---	---	1.91	2.18	2.33	---
CD at 5%	---	NS	5.15	5.13	5.46	---	NS	5.90	6.72	7.20	---

Bio-efficacy of plant extracts (botanicals) against mealy bug

The different treatments and their persistence at different days after application varied significantly in their suppression of mealy bug populations (Table 2-3). Among the seven pesticides evaluated (Table 3) under the present investigation Imidaclorprid was found most effective against mealy bug providing 77.39% suppression, closely followed by Azadirachtin providing 57.38% suppression. Mandal *et al.* (2016) reported that Imidacloprid and Azadirachtin were found effective against sucking pest thrips on som plants recording 75.18% and 64.94% control respectively. Ghosh *et al.* (2016) found that Imidacloprid and Azadirachtin were also very effective on another sucking pest aphid on som plant recording 82.46% and 71.62% control respectively. These results supported the present findings. From over all observation it was revealed that extracts of tobacco, extracts of garlic, extracts of *Spilanthes* and extracts of *Polygonum* plant gave satisfactory results, recording about 50.48%, 48.73%, 45.40% and 40.91% mealy bug suppression respectively. Mandal *et al.* (2016) also reported that plant extracts were found moderate thrips (sucking pest like mealy bug) control. Least effectiveness against mealy bug was recorded from *Pongamia* leaf extracts providing 30.37% suppression.

Table 3 Overall efficacy of plant extracts against mealy bug on Som plant
(Grand Mean of Two years)

Treatments	Dose ml/Liter (%)	Over all efficacy (% reduction or increase)				
		Pre-treatment Obs. mealy bug / 3 leaves	3 DAT	6 DAT	9 DAT	Mean
T_1: Polygonum	50.00 ml/L (5%)	13.49	52.02 (45.98)	37.70 (37.84)	33.00 (34.99)	40.91 (39.60)
T_2: Pongamia	50.00 ml/L (5%)	13.19	31.33 (34.01)	30.63 (33.53)	29.16 (32.61)	30.37 (33.38)
T_3: Azadirachtin (NIMARIN 1500 ppm)	2.5 ml/L	13.39	66.00 (54.40)	58.78 (50.07)	47.36 (43.47)	57.38 (49.31)
T_4: Garlic	50.00 ml/L (5%)	12.21	53.08 (46.77)	49.60 (44.77)	43.53 (41.23)	48.73 (44.26)
T_5: Imidaclorprid (C0NFIDOR 17.8 SL)	1 ml/ 5L	15.17	80.83 (64.10)	86.23 (68.36)	65.11 (53.83)	77.39 (62.10)
T_6: Tobacco	50.00 ml/L (5%)	13.02	51.81 (46.05)	50.52 (45.30)	49.11 (44.50)	50.48 (45.28)
T_7: Spilanthes	50.00 ml/L (5%)	12.84	50.19 (45.11)	47.62 (43.63)	38.40 (38.24)	45.40 (42.32)
T_8: Untreated control	---	14.05	0.00	0.00	0.00	0.00
S Em (±)	---	---	1.79	1.92	2.05	---
CD at 5%	---	NS	5.52	5.92	6.33	---

Mealy bug is a sucking pest and causes heavy damage to the leaves of the som plant through the year. Higher population level was maintained during 2nd standard week to 18th standard meteorological week i.e. 2nd week of January to 1st week of May and peak population (18.68/3 leaves) was recorded on 10th standard week that is on 2nd week of March. Correlation studies between mealy bug population and environmental parameter revealed that mealy bug population had a significant positive (+) correlation with temperature difference while significant negative (-) correlation with temperature (minimum and average) and relative humidity (maximum, minimum and average). On the other hand, non-significant negative (-) correlation found between mealy bug population and maximum temperature. This indicates that activity of mealy bug population decreases with the rise of temperature and relative humidity. Imidaclorprid was found to be most effective against mealy bug providing more than 75% suppression however Tobacco leaf extracts gave a satisfactory mealy bug control, recording more than 50% suppression. But Imidaclorprid is a highly toxic synthetic insecticide, so there is a possibility to contaminate som plant leaf with the toxic chemicals, as som leaf is the major food component of muga silk worm rearing. Plant extracts are biological origin, eco-friendly and so can be incorporated in IPM programme against mealy bug on som plant.

Acknowledgements

This study was carried out with the support of the Department of Agricultural Entomology, Uttar Banga Krishi Viswavidyala and providing laboratory for the study. We thank the Department, as well as all those who have contributed to it.

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