Persian Journal of Acarology, 2015, Vol. 4, No. 4, pp. 425–435.

Article

Evaluation of some indigenous plant extracts against red spider mite, *Oligonychus coffeae* Nietner (Acari: Tetranychydae) in tea

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Abstract

An experiment was conducted to evaluate the toxicity of some locally available indigenous plants such as Bishkatali (*Polygonum hydropiper*), Burweed (*Xanthium strumarium*), Datura (*Datura metel*), Lantana (*Lantana camara*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) at 2.5, 5.0 and 10.0% (w/v) concentrations against red spider mite, *Oligonychus coffeae* under both laboratory and field conditions at Bangladesh Tea Research Institute, Srimangal, Moulvibazar during 2012–2013. Effect of plant extracts on mortality of two natural predators of *Stethorus gilvifrons* (Coccinellidae) and *Oxyopes* sp. (Oxyopidae) and quality of made tea by organoleptic test were also studied. Data were collected at 24 HAT (Hours After Treatment), 48 HAT, 72 HAT in the laboratory and at weekly interval in field condition. Results revealed that aqueous extract of *X. strumarium* showed the highest average mortality (89.66%) of red spider mite at 10% concentration after 72 HAT followed by *S. mahagoni* (86.21%) whereas aqueous extracts of *P. hydropiper*, *D. metel*, *L. camara* and *A. indica* exhibited pronounced acaricidal action (69.94–81.24%) at 72 HAT at the same concentration. Similar trend of toxicity was also observed at 24 HAT and 48 HAT. From the field evaluation it was found that the highest (82.27–83.72%) reduction in mite population was observed at 10% concentrations of *X. strumarium* followed by *S. mahagoni* (79.47–80.94%). The order of toxicity of the tested aqueous plant extracts on adult red spider mite was: *X. strumarium* > *S. mahagoni* > *P. hydropiper* > *L. camara* > *A. indica* > *D. metel* in both laboratory and field conditions. Application of the tested biopesticides did not affect the natural predators such as *Stethorus gilvifrons* and *Oxyopes* sp. at 10% of concentration. Made tea produced from plant extracts treated shoots were found above average quality and taint free when subjected to organoleptic evaluation. These indigenous plants can therefore be incorporated in the integrated pest management (IPM) strategy of red spider mite and reduce the load of synthetic chemicals in tea ecosystem.

Key words: Tea; red spider mite; *Oligonychus coffeae,* botanicals; toxicant; bio-pesticide; IPM.

Introduction

Red spider mite, *Oligonychus coffeae* Nietner (Acari: Tetranychidae) is one of the major and serious pests of tea in Bangladesh (Ahmed 2005; Mamun 2011). Hundreds of spider mites are found on the upper and undersurface of every tea leaf, together with thousands of eggs. Red spider mites are responsible for depredation of yield and debilitation of tea plants causing considerable crop loss. It is estimated that 9.57% crop loss occurred due to this pest (Ali *et al*. 1994). Most of the valley circles reported severe infestation of red spider mites which are more prevalent and alarming round the year for the tea industry in Bangladesh (BTB 2014). The larvae, nymphs and adult mites cause the damage in the mature leaves of tea plants. When large numbers of mites are present, sucking one leaf cell after another and sucking out the contents, the whole leaf eventually changes to a bronze colour, dries up and drops - especially in hot and dry weather.

To combat these problems, pesticides under different groups i.e. organochlorines, organophosphates, pyrethroids, carbamates and some unclassified group have been used in the tea fields since 1960. Different group of pesticides such as sulphur, ethion, quinalphos, propargite, abamectin, dimethoate, fenvalerate, fenpropathrin, fenazaquin, bifenthrin, hexythiazox, spiromesifen and fenpyroxymate, etc. are being used as the commonly used miticides for the control of red spider mite in tea plantation in Bangladesh (Mamun *et al*. 2014a). The large-scale use of synthetic insecticides in tea plantation leads to adverse effects such as development of pesticide resistance, frequent pest out breaks, emergence of new pests, pollution and health hazards and undesirable residues in the finished products. In order to search an environmentally safe alternative, scientists considered the pesticides of biological origin in the place of synthetic insecticides. Replacement of synthetic insecticides by bio-rational insecticide is a universally acceptable and practicable approach worldwide (Rathi and Gopalakrishnan 2006). The various components of the IPM practices in tea with a few specific examples are described by Mamun *et al*. (2014b), since the success stories with the use of IPM practices are numerous and increasing day by day. In this context, biopesticides are being considered as environmentally safe, selective, biodegradable, economical and renewable alternatives for use in IPM programmes in tea.

Biopesticides are natural plant products which are environmentally safe, less hazardous, economic and easily available. Certain products derived from indigenous plants may be used for tea pest control. The pool of plants possessing insecticidal substances is enormous (Kabaru and Gichia 2001). Biopesticides are belong to the so called secondary metabolites, which include alkaloids, terpenoids, phenolics, and minor secondary chemicals. It is estimated that the plants may contain as many as 4,000,000 secondary metabolites. Over the past 50 years, more than 2,000 plant species belonging to different families and genera have been reported to contain toxic principles, which are effective against insects (Isman 1997). Twenty-five of these plants species possess the characteristics required for an ideal botanical insecticide and are therefore more promising for use in tea pest control programmes (Radhakrishnan 2005). Recently, Mamun and Ahmed (2011) reviewed some works on botanicals and their usage in tea pest management. They reported that botanicals like Basaka (*Adhatoda vasica*), Bazna *(Zanthoxylum rhetsa)*, Bhat (*Clerodendron infortunatum*), Bonkalmi (*Ipomoea maxima*), Bishkatali (*Polygonum hydropiper*), Burweed (*Xanthium strumarium*), Datura (*Datura metel*), Durba (*Cynodon dactylon*), Eucalyptus (*Eucalyptus globulus*), Ghora-neem *(Melia sempervirens)*, Hijal *(Barringtonia acutangula)*, Karanja *(Pongamia pinnata)*, Lantana (*Lantana camara*), Mahogoni *(Swietenia mahagoni)*, Marigold (*Tagetes erecta*),

Neem *(Azadirachta indica)*, Nishinda (*Vitex negundo*), Pithraj (*Aphanamixis polystachya*), Sweet flag (*Acorus calamus*), and Tobacco (*Nicotiana tabacum*) have strong insecticidal properties and may be grown by the planters with minimum expense and extracted by indigenous methods. These botanical materials can be used as an alternative to chemical pesticides. This will be very helpful in minimizing the undesirable side effects of synthetic pesticides.

Based on the foregoing, the present study was undertaken to evaluate the toxic effect of six indigenous plant extracts such as Bishkatali (*Polygonum hydropiper*), Burweed (*Xanthium strumarium*), Datura (*Datura metel*), Lantana (*Lantana camara*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) against red spider mite, *Oligonychus coffeae,* a major pest of tea in Bangladesh.

Materials and methods

An experiment was conducted both in the entomology laboratory and the main farm of Bangladesh Tea Research Institute (BTRI), Srimangal, Moulvibazar during 2012–2013. The red spider mites (both male and female) including larvae and adults were collected from the different sections of BTRI main farm and reared in the entomology laboratory, BTRI under control conditions (temperature 27–30 °C, relative humidity 70-80% and photoperiod 16L: 8D h) on a susceptible tea clone, BT2 by following detached leaf culture method of Cranham and Helle (1985) with slight modifications.

Preparation of plant extracts

Fresh leaves, succulent stems, seeds of Bishkatali (*Polygonum hydropiper*), Burweed (*Xanthium strumarium*), Datura (*Datura metel*), Lantana (*Lantana camara*), Mahogani (*Swietenia mahagoni*) and Neem (*Azadirachta indica*) were collected locally from nearby areas of BTRI main farm, Srimangal, Moulvibazar (Table 1). Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 300 g of each powdered plant material were mixed by 1000 ml of distilled water and shaken for 8 hrs in a mechanical shaker and then kept it for 24 hrs. The extract was separated using fine muslin cloth and then filtered. The filtrate was collected and volume was made up to 1000 ml. This was considered as stock solution.

Preparation of stock solution

Stock solutions of plant extracts were prepared separately by diluting the condensed extracts with respective solvent (distilled water). Three concentrations (2.5, 5.0 and 10.0%) of each category of plant extracts were prepared from the stock solution according to Mamun *et al.* (2013).

Laboratory bioassay

From the stock, thirty healthy adult mites were transferred on to a detached fresh tea leaves (6 cm^2) of BT2 clones placed on moistened cotton pads (ca 1.5 cm thick) in plastic trays (40 × 30 × 6.5 cm) for laboratory evaluation of plant extracts. Each concentration of plant extracts (2.5, 5.0 and 10.0%) was sprayed onto the adaxial (upper) and abaxial (lower) surfaces of leaf using glass atomizer (constant pressure 2.5 kgf/cm^2). Unsprayed discs were kept as control. The experiment was designed in Completely Randomized Design (CRD) with three replications. The number of live red spider mite was counted

by a 10× magnifying glass at 24, 48 and 72 hours after treatment (HAT). Original data were corrected by Abbott's (1987) formula.

Table 1. List of some indigenous plants evaluated for miticidal activities against red spider mite, *Oligonychus coffeae* in tea.

Common name	Scientific name	Family	Active ingredient	Plant parts used
Bishkatali	*Polygonum hydropiper*	Polygonaceae	Polygodial	Aerial parts
Burweed	*Xanthium strumarium*	Asteraceae	Xanthinin	Aerial parts
Datura	*Datura metel*	Solanaceae	Hallucinogens	Leaves and fruits
Lantana	*Lantana camara*	Verbenaceae	α-Cubebene, δ-Cadinene	Leaves and twigs
Mahogoni	*Swietenia mahagoni*	Meliaceae	Swietenitin	Leaves and seeds
Neem	*Azadirachta indica*	Meliaceae	Azadirachtin	Leaves and seeds

Field evaluation

A field trial was conducted to evaluate the efficacy of different plant extracts at 2.5, 5.0 and 10.0% concentration against red spider mite in tea fields at BTRI main farm. RSM susceptible clone BT2 planted plot with heavy infestation was chosen for the current study by following complete randomized block design (RCBD) with three replications. Each plot in the experiment was separated by two buffer rows of non-experimental tea. Thirty bushes per replication were considered for each treatment along with unsprayed control. After selection of the plots, pre-treatment count was taken in the respective plots and two rounds of foliar spray were given at 15 days interval with hand operated knapsack sprayer (Model-Cooper Pegler; Capacity- 15 liters) with water volume of 1000L/ha. Mite populations were assessed at weekly interval by collecting 10 mature leaves at random from each block and from each leaf; mites were counted using mite brushing machine (Model-Leedom Engineering, USA) and a compound microscope.

Effect of plant extracts on Stethorus gilvifrons *and* Oxyopes *sp.*

Plant extracts were also tested for its effect on the mortality of two important predators of red spider mite i.e. *Stethorus gilvifrons* and *Oxyopes* sp. Ten adults of predators were placed in rectangular jars (9.5 cm × 7.5 cm × 20 cm) with mite infested tea leaves. Each treatment was replicated thrice. Highest (10%) concentration of tested plant extracts were sprayed directly onto adults of *Stethorus gilvifrons* and *Oxyopes* sp. Spraying was performed as described for the laboratory bioassay and observed every day for mortality up to 14 days.

Organoleptic test in respect of quality

A field experiment was also conducted to study whether aqueous extracts of tested plants have imparted any taint to black tea. Tea shoots were harvested on 7th day after spraying of plant extracts at 10% concentration and processed separately in a mini CTC machine. The samples were forwarded to a professional tea taster for organoleptic test. Leaf infusion, liquor colour, briskness, strength and creaming down parameters were considered for organoleptic test and standard score was as > 34 being excellent (E), 32–34 being above average (AA), 30–32 being average (A) and < 30 being below average (BA) out of 50.

Statistical analysis

The experimental data were statistically analyzed by Completely Randomized Design (factorial CRD) and Randomized Complete Block Design (RCBD) using MSTAT statistical software in a microcomputer. The results are expressed as Mean ± SE and data were statistically analyzed by one-way ANOVA, with the level of significance set at $p < 0.01$. The mean values adjusted by Duncan's Multiple Range Test (DMRT).

Results and discussion

Laboratory bioassay

Results revealed that all the plant extracts had showed the toxic effect on red spider mite in tea and reduced mite population significantly in laboratory conditions. Aqueous extract of *X. strumarium* showed the highest average mortality (89.66%) of red spider mite at 10% concentration after 72 HAT followed by *S. mahagoni* (86.21%) where as aqueous extracts of *P. hydropiper*, *D. metel*, *L. camara* and *A. indica* exhibited pronounced acaricidal action (69.94–81.24%) at 72 HAT at the same concentration (Table 2). Similar trend of toxicity was also observed at 24 HAT and 48 HAT. A least acaricidal action (20.69–37.93%) was noticed at lower concentration (2.5%) of all extracts. Similar trend of toxicity was also observed at 24 HAT and 48 HAT. The mortality was in a linear trend i.e. increasing with increasing concentration and time. The order of toxicity of the tested aqueous plant extracts on adult red spider mite was: *X. strumarium* > *S. mahagoni* > *P. hydropiper* > *L. camara* > *A. indica* > *D. metel* (Fig. 1). Sarmah *et al*. (1999) observed the similar trend of acaricidal activity using different solvent extracts of *P. hydropiper* and *L. camara* against red spider mite in tea.

Field evaluation

Results revealed from the field evaluation of different plant extracts against red spider mites that all the plants have acaricidal value to reduce the infestation of red spider mite infesting tea. The highest (82.27–83.72%) reduction in mite population was observed at 10% concentrations of *X. strumarium* followed by *S. mahagoni* (79.47–80.94%) where the lowest (43.77–44.64%) reduction of mite population was observed at 2.5% concentration of *D. metel* extract. At 5% level of aqueous extracts of *P. hydropiper, X. strumarium, D. metel, L. camara, S. mahagoni* and *A. indica* reduced the mite incidence to the tune of 60.46–63.04%, 71.23–73.46%, 48.08–52.51%, 52.72–53.30%, 63.64–65.91% and 59.18–61.10%, respectively (Table 3). Similar trend of toxicity in respect of acaricidal activity against red spider mite i.e. *X. strumarium* > *S. mahagoni* > *P. hydropiper* > *L. camara* > *A. indica* > *D. metel* was also found in field condition.

Among the test plants, *X. strumarium* extracts showed the highest toxic effect, whereas *D. metel* showed the lowest toxic effect. Control of red spider mite with some indigenous plant extracts were reported by Gogoi *et al*. (2003), Deka *et al*. (1998), and Sarmah and Bhola (2008). The present results are in agreement with the findings of the other workers. Similar observations were made by Rahman *et al*. (2005) when water extract of *C. infortunatum* (5 and 10%) was sprayed against *O. coffeae* (82.0–100.0% reduction in mite incidence) under field condition. Sarmah *et al*. (2009) also found the similar results for the control of red spider mite with *P. hydorper* (67.30–64.70%) and *X. strumarium* (79.90–90.20%) at 10% level of concentration.

Table 2. Acaricidal activity of plant extracts against red spider mite, *Oligonychus coffeae* under laboratory conditions.

Treatment	Conc. (%)	Per cent mortality (%)*			
		24 HAT	48 HAT	72 HAT	Mean
P. hydropiper	2.5	29.16 ± 1.48	33.32 ± 2.34	38.26 ± 2.58	33.58 ± 2.13n
	5.0	51.72 ± 2.04	55.17 ± 1.98	58.62 ± 2.35	55.17 ± 2.12h
	10.0	76.34 ± 2.36	79.31 ± 2.94	81.24 ± 1.86	78.96 ± 2.38c
X. strumarium	2.5	37.93 ± 2.15	41.38 ± 2.88	45.36 ± 3.34	41.56 ± 2.79k
	5.0	58.62 ± 3.28	63.34 ± 3.16	67.07 ± 2.65	63.01 ± 3.03g
	10.0	81.68 ± 2.42	86.21 ± 2.44	89.66 ± 2.67	85.85 ± 2.51a
D. metel	2.5	20.69 ± 1.33	24.35 ± 2.67	29.14 ± 1.73	24.73 ± 1.91p
	5.0	44.83 ± 1.86	47.61 ± 2.38	51.20 ± 2.92	47.88 ± 2.38j
	10.0	60.52 ± 2.14	63.22 ± 3.18	69.94 ± 3.26	64.56 ± 2.86f
L. camara	2.5	28.03 ± 3.26	31.26 ± 2.74	37.93 ± 1.84	32.41 ± 2.61m
	5.0	48.28 ± 2.48	51.08 ± 2.66	53.72 ± 2.28	51.03 ± 2.47i
	10.0	72.41 ± 2.32	75.86 ± 2.52	79.31 ± 2.66	75.86 ± 2.50e
S. mahagoni	2.5	34.21 ± 1.88	37.48 ± 1.98	43.93 ± 2.80	38.54 ± 2.22l
	5.0	55.17 ± 1.44	59.25 ± 3.28	62.14 ± 2.54	58.85 ± 2.42h
	10.0	80.26 ± 2.56	82.76 ± 1.78	86.21 ± 3.14	83.08± 2.49b
A. indica	2.5	22.41 ± 2.72	25.28 ± 2.62	27.16 ± 2.33	24.95 ± 2.56o
	5.0	48.28 ± 3.54	51.72 ± 3.26	53.98 ± 2.68	51.33 ± 3.16i
	10.0	70.69 ± 1.98	72.41 ± 2.38	75.86 ± 2.84	72.99 ± 2.40d
Control	-	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0
Probability			NS		0.01

* Mean of three observations (30 adults/observation); HAT= Hours after treatment; NS = Not Significant; ± Standard error of means at a given concentration; values within column followed by different letter(s) are significantly different by DMRT at $p < 0.01$

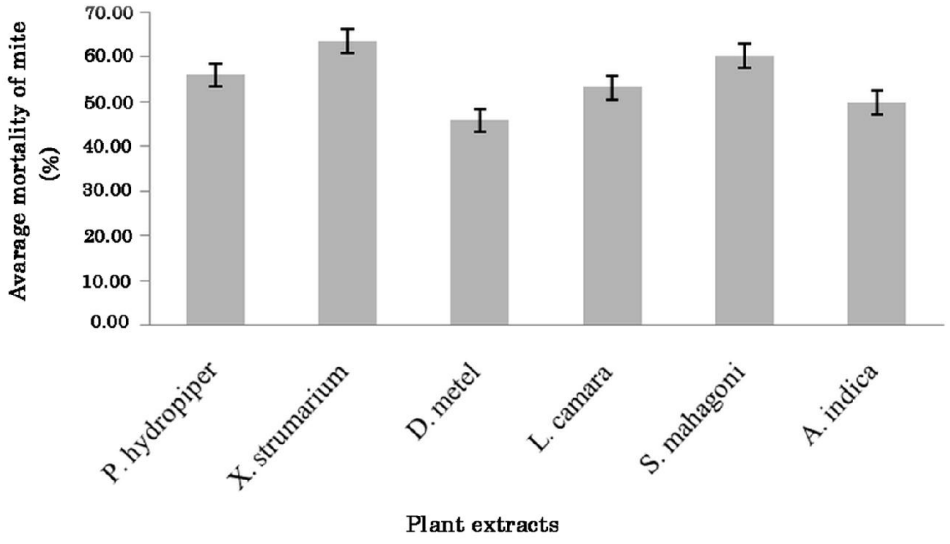

Figure 1. Toxicity of different plant extracts against red spider mite, *Oligonychus coffeae* in tea under laboratory conditions.

Table 3. Field evaluation of different plant extracts against red spider mite, *Oligonychus coffeae* in tea.

Treatment	Conc. (%)	PTP	Post treatment observations*							
			1st spray				2nd spray			
			7 days		14 days		7 days		14 days	
			P	R	P	R	P	R	P	R
P. hydropiper	2.5	338	172	49.11±1.34	185	45.27±1.64	163	51.78±1.42	169	50.00±1.28
	5.0	349	138	60.46±1.52	146	58.17±1.26	122	65.04±1.27	129	63.04±1.32
	10.0	330	78	76.36±1.28	86	73.94±1.50	64	80.61±1.56	72	78.18±1.39
X. strumarium	2.5	324	127	60.80±1.16	135	58.33±1.64	113	65.12±1.60	124	61.73±1.51
	5.0	358	103	71.23±2.10	110	69.27±1.32	81	77.37±1.98	95	73.46±1.64
	10.0	344	61	82.27±1.86	68	80.23±2.08	43	87.50±2.06	56	83.72±1.92
D. metel	2.5	345	194	43.77±1.23	207	40.00±1.12	186	46.09±1.54	191	44.64±0.98
	5.0	339	176	48.08±1.72	182	46.31±1.02	154	54.57±1.48	161	52.51±1.18
	10.0	326	128	60.74±1.46	139	57.36±1.26	118	63.80±1.66	127	61.04±1.26
L. camara	2.5	326	172	47.24±1.32	181	44.48±1.37	163	50.00±1.32	169	48.16±1.43
	5.0	365	149	59.18±1.66	156	57.26±1.42	135	63.01±1.04	142	61.10±1.37
	10.0	337	94	72.11±2.18	108	67.95±1.50	84	75.07±1.86	91	73.00±1.76
S. mahagoni	2.5	305	139	54.43±1.94	145	52.46±1.35	118	61.31±1.52	127	58.36±1.48
	5.0	352	128	63.64±2.04	135	61.65±1.25	112	68.18±1.66	120	65.91±1.54
	10.0	341	70	79.47±1.44	78	77.13±1.24	59	82.70±2.12	65	80.94±1.88
A. indica	2.5	334	182	45.51±1.62	190	43.11±1.06	173	48.20±1.30	178	46.71±1.20
	5.0	349	165	52.72±1.06	179	48.71±1.13	157	55.01±1.68	163	53.30±1.35
	10.0	329	107	67.48±1.22	119	63.83±1.08	104	68.39±1.26	114	65.35±1.56
CV (%)				15.97		16.79		15.14		15.18

* Mean of three replications; PTP = Pre Treatment Population; P = Population; R = Percent reduction;
± Standard error of means at a given concentration

Effect of plant extracts on Stethorus gilvifrons *and* Oxyopes *sp.*

No mortality of adult of *S. gilvifrons* and *Oxyopes* sp. was found till 14 days after spraying in all the treatments. Application of the tested biopesticides did not affect the non-target organisms such as *S. gilvifrons* and *Oxyopes* sp. Sarmah *et al*. (2009) also found no mortality to the adults of *S. gilvifrons* using the aqueous plant extracts, even at higher concentration (10%).

Table 4. Tasters' score of made tea produced from plant extracts treated shoots by organoleptic test.

Treatment	Leaf infusion	Liquor strength	Tasters' score*	Grade	Remarks
P. hydropiper	Coppery (7.6)	Strong (7.6)	33.60	AA	No taint
X. strumarium	Coppery (7.5)	Strong (7.4)	33.80	AA	No taint
D. metel	Coppery (7.7)	Strong (7.3)	32.70	AA	No taint
L. camara	Coppery (7.6)	Strong (7.7)	33.50	AA	No taint
S. mahagoni	Coppery (7.5)	Strong (7.4)	32.20	AA	No taint
A. indica	Coppery (7.4)	Strong (7.6)	32.40	AA	No taint

* Quality score including leaf infusion, liquor colour, briskness, strength and creaming down

Organoleptic test in respect of quality

Tea made prepared from plant extracts sprayed shoots was found taint free when subjected to organoleptic evaluation. Organoleptic test revealed leaf infusions of made teas prepared from plant extracts treated leaves as coppery and liquor strength as strong, scoring 32.20–33.80 with grade above average (AA) on a 50-point scale (Table 4).

Conclusion

The botanicals used in the experiment had direct toxic effect against red spider mite. The tested indigenous plants are available throughout tea growing areas and the planters may use these plants in tea pest management especially for the control of red spider mite, *Oligonychus coffeae* infesting tea in Bangladesh. Therefore, bio-rational pesticide based integrated pest management should be emphasized so that the indigenous plant extracts could be used for sustainable crop protection and also gives inkling for their better use under IPM program ensuring a healthier pesticide-free tea beverage.

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Received: 17 July 2015
Accepted: 26 September 2015
Published: 15 October 2015

ارزیابی چند عصارهٔ گیاهان بومی بر کنهٔ قرمز چای، ***Oligonychus coffeae*** **Nietner (Acari: Tetranychydae) روی چای**

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چکیده

آزمایشی برای ارزیابی سمیت چند گیاه بومی موجود در منطقه مانند فلفل آبی (*Polygonum hydropiper*) ، توق (*Xanthium strumarium*) ، تاتوره (*Datura metel*) ، شاه‌پسند درختچه‌ای (*Lantana camara*) ، درخت ماهون (*Swietenia mahagoni*) و چریش (*Azadirachta indica*) در غلظت ۲/۵، ۵/۰ و ۱۰ درصد (وزن/حجم) برای مبارزه با کنه قرمز چای، *Oligonychus coffeae* ، تحت شرایط آزمایشگاهی و مزرعه‌ای درموسسهٔ پژوهش‌های چای بنگلادش، سریمنگال، مولویبازار در طی سال‌های ۲۰۱۲–۲۰۱۳ انجام شد. اثر عصاره‌های گیاهی در مرگ و میر دو شکارگر طبیعی کفشدوزک *Stethorus gilvifrons* (Coccinellidae) و عنکبوت *Oxyopes* sp. (Oxyopidae) و بر کیفیت چای حاصل از ازمون ارگانولپتیک نیز مطالعه شد. داده‌ها در زمان‌های ۲۴، ۴۸ و ۷۲ ساعت پس از تیمار کردن در آزمایشگاه و به صورت هفتگی در شرایط مزرعه‌ای جمع‌آوری شدند. نتایج نشان داد عصارهٔ آبی توق بیشترین میانگین مرگ و میر (۸۹/۶۶٪) کنه قرمز چای در غلظت ۱۰٪ پس از ۷۲ ساعت پس از تیمار کردن و پس از آن ماهون با ۸۶/۲۱٪ میانگین مرگ و میر را داشتند در حالی‌که عصاره‌های آبی فلفل آبی، تاتوره، شاه‌پسند درختچه‌ای و چریش اثر مشخصی (۶۹/۹۴–۸۱/۲۴) را پس از ۷۲ ساعت در همان غلظت نشان دادند. رویهٔ مشابهی از سمیت پس از ۲۴ و ۴۸ ساعت پس از تیمار

نیز مشاهده شد. در ارزیابی مزرعه‌ای، در غلظت ۱۰٪ توق (۸۲/۲۷–۸۳/۷۲) و پس از آن ماهون (۷۹/۴۷–۸۰/۹۴) بیشترین کاهش در جمعیت کنه را ایجاد کردند. ترتیب سمیت عصاره‌های آبی گیاهان بر کنهٔ کامل قرمز چای در هر دو شرایط آزمایشگاهی و مزرعه‌ای به شرح زیر بود: توق > ماهون > فلفل آبی > شاه‌پسند درختچه‌ای > چریش > تاتوره. کاربرد آفت‌کش‌های زیستی مورد آزمایش در غلظت ۱۰٪ هیچ اثری بر شکارگرهای مذکور نداشت. چای تهیه شده پس از کاربرد عصاره‌های گیاهی روی جوانه‌ها وقتی با ارزیابی ارگانولپتیک بررسی شد کیفیتی بالاتر از میانگین داشتند و جوانه‌ها لکه نداشتند. بنابراین، این گیاهان بومی می‌توانند در راهبرد مدیریت تلفیقی کنهٔ قرمز به کار گرفته شوند و از میزان مصرف آفت‌کش‌های شیمیایی بکاهند.

واژگان کلیدی: چای؛ کنهٔ قرمز چای؛ *Oligonychus coffeae* ؛ عصاره‌های گیاهی؛ مواد سمی؛ آفت‌کش‌های زیستی؛ مدیریت تلفیقی آفات.

تاریخ دریافت: ۱۳۹۴/۴/۲۶

تاریخ پذیرش: ۱۳۹۴/۷/۴

تاریخ چاپ: ۱۳۹۴/۷/۲۳