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JOINT ACTION OF BOTANICALS AGAINST *HELOPELTIS THEIVORA* WATERHOUSE AND *OLIGONYCHUS COFFEAE* NIETNER

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ABSTRACT

Laboratory experiments to evaluate the combined effect of *Chromolaena odorata (Co)* and *Phlogocanthus thyrsiflorus (Pt)* against *Oligonychus coffeae* and *Helopeltis theivora* revealed that the methanolic leaf extracts at a combination of 75% LC_{50} *Pt* + 25% LC_{50} *Co* and 25% LC_{50} *Pt* + 75% LC_{50} *Co* were the most effective against *O. coffeae* and *H. theivora*, respectively. They recorded the highest co-toxicity coefficient and co-toxicity factor values of 206.53 and 63.34 and 398.40 and 100.00, respectively revealing potentiation and synergistic effects. A combination of 50% LC_{50} *Pt* + 50% LC_{50} *Co* can effectively manage both *O. coffeae* and *H. theivora* (76.67% and 100.00% adult mortality, respectively) with the highest co-toxicity coefficient and co-toxicity factors.

Key words: *Chromolaena odorata, Phlogocanthus thyrsiflorus,* leaf extract, LC_{50}, bioefficacy, adult mortality, *Helopeltis theivora, Oligonychus coffeae*, joint action, co-toxicity

Tea [*Camellia sinensis* (L.) O. Kuntze] is one of the most popular, and widely consumed non-alcoholic beverage (Kumar and Shruthi, 2014). India is the largest producer and consumer of black tea (Soni et al., 2015). Tea is an evergreen, perennial, monocultured and commercial crop (Wight,1961). Tea harbours about 1031 species of arthropod pests (Hazarika et al., 2009a) including 250 insects (Barthakur, 2011). Mirids are the major insect pests of tea in Asian countries including India causing about 11 to 100% loss (Hazarika et al., 2009a). Out of 41 described species of mirids belonging to the genus *Helopeltis* in Asia, the tea mosquito bug (TMB) *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) is the major pest in Assam (Somchowdhury et al., 1993). Spider mites are also a serious and persistent pest of tea resulting a crop loss of 17-46%. In India, the red spider mite (RSM) *Oligonychus coffeae* Nietner (Acarina: Tetranychidae) is the most important reported from Assam in 1868 (Hazarika et al*.,* 2009b). To defend the tea crop from insect pests, pesticides are used resulting in resurgence of primary pests, secondary pest outbreak, development of insecticide resistance, and environmental contamination, including undesirable residue (Hazarika et al., 2009a; Sannigrahi and Talukdar, 2003). In contrast, botanicals are an important alternative to pesticides. *Chromolaena odorata* (L.) King & Robinson (Asteraceae) and *Phlogocanthus thyrsiflorus* Nees (Acanthaceae) are the most widely distributed and naturally grown perennial shrub of North Eastern India, which to contain essential oils, antimicrobial flavonoids, alkaloids, fatty acids and phenolic compounds with antioxidant, anti-inflammatory, antifungal, antimicrobial and antiradical properties (Lawal et al., 2015). This study focused on the bioefficacy of solvent extracts of *P. thyrsiflorus* and *C. odorata,* which revealed a strong acaricidal and insecticidal property, respectively (Borbaruah and Kalita, 2019; 2020).

MATERIALS AND METHODS

Mature leaves of *P. thyrsiflorus* and *C. odorata* were collected from their natural habitats of Borbheta and Lichubari areas of Jorhat, Assam (26.746°N, 94.2026°E) during September-October, 2017, shade-dried, powdered using an electric grinder and extracted with methanol using Soxhlet apparatus (Make: Labotech) (Borbaruah and Kalita, 2019; 2020). The methanolic leaf extracts were later dried *in vacuo* and the supernatant was dissolved in equal volume of acetone on w/v basis to make 100% stock solution. The stock solution was then stored in an airtight glass bottle at 4ºC for further use. The mass rearing of the target pests was done at the Physiology Laboratory, Department of Entomology, Assam Agricultural University, Jorhat. The adults of *O. coffeae* and *H. theivora* were collected from the Experimental Garden for Plantation Crops (EGPC), Assam Agricultural University, Jorhat and cultured on detached leaves following the detached leaf technique suggested by Das et al. (2012; 2017). Twenty one-day-old laboratory cultured *O. coffeae* adults were placed on a TV1 clone leaf disc of 2.5 cm^2 area and allowed to

settle for 24 hr (Borbaruah and Kalita 2019; 2020). The leaf discs containing mites were then sprayed with plant extracts at desired concentrations using a hand atomizer (Make: Axiva, Capacity: 50 ml) (Borbaruah and Kalita, 2019; 2020) and data on morality were recorded at 6, 12, 24 and 48 hr after treatment (HAT).

To study the bioefficacy of plant extracts against *H. theivora*, three freshly detached shoots (TV1 clone) with three leaves were collected from EGPC, AAU, wrapped with absorbent cotton and placed in a glass vial (7 x 3.5 cm dia), and the vials were filled with sterilized double distilled water to keep the shoots afresh for a longer period. The glass vials were then caged with hurricane lantern glass chimney covered with muslin cloth to prevent the escape of the insect (Borbaruah and Kalita, 2019; 2020). A total of five one-day aged old adults were then released and sprayed with plant extracts at desired concentrations with a hand atomizer. Treatments were replicated thrice and the data on adult mortality recorded at 6, 12, 24 and 48 HAT. The data on adult mortality was corrected with Abbott's formula (Abbott, 1925) and subjected to angular transformation for ANOVA. The data on corrected mortality was later subjected to the probit analysis for calculation of LC_{50} values using SPSS (ver. 12.0). The joint action analysis of *P. thyrsiflorus* and *C. odorata* against *O. coffeae* and *H. theivora* was carried out with treatment combinations and the co-toxicity coefficient was calculated following Sun and Johnson (1960). When the treatment combination gives a coefficient significantly greater than 100, it indicates synergistic action.

RESULTS AND DISCUSSION

The methanolic leaf extract of *P. thyrsiflorus* was found to have strong acaricidal properties and recorded the lowest LC_{50} value of 0.531% (R=0.05, χ^2= 5.09, Y= 0.36+1.32X) against *O. coffeae* at 48 HAT, while the LC_{50} value against *H. theivora* was recorded to be 28.348% (R=0.11, χ^2= 9.57, Y= -1.75+1.21X) at 48 HAT. Previous studies had also revealed strong pesticidal properties of the methanolic leaf extract against *O. coffeae as* compared to the water extract (Bora et al., 1999; Hazarika et al., 2000). Mech et al. (2015) reported the lowest LC_{50} values of 0.12% against *O. coffeae* on application of the methanolic leaf extract of *Parthenium hysterophorus*. Roy and Gurusubhramanian (2011) reported strong pesticidal properties of commercial neem formulations against *H. theivora* with lower LC_{50} values ranging between 0.16-2.27 ppm. A strong acaricidal property of *P. tubiflorus* was also reported by Hazarika et al. (2009b) causing reduction in fecundity of *O. coffeae*. The strong acaricidal properties of *P. thyrsiflorus* might be due to the presence of β- sitosterol, lupeol, betulin, phloganthoside and phlogantholideon (Ilham et al., 2012). The methanolic leaf extracts of *C. odorata* revealed a strong pesticidal property recording the lowest LC_{50} value of 0.056% (R=0.25, χ^2= 28.24, Y= 3.48+2.81X) against *H. theivora* at 48 HAT. The LC_{50} value of the methanolic leaf extract of *C. odorata* against *O. coffeae* was found to be 0.603% (R=0.05, χ^2= 38.87, Y= 0.28+1.30X) at 48 HAT. A similar kind of strong insecticidal property was reported in the case of *C. odorata* against *Aedesa egypti* (Sukhthankar et al*.,* 2014; Rajmohan and Logankumar, 2011), which might be due to the presence of alkaloids and flavonoids (Man, 2013; Acero, 2014). The lowest LC_{50} values of *C. odorata* and *P. thyrsiflorus* recorded against *O. coffeae* and *H. theivora* were taken into consideration for the joint action analysis.

The joint action analysis of the methanolic leaf extract of *P. thyrsiflorus* and *C. odorata* with different treatment combinations against *O. coffeae* and *H. theivora* revealed the highest of 81.67% adult mortality of *O. coffeae* in the case of T2 (75% LC_{50} *Pt* + 25% LC_{50} *Co*) at 48 HAT, while the treatment combinations *viz*., T3 (50% LC_{50} *Pt* + 50% LC_{50} *Co*) and T4 (25% LC_{50} *Pt* + 75% LC_{50} *Co*) was found to be the best recording 100.00% adult mortality of *H. theivora* at 48 HAT. The joint action analysis based on calculated co-toxicity coefficient revealed *C. odorata* and *P. thyrsiflorus* to be synergistic with probability of similar action. The co-toxicity coefficient (206.53) was reported to be the highest in the treatment T2 (75% LC_{50} *Pt* + 25% LC_{50} *Co*) against *O. coffeae*. The highest co-toxicity coefficient value of 398.40 was recorded in the treatment T4 (25% LC_{50} *Pt* + 75% LC_{50} *Co*) against *H. theivora* (Table 1). The treatment combination T3 (50% LC_{50} *Pt* + 50% LC_{50} *Co*) could be considered as the most prospective one, which recorded the highest adult mortality of 76.67% and 100.00% against *O. coffeae* and *H. theivora* with a higher co-toxicity coefficient of 200.00.

Botanical is considered as an integral part of any ecofriendly management practices to overcome the ill effect of synthetic pesticides, especially the pesticide residue on the made tea. The present study has identified a suitable combination of *C. odorata* and *P. thyrsiflorus* leaf extract that could manage the *H. theivora* and *O. coffeae* with a single spray.

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Table 1. Joint action analysis of *C. odorata* and *P. thyrsiflorus* against *O. coffeae* and *H. theivora*

Treatments	*O. coffeae*			*H. theivora*		
	Adult mortality (%)		Co- toxicity coefficient	Adult mortality (%)		Co-toxicity coefficient
	Expected	Observed		Expected	Observed	
T1 (100% LC_{50} *Pt** + 0% LC_{50} *Co***)	50	53.33	_	50	46.67	_
T2 (75% LC_{50} *Pt* + 25% LC_{50} *Co*)	50	81.67	206.53	50	80.00	133.51
T3 (50% LC_{50} *Pt*+ 50% LC_{50} *Co*)	50	76.67	200.00	50	100.00	200.00
T4 (25% LC_{50} *Pt* + 75% LC_{50} *Co*)	50	56.67	193.90	50	100.00	398.40
T5 (0% LC_{50} *Pt* + 100% LC_{50} *Co*)	50	43.33	_	50	60.00	_

*LC_{50} value of *P. thyrsiflorus* considered against *O. coffeae*= 0.531%, **LC_{50} value of *C. odorata* considered against *H. theivora*= 0.056%

REFERENCES

Acero L H. 2014. Dried Siam weed (*Chromolaena odorata*) as rice weevils (*Sitophilus oryza*) eradicant. International Journal Chemical Engineering Application 5: 363-366.

Barthakur B K. 2011. Recent approach of Tocklai to plant protection in tea in North East India. Scientific Culture 77(9-10): 381-384.

Bora H R, Hazarika L K, Dutta N. 1999. Botanicals for forest and tea pest management. Agnihotri N P, Walia S, Gajbhiye V T (eds.). Green pesticides crop protection and safety evaluation. Society of pesticide Science, New Delhi.

Bora H R, Hazarika L K, Dutta N. 1999. Botanicals for forest and tea pest management. Green pesticides crop production and safety evaluation. Agnihotri N P, Waliga S, Sajbhiye (eds.).V T Society of Pesticides Science, India.

Borbaruah P, Kalita S. 2019. Bioefficacy of *Chromolaena odorata* against *Oligonychus coffeae* Nietner (Acarina: Tetranychidae) and *Helopeltis theivora* Waterhouse (Hemiptera: Miridae) in tea. Journal of Entomology and Zoology Studies 7(5): 418-423.

Borbaruah P, Kalita S. 2020. Efficacy of *Phlogocanthus thyrsiflorus* against *Oligonychus coffeae* and *Helopeltis theivora* in tea. Indian Journal of Entomology 82(3): 532-536.

Das P, Saikia S, Kalita S, Hazarika L K, Dutta S K. 2012. Effect of temperature on biology of red spider mite (*Oligonychus coffeae*) on three different TV clones. Indian Journal of Agricultural Science 82(3): 255-259.

Das P, Saikia S, Kalita S, Hazarika L K. 2017. Tea clonal preference by *Helopeltis theivora* (Hemiptera: Miridae). Journal of Entomology and Zoology Studies 5(6): 97-103.

Hazarika L K, Barua N C, Kalita S, Gogoi N. 2008. In search of green pesticides for tea pest management: *Phlogocanthus thyrsiflorus* experience. Recent trends in insect pest management. Ignacimuthu S, Jayaraj S (eds.). Elite Publishers, New Delhi, pp. 79-90.

Hazarika L K, Bhuyan M, Hazarika B N. 2009a. Insect pest of tea and their management. Annual Review of Entomology 54: 267-284.

Hazarika L K, Puzari K C, Saikia S, Das P. 2000. Biological control of pests and diseases of tea in NE India. Annual Report, DBT Project on Biocontrol, Assam Agricultural University, Jorhat.

Hazarika L K, Puzari K C, Kalita S, Das P, Saikia S. 2009b. *In-vitro* efficacy of botanicals in combination with *Verticillium lecanii* (Zimm.) Viegas for management of red spider mite in Tea. Pesticide Research Journal 21(1): 16-21.

Laskar N and Thappa S. 2015. A Study on the present scenario of tea industry in Assam-challenges ahead. Indian Journal of Applied Research 5(11): 533-537.

Lawal O A, Opoku A R, Ogunwande I A. 2015. Phytoconstituents and insecticidal activity of different solvent leaf extracts of *Chromolaena odorata* L. against *Sitophilus zeamais* (Coleoptera: Curculionidae). European Journal of Medicinal Plant 5(3): 237-247.

Man N C. 2013. Phytochemical analysis of leaves of *Chromolaena odorata*. International Journal of Scientific and Research Publication 3: 1-2.

Rajmohan D, Logankumar K. 2011. Studies on the insecticidal properties of *Chromolaena odorata* (Asteraceae) against the life cycle of the mosquito, *Aedes aegypti* (Diptera: Culicidae). Journal of Research in Biology 1(4): 253-257.

Roy S, Gurusubramanian G. 2011. Bioefficacy of azadirachtin content of neem formulation against three sucking pest of tea plantation of North Bengal, India. Agricultura Tropica et Subtropica 44 (3): 134-143.

Sanigrahi S, Talukdar T. 2003. Pesticide use patterns in Dooars tea industry. Two and A Bud 50: 35-38.

Somchowdhary A K, Samanta A K, Dhar P P. 1993. Approaches to integrated control of tea mosquito bug. Proceedings of International Symposium on Tea, Calcutta, pp. 330-338.

Soni R P, Katoch M, Kumar A, Ladohiya R, Verma P. 2015. Tea: Production, Composition, Consumption and its Potential an Antioxidant and Antimicrobial Agent. International Journal Food and Fermentation Technology 5(2): 95-106.

Sukhthankar J H, Kumar H, Godinho M S H, Kumar A. 2014. Larvicidal activity of methanolic leaf extracts of plant, *Chromolaena odorata* L. (Asteraceae) against vector mosquitoes. International Journal of Mosquito Research 1(3): 33-38.

Sun Y P, Johnson E R. 1960. Analysis of joint action of insecticides against house flies. Journal of Economic Entomology 53: 887-892.

Talukdar U and Hazarika C. 2017. Production and export of value added tea in India and its global competitiveness. Economic Affairs 62(4): 705-710.

Wight W. 1961. Combiners for tea breeding. Two and A Bud 8(3): 19-21.

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