Efficacy of sesame oil and mustard oil formulations against Red Spider Mite of tea

ABSTRACT

Crude formulations of sesame and mustard oil at 0.5%, 0.75% and 1% concentration with or without the addition of cow urine were assessed against red spider mite, *Oligonychus coffeae* (Nietner) in the laboratory. Efficacy tests on oviposition rate, egg hatchability, mortality of nymph and adult mites proved that sesame oil 1%, with or without the addition of cow urine was found to be effective in reducing the rate oviposition and egg hatchability of mites and was at par with the formulation prepared from commercial neem (1 : 1500). Formulations of sesame oil at the rate of 0.75% and 1% with or without cow urine were found to be highly effective for mortality of nymphs and adults of red spider mite respectively which were at par with the formulation prepared from commercial neem.

Key words: Commercial neem, cow urine, mustard oil, Red spider mite, sesame oil, Tea

1. INTRODUCTION

Tea (*Camellia sinensis* (L).O.Kuntze) is an export- oriented, perennial, plantation crop grown in more than 50 countries around the world. The major tea producing countries include China, India, Kenya and Sri Lanka. The tea growing areas North East India lies between 24^0 and 27^0 North latitudes and 88^0 and 95^0 East longitudes and at an elevation ranging from 20m in plains and upto a height of 2000 m in Darjeeling. The red spider mite, *Oligonychus coffeae* (Nietner) is a polyphagous pest widely distributed in almost all tea growing regions. Both nymphs and adults of red spider mite normally attack the upper surface of the mature leaves but in severe cases spreads to the young leaves and also to the under surface of leaves. The bushes are heavily defoliated in severe infestation leading to crop loss from 17 to 46% (Roy *et al*., 2014).

Many acaricides are used worldwide in the management of *O. coffeae*. But frequent application of these acaricides have serious drawbacks other than health hazards and presence of higher levels of residues in made tea (Sharaby, 1988). Pesticide residues has caused dissatisfaction among consumers and importers and has become a major concern to the tea industry. Thus the use of plant based oils may present a viable option. The advantage of plant based oils is that it contains complex mixtures of monoterpenes, phenols, sesquiterpenes which not only repel insects and mites but also have contact and fumigant activity (Koul *et al*., 2008). Several studies pointed out the neurotoxic action of essential oils by acetylcholinesterase (AchE) inhibition or by blocking the octopamine receptors. The essential oils varied in their activity which may be due to variation of their chemical constituents (Enan, 2001). Cow urine spraying on the infested bushes can minimize the harmful effects of synthetic pesticides and it was reported that stored stock is preferred over fresh urine because it can cause

leaf scorching and plant wilting (Gahukar, 2013). In the present investigation cow urine spraying was tested as an attractive alternative to synthetic chemical insecticides.

2. MATERIALS AND METHODS

2.1 Preparation of experimental materials

Crude preparations of mustard oil and sesame oil were used for experimentation on red spider mite, *O. coffeae*. The aqueous solution of 0.5%, 0.75% and 1% of both these oils were made and 2-3 drops of teepol was added to it, (Teepol - AG, National Organic Chemical Industries Limited, Mumbai, India) which acts as an emulsifier. Cow urine was collected from the dairy farm of Assam Agricultural University, Jorhat during November - December, 2020. Cow urine diluted as 5% solution was added to the oils, which served as the treatment. Mature leaves of clone TV 21 maintained at the Experimental Garden for Plantation Crops (EGPC), Assam Agricultural University, Jorhat was utilized for mass rearing of mites and experimentation. Maintenance of *O. coffeae* culture was done using the detached leaf technique proposed by Das *et al*. (2012) in the laboratory during 2019 - 2021and used for the studies.

2.2 Formulations

The experiment was laid in completely randomized designed with 14 treatments replicated six times. The treatments were: T1 - Mustard oil (0.5%),T2 - Mustard oil (0.5%) + cow urine (5%),T3 - Mustard oil (0.75%),T4 - Mustard oil (0.75%) + cow urine (5%),T5 - Mustard oil (1%),T6 - Mustard oil (1%) + cow urine (5%),T7 - Sesame oil (0.5%),T8 - Sesame oil (0.5%) + cow urine (5%),T9 - Sesame oil (0.75%),T10 - Sesame oil (0.75%) + cow urine (5%),T11 - Sesame oil (1%),T12 - Sesame oil (1%) + cow urine (5%),T13 - Commercial neem (1 : 1500),andT14 - Water (Control).

2.3 Evaluation against egg, nymphs and adults of *Oligonychus coffeae*

One-day old *O. coffeae* adults were allowed to settle for 24 hours at the rate of 10 numbers per 2.5 cm^2 leaf disc (TV 21 clone). Respective oil formulation was applied either with or without cow urine at different desired concentrations using a hand atomizer (Make: Axiva, Capacity: 50ml). Each treatment was replicated six times and adult mortality were observed at 24, 48 and 72 hours after treatment (HAT) through a stereoscopic microscope. A control treatment of water spray was maintained. Moreover, commercial neem formulation (1 : 1500) dilution) was also applied to compare the bioefficacy. Same method was followed for evaluation against the nymphs. To evaluate the ovicidal property of different oil formulations along with cow urine or without cow urine, ten gravid females were allowed to lay eggs on leaf disc for 24 hours. Thirty freshly laid eggs were retained for each replication and the other eggs were removed from the leaves along with the adult mites. The eggs were sprayed with tested formulations as above and the first observation was recorded as soon as the eggs in the control hatched. Those eggs which did not hatch during this period were regarded as dead.

The experiments were conducted during October - November, 2020 and repeated during March - April, 2021.

2.4 Statistical analysis

The treatment mean values of the rate of oviposition, percent reduction in egg hatchability, nymph and adult mortality at different time intervals were compared by least significance difference based on ANOVA (Gomez and Gomez, 1984). All computations was carried out by using MS Excel 2007 and OPSTAT software.

3. RESULTS AND DISCUSSION

3.1 Rate of oviposition

During the period October - November, 2020 all the formulations based on sesame oil T7-T12 (2.20-9.33% were found to be equally effective among themselves as well as T13(neem oil) but significantly better than mustard oil formulations (T1-T6) in reducing the ovipositon rate of *O.coffeae* (Table 1). Similar trend was observed in the tests conducted during March - April also. Both the oil formulations were significantly different than control during both tests. For both the periods, all the treatments of sesame oil were at par with the formulation prepared from commercial neem (1:1500). Oils have been proven to be effective oviposition deterrant in earlier studies. The oviposition rate of mites as well as the egg viability decreased significantly on clove oil (*Syzygium aromaticum*)- treated leaf surfaces (Roy *et al*., 2015) . Between *Simarouba glauca* and *Hydnocarpus pentandra* seed oils , *H. pentandra* was more effective in reducing oviposition rate of *O. coffeae* (Dam et *al*., 2021) .

Table 1. Effect of oil based formulations on rate of oviposition of red spider mite

Treatments	Rate of oviposition (%)	
	72 Hours after treatment	
	October - November, 2020	March - April, 2021
T_1	23.88	27.22
T_2	20.00	24.50
T_3	18.50	23.00
T_4	16.00	20.66
T_5	16.11	19.33
T_6	15.33	18.67
T_7	9.33	12.33
T_8	6.11	9.22
T_9	7.11	9.77
T_{10}	4.72	7.71
T_{11}	3.88	6.61

T_{12}	2.20	6.11
T_{13}	2.19	6.10
T_{14}	50.66	65.22
S.Ed	7.99	7.67
CD p = 0.05	12.98	12.33

3.2 Reduction in egg hatchability

During the period October - November, 2020, T13 (63.77) , T12 (62.22%) and T11 (55.55%) were equally effective with the highest percent reduction in egg hatchability(Table 2). Among them T13 and T12 were significantly better than all other treatments while T11 had overlapping levels of significance with several other treatments. Similar trend was observed in the tests conducted in March-April 2021. Among the two selected oil based formulations, sesame oil showed more efficacy on percent reduction in egg hatchability than mustard oil in both the periods. Mustard oil and sesame oil when sprayed with and without cow urine showed effective results than control (water) in both the periods.

During both the tests, T11 and T12 were at par with the formulation prepared from commercial neem. Plant based oils, in general, possess excellent ovicidal properties and are effective even at few parts per million (Benelli, 2015). The oils affected the eggs hatchability without any morphological changes by disrupting or inhibiting embryogenesis and making them unable to come out of the egg shells (Ibrahim, 2019). High ovicidal activity of *Jatropha curcus* and *Allium sativum* even at low concentrations have been proven by Roy (2018). All the plant oils derived from castor, sesame, rose, olive, mustard, groundnut and karanja significantly reduced the egg hatchability but rose oil was most toxic of them followed by karanja oil and olive oil (Roy *et al*.,2018). Single and combined formulations of *S. indicum* and *Millettia pinnata* seed oil at different ratios showed significant ovicidal activity against eggs of *O. coffeae* (Sarmah *et al*., 2020).

Table 2. Effect of oil based formulations on percent reduction in egg hatchability of red spider mite during both the periods

Treatments	**Percent reduction in egg hatchability (%) 72 Hours after treatment**	
	October - November, 2020	**March - April, 2021**
T_1	39.44	34.44
T_2	40.77	38.32

T_3	44.44	41.10
T_4	49.99	46.66
T_5	48.88	46.11
T_6	49.99	46.66
T_7	44.44	42.55
T_8	46.66	42.77
T_9	47.77	44.44
T_{10}	51.66	49.33
T_{11}	55.55	52.21
T_{12}	62.22	58.88
T_{13}	63.77	60.33
T_{14}	23.33	20.22
S.Ed	4.97	5.06
CD p= 0.05	9.95	10.11

3.3 Nymph mortality

The highest nymphal mortality of was observed on T12 among the oil based formulations in both the periods (Table 3). The mortality rates recorded in T12 were 90.67%, 94.33% and 98.00% at 24, 48 and 72 hours after application respectively during the period October-November, 2020 and 88.00%, 95.00% and 96.67% in 24, 48 and 72 hours after application during the period March-April, 2021 respectively, However, observations at 72 hours after treatment in both the periods indicated that T10, T11 and T12 were on par with T13 (the formulation prepared from commercial neem) .

Table 3. Effect of oil based formulations on nymph mortality of red spider mite during both the periods

Treatments	Nymph mortality (%)					
	October - November, 2020			March - April, 2021		
	24 HAT	48 HAT	72 HAT	24 HAT	48 HAT	72 HAT
T_1	46.67	65.00	73.00	38.33	61.67	70.33
T_2	50.33	70.00	78.32	43.33	63.33	73.67

T_3	51.67	75.00	82.33	46.67	65.00	74.33
T_4	61.33	80.00	85.00	65.00	70.33	75.67
T_5	63.33	76.67	83.00	63.80	72.67	76.33
T_6	78.33	80.67	87.00	70.33	73.00	77.00
T_7	80.00	81.33	88.33	73.67	79.00	82.33
T_8	81.33	83.67	90.00	75.33	81.67	85.22
T_9	79.97	86.33	90.67	76.90	86.33	86.67
T_{10}	83.00	91.33	94.33	81.67	88.67	93.00
T_{11}	85.33	93.00	95.67	84.33	92.33	96.33
T_{12}	90.67	94.33	98.00	88.00	95.00	96.67
T_{13}	91.33	98.67	99.33	88.67	95.33	98.67
T_{14}	7.33	8.33	8.67	6.33	7.67	8.33
S.Ed	5.85	4.45	3.82	6.52	5.01	4.35
CD p=0.05	11.70	8.90	7.64	13.05	10.01	8.68

HAT : Hours after treatment

3.4 Adult mortality

Highest adult mortality was observed on T12 among the oil based formulations in both the periods. The mortality rates were 89.67%, 93.33% and 97.00% at 24, 48 and 72 hours after application respectively during October - November, 2020 and 88.33%, 93.00% and 96.67% in 24, 48 and 72 hours after application respectively during March - April, 2021. However, T9, T10, T11 and T12 were at par with the formulation prepared from commercial neem in both the periods, at all the time periods tested. The toxic effect of oils is due to their fumigant (Ayvaz *et al.*, 2009) and/or contact toxicities (Kim *et al*., 2003) of the major components of these oils or by inhibition of acetylcholinesterase activities. Monoterpenoids present in oils cause insect mortality by inhibiting acetylcholinesterase enzyme activity (Sertkaya *et al*., 2010) possibly by activation of octopaminergic receptors (Kostyukovsky, 2002). Among seven plant based oils such as castor oil, sesame oil, rose oil, olive oil, mustard oil, groundnut oil and Karanja oil tested against *O. coffeae* , Roy *et al*. (2018) found karanja oil to be the most toxic adulticide. In two seasons of field trials, the formulations based on S. *indicum* and *M. pinnata* seed oil were found to be highly effective against O. *coffeae* and superior to commonly used chemical acaricide, Ethion 50EC (Sarmah et *al.*, (2020). Significant adult mortality in *O. coffeae* had been achieved due to application of seed oils from *S. glauca* and *H. pentandra* (Dam *et al*., 2021).

Table 4. Effect of oil based formulations on adult mortality of red spider mite during both the periods

Treatments	Adult mortality (%)					
	October - November, 2020			March - April, 2021		
	24 HAT	48 HAT	72 HAT	24 HAT	48 HAT	72 HAT
T_1	38.33	65.67	73.33	33.33	51.67	60.00
T_2	46.63	67.63	75.67	38.33	55.00	58.33
T_3	46.67	69.33	79.33	40.00	60.00	70.00
T_4	68.33	75.00	82.33	60.00	72.33	78.33
T_5	76.67	83.00	83.66	65.00	75.33	79.33
T_6	78.00	83.33	84.00	70.00	77.67	84.00
T_7	80.67	84.67	85.33	72.00	81.00	85.33
T_8	81.00	85.00	87.33	75.00	82.33	86.67
T_9	82.00	85.27	93.67	76.22	86.67	89.33
T_{10}	82.33	90.33	94.00	81.67	90.00	91.33
T_{11}	83.33	92.67	94.67	83.33	91.67	93.67
T_{12}	89.67	93.33	97.00	88.33	93.00	96.67
T_{13}	93.67	96.00	98.33	89.67	95.33	98.67
T_{14}	7.00	8.23	8.36	6.35	7.33	8.00
S.Ed	7.93	7.31	4.91	7.98	6.59	5.70
CD p=0.05	12.35	10.61	9.80	13.95	12.18	11.40

HAT : Hours after treatment

4. CONCLUSION

The laboratory tests with crude formulations based on sesame oil and mustard oil at various concentrations, both alone and in combination with cow urine, has that sesame oil at 0.5- 1% concentrations, with or without the combination with cow urine at 5%, demonstrated significant oviposition deterrent activity as well as ovicidal activity comparable to those achieved with commercial neem-based formulation. Moreover, the sesame oil-based formulations, especially at 0.75% and 1% concentrations with or without the combination of cow urine, exhibited mortality rates

for both nymphs and adult mites, comparable with the commercial neem-based formulation . Further research and field trials may be warranted to validate and optimize these formulations for practical use in pest management strategies.

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