https://doi.org/10.33307/entomon.v44i4.483
ENTOMON 44(4): 301-306 (2019)
Short Communication No. ent. 44409

# Bioefficacy of horticultural mineral oil against spider mite, *Tetranychus truncatus* Ehara (Prostigmata: Tetranychidae) on okra

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**ABSTRACT:** A field study was conducted to evaluate the efficacy of horticultural mineral oil (HMO), combination of HMO + neem oil and neem oil 2 per cent along with a synthetic acaricide, Spiromesifen 240SC and an untreated control against *Tetranychus truncatus* on okra during March, 2018. The plots treated with HMO at 2.5 (92.60%) and 3.0 per cent (93.90%) as well as combination treatments HMO 2.5 per cent + neem oil 2.0 per cent (94.14%) and HMO 3.0 per cent + neem oil 2.0 per cent (96.79%) recorded significant reduction in mite population and were superior to plots treated with either spiromesifen (91.08%) or neem oil alone at 2.0 per cent (90.42%). The high efficacy of HMO against the spider mite *T. truncatus* brought out in the study suggests that HMO can be an effective tool for mite management in vegetable crops. 

**KEYWORDS**: Horticultural mineral oil (HMO), neem oil, spiromesifen, *Tetranychus truncatus*

Okra is cultivated in an area of 5,11,000 hectares in India with a production of 58,49,000 metric tonnes (GOI, 2017). Among several factors responsible for the low productivity of okra, the damage inflicted by insect and mite pests has been considered important (Varadaraju, 2010). More than hundred species of insects have been reported as pests of okra (Santhoshkumar *et al*., 2013). However, among them, only to a few insects such as leaf hopper, aphid, whitefly and shoot and fruit borer are considered as economically important. Among the mite pests, spider mites belonging to the genus *Tetranychus* have emerged as a major pest of okra causing considerable yield loss (Ghosh *et al*., 1996; Srinivasa and Sugeetha, 1999; Kumaran *et al*., 2007). Recent studies at Kerala Agricultural University identified *Tetranychus truncatus* Ehara as the predominant species of mite infesting vegetable crops in Kerala, including okra (Bennur *et al*., 2015).

The spider mites colonise undersurface of the leaves and cause significant damage by feeding on sap. This results in yellowing and speckling of leaves, webbing, premature leaf fall, stunted growth, reduction in photosynthetic activity and ultimately death of the whole plant (Damirel and Cabuk, 2008). Apart from its polyphagous nature, high reproductive potential and short life cycle, factors such as change in climatic conditions and over-use of plant protection chemicals also help to compound the mite problem.Though conventional pesticides offer good control, they have high residue levels and cause resurgence and resistance (Khajehali *et*

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*al*., 2011; Sharma and Bhullar, 2018). Moreover they cannot be recommended during the later stages of the crop, when mite damage typically intensifies. Consequently, biocontrol agents, botanicals and mineral oils are increasingly being evaluated against the mites.

Mineral oils have been used for centuries to control insect and mite pests on several crops (Egho and Emosairue, 2010). With recent advances in technology, refinement of petroleum oil to summer spray oils commonly called as horticultural mineral oils (HMOs) or agricultural mineral oils (AMOs) has made it possible to use them all the year round, without any risk of phytotoxicity (Davidson *et al*., 1991; Agnello, 2002). Oils have several advantages over conventional pesticides, such as low mammalian toxicity, low residual toxicity, minimal risk of resistance development and limited effects on beneficial organism (Beattie *et al*., 2002). Laboratory bioassay studies conducted at Kerala Agricultural University revealed that HMO at 2.0 and 2.5 per cent possess appreciable efficacy against both egg and active stages of *T. truncatus* and is relatively safer to the predatory mite, *Neoseiulus longispinosus* (Yadav and Bhaskar, 2018).

A field experiment was carried out to test the efficacy of HMO against *T. truncatus* on okra (variety Arka Anamika) at College of Horticulture, KAU, Vellanikkara during March, 2018. Two concentrations of HMO namely 2.5 and 3.0 per cent and its combinations with neem oil *viz.,* HMO 2.5 per cent + neem oil 2 per cent and HMO 3.0 per cent + neem oil 2.0 per cent were evaluated along with neem oil 2.0 per cent alone, an acaricide spiromesifen 240 SC @ 0.02 per cent and a control treatment with water spray. The crop was raised as per the Package of Practices Recommendations (KAU, 2016) at a spacing of 60×30cm in plots of 2×2m size. The experiment was laid out in Randomized Block Design with seven treatments and four replications. Mites were released on 45days old okra plant at the rate of 25 active mites/ leaf by stapling mite infested mulberry leaf bit of 3cm$^2$ size each on top, middle and bottom leaf of okra plant. Treatments were imposed two weeks after the release of mites using a hand sprayer.

The number of mites from three windows of 1cm$^2$ each from top, middle and bottom leaves of randomly selected five plants per replication were recorded. The mite count was recorded *in situ* by using a hand lens of 10X magnification one day before spraying and 1, 3, 7, 10 and 14 days after spraying. Data on mean population of mites were transformed using square root transformation. Population difference on one, three, seven, ten and fourteen days after treatment were tested by one way ANOVA. The mean per cent reduction in population of mites over pre count was also worked on seven and fourteen days after treatment application.

The results of the field experiment to evaluate the efficacy of different treatments against *T. truncatus* are presented in Table 1. The mean population of *T. truncatus* before the application of treatments ranged from 17.73 to 18.59 per cm$^2$ leaf area. One day after spraying, all the treatments significantly reduced the population of mite as compared to untreated control. The mean mite population ranged from 4.85 to 18.51 per cm$^2$ leaf area. The lowest mean mite count of 4.85/cm$^2$ leaf area was recorded by HMO 3.0 per cent + neem oil 2.0 per cent followed by HMO 2.5 per cent + neem oil 2.0 per cent (5.15/cm$^2$ leaf area) which were on par with each other. HMO 2.5 and 3.0 per cent recorded 5.46 and 5.33 mites/cm$^2$ leaf area respectively and were on par with each other and also with HMO 2.5 + neem oil 2.0 per cent, HMO 3.0 + neem oil 2.0 per cent and neem oil 2 per cent ( 5.43 mites/ cm$^2$ leaf area). The acaricide spiromesifen 240 SC recorded mite count of 5.88 mites/ cm$^2$ leaf area which was on par with HMO 2.5 per cent, HMO 3.0 per cent and neem oil 2.0 per cent.

Three days after spraying, the plants treated with combination of HMO + neem oil harboured significantly lower mite popultion compared to other treatments. HMO 3.0 per cent + neem oil 2.0 per cent and HMO 2.5 per cent + neem oil 2.0 per cent recorded 1.59 and 1.43 mean mite per cm$^2$

leaf area respectively. This was followed by HMO 2.5 per cent (2.49/cm$^2$ leaf area) and HMO 3.0 per cent (2.31 mites/cm$^2$ leaf area) which were on par with each other and the above treatments. The acaricide, spiromesifen 240 SC recorded 2.87 mites/cm$^2$ leaf area and was on par with neem oil 2 per cent (3.10 mites/cm$^2$ leaf area) and with HMO 2.5 and 3.0 per cent.

At seven days after treatment, all the treatments significantly reduced the mite population as compared to untreated control (15.53 mites/cm$^2$ leaf area). The lowest mite population of 1.04 per cm$^2$ leaf area was recorded by HMO 2.5 per cent + neem oil 2.0 per cent followed by HMO 3.0 per cent (1.08/cm$^2$ leaf area) , HMO 3.0 per cent + neem oil 2.0 per cent (1.11/cm$^2$ leaf area) and HMO 2.5 per cent (1.33/cm$^2$ leaf area). However, these treatments did not differ significantly. Spiromesifen 240 SC (1.82/cm$^2$ leaf area) and neem oil 2.0 per cent (2.32 mites /cm$^2$ leaf area) were on par with each other and differed significantly from treatments of HMO and combination of HMO + neem oil.

Per cent reduction in mite count after seven days of treatment aplication was worked out. By seventh day of treatment, HMO 2.5 per cent + neem oil 2.0 per cent recorded 96.21 per cent reduction in the mite count closely followed by HMO 3.0 per cent + neem oil 2.0 per cent (93.95%), HMO 3.0 per cent (93.90%) and HMO 2.5 per cent (92.60%). This was followed by treatments *viz.,* spiromesifen 240 SC (89.99 %) and neem oil 2.0 per cent (87.26 %).

Similar trend was observed on ten days after spraying where treatments of HMO and combination of HMO + neem oil continued to record lower mean mite counts. The treatments, HMO 2.5 per cent (0.70/cm$^2$ leaf area), HMO 3.0 per cent (0.73/cm$^2$ leaf area), HMO 2.5 per cent + neem oil 2.0 per cent (0.79/cm$^2$ leaf area) and HMO 3.0 per cent + neem oil 2.0 per cent (0.87/cm$^2$ leaf area) recorded mean mite count on par with each other which was significantly lower. Spiromesifen 240 SC and neem oil 2.0 per cent recorded mean mite counts of 1.57 and 2.04 per cm$^2$ leaf area respectively which were on par with each other, but significantly differed from treatments of HMO and combination of HMO + neem oil.

At fourteen days of spraying, all the treatments recorded significant reduction in mite population as compared to untreated control (12.86 / cm$^2$ leaf area). HMO 2.5 per cent recorded lowest mean mite count of 0.54 per cm$^2$ leaf area, followed by HMO 3.0 per cent (0.58/cm$^2$ leaf area), HMO 3.0 per cent + neem oil 2.0 per cent (0.59 /cm$^2$ leaf area) and HMO 2.5 per cent + neem oil 2.0 per cent (0.67/cm$^2$ leaf area) which were all on par with each other and significantly superior over Spiromesifen and neem oil. Mite population count in Spiromesifen 240 SC (1.62/ cm$^2$ leaf area) and neem oil 2.0 per cent (1.74/ cm$^2$ leaf area) were on par with each other.

Per cent reduction in mite count after fourteen days of treatment aplication was worked out. By fourteenth day, the highest reduction in mite population over untreated control was observed in HMO 2.5 per cent (96.99%) followed by, HMO 3.0 per cent + neem oil 2.0 per cent (96.79%), HMO 3.0 per cent (96.72%) and HMO 2.5 per cent + neem oil 2.0 per cent (96.21%), Spiromesifen 240 SC (91.08 %) and neem oil 2 per cent (90.42 %).

In the field experiment, HMO alone (2.5 and 3.0%) and in combination with neem oil (2.0%) were significantly superior to both the acaricide Spiromesifen and neem oil. Spiromesifen, an inhibitor of lipid biosynthesis, is highly toxic to eggs and immature stages of spider mites, while it acts more slowly against adult females, causing reduction in fertility and fecundity (Marcic *et al*., 2011). Krishna and Bhaskar (2013) reported a higher reduction in egg count (15.40%) of *T. urticae* due to Spiromesifen, while it recorded very low adult mortality (3.40%). Similarly, Sato *et al*. (2011) studied the toxicity of Spiromesifen to different developmental stages, and found egg stage of *T. urticae* was most sensitive. But laboratory bioassay had revealed that HMO possess very high efficacy against both egg and adult of *T. truncatus* and recorded 100 per cent mortality of eggs at concentrations of 1.5, 2.0, 2,5 and 3.0 per cent

Table 1. Efficacy of Horticultural Mineral Oil (HMO) against *Tetranychus truncatus* on okra

| Treatments | Mean no. of mite/cm$^2$ leaf area | | | | Per cent reduction on 7 DAT | Mean no. of mite/cm$^2$ leaf area | | Per cent reduction on 14 DAT |
|---|---|---|---|---|---|---|---|---|
| | Pre count | 1 DAT | 3 DAT | 7 DAT | | 10 DAT | 14 DAT | |
| $T_1$ - HMO 2.5% | 17.98 (4.24) | 5.46$^{bc}$ (2.33) | 2.49$^{bc}$ (1.56) | 1.33$^{c}$ (1.15) | 92.60 | 0.70$^{c}$ (0.83) | 0.54$^{c}$ (1.01) | 96.99 |
| $T_2$ - HMO 3.0% | 17.73 (4.21) | 5.33$^{bc}$ (2.31) | 2.31$^{bc}$ (1.49) | 1.08$^{c}$ (1.04) | 93.90 | 0.73$^{c}$ (0.84) | 0.58$^{c}$ (1.03) | 96.72 |
| $T_3$ - HMO 2.5% + neem oil 2.0% | 17.76 (4.21) | 5.15$^{c}$ (2.27) | 1.59$^{c}$ (1.22) | 1.04$^{c}$ (1.02) | 94.14 | 0.79$^{c}$ (0.88) | 0.67$^{c}$ (1.08) | 96.21 |
| $T_4$ - HMO 3.0% + neem oil 2.0% | 18.36 (4.28) | 4.85$^{c}$ (2.20) | 1.43$^{c}$ (1.16) | 1.11$^{c}$ (1.05) | 93.95 | 0.87$^{c}$ (0.93) | 0.59$^{c}$ (1.04) | 96.79 |
| $T_5$ - Neem oil 2.0% | 18.21 (4.26) | 5.43$^{bc}$ (2.33) | 3.10$^{b}$ (1.75) | 2.32$^{b}$ (1.51) | 87.26 | 2.04$^{b}$ (1.43) | 1.74$^{b}$ (1.49) | 90.42 |
| $T_6$ - Spiromesifen 240SC - 0.02% | 18.19 (4.26) | 5.88$^{b}$ (2.42) | 2.87$^{b}$ (1.66) | 1.82$^{b}$ (1.34) | 89.99 | 1.57$^{b}$ (1.24) | 1.62$^{b}$ (1.45) | 91.08 |
| $T_7$ - Control | 18.59 (4.31) | 18.51$^{a}$ (4.29) | 17.91$^{a}$ (4.23) | 15.53$^{a}$ (3.94) | 16.46 | 12.35$^{a}$ (3.51) | 12.86$^{a}$ (3.65) | 30.83 |
| CD value (p=0.05) | NS | 0.15 | 0.43 | 0.18 | 0.34 | 0.21 | 0.26 | 0.65 |

*DAT = Days after treatment. Means followed by same letter in the column do not differ significantly. Figures in the parentheses are square root transformed values.*

(Yadav and Bhaskar, 2018). High efficacy of HMO against both egg and active stages of spider mite might have resulted in significant reduction in the mite count on treated okra plants compared to Spiromesifen, which possess relatively lower efficacy against adult mite. However, field evaluation of HMO at 1.0 and 2.0 per cent concentration against *T. urticae* on brinjal had shown HMO to significantly reduce mite infestation on par with Spiromesifen (Kavya *et al*., 2015). In the present study, HMO was evaluated at higher concentrations of 2.0 and 2.5 per cent. This could be another reason for higher efficacy of HMO over the acaricide, Spiromesifen.

In the study, HMO showed greater persistence in field as indicated by progressive reduction in mite count up to 14 days of treatment application. In addition to its high efficacy against spider mites, HMO was also found to be safe to the predominant mite predator, *Neoseiulus longispinosus* (Yadav and Bhaskar, 2018). These attributes auger well for HMO to be a safer alternative to synthetic acaricides for mite pest management in vegetable crops.

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*(Received September 30, 2019; revised ms accepted November 27, 2019; published December 31, 2019)*