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A review on red spider mite in rice- an emerging pest in Tamil Nadu; Biology and management

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Abstract
Rice is the major crop of India especially Tamil Nadu with an area of 2.16 million hectares. Now in rice among the insects infesting, the important species is rice leaf mite, Oligonychus oryzae Hirst (Acari: Tetranychidae). It is a very small sap-sucking pest that occurs mainly on the leaf surface and can become serious under hot and dry conditions affecting both nursery seedlings and transplanted rice. The life cycle of rice leaf mite consisted of five different stages such as egg, larva, protonymph, deutonymph and adult. Besides rice, this is also found in cassava, cotton, rubber and mango. Secondary metabolites like Terpenes, Phenolic Compounds and Nitrogenous Compounds activities have enhanced due to the infection by Red Spider Mite. Whereas a decrease in chlorophyll, carotenoids, superoxide dismutase, phenylalanine ammonia-lyase, catalase enzyme activities, amino acids, glutathione was observed with mite infetstaion. Spiromecifen, a tetraonic acid derivative acts as inhibitor of acetyl Co A carboxylase, a key enzyme in fatty acid biosynthesis. It is highly toxic to immature stages as well as adults stages of spider mites, and acts slowly against adult females causing reduction in fertility and fecundity. all the novel acaricides tested, spiromecifen, fenopyroximate, propergite and fenazaquin were found effective in reducing the rice leaf mite population.

Keywords: Aedes albopictus, *Solanum xanthocarpum*, Phytochemicals, Mortality, Dengue fever

Introduction

Rice is one of the most important food crops cultivated in India. During 2024–25, rice occupied about 51.27 million hectares in India, producing approximately 150.18 million tonnes with an average productivity of 2,929 kg ha^{-1}. Tamil Nadu contributed about 2.16 million hectares and 7.09 million tonnes of rice production, with a productivity of 3,288 kg ha^{-1}. The large area under rice cultivation provides a substantial crop ecosystem for various insect and diseases. Among these, the rice leaf mite, *Oligonychus oryzae* Hirst (Acari: Tetranychidae), is becoming important particularly under hot and moisture-stressed conditions. the term “red spider mite” is used for several species of tetranychid mites. In rice, the important species in Tamil Nadu is the rice leaf mite, Oligonychus oryzae Hirst (Acari: Tetranychidae). It is a very small sap-sucking pest that occurs mainly on the leaf surface and can become serious under hot and dry conditions. Tamil Nadu Agricultural University identifies O. oryzae as a rice mite affecting both nursery seedlings and transplanted rice. The pest is particularly favored by high temperature, low relative humidity and moisture stress. Research conducted at TNAU found that mite populations increased with maximum and minimum temperature, while relative humidity and rainfall were negatively associated with mite abundance. The rice leaf mite, Oligonychus oryzae Hirst (Acari: Tetranychidae), is an important emerging mite pest of rice in India, particularly under rainfed, upland and moisture-stressed conditions. The pest feeds by sucking sap from rice leaves, resulting in chlorotic or whitish patches, loss of chlorophyll, leaf drying and reduced crop performance. In Tamil Nadu, rice mite has been reported from several rice-growing areas, and have documented significant incidence in districts such as Villupuram and Cuddalore. TNAU research has documented substantial incidence of rice leaf mite in Villupuram and Cuddalore districts, with 22–37% incidence during March 2016. At Aduthurai, the rice variety CR1009 was reported to be highly susceptible during October–November 2016.The pest population is strongly influenced by weather conditions, with higher populations associated with increased temperature and lower relative humidity and rainfall. Consequently, the rice leaf mite has gained increasing importance in Tamil Nadu rice ecosystems, particularly during hot and dry periods. Climate change and increasing episodes of heat and drought are therefore considered important factors in the increasing importance of the rice leaf mite. Leaves develop yellow or pale spots, then turn bronze/brown. Severe infestation can reduce photosynthesis and grain yield. The damage caused, host range, biology of red spider mite, Physiological changes and protection measures against red spider mite was discussed.

Damage and Yield loss due to Red spide mite in rice

Mites have emerged as serious pests of rice causing considerable damage, particularly in South India. The rice leaf mite, *Oligonychus oryzae* (Hirst) (Acari: Tetranychidae) and the sheath mite, *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae) are considered as major mite pests of rice (Laksmi *et al*., 2008). Among these, the rice leaf mite, *O. oryzae* is the predominant one. It was first reported from South India by Cherian (1931) [6]. Later it was reported to damage rice from different regions of India. Large number of different stages of the mite colonise the undersurface of the leaves and desap causing white speckles on the upper surface which eventually turn yellow and dry up. When the mite population increases, they also colonise the upper surface of leaves and cause similar damage. A reduction of yield of upto 25 per cent has been estimated due to the severe infestation of this mite (Misra and Israel, 1968) [18]. Seasonal studies have also demonstrated variation in mite abundance. Srimohanapriya *et al*. (2009) [32] found that rice plants approximately 35–49 days old were preferred by the mite, whereas very young and older plants supported comparatively lower populations. Population levels also varied with sowing time and the availability of alternative weed hosts

Host range of red spider mite

Table 1: list of Major Host plants of Red Spider Mite

Scientific Name	Common Name	Reference
Oryza sativa	Rice	(Cherian, 1931) [6], (Swamiappan, 1986) [33]
Anacardium occidentale	Cashew nut	(Baker and Pritchard 1960) [5]
Cinnamomum camphora	camphor laurel	(Ohno *et al*. 2011) [21]
Citrus limon	Lemon	(Gupta and Gupta 1994) [9]
Camellia arabica	arabica coffee	(Aranda and Flechtmann 1971)
Camellia sinensis	Tea	(Watt and Mann, 1903)
Corchorus capsularis, Corchorus olitorius	Jute	(Gupta and Gupta 1994) [9]
Elaeis guineensis	African oil palm	(Baker and Pritchard 1960) [5]
Eucalyptus globulus	Tasmanian blue gum	(Gutierrez and Schicha 1985)
Gossypium sp.	Cotton	(Gupta and Gupta 1994) [9]
Hevea brasiliensis	rubber	(Gutierrez and Bonato 1994)
Indigofera	Indigo	(Misra 1913) [17]
Malus sylvestris	Europian crab apple	(Aziz *et al*., 2013) [4]
Mangifera indica	Mango	(Baker and Pritchard 1960) [5]
Manihot esculenta	Cassava	(Rodrigues 1968) [27]
Morus alba	Mora	(Gupta and Gupta 1994) [9]
Persea americana	Avocado	(Srikumar, *et al*., 2015)
Ricinus communis	Castor bean	(Gupta and Gupta 1994) [9]
Terminalia catappa	Singapore almond	(Garrett and Haramoto 1967) [7]
Vitis vinifera	grapevine	(Sayed 1946; Jeppson *et al*. 1975) [30, 12]

Biology of rice leaf red spider mite

The life cycle of rice leaf mite consisted of five different stages such as egg, larva, protonymph, deutonymph and adult. In between the stages from larva to adult, short quiescent intervals called nymphochrysalis, deutochrysalis and teleiochrysalis were also observed (Aswin *et al*., 2016) [3].

Morphology and developmental duration of immature stages of *O. oryzae*

Eggs were laid singly or in small groups of 10-12 on the under surface of leaf bits by gravid females. The eggs were spherical in shape and transparent. They were like tiny drops of water when freshly laid. Two dark reddish coloured eye spots, which resembled the simple eye of larvae, were clearly visible on the eggs. But the eggs turned dull white in colour and gradually turned to brown prior to hatching. The mean incubation period was 3.80 days (Aswin *et al*., 2016) [3].

Larva

The eggs hatched out to larvae with 3 pairs of legs. Newly hatched larva was white in colour. It was spherical and small in size and crawled around for sometime. The body colour changed to pale green upon feeding. The simple eyes on the dorsum of propodosoma were clearly distinguishable. The mean larval period recorded was 1.37 days for male and 1.40 days for female (Aswin *et al*., 2016) [3].

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Nymphochrysalis

Nymphochrysalis is the intermediate quiescent stage between larva and protonymph. During this stage, larva stopped feeding, remained attached to leaf surface and entered into quiescence, with the anterior two pairs of legs kept forward and close towards the body and the posterior legs were extended backwards and held close to the sides of opisthosoma. This stage was immediately followed by moulting. Average duration of nymphochrysalis stage was 0.73 days for male and 1.03 days for female(Aswin *et al*., 2016) [3].

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Protonymph

Protonymph stage was the first nymphal stage that came out by splitting open the larval skin. Protonymph was oval shaped, deep amber coloured and larger in size compared to that of larva, with four pairs of legs. The mean protonymph period lasted for 0.91 days for male and 1.04 days for female (Aswin *et al*., 2016) [3].

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Deutochrysalis

Protonymph entered into deutochrysalis which was the second quiescent stage. It remained attached to the leaf surface and on an average, lasted for 0.69 days in the case of male and 1.12 days in the case of female (Aswin *et al*., 2016) [3].

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Deutonymph

Deutonymph was the second nymphal stage and emerged from deutochrysalis after moulting. They were actively moving and feeding. Deutonymph was greyish green in colour when emerged and became dark green later on. During the stage, sexes could be differentiated apparently by body size. Female deutonymph was larger and broader than their male counterpart while male deutonymph was elongate. The mean deutonymph period was 0.98 days for male and 1.30 days for female (Aswin *et al*., 2016) [3].

Teleiochrysalis

Teleiochrysalis was the third quiescent stage immediately after deutonymph. This period on an average lasted for 1.15 days for male and 1.20 days for female (Aswin *et al*., 2016) [3].

Adult

Adult mite emerged after the final moult from teleiochrysalis. The mite exhibited sexual
dimorphism in the adult stage. Male was smaller in sizewith light green hysterosoma and body tapering posteriorly to a blunt point. Female mite was white, larger and plumper with

longer setae all over the body and legs, and turned dark green after mating. Both male and female possessed bright red eye spots on the dorso-lateral propodosoma (Aswin *et al*., 2016) [3].

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Total developmental period

The total developmental period from egg to adult emergence recorded a mean of 9.87 days for male and 10.47 days for female.

Adult longevity

Adult male recorded a mean longevity of 8.00 days while the corresponding figures for mated and unmated females were 10.34 and 12.10 days, respectively.

The duration of development of various life stages of *O. oryzae* recorded in the present study was found to be shorter compared to that reported by Nayak *et al*. (2008) [19] who reported development period of 10.58 + 1.50 days for male and 12.64 + 1.57 days for female in a laboratory study at Raichur during kharif season (June to November). The results indicate that male *O. oryzae* completes development from egg to adult faster than female.

This trend was also reported by Nayak *et al*. (2008) [19] in *O. oryzae* where, males on an average took only 10.58 days in comparison to 12.64 days in females. Longer developmental duration in females was also reported in different species of tetranychid mites by several workers (Nazeh and Ashraf, 2012, Rajkumar, 2003) [20, 25]. Similarly, the males of two spotted spider mite, *Tetranychus urticae* Koch recorded a shorter development period of 6.73 days compared to 7.52 days in females on okra (Krishna and Bhaskar, 2014) [13].

Pre-oviposition, oviposition and postoviposition period of females

The life span of adult female mites consisted of pre-oviposition period, oviposition period and postoviposition period and the duration of life span was found to be longer in unmated females. The mean pre-oviposition period in mated and unmated females lasted for 0.89 and 1.02 days, respectively. Oviposition and post-oviposition periods lasted for 6.27 days and 2.08 days in mated females and 7.31 days and 2.12 days in unmated females, respectively (Aswin *et al*., 2016) [3].

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Fecundity, sex ratio and egg viability

Mated females on an average laid 21.27 eggs whereas unmated females laid only 17.18 eggs. Mated female produced a progeny consisting of both males and females in the ratio 1:3, whereas unmated females produced only males. The eggs of *O. oryzae* recorded a viability of 89.67 per cent 232 for mated females and 81.69 for unmated females. The shorter duration of unmated female in the present study is also in line with previous studies. For instance, the negative influence of mating on the life expectancy of females in tetranychid mites was reported earlier by several workers (Krishna and Bhaskar, 2014) [13]. Laboratory studies carried out at Tamil Nadu Agricultural University on biology of *O. oryzae* atfive different temperatures namely 20, 25, 28, 30 and 35ºC revealed that the duration of developmentof various stages as well as total duration of *O.oryzae* decreased with increase in temperature (Radhakrishnan and Ramaraju, 2009) [24]. At 20ºC, the mite took on an average, 16.10 days for development from egg to adult. The total development period was 13.65, 8.88, 8.35, 8.33 days at temperatures 25, 28, 30 and 35º C, respectively. Temperature was also found to have a profound impact on the duration of development stages of the red spider mite, *Oligonychus coffeae* Nietner on tea, as the mite completed its development in a shorter duration of 6.85 days at 32ºC, while the same duration was prolonged to 14.47 days at 22.5ºC (Mazid *et al*., 2013) [16].

Physiological changes in mite attacked plant

Red Spider Mites are the important pests of tea causing damage in respect of both quantity and quality. The quantity of tea leaf waxes and the phyto hormones like salicylic acid, jasmonic acid, Ethylene and the secondary metabolites like Terpenes, Phenolic Compounds and Nitrogenous Compounds activities have enhanced due to the infection by Red Spider Mite. Whereas a decrease in chlorophyll, carotenoids, superoxide dismutase, phenylalanine ammonia-lyase, catalase enzyme activities, amino acids, glutathione in infested tolerant tea plants (Gopal Sharma *et al*., 2025) [8].

Insecticides and Botanicals against Red Spider Mite

Spiromecifen, a tetraonic acid derivative acts as inhibitor of acetyl Co A carboxylase, a key enzyme in fatty acid biosynthesis. It is highly toxic to immature stages as well as adults stages of spider mites, and acts slowly against adult females causing reduction in fertility and fecundity (Marcic *et al*., 2011) [15]. A complete suppression of *T. urticae* population could be

achieved in ten days under field conditions (Sato *et al*., 2011) [29]. Fenpyroximate is a mitochondrial electron transport inhibitor with similar mode of action as fenazaquin. It causes rapid knockdown effect against larvae, nymph and adults mainly by contact and ingestion. In the present study fenpyroximate significantly reduced mite population from 3rd day after imposition of treatments. Its efficacy was on par with spiromecifen even at 3 days after imposition of treatments with significant reduction in mite population over untreated control. When fenpyroximate was evaluated against *O. oryzae* in rice field of Tamil Nadu, 87.2 per cent reduction in mite population was recorded (AINPAA, 2013). Fenpyroximate recorded 99.89 per cent reduction in the mite population of *T. urticae* on chrysanthemum in polyhouse (Reddy *et al*., 2014) [26]. In the present study fenpyroximate recorded a very high reduction of 82.00 per cent during 2022 and 83.82 per cent during 2023.

Fenazaquin constantly reduced leaf mite population on par with spiromecifen even at 3 days after imposition of treatments. Fenazaquin which has similar mode of action as fenpyroximate, which belongs to quinazoline class of chemicals inhibits mitochondrial electron transport (MET) at complex 1 and has high efficacy against eggs and motile stages of tetranychid mites (Marcic *et al*., 2011) [15]. In field experiment conducted in the rice fields of Tamil Nadu during 2005 and 2006, to evaluate the efficacy of pesticides against *O. oryzae*, fenazaquin was found to be the most effective treatment against mite eggs (Radhakrishnan and Ramaraju, 2009) [24]. A significant reduction in the mite population of motile stages was also reported in this study. Fenazaquin 10 EC was also reported to cause 90.52 per cent mortality of adult mites of *T. macfarlanei* (Patil, 2005) [22]. Study conducted to determine the relative toxicity of different acaricides against *O. coffeae* on tea revealed a fenazaquin was the most toxic compound against the eggs of *O. coffeae* (Roy *et al*., 2011) [28]. In the present study also fenazaquin recorded 80.79 and 81.62 per cent reduction in leaf mite count over control.

Propergite is a sulphate ester compound which is a potent inhibitor of mitochondrial ATP ase effective against synthesis of energy molecules. It is effective against all stages of mite. In the present study its efficacy was on par with other new molecules *viz*., spiromecifen, fenazaquin at 7 days after imposition of treatments, and recorded 78.90 per cent and 80.94 per cent reduction in mite population over untreated check. However, in the rice field of Tamil Nadu only 79.53 per cent reduction in the mite population was recorded by propargite (AINPAA, 2013).

Efficacy of profenophos and dicofol was significantly inferior to new molecules at 3 and 7 days

after imposition of treatments. However, they were found to be effective compared to untreated check. There was considerable reduction in leaf mite population was found with botanicals i.e neem oil (41.83 and 33.92 % reduction over control) and azadirechtin (47.68 and 39.11% reduction over control) during 2022 and 2023, respectively but inferior to insecticides. Patil and Nandihalli, 2009 [23] reported that neem oil 2 per cent exhibited maximum acaricidal action against red spider mite in brinjal. However, the efficacy of botanicals was found to be inferior to new molecules. Field trials conducted in Tamil Nadu to study the efficacy of different acaricides against *O. oryzae* also showed that novel molecules were superior to azadirechtin (Radhakrishnana and Ramaraju, 2009) [24].

Though the efficacy of four tested novel acaricides i.e. spiromesifen 240 SC, fenpyroximate 5

SC, propergite 57 SC and fenzaquin 10 EC against rice leaf mite was on par with each during both the years of study at 7 days after imposition of treatments, the economic analysis of four acaricide treatments indicated that fenpyroximate 5 EC with an incremental cost benefit ratio of 30.70 was found effective and economically profitable against rice leaf mite and it was followed by fenazaquin 10 EC and propergite 57 EC with an incremental cost benefit ratio of 24.04 and 21.60 found economical and effective in controlling rice leaf mite.

Novel acaricides tested, spiromecifen, fenopyroximate, propergite and fenazaquin were found effective in reducing the rice leaf mite population Efficacy of these molecules in reducing mite population was pronounced from 3rd day after imposition of treatments

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