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EVALUATION OF NOVEL ACARICIDES AND BOTANICALS AGAINST RICE LEAF MITE, *OLIGONYCHUS ORYZAE* (HIRST) (ACARI:TETRANYCHIDAE), A KEY PEST OF SUMMER RICE IN ANDHRA PRADESH INDIA

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ABSTRACT

Rice leaf mite, *Oligonychus oryzae* (Hirst) is a key pest of summer rice crop in Nellore district of Andhra Pradesh, where summer/early kharif rice crop cultivation is being practiced. The frequent occurrence of leaf mite reported in alarming proportions and causing considerable yield loss during early kharif season from the district. A field experiment was conducted at Agricultural Research Station, Nellore, Andhra Pradesh (ANGRAU, Guntur) during Early kharif (May- September), 2022 and 2023 to evaluated four novel acaricide molecules, spiromesifen 240 SC, fenpyroximate 5 SC, propergite 57 SC and fenzaquin 10 EC; two botanicals neem oil 2 % and azadirechtin 1500 ppm along with two conventional acaricides, dicofol 18.5 Ec and profenophos 50 EC. The results revealed that at seven days after imposition of treatments the lowest mite count of 3.10 and 1.97 mites/4cm^2 leaf area was recorded in plots treated with spiromecifen 240 SC during 2022 and 2023, respectively. However, it was on par with other three new acaricides fenpyroximate 5 EC, fenazaquin 10EC and propergite 57 EC during both the years of study. Highest mean mite count of 16.89 and 13.39 mites /4cm^2 leaf area were recorded in untreated check during 2022 and 2023, respectively. Highest mean percent reduction of 82.0 and 84.08 % in leaf mite count over control was observed in plots treated with fenpyroximate 5 EC and spiromecifen 240 SC, respectively. 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.
Keywords **:** rice leaf mite, spiromecifen, fenpyroximate, acaricides**.**

Introduction

Rice (*Oryza sativa* L.) is the staple food of nearly half to the population and is mainly grown and consumed in Asian countries such as India. India is the second-largest producer of rice in the world after China. The major 5 states in rice production are West Bengal, UP, Andhra Pradesh, Punjab and Tamil Nadu. Andhra Pradesh is in 3rd position in rice production with 128.95 lakh tons of rice in India. It is a leading rice producer with a production of 12% of total rice produced in the country. In Nellore district of Andhra Pradesh rice being cultivated in three overlapping seasons, Early Kharif (April-May to August-September), Late Kharif (August-September to January-February) and Early Rabi (October-November to February-March). Among the biotic stress insect pests are the major and damage caused by these pests at different stages of crop growth tends to severe yield loss.

Apart from insect pests leaf mite, *Oligonychus oryzae* Hirst. (Acari: Tetranychidae) at times becomes regular and serious under field conditions particularly

during summer months, can cause economic yield loss to the farmers (Gupta, 2012). In India severe outbreak of this mite had been reported in Karnataka state (Rai *et al*., 1977) and considerable yield loss was reported by Swamiappam (1986). Mites have emerged as serious pests of rice causing considerable damage particularly in South India (Muthiah, 2007). Occurrence of the rice leaf mite has also been noticed in Tamil Nadu due to changes in rainfall pattern, prolonged drought which provides a congenial atmosphere for the multiplication of the mites. Nayak *et al*, 2007 have observed higher level rice leaf mite occurrence in areas of incessant rain coupled with high temperature. In Andhra Pradesh, regular occurrence of the leaf mite has been recorded since 2008 form may rice growing areas of Nellore district, where summer/early kharif rice corp cultivation was being practiced. The frequent occurrence of leaf mite reported in alarming proportions and causing considerable yield loss during early kharif season from the district. The absence of rain, prolonged dry spell of summer season provides congenial atmosphere for the multiplication of mite. The nymphs and adults of rice leaf mite are seen on the under surface of leaves and cause damage by sucking the sap form leaves and inflict damage on mesophyll cells of the interveinal tissues. This results in characteristic whitish patches on leaves, which later turn to yellow colour leading to drying from top to down wards (Misra and Israel, 1968), Rao *et al*., 1993 and Rao *et al*., 1995.

Considering the severity of leaf mite on rice during summer the present investigation was under taken for two years to evaluated the efficacies of novel acaricides in comparison with botanicals and conventional acaricides and results were presented hereunder.

Materials and Methods

Experimentation

The field experiment was conducted at Agricultural Research Station, Nellore, Andhra Pradesh (ANGRAU, Guntur) during Early kharif (May- September), 2022 and 2023. In Nellore district of Andhra Pradesh rice being cultivated in three seasons, Early Kharif (summer crop) (April-May to August-September), Late Kharif (August-September to January-February) and Early Rabi (October-November to February-March) (Table 1). The climate at Agricultural Research Station, Nellore is semi-arid, North-East monsoon is very active in and around Nellore during which 64 % of the total rainfall is received, with an average annual rainfall of 1040.7mm.

In Nellore district during early kharif season/ summer season the incidence of *O. oryzae* will commence in the 2nd week of June i.e during 24th SMW and the population increased gradually and reached to peak in the first week of August i.e during 31st SMW and starts to decline from 32nd standard week onwards. Accordingly, experiment was conducted during May - September in a randomized block design (RBD) with 9 treatments and three replications. The entire experimental area was measured as 673.92 m^2, which was divided into three equal blocks. Each block was divided in to 9 plots and the 9 treatments were allotted at random to the plots in each block. Thus, there were 27 (9x3) plots altogether in the experiment each year. The plot size was 24.96 m^2. Borders between plots were 0.6 m to facilitate cultural operations and insecticide applications. A rice variety released from Agricultural Research Station, Nellore, Swetha (NLR 40024), which is commonly grown in summer season was chosen for the experiment during both the years.

The four novel acaricide molecules evaluated in the study were spiromesifen 240 SC, fenpyroximate 5 SC, propergite 57 SC and fenzaquin 10 EC; two botanicals neem oil 2 % and azadirechtin 1500 ppm along with two conventional acaricides, dicofol 18.5 Ec and profenophos 50 EC. The acaricides were used at the rates specified in Table 2. The doses of acaricides were measured with micropipette and sprayed to the assigned plots uniformly. Acaricides were applied by means of hand operated knapsack sprayer using 500 liter of spray fluid per hectare.

Assessment of leaf mite infestation

The observation on population counts of active stages of *O. oryza* were recorded from randomly selected five hills per plot, from each hill three leaves were selected randomly from top (young) middle (nature) and bottom (old) portions of tagged plants were plucked randomly, collected in separated labelled polythene bags and brought to the laboratory without disturbing mites for assessing population from 4 cm^2 leaf length in the same day under stereo binocular microscope. Both upper and lower portions of the leaves were examined. The population counts were recorded one day before spraying and 3rd and 7th day after spraying. For concurrent results, the experiment was executed for two years.

Statistical analysis

The data was analysed using analysis of variance (ANOVA) with SPSS version 13.0 and the treatment means were separated using Duncan's multiple range test (DMRT) at the 5 % level of significance (Gomez and Gomez, 1984).

Table 1: Rice growing seasons in Nellore district, Andhra Pradesh.

Season	Month	Irrigation source
Early Kharif	April-May to August-September	Filter points
Late Kharif	August-September to January-February	Canal and tanks
Early Rabi	October-November to February-March	Canal and tanks

Table 2: Acaricides evaluated against *Oligonychus oryzae* (Hirst)

S. No.	Insecticide name	Dose /ha (in ml)
1	Spiromesifen 240 SC	400
2	Propergite 57 SC	1000
3	Fenpyroximate 5 SC	1000
4	Fenzaquin 10 EC	1250
5	Profenophos 50 EC	1000
6	Neem oil 2%	10000
7	Azadirechtin 1500 ppm	2500
8	Dicofol 18.5 EC	1250
9	Untreated control	--

Results

Evaluation of new acaricides and botanicals against rice leaf mite, *Oligonychus oryzae* (Hirst)

A field experiment was conducted at Agricultural research station, Nellore (ANGRAU) during 2022 and 2023 to evaluate the efficacy of four new acaricides and two botanicals along with conventional acaricides, profenophos and dicofol against the rice leaf mite on rice and the results were presented her under.

Efficacy of treatments against *Oligonychus oryzae* (Hirst) on rice during early kharif 2022

The mean leaf mite count at before application of the treatments i.e., precount was ranged from 15.24 to 16.43/4 cm^2 leaf area and there is no significant difference among the treatments. At three days after application of treatments (Table), all the treatments significantly reduced the mite population compared to untreated check and there is significant difference among the treatments. The lowest mite count of 4.48 mites/4cm^2 leaf area was recorded with plots treated with spiromecifen 240 SC and it was on par with fenazaquin 10 EC and fenpyroximate 5 EC with 4.80 and 5.88 mites/ 4cm^2 leaf area, respectively. It was followed by propergite 57 EC which was recorded mean leaf mite population of 6.20 mites/4cm^2 leaf area. All four tested new acaricides were found effective and superior in reducing leaf mite count and it followed by with dicofol 18.5 EC and profenophos 50 EC with mean mite count of 10.90 and 11.43 mites/ 4cm^2 leaf area. While with neem oil and azadirechtin mite population of 14.18 and 15.13 mites/4cm^2 leaf area were recorded, respectively. All tested treatments were superior over untreated control which recorded a mean mite population of 23.01 mites/4cm^2 leaf area.

At seven days after imposition of treatments (Table 3), the lowest mite count of 3.10 mites/4cm^2 leaf area was recorded in plots treated with spiromecifen 240 SC. However, it was on par with other three new acaricides fenpyroximate 5 EC, fenazaquin 10EC and propergite 57 EC with mean leaf mite count of 3.11,3.27 and 3.38 mites/4cm^2 leaf area, respectively. It was followed by with profenophos 50 EC with 6.10 mites /4cm^2 leaf area and dicofol 18.5 EC with 7.68 mites /4cm^2 leaf area, with azadirechtin and neem oil mean leaf mite count of 8.67 and 9.67 mites/ 4cm^2 leaf area were recorded. Highest mean mite count of 16.89 mites /4cm^2 leaf area were recorded in untreated check.

Highest mean percent reduction (82.0 %) leaf mite count over control was observed in plots treated with fenpyroximate 5 EC and which was followed by with spiromecifen 240 SC with 81.54 % reduction in leaf mite population and fenazaquin 10 EC with 80.79 % and with propergite 57 EC 78.90% reduction in leaf mite count over control was noticed. Among profenophos 50 EC and dicofol 18.5 EC with profenophos 63.95 % reduction and with dicofol 54.82 % reduction in leaf mite count was noticed. Both the neem products neem oil and azadirechtin recorded 41.83 and 47.68 % reduction in leaf mite count over control.

Grain yield: There were significant differences between treatments with regard to the grain yield. Significantly highest grain yield of 53.16 Q/ha was recorded with the plots treated with spiromecifen 240 SC followed by fenpyroximate 5 EC with 51.36 Q/ha of grain yield. And it was on par with fenazaquin 10 EC and propergite 57 EC with 51.21 and 51.10 Q/ha of grain yield. Lowest grain yield of 42.90 Q/ha was recorded in untreated control plots. Plots treated with neemoil (46.12 Q/ha) and azadirechtin (48.01 Q/ha) recorded on par grain yields with untreated control (42.90 Q/ha) and dicofol (47.56 Q/ha), respectively (Table 3).

Efficacy of treatments against *Oligonychus oryzae* (Hirst) on rice during early kharif 2023

The mean leaf mite count at before application of the treatments i.e precount was ranged from 17.15 to 19.38/4 cm^2 leaf area and there is no significant difference among the treatments. At three days after

application of treatments (Table 4), all the treatments significantly reduced the mite population compared to untreated check and there is significant difference among the treatments. The lowest mite count of 3.42 mites/4cm^2 leaf area was recorded with plots treated with spiromecifen 240 SC and it was on par with fenazaquin 10 EC and fenpyroximate 5 EC with 3.74 and 4.82 mites/ 4cm^2 leaf area, respectively. It was followed by propergite 57 EC which was recorded mean leaf mite population of 5.14 mites/4cm^2 leaf area. All four tested new acaricides were found effective and superior in reducing leaf mite count and it followed by with dicofol 18.5 EC and profenophos 50 EC with mean mite count of 9.84 and 10.38 mites/ 4cm^2 leaf area. While with neem oil and azadirechtin mite population of 13.13 and 14.08 mites/4cm^2 leaf area were recorded, respectively. All tested treatments were superior over untreated control which recorded a mean mite population of 19.14 mites/4cm^2 leaf area.

At seven days after imposition of treatments (Table), the lowest mite count of 1.97 mites/4cm^2 leaf area was recorded in plots treated with spiromecifen 240 SC. However, it was on par with other three new acaricides fenpyroximate 5 EC, propergite 57 EC and fenazaquin 10EC with mean leaf mite count of 2.35 and 2.45 mites/4cm^2 leaf area, respectively. It was followed by with profenophos 50 EC with 5.07 mites /4cm^2 leaf area and profenophos recorded on par results with dicofol 18.5 EC and azadirechtin with mean leaf mite count of 6.65 and 7.64 mites/ 4cm^2 leaf area. Highest mean mite count of 13.39 mites /4cm^2 leaf area were recorded in untreated check.

Highest mean percent reduction (84.08 %) leaf mite count over control was observed in plots treated with spiromecifen 240 SC and which was followed by with fenpyroximate 5 EC with 83.82 % reduction in leaf mite population and fenazaquin 10 EC with 80.94 % reduction in leaf mite count over control. Among profenophos 50 EC and dicofol 18.5 EC with profenophos 63.62 % reduction and with dicofol 49.97 % reduction in leaf mite count was noticed. Both the neem products neem oil and azadirechtin recorded 33.92 and 39.11 % reduction in leaf mite count over control.

Grain yield: There were significant differences between treatments with regard to the grain yield. Significantly highest grain yield of 59.68 Q/ha was recorded with the plots treated with spiromecifen 240 SC followed by propergite 57 EC with 56.19 Q/ha if grain yield. And it was on par with fenpyroximate 5 EC and fenazaquin 10 EC with 55.38 and 52.19 Q/ha of grain yield. Lowest grain yield of 33.61 Q/ha was recorded in untreated control plots. Plots treated with neemoil (38.55 Q/ha) and azadirechtin (36.71 Q/ha) recorded on par grain yields with profenophos 50 EC (39.77 Q/ha) (Table 4).

Cost economics of the novel acaricides

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 (Table 5) 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.

Discussion

Field experiment was conducted to evaluate the efficacy of four new acaricides, two botanicals along with profenophos and dicofol and an untreated control against the rice leaf mite on rice at Agricultural Research station, Nellore during early kharif, 2022 and 2023.

The results showed that all the novel acaricides tested, spiromecifen, fenopyroximate, propergite and fenazaquin were found effective in reducing the rice leaf mite population during 2022 and 2023. Efficacy of these molecules in reducing mite population was pronounced from 3rd day after imposition of treatments. The botanicals tested were found to be inferior to all other treatments though significantly reduced the mite population over untreated check.

Spiromecifen consistently recorded lower mite population during both the years tested. And it recorded the highest reduction in mite population over untreated control during both the years of study. 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). A complete suppression of *T. urticae* population could be achieved in ten days under field conditions (Sato *et al*., 2011).

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). 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). 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). 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). 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). 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. In the present study 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. Patil and Nandihalli, 2009 reported that neem oil 2 per cent exhibited maximum acaricidal action against red spider mite in brinjal. When different botanical were tested in the polyhouse against *T. urticae* on rose, neem oil 2 per cent was found to be the most effective treatment (Kumar, 2007). 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).

Table 3: Efficacy of acaricide treatments on population of *Olygonychus oryzae* (Hirst) on rice during Early Kharif, 2022

Treatments	Mean no. of mites /4 cm^2 leaf area			Mean (%) reduction over control	Yield (Kg/ha)
	Pre count	3 DAS	7 DAS		
T_1: Spiromecifen 240SC @ 1ml/L	15.94	4.48 [a]	3.10 [a]	81.54	5316 [d]
T_2: Propargite 57 EC @ 1.5 ml/L	15.24	6.20 [b]	3.38 [a]	78.90	5110 [c]
T_3: Fenpyroximate 5 EC @ 0.5ml/L	16.43	5.88 [a]	3.11 [a]	82.00	5136 [c]
T_4:Fenazaquin 10 EC @ 1.5ml/L	16.17	4.80 [a]	3.27 [a]	80.79	5121 [c]
T_5: Profenophos 50 EC @ 2ml/L	16.09	11.43 [c]	6.10 [b]	63.95	5053 [c]
T_6: Neem oil 2%	15.80	14.18 [d]	9.67 [e]	41.83	4612 [a]
T_7: Azadirachtin 0.005%	15.76	15.13 [d]	8.67 [d]	47.68	4801 [b]
T_8: Dicofol 18.5 EC @ 5ml/L	16.17	10.90 [c]	7.68 [c]	54.82	4756 [b]
T_9: Untreaed control	16.06	23.01 [e]	16.89 [f]	0.00	4290 [a]
Sig.	NS	**	**		*
P value	0.998	0.000	0.000		0.001

Table 4: Efficacy of acaricide treatments on population of *Olygonychus oryzae* (Hirst) on rice during Early Kharif, 2023

Treatments	Mean no. of mites /4 cm^2 leaf area			Mean (%) reduction over control	Yield (Kg/ha)
	Pre count	3 DAS	7 DAS		
T_1: Spiromecifen 240SC @ 1ml/L	17.20	3.42^a	1.97^a	84.08	5968^d
T_2: Propargite 57 EC @ 1.5 ml/L	17.15	5.14^b	2.35^a	80.94	5619^c
T_3: Fenpyroximate 5 EC @ 0.5ml/L	17.87	4.82^a	2.08^a	83.82	5538^c
T_4:Fenazaquin 10 EC @ 1.5ml/L	18.54	3.74^a	2.45^a	81.62	5219^c
T_5: Profenophos 50 EC @ 2ml/L	19.38	10.38^c	5.07^b	63.62	3977^c
T_6: Neem oil 2%	18.18	13.13^d	8.64^b	33.92	3855^b
T_7: Azadirachtin 0.005%	17.45	14.08^d	7.64^d	39.11	3671^b
T_8: Dicofol 18.5 EC @ 5ml/L	18.48	9.84^c	6.65^c	49.97	4125^c
T_9: Untreaed control	18.61	19.14^e	13.39^f	0.00	3361^a
Sig.	NS	**	**		*
P value	0.789	0.000	0.000		0.021

DAS: Days after spraying

Table 5: Cost economics of treatments

Treatments	Grain yield (kg/ha)	Excess yield (kg/ha)	Excess yield (Q/ha)	Additional value	Cost of inputs	ICBR
T1: Spiromecifen 240SC @ 1ml/L	5139	2607	26.07	57354	5200	11.03
T_2: Propargite 57 EC @ 1.5 ml/L	5096	2258	22.58	49676	2300	21.60
T_3: Fenpyroximate 5 EC @ 1.0 ml/L	4984	2177	21.77	47894	1560	30.70
T_4:Fenazaquin 10 EC @ 1.5ml/L	4955	1858	18.58	40876	1700	24.04
T_9: Untreaed control	3711	--	--	--		
One quintal NLR 40024 cost - 2200						

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