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Evaluation of insecticides and in combination with fungicide against panicle mite, *Steneotarsonemus spinki* Smiley in Rice

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Abstract
The field experiments were conducted on the evaluation of insecticides alone and in combination with fungicide against the panicle mite in rice during 2014-16 at Agricultural Research Station, Kampasagar, Nalgonda, Telangana. Four insecticides *viz.,* Diafenthiuron, Propargite, Dicofol, Profenophos alone and in combination with fungicide, Propiconazole were tested and of these, Dicofol 18.5 EC @ 5 ml/lit + Propiconazole 25 EC @ 1 ml/lit recorded high per cent of healthy grains per panicle, low per cent of discoloured grains, discoloured sterile spikelets and normal sterile spikelets per panicle. Maxiumum grain yield was recorded on spray with Profenophos 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit.

Keywords: rice, panicle mite, diafenthiuron, propargite, dicofol, profenophos, propiconazole, yield

Introduction
Rice (*Oryza sativa* L.) is a staple food for more than 60 per cent of the world's population and grown in a wide range of environments [1]. Crop is infested by more than hundred species of insects and about twenty of them are considered to be major pests and cause significant damage to the crop. Recently, mites have become a greater concern to the successful cultivation of rice worldwide. Among the different species of mites associated with rice crop, sheath mite or panicle mite, *Steneotarsonemus spnki* Smiley, and leaf mite, *Oligonychus oryzae* are causing significant damage.

The panicle mite *S. spinki* is the most important and destructive mite pest attacking rice crop worldwide [2], particularly throughout rice growing regions of Asia. It is a small microscopic tarsonemid mite present in colonies in the inter cellular space of the leaf sheaths of rice plants. The mites can be found in the inner part of the midrib of leaf blades (sheath) at the grain development stage and multiply there throughout the vegetative stage of the plant growth. During the reproductive stage, panicle mite feeds on the reproductive parts of flowers resulting in grain sterility and is a vector/carrier of pathogenic fungi like *Acrocyclindrium oryzae*, *Fusarium moniliformae*, *Helminthosporium oryzae etc*. Mites also migrate to the developing grains in milky stage, causes spikelet sterility and partially filled and ill filled grains which results in grain discoloration [3]. Mite damage resulted in deformed panicles and inflorescences, lesions on the inner surface of leaf sheaths and browning of rice hulls [4]. Damage of *S. spinki* along with sheath rot resulted in reduction in panicle size, height and length [5]. In India in the 1930's, several researchers reported *S. spinki* damage on rice crop [6]. In India, mite damage caused significant reduction in rice yields in Gujarat and West Bengal. In recent years, the panicle mite has become a major pest in rice growing areas of Telangana and Andhra Pradesh. The yield losses due to sheath mite, *S. spinki* ranged from 4.9 -23.7% [7] in India and from 30-90% in World [8].

The management of the panicle mite with dicofol and parathion were found highly effective against *S. spinki* reducing mite population by 97.0% and 99.9%, respectively and sterility of rice grains by 7.3% and 7.7%, respectively [9]. Foliar application of Dimethioate 30 EC @ 0.04% at active tillering stage was found most effective in reducing mite population by 88% and grain deterioration by 19% [10]. Spray of Dicofol @ 500 g a.i/ha, ethion @ 500 g a.i/ha, Spiromesifen @ 72 g a.i/ha and Profenophos @ 500 g a.i/ha were found effective against sheath mite in rice [11]. Fenpyroxymate alone and combination sprays *i.e.* Spiromesifen + Propiconazole and diafenthiuron + Propiconazole were effective in controlling the pest and

associated grain discolouration [12]. In Telangana, the management of panicle mite in rice was adequately studied, but the information on other acaricides and their combinations with fungicides was limited. Therefore, the present study was taken up to evaluate the efficacy of different insecticides alone and in combination with fungicide against rice panicle mite under field conditions.

Materials and Methods

The field experiment was conducted during *Kharif* 2014-15 and 2015-16 for the management of rice panicle mite with insecticides alone and in combination with fungicide at Agricultural Research Station, Kampasagar, Nalgonda dist. Telangana, India. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The plot size was 20 m^2 (5×4 m) area, with a spacing of 20×15cm. The rice variety JGL 2844 susceptible to panicle mite was chosen for conducting the experiment. Eight treatments *viz.*, T1-Diafenthiuron 50 W.P. @ 1.5 g/lit+Propiconazole 25 E.C. @ 1 ml/lit, T2-Propargite 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit, T3- Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit, T4- Profenophos 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit, T5-Diafenthiuron 50 W.P.@ 1.5 g/lit, T6- Propargite 50% E.C. @ 2 ml/lit, T7- Dicofol 18.5 E.C. @ 5 ml/lit, T8- Profenophos 50% E.C. @ 2 ml/lit (Table 1) were tested for their efficacy against panicle mite and compared with control. All the recommended agronomic practices were followed in all the treatments except sprayings. The testing insecticides were applied twice at panicle initiation stage and panicle emergence stage (15 days after first spraying) as foliar spray with a knapsack sprayer @ 500 liters spray fluid per ha. Care was taken to avoid drift of spray solution to the adjacent plots. Data was recorded on randomly selected 20 panicles per plot for number of healthy grains per panicle, number of discoloured grains per panicle, number of normal sterile spikelets per panicle and number of discoloured sterile spikelets per panicle and net plot grain yield was taken by leaving two boarder rows on each side. Based on these observations, per cent healthy grains, discoloured grains, normal and discoloured spikelets and grain yield were computed. The data was analyzed through angular root transformation and obtained a clear cut picture about the performance of tested acaricides. The percent increase and decrease of different parameters were also computed.

Results and Discussion

Number of healthy grains: There were no significant differences between treatments and per cent healthy grains per panicle during both the seasons. Numerically, maximum number of per cent healthy grains per panicle was recorded on Propargite 50% E.C. @ 2 ml per liter of water (72.7%), followed by Profenophos 50% EC @ 2 ml/lit (72.2%), Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25E.C. @ 1 ml/lit (71.7%) and Diafenthiuron 50W.P @ 1.5 g/lit + Propiconazole 25 EC @ 1 ml/lit (71.6%) as compared to the untreated control (57.8%) (Table 1). The performance of insecticides alone and in combination with fungicide were tested, the per cent increase and decrease insecticides were computed, which shows that the treatments Propargite 50% E.C. @ 2 ml per liter of water alone recorded the highest per cent increase of healthy grains per panicle (25.8%), followed by Profenophos 50% E.C. @ 2 ml/lit (24.9%) during *Kharif*, 2014-15 (Table 2). The per cent number of healthy grains was more in Dicofol 18.5 E.C. @ 5 ml/lit+Propiconazole 25E.C. @ 1 ml/lit (64.3%), and the next best treatments were profenophos 50% E.C. @ 2 ml/lit (63.3%), propargite 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (62.1%) as compared to the untreated control (52.6%) (Table 1). The per cent increase of healthy grains per panicle maximum was recorded on Dicofol + Propiconazole (22.6%) during *Kharif*, 2015-16 (Table 2). Based on the performance of all the treatments in the both seasons, Dicofol 5 ml/lit+Propiconazole 1 ml/lit followed by Profenophos alone 2 ml/lit were found with high per cent of healthy grains as compared to all other treatments and untreated control. The high per cent increase of healthy grains was found on spiromesifen+propiconazole and fenpyroxymate alone [12], while Milbemectin 1 E.C. @ 1 ml/lit+ propiconazole 25 E.C. @ 1 ml/lit recorded high number of healthy grains [13].

Number of discoloured grains per panicle: The differences between the per cent number of discoloured grains per panicle and treatments were significant. The low per cent discoloured grains per panicle was significantly noticed on Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (13.5%) and Profenophos 50% E.C. @ 2 ml/lit alone (15.1%) which were found on par to each other as compared to untreated control (26.4%). Whereas the per cent decreased discoloured grains was the low on Dicofol 18.5 E.C. @ 5 ml/lit+Propiconazole 25 E.C. @ 1 ml/lit and Profenophos 50% E.C. @ 2 ml/lit alone (-48.9% and -42.8%, respectively) compared to untreated control during *Kharif*, 2014-15 (Table 1). Similarly, the per cent number of discoloured grains per panicle was minimum and non significant on Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (9.7%) followed by Propargite 50% E.C.@ 2 ml/lit alone (9.9%) as compared to untreated control (15.1%) (Table 1) and the per cent reduction of grain discolouration was less on Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @1 ml/lit (-35.6%) and Propargite 50% E.C. @ 2 ml/lit alone (-33.9) during *Kharif*, 2015-16 (Table 2). Among the all treatments in both the seasons, Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit was noticed low per cent of discoloured grains. The low per cent grain discolouration+chaffy grains and per cent reduction of grain discolouration+chaffy grains was high on Dicofol 18.5 E.C + Propiconazole 25 EC @ 5 ml+1 ml/lit [14]. Low per cent of discoloured grains was recorded on Spiromesifen + Propiconazole (24.9%) [12], while Milbemectin 1 E.C. @ 1 ml/lit + propiconazole 25 E.C. @ 1 ml/lit recorded low per cent of discoloured grains [13].

Number of normal sterile spikelets per panicle: Significant differences between the treatments and normal sterile spikelets were noticed. Significantly low per cent of normal sterile spikelets was recorded on Diafenthiuron 50 W.P. @ 1.5 g/lit (3.2%) followed by Profenophos 50% E.C. @ 2.0 ml/lit (3.6%) over the control (13.8%) (Table 1). Similarly, the per cent decrease of normal sterile spikelets was reduced on Diafenthiuron and Profenophos (76.8% and 73.9%, respectively) over the control during *Kharif*, 2014-15 (Table 2). Non significantly low number of normal sterile spikelets was recorded on Diafenthiuron 50 W.P. @ 1.5 g/lit + Propiconazole 25 E.C. @ 1 ml/lit (11.5%) followed by Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (12.0%) as against untreated control (16.2%) (Table 1). High per cent decrease of normal sterile spikelets was

recorded on Diafenthiuron and Propiconazole (29.0%) and Dicofol and Propiconazole (23.4%) over the control during *Kharif*, 2015-16 (Table 2). The low per cent of normal sterile spikelets was recorded on Diafenthiuron [12].

Number of discoloured chaffy grains per panicle: The differences in per cent discoloured sterile spikelets among the treatments were non-significant. Numerically, among the all the treatments the low per cent of discoloured sterile spikelets was noticed on Propargite 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (3.1%) followed by Diafenthiuron 50 W.P.@ 1.5 g/lit. and Profenophos 50% E.C. @ 2 ml/lit (3.7, respectively), which were found on par to each other, compared to the untreated control (5.3%) (Table 1) and relatively the high per cent reduction of grain discolouration of sterile spikelets was observed on Propargite 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (-41.5%) followed by Diafenthiuron 50 W.P. @ 1.5 g/lit and Profenophos 50% E.C. @ 2 ml/lit (-30.2%, respectively), over the control during *Kharif*, 2014-15 (Table 2). The low per cent of discoloured sterile spikelets was observed on Propargite 50% E.C.@ 2 ml/lit+Propiconazole 25 E.C.@ 1 ml/lit (8.8%) followed by Dicofol 18.5 E.C.@ 5 ml/lit+ Propiconazole 25 E.C.@ 1 ml/lit (9.4%) over the control (16.1%) (Table 1). Similarly the low per cent reduction of discoloured sterile spikelets was recorded on Propargite 50% E.C.@ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (45.4%) followed by Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (41.7%) over the control during *Kharif*, 2015-16 (Table 2). Low per cent discoloured sterile spikelets was observed on diafenthuron + propiconazole, spiromesifen + propiconazole and fenpyroxymate alone @1.0 ml/lit [12]. Dicofol 0.05% reduced mite infestation and the proportion of ill filled and chaffy grains was significantly low [15].

Grain yield: There were significant differences between treatments and grain yield. Significantly high grain yield was recorded with Profenophos 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit (7384 kg/ha) followed by Dicofol 18.5 E.C.@5 ml/lit+ Propiconazole 25 E.C. @ 1 ml/lit (7238 kg/ha) as compared to untreated control (5040 kg/ha) during *Kharif* 2014-15. Whereas during 2015-16, maximum grain yield was recorded on Propargite 50% E.C. @ 2 ml/lit alone (7680 kg/ha) over the untreated control (5429 kg/ha) and the gain yield differences were non significant.

Table 1: Effect of certain insecticides and their combinations with fungicides on incidence of panicle mite and yield during *Kharif, 2014*-15 and 2015-16

Treatment	No. of healthy grains per panicle (%)		No. of discolored grains per panicle (%)		No. of discolored sterile spikelet per panicle (%)		No. of normal sterile spikelet per panicle (%)		Grain yield (kg/ha)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1-Diafenthiuron 50 W.P. @ 1.5 g/lit+Propiconazole 25 E.C. @ 1 ml/lit	71.6 (57.9±3.1)	53.5 (47.0±1.9)	15.9 (23.3±1.9)^{ab}	14.2 (22.2±1.2)	4.0 (11.5±0.9)	14.4 (22.2±1.2)	8.4 (16.4±2.8)^{abc}	11.5 (19.4±2.8)	7082.0^{ef}	7105.0
T2-Propargite 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit	61.6 (51.6±0.4)	62.1 (51.9±0.6)	15.3 (22.8±2.2)^{ab}	14.5 (17.1±1.1)	3.1 (10.1±0.4)	8.8 (17.1±1.1)	4.6 (12.3±0.7)^{ab}	13.3 (21.3±1.4)	6770.0^{def}	5663.0
T3- Dicofol 18.5 E.C. @ 5 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit	71.7 (57.8±1.1)	64.3 (53.5±1.0)	13.5 (21.5±0.1)^{a}	9.7 (17.4±2.6)	4.9 (12.6±1.0)	9.4 (17.4±2.6)	9.9 (18.2±0.8)^{bc}	12.0 (20.2±0.7)	7238.0^{ef}	5841.0
T4- Profenophos 50% E.C. @ 2 ml/lit + Propiconazole 25 E.C. @ 1 ml/lit	66.9 (55.0±4.0)	60.3 (51.0±3.4)	18.9 (25.6±1.7)^{ab}	10.1 (21.8±4.0)	4.3 (11.7±1.4)	14.6 (21.8±4.0)	6.5 (14.7±0.8)^{ab}	15.1 (22.4±3.1)	7384.0^{f}	6033.0
T5- Diafenthiuron 50 W.P. @ 1.5 g/lit.	70.1 (56.8±0.5)	54.4 (47.5±1.0)	23.0 (28.6±0.0)^{ab}	12.7 (21.2±0.3)	3.7 (10.9±0.7)	13.2 (21.2±0.3)	3.2 (10.3±0.7)^{a}	12.4 (20.5±1.5)	6630.0^{de}	6355.0
T6- Propargite 50% E.C. @ 2 ml/lit	72.7 (58.5±0.3)	59.9 (50.7±2.3)	16.2 (23.6±1.1)^{ab}	9.9 (21.3±3.7)	5.0 (12.8±0.4)	13.9 (21.3±3.7)	6.1 (14.1±1.0)^{ab}	12.8 (20.9±0.6)	6280.0^{cd}	7680.0
T7-Dicofol 18.5 E.C. @ 5 ml/lit	67.3 (55.2±4.0)	58.8 (50.0±1.8)	20.2 (26.6±1.1)^{ab}	13.5 (19.4±0.6)	4.4 (11.8±1.4)	11.1 (19.4±0.6)	4.8 (12.5±1.1)^{ab}	13.3 (21.3±0.4)	5397.0^{ab}	6072.0
T8- Profenophos 50% E.C. @ 2 ml/lit	72.2 (58.2±0.3)	63.3 (52.7±2.5)	15.1 (22.5±3.1)^{a}	10.1 (19.4±0.6)	3.7 (11.0±0.7)	11.2 (19.4±0.6)	3.6 (10.8±1.1)^{a}	14.4 (21.9±3.0)	5847.0^{bc}	5556.0
T9- Untreated control	57.8 (49.4±1.3)	52.6 (46.5±3.7)	26.4 (30.8±0.9)^{b}	15.1 (23.3±3.0)	5.3 (13.1±1.0)	16.1 (23.3±3.0)	13.8 (21.8±0.1)^{c}	16.2 (23.5±2.1)	5040.0^{a}	5429.0
SEm±	2.3	2.3	1.7	2.4	1	2.4	1.3	2.0	132.3	778.8
SED	3.3	3.3	2.4	3.4	1.4	3.4	1.8	2.9	187.1	1103.1
LSD (P 0.05)	N.S	N.S	5.2	N.S	N.S	N.S	3.9	N.S	396.6	N.S
CV%	7.4	8.2	11.8	20.7	7.4	20.7	15.5	16.8	3.6	22.0

Figures in parenthesis are angular root transformed values.
Means followed by a common letter in a column are not significantly different from each other by DMRT.

Table 2: Effect of certain insecticides and their combinations with fungicides on incidence of panicle mite and yield, *Kharif* 2014 -15 and 2015-16 (Per cent increase or decrease over control).

Treatment	No. of discoloured grains per panicle (%)		No. of discoloured sterile spikelets per panicle (%)		No. of healthy grains per panicle (%)		No. of normal sterile spikelets per panicle (%)		Grain yield (kg/ha)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1-Diafenthiuron 50 W.P. @ 1.5 g/lit+Propiconazole 25 E.C. @ 1 ml/lit	-39.8	-5.9	-24.5	-10.5	23.9	1.7	-39.1	-29.01	40.5	27.9
T2-Propargite 50% E.C. @ 2 ml/lit+Propiconazole 25 E.C. @1 ml/lit	-42.0	-4.0	-41.5	-45.4	6.6	18.0	-66.7	-17.9	34.3	4.3
T3- Dicofol 18.5 E.C. @ 5 ml/lit+Propiconazole 25 E.C. @1 ml/lit	-48.9	-35.6	-7.5	-41.7	24.0	22.6	-28.3	-26.0	43.6	7.6
T4- Profenophos 50% E.C. 2 ml/lit+Propiconazole 25 E.C. @1 ml/lit	-28.4	-33.1	-18.9	-9.3	15.7	14.6	-52.9	-7.1	46.5	11.1

T5- Diafenthiuron 50 W.P.@ 1.5 g/lit.	-12.9	-16.0	-30.2	-18.0	21.3	3.4	-76.8	-23.4	31.5	17.1
T6- Propargite 50% E.C. @ 2 ml/lit	-38.6	-33.9	-5.7	-13.6	25.8	7.3	-55.8	-20.7	24.6	41.5
T7-Dicofol 18.5 E.C. @ 5 ml/lit	-23.5	-10.8	-17.0	-30.9	16.4	11.7	-65.2	-18.1	7.1	11.8
T8- Profenophos 50% E.C. @ 2 ml/lit	-42.8	-33.0	-30.2	-30.5	24.9	20.3	-73.9	-10.9	16.0	2.3
T9- Untreated control	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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