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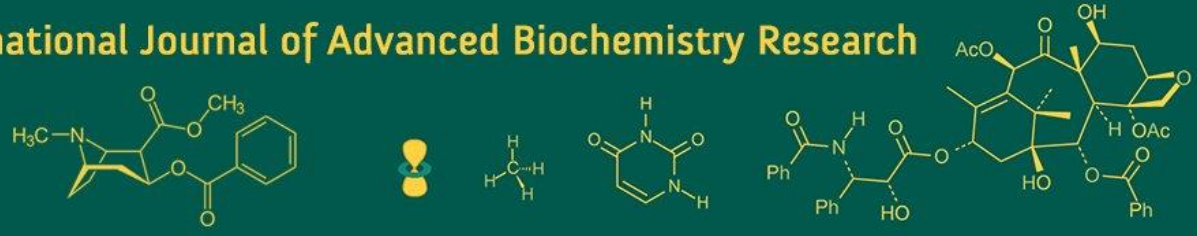

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Bio efficacy of ready-mix insecticides against rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin infesting coconut

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Abstract
The bio efficacy evaluation of ready-mix insecticides against *Aleurodicus rugioperculatus* infesting coconut at two different locations of *Saurashtra* region viz., Sutrapada and Simar revealed that the lowest adult population per frond per palm was recorded in palm treated with Pyriproxyfen 10 + Bifenthrin 10 (20 EC), with 37.78 and 35.52 adults, respectively. This treatment was followed in effectiveness by Diafenthiuron 47 + Bifenthrin 9.40 (56.40 SC), Fipronil 5 + Buprofezin 20 (25 SC) and Pyriproxyfen 5 + Fenpropathrin 15 (20 EC). The highest RSW population among the treated palm was observed in the treatment with Spirotetramat 11.01 + Imidacloprid 11.01 (22.02 SC), which was statistically at par with Acephate 50 + Imidacloprid 1.08 (51.08 SP).

Keywords: *Aleurodicus rugioperculatus*, coconut, ready-mix insecticide

Introduction
The coconut palm (*Cocos nucifera* Linn.) belongs to the palm family Arecaceae. The crop is essentially tropical, monocot and evergreen, monoecious with male and female flowers on the same inflorescence and highly cross-pollinated. On account of this, the palm has been regarded as *kalpavriksha* or Tree of heaven or Tree of life or Tree of abundance and its fruit is called *Lakshmi Phal* and is used in social and religious functions in India, irrespective of whether the palm is locally grown or not. Among the various insect pest which causes significant damage to the coconut palm, the rugose spiralling whitefly is one of the serious pest reported in India as an invasive pest. The rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin. In India, RSW was first reported from a coconut farm in the Pollachi area of Coimbatore district, Tamil Nadu during 2016 (Sundararaj and Selvaraj, 2017). In the recent, RSW was observed in the coastal area of the *Saurashtra* region (Jethva *et al*., 2020). Both nymph and adult are damaging stage and suck the sap from the leaves and causes stress to plants by removing nutrients and water. For combating the RSW population, several management practices have been recommended. Evaluation of newer molecules for their efficacy against RSW is also a continuous process as newer molecules having novel modes of action are introduced in the market.

Materials and Methods
To evaluate the bio-efficacy of different ready-mix insecticides against rugose spiralling whitefly, *A. rugioperculatus* infesting coconut, an experiment was conducted at farmers' fields at two locations, Sutrapada and Simar, during the year 2023-2024 two year old coconut palms. The trial was laid out in a completely randomized design (CRD) with three repetitions. The coconut variety Dwarf × Tall was already established in the farmers' fields, planted at a spacing of 6 m × 6 m (row-to-row and plant-to-plant).
For this study, six different ready-mix insecticides were tested (T_1-Acephate 50 + Imidacloprid 1.08 (51.08% SP), T_2-Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC), T_3-Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC), T_4-Fipronil 5 + Buprofezin 20 (25.00% SC), T_5-Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC), T_6-Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC) and T_7-Control).

The required quantity of spray solution was prepared at the time of application. Application of one percent starch solution was also carried out with before each spray in all the treatments to remove black sooty mold. Spraying was done by using a motorized knapsack sprayer. The second application of insecticides was carried out after 15 days of the first spray. Observations on RSW adult population were recorded from each palm (one frond from each direction) 24 hours before spraying and at 3, 9 and 14 days after each spray. The data on RSW population were subjected to analysis of variance (ANOVA). Prior to analysis, the population data were square root transformed (√x) to normalize the distribution. Treatment means were compared using Duncan's New Multiple Range Test (DNMRT) as described by Steel and Torrie (1980). Periodic data on RSW populations were pooled periods as well as periods and sprays, to assess the consistency and overall efficacy of the treatments.

Results

Sutrapada

The data on the number of adult RSW per frond per palm recorded from each treatment are presented in Table 1. It is clearly evident that the RSW adult population was uniformly distributed across all treatments before spraying, with values ranging from 87.97 to 94.66 adults per frond per palm. At three days after the first spray, the lowest RSW population (59.54 per frond) was recorded in palms treated with Pyriproxyfen 10 + Bifenthrin 10 (20 EC). This treatment was statistically at par with Diafenthiuron 47 + Bifenthrin 9.40 (56.40 SC) and Fipronil 5 + Buprofezin 20 (25 SC), which recorded 63.72 and 70.89 RSW per frond per palm, respectively. Pyriproxyfen 5 + Fenpropathrin 15 (20 EC) and Acephate 50 + Imidacloprid 1.08 (51.08 SP) showed moderate efficacy, with 76.55 and 79.20 RSW per frond, respectively. Among the treatments, Spirotetramat 11.01 + Imidacloprid 11.01 (22.02 SC) was the least effective, recording 81.87 RSW per frond. A similar trend was observed nine and fourteen days after the first spray.

Pooled data from different intervals after the first spray (Table 1) showed that Pyriproxyfen 10 + Bifenthrin 10 (20 EC) and Diafenthiuron + Bifenthrin were the most effective, recording 53.94 and 56.30 RSW per frond, respectively. Fipronil + Buprofezin (64.27) and Pyriproxyfen + Fenpropathrin (71.17) followed in efficacy. Acephate + Imidacloprid (75.04) and Spirotetramat + Imidacloprid (78.92) were least effective and statistically at par.

The second spray of ready-mix insecticide was carried out after 15 days of the first spray. The observations on the RSW population were recorded as per the first spray. *i.e.*, three, nine and fourteen days after spray.Three days after the second spray, all ready-mix insecticide treated palms recorded significantly lower RSW populations compared to the untreated control. As shown in Table 1, the lowest RSW population (39.72/frond) was observed in palms treated with Pyriproxyfen 10 + Bifenthrin 10 (20 EC), which was statistically at par with Diafenthiuron 47 + Bifenthrin 9.40 (56.40 SC), recording 43.29 RSW per frond. The next most effective treatments were Fipronil 5 + Buprofezin 20 (25 SC) and Pyriproxyfen 5 + Fenpropathrin 15 (20 EC), with RSW populations of 51.92 and 63.37 per frond, respectively. Conversely, the highest RSW population (74.25/frond) was recorded in palms treated with Spirotetramat 11.01 + Imidacloprid 11.01 (22.02 SC), which was statistically similar to Acephate 50 + Imidacloprid 1.08 (51.08 SP), recording 69.31 RSW per frond. A similar trend was observed nine and fourteen days after the first spray.

Table 1: Bio efficacy of ready-mix insecticides against RSW in coconut at Sutrapada (1st Spray)

Tr. No.	Treatments	Conc. (%)	Number of RSW per frond				Pooled over periods	Percent reduction over control
			Before spray	Days after spraying				
				3	9	14		
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	9.73 (94.66)	8.90^{bc} (79.20)	8.64^{bc} (74.71)	8.44^{bc} (69.31)	8.66^{d} (75.04)	28.18
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	9.54 (91.03)	7.72^{a} (59.54)	7.39^{a} (54.56)	6.93^{a} (38.04)	7.34^{a} (53.94)	48.05
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	9.38 (87.97)	7.98^{ab} (63.72)	7.42^{a} (55.09)	7.10^{a} (50.48)	7.50^{ab} (56.30)	46.18
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	9.67 (93.46)	8.42^{abc} (70.89)	7.93^{ab} (62.91)	7.70^{ab} (59.28)	8.02^{bc} (64.27)	38.53
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	9.63 (92.76)	8.75^{bc} (76.55)	8.41^{bc} (70.70)	8.15^{bc} (66.43)	8.44^{cd} (71.17)	31.91
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	9.54 (91.03)	9.05^{c} (81.87)	8.89^{c} (78.97)	8.70^{c} (75.98)	8.88^{d} (78.92)	24.78
T_7	Control	--	9.72 (94.49)	10.16^{d} (103.32)	10.42^{d} (108.47)	10.14^{d} (102.86)	10.24^{e} (104.87)	0.00
S.Em.±	T (Treatments)	--	0.30	0.318	0.308	0.326	0.18	--
	P(Period)	--	--	--	--	--	0.12	--
	T × P	--	--	--	--	--	0.31	--
C.D. at 5% T		--	--	0.97	0.94	0.99	0.52	--
CV (%)		--	--	6.33	6.34	6.92	6.54	--

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean (s) with letter (s) in common are non-significant by DNMRT at 5% level of significance

Table 2: Bio efficacy of ready-mix insecticides against RSW in coconut at Sutrapada (2nd Spray)

Tr. No.	Treatments	Conc. (%)	Number of RSW per frond				Pooled over periods	Percent reduction over control
			Before spray	Days after spraying				
				3	9	14		
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	8.44^{bc} (69.31)	8.33^{d} (69.31)	8.16^{de} (66.51)	5.50^{cd} (30.20)	7.33^{e} (53.66)	43.58
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	6.93^{a} (38.04)	6.30^{a} (39.72)	5.36^{a} (28.10)	3.24^{a} (10.51)	4.95^{a} (24.49)	73.37
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	7.10^{a} (50.48)	6.58^{ab} (43.29)	5.93^{ab} (35.20)	3.79^{a} (14.39)	5.44^{b} (29.54)	68.44
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	7.70^{ab} (59.28)	7.21^{bc} (51.92)	6.62^{bc} (43.79)	4.59^{b} (21.09)	6.14^{c} (37.68)	60.39
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	8.15^{bc} (66.43)	7.96^{cd} (63.37)	7.37^{d} (54.27)	5.08^{bc} (25.77)	6.80^{d} (46.26)	51.33
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	8.70^{c} (75.98)	8.62^{d} (74.25)	8.48^{e} (71.83)	6.00^{d} (35.96)	7.70^{e} (59.23)	38.36
T_7	Control	--	10.14^{d} (102.86)	9.95^{e} (98.99)	9.96^{f} (99.12)	9.87^{e} (97.49)	9.93^{f} (98.53)	0.00
S.Em.±	T (Treatments)	--	0.33	0.262	0.261	0.204	0.14	--
	P(Period)	--	--	--	--	--	0.09	--
	T × P	--	--	--	--	--	0.24	--
C.D. at 5% T		--	0.99	0.80	0.79	0.62	0.40	--
CV (%)		--	6.92	5.78	6.07	6.53	6.14	--

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant at 5% level of significance

Pooled data (Table 2) revealed significant variation in RSW management among ready-mix insecticides. Pyriproxyfen 10 + Bifenthrin 10 (20 EC) was most effective, recording the lowest RSW population (24.49/frond), followed by Diafenthiuron + Bifenthrin (29.57), Fipronil + Buprofezin (37.68), and Pyriproxyfen + Fenpropathrin (46.26). The least effective were Acephate + Imidacloprid (53.66) and Spirotetramat + Imidacloprid (59.23), while the untreated control showed the highest infestation (98.53 RSW/frond).

As per Table 2, the efficacy of ready-mix insecticides against RSW ranged from 38.36% to 73.37% over the untreated control. Pyriproxyfen 10 + Bifenthrin 10 (20 EC) was most effective with 73.37% reduction, followed by Diafenthiuron + Bifenthrin (68.44%) and Fipronil + Buprofezin (60.39%). Pyriproxyfen + Fenpropathrin showed moderate efficacy (51.33%), while Spirotetramat + Imidacloprid (38.36%) and Acephate + Imidacloprid (43.58%) were least effective.

Pooled data from Table 3 and Fig. 1 showed that Pyriproxyfen 10 + Bifenthrin 10 (20 EC) recorded the lowest RSW population (37.78/frond), followed by Diafenthiuron + Bifenthrin (41.85), both statistically at par. Fipronil + Buprofezin (50.10) and Pyriproxyfen + Fenpropathrin (58.04) were next, showing significant differences. The highest RSW populations were in Spirotetramat + Imidacloprid (68.72) and Acephate + Imidacloprid (63.90), both at par. The untreated control recorded the maximum population (101.68 RSW/frond), significantly higher than all treatments.

Simar

As per Table 4, the pre-treatment adult RSW population was uniformly distributed across treatments (87.98-93.94 adults/frond). At three days after the first spray, Pyriproxyfen 10 + Bifenthrin 10 (20 EC) recorded the lowest population (57.07), followed by Diafenthiuron + Bifenthrin (59.93) and Fipronil + Buprofezin (67.19), all statistically at par. Pyriproxyfen + Fenpropathrin (74.10) and Acephate + Imidacloprid (77.34) showed moderate control. Spirotetramat + Imidacloprid was least effective, with the highest population of 82.46 RSW per frond. At 9 and 14 days after the first spray (Table 4), Pyriproxyfen 10 + Bifenthrin 10 (20 EC) and Diafenthiuron + Bifenthrin consistently recorded the lowest RSW populations, showing highest efficacy. Moderate control was observed with Fipronil + Buprofezin, Pyriproxyfen + Fenpropathrin, and Acephate + Imidacloprid. Spirotetramat + Imidacloprid remained the least effective treatment, while the untreated control showed the highest infestation.

Pooled data from Table 4 showed that Pyriproxyfen + Bifenthrin (51.22 RSW/frond) and Diafenthiuron + Bifenthrin (53.80) were the most effective treatments. Fipronil + Buprofezin (64.91) and Pyriproxyfen + Fenpropathrin (70.56) showed moderate efficacy. Acephate + Imidacloprid (74.65) and Spirotetramat + Imidacloprid (79.21) were least effective and statistically at par.

Table 3: Bio efficacy of ready-mix insecticides against RSW infesting coconut at Sutrapada (Pooled over sprays)

Tr. No.	Treatments	Conc. (%)	Number of RSW per frond at indicated spray		
			First	Second	Pooled over periods and sprays
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	8.66^{d}	7.33^{e}	7.99^{d}
			(75.04)	(53.66)	(63.9)
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	7.34^{a}	4.95^{a}	6.15^{a}
			(53.94)	(24.49)	(37.78)
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	7.50^{ab}	5.44^{b}	6.47^{a}
			(56.30)	(29.54)	(41.85)
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	8.02^{bc}	6.14^{c}	7.08^{b}
			(64.27)	(37.68)	(50.1)
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	8.44^{cd}	6.80^{d}	7.62^{c}
			(71.17)	(46.26)	(58.04)
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	8.88^{d}	7.70^{e}	8.29^{d}
			(78.92)	(59.23)	(68.72)
T_7	Control	--	10.24^{e}	9.93^{f}	10.08^{e}
			(104.87)	(98.53)	(101.68)
SEm±Treatment (T)		--	0.18	0.14	0.07
Period (P)		--	0.12	0.09	0.11
Spray(S)		--	--	--	0.06
T x P		--	0.31	0.24	0.20
T x S		--	--	--	0.16
P x S		--	--	--	0.10
T x P x S		--	--	--	0.28
CD at 5% Treatment (T)		--	0.52	0.40	0.32
Period (P)		--	0.34	0.26	0.21
Spray(S)		--	--	--	0.17
T x P		--	NS	0.69	0.56
T x S		--	--	--	0.48
P x S		--	--	--	0.32
T x P x S		--	--	--	NS
CV (%)		--	6.54	6.14	6.45

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level of significance
3. Significant parameters and its interaction: P, S, P x S and T x P

Table 4: Bio efficacy of ready-mix insecticides against RSW infesting coconut at Simar (1st Spray)

Tr. No.	Treatments	Conc. (%)	Number of RSW per frond				Pooled over periods	Percent reduction over control
			Before spray	Days after spraying				
				3	9	14		
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	9.66 (93.24)	8.79^{bc} (77.34)	8.63^{bc} (74.53)	8.49^{bc} (72.13)	8.64^{bc} (74.65)	24.16
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	9.50 (90.27)	7.55^{a} (57.07)	7.09^{a} (50.24)	6.83^{a} (46.62)	7.16^{a} (51.22)	47.79
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	9.65 (93.16)	7.74^{a} (59.93)	7.23^{a} (52.21)	7.04^{a} (49.53)	7.34^{a} (53.80)	45.04
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	9.47 (89.61)	8.20^{ab} (67.19)	8.08^{b} (65.25)	7.90^{b} (62.33)	8.06^{b} (64.91)	34.08
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	9.69 (93.94)	8.61^{bc} (74.10)	8.37^{bc} (70.06)	8.22^{b} (67.59)	8.40^{b} (70.56)	28.31
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	9.38 (87.98)	9.08^{c} (82.46)	8.91^{c} (79.44)	8.71^{c} (75.80)	8.90^{c} (79.21)	19.61
T_7	Control	--	9.64 (92.98)	10.06^{d} (101.16)	9.80^{d} (96.10)	9.93^{d} (98.62)	9.93^{d} (98.62)	0.00
S.Em.±	T (Treatments)	--	0.22	0.26	0.27	0.25	0.15	--
	P(Period)	--	--	--	--	--	0.10	--
	T × P	--	--	--	--	--	0.26	--
C.D. at 5% T		--	--	0.78	0.82	0.77	0.42	--
CV (%)		--	--	5.19	5.62	5.40	5.40	--

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level of significance

Three days after the second spray (Table 5), all insecticide treatments significantly reduced RSW populations compared to the control. Pyriproxyfen + Bifenthrin (38.07 RSW/frond) and Diafenthiuron + Bifenthrin (40.98) were most effective. Fipronil + Buprofezin (50.98) and Pyriproxyfen + Fenpropathrin (58.45) showed moderate control. Spirotetramat + Imidacloprid (68.35) and Acephate + Imidacloprid (67.83) were least effective and statistically similar. A similar trend was observed nine and fourteen days after the first spray.

Pooled data from Table 5 showed significant differences among treatments. Pyriproxyfen + Bifenthrin was most effective with the lowest RSW population (22.68/frond), followed by Diafenthiuron + Bifenthrin (26.66), Fipronil + Buprofezin (35.58), and Pyriproxyfen + Fenpropathrin (42.69). Acephate + Imidacloprid (52.05) and Spirotetramat + Imidacloprid (54.90) were least effective, while the untreated control recorded the highest infestation (95.64 RSW/frond).

As per Table 5, the efficacy of ready-mix insecticides against RSW ranged from 41.16% to 74.52%. Pyriproxyfen + Bifenthrin showed the highest reduction (74.52%), followed by Diafenthiuron + Bifenthrin (70.27%) and Fipronil + Buprofezin (61.22%). Pyriproxyfen + Fenpropathrin showed moderate efficacy (53.61%), while Spirotetramat + Imidacloprid (41.16%) and Acephate + Imidacloprid (43.92%) were the least effective.

Pooled data from Table 6 and Fig. 1 showed that Pyriproxyfen + Bifenthrin (35.52 RSW/frond) was the most effective treatment, followed by Diafenthiuron + Bifenthrin (39.05), Fipronil + Buprofezin (49.15), and Pyriproxyfen + Fenpropathrin (55.75), all significantly different. The highest RSW populations were recorded in Spirotetramat + Imidacloprid (66.55) and Acephate + Imidacloprid (62.84), which were statistically at par. The untreated control showed the maximum infestation (97.12 RSW/frond).

Table 5: Bio efficacy of ready-mix insecticides against RSW infesting coconut at Simar (2nd Spray)

Tr. No.	Treatments	Conc. (%)	Number of RSW per frond				Pooled over periods	Percent reduction over control
			Before spray	Days after spraying				
				3	9	14		
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	8.49^{bc} (72.13)	8.24^{c} (67.83)	7.96^{d} (63.44)	5.44^{c} (29.62)	7.21^{e} (52.05)	43.92
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	6.83^{a} (46.62)	6.17^{a} (38.07)	5.04^{a} (25.42)	3.08^{a} (9.46)	4.76^{a} (22.68)	74.52
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	7.04^{a} (49.53)	6.40^{a} (40.98)	5.64^{ab} (31.81)	3.45^{a} (11.89)	5.16^{b} (26.66)	70.27
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	7.90^{b} (62.33)	7.14^{b} (50.98)	6.40^{bc} (40.92)	4.36^{b} (18.98)	5.96^{c} (35.58)	61.22
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	8.22^{b} (67.59)	7.65^{bc} (58.45)	7.14^{c} (51.04)	4.81^{b} (23.15)	6.53^{d} (42.69)	53.61
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	8.71^{c} (75.80)	8.27^{c} (68.35)	8.18^{d} (66.99)	5.79^{c} (33.56)	7.41^{e} (54.90)	41.16
T_7	Control	--	9.93^{d} (98.62)	10.07^{d} (101.47)	9.72^{e} (94.54)	9.54^{d} (91.05)	9.78^{f} (95.64)	0.00
S.Em.±	T (Treatments)	--	0.25	0.22	0.25	0.20	0.29	--
	P(Period)	--	--	--	--	--	0.19	--
	T × P	--	--	--	--	--	0.22	--
C.D. at 5% T		--	--	0.68	0.78	0.62	0.38	--
CV (%)		--	--	5.06	6.20	6.78	5.94	--

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level of significance

Discussion

There are no previous records available to compare the efficacy of these ready-mix insecticides against RSW on coconut. However, Gundannavar *et al.* (2017) [3] reported that the combination of Pyriproxyfen 10% + Bifenthrin 10% EC, applied at doses of 500, 600 and 700 ml/ha, was more effective in controlling cotton whitefly compared to the standard check treatment with the same formulation. Hugar *et al.* (2020) [4] also found that the ready-mix formulation of Diafenthiuron 30 + Pyriproxyfen 8 SE performed better against cotton whiteflies than either Pyriproxyfen 10 EC or Diafenthiuron 50 WP when used individually. Likewise, Mondal *et al.* (2020) [5] demonstrated that RSW populations on coconut were effectively suppressed through the foliar application of Flonicamid 50% WDG @ 5 g/l and Acephate 50% + Imidacloprid 1.8% SP @ 2 g/l, in conjunction with root-feeding of Monocrotophos 36SL @ 4 ml per plant. Furthermore, Ghosal *et al.* (2018) [6] assessed several new insecticides and tank mixtures for managing whiteflies in cotton and found that spiromesifen + imidacloprid achieved the greatest reduction in whitefly population (2.24 per three leaves) compared to the control (13.95 per three leaves). After two applications, the highest population reduction (83.94%) was observed with spiromesifen + imidacloprid, followed by spiromesifen (80.39), flupyradifurone (80.15), sulfoxaflor + buprofezin (75.73), clothianidin (74.60), buprofezin (73.67), imidacloprid (73.40), flonicamid + buprofezin (70.44), sulfoxaflor (68.39), dinotefuran + buprofezin (67.51), flonicamid (66.60) and dinotefuran (64.04).

Table 6: Bio efficacy of ready-mix insecticides against RSW infesting coconut at Simar (Pooled over sprays)

Tr. no.	Treatments	Conc. (%)	Number of RSW per frond at indicated spray		
			First	Second	Pooled over periods and sprays
T_1	Acephate 50 + Imidacloprid 1.08 (51.08% SP)	0.103	8.64^{bc}	7.21^{e}	7.93^{e}
			(74.65)	(52.05)	(62.84)
T_2	Pyriproxyfen 10 + Bifenthrin 10 (20.00% EC)	0.024	7.16^{a}	4.76^{a}	5.96^{a}
			(51.22)	(22.68)	(35.52)
T_3	Diafenthiuron 47 + Bifenthrin 9.40 (56.40% SC)	0.07	7.34^{a}	5.16^{b}	6.25^{b}
			(53.80)	(26.66)	(39.05)
T_4	Fipronil 5 + Buprofezin 20 (25.00% SC)	0.05	8.06^{b}	5.96^{c}	7.01^{c}
			(64.91)	(35.58)	(49.15)
T_5	Pyriproxyfen 05 + Fenpropathrin 15 (20.00% EC)	0.024	8.40^{b}	6.53^{d}	7.47^{d}
			(70.56)	(42.69)	(55.75)
T_6	Spirotetramet 11.01 + Imidacloprid 11.01 (22.02% SC)	0.024	8.90^{c}	7.41^{e}	8.16^{e}
			(79.21)	(54.90)	(66.55)
T_7	Control	--	9.93^{d}	9.78^{f}	9.86^{f}
			(98.62)	(95.64)	(97.12)
S.Em.±Treatment (T)		--	0.15	0.13	0.37
Period (P)		--	0.09	0.08	0.56
Spray (S)		--	--	--	0.05
T x P		--	0.26	0.22	0.17
T x S		--	--	--	0.14
P x S		--	--	--	0.09
T x P x S		--	--	--	0.24
CD at 5% Treatment (T)		--	0.42	0.38	0.28
Period (P)		--	0.28	0.25	0.19
Spray (S)		--	--	--	0.15
T x P		--	0.74	0.65	0.48
T x S		--	--	--	0.69
P x S		--	--	--	0.27
T x P x S		--	--	--	NS
CV (%)		--	5.40	5.94	5.66

Note: 1. Figures in parentheses are retransformed values and those outside are $\sqrt{x}$ transformed values
2. Treatment mean(s) with letter(s) in common are non-significant by DNMRT at 5% level of significance
3. Significant parameters and its interaction: P, S, P x S and T x P

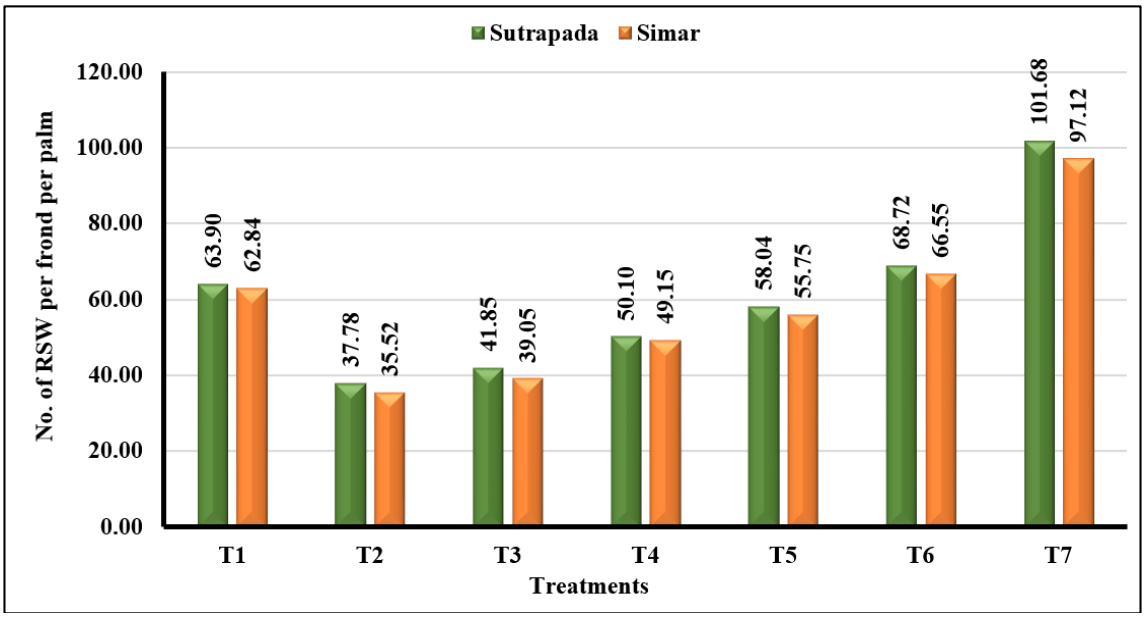

Fig 1: Evaluation of ready-mix insecticides against *A. rugioperculatus* infesting coconut at *Saurashtra* region (Pooled over periods over sprays)

Conclusion

Pyriproxyfen 10 + Bifenthrin 10 (20 EC) was the most effective ready-mix insecticide in reducing RSW adult populations at both Sutrapada and Simar. It was followed by Diafenthiuron + Bifenthrin and Fipronil + Buprofezin, while Spirotetramat + Imidacloprid and Acephate + Imidacloprid were the least effective.

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