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Comparative efficacy of different novel insecticides against white fly (*Bemisia tabaci* Genn.) in cotton (*Gossypium* spp. L.) in new alluvial zone of West Bengal

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Abstract
Nine insecticides, *viz*. Buprofezin 25% SC, Flonicamid 50% WG, Spiromesifen 22.9% SC, Spirotetramat 240 SC, Sulfoxaflor 24% SC, Clothianidin 50% WDG, Dinotefuron 20% SG, Imidacloprid 17.8% SL and Thiamethoxam 25% WG were evaluated for their efficacy against white fly (*Bemisia tabaci* (Genn.)) of cotton (cultivar Surobhi) at "C" block farm of Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal during *rabi* season of 2014 and 2015. The experiment was designed with ten treatments (including control) and tested under Randomized Block Design with three replications. Results revealed that all the treated plots gave significant reduction of white fly population while there was a sharp increase in pest population in the untreated control in both the year. Among the treatments, the most effective insecticide was Spiromesifen 22.9% SC @ 1gm/l (85.97%) followed by Buprofezin 25% SC @ 1.6 ml/l (83.47%) and least effective was Sulfoxaflor 24% SC @ 0.3ml/l (67.63%).

Keywords: cotton, insecticides, *Bemisia tabaci*

1. Introduction
Cotton (*Gossypium* spp. L.) popularly known as "the white gold", is an important commercial fibre crop grown under diverse agroclimatic conditions around the world. It provides fibre, an important raw material for textile industry. In India, cotton is grown in about 118.72 lakh hectare with total production of 30.15 million tonnes [9]. Even though India ranks first with respect to area under cultivation, it stands third in total production, after USA and China and the productivity is very low with 322 kg/ha as against the world average of 621 kg/ha [4]. Among the several factors contributing for low yield of cotton, biotic constraints appear to be very important, of which the ravages caused by insect pest assume greater importance.
Cotton crop is infested by several pests right from germination to harvest and the pest spectrum of cotton is quite complex. In India, the number is limited to 130 species [1]. Among them the boll worms viz., American boll worm, *Helicoverpa armigera* (Hubner), spotted boll worm, *Earias vittella* (Fabricius), spiny boll worm, *Earias insulana* (Boisduval) and pink boll worm, *Pectinophora gossypiella* (Saunders) pose greater threat to cotton production. Besides, a complex of sucking pests viz., Green leaf hopper, *Amrasca biguttula biguttula* (Ishida), thrips, *Thrips tabaci* (Linnman), aphid, *Aphis gossypii* (Glover) and white fly, *Bemisia tabaci* (Gennadius), are known to have occupied major pest status [8] and account for the yield loss of 22.85 per cent [14]. Among them, white fly causes great damage by sucking the cell sap, secreting the honey dews and transmitting the viral diseases to cotton [10, 3, 11]. In 16 out of 27 cotton producing countries, it has been reported as a major pest during mid to late cotton growing season [5] causing 50% reduction in boll production by constantly sucking the cell sap and by secreting honeydews on which sooty mold develops [2] and also acting as a vector of leaf curl virus disease yellow mosaic virus [13]. Hence, the present investigation was conducted to study the efficacy of few new groups of insecticides against important sucking pest of cotton, white fly (*Bemisia tabaci* Genn.).

2. Materials and Methods
2.1 Experimental site
The present field experiment was conducted at "C" block farm of Bidhan Chandra Krishi

Viswavidyalaya, Kalyani, West Bengal, during *rabi* season of 2014 and 2015. The farm was located at 23.5º N latitude, 89º E longitude and 9.75 m above MSL. The soil of the experimental site was sandy loam with pH 6.8 and irrigation facility.

2.2 Experimental Layout

Attempts were made to evaluate the effect of nine insecticides with their recommended doses viz. Buprofezin 25% SC (Biostadt India Limited) @ 1.6 ml/l, flonicamid 50% WG (United Phosphorus Limited) @ 0.4 gm/l, Thiamethoxam 25% WG (Biostadt India Limited) @ 0.3 gm/l, Spiromesifen 22.9% SC (Bayer Crop Science) @ 1 gm/l, Spirotetramat 240 SC (Bayer Crop Science) @ 0.75 ml/l, Imidacloprid 17.8% SL (Biostadt India Limited) @ 0.5 ml/l, Sulfoxaflor 24% SC (Dow AgroSciences) @ 0.3 ml/l, Dinotefuron 20% SG (Indofil Industries Limited) @ 0.3 gm/l and Clothianidin 50% WDG (Bayer Crop Science) @ 0.25 gm/l with untreated control against white fly of cotton (cultivar- Surobhi). The experiment was laid out in Randomized Block Design (RBD) with ten treatments including control with three replications. The control plot was sprayed with water. The experimental plot size was 4m x 3m and the crop was grown on a row spacing of 75 cm x 60 cm (R x P) under normal agronomic practices. The sprayings were done using knapsack sprayer @ 5 litre of spray solution/ha at an interval of fifteen days.

2.3 Observations taken

Pre and post treatment observations of white fly was recorded on three apical leaves (each from top, middle and bottom canopy) from five randomly selected tagged plants from each plot in each replication at 1 day before and 1, 3, 7 and 10 days after first, second and third sprayings, respectively.

2.4 Statistical analysis

To study the effect of few new groups of insecticides against white fly of cotton, 'F' test was done following square root transformation of the data, following Randomized Block Design (RBD) by using the software OPSTAT [15].

3. Results and Discussion

In the year 2014 and 2015, the pre-treatment population of white fly varied from 8.04- 11.12 and 7.62- 10.06 per leaf respectively. In both the year, the variation among the treatments was insignificant, but after each spray, significant reduction of white fly was observed. In first year (2014), highest mean percent reduction of white fly after first spray was found in Thiamethoxam 25% WG @ 0.3 gm/l (85.75%) followed by Buprofezin 25% SC @ 1.6 ml/l (85.59%) and Sulfoxaflor 24% SC @ 0.3 ml/l (71.78%) was least effective. After second spray, highest mean per cent reduction was noted in Spiromesifen 22.9% SC @ 1 gm/l (90.98%) followed by Thiamethoxam 25% WG @ 0.3 gm/l (88.34%) and lowest was in Sulfoxaflor 24% SC @ 0.3 ml/l (68.26%) treated plot. After third spray, highest mean per cent reduction was noted in Buprofezin 25% SC @ 1.6 ml/l (85.17%) followed by Spiromesifen 22.9% SC @ 1 gm/l (84.36%). The overall highest mean per cent reduction of white fly in the year 2014 was noted in Spiromesifen 22.9% SC @ 1 gm/l (86.02%) followed by Buprofezin 25% SC @ 1.6 ml/l (84.95%) treated plot as shown in Table 1.

In second year (2015), Spiromesifen 22.9% SC @ 1 gm/l treated plot showed highest mean per cent reduction of white fly after first (81.63%) and second (91.00%) and third (85.17%) spray. The overall highest mean per cent reduction of white fly was noted in Spiromesifen 22.9% SC @ 1 gm/l (85.93%) followed by Thiamethoxam 25% WG @ 0.3 gm/l (82.83%) and least effective was Sulfoxaflor 24% SC @ 0.3 ml/l (74.66%) treated plot as shown in Table 2.

So, the average overall highest mean per cent reduction of whitefly in two years was noted in Spiromesifen 22.9% SC @ 1 gm/l (85.97%) followed by Buprofezin 25% SC @ 1.6 ml/l (83.47%) treated plot as shown in Table 2.

In an earlier study, Mandal *et al*., [14] found that the order of bio-efficacy on the basis of per cent reduction of cotton white fly over control was: spiromesifen > buprofezin > imidacloprid. Das and lslam [6] stated that buprofezin was effective against whitefly whereas they have not tested the modern pesticides like spirotetramid, spintoram and flonicamid. According to Zidan Lobna *et al*., [17] reported that buprofezin has the translaminar action and is suitable for management for whitefly. A growth regulator, buprofezin affects specifically on immature developmental stages of whitefly resulting in nymphal mortality during ecdysis [16]. De Cock *et al*. [7] reported that buprofezin caused mortality of *B. tabaci* nymphs through its vapour (vapour pressure, 9.4×10-6 mm Hg). The differences among efficacy of different insecticides against cotton white fly are mainly due to different locations and agro-climatic conditions of their experiment.

Table 1: Effect of some novel insecticides against white fly (*Bemisia tabaci* Genn.) on cotton (Pulled data of 2014)

Treatment	Pre- count (No/ leaf)	Percentage reduction/increase (+) after first spray over pre-treatment count					Pre count (N0/ leaf) Before 2nd spray	Percentage reduction/ increase (+) after second spray over pre-treatment count					Pre count (N0/ leaf) Before 3rd spray	Percentage reduction/ increase (+) after third spray over pre-treatment count					Over all mean % reduction
		1 DS*	3 DS*	7 DS*	10 DS*	Mean		1 DS*	3 DS*	7 DS*	10 DS*	Mean		1 DS*	3 DS*	7 DS*	10 DS*	Mean	
Buprofezin 25% SC	8.04	70.14 (56.85)	92.77 (74.37)	85.06 (67.23)	94.42 (76.30)	85.59	9.27	65.14 (53.79)	89.99 (71.52)	92.22 (73.77)	89.00 (70.61)	84.08	10.01	76.99 (61.91)	85.62 (67.89)	88.00 (69.70)	90.08 (72.13)	85.17	84.95
Flonicamid 50% WG	8.55	60.09 (50.80)	72.22 (58.17)	86.09 (68.07)	90.99 (72.50)	77.34	10.01	47.77 (43.70)	75.65 (60.40)	75.00 (60.05)	78.00 (62.00)	69.10	11.30	70.65 (57.18)	79.24 (62.86)	71.69 (57.83)	70.00 (56.81)	72.89	73.11
Thiamethoxam 25% WG	9.60	68.44 (55.80)	90.07 (71.60)	96.66 (79.43)	88.24 (69.96)	85.75	9.98	80.16 (63.52)	88.09 (69.78)	95.13 (77.22)	89.99 (71.52)	88.34	12.89	75.63 (60.39)	80.00 (63.40)	78.18 (62.12)	78.00 (62.01)	75.95	84.01
Spiromesifen 22.9% SC	9.65	78.04 (62.04)	85.55 (67.83)	86.21 (68.20)	81.14 (64.24)	82.73	11.09	85.13 (67.48)	90.01 (71.54)	96.66 (79.43)	92.13 (73.76)	90.98	10.46	85.09 (67.45)	91.32 (72.83)	85.00 (67.37)	76.06 (60.68)	84.36	86.02
Spirotetramat 240 SC	9.12	76.13 (60.70)	82.92 (65.58)	83.00 (65.64)	80.64 (63.87)	80.67	10.27	85.00 (67.14)	80.00 (63.52)	78.94 (62.65)	79.69 (63.18)	80.90	9.78	71.24 (57.54)	80.02 (63.42)	83.33 (65.87)	78.63 (62.44)	78.30	79.95
Imidaclopri 17.8% SL	11.12	25.66 (30.12)	90.05 (71.97)	92.00 (73.56)	98.63 (83.61)	76.58	10.07	22.00 (27.94)	98.00 (82.01)	95.03 (77.13)	98.14 (82.12)	78.29	12.79	12.06 (20.31)	86.66 (68.55)	90.00 (71.92)	96.00 (78.49)	71.18	75.35
Sulfoxaflor 24% SC	10.11	66.07 (54.35)	72.03 (58.04)	78.03 (62.03)	70.99 (57.38)	71.78	9.04	59.06 (50.20)	75.06 (60.09)	78.00 (62.00)	60.92 (51.28)	68.26	9.49	66.94 (54.88)	70.03 (56.83)	72.13 (58.11)	78.00 (62.00)	71.77	70.60
Dinotefuron 20% SG	8.44	75.63 (60.40)	66.42 (54.56)	86.03 (68.03)	82.00 (64.89)	77.52	9.87	86.00 (68.00)	92.00 (73.62)	84.03 (66.41)	88.67 (70.30)	87.67	8.71	83.00 (65.64)	81.16 (64.24)	80.00 (63.41)	69.05 (56.17)	78.30	81.16
Clothianidin 50% WDG	9.47	72.00 (58.03)	70.03 (56.78)	81.03 (64.15)	83.17 (65.75)	76.55	10.54	75.05 (60.08)	84.72 (66.96)	86.13 (68.10)	88.00 (69.70)	83.47	9.45	89.00 (70.61)	81.00 (64.13)	75.06 (60.09)	70.00 (56.76)	78.76	79.59
Untreated control	8.97	+02.45	+50.63	+56.92	+40.39	+37.59	9.77	+52.04	+55.06	+67.53	+72.82	+61.86	9.67	+50.00	+57.32	+68.01	+70.80	+61.53	
S.Em (±)		1.21	1.25	0.60	0.69			0.91	0.87	0.62	0.43			0.82	0.91	1.14	0.73		
C.D. at 5%		3.63	3.76	1.81	2.07			2.74	2.61	1.86	1.31			2.46	2.75	3.43	2.18		

Data after transformation in parenthesis, DS= Days after Spraying, * Significant at 5% level

Table 2: Effect of some novel insecticides against white fly (*Bemisia tabaci* Genn.) on cotton (Pulled data of 2015)

Treatment	Pre-count (No/ leaf)	Percentage reduction/increase (+) after first spray over pre-treatment count					Pre count (N0/ leaf) Before 2nd spray	Percentage reduction/ increase (+) after second spray over pre-treatment count					Pre count (N0/ leaf) Before 3nd spray	Percentage reduction/ increase (+) after third spray over pre-treatment count					Over all Mean % reduction	Average of mean % reduction (2014-15)
		1 DS*	3 DS*	7 DS*	10 DS*	Mean		1 DS*	3 DS*	7 DS*	10 DS*	Mean		1 DS*	3 DS*	7 DS*	10 DS*	Mean		
Buprofezin 25% SC	7.62	60.90 (53.08	94.12 (76.56	79.15 (62.82	82.04 (64.92)	79.05	8.59	92.08 73.65	68.04 55.55	88.30 70.01	80.08 63.48	82.12	10.01	90.04 71.63	80.99 64.13	88.01 69.72	80.20 63.57	84.81	81.99	83.47
Flonicamid 50% WG	8.66	87.64 (69.39	86.99 (68.83	65.44 (54.18	47.00 43.26	71.76	8.69	74.00 59.33	76.67 61.09	89.91 71.46	78.08 62.06	79.66	9.92	77.00 61.32	70.00 56.76	80.00 63.52	78.00 62.00	76.25	75.89	74.50
Thiamethoxam 25% WG	8.17	65.05 (53.00	90.02 (71.94	79.15 (62.87	92.00 73.58	81.55	9.65	80.00 63.42	85.00 67.21	92.80 74.50	90.00 71.59	86.95	10.65	80.00 63.41	78.08 62.07	80.88 64.05	81.02 64.15	79.99	82.83	83.42
Spiromesifen 22.9% SC	9.65	80.92 (64.07	84.17 (66.63	81.40 (64.43	80.04 63.45	81.63	9.12	87.08 68.35	90.03 71.62	94.86 76.90	92.04 73.66	91.00	9.74	83.03 65.67	90.04 71.58	88.80 70.42	78.80 62.57	85.17	85.93	85.97
Spirotetramat 240 SC	10.06	80.00 (63.45	82.13 (64.98	80.90 (64.18	80.04 63.47	80.74	11.12	82.22 65.05	83.04 65.67	82.42 65.22	82.00 64.89	82.42	12.21	80.00 63.40	89.00 70.61	88.00 69.74	80.00 63.40	84.25	82.47	81.21
Imidacloprid17.8% SL	8.76	32.42 (34.50	88.08 (69.87	90.04 (72.33	95.03 71.95	76.31	10.12	22.80 28.49	98.31 82.19	98.84 84.32	98.31 81.64	77.06	9.21	27.80 31.80	90.55 72.49	90.16 71.70	98.10 82.24	76.65	76.67	76.01
Sulfoxaflor 24% SC	9.11	69.39 (56.37	71.91 (57.99	64.19 (53.22	52.98 46.69	64.61	10.00	63.00 52.51	74.77 59.83	72.00 58.03	60.00 50.75	67.44	11.01	55.32 48.03	64.44 53.37	61.99 51.91	66.00 54.32	61.93	64.66	67.63
Dinotefuron 20% SG	8.45	88.04 (69.91	87.40 (69.22	66.54 (54.66	78.01 62.04	79.99	8.55	87.08 68.92	90.88 72.46	82.00 64.89	73.40 58.93	83.44	8.54	82.04 64.90	80.00 63.52	85.04 67.41	64.07 53.15	77.78	80.40	80.78
Clothianidin 50% WDG	8.09	60.00 (50.75	85.02 (67.20	84.90 (67.13	64.00 66.50	78.48	8.94	80.00 63.42	82.22 65.05	75.09 60.04	80.33 63.66	79.41	7.49	75.88 60.56	80.04 63.44	84.00 66.42	82.24 65.05	80.54	79.47	79.53
Untreated control	9.75	+03.49	+40.09	+55.56	+57.02	+39.04	12.01	+52.04	+47.00	+65.55	+67.77	+57.84	13.03	+63.33	+55.02	+65.00	+66.00	+60.33		
S.Em (±)		0.93	0.97	0.94	1.14			0.22	0.42	0.40	0.32			0.37	0.90	0.83	0.61			
C.D. at 5%		2.81	2.94	2.82	3.42			0.66	1.26	1.22	0.96			1.11	2.71	2.50	1.83			

Data after transformation in parenthesis, DS= Days after Spraying, * Significant at 5% level

4. Conclusion

Hence, it can be concluded that the test chemical Buprofezin 25% SC @ 1.6 ml/l may be incorporated in the integrated management practices of cotton white fly. Sulfoxaflor 24% SC @ 0.3 ml/ l, though an effective systemic insecticide against different sucking pests of crops, has been proved as the least effective in terms of reduction of white fly infestation in cotton.

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